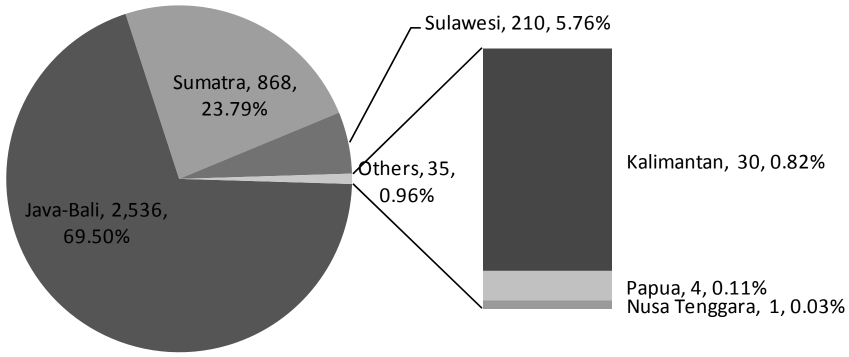
CHAPTER 7 HYDROPOWER DEVELOPMENT MASTER PLAN

7.1 TARGET FOR HYDROPOWER DEVELOPMENT

7.1.1 REVIEW OF RECENT HYDROPOWER DEVELOPMENT

As mentioned in Chapter 3, the total hydro capacity including PLN and IPP was 3,654 MW as of 2009, which comprised of 12.1 percent of total capacity in the same year. Out of the total hydro capacity, that of IPP is 157 MW or 4.3 percent to total, and all of them but PLTA Jatiluhur[1] are small scale ones (PLTM; less than 10 MW).

The region-wise hydropower generation capacity is illustrated in Figure 7.1.1. Java-Bali, Sumatra, and Sulawesi comprises of 99 percent to the total. Around 70 percent was developed in Java, 23.8 percent in Sumatra, and 5.8 percent in Sulawesi. Kalimantan has modest hydro capacity despite its power demand almost equivalent to that of Sulawesi. Papua, Maluku, and Nusa Tenggara, have so far no transmission networks to deliver the electricity generated in a large scale hydro.



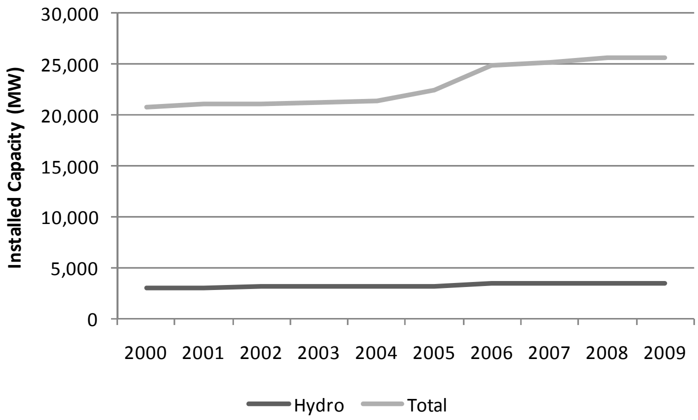
(unit: MW)

Source: JICA Study Team based on RUPTL 2010-2019.

Figure 7.1.1 Region-wise Hydro Generation Capacity

In addition to the regionally uneven development of hydropower generation in the past, development of hydro potential itself has been stalled in recent years. Figure 7.1.2 presents the total installed capacity and hydro capacity of PLN during 2000 to 2009.

[1] PLTA Jatiluhur owned and operated by the Ministry of Public Works, is categorized in IPP.



Source: PLN Statistics 2009.

Figure 7.1.2 Past Trend of Installed Capacity of PLN

As long as the recent 10 years, only nine projects were completed with the total capacity of 653 MW as indicated in Table 7.1.1, most of which were realized in Sumatera. Asahan-1 project is the most recent one commenced in November 2010, and developed by a private investor.

Table 7.1.1 Major Hydropower Projects Commenced after Year 2001

No.	Project	Owner	Region	Year of Installation	Type	Installed Capacity (MW)	Annual Energy (GWh p.a.)
1	Besai-1	PLN	Sumatera	2001	ROR	90.0	402
2	Batu Tegi	PLN		2001	RES	24.0	51
3	Sipansihaporas-1	PLN		2005	RES	33.0	135
4	Sipansihaporas-2	PLN		2005	ROR	17.0	69
5	Renun-1	PLN		2005	ROR	82.0	618
6	Musi-1	PLN		2006	ROR	210.0	1,120
7	Asahan-1	IPP		2010	LHD	180.0	1,360
8	Bili-Bili	PLN	Sulawesi	2005	RES	11.0	70
9	Wonorejo	PLN	Java-Bali	2002	RES	6.3	32
Total						**653**	**3,857**

Source: JICA Study Team.

7.1.2 HYDROPOWER PROJECTS IN RUPTL

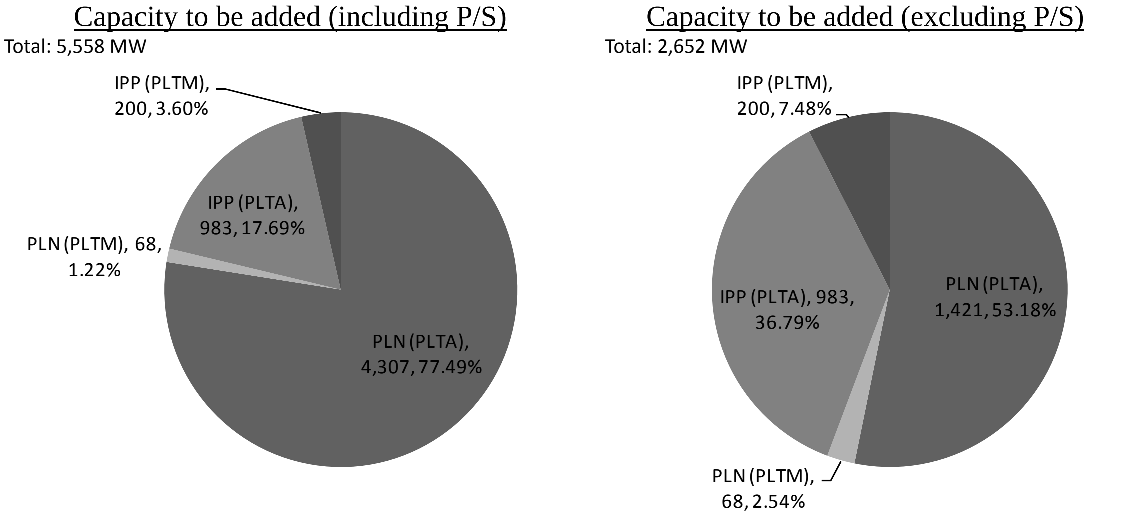
Hydropower projects in the latest RUPTL including small scale hydro (PLTM) are listed in Table 7.1.2.

Total capacity to be developed up to 2019 is 5,558 MW including three pumped storage plants (PS) with 2,887 MW of capacity in Jamali, which accounts for 8.7 percent of total capacity to be developed. Except PS, the capacity will be 2,672 MW or 3.7 percent to the total. Out of 5,558 MW, PLN will develop 4,375 MW or 78.7 percent to the total, including PS and PLTM, and IPP 1,183 MW or 21.3 percent. Excluding PS, the ratio of IPP will increase up to 44 percent, which is considerable compared to the existing capacity.

Table 7.1.2 Hydropower Projects in RUPTL 2010-2019

No	Project	Province	Type	Capacity (MW)	Year of Operation	Status
Sumatra				**1,152.060**		
PLN				**612.000**		
1	Peusangan	NAD	PLTA	86.000	2013	On Going
2	Asahan 3 (FTP 2)	Sumatra Utara	PLTA	174.000	2013	Plan
3	Merangin	Jambi	PLTA	350.000	2017/18	Plan
4	Blangkejeran	NAD	PLTM	2.000	2011/13	Plan
IPP				**540.060**		
1	Lawe Mamas	NAD	PLTA	90.000	2016/17	Plan
2	Asahan 1	Sumatra Utara	PLTA	180.000	2010	On Going
3	Simpang Aur 1 (FTP 2)	Bengkulu	PLTA	12.000	2014	Plan
4	Simpang Aur 2 (FTP 2)	Bengkulu	PLTA	18.000	2014	Plan
5	Asahan 4-5	Sumatra Utara	PLTA	60.000	2016	
6	Wampu	Sumatra Utara	PLTA	45.000	2016	Plan
--	24 PLTMs		PLTM	135.060		
Java Bali				**3,142.000**		
PLN				**2,985.000**		
1	Upper Cisokan Pump Storage	Jawa Barat	PS	1,000.000	2014	Plan
2	Kalikonto	Jawa Timur	PLTA	62.000	2016	Plan
3	Kesamben	Jawa Timur	PLTA	37.000	2017	Plan
4	Matenggeng PS	Jawa Tengah	PS	886.000	2017/18	Plan
5	Grindulu PS	Jawa Timur	PS	1,000.000	2018/19	Plan
IPP				**157.000**		
1	Rajamandala	Jawa Barat	PLTA	47.000	2014	Plan
2	Jatigede	Jawa Barat	PLTA	110.000	2014	Plan
Kalimantan				**314.500**		
PLN				**314.500**		
1	Nanga Pinoh	Kalimantan Barat	PLTA	98.000	2018	Plan
2	Kelai (Kaltim)	Kalimantan Timur	PLTA	150.000	2018/19	Plan
3	Kusan	Kalimantan Selatan	PLTA	65.000	2015	Plan
4	Merasap	Kalimantan Barat	PLTM	1.500	2010	On Going
Sulawesi				**783.500**		
PLN				**314.000**		
1	Konawe	Sulawesi Tenggara	PLTA	50.000	2016/17	Plan
2	Bakaru II	Sulawesi Selatan	PLTA	126.000	2019	Plan
3	Poko	Sulawesi Barat	PLTA	117.000	2019	Plan
--	12 PLTMs		PLTM	21.000	--	
IPP				**469.500**		
1	Poso Energy	Sulawesi Tengah	PLTA	195.000	2011	On Going
2	Sawangan	Sulawesi Utara	PLTA	16.000	2015	Plan
3	Randangan	Gorontalo	PLTA	20.000	2015	Plan
4	Bonto Batu	Sulawesi Selatan	PLTA	100.000	2016	Plan
5	Malea	Sulawesi Selatan	PLTA	90.000	2016	Negotiation
--	22 PLTMs		PLTM	48.500	--	
Maluku				**49.000**		
PLN				**40.000**		
1	Isal	Maluku	PLTA	40.000	2017/18	Plan
IPP				**9.000**		
--	5 PLTMs		PLTM	9.000		
Papua				**91.640**		
PLN				**91.640**		
1	Genyem	Papua	PLTA	20.000	2012	On Going
2	Warsamson	Papua Barat	PLTA	31.000	2016/17	Plan
--	16 PLTMs		PLTM	40.640		
NTT & NTB				**25.150**		
PLN				**17.750**		
1	Sumbawa 1	NTB	PLTA	15.000	2013	Plan
--	2 PLTMs		PLTM	2.750		
IPP				**7.400**		
--	3 PLTMs		PLTM	7.400		
Total Installed Capacity				**5,557.850**		

Source: Compiled by JICA Study Team.

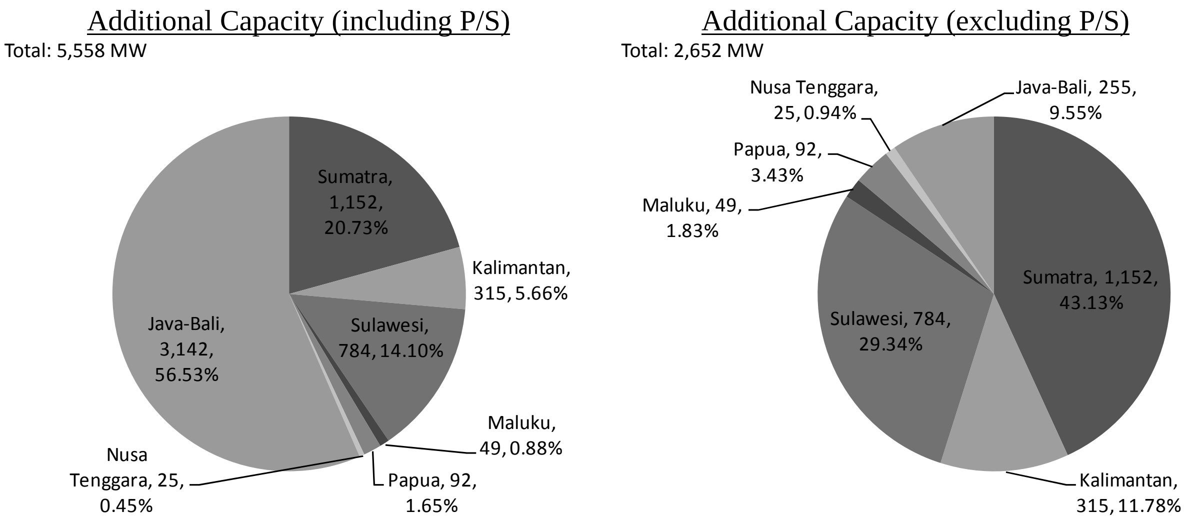


(Unit: MW)

Source: Compiled by JICA Study Team.

Figure 7.1.3　Additional Hydro Capacity by type and owner during 2010-2019

The region-wise additional hydropower capacity listed in RUPTL is illustrated as Figure 7.1.4.　Java makes up 62.6 percent including three PS's, Sumatra 17.9 percent, Sulawesi 16.4 percent and others 3.1 percent.　On the contrary, excluding PS's, Sumatra makes up 42.4 percent, Sulawesi 38.9 percent, others 7.3 percent and Java composition will diminish to 11.4 percent.

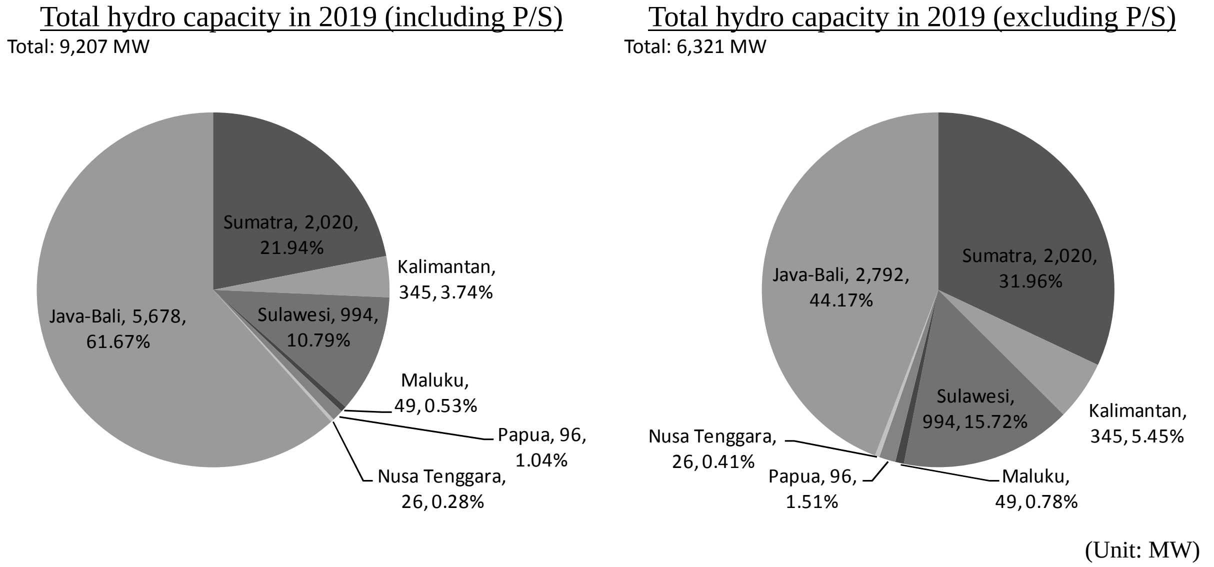


(Unit: MW)

Source: Compiled by JICA Study Team.

Figure 7.1.4　Region-wise Additional Hydropower Capacity during 2010-2019

Adding up the existing capacity and the additional capacity up to 2019, the total hydro capacity as of 2019 will be distributed by the region as Figure 7.1.5.



Source: Compiled by JICA Study Team.

Figure 7.1.5 Region-wise Hydro Capacity in 2019

Hydro development planned in RUPTL will conclusively be summarized in Table 7.1.3. Even though pumped storage plants are taken into account, the percentage of additional hydro capacity during the period is less than the existing hydro capacity, so that the percentage of hydro capacity as of 2019 will decrease to 11.2 percent. Excluding pumped storage since it will not contribute to net electricity generation, the percentage will drop to 8.0 percent.

Table 7.1.3 Hydro Capacity reflecting RUPTL 2010-2019

Region		Existing Capacity 2009			Additional Capacity in RUPTL 2010-19			Total Capacity* As of 2019		
		Total (MW)	Hydro (MW)	% of Hydro	Total (MW)	Hydro (MW)	% of Hydro	Total (MW)	Hydro (MW)	% of Hydro
Sumatra		4,599	868	18.9%	11,123	1,152	10.4%	15,052	2,020	13.4%
Java-Bali	with PS	22,796	2,536	11.1%	36,222	3,142	8.7%	59,018	5,678	9.6%
	w/o PS				33,335	255	0.8%	56,131	2,791	5.0%
Kalimantan		1,036	30	2.9%	2,822	315	11.1%	3,442	345	10.0%
Sulawesi		1,175	210	17.9%	2,581	784	30.4%	3,140	994	31.6%
Papua**		165	4	2.4%	257	92	35.7%	422	96	22.7%
Nusa Tenggara**		258	2	0.8%	804	25	3.1%	1,062	27	2.6%
Maluku**		181	0	0.0%	256	49	19.1%	437	49	11.2%
Total	with PS	**30,210**	**3,650**	**12.1%**	**54,065**	**5,558**	**10.3%**	**82,573**	**9,208**	**11.2%**
	w/o PS				**51,178**	**2,671**	**5.2%**	**79,686**	**6,321**	**7.9%**

* Total capacity does not equal the sum of existing capacity and additional capacity due to decommissioning of aged plants.

** Total capacities in Papua, Nusa Tenggara, and Maluku, as of 2009 are not specified in RUPTL 2010, so that the total capacities in them are calculated by adding existing and additional capacities neglecting decommissioned capacities.

Source: RUPTL 2010-2019, PT PLN (Persero).

7.1.3 HYDRO POTENTIAL AND HYDRO CAPACITY TO BE DEVELOPED

(1) Hydro potential and power demand

The hydro potential in Indonesia has been reported from various sources, although their definitions of 'potential' are not necessarily explicit. "*Potensi Hidro*" published by PLN in 2003, describes 75 GW of capacity potential and 402 TWh of annual energy potential. The former value 75 GW is quoted on many occasion as a hydro potential in Indonesia, and the latter value 402 TWh is equivalent to the technically exploitable capability reported by the World Energy Council (WEC). According to WEC, the gross theoretical capability is 2,147 TWh, and the economically exploitable capability is 40 TWh as of the end of 2005. MEMR announced less hydro potential in RUKN 2008.

Table 7.1.4 Hydro Potential and Future Demand

Region	Potensi Hidro 2003[1)]			RUKN 2008
	Sites (Loc)	Capacity (MW)	Energy (GWh)	Capacity (MW)
Sumatra	447	15,587	84,110	5,490
Java-Bali	120	4,200	18,042	54 [2)]
Kalimantan	160	21,581	107,202	7,547
Sulawesi	105	10,183	52,952	4,479
Papua	205	22,371	133,759	24,974
Nusa Tenggara	120	624	3,287	292
Maluku	53	430	2,292	217
Total	**1,210**	**74,976**	**401,644**	**43,053**

Note)
1) "Potensi Hidro Indonesia", PT PLN (Persero), 2003.
2) Hydro potential in West Java (*Jawa Barat*) is not included.

On the other hand, future demand will also place a limit on hydropower development since hydropower is not transportable. For example, Papua has a large hydro potential 22,371 MW, which accounts for nearly 30 percent of the total potential, however, power demand in Papua is predicted to remain low level; 414 MW even in 2027, corresponding to 0.3 percent of the total power demand.

Table 7.1.5 and Table 7.1.6 present future demand forecasted in RUPTL and in RUKN respectively. In Kalimantan, Sulawesi, and Papua, their peak demand and required capacity are less than their hydro potential even in 2027, and the hydro development in those regions will be constrained by the demand, not the potential.

Table 7.1.5 Future Demand Forecast (RUPTL 2010-2019)

Region	As of 2019					
	Peak Load (MW)	Existing Capacity (MW)	Required Capacity (MW)	Additional Capacity (MW)	Additional Hydro (MW)	Energy Production (GWh)
Sumatra	9,355	2,940	13,666	11,123	1,152	54,807
Kalimantan	2,674	620	3,442	2,822	315	15,493
Sulawesi	2,740	559	3,140	2,581	784	14,519
Maluku	251	*N.A.*	*N.A.*	*N.A.*	49	1,205
Papua	361	*N.A.*	*N.A.*	*N.A.*	92	1,891
Nusa Tenggara	699	*N.A.*	*N.A.*	*N.A.*	25	3,449
Java-Bali	43,367	21,485	58,617	36,222	256	284,924
Total	**58,136**	**25,604**	**78,865**	**52,748**	**2,672**	**369,743**

Source: RUPTL 2010-2019, PT PLN (Persero).

Table 7.1.6 Future Demand Forecast (RUKN 2008)

Region	As of 2019				As of 2027			
	Peak Load (MW)	Existing Capacity (MW)	Required Capacity (MW)	Energy Production (GWh)	Peak Load (MW)	Existing Capacity (MW)	Required Capacity (MW)	Energy Production (GWh)
Sumatra	7,657	2,276	10,720	37,597	15,549	1,936	21,769	76,619
Kalimantan	2,299	391	3,219	10,959	4,584	306	6,418	21,840
Sulawesi	2,053	544	2,874	8,824	3,753	452	5,253	16,209
Maluku	202	33	283	937	329	26	460	1,526
Papua	282	23	394	1,284	414	18	580	1,890
Nusa Tenggara	497	97	695	2,061	928	76	1,299	3,858
Java-Bali	52,364	10,003	68,074	310,161	115,102	6,103	149,632	684,197
Total	**65,354**	**13,367**	**86,259**	**371,823**	**140,659**	**8,917**	**185,411**	**806,139**

Source: RUKN 2008, MEMR.

Existing capacity and scheduled projects should be also considered to estimate the capability of hydropower development in this study. The regional hydro potentials after taking their power demand, existing capacity, and scheduled projects (RUPTL projects) into consideration can be summarized in Table 7.1.7, where “Existing capacity”, “RUPTL 2010-2019 hydro projects” and “hydro capacity as of 2019” are excerpted from Table 7.1.3, and “hydro capability to be developed” presents the smaller value among hydro potential and the required capacity net of existing capacity and additional capacity in RUPTL. Additional hydro potentials are calculated by “Hydro capability” subtracted the “hydro capacity as of 2019”. “Hydro capacity as of 2027” is the sum of “existing hydro capacity” and “hydro capability to be developed”, assuming all the hydro capability is developed. It should be noted that these figures are just give indications of theoretically exploitable hydro capability, and not necessarily realistic. For example, the figures in Kalimantan, Sulawesi, and Papua could be achievable if all the generation to be developed during 2020 to 2027, were made up of hydropower generation only.

Table 7.1.7 Summary of hydro potential

(Unit: MW)

Region	Existing hydro capacity 2009	Hydro projects in RUPTL	Hydro capacity as of 2019	Hydro capability to be developed	Additional hydro potentials 2020-2027	Hydro capacity as of 2027
Sumatra	868	1,133	1,959	9,862	8,710	10,730
Kalimantan	30	314.5	345	3,605	3,290	3,635
Sulawesi	210	783.5	994	3,004	2,220	3,214
Maluku	--	49	49	232	183	232
Papua	4	91.64	96	293	201	297
Nusa Tenggara	1	25.15	26	549	524	550
Java-Bali	2,536	255	2,867	4,200	3,944	6,736
Total	**3,649**	**2,652**	**6,336**	**21,744**	**19,072**	**25,393**

As discussed in Chapter 2, 20 to 30 GW of hydro capacity will be required to achieve the energy mix target in RIKEN or National Energy Policy (KEN), and the total hydro capacity in Table 7.1.7 is almost equivalent to this figure.

(2) Amount of hydro to be developed

The candidate hydro projects to be considered in this study were given by MEMR and PLN in the minutes of meeting dated March 2, 2009, which have been passed through the 3rd screening in the 2nd Hydro Power Potential Study (HPPS2) and ongoing and planned projects which have been under construction, or have experienced pre F/S, F/S or D/D) as listed in Table 7.1.8 and Table 7.1.9.

Table 7.1.8 Hydropower Projects passing 3rd screening in HPPS 2 in 1999

No.	Project name & ID		Type	Total cost (mil.$)	Installed capacity (MW)	Firm energy (GWh)	Secondary energy (GWh)	Annual energy (GWh)	Cost/kW (US$)	kWh cost (US¢)	Cost/kWh (US$)	Remarks
Wilayah I (Daerah Istimewa Aceh): Aceh												
1	Mamas-2	1-190-13	ROR	96.7	51.0	192.1	135.6	327.7	1,896.1	4.9	0.42	
2	Jambo Papeun-3	1-192-04	ROR	60.4	25.4	111.3	94.8	206.1	2,378.0	4.9	0.43	
3	Woyla-2	1-204-05	RES	274.0	242.1	530.2	134.4	664.6	1,131.8	7.4	0.48	
4	Ketambe-2	1-190-11	ROR	46.0	19.4	73.1	51.8	124.9	2,371.1	6.1	0.52	
5	Teunom-2	1-205-09	RES	288.2	230.0	503.7	91.6	595.3	1,253.0	8.7	0.54	
6	Kluel-1	1-192-03	ROR	76.3	40.6	88.9	143.0	231.9	1,879.3	5.5	0.58	
7	Meulaboh-5	1-202-06	ROR	98.4	43.0	109.2	161.9	271.1	2,288.4	6.1	0.62	
8	Kluel-3	1-192-07	ROR	82.1	23.8	104.2	89.8	194.0	3,449.6	7.1	0.63	
9	Ramasan-1	1-027-14	RES	171.6	119.0	260.6	31.3	291.9	1,442.0	10.5	0.64	
10	Sibubung-1	1-192-08	ROR	76.5	32.4	82.3	125.0	207.3	2,361.1	6.2	0.64	
11	Seunangan-3	1-201-03	ROR	69.4	31.2	68.3	111.0	179.3	2,224.4	6.5	0.68	
12	Teripa-4	1-198-05	RES	306.4	184.8	404.7	98.9	503.6	1,658.0	10.9	0.71	
13	Teunom-3	1-205-10	RES	184.0	102.0	223.4	79.8	303.2	1,803.9	10.9	0.74	
14	Meulaboh-2	1-202-02	ROR	93.6	37.0	81.0	131.5	212.5	2,529.7	7.4	0.78	
15	Sibubung-3	1-192-10	ROR	67.7	22.6	57.4	87.5	144.9	2,995.6	7.8	0.81	
Sub-total				1,991.3	1,204.3	2,890.4	1,567.9	4,458.3	1,653.5			
Wilayah II (Sumatera Utara): North Sumatera												
16	Sirahar	1-186-01	ROR	58.9	35.4	133.3	95.0	228.3	1,663.8	4.3	0.36	
17	Ordi-1	1-190-33	ROR	66.3	40.8	153.7	109.3	263.0	1,625.0	4.2	0.36	
18	Simanggo-1	1-190-40	ROR	77.8	44.4	167.3	118.5	285.8	1,752.3	4.6	0.38	
19	Renun-3	1-190-21	ROR	37.1	19.8	74.6	53.2	127.8	1,873.7	4.9	0.41	
20	Kumbih-3	1-190-32	ROR	78.6	41.8	157.5	112.1	269.6	1,880.4	4.9	0.41	
21	Simanggo-2	1-190-41	ROR	108.1	59.0	211.9	155.0	366.9	1,832.2	5.3	0.42	
22	Raisan-1	1-183-01	ROR	52.9	26.2	98.7	69.2	167.9	2,019.1	5.3	0.44	
23	Gunung-2	1-190-26	ROR	46.4	22.6	85.1	60.2	145.3	2,053.1	5.3	0.45	
24	Toru-2	1-178-03	ROR	77.8	33.6	141.3	95.8	237.1	2,315.5	5.5	0.46	
25	Renun-6	1-190-24	ROR	48.0	22.4	84.4	60.4	144.8	2,142.9	5.5	0.47	
26	Sibundong-4	1-184-05	ROR	69.2	31.6	119.0	84.6	203.6	2,189.9	5.7	0.48	
27	Ordi-2	1-190-34	ROR	61.7	26.8	101.0	71.8	172.8	2,302.2	6.0	0.50	
28	Ordi-5	1-190-37	ROR	61.7	26.8	101.0	72.7	173.7	2,302.2	5.9	0.50	
29	Bila-2	1-055-02	ROR	81.3	42.0	92.0	208.6	300.6	1,935.7	4.5	0.53	
30	Ordi-3	1-190-35	ROR	45.5	18.4	69.2	49.9	119.1	2,472.8	6.4	0.54	
31	Silau-1	1-053-01	ROR	52.3	27.4	72.0	75.9	147.9	1,908.8	5.9	0.55	

No.	Project name & ID		Type	Total cost (mil.$)	Installed capacity (MW)	Firm energy (GWh)	Secondary energy (GWh)	Annual energy (GWh)	Cost/kW (US$)	kWh cost (US¢)	Cost/kWh (US$)	Remarks
32	Renun-4	1-190-22	ROR	53.6	20.8	78.4	56.1	134.5	2,576.9	6.7	0.56	
33	Siria	1-190-38	ROR	43.9	16.5	62.3	43.5	105.8	2,660.6	6.9	0.58	
34	Toru-3	1-178-07	RES	322.7	227.6	498.4	17.7	516.1	1,417.8	11.2	0.64	
	Sub-total			1,443.8	783.9	2,501.1	1,609.5	4,110.6	1,841.8			
Wilayah III (Sumatera Barat & Riau): West Sumatera & Riau												
35	Sangir	1-071-12	ROR	73.7	41.8	183.1	148.6	331.7	1,763.2	3.7	0.32	
36	Sinamar-2	1-066-03	ROR	64.4	25.6	112.1	105.0	217.1	2,515.6	5.0	0.45	
37	Air Tuik	1-147-03	ROR	47.1	24.8	54.3	107.1	161.4	1,899.2	4.9	0.55	
38	Sirantih-1	1-145-01	ROR	57.6	18.3	80.2	73.1	153.3	3,147.5	6.3	0.56	
39	Batang Hari-4	1-071-11	RES	288.8	216.0	473.0	71.9	544.9	1,337.0	9.5	0.58	
40	Taratak Tumpatih-1	1-147-01	ROR	59.7	29.6	64.8	127.8	192.6	2,016.9	5.2	0.58	
41	Sinamar-1	1-066-02	ROR	77.7	36.6	80.2	174.7	254.9	2,123.0	5.1	0.59	
42	Masang-2	1-163-02	ROR	91.5	39.6	100.6	155.5	256.1	2,310.6	6.0	0.62	
43	Gumanti-1	1-071-01	ROR	32.2	15.8	36.0	49.4	85.4	2,038.0	6.3	0.63	
44	Anai-1	1-155-01	ROR	39.4	19.1	41.7	67.5	109.2	2,062.8	6.0	0.63	
45	Masang-3	1-163-03	RES	275.5	192.0	420.5	52.5	473.0	1,434.9	10.4	0.63	Pre-FS in 1999
46	Kuantan-2	1-066-16	RES	406.4	272.4	596.6	137.5	734.1	1,491.9	9.9	0.64	
47	Rokan Kiri-1	1-058-08	RES	266.8	183.0	400.8	31.1	431.9	1,457.9	11.1	0.65	
	Sub-total			1,780.8	1,114.6	2,643.9	1,301.7	3,945.6	1,597.7			
Wilayah IV (Sumatera Selatan, Jambi, Bengkulu & Lampung): South Sumatera, Jambi, Bengkulu & Lampung												
48	Mauna-1	1-115-01	ROR	151.1	103.0	415.1	398.9	814.0	1,467.0	3.3	0.28	
49	Langkup-2	1-136-02	ROR	145.0	82.8	362.7	337.8	700.5	1,751.2	3.7	0.31	
50	Merangin-4	1-071-33	RES	252.7	182.0	398.6	93.3	491.9	1,388.5	9.2	0.59	
51	Padang Guci-2	1-113-02	ROR	52.7	21.0	62.6	82.5	145.1	2,509.5	6.1	0.60	
52	Endikat-2	1-074-17	ROR	65.7	22.0	63.6	116.2	179.8	2,986.4	6.1	0.67	
53	Semung-3	1-082-07	ROR	53.0	20.8	45.6	101.3	146.9	2,548.1	6.0	0.70	
54	Menula-2	1-106-02	ROR	63.2	26.8	61.0	91.2	152.2	2,358.2	6.9	0.72	
55	Tebo-2	1-071-17	ROR	96.9	24.4	100.5	88.2	188.7	3,971.3	8.6	0.76	
	Sub-total			880.3	482.8	1,509.7	1,309.4	2,819.1	1,823.3			
Wilayah V (Kalimantan Barat): West Kalimantan												
56	Melawi-9	3-043-52	RES	898.8	590.4	1,293.0	31.8	1,324.8	1,522.4	13.1	0.69	
57	Mandai-5	3-043-20	RES	452.0	140.7	308.1	43.7	351.8	3,212.5	23.0	1.41	
				1,350.8	731.1	1,601.1	75.5	1,676.6	1,847.6			
Wilayah VI (Kalimantan Selatan, Kalimantan Timur & Kalimantan Tengah): South, East and Central Kalimantan												
58	Boh-2	3-014-06	RES	1,475.0	1,119.6	2,451.9	847.3	3,299.2	1,317.4	8.6	0.55	
59	Kelai-1	3-010-01	RES	1,259.3	952.8	2,086.6	19.8	2,106.4	1,321.7	11.6	0.60	
60	Sesayap-20	3-004-20	RES	1,430.2	949.2	2,078.8	554.5	2,633.3	1,506.7	10.5	0.64	
61	Sesayap-11	3-004-11	RES	1,134.1	624.0	1,366.6	668.7	2,035.3	1,817.5	10.8	0.72	
62	Sembakung-3	3-003-03	RES	1,220.9	572.4	1,253.6	14.7	1,268.3	2,132.9	18.6	0.97	
63	Sesayap-15	3-004-15	RES	740.5	313.2	685.9	270.8	956.7	2,364.3	15.0	0.97	
64	Telen	3-014-13	RES	450.6	193.2	423.1	121.3	544.4	2,332.3	14.8	0.98	
	Sub-total			7,710.6	4,724.4	10,346.5	2,497.1	12,843.6	1,632.1			
Wilayah VII (Sulawesi Utara & Sulawesi Tengah): North & Central Sulawesi												
65	Poso-2	4-026-03	ROR	148.7	132.8	581.7	543.7	1,125.4	1,119.7	2.4	0.20	
66	Poso-1	4-026-02	ROR	220.9	204.0	446.8	894.2	1,341.0	1,082.8	2.9	0.31	
67	Lariang-7	4-106-07	RES	725.0	618.0	1,353.4	136.2	1,489.6	1,173.1	9.4	0.52	
68	Lariang-6	4-106-06	RES	308.2	209.4	458.6	157.6	616.2	1,471.8	9.0	0.61	
69	Bone-3	4-003-04	ROR	61.1	20.4	71.5	76.8	148.3	2,995.1	6.9	0.65	
70	Bongka-2	4-030-02	RES	331.1	187.2	410.0	41.3	451.3	1,768.7	13.1	0.78	
71	Solato-1	4-038-01	ROR	83.0	26.6	58.3	117.8	176.1	3,120.3	7.9	0.89	
72	Lariang-8	4-106-08	ROR	45.4	12.8	28.1	57.3	85.4	3,546.9	8.9	1.00	
	Sub-total			1,923.4	1,411.2	3,408.4	2,024.9	5,433.3	1,363.0			
Wilayah VIII (Sulawesi Selatan & Tenggara): South Sulawesi												
73	Karama-2	4-100-03	RES	793.6	762.3	1,669.4	126.7	1,796.1	1,041.1	8.5	0.46	
74	Tamboli	4-055-01	ROR	45.1	20.8	40.1	110.0	150.1	2,168.3	5.0	0.62	Pre-FS in 1999
75	Karama-1	4-100-01	RES	1,162.1	800.0	1,752.0	395.1	2,147.1	1,452.6	10.5	0.62	
76	Masuni	4-095-06	RES	558.6	400.2	876.4	53.8	930.2	1,395.8	11.6	0.63	
77	Mong	4-073-04	RES	392.6	255.6	559.8	59.1	618.9	1,536.0	11.4	0.68	
78	Bonto Batu	4-093-13	RES	385.7	228.3	500.0	60.2	560.2	1,689.4	12.3	0.74	
79	Watunohu-1	4-056-01	ROR	103.5	57.0	54.9	254.1	309.0	1,815.8	6.0	0.79	
80	Lalindu-1	4-047-01	RES	369.6	193.6	424.0	120.1	544.1	1,909.1	12.2	0.80	
81	Pongkeru-3	4-057-03	RES	453.2	227.6	498.4	58.2	556.6	1,991.2	14.6	0.88	
	Sub-total			4,264.0	2,945.4	6,375.0	1,237.3	7,612.3	1,447.7			
Wilayah IX (Maluku): Maluku												
82	Mata-2	14-002-02	ROR	52.7	30.4	66.6	142.4	209.0	1,733.6	4.2	0.48	
83	Mata-1	14-002-01	RES	72.8	27.8	60.9	4.5	65.4	2,618.7	18.6	1.17	
84	Tala	14-012-01	RES	135.9	51.4	112.6	10.1	122.7	2,644.0	19.8	1.18	Pre-FS in 1999
85	Tina	13-004-01	ROR	117.0	22.8	49.9	106.8	156.7	5,131.6	13.4	1.43	Pre-FS in 1999
	Sub-total			378.4	132.4	290.0	263.8	553.8	2,858.0			
Wilayah X (Irian Jaya): Irian Jaya												
86	Warasai	5-042-02	ROR	234.5	231.9	507.9	806.1	1,314.0	1,011.2	3.2	0.31	
87	Jawee-4	5-013-06	ROR	276.5	152.6	668.4	640.2	1,308.6	1,811.9	3.8	0.32	
88	Derewo-7	5-043-07	ROR	261.6	148.8	586.6	593.9	1,180.5	1,758.1	4.0	0.34	
89	Jawee-3	5-013-05	ROR	287.0	147.2	425.5	738.1	1,163.6	1,949.7	4.4	0.44	
90	Endere-1	5-013-07	ROR	242.2	144.8	317.1	716.4	1,033.5	1,672.7	4.2	0.46	
91	Endere-2	5-013-08	ROR	215.6	87.0	327.7	400.1	727.8	2,478.2	5.3	0.48	
92	Derewo-6	5-043-06	ROR	402.3	170.0	461.7	666.7	1,128.4	2,366.5	6.4	0.61	
93	Jawee-2	5-013-04	ROR	280.5	94.2	280.6	475.3	755.9	2,977.7	6.6	0.66	
94	Baliem-7	5-006-08	ROR	393.0	97.8	411.2	423.5	834.7	4,018.4	8.4	0.73	

No.	Project name & ID		Type	Total cost (mil.$)	Installed capacity (MW)	Firm energy (GWh)	Secondary energy (GWh)	Annual energy (GWh)	Cost/kW (US$)	kWh cost (US¢)	Cost/kWh (US$)	Remarks
95	Baliem-5	5-006-06	ROR	543.8	189.2	447.5	953.9	1,401.4	2,874.2	7.5	0.74	
96	Waryori-4	5-036-12	ROR	188.8	94.2	107.3	491.5	598.8	2,004.2	5.6	0.74	
97	Ulawa	5-042-01	ROR	83.0	34.6	75.8	118.8	194.6	2,398.8	7.1	0.75	
98	Gila/Ransiki-1	5-037-91	LOT	101.3	56.2	123.1	13.1	136.2	1,802.5	13.3	0.80	
99	Baliem-6	5-006-07	ROR	388.3	88.2	363.1	391.1	754.2	4,402.5	9.2	0.81	
100	Kladuk-2	5-032-03	RES	447.0	229.0	501.5	65.9	567.4	1,952.0	14.1	0.86	
101	Titinima-3	5-015-05	ROR	184.5	55.6	126.6	275.6	402.2	3,318.3	8.2	0.88	
102	Maredrer	5-020-01	ROR	29.5	8.7	19.1	43.3	62.4	3,390.8	7.9	0.92	
103	Muturi-1	5-026-01	ROR	123.4	45.8	52.2	236.1	288.3	2,694.3	7.7	1.00	
104	Siewa-1	5-043-09	ROR	196.4	58.4	127.9	202.6	330.5	3,363.0	10.6	1.04	
105	Baliem-8	5-006-09	ROR	551.9	138.4	315.2	691.8	1,007.0	3,987.7	10.6	1.06	
Sub-total				5,431.1	2,272.6	6,246.0	8,944.0	15,190.0	2,389.8			
Wilayah XI (Bali, Nusatenggara Barat & Nusatenggara Timur): Bali, West & East Nusatenggara												
106	Parainglala	9-011-01	ROR	31.5	14.9	36.5	49.1	85.6	2,114.1	6.2	0.62	
107	Be Lulic-1	11-012-01	ROR	54.3	21.2	52.0	70.1	122.1	2,561.3	7.4	0.74	to be omitted
108	Watupanggantu	9-012-01	ROR	19.9	7.1	17.5	23.0	40.5	2,802.8	8.2	0.82	
109	Karendi-1	9-001-01	RES	40.6	21.4	46.9	2.6	49.5	1,897.2	13.7	0.85	
110	Teldewaja	7-015-01	ROR	27.8	7.0	27.4	16.8	44.2	3,971.4	10.5	0.86	
111	Kambera-2	9-005-02	RES	142.9	65.4	143.2	10.8	154.0	2,185.0	16.6	0.98	Pre-FS in 1999
112	Wai Ranjang	10-003-02	ROR	32.1	9.3	22.9	30.2	53.1	3,451.6	10.1	1.00	Pre-FS in 1999
Sub-total				349.1	146.3	346.4	202.6	549.0	2,386.2			
Distribusi Jatim (Jawa Timur): East Jawa												
113	Kewsamben	2-057-17	LHD	44.9	16.7	36.6	62.4	99.0	2,688.6	7.6	0.81	FS in 1997
Distribusi Jateng (Jawa Tengah & Daerah Istimewa Yogyakarta): Central Jawa												
114	Rowopening	2-050-01	ROR	49.5	19.6	42.9	95.5	138.4	2,525.5	6.0	0.69	
Distribusi Jabar (Jawa Barat): West Jawa												
115	Cibareno-1	2-108-01	ROR	48.8	17.5	38.2	78.8	117.0	2,788.6	7.0	0.79	
116	Cimandiri-1	2-107-01	ROR	77.3	24.4	53.4	114.1	167.5	3,168.0	7.7	0.88	
Sub-total				126.1	41.9	91.6	192.9	284.5	3,009.5			
Total				27,724.1	16,027.2	38,329.6	21,384.5	59,714.1	29,064.4			

