Indonesia

(Indonesia)
THE PREPARATORY SURVEY ON SMALL HYDRO PROJECTS IN SUMATRA AND SULAWESI IN REPUBLIC OF INDONESIA
Final Report
＜Tornauli＞

February 2014

Independent Administrative Corporation

Japan International Cooperation Agency

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OS
CR (10)
14-005

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Glossary

Abbreviation	English	Indonesian
AMDAL	Environmental Impact Assessment (EIA)	Analisis Mengenai Dampak Lingkungan
ASEAN	Association of South-East Asian Nations	
ARGR	Automatic Rain Gauge Recorder	
AVR	Automatic Voltage Regulator	
AWLR	Automatic Water Level Recorder	
BMG	The Bureau of Meteorology and Geophysics	
BPN	National Land Agency	Badan Pertanahan Nasional
BPPT	Agency for Assessment and Application of Technology	Badan Pengkajian dan Penerapan Teknologi (BPPT)
CDM	Clean Development Mechanism	
CER	Certified Emission Reduction (Unit for CDM)	
CF	Capacity Factor	
COD	Commercial Operation Date	
DESDM	Ministry of Energy and Mineral Resources (MEMR)	Departemen Energi dan Sumber Daya Mineral
EIA	Environmental Impact Assessment	AMDAL
EPC	Engineering, Procurement and Construction	
FIN	Feed In Tariff	
FS	Feasibility Study	
FTP	Fast Track Program	Crash Program (Another name)
GDP	Gross Domestic Product	
GHG	Greenhouse Gas	
GP	General Partnership	
GW	Gigawatt	
HEPP	Hydro Electric Power Project	
IDC	Interest During Construction	
IDX	Indonesia Stock Exchange	Bursa Efek Indonesia
IEA	International Energy Agency	

IEE	Initial Environmental Evaluation	
IMB	Indonesian building permit	Izin Mindirikan Banyunan Bupati
IMF	International Monetary Fund	
IPO	Initial Public Offering	
IPP	Independent Power Producers	
IT	Information Technology	
JICA	Japan International Cooperation Agency	
KKO	-	Kata Kerja Operational
LP	Limited Partnership	-
MEMR	Ministry of Energy and Mineral Resources	Departemen Energi dan Sumber Daya Mineral
MW	Megawatt	-
MWh	Megawatt-hour	-
NEF	New Energy Foundation	-
NJOP	Selling Value of Taxed-Object	-
NRECA	National Rural Electric Cooperative Association	-
ODA	Official Development Assistance	-
Perpres	Presidential Regulation (PR)	Peraturan Presiden
IIGF	Indonesian Infrastructure Guarantee Fund	PT Penjaminan Infrastruktur Indonesia
PIP		Pusat Investasi Pemerintah
PLN	State Electricity Company	Perusahaan Listik Negara
PP	Government Regulation	Peraturan Pemerintah
PPA	Power Purchase Agreement	
PPP	Public-Private Partnership	
SMI		Sarana Multi Infrastruktur
SPC	Special Purpose Company	
TWh	Terawatt-hour	
UKL	Environmental Management Procedure	
UPL	Environmental Monitoring Procedure	
WL	Water Level	

Chapter.1 Introduction

1-1. Background of the Preparatory Survey Regarding the Small Hydro Power Project in Sumatra and Sulawesi

The purpose of implementing the Preparatory survey (hereafter “the Survey”) regarding the small hydro-power project in Sumatra and Sulawesi (hereafter “the Target Project”) is to accelerate the development of the small hydro-power project in Indonesia. The Survey will be conducted according to the following viewpoints: business / project development plan of the Target Project, possibility of installing Japanese technology and equipment and possibility of utilizing funding (capital/loan).

The Survey has been led to start as the electricity demand in Indonesia is soaring and the Indonesian government has considerable expectations for the development of the small hydro-power plants. Sumatra and Sulawesi islands have growing demand in particular (see 1-1-1 for details), leading to higher power purchase price (see 2-4-1 for details), and preliminary study found project owners with intention to run the business for long time instead of planning to sell off the projects.

At the beginning of the Survey, two projects in Sumatra and one project in Sulawesi were selected as the Target Projects. After the project owner conducted the third party review by international technical consulting company and found that the generation capacity would be significantly smaller than previously assumed by the feasibility study, the project owner gave up development of the project. Thus, the Survey has replaced the Target Project from this Sulawesi project to the other in South Sumatra with high possibility of going forward, and the Survey has all three projects in Sumatra.

