APPENDIX 1

Electricity Access: Selected Country Briefs
A1.1 Cambodia

With the exception of Myanmar and most Pacific Island Countries (PICs), Cambodia has the lowest electrification rate in EAP. In 2009 approximately only 26 percent of its 2.8 million HH were connected to several isolated grids. Cambodia’s electrification levels stand in stark contrast to those of its neighbors: Lao PDR (70 percent electricity access), Thailand (99 percent), and Vietnam (95 percent). Access to electricity within Cambodia is highly uneven. Approximately 87 percent of the urban population is covered, compared to only 13 percent of the rural population. The government has set an ambitious target of providing some form of electricity, including access to

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<tr>
<th>Population (2008) (mil)</th>
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<td>CO₂ emissions (M/T per capita, 2007)</td>
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<td>Indicative residential electricity tariffs for rural consumers (2011)</td>
<td>USc23.5/kWh, Ranges 670–1220 Riel</td>
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</table>

Key institutions in the electricity sector

- Ministry of Industry, Mines and Energy (MIME)
- Electricité du Cambodge (EdC)
- Independent regulator: Electricity Authority of Cambodia (EAC)
- Rural Electricity Enterprises (REEs)
minigrid and off-grid electricity, to 70 percent of rural HH by 2030.

**CHALLENGES**
- Government’s leadership and “visible hand” in promoting energy access yet to materialize
- Sector structure fragmented and of low capacity
- Coherent and workable nationwide plan for improving access yet to be developed
- Institutional and financial frameworks for off-grid electrification weak or absent
• High costs of power supply major barrier to scaling up access
• National program to improve access in need of large-scale concessionary financing

STRATEGIES
• Under the leadership of Electricité du Cambodge (EDC), the official power utility, jump-start the national electrification scale-up in a systematic and programmatic mode
• Move toward sector-wide approach (SWAp) and programmatic framework
• Build a comprehensive and credible plan for grid rollout and its off-grid complement
• Rationalize sector structure, especially role of Rural Electricity Enterprises (REEs)
• Develop sustainable financing platform and subsidy and tariff framework
• Revisit centralized planning and implementation of rural electrification and make necessary changes to advance RE program

CHALLENGES

Government’s leadership and “visible hand” in promoting energy access have yet to materialize. Cambodia has set a target of electrifying 100 percent of its villages and 70 percent of its rural HH by 2030. However, there is little evidence of government leadership and “visible hand” advancing this commitment. The targets have not yet been backed by an enabling policy and financial commitment. There does not appear to be “buy-in” at the cabinet level or consensus by the key stakeholders—EDC, EAC, REEs—or the private sector. Overall, the lack of a “champion” with a clear vision has resulted in a policy vacuum and stagnation in the electricity access effort.

Sector structure is fragmented and of low capacity. Electricité du Cambodge (EDC), the national power utility, is structured as a vertically integrated national power company that serves Phnom Penh area and some provincial centers. Additionally, 249 regulated private sector entities called Rural Electricity Enterprises (REEs) are engaged in transmission, generation, and/or distribution of electricity, mainly through diesel-based minigrids throughout the country. Most REEs are in poor technical and financial condition. EDC is much stronger in technical capacity and financial terms than the other entities. Thus, EDC is the only credible sector institution to anchor the planning and implementation of a national grid program for nationwide electrification.

The Electricity Authority of Cambodia (EAC) is the independent regulator. EAC is responsible for licensing electric power suppliers, managing tariffs and fees, and generally regulating the economic environment of power production.

The current structural and transactional framework rules for key sector institutions—EDC, REEs, EAC, and the private sector—are not conducive to national program planning and implementation, even with a ready, willing, and able EDC. There needs to be a clear policy that clarifies the respective roles and scope of sector institutions in the current context and a roadmap for how they would evolve in the future. The principles that should govern the transactions and interface between institutions and regulatory oversight need to be clarified and harmonized into a well-coordinated and functioning whole.

A coherent and workable nationwide plan for improving access has yet to be developed. Cambodia has yet to systematically develop and implement a set of socioeconomic criteria, similar to those used by Lao PDR, Thailand, and Vietnam, to provide a clear, technical basis for network expansion. Consequently, a national grid rollout plan that is analytically sound, comprehensive, spatially representative, and current has yet to be prepared. While Cambodia does use geographic information systems (GIS) in its current power system planning, the technology needs to be upgraded and training provided to raise capacity to acceptable standards.

High cost of power supply is a major barrier to scaling up access. Lack of power supply at
reasonable cost remains a major barrier to scaling up access. EDC has had high generation costs due to high diesel prices, small-scale operation, low technical capacity, weak management, and nontransparent investments in generation and transmission. Consequently, the current tariff rates for EDC (US$0.09–0.23/kWh in Phnom Penh) are among the highest in the world.

Of the 249 REEs, approximately 226 are engaged in distribution and retailing. Fifty percent of them offer 24-hour service; the rest offer only 4–12 hours’ supply per day. Most REEs have a generation capacity in the 1–10MW range and typically serve 500–2,000 customers.

The REEs have the same high-cost features as does EDC. Their costs are even higher than EDCs because they use expensive diesel fuel. Correspondingly, the REE tariffs, in the range US$0.20–1.00 per kWh, are higher than EDC tariffs. Despite their higher fees, most REEs are financially weak. In addition to low technical capacity and weak management, they have little possibility of expanding their operations and gaining economies of scale.

Tariffs are regulated by EAC and are determined separately for each REE licensee. A survey estimated that rural HH can afford to pay approximately US$7.50 monthly for electricity supplies (AECOM 2009). This amount is equivalent to a tariff of approximately US$0.15c/kWh, compared to a cost of supply of US$0.23c/kWh or more. The difference needs to be made up from other sources including cross-subsidies from urban customers, subsidies from the government, and concessionary financing from donors.

**A national program for improving access needs large-scale concessionary financing.** The government’s target of extending access to 70 percent of all HH by 2030 translates to connecting approximately 100,000 rural HH annually between now and 2030, or 2.2 million rural HH in all. The total cost of this electrification program (excluding generation and transmission) is estimated at US$2.6 billion. Given its current large budget deficit, the government is unlikely to be able to make any significant financial contribution to the costs of a rural electrification program from tax revenues.

**Institutional and financial frameworks for off-grid electrification are weak or absent.** Cambodia has no clear institutional focal point that systematically will pursue off-grid electrification. A semi-autonomous Rural Electrification Fund (REF) has been set up with the mission of “rural electrification,” with representation from MIME (Ministry of Industry, Mines and Energy). REF provides a household connection subsidy of US$45/HH for new connections by REEs within their service areas. This subsidy has resulted in over 42,000 additional HH being connected. REF received its initial capitalization from a GEF project but has no provision for reflows back into the fund, and no sector or fiscal funds have been earmarked for fresh capital inflows. REF has the responsibility to promote the solar home system (SHS) program and microhydro grids of approximately below 1MW capacity each. However, REF currently lacks the technical expertise to design either the SHS program and subsidy scheme or the microhydro program.

**Strategies**

**Under EDC’s leadership, jump-start the national electrification program in a systematic and programmatic mode.** Good-practice experience confirms that achieving high national electrification coverage efficiently, effectively, and quickly requires a well-orchestrated and well-managed national grid rollout program implemented by a committed national utility that has the leadership, capacity, autonomy, and means to carry out the task. A national grid extension led by EDC should be the main delivery vehicle of the national electrification program. EDC should be the principal implementing agent of the government for planning and securing adequate and affordable bulk supply. The authority should lead the national grid and MV network rollout as well as the LV network development and retailing in areas in which no REEs are operating or are not likely to operate in the future.
At best, the private sector and off-grid service delivery can play an important and complementary niche role but not as the main organizing instruments of national electrification. The efficient and better performing REEs can play an effective role if they are recast as buyers of cost-competitive bulk power supply and manage the distribution and retailing business in their respective service areas.

**Move toward a sector-wide approach (SWAp) and programmatic framework.** The investments required to fund Cambodia’s national electrification program over the next 20 years are huge. Consequently, Cambodia should mobilize sufficient ongoing financing. Doing so can be achieved most effectively within a programmatic framework, rather than by using a fragmented, project-by-project, and donor-by-donor approach. The SWAp would be led by the government of Cambodia and seek to rally partner engagement in alignment with a common sector-wide investment program and implementation and financing plan (“Sector-Wide Prospectus”).

The key building block of a sector-wide prospectus is a comprehensive, consistent, and credible strategic-level grid rollout implementation, investment, and financing plan for the national electrification program rollout and its off-grid complement for 2012–30. The underlying basis of this plan should be a GIS-based, least-cost spatial grid rollout planning platform and model framework, which in turn would determine the off-grid complement. An illustration of such an exercise is described in box 2.5.

**Rationalize sector structure, especially the roles of REEs.** A well-coordinated and harmonized functioning sector should be established to cover current and future licensees vis-a-vis EDC as well as to define principles that govern interface issues and transactions across key sector institutions and regulatory oversight. A suggested first step would be a rapid assessment of today’s REE sector performance and capacity along selected technical, commercial, and other key indicators of performance. This assessment would help point the way toward a workable and effective framework that would be politically acceptable while promoting efficiency. Specific steps may include, first, rationalization including consolidation of one or more REEs when and where justified. A second step could be to select better-performing REEs to be strengthened as sector-retailing agents with access to bulk supply from EDC grid bulk delivery transfer point(s).

**Develop a sustainable subsidy and tariff framework.** No country has achieved high electrification rates without ongoing concessionary finance being made available to the implementing agents. This issue is particularly relevant to Cambodia given its low income status and limited internal sources of revenue. The bulk of electrification needs in Cambodia are in its rural areas. Outside of the major urban areas, electrification is not commercially viable. Nevertheless, the electrification program cannot be sustained over the duration expected to be extended to create a single interconnected national grid.
without a financially viable utility, which recovers, at a minimum, all recurrent costs through an appropriate tariff and subsidy framework. 

Revisit the centralized planning and implementation of rural electrification and make the necessary changes to advance the RE program. Currently, planning and implementation of the scope, scale, and areas of RE expansion are centralized. A bottom-up approach from the subnational to the national level would be more effective. Such decentralization could pose challenges to EDC at the subnational, if not the national, level. To improve RE planning and implementation, it would be necessary to devolve accountability to the subnational level.
A1.2 Indonesia

Indonesia is characterized by a high population density in the Java-Bali region and progressively lower densities in other regions. As of 2008, 55 percent of Indonesia’s 227 million people lived on Java-Bali (among the most densely populated areas in the world). The remainder was spread across Sumatra (19 percent), Sulawesi (7 percent), Kalimantan (5 percent), Nusa Tengara and Maluku (4 percent), and Papua (10 percent). Starting from a very low base of 2 percent national electricity access in the late 1970s, Indonesia’s national electricity company, PLN, set a scorching pace for electrification. This growth occurred especially in the decade starting in late 1980s and achieved national access of at least 65 percent by 1999. By the same year, PLN was connecting over 1 million rural HH per year. PLN was able to achieve this remarkable success by steadfastly strengthening its implementation capacity for planning, design, procurement, and construction services logistics,

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<td>Indicative residential electricity tariffs for rural consumers (2011)</td>
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<td>(Source: <a href="http://www.pln.co.id">www.pln.co.id</a>)</td>
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<td>Key institutions for electricity sector</td>
<td>Ministry of Energy and Mineral Resources, Perusahaan Listrik Negara (PLN): State-owned utility</td>
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Appendix 1. Electricity Access: Selected Country Briefs

Introduction and Sector Context: Electricity Access

Aftermath of financial crisis. In 1997 the rapid progress of the grid-based electrification rollout program was abruptly and unexpectedly interrupted by the East Asian financial crisis, resulting in the insolvency of PLN. PLN had huge financial commitments denominated in US dollars under...
the power purchase agreements with a number of independent power providers (IPPs). The value of these commitments increased several fold due to the huge devaluation of the rupiah, whereas PLN’s tariffs, denominated in rupiahs, remained unchanged. In 2001 PLN disbanded the rural electrification division at its headquarters and curtailed most of its rural electrification program. The electrification program has not yet regained speed.

**PLN’s poor financial health remains a critical issue.** A key barrier to electricity access scale-up had emerged pre-crisis and has yet to be addressed satisfactorily and sustainably. Specifically, in the years immediately preceding the financial crisis, PLN’s fast-paced national electricity access program had confronted a rapidly rising cost-of-service structure for network extensions and had increased expectations for new connections, including an oil-dominant generation fuel mix, especially outside Java-Bali. By the onset of the financial crisis, the outside-Java operations were losing money in most regions and required increasing and unsustainable levels of cross-subsidies from their Java-Bali operations. On the other hand, PLN’s overall electricity sales revenue growth was (and remains) constrained by the level and structure of the uniform national tariff regime allowable for PLN by the Government of Indonesia (GOI).

**Government initiatives underway: A good start but unfinished sector reform agenda.** The government recognizes that the financial health of the electricity sector is key to Indonesia’s growth and developmental aspirations. Over the last decade, the GOI has introduced several initiatives relating to critical pricing, subsidy, and sector reform issues. Noteworthy initiatives are aimed at PLN’s decentralizing, unbundling, corporatizing, and restructuring, as well as attracting private sector participation, especially in generation:

- **Regional business units created to better manage PLN operations and track costs,** which vary enormously by region. A big first step toward region-specific costing is moving toward tariff and subsidy differentiation and efficient targeting.

- **2003 State Enterprises Law introduced PSO policy.** This law empowers GOI to impose a public service obligation (PSO) on state-owned enterprises (SOEs). The law is accompanied by compensation from state budgets for full associated costs plus a margin.

- **2009 Electricity Law.** This law opens a door to introduce innovative solutions to expand access. For example, it allows PLN to create subsidiaries that operate independently in decisionmaking and establishing locally cost-based tariffs.

- **Tariff adjustments.** GOI recently approved a 10 percent average increase in the national uniform tariff as an initial step toward better alignment with the average cost of service.

**CHALLENGES**

- Ensure adequate and cost-competitive generation supply to keep pace with robust economic growth
- Extend electricity for lighting to over 80 million Indonesians (33 percent of the population). Of these, over 50 percent are outside Java-Bali
- PLN’s financial health remains precarious and a “deal-breaker” for scaling up electricity access outside Java-Bali and for overall sector development

**STRATEGIES**

- Re-energize the national electrification program implementation with special emphasis outside Java-Bali
- Refocus the public service obligation (PSO) subsidy financing mechanism framework to catalyze electrification programs outside Java-Bali within a programmatic framework
- Set a few good examples in a few promising regions (Wilayahs) outside Java-Bali
**CHALLENGES**

*Ensuring adequate and cost-competitive generation supply to keep pace with robust economic growth.*

Economic growth has returned, resulting in electricity demand growth averaging over 7 percent annually in recent years. GOI’s target is to have 55,000 MW in generating capacity online by 2015, compared with approximately 30,000 MW, including PLN and IPPs, installed today.

Its oil-dominant generating mix results in a high cost of service for PLN. Over the medium term, Indonesia has several options by which to invest in cost-competitive energy generation alternatives as well as green energy sources. These options include geothermal, hydro, and larger scale grid-connected solar PV.

The investment costs for an expansion program of this scale and scope, sustained over the medium term, are daunting. Inducing sufficient private sector participation until the related sector reforms are sufficiently advanced remains a challenge. Similarly, the cost to PLN of power purchase obligations needs to be established transparently and competitively. To ensure PLN’s ongoing financial health, it is also crucial that these costs be integrated with GOI’s tariff policy and PSO subsidy design and financing mechanism.