Table 7.1.9 Ongoing and Planned Projects

No.	Project name	Province	PLN Wilayah	Status	Year of Installation	Type	Installed capacity (MW)	Annual energy (GWh)	Capacity factor (%)	Cost/kW in study year (US$/kW)	Cost/kW in 1996 (US$/kW)	Total cost (mil.$)
Sumatera												
16	Asahan-1	Sumatera Utara	Wilayah II	On-going	2010	LHD	180	1,360	86.2%	--	--	--
17	Asahan-3	Sumatera Utara	Wilayah II	On-going	2012	RES	174	1,477	96.8%	--	--	--
6	Peusangan-1	D.I. Aceh	Wilayah I	On-going	2012	ROR	44	176	45.6%	--	--	--
7	Peusangan-2	D.I. Aceh	Wilayah I	On-going	2012	ROR	44	168	43.6%	--	--	--
18	Merangin-2	Jambi	Wilayah III	D/D in 1996	--	ROR	350	1,465	47.8%	1,379	1,379	482.7
19	Tampur-1	D.I. Aceh	Wilayah I	F/S in 1984	--	RES	428	1,214	32.4%	1,283	1,646	704.5
20	Jambu Aye-8	D.I. Aceh	Wilayah I	F/S in 1985	--	RES	160	650	46.3%	2,153	2,706	433.0
21	Wampu	Sumatera Utara	Wilayah II	F/S in 1992	--	ROR	84	475	64.5%	1,393	1,514	127.2
22	Ketaun-1	Bengkulu	Wilayah IV	F/S in 1990	--	RES	84	308	41.8%	1,348	1,527	128.3
23	Ranau	Sumatera Selatan	Wilayah IV	F/S in 1988	--	LOT	60	146	27.8%	3,213	3,794	227.6
24	Teunom-1	D.I. Aceh	Wilayah I	Pre-F/S in 1987	--	RES	24	212	100.8%	3,402	4,102	98.4
25	Aceh-2	D.I. Aceh	Wilayah I	Pre-F/S in 1987	--	RES	7	64	104.3%	6,392	7,707	53.9
26	Peusangan-4	D.I. Aceh	Wilayah I	Pre-F/S in 1987	--	ROR	31	234	86.1%	1,495	1,802	55.9
27	Lawe Alas-4	D.I. Aceh	Wilayah I	Pre-F/S in 1987	--	RES	322	1,549	54.9%	1,219	1,470	473.3
28	Toru-1	Sumatera Utara	Wilayah II	Pre-F/S in 1994	--	RES	38	308	92.5%	1,613	1,647	62.6
29	Merangin-5	Jambi	Wilayah III	Pre-F/S in 1987	--	RES	24	197	93.6%	2,753	3,319	79.7
30	Bayang-1	Sumatera Barat	Wilayah III	Pre-F/S in 1987	--	ROR	13	71	62.3%	2,768	3,337	43.4
31	Bayang-2	Sumatera Barat	Wilayah III	Pre-F/S in 1987	--	ROR	31	203	74.7%	1,421	1,713	53.1
32	Lematang-4	Sumatera Selatan	Wilayah IV	Pre-F/S in 1987	--	RES	12	107	101.7%	10,028	12,091	145.1
Sub-total							2,110	10,384	56.1%	41,860	49,754	3,168.6
Sulawesi												
39	Lasolo	Sulawesi Tengah	Wilayah VII	F/S in 1996	--	ROR	100	770	87.8%	--	--	--
40	Palu-3	Sulawesi Tengah	Wilayah VII	F/S in 1990	--	LOT	75	510	77.6%	1,236	1,400	105.0
41	Bakaru (2nd stage)	Sulawesi Selatan	Wilayah VIII	D/D	--	ROR	126	471	42.6%	1,209	1,260	158.8
42	Poko	Sulawesi Selatan	Wilayah VIII	F/S in 1996	--	RES	233	760	37.2%	1,296	1,296	302.0
43	Malea	Sulawesi Selatan	Wilayah VIII	F/S in 1984	--	ROR	182	1,477	92.6%	1,103	1,415	257.5
44	Konaweha-3	Sulawesi Tengah	Wilayah VII	Pre-F/S in 1996	--	RES	24	116	55.1%	--	--	--
45	Poigar-2	Sulawesi Utara	Wilayah VII	On-going	--	ROR	25	149	68.0%	--	--	--
46	Poigar-3	Sulawesi Utara	Wilayah VII	Pre-F/S in 1987	--	ROR	14	99	80.7%	1,710	2,062	28.9
47	Batu	Sulawesi Selatan	Wilayah VIII	Pre-F/S in 1987	--	RES	271	1,740	73.2%	1,488	1,794	486.2
Sub total							1,050	6,092	66.2%	8,042	9,227	1,338.3
Java-Bali												
75	Maung	Jawa Tengah	Jateng	D/D in 1987	--	RES	360	535	17.0%	1,179	1,421	511.6
76	Rajamandala	Jawa Barat	Jabar	D/D in 1995	--	ROR	58	216	42.5%	2,064	--	--
77	Jatigede	Jawa Barat	Jabar	D/D in 1986	--	RES	175	777	50.7%	3,563	--	--
78	Cibuni-3	Jawa Barat	Jabar	F/S in 1984	--	RES	172	568	37.7%	1,646	2,112	363.3
79	Cipasang	Jawa Barat	Jabar	F/S in 1988	--	RES	400	751	21.4%	1,021	1,206	482.4
80	Cimandiri-3	Jawa Barat	Jabar	F/S in 1990	--	RES	238	600	28.8%	1,300	1,473	350.6
81	Gintung	Jawa Tengah	Jateng	Pre-F/S in 1987	--	RES	19	81	48.6%	5,018	6,050	115.0
82	Rawalo-1	Jawa Tengah	Jateng	Pre-F/S in 1987	--	LHD	0.6	5	95.1%	4,196	5,059	3.0

No.	Project name	Province	PLN Wilayah	Status	Year of Installation	Type	Installed capacity (MW)	Annual energy (GWh)	Capacity factor (%)	Cost/kW in study year (US$/kW)	Cost/kW in 1996 (US$/kW)	Total cost (mil.$)
83	Cibuni-4	Jawa Barat	Jabar	Pre-F/S in 1987	--	RES	71	207	33.3%	1,378	1,661	117.9
84	Cikaso-3	Jawa Barat	Jabar	Pre-F/S in 1987	--	RES	30	189	71.9%	4,155	5,010	150.3
85	Grindulu-2	Jawa Timur	Jatim	Pre-F/S in 1987	--	RES	16	51	36.4%	4,325	5,215	83.4
95	Ayung-1 (Sidan)	Bali	Wilayah XI	F/S in 1989	--	ROR	23	68	33.7%	2,478	2,866	65.9
96	Ayung-2 (Selat)	Bali	Wilayah XI	F/S in 1989	--	ROR	19	52	31.2%	2,099	2,428	46.1
97	Ayung-3 (Buangga)	Bali	Wilayah XI	F/S in 1989	--	LHD	2	12	76.1%	9,944	11,501	20.7
Sub total							1,583	4,112	29.6%	44,366	46,002	2,310.2
Kalimantan												
87	Riam Kiwa	Kalimantan Selatan	Wilayah VI	D/D in 1986	--	RES	42	152	41.3%	4,135	5,090	213.8
88	Pade Kembayung	Kalimantan Barat	Wilayah V	F/S in 1980	--	RES	30	235	89.4%	6,927	9,660	289.8
89	Kusan-3	Kalimantan Selatan	Wilayah VI	D/D	--	RES	68	101	16.9%	1,756	1,989	135.3
90	Amandit-2	Kalimantan Selatan	Wilayah VI	Pre-F/S in 1987	--	RES	2.5	20	91.3%	11,430	13,781	34.5
91	Kelai-2	Kalimantan Timur	Wilayah VI	F/S	--	RES	168	1,103	74.9%	1,599	1,702	285.9
92	Kayan-2	Kalimantan Timur	Wilayah VI	Pre-F/S in 1996	--	RES	500	3,833	87.5%	1,014	1,014	507.0
93	Pinoh	Kalimantan Barat	Wilayah V	Pre-F/S in 1987	--	RES	198	1,375	79.2%	2,177	2,625	519.8
94	Silat	Kalimantan Barat	Wilayah V	Pre-F/S in 1987	--	RES	29	130	51.1%	4,078	4,917	142.6
Sub total							1,038	6,949	76.4%	33,116	40,778	2,128.6
Nusa Tenggara												
98	Beburung	NTB	Wilayah XI	F/S in 1990	--	ROR	22	91	47.2%	1,935	2,192	48.2
99	Putih-1	NTB	Wilayah XI	F/S in 1997	--	ROR	5.6	29	59.1%			
100	Putih-2	NTB	Wilayah XI	F/S in 1997	--	ROR	4.1	22	61.2%	--	3,212	50.7
101	Putih-3	NTB	Wilayah XI	F/S in 1997	--	ROR	6.1	32	59.8%			
Sub total							37.8	174	52.5%	1,935	5,404	99.0
Maluku												
102	Isal-2	Maluk	Wilayah IX	F/S in 1989	--	RES	60	447	85.0%	1,442	1,668	100.1
103	Lamo-1	Maluk	Wilayah IX	Pre-F/S in 1996	--	RES	6	25	50.0%	--	--	--
Sub total							66	472	82.0%	1,442	1,668	100.1
Irian Jaya												
104	Warsamson	Irian Jaya	Wilayah X	F/S in 1996	--	RES	49	248	57.7%	2,704	2,704	132.5
105	Genyem	Irian Jaya	Wilayah X	On-going	2011	ROR	23	68	33.7%	3,672	3,672	84.5
Sub total							72	316	50.1%	6,376	6,376	217.0
Total							5,956	28,499	54.6%	137,137	159,209	9,362

The projects focused in this study are summarized in Table 7.1.10, along with existing hydropower plants. Compared to the figures in Table 7.1.7, the total capacities in Kalimantan, Sulawesi and Papua are larger than their theoretical hydro capacity criteria, and should be accordingly cut off.

Table 7.1.10 Summary of hydropower projects focused in the Study

Region	Existing			Planning & Ongoing			HPPS2			Total		
	Loc	Capacity (MW)	Energy (GWh)	Loc	Capacity (MW)	Energy (GWh)	Loc	Capacity (MW)	Energy (GWh)	Loc	Capacity (MW)	Energy (GWh)
Sumatera*	13	1,443	8,223	20	2,110	10,384	55	3,586	15,334	88	7,139	33,941
Kalimantan	1	30	136	8	1,038	6,949	9	5,456	14,520	18	6,523	21,605
Sulawesi	6	352	1,210	11	1,050	6,092	17	4,357	13,046	34	5,759	20,348
Maluku				2	66	472	4	132	554	6	198	1,026
Papua				2	72	316	20	2,273	15,190	22	2,345	15,506
Nusa Tenggara				4	38	174	6	146	549	10	184	723
Java-Bali	27	2,513	8,098	14	1,583	4,112	4	78	522	45	4,174	12,732
Total	**47**	**4,338**	**17,667**	**61**	**5,956**	**28,499**	**115**	**16,027**	**59,714**	**223**	**26,321**	**105,880**

Note) Existing capacity and Energy of Sumatra includes those of Asahan II project.

Source: JICA Study Team.

In conclusion, hydro capacity to be developed by 2027 or focused in this study will be summarized as Table 7.1.11, considering the hydro potentials, power demands and current status of hydropower development.

Table 7.1.11 Hydro Capacity focused in this Study

(Unit: MW)

Region	Existing Hydro Capacity	Planned & Ongoing	Screened in HPPS2	Total	Hydro Capability*	Focused in this Study	Total
	(A)	(B)	(C)	(D)=(B)+(C)	(E)	(F)=min(D,E)	(A)+(F)
Sumatera	1,443	2,110	3,586	5,696	9,862	5,696	7,139
Kalimantan	30	1,038	5,456	6,493	3,605	3,605	3,635
Sulawesi	352	1,050	4,357	5,407	3,004	3,004	3,356
Maluku	--	66	132	198	232	198	198
Papua	--	72	2,273	2,345	293	293	293
Nusa Tenggara	--	38	146	184	549	184	184
Java-Bali	2,513	1,583	78	1,662	4,200	1,662	4,174
Total	**4,338**	**5,956**	**16,027**	**21,984**	**21,745**	**14,641**	**18,979**

* Hydro capability under the constraint of demand or potential indicated in Table 7.1.7.

Source: JICA Study Team

7.2 DEVELOPMENT SCENARIOS

While hydropower development has been stalling in recent years, the Government has advocated ambitious targets for hydropower development. In this background, keeping the hydro potential and the electricity demand described in the previous section in mind, we established three development scenarios and examined them.

i) Policy Oriented Scenario

In this scenario, all the potential projects indicated in the hydro project list were taken into consideration as much as possible. However, even this scenario missed the target in the National Energy Policy due to constraint in the combination of hydro potential and electricity demand as indicated in Table 7.1.11.

ii) Realistic Scenario

Reviewing the recent experience, social and environmental impacts were one of the most dominant causes to hinder hydro projects. For example, Poigar 2 project in North Sulawesi has long been stalling, part of which project is located within the Conservation Forest (*Hutan Konservasi*) area defined by the Government. Also, implementation of Kusan project in South Kalimantan is suspended due to a rare mammal's inhabitance in the project area. In addition, project economy and electricity demand in the supply area were considered, and more realistic development scenario was made.

The lost hydro capability compared to that of the above scenario has to be made up for by other generation options to meet power demand, and coal thermal generation was taken for base load, and gas turbine generation for peak load, same as the manner in the economic valuation.

The screening methods, criteria and the results were detailed in the following section.

iii) Zero Option

We examined an extreme scenario that no hydropower development was realized, as a "Zero Option", and even the projects for which some actions such as construction financing, detailed studies etc. has been set about, were to be abandoned in this scenario. The alternative supply capability was taken in the same manner as in the "realistic scenario".

The graphic image of the above three scenarios is illustrated in Figure 7.2.1.

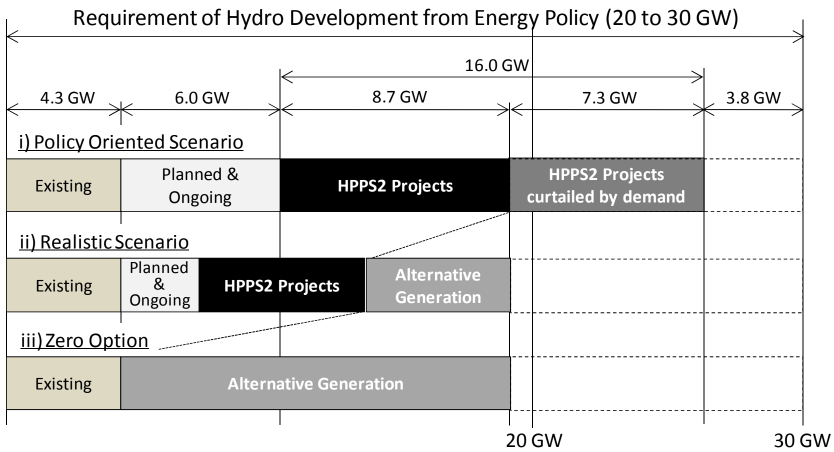


Figure 7.2.1 Graphic Image of Development Scenarios

7.3 PROJECT CLASSIFICATION

7.3.1 FRAMEWORK OF PROJECT CLASSIFICATION

Project classification for selecting projects which should be included in the master plan is conducted in the manner as below:

- Evaluation is made in aspects of natural & social environment, and project economy.
- The electricity demand and the scale of transmission system are checked against the capacity of a project.
- As for impact to natural and social environment, degree of development difficulty at each evaluation items related to natural and social environment are considered as evaluation indicators. Degree of development difficulty is defined from less difficulty up to serious difficulty (i.e., from A to D; D is regarded as the most difficult degree) at each evaluation item based on development possibility. Then, degree of development difficulty of the scheme is evaluated totally based on each evaluation item.
- On the other hand, the project economy will be evaluated by simplified cost-benefit analysis. When uncertain factors (risks) are assumed such as hydrology, geology or other aspects, they will be reflected in the cost or benefit according to the degrees. Superiority or inferiority of the

conditions of location due to the distance of the transmission line and/or the access road are reflected in the cost.

- Evaluation in aspects of natural & social environment, and project economy will be judged overall.

The screening applying the above mentioned framework was conducted based on information basically obtained in the office study. The items that are adopted to evaluate the development difficulty are i) forest classification, ii) involuntary resettlement, and iii) inundation area.

7.3.2 NATURAL AND SOCIAL ENVIRONMENT

(1) Forest Classification

a) Forest Classification

Forests in Indonesia are classified into three types depending on the functions and objectives, as the production forest (*Hutan Produksi*), the protection forest, (*Hutan Lindung*) and the conservation forest (*Hutan Konservasi*) according to the Article 6 in the Law No. 41 of 1999. Furthermore, the classification of conservation forests is described in “the Law No.5/1990 on the conservation of Bio Natural Resources and its ecosystem”.

1) Production Forest (*Hutan Produksi*)

Production forest mainly is defined as the forestry area where production of forest products is sought for. It consists of the following three categories.

- Limited Production Forest (*Hutan Produksi Terbatas*)
- Permanent Production Forest (*Hutan Produksi Tetap*)
- Conversion Forest (*Hutan Konversi*)

2) Protection Forest (*Hutan Lindung*)

Protection forest is the forest area having the main function to sustain water resources, to prevent flood, erosion, water intrusion and to maintain land fertility.

3) Conservation Forest (*Hutan Konservasi*)

Conservation forest is the forest area which is characterized by priciple function to conserve bio-diversity and ecosystem. Conservation forests are furtherly classified into the following three categories.

- Nature Reserve Forest Area (*Kawasan Suaka Alam*)
- Natural Preservation Forest Area (*Kawasan Pelestarian Alam*)

- Hunting Resort (*Taman Buru*)

b) Utilization of Forest Area

Utilization of forest area by development activities besides forestry is only allowed in the production forest area and the protection forest area in accordance with the Article 38 in the Law of the Republic of Indonesia No. 41 of 1999. Therefore, conservation forest (*Hutan Konservasi*) is not permitted to use for other purposes except for forestry production.

The utilizations of forest areas by development activities besides forestry are listed in the following table (The Republic of Indonesia's Government Regulation (No.24, 2010). Utilization of forest areas for development activities besides forestry includes establishing generator, transmission, and electrical distribution installation, as well as new and renewable energy technology.

As for mining activities, mining with open-cast type and underground type can be conducted in the production forest area, whereas underground mining will only be possible within the protection forest. (Governmental Regulation No.24 Section 5)

Table 7.3.1 Utilization of Forest Areas by Development Activities besides Forestry Activities

Forest Classification	Development activities
Production Forest（Hutan Produksi） Protected Forest(Hutan Lindung）	- religious - mining - generator, transmission, and electrical distribution installation, as well as new and renewable energy technology - building telecommunication network, radio transmission station, and television relay station; - road, toll road, and railroad - transportation uncategorized as public transport for manufacturing products transportation - water resources facilities and infrastructure, building water installation network, and clean water and/or waste water channeling. - public facilities - forestry related industries - defense and security - infrastructure supporting public safety; or - temporary holding place for natural disasters victims.

Source: The Republic of Indonesia's Government Regulation (No.24, 2010).

c) Rank of "Difficulty of Development Activities" from the Viewpoint of Natural Environment

As for the impact on natural and social environment, the degree of difficulty in development activities viewed from the points of natural and social environment was examined by the evaluation indicators. Moreover, the degree of difficulty in development activities in terms of natural and social environment aspects was evaluated integrately from the respective evaluation item. Evaluation items to identify the degree of difficulty in development activities will be categorized from less difficulty to seriously difficult (*i.e.*, from A to D; D is regarded as the most difficult degree) at each evaluation item based on development possibility. Forest classification was selected as one of the evaluation items included in natural environment.

As for the ranking of forest classification, the outside of forest area was categorized as "A rank", indicating that it has nothing special difficulties. And the conservation forest which is not allowed to use for any other purposes except for forestry production was then categorized as D.

There is no significant difference between the production forest and the protection forest in terms of forest importance in the related regulation. Considering the stipulation in Governmental regulation No.24 Section 5, the degree of development difficulty of production forest was determined as "B", and those for protected forest as C, respectively.

> *"Mining with open-cast type and underground type within the production forest areas can be performed, whereas only underground mining can be done within the protection forest areas.*

Finally the ranking of "Difficulty of Development" from the viewpoint of natural environment is determined as in the below table.

Table 7.3.2 Ranking of "Difficulty of Development" by Natural Environment

Rank	Description	Definition
A	Areas outside of forest area	Difficulties are expected to be less.
B	Production Forest (HP)	Although certain difficulties are expected, the solution could be found.
C	Protection forest (HL)	The solution for the constraints is considered as difficult.
D	Conservation forest (HK)	The solution for the constraints is considered as very difficult.

(2) Involuntary Resettlement

Involuntary resettlement causes negative impact for both of project affected persons and a project executer despite of its size. Therefore, it shall be avoided where feasible or minimized by exploring all viable alternative project design. By respecting the concept, this Study sets expected impact of involuntary resettlement as one of criteria to evaluate social environmental condition in the first projects screening process.

a) Criterion of Resettlement

Impact of involuntary resettlement was evaluated by the estimated household number of physical replacement. As for the ranking of involuntary resettlement impact, 0 to 50 households resettlement was categorized as "A rank", which was regarded as less difficulties. More than 10,000 households resettlement was considered as serious impact and therefore categorized as "D".

Table 7.3.3 Ranking of "Difficulty of Development" in terms of Resettlement

Rank	Description	Definition
A	0 – 50 households replacement	Difficulties are expected to be less.
B	50 – 400 households replacement	Although certain difficulties are expected, the solution could be found.
C	400 – 1,000 households replacement	The solution for the constraints is considered as difficult.
D	More than 1,000 households replacement	The solution for the constraints is considered as very difficult.

b) Method of Impact Estimation

The number of households to be physically replaced was already estimated by HPPS 2. Since the project location and size in this Study is based on the study result of HPPS 2, number of involuntary resettlement household is estimated by updating the study result of HPPS 2.

The study result of HPPS 2 was updated by applying for the latest census data in 2000 issued by BPS (*Badan Pusat Statistik*)[2]. The projects which were not covered by HPPS 2 were estimated their resettlement household number by updating existing study results such as ANDAL reports, preliminary feasibility study reports, and Hydropower Potentials Study (HPPS) conducted in 1983.

(3) Inundated Area

In the case of projects requesting large inundated area, due consideration to land owners as well as surrounding natural and social environment is necessary. In order to minimize impact caused by inundation, this Study regarded inundated area as another criterion for evaluating social environment.

a) Criterion of Inundated Area

Impact of inundated was evaluated by the estimated size of necessary area for inundated. As for the ranking of inundated area, 0 to 100 ha inundation was categorized as "A rank", which was regarded as less difficulties. More than 10,000 ha inundation was considered as serious impact and therefore categorized as "D".

Table 7.3.4 Ranking of "Difficulty of Development" in terms of Inundated Areas

Ranking	Description	Definition
A	0 – 100 ha	Difficulties are expected to be less.
B	100 – 1,000 ha	Although certain difficulties are expected, the solution could be found.
C	1,000 – 10,000 ha	The solution for the constraints is considered as difficult.
D	10,000 ha	The solution for the constraints is considered as very difficult.

[2] BPS is the national statistic authority. The census is conducted every ten years, and the data in 2000 is the latest population information to be referred as of June 2010.

b) Method of Inundated Area Estimation

The inundated area was already estimated at the HPPS 2. Same as involuntary resettlement, however, there were some projects which were not covered by the HPPS 2. Inundated area of such projects was estimated by existing study result such as ANDAL reports and feasibility study reports. The common issue to be mentioned for most of projects was that the inundated area was bush, forest and cultivated area.

7.3.3 OTHER CRITERIA

(1) Scale of capacity

We examined schemes with the capacity of more than 10 MW, since the amount of less than 10 MW schemes would have little influence on the master plan in terms of capacity and investment. In addition, most of them will be developed by private investors not along with a master plan but on a voluntary basis so that they could enjoy fiscal benefit for small scale hydro schemes.

(2) Project economy

Economic internal rate of return (EIRR) was taken as the indicator of project economies. In Indonesia, PPAs (power purchase agreement) between private investors and PLN (as the single off-taker) are, in principle, determined by energy basis, and the difference of value between peak-time energy and off-peak time energy are not considered, so that financial rate of return (FIRR) may give an priority to base-load generation with high capacity factor. To avoid such unjustified evaluation, we took EIRR as the economic indicator. The criterion to screen the economies of projects was set as 10 percent, and the schemes with less than 10 percent of EIRR were discarded.

(3) Interference with private projects

We encountered, in the course of this study, quite a few small hydro projects particularly in Sumatra for which rights to development (*Izin Lokasi*) have already been issued to private investors by the relevant local governments. Most of them were found to interfere to the projects which have passed through the 3rd screening in HPPS2, and are focused in this study. Furthermore, MOUs (memorandum of understandings) promising exclusive development rights, have been effective for some projects between private investors and PLN regional offices which are given authority to deal with less than 10 MW generation projects, and even PPA (power purchase agreement) have been agreed for other projects. It might be so difficult to abandon such PPAs already agreed that we cannot but discard such project sites where the development has advanced to PPA stage or more.

(4) Demand and Scale of Transmission system

We roughly checked the electricity demand and the scale of transmission system where schemes were located. Detailed inspection was conducted in the following section, and the schemes which capacity is apparently too large compared with the power demand or the scale of transmission system, were discarded in this part.

7.3.4 RESULTS OF SCREENING

Mechanically applying the above screening criteria and according to the following procedures, we determined the priority of the schemes;

i) which passed the 3rd screening of HPPS 2, and
ii) which DD, F/S and pre F/S were conducted for.

1. The schemes which have i) D rank in environment, ii) installed capacity of less than 10 MW, iii) IPP status of PPA or more advanced, or iv) less project economy , v) project scale is too large to the system are shaded by red color in respective cells.

2. The schemes which have i) RES type and C rank in environment, or ii) IPP status of MOU are shaded by yellow color in respective cells.

3. Schemes which are shaded by red color are classified as “✕”.

4. Schemes which are shaded in yellow color are classified as “△”.

5. Among the schemes which are classified as “△”, if C is given in two environmental aspects (e.g. inundation of 1,000ha or more in HL), or ii C is given to resettlement (i.e. 400HH or more), those schemes are classified as “△△”.

6. Schemes which are not shaded by red nor yellow colors are classified as “○”.

7. Priority might be given to schemes in order of “○” > “△” > “△△” > “✕”.

(2) Schemes having passed the 3rd screening in HPPS2

The results of evaluation for schemes which have passed the 3rd screening of HPPS 2 are indicated in Table 7.3.5. Out of 115 schemes, 46 schemes with the capacity of 6,206.9MW have passed the screening. All of nine schemes in Kalimantan and 20 schemes in Papua were discarded due to the reason of power demand in the regions. 13 projects are screened out by the environmental concern with D rank, eight schemes by IPP interference, seven schemes by their less economies, and three schemes by their less capacities, in other regions[3].

Table 7.3.5 Evaluation of Schemes having passed the 3rd screening in HPPS2

Working No.	Scheme Name	Type	Province	Installed Capacity (MW)	Annual Total Energy (GWh)	Peak Time (hrs)	Project Cost (2011US$)	Project EIRR	Forest Classification	Resettlement	Reservoir Area	**Environment**	**IPP**	**Demand**	**Evaluation**
[Sumatra]															
1001	Mamas-2	ROR	NAD	51.0	327.7	10	132.52	18.1%	D	A	A	**D**			✕

[3] The sum of the number here doesn’t equal the number of screened out projects due to duplication of reasons.

Working No.	Scheme Name	Type	Province	Installed Capacity (MW)	Annual Total Energy (GWh)	Peak Time (hrs)	Project Cost (2011US$)	Project EIRR	Forest Classification	Resettlement	Reservoir Area	**Environment**	**IPP**	**Demand**	**Evaluation**
1002	Jambo Papeun-3	ROR	NAD	25.4	206.1	12	80.60	16.9%	C	A	A	**C**			○
1003	Woyla-2	RES	NAD	242.1	664.6	6	367.45	17.0%	C	A	B	**C**			△
1004	Ketambe-2	ROR	NAD	19.4	124.9	10	62.85	13.8%	D	A	A	**D**			×
1005	Teunom-2	RES	NAD	230.0	595.3	6	370.81	15.4%	C	A	C	**C**			△△
1006	Kluet-1	ROR	NAD	40.6	231.9	6	106.39	15.8%	C	A	A	**C**			○
1007	Meulaboh-5	ROR	NAD	43.0	271.1	7	127.55	14.8%	C	A	A	**C**			○
1008	Kluet-3	ROR	NAD	23.8	194.0	12	103.40	11.6%	C	A	A	**C**			○
1009	Ramasan-1	RES	NAD	119.0	291.9	6	237.40	11.8%	C	A	B	**C**			△
1010	Sibubung-1	ROR	NAD	32.4	207.3	7	102.93	13.7%	C	A	A	**C**			○
1011	Seunangan-3	ROR	NAD	31.2	179.3	6	93.41	13.4%	C	A	A	**C**			○
1012	Teripa-4	RES	NAD	184.8	503.6	6	394.68	11.5%	C	B	B	**C**			△
1013	Teunom-3	RES	NAD	102.0	303.2	6	226.37	11.5%	C	A	B	**C**			△
1014	Meulaboh-2	ROR	NAD	37.0	212.5	6	123.74	11.7%	C	A	A	**C**			△
1015	Sibubung-3	ROR	NAD	22.6	144.9	7	87.26	10.8%	C	A	A	**C**			△
1016	Sirahar	ROR	Sumut	35.4	228.3	10	83.91	20.2%	A	A	A	**A**			×
1017	Ordi-1	ROR	Sumut	40.8	263.0	10	93.55	21.1%	C	A	A	**C**	PPA		×
1018	Simanggo-1	ROR	Sumut	44.4	285.8	10	106.27	20.0%	A	A	A	**A**	Operation		×
1019	Renun-3	ROR	Sumut	19.8	33.8	3	52.15	5.7%	A	A	A	**A**			×
1020	Kumbih-3	ROR	Sumut	41.8	269.6	10	105.52	18.7%	B	A	A	**B**			○
1021	Simanggo-2	ROR	Sumut	59.0	366.9	10	145.64	18.8%	A	A	A	**A**			○
1022	Raisan-1	ROR	Sumut	26.2	167.9	10	73.62	16.4%	C	A	A	**C**			○
1023	Gunung-2	ROR	Sumut	22.6	145.3	10	63.68	16.4%	A	A	A	**A**	PPA		×
1024	Toru-2	ROR	Sumut	33.6	237.1	12	102.29	16.2%	C	A	A	**C**			○
1025	Renun-6	ROR	Sumut	22.4	117.9	8	61.66	14.3%	A	A	A	**A**			×
1026	Sibundong-4	ROR	Sumut	31.6	203.6	10	92.94	15.6%	B	A	A	**B**			○
1027	Ordi-2	ROR	Sumut	26.8	172.8	10	82.25	14.8%	C	A	A	**C**	PPA		×
1028	Ordi-5	ROR	Sumut	26.8	173.7	10	79.46	15.5%	B	A	A	**B**			○
1029	Bila-2	ROR	Sumut	42.0	300.6	6	106.68	19.9%	C	A	A	**C**			○
1030	Ordi-3	ROR	Sumut	18.4	119.1	10	59.49	13.9%	B	A	A	**B**			○
1031	Silau-1	ROR	Sumut	27.4	147.9	7	72.56	15.0%	B	A	A	**B**	Operation		×
1032	Renun-4	ROR	Sumut	20.8	66.9	5	70.68	7.2%	A	A	A	**A**			×
1033	Siria	ROR	Sumut	16.5	105.8	10	59.61	12.1%	C	A	A	**C**			○
1034	Toru-3	RES	Sumut	227.6	516.1	6	413.90	12.7%	C	B	C	**C**			△△
1035	Sangir	ROR	Sumbar	41.8	331.7	12	102.71	23.0%	D	A	A	**D**			×
1036	Sinamar-2	ROR	Sumbar	25.6	217.1	12	83.58	16.9%	A	A	A	**A**	MOU		△
1037	Air Tuik	ROR	Sumbar	24.8	161.4	6	66.40	17.1%	D	A	A	**D**			×
1038	Sirantih-1	ROR	Sumbar	18.3	153.3	12	76.96	12.2%	D	A	A	**D**			×
1039	Batang Hari-4	RES	Sumbar	216.0	544.9	6	352.69	15.0%	C	B	C	**C**			△△
1040	Taratak Tumpatih-1	ROR	Sumbar	29.6	192.6	6	82.66	16.2%	D	A	A	**D**			×
1041	Sinamar-1	ROR	Sumbar	36.6	254.9	6	99.69	17.7%	A	A	A	**A**	MOU		△
1042	Masang-2	ROR	Sumbar	39.6	256.1	7	120.32	14.6%	B	A	A	**B**			○
1043	Gumanti-1	ROR	Sumbar	15.8	85.4	6	45.36	13.4%	A	A	A	**A**	MOU		△
1044	Anai-1	ROR	Sumbar	19.1	109.2	6	55.39	13.9%	A	A	A	**A**	MOU		△
1046	Kuantan-2	RES	Sumbar	272.4	734.1	6	467.03	14.7%	C	B	C	**C**			△△
1047	Rokan Kiri-1	RES	Sumbar	183.0	431.9	6	331.16	12.9%	B	B	D	**D**			×
1048	Mauna-1	ROR	Bengkulu	103.0	814.0	11	208.25	29.4%	A	A	A	**A**	Const.		×
1049	Langkup-2	ROR	Bengkulu	82.8	700.5	12	197.50	25.3%	D	A	A	**D**			×
1050	Merangin-4	RES	Jambi	182.0	491.9	6	314.94	14.5%	D	A	B	**D**			×
1051	Padang Guci-2	ROR	Bengkulu	21.0	145.1	8	70.56	13.7%	C	A	A	**C**	MOU		△
1052	Endikat-2	ROR	Sumsel	22.0	179.8	8	85.62	13.1%	A	A	A	**A**			○
1053	Semung-3	ROR	Lampung	20.8	146.9	6	70.45	13.6%	C	A	A	**C**			○
1054	Menula-2	ROR	Lampung	26.8	152.2	6	85.32	12.3%	D	A	A	**D**			×
1055	Tebo-2	ROR	Jambi	24.4	188.7	11	123.21	9.3%	D	A	A	**D**			×
[Kalimantan]															
1056	Melawi-9	RES	Kalbar	590.4	1,324.8	6	1,095.68	12.4%	B	A	D	**D**		less	×
1057	Mandai-5	RES	Kalbar	140.7	351.8	6	548.70	5.3%	B	A	C	**C**		less	×
1058	Boh-2	RES	Kaltim	1,119.6	3,299.2	6	1,832.65	16.3%	B	A	C	**C**		less	×
1059	Kelai-1	RES	Kaltim	952.8	2,106.4	6	1,532.14	14.4%	B	A	D	**D**		less	×

Working No.	Scheme Name	Type	Province	Installed Capacity (MW)	Annual Total Energy (GWh)	Peak Time (hrs)	Project Cost (2011US$)	Project EIRR	Forest Classification	Resettlement	Reservoir Area	**Environment**	**IPP**	**Demand**	**Evaluation**
1060	Sesayap-20	RES	Kaltim	949.2	2,633.3	6	1,656.91	14.7%	A	A	C	**C**		less	×
1061	Sesayap-11	RES	Kaltim	624.0	2,035.3	6	1,399.66	12.1%	D	A	B	**D**		less	×
1062	Sembakung-3	RES	Kaltim	572.4	1,268.3	6	1,444.74	8.7%	A	B	D	**D**		less	×
1063	Sesayap-15	RES	Kaltim	313.2	956.7	6	848.89	9.4%	B	A	C	**C**		less	×
1064	Telen	RES	Kaltim	193.2	544.4	6	552.85	8.4%	B	A	C	**C**		less	×
[Sulawesi]															
1065	Poso-2	ROR	Sulteng	132.8	1,125.4	12	208.93	43.6%	A	A	A	**A**	Const.		○
1066	Poso-1	ROR	Sulteng	204.0	1,341.0	6	300.61	37.6%	A	A	A	**A**	Const.		○
1067	Lariang-7	RES	Sulteng	618.0	1,489.6	6	896.58	16.8%	C	A	C	**C**			△△
1068	Lariang-6	RES	Sulteng	209.4	616.2	6	382.13	14.3%	C	A	B	**C**			△
1069	Bone-3	ROR	Sulut	20.4	148.3	10	78.67	12.2%	D	A	A	**D**			×
1070	Bongka-2	RES	Sulteng	187.2	451.3	6	407.24	10.6%	B	A	C	**C**			△
1071	Solato-1	ROR	Sulteng	26.6	176.1	6	110.53	10.0%	D	A	A	**D**			×
1072	Lariang-8	ROR	Sulteng	12.8	85.4	6	59.48	8.7%	C	A	A	**C**			×
1073	Karama-2	RES	Sulbar	762.3	1,796.1	6	983.86	18.9%	C	B	C	**C**			△△
1075	Karama-1	RES	Sulbar	800.0	2,147.1	6	1,481.11	13.5%	C	A	B	**C**			△
1076	Masuni	RES	Sulsel	400.2	930.2	6	714.01	13.1%	B	A	C	**C**			△
1077	Mong	RES	Sulsel	255.6	618.9	6	474.22	12.8%	A	B	C	**C**			△
1079	Watunohu-1	ROR	Sultra	57.0	309.0	3	142.29	15.6%	C	A	A	**C**			○
1080	Lalindu-1	RES	Sultra	193.6	544.1	6	472.50	10.1%	B	A	C	**C**			△
1081	Pongkeru-3	RES	Sulsel	227.6	556.6	6	562.06	9.3%	B	A	C	**C**			×
[Maluku]															
1082	Mala-2	ROR	Maluku	30.4	209.0	6	73.15	20.5%	C	A	A	**C**			○
1083	Mala-1	RES	Maluku	27.8	65.4	6	92.83	6.1%	C	A	C	**C**			×
[Papua]															
1086	Warasai	ROR	Papua	231.9	1,314.0	6	326.35	35.0%	D	A	B	**D**		less	×
1087	Jawee-4	ROR	Papua	152.6	1,308.6	12	366.95	25.4%	C	A	A	**C**		less	×
1088	Derewo-7	ROR	Papua	148.8	1,180.5	11	339.26	25.3%	C	A	A	**C**		less	×
1089	Jawee-3	ROR	Papua	147.2	1,163.6	8	373.19	21.9%	C	A	A	**C**		less	×
1090	Endere-1	ROR	Papua	144.8	1,033.5	6	323.76	23.5%	C	A	A	**C**		less	×
1091	Endere-2	ROR	Papua	87.0	727.8	10	280.16	17.0%	C	A	A	**C**		less	×
1092	Derewo-6	ROR	Papua	170.0	1,128.4	7	502.18	15.5%	C	A	A	**C**		less	×
1093	Jawee-2	ROR	Papua	94.2	755.9	8	351.39	13.7%	C	A	A	**C**		less	×
1094	Baliem-7	ROR	Papua	97.8	834.7	12	479.85	10.3%	C	A	A	**C**		less	×
1095	Baliem-5	ROR	Papua	189.2	1,401.4	6	670.06	13.5%	B	A	A	**B**		less	×
1096	Waryori-4	ROR	Papua	94.2	598.8	3	249.43	16.8%	C	A	A	**C**		less	×
1097	Ulawa	ROR	Papua	34.6	194.6	6	110.98	12.1%	D	A	A	**D**			×
1098	Gita/Ransiki-1	LOT	Papua	56.2	136.2	6	142.03	8.9%	C	A	C	**C**		less	×
1099	Baliem-6	ROR	Papua	88.2	754.2	11	472.23	9.3%	B	A	A	**B**		less	×
1100	Kladuk-2	RES	Papua	229.0	567.4	6	503.95	10.7%	B	B	C	**C**		less	×
1101	Titinima-3	ROR	Papua	55.6	402.2	6	234.33	10.7%	C	A	A	**C**		less	×
1102	Maredrer	ROR	Papua	8.7	62.4	6	39.27	9.6%	A	A	A	**A**		less	×
1103	Muturi-1	ROR	Papua	45.8	288.3	3	164.16	11.3%	B	A	A	**B**		less	×
1104	Siewa-1	ROR	Papua	58.4	330.5	6	246.76	8.7%	C	A	A	**C**		less	×
1105	Baliem-8	ROR	Papua	138.4	1,007.0	6	664.01	9.2%	C	A	A	**C**		less	×
[Nusa Tenggara]															
1106	Parainglala	ROR	NTT	14.9	85.6	7	43.82	13.8%	D	A	A	**D**			×
1108	Watupanggantu	ROR	NTT	7.1	40.5	7	26.92	10.0%	A	A	A	**A**			×
1109	Karendi-1	RES	NTT	21.4	49.5	6	57.60	7.9%	A	B	B	**B**			×
[Java-Bali]															
1110	Teldewaja	ROR	Bali	7.0	44.2	11	36.48	7.8%	A	A	A	A			×
1115	Cibareno-1	ROR	Jabar	17.5	117.0	6	64.10	11.8%	A	A	A	**A**			○
1116	Cimandiri-1	ROR	Jabar	24.4	167.5	6	98.87	10.7%	A	A	A	**A**			×

Note) Sirahar scheme (No. 1016) in Sumatra and Cimandiri scheme (No. 1116) in Java-Bali are evaluated as "×" based on more detailed examination described in Chapter 9.

Source: JICA Study Team

(3) Ongoing and planned projects

The results of evaluation for ongoing and planned schemes for which DD, F/S or pre-FS has been conducted, are listed in Table 7.3.6. Out of 61 schemes in this category, 24 schemes with the total capacity of 2,926.0 MW have passed the screening. 25 schemes were screened out by the environmental reason, 23 schemes by economic reason, and 2 schemes by the interference with IPP.

