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The Indonesian electricity system - a brief overview

Takeaways

The Indonesian electricity sector is heading towards a crisis, unless significant investments are made. Indonesia's electricity generation capacities are outdated and insufficient, operating at an average capacity factor of 66%, and the country experiences daily blackouts lasting on average 4 hours a day. In addition, Indonesia has an estimated annual demand growth of 9% and is currently 25 percentage points behind the electricification target rate of 90% by 2020.

Renewable generation facilities account for 10% of total on-grid installed capacity. 5% of the total on-grid electricity generation in 2010 (170 TWh) came from renewable energy sources. On-grid renewable capacity consists mainly of large-scale hydropower and geothermal, while off-grid generation capacity include also small-scale hydro, biomass and solar power generation.

Several new laws and regulations are implemented to stimulate renewable energy production. Feed-in-tariffs for renewable electricity production are introduced, independent power producers are allowed and encouraged to operate, standard power purchase agreements are in place and foreign investors are invited to participate. It is still, however, not straight-forward for private players to invest and operate in this field.

The renewable generation capacities have to double to around 13 GW to meet the 15% renewable target by 2025. Current renewable capacities are at 6.1 GW (2.9 GW (on-grid) and 3.2 GW (off-grid)). Most of the increase in absolute terms is expected within geothermal, but also small hydro, PV and wind power is expected to increase significantly. The technical potential is in any case substantial and offers large opportunities for investors and developers.

Contents

What's at stake?

The Indonesian electricity sector is in trouble. The country's strong economic growth (6.1% in 2010) and the expanding middle-class have stimulated a rapid surge in demand for electricity. This has not been matched by a similar increase in supply, and the state-utility PT Perusahaan Listrik Negara's (PLN) has been forced to implement frequent rolling blackouts in Java and Bali.

Moreover, more than 86 million Indonesians – around one third of the total population – still lack even the basic access to electricity. Since 2008, the electrification rate has fallen from 67% to 65%, and the number of people without electricity access has increased by more than 2.5 million per year. This is in sharp contrast to the Indonesian government's goal of 90% national electricity coverage by 2020.

The Indonesian government is therefore forced to accelerate its capacity expansion plans. The government's faith in PLN's ability to solve the situation alone is fading, which forces it to turn to private investors. At the same time the high oil prices are stimulating a growing interest for renewable energy sources, and a series of favourable regulations for renewable energy (RE) generation has recently been implemented.

In this report we will provide a brief overview of the Indonesian electricity system and the regulations that govern this. In another upcoming report, we will use this as the starting point for discussing the renewal energy business opportunities in Indonesia.

The Indonesian electricity system

In 2010, Indonesia's total on-grid generation capacity was 29 GW (about half of installed capacity in Ukraine, see Differ's recent report on http://www.differgroup.com/analysis/?ctl=Details&did=0&mid=6116), or around 0.12 kW/capita. Coal has substituted oil as the main energy source and accounts for 40% of the total capacity (see Table 1). Around 10% of on-grid electricity capacity comes from renewable energy sources (2.9 GW), mainly large-scale hydro and geothermal.

In 2010, the total Indonesian on-grid electricity generation was around 170 TWh. Approximately 83% of this was generated by PLN. With an installed capacity of 29 GW, Indonesia's average capacity factor in 2010 was 66%, an average operational time of 5800 hours a year. This means that the capacity utlization is very high, being for instance around 30% higher than the capacity factor of Romania and Ukraine.

Table 1: Route 66
The figure shows the shares of total installed on-grid generation capacity by technology for Indonesia in 2010.
Source: Indonesia Infrastructure Report (2010)

	Installed capacity		Production		Capacity factor
	GW	*Share*	*TWh*	*Share*	*%*
Coal	11.6	40%	75.6	44.9%	74%
Oil	8.4	29%	43.6	25.9%	59%
Gas	6.1	21%	40.4	24.0%	76%
Hydro	2.3	8%	8.8	5.2%	35%
Geothermal	0.6	2%			
Total	29	100%	168.4	100%	66%

The national electricity demand is expected to grow on average around 9% per year over the period from 2009 to 2019, indicating an electricity demand at around 400 TWh in 2019. With no available electricity import possibilities, the domestic electricity generation in Indonesia must be increased to meet the growing demand.

Indonesia's off-grid capacity is not included in the numbers in Table 1. Diesel generators have been the most common technology for stand-alone generation and are still the dominant technology in rural areas (see Table 2). By 2008, diesel generators contributed to around half of the total electricity generation in rural Indonesia. In 2010, the total installed non-renewable off-grid capacity was approximately 3.2 GW.

