ACHIEVING UNIVERSAL ELECTRICITY ACCESS IN INDONESIA

ASIAN DEVELOPMENT BANK

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Work on this report began in early 2014 and continued through several iterations building on reviewer inputs, findings from work on the Sumba Iconic Island initiative, and, in general, the evolving situation in Indonesia. This report draws on these findings and work related to the Sumba Iconic Island initiative to review electrification mechanisms and efforts at a national level, with the aim of identifying specific measures to help Indonesia achieve universal electricity access.

This study was conducted by Castlerock Consulting under the technical supervision of Pradeep Tharakan, senior energy specialist (Climate Change), and Chong Chi Nai, director, Energy Division, Southeast Asia Department of ADB. The report team gratefully acknowledges the inputs and support provided by Rida Mulyana, director general for New and Renewable Energy and Energy Conservation, Ministry of Energy and Mineral Resources; Dadan Kusdiana, former director of Bioenergy and currently head of the Public Communication Center of the Ministry of Energy and Mineral Resources; staff members from the Directorate General of New and Renewable Energy and Energy Conservation; personnel from the Directorate General of Electricity and the State Electricity Company (PLN), who provided guidance on prevailing electrification and subsidy mechanisms, especially Benhur Tobing, Zaenul Arief, and Wanhar; counterparts in the Mining & Energy Services and the Regional Development Planning Agencies within the four districts (*kabupaten*) of Sumba. The team also wishes to thank Arun Sanghvi who, as an advisor to ADB, reviewed and helped guide the preparation of the report.

Abbreviations

ADB	Asian Development Bank
APBD	Anggaran Pendapatan dan Belanja Daerah (regional government budget)
APBN	Anggaran Pendapatan dan Belanja Negara (national government budget)
APLN	Anggaran PLN (budget of PLN)
BKPM	Badan Koordinasi Penanaman Modal (Investment Coordinating Board)
BUMN	Badan Usaha Milik Negara (state-owned enterprise)
DAK	Dana Alokasi Khusus (special allocation fund)
DGE or DJK	Direktorat Jenderal Kelistrikan (Directorate General of Electricity)
DGNREEC or DJEBTKE	Direktorat Jenderal Energi Baru dan Terbarukan dan Konservasi Energi (Directorate General of New and Renewable Energy and Energy Conservation)
DPR	Dewan Perwakilan Rakyat (House of Representatives)
DPRD	Dewan Perwakilan Rakyat Daerah (Regional Representative Council)
EBT	Energi Baru dan Terbarukan (New and Renewable Energy)
GDP	gross domestic product
GII	Gender Inequality Index
HDI	Human Development Index
IPP	independent power producer
KEN	Kebijakan Energi Nasional (National Energy Policy)
KLPSSM	Koperasi Listrik Pedesaan Sinar Siwo Mego (Sinar Siwo Mego Rural Electric Cooperative)
KPDT or KDPDTT	Kementerian Pembanguan Daerah Tertinggal/Kementerian Desa, Pembangunan Daerah Tertinggal dan Transmigrasi (Ministry for Development of Disadvantaged Regions/Ministry for Villages, Development for Disadvantaged Regions and Transmigration)
KPI	key performance indicators
LisDes	Listrik Pedesaan (rural electrification)
M&E	monitoring and evaluation
MEMR or ESDM	Kementerian Energi dan Sumber Daya Mineral (Ministry of Energy and Mineral Resources)
MOF	Ministry of Finance
MSOE	Ministry of State-Owned Enterprises
NGO	nongovernment organization
NTT	province of Nusa Tenggara Timur

Pemda	Pemerintah Daerah (regional government)
Permen	Peraturan Menteri (ministerial regulation)
Perpres	Peraturan Presiden (presidential regulation)
PLN	Perusahaan Listrik Negara (State Electricity Company)
PMK	Peraturan Menteri Keuangan (Ministry of Finance Regulation)
PNPM	Program Nasional Pemberdayaan Masyrakat (National Program for Community Empowerment)
PSO	public service obligation
RKA-KL	Rencana Kerja dan Anggaran—Kementerian dan Lembaga (Ministry and Agency Work Plan and Budget)
RPJM	Rencana Pembangunan Jangka Menengah (Medium Term Development Plan)
RPJMN	Rencana Pembangunan Jangka Menengah Nasional (National Medium Term Development Plan)
RUED	Rencana Umum Energi Daerah (Regional Energy Plan)
RUEN	Rencana Umum Energi Nasional (National Energy Plan)
RUKD	Rencana Umum Ketenagalistrikan Daerah (Regional Government Electricity Plan)
RUKN	Rencana Umum Ketenagalistrikan Nasional (National Government Electricity Plan)
RUPTL	Rencana Usaha Penyediaan Tenaga Listrik (Business Plan for Electricity Supply)
SEHEN	Super Ekstra Hemat Energi (Super Extra Energy Efficient)
SHS	solar home systems
SII	Sumba Iconic Island
SKPD	Satuan Kerja Perangkat Daerah (regional government work unit)
SLA	service level agreement
UIP	Unit Induk Pembangunan Pembangkit dan Jaringan (Major Generation and Network Projects)
WTP	willingness to pay

WEIGHTS AND MEASURES

GW	gigawatt
GWh	gigawatt-hour
km	kilometer
kWh	kilowatt-hour
MW	megawatt
MVA	megavolt-ampere
Rp	rupiah
VA	volt-ampere

Executive Summary

ES.1 Current Situation

Indonesia has achieved remarkable success in bringing electricity to its people. Despite being an archipelagic nation of some 17,000 islands spanning 5,000 km, Indonesia had attained an 84% electrification ratio[1] by the end of 2014. In the past 10 years alone, the State Electricity Company (PLN), the national electric utility, has managed to connect approximately 20 million households, or some 78 million people. In 2013 alone, PLN connected 3.7 million new consumers.

Given the benefits of electrification, the government aims for near-universal access by 2020. The National Energy Policy (*Kebijakan Energi Nasional,* KEN) adopted in 2014 states that Indonesia should "approach" 100% electrification ratio by 2020. Meanwhile, the 2015–2019 National Medium Term Development Plan (*Rencana Pembangunan Jangka Menengah Nasional*, RPJMN) targets an electrification ratio of 96.6% by the end of 2019.

The government has enacted a range of laws and regulations intended to support the achievement of these targets. In particular, Law 30/2009 on Electricity states that electricity supply is the responsibility of the government and of regional governments (Pemda). They are obliged to provide funding for electricity supply to disadvantaged communities; development of electricity infrastructure in remote, undeveloped, and border regions; as well as for rural electrification.

The revised 2015 State Budget (*Anggaran Pendapatan dan Belanja Negara Perubahan*) allocates some Rp5.5 trillion (about $420 million) for investment in grid and off-grid electrification infrastructure. While this is a substantial amount, it is dwarfed by the Rp66.1 trillion budgeted for the public service obligation (PSO) subsidy of PLN in 2015, which subsidizes operations and consumption rather than capital investment.

Public investment for electrification is currently channeled through three sets of programs:

(i) grid extension executed by PLN,

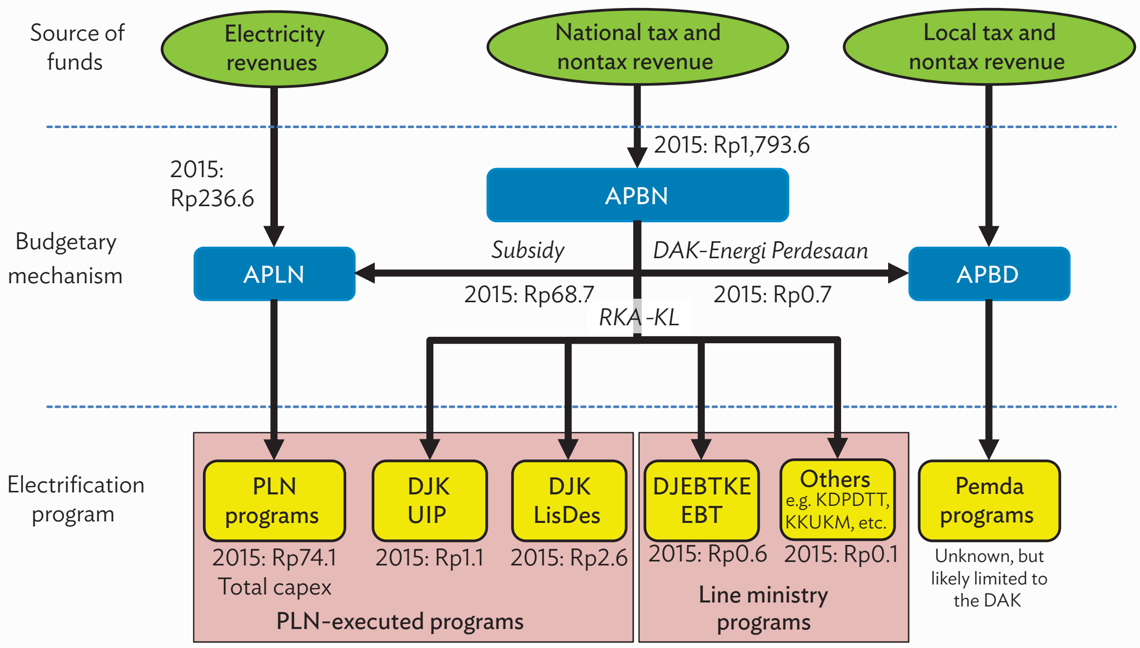
(ii) off-grid programs executed by line ministries, and

(iii) off-grid programs executed by Pemda.

PLN accounts for some 97% of all household connections, whereas the remaining 3% have been delivered principally by line ministries and the Pemda. Of the new PLN connections in 2013, approximately 90% were in-fill connections that did not directly result from public funding for capital investment in electrification. The remaining 10% were connected as part of rural electrification programs with capital funding from PLN budget (APLN) or the national government budget (APBN). Figure ES.1 shows the electrification funding flows budgeted under the original 2015 APBN. The APBN funding for PLN to carry out grid extension is referred to as the "LisDes" (*listrik pedesaan*, or rural electrification) program.

[1] "Electrification ratio" is defined here as the number of households that have been provided with some form of electricity supply divided by the total number of households.

Figure ES.1: Electrification Funding Flows Under the Original 2015 APBN



APBD = Regional Government Budget, APBN = national government budget, APLN = budget of PLN, DAK = Special Allocation Fund, DJEBTKE = Directorate General for New and Renewable Energy and Energy Conservation, DJK = Directorate General for Electricity, EBT = new and renewable energy, KDPDTT = Ministry for Villages, Development of Disadvantaged Regions, and Transmigration, KKUKM = Ministry of Cooperatives and Small and Medium Enterprises, LisDes = Rural Electrification, Pemda = regional government, PLN = State Electricity Company, Rp = rupiah.

Note: All values stated in trillion rupiah, as originally budgeted or forecast. It is understood the APBN has been revised to increase LisDes funding by an additional Rp1.3 trillion.

Sources: APBN 2015, PLN, and ADB estimates.

Data presented in this report show that lack of electricity access is endemic throughout Indonesia. While electrification ratios are lowest in eastern Indonesia, the absolute number of households without electricity is greater by far in western Indonesia. Approximately 46% of the estimated 10.4 million households without electricity are in Java, whereas only 23% are in eastern Indonesia.

This report analyzes the aforementioned data to determine the relationship between provincial electrification ratios and per capita gross domestic product and population densities. The results of this analysis suggest that:

(i) **Electricity access is a matter of policy, not a consequence of wealth or settlement patterns.** In Indonesia, per capita gross domestic product and population density together account for only about one-fifth of the variation in electrification ratios among provinces. Funding is of course important, and settlement patterns will determine, to a large extent, the least-cost means of electrifying regions. Ultimately, however, government policy and commitment will determine whether universal access can be achieved. Electrification is a necessary, though not a sufficient, driver of economic growth rather than a consequence of economic growth.

(ii) **While the challenge of electrification is most acute in eastern Indonesia, efforts to achieve universal access must be nationwide.** The province of West Java, for example, has nearly as many unelectrified households—some 2.4 million—as all of eastern Indonesia combined. Electrification planning must, of course, take into account local conditions, which vary greatly in a country as large and diverse as Indonesia, but policies and programs must be defined at the national level with national scope. The issues facing electrification across these various regions differ in terms of degree and scale rather than substance.

ES.2 The Future Challenge

Formidable and very different challenges from those faced in the past lie ahead as the country aims to achieve universal electricity access. The approaches to electrification that previously served the country so well are increasingly ill-suited to the conditions the sector now faces as it aims to electrify the remaining 16% of its population, representing some 40 million people. In addition to this base of households without electricity, there is natural growth of some 900,000 new households per year.

Experience from countries that have achieved near-universal access (such as the People's Republic of China, Mexico, and Thailand) indicates that the last 10%–15% of the population is the most costly and requires the most time to connect. Starting from a base electrification ratio of 30%–50%, these countries were able to reach electrification ratios of 85%–90% within 20 years. Indonesia has made similar progress.

However, it took these countries another 20 years to advance from 85% to 90% electrification ratio to near-universal access. Indonesia is now reaching that same phase. Electrification efforts must now extend to more remote settlements, which are more costly and technically more difficult to serve. This calls for two general measures:

(i) **Increased use of renewable minigrids and individual household systems for areas where grid extension is prohibitively expensive.** For example, detailed geospatial electrification planning for the island of Sumba in Nusa Tenggara Timur[2] concludes it would be less costly to use renewable off-grid technologies rather than grid extension to serve some 30% of the households remaining to be electrified.

(ii) **Greater public funding for electrification infrastructure on a per household basis.** The Sumba analysis, for example, estimates the capital cost of electrification (excluding the cost of grid-connected generation) to be approximately $1,760 per household. The 2014 LisDes program is characterized by an average capital cost of some $1,000 per household. The cost of PLN supply already exceeds Rp3,800/kilowatt-hour (kWh) in some eastern provinces.[3] Given that the average tariff yield for households in the R-1 450 volt-ampere tariff class (the predominant class in rural areas) is only Rp426/kWh, these consumers require large subsidies.

[2] Asian Development Bank.2014. Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island. ADB TA 8287-INO: Scaling Up Renewable Energy Access in Eastern Indonesia. Manila

[3] For example, in 2013, the audited PLN cost of service for NTT was Rp 3,809/kWh.

ES.3 The Existing Framework is Inadequate

Indonesia's existing electrification framework is inadequate to meet these challenges for the following reasons:

(i) **Current funding levels appear insufficient to achieve near-universal access by 2020.** There has been no rigorous nationwide analysis of how much capital investment is required to achieve universal access, which calls into question whether current funding levels are sufficient to achieve the government's stated targets.

This report estimates a range of required funding based on high- and low-cost scenarios. A high cost of $1,760 per household is based on the Sumba study, and a low cost of $300 per household on average conservatively assumes that going forward 70% of new household connections will be in-fill connections that do not require public funding, whereas 30% will be served through publicly funded grid extension at a cost of $1,000 per household based on the 2014 LisDes budget and the 2015–2024 Electricity Supply Business Plan (*Rencana Usaha Penyediaan Tenaga Listrik*) of PLN.

Multiplying these figures by the number of households with no access to electricity suggests that Rp41 trillion–Rp238 trillion (approximately $3 billion–$18 billion) of capital investment is required. This is some 8–48 times the average annual public investment in electrification at present. Clearly, funding at current levels will not achieve near-universal access by 2020.

(ii) **Current funding mechanisms are cumbersome and inefficient.** Specifically, there are two problems with current funding mechanisms:

(a) *There is no single, national least-cost electrification plan as a basis for the allocation of public funding.* Public funding for electrification is budgeted through several channels. Each agency identifies its own projects based on its own criteria and processes, without reference to a single least-cost plan. This results in inefficient use of limited public resources for electrification.

(b) *The LisDes program is complex and cannot be readily scaled up*. The LisDes program implemented by PLN on behalf of the government is the largest single publicly funded electrification program. Under this program, the Directorate General of Electricity (*Direktorat Jenderal Ketenagalistrikan*) seconds personnel from PLN to run the program. It procures and supervises the construction of electrification infrastructure and, upon commissioning, transfers those assets as in-kind equity to PLN.

However, in recent years, the LisDes program has only added 200,000–250,000 new connections per year. Procurement follows government standards and procedures rather than those of PLN, program management faces political pressures, the program is audited by three separate auditors, and the complexity of asset transfers from government to PLN means that a portion of these assets have not been recognized on the books of the government and PLN, that is, they are government assistance for which the status has not been determined (Government Assistance with Indeterminate Status, *Bantuan Pemerintah Yang Belum Ditetapkan Statusnya*, BPYBDS). Government Assistance with Indeterminate Status associated with PLN has reached more than Rp51 trillion.

(iii) **There is no scalable framework for sustainable off-grid supply.** While there have been some private sector efforts for off-grid supply, they have been ad hoc and hindered by requirements for project-by-project regulatory approvals and a lack of subsidy mechanisms. As a result, off-grid supply has been left to line ministries, Pemda, and PLN.

(a) Line ministries and Pemda have carried out numerous off-grid projects, but these only fund initial installation of the system. In practice, these projects lack mechanisms to ensure financial and technical sustainability. Consequently, there is a very high failure rate for these projects given the lack of funding and technical support for operation and maintenance.

(b) Through the PSO subsidy, its geographical coverage, and its pool of technical personnel, PLN would be better placed to assure the technical and financial sustainability of off-grid systems. However, PLN is not organizationally structured for off-grid supply; it has limited experience with the renewable technologies that would likely be used for off-grid supply; and its resources are already stretched thin, particularly if conventional grid extension is expanded.

ES.4 Principles from Successful Electrification Programs

While countries that have achieved near-universal access offer important lessons, there is no single model for success. Examples of electrification programs from each of those nations are of limited use for revising Indonesia's electrification framework because each of those programs was designed and implemented according to the unique historical, institutional, financial, social, geographical, legislative, and administrative conditions of the respective country.

For example, the majority of high-access countries in Asia have relied on publicly owned and vertically integrated national utilities as the main agents of grid-based electrification. In contrast, several Latin American countries have used private utilities as the primary agents for access scale up (e.g., Peru, Brazil, and Argentina). Elsewhere, publicly owned and operated distribution cooperatives have been the primary agents of scaling-up access, such as in Bangladesh, Costa Rica, and the Philippines.

While each of these countries has deployed a "homegrown" model suited to its specific context, a review of these programs reveals adherence to a few common underlying principles and drivers for performance.[4] Indonesia's performance with respect to each of these necessary conditions is summarized below.

(i) **Visible and committed government leadership.** Unwavering commitment to achieving universal electrification from the highest levels of government and staying the course over the entire duration of program implementation are essential.

Though the government may wish to refine certain aspects of its electrification vision and policies as discussed further below, it has largely demonstrated visible and committed leadership through its development planning, policy targets, and funding of electrification programs over the past decade.

(ii) **An enabling institutional environment.** A comprehensive and conducive institutional and regulatory framework, with accountability for results, is required to ensure efficient and effective investment, management, and operation of the sector.

The institutional framework in Indonesia for electrification is mature and has enabled the country to reach an 84% electrification ratio. However, given the changing nature of the challenge to provide electricity to the remaining 16% of the population, this framework will need to be updated as described in this report.

[4] World Bank. 2011. *One Goal, Two Paths—Achieving Universal Access to Modern Energy in East Asia and the Pacific*. Washington, DC.

(iii) **Sufficient and sustained financing.** Government commitment must be demonstrated by the full funding of the program over its entire life, which could run for decades.

Clearly, Indonesia devotes significant funding to electrification. However, it is unknown whether the current funding levels, despite their magnitude, are sufficient to achieve the government's electrification targets. Measures that would help the government optimize its electrification funding will be discussed in this report.

(iv) **Broad stakeholder engagement and coordination under the principle of "Many Partners, One Team, One Plan."** No country has achieved universal access pursuing a project-by-project approach with the relevant agencies acting in isolation. Rather, the program must:

(a) *Engage many partners…* The program must be inclusive of stakeholders from both within and outside of the electricity sector—both from the private and public sectors;

(b) *…on one team…* An institutional framework is required to engage and coordinate these multiple stakeholders in an effective and timely manner; and

(c) *…working to a single plan*. The activities of these multiple stakeholders must be coordinated through a single plan prepared on least-cost principles, using appropriate tools to plan comprehensive and timely coverage of target regions.

This is a key area for government to focus so as to achieve universal access. Improvements in this area will have implications for the institutional environment and public funding of electrification. Specifically,

(a) **Electrification partners.** The government has thus far relied principally on PLN for electrification, with smaller roles extended to line ministries and Pemda. PLN has proven its ability to implement conventional grid extension on a massive scale. The government should streamline public funding to PLN to facilitate expansion of its grid extension activities.

Line ministries and Pemda have been responsible for off-grid supply, but many of these projects fail because they are not technically and financially sustainable. These activities as currently designed should be eliminated.

The government has provided for off-grid supply by the private sector and nongovernment organizations (NGOs) only on a project-by-project basis that requires, among other things, approval of the tariffs for each project by the provincial legislature (the Regional Representative Council, *Dewan Perwakilan Rakyat Daerah,* DPRD). The lack of a structured and systematic framework to promote and subsidize sustainable off-grid supply by the non-PLN suppliers is a barrier to achieving universal access, particularly since off-grid solutions will play an increasingly important role.

(b) **Framework for coordination and accountability.** There is no programmatic-level monitoring and evaluation (M&E) of electrification efforts, and no institutional mechanism for managing the performance of the organizations that implement electrification programs or for updating overall electrification program design. Moreover, in the absence of an overarching national electrification plan that designates grid and off-grid areas, there is no basis upon which to coordinate these activities.

(c) **Planning.** Although PLN carries out its own rural electrification planning activities through its Road Map LisDes, there is no national least-cost plan that determines the optimal use of grid extension and off-grid supply or the overall investment required to achieve universal access. The development of such a plan is necessary to ensure the efficiency and effectiveness of electrification efforts, to assign roles and responsibilities for implementation, and to determine the funding required and the corresponding targets to be achieved.

ES.5 Elements of a New Electrification Paradigm for Indonesia

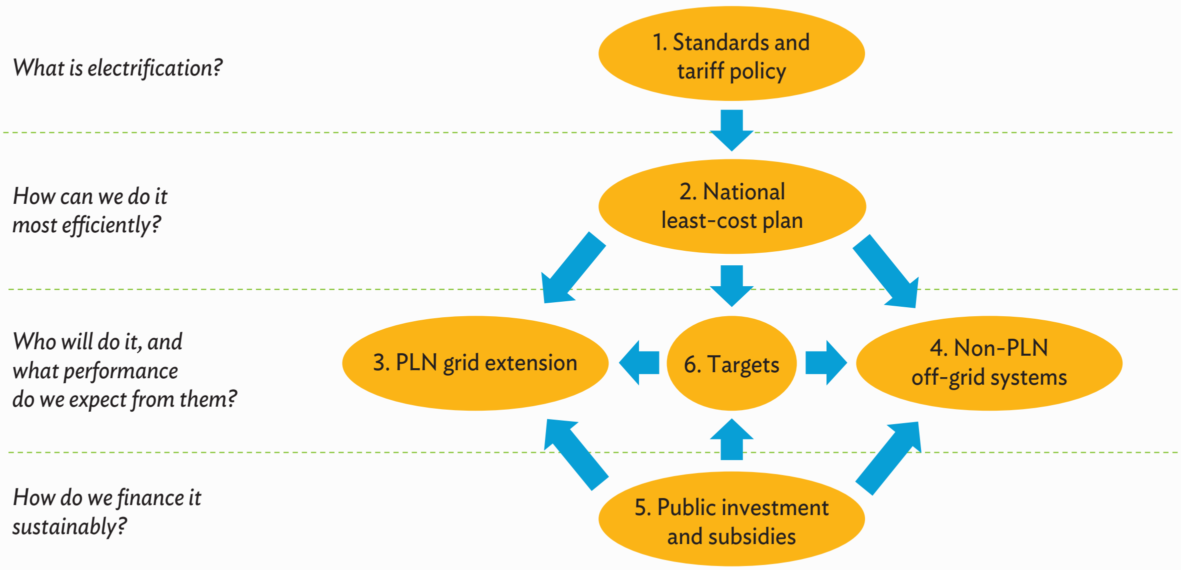
The above review of Indonesia's prevailing electrification framework against these core principles suggests significant changes to the way electrification is carried out. Figure ES.2 depicts the key elements of a new national electrification paradigm and the question that each element must address.

Referring to the numbering in Figure ES.2, the government may wish to consider the following arrangements.

(i) **Standards and tariff policy.** The government should define service and technical standards as well as a pricing policy for off-grid power. Service standards will define the level of service that customers should receive, for example, whether electrification is 24/7 alternating current power supply or direct current power supply for a few hours of lighting every night. The government has established standards for grid supply but has not yet set any standards for off-grid supply. The Sustainable Energy for All program has defined service "tiers" that can guide the discussion of service standards.

In addition to service standards, standards are required to define technical aspects of off-grid infrastructure. For example, the same technical standards that apply for grid-connected wiring could be applied for off-grid systems, so that the off-grid system could be readily integrated with the grid in the future. This, however, would likely be more costly, so the trade-offs between future flexibility versus near-term cost impacts must be carefully considered.

Figure ES.2: Elements of a New Electrification Paradigm



PLN = State Electricity Company.

Source: Author.

Pricing is a particularly important issue with respect to social fairness. The households that will benefit from off-grid supply are among the poorest in the country but are the most costly to serve. The government should address as a matter of policy whether these households should pay less, the same, or more than low-income households that receive grid supply.

Service and technical standards will provide a basis for technical planning of electrification efforts, which together with off-grid pricing policy will determine electrification funding needs.

(ii) **National electrification least-cost plan.** PLN, on behalf of the government, should prepare a national electrification least-cost plan based on these standards to determine the costs of achieving universal access while delineating areas best served by grid extension or off-grid supply. Although this effort can start as an extension of the Road Map LisDes, ideally PLN will adopt geospatial planning tools that provide more accurate and consistent results across regions in a timely manner.

(iii) **PLN grid extension.** PLN should continue to be responsible for grid extension. However, it is likely that grid extension (as opposed to in-fill) activities will need to be scaled up in the coming years. This will require public funding of electrification activities of PLN to be streamlined. There are two options for doing so: direct equity injections to PLN or a results-based subsidy scheme.

The results-based payment scheme would function similar to the administration of the existing PSO subsidy in that PLN would receive payments ex post, that is, after it already incurs the expense. However, unlike the PSO, these payments would not be reimbursements of actual costs incurred by PLN. Rather, fixed payments per unit of delivery would be determined in advance, for example, per kilometer of medium-voltage line, per new household connected, and would only be payable for infrastructure delivered in grid extension areas designated by the government. These unit payments could be fixed at a level that incentivizes efficiency within PLN, that is, PLN would keep any savings that result from incurring costs lower than the results-based payments. Moreover, these results-based unit payments could be set according to the areas to be electrified and adjusted year to year.

Either option requires further investigation, but the results-based payment scheme is preferred due to its transparency and because annual equity injections are difficult to secure on the long-term programmatic basis required here. Equity injections may, however, provide an expedient near-term solution until a results-based scheme can be developed.

(iv) **Non-PLN off-grid systems.** The government should mobilize the non-PLN suppliers (private or regional state-owned companies, NGOs, cooperatives, etc.) to serve off-grid business areas by having them compete for concession areas on the basis of the lowest operational subsidy, and should establish new output-based subsidy mechanisms (e.g., payment per kilowatt-hour delivered) to ensure the financial viability of these suppliers in accordance with the government's off-grid pricing policy. The Directorate General of Electricity would be responsible for identifying off-grid concession areas based on the national least-cost plan and with the concurrence of the Pemda.

There are two models that could be adopted: (i) a build–operate model, in which the construction of the assets is subsidized by the Special Allocation Fund (*dana alokasi khusus*, DAK). The Pemda retains ownership of the assets, and the non-PLN supplier is contracted by the Pemda to build and operate the assets over the life of the concession; or (ii) a build–own–operate–transfer model in which the non-PLN supplier is responsible for financing the assets, and owns those assets over the life of the concession under contract to the Pemda. In either case, the non-PLN supplier directly collects and receives customer payments in addition to the operational results-based subsidy payments paid by the government or the Pemda.

Alternatively, subsidies could be delivered as capital subsidies (or a combination of capital and operational subsidies). Capital subsidies have the advantage in that they could be more readily accommodated through DAK, but they are input-based and lack the transparency and incentives that characterize an output-based operational subsidy.

Moreover, to the extent these non-PLN suppliers would see themselves as conducting an activity that is broader than just selling electricity (e.g., an NGO that aims to improve rural livelihoods, or a private developer that offers credit or sells appliances as well as electricity), the more likely these suppliers will promote productive uses of energy, which are key to maximizing the benefits of electrification for rural communities. Large national electric utilities and government agencies typically do not hold this broader perspective.

Finally, renewable energy will often be the least-cost source of supply for off-grid systems. Non-PLN suppliers have proven themselves more adept at developing and managing small renewable energy systems when proper specifications and incentives are provided.

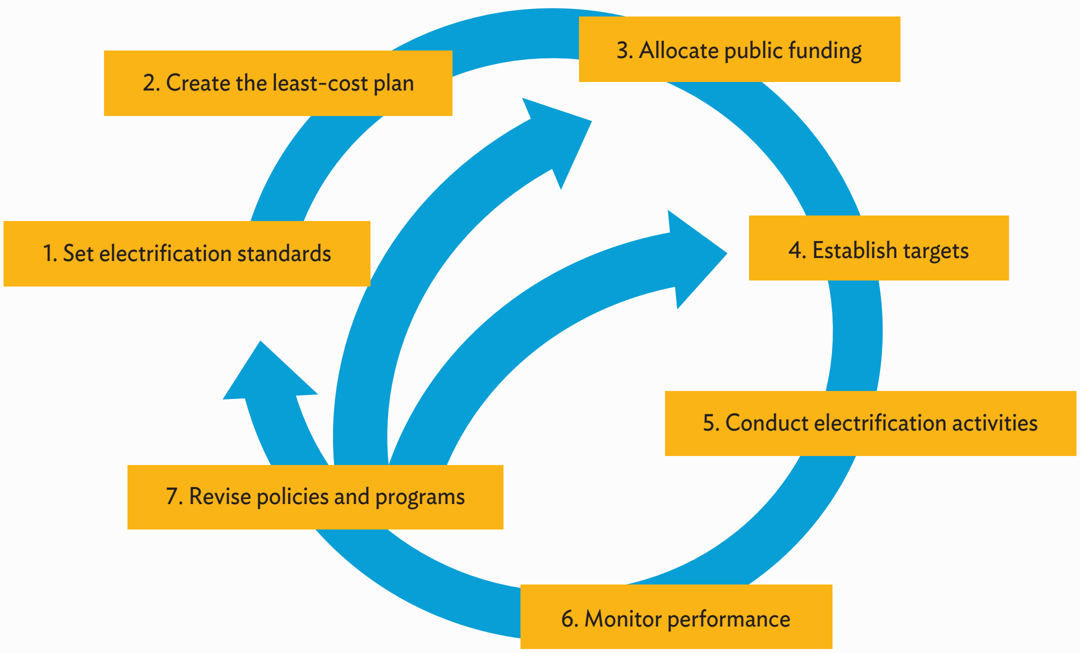
(v) **Public investment and subsidies.** The national least-cost plan will estimate the total investment required to achieve universal access. Annual operational subsidy requirements can also be estimated based on the government's pricing policy. However, public funding toward these requirements will be allocated annually through the state budget. Electrification funding will compete with other government financial needs. This annual allocation will determine the pace at which universal access can be achieved and hence is a key input to setting targets.

Options for delivering public funding or subsidies to PLN and the non-PLN suppliers have already been described. Further work is needed to determine the best institutional mechanism for securing and delivering these subsidies, particularly since investment by the non-PLN suppliers will be forthcoming only upon a reasonable assurance that the government or the Pemda can service its operational subsidy obligations over the life of the concession. PLN already operates under such an assurance by virtue of prevailing laws and regulations. Similar mechanisms must be established for the non-PLN suppliers, and this may entail establishment of a public service agency (*badan layanan umum*, BLU) or direct funding mechanism from the government or the Pemda budget.

(vi) **Targets.** The government should establish electrification targets based on the results of the national least-cost plan and the annual availability of public funding to PLN and the non-PLN suppliers. Performance of these suppliers should be monitored and evaluated against these targets. These results may be used to supervise and compensate PLN and the non-PLN suppliers, and to adjust electrification policies and funding levels.

Setting electrification standards, creating a plan, budgeting for public investment, and establishing targets are therefore an iterative process as shown in Figure ES.3. On the basis of the M&E of electrification activities conducted on both PLN and the non-PLN suppliers, the government may make changes in electrification standards, modify the level of public funding, or amend electrification targets.

Figure ES.3: Electrification Planning and Implementation as an Iterative Process



Source: Author.

ES.6 Next Steps

Such measures would constitute a new electrification paradigm for Indonesia that is comprehensive, effective, efficient, and sustainable. The design and implementation of this new paradigm requires collaboration of national and local governments, PLN, the private sector, beneficiary communities, and development partners.

The next step, therefore, is to establish an interministerial working group to prepare a National Electricity Access Policy that defines this paradigm for consideration of the Minister of Energy and Mineral Resources or the President. The National Electricity Access Policy should define:

(i) service levels and technical standards by type of supply (e.g., grid vs. off-grid standards);

(ii) pricing by type of supply (e.g., should the uniform national tariff for grid supply also be applied for off-grid supply?);

(iii) the role of renewable energy for off-grid supply (e.g., for any off-grid operation to be eligible for government subsidy, is a minimum level of renewable energy utilization required?);

(iv) the role of PLN in helping the government prepare a national least-cost electrification plan;

(v) the role of non-PLN suppliers for off-grid electrification; and

(vi) the (re)design of public funding and subsidy mechanisms for grid and off-grid supply.

The National Electricity Access Policy would not be a stand-alone document but would supplement the National Energy Policy (*Kebijakan Energi Nasional*, KEN) and the National Public Electricity Plan (*Rencana Umum Ketenagalistrikan Nasional*, RUKN), providing more specific guidance for electrification activities going forward.

This policy touches on many issues, including development planning, public finance, electricity regulation, regional autonomy, and development of technical infrastructure. Consequently, a wide range of agencies would be expected to participate in the working group. This working group could be convened by the Coordinating Ministry of Economic Affairs, and should include representation from the following groups:

(i) Ministry of Finance, especially the Fiscal Policy Office, the Directorate General of Budget, and the Directorate General of Financing and Risk Management (responsible for subsidy policy and public finance);
(ii) National Development Planning Agency (Bappenas) (responsible for national development planning);
(iii) Ministry of Energy and Mineral Resources (technical ministry responsible for electrification);
(iv) Ministry of Home Affairs (responsible for regional autonomy);
(v) Ministry of Forestry and Environment (responsible for land access in many unelectrified regions);
(vi) Ministry of Villages, Disadvantaged Regions and Transmigration (responsible for some off-grid projects);
(vii) Ministry of Cooperatives and Small and Medium Enterprises (responsible for some off-grid projects);
(viii) PLN (the national electricity company, which would be responsible for grid extension); and
(ix) industry groups such as the Indonesian Electricity Society (Masyrakat Ketenagalistrikan Indonesia, MKI) and the Indonesian Renewable Energy Society (Masyrakat Energi Terbarukan Indonesia, METI) (representing non-PLN suppliers).

Once the policy has been prepared, the following activities could be conducted accordingly:

(i) any regulatory or legal instruments could be prepared, as required, to implement the policy framework;
(ii) a national electrification least-cost plan can be prepared;
(iii) off-grid business areas can be designated;
(iv) public funding committed;
(v) electrification targets established;
(vi) off-grid tenders conducted;
(vii) implementation monitored and evaluated; and
(viii) the National Electricity Access Policy eventually updated based on M&E findings.

Key milestones could be scheduled as follows:

(i) identification of electrification issues and options within the National Public Electricity Plan (RUKN) to be presented to the House of Representatives (DPR) in mid-2015,
(ii) establishment of the Electrification Working Group by mid-2015,
(iii) submission of the National Electricity Access Policy by the fourth quarter of 2015,

(iv) preparation and release of any required implementing regulations by the second quarter of 2016,

(v) completion of the first National Least-Cost Electrification Plan by mid-2016,

(vi) budgeting of subsidies and/or public funding for PLN and non-PLN electrification activities during 2016 for the 2017 state budget, and

(vii) implementation of the new electrification framework starting in 2017.

The working group could also consider how best to access external resources available to support electrification activities. Development partners are prepared to support Indonesia's efforts to achieve universal access by providing technical assistance drawing on international experience as well as potentially financing electrification activities. Such financing could be direct, such as results-based lending to PLN for grid extension, or indirect, such as providing funds to domestic development finance institutions to finance off-grid systems undertaken by the non-PLN suppliers.

Regarding technical assistance, the Sustainable Energy for All program[5] brings together an unparalleled global network of leaders from all sectors of society—governments, business, and civil society—into a partnership to help achieve universal access to modern energy. The program mobilizes stakeholders around best practices and supports the adoption of innovative solutions. The initiative is helping to create the conditions that will enable a massive scale up of private investment in energy access and clean energy, and it tracks progress toward its objectives in a transparent, accountable manner. The program can be accessed through the Asian Development Bank, which serves as the hub for the Asia and Pacific region.

[5] The Sustainable Energy for All initiative is a multistakeholder partnership between governments, private sector, and civil society. Launched by the UN Secretary-General in 2011, it has three interlinked objectives to be achieved by 2030: (i) ensure universal access to modern energy services; (ii) double the global rate of improvement in energy efficiency; and (iii) double the share of renewable energy in the global energy mix.

1 Introduction

1.1 Indonesia's Electrification Challenge

This report describes the remarkable progress that Indonesia has achieved in bringing electricity to its people. Despite being an archipelagic nation of some 17,000 islands spanning 5,000 km, Indonesia had attained an 84% electrification ratio[1] by the end of 2014. In the past 10 years alone, the State Electricity Company (PLN), the national electric utility, has managed to connect approximately 20 million households, or some 78 million people.

This report also describes the formidable and the very different challenges that lie ahead as the country aims to achieve universal electricity access. The approaches to electrification that have served the country so well in the past are increasingly ill-suited to the conditions the sector faces now as it aims to provide electricity to the remaining 16% of its population, representing some 40 million people.