Among the projects screened out, Kelai-2 (Kelai), Pinoh (Nanga Pinoh) which have too large reservoirs, in Kalimantan, and Jatigede which would bring about too much resettlement, in Java-Bali were brought back to the master plan since they were scheduled in the latest RUPTL, and their defect did not seem to be fatal for their development. However, we made Kusan-3 scheme which was also listed in RUPTL, remain being discarded, due to its low economy and a fatal environmental defect found in another JICA study.

Table 7.3.6 Evaluation of ongoing and planned projects

Working No.	Scheme Name	Type	Province	Installed Capacity (MW)	Annual Total Energy (GWh)	Peak Time (hrs)	Project Cost (2011US$)	Project EIRR	Forest Classification	Resettlement	Reservoir Area	**Environment**	**IPP**	**Demand**	**Evaluation**
[Sumatra]															
3001	Merangin-2	ROR	Jambi	350.0	1,464.5	6	559.87	23.3%	A	A	A	**A**			○
3002	Tampur-1	RES	NAD	330.0	1,067.0	6	668.16	13.5%	C	A	C	**C**			△△
3003	Jambu Aye-8	RES	NAD	160.0	650.0	11	502.23	10.9%	A	B	D	**D**			×
3004	Wampu	ROR	Sumut	84.0	475.3	7.5	147.52	26.3%	C	A	A	C			○
3005	Ketaun-1	RES	Bengkulu	84.0	308.1	4	148.79	16.3%	D	C	B	**D**			×
3006	Ranau	LOT	Sumsel	60.0	146.0	5	264.06	3.7%	A	A	A	**D***			×
3007	Teunom-1	RES	NAD	24.3	212.4	12	115.63	10.1%	C	A	B	**C**			△
3008	Aceh-2	RES	NAD	7.3	64.3	12	65.26	4.2%	A	A	A	**A**			×
3009	Peusangan-4	ROR	NAD	30.9	234.2	10.5	64.59	27.2%	A	A	A	**A**			○
3010	Lawe Alas-4	RES	NAD	322.0	1,549.1	12	549.07	22.0%	D	B	C	**D**			×
3011	Toru-1	ROR	Sumut	38.4	308.1	24	73.36	31.2%	A	A	A	**A**	PPA		×
3012	Merangin-5	RES	Jambi	23.9	196.8	12	92.02	12.5%	A	B	C	**C**			△
3013	Bayang-1	ROR	Sumbar	13.2	71.3	2.5	51.10	8.8%	D	A	A	**D**			×
3014	Bayang-2	ROR	Sumbar	30.9	202.7	6.5	61.40	25.4%	D	A	A	**D**			×
3015	Lamatang-4	RES	Sumsel	12.2	106.5	12	171.11	--	A	B	B	**B**			×
1045	Masang-3	RES	Sumbar	88.6	326.3	6	188.23	13.7%	D	A	B	**D**			×
	Besai-2	ROR	Lampung	44.0	160.0	4	100.00	13.0%	C	A	A	**C**			○
[Kalimantan]															
3035	Riam Kiwa	RES	Kalsel	42.0	151.6	7.5	247.98	3.7%	A	D	D	**D**			×
3036	Kusan-3	RES	Kalsel	68.0	100.5	3.5	156.89	6.7%	C	A	C	**D***			×
3037	Pade Kembayung	RES	Kalbar	30.0	235.0	12	336.17	--	D	A	B	**D**			×
3038	Kelai-2	RES	Kaltim	168.0	1,102.9	12	331.69	22.6%	A	A	D	**D**			×
3039	Amandit-2	RES	Kalsel	2.5	20.1	12	39.96	--	B	C	B	**C**			×
3040	Kayan-2	RES	Kaltim	500.0	3,832.5	11.5	588.12	42.9%	C	D	D	**D**			×
3041	Pinoh	RES	Kalbar	198.0	1,374.8	17.5	602.91	16.1%	A	A	D	**D**			×
3042	Silat	RES	Kalbar	29.0	129.5	11.5	165.41	5.7%	A	D	D	**D**			×
[Sulawesi]															
3016	Bakaru (2nd)	ROR	Sulsel	126.0	471.0	10	184.16	24.9%	A	A	A	**A**			○
3017	Lasolo-4	RES	Sulteng	100.0	770.0	21	232.00	22.8%	C	B	C	**C**			△△
3018	Palu-3	LOT	Sulteng	75.0	510.0	15.5	121.80	28.4%	D	B	A	**D**			×
3019	Poko	RES	Sulsel	233.0	760.0	5	350.28	18.6%	B	B	B	**B**			○
3020	Malea	ROR	Sulsel	182.0	1,477.0	12	298.73	39.6%	A	A	A	**A**			○
3021	Konaweha-3	RES	Sulteng	24.0	116.0	12	55.68	16.3%	C	C	C	**C**			△△
3022	Poigar-3	ROR	Sulut	14.0	98.6	6.5	33.49	21.3%	D	A	A	**D**			×
3023	Batu	RES	Sulsel	271.0	1,740.2	12	563.96	21.1%	C	B	C	**C**			△△
1074	Tamboli	ROR	Sultra	25.8	158.9	6	47.79	26.3%	C	A	A	**C**			○

Working No.	Scheme Name	Type	Province	Installed Capacity (MW)	Annual Total Energy (GWh)	Peak Time (hrs)	Project Cost (2011US$)	Project EIRR	Forest Classification	Resettlement	Reservoir Area	**Environment**	**IPP**	**Demand**	**Evaluation**
	Sawangan	ROR	Sulut	16.0	73.5	8	26.01	24.8%	A	A	A	**A**			○
[Maluku]															
3050	Isal-2	RES	Maluku	60.0	447.0	18	116.09	25.6%	C	A	B	**C**			△
3051	Lamo-1	RES	Maluku	5.7	25.0	3.5	13.22	13.3%	-	-	-				×
1084	Tala	RES	Maluku	54.0	167.0	6	118.61	12.0%	B	B	C	**C**			△
1085	Tina	ROR	Maluku	12.0	49.3	6	33.83	11.3%	B	A	A	**B**			○
	Talawi	RES	Maluku	7.5	26.4	6	39.08	4.1%							×
[Papua]															
3052	Warsamson	RES	Papua	49.0	248.0	8.5	153.70	11.3%	B	A	C	**C**			△
[Nusa Tenggara]															
3046	Beburung	ROR	NTB	22.0	90.6	11	55.94	14.6%	D	A	A	**D**			×
3047	Putih-1	ROR	NTB	5.6	29.0	6.5	20.87	9.5%	-	-	-				×
3048	Putih-2	ROR	NTB	4.1	22.0	6.5	15.28	9.8%	-	-	-				×
3049	Putih-3	ROR	NTB	6.1	32.0	7.5	22.73	9.8%	-	-	-				×
1111	Kambera-2	RES	NTT	17.0	65.2	6	52.84	9.1%	A	B	B	**B**			×
1112	Wai Ranjang	ROR	NTT	11.1	59.4	4	32.60	12.7%	C	A	A	**C**			○
	Sitoto	RES	NTT	15.2	46.5	5.5	118.54	--	C	A	B	**C**			×
[Java-Bali]															
3024	Maung	RES	Jateng	360.0	534.9	3.5	593.41	10.5%	A	C	B	**C**			△△
3025	Rajamandala	ROR	Jabar	58.0	215.9	6	134.56	13.5%	A	B	B	**B**			○
3026	Jatigede	RES	Jabar	175.0	777.0	12	406.00	15.8%	A	D	C	**D**			×
3027	Cibuni-3	RES	Jabar	172.0	568.0	6	421.39	11.0%	A	D	C	**D**			×
3028	Cipasang	RES	Jabar	400.0	751.1	4	559.58	14.7%	A	D	C	**D**			×
3029	Cimandiri-3	RES	Jabar	238.0	600.0	5	406.67	13.9%	A	D	C	**D**			×
3030	Gintung	RES	Jateng	19.0	81.4	6	133.34	2.7%	A	D	C	**D**			×
3031	Rawalo-1	LHD	Jateng	0.6	5.2	13	3.52	7.7%	A	A	B	**B**			×
3032	Cibuni-4	RES	Jabar	71.0	207.3	6	136.80	13.5%	A	C	B	**C**	Const.		×
3033	Cikaso-3	RES	Jabar	30.0	188.9	6	174.35	5.8%	A	A	B	**B**			×
3034	Grindulu-2	RES	Jateng	16.0	51.3	6	96.79	2.7%	A	D	B	**D**			×
3043	Ayung-1 (Sidan)	ROR	Bali	23.0	68.0	6	76.46	7.4%	A	A	A	**D***			×
3044	Ayung-2 (Selat)	ROR	Bali	19.0	51.6	6	53.51	8.8%	A	A	A	**D***			×
3045	Ayung-3 (Buangga)	LHD	Bali	1.8	12.1	15	24.01	--	A	A	A	**D***			×
1113	Kesamben	LHD	Jatim	37.0	60.0	3.5	96.06	5.9%	A	B	A	**B**			×

Source: JICA Study Team

(4) Other projects

Other than the schemes examined above, the following hydro schemes were taken into the master plan.

i) Pumped storage

Besides the conventional hydropower projects, pumped storage projects are planned in Java-Bali system, and also the necessity of PS in Sumatra is under discussion, from the system requirement. Among the candidate projects listed in Table 7.3.7, Upper Cisokan project is approaching the construction stage, which will be commenced in 2014 according to RUPTL. RUPTL also listed Matenggeng project (aka Cijulang PS-2 in HPPS2) and Grindulu project, which are expected to start operation in 2017/18 and 2018/19 respectively. Other than those projects listed in RUPTL, Kali Konto project was examined, corresponding to the Java-Bali system expansion up to 2027.

In Sumatra, although there is no description about pumped storage in RUPTL, PLN has started discussion considering the expansion of total system capacity and the base load capacity resulting from the promotion of coal thermal and geothermal power plants prescribed in the two fast track programmes. Generally, diversion of a natural lake for a lower pond promises economic benefit, and there are some potential sites in Sumatra in accordance with the condition. Taking the total system capacity and other generation options in 2019 and 2027 into account, one pumped storage project was examined which would utilize Toba lake (*Danau Toba*) as the lower pondage located in North Sumatra.

ii) Extension of existing plants

Another JICA Study[4] which formulated optimal rehabilitation plan for the existing hydropower stations, recommended a rehabilitation and extension project for the existing Karankates (Sutami) hydro power station, and the project, which was likely to have no environmental concern, were taken into consideration in the master plan.

iii) Modification of scheme

The Bonto Batu scheme in South Sulawesi was originally planned as a reservoir type one with the capacity of 228 MW in the HPPS2, however it was modified to run of the river type scheme in order to promote the implementation taking past successful examples in Asahan -3 scheme and others into consideration. While the capacity was shrunk to 100 MW, the energy production remain the same level, and environmental impacts are mitigated to acceptable level.

Table 7.3.7 Evaluation of pumped storage and other projects

Working No.	Scheme Name	Type	Province	Installed Capacity (MW)	Annual Total Energy (GWh)	Peak Time (hrs)	Project Cost (2011US$)	Project EIRR	Forest Classification	Resettlement	Reservoir Area	**Environment**	**IPP**	**Demand**	**Evaluation**
[PUMPED STORAGE]															
6001	Matenggeng (Cijulang PS-2)	PST	Jabar	887	1,062.0	3.28	611.09		B	B	B	B			○
6002	Cibuni-PS-1	PST	Jabar	1,000	905.2	2.48	726.57		A	B	B	B			
6003	Upper Cisokan-PS	PST	Jabar	1,000											
6004	Cibareno-PS-2	PST	Jabar	1,000	905.2	2.48	736.78		D	B	B	D			
6005	Cikalong-PS	PST	Jabar	1,000	905.2	2.48	743.56		A	B	B	B			
6006	Klegung-PS	PST	Jateng	1,000	905.2	2.48	715.48		A	A	A	A			
6007	Dolok-PS	PST	Jateng	1,000	905.2	2.48	711.47		C	A	A	C			
6008	Laban-PS	PST	Jateng	1,000	905.2	2.48	718.95		A	B	B	B			
6009	Grindulu-PS-3	PST	Jatim	1,000	905.2	2.48	724.00		A	B	B	B			○
6010	K. Konto-PS	PST	Jatim	1,000	905.2	2.48	719.98		B	A	A	B			○
	Lake Toba	PST	Sumut	400					C	A	A	C			○
[EXPANSION OF THE EXISTING POWER PLANT]															
	Karangkates Ext.	RES	Jateng	100.0	164.6	4.5	112.89		A	A	A	**A**			○
[MODIFICATION OF RESERVOIR SCHEME TO RUN-OF-RIVER SCHEME]															
1078	Bonto Batu	ROR	Sulsel	100.0	578.0	4			C	A	A	A			○

Source: JICA Study Team

iv) Other projects in RUPTL

Most of the hydro projects listed in RUPTL are overlapped with the ongoing and planned projects listed in Table 7.1.9. However, there are several projects listed in Table 7.3.8, which are not covered

4 "Study for Rehabilitation of Hydropower Stations in Indonesia", 2010.

in the previous study. We took such projects into consideration along with the specification described in RUPTL, as in Table 7.3.8.

Table 7.3.8 Other hydro projects listed in RUPTL

No	Scheme Name	Type	Region	Province	Developer	Installed Capacity (MW)	Year of Operation
1	Peusangan 1-2*	ROR	Sumatra	NAD	PLN	86.0	2013→2015
2	Asahan 3*	ROR	Sumatra	Sumut	PLN	174.0	2013→2015
3	Lawe Mamas	ROR	Sumatra	NAD	IPP	50.0	2016/17
4	Asahan 4-5	RES	Sumatra	Sumut	IPP	60.0	2016
5	Simpang Aur	ROR	Sumatra	Bengkulu	IPP	29.0	2014
6	Konawe	RES	Sulawesi	Sultra	PLN	50.0	2016/17
7	Lalindu	RES	Sulawesi	Sultra	PLN	100.0	--
8	Randangan		Sulawesi	Gorontalo	IPP	20.0	2015
9	Kalikonto-2		Java-Bali	E. Jawa	PLN	62.0	2016

Note) "Year of operation" of Peusangan and Asahan schemes are modified according to the actual project progress by the Study Team.

Source: RUPTL 2010-2019, PT PLN (Perseero).

(5) Summary

In conclusion, the results of screening of candidate schemes were summarized in Table 7.3.9. Compared to Table 7.1.11 which indicates the maximum capability considering hydro potential and power demand, 70 schemes with the capacity of 9,133 MW in total have passed the screening out of 16,108 MW capability as of 2027, which yields 56.7 percent of total potential, or 60.8 percent together with the other projects. Among the projects which have passed the 3rd screening in HPPS2, 46 projects with 6,206 MW capacity have passed the screening out of 10,151 MW capability, yielding 61.1 percent, and among ongoing and planned projects, 24 projects with 2,926 MW capacity which is bit larger than 2,652 MW placed in RUPTL, have passed the screening out of 5,956 MW capability, yielding 49.1 percent.

Table 7.3.9 Summary of screening results

	HPPS2			Ongoing & Planned			Pumped Storage		Others		Total		
	Loc	Capacity (MW)	Energy (GWh)	Loc	Capacity (MW)	Energy (GWh)	Loc	Capacity (MW)	Loc	Capacity (MW)	Loc	Capacity (MW)	
												incl. PS	excl. PS
Sumatra	33	2,346.3	9,139.6	6	803.1	3,334.9	1	400.0	5	399.0	45	3,948.4	3,548.4
Kalimantan	--	--	--	2	366.0	2,477.7	--	--	--	--	2	366.0	366.0
Sulawesi	11	3,820.1	11,368.9	8	977.8	5,566.6	--	--	1	100.0	20	4,897.9	4,897.9
Maluku	1	30.4	209.0	3	126.0	663.2	--	--	--	--	4	156.4	156.4
Papua	--	--	--	1	49.0	248.0	--	--	--	--	1	49.0	49.0
Nusa Tenggara	--	--	--	1	11.1	59.4	--	--	--	--	1	11.1	11.1
Java-Bali	1	17.5	117.0	3	593.0	1,527.8	4	3,887.0	2	162.0	10	4,659.5	772.5
Total	46	6,214.3	20,834.5	24	2,926.0	13,877.6	5	4,287.0	8	661.0	83	14,088.3	9,801.3

7.4 INSPECTION OF DEVELOPMENT SCHENARIOS

7.4.1 HYDRO DEVELOPMENT ALONG EACH SCENARIO

(1) Policy Oriented Scenario

In this scenario, all the hydro schemes listed in Table 7.1.8 and Table 7.1.9 were taken into account to meet the energy policies' requirement, as stated in Section 7.2. However, unnecessary or inadequate hydro development should be avoided for the sake of saving of natural resource and finance. In this context, we adjusted the capacity to be developed in Kalimantan, Sulawesi, and Papua, consistent with the system demand and other generation options.

Table 7.4.1 Hydro development in Policy Oriented Scenario

Region	HPPS2				Ongoing & Planned				Total*			
	Loc	Capacity (MW)	Energy (GWh)	Capital Cost (mil. $)	Loc	Capacity (MW)	Energy (GWh)	Capital Cost (mil. $)	Loc	Capacity (MW)	Energy (GWh)	Capital Cost (mil. $)
Sumatra	53	3,394	14,672	7,583	17	1,704	7,543	3,822	76	5,496	23,962	12,203
Kalimantan	4	2,575	7,434	4,891	8	1,038	6,947	2,469	12	3,613	14,380	7,360
Sulawesi	7	2,059	7,088	3,703	10	1,067	6,175	1,914	18	3,226	13,841	5,817
Maluku	2	58	274	166	5	139	715	321	7	197	989	487
Papua	5	225	1,220	827	1	49	248	154	6	274	1,468	980
Nusa Tenggara	3	43	176	128	7	81	345	319	10	125	520	447
Java-Bali	3	49	329	199	15	1,620	4,173	3,317	20	1,831	4,938	3,753
Total	**77**	**8,403**	**31,192**	**17,498**	**63**	**5,698**	**26,145**	**12,315**	**149**	**14,762**	**60,098**	**31,048**

* Total amounts include those of other projects indicated in Table 7.3.9.

(2) Realistic Scenario

In this scenario, hydro projects summarized in Table 7.3.9 were considered, but four projects with less priority in Sulawesi where required capacity (3,004 MW) in the power system is less than the screened capacity (4,897 MW).

Table 7.4.2 Hydro development in Realistic Scenario

Region	HPPS2				Ongoing & Planned				Total*			
	Loc	Capacity (MW)	Energy (GWh)	Capital Cost (mil. $)	Loc	Capacity (MW)	Energy (GWh)	Capital Cost (mil. $)	Loc	Capacity (MW)	Energy (GWh)	Capital Cost (mil. $)
Sumatra	33	2,346	9,140	5,112	6	803	3,335	1,600	44	3,548	14,222	7,510
Kalimantan	--	--	--	--	2	366	2,478	935	2	366	2,478	935
Sulawesi	7	2,059	7,088	3,703	8	978	5,567	1,759	16	3,137	13,232	5,662
Maluku	1	30	209	73	3	126	663	269	4	156	872	342
Papua	--	--	--	--	1	49	248	154	1	49	248	154
Nusa Tenggara	--	--	--	--	1	11	59	33	1	11	59	33
Java-Bali	1	18	117	64	3	593	1,528	1,134	6	773	2,081	1,435
Total	**42**	**4,453**	**16,553**	**8,952**	**24**	**2,926**	**13,878**	**5,882**	**74**	**8,040**	**33,193**	**16,070**

* Total amounts include those of other projects indicated in Table 7.3.9.

Less amount compared to Table 7.4.1 were made up for by coal thermal generation (PLTU) and gas-turbine generation (PLTG), and the following assumptions are used for estimation of alternative generation presented in Table 7.4.3.

- Base load (off-peak load) by PLTU (coal) with 80 percent of capacity factor;

- Peak load by PLTG with the capacity, conforming to the total hydro capacity from which are subtracted the capacity of PLTU above; and

- Unit capital cost: US$ 1,300/kW for PLTU, and US$ 600/kW for PLTG; in reference to RUPTL 2009-2018[5].

Table 7.4.3 Alternative generation for 'Realistic Scenario'

Region	Capacity (MW)	Annual Energy			PLTU			PLTG		
		Energy (GWh)	Peak (GWh)	Off-peak (GWh)	Cap. (MW)	CF (%)	Invest. (mil $)	Cap. (MW)	CF (%)	Invest. (mil $)
Sumatra	1,948	9,740	6,542	3,556	476	80	619	1,472	49.7	883
Kalimantan	3,247	11,903	8,204	3,698	528		686	2,719	34.4	1,631
Sulawesi	89	609	458	151	22		28	67	77.4	40
Maluku	41	117	85	32	5		6	36	29.3	22
Papua	225	1,220	442	778	111		144	114	44.4	68
Nusa Tenggara	113	461	299	162	23		30	90	37.8	54
Java-Bali	1,059	2,857	1,926	930	133		173	926	23.7	556
Total	**6,721**	**26,905**	**17,817**	**9,089**	**1,297**	**80**	**1,686**	**5,425**	**37.5**	**3,255**

(3) Zero Option

In this scenario, all of the energy which hydro generation is expected to bear, has to be compensated by alternative generation. Based on the same assumptions as taken for the realistic scenario, the amounts of alternative generation are calculated in Table 7.4.4.

Table 7.4.4 Alternative generation for 'Zero Option'

Region	Capacity (MW)	Annual Energy			PLTU			PLTG		
		Total (GWh)	Peak (GWh)	Off-peak (GWh)	Cap. (MW)	CF (%)	Invest. (mil $)	Cap. (MW)	CF (%)	Invest. (mil $)
Sumatra	5,496	23,962	14,939	9,023	1,288	80	1,674	4,209	40.5	2,525
Kalimantan	3,613	14,380	10,205	4,176	596		775	3,017	38.6	1,810
Sulawesi	3,226	13,841	9,185	4,656	664		864	2,561	40.9	1,537
Maluku	197	989	690	299	43		55	155	50.9	93
Papua	274	1,468	594	874	125		162	149	45.5	89
Nusa Tenggara	125	520	315	205	29		38	95	37.8	57
Java-Bali	1,831	4,938	3,618	1,320	188		245	1,643	25.1	986
Total	**14,762**	**60,098**	**39,546**	**20,552**	**2,933**	**80**	**3,812**	**11,829**	**38.2**	**7,097**

7.4.2 COMPARISON AMONG SCENARIOS

Table 7.4.5 summarizes the comparison among the three scenarios in terms of policy consistency, economical and financial aspects, and social and natural environmental aspects. Policy Oriented Scenario was taken as the base scenario in which capacity (14,762 MW) and energy production (60,098 GWh p.a.) by hydropower generation are the basis for the evaluation of alternative generation and accompanying issues such as capital requirement, CO_2 and other emissions, etc. Hence, it should be noted that the table does illustrate the partial picture focused in this study.

[5] There figures are not found in the latest version, RUPTL 2010-2019.

Table 7.4.5 Comparative Table among development scenarios

Item		Policy Oriented Scenario		Realistic Scenario		Zero Option	
Generation indicators	(1) Hydro Capacity to be developed	-	14,762 MW at 149 locations (19,100 MW in total)	-	8,040 MW at 74 locations (12,378 MW in total)	-	Nil (4,338 MW in total)
	(2) Hydro energy production	-	60,098 GWh p.a.	-	33,193 GWh p.a.	-	Nil
	(3) Alternative generation	-	Nil.	-	PLTU: 1,297 MW PLTG: 5,425 MW	-	PLTU: 2,933 MW PLTG:11,829 MW
Policy consistency	(4) Consistency with Energy Policies	○	Nearly equivalent to the target in KEN.	△	Miss the target by half.	×	Miss the target widely.
	(5) Utilization of indigenous energy	○	100 % renewable and indigenous energy.	△	Fossil fuels are indigenous, but unevenly distributed. Expensive and imported oil will be required for PLTG in the region with no gas supply.	×	Fossil fuels are indigenous, but unevenly distributed. Expensive and imported oil will be required for PLTG in the region with no gas supply.
Economic and Financial Aspects	(6) Require capital for hydro development	×	$ 31.0 billion (2011US$)	△	$ 16.1 billion (2011US$)	○	Nil
	(7) Total capital investment	×	$ 31.0 billion (2011 US$)	△	$ 21.0 billion (2011 US$)	○	$ 10.9 billion (2011 US$)
	(8) Economic efficiency	○	Expected high percentage of local procurement in civil works.	△	Relatively high percentage of local procurement.	×	Low percentage of local procurement.
	(9) Uncertainty of operating cost	○	Almost no influence by the change of fuel price.	△	PLTG will be vulnerable to the change of fuel prices, particularly in the region with no gas supply.	×	PLTG will be vulnerable to the change of fuel prices, particularly in the region with no gas supply.
Social and Natural Environmental Aspects	(10) Involuntary resettlement	×	46,000 HHs	△	2,500 HHs	○	Can be nil.
	(11) Local economy such as employment and livelihood	○	Contribution to creating jobs mostly in poverty areas	△	Contribution to creating jobs in poverty areas	×	Contribution to creating jobs mostly in urban area
	(12) Land use and utilization of local resources	× ×	Projects located in protected areas: 20 Nos. Inundated Area: 298,000 ha	○ △	Projects located in protected areas: Nil. Inundated Area: 114,000 ha	○ ○	Projects located in protected areas: Nil. Inundated Area: Nil.
	(13) Air pollution as of 2027	○	SOx: Nil NOx: Nil	△	SOx: 18,177 tons/year NOx: 118,383 tons/year	×	SOx: 41,104 tons/year NOx: 264,431 tons/year
	(14) Global warming as of 2027	○	CO_2 emission: Nil	△	CO_2 emission: 16.6 MT/year	×	CO_2 emission: 37.1 MT/year

Legend) ○: favorable, △: neutral or medium, and ×: unfavorable

7.4.3 CONCLUSION

Each scenario has advantages and disadvantages derived from the characteristics of hydropower generation, and it is difficult to weigh such advantages and disadvantages in a balance. In this background, realistic scenario is well-balanced, and remarkably the number of involuntary resettlement, the number of projects violating protected area, which are selected as screening criteria in this study, are well managed unproportional to the amount of hydro development, while other items are almost proportional to them. Consequently, we took realistic scenario as the recommendable scenario, and further discussion were conducted on the basis of realistic scenario in the following parts.

7.5 HYDRO DEVELOPMENT MASTER PLAN

7.5.1 BASIC POLICIES ON FORMULATING MASTER PLAN

(1) Preparation and construction term

The development of hydropower will generally relatively longer period, and also require preparation period for studies such as pre F/S, F/S, and D/D, since the development of hydropower generation is heavily dependent upon natural conditions of the site such as geological, meteorological ones, and requires deliberate consideration on social and natural environmental issues. For this reason, we took, in principle, the following terms for preparation and construction reviewing the past experience:

i) Pre F/S, F/S, and D/D: 1 year respectively,

ii) Financing: 1 year after F/S is completed,

iii) Bidding: 1 year after D/D is completed, and;

iv) Construction: 4 years for run of the river (ROR) type, and
5 years for reservoir (RES) type.

(2) Projects during the period covered by RUPTL

PT PLN (Persero), in principle, places the projects for which pre-F/S has been conducted at least, to secure the reliability of its business plan (RUPTL). We also followed the same rule, which is almost consistent with the above principle regarding project terms; that is to say, it will take at least 9 years to realize the projects for which no study has been conducted so far.

(3) Arrangement of candidate projects

According to the priority in the descendent order of A, B, and C, the screened schemes are arranged in each region, making the amount of capacity commenced in each year equal as much as possible.

7.5.2 HYDRO DEVELOPMENT PLAN

Hydro development plan along with the formulation policies are shown in Table 7.5.1 and Table 7.5.2.

It is noted that this plan shall not be regarded as "definitive", but shall be used as a guide for preparation of the projects. It is possible that some of the projects among this will be discarded as a result of further detailed project examination.

Table 7.5.1 Hydro Development Master Plan (1)

Working No.	Scheme Name	Type	Region	Province	Installed Capacity	Implementation Schedule																																				Remark
					(MW)	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		2023		2024		2025		2026		2027		2028		
CONVENTIONAL HYDROPOWER SCHEMES which passed the 3rd Screening in HPPS2																																										
1002	Jambo Papeun-3	ROR	Sumatra	NAD	25.4	Pre FS		FS		Financing		DD		Bidding		Construction							25																			
1003	Woyla-2	RES	Sumatra	NAD	242.1									Pre FS		FS		Financing		DD		Bidding		Construction									242									
1005	Teunom-2	RES	Sumatra	NAD	230.0													Pre FS		FS		Financing		DD		Bidding		Construction									230					
1006	Kluet-1	ROR	Sumatra	NAD	40.6	Pre FS		FS		Financing		DD		Bidding		Construction							41																			
1007	Meulaboh-5	ROR	Sumatra	NAD	43.0	Pre FS		FS		Financing		DD		Bidding		Construction							43																			
1008	Kluet-3	ROR	Sumatra	NAD	23.8					Pre FS		FS		Financing		DD		Bidding		Construction							24															
1009	Ramasan-1	RES	Sumatra	NAD	119.0									Pre FS		FS		Financing		DD		Bidding		Construction									119									
1010	Sibubung-1	ROR	Sumatra	NAD	32.4					Pre FS		FS		Financing		DD		Bidding		Construction							32															
1011	Seunangan-3	ROR	Sumatra	NAD	31.2					Pre FS		FS		Financing		DD		Bidding		Construction							31															
1012	Teripa-4	RES	Sumatra	NAD	184.8									Pre FS		FS		Financing		DD		Bidding		Construction									185									
1013	Teunom-3	RES	Sumatra	NAD	102.0									Pre FS		FS		Financing		DD		Bidding		Construction									102									
1014	Meulaboh-2	ROR	Sumatra	NAD	37.0													Pre FS		FS		Financing		DD		Bidding		Construction									37					
1015	Sibubung-3	ROR	Sumatra	NAD	22.6													Pre FS		FS		Financing		DD		Bidding		Construction									23					
1020	Kumbih-3	ROR	Sumatra	N. Sumatra	41.8	Pre FS		FS		Financing		DD		Bidding		Construction							42																			
1021	Simanggo-2	ROR	Sumatra	N. Sumatra	59.0	FS		Financing		DD		Bidding		Construction							59																					
1022	Raisan-1	ROR	Sumatra	N. Sumatra	26.2			Pre FS		FS		Financing		DD		Bidding		Construction							26																	
1024	Toru-2	ROR	Sumatra	N. Sumatra	33.6			Pre FS		FS		Financing		DD		Bidding		Construction							34																	
1026	Sibundong-4	ROR	Sumatra	N. Sumatra	31.6	Pre FS		FS		Financing		DD		Bidding		Construction							32																			
1028	Ordi-5	ROR	Sumatra	N. Sumatra	26.8			Pre FS		FS		Financing		DD		Bidding		Construction							27																	
1029	Bila-2	ROR	Sumatra	N. Sumatra	42.0	Pre FS		FS		Financing		DD		Bidding		Construction							42																			
1030	Ordi-3	ROR	Sumatra	N. Sumatra	18.4			Pre FS		FS		Financing		DD		Bidding		Construction							18																	
1033	Siria	ROR	Sumatra	N. Sumatra	16.5			Pre FS		FS		Financing		DD		Bidding		Construction							17																	
1034	Toru-3	RES	Sumatra	N. Sumatra	227.6													Pre FS		FS		Financing		DD		Bidding		Construction									228					
1036	Sinamar-2	ROR	Sumatra	W. Sumatra	25.6			Pre FS		FS		Financing		DD		Bidding		Construction							26																	
1039	Batang Hari-4	RES	Sumatra	W. Sumatra	216.0															Pre FS		FS		Financing		DD		Bidding		Construction									216			
1041	Sinamar-1	ROR	Sumatra	W. Sumatra	36.6			Pre FS		FS		Financing		DD		Bidding		Construction							37																	
1042	Masang-2	ROR	Sumatra	W. Sumatra	39.6	FS		Financing		DD		Bidding		Construction							40																					
1043	Gumanti-1	ROR	Sumatra	W. Sumatra	15.8			Pre FS		FS		Financing		DD		Bidding		Construction							16																	
1044	Anai-1	ROR	Sumatra	W. Sumatra	19.1			Pre FS		FS		Financing		DD		Bidding		Construction							19																	
1046	Kuantan-2	RES	Sumatra	W. Sumatra	272.4																	Pre FS		FS		Financing		DD		Bidding		Construction									272	
1051	Padang Guci-2	ROR	Sumatra	Bengkulu	21.0			Pre FS		FS		Financing		DD		Bidding		Construction							21																	
1052	Endikat-2	ROR	Sumatra	S. Sumatra	22.0	Pre FS		FS		Financing		DD		Bidding		Construction							22																			
1053	Semung-3	ROR	Sumatra	Lampung	20.8			Pre FS		FS		Financing		DD		Bidding		Construction							21																	
1065	Poso-2	ROR	Sulawesi	C. Sulawesi	132.8																																					
1066	Poso-1	ROR	Sulawesi	C. Sulawesi	204.0		195																																			
1068	Lariang-6	RES	Sulawesi	C. Sulawesi	209.4									Pre FS		FS		Financing		DD		Bidding		Construction									209									
1075	Karama-1	RES	Sulawesi	S. Sulawesi	800.0					Pre FS		FS		Financing		DD		Bidding		Construction									800													
1076	Masuni	RES	Sulawesi	S. Sulawesi	400.2							Pre FS		FS		Financing		DD		Bidding		Construction									400											
1077	Mong	RES	Sulawesi	S. Sulawesi	255.6									Pre FS		FS		Financing		DD		Bidding		Construction									256									
1079	Watunohu-1	ROR	Sulawesi	S.E. Sulawesi	57.0			Pre FS		FS		Financing		DD		Bidding		Construction							57																	
1082	Mala-2	ROR	Maluku	Maluku	30.4			Pre FS		FS		Financing		DD		Bidding		Construction							30																	
1115	Cibareno-1	ROR	Java&Bali	W. Jawa	17.5			Pre FS		FS		Financing		DD		Bidding		Construction							17																	

Table 7.5.2 Hydro Development Master Plan (2)

Working No.	Scheme Name	Type	Region	Province	Installed Capacity (MW)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Remark
CONVENTIONAL HYDROPOWER SCHEMES for which DD, F/S or pre FS were conducted																								
3001	Merangin-2	ROR	Sumatra	Jambi	350.0	Financing	Bidding	Construction			350													RUPTL (2010-2019)
3002	Tampur-1	RES	Sumatra	NAD	330.0							FS review	Financing	DD	Bidding	Construction				330				
3004	Wampu	ROR	Sumatra	N. Sumatra	84.0	Financing	DD	Construction			45													RUPTL (2010-2019)
3007	Teunom-1	RES	Sumatra	NAD	24.3						FS	Financing	DD	Bidding	Construction			24						
3009	Peusangan-4	ROR	Sumatra	NAD	30.9		FS	Financing	DD	Bidding	Construction			31										
3012	Merangin-5	RES	Sumatra	Jambi	23.9						FS	Financing	DD	Bidding	Construction				24					
3016	Bakaru (2nd)	ROR	Sulawesi	S. Sulawesi	126.0	DD	Bidding	Construction			126													RUPTL (2010-2019)
3017	Lasolo-4	RES	Sulawesi	C. Sulawesi	100.0								FS	Financing	DD	Bidding	Construction				100			
3019	Poko	RES	Sulawesi	S. Sulawesi	233.0				Financing	DD	Bidding	Construction			233									RUPTL (2010-2019)
3020	Malea	ROR	Sulawesi	S. Sulawesi	182.0	FS	Financing	DD	Construction			182												RUPTL (2010-2019)
3021	Konaweha-3	RES	Sulawesi	C. Sulawesi	24.0								FS	Financing	DD	Bidding	Construction				24			
3023	Batu	RES	Sulawesi	S. Sulawesi	271.0									FS	Financing	DD	Bidding	Construction				271		
3024	Maung	RES	Java&Bali	C. Jawa	360.0											Financing	DD	Bidding	Construction				360	
3025	Rajamandala	ROR	Java&Bali	W. Jawa	58.0	Construction			47															RUPTL (2010-2019)
3026	Jatigede	RES	Java&Bali	W. Jawa	175.0	Construction			110															RUPTL (2010-2019)
3038	Kelai-2	RES	Kalimantan	E. Kalimantan	168.0		FS	Financing	DD	Bidding	Construction				168									RUPTL (2010-2019)
3041	Pinoh	RES	Kalimantan	W. Kalimantan	198.0		FS	Financing	DD	Bidding	Construction				198									RUPTL (2010-2019)
3050	Isal-2	RES	Maluku	Maluku	60.0		Financing	DD	Bidding	Construction				60										RUPTL (2010-2019)
3052	Warsamson	RES	Papua	Irian Jaya	49.0		Financing	DD	Bidding	Construction				49										RUPTL (2010-2019)
1074	Tamboli	ROR	Sulawesi	S.E. Sulawesi	25.8		Pre FS	FS	Financing	DD	Bidding	Construction			26									
1084	Tala	RES	Maluku	Maluku	54.0		Pre FS	FS	Financing	DD	Bidding	Construction				54								
1085	Tina	ROR	Maluku	Maluku	12.0		Pre FS	FS	Financing	DD	Bidding	Construction			12									
1112	Wai Ranjang	ROR	NTT&NTB	NTT	11.1		Pre FS	FS	Financing	DD	Bidding	Construction			11									
	Sawangan	ROR	Sulawesi	N. Sulawesi	16.0		FS	Financing	DD	Bidding	Construction			16										RUPTL (2010-2019)
	Besai-2	ROR	Sumatra	Lampung	44.0		Pre FS	FS	Financing	DD	Bidding	Construction			44									
PUMPED STORAGE SCHEMES in Jawa screened in HPPS2																								
6003	Upper Cisokan-PS	PST	Java&Bali	W. Jawa	1,000.0	Construction				1000														
6009	Grindulu-PS-3	PST	Java&Bali	E. Jawa	1,000.0		Pre FS	FS	Financing	DD	Bidding	Construction				1,000								
6010	K. Konto-PS	PST	Java&Bali	E. Jawa	1,000.0								Pre FS	FS	Financing	DD	Bidding	Construction				1,000		
6001	Matenggeng	PST	Java&Bali	W. Jawa	887.0		FS	Financing	DD	Bidding	Construction				887									(Cijulang-PS-2)
EXPANSION OF THE EXISTING POWER PLANT																								
	Karangkates Ext.	RES	Java&Bali	E. Jawa	100.0		Financing	DD	Bidding	Construction														
PUMPED STORAGE SCHEME IN SUMATRA																								
	Lake Toba	PST	Sumatra	N. Sumatra	400.0	Pre FS	FS	Financing	DD	Bidding	Construction													
MODIFICATION OF RESERVOIR SCHEME TO RUN-OF-RIVER SCHEME																								
1078	Bonto Batu	ROR	Sulawesi	S. Sulawesi	100.0	FS	Financing	DD	Construction			100												
OTHERS LISTED in RUPTL																								
	Peusangan 1-2	ROR	Sumatra	NAD	86.0	Construction				86														Commissioned in Jan. 2015
	Asahan 3	ROR	Sumatra	N. Sumatra	174.0	Construction				174														Commissioned in Jun. 2015
	Lawe Mamas	ROR	Sumatra	NAD	50.0	PPA	Financing	Construction			50													
	Asahan 4-5	RES	Sumatra	N. Sumatra	60.0	PPA	Financing	Construction				60												
	Simpang Aur	ROR	Sumatra	Bengkulu	29.0	Construction			29															
	Kalikonto-2		Java&Bali	E. Jawa	62.0	Financing	DD	Bidding	Construction		62													

7.6 TRANSMISSION DEVELOPMENT PLAN AND SYSTEM ANALYSIS

7.6.1 METHODOLOGY

In connection with the aforementioned planning list for input of hydropower sources based on the Realistic Scenario, the Study Team checked the justification of them from the standpoint of system operation (supply-demand balance) while the plans for transmission line construction are being implemented. Furthermore, alternative strategic programs are designed for certain systems that have complementary demand indicator mentioned in Chapter 3, not as same as figure of demand forecast mentioned in RUKN2008.

Based on the power source development plan contained in RUPTL 2010 - 2019[6], the Study Team examined the year(s) for input of candidate hydropower sources on the aforementioned list. This examination applied the aforementioned demand forecast indicators and was based on the following common and region-specific objectives.

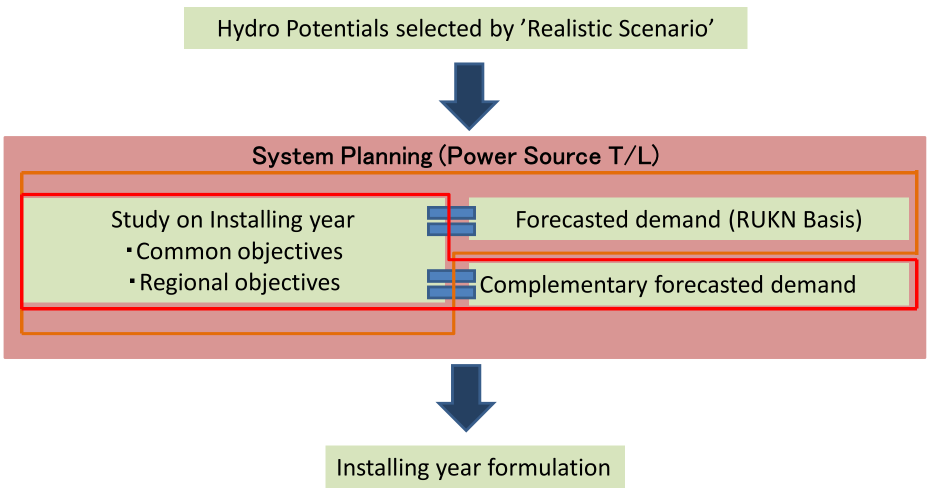


Figure 7.6.1 Flowchart for System analysis and transmission planning

(Common objectives)

Run-of-river-type hydropower stations have power generation capacities on a medium scale[7] or lower. For this reason, the Study Team examined the type of connection and input year for the purpose of improving the quality of regional power.

Reservoir-type hydropower stations have capacities ranging from medium to large, and the Study

[6] Hydro candidates nominated in RUPTL2010-2019 are not mentioned anew in this report. In addition, for systems that have divergence between demand forecast in RUKN2008 and that of RUPTL as with Sulselrabar system, the generation development plans mentioned in RUPTL could be modified in order to apply to prerequisite for hydrogenation development study.