Over 80 million Indonesians, or 33 percent of the population, remain in the dark; of these, over 50 percent are outside Java-Bali. The government has set ambitious targets of achieving an overall access of 90 percent by 2020 and near-universal access by 2025 across most of Indonesia. To meet these goals will require adding approximately 2 million connections per year from today. In reality, PLN is connecting approximately only 1 million customers annually today—mostly urban and on Java-Bali—and is challenged to ramp up its implementation rate.

Investment costs for the medium and low voltage network extensions required for the access scale-up program are estimated at US$1.3 billion/year through 2025. This estimate assumes widespread deployment of low-cost appropriate network designs and equipment standards as well as cost-conscious construction practices. While physical implementation capacity is a factor, it can be addressed readily.

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**Figure A1.2.1 Electricity Access in Indonesia: Urban versus Rural, 2009**

![Graph showing electricity access in Indonesia](source: Government of Indonesia.)
A significant challenge is to mainstream cost-conscious network design and equipment standards and specifications appropriate for lower density, rural area network extension, especially outside Java-Bali. These features are well proven and widely deployed elsewhere. They help minimize the national subsidy and financing burdens imposed by a rapidly rising cost structure typically faced by the country in its grid extension programs, especially outside Java-Bali.

**PLN’s financial health remains precarious and a “deal-breaker” for scaling up electricity access outside Java-Bali and for overall sector development.** The GOI imposes a public service obligation (PSO) on PLN to connect and supply electricity to all Indonesians. At the same time, the government regulates the average level and structure of retail tariffs that PLN is permitted to charge nationally on a uniform basis. This policy has resulted in PLN facing a tight financial situation despite substantial subsidies to PLN via GOI’s PSO financing mechanism towards capital and operating costs.35

Due to the importance attached to ensuring the financial health of SOEs tasked with public service obligations, government has opted to progressively refine procedures and processes through piloting their implementation on the most important public service obligation (PSO) providers, notably PLN and PERTAMINA. Considerable progress already has been made in the short period since Law 19/2003 was enacted and Government Regulation (GR) 45/2005 was issued. The government has developed Infrastructure Policy Package maps that identify a set of actions designed to refine the policy framework for subsidy and PSO management in sectors including power.

In summary, attracting qualified IPPs in sufficient numbers and enabling PLN to play its due roles in sector expansion in a timely, efficient, and sustainable manner hinges on effectively addressing the key outstanding pricing and subsidy policy issues. Moreover, the PSO financing mechanism can be more effective in scaling up the access agenda by calibrating its structure and design, and targeting appropriately. Additionally, for sector development to keep pace with robust and sustained economic growth at least cost, attracting private sector participation requires pressing ahead with the enabling reforms. These reforms comprise decentralizing PLN; helping regions to create fully functioning business units with established cost structures; and advancing reforms to encourage transparent and competitive IPP participation.

### Strategies

**Re-energize the national electrification program implementation with special emphasis outside Java-Bali.** Large areas of southern Sumatra, much of Southern Sulawesi, and some coastal city areas of Kalimantan in particular offer relatively high economic and demographic density, so are appropriate for a medium-sized grid systems rollout. Specifically:

- **Sumatra** (population: 45 million). The southern Sumatra Wilayahs of PLN together are akin to the “the next Java-Bali,” but with a scaled-down interconnected system
- **Sulawesi, Kalimantan** (population: 28 million). Medium-small-scale grid network
solutions especially in Southern Sulawesi and the areas on Kalimantan that have concentrations of economic and demographic density.

In the regions and areas broadly identified above, small-scale decentralized electrification solutions also are worth pursuing at the margins to complement the expansion of the grid system.

- **Eastern Indonesian Islands: Nusa Tenggara Timur Province (NTT) and Papua.** The Eastern Islands of Indonesia consist of NTT (population 9 million) and Papua (24 million). These islands have low economic density and comprise primarily widely spread and scattered small settlements. For these islands, a mix of technically feasible and economically viable service delivery modes can be applied. Small grid systems (mostly diesel) are appropriate for major towns and surroundings; otherwise, whatever grids are available: hydro, geothermal, and grid-connected solar PV systems. For the remaining populations living outside grid-accessible areas, portable solar products for lighting, powering cell phones, and powering small radio batteries offer an immediate life-changing option. SHS service delivery programs also can be an effective option. They can be structured not as programs with a focus on technology but as service delivery programs with integrated regular maintenance akin to a utility service. Moreover, they should be targeted on a priority basis to entities that deliver social and administrative services.

**Refocus the PSO subsidy financing mechanism to catalyze electrification programs outside Java-Bali within a programmatic framework.** The PSO mechanism is a key to effectively address the interlocking issues of maintaining the policy of uniform national tariffs, and to effectively target and subsidize the higher cost of service outside Java-Bali. Essentially, these three goals can be achieved by redesigning the PSO subsidy from PLN’s customer categories to PLN regions/Wilayahs. This redesign implies a shift of cross-subsidies across customer classes nationwide to stay within each particular region rather than among regions within customer classes.

A second and key building block, and an essential complement to implement the above strategy, is to advance the formation of standalone business units in PLN Wilayahs. Properly designed and functioning decentralized business units of PLN will enable a verifiable basis on which to establish the differentiation of cost structures across regions outside Java-Bali. Such decentralized units will enable establishing the cost-accounting links to the redesigned PSO mechanism. If designed well and implemented accordingly, such a strategy can yield a “triple win” in meeting the access targets outside Java-Bali consistent with the government’s National Electricity Plan timeline. These targets are better poverty targeting, better access targeting, and better green energy targeting.

**Setting a few good examples.** The strategy outlined above can be tested in a few promising Wilayahs that span the range of cost variation outside Java-Bali. Another potential consideration concerns supportive regional governor(s) who may be willing to champion aggressive implementation backed by financing from provincial/local administration funds. These funds would complement a better targeted PSO subsidy allocation adequate to cover the true margin between PLN’s revenue in that region and the cost structure to expand access. Evidence shows that Southern Sumatra and South Sulawesi are strong candidates. It also would be important to apply the redesigned PSO mechanism and strategy in two islands in the Eastern Indonesia region, as these islands are defined by different cost structures and a much higher share of decentralized and small local-grid supply.
A1.3 Lao People’s Democratic Republic (Lao PDR)

Over 15 years (1995–2009), electricity access in Lao PDR has more than quadrupled, from approximately 15 percent in 1995 to 70 percent in 2010. Of the latter amount, approximately 2 percent comes from the off-grid program. This expanded electricity access has resulted in over 700,000 HH grid connections by 2010, up from approximately 120,000 HH connected in 1995. The Lao program has maintained a faster pace of implementation than have most other countries. Lao PDR has managed to achieve this result at a relatively low level of GDP per capita, comparable to the experiences of Vietnam and China.

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<td>Population served by off-grid sources (minigrids and HH systems) (%)</td>
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<td>0.3</td>
</tr>
<tr>
<td>Indicative residential electricity tariffs for rural consumers (2011)</td>
<td></td>
</tr>
<tr>
<td>0–25 kWh:</td>
<td>269 lak (US$3.36)</td>
</tr>
<tr>
<td>26–150 kWh:</td>
<td>773 lak (US$9.66)</td>
</tr>
<tr>
<td>Above 150 kWh:</td>
<td>320 lak (US$4.00)</td>
</tr>
<tr>
<td>(Source: <a href="http://www.edl-laos.com">www.edl-laos.com</a>)</td>
<td></td>
</tr>
<tr>
<td>Key institutions for electricity sector</td>
<td>Ministry for Energy and Mines</td>
</tr>
<tr>
<td></td>
<td>Electricité du Laos (EDL)</td>
</tr>
</tbody>
</table>

Lao PDR is located in Southeastern Asia, northeast of Thailand and west of Vietnam. The topography of Lao PDR is largely mountainous with elevations above 500 meters, typically characterized by steep terrain and narrow river valleys. This mountainous landscape extends across most of the north of the country, except for the plain of Vientiane and the Plain of Jars in Xiangkhoang Province. The southern “panhandle” of the country contains large level areas in Savannakhet and Champasak provinces. Much of Khammouan Province and the eastern part of all of the southern provinces are mountainous.

Table A1.3.1 Lao PDR: Scenario Analysis for Universal Electricity Access by 2030

<table>
<thead>
<tr>
<th>Period</th>
<th>Total investment needs (US$ mil)</th>
<th>Incremental needs for universal access (US$ mil)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Business-as-Usual scenario</td>
<td>Universal Access scenario</td>
</tr>
<tr>
<td>2011–20</td>
<td>470</td>
<td>491</td>
</tr>
<tr>
<td>2021–30</td>
<td>223</td>
<td>196</td>
</tr>
<tr>
<td>2011–30</td>
<td>694</td>
<td>687</td>
</tr>
</tbody>
</table>

Annual requirements:

Note: No. of HH without electricity in Business-as-Usual scenario by 2030: <1%.

**Challenges**

- Grid rollout: Approaching economic limits
- Off-grid program: High expectations; weak institutional and financial framework

**Strategies**

- Address “last-mile” challenges of grid extension through systematic planning and greater use of proven low-cost solutions
• Off-grid electrification program: Gearing up for acceleration, scale-up, and reach.
• Approach solar home system (SHS) electrification as a program to provide and maintain electricity service, not as an exercise in the procurement and installation of SHS equipment.
• Conduct targeted campaigns for SHS electrification based on specific connection targets for delineated areas within each province.
• Use EDL as a technically competent entity to implement off-grid programs.

**Challenges**

Lao PDR is on the threshold of graduating from Low Income status. The country’s power sector, anchored by the national utility Electricité du Laos (EDL), has been a key partner and enabler of the nation’s development. The overwhelming majority of electric connections to date—approximately 68 percent of the 70 percent national coverage—have been implemented by EDL through effectively extending the grid. This extensive use of the grid was made possible through a least-cost expansion plan, which included a simple but rigorous prioritization and village-screening process and deployment of many cost-cutting technical innovations.

As the grid spreads into less accessible and less densely populated areas, the current approach to electrification is becoming very expensive. Looking ahead, new demands and expectations from the sector are posing challenges of greater scale and scope than were encountered earlier. To keep up the current rate of progress in electrification, it will not suffice merely to do more of the same on both the grid and off-grid electrification fronts.

**Grid expansion is approaching its economic limits.** In Lao PDR, an increasing share of the population without electricity access lives in scattered communities in ever more remote villages, many of which are hard to reach, including mountainous areas. As a result, the average cost of grid extension has nearly doubled from US$450–550/HH 7 years ago, when national access levels were approximately 50 percent, to approximately US$900 today. However, the cost per connection at the fringes of the EDL grid is likely to be 33 percent–50 percent more than the current average and will continue to rise rapidly as the grid is extended.

**Off-grid connections program: High expectations and big challenges.** The government has set a national target of 90 percent electricity access by 2020. Given the economic limits of grid expansion, off-grid electrification will need to increase 3–4-fold over the next decade. This increase translates to an annual off-grid connection rate of 8,000–10,000 connections every year over the medium term. This target is much higher than the current annual rate of approximately 2,000 systems under the SHS program being implemented by the Department of Electricity (DOE). Moreover, the current SHS program framework is already challenged by the rising costs of extending delivery chains beyond the close-in rural areas outside the grid’s footprint. The program also is encumbered by an inadequate design and incentive framework that covers multiple agents across an overly extended supply chain. The apex agent lacks the capacity to manage the overall project day to day. Private sector/community-based schemes for mini/micro grids have been planned but are still nascent.

**Strategies**

**Stretching the limits of grid extension: Confronting the “last-mile” challenges.** EDL recognizes that the next stage of grid network extensions increasingly will be challenged by population settlement patterns that are less nucleated and require longer line distance–per-kilovolt-Ampere (kVA) connections than typically encountered so far. There is a pressing economic case for systematic planning and widespread deployment of the lowest cost network designs and reticulation that are cost-effective.

effective for the next stage of grid electrification. In developing its strategic approach to farther grid extension, EDL can benefit from the experience of other nations’ electrification programs that are recognized as good practice. These have successfully dealt with “last-mile” access challenges while being mindful of cost-effectiveness and financial viability. Among the proven and promising technical options for grid extensions that have withstood the test of time are conventional single-phase primary network designs and, where appropriate, single-wire earth-return (SWER) spur lines.

Specific cases that are relevant to the Lao PDR context include Brazil, Peru, South Africa, and Tunisia. In all of these countries, single-phase primary networks are a prominent feature of their “last-mile” network design, and helped achieve cost savings of 30 percent–50 percent compared to conventional network design. Furthermore, South Africa and Tunisia in particular have effectively integrated the use of SWER spur lines with single-phase and three-phase medium voltage (MV) primary networks. Together, these networks stretch the reach of the grid coverage to the maximum extent, in some instances reaching loads as remote as 100 km from the MV network.

Off-grid electrification program: Gearing up for acceleration, scale-up, and reach. If it is to succeed at the formidable challenge of quadrupling its present rate of implementing new off-grid connections to meet its overall access target, Lao PDR needs to substantially refocus the strategy and design of its off-grid electrification program.

A key first step is to reassess its current pace of implementing off-grid connections. It is important to establish realistic and achievable targets to expand off-grid connections in the context of the overall national access targets. This determination should take into account the relative costs per connection of various technical options, and—critically—the proven implementation capabilities and speed of grid rollout compared to the pace at which primary off-grid agents can be mobilized for the task. This approach clearly goes beyond a narrow, simplistic comparison of the economic cost of new connections at the margins between grid and off-grid options. Finally, a results-driven off-grid electrification strategy and implementation plan that can be counted on to deliver the national targets on time need to be developed. In this context, the following three steps, derived from the experience of better performing off-grid designs in other countries, are proposed for Lao PDR’s off-grid implementation program.

• Ongoing assessment of the off-grid “space” and grid interface. If EDL were to embrace a systematic and widespread deployment of lower cost single-phase primary network design and reticulation and maximize the use of SWER line spurs where appropriate, the nation could greatly expand the reach and coverage of its grid. This type of deployment clearly would require updating the off-grid program targets each year. To continually make this assessment, it is crucial to have a nationwide spatial grid expansion plan that is updated continuously and reflects EDL’s grid extension strategy as it is implemented. A planning and rapid appraisal platform especially relevant for developing such a plan is available from the recent generation of GIS-based spatial planning models. In contrast to the traditional (and cumbersome) Master Plan analysis approach, analysis that is based on a GIS-based appraisal platform provides a quantitative and representative spatial reference frame for (a) tracking and updating
ongoing actual progress and (b) more sharply delineating the evolving off-grid program space in relation to the grid. (See box 2.5 for an illustration of the GIS-based spatial planning technique.)

• Solar home system (SHS) electrification program: Targeted campaigns with connection targets, staged by delineated areas within each province. In seeking to expand its SHS electrification program, Lao PDR can learn from Peru’s main off-grid electrification program. It offers particularly relevant lessons and design insights for developing a program of the required scale, speed, and enhanced spatial reach and coverage.

Peru’s national electrification coverage is approximately 80 percent–95 percent in urban areas, and approximately 35 percent in rural areas—mostly from the grid. The limits of grid coverage from the ongoing electrification are projected to be 90 percent. The reason is that large parts of the country consist of highly challenging mountainous terrain with spatially dispersed small settlements akin to the northern Lao PDR region. For these settlements, in parallel to its grid rollout program, Peru is orchestrating a well-planned, targeted, and structured off-grid electrification program. Its main driver is an SHS-based electrification service targeted to reach approximately 300,000 HH and staged in a programmatic manner.