Drawing on principles that have helped other countries achieve universal or near-universal access, and taking into account the strengths and weaknesses of Indonesia's current electrification framework and the country's unique circumstances, this report suggests a more effective paradigm for national electrification to achieve universal access.

1.2 The Importance of Electrification

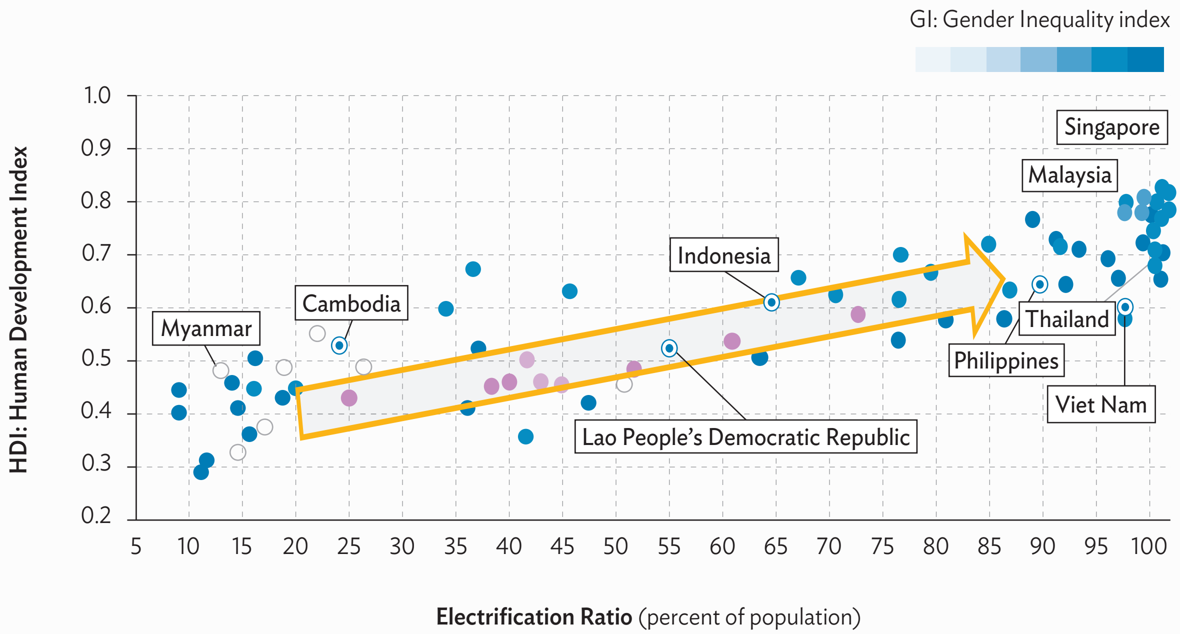
An electrification ratio of 84% is an impressive achievement for any country, especially for a country as large and diverse as Indonesia. But it is not enough if the country is to realize the prerogatives of its Constitution, which obliges the state to provide public services such as electricity wherever feasible, and to fulfill the government's vision for a more equitable and prosperous society throughout the country.

The government recognizes that access to electricity is essential for national development, and hence has set a target of universal access. Experience worldwide has demonstrated that electricity access is closely correlated with human development and well-being. Figure 1.1 shows the relationship between the Human Development Index (HDI)[2] and electrification ratio for countries around the world. Countries with higher electrification ratios are able to achieve higher HDI levels since higher availability of electricity facilitates expanded economic activities, better health services, and greater educational opportunities and attainment.

1 "Electrification ratio" is defined here as the number of households that have been provided with some form of electricity supply divided by the total number of households.

2 HDI is a measure calculated by the United Nations Development Programme that is derived from four indicators (life expectancy at birth, mean years of schooling, expected years of schooling, and gross national income per capita) representing the three dimensions of human development: health, education, and living standards.

Figure 1.1: Relationship between Human Development Index and Gender Inequality Index with Electrification Rate, 2009



Source: United Nations Development Programme. *Human Development Report 2013.* Geneva.

Figure 1.1 also indicates that greater gender equality (as measured by the Gender Inequality Index, GII[3]) is associated with higher electrification ratios. (In Figure 1.1, lighter blue dots indicate lower gender inequality.) As electrification ratios increase, households have better access to information and media that can help shape awareness, perceptions, and values. In addition, household electrification enables additional economic opportunities for women, expanded educational opportunities for girls, and improved security at home and in the community due to better lighting. Electrification also enables time savings on time-consuming tasks such as collecting water when applied to technologies such as water pumping.

However, improvements in welfare and gender equality do not result automatically from simply providing households with electricity. While electrification is a necessary enabler, electrification alone is insufficient to achieve better living standards and greater opportunities for all. Electrification must be part of a broader, culturally specific, and inclusive development strategy that is integrated with health, education, government administration, and entrepreneurship initiatives to yield the full desired benefits. Identifying and capitalizing on opportunities for productive uses of electricity is particularly important. Increased electrification, when combined with complementary programs to alleviate poverty, creates economic opportunity and improves gender equality, thereby providing the basis for greater prosperity and more equitable development.

[3] The GII is a composite measure reflecting inequality in achievements between women and men in three dimensions: reproductive health, empowerment, and the labor market. For details on both the GII and HDI, see UNDP. *United Nations Human Development Report 2012.* http://hdr.undp.org/en/media/HDR_2012_EN_TechNotes.pdf).

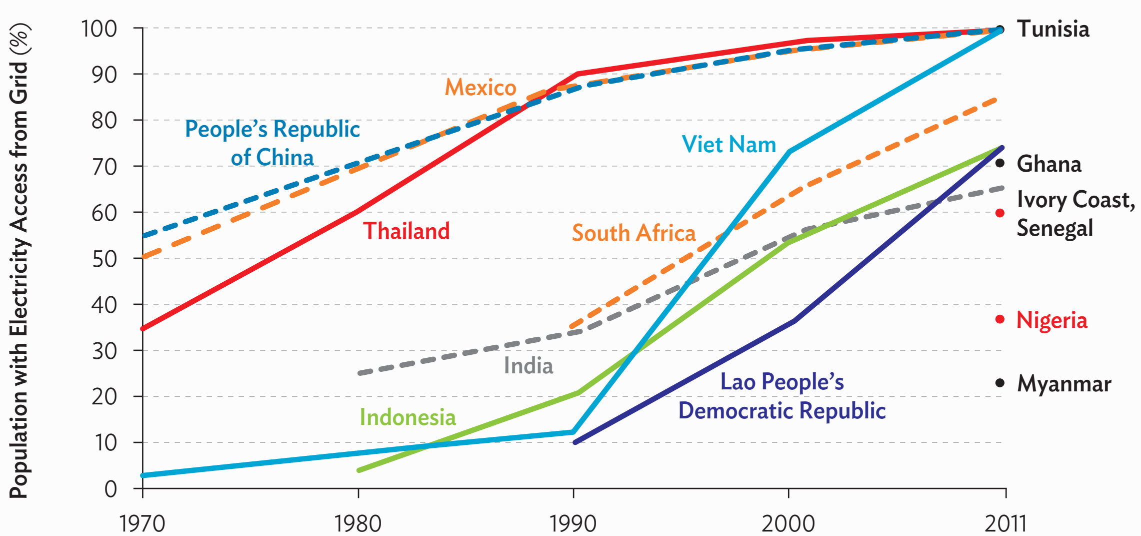
1.3 Principles for Successful Electrification Programs

Several countries have designed and systematically implemented national electrification programs to achieve universal access. These programs have typically involved sustained effort over decades. Figure 1.2 shows the speed of access scale up via new grid connections in several countries. The People's Republic of China, Mexico, Thailand, and Viet Nam are notable examples for having achieved access of 97% or more.

Indonesia has made good progress relative to other countries. Certainly, the scale of Indonesia's electrification efforts is among the largest in the world; in recent years, PLN has been adding more than 3.5 million new grid connections per year across a service territory consisting of more than 17,000 islands and spanning more than 5,000 km from end to end. However, as experience in these countries that have reached near-universal access shows, providing electricity for the last 10% of the population is typically the most difficult, and it requires more time than in the case of the previous 30%–60%. Indonesia is rapidly approaching this stage.

While countries that have achieved near-universal access offer important lessons, there is no single model for success. Each of those nations designed and implemented a national electrification rollout program suited to its own unique conditions and circumstances at the time. For example, the majority of high-access countries in Asia have relied on publicly owned and vertically integrated national utilities as the main agents of grid-based electrification. In contrast, several Latin American nations have used private utilities as the primary agents for access scale up (e.g., Argentina,[4] Brazil, and Peru). Elsewhere, publicly owned and operated distribution cooperatives have been the primary agents of access scale up, such as in Bangladesh, Costa Rica, and the Philippines.

Figure 1.2: International Experience with Access Scale Up



Sources: ADB estimates; International Bank for Reconstruction and Development/World Bank Group. Energy Sector Management Assistance Program. Washington, DC; World Bank. 2011. *One Goal, Two Paths—Achieving Universal Access to Modern Energy in East Asia and the Pacific.* Washington, DC.

[4] These nations have a long-standing tradition and experience with private distribution utilities operating in concession areas, with effective regulatory frameworks in place for the requisite oversight of the access scale up implementation program.

While each of these countries has deployed a "homegrown" model suited to its specific context, a review of these programs reveals adherence to a few common underlying principles and drivers for performance. These necessary conditions include:

(i) **Visible and committed government leadership.** Unwavering commitment to achieving universal electrification from the highest levels of government and staying the course over the entire duration of program implementation are essential.

(ii) **An enabling institutional environment.** A comprehensive and conducive institutional and regulatory framework, with accountability for results, is required to ensure efficient and effective investment, management, and operation of the sector.

(iii) **Sufficient and sustained financing.** Government commitment must be demonstrated by the full funding of the program over its entire life, which will likely run for decades.

(iv) **Broad stakeholder engagement and coordination under the principle of "Many Partners, One Team, One Plan."** No country has achieved universal access pursing a project-by-project approach with the relevant agencies acting in isolation. Rather, the program must:

  (a) *Engage many partners ...* The program must be inclusive of stakeholders from both within and outside of the electricity sector—both from the private and public sectors;

  (b) *...on one team ...* An institutional framework is required to engage and coordinate these multiple stakeholders in an effective and timely manner;

  (c) *...working to a single plan*. The activities of these multiple stakeholders must be coordinated through a single plan prepared on least-cost principles, using appropriate tools to plan comprehensive and timely coverage of target regions.

This report later considers the application of these lessons to the specific challenges that Indonesia faces in providing timely access to the 10.4 million households that remain without electricity.

1.4 Scope of this Report

This report focuses on *electricity access for all*. In that spirit, it does not distinguish between rural and urban electrification, nor does it differentiate between electrification in eastern and western Indonesia. The issues facing electrification of these various regions or among these groups differ in terms of degree and scale rather than substance. The fundamental nature of the challenges remains the same, and solutions will be applied nationally. Nonetheless, the report highlights electrification examples from eastern Indonesia, as these encapsulate the challenges facing electrification efforts in Indonesia going forward regardless of location. In particular, the report draws on the experience with the Sumba Iconic Island initiative, which is described in Box 1.1.

The focus of this report on electrification does not imply that access to other sources of energy, especially for cooking and productive use, is not important, both in terms of health and development impacts. It is only that the complexities and challenges of electrification warrant dedicated treatment.

In this report, "electricity access" refers to the actual provision of electricity to households, not merely bringing supply to within some distance of households or to some administrative unit. After all, the benefits of electrification only accrue when households and communities actually use electricity.

Box 1.1: The Sumba Iconic Island Initiative

The Government of Indonesia launched the Sumba Iconic Island (SII) initiative in 2010 jointly with the support of Hivos, a nongovernment organization (NGO) based in the Netherlands. The initiative aims to achieve the following by 2025:

(i) increase the electrification ratio on the island of Sumba from a current level of approximately 30% of households to 95%, and
(ii) increase the share of electricity produced from renewable resources on Sumba from approximately 15% to 100%.

In addition to providing the people of Sumba with sustainable, universal access, the SII initiative is intended to provide a model for renewable energy-based access that can be replicated elsewhere in Indonesia.

The initiative is a multistakeholder undertaking led by the Directorate General of New and Renewable Energy and Energy Conservation within the Ministry of Energy and Mineral Resources, in partnership with Hivos; the provincial government of Nusa Tenggara Timur; the four districts of Sumba; the State Electricity Company (PLN), the Indonesian national utility; other government ministries and NGOs; the private sector; and development partners, including the Asian Development Bank and the Government of Norway. Other development partners such as Agence Française de Développement, Danida, and Millennium Challenge Account Indonesia are also exploring participation in the initiative.

The program and involvement of stakeholders is formalized through a decree issued annually by the Directorate General of New and Renewable Energy and Energy Conservation. This decree designates the composition and roles of the members of the SII task force. The most recent decree for the SII initiative is the Decree of the Minister of Energy and Mineral Resources No. 556 K/73/DJE/2015 dated 27 August 2015.

Stakeholders participate through three working groups: (i) Policy, (ii) Supply and Utilization of Energy, and (iii) Funding and Coordination. The stakeholders meet twice every year to plan and coordinate activities, and review progress during the previous period. Activities conducted under the initiative include capacity building, technical assistance, investment planning, project implementation, and monitoring and evaluation.

A number of renewable energy projects have been implemented through the program, and other work conducted under this Asian Development Bank technical assistance project has provided a comprehensive least-cost electricity plan that will serve as the basis for future investment planning and the conduct of an investor forum in late 2015. Appendix 1 provides an overview of the least-cost electrification plan prepared for Sumba.

Source: ADB. 2014. *Technical Assistance to Indonesia for Scaling Up Renewable Energy Access in Eastern Indonesia.* Manila (TA 8287).

This report does not suggest a target level of service for electricity access, nor does it seek to economically justify the investment required for universal access. It takes the Government of Indonesia's target of universal access as a worthy goal, but also recognizes that the timing or level of this target may change over time as the government must allocate limited resources to competing needs. Therefore, references to "electricity access" in this report encompass limited service restricted to evening lighting from a couple of direct current lamps all the way through to unlimited 24-hour alternating current supply. This corresponds to Tier 1 service and above, as defined by the Sustainable Energy for All program.[5]

[5] The Sustainable Energy for All program has established a Global Tracking Framework (http://issuu.com/world.bank.publications/docs/globaltrackingframework) that identifies five "tiers" of electricity access, which can provide a basis for defining target service standards.

This report follows earlier reviews of electrification policy and programs in Indonesia. In particular, in 2005, the World Bank released the report *Electricity for All: Options for Increasing Access in Indonesia.*[6] That report presented institutional options for scaling up electricity access in Indonesia. Variations of some of the institutional models presented there, such as utilization of decentralized, non-PLN suppliers, are also considered in this report. However, that report was prepared prior to several key developments, including the following:

(i) the enactment of Law 30/2009 on Electricity and associated implementing regulations, which provide a legal basis for national and local government funding of electrification infrastructure and the designation of the non-PLN electricity business areas;

(ii) implementation of Ministry of Finance Regulation 170/2013 which provides a robust subsidy mechanism for PLN, so that PLN is no longer financially disadvantaged from supplying remote, high-cost areas;

(iii) the evolution of central government funding mechanisms such as the Special Allocation Fund (DAK) to specifically fund rural electricity and energy projects by regional governments; and

(iv) the sharp decline in costs of renewable energy, particularly photovoltaics, and the development of low-cost prepayment or mobile payment systems for household electricity purchases.

This report takes into account these developments to propose specific mechanisms, processes, and institutional arrangements to ensure the financial and technical sustainability of electrification efforts leading to near-universal access on a least-cost basis under current conditions. It begins with a review of Indonesia's current situation with respect to electrification, including past performance, prevailing targets and institutional setting, electrification planning and implementation processes that are currently employed, and mechanisms in use for financing and subsidizing electrification.

The report will then describe why the existing framework can no longer be expected to achieve universal access. These challenges arise from the fact that mechanisms that succeeded in achieving 84% electrification are not well-suited to the conditions that will be faced in electrifying the remaining 16% of the households.

The Indonesian situation will be reviewed in the context of principles for scale up success that have been gained from experience elsewhere in the world. The purpose is to determine how these principles can be applied in Indonesia, and to try not to import specific models that have been used in other countries. Each country that has achieved universal or near-universal access has taken an approach that builds upon the unique institutional and cultural setting of that country, so that specific measures or models from one country are seldom directly transferable to another.

Finally, steps will be proposed that the Government of Indonesia can take to overcome the challenges it now faces and achieve universal access. These proposed mechanisms draw on the principles gained from international experience but also take into account the specific conditions in Indonesia.

[6] World Bank. 2005. *Electricity for All: Options for Increasing Access in Indonesia.* http://siteresources.worldbank.org/INTEAPASTAE/Resources/Electricity_for_All-Increasing_Access_in_Indonesia.pdf

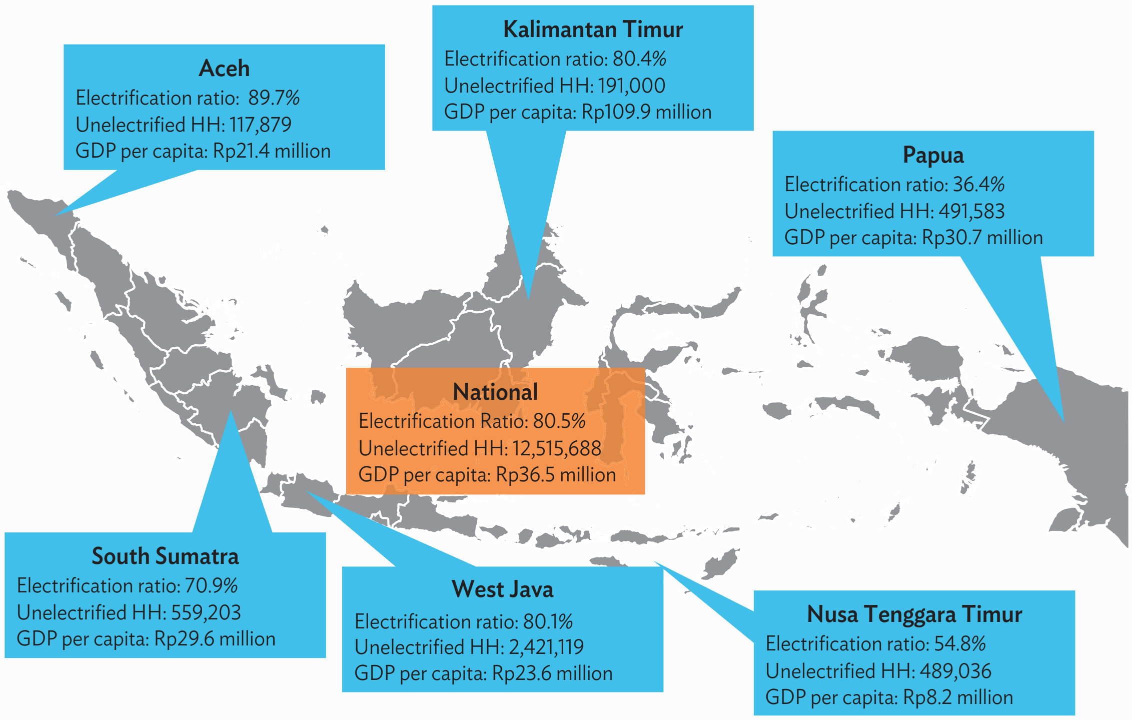
2 The Current Electrification Environment

2.1 Present Levels of Electricity Access

Indonesian living standards have improved remarkably over the past generation. Indonesia's national electrification ratio has increased accordingly, from approximately 43% in 1995 to 84.1% in January 2015.

However, the aggregate national data conceal regional disparities, particularly with respect to access to electricity. Figure 2.1 highlights the electrification ratio,[7] number of unelectrified households, and gross domestic product (GDP) per capita in selected provinces and at the national level as of the end of 2013. The most recent electrification data by province can be found in Appendix 2.

Figure 2.1: Regional Disparities in Electricity Access



BJS = Central Statistics Bureau, DJK = Directorate General of Electricity, GDP = gross domestic product, HH = household, PLN = State Electricity Company, Rp = rupiah.

Note: As of January 2015, the electrification ratio was 84.1%. Figure 2.1 includes both PLN and non-PLN connections.

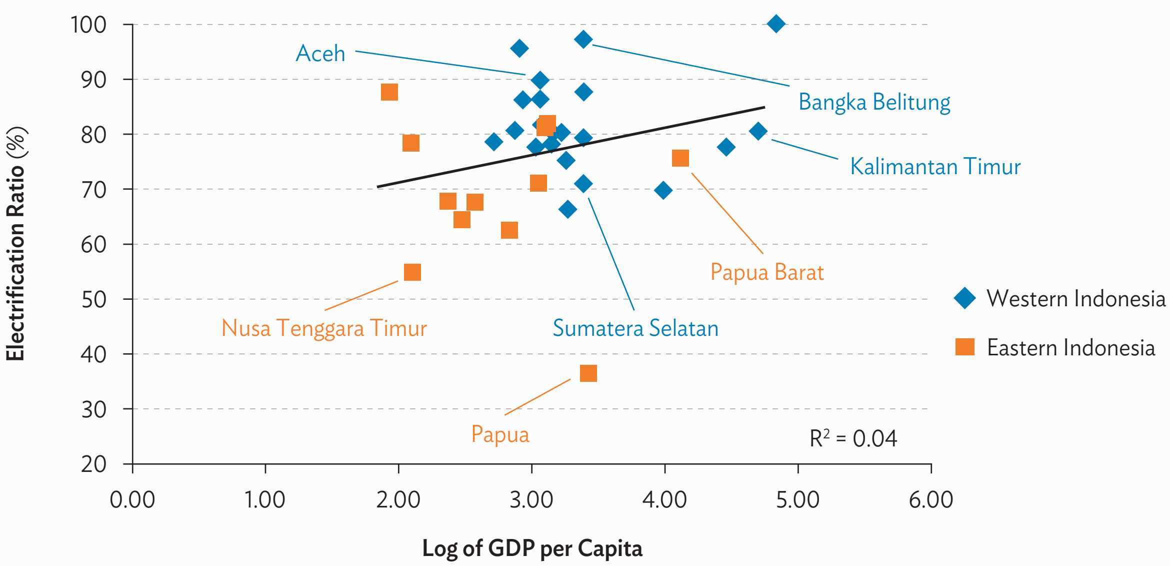
Sources: Directorate General of Electricity, and Central Statistics Bureau for December 2013 as presented in Appendix 1.

[7] Different Indonesian agencies measure "electrification ratio" differently. These definitions are discussed in Section 2.2.

In general, the provinces of eastern Indonesia are characterized by the lowest electrification ratios. The province of Papua has the lowest electrification ratio of all; only about one out of three households has electricity. In contrast, the provinces of Aceh (90%), Kalimantan Barat (96%), Bangka Belitung (97%), and Jakarta (99.99%) have the highest electrification ratios.[8] However, although eastern Indonesia has the lowest electrification ratio, western Indonesia has nearly four times as many unelectrified households as eastern Indonesia in absolute terms.

This regional disparity in electrification ratios is not because eastern Indonesia is a poorer region. Figure 2.2, using data presented in Appendix 2, shows provincial electrification ratio as a function of the natural log of per capita provincial GDP.[9] The figure shows that while eastern Indonesia is characterized by the lowest electrification ratios in the country, differences in per capita provincial GDP account for only about 4% of the differences in electrification ratios. For example, even though Papua Barat (West Papua) has significantly higher per capita GDP than all but three Indonesian provinces, its electrification ratio is lower than all but three provinces of western Indonesia. Kalimantan Timur (East Kalimantan) has the second-highest per capita GDP in Indonesia, but an electrification ratio below the national average. Conversely, though Bangka Belitung, Kalimantan Barat, and Aceh are characterized by per capita GDP below the national average, their electrification ratios are among the highest of all provinces.

Figure 2.2: Provincial Electrification Ratios and per Capita GDP



GDP = gross domestic product.

Note: "Eastern Indonesia" here refers to the part of Indonesia east of Bali, consisting of the islands of Sulawesi, Maluku, Papua, and Nusa Tenggara.

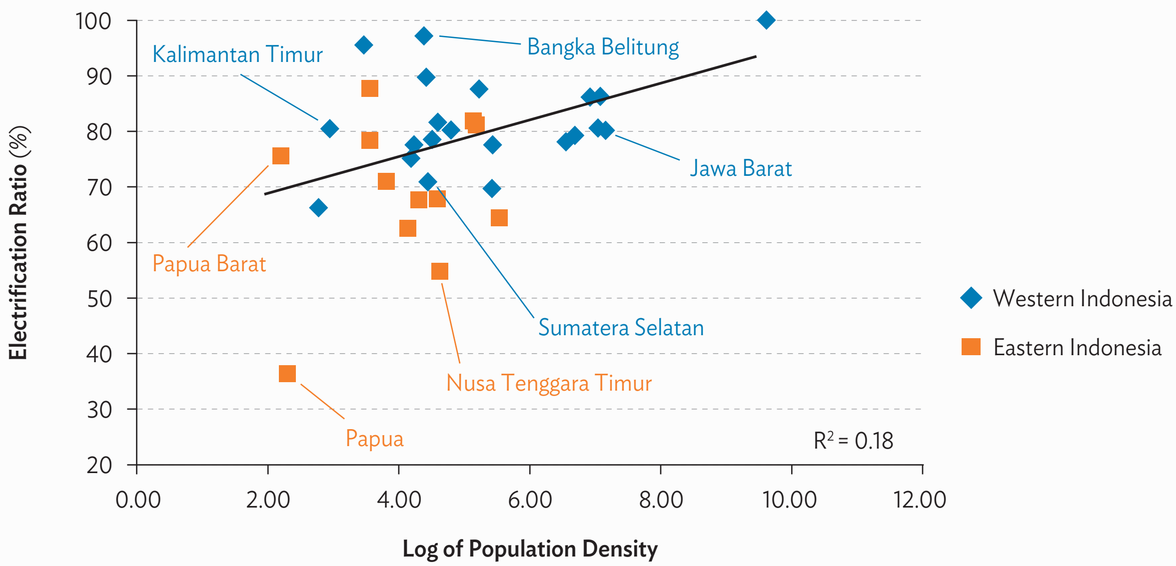
Source: ADB estimates using data from Appendix 2.

8 The data cited throughout this section and used as basis for the calculations and analysis are from the Directorate General of Electricity, as presented in Appendix 2.

9 The natural log is used as it symmetrizes the distribution of residuals of the regression better than using a simple linear regression.

Also, electrification has not lagged in eastern Indonesia due to lower population densities which, in turn, increase the costs and difficulty of connecting rural areas. Figure 2.3 shows the relationship between provincial electrification ratio and the natural log of population density using data in Appendix 2. Provinces in eastern Indonesia are characterized by lower electrification ratios than western Indonesia.

Figure 2.3: Provincial Electrification Ratios and Population Density



Note: "Eastern Indonesia" here refers to the part of Indonesia east of Bali, consisting of the islands of Sulawesi, Maluku, Papua, and Nusa Tenggara.
Source: ADB estimates using data from Appendix 2.

Based on this analysis, changes in population density account for only 18% of the differences in electrification ratios. For example, though West Nusa Tenggara (Nusa Tenggara Barat) has higher population density than most provinces in Indonesia, it has one of the lowest electrification ratios. Conversely, Bangka Belitung has an average population density but has the second-highest electrification ratio of all provinces.

This analysis of the relationships between provincial electrification ratios and per capita GDP and population densities suggests the following conclusions.

(i) **Electricity access is a matter of policy, not a consequence of wealth or settlement patterns.** In Indonesia, per capita GDP and population density together account only for about one-fifth of the variation in electrification ratios among provinces. Funding is of course important, and settlement patterns will determine, to a large extent, the least-cost means of electrifying regions. Ultimately, however, government policy and commitment will determine whether universal access can be achieved. Electrification is a necessary, though not a sufficient, driver of economic growth rather than a consequence of economic growth.

(ii) **While the challenge of electrification is most acute in eastern Indonesia, efforts to achieve universal access must be nationwide.** The province of West Java, for example, has nearly as many unelectrified households—some 2.4 million—as all of eastern Indonesia combined. Electrification planning must of course take into account local conditions, which vary greatly in a country as large and diverse as Indonesia, but policies and programs must be defined at the national level with national scope.

2.2 Electrification Targets

The first step in developing such a program is the definition of electrification targets.

Providing electricity access to rural and disadvantaged regions has been, and will likely continue to be, a key development objective of the government. Electricity Law 30/2009 assigns the central and the local governments to allocate funds for provision of electricity access and infrastructure to disadvantaged communities, including rural electrification programs. However, as expected, the law does not stipulate a target electrification ratio.

The Medium Term National Development Plan 2015–2019 (RPJMN 2015–2019), which was adopted under Presidential Regulation (Perpres) No. 2/2015 and amended by Perpres 3/2015, sets a target of 96.6% electrification ratio by 2019. The National Energy Policy 2014–2050 (KEN), which was approved by the Indonesian legislature (the House of Representatives, DPR) in February 2014, prioritizes the provision of energy for people without access to electricity, and sets forth a target electrification ratio of 85% by 2015 and "approaching" 100% by 2020. How the government and PLN measure electrification ratio is described in Box 2.1.[10]

The KEN and the RPJMN will be used as references to prepare and update the National Energy Plan (RUEN) and the National Electricity Plan (RUKN). Provincial and district energy plans (RUED-P and RUED-Kab/Kota) will refer to RUEN, and provincial electricity plans (RUKD) will refer to the RUKN. The RUEN, RUKN, RUED-P, and RUED-Kab/Kota will be developed and prepared based on Perpres 1/2014.

The RUKN has not yet been updated to reflect the latest national-level targets defined in the KEN and the RPJMN. Although a draft RUKN for 2015–2034 has been prepared and submitted to the DPR for review in mid-2015, the most recent RUKN that is available is the draft 2012–2031 version (which had not been finalized pending issuance of the KEN). It provides an electrification ratio target, by province, as shown in Table 2.1. The targets in the KEN, RPJMN, and draft RUKN are all roughly consistent, establishing a target of near-universal (>97%) access by 2020.

[10] Although Indonesia defines electrification ratio in terms of the number of households with electricity access, the government also tracks electrification in terms of the ratio of villages (*desa*) with electricity supply to the overall number of villages in the country. According to the Central Statistics Bureau Village Potential Survey (*Potensi Desa*, Podes) data for 2014, some 97.3% of all villages in Indonesia, amounting to 92,543 villages, had some electricity supply, whereas about 2.7% of the villages in Indonesia still have no electricity supply. See http://www.bps.go.id/tab_sub/view.php?kat=1&tabel=1&daftar=1&id_subyek=61&notab=1

Box 2.1: How Electrification Ratio is Measured in Indonesia

"Electrification ratio" is a measure of the prevalence of households with electricity access in a country. In general, electrification ratio is defined as the ratio of the number of households with access to electricity to the total number of households. The Ministry of Energy and Mineral Resources (MEMR) Regulation (*Permen ESDM*) 13/2013 on key performance indicators for activities under MEMR includes electrification ratio as one of the key performance indicators to be measured for the Directorate General of Electricity. This regulation states that the rationale for measuring electrification ratio is to assess the number of households with access to electricity, but it does not define what constitutes "access to electricity."

The specific definition of the numerator (households with access to electricity) and the denominator (total number of households) differs between the State Electricity Company (PLN) and the MEMR. The most recent electrification figures from the Directorate General of Electricity and from PLN are provided in Appendix 2.

(i) The national electricity plan prepared by the MEMR defines the electrification ratio as the ratio between the number of households that "have the benefits from electricity" (numerator) and the total number of households (denominator). As noted earlier, it is therefore a measure of actual electricity connections, rather than merely proximity to supply.

The numerator includes not only households connected to PLN grid but also the nongrid PLN customers (e.g., households that have Super Extra Energy Efficient (SEHEN) individual photovoltaic systems, which are managed by PLN), as well as those with electricity supply from the non-PLN sources (e.g., households that have solar home systems or are served by solar minigrids provided under the non-PLN rural electrification programs). The denominator is taken from the regular population data compiled by the Central Statistics Bureau (*Badan Pusat Statistik*).

(ii) The electrification ratio defined in the annual PLN statistics is based only on households that receive electricity as PLN customers, either from the grid or from nongrid sources such as the SEHEN, while the denominator is taken from the regular Central Statistics Bureau population data.

Officials from both PLN and the MEMR have noted that "households that have benefits from electricity" receive at least electric lighting, regardless of whether it is grid-connected or nongrid connected. This appears to correspond to Tier 1 service within the Sustainable Energy for All framework.

However, there is no monitoring or measurement of whether this supply actually functions. PLN measures system annual interruption duration index (SAIDI) and system annual interruption frequency index (SAIFI), so that the quality of grid supply can be assessed. But neither PLN nor the non-PLN programs for off-grid supply, such as the SEHEN and solar minigrids, measure whether those systems continue to work after installation (though Permen ESDM 10/2012 calls for periodic operational reporting by Pemda for projects developed under that mechanism).

Reviews of other programs indicate a high failure rate among individual household as well as minigrid photovoltaic system. Unfortunately, PLN and other government programs have not established comprehensive monitoring and evaluation procedures to confirm whether households with off-grid supply actually continue to receive the benefits of electricity after initial installation of the systems.

Sources: Asian Development Bank; discussions with PLN and MEMR personnel.

Table 2.1: Draft 2012–2031 RUKN Electrification Targets (%)

No.	Province	2012	2017	2022	2027	2031
1.	Aceh	89.79	97.24	99.99	100.00	100.00
2.	Sumatera Utara	87.01	95.85	99.99	100.00	100.00
3.	Sumatera Barat	80.19	92.44	99.99	100.00	100.00
4.	Riau	79.09	91.89	99.99	100.00	100.00
5.	Kepulauan Riau (including Batam)	91.68	98.19	99.99	100.00	100.00
6.	Sumatera Selatan	74.83	88.96	99.99	100.00	100.00
7.	Jambi	78.17	91.43	99.99	100.00	100.00
8.	Bengkulu	73.23	89.76	99.99	100.00	100.00
9.	Lampung	72.88	94.04	99.99	100.00	100.00
10.	Kepulauan Bangka Belitung	83.39	88.79	99.99	100.00	100.00
11.	Bali	71.56	87.35	100.00	100.00	100.00
12.	Jawa Timur	74.98	100.00	100.00	100.00	100.00
13.	Jawa Tengah	80.74	88.97	100.00	100.00	100.00
14.	DI Yogyakarta	77.96	92.95	100.00	100.00	100.00
15.	Jawa Barat	72.77	91.56	100.00	100.00	100.00
16.	Banten	69.53	90.07	100.00	100.00	100.00
17.	DKI Jakarta	99.99	88.36	100.00	100.00	100.00
18.	Kalimantan Timur dan Utara	64.02	86.28	99.99	100.00	100.00
19.	Kalimantan Selatan	77.70	86.95	99.99	100.00	100.00
20.	Kalimantan Tengah	69.20	91.20	99.99	100.00	100.00
21.	Kalimantan Barat	67.87	84.36	99.99	100.00	100.00
22.	Sulawesi Utara	75.68	87.69	95.91	98.18	100.00
23.	Sulawesi Tengah	66.60	80.29	99.99	100.00	100.00
24.	Gorontalo	55.88	83.15	95.91	98.18	100.00
25.	Sulawesi Selatan	76.86	84.98	99.99	100.00	100.00
26.	Sulawesi Tenggara	57.90	90.78	99.99	100.00	100.00
27.	Sulawesi Barat	65.26	78.80	95.91	98.18	100.00
28.	Nusa Tenggara Barat	54.77	74.74	91.82	96.36	100.00
29.	Nusa Tenggara Timur	44.49	69.60	91.82	96.36	100.00
30.	Maluku	72.01	83.36	91.82	96.36	100.00
31.	Maluku Utara	71.68	83.19	91.82	96.36	100.00
32.	Papua and Papua Barat	40.84	67.77	91.82	96.36	100.00
	Indonesia	75.30	86.37	99.33	99.69	100.00

RUKN = Rencana Umum Ketenagalistrikan Nasional (National Government Electricity Plan).

Source: Government of Indonesia. 2012. National Electricity Plan (RUKN), 2012–2031. Jakarta.

The targets set forth in the KEN, RPJMN, and draft RUKN represent strategic policy objectives of the government rather than the result of a structured planning process that weighs the costs and benefits of electrification or analyzes what is achievable within available budgets. That said, the draft RUKN explicitly recognizes the importance of providing electricity to increase household welfare as well as the challenges of increasing electrification in rural areas, including:

(i) low population with low incomes, and consequently low electrical energy demand per person, resulting in low load density;

(ii) low ability and willingness of these populations to pay for electricity service; and

(iii) undeveloped economies that impede the uptake of electricity for productive uses.

It also defines, in qualitative terms, measures required to accelerate electrification and the benefits it can deliver, including:

(i) the need for special financing arrangements;

(ii) the development of design and construction standards specially formulated to fit the realities that exist in the unelectrified regions of Indonesia;

(iii) the need to keep tariffs at affordable levels;

(iv) the preparation of programs that link electrification to rural economic development and support programs for health, basic education, and water supply; and

(v) the importance of supply reliability.

2.3 The Institutional Setting

2.3.1 Legal and Regulatory Framework

The conduct of electrification is governed by several laws and regulations. There is a suite of finance-related laws that underpin the budgeting and disbursement of government funds, including for electrification programs, which are not discussed here.[11] Only those aspects of these laws and regulations that directly influence electrification are described below:

(i) **Law 19/2003 on State Enterprises.** The law covers establishment, performance management, and corporate governance of state-owned enterprises (*badan usaha milik negara*, BUMNs) such as PLN.

[11] The State Finance Law 17/2003 details the constitutional provisions for the budget process, mandates specific milestones and dates for the preparation and adoption of the budget, specifies general principles and authorities for the management and accountability of state finances, and establishes the financial relationship between the central government and other institutions.

The State Treasury Law 1/2004 outlines the responsibilities of the treasury and articulates the creation of treasurers in government ministries and agencies, together with general principles on the management and accountability of public funds.

The State Planning Law 25/2004 outlines the national development planning process, the preparation and approval of plans, and the role of the National Development Planning Agency.

The Regional Governance Law 32/2004 outlines the responsibility of regional governments for a range of public services, including education, health, public infrastructure, agriculture, industry and trade, investment, environment, land, labor, and transport. It replaced an earlier law from 1999.