[7] 30-50MW

Team therefore examined the type of connection and input year with consideration of the wide-area supply-demand balance.

(Region-specific objectives)

a) Jamali・Sumatra

In these regions, where large-scale transmission systems have been constructed, the transmission network has developed over a wide area, and the generation capacity of the candidate sites is small for the system capacity. In addition, there are plans for input of large-scale coal-fired and geothermal power stations as part of FTP I and FTP II. This will make the coverage rate for base power extremely high. The Study Team consequently checked the propriety of the hydropower input year from the following perspectives.

・In the case of candidate sites with a small-scale generation capacity[8]: supply-demand balance of the local load system in the vicinity of the candidate sites and presence or absence of power flow bottlenecks

・In the case of candidate sites with a large-scale generation capacity[9]: supply-demand balance of the medium-area load system and presence or absence of power flow bottlenecks

b) Sulawesi and Kalimantan systems

In these regions, the transmission systems are in the stage of development (enhancement), and are centered around the major demand sites. The agenda include expansion of system capacity and reorganization of the power mix, through interconnection of systems for rationalization of reserve capacity (to form large-scale systems) and consolidation of isolated systems on the periphery.

・Establishment of the supply-demand balance in each block within the system, toward the goal of de-dieselization[10].

・Targeting of a 30-percent reserve margin[11]

c) Other systems

Systems in regions other than those noted above consist of isolated systems without transmission systems (major grids). The Study Team considered the propriety of the years of hydropower station input from the following perspective, with construction of grids occasioned by input of the candidate sites.

・Establishment of the supply-demand balance aimed at de-dieselization

8 Below 30MW
9 Above 100MW
10 The term "de-dieselization" refers to the target posted in RUPTL of lowering dependence on oil-fired power stations as far as possible
11 It is decided to standardize as unit target value in whole Indonesia to make consistent with primary definition.

・Targeting of a 30-percent reserve margin

7.6.2 TRANSMISSION DEVELOPMENT PLAN AND POSSIBLE ADJUSTMENT TO GENERATION DEVELOPMENT PLAN

Result with RUKN2008 demand forecast

The study results are as follows.

(1) Jamali

a) Generation Development Plan

Hydro candidates selected by Realistic Scenario are as follows.

Table 7.6.1 Hydro candidates (Jamali system)

	ID	Type	Installed.Cap. (MW)	Annual Energy (GWh)
West Java				
1	Cibareno-1	ROR	17.5	117.0
Central Java				
2	Maung	RES	360.0	534.9

b) Transmission Plan

Table 7.6.2 Transmission development plan (Jamali)

	From	To	Voltage (kV)	Kind	Lengths (kms)	COD
1	PLTA Cibareno-1	2phi inc. (Bayah- Pelabuhan Ratu)	150	2Zebra 2ccts	20	2020
2	PLTA Maung	2phi inc. (PLTA Mrica-Wonosobo)	150	2TACSR410 2ccts	80	2028
	PLTA Mrica	Wonosoo	150	2TACSR410 2ccts	—	2028

i) PLTA Cibareno-1

PLTA Cibareno-1 is positioned about midway between Baya and Sukabumi in the southern part of Banten Province. Southern Banten is not yet equipped with a transmission system. There are plans for interconnection of GI Saketill-Malingping-Bayah-Pelabuhan Ratu in southern Banten. The objective of this transmission line is not only to improve the power quality in southern Banten but also to assure a reserve transmission route to that district. Therefore, the aforementioned transmission line was designed for connection to 2-pi incomer type.

ii) PLTA Maung

On the outskirts of PLTA Maung, the power sources PLTA Mrica (180.4 MW), PLTA Gerung (26.4 MW), and PLTP Dieng (60MW) assure the supply of base power, and are interconnected by a 150kV system. The supply from these power sources is directed to Purwokerto located on the western side and DIY on the eastern side. Because these two destinations are equipped with a 500kV system, they can obtain the power supplied by load system sources while receiving support for sustainment of power quality by the 500kV system. In addition, PLTA Maung is a reservoir-type of station, and can adjust its operation in correspondence with the peak demand.

There is some apprehension about the prospect of a transmission capacity excess on the existing transmission lines, because the current design calls for incorporation of PLTA Maung into the PLTA Mrica power lines. A further study must be made of the possibilities of making effective use of the existing transmission towers.

(2) Sumatra

a) Generation Development Plan

Hydro candidates selected by Realistic Scenario are as follows.

Table 7.6.3 Hydro candidates (Sumatra system)

	ID	Type	Installed.Cap. (MW)	Annual Energy (GWh)
NAD				
1	Meulaboh-5	ROR	43.0	271.1
2	Kluet-1	ROR	40.6	231.9
3	Sibubung-1	ROR	32.4	207.3
4	Seunangan-3	ROR	31.2	179.3
5	Jambo Papeun-3	ROR	25.4	206.1
6	Woyla-2	RES	242.1	664.6
7	Kluet-3	ROR	23.8	194.0
8	Ramasan-1	RES	119.0	291.9
9	Teripa-4	RES	184.8	503.6
10	Teunom-3	RES	102.0	303.2
11	Tampur-1	RES	330.0	1067.0
12	Teunom-2	RES	230.0	595.3
13	Peusangan-4	ROR	30.9	234.2
14	Teunom-1	RES	23.3	212.4
North Sumatra				
15	Sibundong-4	ROR	31.6	203.6
16	Bila-2	ROR	42.0	300.6
17	Toru-2	ROR	33.6	237.1
18	Ordi-5	ROR	26.8	173.7
19	Ordi-3	ROR	18.4	119.1
20	Siria	ROR	16.5	105.8
21	Toru-3	RES	227.6	516.1
22	Kumbih-3	ROR	41.8	269.6
23	Raisan-1	ROR	26.2	167.9
West Sumatra				
24	Batang Hari-4	RES	216.0	544.9
25	Kuatan-2	RES	272.4	734.1
26	Sinamar-1	ROR	36.6	254.9
27	Sinamar-2	ROR	25.6	217.1
28	Gumanti-1	ROR	15.8	85.4
29	Anai-1	ROR	19.1	109.2
Jambi				
30	Merangin-5	ROR	23.9	196.8
Bengkulu				
31	Padang Guci-2	ROR	21.0	145.1
South Sumatra				
32	Endikat-2	ROR	22.0	179.8
33	Semung-3	ROR	20.8	146.9
34	Besai-2	ROR	44.0	160.0

b) Transmission Plan

Table 7.6.4 Transmission development plan (Sumatra system)

	From	To	Voltage (kV)	Kind	Lengths (kms)	COD
1	PLTA Meulaboh-5	GI Meulaboh	150	1Hawk 2ccts	56	2019
2	PLTA Kluet-1	GI Blangpidie	150	1Hawk 2ccts	36	2019
3	PLTA Sibubung-1	GI Tapaktuan	150	1Hawk 2ccts	26	2021
4	PLTA Seunangan-3	2phi inc. (Meulaboh-PLTA Meulaboh-5)	150	1Hawk 2ccts	10	2021
5	PLTA Jambo Papeun-3	PLTA Kuet-1	150	1Hawk 2ccts	8	2019
6	PLTA Woyla-2	GI Meulaboh	150	2Zebra 2ccts	60	2024
	GI Meulaboh	GI Calang	150	1Hawk 2ccts	160	↓
7	PLTA Kluet-3	GI Tapaktuan	150	1Hawk 2ccts	20	2021

8	PLTA Ramasan-1	GI Pantonlabu	150	1Zebra 2ccts	200	2024
9	PLTA Teripa-4	GI Blangkejelan	150	2Hawk 2ccts	30	2024
10	PLTA Teunom-3	GI Geumpang (New)	150	2Zebra 2ccts	20	2024
	GI Geumpang	GI Sigli	275	2→4Zebra	80	↓
	GI Lhokseumawe	GI Pangkalan Susu	275	2Zebra 2ccts	300	2025
11	PLTA Tampur-1	GI Blangkeleren	275	2Zebra 2ccts	50	2025
	GI Balngkejelen	GI Brastagi	275	2Zebra 2ccts	400	2024
	GI Brastagi	GI Galang	275	2Zebra 2ccts	50	2024
12	PLTA Teunom-2	2phi inc. (PLTA Teunom-3-Geumpang)	150	2Zebra 2ccts	20	2026
13	PLTA Peusangan-4	2phi inc. (Peusangan-2 - Bireun	150	1Hawk 2ccts	20	2019
14	PLTA Teunom-1	PLTA Peusangan-1	150	1Hawk 2ccts	20	2019
15	PLTA Sibundong-4	1phi inc. (PLTP Pusuk Bukkit- Tarutung)	150	2Hawk 2ccts	16	2019
16	PLTA Bila-2	GI Padang Sidempuan	150	1Hawk 2ccts	6	2019
17	PLTA Toru-2	GI Tarutung	150	1Hawk 2ccts	16	2020
18	PLTA Ordi-5	PLTA Kumbih-3	150	1Hawk 2ccts	10	2020
19	PLTA Ordi-3	PLTA Ordi-5	150	1Hawk 2ccts	6	2020
20	PLTA Siria	GI Barus(New)	150	1Hawk 2ccts	10	2020
	GI Barus(New)	PLTU Labuhan Angin	150	1Hawk 2ccts	20	↓
21	PLTA Toru-3	GI Padang Sidempuan	150	2Zebra 2ccts	100	2026
22	PLTA Kumbih-3	2phi inc. (Sidikarang-Sabulussalam)	150	1Hawk 2ccts	20	2019
23	PLTA Raisan-1	GI Sibolga	150	1Hawk 2ccts	10	2020
		Uprating existing T/L				
24	PLTA Batang Hari-4	GI Kiliranjao	150	2Zebra 2ccts	60	2027
25	PLTA Kuatan-2	GI Kiliranjao	150	2Zebra 2ccts	50	2028
26	PLTA Sinamar-1	GI Batusangkar	150	1Hawk 2ccts		2020
27	PLTA Sinamar-2	PLTA Sinamar-1	150	1Hark 2ccts		2020
		2nd cct (Singkarak – Batusangkar)	150			
28	PLTA Gumanti-1	GIIndarung	150	1Harwk 2ccts	30	2020
29	PLTA Anai-1	GI Lubuk alung	150	1Hawk 2ccts	30	2020
30	PLTA Merangin-5	GI Bangko	150	1Hawk 2ccts	40	2024
31	PLTA Padang Guci-2	2phi inc. (Manna – Pagar Alam)	150	1Hawk 2ccts	30	2024
32	PLTA Endikat-2	GI Pagar Alam	150	1Hawk 2ccts	32	2019
33	PLTA Semung-3	GI Liwa	150	1Hawk 2ccts	30	2020
34	Besai-2	PLTA Besai	150	1Hawk 2ccts	20	2020
		Uprating existing T/L	150			

i) Candidates in NAD

Candidate sites 1 and 4 (interconnection to GI Meulaboh, gross generation capacity of 74.2 MW), 3 and 7 (interconnection to GI Takakutuan, gross generation capacity of 56.2 MW), and 2 and 5 (interconnection to GI Blangpidie, gross generation capacity of 66.0 MW) are to be input in 2022 for construction of transmission lines on the coast of the Indian Ocean. As a result, hydropower stations will take over as the sources for the main part of the base power in this area. The power from PLTU Meulaboh will be supplied in the Banda Aceh direction as (upstream) flow for an increase to 275 kV. With the input of candidate site 6 in 2025, hydropower will assure the supply of almost all base power in the area and enable response to peak power. It will also become possible to supply power to the 275kV system for the peak power requirement.

A new 275kV transmission line was planned in this study. It was assumed that candidate sites 9 and 11 (gross generation capacity of 514.8 MW) in the vicinity of Blangkejelen would provide power for providing the peak power sent to North Sumatra Province, which has a large system capacity.

In addition to the large power flow from the Meulaboh direction as noted above, it was decided to incorporate reservoir-type hydropower sources in the vicinity of 275kV transmission lines (candidate 10 and 12, gross generation capacity of 332 MW) into the existing 275kV system, and use their supply to cope with the peak power requirement Banda Aceh direction. It should be noted that the related interconnections will require a reinforcement of the transmission lines.

ii) Candidates in North Sumatra

The existing power line for interconnection of candidate site 15 (Sibundong-4) is scheduled to be constructed with 2 Hawk wire. The transmission capacity will be relatively high for the generation capacity of the source (PLTP Pusuk Bukkit). Because PLTP expansion is anticipated, it will be necessary to change the type of transmission wire in correspondence with future progress.

The design for candidate site 20 (Siria) calls for placement of a substation in Barus, a neighboring city, and connection to PLTU Labuhan Angin. The establishment of GI Barus holds prospects for stable supply of power to the area along the coast of the Mentawai Strait in North Sumatra Province.

Candidate sites 18, 19 and 22 would make a big contribution to improvement of system voltage at GI Sabulussalam. The design was prepared so that the interconnection to GI Padang Sidempuan (candidate site 21) would supply power efficiently to the whole system.

iii) Candidates in West Sumatra

Candidate sites 24 and 25 would supply power to North Sumatra and Riau provinces through connection to the 275kV substation GI Liliranjao by means of 150kV transmission lines. They would also serve as sources for supply of base and peak power in West Sumatra Province.

iv) Candidates in Jambi

The transmission lines connected to candidate sites 30 would all be purely power lines. A connection would be made to the 275kV system at Bangko.

v) Candidates in Bengkulu

Bengkulu Province has hydropower sources including the existing PLTA Musi (3 units x 70 MW), and hydropower occupies a high share of the power mix. The forecast envisions a peak demand of 414 MW and generating-end energy output of 2,429 GWh in 2027. The energy supply by candidate site 31 will assure the quality improvement of electricity in Manna.

vi) Candidates in South Sumatra

Candidate site 32 (Endikat-2) would be connected to GI Pagar Alam, which has the transmission line controlling the supply of power to GI Manna in Bengkulu Province. It is backed by a 275kV system, and may be considered a strong system. The power from this candidate site would be consumed at GI Pagar Alam.

vii) Candidates in Lampung

Candidate site 33 (Semung-3) would be the base source for GI Bengkuat, which is interconnected with GI Liwa and isolated systems in the western part of Lampung Province. It will help to improve the system voltage in supply to GI Bengkuat.

(3) Kalimantan

a) Generation Development Plan

Hydro candidates selected by Realistic Scenario are as follows.

Table 7.6.5 Hydro candidates (Kalimantan systems)

	ID	Type	Installed.Cap. (MW)	Annual Energy (GWh)
West Kalimantan				
1	Pinoh[12]	RES	198	1374.8
East Kalimantan				
2	Kelai-2[13]	RES	168	1102.9

b) Transmission Plan

Table 7.6.6 Transmission Development Plan (Kalimantan)

	From	To	Voltage (kV)	Kind	Lengths (kms)	COD
1	PLTA Pinoh	Nanga Pinoh	150	2Hawk 2ccts	40	2019
2	PLTA Kelai-2	System Tanjngredeb	150	1Zebra 2ccts	160	2019

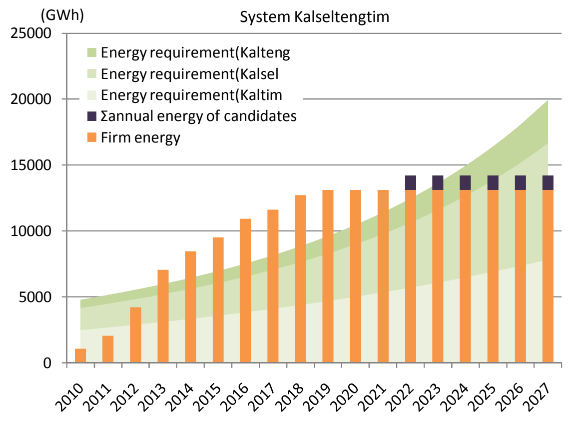
i) Kalseltengtim

➢ Supply and demand balance examination

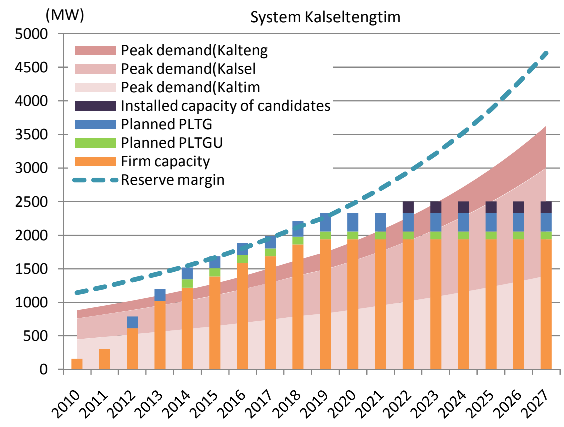
The figure[14] below shows the supply-demand balance in the Kalseltengtim system.

In terms of both firm capacity and firm energy calculated on the basis of RUPTL 2010 – 2019, the system exhibits a greater tendency toward shortage of peak power than electrical energy. The candidate site, Kelai-2 lies in the northern part of East Kalimantan Province. It can be improved both system quality and supply-demand balance of major cities, Tanjungselor and Tanjungredeb, demand center in East Kalimantan. Assuming that the candidate site would be input to help alleviate this peak power shortage, the advisable approach would be input in 2022.

[12] The plan causing interference with this candidate is already nominated in RUPTL2010-2019.(98MW COD 2018)
[13] Ditto(150MW COD 2018/19)
[14] The term "firm capacity" refers to the gross generation capacity of PLTA, PLTU, and PLTP facilities for the load of base power and electrical energy in the year in question. The term "firm energy" indicates the estimated annual amou
nt of electrical energy generated by the aforementioned power sources. It is basically synonymous with the base electrical energy



(a) Energy basis



(b) Power basis

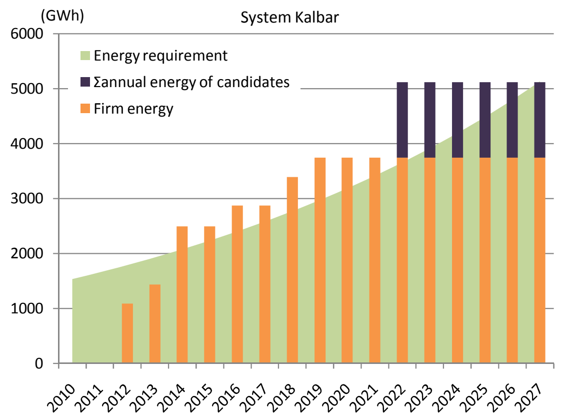
Figure 7.6.2 Supply and Demand Balance (Kalseltengtim System)

ii) Kalbar System

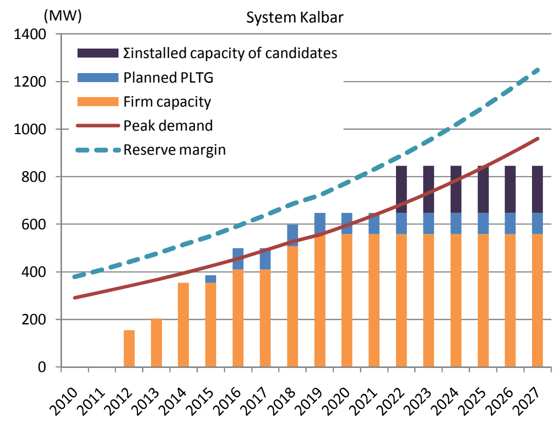
➢ Supply and demand balance examination

The figure below shows the supply-demand balance in the Kalbar system.

In terms of both firm capacity and firm energy calculated on the basis of RUPTL 2010 – 2019, the system exhibits a greater tendency toward shortage of peak power than electrical energy. The candidate site, Pinoh lies in interior area of West Kalimantan Province and can be improved both system quality and peak power supply in it and stretch of Pontianak.



(a) Energy basis



(b) Power basis

Figure 7.6.3 Supply and Demand Balance (Kalbar System)

(4) Sulawesi

a) Generation Development Plan

The candidate sites for hydropower sources on the list selected by Realistic Scenario are as follows. Some of the candidate sites in the Sulawesi region are included in the plans for development within the next 10 years in RUPTL 2010 - 2019. Because of this overlapping, they are set forth as preparation in this section.

Table 7.6.7 Hydro candidates (Sulawesi)

	ID	Type	Installed.Cap. (MW)	Annual Energy (GWh)	Remark
North Sulawesi					
1	Sawangan	ROR	16.0	73.5	PLTA Sawangan is plotted in 2015 in RUPTL
Central Sulawesi					
2	Poso-2	ROR	132.8	1125.4	PLTA Poso is plotted in 2011.
3	Poso-1	ROR	204.0	1341.0	
4	Bakau(2nd)	ROR	126.0	471.0	PLTA Bakaru2 is plotted in 2019 in RUPTL
5	Lariang-6	RES	209.4	616.2	-
South Sulawesi					
6	Malea	ROR	182.0	1477.0	PLTA Malea is plotted in 2016 in RUPTL
7	Karama-1	RES	800.0	2147.1	-
8	Masuni	RES	400.2	930.2	-
9	Mong	RES	255.6	618.9	-
10	Batu	RES	271.0	1740.2	-
11	Poko	RES	233.0	760.0	PLTA Poko is plotted in 2018/19 in RUPTL
Southwest Sulawesi					
12	Konaweha-3	RES	24.0	116.0	-
13	Watunohu-1	ROR	57.0	309.0	-
14	Lasolo-4	RES	100.0	770.0	-
15	Tamboli	ROR	25.8	158.9	-

b) Transmission Plan

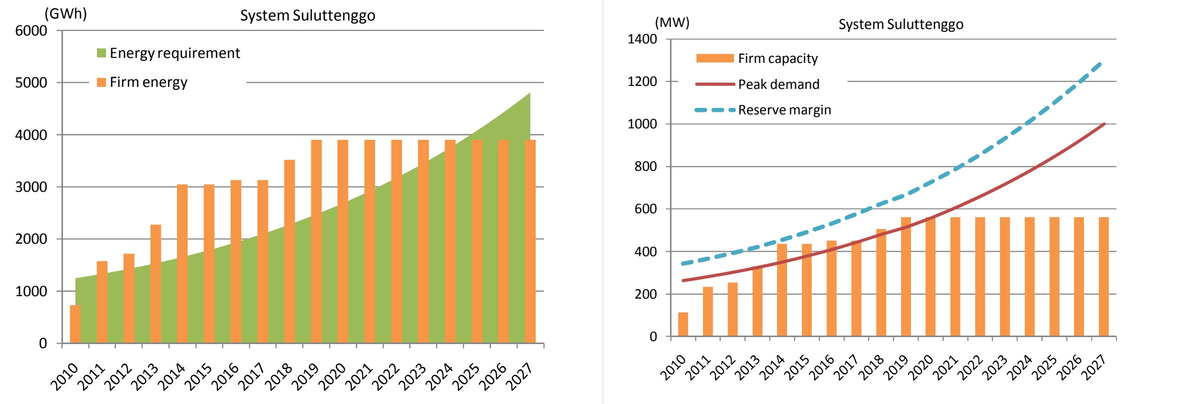
Table 7.6.8 Transmission Development Plan (Sulawesi)

	From	To	Voltage (kV)	Kind	Lengths (kms)	COD
5	PLTA Lariang-6	Karama-1	150	2Hawk 2ccts	200	2024
7	PLTA Karama-1	GI Polewali	275	4Zebra 2ccts	250	2022
	GI Polewali	GI Sidenreng	275	4Zebra 2ccts	180	↓
	GI Sidenreng	GI Makassar	275	4Zebra 2ccts	220	↓
8	PLTA Masuni	GI Polewari	275	4Zebra 2ccts	80	2023
	PLTA Masuni	GI Polmas	150	1Hawk 2ccts	2	↓
9	PLTA Mong	GI Soppeng	150	2Zebra 2ccts	60	2024
	GI Soppeng	GI Jeneponto	150	Uprating		↓
10	PLTA Batu	GI Sidenreng	150	2Hawk 2ccts	10	2027
12	PLTA Konaweha-3	GI Unaaha	150	1Hawk 2ccts	40	2026
13	PLTA Watunohu-1	2phi inc. (Malili-Lasusua)	150	1Hawk 2ccts	80	2020
14	PLTA Lasolo-4	GI Kendari	150	1Zebra 2ccts	160	2026
15	PLTATamboli	2phi inc.(Kolaka– Lasusua)	150	1Hawk 2ccts	40	2020

i) Suluttenggo

➢ Supply and demand balance examination

The Suluttenggo system is to be interconnected with the Minahasa and Gorontalo systems and expanded to the northern part of central Sulawesi Province (the areas of Leok, Toli-toli, and Moutong). Its major power consumption sites are Manado on its eastern end and Gorontalo in its middle. As shown in the figure below, the supply of power should be ample on the energy basis until 2024, but could be short on the capacity basis beginning in 2021. The aforementioned candidate sites 1 and 2 are of the ROR type and on a small scale in respect of both generation capacity and annual energy.



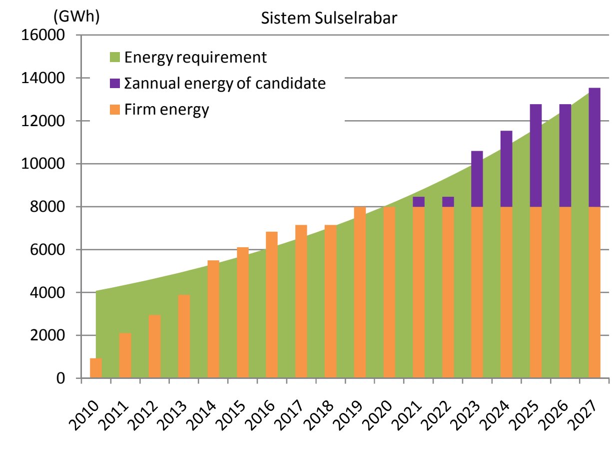
(a) Energy basis (b) Power basis

Figure 7.6.4 Demand and Supply Balance (Suluttenggo system)

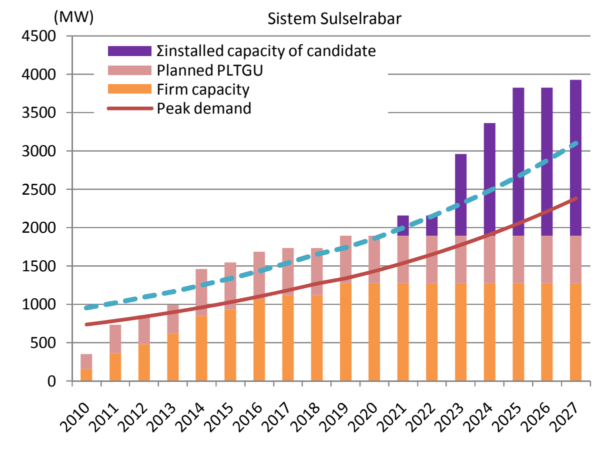
ii) Sulselrabar

➢ Supply and demand balance examination

The Sulselrabar system consists of the systems in the provinces of a part of Central Sulawesi (south of Palu), West Sulawesi, Southwest Sulawesi and South Sulawesi. Along with the development of large-scale power sources in Central Sulawesi Province, the systems in Central, Southeast, and South Sulawesi provinces are being interlinked by means of a 275kV system for the purpose of power reserve rationalization. Most of the demand in this region is occupied by the Makassar branch. Relative to this demand, the large-scale candidate sites are concentrated in the area from west side of Central to South Sulawesi. Judging from the gross generation capacity, it would be appropriate to introduce a 275kV system. A 275kV trunk system with a total length of approximately 400 km from potential site (Karama-1) to Makassar city will be needed beginning in 2022. Power could be efficiently transmitted by setting up 275/150kV GI sites at three locations in the northern, central, and southern parts of South Sulawesi. This would make it possible to achieve the system change for easy reinforcement of the existing load system.



(a) Energy basis



(b) Power basis

Figure 7.6.5 Demand and Supply Balance (Sulselrabar System)

(5) NTB

The examination for this region was omitted because of no prospective aforementioned in previous section.

(6) NTT

A. System plan in line with demand forecast in RUKN

a) Generation Development Plan

Hydro candidates selected by Realistic Scenario are as follows.

Table 7.6.9 Hydro candidate (NTT)

ID	Type	Location	Installed.Cap. (MW)	Annual Energy (GWh)
Wai Ranjang	ROR	Flores island	11.1	59.4

- ➢ Transmission planning

Table 7.6.10 Transmission development plan (NTT(FloresSystem))

From	To	Voltage (kV)	Kind	Lengths (kms)	COD
PLTA Wai Ranjang	GI Ruteng	70	1Ostrich 2ccts	20	2020

- ➢ Supply and demand balance examination

  Following figure shows the contribution with hydro candidate mentioned above, will be commenced in 2021, for Flores system. It will be owed around a quarter percent of demand in commencement year as the base-load supplier.

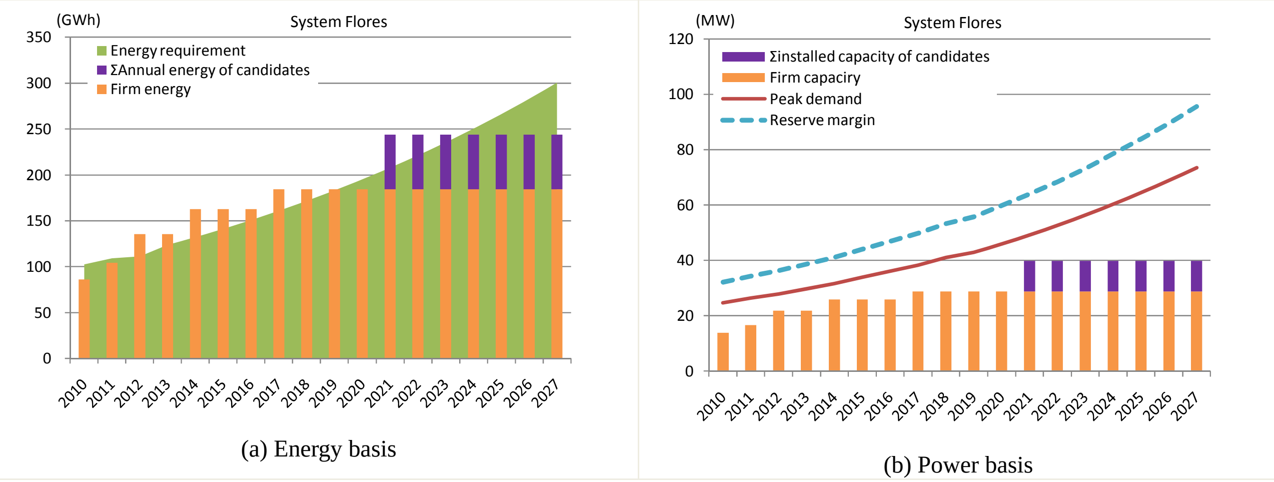


Figure 7.6.6 Supply and Demand Balance (NTT(Flores System))

(7) Maluku

a) Generation Development Plan

Table 7.6.11 Hydro candidates (Maluku)

	ID	Type	Location	Installed.Cap. (MW)	Annual Energy (GWh)
1	Tala	RES	West region in Seram island	54.0	167
2	Tina	ROR	Buru island	12	49.3

i) Tala

This candidate site will be connected to the Ambon-Seram system interconnecting Ambon and Seram islands.

- Transmission planning

  It was assumed that the transmission lines for PLTA Tala would be connected to Masohi-Kairatu transmission line. There are no particular apprehensions about the system plans. The transmission capacity of the undersea cable[15] between Ambon and Seram island could possibly constrain the transmission capacity, and this requires study of measures such as circuit addition at the proper time.

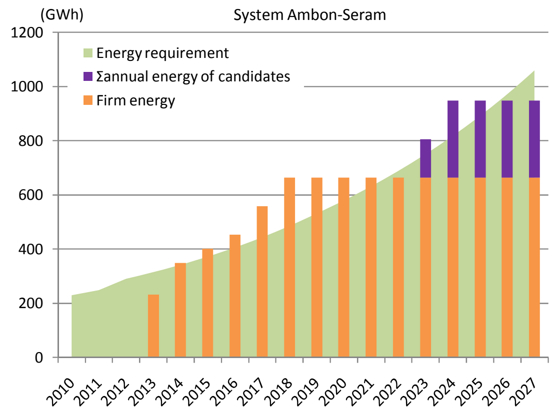
Table 7.6.12 Transmission Development Plan (Seram System)

	From	To	Voltage (kV)	Kind	Lengths (kms)	COD
1	PLTA Tala	2phi inc. (Masohi-Kairatu)	150	1Hawk 2ccts	10	2022

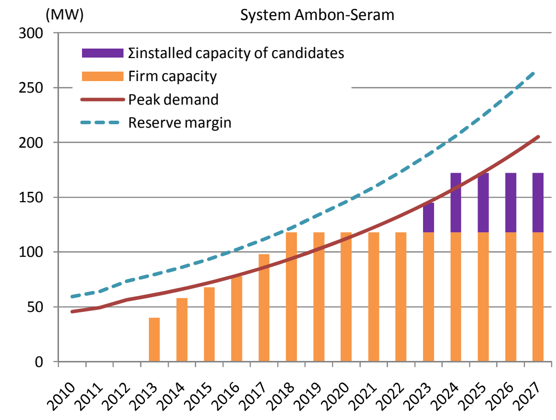
- Supply and demand balance examination

  On the electrical energy basis, PLTA Tala, whose annual generation energy is 284GWh, will push a supply capability of 50 percent relate to the combined capacity of PLTU, PLTP, and PLTA sources whose year of input is explicitly specified in RUPTL 2010 – 2019. Assuming that the candidate site would be input to help alleviate this energy shortage, although this site is RES to be able to feed peak power, the advisable approach would be phased input in 2023 and 2024.

[15] In case of 150kV-XLPE, approximately 130MVA at the maximum can be applied for thermal capacity.



(a) Energy basis



(b) Power basis

Figure 7.6.7 Supply and Demand Balance (Ambon - Seram System)

ii) Tina

Tina is to be connected to Namlea, an isolated system on the Buru island.

- Transmission planning

  The only system on Buru is an interconnection to a 20kV distribution system; there is no transmission system. The Study Team made estimates for the system planned for operation of PLTA Tina as follows. There are no particular apprehensions about the system plans.

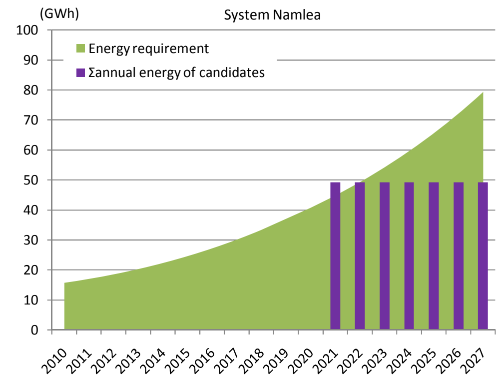
Table 7.6.13 Transmission Development Plan (Namlea System)

	From	To	Voltage (kV)	Kind	Lengths (kms)	COD
4	PLTA Tina	Namlea	70	1Hawk 2ccts	130	2020

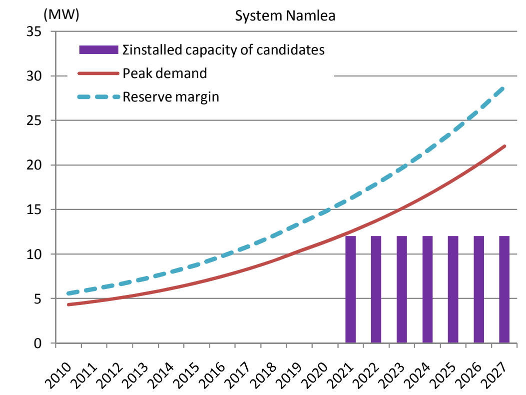
- Supply and demand balance examination

  If there are plans for input into the supply-demand balance in 2021, the supply could be sufficiently assured on the electrical energy basis.

  In addition, it may be noted that the provision for peak power and reserve margin would be on about the same level as in 2018. Input in that year would therefore be advisable to assure supply in the event of loss of the assumable unit capacity (6 MW) at PLTA Tina and efficient operation of the existing sources. In this case, however, it must be understood that overflow power of about 30 GWh will be derived.



(a) Energy basis



(b) Power basis

Figure 7.6.8 Supply and Demand Balance (Namlea System)

(8) Papua

The examination for this region was omitted because of no prospective aforementioned in previous section.

<u>Result with complementary demand forecast</u>

The study results are follows. Focused areas are following.

- Sulselrabar
- NTB
- NTT
- Papua

(1) Sulselrabar

a) Generation Development Plan

All candidate sites for hydropower sources mentioned in Chapter 7.3.4 are as follows.

Table 7.6.14 Hydro candidates (Sulteng, Sulselrabar)

	ID	Type	Installed.Cap. (MW)	Annual Energy (GWh)	Operation Year	
Central Sulawesi						
1	Poso-2	ROR	132.8	1125.4		
2	Poso-1	ROR	204.0	1341.0		
3	Lariang-6	RES	209.4	616.2	2025	**2026**
4	Bongka-2	RES	187.2	451.3		**2026**
5	Lariang-7	RES	618.0	1489.6		**2028**
6	Palu-3	LOT	75.0	510.0		
7	Lariang-8	ROR	12.8	85.4		
8	Solato-1	ROR	26.6	176.1		

South Sulawesi						
9	Malea	ROR	182.0	1477.0		
10	Karama-1	RES	800.0	2147.1	2023	**2022**
11	Masuni	RES	400.2	930.2	2024	**2023**
12	Mong	RES	255.6	618.9	2025	
13	Pongkeru-3	RES	227.6	556.6		
14	Batu	RES	271.0	1740.2	2028	**2024**
15	Karama-2	RES	800.0	2147.1		**2027**
16	Poko	RES	233.0	760.0	2021	
Southwest Sulawesi						
17	Konaweha-3	RES	24.0	116.0	2027	**2023**
18	Watunohu-1	ROR	57.0	309.0	2021	**2020**
19	Lalindu-1	RES	193.6	544.1		**2026**
20	Lasolo-4	RES	100.0	770.0	2027	**2024**
21	Tamboli	ROR	25.8	158.9	2021	

b) Transmission Plan

Table 7.6.15 Transmission Development Plan (Sulteng, Sulselrabar)

	From	To	Voltage (kV)	Kind	Lengths (kms)	COD
3	PLTA Lariang-6	Karama-1	500	4Gannet 2ccts	200	2025
4	PLTA Bongka-2	GI Ampana	150	2Hawk 2ccts	100	2026
	GI Poso	GI Ampana	150	1→2Hawk	248	↓
5	PLTA Lariang-7	PLTA Lariang-6	500	4Gannet 2ccts	200	2027
10	PLTA Karama-1	GI Polewali	500	4Zebra 2ccts	250	2021
	GI Polewali	GI Sidenreng	500	4Zebra 2ccts	180	↓
	GI Sidenreng	GI Makassar	500	4Zebra 2ccts	220	↓
11	PLTA Masuni	GI Polewari	500	4Zebra 2ccts	80	2022
	PLTA Masuni	GI Polmas	150	1Hawk 2ccts	2	↓
12	PLTA Mong	GI Soppeng	150	2Zebra 2ccts	60	2024
	GI Soppeng	GI Jeneponto	150	Uprating		↓
14	PLTA Batu	GI Sidenreng	150	2Hawk 2ccts	10	2023
15	PLTA Karama-2	PLTA Karama-1	500	2Zebra 2ccts	160	2026
17	PLTA Konaweha-3	GI Unaaha	150	1Hawk 2ccts	40	2026
18	PLTA Watunohu-1	2phi inc. (Malili-Lasusua)	150	1Hawk 2ccts	80	2019
19	PLTA Lalindu-1	PLTA Lasolo-4	150	2Hawk 2ccts	200	2025
	PLTA Lalindu-1	GI Bungku	150	1Hawk 2ccts	150	↓
	(GI Bungku	GI Kolonedale	150	1Hawk 2ccts	200)	
20	PLTA Lasolo-4	GI Kendari	150	1Zebra 2ccts	160	2023
21	PLTATamboli	2phi inc.(Kolaka– Lasusua)	150	1Hawk 2ccts	40	2020

In order to analyze the balance specifically, the JICA Study Team examined in two systems, Sulawesi Tenggara quarter and mass of Central, West and South Sulawesi region.

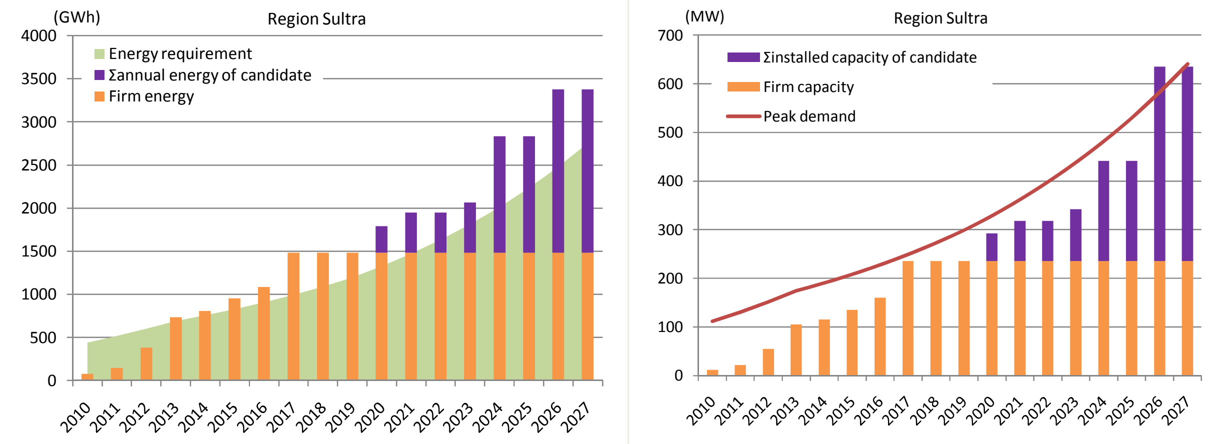
i) Southeast Sulawesi (Sultra)

- Supply and demand balance examination

In 2011, the system serving Sulawesi Tenggara is to be interconnected with the Sulsel and Sulteng systems by means of a 275kV system. It is to be extended down the western coast for connection of points as far as Raha at the southern end on the grid by means of 150kV transmission lines. This will increase the total length (between Malili and Raha) to 475 km. The main demand sites in this area are Kolaka and Kendari in the south. They account for about 60 percent of the power demand in the Sulawesi Tenggara (Sultra) area.

In consideration of supply-demand balance and system operation (and particularly the problem of voltage drop due to the aforementioned long-distance transmission), it was decided to move the start of operation of PLTA Wotunohu-1 up one year from 2021 to 2020, and that of PLTA Konaweha-3, in 2023 and also that of PLTA Lasolo-4, in 2024.　It was also decided to delay PLTA Lalindu-1 in 2026.