Hydropower generation accounted for 13% of distributed generation, whereas geothermal accounted for less than 1%. Solar Home Systems (SHS) are also widely distributed; although numbers have declined following several failed electrification schemes. Small-scale hydropower generation is gaining popularity and has increased by

Table 2: Large number of off-grid generators
The table outlines the number of installed off-grid generators in 2008.

Type	Number
Small diesel gensets	30 000
Solar home systems	17 200
Mini-grid diesel gensets	4 700
Centralized PV	53
Small-scale hydro	51

Table 3: Total capacities
The figure shows the installed capacities in 2010 in GW.
Source: Indonesia Infrastructure Report (2010)

	Off-grid	On-grid	Total
Renewable	3.2	2.9	6.1
Non-renewable	3.2	26.1	29.3
Total	6.4	29.0	35.4

more than 700% since 2000. But increasing steeply percent-wise from a very low number, still gives a low number.

The total off-grid renewable generation capacity is around 3.2 GW. Hence, in 2010, the total installed off-grid capacity was approximately 6.4 GW (see Table 3). The total installed renewable capacity of including both off-grid and on-grid was then around 6.1 GW. The overall generation capacity in 2010 was then around 35.4 GW.

Over the past five years, RE electricity generation in Indonesia has increased by more than 5% annually. PLN has contributed to this increase, mainly by developing large-scale hydropower and geothermal generation facilities. Recently, also private developers have entered the Indonesian market after a down period following the Asian financial crisis. So far, their focus has been on large-scale projects as these are believed to bring the largest profits.

The Indonesian power system consists of eight domestic interconnected systems and 600 isolated grids, which are all operated by PLN. The Java-Bali system is the main high-voltage transmission grid and is characterized by high transmission losses and electricity theft. In 2008, the technical transmission losses were close to 11%, a consequence of the five year-long period lacking necessary investments and maintenance.

However, a new interconnector grid linking Sumatra to Malaysia is planned to be implemented before 2020. The new seacable and grid upgrade will most likely reduce transmission losses, and for the first time enable Indonesian producers to export potential excess electricity, as well as import electricity in peak periods.

Table 4: Large cost of daily blackouts
Average daily blackout duration (hrs) (2008-2009).
Source: GE Energy Region (2010)

Area	Hours
Jakarta	3
Makassar	4
Kalimantan	4
Bali	5
Pankanbaru	8

Currently, Indonesia's generation run at full capacity to cover demand, leaving a limited buffer to cover for demand hikes. Rather on the contrary, peak-demand forces PLN to implement rolling blackouts in critical areas to avoid the risk of a full blackout of the entire system. In 2009, the national average hours of blackouts per day were 3.8 hours. Table 4 shows average daily black-outs in selected areas.

The uncertainty associated with blackouts and the costs of disrupted supply stimulate the use of captive generation. Blackouts make grid-connected hospitals, hotels and other public facilities dependent on access to emergency systems and diesel generators are most commonly used.

The regulatory landscape

The growing capacity deficiency of the electricity sector has pushed forward several new regulations and policies regarding energy security, electricity access and the use of renewable energy sources for electricity generation over the past eight years. Table 5 outlines the development of the regulatory framework concerning renewable energy generation.

Three regulations are particularly important for the renewable energy sector (in bold in Table 5):

- The Ministral Decree in 2006 stating that PLN is obliged to purchase electricity from renewable energy producers.
- Energy Law of 2009 stating that PLN no longer has monopoly in supplying electricity to end-users, opening up for Independent Power Producers (IPPs).
- Energy Regulation of 2009 stating the conditions for the Power Purchase Agreement (PPA) between PLN and IPPs.

One of the most important changes in the regulatory framework is The Energy Law No. 30/2009 that allows IPPs to generate and sell electricity to end-users in the Indonesian market. Consequently, this ends PLN's 60 year-long monopoly as the single electricity supplier in Indonesia. Table 6 outlines some aspects of the Energy Law.

Although PLN is no longer a monopolist in the supply of electricity, the state-utility still holds a strong position in the Indonesian market as a monopolist of the transmis-

Table 5: Regulations galore
The table outlines the legislative framework concerning participants in the Indonesian electricity sector. It outlines the main laws, policies and programs focusing on electricity generation by renewable energy sources.