The Fiscal Balance Law 33/2004 outlines the responsibility of regional governments for managing their own public finances, their revenue-raising authority, and the system of transfers from the national government. It replaced an earlier law from 1999.

The State Audit Law 15/2004 outlines the operational framework of the Supreme Audit Agency (Badan Pemeriksa Keuangan, BPK), and mandates it as a professional and independent institution required to submit its reports to the DPR.

Of particular relevance to electrification, the law provides the legal basis for subsidies to the sector. As a *persero*, PLN is a state-owned limited liability company with the main objective of earning profit. The government may assign a BUMN a function to provide certain services for the benefit of the public, but the government remains obliged to ensure such an assignment does not compromise the financial performance of the company. This gives rise to government subsidy for the performance of a public service obligation, as stipulated under the elucidation of Article 66. These subsidies must compensate the BUMN for all costs incurred in delivering that service plus a margin.

(ii) **Ministry of Finance (MOF) Regulation (Peraturan Menteri Keuangan, PMK) 170/2013 on Procedures for Budgeting, Calculation, Payment, and Responsibility for Electricity Subsidies.**[12] This regulation implements the electricity subsidy mechanism provided under Law 19/2003. The subsidy to be administered by the MOF to PLN out of the state budget is estimated by the Ministry of Energy and Mineral Resources (MEMR) for the preparation of the State Budget on the basis of the total difference between PLN revenues and the cost of supply plus margin. The subsidy is then paid in arrears based on actual costs and revenues. Among other things, the regulation defines the allowable elements of the cost of supply. It also provides flexibility in the payment of subsidies in the event of unexpected changes in the projections used to budget for subsidies.

(iii) **Law 30/2007 on Energy.** Article 33 of the Indonesian Constitution states that energy resources shall be controlled by the state and used for the greatest benefit of the people. Law 30/2007 lays out how the government is to implement this obligation. In particular, it states that one objective of energy management is to improve energy access for the poor and people living in remote areas. The government shall provide assistance to increase availability of energy for the poor, and develop supply infrastructure in remote areas. Energy shall be priced at its fair economic value, and the government shall subsidize supply to the poor.

The government is obliged to establish a National Energy Policy (KEN) that is to be approved by the DPR and, among other things, enumerates energy development priorities. The KEN is prepared by a national energy council (*dewan energi nasional*, DEN) and provides the basis for the National Energy Plan (RUEN). Regional governments are required to prepare regional energy plans (RUED) based on the RUEN. The use of local and renewable energy sources is prioritized, and the central or regional governments may provide incentives for the development or utilization of new and renewable energy resources until they become economically viable.

(iv) **Law 30/2009 on Electricity.** This law defines the principles that guide development of the power sector; the various activities that constitute electricity supply; the authorities for licensing, tariff setting, and otherwise regulating each of these supply activities; and responsibilities for sector planning. The government and the Pemda are responsible for controlling electricity supply activities, and shall appoint state-owned enterprises to implement electrification on their behalf. The private sector and other forms of public entities (e.g., cooperatives) may also participate in the sector to help fulfill power supply needs.

Of particular relevance to electrification, Article 4 states that the central and the regional governments shall provide funds to supply electricity for indigent communities, construction of electricity supply infrastructure in less-developed regions, electric power development in remote or frontier areas, and rural electrification.

[12] This subsidy scheme has been replaced by PMK 195/2015, which will introduce performance-based regulation starting in 2017.

The government defines geographical business areas for distribution, retailing, or vertically integrated supply, which may be undertaken by only one entity in each area. These business areas shall not be defined in terms of government administrative units. State-owned entities shall be given first priority to provide electricity supply to an area, but the government shall extend the opportunity to other entities as well. If there is no entity to undertake supply in a given area, the government must appoint a state-owned enterprise to do so. The law prioritizes the use of new and renewable primary energy sources for electricity generation, and also addresses land access and cross-border electricity trading.

Both the central and the regional governments are required to prepare public electricity plans (*rencana umum ketenagalistrikan nasional/daerah*, RUKN/D) and set tariffs with the approval of the corresponding legislature. Tariff setting by the Pemda shall follow guidelines established by the government. In the event a regional government is unable to establish a tariff, then the government shall set the regional tariff. The RUKD must follow the RUKN. The RUKN shall be prepared by the government in consultation with the DPR, and shall be based on the KEN.

(v) **Government Regulation (Peraturan Pemerintah, PP) 14/2012 on Electricity Supply Business Activities** (as revised by PP 23/2014)**.** This is the principal implementing regulation for Law 30/2009 on Electricity with respect to both public supply as well as own (captive) supply. The regulation provides for open access; stipulates the procedures and authorities for defining service territories, licensing, tariff setting, land use, technical regulation, and supervision; and specifies sanctions. Public electricity supply activities are to be conducted in accordance with the RUKN/D and the supplier's business plan for electricity supply (*rencana usaha penyediaan tenaga listrik*, RUPTL),[13] as approved by the licensing authority.

Of particular relevance to electrification, the authority for licensing and pricing of supply to unserved areas rests with the central government (through the MEMR), the provincial government, or the *kabupaten*/municipal government depending on (i) the administrative units within the supplier's service territory, (ii) whether the entity is a BUMN, and (iii) if the entity will sell bulk power or rent network capacity to another entity, the level of government that licensed the buying entity. Permen ESDM 35/2014 on Procedure for Electricity Licensing stipulates the specific process and requirements. However, while the processes remain the same, the authority of different levels of government to plan, license and approve tariffs have been reconfigured under Law 23/2014.

Service territories for distribution, retailing, or vertically integrated supply are defined by the MEMR based on the supplier's application, provided the regional government (Pemda) has provided a recommendation letter. BUMNs (e.g., PLN) are prioritized for supplying electricity to any area, but if they are unable to do so, then the competent government authority may provide the opportunity to other legal entities.

In addition, tariffs should balance several factors, including the affordability to consumers, production costs, the availability of funds, and the commercial viability of the supplier. Permen ESDM 31/2014 and 9/2015 are the most recent regulations to establish tariffs. These regulations have phased out subsidies for all consumers except residential consumers with connections less than 1,300 volt-amperes.

[13] Although the RUKN is prepared by the central government, and the RUKD is prepared by the regional government, the RUPTL is prepared by licensees and license applicants conducting the activities of distribution, retailing, or vertically integrated supply. Each RUPTL is approved by the level of government that issued the license for that supplier, or to which the license applicant submitted its application.

(vi) **Ministry of Energy and Mineral Resources Regulation (*Peraturan Menteri Energi and Sumber Daya Mineral*, Permen ESDM) 28/2012 on Procedure to Request an Electricity Business Area.** This regulation defines the procedure for the application and approval of an electricity business area, as referenced in Article 20 of PP 14/2012. Only one entity may serve a given business area. The entity may be a national or regional government, state-owned enterprise; private company established in Indonesia; a cooperative; or community initiative through a nongovernment organization (NGO). The Directorate General of Electricity (DGE) is authorized to define these business areas on behalf of the minister. The process appears to be relatively fast.

(vii) **Permen ESDM 33/2014 on Service Quality Standards and Costs Associated with Electricity Distribution by PLN (Persero).** This regulation defines 13 service indicators, including interruption frequency and duration indices, time needed to get a new connection, time required to correct billing errors, etc. DGE defines standards for each of these indicators, and each PLN unit must report performance against these standards on a quarterly basis. Failure of PLN to meet these standards results in billing credits to customers. The regulation also stipulates connection costs and late payment penalties.

(viii) **Permen ESDM 35/2014 on Delegation of Authority for Electricity Business Licenses under Implementation of a Single Window Service to the Investment Coordinating Agency (Badan Koordinasi Penanaman Modal, BKPM).** All electricity sector licensing, including applications for electricity business areas, are now handled through the single window function of BKPM. Responsibility for all technical matters remains with the ESDM, which seconds staff to BKPM to review and process applications. This regulation only covers licensing under the authority of the ESDM; provincial licensing authority remains with the governor of the province, who may (but is not required to) delegate administration of electricity licensing to the provincial investment unit (Provincial Apparatus for Investment, *Perangkat Daerah Provinsi di Bidang Penanaman Modal*, PDPPM).

(ix) **Permen ESDM 10/2012 on Implementation of Physical Activities for Utilization of New and Renewable Energy.** This regulation lays out a mechanism for the Directorate General of New and Renewable Energy and Energy Conservation (DGNREEC) to promote the development of renewable energy and supply energy to remote communities as called for by Law 30/2007. A Pemda can propose a renewable energy project to DGNREEC, which, if it approves, will procure the facility out of its own budget and then hand it over to the Pemda after commissioning. The Pemda is then responsible for operation of the system and periodic operational reporting to the DGNREEC.

(x) **Permen ESDM 3/2014 on Technical Instructions for Use of the Special Fund Allocation for Rural Energy for Fiscal Year 2014.** Whereas Permen ESDM 10/2012 provides for the funding of renewable energy projects out of the DGNREEC budget, this regulation provides for funding of such projects out of the rural energy component of the special allocation fund (DAK), which is a portion of the state budget available to the Pemda under certain conditions. The funding is available for off-grid microhydroelectric power, household biogas, and photovoltaic minigrids or individual household systems.

Another purpose of this funding is to provide electricity supply in areas not served by PLN. The funding and physical implementation of the project is the responsibility of the regional government work unit (*Satuan Kerja Perangkat Daerah*, SKPD), which is responsible for energy according to the technical guidelines laid out in the regulation. Permen ESDM 2/2014 devolves to the provincial government responsibility for socialization of these instructions to districts (*kabupaten)* and monitoring and evaluation (M&E) of the expenditure. However, Law 23/2014 eliminates *kabupaten* authority for any electricity matters. Consequently, there are no longer any SKPD at the *kabupaten* level responsible for electricity matters.

(xi) **Decree of the Minister for Development of Disadvantaged Regions 175/2013 on Determination of Social Assistance for Development of Special Areas for Budget Year 2014.** This ministerial decree (*keputusan menteri*, kepmen) decides the amount the Ministry for Development of Disadvantaged Regions (*Kementerian Pembanguan Daerah Tertinggal*, KPDT)[14] has allocated out of its budget for various social assistance programs across the country. With respect to electrification, the kepmen identifies Rp73.9 billion of expenditure in budget year 2014 for projects in 16 different districts for electricity infrastructure and photovoltaic minigrids.

(xii) **Law 23/2014 on Regional Government.** Among other things, this wide-ranging law revises key aspects of Law 30/2009 on Electricity and PP 14/2009 on Electricity Business Supply Activities with respect to authority for electricity licensing and tariff setting. District-level government no longer has any authority for electricity licensing or tariff setting. Licensing and tariff setting for all projects that do not involve BUMNs and do not cross provincial boundaries are now handled by the provincial government. The processes outlined in PP 14/2012 otherwise remain intact.

(xiii) **Presidential Regulation (Peraturan Presiden, Perpres) 1/2014 on Guidelines for the Preparation of the National Public Energy Plan.** This is an implementing regulation of Law 30/2007 on Energy that stipulates how the RUEN and RUED are to be prepared. The RUEN is to be issued within 1 year of the KEN.

(xiv) **Presidential Regulation 43/2014 on the Government Work Plan (Rencana Kerja Pemerintah, RKP) for 2015.** This regulation is issued annually to guide preparation of ministry work plans and budgets in the coming year, drawing on the Medium Term Development Plan (*Rencana Pembangunan Jangka Menengah*) and the strategic direction of the President. With respect to electrification, it documents specific targets for each ministry and activity, for example, length of new distribution line to be added and capacity of new off-grid renewable energy systems to be constructed. This provides a basis for the preparation of the State Budget.

(xv) **Law 27/2014 on the State Budget.** This law stipulates the budget allocated for electrification activities in 2015. Details are presented in Perpres 162/2014. A revised 2015 State Budget was issued in March 2015 (Law 3/2015), with details provided in Perpres 36/2015. However, at the time of writing this report, the detailed attachments of Perpres 36/2015 were not yet available, so reference is made to Perpres 162/2014 for the rest of this report.

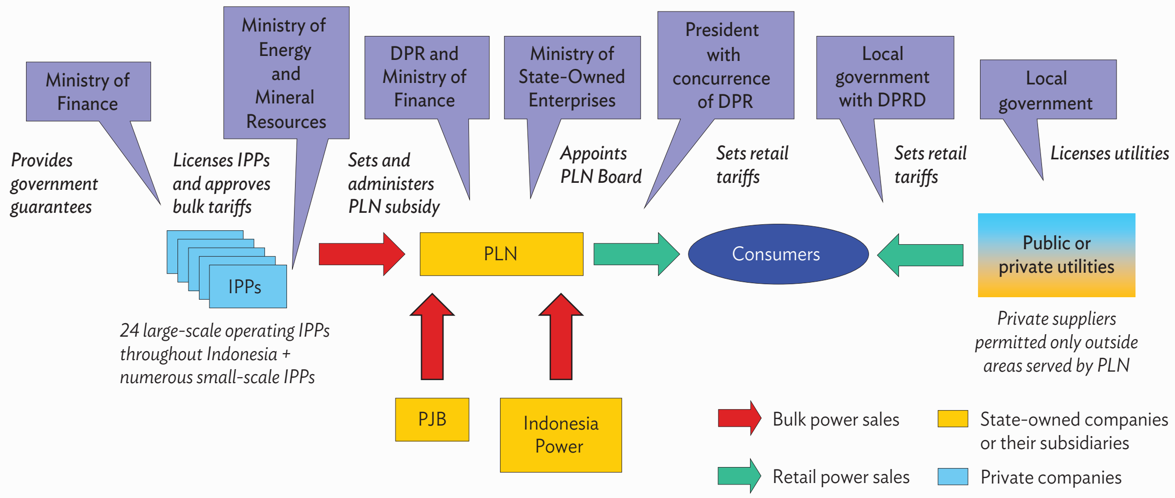
(xvi) **Perpres 39/2014 on List of Business Fields Closed to Investment and Business Fields Open with Conditions to Investment.** This regulation places different conditions on foreign investment in each of the activities of generation, distribution, and operation and maintenance of electrical installations. Neither retailing nor integrated electricity supply is listed.

[14] This ministry has recently been renamed the Ministry for Villages, Development of Disadvantaged Regions and Transmigration (*Kementerian Desa, Pembangunan Daerah Tertinggal dan Transmigrasi*).

2.3.2 Principal Agencies and Institutions

Figure 2.4 shows the overall structure of the Indonesian electricity sector, highlighting the role of various government agencies in policy making, regulation, and ownership, as well as the private sector.

Figure 2.4: Institutional Roles Within the Indonesian Electricity Sector



DPR = House of Representatives, DPRD = Regional Representative Council, IPP = independent power producer, PJB = Java Bali Generation Limited Liability Company, PLN = State Electricity Company.

Source: Author.

PLN: PLN (Persero) is a 100% state-owned vertically integrated electricity company that, together with its subsidiaries, is responsible for most electricity generation in the country, all transmission, and virtually all distribution and retail. Other public or private electric utilities are allowed by law to supply electricity in areas that are not served by PLN, but there are few instances of such arrangements.

PLN subsidiaries, Java Bali Generation (*Pembangkitan Jawa Bali*, PJB) and *Indonesia Power*, operate under generating licenses, and sell bulk power to PLN, which acts as a single buyer. In addition, PLN has two other subsidiaries: PLN Batam, which undertake supply on Batam Island, and PLN Tarakan, which undertakes supply on Tarakan Island. Retail sales in these two service territories follow their own tariff schedules, whereas PLN sells power to consumers throughout the rest of the country under the uniform national tariff (*tarif dasar listrik*, TDL), which per Law 30/2009 is prepared by the MEMR, proposed by the President, and is approved by the national legislature (DPR).

Ministry of State-Owned Enterprise (MSOE): MSOE functions as the shareholder of PLN. It appoints the board of directors of PLN and sets the company's performance targets.

Ministry of Energy and Mineral Resources (MEMR): MEMR functions as the policy maker and regulator for the sector, and is responsible for code development and enforcement, licensing, approval of bulk tariffs, setting of feed-in tariffs and other terms for small-scale renewable power projects, development of retail tariffs, and preparation of the RUKN. Many of these functions are conducted by the DGE within MEMR, particularly those related to electrification. In addition, the DGNREEC is responsible for renewable energy, including applications in off-grid areas.

Ministry of Finance (MOF): The MOF also has a role in the sector in terms of establishing arrangements for loan guarantees that may be used by the independent power producers (IPPs), and for working with the line ministries, other government agencies, and the DPR to prepare the state budget, which includes electricity subsidies. It also administers the subsidy to PLN.

Private Sector: The principal role of the private sector is as IPPs. They operate under generating licenses and sell bulk power to PLN, which acts as a single buyer. There is also scope under the Law 30/2009 for the private sector to supply power directly to consumers in areas not served by PLN, but few examples exist. In addition, the law and implementing regulations allow for power wheeling between private generators and consumers.

Local Governments—Provincial and District Levels: Law No 30/2009 no longer designates a special role for a state-owned enterprise, for example, PLN, to carry out electricity supply apart from being given priority to serve any given area. Regional government-owned enterprises (BUMD, *Badan Usaha Milik Daerah*), private enterprises, cooperatives, and self-reliant communities (through a legal establishment) are eligible to supply electricity. The Pemdas are responsible for preparing the RUKDs, which are supposed to be updated annually (although in practice, many Pemdas have not yet prepared the RUKD due to limitations in human resources). Where the electricity business activity is entirely within a province or a district/city, authority for tariff setting and licensing has been devolved to local governments. According to Law 30/2009, retail tariffs in this context are to be set by the local government on commercial principles with approval from the local legislatures (*Dewan Perwakilan Rakyat Daerah*, DPRD). However, as noted in Section 2.3.1, Law 23/2014 on regional government only authorizes provincial government to manage electricity matters. There is no longer a role for the district.

2.4 The Prevailing Planning and Implementation Process

There are currently three principal electrification programs in Indonesia:

(i) programs executed by PLN,
(ii) programs executed by the line ministries, and
(iii) programs executed by the Pemda.

Programs carried out by PLN account for some 97% of all household connections, whereas the remaining 3% have been delivered by the line ministries, the Pemda, the NGOs, and other programs such as the National Program for Community Empowerment (*Program Nasional Pemberdayaan Masyrakat,* PNPM), as described below.

There have been other electrification programs in the past. For example, the PNPM program, which was administered through the Ministry of Home Affairs, previously funded microhydro and photovoltaic minigrids based on community initiative and in-kind contributions to the projects. However, this program has ended as Law 6/2014 on Villages established a mechanism for providing funding from the state budget directly to each village (*desa*).

There have also been community electrification programs conducted by NGOs such as IBEKA, which typically use renewable energy technologies for power generation. Sometimes, these projects are funded through corporate social responsibility programs. However, to be sustainable, such projects presumably need to apply a tariff, but there is no known case of such a project having been conducted in accordance with Law 30/2009 or Law 23/2014.

The Agency for the Assessment and Application of Technology (*Badan Pengkajian dan Penerapan Teknologi*, BPPT) and the Indonesian Institute of Science (*Lembaga Ilmu Penghetahuan Indonesia*, LIPI) also develop grid and off-grid power supply projects. However, these are not discussed further as they are conducted for research purposes.

2.4.1 PLN Programs

PLN executes the largest electrification programs in the country. Historically, PLN programs have been carried out as conventional grid extension, though the Super Extra Energy Efficient (*Super Ekstra Hemat Energi*, SEHEN) program, which provided small individual households photovoltaic systems with three light points, is a notable exception. The conventional grid extension programs are integrated with generation and transmission development, as would be expected from a vertically integrated utility such as PLN.

PLN electrification programs are financed out of two sources: PLN's own budget (*Anggaran PLN*, APLN) and the national government budget (*Anggaran Pendapatan dan Belanja Negara*, APBN). The planning and implementation of these programs depend upon the source of funding.

The predecessor of PLN was a government department formed in 1945 to take over 157.5 megawatts (MW) of generation assets that had been developed by the Dutch and subsequently operated by the Japanese until their surrender.

In the 1950s, various separatist movements threatened the unity of Indonesia. During this period, the government promoted regional grid development and promulgated a national uniform electricity tariff to help reinforce national unity. The government's efforts to ensure the affordability of electricity to households resulted in pervasive cross-subsidies that have continued until recently, but are now being phased out.

In 1965, the government energy department was dissolved and two state-owned enterprises were established in its place: the State Electricity Company (PLN) to manage electricity and the State Gas Company (*Perusahaan Gas Negara*, PGN) to manage gas supply.

In 1972, in accordance with Government Regulation No. 17, the state-owned electricity company was designated as the sole authorized agency for electricity business (*Pemegang Kuasa Usaha Ketenagalistrikan*, PKUK) responsible to provide electricity to meet public needs. PLN held that special status until Law 30/2009.

Throughout its history, PLN has expanded electricity access throughout Indonesia using its own budget. Starting in 1976, the government augmented the funding for PLN electrification programs with the launch of the Rural Electrification Program (*Program Listrik Perdesaan*, LisDes). This program is funded directly from the APBN. During its first year of operation (budget year 1977–1978), the program electrified 3,800 customers in 76 *desas*. The program now funds medium-voltage lines, low-voltage distribution lines, and medium-voltage/low-voltage transformers.

There are two associated programs funded from the APBN:

(i) the Efficient and Inexpensive Electricity Program (*Program Listrik Hemat dan Murah*) provides a free connection and basic interior wiring to connect poor consumers. It includes provision of a prepayment meter, three lighting points with compact fluorescent lamps, and one plug outlet; and

(ii) the Major Generation and Network Projects (*Proyek Induk Pembangkit dan Jaringan*), referred to as UIP–APBN,[15] which is available for finance generation, high-voltage transmission lines, and high-voltage/medium-voltage substations.

Since the launch of the first LisDes program in 1976, these APBN-funded programs have grown considerably. The 2015 budget[16] provides for

(i) 519 km of HV line with a budget of Rp 349.8 billion;

(ii) 1,810 MVA of HV/MV substations, with a budget of Rp792.3 billion;

(iii) 7,141 km of medium-voltage and low-voltage lines, with a budget of Rp2,015.8 billion;

(iv) 147 MVA of medium-voltage/low-voltage transformers, with a budget of Rp337.6 billion; and

(v) 93,333 household connections, with a budget of Rp210.0 billion.

Among the abovementioned points, points (i) and (ii) comprise the UIP–APBN, points (iii) and (iv) comprise the LisDes, and point (v) comprises the *Program Listrik Hemat dan Murah* (Efficient and Inexpensive Electricity Program). The APBN does not refer specifically to the UIP, the LisDes, or the *Program Listrik Hemat dan Murah*, but rather lists the five components above as separate output and/or budget line items under ESDM > DGE > Electricity Management Program > Activity for Policy Formulation and Program Implementation and Evaluation of Electricity Policy.

The government appoints PLN to manage these APBN-funded projects on its behalf. Once these projects are completed, the government transfers the assets to PLN as government equity.

Despite the size of the LisDes program, in 2013, it facilitated connection of only about 220,000 households out of a total of approximately 3.7 million new connections made by PLN.[17] However, the vast majority of these new PLN connections were in-fill. The physical quantities of rural low-voltage and medium-voltage lines and medium-voltage/low-voltage transformers funded out of the LisDes and PLN's own budget may vary by PLN regional office (which generally but not always correspond to a province), but in Nusa Tenggara Timur, for example, in 2013, the quantities funded out of PLN budget were about half of those funded out of the LisDes. In terms of rural electrification to new areas, as opposed to simply connecting more households in areas where the grid already exists (i.e., in-fill), the LisDes plays a relatively important role—though at this level of funding, not necessarily a decisive role in achieving Indonesia's target of universal access.

[15] "UIP" stands for *Unit Induk Pembangunan Pembangkit dan Jaringan*. The portion funded by the APBN is specifically referred to as "UIP–APBN" because PLN also operates a UIP program funded out of the APLN. The UIP–APBN has not financed a significant amount of generation in the past 5 years or so due to concerns about the ability of PLN to secure the land and permits for generation projects within the funding window.

[16] The 2015 budget has been revised, and it is understood that there has been an Rp1.3 trillion increase in the LisDes budget, which would change the physical quantities of infrastructure to be funded under the program. However, the details were not available at the time of writing this report.

[17] The RUPTL 2015–2024 projects a steadily declining rate of new connections per year: 3.3 million in 2016, 2.6 million in 2017, and so forth. The average rate over 2015–2024 is 2.1 million per year.

Figure 2.5 shows the planning, budgeting, and implementation process for electrification projects executed by PLN, including programs funded by APLN and APBN, and the steps in this process according to whether they are related to setting government electrification targets, PLN planning, government budgeting, PLN implementation, and asset transfer, operation and monitoring. The principal steps are as follows:

(i) The KEN provides guidance for the RUKN, which is prepared for a 20-year time horizon but may be updated from time to time. As noted earlier, the RUKN provides electrification targets and is finalized in consultation with the DPR.

(ii) The RUKN provides a basis for electrification targets included in the RPJMN. This plan is prepared every 5 years for a 5-year time horizon. It, in turn, provides guidance for the annual RKP.

(iii) The RKP is a principal input to the development of indicative budget ceilings by the MOF, principally through the Directorate General of Budget (*Direktorat Jendral Anggaran*). These budget ceilings include amounts available for electrification programs; the final state budget may differ.[18]

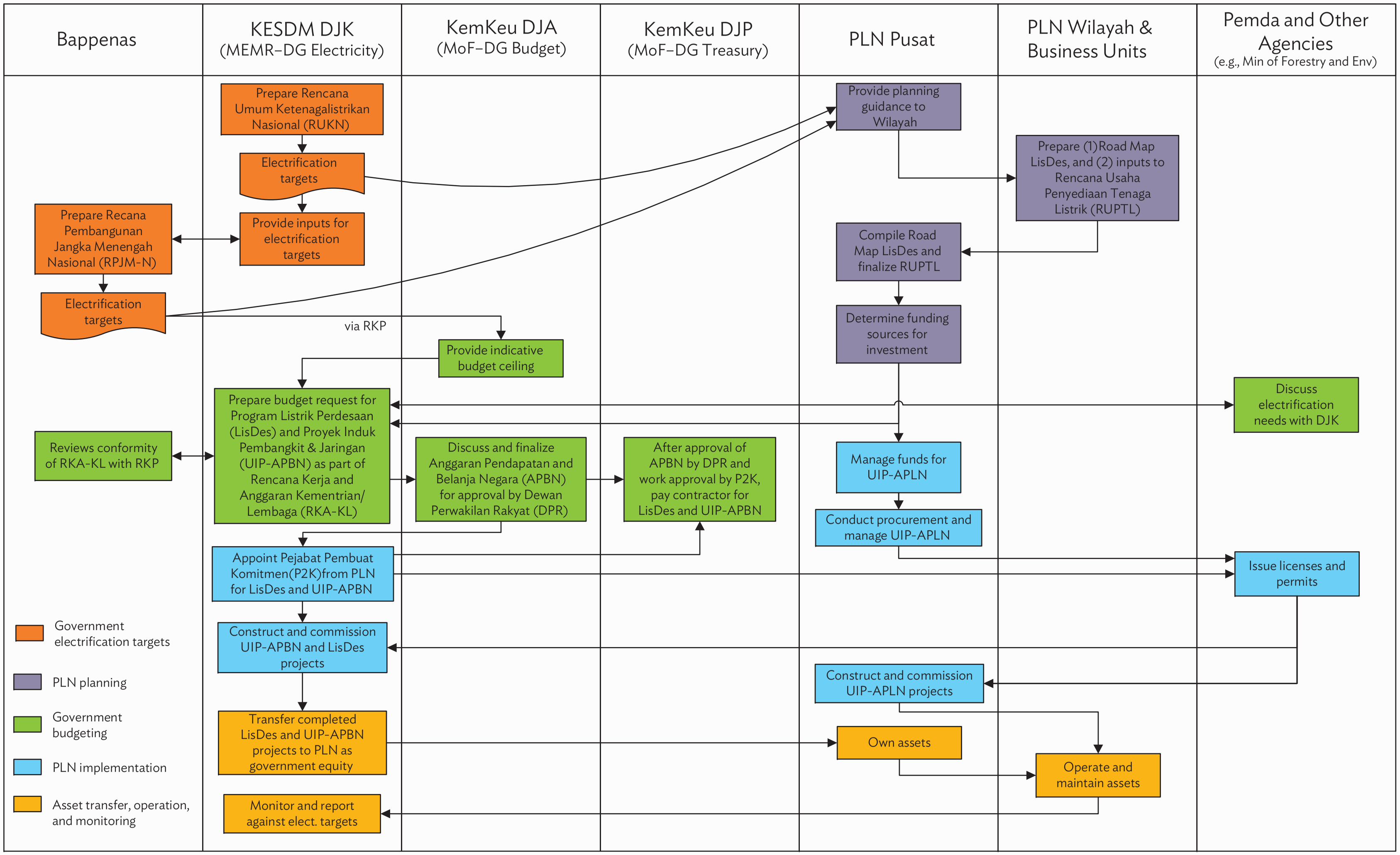
(iv) The RUKN also provides guidance to PLN for the preparation of the RUPTL, which is PLN's system expansion plan. The RUPTL is updated annually for a 10-year time horizon. The preparation of the RUPTL starts with the planning guidance disseminated by PLN headquarters (*Pusat*) to all PLN business units, which then prepare inputs to the plan for their specific business activities. These inputs include the results of the rural electrification road maps (*Road Map LisDes*) prepared by each PLN regional office. *Pusat* then compiles these inputs into the full RUPTL, which is approved by the Minister of MEMR. Appendix 3 describes the preparation of the RUPTL and Road Map LisDes in further detail.

(v) The RUPTL projects overall funding requirements by type of activity (generation, transmission, and distribution), as well as by the principal operational region (Java–Bali and outside Java–Bali). These projections take into account electrification needs as identified in the Road Map LisDes. The RUPTL also proposes the source of funds for these investments, including private generation (through IPPs), APLN, loans and bonds, and government equity (through the APBN-financed programs identified). This allocation of funding needs by source is determined in part by the forecast of the financial performance of PLN against covenants for its global bonds (e.g., the requirement to maintain a debt service coverage ratio of at least 1.5).

(vi) The DGE prepares a preliminary program for APBN electrification funding for the coming year in consultation with PLN (drawing on the Road Map LisDes and RUPTL) and the provincial government. The DGE establishes a rural electrification working group (*satuan kerja listrik perdesaan*, *satker lisdes*) for each province with representation from the three stakeholders (DGE, Pemda, and PLN). The *satker lisdes* compiles the available information about power generation resources, needs, and existing conditions in each area, drawing on the Road Map LisDes of PLN and other sources of data. There are currently 31 *satker lisdes*, roughly corresponding to each province.

[18] For comparison, the 2015 APBN targets noted above compare to 2015 RKP targets of:
(i) 402.8 km of high-voltage line with a budget of Rp418.5 billion;
(ii) 240 MVA of high-voltage/medium-voltage substations, with a budget of Rp140.0 billion;
(iii) 14,082.8 km of medium-voltage and low-voltage line, with a budget of Rp4,094.2 billion;
(iv) 267.2 MVA of medium-voltage/low-voltage transformers, with a budget of Rp607.1 billion; and
(v) 93,323 household connections, with a budget of Rp210.0 billion.

Figure 2.5: The Planning, Budgeting, and Implementation Process for Electrification Programs Executed by PLN



Bappenas = National Development Planning Agency, DJA = Directorate General of Budget, DJK = Directorate General of Electricity, DJP = Directorate General of Treasury, KemKeu = Ministry of Finance, KESDM = Ministry of Energy and Mineral Resources, LisDes = Rural Electrification, P2K = Commitment Maker, Pemda = regional government, PLN = State Electricity Company,Pusat = headquarters, RKP = Government Workplan, RPJMN = Medium-Term Developmen Plan, RUKN = National Government Electricity Plan, RUPTL = Business Plan for Electricity Supply, UIP-APLN = Major Generation and Network Projects, PLN Budget, *wilayah* = regional office.

Source: Author.

(vii) The DGE reviews and discusses the projects brought forward by each *satker lisdes*. For projects that are selected for funding, the DGE proposes these projects to the the Directorate General of Budget for funding in the coming year. The National Development Planning Agency also reviews these projects for alignment with the RKP. The creation and finalization of the budget for these programs is an iterative process that results in DPR approval of the State Budget.

(viii) For projects financed out of the APBN, the DGE appoints a PLN employee as the Official Commitment Maker (*Pejabat Pembuat Komitmen*, P2K) who is responsible for executing the projects on behalf of the DGE. Working with the *satker lisdes*, the P2K will then conduct the same steps as PLN does for projects financed out of the APLN. However, the assets will remain government assets until the DGE hands them over to PLN as government equity once they have been commissioned. An example of a procurement notice for the *Program Listrik Hemat dan Murah* is provided in Appendix 4.

(ix) For projects financed out of the APLN, PLN conducts the procurement, secures land and permits, and constructs and commissions the projects. The projects are owned by PLN and operated and maintained by its business units.

(x) The DGE then monitors and reports electrification performance. PLN also conducts M&E on a project-by-project basis (particularly for transmission and generation projects involving foreign loan because M&E activity is included as the terms and conditions for the financing). It does not conduct M&E on a programmatic level.

Ultimately, PLN is the organization that must consider the budgetary constraints and the detailed technical and financial trade-offs that may be associated with the implementation of any particular government policy guidance or funding for electrification programs. Though PLN takes into account government electrification targets in its system planning (through its load forecasting work), the corporate key performance indicators of PLN do not include provincial or national electrification ratios, presumably because they depend so heavily on government support and because the principal focus has been on efficiency improvement.

This may change as PLN's "service level agreement" (SLA) evolves, but the initial version focuses on subsidy reduction rather than electrification. Box 2.2 provides further details about the SLA. The Presidential Working Unit for Development Monitoring and Control (*Unit Kerja Presiden Bidang Pengawasan dan Pengendalian Pembangunan*, UKP4) played a key role in coordinating the preparation of the SLA across ministries. Now that the UKP4 has been dissolved by the current administration, the future of the SLA is unclear. This coordinating role may be taken up by a new Performance Management Unit (*Unit Pengendali Kinerja*, UPK) that has been established within the MEMR.

PLN's electrification activities typically face a number of challenges:

(i) **Permitting and land access.** Though Law 30/2009 on Electricity provides access to land for the purposes of installing, operating, and maintaining grid infrastructure, in practice, PLN faces the same issues as any infrastructure developer in Indonesia. Compensation to private landholders (or unwillingness of landholders to allow access under any conditions), negotiation with clans or communities for traditional (*adat*) land and recognition of local cultural beliefs and practices, and difficulties in obtaining timely permits from ministries (e.g., from the Ministry of Forestry for the installation of electricity infrastructure crossing or within forest and protected areas)—all have the potential (and often do) delay projects indefinitely.

Box 2.2: State Electricity Company's Service Level Agreement

On 23 March 2013, the State Electricity Company (PLN) signed a service level agreement (SLA) with 12 ministers and heads of agencies. The SLA documents the support of various ministries and government agencies for the sound development and operation of the power sector through the fulfillment of the key performance indicators (KPIs) of PLN. This initial SLA focused on subsidy reduction.

In the SLA, there are 12 major electricity sector issues that require immediate resolution by the signatories through the fulfillment of 17 KPIs. These issues include the increase in the generating capacity of PLN, the increase in the capacity of the Independent Power Producers, sufficient reserve margin, improved operational efficiency, increased gas supply, management of fuel price volatility, increased utilization of renewable energy, improved budget certainty, the adequacy of PLN revenue (cost plus margin), the allocation of risks, the low business returns of PLN, and tariffs that do not reflect costs.

For PLN, the SLA refreshes its development program and execution of its electrification role in Indonesia. The SLA acknowledges that there are 11 other institutions apart from PLN that also contribute to the development of the power sector. These other agencies are expected to address barriers such as lack of investment budget from the government, the unavailability of land for power plants and transmission, and difficulty in licensing and permitting. These issues are to be addressed through synchronization of electricity programs among the relevant institutions.

Electrification may eventually become a PLN KPI as the SLA of PLN evolves, but further refinement and application of the SLA depends on how the Ministry of Energy and Mineral Resources chooses to continue management of the SLA now that the Presidential Working Unit for Development Monitoring and Control has been dissolved. The ministry's Performance Management Unit may play a key role.

Source: Author's discussions with government and PLN personnel.

(ii) **Unqualified developers.** Small (<10 MW) renewable energy projects play a larger role for meeting the power needs of PLN in remote areas than on the larger grids of western Indonesia. A 3 MW hydro project on a 15 MW system can make a difference between electrification scale up and no new connections, whereas on the 5,000 MW peak demand Sumatera system, it would be "lost in the noise." These small projects are awarded on a first-come, first-served basis, and many local firms with little or no previous experience have seized the opportunity.

Though the government has amended regulations in an effort to ensure that better qualified developers secure projects, there are many cases where renewable energy projects that were expected to make significant contributions to generation capacity needs have not materialized or have been significantly delayed because of the developer's unrealistic resource assessment, poor design or construction, or inability to secure financing.

(iii) **Inadequate investment.** Though PLN is heavily subsidized, it does not have access to unlimited funds. The actual availability of funding may constrain implementation of the RUPTL, and, in many cases, the necessary upgrading of transmission and distribution infrastructure does not occur in the proactive manner required to satisfy continued load growth. For example, much of the 20 kV system on Sumba has been conducted with 50 mm^2 or 70 mm^2 cable. Although this may have served the distribution needs of the past, it will not serve the transmission needs of the future resulting from the geographical dispersion and variable output of renewable generation that is envisioned on that system and the increase in load associated with near-universal access.

(iv) **Geospatial load patterns and reliance on diesel generation.** Given the archipelagic nature of the most underserved regions, for example, eastern Indonesia, the relative poverty and lack of economic activity, and the sometimes challenging terrain, potential loads are geographically dispersed. Consequently, until now there has been considerable reliance on costly diesel generators to supply electricity to these regions. The operating costs of these systems reduce the funding available for adding capacity and infrastructure.