The reason is that the long-distance 150kV transmission line (2-Hawk wire) south of Malili is the bottleneck in the system serving Sulawesi Tenggara, and the Study Team adopted a design for operation with an adequate power flow.　Plans were prepared so that the input of PLTA Lalindu-1 would be timed to coincide with placement of the Bungku system (an isolated system) on the grid.　That means that there will be two routes in Sultra in order to strengthen the feeding paths.



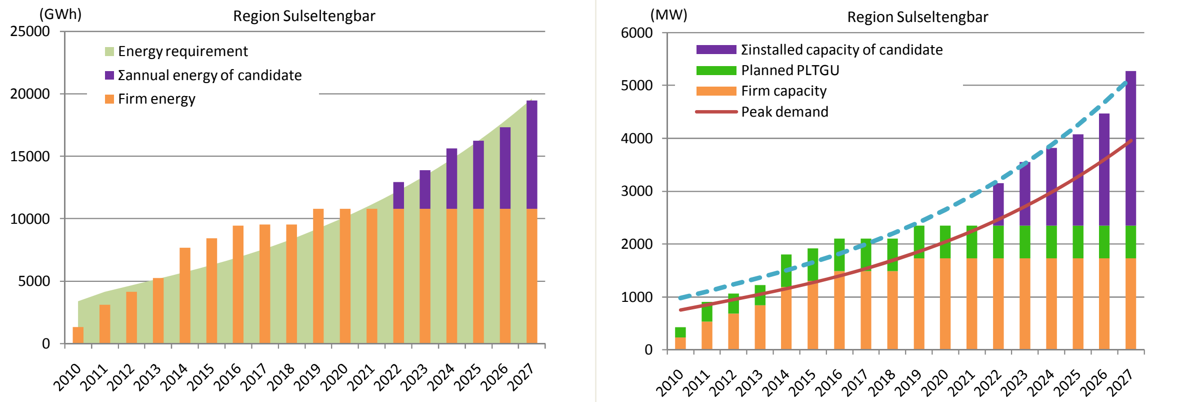
(a) Energy basis　　(b) Power basis

Figure 7.6.9　Demand and Supply Balance (Sultra region)

iii)　Central, West and South Sulawesi (Sulseltengbar)

➢　Supply and demand balance examination

The Sulselrabar system consists of the systems in the provinces of Central Sulawesi (south of Palu), West Sulawesi, South Sulawesi, and the aforementioned Southeast Sulawesi.　As noted above, along with the development of large-scale power sources in Central Sulawesi Province, the systems in Central, Southeast, and South Sulawesi provinces are being interlinked by means of a 275kV system for the purpose of power reserve rationalization.　The Study Team examined the supply-demand balance in the regions remaining after subtraction of the balance in the area of Southeast Sulawesi, as shown in the figure below.



(a) Energy basis (b) Power basis

Figure 7.6.10 Demand and Supply Balance (Sulseltengbar region)

Most of the demand in this region is occupied by the Makassar branch. Relative to this demand, the large-scale candidate sites are concentrated in the area from Central to northern South Sulawesi. Judging from the gross generation capacity, it would be appropriate to introduce a 500kV system. A 500kV trunk system with a total length of more than 500 km from candidate site 7 (Lariang 7) to the Makassar vicinity will be needed beginning in 2022. Power could be efficiently transmitted by setting up 500/150kV GI sites at three locations in the northern, central, and southern parts of South Sulawesi at least. This would make it possible to achieve the system change for easy reinforcement of the existing load system.

As for other hydropower candidate sites, candidate 6 (Bungka-2) would have a large generation capacity for the nearby demand, and transmission toward Poso and Sultra would be a prerequisite. The existing transmission line would have to be reinforced to this end.

(2) NTB

a) Generation Development Plan

All hydro candidates described in Chapter 7.3.4 are as follows. All candidates are located in Lombok island.

Table 7.6.16 Hydro candidates (NTB)

	ID	Type	Location	Installed.Cap. (MW)	Annual Energy (GWh)
1	Beburung	ROR	Lombok island	22.0	90.6
2	Putih-1	ROR	Lombok island	5.6	29.0
3	Putih-2	ROR	Lombok island	4.1	22.0
4	Putih-3	ROR	Lombok island	6.1	32.0

In the Lombok system, a 150kV system is slated for input in 2010. Along with the PLTU and PLTP construction, a southern route is to be constructed from the western to the eastern part of the island.

➢ Transmission planning

Candidate sites 1 - 4 lie in the northwestern and western parts of Lombok island. The nearest transmission line is PLTP Beburung, which is slated for construction in 2013. The Study Team therefore estimated the transmission line plans on the assumption of access to this point.

Table 7.6.17　Transmission Development Plan (Lombok)

	From	To	Voltage (kV)	Kind	Lengths (kms)	COD
1	PLTA Beburung	PLTP Sembalun	150	1Hawk 2ccts	20	2019
2	PLTA Putih-1	PLTA Beburung	150	1Hawk 2ccts	12	2020
3	PLTA Putih-2	PLTA Beburung	150	1Hawk 2ccts	6	—
4	PLTA Putih-3	PLTA Beburung	150	1Hawk 2ccts	6	2020

- Supply and demand balance examination

In RUPTL 2010 - 2019, there are plans for construction of a PLTM site (PLTM Kokok Putih, 4 MW) at the Putih river under IPP leadership. There is a strong possibility that this would compete with the aforementioned hydropower candidate site on the Putih river. Candidate site 3, which has basically equivalent generation capacity, was consequently excluded from consideration.

Construction of PLTG with a total capacity of 50 MW for middle to peak power in 2015 and 2016 is being considered for diversification of power sources, but there would be a shortage of both capacity and electrical energy. If the aim is aggressive input of hydropower sources, it would be advisable to input candidate site 1 in 2020 and candidate sites 2 and 4 in 2021.

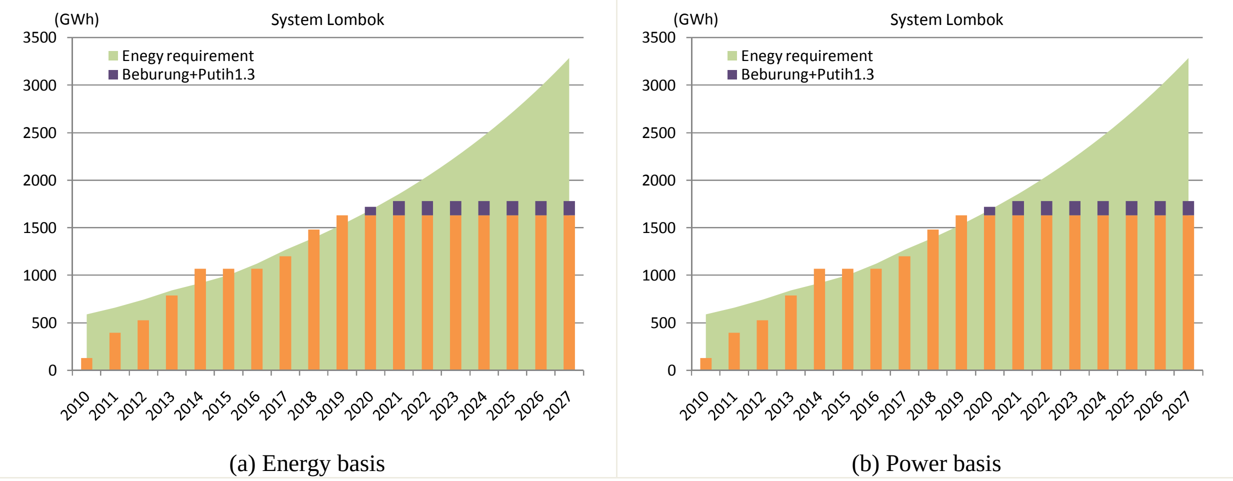


Figure 7.6.11　Supply and Demand Balance (Lombok System)

In the NTB region, Lombok island is the biggest power consumer, and is anticipated to continue exhibiting rapid demand growth over the coming years. Because the island is located only about 40 km from Bali, there is room for future study of an interconnection by 150kV undersea cable.

(3) NTT

All hydro candidates described in Chapter 7.3.4 are as follows. There are some candidates in Sumba and Flores islands.

a) Generation Development Plan

Table 7.6.18 Hydro candidates (NTT)

	ID	Type	Location	Installed.Cap. (MW)	Annual Energy (GWh)
1	Karendi-1	RES	Sumba island (Waikabubak	21.4	49.5
2	Watupanggantu	ROR	Sumba island (Waikabubak	7.1	40.5
3	Kambera-2	RES	Sumba island (Waingapu	17.0	65.2
4	Wai Ranjang	ROR	Flores island	11.1	59.4
5	Parainglala	ROR	Sumba island (Waikabubak	14.9	85.6

i) Wai Ranjang (Candidate site 4)

The candidate site is to be connected on Flores Island. The plans for the island system envision construction of transmission lines upon input of PLTP Sukoria and linkage of various points with a 70kV system in 2014.

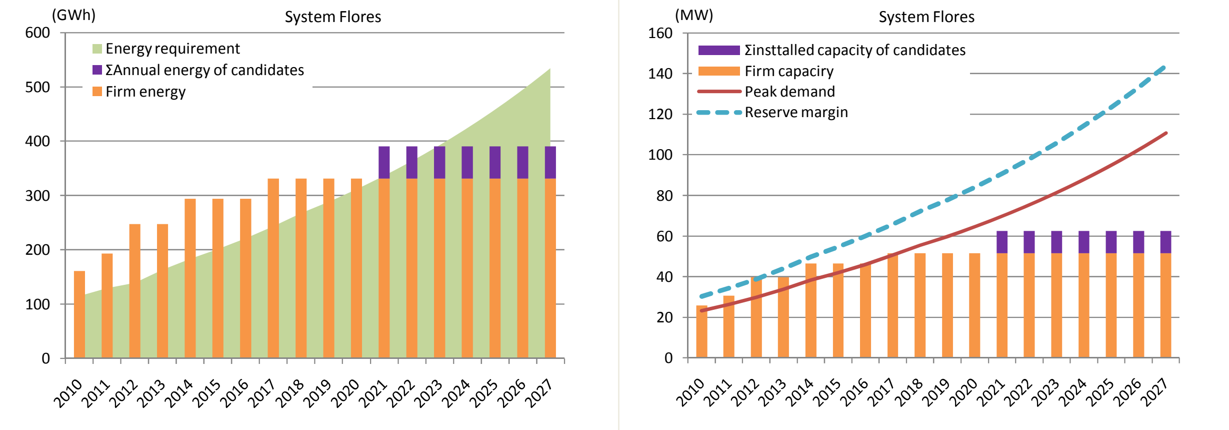
➢ Transmission planning

Table 7.6.19 Transmission development plan (Flores system)

	From	To	Voltage (kV)	Kind	Lengths (kms)	COD
4	PLTA Wai Ranjang	GI Ruteng	70	1Ostrich 2ccts	20	2020

➢ Supply and demand balance examination

Flores should have an ample supply of base power by 2017, in light of the plans for input of a 20MW coal-fired, 26MW geothermal, and 3.6[16] MW hydropower source, for a total capacity of 49.6 MW. PLTA Wai Ranjang will be a ROR hydropower station and could not serve as a source for peak power. It would therefore be advisable to introduce it in 2021, as shown in the figure below. If it would be possible to make a shift to a hydropower station with a regulating reservoir capable of daily adjustment, the input could be made in 2019.



(a) Energy basis (b) Power basis

Figure 7.6.12 Supply and Demand Balance (Flores System)

ii) Candidates in the Sumba island (Karendi-1, Watupanggantu, Kambera-2, Parainglala)

Candidate sites 1, 2, and 5 are to be connected to the Waikabubak system in the western part of Sumba

[16] PLTMs are not included.

island, and candidate site 3, to the Waingapu system in the eastern part. It should be noted that the current plans for the island do not include transmission line construction.

➢ Transmission planning

The Study Team made estimates for a plan for a transmission line linking Waikabubak and Waingapu, the main systems on Sumba island.

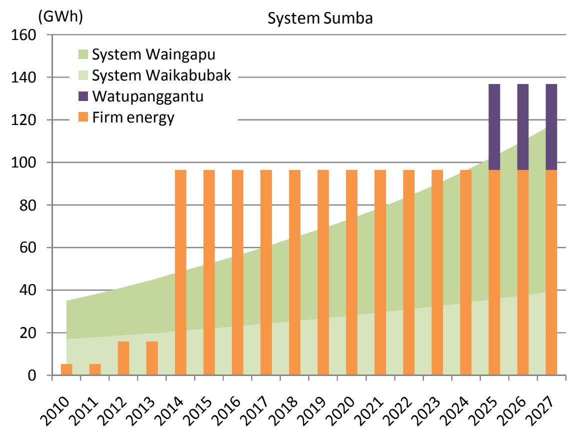
Table 7.6.20 Transmission development plan (Sumba System)

	From	To	Voltage (kV)	Kind	Lengths (kms)
1	PLTA Karendi-1	GI Waikabubak	70	1Ostrich 2ccts	40
2	PLTA Watupanggantu	GI Waikabubak	70	1 Ostrich 2ccts	40
3	PLTA Parainglala	2phi inc.(Waikabubak-Waingapu)	70	1 Ostrich 2ccts	40
5	PLTA Kambera-2	GI Waingapu	70	1 Ostrich 2ccts	60
	GI Waikabubak	GI Waingapu	70	1Hawk 2ccts	200

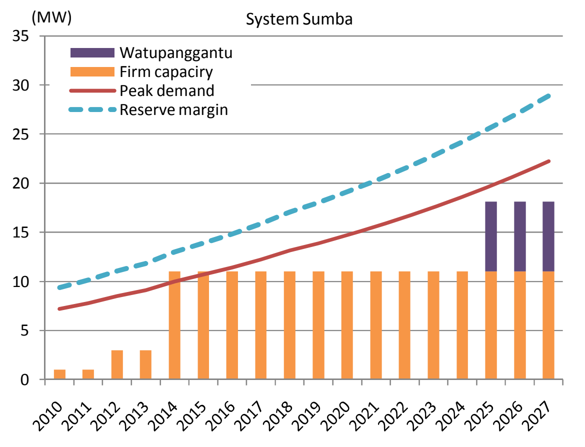
➢ Supply and demand balance examination

The Sumba island systems (Wakabubak and Waingapu combined) will be equipped with a sufficient supply capacity in respect of electrical energy upon the input of PLTU Waingapu (2 x 4 MW) by KPI in 2014. Nevertheless, there will continue to be a short supply for peak demand, and not enough reserve power to cover and subserve the loss of the largest unit (PLTU Waingapu, 4 MW).

This section probes the year for input of PLTA Watupanggantu, which has the highest possibility of development. As shown in the figure below, if the aim is aggressive input of hydropower sources, it would be advisable to input this site upon preparation of the transmission line in 2025.



(a) Energy basis



(b) Power basis

Figure 7.6.13 Demand and Supply Balance (Sumba System)

(4) Papua

a) Generation Development Plan

All hydro candidates described in Chapter 7.3.4 are as follows.

Table 7.6.21 Hydro Candidates (Papua)

	ID	Location <Vicinal system>	Installed.Cap. (MW)	Annual Energy (GWh)
1	Warasai	Nabire system (Papua	231.9	1314.0
2	Jawee-4	Timika system (Papua	152.6	1308.6
3	Derewo-7	Nabire system (Papua	148.8	1180.5
4	Jawee-3	Timika system (Papua	147.2	1163.6
5	Endere-1	Timika system (Papua	144.8	1033.5
6	Endere-2	Timika system (Papua	87.0	727.8
7	Derewo-6	Nabire system (Papua	170.0	1128.4
8	Jawee-2	Timika system (Papua	94.2	755.9
9	Baliem-7	Wamena system (Papua	97.8	834.7
10	Baliem-5	Wamena system (Papua	189.2	1401.4
11	Waryori-4	Manokwari system (West Papua	94.2	598.8
12	Ulawa	Nabire system (Papua	34.6	194.6
13	Gita/Ransiki-1	Manokwari system (West Papua	56.2	136.2
14	Baliem-6	Wamena system (Papua	88.2	754.2
15	Kladuk-2	Sorong system (West Papua	229.0	567.4
16	Tatinima-3	Nabire system (Papua	55.6	402.2
17	Maredrer	Fak fak system (West Papua	8.7	62.4
18	Muturi-1	Manokwari system (West Papua	45.8	288.3
19	Siewa-1	Nabire system (Papua	58.4	330.5
20	Baliem-8	Wamena system (Papua	138.4	1007.0

Among the isolated systems in the Papua region, the biggest demand belongs to the Jayapura system and is forecast to reach 615GWh/108 MW in 2019 and 1,225GWh/215 MW in 2027. This is followed by the demand in the Sorong system, which is forecast to reach 408GWh/215 MW in 2019 and 940GWh/150MWh in 2027. The other isolated systems all have a small demand, and the distance between them is 300 km at the shortest. Achievement of efficient power transportation requires the construction of extra high voltage transmission lines (with a voltage of at least 275 kV), and it would be hard to make this cost-effective. In addition, the generation capacity of candidates would be high for the capacity of the related isolated system in many cases, and this would make it difficult to determine the right year for source input. Therefore, the Study Team made examinations with a view to achieving interconnection of isolated systems as far as possible, with consideration of factors such as the location of the candidate hydropower sites and capacity of isolated systems in the vicinity.

b) Transmission planning (Study on access to individuals)

Table 7.6.22 Transmission Development Plan (Papua)

	From	To	Voltage (kV)	Kind	Lengths (kms)	Remark
Papua Barat - Manokwari system						
11	Waryori-4	Manokwari	150	2Hawk 2ccts	100	ROR
13	Gita/Ransiki-1	Manokwari	150	2Hawk 2ccts	100	LOT
18	Muturi-1	PLTA Gita/Ransiki-1	150	2Hawk 2ccts	40	ROR
Papua Barat - Sorong system						
15	Kladuk-2	Sorong	150	2Hawk 2ccts	120	RES
Papua Barat - Fak fak system						
17	Maredrer	Fak fak	150	1Hawk 2ccts	20	ROR
Papua - Nabire system						
1	Warasai	PLTA Ulawa	150	2Zebra 2ccts	30	ROR
2	Derewo-7	PLTA Derewo-6	150	2Hawk 2ccts	40	ROR
7	Derewo-6	Nabire	150	2Hawk 2ccts	160	ROR
12	Ulawa	Nabire	150	2Zebra 2ccts	200	ROR
16	Tatinima-3	Nabire	150	2Zebra 2ccts	260	ROR
19	Siewa-1	Nabire	150	2Hawk 2ccts	300	ROR

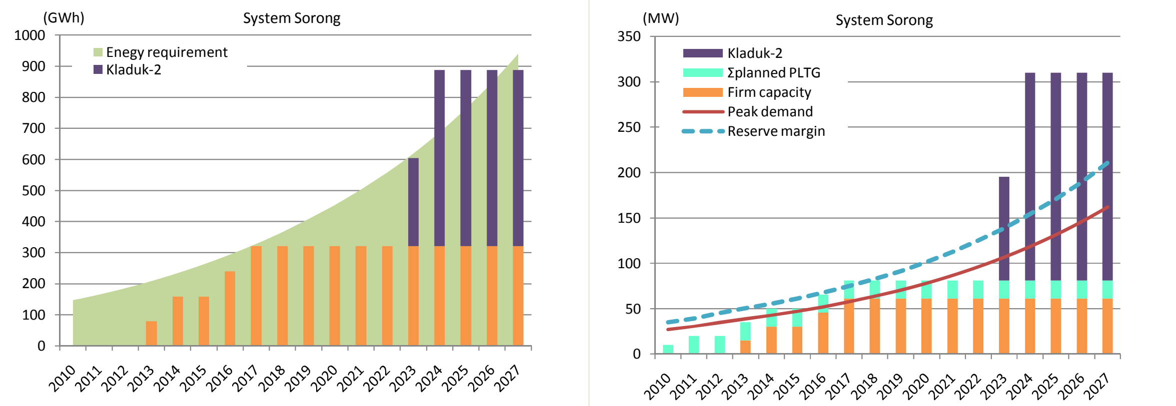
Papua - Timika system						
2	Jawee-4	PLTA Endere-1	150	2Zebra 2ccts	20	ROR
4	Jawee-3	PLTA Endere-1	150	2Zebra 2ccts	20	ROR
5	Endere-1	PLTA Endere-2	150	2Zebra 2ccts	20	ROR
6	Endere-2	PLTA Jawee-2	150	2Zebra 2ccts	20	ROR
8	Jawee-2	Timika	150	2Zebra 2ccts	300	ROR
Papua - Wamena system						
9	Baliem-7	PLTA Baliem-6	150	2Zebra 2ccts	16	ROR
10	Baliem-5	Wamena	150	2Zebra 2ccts	100	ROR
14	Baliem-6	PLTA Baliem-5	150	2Zebra 2ccts	20	ROR
20	Baliem-8	PLTA Baliem7	150	2Zebra 2ccts	20	ROR

i) Candidates nearby Sorong system

➢ Supply and demand balance examination

The Sorong system is situated on the western end of West Papua Province. Candidate site 15 (Kladuk-2) is a large-scale reservoir-type hydropower station with a rated capacity of 229 MW, more than the system capacity. Even assuming a unit capacity of 57.25 MW (one-fourth as large as the rated capacity), assurance of reserve capability in the event of loss of one unit would have to be done with the other units in the same station.

The Sorong system exhibits a greater tendency toward shortage of electrical energy than peak power. Assuming that the candidate site would be input to help alleviate this energy shortage, the advisable approach would be phased input in 2023 and 2024.



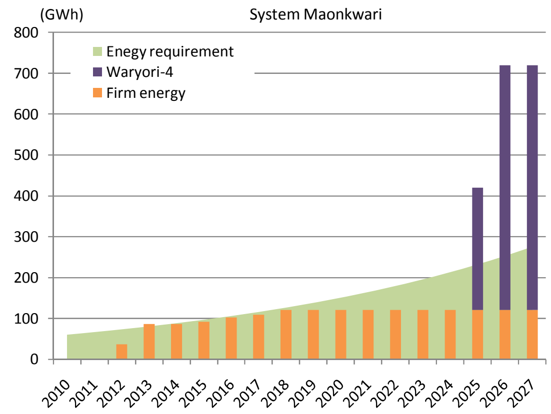
(a) Energy basis (b) Power basis

Figure7.6.14 Supply and Demand Balance (Sorong System)

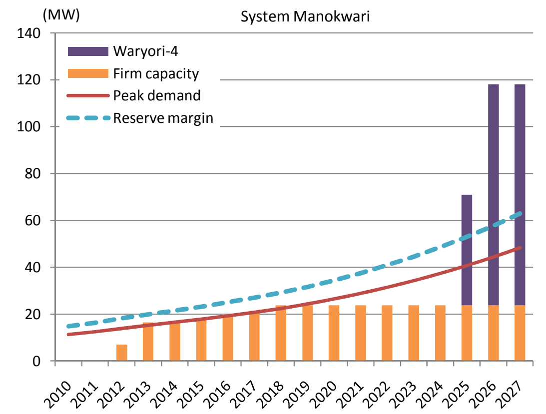
ii) Candidates nearby Manokwari system

➢ Supply and demand balance examination

The Manokwari system lies in the northeastern part of West Papua Province. Candidate sites 11, 13, and 18 have a larger rated capacity than the system capacity, and would have to be input in phases, as in the case of the Sorong system. Moreover, the demand growth is slower than in the Sorong system. Even assuming input of candidate site 11 (Waryori-4), which offers the highest economic internal rate of return (EIRR), there would be an excess of supply until 2027.



(a) Energy basis



(b) Power basis

Figure7.6.15 Supply and Demand Balance (Manokwari System)

iii) Sorong-Manokwari interconnection System

The Sorong and Manokwari systems described in the preceding items are thought to present relatively few obstacles to construction of transmission lines. The physical distance involved is on the order of 300 km, and access roads are available. As noted above, the rated capacity of the hydropower candidate sites is quite large for the system capacity, and this would work against aggressive input of hydropower. The Study Team therefore considered the prospect of hydropower input for an interconnected Sorong-Manokwari system.

➢ Transmission planning (Study of an interconnected system)

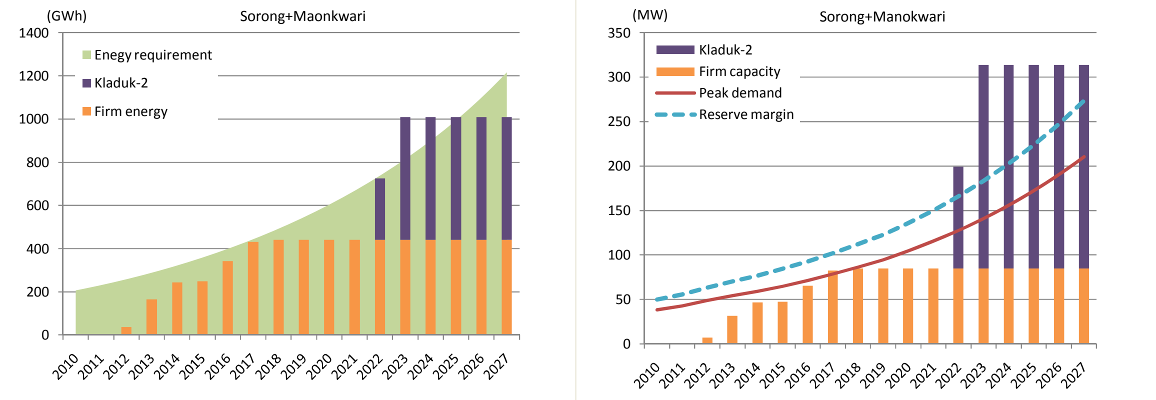
In view of the distance from the interconnected system and the prospects for expansion of the regional load system, candidate site 15 (Kladuk-2) was selected as the site for hydropower input.

Table 7.6.23 Transmission Development Plan (Sorong – Manokwari System)

	From	To	Voltage (kV)	Kind	Lengths (kms)
4	PLTA Kladuk-2	GI Megamo	150	2Hawk 2ccts	70
	GI Sorong	GI Megamo	275	1Zebra 2ccts	140
	GI Megamo	GI Maknowari	275	1Zebra 2ccts	250

➢ Supply and demand balance examination

As shown in the figure below, the Study Team envisioned a phased input in 2022 and 2023.



(a) Energy basis

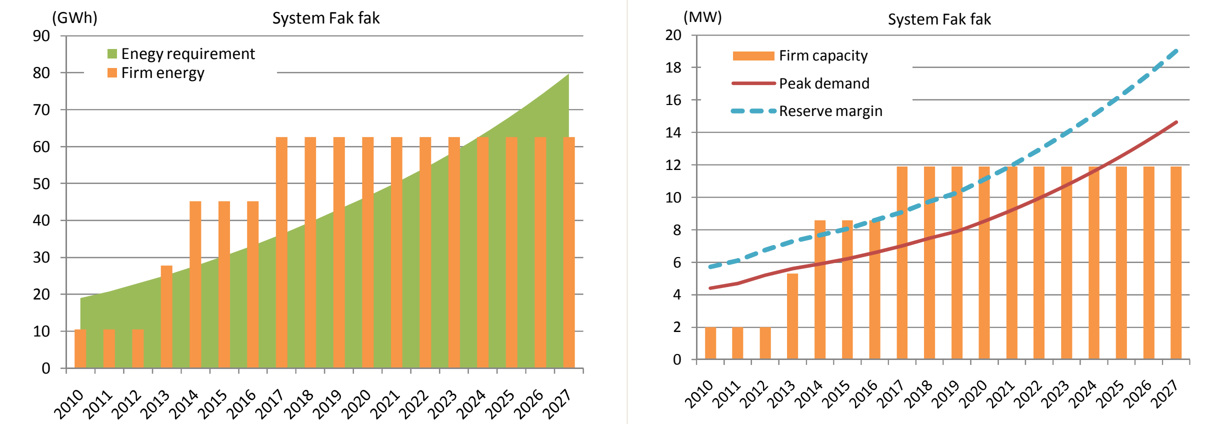
(b) Power basis

Figure7.6.16 Supply and Demand Balance (Sorong-Manokwari interconnection System)

iv) Candidates nearby Fak fak System

➢ Supply and demand balance examination

The Fak-fak system is situated in the southern part of Papua Province. In terms of both firm capacity and firm energy calculated on the basis of RUPTL 2010 - 2019, its supply should be sufficient for the time being, and input of candidate site 17 (Maredrer; generation capacity of 8.7 MW, annual energy of 62.4 GW) would cause a situation of excess supply. It would also be difficult to make an interconnection with the nearest isolated system.



(a) Energy basis

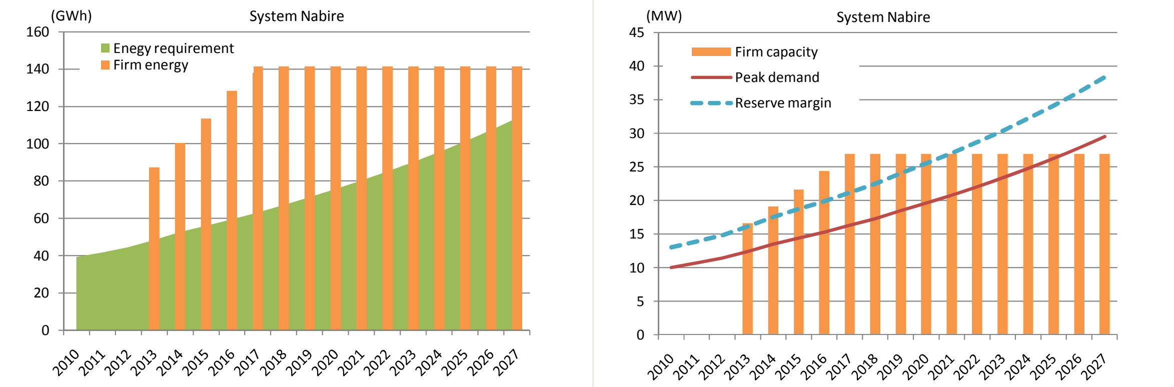
(b) Power basis

Figure 7.6.17 Supply and Demand Balance (Fak fak System)

v) Candidates nearby Nabire System

➢ Supply and demand balance examination

The Nabire system faces Cendrawasih Gulf in the western part of Papua Province. According to RUPTL 2010 - 2019, it should be sufficient in terms of both firm capacity and firm energy for the foreseeable future. Input of candidate sites 1 - 8, which have large generation capacities, would not make sense at this time.



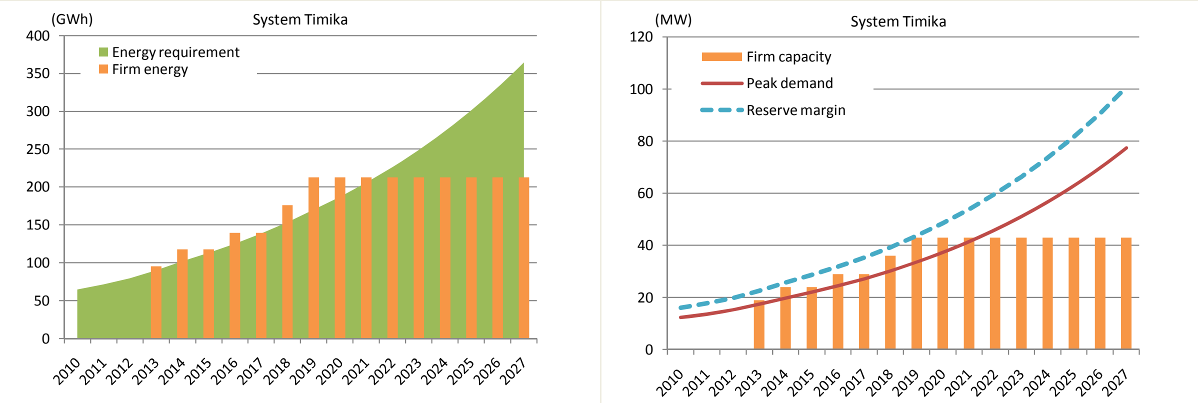
(a) Energy basis (b) Power basis

Figure 7.6.18 Supply and Demand Balance (Nabire System)

vi) Candidates nearby Timika System

➢ Supply and demand balance examination

The Timika system is situated in the southern part of Papua Province. Its supply will become short in terms of both electrical energy and capacity in 2021. However, candidate sites 1, 3, 7, 12, 16, and 19, which are in the vicinity of the system, each have larger generation capacities than the system capacity, and their introduction would not make sense.



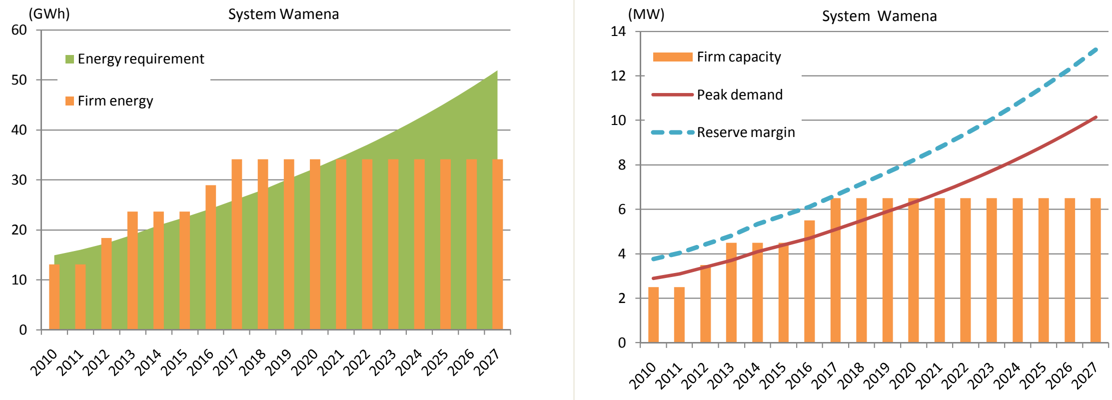
(a) Energy basis (b) Power basis

Figure 7.6.19 Supply and Demand Balance (Timika System)

vii) Candidates nearby Wamena System

➢ Supply and demand balance examination

The Wamena system is situated in the Baliem Valley in the central part of Papua Province. Its supply will become short in terms of both electrical energy and capacity in 2020. However, candidate sites 9, 10, 14, and 20, which are in the vicinity of the system, each have larger generation capacities than the system capacity, and their introduction would not make sense.



(a) Energy basis (b) Power basis

Figure 7.6.20 Supply and Demand Balance (Wamena System)

viii) Wamena－Jayapura interconnection System

There are no hydropower candidate sites in the vicinity of the Jayapura system, which is in the area with the biggest demand in the Papua region. The nearest isolated system is Wamena, which is taken up in aforementioned item and has a large-scale hydropower candidate sites nearby. The Study Team therefore considered a Wamena-Jayapura interconnection to examine the prospect of hydropower input for supply to the site of large-scale demand.

➢ Transmission planning (Study of an interconnected system)

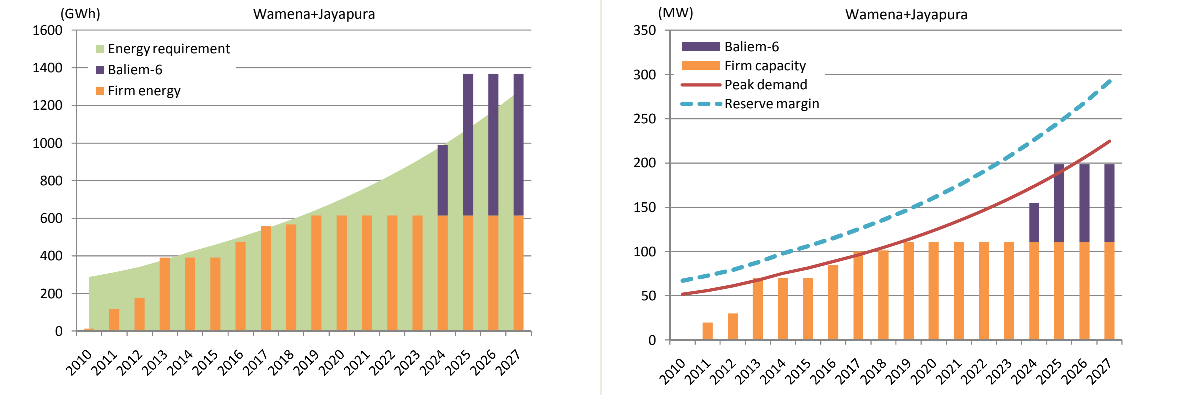
In consideration of the generation capacity, the Study Team selected candidate site 14 (Baliem-6) as the site for hydropower input.

Table 7.6.24 Transmission Development Plan (Wamena - Jayapura interconnection System)

	From	To	Voltage (kV)	Kind	Lengths (kms)
6	PLTA Baliem-6	GI Wamena	275	2Zebra 2ccts	120
	GI Wamena	GI Jayapura	275	2Zebra 2ccts	640

➢ Supply and demand balance examination

As shown in the figure below, the plan envisions phased input in 2024 and 2025.



(a) Energy basis

(b) Power basis

Figure 7.6.21 Supply and Demand Balance (Wamena - Jayapura interconnection System)

7.6.3 PRELIMINARY STUDY CONCERNING THE POSSIBILITY OF INPUT OF PUMPED STORAGE HYDROPOWER SOURCES INTO THE SUMATRA SYSTEM

There are plans for input of pumped storage hydropower sources in the Java-Madura-Bali system as a measure to meet the increasing peak power. In collaborative work with the counterpart, the Study Team learned that pumped storage hydropower is being considered as a possible type of power source for peak power in the Sumatra system, and was requested to make a preliminary study of this prospect in the context of this study. In response, the Study Team made a preliminary examination of this possibility from the perspective of system operation, in order to study power sources for peak power in the Sumatra system.

The plans for generation development in the Sumatra system in RUPTL 2010 - 2019 are premised on an increase in the amount of electrical energy generated by HSD beginning in 2018 after a temporary decrease. This indicates another rise in HSD-use power sources due to the shortage of sources for peak power supply, and is out of step with the aim of de-dieselization.

Table 7.6.25 Breakdown of energy balance by type of fuel（Sumatra System）

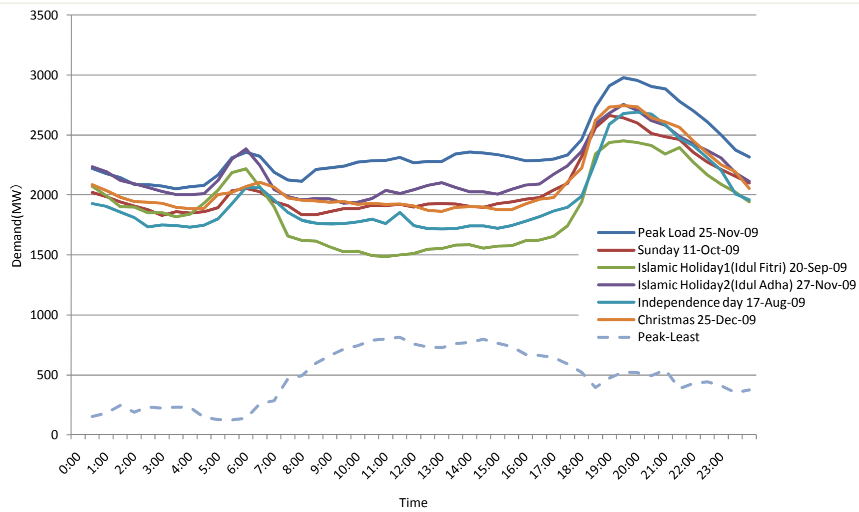
(GWh)

Kind	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Coal	5564	8177	10939	11854	13937	16706	19492	24960	27142	31292
Gas	6455	7143	8849	8725	7398	7347	6988	4927	5819	5354
HSD	4573	3123	1218	65	57	90	279	574	1287	1295
Geothermal	64	416	804	4094	6830	7965	9454	9736	10151	11639
Hydro	3457	3353	2999	3607	3607	3697	4053	4689	5227	5227
Total	21533	23470	25707	28345	31829	35805	40266	44886	49626	54807
Peak Load(MW)	3832	4133	4460	4816	5202	5622	6090	6602	7164	7657

Source : RUPTL 2010-2019, and RUKN 2008-2027

(1) Daily load curve forecasting

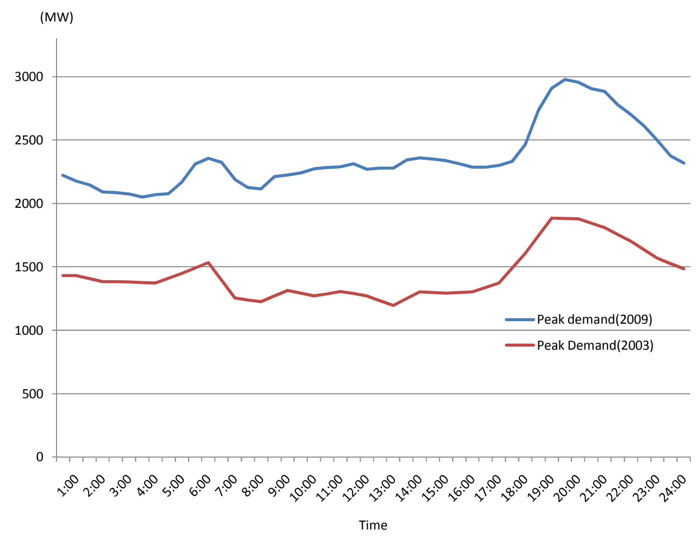
Figure shown below represents several records of Sumatra system's daily load curve in 2009.