Under Peru’s approach, qualified service providers undertake SHS electrification of targeted areas within an established technical and regulatory framework that covers equipment and service standards, and modalities for financing and subsidy.

The objective is not a program paradigm designed and managed to procure and install SHS equipment. The objective and guiding philosophy of this program is to provide and thereafter maintain electricity service. In keeping with this approach, customers pay an equivalent monthly tariff for an electricity utility service type of arrangement.

Bids from qualified service providers—private sector, NGOs, and other qualified agents—are evaluated on a competitive basis for each package. To date, a notable feature of Peru’s off-grid program design and experience is that the SHS electrification bid packages also are open to the regional electric utilities. Indeed, in several instances, utilities have won the bid. The utilities then undertake all of the key functions including overall project management of the delivery and installation of the systems, and, significantly, manage the ongoing provision of the electricity service.38

• Utilities can be effective implementation agents for off-grid programs. In addition to Peru, Argentina and Brazil offer instructive examples for the Lao PDR off-grid program. In many countries, electricity utilities have been effectively mobilized, together with the private sector, to implement one or more off-grid program components. Brazil’s off-grid program covers over 3,000 isolated diesel minigrid systems that are embedded in the respective service areas of the distribution utility serving that area. A nationally operated cross-subsidy mechanism funds the Universal Access fund, which compensates each utility for 90

38. In Peru, it is common to find instances in which the regional electric utility proximate to the bid area is the winning bidder. The utility is already familiar with the area demographics and other characteristics. Moreover, it has the capacity to undertake effectively project management and, later, maintenance and commercial functions. The reason for the utilities’ success is that an integral part of their core business model for grid-based services has been outsourcing a broad range of technical and commercial activities to small private enterprises. The regulatory and subsidy arrangements for the solar PV connections allow for a full cost recovery tariff (as for grid connections) and are financially structured to enable the most efficient agents to make a profit. In many instances—although not in every case—the regional local electric utility has both a competitive edge and an interest.
percent of the allowable investment cost in addition to any operating losses. Tariffs are more or less uniform across the nation. A significant component of Argentina’s last-mile electrification strategy is the staged implementation of a SHS electrification program with ongoing maintenance service charged on a monthly billing basis, akin to a normal grid customer’s monthly bill. In Argentina, the regional electric utility companies have set up subsidiaries whose core business is to manage and operate the off-grid SHS electrification service program.

In short, established national and regional utilities—public or private—with proven track records represent valuable national assets that could be deployed to implement one or more off-grid program components. These technical and management capacities, and the professionalism and results-oriented culture, of these utilities can be harnessed under a supportive regulatory, policy, and incentive framework for effective off-grid program delivery.

From these three steps, it follows that there is a strong case for establishing an EDL subsidiary whose core business would be solely off-grid project design, management, and operations. This subsidiary would undertake this program on a fully costed fee basis charged to the Department of Energy. Subsidy funds for a scaled-up off-grid program can be sourced from a properly designed and capitalized Rural Electrification Fund and disbursement mechanism. Such a subsidiary would be open to compete with other qualified agents for a range of functions and services. These could include project management and oversight for scaled-up SHS program design, installations, and services and maintenance thereafter; as well as minigrid design and construction oversight.
**A1.4 MONGOLIA**

Approximately 90 percent of Mongolia’s population has access to electricity, but with wide disparities between urban and rural areas. Nearly 99 percent of urban residents, including Ulanbaatar and the aimag (province centers), have access to electricity; compared to 80 percent of soum (district) center residents and to only 25 percent of the herder population of approximately 850,000 (approximately 30 percent of the country’s population). In the soum centers, electricity is provided through isolated grids based on diesel systems. The electricity is of significantly lower

<table>
<thead>
<tr>
<th>Population (2008) (mil)</th>
<th>2.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural population (% total population, 2008)</td>
<td>43</td>
</tr>
<tr>
<td>Population density (people/sq km)</td>
<td>2</td>
</tr>
<tr>
<td>Land area (sq km)</td>
<td>1,560,000</td>
</tr>
<tr>
<td>GNI per capita (Atlas Method: Current US$, 2008)</td>
<td>1,679</td>
</tr>
<tr>
<td>Access to modern cooking fuels</td>
<td>23</td>
</tr>
<tr>
<td>Urban (% HH, 2008)</td>
<td>31</td>
</tr>
<tr>
<td>Rural (% HH, 2008)</td>
<td>2</td>
</tr>
<tr>
<td>Electricity access, national (% HH, 2009)</td>
<td>90</td>
</tr>
<tr>
<td>Urban (% HH, 2008)</td>
<td>99</td>
</tr>
<tr>
<td>Rural (% HH, 2008)</td>
<td>75</td>
</tr>
<tr>
<td>No. of people w/o access to electricity (2009) (mil)</td>
<td>0.63</td>
</tr>
<tr>
<td>Population served by off-grid sources (minigrids and HH systems) (%)</td>
<td>20</td>
</tr>
<tr>
<td>Electricity access target and year (% HH)</td>
<td>100; 2020</td>
</tr>
<tr>
<td>Electric power consumption (kWh per capita, 2007)</td>
<td>1369</td>
</tr>
<tr>
<td>Installed capacity (MW 2008)</td>
<td>382</td>
</tr>
<tr>
<td>Thermal</td>
<td>382</td>
</tr>
<tr>
<td>Hydro</td>
<td>—</td>
</tr>
<tr>
<td>Other renewable</td>
<td>—</td>
</tr>
<tr>
<td>Electricity net generation (bil kWh)</td>
<td>3.9</td>
</tr>
<tr>
<td>Distribution losses (% net generation)</td>
<td>11</td>
</tr>
<tr>
<td>CO₂ emissions (M/T per capita, 2007)</td>
<td>4.0</td>
</tr>
<tr>
<td>Indicative residential electricity tariffs for rural consumers (2011)</td>
<td>US 2.9c/kWh in all aimags and soums if under 50kWh/month (Source: Energy Regulatory Authority Annual Report 2009)</td>
</tr>
<tr>
<td>Key institutions for electricity sector</td>
<td>Ministry of Mineral Resources and Energy (MMRE) \nElectricity Authority (EA) \nElectricity Regulatory Authority</td>
</tr>
</tbody>
</table>

duration, quality, and reliability compared to Ulaanbaatar and the aimag centers. With limited or no access to electricity, rural (mostly remote soum centers, and herder communities) living standards are constrained by low agricultural and livestock productivity and very few opportunities for nonfarm employment or other value-adding economic activities.

### Sector Structure
Mongolia’s Ministry of Mineral Resources and Energy (MMRE) has overall responsibility for the power sector. The Energy Authority (EA), which reports to MMRE, is charged with policymaking and project implementation. The Energy Regulatory Authority oversees licensing, tariff-setting, and promotion of competition. In 2001,
to improve the efficiency of the sector, the power sector was unbundled into 18 generation, transmission, and distribution companies. However, these reforms have yet to yield the desired results.

**Consumer Groups**

The power sector in Mongolia is segmented into three consumer groups: urban, soum (district), and herders.

- **Urban.** The urban consumer group is the largest and includes all grid-connected cities and towns. This group is served by three grids: Central, which supplies Ulaanbaatar; Eastern; and Western Energy Systems. These three supply mostly coal-based power and account for approximately 97 percent of the electricity sales in Mongolia.

- **Soums.** Of the 314 soum centers in the country, only 117 are connected to the national or regional grids. The remaining 197 soum centers depend on small diesel generators and microgrids, which are owned and operated by local governments. These small systems provide at most 4–6 hours a day of electricity to the soum residents. Several off-grid soum centers have been provided with new “free” diesel generators through bilateral assistance, but, otherwise, local governments have been left to fend for themselves in operating and maintaining these generators, and financing operating costs.

To increase rural coverage and improve the cost-effectiveness of the isolated grids in remote soum centers, the government’s National Renewable Energy Program has set ambitious goals for broad-based renewable energy development. These goals are to increase the share of renewable energy technologies in total energy supply from 0.9 percent in 2005 to 3.0 percent–5.0 percent by 2010; and to 20.0 percent–25.0 percent by 2020.

- **Herders.** This group consists of nomadic herders. Household-based power supply systems are the only option for this market.

At present, approximately 60,000 independent solar PV systems are being used by herders to operate lights, radios, televisions, and satellite dishes. Under the “100,000 Ger” program, the government has financed, procured, sold, and installed over 40,000 SHS. The government is on track to reach 92,500 in the next phase, operating through a combination of the soum administration network, private dealers, and sales and service centers (SSCs). An additional 60,000 SHS are expected to be delivered through the WB-financed Renewable Energy for Rural Access Project (REAP).

**Rural Targets**

The government has assigned off-grid soum and HH electrification an ambitious target of 150,000 HH by 2020. This target envisages that up to 20 percent of the rural population located in isolated areas can be powered with indigenous energy resources, including solar, picohydro generator units, biomass, and wind.

**Use of Off-Grid Renewable Systems**

The government plans to expand the use of off-grid renewable systems while preserving service quality and affordability. The strategy is to expand electrification while improving service quality and affordability through (1) increasing electricity access through SHSs and small wind turbine systems (WTSs) and (2) developing renewable or renewable-diesel hybrid systems among off-grid soum centers. The government also aims to improve the financial viability of the soum center electricity service by making it more commercially oriented and encouraging private sector and community participation in providing electricity service.

**CHALLENGES**

- Low capacity in the Energy Authority (EA) for integrated rural access planning

39. A ger is a felt-lined tent home used by Mongolian nomads.
• Low financial and operating viability of most soum center minigrids
• Lack of effective mechanism for SHS/wind system rollout

STRATEGIES
• Improve planning capacity through targeted external technical assistance and expertise
• Improve financial and operating viability for soum grids
• Develop a service-oriented approach to SHS and wind turbine systems
• Secure concessional finance for wind-diesel and wind-solar-diesel hybrid power stations by mobilizing a common platform of donors and leveraging climate change funds

CHALLENGES

Low capacity for planning in the Energy Authority (EA) in the overall context of integrated rural planning. Soum-based rural electrification projects are constrained by weak rural electrification planning capacity in the Energy Authority. More generally, in the absence of integrated rural development planning, income-generating electricity uses have not increased enough to make rural power supply financially viable.

Lack of financial viability and operating capacity of soum center minigrids. Soum center minigrids display generation inefficiencies and high distribution losses. In addition, generation costs are high due to diesel prices. Tariffs do cover the operating costs. There are no clear tariff-setting mechanisms or rate classes among customers. For the most part, electricity consumption is not metered, except for large public institutional facilities. It is estimated that rural HH consume 80 percent of the total electricity while providing approximately only 33 percent of the total revenues. In other words, rural HH effectively are being cross-subsidized by the rural public institutions. Soum centers must pay for diesel in cash. When the cash cost of operation goes up due to increases in diesel prices, and if the customers collectively cannot pay the additional costs, the hours of service are reduced to cut overall fuel costs.

The government plans to connect most off-grid soum centers with national or regional grids in the next 10 years or so. However, approximately 70 off-grid soum centers are considered uneconomical for grid connection due to their remoteness and will need financially sustainable solutions to improve the reliability of their services.

Lack of effective mechanism for SHS/wind system rollout. Multiple factors have inhibited the expansion of the herders’ SHS market:

• The incomes of the target group are low. Approximately 40 percent of the estimated 170,000 herder HH have annual cash incomes below US$450 (2006) and cannot afford the capital costs of solar home systems (SHS), which today normally would exceed $500.
• It is difficult to develop an effective supply chain to support a decentralized market for a small and mobile customer base spread over a vast area.
• Basic quality and services standards are lacking for SHS.
• Even though there is a growing microfinance market, because of the unpredictable market and regulations and the perception of high risks in investing in the supply chains, the private sector does not participate in the SHS market.
• Private sector capacity for scaling up implementation of rural electrification through retail systems for private HH and public institutions or for soum center grid electrification is limited.
• Financing, whether grant or concessional debt, for RE is insufficiently available.

Approximately 40,000 HH solar PV and wind power systems and 3,000 wind turbine systems (most of which were donated by the governments of China and Japan) have been sold in Mongolia,
sometimes with heavy and poorly targeted subsidies. Some public investments have been made in PV, wind, or hybrid systems for institutional use (schools, hospitals).

**Strategies**

**Improve EA’s technical and planning capacity.** External TA is needed to develop the capacity for technical operation and management in the relevant government departments, the Energy Authority, and the independent regulator. Without this capacity, it will be difficult to meet the government’s access targets.

**Improve financial and operating viability for soum grids.** Improving the technical and financial performance of the soum microgrids is the first step toward universal HH coverage within the soum center areas. To improve their performances, Mongolia needs to (1) adopt a rational tariff and subsidy policy based on clear performance benchmarks; (2) reorient soum center electricity service to be more commercial; and (3) actively pursue private sector and community participation in the provision of electricity service. Additional actions to strengthen the viability of soum microgrids would be to (4) invest in network rehabilitation and (5) develop generation options with lower operating costs, including full or hybrid renewable energy power generation.

**Develop a service-based approach for SHS and WTS.** One option is a shift to provide off-grid electrification as a service, not as a program paradigm designed and managed to procure and install SHS or other off-grid equipment. In keeping with this approach, for being provided with reliable service from off-grids sources, customers would pay a monthly tariff as is done for grid electricity. The institution charged with providing the service must have adequate capacity for this task. Such a service-oriented approach would need to be anchored by an institution with adequate capacity and familiarity with the consumer base.

**Secure concessional finance for renewable energy and hybrid power stations by mobilizing a common platform of donors and leveraging climate change funds.** Expanding the base of renewable energy will need substantial investments that will require external financial and technical assistance. Mongolia should develop a phased spatial electrification rollout plan to cover the unconnected HH. Such a plan could be the basis for obtaining external programmatic assistance. The plan also could be used to leverage climate change funds that support renewable energy.
The Government of the Philippines (GOP) plans to increase the share of electrified households.\(^{40}\)

40. Targeting connections is relatively new for the country, as the main goal of electrification policy had been the interim target of achieving full barangay (local district) electrification. The DOE considers the goal of full barangay electrification to have been reached this year (2010). In practice, a barangay is considered electrified if a very basic level of service has been established (for example, the barangay district office has a connection and/or a street light has been installed).
from the present estimated level of 65 percent. To reach these targets, electricity will have to be provided to 3.4 million households over 2000–17. Generation capacity is presently a constraint. To respond, under the Missionary Electrification Development Plan (2009–18), the GOP intends to expand electricity generation capacity in approximately 200 nonelectrified areas through subsidies and private sector participation programs. Over 2009–17, nearly 1 million households will have be served by solar home systems (SHS) because it is not possible to connect these households at
reasonable cost to either the major regional grids or any of the isolated systems in remote locations throughout the archipelagic nation.

**Background**

**Institutions.** Several agencies are involved in providing power supply to rural and remote locations. These agencies include the Small Power Utilities Group (SPUG) of the National Power Corporation, 41 119 rural electric cooperatives (RECs), local government units (LGUs), private distribution companies, and “qualified third parties” (QTPs). 42 SPUG operates in 78 islands and an additional 8 isolated areas on major islands. It has over 300 generators totaling approximately 129 megawatts, almost all of which are diesel fired. Most of the buyers of SPUG’s generated power are RECs and private QTPs. LGUs no longer are major buyers of SPUG power.