PLN developed the SEHEN individual household photovoltaic system to supply basic lighting needs to households for which it would have been otherwise impractical to connect to the grid. More than 100,000 such systems have been installed in eastern Indonesia. However, the program has faced serious challenges in terms of longer-term technical performance, service delivery, and maintenance of the systems, as well as the willingness of households to continue to pay for the system.[19] PLN has had to reclaim many of these systems from households due to lack of payment.[20]

Geospatial planning tools can help optimize electrification investment under these circumstances, as discussed in Appendixes 1 and 2. However, PLN has not yet integrated geospatial tools into its electrification planning process. The existing process is driven by the on-the-ground knowledge of its field staff, data from other agencies such as the Central Statistics Bureau (BPS), and the standard processes and basic tools it has put in place. Although such tools, processes, and human resources are critical for planning and subsequent implementation of grid extension projects, the absence of geospatial planning results in suboptimal planning and incomplete or weak determination of funding needs.

The preparation for the Thousand Islands electrification project of PLN (supported by the World Bank and KfW) and the Sumba Iconic Island project (supported by the Asian Development Bank, among others) have introduced geospatial electrification planning to PLN and other stakeholders. Both the Thousand Island and Sumba initiatives have used the Network Planner tool developed and hosted by The Earth Institute at Columbia University, though other such tools are available, as discussed in the Mid-Term Report prepared under this Asian Development Bank technical assistance.

However, as the experience with SEHEN suggests, economically optimal solutions can fulfill power supply needs only if there are effective business models for implementation. To date, such models have been lacking in Indonesia. Subsequent chapters of this report discuss potential solutions.

[19] Issues regarding the SEHEN program were discussed in the Inception Report and Deliverable B: Energy Resources for Grid Supply and Electricity Demand Analysis for Sumba prepared under this ADB technical assistance project. In particular, Deliverable B includes a willingness-to-pay (WTP) analysis, which indicates that the SEHEN program is currently priced above the WTP.

[20] For example, see http://www.waingapu.com/berita/12-tingginya-tunggakan-ribuan-pelanggan-listrik-sehen-diputuskan-pln.html and http://www.floresbangkit.com/2013/03/tunggak-iuran-6000-lebih-lampu-sehen-terancam-ditarik/

2.4.2 Line Ministry Programs

In addition to the APBN-financed programs administered by the DGE and executed by PLN, some other line ministries also execute their own electrification programs with financing from the APBN, typically using renewable energy for isolated (off-grid) supply. These may be individual household systems or community systems with minigrids. The 2015 APBN includes the following programs:

(i) The Ministry of Cooperatives and Small and Medium Enterprises (*Kementerian Koperasi dan Usaha Kecil dan Menengah*) has budgeted Rp15.4 billion to establish eight cooperatives to supply power with microhydro systems. In mid-2014, The Ministry of Cooperatives and Small and Medium Enterprises and the MEMR signed a memorandum of understanding for cooperation.

(ii) The Ministry of Manpower and Transmigration (*Kementerian Tenaga Kerja dan Transmigrasi*) has budgeted Rp6 billion for lighting and renewable energy projects totaling 544 kW in transmigration areas. It is possible these may be moved to the Ministry for Villages, Development for Disadvantaged Regions and Transmigration (KDPDTT) (previously KPDT), since responsibility for transmigration has been merged into KDPDTT.

(iii) The KDPDTT has budgeted Rp64.5 billion for the provision of 4,513 renewable energy units, presumably for individual households.

(iv) The DGNREEC under the MEMR has budgeted Rp582.2 billion for the provision of 89 photovoltaic minigrid systems.

Total funding through these programs executed by the line ministries is approximately Rp668.1 billion. (These figures are cited from the original 2015 State budget, rather than the amended version, since the details of the amended 2015 State budget were not available during the preparation of this report.)

The administration of these programs is simpler than for the programs executed by PLN. Generally, they follow the process outlined for the DGNREEC systems in Permen ESDM 10/2012. A Pemda can propose a qualifying project to the line ministry, which, if it approves, will procure the facility out of its own budget and then hand it over to the Pemda after commissioning. The Pemda is responsible for the operation of the system and periodic operational reporting.

These programs may incorporate M&E activities. The DGNREEC program on rural electrification, including provision of solar home systems and photovoltaic minigrids, incorporates a "simple" form of monitoring to ensure that the construction of the system has been completed. This is conducted on a project-by-project basis. However, GIZ-financed support provided to the DGNREEC through the EnDev project specifically includes M&E among its objectives. It carried out a rigorous, programmatic M&E of 136 microhydro projects and 112 photovoltaic minigrids that were commissioned by the EBTKE from late 2012 to early 2013. This effort continued through 2014.

However, these line ministry programs often focus exclusively on the installation of prepackaged solutions, with little attention to the needs of specific communities or the long-term financial and technical sustainability of the projects. For example, the Deliverable B report found that a large number of solar home systems and some photovoltaic minigrids on Sumba had failed after only a short period of operation (e.g., 1–3 years). Of the 47 minigrid photovoltaic systems that had been installed on Sumba, only 19 were fully or partially operational.

Of these 47 minigrids, 31 had been established under the PNPM program, and of those, only five were fully or partially operational. Projects funded by the MEMR and the KPDT fared better. Out of 13 such projects, only the two oldest projects (established in 2007 and 2008) were no longer operational. Nonetheless, further attention to the long-term sustainability of these systems is required.

2.4.3 Pemda Programs

The Pemdas also have their own regional budgets (*Anggaran Pendapatan dan Belanja Daerah*, APBD). Because the Pemdas in the poorer regions have limited scope to raise their own funds through local taxes and nontax fees, most of their funds are provided by transfers from the central government. Nationally, transfers from the central government made up nearly two-thirds of the total APBD revenues, whereas for eastern Indonesia this portion increases to nearly three-quarters.

About one-third of the 2015 APBN is transferred to the Pemda and the *desa*. About 55% of this transfer is through the general allocation fund (*dana alokasi umum*, DAU). This funding is used for the operational expenses of the Pemda, such as government salaries. Another 40% represents special autonomy funds, teachers' salaries, production sharing revenue, and other Pemda-specific funding (including about 1% to *desa* administrations).

The remaining 5% (Rp35.8 trillion in 2015) is distributed through the DAK, which is provided by the government for national priority programs in areas such as health, education, and infrastructure. This funding is available to any Pemda that meets the program criteria. About Rp0.7 trillion of the DAK has been budgeted for rural energy in 2015.

The Pemdas are free to use other funds out of their budgets for rural energy or electrification projects as they may decide. However, given the heavy reliance on transfers from the central government, and that Pemdas spend, on average, only about 25% of their budgets on all capital expenditure,[21] the DAK likely represents the principal source of Pemda spending on electrification. More generally, average "fiscal space" (the percentage of budget available for discretionary expenditure by the Pemda) for APBD nationally is approximately 40%, though in regions such as Nusa Tenggara Timur and Nusa Tenggara Barat, it is between 25% and 30%.

Criteria to access the DAK funds are defined by the line ministries. The line ministries prepare detailed technical instructions (*petunjunk teknis*, juknis) governing how the funds for a particular program are to be used. These technical instructions may be updated annually. Qualifying Pemdas are then expected to follow these guidelines while using the funding. The line ministries preparing such guidelines can vary year to year. For example, the KPDT prepared guidelines for the use of DAK funds for rural energy through budget year 2012, but has not done so since then.

Permen ESDM 3/2014 outlines how the DAK for rural energy may be accessed and used. The funding is available for off-grid microhydroelectric, household biogas, and photovoltaic minigrids or individual household systems. With respect to electricity, the purpose of the funding is to provide supply in areas not served by

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21 In regions with low electrification ratio, such as Nusa Tenggara Timur, Nusa Tenggara Barat, and Maluku, the percentage of APBD spent on capital projects is about 20%.

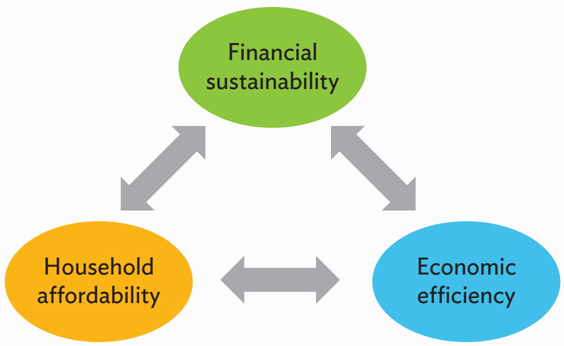
PLN. Until this year, the funding and the physical implementation of the project were the responsibility of the regional government work unit (*Satuan Kerja Perangkat Daerah*, SKPD) handling energy. However, Law 23/2014 on regional government removes district-level government from electricity planning, regulation, and implementation. Regional government involvement is now concentrated at the provincial level.

2.5 Financing Electrification

2.5.1 Considerations for Electrification Financing

The fundamental challenge of financing electricity access scale up is to simultaneously balance the three considerations shown in Figure 2.6.

Figure 2.6: Three Dimensions of Financing Electricity Access Scale Up



Source: Author.

(i) **Financial sustainability.** Regardless of whether the public or private sector is responsible for electricity access scale up, the long-term nature of the undertaking requires that implementing organizations earn sufficient revenue to support their investments and operations, and that the government can bear the funding required for subsidies.

(ii) **Household affordability.** Electricity access scale up can achieve its electrification target only if both initial connection costs and subsequent costs of consumption are affordable to households. Particular consideration must be given to poor households.

(iii) **Economic efficiency.** The resources available for electricity access come at a high cost. Pricing of electricity supply, and the associated subsidies to consumers and producers, should be designed to promote economic efficiency so as to ensure that limited resources yield maximum benefits.

The financial sustainability of electricity access scale up program means that the following equation must hold:

Revenue Requirements = Consumer Payments + Government Subsidies

The "revenue requirement" is the amount of revenue an organization providing electricity service must receive to cover its costs (both capital and operating) and earn a profit. "Consumer payments" are the connection fees and tariffs paid by consumers to the service provider. These may incorporate cross-subsidies between tariff classes. "Government subsidies" are funds paid or other benefits extended by the government to the service provider for delivering the service or making the necessary investments.

Revenue requirements are based on the costs of generation, transmission, distribution, and retailing. Efforts for procurement standardization, competitive bulk procurement, energy efficiency, loss reduction, and prudent asset maintenance and management go hand in hand with access scale up by reducing revenue requirements, and freeing up resources for investment to expand electrification.

Because the revenue requirement depends in part on the electrification targets and standards that have been set by the government, if available funds are insufficient to support the revenue requirement, then the government may choose to modify these targets and/or standards to reduce the revenue requirement in an effort to ensure financial sustainability.

Though household electrification has a high socioeconomic value, it does not mean that households can readily afford it. *Consumer payments* must therefore be carefully designed to ensure that all target groups gain access to electricity. High connection costs in particular can be serious impediments to electrification uptake. Successful access scale up programs in other countries have specifically addressed connection costs. Indonesia has done so through the *Program Listrik Hemat dan Murah*.

Alternatively, *government subsidies* transfer funds or other benefits derived from taxpayers or government nontax revenue to electricity producers or consumers. Funding for subsidies might also originate from external sources such as development partners or banks through grants and loans. Government subsidies could also include sovereign guarantees extended to private investors, which would be recognized as contingent liabilities on the government's balance sheet.

Effective subsidy schemes are well targeted to the desired beneficiaries, are transparent in design and administration, are based on sound analysis of costs and benefits, and have clear conditions for continued application, while preserving incentives for efficient delivery and consumption of electricity.

The government therefore must establish a framework that ensures:

(i) the electricity supplier earns enough revenue to invest and operate in a financially viable manner. Capital and operating costs typically increase as service extends into remote, low-load areas;

(ii) the prices paid by households to get connected and consume electricity are affordable. Lower prices are needed to extend service to the poor households or into remote areas where household incomes typically decline; and

(iii) the government is able to fund and sustain the subsidies (and/or implement cross-subsidies) required for household affordability and the financial viability of the supplier.

2.5.2 Current Financing Flows

Electrification funding originates from three sources:

(i) PLN's own budget (including any PLN corporate borrowing; PLN does not use project finance);

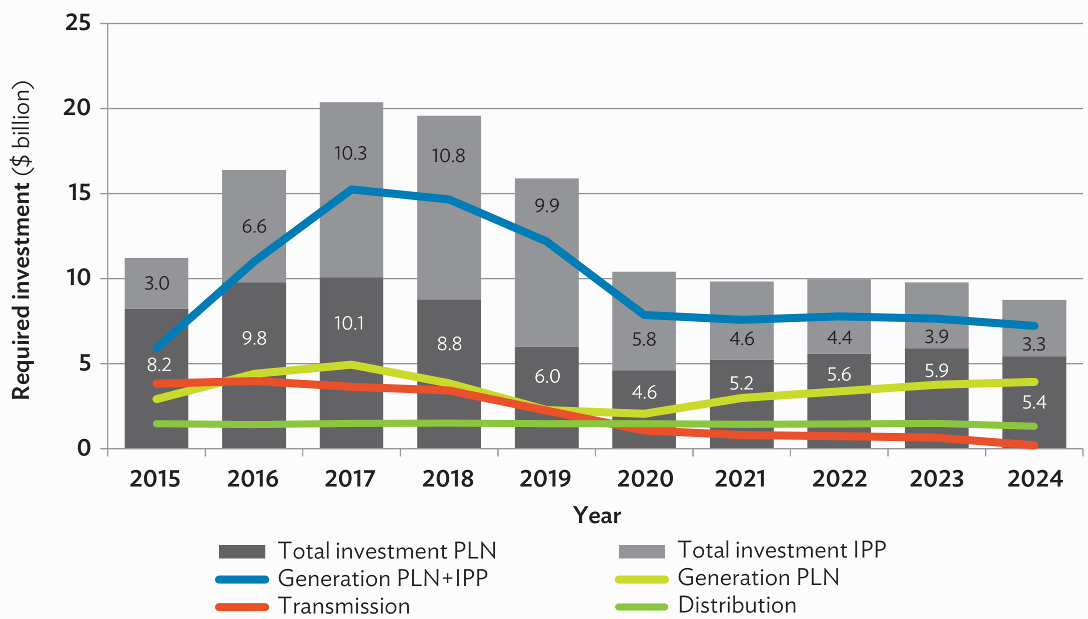
(ii) APBN (which may be delivered directly as projects by the line ministries, or as PLN equity); and

(iii) Regional Government Budget (APBD) (principally through the DAK provided from the APBN).

In 2013, PLN added a total of nearly 3.7 million residential customers of which only 220,000 were connected through the APBN-funded LisDes program. The cost of adding all residential consumers should be counted as expenditure for electrification, since it is this total that contributes to the electrification ratio. Moreover, without corresponding investments in generation, transmission, and distribution, it would not be possible to serve these new customers. And given that most currently unserved households are located in western Indonesia, PLN investment across Indonesia should be counted.

Therefore, for the purposes of estimating electrification financing flows, the total PLN investment is counted. The 2015–2024 RUPTL projects the investment of PLN to be $8.2 billion in 2015, or about Rp102.5 trillion at an exchange rate of $1 = Rp12,500 (although a lower rate may have been used when the RUPTL was prepared). Investment in IPPs has been omitted here on the crude assumption that this additional generation capacity is required for nonhousehold consumption. Figure 2.7 shows the projection of power sector investment needs of PLN from the 2015–2024 RUPTL.

Figure 2.7: PLN Projection of Power Sector Investment Needs



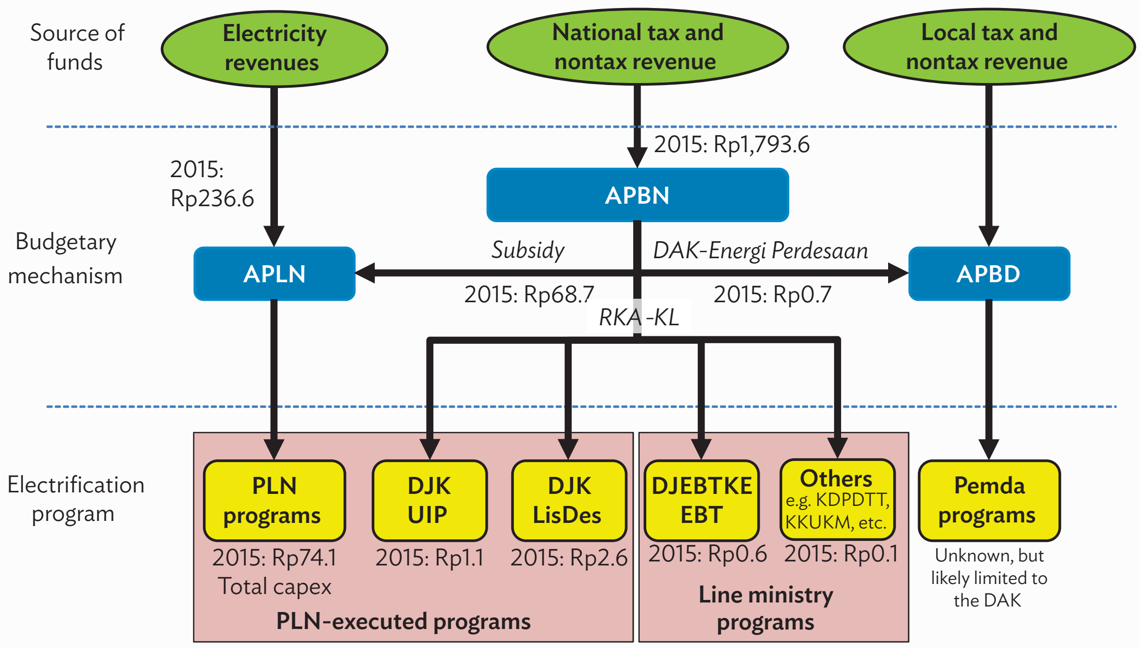
IPP = independent power producer, PLN = State Electricity Company.

Source: PLN. 2014. *Electricity Power Supply Business Plan (RUPTL 2015–2024)*. Jakarta.

The projection of the total PLN investment shown in Figure 2.7 was prepared in 2014. PLN has recently forecast its total capital expenditure for 2015 to be Rp74.1 trillion (the exchange rate assumed by PLN for the forecast is unknown).

This lower number is used to provide a reference for the relative flows of electrification funding (Figure 2.8). Other values noted in this figure are also subject to change. As noted previously, the 2015 APBN budget has recently been revised, and some savings from the reduction in fuel subsidies are understood to have been reprogrammed to the LisDes, resulting in a subsidy of Rp66.6 trillion.

Figure 2.8: Current Electrification Funding Flows



APBD = Regional Government Budget, APBN = National Government Budget, APLN = PLN budget, DAK = Special Allocation Fund, DJEBTKE = Directorate General of New and Renewable Energy and Energy Conservation, DJK = Directorate General of Elecricity, EBT = new and renewable energy, KDPDTT = Ministry of Villages, Development for Disadvantaged Regions, and Transmigration, KKUKM = Ministry of Cooperatives and Small and Medium Enterprises, LisDes = Rural Electrification, Pemda = Regional Government, PLN = State Electricity Company, Rp = rupiah.

Note: All values stated in trillion rupiah, as originally budgeted or forecast. It is understood the 2015 APBN has been revised to increase LisDes funding by an additional Rp1.3 trillion.

Source: Asian Development Bank.

Most funding flows into electrification programs executed by PLN, even if PLN's own capital expenditure is not considered; the 2015 LisDes alone was originally funded at Rp2.6 trillion (approximately $206 million) and is understood to have been increased to Rp3.6 trillion (approximately $288 million). The funds flowing into the line ministry and the DAK programs are also substantial, budgeted at Rp1.4 trillion for 2015 (approximately $112 million).

Clearly, Indonesia devotes significant funding to electrification. However, there is no explicit linkage between the level of funding that is allocated and the electrification target. Consequently, it is unknown whether the current funding levels, despite their magnitude, are sufficient to achieve the government's electrification targets. Moreover, in the absence of an overarching planning or coordination framework, the multiplicity of electrification programs is unlikely to achieve the desired outcomes in an efficient manner.

The above discussion focuses on electrification financing flows within PLN, the government, and the Pemda because there are no other organizations or groups that conduct electrification on a significant scale. If other groups, such as the private sector, are to be mobilized to participate more broadly in electrification efforts, financing mechanisms must be established for them as well. Such options are discussed in Chapter 5.

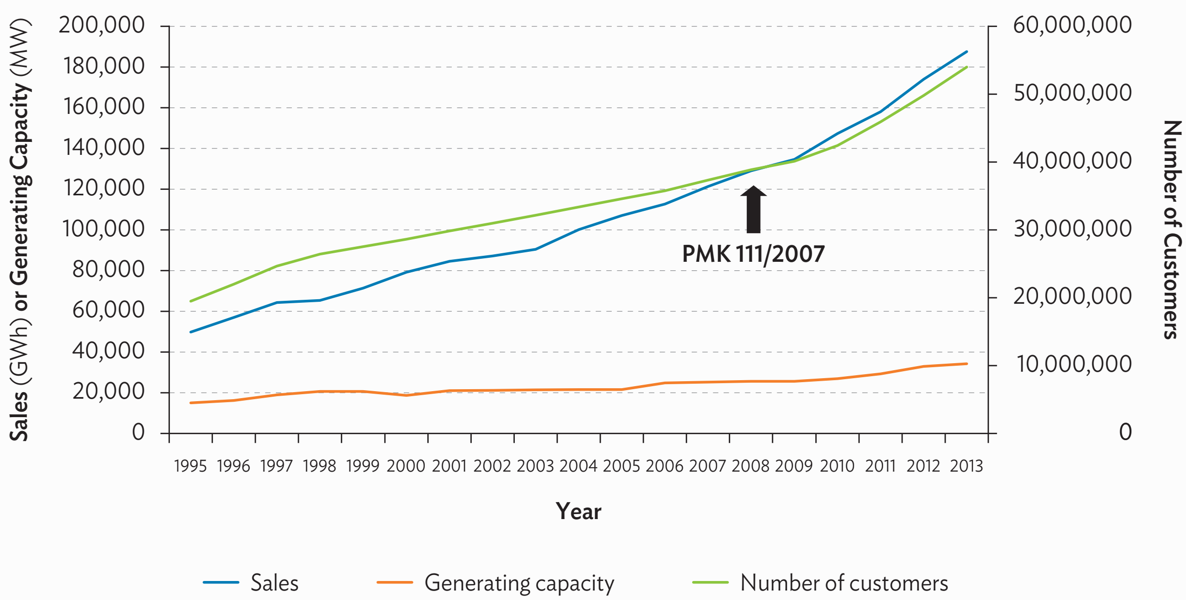
2.5.3 PLN Subsidy

Law 19/2003 obliges the government to subsidize any state-owned enterprise that it assigns to undertake a service to consumers at below cost, that is, to provide subsidies for public service obligations. The amount of the subsidy must be sufficient to cover all costs plus a margin. PMK 170/2013 stipulates how the subsidy is calculated for PLN. To determine the subsidy payment, the government currently grants PLN a 7% margin on allowable costs (Starting in 2017, the PLN subsidy will be based on PMK 195/2015).

Prior to the Asian financial crisis that started in 1997, PLN was not subsidized, though the tariff structure provided cross-subsidies. Tariffs were automatically adjusted quarterly based on changes in external indices such as the foreign exchange rate. However, when the rupiah depreciated rapidly starting late 1997, the government's attempt to adjust the prices for fuel and energy led to the downfall of the Suharto regime in 1998. The automatic tariff adjustment mechanism was suspended, and in the following 14 years, tariffs were adjusted only once (in 2003).

This crippled PLN financially, and the government was forced to provide financial support to PLN. This started on an ad hoc basis, and Law 19/2003 subsequently provided a legal basis for the subsidy. However, these early ad hoc subsidies aimed only to stanch the bleeding. They did not incentivize PLN to add rural consumers, who create the greatest losses (due to the nature of rural distribution), have the lowest load factors (so that the capital cost of generation, transmission, and distribution infrastructure required to serve these customers is greater per kilowatt-hour delivered than for other customer classes), and relative to other tariff classes account for the largest share of peak period energy, which at the margin is typically the most costly to generate. Though they are the costliest to serve, they pay the lowest tariffs.

Figure 2.9: Residential Customers, Energy Sales, and Generation Capacity by Year



GWh = gigawatt-hour, MW = megawatt, PMK = Ministry of Finance Regulation.

Source: Author compilation of historical PLN data.

Figure 2.10: New Residential Connections and Government Subsidy by Year

GWh = gigawatt-hour, MW = megawatt, Rp = rupiah.

Source: Author compilation of historical data from PLN.

The precursor to PMK 170/2015, PMK 111/2007 provided a formulation that enabled PLN to provide electricity to millions of new consumers every year while maintaining sufficient financial viability of the company to access global bond markets. The impact of this subsidy mechanism on the rate of new residential connections is shown in Figures 2.9 and 2.10.

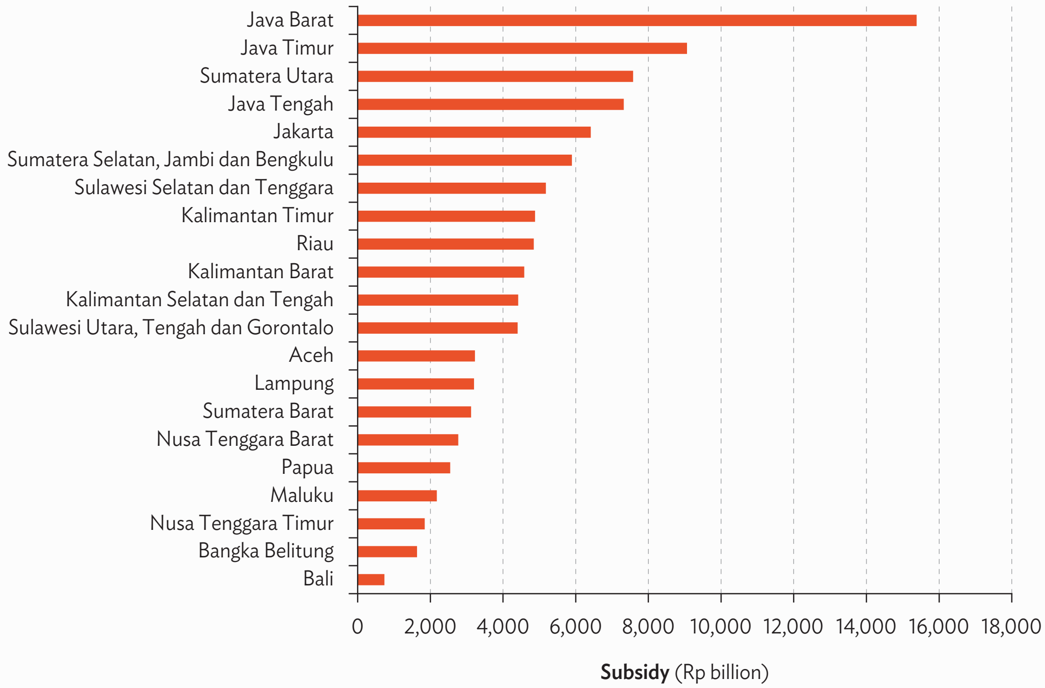
Until recently, all tariff classes received some subsidy, and it was convenient to subsidize PLN at the corporate level rather than on the basis of service to particular tariff classes.[22] However, regional differences in the cost of supply and the number and composition of customers means that, in fact, there are striking differences between regions in terms of electricity subsidy.

Figure 2.11 shows the total electricity subsidy per region based on data provided by the DGE for 2013, the most recent year for which audited results are available. The total electricity subsidy paid that year was Rp101.2 trillion. Java Barat (West Java), which has the next lowest cost of supply after Jakarta, accounted for the largest subsidy. Though West Java has the highest number of unelectrified households among all provinces in Indonesia, it is questionable whether delivering such a large subsidy to one of the most economically advanced regions in the country is the most effective way to achieve universal access to electricity and promote economic growth.

Figure 2.12 shows the cost of supply and average tariff yield by region. In general, regions with the highest cost of supply are those with the lowest electrification ratios. The cost of supply quantifies the difficulties involved in providing electricity to a particular region, and highlights the need for new technologies and business models for electrification, as well as increased financial support from the public sector.

[22] This has changed with the implementation of Permen ESDM 31/2014 and Permen ESDM 9/2015, which now establish cost-reflective tariffs for all consumers except households with connections of 900 VA or less.

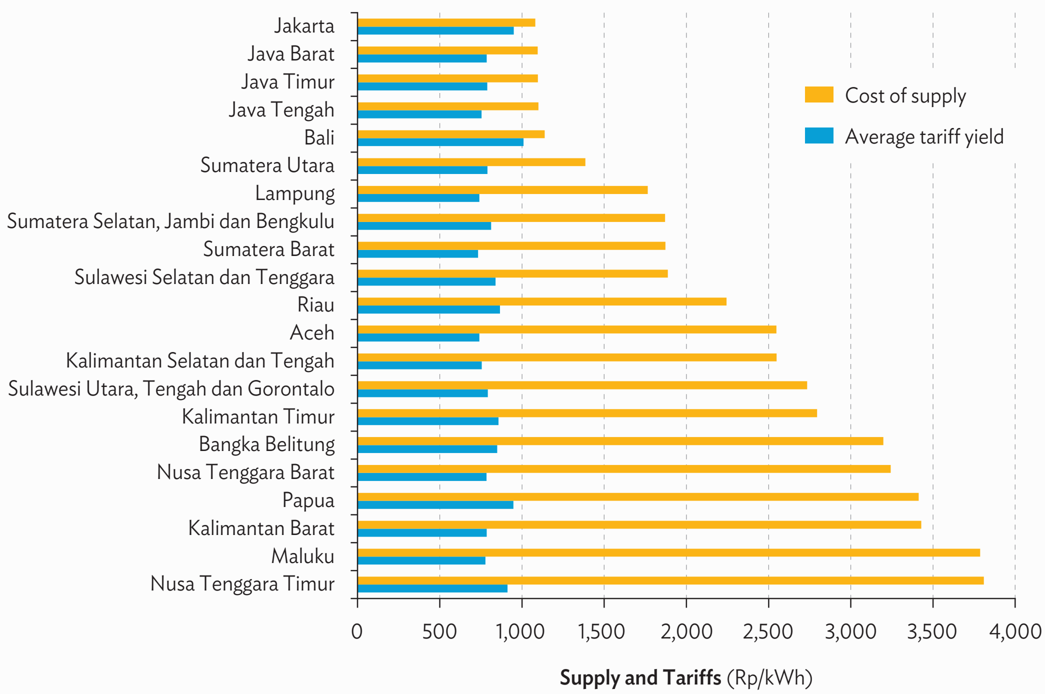
Figure 2.11: Total Electricity Subsidy by Region, 2013



Rp = rupiah.

Source: Directorate General of Electricity.

Figure 2.12: Cost of Supply and Tariff Yield by Region, 2013



kWh = kilowatt-hour, Rp = rupiah.

Source: Directorate General of Electricity.

The government has recognized the need to rationalize tariffs in line with Law 30/2009, which obliges the government to subsidize supply only to the poor and remote areas. Permen ESDM 31/2014 represents a major milestone in this process as it brought tariffs for several classes closer in line with the cost of supply, and more importantly, reintroduced the automatic tariff adjustment mechanism. This updated adjustment mechanism is applied monthly to 12 tariff classes. Permen ESDM 9/2015 extends this treatment to residential consumers with R-1 1,300 VA and 2,200 VA connections. The automatic tariff adjustment mechanism adjusts tariffs based on the following indices:

(i) the $/Rp exchange rate,

(ii) the Indonesian crude oil price, and

(iii) inflation.

Re-introducing an automatic adjustment mechanism is a cornerstone of the government's subsidy road map (Table 2.2), which here has been updated to account for the impacts of Permen ESDM 31/2014 and Permen ESDM 9/2015.

Through this initiative, the government will target electricity subsidies better. Ultimately, the savings can then be used to subsidize electricity infrastructure for remote areas and connections, and supply for the poor, as required by law. This will allow the government to transition its principal financial support for electrification from a subsidy that covers allowable expenses to capital injections or other forms of direct capital support. Given that the current level of the annual electricity subsidy is nearly equivalent to PLN's total annual capital expenditure, and some 26 times greater than the level of LisDes funding in the original 2015 APBN, saving even a fraction of the current subsidy and reapplying it for electrification infrastructure may have a huge impact on the ability to achieve universal access.

Regardless of what other players are mobilized to scale up access, PLN will remain the leading agent of electrification. However, its ability to borrow is constrained by its covenants on its global bonds, which require a consolidated interest cover ratio of at least 2.0 and debt service coverage ratio (DSCR) of at least 1.5. Figure 2.13 shows the level of these indicators for PLN over 2002–2013, as reported in the 2015–2024 RUPTL.

During the early years of this period, PLN had substantial flexibility in terms of these indicators, principally because it had stopped borrowing during the Asian financial crisis. In more recent years, though, these indicators have converged to near the covenant limits. Increasing tariffs incrementally will not help improve the ability of PLN to borrow, since this would only be offset by reductions in the subsidy.

Rather, an obvious solution would be for the government to reinvest the savings from better targeting of subsidies as equity for electricity supply infrastructure required to increase the electrification ratio. This and alternatives are discussed in Chapter 5.

Table 2.2: Subsidy Road Map Updated for Permen ESDM 31/2014

	Tariff Category	2013	2014	2015	2016	2017	2018
1	R–3 6.600 VA and above B–2 6.600 s.d 200 kVA B–3 = 200 kVA P–1 6.600 s.d 200 kVA	Subsidy reduction through gradual tariff increases	*ATAM*	*ATAM* Simplification of tariff category	*ATAM*	*ATAM*	*ATAM*
2	I–3 = 200 kVA *go public* I–4 30.000 kVA and above		Subsidy reduction through gradual tariff increases	*ATAM* Simplification of tariff category	*ATAM*	*ATAM*	*ATAM*
3	I–3 >200 kVA *non go public* R–2/>3.500 s.d 5 500 VA P–2/>200 kVA R–1 2.200 VA P–3 R–1 1.300 VA		Subsidy reduction through gradual tariff increases	*ATAM* Simplification of tariff category	*ATAM*	*ATAM*	*ATAM*
4	S–2 2.200 VA S–2 3.500 VA S–3 >200 kVA B–1 2.200 s.d 5.500 VA I–1 2.200 VA I–1 3.500 s.d 14 kVA I.2/>14 kVA s.d 200 kVA P–1 2.200 s.d 5.500 VA			Simplification of tariff category	Subsidy reduction through gradual tariff increases – 4% per quarter	Subsidy reduction through gradual tariff increases	*ATAM*
5	S–2 1.300 VA B–1 1.300 VA I–1 1.300 VA P–1 1.300VA			Simplification of tariff category	Subsidy reduction through gradual tariff increases – 4% per quarter	Subsidy reduction through gradual tariff increases	*ATAM*
6	S–2; 450 s.d 900 VA R–1/ 450 s.d 900 VA B–1/ 450 s.d 900 VA I–1/ 450 s.d 900 VA P–1/450 s.d 900 VA			Simplification of tariff category	Application of progressive tariff Block I – up to 60 kWh – Subsidized Tariff Block II for over 60 kWh – subsidy reduction through gradual tariff increases – 4% per quarter	Application of progressive tariff Block I – up to 60 kWh – Subsidized Tariff Block II for over 60 kWh – subsidy reduction through gradual tariff increases – 4% per quarter	Application of progressive tariff Block I – up to 60 kWh – Subsidized Tariff Block II for over 60 kWh – subsidy reduction through gradual tariff increases – 4% per quarter

ATAM = automatic tariff adjustment mechanism, kWh = kilowatt-hour, VA = volt-ampere.

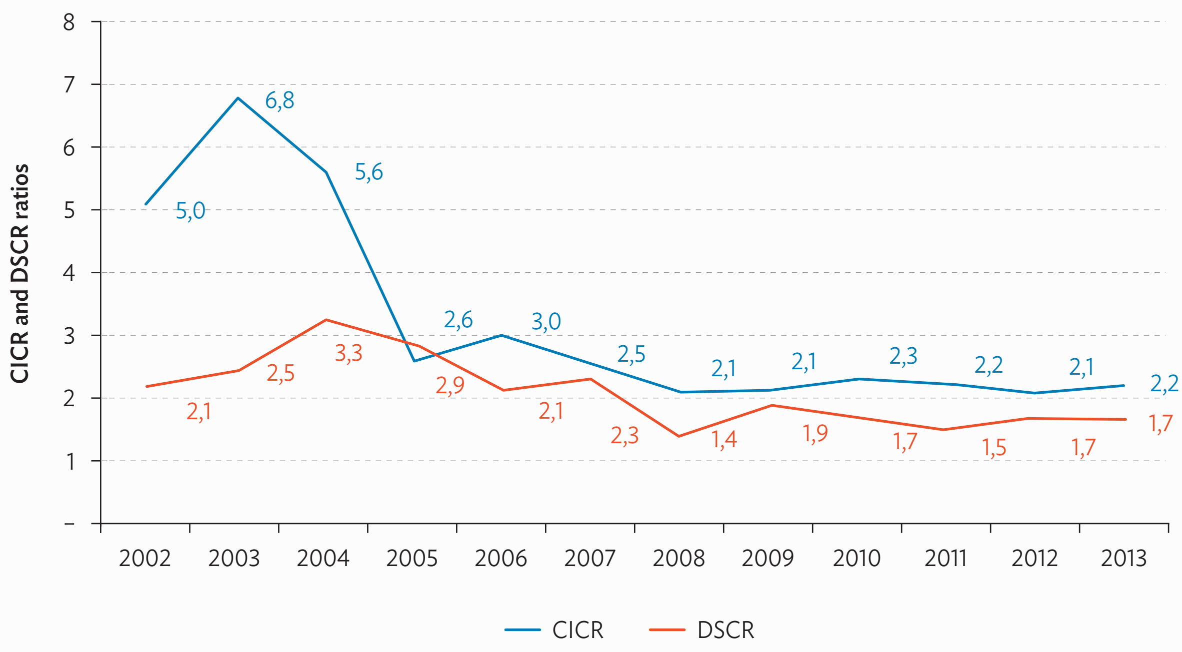
Source: Directorate General of Electricity, with author modifications.

2.5.4 Household Willingness to Pay

Universal access can be achieved only if electricity remains affordable to low-income households. PLN prices electricity according to customer type (e.g., residential, commercial, industrial) and the voltage level and amperage of the connection. The tariff class serving the lowest income households typically uses a 450 VA breaker (the R-1 450 VA class).[23] Consumption in this class averages about 40 kWh/month nationally, and the average tariff yield is about Rp426/kWh.