1-1-1. Development issues and situations of infrastructures and electricity demands in Indonesia

Although the electricity demand in Indonesia has steadily grown since the Economic Crisis in 1997, it has been recognized that electricity supply in the country is scarce compared to the commercial and industrial electricity demand, which is one of the bottleneck for the country’s economic growth. For example, PLN does not have enough capacity to meet the rapidly growing electricity demand. In addition, the country’s electrification ratio is mere 71.2% (as of 2011), which means that nearly 20 Million[1] households do not have publicly supplied electricity. In the case of Indonesia, it is projected that due to its rapid economic and population growth, the electricity demand will grow 7-9% p.a., which makes the electricity supply even more urgent.

The maximum electricity demand in Sumatra-grid is 4,601MW as of 2011, and is reaching 9,641MW by 2020. The maximum electricity demand in Sulawesi-grid is 1,087MW as of 2011, and is expected to grow by 2,718MW by 2020. It is essential for both grids to develop new power plants to meet the above demand, especially factoring in sudden stoppage due to decrepit existing facilities.

[1] Price Waterhouse Coopers ”Electricity in Indonesia-Investment and Taxation Guide”

1-1-2. Necessity of developing the Target Project as Public Private Project

The fundamental of the governmental policy for the electricity issues is that the government has restrained the retail sales price of electricity in order to reduce the payment burden of households. Therefore, the cost of power generation is higher than the cost of electricity price in Indonesia. This has caused PLN some cash shortage and it is obvious that PLN has difficulty to develop the power generation plants by itself to meet country's growing electricity demand. Thus, the government of Indonesia amends Electricity Business Act, consolidates a legal system such as enacting FIT, and expects private capital emergence which can be seen in 'Fast Track Program'.

1-2. The Aim of the Survey

Although the policy pertaining to support renewable energy projects has been put into place, the development of the small hydro-power project has not seen much progress as expected. This is because that the local financial institutions usually do not provide the loan by project finance scheme, and instead assess projects by credit of the company. And most project owners of small hydro-power projects are small and medium size enterprises that they have difficulty even to get approval for Power Purchase Agreement (PPA) or other permission and authorization due to their low creditworthiness.

Hence, the aim of the Survey is to see how the small hydro-power projects can be developed by utilizing Japanese technology, equipment and funding and is to help the steady economic growth in Sumatra and Sulawesi by developing the small hydro power in both islands.

The survey report uses 111.200IDR/YEN as the reference rate of IDR/YEN as of December 31, 2012.

Chapter.2 Confirmation of the Current Status and Future Projections of Small Hydroelectric Power Projects in Indonesia

2-1. Current status, Challenges and the Future Plan of the Indonesian Electricity Sector with Some Focus on Renewable Energy

Indonesia possesses abundant oil, natural gas and coal. As a result, it is largely dependent on thermal power generation. As of 2010, generating capacity was 33.2GW and the gross generation was 169.8TWh. During the 20 years from 2010 to 2030, the gross generation will increase at the rate of approximately 9.1% per year.