Source : JICA Study Team based on evidences by P3B Sumatera

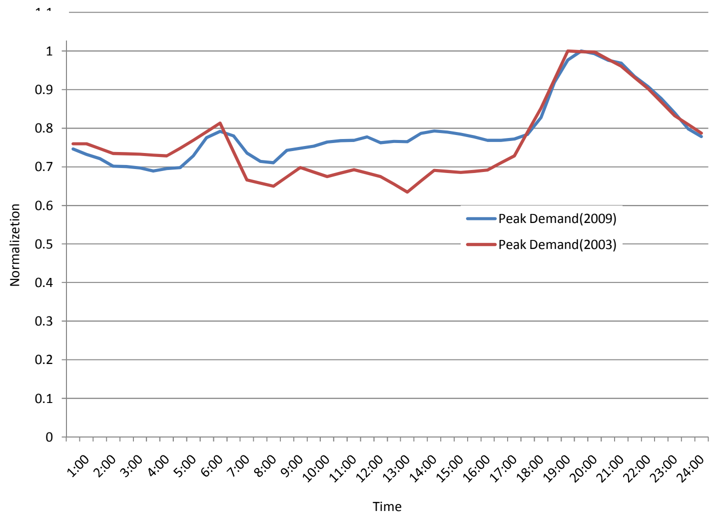
Figure 7.6.22 Daily load curves in Sumatra system (2009)

In the Sumatra system, the peak comes during the lighting hours (6 - 10:00 PM). A comparison was drawn between the typical daily load curve in 2003 and the daily load curve recording peak power in 2009. Over the intervening six years, the system capacity underwent a 1.5-fold increase from 2,000 to 3,000 MW. As shown in the chart, which is normalized by peak power, the patterns during the early morning and lighting hours proximate each other, and the daytime demand has increased by about 10 percent. This is presumably due to a substantial increase in the daytime demand driven by industrial sector. These signs are also clear from the peak-least curve shown in Figure 7.6.24. It is thought that coming years will bring a continuation of this trend and further increase in the daytime demand. Similarly, the electrification rate, which is still low, will probably approach the figures targeted by the national government along with the dramatic expansion of the Sumatra system. Figure 7.6.27 shows the forecast for the daily load curve during the peak power hours in 2019 and 2027. This forecast took account of the aforementioned conditions and was based on the power demand forecast presented in previous sections as well as the indicators in the forecast of the Sumatra system power demand in PUKN 2008 - 2027.The forecast daily load curve in 2019 indicates that the daytime peak power will already be larger than the early morning peak power in that year. Due to the rise in daytime peak power, the gap between peak power and off-peak power is expected to reach a maximum of 2,500 MW in 2009 and 5,000 MW in 2027. The following section examines the balance operation to determine the amount of nighttime surplus power as viewed from the power source constitution.



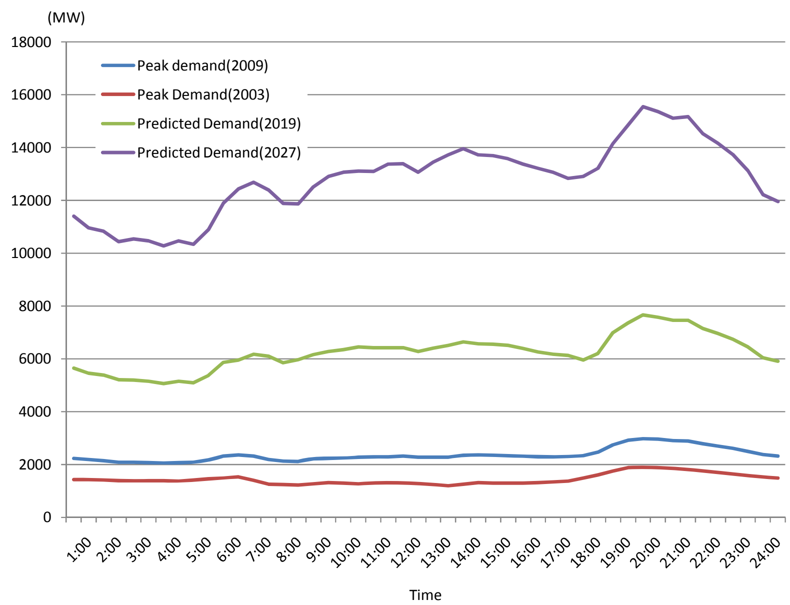
Source : JICA Study Team based on evidences by P3B Sumatera, and Sumatra MP(JICA)

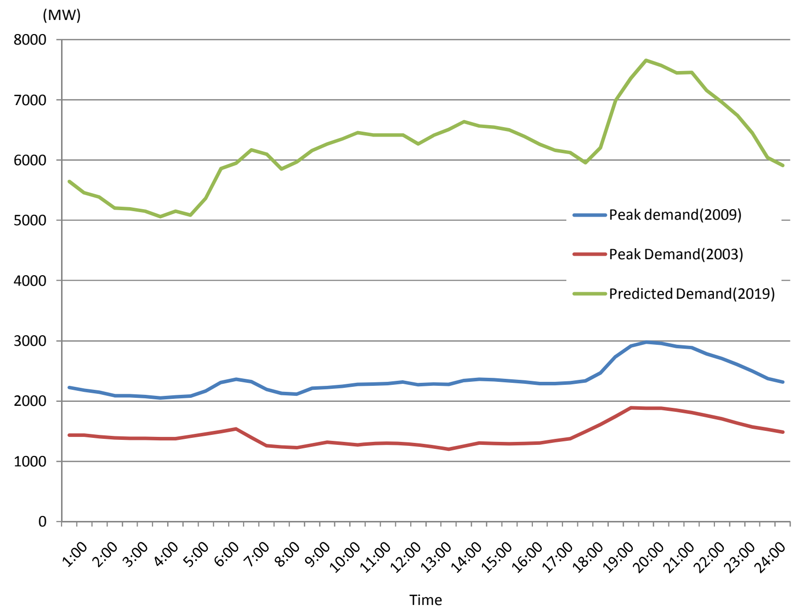
Figure 7.6.23 Transition of daily load curve shapes in Sumatra system (2003 and 2009)



Source : JICA Study Team based on evidences by P3B Sumatera, and Sumatra MP(JICA)

Figure 7.6.24 Transition of daily load curves in Sumatra system (normalization with peak power)





Source : JICA Study Team

Figure 7.6.25 Forecasted Daily Load Curve (2019, 2027)

(2) Determination of the amount of surplus power capacity and requisite pondage capacity

There are two major types of pumped storage hydropower stations: purely pumped storage stations, which have almost no natural inflow into the reservoirs behind them, and hybrid stations, which have some natural inflow. This examination focused on the former, which offer no prospects for a natural increase in amount of water used for power generation. The Study Team estimated that the motors for pumping up water could be operated for about six hours a day, based on the aforementioned nighttime demand shape.. Assuming that the station could be run on a daily cycle, the total load operation duration (hours) can be obtained by the following simple equation.

Possible pumping hours（6h） × total pumping efficiency (0.7) ×

pumping power/generated power ratio (0.85~1)＝3.5～4.2hours

As a result, the hours enabling full-load operation during peak periods are estimated to number about four per day. Excluding factors of instability such as shortage of power for pumping water due to the incidence of major failures during the pumping hours and assurance of water in storage for tight supply in off-peak hours or other situations, it is thought that maximum load operation would definitely be available for at least three hours a day.

As is also clear from the daily load curve on Sundays in 2009, the aforementioned shortages of water in storage due to a shortage of pumping water power and emergency generation to resolve tight supply could be sufficiently resolved by operation of pumps on weekends.

(3) Conformance with generation development plans

a) Estimate of power available for pumping

The Study Team confirmed the power sources and power that could be available for pumping, based on the existing generation development plans. The power source capacity in 2019 indicated in RUPTL 2010 - 2019 and related documents provided the basis for calculation of the anticipated generation capacity (firm portion) that would be operable in the scope of supply-demand balance operation.

Table 7.6.26 Generation constitution at off-peak time situation (2019)

Kind	Installed Capacity (MW)	Unit capacity (MW)	FOR (%)	Maintenance days (days)	Anticipated generation capacity in off-peak time	
					Installed Capacity basis	Net capacity basis
PLTP	2340	55	5	30	1980	1584
PLTU	7319*	100	12	28	2900**	2610**
		200	12	35	1400**	1400**
		300	12	35	600**	600**
PLTA	1717	40	10	30	1360	680
PLTG	1638	100	10	21	(1300)	-
PLTGU	1251	120(40×2+40)	10	42	(840)	-
PLTD	390	10	7	21	(330)	-
Total	18304	-	-	-		6784

Note : cannot be considered extinct generators *: including all fuel types ** : confined to coal-fired thermals.

Source : JICA Study Team based on RUPTL 2010-2019 and evidences from P3B Sumatera

This figure indicates the off-peak power that could definitely be secured in the event of input of power sources in accordance with the generation development plans contained in RUPTL 2010 - 2019. If applied to the daily load curve, it would make for an extremely abundant supply of power, as shown below.

The Study Team considered the degree of influence that a delay in the generation development plans would have on power available for pumping. The results indicated that, to assure a sufficient supply of surplus power in 2019, the sources for base power would have to be operating as planned at least by 2017. The conclusion is the same for 2018, but in 2017 and preceding years, there would be margin for a planning delay of only about one year, and it would be difficult to assure power availability for pumping.

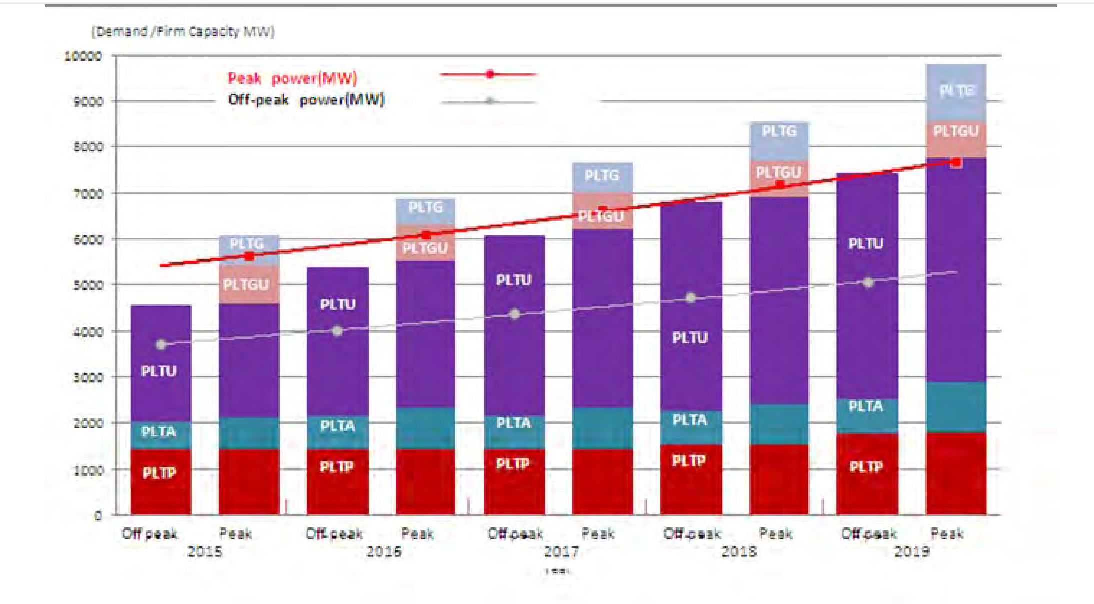


Figure 7.6.26 Firm Capacity at peak time and off-peak time

b) Estimate of power sources for peak power

As described above, an estimate was made of power sources (firm portion) available during the period of peak power occurrence. In 2019, there would be absolutely no problem if the sources are input as planned (on schedule), but delayed input would probably create a need for reserve capacity as additional peak power sources even if the plans are implemented on schedule up to and including 2017. This result conduces that feasible introduction of pumped storage power is after 2018 to ensure reliable power sources of water pumping.

Table 7.6.27 Generation constitution at peak time situation (2019)

Kind	Installed Capacity (MW)	Unit capacity (MW)	FOR (%)	Maintenance days (days)	Anticipated generation capacity in peak time	
					Installed Capacity basis	Net capacity basis
PLTP	2340	55	5	30	1980	1584
PLTU	7319*	100	12	28	2900**	2610**
		200	12	35	1400**	1400**
		300	12	35	600**	600**
PLTA	1717	40	10	30	1360	952
PLTG	1638	100	10	21	1300	1235
PLTGU	1251	120(40×2+40)	10	42	840	798
PLTD	390	10	7	21	330	-
Total	18304	-	-	-	-	9179

Note : cannot be considered extinct generators * : including all fuel types ** : confined to

coal-fired thermals.
Source : JICA Study Team based on RUPTL 2010-2019 and evidences from P3B Sumatera

(4) Correlation between demand grade and supply capability

Stable supply of quality power for the constantly fluctuating demand requires a proper governor-free (GF) [17]capacity and load frequency control (LFC)[18] capacity.

The situation of most concern as regards size of capacity is the incidence of sharp and sudden demand fluctuation. The Study Team considered the prospects for retaining a sufficient reserve capacity in the following timing.

As percentage of system capacity, this study assumed a GF capacity of 3 - 5 percent and an LFC capacity of 5 - 7 percent.

In addition to the above, it is also necessary to ascertain whether the supply capability can be changed with sufficient agility to follow the demand fluctuation, which is an important factor in system operation. The table below shows the basic ramping rates (output response time). The Study Team also made an examination on this point[19].

Table 7.6.28 Applied ramping rate

Kind	Ramping rate (MW/min.)	Remark
PLTU(100MW)	5	
PLTU(200, 300MW)	5	PLTU Suralaya
PLTG	15	
PLTGU	15	In combined running
PLTA	20	

Consequently, it can be confirmed that the situation which generation development, especially development of peak power source, will be delay is not acceptable as shown in the table below.

In other word, there would be plenty of capacity for supply of base power, but also points to the risk that the power source structure would be somewhat lacking in respect of supply capability for peak power, and particularly system soundness in the face of abrupt demand fluctuation.

As aforementioned, it is necessary to develop large scale hydropower (pumped storage hydropower) needs at least 10 years longer as overheads. And it is also feasible to input them in 2019 or 2020 even if the development will be carried out as soon as practicable.

Target installation year	Possibility of source of	Unnecessity of	Development term	Evaluation

[17]The power generation regulation capacity that should be assured as instantaneous reserve power for fine load fluctuations lasting less than a few minutes. Together with the system self-control characteristics, it makes a contribution to the system's frequency stability.

[18]The power generation regulation capacity that should be assured as operating reserve power for comparatively long-term load fluctuation constituents lasting less from a few minutes to over ten minutes. It corresponds to generator surplus during operation at partial load and generators that can be started up and begin supplying power in a fairly short time (hydropower stations including pumped storage types and gas-fired stations).

[19]In the case of gas-fired combined-cycle power stations, the GF capacity was put at zero (i.e., load limit operation) in consideration of operating safety.

(the earliest)	pumping water	supplementary development of peaking generator	(10-year)	
2018	Plan as of 2016 (2-year-delay margin)	Plan as of 2017 (1-year-delay margin)	NG	—
2019	Plan as of 2016 (3-year-advantage)	Plan as of 2017 (2-year-delay margin)	NG	—
2020	Plan as of 2016 (4-year-advantage)	Plan as of 2018 (2-year-delay margin)	OK	○

Based on these results, the Study Team concluded that pumped storage sources would become necessary in 2020 at the earliest.

(5) Estimate of requisite pumped-storage hydropower capacity

While accurate estimation of requisite peak power sources, and particularly LFC capacity, requires consideration of the system frequency characteristics, the Study Team made a simpler estimate of the requisite pumped storage capacity.

The assumptions in the calculations for this simplified estimate were as follows.

- Ability to cope with the loss of the capacity of the biggest single unit within the scope of the system supply-demand balance
- No more than 10 percent of the system capacity

On this basis, the Study Team estimated that a capacity of 400 MW at minimum would be needed to compensate for the loss of a 400MW coal-fired power station, which has the biggest capacity in the generation development plans, and that one of 800 MW at maximum would be needed to curtail the loss to no more than 10 percent of the system capacity in 2020. These figures are basically in conformance with the quotient of division of the electrical energy deriving from HSD in 2019 shown in Table 7.6.26 by operation for an average of four hours per day. They translate into a requisite pumped storage power of 1,030 - 2,060GWh, for which the requisite surplus power could be fully secured.

Pumped storage hydropower plants are one of the best types of source for supply of peak power and for LFC. They are also attracting attention as means[20] of system stabilization along with the recent spread of large-scale photovoltaic (PV) and wind power sources.

[20]Variable speed pumped storage hydropower

CHAPTER 8 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

8.1 INTRODUCTION

Candidate sites for hydropower development were prioritized in the Study by referring the results of “Hydro Inventory & Pre-FS(HPPS2：1999). Upon this, the investment program will be embodied.

While several hydropower development plans has been so far realized, the progress of rather new hydropower projects have been no remarkable. This is because of natural and social environmental issues that were not identified or not fully examined their negative impacts in the previous studies. One of the examples is “the Poigar Second Hydropower Plant” financed by ADB: it was suspended because it was found in the middle of the construction that the project site was located in the part of forest reserve.

JICA requests the recipient governments to introduce the concept of Strategic Environmental Assessment (SEA) when conducting Master Plan studies based on the “JICA Guideline for Environmental and Social Considerations (April 2004)”. The objective of the SEA is to address a wide range of environmental and social factors from an early stage to project monitoring stage so as to ensure appropriate environmental and social consideration of the proposed projects.

As described in the Chapter 7, the evaluation for project classification was conducted using three natural and social environment parameters in the course of the environmental and social consideration of IEE level to address environmental and social issues as early stage as possible.

In this chapter, first, the legal framework of environmental administration and the policy of land acquisition and resettlement of Indonesian government were reviewed. Then, the characteristics of environmental and social aspects of the two generation systems which are applied in the Master Plan were clarified. The results of the clarification were summarized in the form of “Environmental Check list”. The alternatives for the Master Plan from the view points of the environmental and social consideration were examined for policy making by applying SEA.

The stakeholders meeting (SHM) were held three times for the Study and the results of the discussion in the SHMs were taken the account in to the Draft final report for the Study.

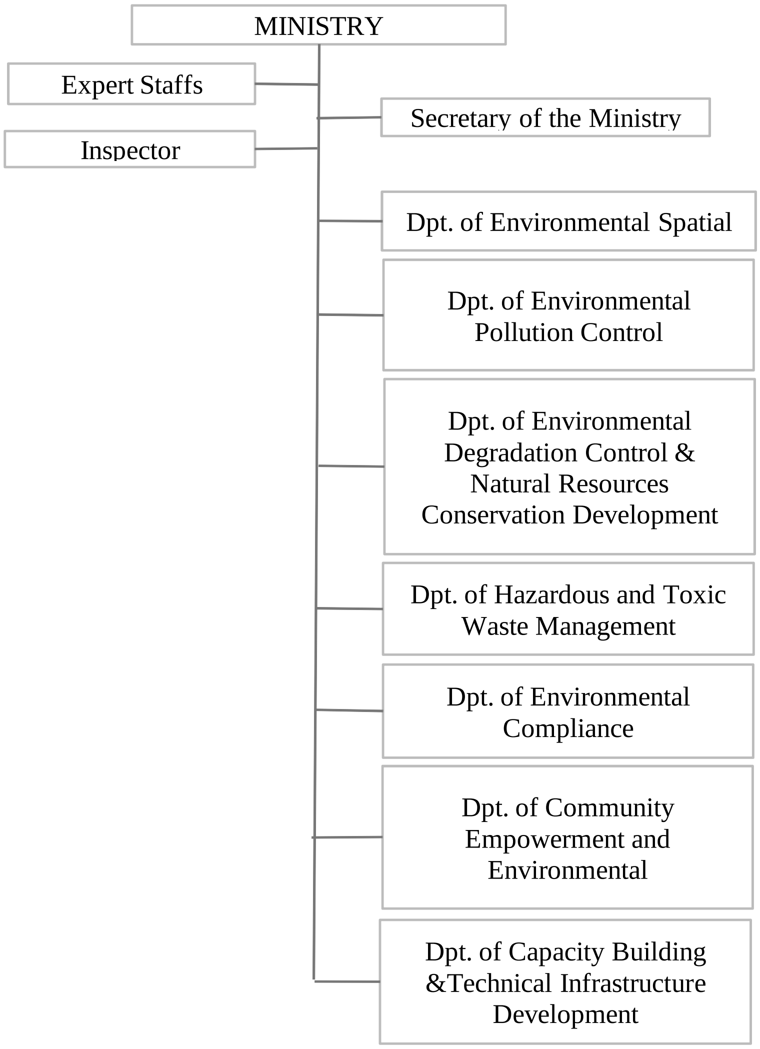
8.2 LEGAL FRAMEWORK OF ENVIRONMENTAL ADMINISTRATION

8.2.1 ENVIRONMENTAL ADMINISTRATION

After absorption of the Environmental Impact Management Agency (BAPEDAL) into the Ministry of Environment (MOE） in 2002, the MOE is the central responsible agency for environmental administration. The responsibilities and duties for the MOE are as follows;

- Establishment of environmental strategies, policies, environmental standards,
- Regulation and management of hazardous and toxic substances,
- Environmental monitoring,
- Capacity building,
- AMDAL,
- Environmental research,
- Environmental data collection,
- Environmental management, and
- Public relations etc.

Figure 8.2.1 shows the organization of MOE.



Source: State Ministry of Environment

Figure 8.2.1 Organization of MOE

8.2.2 ENVIRONMENTAL PROTECTION AND MANAGEMENT LAW (NO.32/2009)

Environmental Protection and Management Law in Indonesia was established in 1982 and amended in 2009 as Environmental Protection and Management Law (No.32/2009). It provides the responsibilities for execution of environmental impact assessment (AMDAL). The stipulate describes criteria for substantial affecting business and/or activity which are obliged to have AMDAL as follows.

(1) Criteria for substantial affecting business and/or activity which are oblige to have AMDAL shall consist of:

- Change in form of land and landscape;
- Exploitation of natural resources, renewable or non-renewable;
- Process and activity potential to cause environmental pollution and/or damage as well as the

squandering and degradation of natural resources in the utilization;

- Process and activity whose output could influence natural environment, artificial environment as well as socio and cultural environment;
- Process and activity whose output would influence the preservation of natural resource conservation area and/or protection of cultural reserve;
- Introduction of plants, animals and micro-organisms;
- Production and utilization of biological and non-biological substances;
- Activity containing high risk and/or influence state defense; and/or
- Technology application predicted to influence the environment potentially.

(2) The document of AMDAL shall contain:

- Analysis of impacts of the planned business and/or activity;
- Evaluation of activities around the location of the planned business and/or activity;
- Recommendation, input as well as response of the people to the planned business and/or activity;
- Estimates related to the quantity of impacts and substantial characteristics of impacts which arise if the planned business and/or activity is implemented;
- Holistic evaluation of the arising impacts to determine whether the environment is feasible or not; and
- Environmental management and monitoring plan.

8.2.3 ACTIVITIES NEEDED TO CONDUCT ENVIRONMENTAL IMPACT ASSESSMENT (AMDAL)

Type of business plans and / or activity that should be completed with the environmental impact assessment is indicated in State Ministry of Environment Regulation No.11/2006. Table 8.2.1 shows those types of business and/or activity included in Electricity and energy utilization.

Table 8.2.1 Activities Needed to Conduct AMDAL(Electricity and energy utilization)

NO	ACTIVITY	SCALE
1	Construction of the transmission network	- > 150 kV
2	Development a. PLTD / Gas Power Plant / Power Plant / Combined Cycle Power Plant	≥ 100 MW (in one location)
	b. Development PLTP (geothermal development)	≥ 55 MW
	c. Hydroelectric Development by: - High dam, or - Area of inundation, or - Installed capacity	 ≥ 15 m ≥ 200 ha ≥ 50 MW

NO	ACTIVITY	SCALE
	d. Construction of power plants from other species (such as: OTEC (Ocean Thermal Energy Conversion), Solar, Wind, Biomass, Peat, etc.)	≥ 10 MW

Source: State Ministry of Environment Regulation No.11/2006

8.2.4 ENVIRONMENTAL IMPACT ASSESSMENT (AMDAL)

(1) Documents Necessary for the AMDAL

According to the State Ministry of Environment Decree No.8/2006, documents necessary for the AMDAL consist of following items.

1) Terms of References Framework for Environmental Impact Analysis (KA-ANDAL)

KA-ANDAL is prepared for formulating the scope and depth of Environmental Impact Analysis (ANDAL).

2) Environmental Impact Analysis (ANDAL)

ANDAL describes expected significant environmental impacts, evaluation of the impacts including selection of alternative and preparation of appropriate environmental mitigation measures in terms of implementation of the proposed project.

3) Environmental Management Plan (RKL)

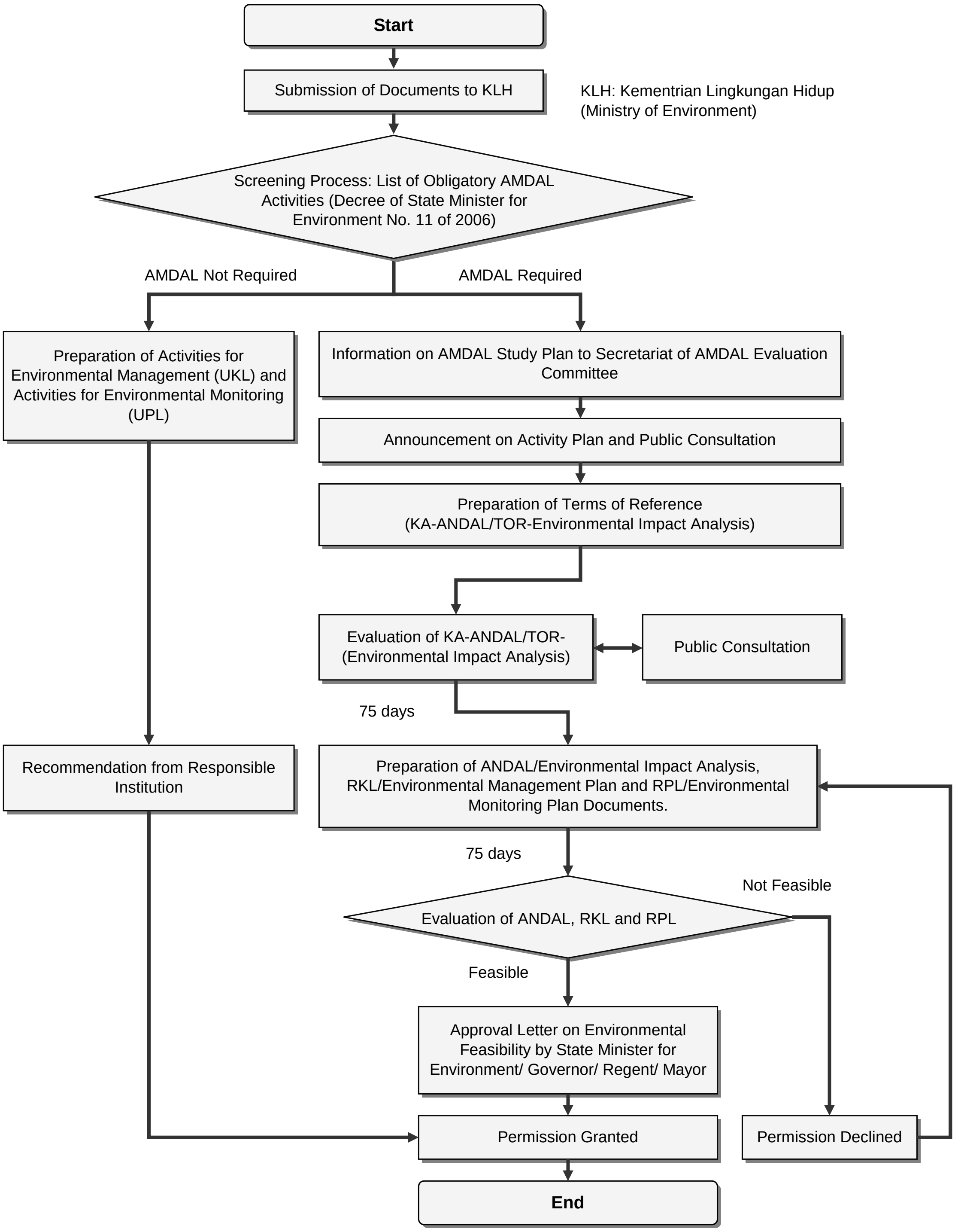
RKL mentions environmental management approaches for mitigating environmental negative impacts forecasted in ANDAL.

4) Environmental Monitoring Plan (RPL)

RPL is the document that has objectives to examine the effectiveness of proposed environmental management plan.

(2) Procedures for AMDAL Implementation

The Government regulation No.27/1999 describes the procedures for AMDAL as shown in Figure 8.2.2.



Source: Study Team based on Government regulation No.27/1999

Figure 8.2.2 Procedural Flow of Environmental Impact Analysis (AMDAL)

(3) Committee of AMDAL

Committee of AMDAL is established to conduct review of the AK-ANDAL, ANDAL, RKL and RPL for proposed projects. The Committee will be established in project-wise by approval authorities such as Minister of Environment, Governor and Mayer decided depending on the size of the proposed project. According to the Article.30 of the Environmental Protection and Management Law (No.32/2009), the AMDALcommittee consists of following members.

1) Membership of Committee of AMDAL

- Representative from environmental institution;
- Representative from related technical institution;
- Expert in related knowledge with kind of effort and/or activity which has been studied;
- Expert related knowledge with impact that may occur from effort and/or activity which has been studied;
- Representative from community who has potency to be effected by impact; and
- Representative from environmental Non-Governmental Organization

The AMDAL committee are classified into the central, provintial and district AMDAL committee depending on the category and size of the proposed project. The State Ministry of Environment Decree No.5/2008 indicates the responsible AMDAL Comiittee for each category and/or size of the proposed projectfor as follows:

1) Central AMDAL Committee: to assess types of business and / or activities is located in more than one area of the province; in the territory dispute with another country;
2) Provincial AMDAL Committee: to assess types of business and / or activities is located in more than one district / city and/or in cross-district / city; and
3) District AMDAL Committee: to assess types of business and / or activities is located in single district.

8.3 POLICY OF LAND ACQUISITION AND RESETTLEMENT

Major relevant regulations of social environmental aspects are outlined below.

8.3.1 CULTURAL PROPERTIES

(1) Relevant Regulations and Authorities

The Law No. 05/1992 regarding Cultural Heritage Objectives as the basic law gives authorization for the state to controle cultural heritages, and Ministry of Education and Culture is the responsible authority. According to the latest information by Ministry of Education and Culture, there are 8,232 sites of cultural heritage at the entire Indonesia in 2007.

8.3.2 SOCIALLY VULNERABLE PEOPLE

(1) Relevant Regulations and Responsible Authorities

The Constitution of Indonesia and Law No.39 of 1990 concerning Human Rights are the fundamental regulations on protection of human rights. In addition, Indonesia ratified International Covenant on Civil and Political Rights (ICCPR) in 2005. However, there is no specific regulation focusing on socially vulnerable people such as the poor, women-headed families or ethnic minority groups.

8.3.3 LAND ACQUISITION AND RESETTLEMENT

(1) Relevant Regulations

The fundamental law on land in Indonesia is the Law No.5 of 1960 concerning Basic Regulation on Agrarian Principles. The major rights related to the project implementation are summarized in the Table 8.3.1.

Table 8.3.1 Rights on Land

Rights	Description
The right of ownership (*Hak milik*)	This is the hereditary and strongest as well as fullest right. Only Indonesian citizen and corporations satisfying Governmental requirements can posse the right of ownership. This right can be transferred to another party.
The right of exploitation (*Hak guna usaha*)	This is the right to cultivate the land which is directly controlled by the Government. 25 years are granted for exploitation to the land more than 5 ha, and 35 years are granted for corporation if 25 years are not enough. This right can be transferred to another party.
The right of building (*Hak guna bangunan*)	This is the right to build or to own a structure on land despite of land ownership. Only Indonesian citizen and corporations domiciling in Indonesia can posse the right. They are granted 30 years, and further 20 years are allowed to be extended. This right can be transferred to another party.
The right of use (*Hak pakai*)	This is the right to use and/or collect products from land despite of land ownership. Indonesian citizen, foreigner residing in Indonesia, corporations domiciling in Indonesia and foreign corporations having a representation in Indonesia are granted for a certain period in a form of gratis, against payment or against services. This right can be transferred if it is possible in the agreement concerned.
The right of lease (Hak sewa)	This is the right to lease the land by paying an amount of money as the rent for its owner. Indonesian citizen, foreigner residing in Indonesia, corporations domiciling in Indonesia and foreign corporations having a representation in Indonesia are granted the right.
The right of opening-up land (*Hak membuka tanah*)	This is the right to opening-up the land, and is granted to Indonesian citizen and one regulated by Government regulations.
The right of collecting forest product (*Hak memungut hasil hutan*)	This is the right to collect forest products, and is granted to Indonesian citizen and one regulated by Government regulations.

Source: Law No.5 of 1960 concerning Basic Regulation on Agrarian Principles compiled by JICA Study Team

Law No. 20/1961 is the basic law for land acquisition in Indonesia, and presidential decrees and another decree define a practical method of land acquisition and consultation. However, there is no regulation which defines resettlement, and therefore resettlement is conducted based on consultation between a project executer and relevant authorities. Table 8.3.2 shows the relevant regulations on land acquisition in Indonesia.

Table 8.3.2 Relevant Regulations

Regulation Name	Description
Law No. 20/1961 regarding Revocation of Right to Land and Materials on Land	It stipulates land acquisition by force and defines land acquisition by force is the last method of land acquisition for the public interest
Presidential Decree No. 36/2005 regarding Procurement of Land for Realizing Development for Public Interest	It stipulates the procedure of land acquisition for public interest.
Presidential Decree No. 65/2006 regarding Amendment of Presidential Decree No. 36/2005 regarding Procurement of Land for Realizing Development for Public Interest	It describes amendment of Presidential Decree No.36/2005. it defines that land acquisition is the activity to obtain land by compensating for the people who abundant their land.
Head of National Land Affairs Agency Decree No. 03/2007 regarding Guideline for Land Acquisition for Public Facilities	This is the basic regulation on land acquisition. It stipulates land acquisition, consultation, compensation and grievance system based on Presidential Decree No. 36/2005 and 65/2006.

Source: JICA Study Team

(2) Targeting Projects for Public Interest

According to the Head of National Land Affairs Agency Decree No. 36/2005 regarding Land Procurement for the Implementation of Development for Public Interest, the following development projects implemented by government or local government are regarded as public interest.

- Public road, highway, road (on land, above the land area, subway), drinking water/clean water network, drainage and sanitations
- Reservoir, dam, irrigation, and water resource construction
- Sea port, air port, railway station, bus station
- Waste disposal facility
- Natural (sanctuary) and cultural preserve
- Electricity power generator, transmission, and distribution

(3) Responsible Authority for Land Acquisition and Resettlement

Land acquisition for public interest is implemented by a project proponent supported by Land Procurement Committee (LPC) and Land Value Appraising Institution or Team (LPAI/T). LPC is established at area-wise according to the location and size of a project based on Head of National land Affairs Agency Decree No. 03/2007 with the definition in Table 8.3.3.

Table 8.3.3 Component of Land Procurement Committee

	City/District Level	Province Level	Central Level
Project location	One District/City	More than Two Districts/Cities	More than Two Provinces
Committee leader	Mayor	Governor	General Secretary at Department of Domestic Affairs

Committee member	a. District Secretary as both Head and Member b. Functionary from local government at the level of echelon II as Vice Head and Member c. Head of District/City Land Office or any functionary appointed as Secretary and Member; and d. Head of agency/office/board in the city/district level related to the implementation of land procurement or any functionary appointed, as Member.	a. Functionary from provincial government at the same level as echelon II as Vice Head and Member; b. Head of Provincial Office of National Land Board or any functionary appointed as Secretary and Member; and c. Head of agency/office/board in the provincial level related to the implementation of land procurement or any functionary appointed as Member.	a. Functionary Echelon I at Department of Public Works as vice head and member b. Functionary Echelon I at National Land Board as secretary and member, c. Director of General/Assistant of Minister/Deputy at related institution to implantation of land procurement as member d. Governor or any functionary appointed at the same level as Echelon II as member e. The mayor or any functionary appointed at the same level as Echelon II as member

Source: Head of National Land Affairs Agency Decree No. 03/2007 regarding Guideline for Land Acquisition for Public Facilities complied by JICA Study Team

Tasks of LPC and LVAI/T are described below;

Table 8.3.4 Tasks of Land Acquisition Committee and Land Price Appraisal Team

Tasks of LPC	Tasks of LPAT
- Conducting consultation with a targeting community of land acquisition - Conducting research and inventory survey on land, buildings and crops/plantations to be acquired, and other objectives attached to the land to be acquired - Confirmation of legal status of the land to be acquired - Conducting negotiation with land owners and a project proponent - Estimation of compensation amount - Confirmation of progress of land acquisition - Preparation of necessary documents on land acquisition	- Calculating compensation amount based on location, regional development plan, condition of infrastructure - Reporting calculation result to LPC

Source: Head of National Land Affairs Agency Decree No. 03/2007 regarding Guideline for Land Acquisition for Public Facilities complied by JICA Study Team

Compensation for land acquisition is conducted with the following form according to Presidential Decree No. 65/2006;

- Money (Cash), and/or
- Replacement land, and/or
- Resettlement, and/or
- Combination of two or more forms of compensation as aforementioned,
- Other forms which are agreed / approved by the related parties.

(4) Procedure of Land Acquisition and Resettlement

Land acquisition for public interests requesting larger than 1ha area is conducted according to Head of

National Land Affairs Agency Decree No. 3/2007 with the following the procedure[1].

1) Preparatory Period

A project proponent prepares the documents of land acquisition, and submits them to the regional land authority for appraisal. The regional land authority evaluates the documents, and approves the land acquisition for public interests with the following condition.

Table 8.3.5 Condition for Approval of Land Acquisition

Acquisition Area	Approval Condition
Less than 25 ha	One year period for land acquisition
Larger than 25 ha	Two years period for land acquisition
Lager than 50 ha	Three years period for land acquisition

Source: Head of National Land Affairs Agency Decree No. 03/2007 regarding Guideline for Land Acquisition for Public Facilities complied by JICA Study Team

Extension of the land acquisition period is approved if 50% of land has been acquired within the designated period in the Table 8.3.5.

A LPC is established, and consultation with project affected persons is conducted with a project executer. In the case that more than 25% of project affected persons disagree with the land acquisition, a LPC suggests to a project proponent to examine alternative land.

2) Inventory Preparation Period

A LPC conducts an inventory study of land possession, utilization and ownership of land, building and other objectives attached to the land when the targeting community accepted the construction plan. The study result is disclosed at the regional authority or website for seven days.

Land value is evaluated by Land Value Appraisal Institute or Land Value Appraisal Team appointed by LPC[2]. Land is valuated based on the Selling Value of Taxed-Object (NJOP) or real/actual market value with other necessary issues such as location and land status.

3) Negotiation Period

Negotiation about land acquisition is held between land owners and a project executer chaired by LPC. If the following conditions are achieved, land acquisition is regarded as succeeded;

- 75% of required land area/location for construction is obtained
- 75% of project affected land owners agreed on the form and/or amount of compensation

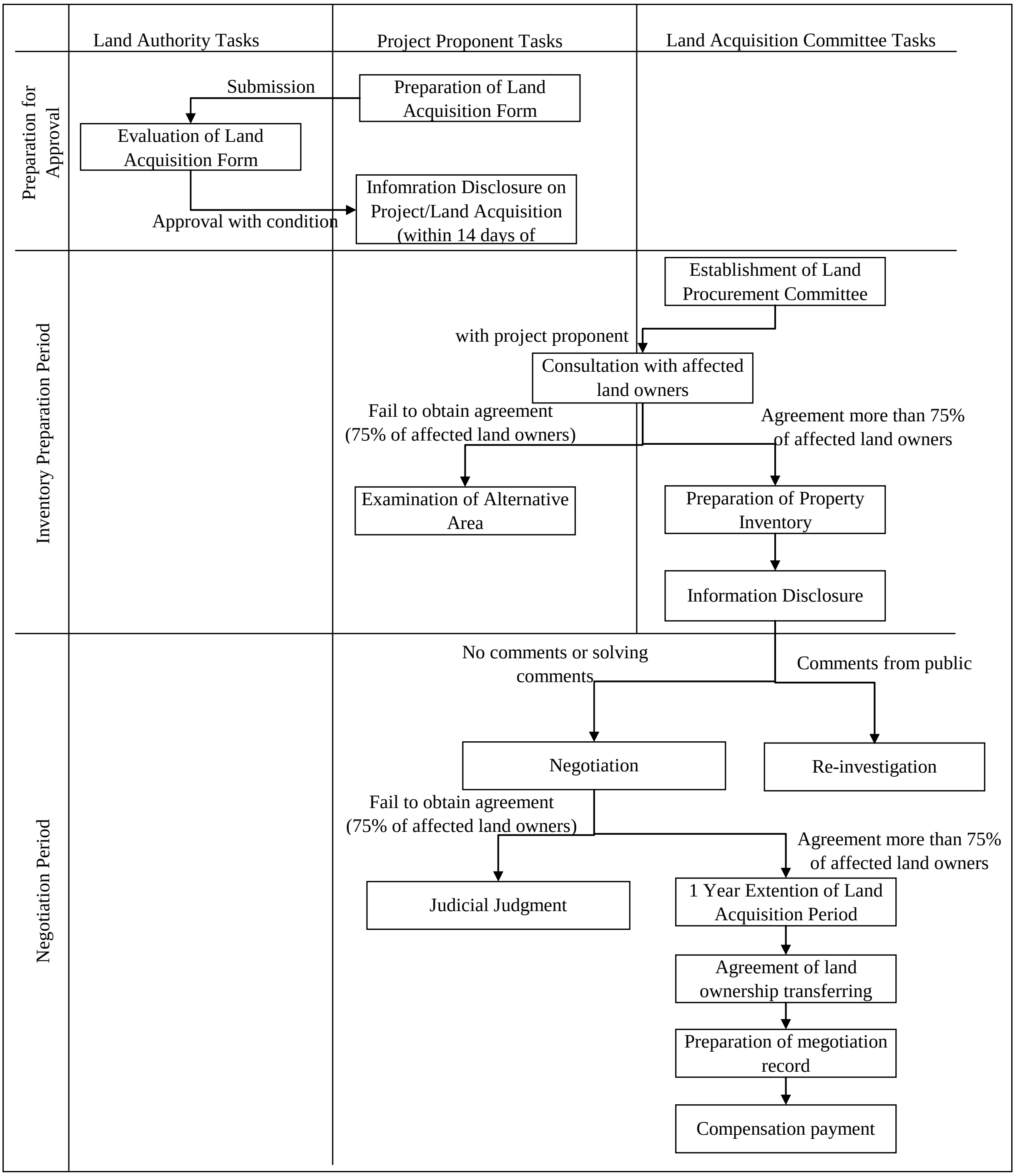
If negotiation is not succeeded within 120 days after consultation, the court handles negotiation.

4) Implementation

LPC prepares the report of negotiation result. A decision of land acquisition including

[1] In the case of a public interest project requesting less than 1 ha, land acquisition is implemented by direct communication between a project proponent and land owners.
[2] If land value appraisal institution does not exist in the area, land value appraisal team is established.

compensation amount and recipients of compensation is issued. Land owners are entitled a right of grievance within fourteen days of the decision issue, and 30 days are given for mayor/governor/Minister of Domestic Affairs to settle grievances. Compensation in cash is paid within 60 days of negotiation. In the case of other forms of compensation, it is done within the agreed period. The procedure of land acquisition is briefly shown in the Figure 8.3.1.