As part of the technical assistance provided by ADB under TA 8287-INO Scaling-up Renewable Energy Access in Eastern Indonesia, a report was developed which assessed energy resources and conducted an electricity demand analysis for Sumba Island.[24] This report analyzed household willingness to pay (WTP) for electricity based on 2012 National Socioeconomic Survey (SUSENAS) data for Sumba. Though the data are limited to that one island, these results are likely indicative of the behavior of low-income households in Indonesia more broadly, particularly in areas with low electrification ratios. The resulting demand curves for the bottom two expenditure quintiles, the average household, and the upper two expenditure quintiles are shown in Figure 2.14.

Figure 2.13: Consolidated Interest Cover Ratio and Debt Service Coverage Ratio of PLN, 2002–2012



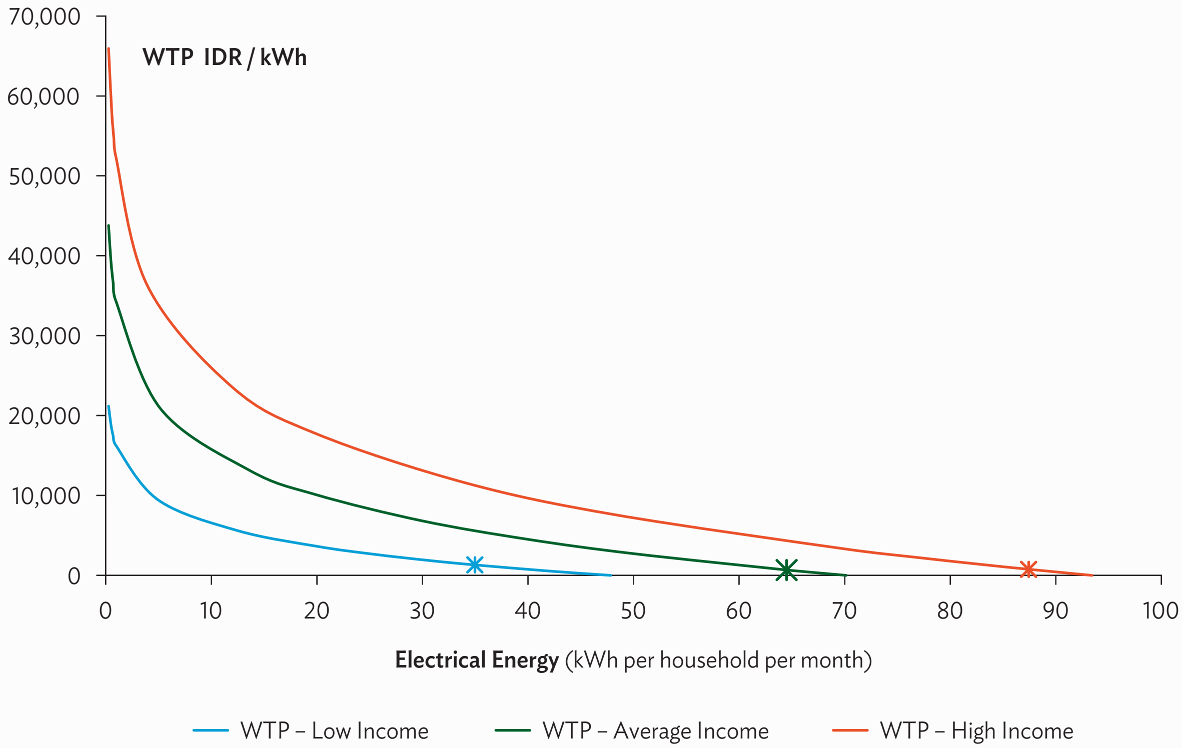
CICR = consolidated interest cover ratio, DSCR = debt service coverage ratio, PLN = State Electricity Company.

Source: PLN. 2014. *Electricity Power Supply Business Plan (RUPTL 2015–2024).* Jakarta.

[23] SEHEN customers are counted under the S-1/220 VA class. Customers pay a fixed Rp35,000 per month, and receive service equivalent to 1–2 kWh per month.

[24] ADB. 2014. *Energy Resources for Grid Supply and Electricity Demand Analysis for Sumba.* Prepared under the ADB technical assistance project, TA-8287. http://www.adb.org/projects/45274-001/main

Figure 2.14: Household Willingness to Pay for Electricity in Sumba, 2012 Data



kWh = kilowatt-hour, Rp = rupiah, WTP = willingness to pay.

Source: ADB. 2014. *Energy Resources for Grid Supply and Electricity Demand Analysis for Sumba.* Prepared under the ADB technical assistance project, TA-8287.

These findings suggest the following:

(i) At prevailing grid electricity prices, households are consuming electricity (marked by "*") close to the limits set by their ability to pay for the appliances that consume electricity. That is, even if electricity were free, households would not consume much more because they could not afford more appliances (or in the case of lighting, they have already saturated their demand);

(ii) While WTP for the first kWh of electricity is much higher than current tariffs, these limits can be quickly reached, as with SEHEN systems. These systems provide 1–2 kWh per month for the most basic needs, but at a price of Rp35,000 per month, the cost exceeds the WTP of households in lower-income groups for this level of service; and

(iii) Any program intended to reach households that are not governed by the uniform national tariff (e.g., non-PLN off-grid supply) will have to take this into account when setting cost recovery or subsidy mechanisms to ensure both financial viability of the programs as well as affordability to consumers. Since most households in remote areas will be in the lower expenditure classes, findings for low expenditure households should provide the reference.

Households must be able to afford the cost of the initial connection as well as that of ongoing consumption. Consistent with the uniform national tariff, the connection cost for the R-1 450 VA tariff class is fixed at Rp362,500 (~$29) throughout the country. This does not include any interior wiring or service panel. The cost of higher amperage connections increases accordingly; for example, a 900 VA connection costs Rp700,000. In addition, deposits are required for postpaid customers.

The impact of connection costs on household willingness to connect cannot be analyzed with the SUSENAS data because (i) it is unknown as to which households had to pay for electricity connections and which received electricity connections for free as part of the government's *Listrik Hemat dan Murah* program, which pays for connections and basic interior wiring; and (ii) it is unknown when households received their connections, or in the case of unelectrified households, whether they would be able to get a connection even if they were willing and able to pay for one.

However, the SUSENAS data for Sumba indicate that for the lowest household expenditure quintile (in which about 11% of households have been provided with electricity), the total average monthly household expenditure is about Rp800,000. Given that a connection excluding the cost of internal wiring is nearly half of the total monthly expenditure of a household, it is expected that connection costs will be an impediment to achieving universal access. Expansion of the *Listrik Hemat dan Murah* program is likely required, perhaps as part of a rebalancing of the distribution of subsidized supply from the areas with the most consumers to the areas with the lowest electrification ratios.

3 Challenges to Achieving Universal Access

Indonesia has established a strong foundation for achieving the goal of universal access to electricity:

(i) high-level targets for electrification, which are embedded in the fundamental guiding energy policies and plans of the country;

(ii) a strong national utility that continues to provide new connections to millions of households every year throughout the country;

(iii) a subsidy mechanism based on law that ensures affordability to the consumer and the financial viability of the supplier; and

(iv) hundreds of millions of dollars per year in direct government financing for electrification programs.

However, as noted earlier in this report, the mechanisms required for electrification of the last 16% of the population often differ from those enabling electrification of the first 84%. Access is more difficult, costs are higher, off-grid solutions take on greater prominence, subsidy and capital investment support mechanisms need to be reconsidered, and efficiency of the effort becomes critical. Based on the preceding review of the current electrification environment in Indonesia, there are four areas that Indonesia must address to achieve universal access:

(i) link funding to targets;

(ii) ensure necessary funding is delivered as effectively as possible;

(iii) develop a single, least-cost plan to guide and coordinate all efforts; and

(iv) develop sustainable off-grid delivery models.

Each of these issues is discussed in turn below.

3.1 Financial Adequacy: How Much is Enough?

The State Electricity Company (PLN) plans to spend Rp74.1 trillion (approximately $5.9 billion) on power sector infrastructure in 2015. The government has budgeted at least an additional Rp3.7 trillion (approximately $296 million) specifically for network development and rural electrification as well as Rp1.4 trillion (approximately $112 million) for off-grid projects. Similar amounts are projected for future years.

The LisDes program currently extends service to households at a cost of about $1,000 per household. Out of the 3.7 million households connected by PLN in 2013, approximately 220,000 were connected by the LisDes program funded through the national government budget, and perhaps 50% of that number[25] was connected

[25] Based on a review of Nusa Tenggara Timur Road Map LisDes of PLN2013–2017.

under the LisDes program financed through PLN budget. Therefore, in 2013, approximately 10% of new connections were made through the LisDes program at a cost of approximately $1,000 per household, while the rest were in-fill connections made at an assumed cost of approximately $250 per household.

Clearly, these are substantial amounts. But is it enough to achieve the electrification targets the government has put forward?

No one knows. The government and PLN have demonstrated a strong and continuing commitment to electrification, but there is no evidence of any rigorous analysis to determine the funding required to achieve near-universal access by 2020. Simply using rules of thumb based on past experience to estimate future needs will underestimate the funding required, since in general it will be considerably more expensive per household to connect the remaining 16% of households than for those that have already been provided with electricity, that is, electrification efforts will be characterized by increasing marginal cost of supply as the electrification ratio increases.

PLN has estimated the physical infrastructure and costs for rural electrification activities in the RUPTL, as summarized in Table 3.1. However, these estimates

(i) do not include off-grid systems, which will play an increasing role in achieving universal access;

(ii) appear far lower than the infrastructure additions identified in PLN Road Map LisDes 2013–2017. For example, a summary of all PLN Road Map LisDes 2013–2017 compiled by the Directorate General of Electricity indicates much higher physical quantities for the years 2015–2017; and

(iii) do not take into account inflation or the likely increase in the number of households requiring electricity connections for free.

Table 3.1: Rural Electrification Forecast of PLN

Component	Units	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
MV line	km	3,530	4,866	5,143	5,552	5,986	6,110	6,232	6,370	6,496	6,639	56,924
	billion Rp	1,366	1,957	2,064	2,227	2,404	2,460	2,502	2,548	2,608	2,656	22,794
LV Line	km	3,611	4,916	5,204	5,635	6,071	6,173	6,339	6,510	6,607	6,785	57,851
	billion Rp	649	896	950	1,028	1,110	1,130	1,161	1,190	1,210	1,241	10,566
MV/LV Transformers	MVA	147	208	222	238	257	260	266	271	277	283	2,430
	number	2,367	3,191	3,374	3,638	3,923	3,991	4,088	4,186	4,261	4,364	37,382
	billion Rp	338	482	512	551	593	603	618	632	644	659	5,633
Number of Customers	thousands	209	259	275	296	318	324	332	338	346	353	3,049
Customers receiving free connections (Program Listrik Murah dan Hemat)	'000 HH	93	93	93	93	93	93	93	93	93	93	933
	billion Rp	210	210	210	210	210	210	210	210	210	210	2,100
Subtotal Lines + Trans.	billion Rp	2,353	3,334	3,527	3,806	4,107	4,193	4,281	4,371	4,463	4,556	38,993
Total Cost	billion Rp	2,563	3,544	3,737	4,016	4,317	4,403	4,491	4,581	4,673	4,766	41,093

HH = households, km = kilometer, LV = low voltage, MV = medium voltage, MVA = megavolt-ampere, PLN = State Electricity Company, Rp = rupiah.

Note: 2015 figures are based on 2015 Ministerial and Institutional Work Plan and Budget, Directorate General of Electricity.

Source: PLN. 2014. *Electricity Power Supply Business Plan (RUPTL 2015–2024)*. Jakarta.

Also, the Road Map LisDes that has been prepared to date by each PLN is conducted at the level of the *desa.* This is insufficiently granular to capture the actual number of households or their geospatial distribution required to estimate electrification costs. On Sumba, for example, the largest *desa* in 2011 was 225 km^2, and the most populous *desa* had over 11,000 inhabitants.

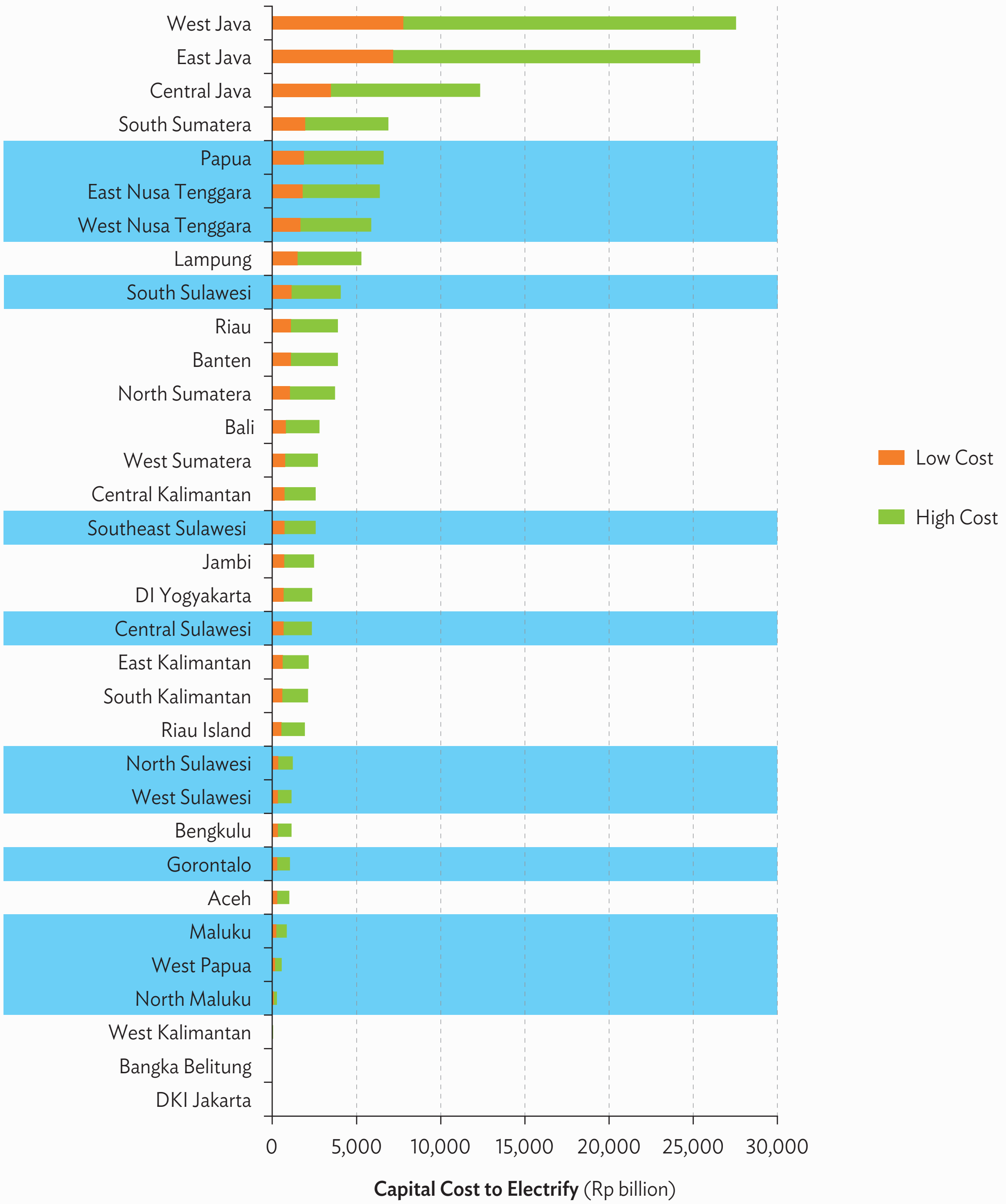
The investment required to achieve universal access can be estimated as a range in which the lower bound is based on the estimates of PLN in the RUPTL 2015–2024 (Table 3.1), and the upper bound is based on the analysis from Sumba conducted under ADB TA 8287-INO: Scaling Up Renewable Energy Access in Eastern Indonesia. Both of these sources provide an average cost to provide electricity to a household. Since the number of households that do not yet have electricity is known, multiplying these unit costs by the number of households without electricity adjusted for the portion that will not be in-fill connections provides a rough estimate of the investment needs. Both of these figures exclude the cost of additional grid-connected generation needed to serve the new demand:

(i) **Low-cost assumption.** This case is based on the figures from PLN (Table 3.1). Given that there are 10.4 million households currently without electricity, the plan of PLN to connect some 3 million users over the next 10 years through rural electrification programs implies that about 30% will require rural electrification infrastructure; this portion is assumed to be uniform across provinces. Based on Table 3.1 as well as the 2014 LisDes budget, the capital cost of this infrastructure is approximately $1,000 per household.

(ii) **High-cost assumption.** Alternatively, the Sumba analysis indicates an average capital cost of about $1,760 per target household to achieve 95% electrification ratio there. This includes in-fill, grid extension (but not grid generation), as well as off-grid supply, which is typically characterized by much higher investment costs per household given the reliance on renewable energy (which typically has lower operating costs). Because this figure already takes into account in-fill connections, this per household cost is applied to all unelectrified households.

Using these figures as upper and lower bounds, and taking into account the approximately 10.4 million households still to be provided with electricity, a first-order estimate of the capital cost to provide these households with electricity is Rp41 trillion–Rp238 trillion (approximately $3 billion–$18 billion). This is some 8–48 times the average annual public investment in electrification at present. Clearly, funding at current levels will not achieve near-universal access by 2020. Interestingly, about 23% of this investment is needed for eastern Indonesia, whereas 77% is needed for western Indonesia. Java alone represents 46% of the required investment. Figure 3.1 shows investment requirements by province. Those shaded blue are provinces in eastern Indonesia.

Figure 3.1: Required Electrification Investment to Achieve Universal Access by Province



DI Yogyakarta = Special District of Yogyakarta, DKI Jakarta = Special Capital City District of Jakarta, Rp = rupiah.

Note: Those shaded blue are provinces in eastern Indonesia.

Source: Author estimates.

3.2 Funding Effectiveness

A related issue is *how* the required amount should be funded. As pointed out in Chapter 2, PLN is nearing the debt ceiling imposed by its global bond covenants. Entrusting the responsibility to provide electricity with the private sector without any subsidies would result in tariffs that exceed willingness to pay in the most remote areas, or otherwise burden the least financially capable households with the highest electricity rates, contrary to the philosophy of a uniform national tariff and the intent of Law 30/2007 and Law 30/2009.

The existing LisDes mechanism is cumbersome and is unlikely to provide an effective mechanism for funding electrification scale up by PLN for the following reasons.

(i) As with any program involving three different agencies with different interests (national government, local government, and PLN), decision making can be slow and project selection and implementation can be influenced by nontechnical factors. In particular, PLN (especially the Official Commitment Maker) is held accountable for program results, but is under pressure from the Ministry of Energy and Mineral Resources and other political forces as to how the program is procured and implemented.

(ii) Procurement follows government rather than PLN processes and standards. These are not well-suited for procurement of electricity infrastructure.

(iii) Given the funding flows and asset transfers across agencies, these projects are audited by three different audit agencies.

(iv) While in principle the LisDes program avoids increasing PLN indebtedness by funding assets that are subsequently booked as equity contributions, in practice a significant portion of these transferred assets are never recognized as such. The transfer of grant assets from government to a state-owned enterprise must go through several steps to be recognized as equity by both parties, starting with agreement on the value of the asset, followed by processing of the transfer within the government bureaucracy, and eventually leading to approval of the transfer by the House of Representatives and legalization through a government regulation. A significant portion of such transfers get stuck somewhere along this process. These assets are referred to as Government Assistance with Indeterminate Status (*Bantuan Pemerintah Yang Belum Ditentukan Statusnya,* BPYBDS). The value of the BPYBDS associated with PLN has reached Rp51.2 trillion.[26]

Despite the shortcomings of the LisDes program, its combination with the public service obligation (PSO) subsidy means at least that PLN is incentivized (or at least not financially disadvantaged) to ensure continued operation of supply to rural areas. In contrast, government off-grid programs to date focus only on the installation of systems with inadequate consideration of how operation of these systems will be sustained financially. And there are no mechanisms whatsoever in place for capital or operational subsidies to facilitate electrification by the private sector.

New funding mechanisms, commensurate with the level of financing required, are needed. It is likely the government will have to revitalize the national electrification program by finding new ways of funding PLN for electrification activities, rationalizing government off-grid programs, and developing mechanisms for capital and operating subsidies for the private sector.

[26] http://www.ekon.go.id/berita/print/penyelesaian-proses-penetapan.1212.html

3.3 The Need for a Single Plan

The introduction of the Road Map LisDes by PLN in 2012 was an important step for national electrification planning. Appendix 3 describes the Road Map LisDes in further detail. This bottom-up electrification plan supports development of the broader RUPTL (which ensures generation and transmission investment commensurate with electrification efforts) and informs government budgeting for the LisDes through the work of the *satker lisdes*.

As discussed in Appendix 3, PLN could adopt geospatial planning tools to improve the consistency, timeliness, and accuracy of the Road Map LisDes. Appendix 1 provides an example of the use of such tools. But a greater concern is that more than $100 million is spent every year on government electrification programs that are not explicitly coordinated with PLN-executed programs, and include projects that have not been identified on least-cost principles.

As the costs of electrification increase due to the targeting of smaller and more remotely located communities, efficiency of program spending becomes increasingly important. While the mobilization of all competent agents and funding sources for electrification efforts is appropriate, it should be done in a manner that eliminates program gaps, avoids duplication of efforts, and ensures that the overall electrification targets are met at least cost.

This requires a single plan that is accepted by all stakeholders along with mechanisms to coordinate activities across stakeholders. Formalizing the role of the *satker lisdes* in this regard, or otherwise having PLN develop electrification plans that explicitly carve out areas for non-PLN electrification, could be useful.

3.4 Unsustainable Off-Grid Delivery Models

Analysis from Sumba, the preparation of PLN Thousand Islands electrification program, and experience elsewhere in the world suggests that electrification of the remaining 16% of households will rely increasingly on off-grid solutions. In particular, the analysis for Sumba presented in the Mid-Term Report under this technical assistance indicates that with an electrification target of 95%, off-grid solutions would represent the least-cost choice for some 30% of households that have not yet received electricity.

Over the past several years, PLN and various government agencies have implemented off-grid electrification programs, typically using renewable energy resources. However, the experience has been mixed at best. These programs have encountered the following problems:

(i) failure to take into account the full present and future electricity needs of the target communities;

(ii) poor design, materials, or workmanship, which compromises technical performance or longevity;

(iii) lack of financing mechanisms and/or payment discipline among consumers needed for continuing operation and maintenance of the systems;

(iv) lack of human resources qualified to operate and maintain the systems; and

(v) pricing inconsistent with willingness to pay, that is, unaffordability.

In addition, the scale up of off-grid solutions requires engaging and mobilizing other stakeholders such as the local government, nongovernment organizations (NGOs), the private sector, as well as the community and other beneficiaries of electrification. PLN is capable and has extensive geographic reach, but it cannot do it all, particularly given its risk-averse culture, organizational orientation to conventional grid extension, and financial limitations. The private sector may be better at innovation, flexibility, and risk management required for the successful rollout of off-grid solutions. Although prevailing regulations allow for private participation in instances where PLN cannot serve a particular area, the following impediments have to be addressed:

(i) Government has not made any effort to identify such areas or actively promote initiatives by the private sector or others to ensure supply in these areas.[27]

(ii) There are no mechanisms in place to ensure that the most qualified developers, whether from community groups, regional state-owned companies, NGOs, or the private sector, secure these areas.

(iii) There is no policy and corresponding subsidy mechanism in place to enable any supplier other than PLN to deliver off-grid supply profitably at prices affordable to consumers. For example, should supply to remote communities be delivered at the uniform national tariff, or although they are often the poorest communities, should they pay tariffs higher than the basic (uniform) electricity tariff (TDL)?[28]

New delivery models for off-grid supply are required if Indonesia is to achieve universal access. However, experience under ADB TA 8287-INO: Scaling Up Renewable Energy Access in Eastern Indonesia (as described in Box 3.1) highlights the difficulties in even piloting new models under the prevailing regulations.

PLN for one recognizes that fundamental changes are necessary within the power sector. The 2015–2024 RUPTL states:

> *So that service to society is not compromised by PLN's financial limitations, breakthrough changes are required to the electricity business model. These steps include providing opportunities to non-IPP third parties to participate in generation development as well as supplying industry so that PLN does not become the sole off-taker, for example by using power wheeling and working across business areas. With this sort of business model, investment made by non-IPP third parties will not burden PLN's long run finances.*

While this statement is directed at finding new business models suitable for Indonesia's larger grids, the same philosophy applies to electrification. New delivery models are required that better meet the long-term needs of target communities, are technically and financially sustainable, and mobilize private sector initiative while preserving affordability.

27 The PNPM program mentioned in Section 2.4 was an example of a government program that mobilized communities to install, manage, and operate their own off-grid systems. A review conducted for the World Bank found that these programs were generally sustainable and effective (Castlerock Consulting, 2012. *Micro Hydro Power (MHP) Return of Investment and Cost Effectiveness Analysis*). However, as noted in Section 2.4, the PNPM program has ceased with the introduction of Law 6/2014 on villages.

28 Until several years ago, there were some cooperatives operating small isolated diesel systems in certain areas outside Java-Bali, or otherwise purchasing bulk power from PLN and distributing it to rural areas. These cooperatives received no subsidy. One of the most well-known cooperatives, Sinar Siwo Mego Rural Electric Cooperative (*Koperasi Listrik Pedesaan Sinar Siwo Mego*, KLPSSM), served 72,000 consumers in Lampung. However, in 2011, PLN took over the electricity distribution and retailing function of KLPSSM because the cooperative's electricity supply operation was not financially viable.

Box 3.1: Proposed ADB Photovoltaic Minigrid Pilot Program

The least-cost electrification plan for Sumba prepared under the Asian Development Bank (ADB) technical assistance 8287-INO: Scaling Up Renewable Energy Access in Eastern Indonesia determined that off-grid power supply through photovoltaic minigrids would be the least-cost source of supply for up to 20% of all households on Sumba if 95% electrification ratio were achieved. However, given the mixed experience with photovoltaic minigrid programs to date, ADB planned a pilot project to develop and demonstrate a financially and technically sustainable photovoltaic minigrid implementation model that could be quickly replicated to overcome the deficiencies of earlier approaches.

The initial design, which is documented in the Mid-Term Report, sought to involve the State Electricity Company (PLN) to operate and maintain the systems. PLN offers technical capability, permanent presence, geographic coverage, billing and collection systems, and access to government subsidies that would ensure continued and affordable supply for the candidate villages. Four villages were selected, one in each district of Sumba, through a systematic screening process.

Because it is difficult for PLN to receive grant assets, the systems would be procured by ADB but transferred via the Ministry of Energy and Mineral Resources to the district governments, which would then own the assets. The legal basis for the initial design was Permen ESDM 4/2012, which obliges PLN to purchase power from renewable generation at designated feed-in tariffs. The concept was to treat each photovoltaic system as a "mini-independent power producer" with its own low-voltage reticulation. It would not connect to the network of PLN, and hence would not be subject to the competitive tender obligations of Permen ESDM 17/2013 for grid-connected photovoltaic systems. PLN would purchase the power and provide the retailing function, selling power to the households according to the uniform national tariff, and would operate and maintain the system on behalf of the district through a separate operation and maintenance (O&M) agreement.

Although Permen ESDM 4/2012 has not been formally revoked and the pilot projects would not be connected to PLN grid, personnel of the Directorate General of New and Renewable Energy and Energy Conservation suggested that the project would instead need to be developed as an off-grid project as provided by PP 14/2012. Under this model, PLN would need to establish a joint operation with the district under which PLN would operate and maintain the assets owned by the district. However, the staff at PLN *wilayah* were wary of such an arrangement, since they would not have control over the design and construction of the assets, but would be responsible for their O&M. In the event of any asset failure, PLN was concerned that the local communities would blame PLN regardless of the responsibilities that may have been agreed in the joint operating agreement. PLN staff were particularly concerned about the use of photovoltaic technology, as opposed to more familiar technologies like microhydro systems.

The proposed model was again reconfigured to involve the private sector instead of PLN, using a build–operate model. A private developer would be competitively selected by ADB to build the assets and then operate and maintain them. The developer's ongoing revenue stream would be the tariffs paid by the consumers, which would be significantly higher than the uniform national tariff, since there is no subsidy mechanism in place similar to what PLN receives. As before, the district would own the assets. The assets would in effect be delivered as a capital grant, and the tariffs would be set to recover O&M costs. However, following PP 14/2012, these tariffs would have to be approved by the DPRD *after* the project was tendered (since only then would O&M costs be known). Moreover, following Law 23/2014, these tariffs would have to be approved by the provincial DPRD.

The uncertainty as to whether, and if so when, the DPRD would approve tariffs at the required level introduced an unsurmountable risk to the project. In a final effort to find an acceptable legal basis for the projects, Law 6/2014 on Villages was reviewed to see whether projects on such a small scale could be developed under the authority of the *desa*, but that Law does not include electricity as an area of *desa* authority.

Consequently, the project had been dropped, and efforts had been refocused on creating an enabling environment. Once such a framework is in place, it is hoped that a pilot project can proceed. This experience highlights the need to develop a new regulatory paradigm that will encourage the development of off-grid power solutions, which will be required if Indonesia is to achieve universal access on a least-cost basis.

Source: ADB. 2013. *Technical Assistance to Indonesia for Scaling Up Renewable Energy Access in Eastern Indonesia.* Manila (TA 8287).

4 Applying Principles from Successful Electrification Programs

As discussed in Section 1.3, every country that has achieved universal or near-universal access developed and implemented a customized approach to electrification suited to its unique institutional, cultural, and geographical setting. However, there are four fundamental requirements for electrification program design and implementation that arise from the experience in these countries. They are as follows:

(i) Visible and committed government leadership.

(ii) An enabling institutional environment.

(iii) Sufficient and sustained financing.

(iv) Broad stakeholder engagement and coordination under the principle of "Many Partners, One Team, One Plan".

This chapter assesses Indonesia's prevailing electrification efforts against these four requirements with a view toward identifying how the existing electrification paradigm can be improved. The following chapter proposes specific measures for Indonesia to achieve universal access.

4.1 Government Commitment and Leadership

The Government of Indonesia has demonstrated a clear commitment to achieving universal access. The Indonesian Constitution obliges the government to provide public services such as electricity, wherever it is feasible. The government has also enacted Law 30/2007 on Energy and Law 30/2009 on Electricity, which oblige both central and regional governments to provide access to remote communities and the poor. The National Energy Policy established a policy target of "approaching" universal access by 2020, and the National Medium Term Development Plan has set a target of 96.6% electrification ratio by 2019. The new National Government Electricity Plan under preparation is expected to adopt a similar near-universal access target. The government has in reality appointed the State Electricity Company (PLN), a competent national utility, to implement electrification efforts on its behalf. In particular, the government has established a subsidy mechanism that has allowed PLN to connect more than 3 million new households every year for the past several years. Finally, apart from PLN investment (which is facilitated by the government subsidy to PLN), the government itself directly allocates some Rp4 trillion (approximately $320 million) per year to electrification activities.

These measures suggest a serious government commitment to electrification. However, this strong commitment may not be enough to achieve the policy target. The question remains whether these resources are sufficient to achieve near-universal access by 2020, and for whatever resources are committed to the effort, whether strategies and policies are in place to maximize the effectiveness and efficiency of the available funds.

A rigorous assessment of the costs for providing electricity to the remaining 16% of the population is necessary to determine realistic funding for and timing of electrification efforts. This, in turn, requires a clear policy regarding standards for electrification, for example, whether, and if so under what circumstances, electricity service is limited to direct current supply, is available only in the evenings, or is restricted in terms of the amount of power that may be drawn. The Sustainable Energy for All program provides a useful framework for defining service levels (footnote 5). The government, through Permen ESDM 33/2014, has already established service performance indicators for PLN grid supply, for which the Directorate General of Electricity will set target service levels against which PLN must report performance. A similar regulation is required for off-grid supply standards.

4.2 An Enabling Institutional Environment

Indonesia has established a number of institutional arrangements that support the goal of universal access, including:

(i) a subsidy mechanism that allows PLN to connect households in remote areas without compromising its financial viability,

(ii) a national uniform tariff that is affordable to even low-income households,

(iii) a government program that provides free connections and basic internal wiring for low-income households,

(iv) regulatory recognition that off-grid solutions have a role to play,

(v) funding mechanisms for off-grid programs additional to the efforts of PLN, and

(vi) feed-in tariffs for the development of renewable resources in areas that would otherwise rely on expensive diesel generation.

However, the prevailing institutional arrangements function smoothly only for PLN. Current regulations require that for non-PLN off-grid projects, no matter how small:

(i) the Ministry of Energy and Mineral Resources must define a business area in advance;

(ii) the governor must license the project (provided the project is within a single province);

(iii) the Regional Representative Council (DPRD) at the provincial level must approve the tariff; and

(iv) there is no existing subsidy mechanism available to support ongoing operation and maintenance of these systems. Though existing regulations allow for ad hoc subsidies, as a practical matter, regional governments have limited financial resources and there is no established subsidy framework such as that currently employed with PLN.

If PLN were in a position to roll out off-grid projects on the scale required to meet national electrification targets, this would not be an issue. However, conventional grid extension efforts appear to have stretched the resources of PLN to their limit, PLN is increasingly constrained in terms of its ability to finance capital investment other than through additional government equity injections, and PLN experience with off-grid solutions has not been positive, leaving regional staff reluctant to pursue new off-grid initiatives.

There are no other government institutions or BUMNs that have the capability to undertake off-grid electrification on the required scale. On the contrary, while there is private sector capability available in Indonesia for such undertakings, and there are examples (though limited in number) of successful nongovernment organization (NGO), community-based, and private sector electrification efforts,[29] government policy and the prevailing regulations are not conducive to the mobilization of non-PLN organizations for the reasons noted above. The question arises whether it is more promising to assign PLN the full responsibility for off-grid electrification, which is not fully aligned with its principal activities and mission, or to open the door for other entities to provide such services. In either case, the government needs to adopt a new electrification strategy.

The experience with the photovoltaic minigrid pilot projects that were planned by the Asian Development Bank highlights the impediments to the rollout of off-grid solutions. These impediments are all the more striking in light of the initiatives such as the Green Prosperity Program under the Millennium Challenge Account–Indonesia, which is providing hundreds of millions of dollars for non-PLN off-grid power development. It is unclear how this development can take place under the prevailing regulatory framework on the scale and timetable contemplated.

4.3 Sufficient and Sustained Financing

As a corollary to the first principle of government leadership and commitment, the government has institutionalized mechanisms to ensure the financial viability of PLN through the subsidy for the public service obligation of PLN. In addition, it provides substantial funding for electrification by PLN in the form of capital injections through the Major Generation and Network Projects–National Government Budget (UIP), LisDes, and the *Program Listrik Hemat dan Murah*.

However, as noted earlier, PLN is approaching a ceiling on borrowing due to its global bond covenants, and the existing programs involving asset transfer face numerous problems. Increased equity injections by the government are one way to ensure that PLN continues to have access to the capital required for electrification activities. Another approach, discussed further in Chapter 5, is the introduction of a results-based payment scheme. The rationalization of electricity tariffs and fuel subsidies raises the prospect of additional government funds available for this purpose within the constraints of the national budget.

The government has also allocated significant funding—more than $100 million per year—for non-PLN electrification projects. However, given the lack of an overarching least-cost plan and a mechanism for interagency coordination, the efficiency and effectiveness of this expenditure is questionable. The issue is not so much the availability and sustainability of funding, but how those funds are best used.

[29] Examples include the community-based microhydro projects implemented under the PNPM, renewable minigrids developed by nongovernment organizations (NGOs) such as IBEKA, as well as some private sector projects.

4.4 Stakeholder Engagement and Coordination

National electrification efforts must engage and coordinate a wide range of stakeholders to be successful. These stakeholders will typically include entities or groups from:

(i) the public sector, NGOs, as well as the private sector, such as developers and contractors;
(ii) local and national agencies as well as foreign agencies such as development partners;
(iii) agencies from both within the power sector as well as outside the power sector, such as the Ministry of Finance;
(iv) electric utilities; and
(v) affected communities.

This engagement and coordination follows the principle of "many partners, one team, one plan."[30]

Indonesia's electrification efforts entail programs by a number of different line ministries at the national level as well programs by regional governments (now limited to provincial government, as per Law 23/2014). However, a systematic framework for the involvement of the private sector and other nongovernment players is conspicuously absent. Although prevailing laws and regulations provide for private sector involvement in electrification, these provisions are ad hoc, and the government has not actively promoted this involvement through its policies. In addition, while the function of the *satker lisdes* allows for local government inputs into the planning of the electrification activities of PLN, there is no structural involvement of agencies responsible for health, education, and other government services. Formal involvement of these agencies as users of electricity could enhance the development benefits of electrification.

Although multiple agencies participate in electrification activities, there is no formal mechanism to coordinate these activities. In particular, there is no single least-cost plan that can prevent duplication of efforts and gaps in service as well as optimize expenditure. In the absence of such a plan, it is questionable whether the significant funding devoted to non-PLN electrification is efficient or effective.

Moreover, the absence of monitoring and evaluation at a programmatic level inhibits the continuous improvement of electrification efforts based on past experience in the field. There is little or no institutional accountability to set, fund, and achieve targets. This is particularly true with respect to the sustainability of off-grid solutions.

The Sumba Iconic Island initiative provides an example of multistakeholder engagement and coordination in Indonesia, albeit on a scale limited to a single island. As described in Box 1.1, the Sumba Iconic Island initiative has brought a broad range of stakeholders together on a continuing basis to plan and coordinate activities. The preparation of a least-cost electrification plan will help ensure the effectiveness and efficiency of future activities, and incorporation of programmatic monitoring and evaluation into the initiative will enhance the design and management of activities going forward.

[30] This engagement and coordination may be implemented as a "Sector-Wide Approach" (SWAp), which may entail the formal adoption of a platform of operating principles and funding processes by stakeholders.

5 Measures to Achieve Universal Access in Indonesia

Based on the assessment of the preceding chapters, a new electrification paradigm is proposed for Indonesia to address the following four questions:

(i) What is electrification?