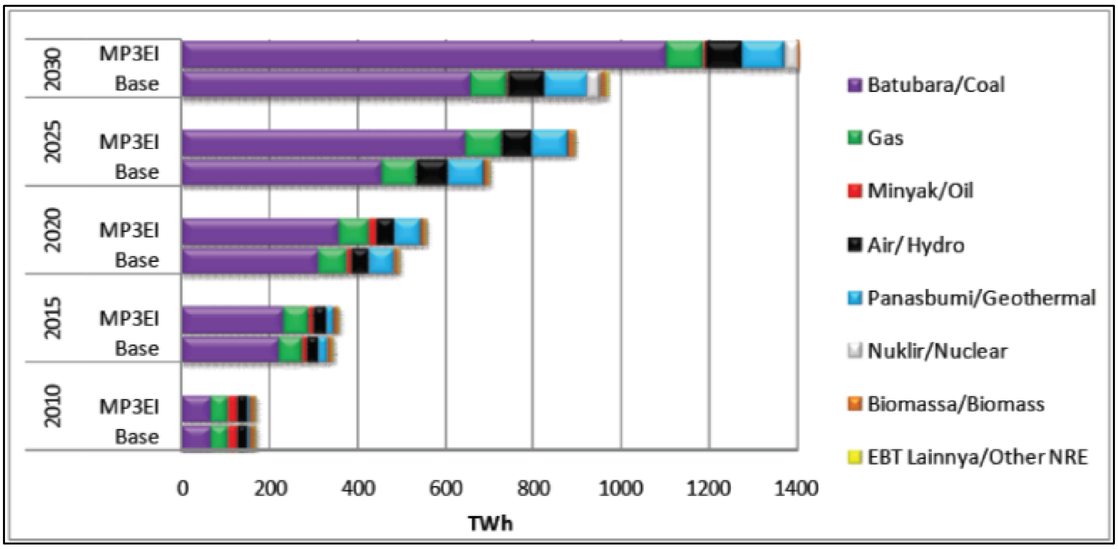

Figure 2-1 Trend of Gross Generation (By Fuel Type)[2]

Source: BPPT. "Outlook Energy Indonesia 2012"

However, due to the rapid economic development, since 2004 Indonesia has become a net-importer of oil. Combined with the rising global oil prices, the Indonesian government has stated that it will strive to reduce its dependency on oil[3]. Therefore, in order to compensate for the electricity demand, growing at the rate of more than 9% per year, Indonesian government has planned and executed "Fast Track Program", aiming for the large scale development and construction of power generating plants by using coal and renewable energy sources.

[2] "MP33EI" is an abbreviation of "Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia"

[3] Ministry of Energy and Resources, "UPDATES ON POLICY TO PROMOTE RENEWABLE ENERGY DEVELOPMENT AND ENERGY CONSERVATION IN INDONESIA, November 2011"

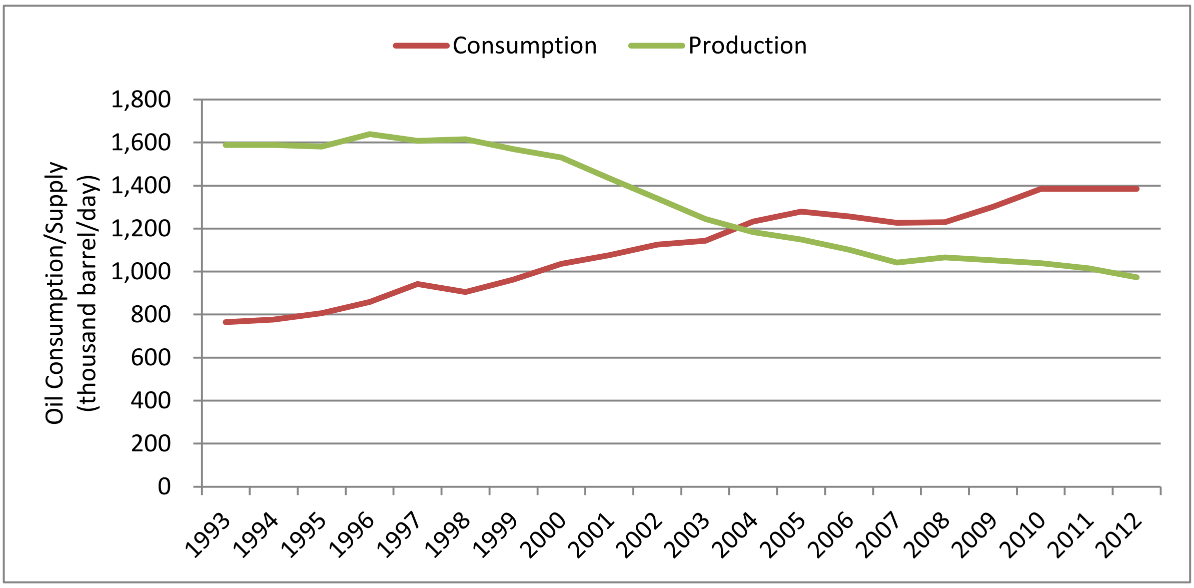

Figure 2-2 Volume of Oil Consumption and Supply

Source: Energy Information Association (U.S.A.)