Over the years, the government has undertaken several institutional reforms to meet increasing demand and improve performance, particularly through the 2001 Electric Power Industry Reform Act (EPIRA). Several LGUs are small and loss making. If potentially viable, their operations are sold off. If not, the assets typically are transferred to SPUG or the RECs. A handful of QTP operations still exist in the country, although not nearly as many as the government had hoped for. Combined, the state agencies, RECs, and QTPs have considerable capacity and experience to provide electricity services.

**Rural electric cooperatives.** In the rural Philippines, power distribution is under the purview of 119 rural electric cooperatives (RECs), although RECs do not serve exclusively rural areas. RECs are supervised by NEA, which traditionally has provided technical support and financial support to them. However, since 2001, EPIRA has been expected to prepare the RECs for the implementation of various industry reforms, including wholesale electricity market trading (WESM) and retail competition. RECs’ customer bases vary widely from 1,000 to over 130,000 customers each.

RECs’ financial performance has been uneven due to low cost recovery from socially acceptable tariffs, poor financial management, decline in bill collection rates, and increasing political interference. Regardless of the conditions in its service territory, each REC is required to meet the same financial efficiency standards. This requirement imposes financial strains on RECs that must operate under unfavorable conditions. In fact, in some cases, regulatory pressure on rates can reduce efficiency by preventing RECs from spending adequately for maintenance and renewals. It is estimated that, given current tariffs, 33 percent of RECs are not financially viable; and many do not meet the technical and financial requirements necessary to recover costs. Options to improve the performance of RECs include reorganizing and/or merging RECs into viable units, or converting them into joint stock companies. However, these approaches can be difficult to implement.

Improving governance and management is key to improve the performance of RECs, which are independent entities that have the freedom to make decisions on most issues. For a well-run REC, access to capital should not be a constraint. Potential sources include NEA, the Development Bank of the Philippines (DBP), LGU Guarantee Corporation (LGUGC), and the Rural Electrification Financing Corporation (REFC). Nevertheless, the reality is that several RECs need to improve their operations, finances, and governance in some combination to become attractive even to public sector lenders such as NEA.

The ending of the government role as supplier of last resort through the National Power Company/Power Sector Assets and Liabilities...
Management Corporation (NPC/PSALM) presents an opportunity to improve accountability and performance in RECs. A utility that does not pay for electricity supply risks being cut off, and, perhaps more important from the viewpoint of an individual REC, risks having NEA exercise its step-in rights to replace existing management and dissolve the board. This prospect, which has materialized in some cases, has significantly improved the RECs’ performance.

CHALLENGES

- Address large financing gap for operating costs and new investments in rural areas
- Improve REC performance
- Promote private sector role in rural electrification.

STRATEGIES

- Develop well-costed and time-bound spatial electrification plan as basis for channeling programmatic assistance
- Explore opportunities for output-based aid
- Move toward tailored standards for distribution losses and reinvestment allowance for RECs
- Encourage “service” approach for off-grid renewable applications

Challenges

Addressing large financing gap for operating costs and new investments in rural areas. This mismatch between policy objectives and the level of allocated resources is a critical barrier to expanding rural electrification in the Philippines. Under almost any circumstance, though, there is likely to be a significant funding gap that cannot be filled without the government’s committing additional funds.

DOE’s electrification plan calls for significantly expanding SPUG activities to over 70 new areas. Doing so would require an additional 54 MW of new generating capacity. However, SPUG’s poor financial condition makes this expansion extremely difficult. Missionary electrification programs are expected to be financed through the “universal charge for missionary electrification” (UC-ME), which is added to the bills of all customers on the integrated networks. The main use of UC-ME revenue is to cover SPUG’s operating losses. However, added to the fact that the level of actual UC-ME revenue and the timeliness with which SPUG receives it are not adequate, there simply is not enough money to support electrification expansion programs.

SPUG’s annual subsidy requirement is estimated by DOE at 18 billion pesos (US$400 million). Most of this amount is intended to pay for oil-fired generation and reflects the difference between the cost of generation, which is at least 20 pesos (45 cents) per kWh, and the socially acceptable charge for service of approximately 8 pesos (18 cents) per kWh.

Improving REC performance. Despite overall improvements in recent years, REC performance continues to be constrained by governance issues, inadequate management, and poor technical performance.

Promoting private sector role in rural electrification. The government’s policy provides for a substantial private sector role. However, in practice, the private sector has a limited appetite for rural electrification, whether as generators, distributors, or SHS providers. Green-site mini/microgrids with private sector/community-based schemes as a service delivery model operate outside mainstream frameworks and are still few in number.

Part of the reason for the reluctance is that GOP programs are limited, often by the amount of money that can be attracted from specific donors such as GEF, the World Bank, and ADB. However, even for limited operations, private and public operators alike must deal with difficult and expensive supply chains; and service territories with difficult geography, dispersed and poor households, and limited economic growth prospects. Many remote regions also have a law and order problem. Finally, even if a company wanted to be in the business of providing energy services to remote areas, it is very difficult to find qualified people willing to do this kind of work.
**Strategies**

**Develop a well-costed and time-bound spatial electrification plan as the basis for channeling programmatic assistance.** External assistance will be required on a significant scale to supplement government funds for making necessary investments in generation and off-grid technologies and for distribution of assets. A pragmatic approach would be to prepare a spatial and time-sequenced plan that would (1) systematically identify the communities and clusters that need to be served—by both minigrid and household systems; (2) estimate costs; (3) identify subsidy requirements and sources; and (4) sequence investments. Such a plan could provide an improved basis for attracting programmatic lending from donors and sources of concessional finance. For the greatest impact, these sources of funds then should be passed on at similar concessionary terms for investments.

**Explore opportunities for output-based aid.** The Philippines’ rapid rate of urbanization suggests that many of the millions of future connections will be made by distribution companies in urban and peri-urban areas. A large proportion of the projected 1 million SHS connections will be very expensive. Output-based aid can be a promising option to (1) subsidize the initial connection and (2) develop a regulated utility model so that service providers can be fairly compensated for ongoing services and held accountable to specific service standards. A well-designed OBA model could attract multilateral and bilateral donor assistance.

**For RECs, move toward tailored standards for distribution losses and reinvestment allowance.** RECs vary widely in size and in the geographical conditions under which they operate. Better-performing RECs serve large and progressive provincial cities, whereas the poor-performing RECs normally serve small islands or those with law and order problems. A regulatory approach of stipulating common standards for distribution losses and reinvestment allowances is ineffective in promoting efficiency. On the contrary, regulatory pressure on rates can reduce efficiency by preventing RECs from spending enough on maintenance and renewals. The regulator (ERC) should undertake a detailed examination of costs for each REC. ERC then should create efficiency standards that are specific to each entity against which to judge its performance and to provide a basis for “smart” subsidies. The regulator already has moved toward a performance-linked benchmarking system for the ECs that differentiates among the cost structures of individual ECs.

**Encourage “service” approach for off-grid renewable applications.** It will be important to leverage the strengths of existing entities to design and implement off-grid investments and services, such as minigrids and SHS systems design, technical oversight, investment rollout, and operation of off-grid services. In contrast to a “dealer” approach, a “service” approach should be tried for off-grid HH applications in which the customer pays a monthly fee for equipment that is maintained by the service provider. Peru has such a system. In Argentina, the regional electricity utility companies have set up subsidiaries whose core business is to manage and operate the off-grid SHS electrification service program. The Philippines has made a start in this regard with a few RECs’ attempts to install approximately 2000 SHS.
A1.6 Pacific Island Countries (PICs)

Shared Context: Economic Geography Shaping Development Challenges Far More Than Elsewhere

The 12 Pacific Island Countries (PICs) in the World Bank’s East Asia and the Pacific Region include approximately 10 million people (approximately 2.2 million people if Papua New Guinea and Timor-Leste are excluded). Of the 12 PICs, 8 have populations well below 200,000 (table A1.6.1). The per capita GNI in most of these countries is US$4,000. Several are characterized by high population growth rates. Literacy rates exceed 90 percent in most of the countries, excluding PNG, Timor-Leste, and Vanuatu. The Region is relatively aid abundant on a per capita basis, and several of these island economies rely heavily on development cooperation flows. In particular, the North Pacific region states receive some of the highest levels of aid per capita of any countries in the world (up to as much as US$1,000 per capita, or approximately 50 percent of the GNI per capita). However, in many PICs, development results in both service delivery and growth have not matched the aid (table A1.6.1).

The citizens of most Pacific Island nations put up with low access to secure, reliable, and affordable energy. Of the nearly 10 million people living in the Pacific Island Countries, an estimated 8 million do not have access to electricity (0.9 million excluding PNG and Timor-Leste) (table A1.6.2).

As a group, PICs have some unique features. For one, in most instances, even the fortunate few with grid service pay unit prices for electricity that rank among the highest in the world (25–50+ USc/kWh). High unit prices pose a significant affordability barrier and overly restrict household consumption and its derived benefits.

High electricity tariffs also put additional pressure on enterprises by raising the already high costs of doing business. Finally, those not connected to the grid incur even higher costs by self-generating with heavily taxed fuels.

The high grid electricity prices are due in part to the dependence on high-cost diesel-based generation and, in some instances, to avoidable operational inefficiencies, particularly high network losses and high unit fuel consumption rates. Many grid utilities also have chronic problems of service unreliability and poor revenue management. Some are substantially dependent on recurrent subsidies from their governments. These subsidies take the form of direct transfers or contingent liabilities arising from financial guarantees provided to utilities to procure oil. Such direct and implicit subsidies often are significant in magnitude, adding to the countries’ fiscal and macroeconomic management challenges.

Another special facet of the PICs is the challenge of meeting even the most basic electricity services needs of two large populations. One group lives outside the grid coverage today and for the foreseeable future. The second group is scattered widely across far-flung islands and remote small communities. Combined, these 2 groups comprise 80 percent of the PICs population on a regional basis (41 percent excluding PNG and Timor-Leste) (table A1.6.3). The extent of spatial dispersion of settlements in the PICs contrasts sharply with the situations of most other countries, whose geographic and settlement patterns generally permit 85 percent–95 percent of the population ultimately to be connected to the grid through a least-cost grid rollout plan.

This chapter highlights the key relevant strategic and policy directions worthy of consideration in addressing the interlocked set of challenges to secure, affordable, and widely accessible quality energy services for all PIC citizens. These

43. The World Bank’s East Asia and the Pacific (EAP) Region comprises 12 Pacific Island Country members: Melanesia (Fiji, Solomon Islands, and Vanuatu), Polynesia (Samoa, Tonga, and Tuvalu), Micronesia (Kiribati and Republic of Marshall Islands, or RMI), Federated States of Micronesia (or FSM, and Palau), Papua-New Guinea (PNG), and Timor-Leste.

44. There is considerable scope for improvements in the customer-side efficiency of electricity use as well.
suggestions are grounded in established good practice lessons drawn from relevant worldwide experience. These lessons include regional good practices, especially experience with deployment of grid-renewable energy generation systems on the scale of island utilities that can substantially reduce the diesel dependency and lower unit costs of Pacific Island grid systems.

For the nearly 80 percent of the PICs population who live in dispersed settlements outside of grid system footprint areas, of particular significance are the experience and trends in the market for consumer friendly “picosolar” products. These relatively low-cost, user-friendly gadgets provide high-quality modern light-emitting diode (LED) lighting and sufficient power for cell phone and small radio battery charging. Taken together, this “basic electricity” service potential represents an immediate life-changing prospect for off-grid populations (box 3.5).

Remote and “sea locked.” The total land area of the PICs (excluding PNG), comprising hundreds of small islands and atolls, is only 89,000 square kilometers (sq km), or approximately one-third the size of New Zealand. This land area is widely scattered across an ocean area that is equivalent to approximately 15 percent of the earth’s surface. The physical distances from the world’s trade centers make these populations among the most isolated anywhere. For most of these islands, the closest major ports and export markets are Auckland, Sydney, or Tokyo, which are over 3,000 km away on average. The least remote island, Palau, is 1,677 km from Manila (figure A1.6.1). As a consequence, the petroleum supply chains to the PICs are among the most extended and have low economies of scale.

Fragmentation and remoteness within. Significantly, in the majority of the small island nations,
less than half the population lives on the main island; and, typically, less than 30 percent lives in cities. PNG’s rugged geography means that the majority of people live in highly remote communities with almost no road access to neighboring districts and with very distinct cultural and linguistic practices. For instance, in PNG, the large number of highly fragmented communities comprise over 1,000 languages in PNG, Solomon Islands, and Vanuatu. Another illustration of remoteness within a country is found in Kiribati. Its population of approximately 100,000 is spread over 33 low-lying atolls scattered over 4,000 km of ocean from east to west, and 2,000 km from north to south (a sea footprint equivalent to the land area of the lower 48 states of the United States). The 233,000 inhabitants of Vanuatu are spread over 80 mostly volcanic islands in an 800-km north-south-aligned chain (figure A1.6.1).45

**Economic isolation.** Perhaps more than any other countries, the Pacific Island nations are shaped by their economic geographies. In general the correlation between access to markets and economic growth is strong. Besides their small market sizes, PICs’ long distances from main centers of economic activity have hampered their development. The *World Development Report 2009* (WDR) presents several potential market remoteness measures for the Pacific Island Countries. The mean GDP-weighted distance rank for all the islands is 197 of 219 countries. Micronesia is ranked at 176; Polynesia and Melanesia tied at rank 207.46

**PIC governments are especially challenged to deliver vital services to their far-flung citizens.** PICs’ geographic constraints not only have played a major role in shaping economic opportunities in the Pacific but also pose special challenges to the provision of basic infrastructure delivery and other priority services. As noted above, populations are widely dispersed and located at great distances from capital cities and economic hubs; transportation (intra- and interisland) as well as communication and information flow links tend to be limited and expensive; and regional and

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45. Melanesia is characterized by larger land masses and populations, Polynesia by smaller but relatively compact land masses, and Micronesia by very small and widely dispersed land masses. Melanesia tends to be relatively resource rich; Polynesia generally possesses adequate resources; Micronesia tends to be resource poor.