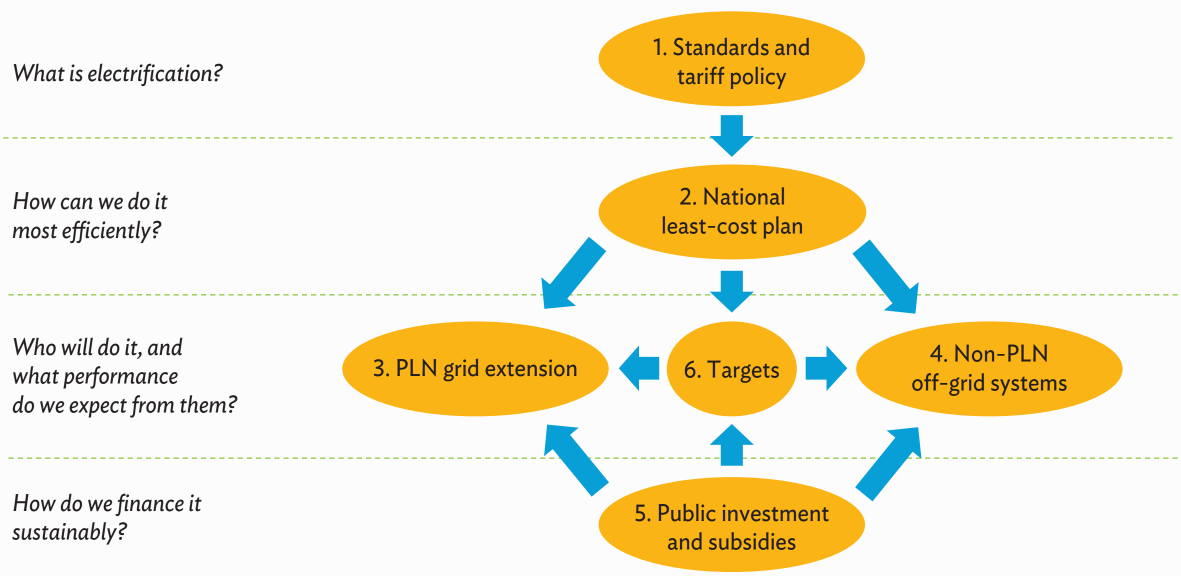
(ii) How can electrification be achieved most efficiently?

(iii) Who will implement electrification programs, and what performance do we expect from them?

(iv) How do we finance electrification sustainably?

This new paradigm may be implemented on the basis of an electrification policy encompassing six elements (Figure 5.1).

Figure 5.1: Scope of a New Electrification Policy



PLN = State Electricity Company.

Source: Author.

The six elements of the policy are as follows:

(i) **Standards and tariff policy.** There has been no explicit policy about the level of service that should be delivered by electrification, or the technical standards for off-grid supply. In practice, publicly funded programs have delivered service ranging from 24/7 supply with a modest (450 VA) alternating current power limitation to a couple of lights for a few hours per night. Moreover, although there is a uniform national tariff for grid supply, there is no pricing policy in place with respect to off-grid supply. This creates a situation in which the households least able to pay for electricity potentially face the highest tariffs. Explicit government policies regarding service and technical standards and tariffs for off-grid as well as grid-connected supply are required to establish systematic financing and rollout programs, as opposed to the current ad hoc arrangements for off-grid supply.

(ii) **A national least-cost electrification plan.** The State Electricity Company (PLN) prepares the Road Map LisDes to plan its own electrification activities and determine the corresponding funding required from PLN's budget (APLN) and the National Government Budget (APBN). However, this plan considers incremental expansion by PLN rather than a comprehensive assessment of how to achieve universal access at least cost. Such a plan is required to guide all electrification activities, not just those of PLN. Moreover, a geospatial approach that quickly and systematically assesses the technological options for serving each settlement would help ensure consistency across regions, timely preparation and updating of the plan, comprehensive geographical coverage, and rigorous least-cost planning discipline.

(iii) **PLN grid extension.** PLN has achieved remarkable results with its grid extension activities over the years. Grid extension will remain the predominant means of electrification, even as the last 16% of the population is served. PLN will, therefore, continue to play a key role in Indonesia's efforts to provide universal access. However, these PLN activities should be facilitated and scaled up through improved public funding mechanisms, as discussed below.

(iv) **Non-PLN off-grid systems.** Though PLN operates thousands of small, isolated diesel systems, it actively aims to eliminate these systems through interconnection with the larger systems. PLN has limited experience with renewable energy technologies,[31] is not organizationally set up to expand the installation and management of isolated minigrids, and has numerous competing needs on its human and financial resources. Though existing regulations provide for off-grid supply by entities other than PLN (e.g., cooperatives, nongovernment organizations [NGOs], regional state-owned companies, and the private sector) on an *ad hoc* basis, there has been no systematic effort to mobilize non-PLN suppliers. Off-grid supply will play a significant role in serving the remaining 16% of the Indonesian population. A new framework is needed to engage non-PLN suppliers for off-grid supply in a systematic, efficient, and financially viable and sustainable manner that can be scaled up across the country.

(v) **Public investment and subsidies.** Experience throughout the world demonstrates that public investment and subsidies are required to achieve near-universal access. The existing mechanisms for public investment through PLN are cumbersome and difficult to scale up. There are no existing mechanisms for public investment or operational subsidies for non-PLN supply. Funding mechanisms for both PLN and non-PLN supply must be rationalized or developed to ensure financial sustainability of electrification programs.

(vi) **Targets.** The management of a national electrification initiative requires metrics against which performance can be measured and implementing agencies held accountable.

In this framework, the least-cost plan indicates the total level of capital investment required to achieve universal access, while the annual public funding determines the rate at which households can be provided with electricity. The government can use this information to establish targets for electrification in terms of the number of households to be connected per year, and the corresponding

[31] Moreover, the experience of PLN to date with renewable energy has not been positive, such as with the Super Extra Energy Efficient (SEHEN) program.

electrification ratio. These targets allow the government to assess progress, adjust targets, and supervise the entities responsible for program implementation. Moreover, establishing electrification targets based on the annual availability of subsidy funds relative to the total investment required to achieve universal access ensures meaningful targets by aligning targets with funding.

The measures encompassed by the new electrification paradigm entail strengthening of the existing institutions, reassignment of roles, and the introduction of new processes. It appears possible to implement these new policies within the prevailing legal and regulatory framework.

Given the strength of key institutions such as PLN and the capability in the private sector, the creation of new national electrification agencies does not appear necessary. Moreover, creating such agencies would fragment the integrated planning of generation, transmission, and distribution that is key to successful electrification.

Each of the elements of the proposed policy is discussed in detail. Public investment and subsidy mechanisms are discussed in the respective sections on PLN and non-PLN suppliers.

5.1 Define Service Standards and Tariffs

To date, the government in reality has followed a policy that counts electrification as the initial supply of electricity to a household, regardless of whether it is direct current supply limited to a few hours of basic lighting every night, or full alternating current supply available 24 hours a day, regardless of whether that supply continues to operate after initial installation.

A service standard for electrification will determine the load to be served, which in turn will determine the least-cost supply technology and associated capital and operating costs of the electrification program. Higher standards of service will result in higher loads and greater investment needs. Consequently, the government may wish to differentiate initially between standards for grid-connected and off-grid supply, and adopt lower service standards for off-grid supply, for example, the Sustainable Energy for All Tier 1 service. Later, after near-universal access to at least basic supply has been achieved, it can then go back and upgrade service levels as funding allows.

In addition, technical standards should also be defined for wiring and other key components of off-grid systems, much as they are for grid-connected systems. The government may consider applying grid-connected technical standards to off-grid applications, so that any off-grid system can be readily connected to the grid in the future. However, this flexibility may come at a higher cost.

It is therefore necessary to define service and technical standards at the outset as an input to least-cost planning. In addition, the establishment of a tariff policy for non-PLN supply would enable calculation of subsidy needs. The following are three options:

(i) leaving off-grid tariffs to be approved by the Regional Representative Council at the provincial level on an ad hoc basis,
(ii) establishing regional or technology-based tariffs that at least partially reflect costs, or
(iii) applying basic (uniform) electricity tariff (TDL).

The first option is the default under existing law and regulation. However, it means that tariffs for any off-grid supply must be set on a project-by-project basis through a lengthy legislative process. The level of developer effort that would go into this process, and the uncertainty of the outcome, deters investment. It can also result in substantially higher tariffs for off-grid communities, which are generally the poorest in the country. The question arises as to why the poorest households should pay the highest tariffs. And as past experience with electricity cooperatives in Indonesia suggests, tariff disparity in which off-grid consumers pay higher rates than PLN consumers has contributed to the failure of off-grid suppliers as local communities become aware of the lower tariffs paid by their fellow citizens who are served by the national utility.

The second option provides greater certainty to the process, and facilitates the planning and budgeting of subsidies. However, as with the first option, it can still result in the poorest households paying the highest rates.

The third option yields social equity but will also require subsidies that may be significant at the local level. If the average cost of supplying the remaining 10.4 million households is the average production cost of the costliest PLN area (*wilayah*) (reported as Rp3,809/kWh in Nusa Tenggara Timur for 2013), subtracting the average R-1 450 VA tariff yield of Rp426/kWh, and assuming average consumption of 480 kWh/year and 10.4 million households remaining to receive electricity, then the total operational subsidy required would be approximately Rp16.7 trillion, equivalent to nearly 26% of the total public service obligation (PSO) subsidy forecast of PLN in the 2015 APBN-P (Rp66.1 trillion).

The launch of government policies regarding technical and service standards and tariffs for off-grid supply will provide the basis for the preparation of a national least-cost electrification plan, the determination of subsidies, and the definition of targets for electrification efforts, as described in the following sections.

5.2 Establish a Comprehensive Least-Cost Plan

PLN carries out the bulk of electrification activities and plans these investments through the preparation of the Road Map LisDes and the Electricity Supply Business Plan (RUPTL). Where practical, PLN carries out this planning on a least-cost basis.

However, the government allocates a significant amount of electrification funding outside of this PLN planning cycle, and it is unknown whether this funding is efficient or effective in terms of meeting the target of universal access. A comprehensive least-cost plan is required against which *all* electrification activities may be planned and funded, not just those carried out by PLN. This is particularly important if non-PLN suppliers are to play a greater role in electrification, as will be proposed in this chapter.

It is therefore proposed that a single least-cost electrification plan be prepared that explicitly considers both grid extension and off-grid supply with a target of 100% electrification ratio. PLN is the only organization with the requisite geographical coverage and technical capability to prepare such a plan. As discussed in this chapter, the implementation of on-grid electrification would remain with PLN, while off-grid electrification would be carried out by non-PLN suppliers.

Establishing this comprehensive least-cost plan would entail the following steps.[32]

(i) **Strengthening PLN's electrification planning.** While the Road Map LisDes is a positive development, the utilization of geospatial models would further improve the timeliness and consistency of PLN's electrification planning, increase the granularity of investment needs, and help ensure least-cost electrification rollout. Appendix 3 describes in further detail the scope of geospatial planning and how it differs from the existing Road Map LisDes, while Appendix 1 provides an example from Sumba. This would require a comprehensive, long-term capacity building program for planning divisions within PLN *wilayah*, building upon work that has already been done.

(ii) **Prepare the plans.** Each PLN *wilayah* would prepare its own plan, as it does now with the Road Map LisDes. However, going forward, this plan would not only be limited to conventional grid extension by PLN but would also consider off-grid solutions that may be implemented by others such as the private sector. It would also target 100% electrification to determine the overall least-cost mix and costs of electrification technologies; current PLN Road Map LisDes plans do not necessarily aim for universal access, so the cost of achieving universal access and the role of off-grid solutions remains unknown. Initially, these plans may be developed following the existing Road Map LisDes process, but as capacity is strengthening in PLN, geospatial analysis should be introduced.

(iii) **Propose service areas.** Once each PLN *wilayah* has completed the plan for its region, it would forward the plan either to the *satker lisdes* or directly to PLN Pusat. The *satker lisdes* or PLN Pusat would then propose to Directorate General of Electricity (DGE):

   (a) areas to be connected by PLN with funding from the APLN;

   (b) areas to be connected by PLN with funding from the LisDes or new public funding mechanism; and

   (c) areas to be defined as off-grid business areas, which would be put forward for private sector participation as described below.

   The *satker lisdes* is well placed to propose these areas since its membership includes representatives from PLN, the DGE, and the regional government (Pemda). The *satker lisdes* has traditionally functioned in a technical role; this would be a modest expansion of its current role.

   Alternatively, the process need not involve the *satker lisdes*, which is established by the government. As discussed in Section 5.4, it may be more efficient to allow PLN to work, plan, and operate autonomously under government policy and supervision. Each PLN *wilayah* could forward proposals directly to PLN Pusat, which would then review and compile the proposals and submit a final comprehensive service area proposal to the DGE. A decision on whether to assign this role to PLN or the *satker lisdes* requires broader consideration and consensus among stakeholders.

(iv) **Compile the plan.** The DGE would compile the least-cost plans prepared by PLN and the service areas proposed by each *satker lisdes* or PLN Pusat. The plan would cover all regions that are not fully electrified, not just areas with low electrification ratios. West Java, for example, has 19% of all unelectrified households, and therefore must be explicitly considered as part of any effort to achieve near-universal access. These final plans would therefore provide the following:

   (a) Estimates of the total capital costs required to achieve universal access for each region (province off-grid and on-grid) by funding source (APBN and APLN, as well as the Regional Government

[32] An alternative arising from the launch of a renewable energy Center of Excellence by MEMR in February 2016 is for the Center to conduct step (ii) below using the geospatial decision support system that is under development.

Budget as in this chapter). This would be an important input into the annual work plan of the DGE and government electrification budget discussions with the Directorate General of Budget as well as for the analysis required to align longer-term targets with financing needs.

(b) The DGE would promote to the private sector those areas approved as separate business areas, as described below under the proposed mechanism for mobilization of non-PLN supply in off-grid areas.

5.3 Streamline Funding for PLN Electrification Programs

PLN has proven its capability to extend the grid and connect new consumers on a massive scale. If Indonesia is to reach near-universal access, the role of PLN must be strengthened and the flow of public funding for its electrification activities increased. As discussed in Sections 3.2 and 4.3, public funding for on-grid electrification is stipulated by law and is essential for achieving near-universal access.

However, as discussed in Section 3.2, the current planning, funding, and implementation framework for publicly funded PLN electrification activities is slow and cumbersome, and gives rise to issues such as increasing Government Assistance with Indeterminate Status. Moreover, as Indonesia approaches universal access, the emphasis will shift from in-fill to grid extension, which will require higher levels of public funding to build the infrastructure.

The existing LisDes process arose as a way for the government to fund rural electrification while relying on PLN to manage the implementation and subsequently operate and maintain the infrastructure. PLN could presumably implement these electrification activities faster and more smoothly without having to function through the *satker lisdes*. But because PLN'scapacity to borrow is restricted, as discussed in Section 2.5.2, public funding is being delivered as in-kind equity. Under such an arrangement, the government must control the planning, funding, and procurement of the assets that are ultimately transferred to PLN as equity.

However, there are at least two alternatives to this arrangement:

(i) **Direct equity injections to PLN.** An obvious way to finance electrification infrastructure and avoid the problems associated with asset transfers under the LisDes would be to provide direct equity injections to PLN annually. However,

(a) *Equity is fungible.* It is not possible to trace exactly how this money is used. Equity injections for electrification would have to be accompanied by a service level agreement that specifies electrification targets corresponding to the equity injection provided and the consequences of not achieving those targets. This could be done building on the experience of the earlier service level agreement of PLN.

(b) *Equity injections are not programmatic.* The revised 2015 APBN was unusual in that it budgeted Rp64.8 trillion worth of government equity injections (state capital investment, *Penanaman Modal Negara*, PMN) for state-owned enterprises (of which Rp5.0 trillion was allocated to PLN). This compares with Rp3.0 trillion of such equity injections across all state-owned enterprises in 2014. Government equity injections are the exception, not the norm. It would be risky to try to sustain a multiyear electrification program through equity injections.

(c) *Equity injections are not simple*. State-owned enterprises that seek equity injections must, of course, prepare a business plan for use of the funds. PLN could prepare such a plan based on the least-cost planning discussed in Section 5.2. But in addition, the review and processing of those applications involve multiple ministries, and ultimately must be approved by the House of Representatives (DPR) as part of the annual state budgeting process. Capital injections for consecutive years would likely increase scrutiny from the DPR and audit agencies who might view the injections as a way to circumvent institutional supervision of government programs. Indeed, observers have criticized these large equity injections for their lack of transparency.[33]

The last two considerations above suggest that direct equity injections are not well-suited for funding long-term programmatic electrification efforts by PLN.

(ii) **Results-based electrification payments.** An alternative would be to follow the approach used in the delivery of the PSO subsidy, in which government support is booked as PLN revenue, rather than as debt or equity. Like the PSO subsidy, payments would be made *ex post*, based on actual performance. A possible process is depicted in Figure 5.2, similar to the process outline in PMK 170/2013 for administration of the PSO subsidy. In this case, however, the Ministry of Finance would pay PLN per kilometer of line, per transformer, per connection, etc., after PLN installs and commissions the infrastructure, using unit costs agreed in advance for projects that have been deemed eligible by the government (based on the least-cost plan). Rather than an input-based payment scheme, this would be an output-based or results-based scheme. This could ease implementation, improve accountability, and enhance transparency.

However, the development of this mechanism must consider several key issues. The first issue to be determined would be the basis on which the Ministry of Energy and Mineral Resources would determine whether particular electrification projects would be eligible for results-based payments (e.g., presumably in-fill electrification would not be) and the applicable unit costs (e.g., whether by pooling all electrification activities planned for the year, or determining unit payments for results on a region-by-region or project-by-project basis). A second issue is whether PLN has sufficient cash flow to facilitate the scale up of grid extension relying on results-based payments (that is, payment postconstruction). The third issue is whether the Supreme Audit Agency (BPK) would indeed treat the output-based payments as PLN revenue as opposed to debt or equity. A final issue includes the institutional responsibilities and procedures for auditing these activities.

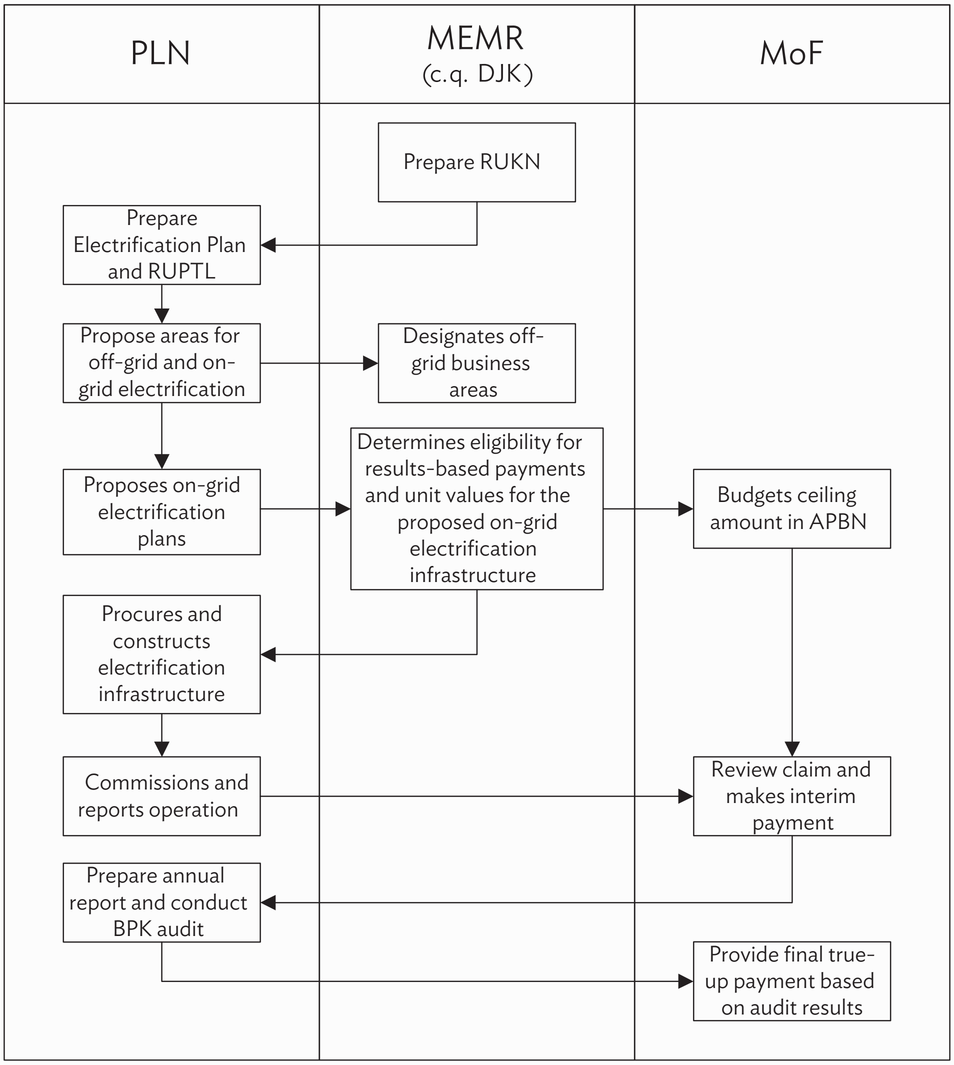
These options can be considered by an interministerial working group as part of formulation of an electrification policy.

5.4 Mobilize Non-PLN Suppliers for Off-Grid Electrification

Responsibility for off-grid electrification could be explicitly extended to PLN, retained under line ministry and Pemda programs as it is now or with some modification, or formally opened up to the private sector, NGOs, community groups, and others. This report refers to supply by these other parties besides PLN and the government as “non-PLN” or “private sector” supply.

33 See, for example, http://fastnewsindonesia.com/article/didik-rachbini-pmn-rp648t-itu-kolusi-kreasi-baru-illegal-dibungkus-legal

Figure 5.2: Alternative Mechanism for Funding Grid Extension by PLN



APBN = National Government Budget, BPK = Investment Coordinating Board, MEMR = Ministry of Energy and Mineral Resources, MOF = Ministry of Finance, PLN = State Electricity Company, RUKN = National Government Electricity Plan, RUPTL = business plan for electricity supply.

Source: Author.

PLN has the technical capability and geographic reach that makes it an attractive candidate to implement off-grid supply. It also benefits from an institutionalized subsidy mechanism that ensures the continued funding of operation and maintenance of the long-term financial viability of such activities. However, it has not systematically pursued such activities until now other than the SEHEN program (which it is not inclined to expand, given experience to date). It operates thousands of small diesel generators powering isolated minigrids throughout the country, but these are costly legacy systems that it aims to integrate into larger grids. PLN, which is not organizationally structured for off-grid development and operation (especially using renewables, which will generally be the least-cost source of supply for off-grid systems; see Appendix 1), is focused on grid extension and operation, and faces many competing needs for the limited funding available to it. A scale up of grid extension activities would likely stretch its existing resources to the limit.

There is a strong case to eliminate the current role of line ministries and Pemda for implementation of off-grid projects. While the quality of some of these projects have improved (projects implemented by the Directorate General of New and Renewable Energy and Energy Conservation in particular), the preparation and nature of funding for these projects are misaligned with the long-term funding required for technical and financial sustainability. Line ministries and the Pemda may be better suited to help fund, tender, and supervise off-grid projects implemented, operated, and maintained by others. Moreover, unless the line ministries and the Pemda are going to take responsibility for electrification of entire business areas designated by the DGE, the involvement of these agencies is contrary to the existing regulatory framework.

As discussed earlier in the report, the private sector[34] is a largely untapped source of capability for off-grid electrification. There is considerable depth and breadth in the capabilities of the Indonesian and the international private sector in this regard, as well as access to capital. Despite an unsupportive regulatory environment, there are examples throughout Indonesia of successful NGO, community-based, and private sector minigrids that continue to operate. There are many examples of private off-grid supply from around the world.[35]

Moreover, to the extent these private sector suppliers see themselves as conducting an activity that is broader than just selling electricity (e.g., an NGO that aims to improve rural livelihoods, or a private developer that offers credit or sells appliances as well as electricity), the more likely these suppliers will promote productive uses of energy, which are key to maximizing the benefits of electrification for rural communities. Large national electric utilities and government agencies typically do not hold this broader perspective.

However, as with Sinar Siwo Mego Rural Electric Cooperative (KLPSSM) in Indonesia, not all of these undertakings have been successful. These failures highlight the importance of the principles discussed in Chapter 4. The mobilization of non-PLN supply proposed here specifically addresses the issues of policy and regulatory clarity, least-cost planning, geographical exclusivity, willingness to pay, and need for public funding, without which non-PLN supply will fail or only achieve limited impact.

Specifically, any mechanism to mobilize private sector participation for off-grid supply should incorporate the following features.

(i) Private sector involvement should be structured around long-term incentives to ensure technical and financial sustainability of the supply.

(ii) Where necessary, capital and/or operational subsidies should be made available on a systematic (not ad hoc) basis to ensure affordability and sustainability of this supply.

[34] Henceforth, the term "private sector" is used broadly to refer to any Indonesian legal entity other than PLN that is prepared to secure an off-grid business area through competitive tender. This can be an Indonesian company, an NGO, a community-based group such as a cooperative, or even regional government-owned enterprises (BUMD).

[35] For example, see World Bank. 2014. *From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa.* Washington, DC; P. Bardouille and D. Muench. 2014. *How a New Breed of Distributed Energy Services Companies can Reach 500 Million Energy-poor Customers within a Decade: A Commercial Solution to the Energy Access Challenge.* http://global-off-grid-lighting-association.org/resources/externalresources/; and a related paper available from http://static1.squarespace.com/static/52ce9657e4b00cd70d0900fb/t/53eaba55e4b008c8943d454e/1407892053484/Annex+I_DESCOs+in+Bangladesh_final.pdf

(iii) The provision of any subsidies should be on the basis of results achieved, that is, output-based rather than input-based.

(iv) The selection of a firm to conduct electrification in any particular business area should be done on the basis of competitive tender.

As shown in Figure 5.3, one approach could be with details as follows.

(i) The DGE compiles the list of approved off-grid business areas based on the least-cost planning exercise described above, and through the *satker lisdes* or direct contact with the provincial government, DGE determines which provinces are prepared to tender these areas.

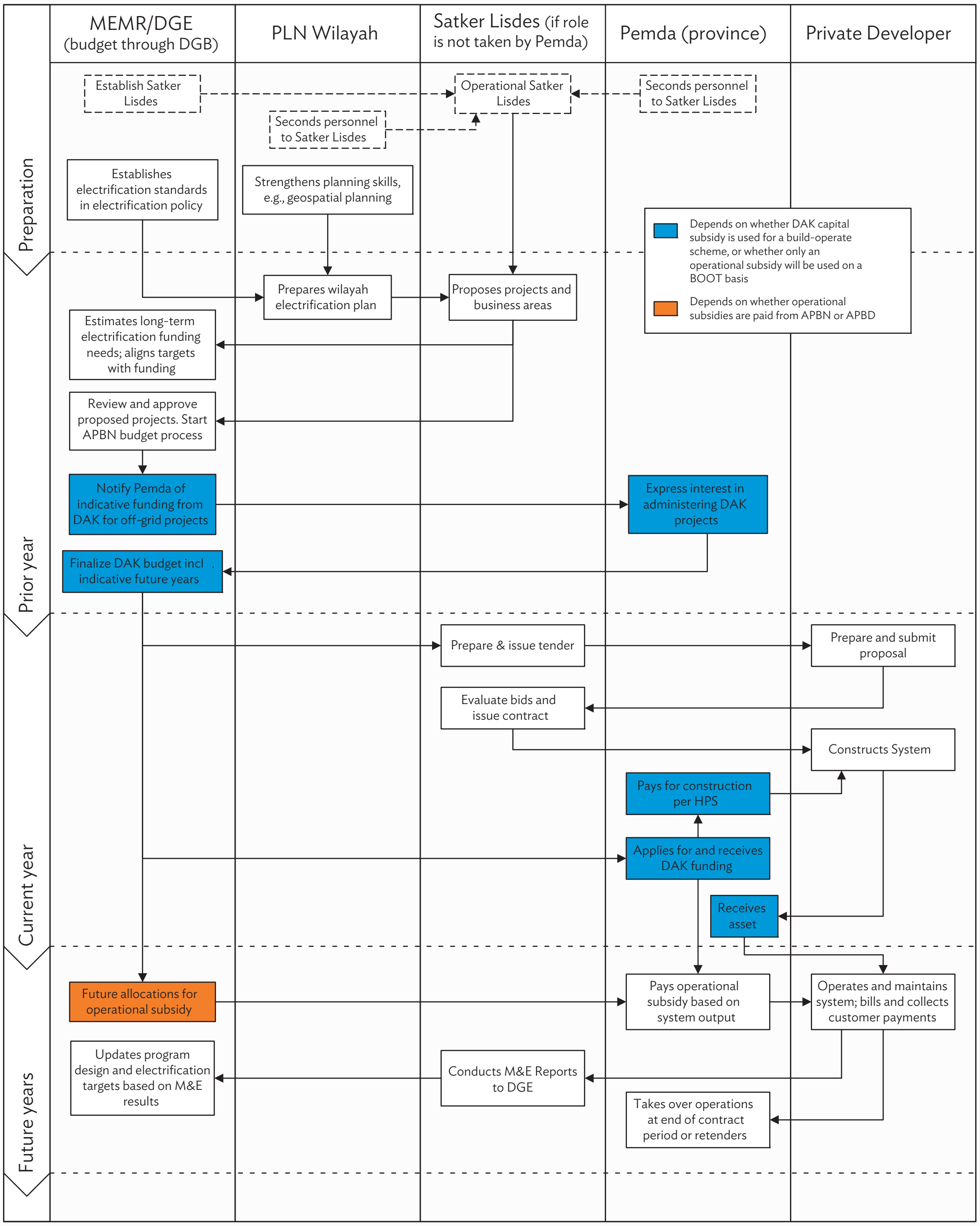
(ii) The capital cost estimate from the least-cost planning exercise can be used as a basis to determine the special allocation fund (DAK) budget for the coming year as a capital subsidy to be implemented by those provinces that wish to proceed with tendering of the designated business areas. Alternatively, instead of providing a capital subsidy, a purely operational subsidy could be used. One difference between providing a capital subsidy through the DAK together with an operational subsidy versus providing only an operational subsidy is that in the former case, the assets remain the property of the Pemda. This entails a *build–operate model* in which the developer constructs and operates the systems on behalf of the Pemda. In the case of the operational subsidy, the assets are the property of the developer, who must also finance the construction without any capital subsidy, but would transfer the assets to the Pemda at the end of the concession period. This would entail a *build–own–operate–transfer model*.

(iii) The *satker lisdes* or the provincial government then tenders the designated business areas for that province on the basis of which the bidder submits a technically compliant bid with the lowest operational subsidy requirement. If the build–operate model is used, the bid documents will stipulate the amount of capital costs that will be paid for construction of the assets as a capital subsidy, and the associated payment milestones. The developer may, in fact, estimate the capital costs to be higher or lower than the capital subsidy provided. This deviation will be compensated for by the private developer's bid for the operational subsidy, as discussed in Section 5.4. The bid documents will also stipulate the retail tariff that the developer is allowed to charge consumers over the life of the project (per government policy), with a provision that the total tariff receipts plus operational subsidy will be guaranteed (to accommodate possible tariff adjustments in the future).

(iv) If the build–operate model is used, the assets constructed by the developer will remain the property of the provincial government, in line with Law 23/2014. The subsidy is therefore paid partially input based (for construction of the asset) and partially output based (for the delivery of electricity service to consumers). On the contrary, if the build–own–operate–transfer model is used, the assets constructed by the developer are financed and owned by the developer but are handed over to the Pemda at the end of the concession period.

(v) The private developer will then operate and maintain the assets for the duration of the contract, perhaps 5–10 years or more. It will receive customer payments as well as the operational subsidy paid on an output basis. An organization will be required to evaluate the performance of each business area holder. This could be performed by the Provincial Energy and Mining Agency (*Dinas Pertambangan dan Energi*), under guidelines prepared by the DGE.

Figure 5.3: Proposed Process for Private Sector Involvement in Off-Grid Supply



APBD = Regional Government Budget, APBN = national government budget, BOOT = build–own–operate–transfer, DAK = special allocation fund, DGB = Directorate General of Budget, DGE = Directorate General of Electricity, HPS = owner's estimate (of a price) (*harga perkiraan sendiri*), M&E = monitoring and evaluation, MEMR = Ministry of Energy and Mineral Resources, PLN = State Electricity Company.

Source: Author.

Several countries have adopted similar models of electricity supply based on private sector bidding for the lowest subsidy required. More importantly, Indonesia already operates such a system for the award of "pioneer" land, sea, and air transport routes (*angkutan perintis*) on an annual basis. This is an adaptation of an existing Indonesian subsidy mechanism used by the transport sector for electrification. A key difference, however, is that because the assets involved (e.g., buses, ships, and airplanes) are movable, "pioneer" operators are willing to accept operational subsidy commitments on an annual basis. Because electrification assets are truly fixed assets, developers will look for an operational subsidy commitment and disbursement mechanism over the life of the concession. This is discussed further below as a prerequisite for this option.

Apart from any requirements the government may wish to impose regarding the use of renewable energy for off-grid supply, developers are free to use any mix of supply technologies, that is, this approach is technology neutral. Developers are incentivized to use the least-cost technology whatever it may be, as that will allow them to minimize their operational subsidy bid.

The potential discrepancy between technologies and associated costs assumed in the national least-cost plan (and the resulting capital subsidies, if any) on the one hand, and the actual technologies and costs incurred by the developer on the other is compensated by the developer's operational subsidy bid.

Specifically, off-grid business areas will be defined on the basis of the national least-cost electrification plan. Geospatial models likely to be used for national planning typically allow for only one or two off-grid technology options to be defined, for example, photovoltaic minigrids and individual household photovoltaic systems. Consequently, off-grid areas will be defined and capital costs estimated based on the off-grid technologies assumed for the preparation of the least-cost plan. If the build–operate model is used, these estimated capital costs will serve as a basis for setting the capital subsidies.

In reality, developers are likely to apply a variety of technologies within any particular business area, including others besides those assumed in the least-cost plan, with costs that also differ from those assumed in the least-cost plan. However, the developer will presumably factor this cost differential into the proposed operational subsidy. It is conceivable that a developer could even bid a "negative operational subsidy," that is, pay the government for the right to operate the concession, in the event of the capital subsidy and consumer revenue being high enough. Under this model, the developer bears the costs and risks of selecting, constructing, operating, and maintaining the supply technology but is compensated for those costs and risks through the operational subsidy it proposes.

This approach has the following prerequisites:

(i) The Government of Indonesia establishes a new policy for pricing of electricity to off-grid areas, and the corresponding service levels, as proposed in the mechanism described in Section 5.1. This policy might allow for differences in service levels and/or prices depending on the size or nature of the off-grid supply. Alternatively, it may stipulate that all low-income or remote households will have access to electricity at the uniform national tariff, although with differences in service levels.[36] This will provide an important input to the tendering of business areas and budgeting of subsidies.

[36] An issue here will be what to do with settlements too small for minigrid solutions, for example, less than 15 households, where metered solutions might be too expensive.

(ii) A mechanism is established to ensure the availability of operational subsidies for the life of the concession. Currently, the DAK is provided on a year-to-year basis without any commitment for future years. It is likely a different mechanism will be required, just as the operational subsidy for PLN is secured by PMK 170/2014.

(iii) The Directorate General of New and Renewable Energy and Energy Conservation or the DGE develops technical instructions for tendering of business areas and the administration of subsidies. However, this should not be overly prescriptive, and should allow for private sector innovation. If the DAK is funded for capital costs, an indicative provision would still be made for future operational subsidies as well.

(iv) PP 14/2012 may need to be amended to allow for the use of the uniform national tariff as a default or as a condition for the provision of the DAK funding, although it may be possible to establish such a system under Law 30/2009,[37] so that projects would not be delayed or developers discouraged by the uncertainty surrounding approval of tariffs by the Regional Representative Council (DPRD).

5.5 Set Targets and Monitor Performance

The least-cost plan indicates the total level of capital investment required to achieve universal access, whereas the annual public funding determines the rate at which households can be provided with electricity. The government can use this information to establish targets for electrification in terms of the number of households to be connected per year and the corresponding electrification ratio. These targets can serve to:

(i) help the government assess whether greater public spending, extended timelines for achieving near-universal access, and/or relaxed electrification standards are called for to achieve the government's electrification vision;

(ii) provide a metric against which overall electrification policy and program effectiveness can be evaluated, as an input for modifying these policies and programs; and

(iii) hold accountable the organizations responsible for implementing electrification programs, that is, PLN and the non-PLN suppliers.

Establishing electrification targets based on the annual availability of subsidy funds relative to the total investment required to achieve universal access ensures meaningful targets by aligning targets with funding.

Setting electrification standards and tariffs, creating a plan, budgeting for public investment, and establishing targets constitute an iterative process (Figure 5.4). On the basis of the monitoring and evaluation (M&E) of electrification activities conducted by both PLN and the non-PLN suppliers, the government may make changes

[37] Clauses (2) and (3) of Article 4 of Law 30/2009 on Electricity stipulates that the Pemda will set tariffs for non-PLN business areas on the basis of approval by the DPRD and based on the guidelines prepared by the government. However, in the event of the Pemda being unable to set such tariffs, the government can set the tariffs with the approval of the DPR. Presumably, this allows sufficient flexibility for the government to require the Pemda to apply whatever pricing policy it adopts for off-grid areas as a condition for receiving any funding for off-grid electrification subsidies. Specifically, those clauses read as follows:

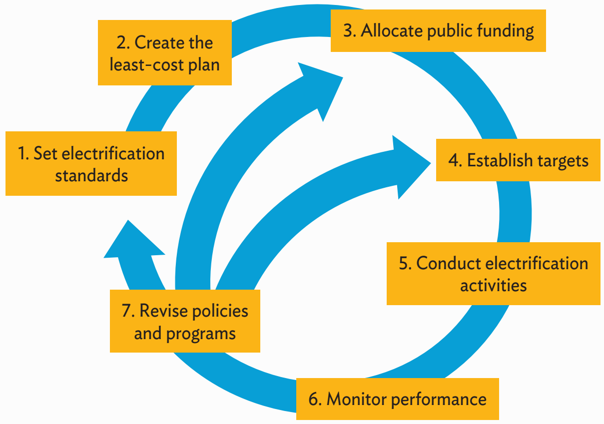
(2) *Pemerintah daerah sesuai dengan kewenangannya menetapkan tarif tenaga listrik untuk konsumen dengan persetujuan Dewan Perwakilan Rakyat Daerah berdasarkan pedoman yang ditetapkan oleh Pemerintah.*

(3) *Dalam hal pemerintah daerah tidak dapat menetapkan tarif tenaga listrik sebagaimana dimaksud pada ayat (2), Pemerintah menetapkan tarif tenaga listrik untuk daerah tersebut dengan persetujuan Dewan Perwakilan Rakyat Republik Indonesia.*

in electrification standards or tariffs, modify the level of public funding, or amend electrification targets.