Law/Policy/Program	When	Activity/Plan	Goal
Development of National Electricity Industry (2003-2020)	2003	Plan for the development of the Indonesian electricity	90% electrification by 2020
Ministerial Decree No. 2	2004	Green Energy Policy	Maximum utilization of RE Efficient utilization of energy Public awareness of EE
Presidential Regulation No. 5	2006	National Energy Policy: Energy Diversification	Reducing oil use by 20% by 2025 Increase the new and green capacity mix to 15% by 2025 - 5% biofuel - 5% geothermal - 5% biomass, nuclear, hydro, solar
Government Regulation No. 26	2006	Electricity supply and utilization	Prioritizing utilizing renewable energy for power generation
Ministerial Decree No. 2/2006 on Medium Scale Power Generation using Renewable Energy	**2006**	**Obliges PLN to purchase electricity generated from renewable energy from facilities with a capacity 1 MW < Cap < 10 MW: FiT: 60% of utility's generation costs (low volt.) FiT: 80% of utility's generation costs (med. volt) 10 years purchase contract (may be extended)**	**Increasing the share of small-scale electricity generation**
Presidential Regulation No. 71/2006	2006	1st 10 000 MW Fast-Track Program Crash-program to add 10 000 MW capacity Substituting oil for coal in electricity generation Conducted solely by PLN	Increasing generation capacity through fuel switch Reducing PLN's need for state subsidies
Law No. 30/2007	2007	Energy law	Energy diversification and increased use of RE for reducing dependency of fuel fossils Energy conservation
Law No. 30/2009	**2009**	**Partial liberalization of the electricity sector to increase generation capacity and reduce capacity deficiencies Risk-sharing between the state and private investors**	**Increase private participation in for electricity generation Terminate PLN's monopoly Increase regional autonomy**
Ministry of Energy Regulation No. 31	**2009**	**Application: Small-scale hydropower generation up to 10MW Contract specifications: 15 years Quantity specifications: None FiT: Low voltage: 1004 Rp/kWh Fit: Medium voltage: 656 Rp/kWh**	**Increasing generation capacity Increasing use of small-scale RE**
Presidential Decree No. 4	2010	2nd 10 000 MW Fast-Track Program Crash-program to add 10 000 MW capacity Geothermal, hydro and biomass PLN, IPP projects or IPPs in cooperation with the Indonesian government	Increasing generation capacity Increasing use of RE Increased participation by IPP
Ministry of Energy Regulation No. 7	2010	Cross-subsidization through electricity tariff system	Providing electricity at reasonable prices

Table 6: New kids on the block
Regulatory changes and new responsibilities for the main actors in the Indonesian electricity sector, following the implementation of the new energy law in 2009.

Actors	Conditions and responsibilities
PLN	**Market conditions** - "First right of refusal": PLN has the first right in for electricity supply in Indonesia - Not unbundled - Monopolist in the existing transmission and distribution grid, Systems operator - No longer monopolist in generation: Corporate bodies, cooperatives and self-supporting communities are for the first time allowed to participate in the supply of electrical power to end-users **Responsibilities** - "Obligation to serve": Appointed by law to serve areas where no private interest has been shown - Obliged to purchase electricity generated from smaller than 10 MW renewable power plants
Regional Authorities	**Market conditions** - Private companies may sell electricity directly to the regional government through PPAs, or cooperate with local government for small-scale projects **Responsibilities** - Increased autonomy regarding electricity supply - May provide licenses for projects that do not involve PLN or grid-connected IPPs
IPP	**Market conditions** - Areas not already served by PLN may be served by private businesses as long as the specific area is not included in PLN's plans for electrification - IPPs generating electricity in areas already served by PLN may only sell electricity to PLN (PPA) - Captive generation: May be conducted by government agencies, regional government, state-owned companies, regional-owned companies, private corporate bodies, cooperatives and individuals. Needs to hold a government issued permit **Responsibilities** - Private business need a license to provide electricity for public use - an IUPTL - granted by the central government to sell electricity directly to end-users - Need to build transmission and distribution grid if supplying directly to end-users

sion and distribution grids, as well as being the functioning systems operator.

Moreover, PLN has the main responsibility for electricity supply in Indonesia through the "right of first refusal" clause, and IPPs can only serve areas that have been declined by PLN and are not included in PLN's plans for electrification.

Decentralisation following the implementation of the new energy law has increased the autonomy of regional authorities, which is believed to increase rural electrification and ease the implementation of new projects and stimulate collaboration between regional authorities and private actors.

Independent Power Producers (IPPs) wishing to use the existing grid must enter into a Power Purchase Agreement (PPA) with PLN, while IPPs wishing to sell electricity directly to end-users must build their own grid. Captive generation is still unregulated and open for all.