Source: Head of National Land Affairs Agency Decree No. 03/2007 regarding Guideline for Land Acquisition for Public Facilities complied by JICA Study Team

Figure 8.3.1 Procedural Flow of Land Acquisition

8.3.4 CONSISTENCY WITH JICA GUIDELINES

(1) Requirements in JICA Guidelines for Environmental and Social Considerations (April 2010)

Basic concepts of JICA Guidelines for Environmental and Social Considerations (April 2010, hereafter JICA Guidelines (April 2010)) on land acquisition and involuntary resettlement are summarized below, and a recipient country is requested to achieve in the case of ODA projects. Although the Study applies for the JICA Guidelines for Environmental and Social Considerations (April 2004), JICA Guidelines (April 2010) is referred to examine difference from Indonesian regulations, considering the next step.

- Effective measures should be examined to minimize impact. And, consultation with PAPs shall be held to examine compensation for their loss if land acquisition and resettlement are inevitable.
- Sufficient compensation at full replacement cost if possible shall be provided to PAPs in timely manner. Necessary considerations and support shall be provided to PAPs in order to stabilize or improve their livelihood at pre-project level at least.
- Appropriate participation from PAPs and their community shall be promoted in planning, implementation, and monitoring of resettlement action plans and measures. Appropriate and accessible grievance mechanisms shall be established for PAPs and their communities.
- A project of large-scale resettlement shall be prepared resettlement action plan based on consultation with PAPs and disclosed to public. Resettlement action plan is desirable to include the contents described in OP4.12 Annex A of World Bank Safeguard Policy.

(2) Policy Gap between JICA Guidelines and Indonesian Regulations

There are some differences between the JICA Guidelines and the Indonesian regulations on land acquisition and resettlement. Major points are summarized below in Table 8.3.6.

Table 8.3.6 Comparison between JICA Guidelines and Indonesian Regulations

Item	JICA Guidelines/ OP4.12	Indonesian Regulations
RAP Preparation	Preparation of RAP by involving PAPs is requested.	There is no description in the national regulations to prepare RAP as an obligation of a project proponent.
Restoration of Livelihood	Host countries must make efforts to enable people affected by projects and to improve their standard of living, income opportunities, and production levels or at least restore these to pre-project level.	There is no description in the national regulations.
Eligibility of non-title holders	Illegal occupants shall be provided resettlement assistance.	Title holders of affected properties legally or religiously are entitled to receive compensation for their affected properties.
Compensation Calculation	Compensation shall be provided by full replacement cost as much as possible.	Compensation is calculated based on NJOP or current market value by independent valuators.
Socially Vulnerable People	Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, the poor, and ethnic minorities.	There is no description in the national regulations.
Public Participation	Appropriate participation by the people affected and their communities must be promoted in planning, implementation and monitoring of involuntary resettlement plans and measures against the loss of their means of livelihood	Disseminating information of project description and land acquisition is requested within 14 days of project approval. Furthermore, consultation with project affected land owners is requested to be held, and consultation result is necessary to be

		disseminated through website or media.
Grievance Redness	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	There is no description in the national regulations.
Monitoring	Appropriate follow-up plans and systems, such as monitoring plans and environmental management plans, must be prepared; and costs of implementing such plans and systems, and financial methods to fund such costs, must be determined.	There is no description in the national regulations.

Source: JICA Guidelines, Head of National Land Affairs Agency Decree No. 03/2007 regarding Guideline for Land Acquisition for Public Facilities complied by JICA Study Team

(3) Experience of Donor Funding Projects in Indonesia

There were several projects at various sectors funded by World Bank (WB), Asian Development Bank (ADB), JICA, etc. As for PLN projects, the majority of donor funding projects were ADB so far. According to interview to PLN officers, there was a tendency to prepare Land Acquisition and Resettlement Action Plan (LARAP) since the year of 2000 only for donor funding projects though there was no mandatory to prepare such report under Indonesian regulations. At this moment, PLN prepared thirteen LARAP by considering donor policies.

(4) Findings and Actions to be Taken for Achievement of Requirements in JICA Guidelines

From LARAP prepared at the previous projects of PLN, solutions to cover the gaps are confirmed as described in the Table 8.3.7.

Table 8.3.7 Actions Taken for Solving Gaps at Previous Donor Projects

Item of Gaps Confirmed	Actions Taken
RAP Preparation	LARAP is prepared for donor funding projects by considering donor policies.
Restoration of Livelihood	Necessary restoration or rehabilitation is provided in addition to compensation if necessary based on the consultation with PAPs.
Eligibility of Non-title holders	Illegal occupant is provided resettlement assistance by discussing relevant agencies such as Ministry of Forestry.
Compensation Calculation	Compensation is calculated by referring the current market value. If current market value is not enough, additional assistance is provided by a method of non-money assistance based on consultation with PAPs.
Socially Vulnerable People	Appropriate consideration is provided to socially vulnerable people such as women-headed family based on consultation with them.
Public Participation	Public is involved into the project at the public consultation in the process of ANDAL study and socialization for land acquisition.
Grievance Redness	Village leaders usually collect any grievances, and collected grievances are conveyed to PLN local offices.
Monitoring	Internal monitoring is basically conducted in the environmental monitoring at AMDAL, and external monitoring is conducted by hiring independent consultant.

Source: JICA Study Team

It was found from the previous donor funding projects that PLN already experience to solve the gaps found between donor policies and Indonesian regulations. Thus, PLN is capable to challenge to solve gaps between JICA Guidelines and Indonesian regulations by referring previous experience. In order to realize the project, it is necessary to implement compensation and rehabilitation assistance in order to satisfy JICA Guidelines.

8.4 STAKEHOLDER MEETING

A stakeholder meeting (or public consultation) is regulated to conduct three times in the process of AMDAL study according to Indonesian regulations; i) explanation of the project before AMDAL procedure, ii) preparation of KA-ANDAL (TOR), and iii) preparation of ANDAL, RKL, RPL. Thus, stakeholder meeting in the Master Plan study or preliminary feasibility study is not requested in Indonesian legal framework. On the other hand, the basic concept of JICA Guidelines is to disclose information of a project to public and encourage their participation to a project from the early stage of project planning.

In order to respect the concept of JICA Guidelines, stakeholder meetings were held three times in this Study; i) beginning of the study, ii) after preparing interim report, and iii) preparation of draft final report. The lesson-learnt from the stakeholder meetings conducted in this Study and example of Japanese Public Involvement are compiled as “Good Practice for Holding Public Consultation (hereafter “Good Practice”) as enclosed in Appendix 2 to be referential information for PLN to conduct stakeholder meeting in own studies. The Good Practice will be utilized by PLN and updated accordingly in the process of own studies.

(1) First Stakeholder Meeting

The first stakeholder meeting was held on 16th February 2010 at the meeting room in MEMR building. The meeting was hosted by MEMR and PLN support by JICA Study Team. Since holding stakeholder meeting at master plan study level is not common in Indonesia, announcement was made by invitation letter to wide range of stakeholders. A total of 60 people attended, and the main opinions raised from attendants are outlined below.

Table 8.4.1 Outline of 1st Stakeholder Meeting in Jakarta

Item	Description
Purpose	- Background of the Study - Study method and schedule - Explanation of JICA Guidelines
Attendants	MEMR, PLN, Ministry of Environment, Ministry of Forest, NGOs (YBUL), Academic Institutes (IPB)
Main Discussion Point	- Whether or not non-counterparts are able to participate in transfer of technical knowledge program in the Study - What is the difference between HPPS 2 conducted in 1999 and this Study - What is the status of power supply emergency at local area in this Study - What is the reason to apply JICA Guidelines (April 2004) in this Study - Which relevant authorities will participate in this Study

Source: JICA Study Team

Comments from the attendants were mainly focused on approach of the Study. MEMR, PLN and JICA Study Team explained the basic methodology of the Study for the understanding of the attendants.

(2) Second Stakeholder Meeting

The second stakeholder meeting was held on 22nd June 2010 hosted by MEMR and PLN support by JICA Study Team. A total of 50 people attended, and the main opinions raised from attendants are outlined below.

Table 8.4.2 Outline of 2nd Stakeholder Meeting in Jakarta

Item	Description
Purpose	- Project outline - Interim report of the Study - Outline of further investigation
Attendants	MEMR, PLN, Ministry of Forest, NGOs (IBEKA, IIEE, LP3ES, Pelangi), Academic Institutes (ITB)
Main Discussion Point	- Conservation of upstream area is necessary. - The approval procedure defined in the relevant regulations to use forest area is necessary. - Consideration of impact to society, economy and culture is necessary at the construction stage. - Measures how to cope with sedimentation. - Result of selection of Pre FS sites.

Source: JICA Study Team

Ministry of Forest offered assistance to provide various information for smooth implementation of the Study. Further consultation with the ministry was made in conducting the Pre F/S.

(3) Third Stakeholder Meeting

The third stakeholder meeting was held with the objectives of; i) explanation of draft final report including the master plan, ii) explanation of the result of pre-feasibility studies, and iii) explanation of environmental and social considerations for the master plan and pre-feasibility studies.

The third stakeholder meeting was held at the two levels; i) focus group discussion around the site of pre-feasibility studies by inviting regional stakeholders, and ii) open style meeting by inviting central stakeholders at Jakarta. Focus group discussion was held in two times; once in Medan and the other in Bukit Tinggi.

Focus group discussion in Meden was held on 16th June, 2011 to discuss the result of pre-feasibility study for Simanggo-2 hydropower project in North Sumatra Province. A total of 20 people attended and the main opinions raised from attendants are outlined below.

Table 8.4.3 Outline of Focus Groups Discussion at 3rd Stakeholder Meeting in Medan

Item	Description
Purpose	Result of pre-feasibility study for Simanggo-2
Attendants	MEMR, PLN, Officers from Humbang Hasundutan Regency and North Sumatra Province
Main Discussion Point	- Proponent and optimal development scale - Necessity of application for “izin prinsip” for further study - Importance of socialization in EIA stage, especially involving traditional chiefs at the area

Source: JICA Study Team

Focus group discussion in Bukit Tinggi was held on 23rd June, 2011 to discuss the result of pre-feasibility study for Masang-2 hydropower project in West Sumatra Province. A total of 40 people attended and the main opinion raised form attendants are outlined below.

Table 8.2.4 Outline of Focus Groups Discussion at 3rd Stakeholder Meeting in Bukit Tinggi

Item	Description
Purpose	Result of pre-feasibility study for Masang-2
Attendants	MEMR, PLN, Officers from Agam, Pasaman, West Pasaman Regencies and West Sumatra Province
Main Discussion Point	- Necessity of coordination & cooperation among PLN, sub-district, regency and province - Importance of socialization in EIA stage - Possible impact due to sedimentation, flood, water recession, etc.

Source: JICA Study Team

Open style meeting in Jakarta was held on 28th June, 2011. A total of 50 people attended and the main opinion raised from attendants are outlined below.

Table 8.2.5 Outline of Open Style Meeting at 3rd Stakeholder Meeting in Jakarta

Item	Description
Purpose	- Result of pre-feasibility study - Result of focus groups discussion - Result of master plan study
Attendants	MEMR, PLN, Ministry of Environment, Ministry of Forest, BAPPENAS, BPPT, IBRD, NGOs (WWF, Pelangi, IIEE)
Main Discussion Point	- How the optimal scale and maximum plant discharge were determined in Pre F/S - Contribution to power supply in surrounding area of the projects - Application of CDM for the schemes in Pre F/S - Importance of socialization in EIA stage - Necessity of coordination & cooperation with authorities related to forest conservation

Source: JICA Study Team

Attendants at the stakeholder meetings above referred to importance of conducting socialization in the EIA stage, and necessity of coordination and cooperation with the authorities concerned in implementing the projects.

Discussions in detail in the stakeholder meetings are attached in Appendix 2 of this report.

8.5 ENVIRONMENTAL AND SOCIAL CONSIDERATION OF IEE LEVEL

8.5.1 GENERAL

As mentioned already, any environmental studies are not required in the Master Plan stage in Indonesia. While, JICA requests the recipient governments to conduct environmental and social consideration of IEE level in the course of Strategic Environmental Assessment (SEA) when conducting Master Plan studies based on the "JICA Guideline for Environmental and Social Considerations".

The evaluation for project classification was conducted using three natural and social environment parameters in the course of the environmental and social consideration of IEE level to address environmental and social issues as early stage as possible. The three natural and social environment parameters are Forest Classification Involuntary Resettlement and Inundated Area. The evaluation based on the environmental and social consideration contributed to conduct appropriate project prioritization.

In this chapter, environmental check list was prepared based on the clarification of characteristics of the generation system which are included in the M/P and the discussion for alternative for the M/P was carried out in the part of the environmental and social consideration of IEE level.

8.5.2 SUMMARY OF THE MASTER PLAN

According to the M/P, the number of the conventional hydropower projects targeting at 2011-2027 are seventy-two (74) projects as seen in Table 7.4.2.

8.5.3 ENVIRONMENTAL AND SOCIAL CONSIDERATION DEPENDING ON THE GENERATION TYPE

(1) The each characteristics of generation type from the viewpoint of environmental and social consideration

The M/P consists of two generation types, namely run of river type and reservoir type. The problems and basic counter measures were examined through clarification of each characteristics of generation type from the viewpoint of environmental and social consideration.

1) Run of River (ROR)Type

a) Problems

The construction of ROR which includes construction of duct and power house on the ground might cause involuntary resettlement. The occurrence of "water recession section" might cause negative impact on the livelihood of local people living along the section in terms of disturbance on water use for irrigation, fisheries and dairy life. The occurrence of "water recession section" will also cause negative impact on wildlife including endangered species and block the movement of migratory fish species. The construction of duct and power house might cause negative impact on cultural heritages and affect natural landscapes which are part of the source of the tourism. The construction of the linier structures such as open ditch and duct could restrict the movement of wildlife and the habitat of wildlife might be segmented consequently. The construction of open ditch and duct might also induce the increasing of poaching and illegal logging through providing new access to inside of the project areas. The ROR systems has minimum negative impact on global warming due to no using fossil fuel in the process of power generation. Note that air pollution, noise and vibration by construction equipment during construction stage might affect to surround natural environment.

b) Counter measures

It is desirable that establishment of the ROR should be avoided in the areas where involuntary resettlement might be occurred. In order to make the impact in the water recession section on the local people minimum, the present condition of water use and fisheries at the section should be carefully studied in advance. The minimum amount of the river flow meeting the water demand of local people will be ensured based on those study results. As for the wildlife living along the section, especially on endangered species and migratory fish species, it is indispensable to examine the present status to avoid serious negative impact on those wildlife then confirm the minimum amount of the river flow for that. Investigation on cultural heritages at site for the construction of duct and power house should be conducted. In addition, investigation on the surround areas of the site for power houses should be conducted to avoid serious negative impact in terms of the potential as tourist point.

In the process of planning of power station, the present status of wildlife living at surround areas of the site should be investigated so that the construction of open ditch and duct will not disturb the movement of the wildlife. The access road to related facility such as open ditches and ducts will be constructed by the Project. The construction of these roads might induce poach and illegal logging. In order to avoid these illegal behaviors, the establishment of gate at the entrance of the road to restrict those intrusion and periodical patrol should be considered.

Regarding air pollution, noise and vibration by construction equipment during construction stage, appropriate mitigation measures which meet related environmental standard should be established.

2) Reservoir Type

a) Problems

The construction of dam for reservoir type power plant will cause large scale involuntary resettlement in case of planning in the areas where many people are living. In addition, the construction of dam will have negative impact at the downstream in terms of water use, fisheries, river transportation and aquatic ecosystem. The valuable cultural heritages might be under water with the construction of dam. The occurrences of reservoir might disturb existing natural landscape which consists of the tourism resources of the area. On the other hand, the reservoir has certain potential to be new tourism resources which attract tourists and to provide new opportunities for fisheries. However, degradation of water quality of reservoir will cause negative impact on water use at the downstream including irrigation water and water use for daily life as well as inland fisheries and cause negative impact on livelihood of local people consequently. Note that air pollution, noise and vibration by construction equipment during construction stage might affect to surround environment.

Due to the inflow of the trofic salts into the reservoir, eutrophication has been proceeded in the reservoir. The eutrophication induces the outbreak of floating weed and phytoplankton in the reservoir and methane will be emitted consequently. The methane is a kind of "Green house Gas: GHG). Therefore, the construction of reservoir has possibility of generation of large source of GHG.

b) Counter Measure

It is desirable that establishment of the reservoir type power station should be avoided in the areas where involuntary resettlement might be occurred. In order to make the negative impact on the local people minimum, the present condition of water use, fisheries, river transportation and aquatic eco-system of downstream of the dam should be carefully studied in advance. The negative impacts are mainly caused by decreasing of the river level at the downstream of the dam. Investigation on cultural heritages at site for the construction of dam, reservoir and power house should be conducted. In addition, investigation on the surround areas of the site for power houses should be conducted to avoid serious negative impact in terms of the potential as tourist point. In case of disruption of river transportation which is indispensable for local people by construction of dam, the alternative transportation measures should be provided.

In the process of planning of power station, the present status of flora, fauna and eco-system of surround areas of the site should be investigated so that the construction of reservoir will not cause serious negative impact on endangered species, rare species and valuable eco-system etc.

In case of occurring of migratory fish species, the construction of access path in river for those aquatic fauna should be considered as necessary.

Degradation of water quality of reservoir caused by eutrophication will affect water use, fisheries and aquatic eco-system at the downstream of dam and it will induce to generate methane. Therefore, it is important to conduct of monitoring of water quality of the reservoir and to establish mitigation measures such as restriction of water discharge as necessary. Regarding air pollution, noise and vibration by construction equipment during construction stage, appropriate mitigation measures which meet related environmental standard should be established.

(2) Environmental Check List

The environmental check list which highlights important environmental issues is proposed to realize the Master Plan smoothly based on the clarification of the above two electricity generation systems as shown in the Table 8.5.1.

Table 8.5.1 Environmental Check List

Environmental Item	Main Check Items
Social Environment	
(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?
(2) Living and Livelihood	(a) Is there any possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there any possibility that the project causes the change of land uses in the neighboring areas to affect adversely livelihood of local people? (c) Is there any possibility that the project facilities adversely affect the traffic systems? (d) Is there any possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (e) Is the minimum flow required for maintaining downstream water uses secured? (f) Is there any possibility that reductions in water flow downstream or seawater intrusion will have impacts on downstream water and land uses? (g) Is there any possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? (h) Is there any possibility that fishery rights, water usage rights, and common usage rights, etc. would be restricted?
(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?
(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?

(5) Ethnic Minorities and Indigenous Peoples	(a) Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples? (b) Are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples?
Natural Environment	
(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?
(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that the project will adversely affect downstream aquatic organisms, animals, plants, and ecosystems? Are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that installation of structures, such as dams will block the movement of the migratory fish species (such as salmon, trout and eel those move between rivers and sea for spawning)? Are adequate measures taken to reduce the impacts on these species?
(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the installation of structures, such as weirs will adversely affect the surface and groundwater flows (especially in "run of the river generation" projects)?
(4) Topography and Geology	(a) Is there a possibility that reductions in sediment loads downstream due to settling of suspended particles in the reservoir will cause impacts, such as scouring of the downstream riverbeds and soil erosion? Is there a possibility that sedimentation of the reservoir will cause loss of the storage capacity, water logging upstream, and formation of sediment deposits at the reservoir entrance? Are the possibilities of the impacts studied, and adequate prevention measures taken? (b) Is there a possibility that the project will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas (especially in run of the river generation projects and geothermal power generation projects)?
(5)Global Warming	(a) No emission of GHG(Methane) due to eutrophication of reservoir?
Environmental Pollution	
(1) Water Quality	(a) Does the water quality of dam pond/reservoir comply with the country's ambient water quality standards? Is there a possibility that proliferation of phytoplankton and zooplankton will occur? (b) Does the quality of water discharged from the dam pond/reservoir comply with the country's ambient water quality standards? (c) Are adequate measures, such as clearance of woody vegetation from the inundation zone prior to flooding planned to prevent water quality degradation in the dam pond/reservoir? (d) Is there a possibility that reduced the river flow downstream will cause water quality degradation resulting in areas that do not comply with the country's ambient water quality standards? (e) Is the discharge of water from the lower portion of the dam pond/reservoir (the water temperature of the lower portion is generally lower than the water temperature of the upper portion) planned by considering the impacts to downstream areas?
(2) Wastes	(a) Are earth and sand generated by excavation properly treated and disposed of in accordance with the country's regulations?

Others	
(1) Impacts during Construction	(a) Is there a possibility that temporary land occupation, quarrying, earth borrowing and waste disposal will impact on surface vegetation, and cause soil erosion? (b) Is there a possibility that construction disturbance will affect the habitats of terrestrial animals? (c) Is there a possibility that wastewater from production and living areas of construction will affect the surrounding water environment? (d) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (e) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (f) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?
(2) Operation	(a) Fluctuation of water level in the river from off-peak time to peak time is not dangerous for local inhabitants? Are adequate measures considered to mitigate the impact, if any?
(3) Monitoring	(b) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (c) Are the items, methods and frequencies included in the monitoring program judged to be appropriate? (d) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (e) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?

Source: JICA Study Team based on the JICA environmental check list

8.5.4 DISCUSSION OF ALTERNATIVES FOR MASTER PLAN

The comparative analysis among three development scenario was conducted in the Chapter 7. The three scenarios are as follows.

Zero Option : All of the electricity demand is covered by thermal power generation without any hydropower generation.

Realistic Scenario：Implementing prioritized projects in the Policy Oriented Scenario (The prioritized project will be reached at approximately 54% of the target. The rest of the target will be covered by thermal power generation）

Policy Oriented Scenario：Hydro potentials are taken into account as much as possible to achieve the target in the National Energy Policy.

Below factors related environmental and social consideration were considered in the discussion of alternatives

(1) The number of projects which contain any protected areas

(2) The estimated number of involuntary resettlement

(3) Inundated area

(4) Amount of discharge of Exhaust Gas (CO2, NOx, Sox) as of 2027

The results of comparative analysis for alternatives from the viewpoint of environmental and social considerations are shown as below.

Table 8.5.2 Result of Comparative Analysis

Items	The number of projects which contain any protected areas	The estimated number of involuntary resettlement(HHs)	Inundated Area (ha)	amount of discharge of Exhaust Gas
Zero Option	0	0	0	SOx: 41,104 tons/year NOx: 264,431 tons/year CO2: 37.1 MT/year
Realistic Scenario	0	2,500	114,000	SOx: 18,177 tons/year NOx: 118,383 tons/year CO2: 16.6 MT/year
Policy Oriented Scenario	20	46,000	298,000	SOx: Nil NOx: Nil CO2: Nil

Source: JICA Study Team

8.6 CONCLUSION AND RECOMMENDATION

The proposed Master Plan is acceptable from the viewpoint of environmental and social considerations due to the reasons mentioned below.

- The projects under ROR system which have comparably low environmental impacts are ranked in high priority.
- The projects under Reservoir system which has concerns of environmental negative impact such as involuntary resettlement or impact to wildlife living are selected among those which contain comparatively small scale reservoir.

In order to implement of construction of hydropower plants based on the Master Plan surely, the environmental study which is necessary for obtaining environmental approval should be conducted after determination of sub-project (i.e. feasibility study phase).

The environmental and social consideration items included in the environmental check list shown the above should be considered in the studies. Although the study level will be different depending on the expected environmental negative impacts, those studies including AMDAL, UKL+UPL should contain preparation of environmental mitigation measures.

Note that the confirmation on the consistency of scope of work in the environmental study between Indonesian environmental regulations and JICA Guidelines for environmental and social considerations which request to hold stakeholder meetings and to conduct information disclosure for the project etc. is indispensable when the projects will be subject of Japanese yen loan.

Regarding land acquisition and involuntary resettlement for the project, Indonesian regulations do not stipulate preparation of Land Acquisition and Resettlement Action Plan (LARAP). However, preparation and disclosure of LARAP are premises of appraisal for project implementation by ODA if the project requires land acquisition and/or involuntary resettlement in large scale. Therefore, the necessary investigation and procedure for LARAP preparation should be confirmed in advance.

CHAPTER 9 SELECTION OF PROJECTS FOR PRE F/S

9.1 SELECTION OF CANDIDATE PROJECTS FOR PRE F/S

In parallel with formulating the hydro development master plan described in Chapter 7, selection of candidate projects for Pre F/S to be worked in this Study was conducted in the early stage of the Study.

Adopted criteria for this purpose were; i) the projects are categorized as Rank “A” or “B” as for development difficulty due to environmental aspects, with high project economy, and ii) there are no IPP projects in stages of construction or PPA process, which are mutually exclusive with those candidate projects. After consultation with the counterpart, the following eight projects were selected.

Table 9.1.1 Development Plan of Candidate Projects for Pre F/S

Sirahar		**Simanggo-2**	
Province	: North Sumatra	Province	: North Sumatra
Catchment Area	: 207 km^2	Catchment Area	: 480 km^2
Type of Development	: Run-of-river	Type of Development	: Run-of-river
Installed Capacity	: 35.4 MW	Installed Capacity	: 59.0 MW
Annual Total Energy	: 228.3 GWh	Annual Total Energy	: 366.9 GWh
Max. Plant Discharge	: 16.7 m^3/s	Max. Plant Discharge	: 38.1 m^3/s
Average Net Head	: 256.3 m	Average Net Head	: 187.4 m
Reservoir		Reservoir	
- Full Supply Level	: EL.389.5m	- Full Supply Level	: EL.497.0m
- Min. Operation Level	: EL.384.0m	- Min. Operation Level	: EL.490.1m
- Active Storage Volume	: 0.4 $mil.m^3$	- Active Storage Volume	: 0.8 $mil.m^3$
Weir		Weir	
- Type	: Gated Weir	- Type	: Gated Weir
- Crest Elevation	: EL.392.5m	- Crest Elevation	: EL.500.0m
- Weir Height	: 12.5m	- Weir Height	: 15.0m
Headrace Tunnel		Headrace Tunnel	
- Type	: Pressure	- Type	: Pressure
- Length	: 2,990.0m	- Length	: 4,750.0m
- Diameter	: 3.0m	- Diameter	: 4.1m
Surge Tank		Surge Tank	
- Height	: 21.1m	- Height	: 30.7m
- Diameter	: 12.0m	- Diameter	: 16.3m
Penstock		Penstock	
- Type	: Inclined Pressure Shaft	- Type	: Inclined Pressure Shaft
- Length	: 524.0m	- Length	: 429.0m
- Diameter	: 2.3m	- Diameter	: 3.2m
Tailrace		Tailrace	
- Type	: Open Channel	- Type	: Open Channel
- Length	: 30.0m	- Length	: 30.0m
- Width	: 16.8m	- Width	: 22.9m

Gumanti-1		Anai-1	
Province	: West Sumatra	Province	: West Sumatra
Catchment Area	: 129 km^2	Catchment Area	: 86 km^2
Type of Development	: Run-of-river	Type of Development	: Run-of-river
Installed Capacity	: 15.8 MW	Installed Capacity	: 19.1 MW
Annual Total Energy	: 85.4 GWh	Annual Total Energy	: 109.2 GWh
Max. Plant Discharge	: 11.6 m^3/s	Max. Plant Discharge	: 11.0 m^3/s
Average Net Head	: 165.5 m	Average Net Head	: 210.4 m
Reservoir		Reservoir	
- Full Supply Level	: EL.1,077.3m	- Full Supply Level	: EL.501.6m
- Min. Operation Level	: EL.1,073.6m	- Min. Operation Level	: EL.493.6m
- Active Storage Volume	: 0.2 mil.m^3	- Active Storage Volume	: 0.2 mil.m^3
Weir		Weir	
- Type	: Gated Weir	- Type	: Gated Weir
- Crest Elevation	: EL.1,080.3m	- Crest Elevation	: EL.504.6m
- Weir Height	: 10.3m	- Weir Height	: 14.6m
Headrace Tunnel		Headrace Tunnel	
- Type	: Pressure	- Type	: Pressure
- Length	: 3,000.0m	- Length	: 2,500.0m
- Diameter	: 2.6m	- Diameter	: 2.6m
Surge Tank		Surge Tank	
- Height	: 17.7m	- Height	: 21.0m
- Diameter	: 10.5m	- Diameter	: 10.3m
Penstock		Penstock	
- Type	: Inclined Pressure Shaft	- Type	: Inclined Pressure Shaft
- Length	: 600.0m	- Length	: 1,000.0m
- Diameter	: 2.0m	- Diameter	: 1.9m
Tailrace		Tailrace	
- Type	: Open Channel	- Type	: Open Channel
- Length	: 30.0m	- Length	: 30.0m
- Width	: 14.5m	- Width	: 14.7m

Endikat-2		Cibareno-1	
Province	: South Sumatra	Province	: Banten
Catchment Area	: 306 km^2	Catchment Area	: 161 km^2
Type of Development	: Run-of-river	Type of Development	: Run-of-river
Installed Capacity	: 22.0 MW	Installed Capacity	: 17.5 MW
Annual Total Energy	: 179.8 GWh	Annual Total Energy	: 117.0 GWh
Max. Plant Discharge	: 19.8 m^3/s	Max. Plant Discharge	: 21.1 m^3/s
Average Net Head	: 134.1 m	Average Net Head	: 100.4 m
Reservoir		Reservoir	
- Full Supply Level	: EL.721.9m	- Full Supply Level	: EL.386.3m
- Min. Operation Level	: EL.714.2m	- Min. Operation Level	: EL.379.3m
- Active Storage Volume	: 0.4 mil.m^3	- Active Storage Volume	: 0.3 mil.m^3
Weir		Weir	
- Type	: Gated Weir	- Type	: Gated Weir
- Crest Elevation	: EL.724.9m	- Crest Elevation	: EL.389.3m
- Crest Length	: 14.9m	- Crest Length	: 14.3m
Headrace Tunnel		Headrace Tunnel	
- Type	: Pressure	- Type	: Pressure
- Length	: 3,700.0m	- Length	: 3,255.0m
- Diameter	: 3.2m	- Diameter	: 3.2m
Surge Tank		Surge Tank	
- Height	: 25.4m	- Height	: 24.2m
- Diameter	: 12.8m	- Diameter	: 13.1m
Penstock		Penstock	
- Type	: Inclined Pressure Shaft	- Type	: Inclined Pressure Shaft

- Length	: 500.0m	- Length	: 429.6m
- Diameter	: 2.5m	- Diameter	: 2.6m
Tailrace		Tailrace	
- Type	: Open Channel	- Type	: Open Channel
- Length	: 30.0m	- Length	: 30.0m
- Width	: 16.0m	- Width	: 15.6m

Cimandiri-1		Masang-2	
Province	: West Java	Province	: West Sumatra
Catchment Area	: 428 km^2	Catchment Area	: 409 km^2
Type of Development	: Run-of-river	Type of Development	: Run-of-river
Installed Capacity	: 24.4 MW	Installed Capacity	: 39.6 MW
Annual Total Energy	: 167.5 GWh	Annual Total Energy	: 256.1 GWh
Max. Plant Discharge	: 31.0 m^3/s	Max. Plant Discharge	: 33.2 m^3/s
Average Net Head	: 95.3 m	Average Net Head	: 144.3 m
Reservoir		Reservoir	
- Full Supply Level	: EL.374.2m	- Full Supply Level	: EL.361.9m
- Min. Operation Level	: EL.369.8.2m	- Min. Operation Level	: EL.354.9m
- Active Storage Volume	: 0.5 mil.m^3	- Active Storage Volume	: 0.6 mil.m^3
Weir		Weir	
- Type	: Gated Weir	- Type	: Gated Weir
- Crest Elevation	: EL.377.2m	- Crest Elevation	: EL.364.9m
- Crest Length	: 12.2m	- Crest Length	: 14.9m
Headrace Tunnel		Headrace Tunnel	
- Type	: Pressure	- Type	: Pressure
- Length	: 2,350.0m	- Length	: 6,700.0m
- Diameter	: 3.8m	- Diameter	: 3.9m
Surge Tank		Surge Tank	
- Height	: 21.5m	- Height	: 33.5m
- Diameter	: 15.1m	- Diameter	: 15.5m
Penstock		Penstock	
- Type	: Inclined Pressure Shaft	- Type	: Inclined Pressure Shaft
- Length	: 2,600.0m	- Length	: 500.0m
- Diameter	: 3.1m	- Diameter	: 3.1m
Tailrace		Tailrace	
- Type	: Open Channel	- Type	: Open Channel
- Length	: 30.0m	- Length	: 30.0m
- Width	: 18.1m	- Width	: 20.2m

Source: HPPS2 (1999)

9.2 STATUS OF PROJECT IMPLEMENTATION BY IPP

There exist some IPP plans which are mutually exclusive with some projects in the above. However, as those IPP plans have not yet entered into construction stage or PPA negotiation stage, existence of such IPP plans are not regarded as decisive factor to evaluate each project.

9.3 NATURAL AND SOCIAL ENVIRONMENT

9.3.1 KEY POINTS OF ENVIRONMENTAL RECONNAISSANCE

Following items were highlighted in terms of environmental and social environment in the field investigations on the candidate projects which were selected through first screening process in this study.

(1) Involuntary Resettlement

The possiblity of involuntary resettlement caused by the project implementation was confirmed.

(2) Present Status of Land Use and Water Use in the Section of Water Recession

Section of water recession will be come out between intake point and powwer house point resulting from the project impelementation. Present status of land use and water use including irrigation system in the section was confirmed.

(3) Erosion and Sedimentation

Geological stablity has close relation with soil erosion and sedimentaion associated with the project implemenetation.

(4) Others

Inteviews to local people were conducted to get referential information on minolities/ indigenous people living around the project site and current status of utilization of the river water by local people.

9.3.2 ENVIRONMENTAL RECONNAISSANCE RESULT

Main findings ideintied through the investigations are summarized as follows. The detailed records are given in Volume III Supporting Report (1) Hydropower Development Master Plan.

<General>

- Involuntary resettlement for the construction of intake, weir and powerhouse for the all proposed projects including will not be necessary. Note that there is a possibility of involuntary resettlement due to expand of existing road for access road though its impact is considered as not significant.
- All proposed project sites have stable topographical condition.
- Components of the most projects are located in the secondary forest.
- As for the section of water recession, confirmation on present condition of land use and water use will be indispensable at every project site.
- The length of access/construction roads for each project should be planned as shortly as possible so that the areas of felling trees will be minimized.

<Individual>

- **Masang- 2** might be located in the “Production Forest” and **Anai-1** also located in “Protection Forest” which is necessary to take procedure for utilization of the forest, respectively.

- In the process of the 1st screening, **Endicat-2** was evaluated as "A rank" project. However, it was found from interview to local people and relevant parties that a part of the site might locate in "Protection Forest". Further confirmation is necessary.
- Impacts on existing irrigation scheme are expected at **Cimandiri-1.**
- Regarding the length of the section of water recession, **Simmango 2** has longest one (approx. 7.8km) and **Gumanti-1** is shortest (approx.3.2km) among the proposed projects.

9.4 GEOLOGY

9.4.1 GENERAL

Geological reconnaissance was conducted on the selected eight ROR type project sites, as listed in Table 9.4.1. In addition, two IPP project sites were also inspected for reference purpose; one is Simanggo-1 which is under construction and the other is Gunung-2 which is at the process of PPA.

Table 9.4.1 Selected Projects for Site Reconnaissance

No.	Scheme Name	Project ID	Type	Province	Remarks
1	Sirahar	1-186-01	ROR	N. Sumatra	Candidate site for Pre F/S
2	Simanggo-2	1-190-41	ROR	N. Sumatra	Candidate site for Pre F/S
3	Gumanti-1	1-071-01	ROR	W. Sumatra	Candidate site for Pre F/S
4	Anai-1	1-155-01	ROR	W. Sumatra	Candidate site for Pre F/S
5	Masang-2	1-163-02	ROR	W. Sumatra	Candidate site for Pre F/S
6	Endikat-2	1-074-17	ROR	S. Sumatra	Candidate site for Pre F/S
7	Cibareno-1	2-108-01	ROR	W. Java	Candidate site for Pre F/S
8	Cimandiri-1	2-107-01	ROR	W. Java	Candidate site for Pre F/S
9	Simanggo-1	1-190-40	ROR	N. Sumatra	IPP project under construction
10	Gunung-2	1-190-26	ROR	N. Sumatra	IPP project at process of PPA

Source: JICA Study Team

This section describes site geological conditions of these selected projects through site reconnaissance, and thereby gives some geological recommendations relating to plan and construction of these projects. Photographs of each project site are given in Volume III Supporting Report (1) Hydropower Development Master Plan.

9.4.2 GEOLOGICAL RECONNAISSANCE

(1) Sirahar Project Site (1-186-01)

The Sirahar ROR hydropower project is situated around Pakkat village, about 40km southwest of Doloksanggul City. The potential weir site is on the lower reach of the Sirahar river, a branch of the Aek Betugarigis River.

Physiographically, the project site is located on the western boundary of the Barisan Mountains. The Sirahar river runs on the west slope of the Barisan Mountains. It originates from Mt. Pinapan (El. 2037.3m), flows to southwest, then joins the Aek Betugarigis and finally discharges into the Indian Ocean.

The proposed weir site lies at 2°7'17.78" of the north latitude and 98°29'19.94" of the east longitude, and the proposed powerhouse is on the left bank slope at 2°5'41.10" of the north latitude and 98°30'6.07" of the east longitude, about 3,000 m downstream of the weir site. The Sirahar river around the weir site, generally 10 to 15 m wide, has a riverbed gradient of about 5 degreases through compass measurement and shows deep, V-shaped valley. Similarly, around the powerhouse site the river presents deep gorge.

The published geological map indicates that the region is underlain mainly by Kluet Formation (geological map symbol **Puk**) and Tobu Tuffs (**Qvt**). The Kluet Formation, probably Late Carboniferous to Early Permian, is regional basement rocks and consists of low grade meta-sedimentary rocks, such as quartzites, slate, siltstones and phyllites. The Tobu Tuffs of Pleistocene age, is rhyodacitic tuffs, including partially welded and unwelded.

The interpretation of topographical map and satellite image indicates that some lineaments are distributed around the project site vicinity. However, according to the published geological map (scale 1:250,000), there are no any known clear faults in the vicinity of the project site.

On the basis of the exposed rocks around the weir and intake sites, the geology of the project site consists mainly of slate and overlying tuffs. The slate rocks around the intake and weir sites are very massive with few joints or cracks. The tuffs overlaying the slate around the project site are uniform and very massive when welded, or highly fractured or jointed when unwelded.

In addition, at about 1,000 m upstream of the proposed weir site, an over 100 m deep waterfall is present; this may indicate the river at the waterfall point is cutting through a weaker zone or geological-structure line.

At the upstream of the weir site, some small-scale rock collapses were observed on the both bank slopes. These rock collapses are small and shallow, presumably due to vertically or sub-vertically joints or combination of some sets of joints. Because of their small scale and small volume of collapsed materials, these collapses would have a less or no impact on the construction of the project.

Around the weir site, plenty of gravels and cobbles are distributed on the riverbed. These riverbed gravels and boulders are mainly from two types of rock sources, welded dacitic tuffs and slate. These riverbed deposits are suitable for the coarse aggregates of concrete, gabion, stone riprap, etc. On the other hand, at the downstream of the proposed powerhouse, riverbed sands are widely distributed along the Sirahar river and they can be used as the fine aggregates of concrete.

At about 500 m upstream of the proposed weir site, the elevation of the riverbed was checked, through

GPS measurement, to be approximately 260 m, which was quite different from that of the original riverbed at the weir site with an expected elevation of 380m. Level or spot height needs to be verified by a detailed survey prior to concept study or pre-feasibility study.

(2) Simanggo-2 Project Site (1-1901-41)

The Simanggo-2 ROR hydropower project is situated around Rarabintang village, about 40km west of Doloksanggul City. Physiographically, the project site is located on the Barisan Mountains. The Simanggo river runs on the west slope of the Barisan Mountains and originates from Mt. Simangan Dungi (El. 1460.0m) and the Mt. Ginjang (El. 1685.2m). The river flows to southwest, then joins the Lae Cinendang River and finally discharges into the Indian Ocean. The project site is on the middle course of the Simanggo river.

The proposed Simanggo-2 weir site is located at 2°18’6.01” of the north latitude and 98°25’19.30” of the east longitude on the northsouth direction course of the Simanggo river. After the junction with the Aek Rambe river, the Simanggo river sharply turns to the northwest and the proposed Simabggo-2 powerhouse site is at the right bank side on the northwest direction course of the Simanggo river and at 2°18’38.39” of the north latitude and6 98°25’30.” of the east longitude. The Simanggo river is about 20 to 25 m wide with a riverbed slope of about 3 degrees by compass measurement around the weir site and 30 m wide with a riverbed gradient of 1 to 2 degrees around the powerhouse site.

According to existing geological map, some faults, definite and indefinite, are distributed in the vicinity of the Simanggo-2 project site. Especially two definite faults run along the Simanggo river within the project site area; this indicates that the Simanggo river valley within the project site area may be formed due to faulting, further indicating that the weir foundation may be highly fractured as a result of fault activity. Besides these faults, some lineaments were identified on the basis of topographical interpretation.

The existing geological literatures indicate that the geology of the Simanggo-2 project site consists mainly of Kluet formation (**Puk**) and Tobu Tuffs (**Qvt**). The Pleistocenee Tobu Tuffs are extensively exposed along the Simanggo river valley. Based on the exposed rocks along the river valley, the tuffs are partially melded and generally very massive with a few joints. On the other hand, the Late Carboniferous to Early Permian Kluet formation mainly includes quartzites, slate, siltstones and phyllites and these rock units will be expected to be encountered along the proposed waterway route.

Along the Simanggo river in the vicinity of the proposed powerhouse site, the riverbed deposits consist mainly of coarse sand and gravels with some cobbles and boulders. These riverbed deposits are suitable for the fine aggregates of concrete. In addition, some potential slate quarry sites will be expected to be available near the powerhouse and weir sites according to existing geological map. Rock blocks from these potential quarry sites will be expected to be used for the coarse aggregates of concrete, gabion, stone riprap, masonry, etc. Further, as state above, quartzites and slates would be encountered for the excavation of waterway, the materials to be excavated for waterways will be expected to be recommendable as the coarse aggregates of concrete, gabion, stone riprap, etc.