For example, given the trade-off between funding electrification versus other basic needs, if funding available for electrification is not adequate to increase access as quickly as the government may wish, it may desire to relax electrification standards. The government may opt to adjust the definition of electrification and associated standards so as to achieve a basic level of service within a quicker time period. The standards therefore depend on a dynamic balance between the cost of supply at a given standard, the willingness and ability of households to pay for electricity, and the ability of the state to subsidize electrification. This balance may change over time, starting with minimum service levels at the outset (so as to minimize costs and subsidies) and moving toward more robust supply over time.

Figure 5.4: Electrification Planning and Implementation as an Iterative Process



Source: Author.

Conversely, if electrification targets are held paramount, then this analysis is necessary to determine whether sufficient funding is being allocated. This is an essential aspect of the performance-based budgeting that the Ministry of Finance envisions for the public sector.

Aligning targets with funding would be the role of the DGE as an adjunct to the process of developing and updating the National Government Electricity Plan (RUKN). As is done with the RUKN, the DGE would not have conducted the detailed, primary analysis on its own, but could build upon the results of the national least-cost plan prepared by PLN.

Targets are meaningful only to the extent they are used to measure and manage performance. This in turn requires a dedicated M&E effort. Other than programmatic evaluation of the off-grid photovoltaic projects conducted by the EnDev project, most electrification M&E activities to date have been ad hoc and have focused on how inputs are used rather than what outcomes are achieved. These findings have not been systematically taken into account for developing programs or projects going forward.

Figure 5.3 specifically designates roles for M&E as a feedback into electrification planning and policies. The DGE will ultimately be responsible to compile M&E findings from regionally based agencies that can assess the performance of PLN and the non-PLN suppliers, and as an input to policy review and development. In Figure 5.3, the *satker lisdes* is given this role, but others could also be assigned this function. This will be essential to ensure midcourse corrections in Indonesia's electrification efforts to ensure the timely achievement of universal access at least cost.

5.6 Next Steps

The challenge of providing electricity to the 16% of the Indonesian population that remains in the dark requires significant changes to the way electrification has been conducted in the past. Specifically, the government may wish to consider the following arrangements.

(i) The government should define technical and service *standards and pricing for off-grid power.*

(ii) PLN, on behalf of the government, should prepare *a national electrification least-cost plan* based on these standards to determine the costs of achieving universal access and delineating areas best served by grid extension or off-grid supply.

(iii) PLN should continue to be responsible for grid extension, but with a rationalized mechanism for public funding.

(iv) The government should mobilize the *non-PLN suppliers* to serve off-grid business areas by having them compete for concession areas on the basis of the lowest operational subsidy, and should establish new output-based subsidy mechanisms to ensure the financial viability of these suppliers in accordance with the government's off-grid pricing policy.

(v) The government should establish electrification *targets* based on the results of the national least-cost plan and the annual availability of public funding to PLN and the non-PLN suppliers. Performance of these companies should be monitored and evaluated against these targets. These results may be used to supervise PLN and the non-PLN suppliers and to adjust electrification policies and funding levels.

These measures constitute a new electrification paradigm for Indonesia that is comprehensive, efficient, and sustainable. The design and implementation of this new paradigm requires collaboration of national and local governments, PLN, the private sector, beneficiary communities, and development partners.

The next step, therefore, is to establish an interministerial working group to prepare a National Electricity Access Policy for consideration of the minister of Energy and Mineral Resources or the President. The National Electricity Access Policy should define

(i) service level by type of supply (e.g., grid vs. off-grid service standards);

(ii) pricing by type of supply (e.g., whether the national uniform electricity tariff [TDL] applies for off-grid as well as grid-connected consumers).

(iii) the role of renewable energy for off-grid supply (e.g., for any off-grid operation to be eligible for government subsidy, is a minimum level of renewable energy utilization required);

(iv) the role of PLN in helping the government prepare a national least-cost electrification plan;

(v) the role of the nongovernment and/or private sector in off-grid electrification; and

(vi) the (re)design of public funding and subsidy mechanisms for grid and off-grid supply.

The National Electricity Access Policy would not be a stand-alone document, but would supplement the National Energy Policy (KEN) and the RUKN, providing more specific guidance for electrification activities going forward.

This policy touches on many issues, including development planning, public finance, electricity regulation, regional autonomy, and technical development. Consequently, a wide range of agencies would be expected to participate in the working group. This working group could be convened by the Coordinating Ministry of Economic Affairs, and should include representation from the following entities:

(i) Ministry of Finance, especially the Fiscal Policy Office; the Directorate General of Budget; and the Directorate General of Financing and Risk Management (responsible for subsidy policy and public finance);
(ii) National Development Planning Agency (Bappenas) (responsible for national development planning);
(iii) Ministry of Energy and Mineral Resources (technical ministry responsible for electrification);
(iv) Ministry of Home Affairs (responsible for regional autonomy);
(v) Ministry of Forestry and Environment (responsible for land access in many unelectrified regions);
(vi) Ministry of Villages, Disadvantage Regions and Transmigration (responsible for some off-grid projects);
(vii) Ministry of Cooperatives and Small and Medium Enterprises (responsible for some off-grid projects);
(viii) PLN (the national electricity company, which would remain responsible for grid extension); and
(ix) Industry groups such as the Indonesian Electricity Society (*Masyrakat Ketenagalistrikan Indonesia*, MKI) and the Indonesian Renewable Energy Society (*Masyrakat Energi Terbarukan Indonesia*, METI) (representing the non-PLN suppliers).

Once the policy has been prepared, the following activities could be conducted accordingly:

(i) any regulatory or legal instruments could be prepared, as required, to implement the policy framework;
(ii) national electrification least-cost plan can be prepared;
(iii) off-grid business areas can be designated;
(iv) public funding committed;
(v) electrification targets established;
(vi) off-grid tenders conducted;
(vii) implementation monitored and evaluated; and
(viii) updating of the National Electricity Access Policy based on the M&E findings.

Key milestones could be scheduled as follows:

(i) identification of electrification issues and options within the RUKN to be presented to the DPR in mid-2015;
(ii) establishment of the Electrification Working Group by mid-2015;
(iii) submission of the National Electricity Access Policy by the fourth quarter of 2015;
(iv) preparation and release of any required implementing regulations by the second quarter of 2016;
(v) completion of the first National Least-Cost Electrification Plan by mid-2016;
(vi) budgeting of subsidies and/or public funding for PLN and non-PLN electrification activities during 2016 for the 2017 state budget; and
(vii) implementation of the new electrification framework starting in 2017.

The working group could also consider how best to access external resources available to support electrification activities. Development partners are prepared to support Indonesia's efforts to achieve universal access by providing technical assistance drawing on international experience as well as potentially financing electrification activities. Such financing could be direct, such as results-based lending to PLN for grid extension, or indirect, such as providing funds to domestic development finance institutions to finance off-grid systems undertaken by the non-PLN suppliers.

Regarding technical assistance, the Sustainable Energy for All program (footnote 5) brings together an unparalleled global network of leaders from all sectors of society—governments, business, and civil society—into a partnership to help achieve universal access to modern energy. The program mobilizes stakeholders around best practices and supports the adoption of innovative solutions. The initiative is helping to create the conditions that will enable a massive scale up of private investment in energy access and clean energy, and it tracks progress toward its objectives in a transparent, accountable manner. The program can be accessed through the Asian Development Bank, which serves as the regional hub for the Asia and Pacific region.

APPENDIX 1

The Sumba Least-Cost Electrification Plan

1.1 Introduction

The Sumba Iconic Island (SII) initiative was launched in 2010. Since that time, a number of on-grid and off-grid electrification projects have been carried out. Those efforts provided insights and experience regarding the opportunities for and challenges to achieving the SII targets. This experience resulted in a comprehensive plan in 2014 to guide and coordinate stakeholder activities going forward as well as to determine the capital investment required to achieve the SII targets of 95% electrification ratio and maximum use of renewables.[1] The SII planning process can be used as a model for other regions.

The principal features of the plan are as follows.

(i) **Comprehensive.** The analysis and resulting plan is comprehensive in that it takes into account measures to achieve the electrification ratio target as well as the renewable contribution target. It is also comprehensive in that it considers the potential role of all principal classes of electrification technologies: off-grid (individual household photovoltaic systems), minigrid (isolated photovoltaic-powered minigrids), and grid extension to meet the electrification target. For grid supply, it considers the potential contribution of all renewable resources identified in the Deliverable B report prepared under the project.

(ii) **Least cost.** The plan is based on least-cost principles. Specifically, the analysis determines the mix of off-grid, minigrid, and grid solutions to achieve the lowest life-cycle cost corresponding to the electrification ratio target. For grid supply, it then determines the least-cost mix of grid-connected generation options to meet future load, based on the availability of renewable energy resources presented in Deliverable B. Because investment capital is limited, it is important to optimize the use of that capital, particularly from public sources, through least-cost analysis. Moreover, private investors typically seek assurance that their investments are part of a least-cost plan to minimize the risk that their projects will be displaced by lower-cost projects in the future.

(iii) **Consistent.** The analysis upon which the plan is based relies on publicly available information from the Geospatial Information Agency (*Badan Informasi Geospatial*) and the Central Statistics Bureau, as well as data from key stakeholders such as the State Electricity Company (PLN) and the Sumba district. This helps ensure that these results can be readily accepted by and integrated with the planning efforts of other stakeholders.

[1] ADB. 2014. *Midterm Report: Scaling-up Renewable Energy Access in Eastern Indonesia.* Manila (TA 8287).

(iv) **Readily updated.** The plan presented here provides only an initial direction based on current conditions and available information. It will need to be updated as better information becomes available and as conditions change. The least-cost electrification plan for Sumba has been developed using commercial off-the-shelf software tools that are available in Indonesia, have already been introduced to key stakeholders such as PLN, and are either free or relatively low cost. This will facilitate updating the plan in the future.

The planning methodology comprises three steps:

(i) **Determine electrification modality by settlement.** The first step is to identify which electrification technology is best suited to serve each settlement on Sumba. A key input to this analysis is the target electrification ratio. The technologies considered are as follows:

(a) grid extension,

(b) isolated minigrids supplied by photovoltaic arrays, and

(c) individual household photovoltaic systems.

This analysis uses the Network Planner model.[2]

(ii) **Prepare a least-cost generation expansion plan for the grid.** The above analysis determines the future grid load. In addition, Deliverable B prepared under this assignment documents the availability of renewable energy resources on Sumba suitable for grid connection. This second step uses this information to determine the least-cost mix of generation to serve the future network load. This analysis uses the HOMER® model.[3]

(iii) **Identify required network investment.** Step 1 determines the spatial distribution of the future electric load, whereas Step 2 determines the size, location, and nature of generators to serve that load. A transmission and distribution network is required to connect the future generators with the future loads. A load flow analysis was conducted to determine the network infrastructure required to transmit power throughout the island. This analysis uses the ETAP model.[4]

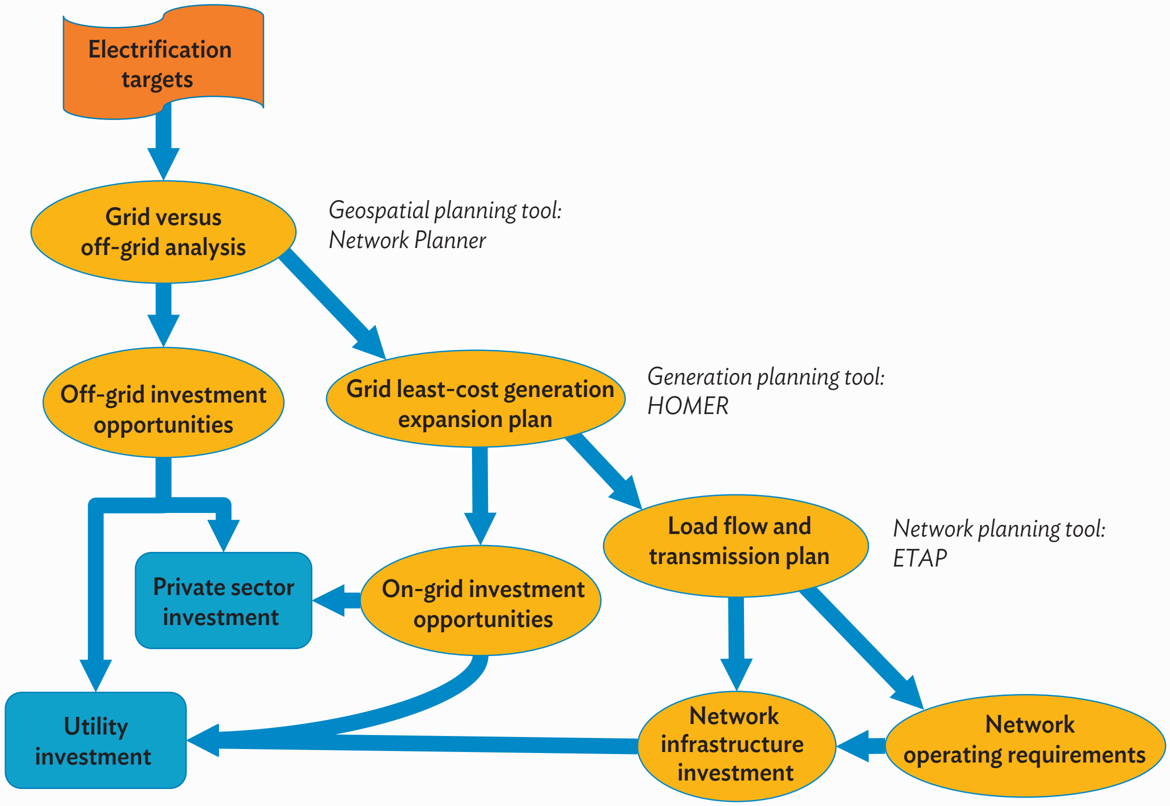
In addition, the grid will require a control system to facilitate dispatch and safe operation, and ensure stability and reliability. A notional cost estimate for such a system is included in the network investment.

2 Network Planner is a publicly available, web-based model developed by The Earth Institute of Columbia University. The model takes into account existing geospatial settlement patterns, the location of existing transmission infrastructure, expected load growth, as well as the cost and performance of various electrification technologies to determine the least-cost means of electrifying each settlement within a selected region. The model considers three electrification options: grid extension, isolated minigrids, and individual household solutions such as solar photovoltaic home systems. As part of an electrification planning study for the provinces of Maluku, North Maluku, and Nusa Tenggara Timur, the World Bank has provided Network Planner training to PLN.

3 The HOMER Micropower Optimization Model is a computer model developed by the United States National Renewable Energy Laboratory (NREL) to assist in the design of renewable power systems. HOMER models a power system's physical behavior for every hour over a 1-year period, and determines the corresponding system lifecycle cost, which is the total present value cost of installing and operating the system over its lifetime. By simulating and comparing various system configurations defined by the user, HOMER can identify the optimal (least-cost) mix of generation technologies. There are some 100,000 users of HOMER across 193 countries. In 2012, 50 PLN personnel were trained in hybrid and renewable system design and evaluation using the HOMER model.

4 ETAP is electrical engineering software for the design, simulation, operation, and automation of power networks, including load flow analysis. PLN uses ETAP for its grid development studies.

Figure A1.1: The Planning Methodology



ETAP = ETAP Power System Software.
Source: Asian Development Bank.

The flow of this analysis is shown in Figure A1.1. Each stage of the analysis identifies investment opportunities for off-grid systems, grid-connected generation, and network infrastructure. While both the private sector and PLN are candidates to invest in off-grid systems and grid-connected generation, investments in network infrastructure are the exclusive domain of PLN.

As part of this work, a web-based geographical information system was developed to allow stakeholders to visualize geospatial data and analytical results, and conduct their own queries of the available data. The project web-based geographical information system is publicly available online (http://castlerockasia.com/sumba/sii.html).

The principal results of each stage of the analysis are described below.

1.2 Geospatial Analysis

The geospatial analysis determines the least-cost means of electrification for each settlement on Sumba consistent with the electrification ratio target. Three different electrification options were considered:

(i) Off-grid: individual household photovoltaic systems similar to the Super Extra Energy Efficient (SEHEN) systems of PLN;[5]

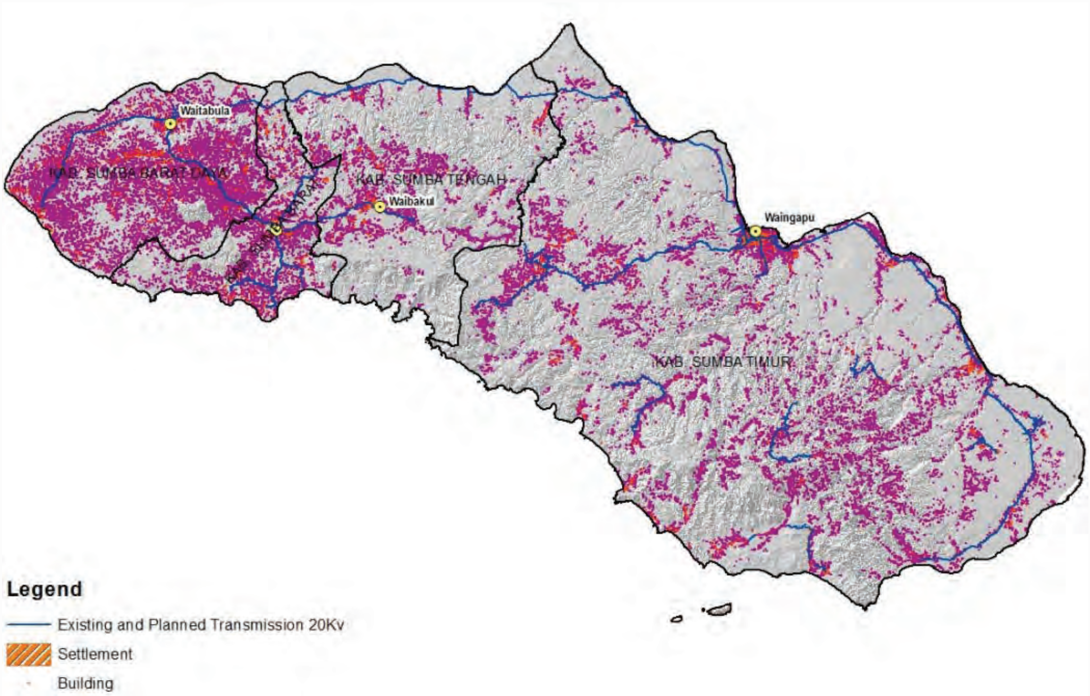
(ii) Minigrid: isolated photovoltaic-powered low-voltage grids to supply an entire community;

(iii) Grid extension: connection of households to the Sumba grid of PLN through conventional grid expansion activities.

This geospatial analysis entailed four steps.

(i) Identify and characterize existing settlements and medium-voltage network. This is shown in Figure A1.2.

Figure A1.2: Current Settlement Patterns and Medium-Voltage Network



Source: ADB. 2014. *Scaling Up Renewable Energy Access in Eastern Indonesia.* Manila (TA 8287).

[5] The Super Extra Energy Efficient (SEHEN) household photovoltaic systems typically comprise a 14 peak watts photovoltaic panel with three 3-watt LED lamps and associated batteries and controller.

(ii) Aggregate settlements into areas that can be served by low-voltage supply. A total of 2,982 such settlement aggregations were identified in addition to 3,344 individual households outside of settlements. Each aggregation of settlements was subsequently represented by the centroid of the aggregation (the "node").

(iii) Determine future electricity demand for each node.

(iv) Characterize electrification options and run the Network Planner to determine the least-cost means of electrifying each settlement and estimating the electrification costs.

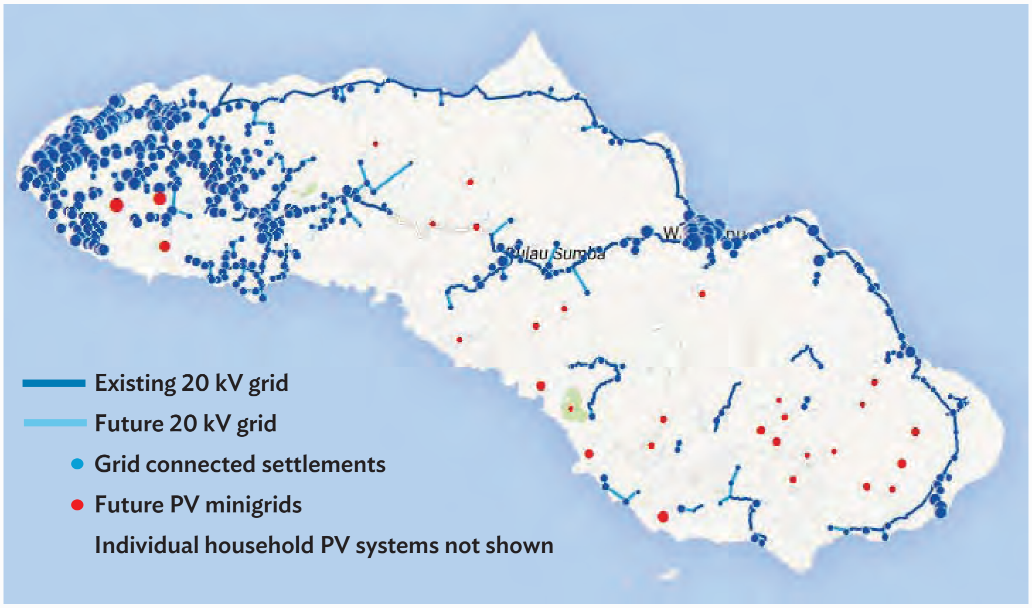
Two scenarios were considered:

(i) a Base Case that represents prevailing technology costs and performance, including grid energy costs reflecting continued use of diesel; and

(ii) a Low Case that represents a substantial reduction in grid energy costs corresponding to high penetration of lower-cost renewable generation, lower minigrid battery costs, and lower low-voltage reticulation costs.

Figure A1.3 depicts the Base Case result and Figure A1.4 depicts the Low Case result. Table A1.1 summarizes the incidence of the electrification technologies under each scenario.

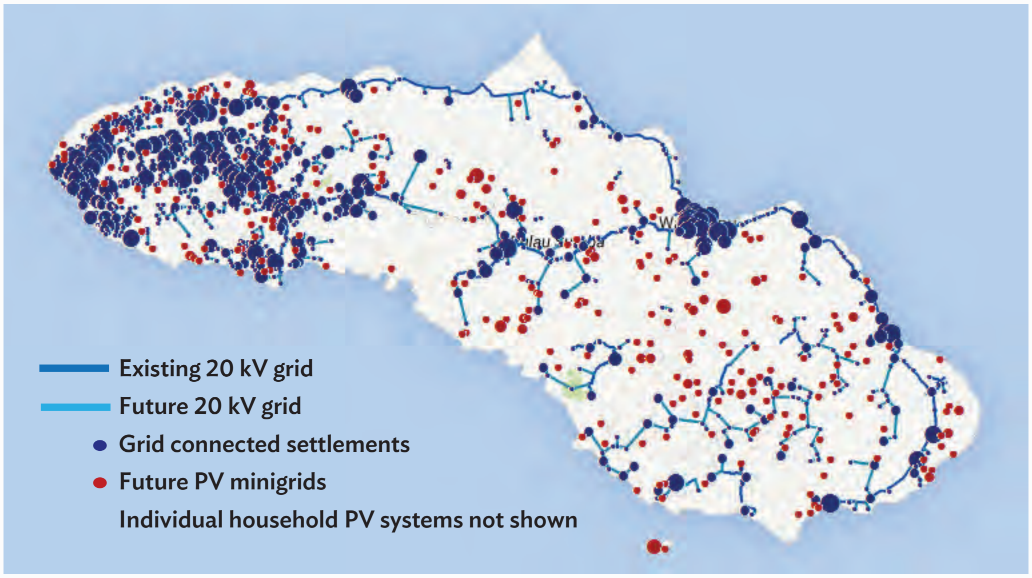
Figure A1.3: Base Case Results for 2025



kV = kilovolt, PV = photovoltaic.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

Figure A1.4: Low Case Results for 2025



kV = kilovolt, PV = photovoltaic.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

Table A1.1: Summary of Geospatial Analysis Results

	Base Case	Low Case
Minigrids		
capital cost ($)	6.6 million	21.2 million
number of households	4,162 (3%)	17,208 (10%)
capex/household ($)	1,597	1,234
Off-Grid		
capital cost ($)	43.1 million	6.2 million
number of households	33,396 (26%)	10,810 (7%)
capex/household ($)	1,290	574
Grid		
number of households	129,130 (77%)	138,670 (83%)
Total annual grid sales (GWh)	285.9	290.0
Total number of electrified households in 2025	166,688 (100%)	166,688 (100%)

GWh = gigawatt-hour.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

1.3 Grid Generation Least-Cost Plan

The geospatial analysis yields a forecast of total energy sales on the grid for 2025 (Table A1.1). Existing system load patterns were scaled by this load to provide a forecast of 2025 hourly loads that have been used as the basis for the generation production simulation within HOMER.

Resource data from Deliverable B was also entered into HOMER along with estimates of capital, operation and maintenance, and fuel costs for each generation type. Three generation scenarios were considered:

(i) a Base Case with a 10-megawatt (MW) storage hydro plant available for base load service and no pumped storage;

(ii) a Base Case with a 20 MW storage hydro plant available for peaking service and no pumped storage; and

(iii) Pumped Storage Case with a 10 MW storage hydro plant available along with an 18 MW pumped storage station.

The maximum available capacity for each generation resource under these three scenarios is shown in Table A1.2. These capacity totals consolidate the maximum contribution from 24 different candidate generation plants representing the existing generation stations of PLN and the resources identified in the Deliverable B. HOMER then calculated the least-cost mix of generation on a lifecycle cost basis based on a simulation of various permutations of capacity availability for each type of generation under each scenario.

Table A1.2: Generation Scenarios

Maximum Available Megawatt	No Pumped Storage	With Pumped Storage
PV	10	30
Wind	10	20
Biomass	10	10
Run-of-river Hydro	6.8	6.8
Storage Hydro	10/20	10
Pumped Storage	0	18
Diesel	60	60

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

Monthly generation for the least-cost mix under the Base Case is shown in Figure A1.5, and the Pumped Storage Case results are shown in Figure A1.6. The Base Case results in a 71% renewable contribution, whereas the Pumped Storage Case increases the renewable contribution to 87%. The principal findings are as follows:

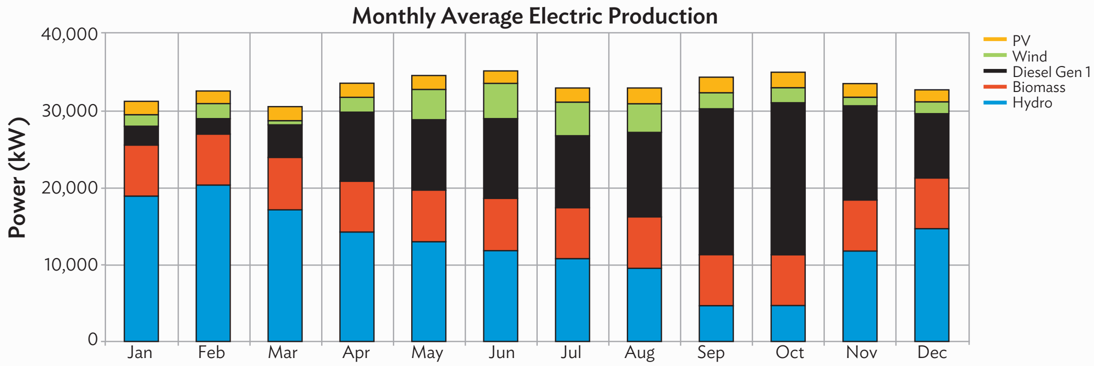
(i) The seasonality of wind and hydro resources results in continued reliance on diesel during the late dry season. Use of pumped storage would reduce this reliance, but would not eliminate it.

(ii) The diurnal mismatch of photovoltaic production and system peak load in the Base Case means that some diesel is required for most of the year. However, the use of pumped storage nearly eliminates the use of diesel outside of the late dry season.

(iii) Use of run-of-river hydro almost eliminates diesel utilization during the rainy season.

(iv) Although wind and solar resources are both limited during the late dry season, they are otherwise relatively uncorrelated on a diurnal basis. This complementarity facilitates their joint utilization on the system.

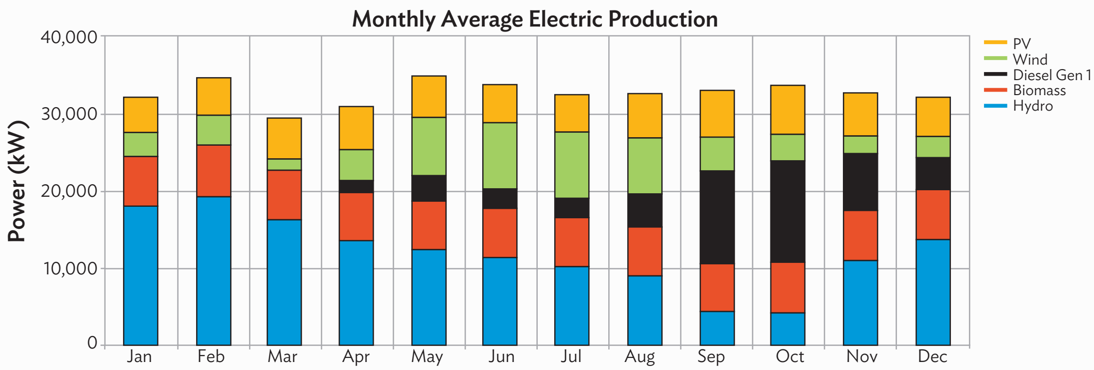
Figure A1.5: Base Case Least-Cost Generation Mix



kW = kilowatt.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

Figure A1.6: Least-Cost Generation Mix with Pumped Storage



kW = kilowatt.

Note: HOMER treats pumped storage as a storage technology and not as a generation technology; hence, it does not appear in the above figure as a source of energy production. Pumped storage only shifts the time when energy produced by other generators is available. However, the impacts of pumped storage on the energy mix are seen in the increased photovoltaic and wind generation, since pumped storage stores what would otherwise be excess generation from these sources for use during periods of peak demand.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

Table A1.3 summarizes the least-cost mix under each scenario, including the capital costs for each type of generation and the system-levelized cost of energy for each mix. These levelized costs compare to $0.450/kWh for a pure diesel system. Although the Pumped Storage Case has the highest capital cost, it offers the lowest levelized cost of energy, and therefore represents the optimal configuration.

Table A1.3: Summary of Least-Cost Generation Capital Costs and Performance

	Base case—20 MW storage hydro			Base case—10 MW storage hydro			Pump storage case—10 MW storage hydro		
	Capacity (MW)	Production share (%)	Capital cost ($ million)	Capacity (MW)	Production share (%)	Capital cost ($ million)	Capacity (MW)	Production share (%)	Capital cost ($ million)
PV	10.0	6	30.0	10.0	6	30.0	30.0	16	90.0
Wind	10.0	8	33.0	10.0	8	33.0	20.0	15	66.0
Hydro (ROR)	6.8	37	20.6	6.8	37	20.6	6.8	36	20.6
Hydro (storage)	20.0	37	80.0	10.0	37	45.0	10.0	36	45.0
Pumped storage	–	–	–	–	–	–	18.0	8	126.0
Biomass	10.0	20	45.0	10.0	20	45.0	10.0	20	45.0
Diesel	60.0	29	60.0	60.0	29	60.0	60.0	13	60.0
Total	**116.8**	**100**	**268.6**	**106.8**	**100**	**233.6**	**154.8**	**108**[a]	**452.6**
less existing RoR hydro[b]	2.3		7.0	2.3		7.0	2.3		7.0
less existing diesel[c]	10.7		10.7	10.7		10.7	10.7		10.7
Total excluding existing	**103.8**		**250.9**	**93.8**		**215.9**	**141.8**		**434.9**
Levelized cost of energy[d]	**$0.357/kWh**			**$0.279/kWh**			**$0.276/kWh**		

– = not available, RoR = run-of-river.

Notes:

[a] Percentage of consumer load. Sums to >100% because of production required to operate pumped storage as well as meet load.

[b] Based on PLN data for Lokomboro A&B (derated), April 2013.

[c] Based on PLN data for all diesel sets >350 kW and derated, April 2013.

[d] Total system generation levelized costs at the busbar, including existing plant. Network costs are excluded.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

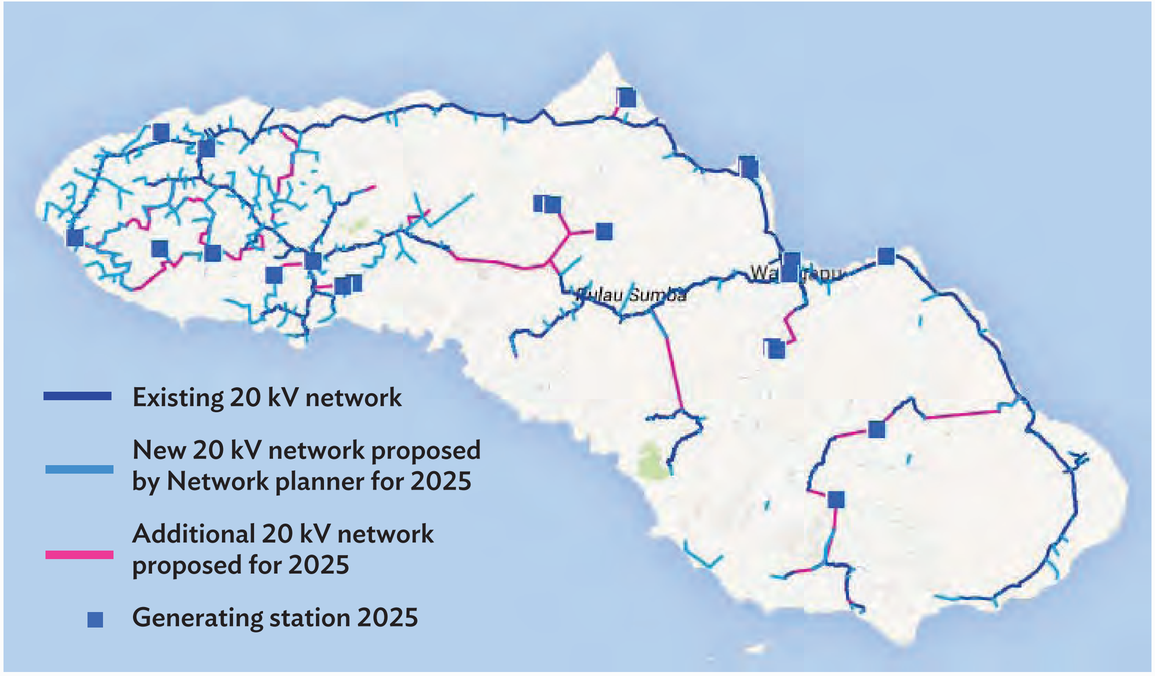
1.4 Network Requirements

The geospatial analysis using the Network Planner identifies where, and how much, energy will be needed in 2025 if the target of 95% electrification is to be achieved. The Deliverable B and HOMER analysis identified the least-cost generation mix for grid supply to meet that energy demand and the locations of the corresponding generating plants. The network analysis determines the transmission infrastructure required to move power from those generation plants to where it would be used by consumers in 2025.

Figure A1.7 shows the existing 20 kV network, the 20 kV extensions identified by the Network Planner for 2025 under the Base Case scenario, and additional 20 kV lines that have been added to connect new generation or improve the operation of the network. The 24 generating stations are also identified.

Load flow analysis was conducted to determine the network infrastructure required to operate the system under 2025 conditions. Spur lines were pruned. Loads within each *desa* (including those served by spur lines) were consolidated ("lumped") at either the end of the 20 kV line or at the midpoint of a line's transit across the *desa*, so that loads were represented spatially as 78 nodes. Figure A1.8 shows the resulting simplified system representation used for the load flow analysis.

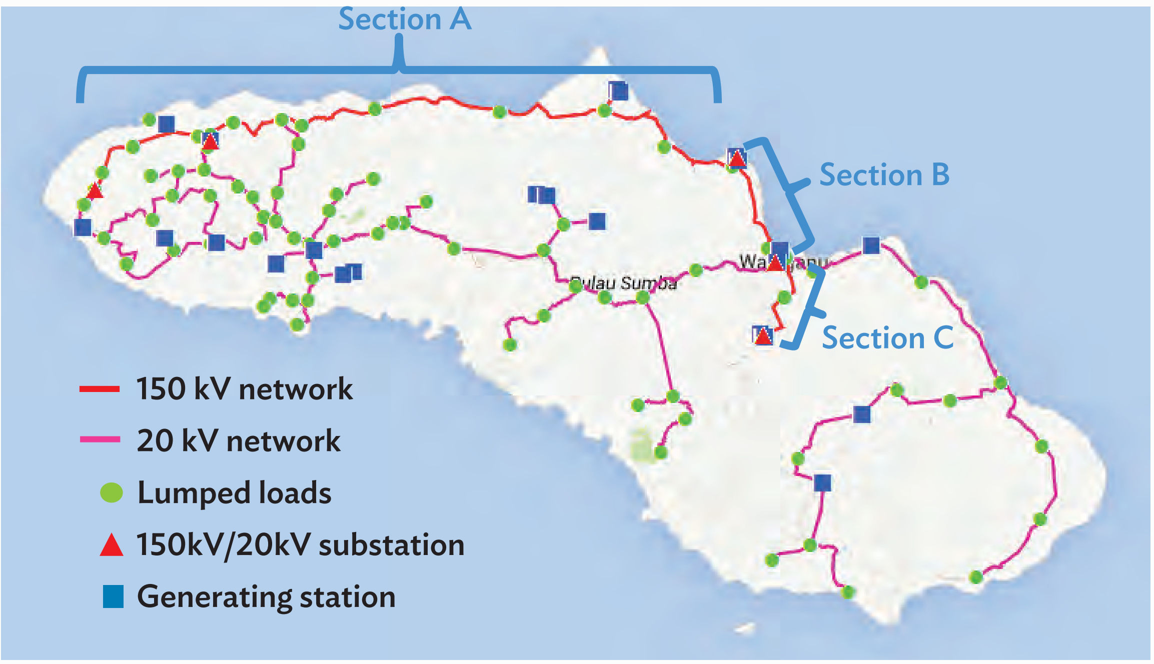
Figure A1.7: Sumba Network in 2025



kV = kilovolt.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

Figure A1.8: Representation of 2025 Network



kV = kilovolt.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

Roughly two-thirds of system generating capacity under the pumped storage scenario is located in East Sumba, whereas roughly two-thirds of the load is located in western Sumba. The load flow analysis identified the need for reconductoring of much of the 20 kV line, installation of voltage regulators on some sections of the network, as well as the construction of a 150 kV line running east–west as shown as the red line in Figure A1.8. A 150 kV was proposed rather than a 70 kV line since the incremental cost is relatively small and PLN is moving to 150 kV line as its principal high-voltage standard throughout Indonesia.