46. Overall, the PICs are considerably smaller and far more remote from key export markets than are the Caribbean islands. The approximately 40 million people in the Caribbean live across a sea area equivalent to 0.5 percent of the world’s surface area and are fewer than 1,000 km from the huge US market. The 2009 WDR estimated the Caribbean island country remoteness index mean to be 100 of 219.
## Table A1.6.3 EAP Pacific Island Countries: Physical Geography and Population Settlement Patterns

<table>
<thead>
<tr>
<th>Country</th>
<th>Pop. (000s)</th>
<th>Avg. HH size</th>
<th>Area (000 sq km)</th>
<th>Urban pop. (%)</th>
<th>Selected physical and spatial geography characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiji</td>
<td>843</td>
<td>4.8</td>
<td>18.0</td>
<td>52</td>
<td>320 islands (approx. 100 inhabited). Largest 2 islands comprise approx. 87% of land and 95% of pop. (Viti Levu, Vanua Levu).</td>
</tr>
<tr>
<td>Kiribati</td>
<td>100*</td>
<td>6.3</td>
<td>0.8</td>
<td>44</td>
<td>32 widely scattered low coral atolls in 3 groups and 1 raised coral island. They stretch 4200 km east-west, 2000 km north-south. Approx. 48% of pop. resides on islets of S. Tarawa atoll.</td>
</tr>
<tr>
<td>Republic of Marshall Islands</td>
<td>60</td>
<td>7.2</td>
<td>0.2</td>
<td>71</td>
<td>Two archipelagic island chains of 29 atolls; (22 inhabited) and 5 raised coral islands (4 inhabited).</td>
</tr>
<tr>
<td>Fed. States of Micronesia</td>
<td>111</td>
<td>6.7</td>
<td>0.7</td>
<td>23</td>
<td>607 islands varying from mountainous to low coral atolls; spread over 2500 km east-west and 1000 km north-south.</td>
</tr>
<tr>
<td>Palau</td>
<td>20</td>
<td>3.9</td>
<td>0.5</td>
<td>77</td>
<td>200+ islands; most very small (9 permanently inhabited). 95% of islands and 90% of pop. is within main reef containing Babeldao, Koror, and Peleliu islands.</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>6,599</td>
<td>5.5</td>
<td>453.0</td>
<td>13</td>
<td>600+ islands; 80% of pop. in eastern half of island of New Guinea.</td>
</tr>
<tr>
<td>Samoa</td>
<td>179</td>
<td>7.6</td>
<td>2.8</td>
<td>23</td>
<td>Two volcanic islands with rugged high mountains and narrow coastal plains: Sava'i (58% of land and 24% of pop.) and Upolu (38% land and 76% of pop.), plus 8 small islands.</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>510</td>
<td>6.3</td>
<td>29.0</td>
<td>18</td>
<td>Nearly 1,000 islands; mixed group of mountainous and coral atolls (350 inhabited). Six main islands account for 80% of land area and bulk of pop.</td>
</tr>
<tr>
<td>Timor-Leste</td>
<td>1,098</td>
<td>—</td>
<td>15.0</td>
<td>27</td>
<td>Located on southernmost edge of Indonesian archipelago. Country includes eastern half of Timor island, Oecussi enclave in northwest Indonesian West Timor, and islands of Atauro and Jaco.</td>
</tr>
<tr>
<td>Tonga</td>
<td>103</td>
<td>5.8</td>
<td>0.8</td>
<td>25</td>
<td>Archipelago; 176 islands in 4 groups (Tongatapu, Ha'apai, Vava'u, Niua) (36 inhabited).</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>12</td>
<td>—</td>
<td>0.026</td>
<td>—</td>
<td>Six atolls with large lagoons enclosed by a reef plus 3 raised coral islands without large lagoons. Funafuti has 22% of land and over 48% of pop.</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>233*</td>
<td>5.1</td>
<td>12.0</td>
<td>25</td>
<td>Over 80 mountainous islands of volcanic origin with narrow coastal plains; 90% of pop. on 4 islands.</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9,868</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

local markets typically are low in both supply and demand.

**Energy Sector: Extreme Vulnerability to Oil Supply and Price Shocks**

PICs are among the highest petroleum-dependent nations. Imported petroleum fuels account for an estimated 99 percent of commercial energy use in the PICs, except for PNG and Fiji. In PNG and Fiji, petroleum fuels account for 60 percent and 20 percent of commercial energy use, respectively (ADB 2009). The 99 percent petroleum dependency rate in the PICs (excluding PNG and Fiji) is the highest in the world. Available sectoral consumption data for the PICs—transport (land, maritime), utility generation, private sector self-generation—are neither reliable nor up to date. Indicatively, in most cases, diesel fuel consumption in PIC electricity grid systems accounts for 30 percent–40 percent of total petroleum imports (approximately 50 percent in the case of Kiribati and 25 percent in Solomon Islands). Also significant, in the vast majority of PICs, the electricity sectors are characterized by nearly 100 percent dependency on imported diesel for power generation.

**Extreme vulnerability to oil supply and price shocks.** Petroleum dependency makes the Pacific Islands highly vulnerable to oil price shocks—which feed into the affordability of food imports, electricity, and transport. This issue was highlighted in 2008, when world crude oil prices peaked at over US$140 per barrel. However, it should be noted that many Pacific Island countries effectively were enclave mine operations, resorts, and other enclave developments with self-generation. Such data are not readily identifiable in available statistics.


paying over US$100 per barrel well before then due to the high costs associated with transporting and distributing fuel across the Pacific and among remote islands within each PIC. Many PICs remain exposed due to reliance on spot market purchases of petroleum products with no mitigation measures such as petroleum supply contracts. Those would limit the risks that PICs face from rising oil prices and enable them to capture some of the benefits from falling oil prices.

**PICs pay among the highest retail energy product prices in the world.** Unleaded petrol and automotive diesel oil (ADO) typically are US$1.30–$1.50 per liter (including taxes) in urban areas but substantially higher elsewhere. The scattered island settlements on the outer islands or in remote small communities on the main islands commonly rely on kerosene for lighting. They pay extremely high retail prices at the end of the supply chain—approximately US$3.00 or more per liter although they generally are not taxed.

**Electricity Sector Context**

**Approximately 8 million people in EAP are in the dark (0.9 million excluding PNG and Timor-Leste).** Overall electricity grid access in the PICs is estimated at 59 percent (excluding PNG, in which access is considerably lower). Table A1.6.2 shows the wide variation in coverage levels achieved across the Region. Coverage ranges from near universal access in the Polynesian island nations to under 20 percent for some (Solomon Islands, Timor-Leste) to a low of less than 10 percent in PNG.

**Without a fresh start, prospects dim for near-term change.** Region-wide, approximately 80 percent of the EAP population lives well outside the reach of existing main grid systems. Approximately 41 percent of the people (excluding in PNG and Timor-Leste) tend to be spread across remote communities of the main islands and outer islands. The human costs of their extreme isolation—from the world at large and within their own country or island—tend to be huge. The ability to participate in the formal Regional economy, communicate in real time, and access basic information and other services to improve their lives is severely limited, if not totally denied.

Indeed, revealed preferences and health statistics point to the two most highly valued benefits derived from even basic electricity access. These benefits enable them to take control of their lives in a way that they are not free to do otherwise. These benefits are (1) communication—the ability to stay “connected” and in touch with people and events outside of their immediate proximate spatial location. Examples of such empowerment are cell phones for voice communications with family and friends, for business and official transactions, and for emergencies; and radio broadcasts for information and entertainment. In addition, (2) at the mere flick of a switch, the ability to turn on a modern—safe and clean—light to read and study for school, extend evening hours, enhance night-time security, and increase income-generation opportunities through both more schooling and later work hours.

**Electricity grid systems’ performance commonly is plagued by high-cost generation fuel mix and operational efficiency limitations.** Electricity grid
systems in the PICs are operated most commonly by government-owned, vertically integrated utilities. These systems typically serve the larger concentrations of the population in the urban areas of the major towns and the immediate environs as well as the settlements along the higher density coastal belt areas found in some islands. Due to the archipelagic nature of the island nations, a large number of such independent grid systems are operating. They range in size from tiny (“microgrid”) systems, with installed capacity on the order of magnitude of 0.1 MW and typically serving approximately 500 customers or fewer to 3 relatively “large” systems. These have generating capacity of 100 MW–150 MW that serves in excess of 125,000 customers each. Most grid systems are in the middle range. Each of 40 such grid systems serves peak demands in the range 1 MW–15 MW. Combined, these mid-size grid systems account for an installed generating capacity of 400 MW–500 MW, almost all diesel based. They serve a combined maximum demand of 250 MW–300 MW. Together, the 3 large systems and the nearly 40 mid-size range grid systems among others account for almost the entire 59 percent coverage statistic reported in table A1.6.2.

Financial sustainability a constant challenge for most. Due to a generation fuel mix heavily skewed by diesel fuel as well as operational efficiency standards generally well below efficient practice, most Pacific Island grid system utilities are characterized by a high cost structure. It is not uncommon to find network losses in the 30 percent range. Retail tariffs in the PICs typically range between US$0.35/kWh–$0.75/kWh. Fiji Electricity Authority’s (FEA) average tariff, approximately $0.17/kWh, is the lowest due to a nearly 60 percent share of generation from hydro and operational efficiency standards that define Regional best practice. With the exception of Unelco, the private sector utility in Vanuatu, and the public utility, FEA, the utility tariff formulae applied generally do not recover capital costs. Cost recovery would necessitate raising tariffs even higher, when most domestic and small business customer consumption already is severely limited due to the lack of affordability of electricity bills in relation to HH budgets.

For most PIC utilities, the dream of achieving financial sustainability is oriented at best toward an initial big step of achieving recurrent cost recovery via retail tariffs. The ability to do so means that utilities need to begin with a proper least-cost plan and large-scale investment in diesel fuel substitution. This substitution should go from grid-connected, cost-effective renewable energy options—hydro, geothermal, and solar PV—and investment to lower network losses and the specific fuel consumption of existing diesel stations. However, donors generally have not supported efforts to maintain infrastructure as an economic and productive asset. Furthermore, the practice has been that, rather than being systematically planned and implemented at the optimal times, new investment is rare. Customarily, planning is not the driver of new generation and network investment timing and of the type and specifications. Rather, investment tends to be wholly grant financed and off balance sheet. Moreover, its timing usually depends on the whims of donors, most crucially, when an interested donor may step forward to invest to keep the lights on. These actions typically occur in response to a looming crisis, with the donor specifying the choice and type of equipment.

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50. An exception is the private utility, UNELCO, in Vanuatu. In Tonga, the private utility, Shoreline, was sold back to the state in 2008. The 100% state-owned successor, Tonga Power Ltd (TPL) has a regulatory contract that specifies a 12.9% return on regulated assets and, in principle, should be able to cover capital costs. In Fiji, a 9 MW biomass-based IPP sells to FEA and plans call for more IPP development. In PNG, entities other than PPL increasingly are generating power. Such entities include provincial-government-operated small grid systems and mining enclave operations and church organizations that supply and distribute power to adjacent communities.

51. Fiji Electricity Authority (FEA)-operated grid systems on the main island of Viti Levu have installed generation capacity of 185 MW. PNG Power, Ltd (PPL) Port Moresby grid system has an installed capacity of approximately 140 MW, and the Ramu grid system has 200 MW of installed capacity.
Renewable energy: Weak record due to misdirected efforts. Starting in the early 1990s, donors directed substantial interest and support to increasing the use of renewable energy technology in the energy supply mix, almost as an end in itself. This interest shows prominently in the form of numerous studies and project activities in the Region. In the absence of national or utility strategic planning to indicate priorities, donor financing has been largely misdirected, driven by funds earmarked for priorities developed at a global scale rather than for PIC-specific priorities. A disproportionate amount of funding has been directed to off-grid renewable energy technologies for access and otherwise driven by climate change, which is a developed country agenda.

National energy infrastructure investments and related support for the main grid systems largely have been neglected. Furthermore, even in off-grid areas to which investment has been delivered, the results and performance do not measure up. For example, in most countries, solar home systems (40Wp–100Wp range) have yet to achieve measurably significant penetration areas.53 Furthermore, instances of renewable-energy-based micro/small grids that have been running with a track record of good performance and maintainability as well as cost competitiveness are hard to find. Donors generally have focused more on demonstration and testing, and less on achieving efficient costs, reliable performance, and scalability.

52. A notable exception is Fiji, which has aggressively developed hydropower resources; has a power purchase agreement with a biomass-based IPP; and has an active program to further promote expand cost-competitive, renewable-based generation supply. Vanuatu’s promotion of coconut oil so far has been uneconomical.

53. One notable exception is Kiribati’s outer islands electrification program. It has been operated for several years by a government-owned entity, Kiribati Solar Electricity Corporation (KESC). With grant financing of its capital costs by the European Union, KESC operates a fee-for-service-based SHS program on the outer islands for homes, community halls, and key institutions.

Energy Sector: Main Policy Challenges
Managing energy security risks: Continuing key role of hydrocarbons. The petroleum supply chains to the Pacific Islands are long, narrow, and vulnerable to disruption. Increasing the share of renewable energy will reduce the extent of oil dependence and the risk of supply disruptions as well as reduce the economic vulnerability of these countries to oil price shocks. However, for the foreseeable future, imported petroleum fuels will continue to play a major role in energy supply and demand, and not only in the transport sector. To reduce the growth of demand for imported fuel and to reduce costs and cost volatility, improvements in the petroleum supply chain and in price risk management, as well as improved customer efficiency, must be priorities. These improvements will require significant investment in new assets in the petroleum supply chain and in the electricity-generation sector. Just as urgently, improvements, including investment, are needed in safety and emergency response systems and readiness. However, most Pacific Island governments are suffering severe budget pressures from shrinking income sources, and rising costs, one of which is for oil. Tight budgets restrict possibilities for investment in initiatives for oil substitution or efficiency improvements. Meanwhile, as noted above, development partners have tended to direct their support to off-grid activities.

Addressing climate change: Putting people first. The global nature of greenhouse gas (GHG) emissions puts pressures on all nations to reduce their carbon footprints and at times introduces conditions for access to external funding sources that have more to do with global trends than national priorities. Nevertheless, even if access to fossil energy increased significantly across the Pacific Islands, their emissions would add negligibly to global GHGs. The challenge is to formulate and implement a balanced set of energy policies and initiatives. These can be identified through a credible least-cost planning process that highlights the expanding role of low-carbon energy forms while recognizing that petroleum will continue to play a key role in meeting PIC energy needs.
The Regional energy agenda is framed appropriately as one to improve energy security rather than to promote renewable energy. The latter agenda is driven by global climate change concerns. Development of the renewable energy supply is an important part of the diversification strategy to improve energy security. Specifically, increasing the share of renewable energy—on- and off-grid—should not be seen as an end in itself nor even as the sole effective route to reduce GHG emissions. Rather, increasing the renewable energy share is one among several means to be deployed and assessed within a balanced, bigger-picture approach to energy issues. The ends sought are to ensure secure, affordable, widely accessible, high-quality energy services to the people of the Pacific.

**Strategic Directions: New Horizons and Opportunities**

This section draws attention to relevant strategic and policy directions to address the interlocked set of challenges to secure and affordable energy access for the citizens of the Pacific Island Countries. The key messages that follow are intended to inform the approach, scope, and depth of country-specific strategies and policies; and the staging of actions and specific investments tailored to the PICs’ respective national priorities and sectoral contexts.

**20-20 vision of the problem definition: “An Energy-Secure Pacific.”** Pacific Island nations face a tangled web of challenges and constraints to the formulation of a coherent set of national and regional energy policies and actions coordinated across key sectors and stakeholders. The 2010 endorsement of the “Framework for Action on Energy Security in the Pacific” was a significant milestone and a big first step in the right direction. This framework recognized that the common thread weaving throughout the energy sector challenge and those related to addressing energy access is the PICs’ extreme vulnerability to high oil dependency, high import costs, and supply and price shocks. Accordingly, the framework formulated a clear and concise vision of an “energy-secure Pacific”:

“Energy security exists when all people at all times have access to sufficient sustainable sources of clean and affordable energy and services to enhance their social and economic well being.”


**Bringing it all together: “Whole-of-sector” framework and principle of “many partners, one team, one plan.”** Besides clearly articulating the problem definition and development outcome sought for the energy sector, the forum leadership rightly signaled the imperative to break from the past. This shift can be characterized as a move away from a fragmented “project-by-project and donor-by-donor approach” toward a programmatic approach. The latter will be embedded in a sector-wide framework and process that is country owned and country driven with joint accountability for results that are aligned with national priorities. A notable and example-setting application of the whole-of-sector approach and organizing principles is the recently completed Tonga Roadmap (box A1.6.1).