IPPs have five possibilities– or a combination of these – for selling their electricity (see Figure 1):

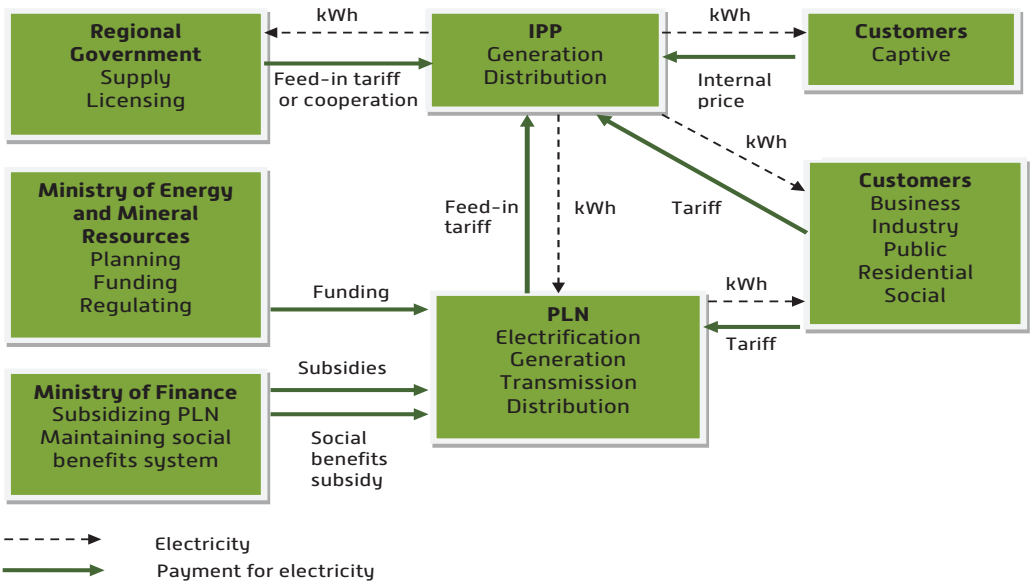
- To PLN by the use of PPAs (License granted by the Central Government)
- To the regional government through the use of PPAs. Regional government needs a license to provide electricity for public use (a so-called IUPTL)
- To local government through Public Private Partnerships (PPP). Partnership needs IUPTL to sell to end-users.
- To end-users at current tariffs after being granted IUPTL permit and building its own transmission and distribution network
- Own use (captive generation) after being granted an Operation License

Figure 1 shows the flows of electricity and revenues for PLN and IPPs as regulated by the Electricity Law.

On average, PLN suffers a cash deficit and is dependent on subsidies from the Ministry of Finance. In 2009, PLN received US$ 4.9 billion in subsidies, which means that the average share of subsidy per kWh supplied to end-users was just above 40%.

The Ministry of Energy Regulation No. 31/2009 obliges PLN to purchase electricity generated from renewable

Figure 1: The organisation of the Indonesian electricity sector
The figure shows the major players in and organization of the Indonesian electricity sector, including the flows of electricity and payments between these.



energy power plants up to 10MW at a regulated Feed-in-Tariff (FiT) and under the regulated contract specifications outlined in the standardized PPA. Although this reduces the costs of individual price negotiations between, often small IPPs and PLN, so far this is only applicable for small-scale hydropower and biomass.

The necessity of private participation in the development of the Indonesian infrastructure is well understood by the Indonesian government. In 2010, the Indonesian Ministry of Economic Affairs specifically addressed foreign ownership in the electricity sector. Indonesian electricity generation projects smaller than 1 MW installed capacity are currently closed for foreign investments, whilst small-scale projects (1-10 MW) are open, but only through local partnership. Large-scale projects (> 10 MW) can now have up to 95% foreign ownership.

Construction of electricity infrastructure, power plants, transmission and distribution grids, must fulfill the 'Local Content Level'. This means that local or foreign bidders for energy service contracts must use a minimum of 35% domestic content in their operations. Hence, although the authorities are eager to attract foreign investors and capital, there are limitations to this that might be hard to overcome.

Renewable potential and goals

Recently implemented regulations have ended PLN's monopoly, opened up for foreign investors and made it easier for independent power producers to enter the market through standardised power purchase agreements. But what is actually the potential for renewable energy in Indonesia?