Table A1.4 provides a breakdown of the capital costs of the additional network infrastructure required to serve load under probable conditions projected for 2025.

Table A1.4: Capital Costs for Network Development

	Total capex ($ million)
150 kV lines	23.7
150 kV substations	19.8
New 20 kV lines	48.0
New 20/0.4 kV transformers	15.3
20 kV line regulators	0.3
20 kV field circuit breakers	0.6
LV line	48.2
Customer connections	16.0
Total	**171.9**

Capex = capital expenditure, kV = kilovolt, LV = low voltage.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

In addition, a control and communications study is required to determine the design and configuration of a control system to operate the system. This would be followed by the procurement and installation of the control system.

1.5 Cost Summary

Table A1.5 consolidates the off-grid, minigrid generation, and network capital costs by scenario. The "71% Renewable" scenario refers to that portion of grid supply produced by renewables under the Base Case with 10 MW storage hydro, whereas the "87% Renewable" refers to that portion of grid supply produced by renewables under the Pumped Storage Case.

Again, despite the significant levels of capital investment required, these scenarios represent the least-cost means to meet future load corresponding to a 95% electrification ratio in 2025.

Like a ship starting on a long journey, these results are only intended to provide an initial heading. Midcourse adjustments will be required as conditions change. There are a number of assumptions and caveats associated with these initial findings. This analysis should be updated as conditions change or the values of key parameters become more certain, especially with regard to the following:

1. **Resource confirmation.** The availability and nature of renewable energy resources on Sumba will be known with greater accuracy as long-term measurement is conducted. In addition, the availability of some resources such as biomass will depend in part on government policies and human effort.

Table A1.5: Consolidated Summary of Capital Costs Required to Achieve 95% Electrification Ratio by 2025

	71% Renewable	87% Renewable
Off-grid and Minigrid[a]	49.7	49.7
Grid		
Generation[b]	215.9	434.9
Network	171.9	171.9
Other[c]	12.9	19.5
Total	**450.4**	**676.0**
Total per household	**3,475**	**5,216**

Notes: Values stated as overnight capital costs in million US dollars, except for "total per household," which is stated in US dollars. With 95% electrification ratio, there is a total of 166,688 electrified households in 2025, compared with 32,091 grid-connected households and 22,978 SEHEN households reported by PLN in April 2013. Since many SEHEN systems are either not operating or have been withdrawn by PLN due to nonpayment, only 5,000 additional households have been connected to the grid since April 2013, and the "total per household" is calculated on the basis of an estimated 129,597 households to be provided with electricity over a period of 10 years starting 2015. Excluding generation and its share of Other costs (but including transmission costs as part of network costs), cost per household is $1,761.

[a] Base Case is used since the Low Case assumed a 55% reduction in busbar energy costs resulting from high renewable penetration, but based on the HOMER results it appears that the reduction is more on the order of 15%.

[b] Net of existing plant.

[c] "Other," assumed to be 3% of all grid capital expenditure, represents an estimate of the costs of a control system and other studies and implementation activities.

Source: ADB. 2014. *Mid-Term Report (Final): Least-Cost Electrification Plan for the Iconic Island.* Manila.

2. **Effective implementation models.** These results assume the availability of business models that can support the implementation of the various projects and technologies. In fact, as documented in the Inception Report and Deliverable B, there are serious challenges that must be overcome with respect to off-grid and minigrid solutions. Unless effective delivery models can be developed for these technologies that will make them technologically and financially sustainable, it will not be possible to scale up their deployment successfully.
3. **Sufficient subsidy.** The willingness-to-pay analysis of Deliverable B indicates significant price sensitivity. The demand model formulated here assumes that electricity remains as affordable as it is today. This will require continued subsidy.
4. **Design philosophy.** This analysis has been conducted assuming a conventional model of grid extension and system operation in which a single network is developed on Sumba. However, there are alternative system models such as setting up the system as a set of smaller grids that can be operated independently or on an interconnected basis (although this would likely require continued reliance on at least some diesel generation).
5. **Prices.** The modeling depends on assumptions about fuel costs, installed capital costs of each technology, and operating costs of each project. These may change in unexpected ways in the coming years.
6. **Technological progress.** New technologies or significant improvements to existing technologies may emerge.

7. **Future load by settlement.** The results depend strongly on the load forecast. Future load characteristics may differ from those developed here due to the following factors:
   (i) Implementation of end-use energy efficiency and demand-side management.
   (ii) Introduction of new electricity demands such as electric vehicles.
   (iii) Changes in customer composition, for example, accelerated tourism development.
   (iv) Changes in other forecasting parameters such as the population growth rate, income growth rate, and income elasticity of demand, as well as the estimate of total demand per household as a function of settlement size.
8. **Operational considerations and control systems.** Operation of the future grid will require a more sophisticated control system, which could affect the maximum penetration of technologies such as photovoltaic and wind generation, and perhaps result in a different level of renewable contribution than identified in this report.

APPENDIX 2

Directorate General of Electricity and State Electricity Company Electrification Data by Province

This appendix summarizes the most recent data (end of year 2013) officially available from the Director General of Electricity and State Electricity Company (PLN) regarding electrification. Relevant data from the Central Statistics Bureau has also been included. The resulting national electrification ratio at the end of 2013 is 80.5%. This increased to 84.1% by the end of 2014, but a provincial breakdown is not yet available.

Table A2.1: Electrification Data Reported by DJK for 2013

			Keluarga Berlistrik (PLN)	Keluarga Berlistrik (Non-PLN)	Jumlah Keluarga (x 1,000)	Rasio Elektrifikasi (%)	PDB per Kapita (Rp juta)	Kepadatan Penduduk per km²	Rata-Rata Banyaknya Anggota Rumah Tangga	Jumlah Keluarga Tidak Berlistrik	Jumlah Penduduk Tidak Berlistrik
			Electrified Households (PLN)	Electrified Households (Non-PLN)	Total Households (x 1,000)	Electrification Ratio (%)	GDP Per Capita (Rp million)	Population Density per km²	Average Number of People per Household	Total Unelectrified Households	Total Unelectrified Population
			Source: DJK	Source: DJK	Source: DJK	Source: DJK	Source: BPS	Source: BPS	Source: BPS	Calculated	Calculated
No.	Propinsi	Province	(a)	(b)	(c)	$(d) = \frac{(a+b)}{c*100\%}$	(e)	(f)	(g)	c – (b+c) = (h)	(i) = h*g
1	Aceh	Aceh	1,016,898	12,105	1,146,882	89.72	21.4	83	4.2	117,879	495,092
2	Sumatera Utara	North Sumatera	2,749,091	8,674	3,147,545	87.62	29.7	186	4.3	389,780	1,676,054
3	Sumatera Barat	West Sumatera	918,859	45,961	1,202,729	80.22	25.1	121	4.2	237,909	999,218
4	Riau	Riau	905,341	242,888	1,480,493	77.56	86.6	69	4.2	332,264	1,395,509
5	Kepulauan Riau	Riau Island	343,230	13,524	512,111	69.66	53.9	227	3.8	155,357	590,357
6	Sumatera Selatan	South Sumatera	1,309,909	52,276	1,921,388	70.90	29.6	85	4.1	559,203	2,292,732
7	Jambi	Jambi	571,733	54,708	833,678	75.14	26.0	66	4.0	207,237	828,948
8	Bengkulu	Bengkulu	357,025	1,257	456,208	78.53	15.1	91	4.0	97,926	391,704
9	Bangka Belitung	Bangka Belitung	277,174	55,350	342,352	97.13	29.6	80	3.9	9,828	38,329
10	Lampung	Lampung	1,467,352	93,682	2,012,980	77.55	20.7	229	3.9	451,946	1,762,589
11	DKI Jakarta	DKI Jakarta	2,623,656	—	2,623,918	99.99	126.0	15,015	3.8	262	996
12	Banten	Banten	2,429,290	9,529	2,827,046	86.27	21.4	1,185	4.1	388,227	1,591,731
13	Jawa Barat	West Java	9,711,038	63,087	12,195,244	80.15	23.6	1,282	3.7	2,421,119	8,958,140
14	Jawa Tengah	Central Java	7,591,588	10,111	8,825,423	86.13	18.8	1,014	3.7	1,223,724	4,527,779

continued on next page

Table A2.1 continued

No.	Propinsi	Province	Keluarga Berlistrik (PLN) / Electrified Households (PLN) / Source: DJK	Keluarga Berlistrik (Non-PLN) / Electrified Households (Non-PLN) / Source: DJK	Jumlah Keluarga (x 1,000) / Total Households (x 1,000) / Source: DJK	Rasio Elektrifikasi (%) / Electrification Ratio (%) / Source: DJK	PDB per Kapita (Rp juta) / GDP Per Capita (Rp million) / Source: BPS	Kepadatan Penduduk per km² / Population Density per km² / Source: BPS	Rata-Rata Banyaknya Anggota Rumah Tangga / Average Number of People per Household / Source: BPS	Jumlah Keluarga Tidak Berlistrik / Total Unelectrified Households / Calculated	Jumlah Penduduk Tidak Berlistrik / Total Unelectrified Population / Calculated
			(a)	(b)	(c)	$(d) = \frac{(a+b)}{c*100\%}$	(e)	(f)	(g)	c – (b+c) = (h)	(i) = h*g
15	DI Yogyakarta	DI Yogyakarta	864,833	170	1,073,607	80.57	17.7	1,147	3.3	208,604	688,393
16	Jawa Timur	East Java	8,434,763	4,690	10,648,050	79.26	29.6	803	3.6	2,208,597	7,950,949
17	Bali	Bali	856,498	1,608	1,099,036	78.08	23.3	702	3.8	240,930	915,534
18	Kalimantan Barat	West Kalimantan	730,015	277,175	1,054,142	95.55	18.3	32	4.3	46,952	201,894
19	Kalimantan Tengah	Central Kalimantan	356,164	44,954	605,815	66.21	26.3	16	3.9	204,697	798,318
20	Kalimantan Selatan	South Kalimantan	838,911	7,767	1,037,486	81.61	21.6	99	3.7	190,808	705,990
21	Kalimantan Timur	East Kalimantan	692,165	93,895	977,060	80.45	109.9	19	4.1	191,000	783,100
22	Nusa Tenggara Barat	West Nusa Tenggara	824,665	13,381	1,300,673	64.43	11.9	254	3.6	462,627	1,665,457
23	Nusa Tenggara Timur	East Nusa Tenggara	522,221	69,957	1,081,214	54.77	8.2	102	4.6	489,036	2,249,566
24	Sulawesi Utara	North Sulawesi	487,158	8,868	606,216	81.82	22.6	170	3.9	110,190	429,741
25	Sulawesi Tengah	Central Sulawesi	418,918	49,285	659,275	71.02	21.1	45	4.2	191,072	802,502
26	Sulawesi Selatan	South Sulawesi	1,480,342	76,70X8	1,918,871	81.14	22.2	179	4.3	361,821	1,555,830
27	Sulawesi Tenggara	Southeast Sulawesi	307,103	27,657	535,545	62.51	17.0	63	4.4	200,785	883,454
28	Sulawesi Barat	West Sulawesi	132,556	57,198	280,703	67.60	13.1	74	4.5	90,949	409,271
29	Gorontalo	Gorontalo	164,155	13,274	261,640	67.81	10.7	98	4.3	84,211	362,107
30	Maluku	Maluku	233,074	37,196	344,918	78.36	8.1	35	4.8	74,648	358,310
31	Maluku Utara	North Maluku	147,576	55,161	231,246	87.67	6.9	35	4.8	28,509	136,843
32	Papua	Papua	235,623	45,898	773,104	36.41	30.7	10	4.3	491,583	2,113,807
33	Papua Barat	West Papua	117,203	24,806	188,017	75.53	61.5	9	4.5	46,008	207,036
TOTAL INDONESIA			**50,116,127**	**1,572,800**	**64,204,615**	**80.51**	**36.5**	**130**	**3.9**	**12,515,688**	**48,767,280**

BPS = Badan Pusat Statistik (Statistics Indonesia), DJK = Direktorat Jenderal Kelistrikan (Directorate General of Electricity), PLN = Perusahaan Listrik Negara (State Electricity Company), Rp = rupiah.

Notes:

[a] The original DJK source document states that:
- (i) Data on PLN customers is taken from PLN.
- (ii) Data on households electrified from non-PLN sources is taken from the BPS Population Census 2010 and Provincial Mining and Energy Departments.
- (iii) Data on the number of households taken from the BPS Population Census 2010 and projected with a population growth rate of 1.49% and average 3.88 people per household.

[b] The original DJK source data appears to have switched the data for Papua and West Papua. This table corrects the error.

Sources: DJK source data for 2013 taken from Table 27 of Direktorat Jenderal Ketenagalistrikan. 2014. *Statistic Ketenagalistrikan*. Jakarta; BPS source data for gross domestic product per capita taken from http://www.bps.go.id/hasil_publikasi/pdrb_kab_kota_2009_2013/index3.php?pub=Produk%20Domestik%20Regional%20Bruto%20Kabupaten/Kota%20di%20Indonesia%202009-2013; BPS source data for population density and average household size taken from http://www.bps.go.id/menutab.php?tabel=1&kat=1&id_subyek=12

Table A2.2: Electrification Data Reported by PLN for 2013

	Province	Population (x 1,000)	Households (x 1,000)	Residential Customers	PLN Electrification Ratio	kWh Sold per Capita	Unelectrified Households (calculated)	Persons per HH (calculated)	Unelectrified Population (calculated)
1	Aceh	4,811.1	1,146.9	1,016,898	88.67	377.3	129.9	4.19	545.1
2	North Sumatera	13,590.3	3,147.5	2,749,091	87.34	582.6	398.5	4.32	1,720.5
3	West Sumatera	5,066.5	1,202.7	984,617	81.87	549.0	218.0	4.21	918.6
4	Riau	6,033.3	1,480.5	900,679	60.84	497.5	579.8	4.08	2,362.6
5	Riau Archipelago[a]	1,861.4	512.1	347,892	67.93	320.1	164.2	3.63	596.9
6	South Sumatera	7,828.7	1,921.4	1,304,651	67.90	527.2	616.8	4.07	2,513.0
7	Jambi	3,286.1	833.7	511,233	61.32	290.8	322.5	3.94	1,271.1
8	Bengkulu	1,814.4	456.2	357,025	78.26	353.6	99.2	3.98	394.5
9	Bangka Belitung	1,315.1	342.4	277,174	80.96	548.4	65.2	3.84	250.4
10	Lampung	7,932.1	2,013.0	1,467,352	72.89	401.1	545.7	3.94	2,150.4
11	West Kalimantan	4,641.4	1,054.1	730,015	69.25	375.0	324.1	4.40	1,427.2
12	South Kalimantan	3,854.5	1,037.5	838,911	80.86	487.9	198.6	3.72	737.8
13	Central Kalimantan	2,384.7	605.8	356,164	58.79	358.4	249.7	3.94	982.7
14	East and North Kalimantan[b]	3,870.8	977.0	692,165	70.85	649.1	284.8	3.96	1,128.5
15	North Sulawesi[c]	2,360.4	606.2	483,765	73.85	505.2	158.5	3.89	617.2
16	Gorontalo	1,098.0	261.6	167,548	64.04	299.1	94.1	4.20	394.8
17	Central Sulawesi[c]	2,785.5	659.3	418,918	73.38	272.4	175.5	4.22	741.5
18	South Sulawesi	8,342.0	1,918.9	1,480,342	77.15	498.3	438.5	4.35	1,906.1
19	Southeast Sulawesi	2,396.7	535.5	307,103	57.34	259.4	228.4	4.48	1,022.4
20	West Sulawesi	1,234.3	280.7	132,556	47.22	168.2	148.2	4.40	651.5
21	Maluku	1,628.4	344.9	233,076	67.57	288.6	111.9	4.72	528.1
22	North Maluku	1,114.9	231.2	147,574	63.82	232.4	83.6	4.82	403.4
23	Papua	3,032.5	773.1	215,933	27.93	217.6	557.2	3.92	2,185.5
24	West Papua	828.3	188.0	136,893	72.81	463.6	51.1	4.41	225.2
25	Bali	4,056.3	1,099.0	856,498	77.93	965.0	242.5	3.69	895.2
26	West Nusa Tenggara	4,710.8	1,300.7	824,665	63.40	240.6	476.1	3.62	1,724.2
27	East Nusa Tenggara	4,954.0	1,081.2	522,221	48.30	129.1	559.0	4.58	2,561.2
28	East Java	38,363.2	10,648.1	8,434,763	79.21	748.3	2,213.7	3.60	7,975.7
29	Central Java	33,264.3	8,825.4	7,591,588	86.02	547.3	1,233.8	3.77	4,650.3
30	D.I. Yogyakarta	3,594.9	1,073.6	864,833	80.55	613.6	208.8	3.35	699.2
31	West Java	45,340.8	12,195.2	9,698,695	79.53	857.5	2,496.4	3.72	9,281.3
32	Banten[d]	11,452.5	2,796.9	981,982	83.92	794.0	449.7	4.09	1,841.6
33	Distr. Jakarta Raya and Tangerang[e]	9,969.9	4,280.8	4,083,307	95.39	4,005.8	197.3	3.80	749.9
		248,818.1	**65,831.1**	**50,116,127**	**76.13**		**14,321.3**	**3.78**	**54,129.4**

HH = household, kWh = kilowatt-hour, PLN = Perusahaan Listrik Negara (State Electricity Company).

[a] Includes PLN Batam.

[b] Includes PLN Tarakan.

[c] The numbers shown for PLN customers in North and Central Sulawesi are inconsistent with Table 5 of the PLN source document.

[d] The original PLN table misreports the number of households in Banten as 1,170,100. The BPS 2013 estimate of 2,796,900 is shown.

[e] Portions of the provinces of West Java and Banten are served by Distribution Jakarta Raya and Tangerang; household size has been updated using the BPS 2013 estimate for Jakarta.

Source: Table 19 of PLN Statistics 2013—published May 2014 for year 2013.

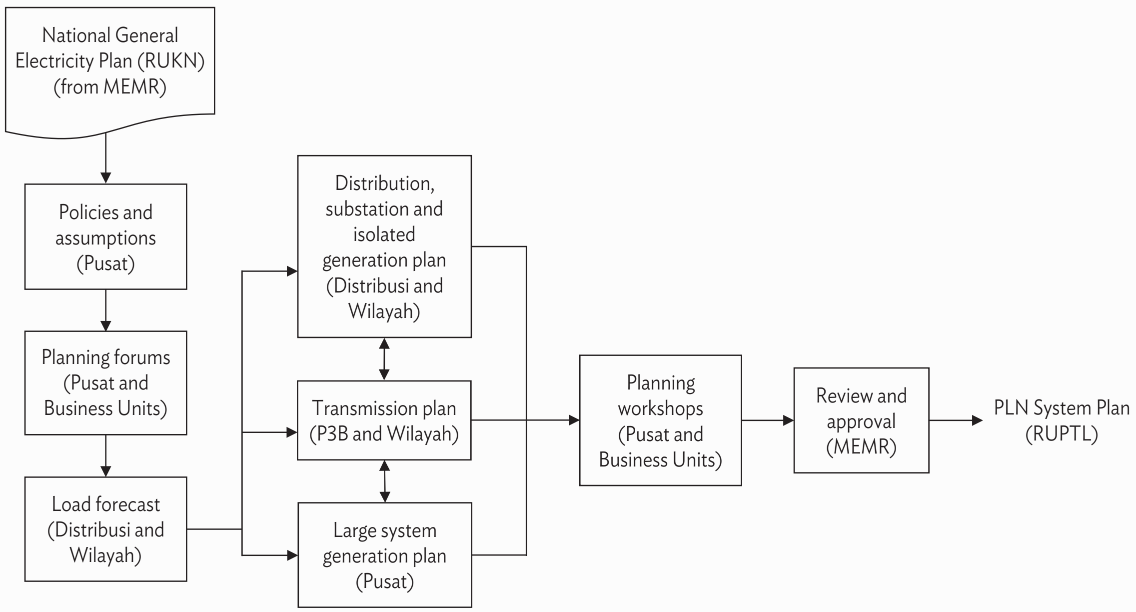
APPENDIX 3

The RUPTL, the Road Map LisDes, and Planning Alternatives

The State Electricity Company (PLN) produces an annual business plan for electricity supply (RUPTL) that lays out additions to generation, transmission, and distribution for the next 10 years. Figure A3.1 shows the RUPTL process. The process starts with the National Government Electricity Plan (RUKN) issued by the Ministry of Energy and Mineral Resources. In addition to target electrification ratios by province, the RUKN provides policy guidance on primary energy mix, generation development, renewable energy promotion, etc.

The RUKN only provides guidance to PLN; PLN is not required to follow strictly the RUKN targets.[6] PLN ultimately is the organization that must consider the budgetary constraints and the detailed technical and financial trade-offs that may be associated with implementation of any particular government policy guidance or funding for electrification programs. Moreover, although PLN takes into account government electrification targets in its system planning (through its load forecasting work), the corporate key performance indicators of PLN do not include provincial or national electrification ratios as noted in the main text.

Figure A3.1: System Planning Process of PLN



MEMR = Ministry of Energy and Mineral Resources, PLN = State Electricity Company, RUPTL = Business Plan for Electricity Supply.

Source: Asian Development Bank.

6 For example, the target electrification ratio of PLN for 2017 in the 2013–2022 RUPTL is higher than the draft RUKN target for that year, that is, 91.9% versus 86.4%.

Taking into account the guidance of the RUKN, PLN headquarters (*Pusat*) determines assumptions and policies for the development of a system plan for PLN, the Commercial Plan for Electricity Supply (RUPTL). These inputs are discussed and agreed upon in "planning forums" conducted with PLN business units. This enables the retailing units (*distribusi* and *wilayah*) to prepare load forecasts, which are then used to create plans for distribution, substations, and isolated generation (by *distribusi* and *wilayah*); transmission (by *Unit Bisnis Penyaluran dan Pusat Pengatur Beban* [P3B] on Java-Bali and the *wilayah* who have transmission); and large system generation expansion (by *Pusat*). The load forecasts are based in part on the electrification targets for units down to the subdistrict (*kecamatan*) level. There may be coordination and iteration between these planning streams. The RUPTL is not top-down but is built bottom-up from the business units of PLN under the supervision and coordination of the *Pusat*—which is not surprising given the huge geographical expanse of PLN operations and the number of customers they serve.

These planning results are then discussed and finalized in "planning workshops" conducted by the *Pusat* with the business units and documented by the *Pusat* in a draft RUPTL, which is sent to the Ministry of Energy and Mineral Resources for review and approval.

Under Permen 4/2012 and subsequent renewable energy regulations, PLN is obliged to purchase power with no more than 10 MW capacity from renewable resources, but subject to electricity supply needs. These projects are not identified by PLN through a least-cost planning process, but PLN must nonetheless incorporate them into the generation mix. On the larger grids, such as Java–Bali and Sumatra, these projects are not critical for the overall supply and demand balance, but on smaller systems in eastern Indonesia, such plants can be critical for PLN to meet its electrification targets.

Distinct from the RUPTL, each PLN region also prepares a 5-year Rural Electrification Road Map (*Road Map LisDes*) to support this RUPTL process and rural electrification efforts more generally. PLN Pusat initiated this rural electrification planning initiative in 2012.

The Road Map for each region includes discussion of the socioeconomic conditions in the region, applicable technical standards, and load forecasts and supply assessment (including both grid extension and use of Super Extra Energy Efficient systems). It then looks at each village settlement with the region (*desa* down to *dusun*) and determines whether the village is to be supplied by grid extension, installation of isolated communal (minigrid) systems, or individual Super Extra Energy Efficient systems. This analysis is based on factors such as the location and spatial distribution of the households within the settlement, the existing sources of lighting, quality of existing electricity supply (if any), and the economic activities and potential of the settlement.

The Road Map indicates the total medium-voltage and low-voltage line additions, medium-voltage/low-voltage transformers, number of customers to be connected, and distance from the existing grids. It then rolls up these data to determine the overall investment requirement. It disaggregates the funding requirements between those proposed for funding from the State budget through the national government budget and those to be funded from PLN's own budget, the APLN. An example of the APLN portion from PLN Nusa Tenggara Timur for 2013–2017 is shown in Table A3.1.

Each PLN *wilayah* (which corresponds to a province) prepared its own Road Map LisDes based on guidelines provided by PLN headquarters. The Road Map LisDes evaluates sociocultural, technical, and economic factors within each *desa* to prioritize those *desa* for electrification under the Government of Indonesia's rural

Table A3.1: Example from Nusa Tenggara Timur of PLN Road Map LisDes APLN "Roll Up"

No.	Tahun	Unit	Pembangunan Fisik				Prakiraan Kebutuhan Anggaran
					Gardu		
			JTM (kms)	JTR (kms)	50 kVA (bh)	100 kVA (bh)	(Rp x l,OOO)
1.	2013	Area Kupang	0,00	0,00	0	0	
		Area Flores (Western Section)	117,63	122,17	29	14	65.163.975
		Area Sumba	109,25	92,50	25	1	54.671.250
		Area Flores (Eastern Section)	88,55	69,83	26	0	43.931.595
			315,43	284,50	80	15	163.766.820
2.	2014	Area Kupang	310,31	160,48	61	0	134.756.895
		Area Flores (Western Section)	97,29	87,44	16	0	48.743.120
		Area Sumba	188,40	84,00	22	0	77.526.000
		Area Flores (Eastern Section)	125,60	61,79	21	0	53.516.965
			721,61	393,71	120	0	314.542.980
3.	2015	Area Kupang	226,46	138,91	61,00	0,00	104.353.955
		Area Flores (Western Section)	5925,25	331,51	103,00	8,00	1.941.304.285
		Area Sumba	263,00	60,00	17,00	0,00	95.985.000
		Area Flores (Eastern Section)	13,44	8,60	6,00	0,00	6.544.285
			6428,16	539,02	187	8	2.148.187.525
4.	2016	Area Kupang	440,00	167,53	63,00	0,00	177.153.050
		Area Flores (Western Section)	117,63	157,70	40,00	10,00	72.478.505
		Area Sumba	0,00	0,00	0,00	0,00	–
		Area Flores (Eastern Section)	36,60	24,75	9,00	0,00	17.187.750
			594,23	349,98	112	10	266.819.305
5.	2017	Area Kupang	229,90	136,81	52,00	0,00	103.968.350
		Area Flores (Western Section)	95,50	126,23	39,00	2,00	58.404.680
		Area Sumba	0,00	0,00	0,00	0,00	–
		Area Flores (Eastern Section)	15,00	2,40	2,00	0,00	5.409.000
			340,40	265,44	93	2	167.782.030

– = not available, bh = units *(buah)*, JTM = Medium Voltage Networks, JTR = Low-Voltage Networks, km = kilometer, MVA = megavolt-ampere, Rp = rupiah.
Source: PLN. Road Map LisDes for NTT 2012–2017. Jakarta.

electrification program. To indicate the scale of this effort, PLN *Wilayah* Nusa Tenggara Timur includes some 640 *desa*, 348 of which are in Sumba.

The Road Map LisDes of PLN represents a structured, comprehensive evaluation to guide requests for rural electrification funding from the state budget. It is therefore a positive and important milestone in the evolution of electrification planning in Indonesia. However, this bottom-up approach has several shortcomings:

(i) It is cumbersome and cannot be easily updated or revised to reflect changes in budget availability or electrification targets.

(ii) It does not readily lend itself to identifying the least-cost means of electrification for each settlement in a consistent fashion.

(iii) The assessment is conducted at the level of the *desa*, which lacks the spatial granularity (i.e., the settlement level) required for accurate least-cost planning. For example, the largest *desa* on Sumba is almost 225 square kilometers, and the most populous *desa* had nearly 11,000 inhabitants as of 2011 (as reported by the Central Statistics Bureau for 2012).

An alternative is geospatial electricity access planning, which determines the least-cost means of electrifying settlements throughout an entire region based on:

(i) the target electrification ratio;

(ii) the spatial distribution of future electricity loads corresponding to this target ratio;

(iii) the costs and performance of available electrification technologies, in this case grid extension, photovoltaic minigrids, and individual household photovoltaic systems; and

(iv) the distance to existing transmission infrastructure.

A comparison of conventional and geospatial approaches for electrification planning is shown in Table A3.2. Geospatial planning was the approach used to develop the least-cost electrification plan for Sumba as described in Appendix 1.

Table A3.2: Comparison of Conventional and Geospatial Electrification Planning

Aspect	Conventional Rural Electrification Planning	Geospatial Access Planning
Scale	Local	Regional and/or national
Orientation	Engineering design	Financial planning
Key outputs	Infrastructure specification	Prioritized investment plan
Technology selection	Ad hoc	Comprehensive and automated
Data requirement	Field surveys	Census and geospatial data
Planning horizon	Static	Dynamic
Timeliness	Incremental (years)	Rapid (months)
Platform	Proprietary and/or Bespoke	Open

Source: Author.

A number of geospatial electrification planning models are available:

(i) Network Planner, which has been created by the Sustainable Energy Lab of The Earth Institute at Columbia University, New York. It is a web-based model available to any user free of cost at http://networkplanner.modilabs.org/. The model is continuously updated, and source code is provided on the website.

(ii) ViPOR (Village Power Optimization Model for Renewables, which was originally developed under the National Renewable Energy Laboratory of the United States, is now available from HOMER Energy of the United States. However, the model is not maintained as an off-the-shelf commercial product.

(iii) Geosim, which is a commercially available tool developed and supported by Innovation Energie Développement of France. Further information on this model is available online (http://www.geosim.fr/index.php?page=buy).

Both Geosim and Network Planner have been applied in many countries around the world. The Network Planner was selected for the Sumba assignment because:

(i) it was recently used for a World Bank-financed study with PLN to prepare electrification plans for the provinces of Maluku, North Maluku, and Nusa Tenggara Timur;[7]

(ii) it is available at no cost; and

(iii) it is web-based and can be accessed by anyone with an internet connection.

The Network Planner uses Kruskal's algorithm to determine the minimum spanning tree for a set of vertices or nodes. In this case, the nodes represent settlements on Sumba, and the minimum spanning tree represents the least-cost means of connecting them, that is, an "efficient" electricity grid. The Network Planner algorithm also calculates the cost of serving each settlement by alternative technologies, in this case photovoltaic minigrids or individual household photovoltaic systems. Taking into account the costs of grid connection, Network Planner then calculates the maximum distance for grid extension that would be least-cost compared with the photovoltaic minigrids and individual household systems. If the minimum spanning tree segment connecting a node is shorter than this maximum distance, then the settlement is connected to the grid. If not, then the Network Planner chooses the less costly of a photovoltaic minigrid or individual household systems to serve the settlement.

As indicated above, the least-cost grid extension program identified by the Network Planner is not an engineering design of line corridors, but the economically optimal means of connecting all nodes (settlements) by straight lines. In practice, power lines follow roads and avoid protected areas, typically resulting in lengths greater than straight lines.

Consequently, the Network Planner does not aim to produce a literal representation of the future optimal power system. Rather, it quickly and consistently captures settlement (and hence spatial load) patterns on a regional scale to determine areas where particular electrification technologies are least-cost, the mix of these technologies over the entire region, and the overall investment costs required to achieve a given electrification target. Results should never be interpreted as indicating, for example, the location of a particular transformer or the exact route of a specific line. It instead provides an economic selection of technologies consistent with the overall spatial load patterns found in a region.

Because the model treats electrification options consistently across all settlements, the Network Planner is able to determine the relative attractiveness of various electrification options. That actual line routes may be longer than straight lines can be addressed through sensitivity analysis on line unit costs.

[7] A summary description of this work is available at http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/01/30/000461832_20140130154855/Rendered/PDF/843140BRI0Indo0ox0382136B00PUBLIC00.pdf

APPENDIX 4 Sample LisDes Procurement Notice

PT PLN (PERSERO)
UNIT PELAKSANA KONSTRUKSI KELISTRIKAN BANTEN
SATUAN KERJA LISTRIK PERDESAAN BANTEN

PENGUMUMAN PELELANGAN
No. 004.P/611/LD-BTN/2014

Menunjuk Surat Pengesahan Daftar Isian Pelaksanaan Anggaran, Tahun Anggaran 2014 Nomor : DIPA-020.05.1.447070/2014, Unit Layanan Pengadaan Jawa Barat dan Banten, Kelompok Kerja Pengadaan Banten berkedudukan di Jalan Raya Pandeglang KM 1 No. 50 Sempu Serang akan segera mengadakan **Pelelangan Umum Secara Elektronik** dengan Pascakualifikasi Bidang Elektrikal kualifikasi **Kecil/Gred 2,3,4** sebanyak **6 (Enam)** paket pekerjaan seperti tersebut dibawah ini :

No.	Nama paket pekerjaan	Uraian Pekerjaan	Nomor Dokumen Pengadaan	Jumlah Rumah Tangga Sasaran	Kualifikasi Peserta	PAGU/HPS
1	Penyambungan dan Instalasi Gratis Kepada Nelayan dan Rakyat Tidak Mampu Paket 8	Penyambungan dan Instalasi Listrik Masyarakat Desa Tengkurak, Desa Susukan Kec Tirtayasa. Desa Kadu Agung Kec Gunungsari Kabupaten Serang	008/DP-LMH/LISDES BANTEN/2014	397 RTS	Kecil/ Gred 2,3,4	Rp 547.648.000
2	Penyambungan dan Instalasi Gratis Kepada Nelayan dan Rakyat Tidak Mampu Paket 9	Penyambungan dan Instalasi Listrik Masyarakat Desa Citorek Barat Kec Cibeber, Desa Sindanglaya Kec Sobang, Desa Cilegongilir Kec Banjarsari Kabupaten Lebak	009/DP-LMH/LISDES BANTEN/2014	694 RTS	Kecil/ Gred 2,3,4	Rp 957.349.000
3	Penyambungan dan Instalasi Gratis Kepada Nelayan dan Rakyat Tidak Mampu Paket 10	Penyambungan dan Instalasi Listrik Masyarakat Kalanganyar Kec Pandeglang, Desa Ramea Kec Mandalawangi Desa Sukasari Kec Pulosari Kabupaten Pandeglang	010/DP-LMH/LISDES BANTEN/2014	289 RTS	Kecil/ Gred 2,3,4	Rp 398.666.000
4	Penyambungan dan Instalasi Gratis Kepada Nelayan dan Rakyat Tidak Mampu Paket 11	Penyambungan dan Instalasi Listrik Masyarakat Desa Weru Kec Sukaresmi, Desa Kadu Malati Kec Singdangresmi, Desa Babakan keusik Kec Patia Kabupaten Pandeglang	011/DP-LMH/LISDES BANTEN/2014	385 RTS	Kecil/ Gred 2,3,4	Rp 531.094.000
5	Penyambungan dan Instalasi Gratis Kepada Nelayan dan Rakyat Tidak Mampu Paket 12	Penyambungan dan Instalasi Listrik Masyarakat Desa Sukasaba, Desa Pasanggrahan Kec Munjul, Desa Curugciung Kec Cikeusik, Desa Kadubera Kec Picung Kabupaten Pandeglang	012/DP-LMH/LISDES BANTEN/2014	349 RTS	Kecil/ Gred 2,3,4	Rp 481.433.000
6	Penyambungan dan Instalasi Gratis Kepada Nelayan dan Rakyat Tidak Mampu Paket 13	Penyambungan dan Instalasi Listrik Masyarakat Desa Kutakarang Kec Cibitung, Desa Cibarani Kec Cisata Kabupaten Pandeglang	013/DP-LMH/LISDES BANTEN/2014	450 RTS	Kecil/ Gred 2,3,4	Rp 620.759.000

I. Ketentuan Pelelangan :

Penawaran harus sesuai/mengikuti syarat-syarat yang tercantum dalam PERPRES No. 70 Tahun 2012 sebagai perubahan kedua atas PERPRES No. 54 tahun 2010 tentang Pedoman Pelaksanaan Pengadaan Barang/Jasa Pemerintah dan RKS (Rencana Kerja dan Syarat-syarat) masing-masing paket pekerjaan.

II. Pendaftaran peserta lelang :

Pendaftaran peserta dapat dilakukan pada situs http://eproc-lpse.pln.co.id

III. Jadwal Pelelangan :

Jadwal Pelelangan dapat dilihat pada situs http://eproc-lpse.phi.co.id

Demikian kami informasikan, terimakasih

Serang, 7 Mei 2014
UNIT LAYANAN PENGADAAN JAWA BARAT DAN BANTEN
KELOMPOK KERJA PENGADAAN BANTEN
APBN TAHUN ANGGARAN 2014

TTD

SUPIADIN
Ketua

Achieving Universal Electricity Access in Indonesia

Indonesia has achieved an impressive 84% electrification ratio, but faces significant challenges in reaching the remaining 16% of its households. This report describes Indonesia's electrification environment and identifies barriers to achieving universal electricity access. Principles drawn from international best practices such as government commitment, enabling institutional environments, adequate and sustainable financing, and stakeholder coordination are discussed in the context of Indonesia's energy sector. The report gives recommendations for establishing service standards, streamlining financing, setting appropriate targets, and monitoring and evaluation, as well as near-term steps to help achieve universal electricity access.

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