**Grid Electricity Systems: Time for Strategic Investment in Renewable Energy**

Substituting diesel fuel in grid-based electricity generation arguably would be the most effective way to reduce the sector’s petroleum dependency. Substitution could be achieved through improving energy efficiency and cost-competitive and proven units at other organizations; bilateral and multilateral development organizations; and development partners from Australia, China, Italy, Japan, and New Zealand, among others. On June 30, 2010, a special forum of energy ministers was convened in Brisbane as part of the lead-up to the Forum Leadership summit held August 5, 2010 in Port Vila, Vanuatu.
Box A1.6.1 Tonga Energy Roadmap: Many Partners, One Team, One Plan

“Energy is a fundamental building block for the Kingdom in its social and economic development and in enhancing the livelihood and well-being of all Tongans. It affects all businesses and every household. Accessible, affordable and sustainable electricity that is environmentally responsible and commercially viable is a high priority. My government recognized the importance of having dependable, accessible and reasonably priced power as a key catalyst for sustainable economic growth. Achievement of these goals is crucial to achieve the government’s primary target of ‘poverty alleviation’ including 100 percent accessibility to electricity.”

—Hon. Dr. Fred Vaka’uta Sevele, Prime Minister of Tonga, April 2010

The “Tonga Energy Roadmap” (TERM) effort was led by the government of Tonga (GOT) in coordination with the World Bank. The effort convened development partners and embarked on a sector-wide review to improve the performance of the energy sector and to mitigate the risks. In so doing, TERM recalled and redefined a sector-wide framework and process that colloquially has become known as a “whole-of-sector” approach to energy planning and investment.

Development of TERM involved unprecedented information sharing by government ministries and Tonga Power Ltd (TPL). The process set a new standard in the Pacific for government leadership and coordinated development partner support. Over the past year, the process has benefited from the active participation of more than 15 development partners, including multi- and bilateral agencies and regional organizations responsible for energy in the Pacific. TERM is important not only for its expected impact on the Tongan energy sector. Other PIC energy sector discussions already are citing the roadmap as exemplary and citing the government’s leadership and development partners’ coordination of sector-wide planning applicable to infrastructure more broadly.

The roadmap covers 1 decade starting in 2010. It addresses improvements in the petroleum supply chain and considers price-hedging instruments. These comprise reducing cost and volatility in the price of petroleum imports and delinking electricity production from petroleum to the extent feasible. TERM also focuses on (1) increased efficiency in electricity supply and use, (2) development of grid-connected domestic renewable energy resources, (3) improved access to quality electricity services in remote areas, (4) reduced environmental impacts both locally and globally, (5) enhanced energy security, and (6) overall sector financial viability. TERM’s scope also includes policy, legal, regulatory, and institutional aspects of the sector as well as investment. It is envisioned that TERM will be updated periodically to take into account technologies, costs, demand for electricity, and sources of financing as they evolve.

GOT formally adopted TERM in August 2010. The World Bank is providing GOT ongoing support to implement TERM via the Tonga Energy Roadmap Project, which is under preparation. The project will reinforce the focus on, and provide the support to achieve, the medium-term energy sector outcomes highlighted for this proposed operation. Other development partners also are working with GOT to prepare support aligned with specific aspects of TERM implementation.

renewable energy-generating options: hydro and geothermal power generation. Diesel substitution would be followed by efficiency improvements on the utility and customer sides.\textsuperscript{55} Moreover, grid-connected large-scale solar PV generation increasingly is being deployed effectively in island contexts all over the world. Examples include remote operations on several Caribbean basin island utilities, Reunion Island in the Indian Ocean, and, more recently, in EAP.\textsuperscript{56} Present-day good-practice technical designs and component

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\textsuperscript{55} Estimated by the scale of efficiency improvements relative to the timeframe per unit of investment.

\textsuperscript{56} New Caledonia: 2.1 MW grid-connected central power station, operational since April 2010; Tuvalu: 40 kW solar PV power station.
specifications for key equipment components, such as inverters, can effectively address performance and maintenance issues in the earlier generation installations, even in remote settings. Nevertheless, until recently, the deployment of such designs in the PICs’ grid systems usually was absent.

For many PICs, hydro, geothermal, and solar-PV-grid-connected generation—grid systems—represent the largest scale, fastest, and most cost-effective interventions for increasing access to electricity. More specifically, in the Pacific Island context, electricity generated from utility-scale, grid-connected solar power stations already is competitive with today’s oil prices. On both a total-cost basis ($26USc/kWh–$28c/kWh versus $30c/kWh–$35c/kWh), and a variable-cost-only basis, solar PV generation is far more cost-effective than diesel($1c/kWh–$1.5c/kWh versus $25c/kWh–$30c/kWh). Looking ahead, unit costs of module production are expected to decline further along the “technology learning cost curve” in response to the rapid global increases in the annual capacity of installations of solar PV module capacity. As this decline continues, the cost advantage in favor of solar PV generation will continue to increase. However, it needs to be kept in mind that the amount of solar PV power that can be added and its impact on total cost is limited by its intermittent nature without the means for storage.

A separate goal of 50MW of grid-connected capacity from renewable and other sources including solar PV, wind, and biomass is an indicative target to be phased in over the medium to long term.

57. Grid-connected solar PV has grown by an average of 60% every year of the past decade, increasing 100-fold since 2000 (Ren21 2010).

58. Additionally, PNG has captive power generation, mainly for the mining industry, of approximately 300MW.

59. Where available, hydro or geothermal energy; otherwise, primarily solar PV and, in some instances, biomass or wind energy.

60. Outside of PNG, electricity demand growth is projected to be low in the short to medium term. As a consequence, for most PIC grid systems, the renewable energy generation investments will be driven by a “conversion/diesel substitution” program. The program’s objectives will be to (a) lower the costs of electricity generation and tariff relief for electricity users, and (b) diversify fuel to enhance energy security via reduced supply risk.

61. Fiji already has established a diversified generation mix and has additional plans to diversify: PNG’s considerable hydro and other resources tend to be the dominant prospects. The Solomon Islands have good hydro prospects.
During periods of peak demand (“peak shaving”). Along the way, PIC utilities will gain operating experience in integrating intermittent systems—with and without some storage (see below)—and in building institutional capacity. These developments will set the foundations for those interested in deploying even “deeper penetration” of grid-connected solar PV capacity that uses sophisticated control systems hardware and software to manage the network operation system.

In this future context, a relevant development is that battery storage technologies are making it increasingly feasible and attractive to use solar PV power as a dispatchable resource for peak shaving. A case in point is sodium sulfur (NaS) battery technology, which has been proven over 2 decades in utility-scale applications. This technology was applied in the Tokyo Electric Power Company grid system (200MW of NAS batteries); in northern Japan (51MW hydro station coupled with 34MW NAS battery system); and more recently in Texas (4MW battery). In addition, use of the NAS batteries in a remote island context is undergoing ongoing testing and measuring over 2010–12 in Reunion Island in the Indian Ocean. However, the investment and operating costs likely will remain a major constraint in the near future versus deployment in the PICs (box A1.6.2).

What is most important are to (1) get supporting financing and TA mechanisms in place to enable a Region-wide push, and (2) organize and implement a systematic programmatic framework. Once the program is underway, timeframes can be better calibrated as they are informed by evolving implementation and operation experience. The first-phase buildup of grid-connected renewable energy generation investments also will help set the stage for longer term, least-cost expansion plans.

Using Simple Power Solutions to Change Lives of Poor and Remote Dense Populations: Thinking and Acting Differently

Approximately 8 million people in the PICs live in off-grid areas (6.6m in PNG, 0.9m in Timor Leste, and approximately 0.5m in the other PICs). Most of these people are unlikely to receive grid service in the foreseeable future. Conventional solar home systems (SHS) (that power 2–3 lights and a black and white TV) are not affordable for most poor HH. Typically, these systems cost at least US$400–1,000+ (2–5 times the per capita income of most PICs) coupled with US$10–$15 monthly service fees for the huge costs of supporting extended and specialized service and maintenance chains. Furthermore, with the exception of Kiribati (mentioned earlier), SHS have not achieved significant market penetration.

A recent generation of pico (“very small”) solar charger consumer products is available for the most essential life-giving elements that have been denied to remote and poor populations. These

Operational Efficiency Improvements: Capacity Building and Upstream Technical Assistance for the Grid System

For many PIC utilities, a top priority is first to get their own houses operationally in order. Among the highest priority interventions are implementing network loss reduction programs (many PICs have system losses in the high 20 percent–low 30 percent range62), reducing specific fuel consumption (SFC) of diesel power stations, improving billing and revenue management practices and systems, and sound advance planning. These interventions will need ongoing investment. Also crucial will be dependable and relevant TA as well as strengthened institutional capacity to diagnose and scope, design, and manage ongoing specific operations improvement programs. In this context, the Fiji Electricity Authority (FEA) is considered the Region’s best-practice utility (box A1.6.3).

62. Systematically collected and up-to-date reporting of data is vital to inform the diagnostics for each grid system because key performance indicators—technical, commercial, and customer service—are not yet readily available.

63. In the long run, it is projected that approximately 2.2 million of the 8 million are likely to be served by grid systems in PNG and Timor Leste.
Box A1.6.2  Advanced Battery Storage Technologies Enhance Integration Potential of Intermittent Renewable Energy Generation into Grid

Solar, and more so, wind energy generation are inherently intermittent. This reality limits the typical extent to which such generation can be absorbed by island-scale grid systems to under 15 percent–20 percent. This limitation is determined by several operational considerations. These derive from the technical imperative that requires that supply and demand in a grid system be matched instantaneously and ongoing. Specifically, in the absence of storage, intermittent generation reduces power quality (harmonics and voltage fluctuations) while it increases the need for balancing in real time. This balance is achieved by increasing the reserve firm capacity on line to maintain the grid system frequency to rated 50Hz. However, when coupled with proper storage, otherwise intermittent renewable energy from grid-connected solar PV power stations and wind can be stabilized as well as counted on as a firm dispatchable resource to balance system demand and supply at each instant.

NaS Battery Storage System

Over the years, many battery technologies have been proposed and developed for electrical energy storage applications. Nonetheless, only a handful have been used in field systems and proven on a utility scale. A promising case in point is the sodium-sulfur (NaS) battery storage system. NaS batteries have a relatively small footprint (high energy density); high discharge efficiency (89 percent–92 percent) if used regularly; integral thermal management; and low maintenance requirements. NaS batteries also offer cycling flexibility and long cycle life, and are fabricated from inexpensive materials.

Currently, NaS battery costs are approximately US$2,500 per kilowatt—approximately 10 percent more than the cost per kW of a new coal-fired plant. Mass production is expected to drive down NaS battery prices.

Reunion Island Grid System Installation of a 1MW NaS Battery

Since 2009, an NaS battery system has been piloted in France’s Reunion Island in the Indian Ocean to provide firm peak shaving power on the island grid system. The installation is integral to a grid-connected solar PV power station, and is rated for 7 hours of firm power per day and for 2,500 cycles over its lifetime. The battery supplier guarantees a 15-year life and performance, and provides turn-key scheduled maintenance per design and performance specification. The NaS battery system requires scheduled maintenance every 3 years, and the entire battery module to be replaced every 15 years, with recycling included.

**Box A1.6.3 Fiji Electricity Authority: Good-Practice Neighbor Offering a Helping Hand**

The Fiji Electricity Authority’s (FEA) record of accomplishments and performance is exemplary. FEA’s record not only stands out in the context of Pacific Islands national utilities but also places it among the best of island nation utilities globally.

Beginning in 1966, FEA had a generating capacity of 3,394 kilowatts and only 2000 customers. The utility has grown steadily and now provides electricity supply via several grid systems to approximately 150,000 customers in the 3 main islands of Viti Levu, Vanua Levu, and Ovalau (81 percent coverage overall). Today, the installed generating capacity stands at 205MW, comprising a combination of hydro, a wind farm, and several diesel power stations (100MW). An independent power producer (IPP) supplies electricity to FEA via biomass generation.

Noteworthy examples that serve to highlight FEA’s impressive and sustained efficiency gains and serve as reference benchmark beacons for PIC utilities follow.

**System Losses at Best-Practice Levels**

The moving average system loss—network losses and auxiliary station usage—for the last 5 years ranges from 8.70 percent to 10.23 percent. These numbers compare favorably with the international benchmark of approximately 10.00 percent.

**Diesel Station Fuel Performance**

FEA operates 9 thermal power stations with an installed capacity of 110 MW. The average specific fuel consumption (SFC) across all these diesel stations is 0.2419L/kWh with the station usage at 1.84 percent of total generation. This good-practice performance is underpinned by effective work practices and discipline. These include regularly scheduled maintenance on all fuel injection systems, tuning fuel pump timing, ensuring loadings of the generator sets for optimum fuel efficiency, and attending to fuel supply quality management. FEA recently signed a Fuel Purchase Agreement with an international supplier. This agreement includes a value-added initiative undertaken by the supplier: implementation of improvements in fuel consumption of the diesel generation sets. This initiative will lead to a minimum additional 1 percent fuel efficiency and savings.

Throughout the 1990s through 2008, FEA’s average tariff level stayed nearly flat in nominal terms at approximately 21FJc/kWh–22 FJc/kWh. In 2009 the tariff rose to 25.5FJc/kWh (still well below inflation). In June 2010, the Commerce Commission approved a price increase that raised the average to 32.3 FJc/KWh. In comparison, tariffs in Australia and New Zealand are 42.4FJc/kWh and 47.5FJc/kWh, respectively. Apart from Fiji and Palau, tariffs for all other PICs range from 60FJc/kWh (PNG) to 147FJc/kWh (Solomon Islands) (box figure A1.6.3.2).

This tariff story is a proxy bottom-line testament to FEA’s management- and results-driven culture. This culture is driven by technical excellence, professionalism, and accountability instilled throughout the organization; orchestrating a sustained and impressive record of cost containment and productivity gains, while continuously expanding and improving service and maintaining financial soundness.

(continued)
devices are powered by a small solar PV panel. They contain a built-in battery that can store sufficient electrical energy to charge cell phones and small radio batteries, and power a light-emitting diode (LED) light. Pico chargers’ small size and portability have been made possible by the development of LED bulbs, which are 30 percent–50 percent more efficient than even high-efficiency compact fluorescent lamps (CFLs). Conveniently as well, LEDs use DC power, which is the output of a solar panel. In contrast, CFLs use AC power, which requires an additional inverter component, thereby adding to CFLs’ cost and complexity.

**Rapid Scale-up Potential with Genuine Global Reach.** The better performers among these solar chargers are user friendly and have robust circuitry for long-life performance to withstand high heat and humidity and rough use. These solar chargers do not need special-purpose and high-cost supply and after-sales maintenance chains, as do SHS. Instead, these products are characterized by cash-and-carry, plug-and-play features. Hence, they are readily piggy-backed on established retail trade supply chains and other existing networks, such as those of rural NGOs, church organizations, and cell phone service operators, that extend out to Regional and localized markets commonly found in the PICs. These small solar-powered devices

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64. These “plug-and-play” devices can be replaced at relatively low cost. In comparison, for people in remote rural areas, SHS require constant and ongoing maintenance by the users and servicing chains.
offer the real prospect for rapid market penetration within a decade (box 3.5).

**Right push needed at this early “starter-market” phase.** In the formative stages, government’s roles include enabling market development by helping promote product awareness, providing reliable information on product(s) quality and price, providing incentives to improve product quality, and enabling wholesale trade finance. Also vital at this early stage is a modest capital subsidy.