There is a local road, about 6 to 6 wide, to the proposed powerhouse site via Tarabintang village. An access road needs to be extended from the Tarabintang village to the proposed weir site, on the left bank slope along the existing mountain road. A bridge over the Simanggo river would be built around the junction with the Aek Rambe river.

(3) Gumanti-1 Project Site (1-071-01)

The Gumanti-1 ROR project is located on the most upstream reach of the Gumanti River around the Talang Barat village, about 60 km southeast of Padang city, West Sumatra.

Geologically, the Gumanti river runs along the boundary of different rock units. According to the existing geological map, the project site is underlain by Permian meta-sedimentary rocks on the right and by Tertiary sedimentary rocks on the left. The Permian meta-sedimentary rocks - the Barisan formation consists mainly of phyllite, slate, limestone horenfels and meta-greywacke; while the Tertiary sedimentary rocks - the Ombilin formation is composed mainly of sandy claystone, tuffaceous sandstone, glauconitic, marly sandstone, shale, coal seams and conglomerate with andesitic components.

Toward the upstream of the proposed weir site the volcanic lava of early Quaternary age widely spreads, forming the flat plateau. Around the weir site and its downstream, the mountainous bodies of pre-Tertiary and Tertiary sedimentary rocks stick towards the Gumanti river, leading to narrow neck-shaped valley at the weir site, consequently providing the suitable locations for weir site.

Around the weir site, the valley slopes are very steep, both with a slope gradient of 40-50 degrees. On the left abutment slope exposed is mainly Tertiary shale, which is generally slightly weathered. At immediate downstream of the weir site on the right bank side, a small-scale, shallow collapse occurred, presumably due to weathered bedrock. In addition, around the weir site riverbed deposits, about 10 m wide and 2 m thick, mainly contains sand and gravel, and spreads mostly along the right bank. Some cobble and boulder, up to 5 m in diameter, of shale and andesite origin, is scattered on the riverbed.

The proposed intake site is on the left bank slope with fresh shale outcrops. In addition, at immediate upstream of the intake site, the river bends sharply towards right, and therefore the bank slope at the intake is prone to erosion and scour of flowing water. Accordingly, the slight shift of the intake location would be desirable.

The proposed waterway runs along the mountainous of Tertiary sedimentary rocks on the left bank slope. No significant landslide or potential unstable slopes, and faults were recognized during site visit.

The powerhouse was planned to be on the left bank side at hillside of the mountainous ridge. Around the powerhouse area the hill slope is very steep, generally 40-50 degrees, no landslides were observed at site visit. In addition, in the powerhouse area, the riverbed deposits consist of gravels with some boulders of over 5m in diameter, and the thickness of the riverbed deposits was estimated to be approximately 3m.

With regard to construction materials, riverbed deposits, andesitic lava gravel and boulder distributed on the upstream of the project site, are sound and massive, and therefore expected to be used as fine and coarse aggregates of concrete and others.

Accesses to project sites (weir, powerhouse) can be via the existing roads running in parallel to the river in construction period but they may needs to be expanded as presently used as lifeline.

(4) Anai-1 Project Site (1-155-01)

The Anai-1 ROR project is on the upstream of the Anai river around the Sicincin village, about 50 km north of Padang city, West Sumatra.

Geologically, in the vicinity of the project site the Anai river runs mostly along the boundary of the Permian meta-sedimentary rocks on the left side and the Quaternary volcanical rocks from Mt. Tandikat on the right side. The meta-sedimentary rocks consist mainly of phyllite, slate, hornblende and mica-greywacke. These meta-sedimentary rocks generally dip vertically with a NW strike.

Around the weir site, the river valley slopes are very steep, up to 70 degrees. The slate/schist outcrop of the Permian meta-sedimentary member is generally slightly weathered. The riverbed, about 10m wide, is covered locally by sand/gravel deposits.

The proposed intake is along a steep cliff of 70-80 degrees and over 100m high, on the left bank. Around the intake area a small-scale rock collapse occurred, probably due to jointing and weathering of the rock. The collapsed rock blocks are distributed on the bottom of the cliff, indicating a recent occurrence.

The waterway was planned along the mountain ridge with a cover of 150 to 200 m in thickness. According to the existing geology map, a local indefinite fault is distributed approximately 300m upstream of the proposed waterway, but is not identified through satellite image interpretation and site reconnaissance around the site. The powerhouse was proposed on the left bank slope of 40 degrees. Around the powerhouse area, no landslides or potential unstable slopes were identified through site reconnaissance.

At immediate downstream of the project site, large amount of sand and gravel deposits are distributed along the river bank, these riverbed materials can be used as fine aggregate of concrete; while at the upstream of the project site, andesitic lava are sound and hard with less weathering and jointing, would be potential sources of coarse aggregate of concrete.

In addition, an existing local road parallel to the river is a easy access to the project site (weir and powerhouse sites).

(5) Masang-2 Project Site (1-163-02)

The Masang-2 ROR project is located on the most upstream of the Masang River, about 15 km north of Lake Maninjau and 90 km north of Padang city, West Sumatra.

According to the existing geological map, the project site is underlain by Quaternary volcanical rocks, mainly including tuff with some andesitic or basaltic lava. In the vicinity of the project site the Masang river flows to the northwest, nearly parallel to the Great Sumatra Fault (GSF) zone on the right (northeast) side of the Masang river.

The weir was planned at about 1,000 m downstream of the junction of the Masang river with its tributary - the Gutung river. The Gutung river, generally 10 m wide, is covered widely with alluvial deposits. Around the weir site, alluvial deposits are widely distributed on both bank sides, about 200 to 300 m wide in the right bank and about 50 m wide in the left bank. These alluvial deposits was estimated to be 3 to 5 m thick. Further, at about 2,000 m upstream of the confluence, the Masang river, approximately 20 m wide, is widely covered with alluvial deposits on the both bank sides. The alluvial deposits are estimated to be 3 to 5 m thick and consist mainly of gravel and coarse sand, locally with some boulder/cobble of 1 m in diameter. These boulders and cobbles are mainly andesitic and tuffaceous origins. Some sand mining is in operation at the upstream of the weir site.

The waterway was planned on the left bank side, far from the GSF. Andesitic rocks or tuffs are expected to be encountered along the waterway route. In addition, based on the existing geological map, some local faults run obliquely through the proposed waterway line, and therefore would have some impact on the excavation of the waterway.

The proposed powerhouse was proposed on the left bank side. The left bank slope is very steep with outcrops of andesitic rocks. These andesitic rocks are generally fresh to slightly weathered with a few joints. In addition, no landslides and potential unstable slopes were recognized around the powerhouse area at site reconnaissance.

The riverbed sediments, including coarse sands, gravels and boulders of andesite and sandstone origins, can be used as fine and coarse aggregates of concrete.

An existing road can reach about 2 km east of the powerhouse, further access to the powerhouse and weir sites need to be constructed.

(6) Endikat-2 Project Site (1-074-17)

The Endikat-2 ROR project is located in South Sumatra, nearly to the westward end of the Island about 150km Souteastwards of Benkulu city. The project site is on the most upstream of the Endikat River, with a steep V-shaped valley of 150-200m in depth.

The project site is geographically situated on the eastern slope of the Barsan mountains, 30 km from the Great Sumatra Fault zone and is underlain by the Holocene volcanic rocks. The volcanic rocks consist of andesitic to basaltic volcanic breccias, lava and tuffs. From site reconnaissance, around the weir site exposed are mainly tuffs and partially welded tuffs, which appeared to be prone to weathering. At the weir site the river is about 10 to 20 m wide, and both abutment slopes, about 150 m high, are very steep. Alluvial deposits mixing with talus deposits, approximately 50 m wider from the present river course and 300 m long, are distributed widely along the left bank side. The riverbed sediments at the site were estimated to be 1 to 2 m thick and consist of gravels and cobbles with some boulders of over 3 m in diameter. In addition, a potential landslide, 300 m wider and 200m long, is present at 50m upstream of the downstream candidate weir. The landslide is considered to be stable at present but would be likely to be reactivated due to the construction and operation of the project.

In view of the impact of the potential landslide on the project, an upstream alternative weir site was also investigated. The site is about 400 m upstream of the originally proposed weir site, just upstream of the potential landslide. Geological and river morphological features at the site were basically the same as those at the original weir site, expect for the existence of the potential landslide.

The waterway was proposed along pyroclastic plateau in the right bank side. The plateau, with a top of El. 800 to 850 m, is underlain mainly by tuffs and partially welded tuffs. From limited outcrops, these tuffs were generally slightly jointed and weathered. The rock masses along the waterway were expected to be fresh to slightly weathered and slightly jointed.

Around the proposed powerhouse site, the river is about 20 to 30 m wide. The right bank slope, generally gentle with a slope of 20 to 30 degrees, is exposed with tuffs; whereas the left bank slope, very steep up to 40 degrees, is underlain by tuffs and partially welded tuffs.

As described above, large amount of riverbed sediments are distributed along the river banks. The sediments are of andesitic origin and can be used as fine and coarse aggregates of concrete.

The existing road can reach the vicinity of the weir site. Access between the weir and powerhouse sites needs to be constructed.

(7) Cibareno-1 Project Site (2-108-01)

The Cibareno-1 ROR project is located around the Desa Gunungkaramat, about 30 km northwest of Pelabuhanratu City, 80 km west of Sukabumi City, West Java. The project site is on the middle reach of the Cibareno river, the potential weir site lies at 6°51’21.50” of the south latitude and 106°25’48.27” of the east longitude, and the proposed powerhouse at 6°52’51.81” of the south latitude and 106°25’3.00” of the east longitude on the right bank slope.

The Cibareno river originates from Mt. Halimun (El. 1929m), runs on the southern slope of the Mt. Halimun, flows to the south and then discharges into Pelabuhan Ratu Bay. In addition, the Cibareno river is on the boundary between Kabupaten Sukabumi in the east and Kabupaten Lebak in the west.

The project site is within the modern volcanic arc tectonic province - an active andesitic volcanism related to subduction of Indian Oceanic Plate below Sundaland Continent (Gede-Panggrango, Salak, Halimun, etc., volcanoes). According to existing geological map (scale 1:100,000, Leuwidamar Quadrangle), the geology of the project site consists mainly of mainly the Cikotok formation (**Temv**) and locally the Cimapag formation (**Tmc**). The Cikotok formation, Oligocene to Late Eocene, mainly includes volcanic breccia, tuff and lava. The Cimapag formation, Early Miocene, is composed chiefly of conglomerate, claystone, and some tuffs and lava. The two formations are in a local fault contact in the vicinity of the project site.

Besides a known local fault that passes through the proposed waterway on the western bank side (right bank side), from topographical interpretation, some unusual parallel alignments of tributary streams are present in the vicinity of the project site. This could be due to faulting activity or variation in rock types or rock conditions.

From site reconnaissance, the Cibareno river is deeply incised around the proposed weir and intake sites with rocks outcropping in both bank slopes. The rocks exposed at the point are mainly tuffaceous breccias and andesitic tuffs. The tuffaceous breccia and tuffs are generally massive, locally slightly to moderately fractured or jointed by two sets of joints.

The riverbed is 10 to 15 m wide around the proposed weir site with a riverbed gradient of about 3 to 5 degrees. Plenty of boulders of andesitic tuffs and tuffaceous sandstones are distributed on the riverbed in the vicinity of the project sites. These riverbed boulders can be used as coarse aggregates of concrete, gabion, stone riprap, etc.

In addition, a small-scale shallow soil collapse was observed on the right bank slope at the downstream of the proposed weir site at site visit. However, significant large-scale landslides were considered to be less likely to occur around the proposed weir and intake sites because of good cover of vegetation on both the bank slopes.

(8) Cimandiri-1 Project Site (2-107-01)

The Cimandiri-1 ROR project is located near Sukabumi city, about 70 km southwest of Jakarta, West Java.

Around the project site the Cimandiri river flows to the west with great meanders, presumably indicating strong stream bank erosion and also inferring that the river supplies a large amount of sediments for the flat fluvial plain.

According to the existing geological map, Quaternary volcanic rocks are distributed on the northern side of the river and Tertiary Miocene sedimentary rocks on the southern side of the river around the project site.

The originally proposed weir site is situated at immediate downstream of the confluence of the Cimandiri river and its tributary. The left bank is a thin andesite ridge of approximately 100m in width and 30m in height. The right bank is a gentle slope that is covered by thick alluvial deposits. In addition, a alternative weir site at about 100m downstream of the original site was also inspected.

Around the site, the riverbed becomes narrow with outcrops of volcanic rocks.

The intake site is planned on a steep slope of 40 degrees, about 400 m upstream of the weir. Small-scale shallow collapse was observed in the vicinity of the intake slope, but was considered to have less or no impact on the implementation of the project because of its small size.

The waterway route is underlain mostly by the Quaternary volcanic rocks. However, towards the downstream, the waterway would locally run through alluvial deposits.

The proposed powerhouse site is located in wide flat fluvial/alluvial plain. Because of alluvial/fluvial cover, no rock outcrops were observed at site reconnaissance.

The riverbed sediments, consisting mainly of coarse sands and gravels, is suitable for fine aggregate of concrete, however, coarse aggregate probably needs to be imported.

It is easy access to reach the project site through the existing roads. Additional access roads within the project site need to be constructed.

(9) Simanggo-1 Project Site (1-190-40)/IPP Project Site

Around the Simanggo-1 project site, an IPP small hydropower project is under construction, and the civil works of the IPP project was commenced in 2005 and completed in 2010. The site reconnaissance was to make observations regarding the IPP project arrangement and the potential for further hydropower development.

The Simanggo-1 ROR hydropower project is situated around Parlilitan village, about 40km west of Doloksanggul City. The potential weir site is on the upstream reach of the Simanggo river, a branch of the Lae Cinendang River.

From site inspection, the IPP project features include a concrete weir with intake facility on the left bank side, open division channel along the left bank slope, forebay tank, penstock, powerhouse on the left bank side and access road from Parlilitan village to project site.

The IPP weir was located just in the location of the proposed Simanggo-1 weir site at immediate downstream of the junction with the Aek Sibulahan stream – a tributary of the Simanggo river. The weir site is at 2°19’46.6” of the north latitude and 98°25’18.2” of the east longitude by GPS measurement. The weir was designed to rest on massive tuffs – Tobu tuffs (**Qvt**). The tuffs around the weir site, generally light gray, are partially melded, slightly jointed and slightly to moderately weathered.

On the other hand, the IPP powerhouse is at approximately 1,500 m downstream of the weir site at 2°20’11.4” of the north latitude and 98°25’55.7” of the east longitude by GPS measurement. Around the powerhouse site, the Simanggo river is rocky, deep, V-shaped valley with extensive outcrops of tuffs. Similar to that around the weir site, the tuffs around the powerhouse are partially melded, very massive, slightly jointed and slightly to moderately weathered.

(10) Gunung-2 Project Site (1-190-26)/IPP Project Site

The Gunung-2 ROR project is located around the Desa Kutabuluh Pasar, about 50 km south of Kabanjahe City. An IPP small hydropower project in the vicinity of the proposed Gunung-2 project site is under the process of PPA. The project site was visited to understand the IPP project arrangement for reference purpose.

From an interview with PLN regional office in Medan, the IPP project features mainly include a concrete weir with intake facility on the left bank side, open division channel along the left bank slope, forebay tank, penstock, powerhouse on the left bank side. The IPP weir site lies just at the location of the proposed weir site, while the IPP powerhouse is at 600m upstream of the proposed powerhouse.

The weir was planned on the straight course of the Gunung river with a riverbed width of about 10 m. Around the weir site, calcareous sandstone and siltstone are extensively exposed, especially on the left bank slope, an high and steep escapement of sandstone and siltstone was observable. From rock outcrop observation, the rocks around weir site are slightly jointed and weathered, however, according to the existing geological map a definite fault runs along the Gunung river, indicating that the rocks along the riverbed may be highly fractured. The site was considered suitable for the construction of the proposed weir and intake structures, however, the fault feature and the associated rock mass fracture condition should be clarified in view of foundation stability and leakage.

On the other hand, around the proposed powerhouse site rock outcrops were seldom observed because of overburden and vegetation covers. The Gunung river around the powerhouse site, about 50 m wide, has a flat gradient. Alluvial deposits are widely and thickly distributed along the river. The alluvial deposits consist mainly of coarse sand and gravels locally with large amount of boulders. The alluvial deposits can be used as fine and coarse aggregates of concrete.

9.4.3 GEOLOGICAL EVALUATIONS

On the basis of the review of published maps and previous study reports, the interpretation of topographical maps and satellite image, and the result of brief site reconnaissance, there were no significant geological constraints to the implementation of the selected ten ROR hydropower projects. In conclusion, the selected ten project sites were thus considered feasible and suitable for the implementation of these proposed projects from geological and geotechnical perspective, as summarized in Table 9.4.2, together with the consideration of construction material and accessibility.

Table 9.4.2 Summary of Geological Evaluations

No.	Scheme Name	Geological Foundations	Construction Material	Accessibility	Geological Evaluation
1	Sirahar	Very good	Nearby available	Difficult	OK
2	Simanggo-2	Good	Nearby available	Slightly difficult	OK
3	Gumanti-1	Good	Nearby available	Easy	OK

4	Anai-1	Good	Nearby available	Easy	OK
5	Masang-2	Good	Nearby available	Slightly difficult	OK
6	Endikat-2	Good	Nearby available	Slightly difficult	OK
7	Cibareno-1	Good	Nearby available	Slightly difficult	OK
8	Cimandiri-1	Good	Nearby available	Slightly difficult	OK

Source: JICA Study Team

9.5 HYDROLOGY

9.5.1 PURPOSE OF HYDROLOGICAL RECONNAISSANCE

Site reconnaissance to the selected eight project sites was conducted to confirm the existence of a consistent flow of river water through visual observation and simple measurements. Main items or points observed and inspected during the site reconnaissance are shown below:

- Water flow around the weir or intake sites;
- Sediment load concentration of river water;
- Distribution and content of riverbed sediments;

9.5.2 RECONNAISSANCE RESULT

The site reconnaissance results for the selected project sites are summarized in Tables 9.5.1

Water flow was roughly estimated through visible observation and measurements at site inspection. According to topographical interpretation (1:25,000 or 1:50,000), the riverbed slope between the proposed weir/intake and powerhouse is generally between 1/100 and 10/100, on average, the water velocity around the project site was thus assumed to be 2 m/sec for the estimation of water flow.

As shown in Table 9.5.1, sediment load concentration in river was categorized for the purpose of simple evaluation, into three classes through visible observation, that is, a) Clean with no or less silt or clay grains, b) Mean with some silt and clay grains and c) Muddy with much sand, silt and clay grains.

Riverbed sediments around the proposed weir or intake sites were observed and evaluated in terms of sediment thickness, distribution, main composition, etc.

Table 9.5.1 Conditions of Water Flow and Sedimentation in River

No.	Scheme Name	Estimated Water Flow (m3/sec)	Sediment Load Concentration	Riverbed Materials
1	Sirahar	20	Clean	Rock outcrop with some boulder and gravel
2	Simanggo-2	50	Clean	Rock outcrop
3	Gumanti-1	20	Clean	Rock outcrop with boulder and gravel
4	Anai-1	20	Clean	Rock outcrop with boulder and

				gravel
5	Masang-2	30	Mean	Rock outcrop with much boulder and gravel
6	Endikat-2	20	Mean	Rock outcrop with much boulder and gravel
7	Cibareno-1	30	Clean	Rock outcrop, locally with boulder and a little gravel
8	Cimandiri-1	30	Mean	Rock outcrop with much boulder and gravel

Source: JICA Study Team

9.5.3 HYDROLOGICAL EVALUATION

Preliminary evaluation results are summarized in Table 9.5.2 below. As seen from the table, all project sites were considered suitable for the implementation of the proposed project features mainly in consideration of hydrological aspect.

Table 9.5.2 Summary of Hydrological Evaluation

No.	Scheme Name	Water Flow	Sediment Load	Evaluation
1	Sirahar	More	Low	OK
2	Simanggo-2	More	Low	OK
3	Gumanti-1	More	Low	OK
4	Anai-1	More	Low	OK
5	Masang-2	More	Low	OK
6	Endikat-2	More	Low	OK
7	Cibareno-1	More	Low	OK
8	Cimandiri-1	More	Low	OK

Notes: 1) More = water flow is more than or nearly the same as the expected, 2) Less = water flow is much less than the expected, 3) Low = sediment load concentration is low and thus no significant concern with implementation of hydropower project.

9.6 TOPOGRAPHY

9.6.1 PURPOSE OF TOPOGRAPHICAL RECONNAISSANCE

Site reconnaissance to the selected eight project sites was conducted to confirm the general topography as well as usable head through visual observation and simple measurements. Main items or points observed and inspected during the site reconnaissance are shown below:

- Elevation at the proposed weir and powerhouse sites;
- General topography which enable suitable layout of main structures;

9.6.2 RECONNAISSANCE RESULT

The site reconnaissance results for the selected project sites are summarized in Tables 9.6.1 and 9.6.2.

As shown in Table 9.6.1, the elevations at the proposed weir and powerhouse sites were checked by means of GPS. In addition, for comparative purpose, the planned level or head for these projects are incorporated in Table 9.6.1.

As shown in Table 9.6.2, general topography was categorized for the purpose of simple evaluation, into two classes through visible observation, that is, a) Good which allows suitable layout of the project, and b) N.G. which leads to unsuitable layout.

Table 9.6.1 Summary of the Checked Elevations and Heads for Each Project Site

No.	Scheme Name	Planed Level or Head (m)			Checked Elevation and Head (m)		
		Ave. operating level	Tailwater level	Ave. net head	El. At weir	El. At powerhouse	Head[1)]
1	Sirahar	386.8	120.0	256.3	260	120	140
2	Simanggo-2	493.5	295.0	187.4	530	330	200
3	Gumanti-1	1,075.4	900.0	165.5	1,090	920	170
4	Anai-1	497.6	275.0	210.4	510	290	230
5	Masang-2	358.4	200.0	142.7	380	215	165
6	Endikat-2	718.0	575.0	134.1	760	620	140
7	Cibareno-1	382.8	275.0	100.4	430	300	130
8	Cimandiri-1	372.0	260	95.3	380	260	120

Note: 1) Head = Difference in elevation between the proposed weir and powerhouse sites.

Table 9.6.2 Conditions of General Topography

No.	Scheme Name	Topography	Remarks
1	Sirahar	Poor	Head is far less.
2	Simanggo-2	Good	
3	Gumanti-1	Good	
4	Anai-1	Good	
5	Masang-2	Good	
6	Endikat-2	Good	
7	Cibareno-1	Good	
8	Cimandiri-1	Poor	Penstock becomes too long.

Source: JICA Study Team

9.6.3 TOPOGRAPHICAL EVALUATION

Preliminary evaluation results are summarized in Table 9.6.3 below. As seen from the table, except for the Sirahar and Cimandiri-1 project sites, the other six project sites were considered suitable for the implementation of the proposed project features mainly in consideration of head and project layout. At the Sirahar project site, the head between the proposed weir and powerhouse sites, approximately 140 m, is much less than the expected and this leads to less project output. Meanwhile, the Cimandiri-1 project site has a topography which only allows to layout an extremely long penstock and leads to excessive water hammer to be induced for that.

Table 9.6.3 Summary of Topographical Evaluation

No.	Scheme Name	Head	Topography	Evaluation
1	Sirahar	Less	N.G.	To be Discarded
2	Simanggo-2	More	Good	OK
3	Gumanti-1	More	Good	OK
4	Anai-1	More	Good	OK
5	Masang-2	More	Good	OK
6	Endikat-2	More	Good	OK
7	Cibareno-1	More	Good	OK
8	Cimandiri-1	More	N.G.	To be Discarded

Source: JICA Study Team

Project economy of the Sirahar and Cimandiri-1 projects will become less than the required due to the topographic conditions above, and thus the both are discarded from the comparative study among the eight prospective sites.

9.7 ACCESS ROAD AND TRANSMISSION LINE

9.7.1 ACCESS ROAD

Required lengths of permanent access road to intake weir and powerhouse site are reviewed and roughly re-estimated as shown in Table 9.7.1 based on the available topographic map as well as site reconnaissance result.

Table 9.7.1 Access Road Plan of Candidate Projects for Pre F/S

Project	Length to Intake Weir (km)	Length to P/H (km)	Total Length (km)
Sirahar	5	5	10
Simanggo-2	4	4	8
Gumanti-1	1	1	2
Anai-1	0	1	1
Endikat-2	2	2	4
Cibareno-1	5	3	8
Cimandiri-1	2	0	2
Masang-2	1	2	3

Source: JICA Study Team

9.7.2 TRANSMISSION LINE

In a strict sense, development of transmission lines (power source lines) needs multidisciplinary studies on the prospective construction routes with coverage of items including the selection of route zones, capacity of accessing power transmission facilities, and other technical issues, as well as economic merit, environmental and social considerations, and apprehensions in the aspect of meteorological conditions. This section, however, presents the results of a summary screening based on estimates of the access to the nearest power facilities (substations or transmission lines) in the next few years, and with respect to the degree of impact (transmission loss sensitivity), which depends greatly on the distances involved in transmission line construction..

This sort of simple screening method was utilized this time for the following reasons: 1) factors of uncertainty are too large for an in-depth study at the present time; and 2) construction of the station proper generally accounts for the majority of the total cost of hydropower station construction; the share occupied by construction of transmission facilities such as transformers, switching units, and transmission lines is small (no more than about 10 percent). Because of the latter factor in particular, it was judged that it would be unadvisable to make detailed estimates and comparisons of costs for construction of transmission facilities at this point, and that the important thing was to make a decision based on the outline.

(1) Estimate of Type of System Access

The sites with hydropower potential will presumably be connected to the system access points offered by the nearest ends of existing and future transmission and transformation facilities. Strictly speaking, selection of system access points to existing transformation facilities (substation: GI) must be preceded by studies of factors such as the availability of space for installation of additional facilities at the GI. This study does not include the examination of such details.

There are two major alternative options for access to system access points, as noted below. The following section also notes the prerequisites common to both.

- Extension
- Branching

(Common prerequisites)

- The extension of transmission lines to the system access point will consist of two parallel circuits[1].
- A selection is made of the proper voltage class for the access system based on comparison of the anticipated generation rated capacity of the hydropower potential and the transmission capacity of the standard transmission lines in each voltage class. As noted in RUPTL, however, access to 70-kV transmission lines is to be excluded from consideration because such lines are to be phased out of the Jamali system eventually.

1) Extension

If the nearest power transmission facility from the hydropower potential site is a substation (GI), the GI is accessed by extension of a transmission line from the site. In this case, the requisite transmission facilities are as follows.

[1] This is because the standard transmission line facilities in Indonesia consist of two parallel circuits.

- Selected voltage class IBT + Trf.B: 2 units (determination of transformer capacity based on the rated capacity of the generator)
- Selected voltage class LB: 2 units x 2 locations
- Selected voltage class transmission line: 2 circuits from the hydropower potential site to the nearest substation

2) Branching[2]

If the nearest power transmission facility from the hydropower potential site is a transmission line, the line is connected to the site by pi feeder. In this case, the requisite transmission facilities are as follows.

- Selected voltage class IBT + Trf.B: 2 units (determination of transformer capacity based on the rated capacity of the generator)
- Selected voltage class LB: 4 units
- Selected voltage class transmission line: 4 circuits from the hydropower potential site to the nearest transmission line branching location

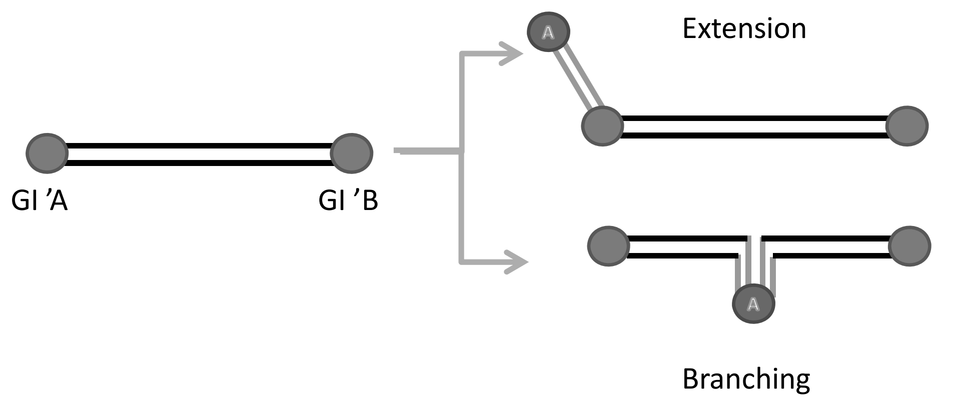


Figure 9.7.1 Types of System Access

Comparing the aforementioned requisite facilities, the difference in transmission line distance in the case of different hydropower potential sites with a generator rated capacity on the same scale appears as a cost difference. Because a difference in transmission line length may be equated with a difference of transmission loss, assessment of transmission loss may be equated with assessment of the cost level.

(2) Impact (degree of transmission loss sensitivity)

A sensitivity analysis was made for transmission loss on the transmission lines posited in Section (1). The loss sensitivity was sought for the types of transmission wire with a high frequency of use in the

2 A T-type feeder is another option, but it was decided to use the pi-type feeder in the study because there are few locations in the Indonesia power system where T-type feeders are employed in operation of other terminal systems.

Java[3] system at present, in each voltage class.

Class	Kind	R_{AC}(effective level/km)
500kV	Dove×4	0.104
275kV	Zebra×2	0.071
150kV	Zebra×2	0.071

Here, transmission loss was calculated by obtaining the value for I^2 x R_{AC} from the current flowing through each type of transmission line. The impact was judged to be "normal" (problem-free) if the loss rate did not exceed about 0.5 percent[4], "big" at higher rates, and "small" at very low rates.

(3) Estimated Length of Transmission Line

Required lengths of transmission line are reviewed and roughly re-estimated as shown in Table 9.6.2 based on the existing or planned transmission line system as well as site reconnaissance result.

Table 9.7.2 Transmission Line Plan of Candidate Projects for Pre F/S

Project	Grade (kV)	Length (km)	Connection Point
Sirahar	150	58	PLTP Pumuk Bukit
Simanggo-2	150	40	Dolok Sanggul
Gumanti-1	150	80	Solok
Anai-1	150	40	Singkara
Endikat-2	150	32	Pagar Alam
Cibareno-1	150	50	Bunar
Cimandiri-1	150	18	Sukabumi
Masang-2	150	36	Simpan Empat, Maninjau

Source: JICA Study Team

9.8 SELECTION OF PROJECTS FOR PRE F/S

Result of comparison from view point of environmental, technical, and economical aspects are shown in Table 9.8.1.

Simanggo-2 and Masang-2 are suggested to be adopted for Pre F/S in this Study, because these schemes have higher project economy, and difficulties to be encountered in environmental and technical aspects are assumed to be less at this stage. Nevertheless, detailed assessment on environmental and technical aspects is required to confirm the project viability in the further studies.

General layouts of these two schemes (Simanggo-2 and Masang-2) which were planned in HPPS2 are hereto attached.

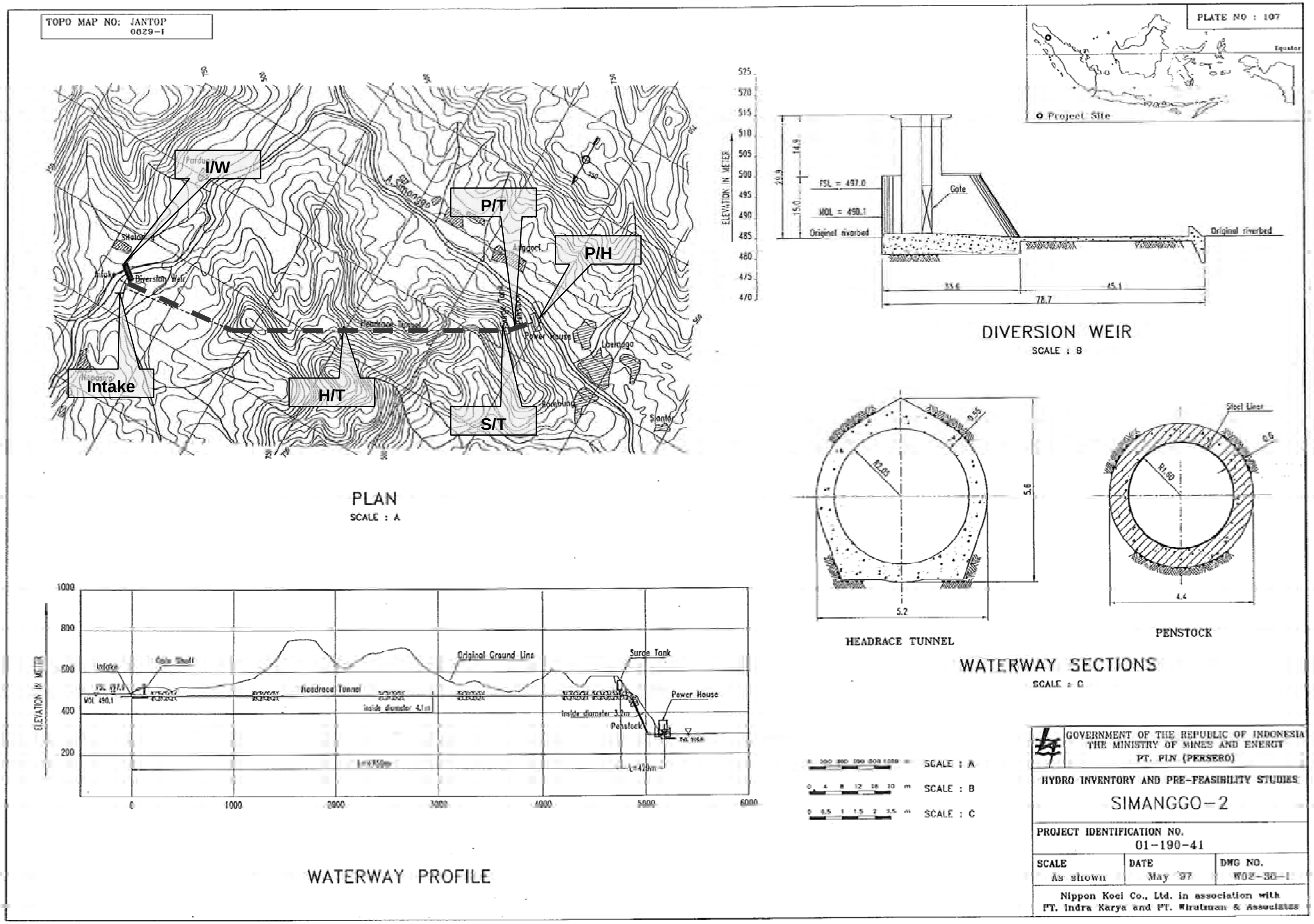
[3] Transmission lines in the Java system tend to have lower levels of loss due to the high-capacity transmission specifications. Transmission lines with specifications for lower capacities are scheduled for adoption, particularly on the outer island systems.

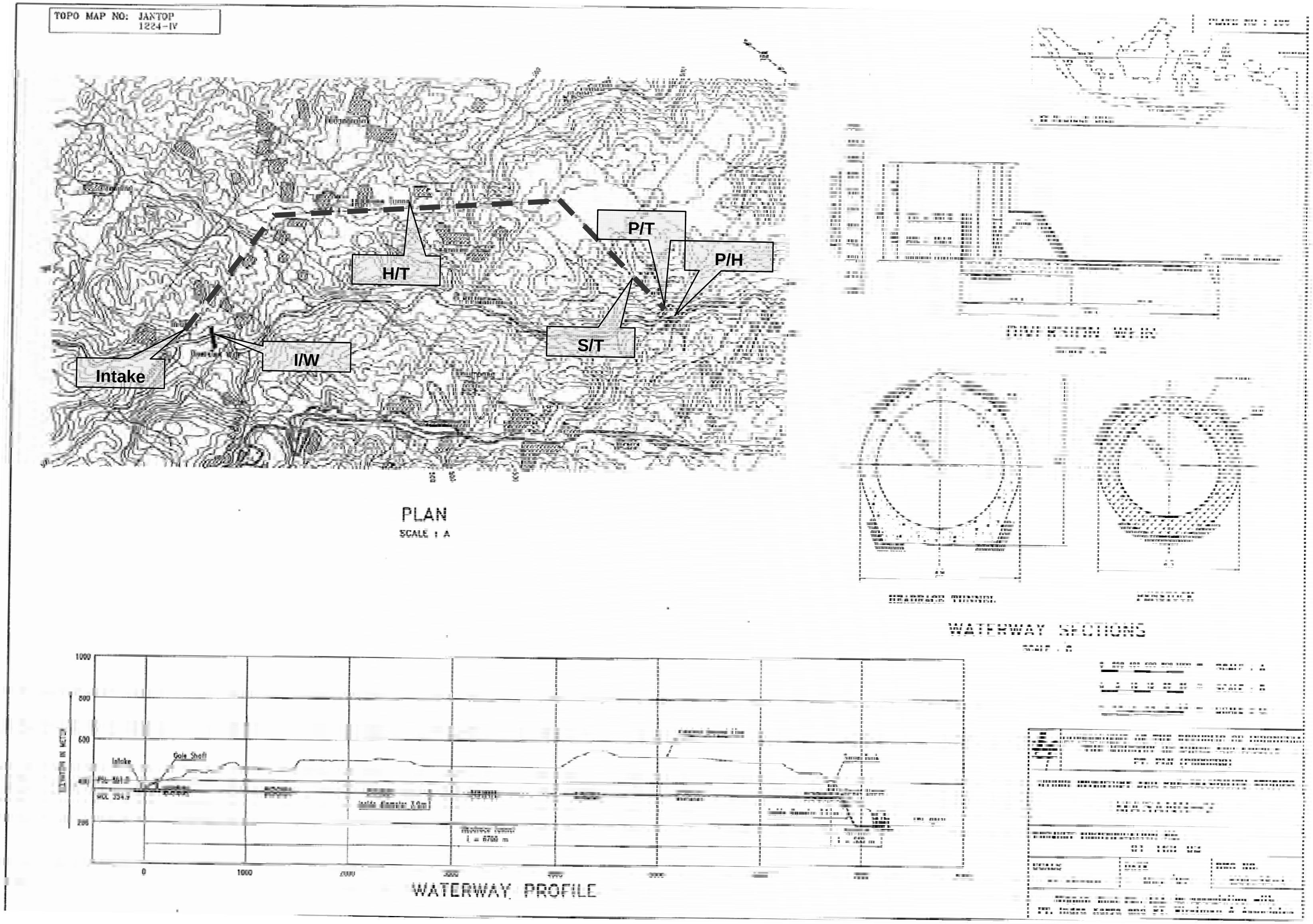
[4] Indonesia has posted the target of reducing transmission and distribution loss to no more than 10 percent. To this end, it is necessary to target a rate of no more than about 3 percent for the total transmission loss in all systems. For this reason, the rate of loss in local transmission from a given site to the nearest transmission facility was put at a minimum of 0.5 percent. Properly speaking, the study would also have to take account of loss related to reactive power. This item was nevertheless excluded from consideration because it does not have much importance in a localized study of this nature.

Table 9.8.1 Evaluation Result for Selecting Pre FS Sites

Scheme Name	Environmental		Technical					Economical	Evaluation
	Natural	Social	Topography	Geology	Hydrology	Access	T/L		
Sirahar	◎ Forest Type A	◎ No inhabitants around the site	× Actual riverbed elevation at weir site is lower by 120m.	◎	○ CA= 207km^2 Qf= 7.1 m^3/s	× Access is difficult due to steep topography.	○ L=58km (PLTP Pumuk Bukit)	× EIRR<10%	
Simanggo-2	◎ Forest Type A	○	○	○	◎ CA= 480km^2 Qf= 15.7m^3/s	○	◎ L=40km (Dolok Sanggui)	◎ EIRR=18.8%	Pre FS
Gumanti-1	◎ Forest Type A	○	○	○	△ CA= 129km^2 Qf= 3.1 m^3/s	◎ Access is easy.	○ L=80km (Solok)	△ EIRR=13.4%	
Anai-1	△ Most part in Forest Type C	△ Scenic place	○	○	△ CA= 86km^2 Qf= 2.7 m^3/s	◎ Access is easy.	◎ L=40km (Singkara)	△ EIRR=13.9%	
Endikat-2	○ Forest Type A, partly C	○	○	○	○ CA= 306km^2 Qf= 6.6 m^3/s	○	◎ L=32km (Pagar Alam)	△ EIRR=13.1%	
Cibareno-1	◎ Forest Type A	○	○	○	○ CA= 161km^2 Qf= 5.3 m^3/s	△ Access to intake weir is difficult due to steep topography.	◎ L=50km (Bunar)	△ EIRR=11.8%	
Cimandiri-1	◎ Forest Type A	△ Impact on existing irrigation	△ Insufficient ground level at the headrace tunnel	○	○ CA= 428km^2 Qf= 7.7 m^3/s	○	◎ L=18km (Sukabumi)	× EIRR<10%	
Masang-2	○ Forest Type B	○	○	○	○ CA= 409km^2 Qf= 9.7 m^3/s	○	◎ L=36km (Simpang Empat,Maninja u)	○ EIRR=14.6%	Pre FS

Source: JICA Study Team


TOPO MAP NO: JANTOP 0829-I
PLATE NO : 107
Equator
Project Site
I/W
P/T
P/H
Intake
H/T
S/T
Diversion Weir
Headrace Tunnel
Power House
PLAN
SCALE : A
DIVERSION WEIR
SCALE : B
FSL = 497.0
MOL = 490.1
Original riverbed
Gate
ELEVATION IN METER
HEADRACE TUNNEL
PENSTOCK
Steel Liner
WATERWAY SECTIONS
SCALE : C
Original Ground Line
Surge Tank
Power House
Penstock
Headrace Tunnel
WATERWAY PROFILE
SCALE : A
SCALE : B
SCALE : C
GOVERNMENT OF THE REPUBLIC OF INDONESIA
THE MINISTRY OF MINES AND ENERGY
PT. PLN (PERSERO)
HYDRO INVENTORY AND PRE-FEASIBILITY STUDIES
SIMANGGO-2
PROJECT IDENTIFICATION NO.
01-190-41
SCALE
As shown
DATE
May '97
DWG NO.
W02-36-1
Nippon Koei Co., Ltd. in association with
PT. Indra Karya and PT. Wiratman & Associates


TOPO MAP NO: JANTOP 1224-IV
Intake
I/W
H/T
S/T
P/T
P/H
PLAN
DIVERSION WEIR
HEADRACE TUNNEL
PENSTOCK
WATERWAY SECTIONS
Intake
Gate Shaft
WATERWAY PROFILE