Indonesia's potential within renewable energy is substantial both in variety and quantity. Large-scale hydropower electricity generation offers the largest technical potential (76 GW) and could add a maximum of 670 TWh per year if assuming a capacity factor of 100%. The country's

Table 7: Renewable energy potential
The table shows the estimated technical potential for generation capacity by technology, and also the how much of this which was already developed in 2010. Source: Directorate General for Electricity and Energy Utilization (2005)

Source	Size	Developed
Hydropower (- mini/micro hydro)	76 GW (0.5 GW)	4.2 GW 0.2 GW
Biomass	50 GW	0.5 GW
Geothermal	28 GW	1.2 GW
Wind	1 GW	0.003 GW
Solar	(4.8 kWh/m2,day)	0.025 GW
Total	155 GW	6.13 GW

Table 8: Renewable targets by source
The table outlines the Indonesian government's targets for installed generation capacity based on renewables by 2025. Source: National Energy Blueprint (2005)

Source	Targets	Share	% of existing capacity	% of total potential
	GW	%	%	%
Geothermal	9.5	83	792	34
Biomass	0.81	7	162	2
Micro-hydro (on-grid) Micro-hydro (off-grid)	0.5 0.33	4.4 2.9	415	184
Wind	0.26	2	8500	26
Solar	0.08	0.7	320	n.a.
Total	11.5	100	187	7

Table 8 shows the technology specific renewable targets of the Indonesian government as reflected in the National Energy Blueprint 2005-2025 from 2006. The total target of 11.5 GW capacity, will exploit about 7% of the total renewable potential. To reach the target, another 5.4 GW of renewable generation capacity is needed before 2025.

numerous volcanoes offer possibilities for large-scale geothermal generation capacities (potentially 240 TWh with 100% capacity factor), whilst the potential electricity generation by hydro, biomass, PV and wind power could also be exploited by small-scale capacity.

The total technical potential for renewable capacity on hydropower, biomass, geothermal and mini/micro hydro is estimated at 155 GW, which could add around 1,350 TWh if operated on a continuous basis. Assuming the current overall capacity factor of 66% (see Table 1), the technical renewable potential could add around 900 TWh. By comparison, the electricity demand is expected to be around 600 TWh in 2025 (assuming a 9% annual growth). The technical potential mentioned above does not include the potential for solar power (4.8 kWh/m2/day), which could contribute significantly if fully utilized.

Indonesia's current targets for installed renewable generation capacity is laid out in the National Energy Policy from 2006. By 2025, 15% of Indonesia's total energy mix should be based on renewable and new energy sources (5% geothermal, 5% biofuel, 5% biomass, nuclear, hydro, solar).

Vision 25/25 is the latest draft for a new energy policy in Indonesia. It proposes that the share of renewables is increased to 25% of total energy mix in 2025. Whilst positive for the development of the renewable sector, the target is not official, as nothing has been formalized yet.

PLN forecasts that the total electricity generation capacity needs to be around 83 GW by 2025 to meet the demand. Assuming that the renewable share in electricity production should equal the renewable share in the total energy production (15%), the installed renewable generation capacity should be around 12.5 GW. This is around double of the current renewable generation capacity (see Table 3).

What's in it for investors?

The overall picture is - in any case - that significantly amounts of renewable generation capacities must be installed in Indonesia over the next decade. Given the governmental goals, the new regulations and the obvious need for more power, what are the opportunities for private investors?

In PLN's Development Plan Power Generation Capacity from 2010, further goals are outlined for private participation for capacity expansion.

- New capacity of 54 GW estimated to be needed over the period from 2009-2019
- Increasing IPP participation to 42.4% of total capacity
- 57% of total capacity of green energy power production will be expected from IPPs
- 3% of total capacity expansion expected from small-scale and new energy power plant
- Total micro-hydro capacity expansion planned before 2019: 1 GW

Of special interest is the goal specifying that 3% of total capacity expansion by 2019 will be from small-scale and new energy power production. This combined with the 25% deficiency in electrification may pose business opportunities for small-scale RE.

But what are the realities when it comes to investments in the electricity sector in Indonesia? Is it profitable? How is the investment climate for private investors in general and foreign investors in particular? And where to invest? These questions will be discussed in our next report on Indonesia.

About

Differ (www.differgroup.com)

Differ's business idea is to help scale up small-scale carbon reduction technologies (e.g. renewable energy and energy efficiency) in selected developing countries through i) providing free in-depth analysis on e.g. market conditions, feed-in-tariffs, financing and business opportunities, ii) advising project developers, project owners, investors and other decision makers, iii) developing our own concepts and companies and iv) investing in start-ups.

Differ was founded in November 2010 by entrepreneurs that previously have started and developed companies like Renewable Energy Corporation (REC) and Point Carbon.

Differ Analysis series

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