**Case for price subsidies in starter-market development phase.** Specifically, under today’s conditions, to achieve retail prices for pico solar devices that range between US$10–$25 depending on the features, price subsidies are required. Such subsidies can range from 35 percent to 60 percent (for high-end phone chargers), equivalent to subsidies of $20–$35, respectively. Eventually, it is expected that today’s better performing devices will rapidly achieve high market scale at prices affordable to the majority of beneficiaries.

**Delivering better value for money: Partnerships and funding mechanisms that align with national and Regional priorities.** Above all, PICs need financial assistance to formulate realistic plans to expand grid-renewable energy and improve operations. Funding should align with national and Regional priorities and avoid being tied to specific technologies. Past funding decisions too often were driven by donor priorities or global agendas. These priorities and PICs’ needs frequently are not the same.

Successful implementation of the strategy and wide-ranging actions underpinning the vision of an energy-secure Pacific hinges on:

- The degree of success achieved by PIC governments in fostering and leading effective working partnerships across key Regional institutions
- Leveraging resources from development partners, and possibly from “special global funds,” for jointly agreed Regional and national investment and TA plans aligned with Regional and national priorities.

A noteworthy initial step away from the donor-by-donor and fragmented approach was established with the formation in 2008 of the Pacific Region Infrastructure Facility. PRIF is under the joint leadership of Australia, New Zealand, the Asian Development Bank, and the World Bank. The facility emphasizes better linking of investments to longer term reforms in the way that Pacific Island countries plan, manage, and finance their infrastructure needs. In addition, PRIF provides an effective mechanism to marshal coordinated donor support for investments in economic infrastructure and to address the problem of funding for infrastructure asset maintenance. PRIF has a way to go to achieve the goals of harmonization, alignment, and coordination across a wider set of donors. However, formation of this facility does mark a promising significant step in the right direction.

**Enhanced expectations for key Regional institutions: The “many partners, one team, one plan” approach.** Finally, progress in implementing the framework for an energy-secure Pacific will require harnessing and exploiting to the fullest the synergies arising from the respective

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65. PIC governments and donors have been subsidizing new connections for grid and off-grid beneficiaries all along. These capital investment subsidies arguably exceed $1,000 per grid connection and at least $500 per off-grid SHS connection plus subsidies for overhead costs of the SHS program.

66. The following are examples of ongoing PRIF efforts, especially those involving Australia and World Bank, that capture the reasons underlying several of the strategic directions outlined in the preceding section. They are (a) Tonga: Energy Roadmap (support for some elements of the preparation); (b) Kiribati: Grid-connected solar PV power generation—central station and distributed—for diesel fuel substitution of the S. Tarawa grid system (investment, TA, and project preparation); and (c) Vanuatu: (1) Efate Geothermal Power and Island Ring Grid Development Program and Framework (pre-feasibility study) and (2) Hydrocarbon Supply Chain Management Efficiency Study.
mandates and comparative strengths of the key relevant regional institutions and organizations.

An example would be a grid-connected renewable energy program mounted along the lines outlined above. There is a clear, urgent need for a collaborative and coordinated program going forward. This program could involve a joint working partnership of the Secretariat of the Pacific Community (SPC), Pacific Power Association (PPA), World Bank, and other interested partners. The purpose of the partnership would be to monitor and assess in real time the on-the-ground experience with grid-connected renewable energy in the PICs (as well as in relevant countries outside the Pacific). This partnership could feed back pertinent lessons learned to countries that are trying to increase grid-connected renewable energy and strengthen their capacities to chart their courses in that direction.
A1.7 Vietnam

The rural electrification effort in Vietnam has been a remarkable achievement. The share of HH with electricity access grew from 2.5 percent in 1975 to 96 percent by 2009 (World Bank 2011b). Through an unparalleled effort, the country provided access to more than 80 million people over 33 years. Vietnamese with access to electricity increased from 1.2 million in 1976 to approximately 82.0 million in 2009.

Along the way, the government addressed a wide array of challenges. For example, it successfully balanced the sometimes-competing interests of local, provincial, and central governments; government programs; and, in later years, support from

<table>
<thead>
<tr>
<th>Population (2008) (mil)</th>
<th>86.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural population (% total population, 2008)</td>
<td>72</td>
</tr>
<tr>
<td>Population density (people/sq km)</td>
<td>278</td>
</tr>
<tr>
<td>Land area (sq km)</td>
<td>310,070</td>
</tr>
<tr>
<td>Access to modern cooking fuels</td>
<td>34</td>
</tr>
<tr>
<td>Urban (% HH, 2008)</td>
<td>76</td>
</tr>
<tr>
<td>Rural (% HH, 2008)</td>
<td>20</td>
</tr>
<tr>
<td>Electricity access, national (% HH, 2009)</td>
<td>96</td>
</tr>
<tr>
<td>Urban (% HH, 2008)</td>
<td>99</td>
</tr>
<tr>
<td>Rural (% HH, 2008)</td>
<td>94</td>
</tr>
<tr>
<td>No. of people w/o access to electricity (2009) (mil)</td>
<td>4–5</td>
</tr>
<tr>
<td>Population served by off-grid sources (minigrids and HH systems) (%)</td>
<td>1</td>
</tr>
<tr>
<td>Electricity access target and year (% HH)</td>
<td>100; 2020</td>
</tr>
<tr>
<td>Electric power consumption (kWh per capita, 2007)</td>
<td>728</td>
</tr>
<tr>
<td>Installed capacity (MW 2008)</td>
<td>13,850</td>
</tr>
<tr>
<td>Thermal</td>
<td>8,350</td>
</tr>
<tr>
<td>Hydro</td>
<td>5,500</td>
</tr>
<tr>
<td>Other renewable</td>
<td>—</td>
</tr>
<tr>
<td>Electricity net generation (bil kWh)</td>
<td>69,965</td>
</tr>
<tr>
<td>Distribution losses (% net generation)</td>
<td>10.5</td>
</tr>
<tr>
<td>CO₂ emissions (M/T per capita, 2007)</td>
<td>1.3</td>
</tr>
<tr>
<td>Indicative residential electricity tariffs for rural consumers (2011)</td>
<td>US$c3.1/kWh; EVN customers, first 50 kwh @600 VND/kwh (Source: EVN)</td>
</tr>
</tbody>
</table>

Key institutions for electricity sector
- Electricity of Vietnam (EVN)
- Electricity Regulatory Authority of Vietnam (ERAV)
- Ministry of Industry
- Distribution Power Corporations (PCs)

development partners, to create an institutional structure for rural electricity supply that bodes well for long-term sustainable development.

Over time, Vietnam’s rural electrification (RE) program and its priorities have evolved. The issues encountered during the RE effort were constantly changing and the challenges daunting. At the outset, the country did not have one unified master plan. The government continually evolved in the ways that it tackled the challenges, which themselves were shifting. The challenge of the early stages—to provide simple connections—evolved into one of securing quantity and quality of supply combined with

<table>
<thead>
<tr>
<th>Period</th>
<th>Total investment needs (US$ mil)</th>
<th>Incremental needs for universal access (US$ mil)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Business-as-Usual scenario</td>
<td>Universal Access scenario</td>
</tr>
<tr>
<td>2011–20</td>
<td>1,459</td>
<td>1,459</td>
</tr>
<tr>
<td>2021–30</td>
<td>1,064</td>
<td>1,064</td>
</tr>
<tr>
<td>2011–30</td>
<td>2,522</td>
<td>2,522</td>
</tr>
</tbody>
</table>

Annual requirements:

Note: No. of HH without electricity in Business-as-Usual scenario by 2030: <1%.
meeting ever burgeoning urban and rural energy demand.

**Progress of Rural Electrification in Vietnam**

Vietnam’s electrification progressed through several phases, or periods, to its present level:

**Recovery period** (1976–85). After three decades of war, with underdeveloped and isolated systems, electricity supply was available only for cities and large industries. “Productive uses” were given priority. The HH electrification rate grew from 2.5 percent to 9.3 percent.

**Preparation period** (1986–93). The Doi Moi reforms were implemented. They resulted in an increase in rural incomes, the development of several large power plants across the country, the start of the construction of the 500 kV transmission line running the length of the country, and the building of medium voltage networks. The foundations laid by these important developments enabled significant progress in rural electrification in the subsequent periods.

**“Take-off” period** (1994–97). Electrification experienced remarkable growth. The HH electricity access rate more than quadrupled from 14 percent to 61 percent. The local and central government authorities responded to the strong societal demand for electricity. Indeed, by the mid-1990s, electricity access rates had become one of the key indicators in the annual socioeconomic development assessment of every commune, district, and province. Meeting the increase in demand for electricity access had become possible as a result of the completion and coming online of two significant sources. They were (1) the last unit of the Hoa Binh Hydropower station as well as other relatively large power plants; and (2) the 500 kV transmission line, which made abundant power sources available throughout the whole country. Other important developments during this period were the establishment of Vietnam Electricity (EVN) in 1995 and the clear nationwide electrification targets set by the government in 1996. During this period, the government and the World Bank began preparing their first joint energy sector project.

**Focus on regulation** (1998–2004). The growth in electricity access rates over these 7 years from 61 percent to 87 percent of HH was slower than in the previous period. Instead, this period was host to a series of fundamental changes in the sector that would pave the way for future sustained success. A significant feature was more pronounced government involvement in determining the course of rural electrification through three means. They comprised (1) defining strategies for the planning, implementation, and management of rural electrification; (2) setting the legal framework for the sector; and (3) engaging with Vietnam’s international partners to implement its strategic priorities. Two important actions that resulted were Decision 22 and Decree 45, which set out institutional and financial arrangements for the electricity system.

This period also witnessed the passage of the country’s first electricity law and the issuance of a policy paper on rural electrification. Another critical government initiative was to set a ceiling tariff for rural customers as a step toward establishing financial controls over the rural electricity supply business. Technical specifications for rural electricity systems also were developed, and were formally adopted in later years.

During this period, institutional arrangements and sources of financing for rural electrification shifted significantly. EVN began a pilot program for operating low voltage (LV) systems and started to acquire medium voltage (MV) systems that had been financed, by other entities. Under the service agent model, created under the First Rural Energy Project, local community members maintained LV systems on behalf of the PCs, carried out simple repairs, and handled collections. This model helped ensure accountability within local communities, minimize non-payment, reduce system losses, and significantly

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67. “Doi Moi” refers to the economic reforms initiated in Vietnam in 1986 with the goal of creating a “socialist-oriented market economy.”
lower the costs of system operations and management (O&M) for the PCs.

**Focus on quality and regulation** (2005–09). Meanwhile, the quality and reliability of electricity supply were emerging as important issues. The government chose to pay attention to these issues and to continued expansion of electricity access. This period could be characterized by the enforcement of legal requirements; a shift in focus from network extension to rehabilitation; and direct government support for extending electricity access, particularly to minorities and those in remote areas. The government’s focus was not only on increasing electrification rates but also on ensuring efficiency and addressing institutional shortcomings in the sector.

**Consolidation for the last mile** (2009). The period from 2009 onward was characterized by solidifying the focus on ensuring the sustainability of the rural electricity supply business. Simultaneously, the government was pushing for greater accountability, working to determine the most appropriate strategies for extending access to those without electricity, and ensuring the affordability of electricity for the poor.

An important milestone of this period was the Prime Minister’s Decision 21, issued in February 2009. It stipulated a unified tariff for all consumers, along with an incremental block tariff arrangement, with a new lifeline block. The decision also enabled the takeover of financially weak local distribution utilities (LDUs) by the PCs, now renamed Power Corporations. In fact, a significant consolidation of the rural electricity distribution and retail business took place in which smaller and financially weak LDUs were absorbed by the larger PCs. In 2010 the Vietnam Distribution Code was approved. It outlined the rights and obligations of PCs and their customers, including provisions regarding quality of service obligations and consumer protection.

Certain features of Vietnam’s experience, especially the ways in which the government tackled the challenges that emerged, can provide useful lessons for other countries. The lessons learned are organized in two parts. The first is from the perspective of the government. These lessons can inform the strategies of other developing countries in their efforts to expand access to electricity. The second part came from the World Bank experience. These lessons can be relevant during the development of future projects.

Vietnam’s success in rural electrification can be explained by a range of factors:

1. Unwavering government commitment, responsive to strong demand from society
2. Long-term vision, gradual and flexible approach
3. Responsibilities shared by all levels of government, sector participants, and consumers
4. Costs and mobilization of various resources shared by all stakeholders
5. Flexibility in the management and operation of rural networks.

Key lessons learned from Vietnam’s experience are summarized below.

**Lesson 1:** Vietnam’s success can be credited to its unwavering national commitment to rural electrification. A significant feature of Vietnam’s experience has been the bottom-up manner in which the drive for RE manifested. Demand for electricity was very high across Vietnam. However, one can easily argue that high demand for electricity is present almost everywhere in the world. What was distinctive about the Vietnamese experience was the way that this high demand translated into action and, eventually, results. The local and central governments listened to the people and were responsive to their strong desire for electricity access. Local authorities’ responsiveness to the strong societal demand, their choice to accord adequate priority to this issue, and the culmination of this in a national agenda item were key factors for success. Dedication and collaboration were persistent among central government policymakers; provincial, district, and commune authorities; as well as EVN and local communities.
Appendix 1. Electricity Access: Selected Country Briefs

Lesson 2: Transformation in the rural sector needs to be seen in a long-term context. The Vietnamese government maintained a strategic vision for achieving its electrification targets. The core tenet was to achieve RE through extending the national grid. An important factor for success was setting targets for a gradual and flexible program based on a realistic analysis of what can be achieved given the available resources.

Lesson 3: The presence of a long-term vision and a systematic plan is important for grid extension. When based on a realistic assessment of what can be achieved within available means, such a plan can help maintain costs at reasonable levels, improve revenues in the early years to support later system expansion, manage expectations, and keep political pressure to extend the grid to unsuitable areas to a minimum. On the other hand, where grid extension to some remote areas is deemed not feasible or economically viable, alternative means to secure access to electricity should be explored. The framework for alternative options including financial and other incentives should be communicated to stakeholders through policy statements and other means.

Lesson 4: Vietnam’s electrification success story is rooted in a strategy that was anchored in very clear objectives, implemented gradually, and fine-tuned over time to reflect changing priorities. The central government, in collaboration with various levels of local authorities and stakeholders, continually assessed how to advance the program. Building flexibility into the design and implementation of RE programs also proved useful. All actions were taken without losing sight of the overarching goal of electrification. This unified thought, in turn, contributed to the high-level political goal of national solidarity.

Lesson 5: In the early years of its existence as a commercial entity, Electricity of Vietnam (EVN) stayed out of the rural electricity supply business. However, EVN’s emergence as a strong champion for rural electrification in the late 1990s has been an important factor in ensuring the quality and sustainability of rural electricity supply going forward. Despite recognizing the high societal demand and government support for RE, EVN initially was reluctant to engage in rural electricity supply due to concerns over the apparent unprofitability of RE and the limits on its own financing capacity. From 1999 on, the central government made it possible and, even more importantly, profitable, for EVN to participate in RE. Through a series of decisions, such as Decision 22 and Decree 45, the Prime Minister’s office equipped EVN with the mandate and resources it needed to lead RE in a financially sustainable way. The resulting reorganization of the rural electricity supply sector had considerable impact on the pursuit of the access agenda.

As Vietnam’s experience demonstrates, ensuring the sustainability of rural electricity supply businesses is critical. In the case of expansion of access through large-scale grid extensions, a precondition of sustainability is to secure interest, commitment, and dedication from the country’s main utility. These can be obtained by enabling the utility to participate in rural electrification on terms by which it can meet its commercial objectives. The utility should be equipped with a clear mandate and provided with the resources it needs to perform its leadership role in electrifying rural areas through grid extension.

Lesson 6: The presence of cost sharing among different parties has been an important contributor to the success of Vietnam’s rural electrification program. In addition to making financing and building rural systems easier, cost sharing helped create a sense of ownership by the parties involved. Financial support by provincial, commune, and district authorities and the Prime Minister’s office was a critical element in ensuring the rapid increase in rural access to electricity.

Lesson 7: A well-formulated and properly communicated program with achievable goals and investments from multiple sources has proved very
effective. Issuing policy documents that outlined the principles underlying this program was useful in formalizing the government’s commitment and sending a clear message to all stakeholders that government resources would be available to backstop local resources.

**Lesson 8:** The culture of payment is likely to have a significant bearing on the success of rural electrification. It may not be possible to replicate Vietnam’s strong culture of payment in other countries. However, countries easily can adopt local involvement in the management and operations of rural electricity networks, particularly bill collection. The service agent model adopted in the early 2000s is a good illustration of how local involvement can be accomplished. This model helped ensure accountability within local communities and minimize nonpayment. It also reduced system losses and lowered PCs’ system operation and management costs. Overall, the involvement of local people in managing and operating the LV system played an important role in ensuring the success and sustainability of scaling up electricity access.

**Lesson 9:** It is important to note that ensuring the financial viability of grid extension for rural electrification does not mean a private-sector style rate of return. Rather, the focus should be on allowing reasonable returns to investors while seeking to make new connections as affordable as possible. When grid extension covers customers who cannot afford to pay the full cost of connections, there should be mechanisms that compensate the investors.

**Lesson 10:** The separation of responsibilities for MV and LV systems, and the multiplicity of entities being allowed to build, manage, and operate rural networks proved to be very effective in facilitating the rapid expansion of access. However, this rapid build-up of networks was carried out without minimal technical standards for the equipment and materials used. As a result, issues with system performance, including low efficiency, high losses, and low supply quality, led to a series of medium- and long-term costs that eventually had to be recovered.

Thus, it is critical for decisionmakers to be aware of the trade-offs involved in the various options and their long-term consequences. It will be important to carefully weigh the benefits and costs of introducing some kind of minimal technical standards for rural systems and specifications for equipment and materials used.

- If decisionmakers’ focus is to rapidly expand access to electricity, the option of allowing multiple entities and financing arrangements for the construction, management, and operation of rural networks is likely to provide the fastest expansion of access.
- Some decisionmakers would like to focus instead on the longer term sustainability of rural electrification. For these decisionmakers, the suitable choice would be to limit the number of actors that can build, manage, and operate rural networks; and to introduce minimal technical standards that should be adhered to. In this case, decisionmakers should expect to move more slowly, as was Vietnam’s experience after 2004.

As a general principle, it may be useful to distinguish between sharing costs and sharing responsibilities for building costs and sharing responsibilities for building, management, and operation of rural networks. Sharing is a must so it is important to determine the most appropriate ways of combining different funding sources and allocating costs proportionally. On the other hand, it is advisable to allocate responsibilities in a way that will not hamper the coordinated construction, management, and operation of the systems themselves.

**Lesson 11:** After the initial delay, the beginning of EVN’s involvement in the rural energy supply business was a major turning point in ensuring the technical quality of the rural energy networks. In the later years, the introduction of

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68. Without imposing minimal technical requirements, as was the case in Vietnam until the late 1990s.
national technical specifications further buttressed improvements in power supply quality, alongside a significant reduction in technical losses, costs, and tariffs. This reduction, in turn, helped generate significant long-term savings.

**Lesson 12:** Rural electrification is as much about electrifying households as it is about providing electricity for other uses. The initial focus on productive uses may have been helpful to rapidly develop networks. However, to capture the full potential benefits from rural electrification, once basic constraints with respect to availability of supply are overcome, it is crucial not to lose sight of the importance of HH connections.

**The Way Forward**

Going forward, a number of tasks need to be fulfilled as part of Vietnam’s rural electrification program.

1. **Continued investment in existing distribution networks.** In the years ahead, significant investment will be needed to rehabilitate existing LV systems to reduce losses, and to upgrade the MV networks to meet growing demand.

   • **Investment to rehabilitate existing LV systems.** Many of the small LV systems developed during the 1990s in rural communes remain relatively weak. These systems need to be rehabilitated to reduce losses and to increase the quality and quantity of power supply. A significant amount of resources and effort will need to be dedicated to rehabilitate LV networks in approximately 3,000 communes. Based on preliminary EVN estimates, bringing existing LV systems up to current Vietnamese standards could cost US$2 billion–$3 billion.

   • **Investment to upgrade MV networks.** The growth in LV systems and increased demand in rural areas imply greater need to improve the MV distribution network over the medium term. Quality of service is of concern in some rural areas because existing systems are becoming unable to meet existing and projected load requirements. In some instances, the MV systems bottlenecked the power flow from the transmission system to the low voltage systems in the communes.

2. **Ensuring the sustainability of rural electricity networks.** In February 2009, Decision 21 made it possible for a PC to take over the management and assets of any local distribution utility (LDU) that was financially weak. The challenge going forward is to ensure that the transfer of the responsibility for managing and operating existing LV systems that came from financially weak LDUs is paced according to the absorptive capacity of the PCs. To be sure, it may be necessary to find the most effective ways to build the institutional capacity of PCs to equip them to manage and operate rural electricity networks efficiently and sustainably.

3. **Extending access to those still without it.** Approximately 1 million Vietnamese households, mainly poor and in mountainous areas and islands, still lack access to electricity. The objective of expanding electricity access to unserved rural and mountainous areas of the country was included in the December 2007 National Energy Development Strategy. This strategy envisages that all rural HH will have access to electricity by 2020. The challenge will be to identify the most appropriate way of electrifying these remaining HH.

4. **Continuing to ensure that electricity is affordable to the poor.** As the country expands access to a greater number of people, chances are that a greater number of poor people will be connected to the system. The Prime Minister’s Decision 21, issued in February 2009, established a clear framework for providing energy to the poor. The decision stipulates an incremental block tariff with a lifeline block that
pays a lower electricity price for the first 50kWh of consumption. Decision 21 also allows the PCs to recover operating costs through the tariffs charged to all consumers in their territory, in effect, cross-subsidizing the remote and poor consumers with revenues generated from other low-cost consumers. If, in the future, policymakers, for any reason, wish to make subsidies more transparent, they will need to make a determination as to how this can be achieved through a new mechanism.

Vietnam needs to make hard choices concerning the future of its rural electrification program. The country’s policymakers must determine how to allocate the scarce resources among the country’s competing priorities. The lawmakers will have to determine how to allocate resources among investments to rehabilitate LV systems, upgrade MV networks, and expand electricity access to those remaining without it. Simultaneously, policymakers will need to set aside resources to continue to provide for the poor and build institutional capacity for the sustainable management and operation of the rural networks. There is no doubt that improving the existing distribution systems will benefit a larger number of people. On the other hand, completing the last mile of the access agenda to connect the unserved populations is a key priority for the government. The question is how the upgrading can be done sustainably and from what sources the necessary resources will be forthcoming.
### Appendix 2. Energy Access Projects Funded in the EAP Region by IBRD, IDA and GEF, 2001–10 (US$ mil)

<table>
<thead>
<tr>
<th>Country</th>
<th>Project</th>
<th>Effective from</th>
<th>Objective</th>
<th>Project cost</th>
<th>IBRD</th>
<th>IDA</th>
<th>GEF</th>
</tr>
</thead>
</table>
| Cambodia | Rural Electrification and Transmission | 2003 | a. Improve power sector efficiency and reliability and reduce electricity supply costs.  
  b. Improve standards of living and foster economic growth in rural areas by expanding rural electricity supplies.  
  c. Strengthen electricity institutions, regulatory framework, and “enabling environment” for sector commercialization and privatization.  
  Global environment objective: Overcome barriers to renewable energy development in Cambodia, including those related to lack of policy framework, financing, information, and institutional capacity. | 150.0 | — | 40 | 5.75 |
| Lao PDR | Rural Electrification Phase I | 2006 | a. Increase access to electricity of rural households in villages of targeted provinces.  
b. Improve financial performance of power sector. | 36.3 | 10.0 | — | 5.00 |
| Lao PDR | Rural Electrification Phase II | 2010 | | 34.8 | 20.0 | — | — |
| Mongolia | Renewable Energy for Rural Access | 2006 | Increase access to electricity and improve reliability of electricity service among herder population and in off-grid soum centers. REREP addresses 30% of isolated soum centers and 40% of herders’ market.  
Global development objective: Remove barriers to development and use of renewable energy technologies in grid- and off-grid-connected systems and reduce CO₂ emissions. | 27.0 | 3.0 | — | 4.60 |

(continued)
### Appendix 2. Energy Access Projects Funded in the EAP Region by IBRD, IDA and GEF, 2001–10 (US$ mil) (continued)

<table>
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<tr>
<th>Country</th>
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<th>Effective from</th>
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<th>Project cost</th>
<th>IBRD</th>
<th>IDA</th>
<th>GEF</th>
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</table>
| Philippines  | Rural Power            | 2004           | a. Test and demonstrate viable business models that maximize leveraging of public resources with private investment for decentralized electrification.  
b. Support transformation of electric cooperatives (ECs) through institutional and operational improvements.  
c. Avoid CO₂ emissions through wider use of renewable energy.                                                                                                                                                                | 26.7          | 10.0 | —   | 9.0 |
| Philippines  | Electrical Cooperative | 2004           | Achieve significant and sustained energy efficiency improvements in ECs to provide current and prospective viable EC customers with reliable and least-cost power supply over long term.  
To this end:  
a. Develop and test financial and contractual mechanisms to support private sector investment, operations and management, and risk-sharing to support system loss reduction measures in selected ECs.  
b. Support commercial lending to qualified ECs for efficiency improvements                                                                                      | 62.3          | —    | —   | 12.0|
| Timor-Leste  | Energy Services Delivery | 2006         | Stabilize power services in Dili by restoring or improving operational efficiency, reliability, safety, and availability of power supply; promote sustainability of power sector.                                                                                                                                                           | 8.5           | —    | 4.5 | 2.0 |
| Vietnam      | Rural Energy           | 2000           | a. Expand rural access to electricity in 902 communes located in 34 provinces of Vietnam through extending grid.  
b. Define and establish institutional mechanisms and strategy for rural electrification.  
c. Promote application of renewable energy sources in areas inaccessible to national grid and supplement grid power supply.                                                                                       | 216.0         | —    | 150.0 | —   |
### Appendix 2. Energy Access Projects Funded in the EAP Region by IBRD, IDA and GEF, 2001–10 (US$ mil) (continued)

<table>
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<tr>
<th>Country</th>
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<th>Effective from</th>
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<th>IBRD</th>
<th>IDA</th>
<th>GEF</th>
</tr>
</thead>
</table>
| Vietnam | Second Rural Energy      | 2005           | Improve access to good-quality, affordable electricity services efficiently and sustainably to rural communities to support Vietnam’s efforts toward socioeconomic development through:  
|         |                          |                | a. Major upgrade and/or expansion of rural power networks in approximately 1,200 communes.  
|         |                          |                | b. Conversion of current ad-hoc local electricity management systems to LDUs as legal entities.  
|         |                          |                | c. Capacity building assistance for LDUs, provincial authorities, participating regional power companies, and national authorities involved in planning and regulating rural electrification. | 329.5        | —    | 200.0| 5.25 |
| Vietnam | Rural Distribution       | 2008           | Improve reliability and quality of medium voltage service to targeted retail electricity distribution systems.                                                                                              | 207.5        | —    | 150.0| —    |
| Vietnam | Renewable Energy Development | 2009       | Increase supply of electricity to national grid from renewable energy sources on a commercially, environmentally, and socially sustainable basis.                                                             | 318.0        | —    | 202.0| —    |
| **Total** |                          |                |                                                                                                                                             | **1416.6**   | **43** | **746.5** | **43.60** |


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Mummsen, Y., L. Johannes, and G. Kumar. 2010. “Output-Based Aid: Lessons Learned and Best Practices.” GPOBA (Global Partnership on Output-Based Aid), World Bank, Washington, DC.


____. 2008e. World Development Indicators 2008. Washington, DC.
____. 2010d. “Rural Poverty Reduction in Northeast Brazil: Achieving Results through Community-Driven Development.” Washington, DC.
____. 2010e. World Development Indicators. Washington, DC.
____. Forthcoming 2011. “Power to the People: Twenty Years of National Electrification Effort in Lao PDR.” East Asia Sustainable Development Department, Washington, DC.
### Helpful URLs

Selected national electricity utility/institution websites:

<table>
<thead>
<tr>
<th>Institution</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricité du Cambodge (EDC)</td>
<td><a href="http://www.edc.com.kh">www.edc.com.kh</a></td>
</tr>
<tr>
<td>Electricité du Laos (EDL)</td>
<td><a href="http://www.edl-laos.com">www.edl-laos.com</a></td>
</tr>
<tr>
<td>Electricity of Vietnam (EVN)</td>
<td><a href="http://www.evn.com.vn">www.evn.com.vn</a></td>
</tr>
<tr>
<td>Fiji Electricity Authority (FEA)</td>
<td><a href="http://www.fea.com.fj">www.fea.com.fj</a></td>
</tr>
<tr>
<td>National Electricity Authority (NEA) (Philippines)</td>
<td><a href="http://www.nea.gov.ph">www.nea.gov.ph</a></td>
</tr>
<tr>
<td>Perusahaan Listrik Negara (PLN) (Indonesia)</td>
<td><a href="http://www.pln.co.id">www.pln.co.id</a></td>
</tr>
<tr>
<td>PNG Power Ltd</td>
<td><a href="http://www.pngpower.com.pg">www.pngpower.com.pg</a></td>
</tr>
<tr>
<td>Provincial Electricity Authority (PEA) (Thailand)</td>
<td><a href="http://www.pea.co.th">www.pea.co.th</a></td>
</tr>
</tbody>
</table>

### Other relevant URLs

<table>
<thead>
<tr>
<th>Organization</th>
<th>Website</th>
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<tbody>
<tr>
<td>Community Development Carbon Fund</td>
<td><a href="http://www.go.worldbank.org/QNLHGWLP50">www.go.worldbank.org/QNLHGWLP50</a></td>
</tr>
<tr>
<td>Global Alliance for Clean Cookstoves</td>
<td><a href="http://cleancookstoves.org">http://cleancookstoves.org</a></td>
</tr>
<tr>
<td>Groupe Energies Renouvelables, Environnement et Solidarités</td>
<td><a href="http://www.geres.eu">www.geres.eu</a></td>
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<tr>
<td>Global Alliance for Clean Cookstoves</td>
<td><a href="http://cleancookstoves.org/">http://cleancookstoves.org/</a></td>
</tr>
<tr>
<td>Lighting Africa Project</td>
<td><a href="http://www.lightingafrica.org">www.lightingafrica.org</a></td>
</tr>
<tr>
<td>Water and Sanitation Program</td>
<td><a href="http://www.wsp.org">www.wsp.org</a></td>
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