In order to meet the expanding electricity demand, the "First Fast Track Program" planned to meet the electric development capacity target solely through coal-fired power plants. However, facing the environmental concerns, the government was requested to revisit the power development plan focusing on coal-fired power plants. Although the "First Fast Track Program" was executed by the PLN, the "Second Fast Track Program" outlined a plan to utilize Independent Power Producer (IPP). The "Second Fast Track Program" also planned to utilize renewable energy sources, with a development target of 18.1GW, close to four times as much as that of nowadays, by 2030[4].

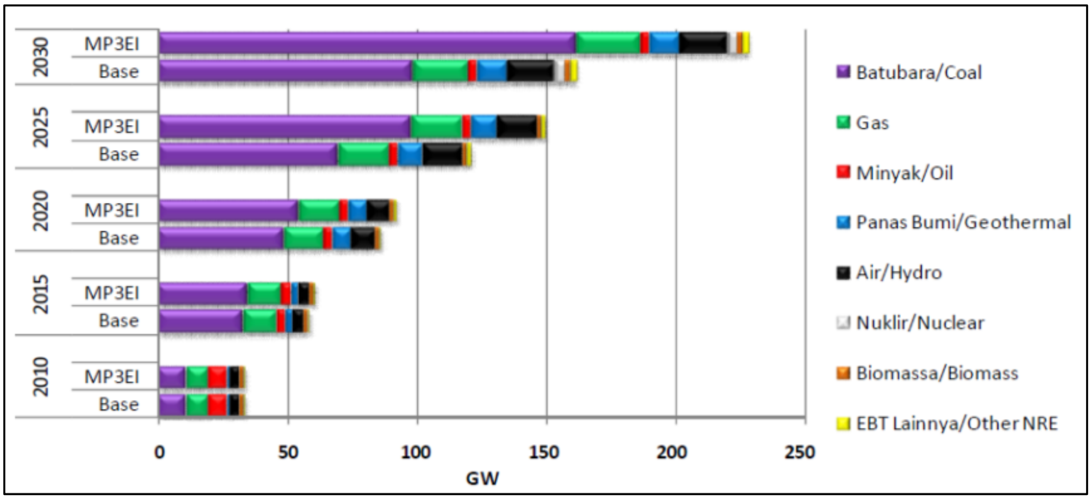

Figure 2-3 Estimated Composition of Generation Capacity by Fuel

Source: BPPT "Outlook Energi Indonesia 2012"

4 Badan Pengkajian dan Penerapan Teknologi(BPPT), "Outlook Energy Indonesia 2011"

Table 2-1 Fast Track Programs

	First Fast Track Program	Second Fast Track Program
Period	2006～2009	2010～2014
Scale of Development	10,000MW	10,153MW
Type of Fuel	Coal 10,000 MW (100%)	Coal 3,312 MW (33%) Gas 1,660 MW (16%) Geo-thermal 3,977 MW (39%) Hydro 1,204 MW (12%)

Source: PLN

Indonesia has the highest potential in developing geo-thermal power plants. Due to this, many companies, including Japanese companies, are actively engaged in the development of boring geo-thermal and geo-thermal power plants projects. It has been pointed out that the development of the geothermal power generation generally takes much time and cost, from geological survey to the start of operations, therefore, limiting the potential developers to those companies which have abundant capital to implement the projects.

Table 2-2 Potential of Development of Thermal Power Plants

Country	Number of Active Volcanoes	Volume of Geo-thermal Source（MW）
Indonesia	150	27,791
USA	133	23,000
Japan	100	20,540
Philippine	53	6,000
Mexico	35	6,000
Iceland	33	58,000
New Zealand	19	3,650
Italy	14	3,267

Source: The Agency of Energy and Resource, “On the development of thermal resource”, Oct.2011

On the other hand, although the development cost of large size the hydraulic power plants with sufficiently abundant resources is likewise costly, the construction of small hydroelectric generation projects of 10MW or less does not require such high costs, thus, keeping initial investment low and having the development period short. Due to these reasons, considering the increasing electricity demand, small-scale hydroelectric power is considered to be the most suitable means to meet the demands.

Table 2-3 Development Potential of Hydro Power Plants (MW)

Type	Development Potential	Existing Generation Capacity	Rate
Hydro	75,769 MW	7,571 MW	9.99%
Geothermal	29,164 MW	1,341 MW	4.6%
Biomass	49,810 MW	1,644 MW	3.3%
Solar PV	4.80 kWh/m^2/day	42.78 MW	-
Wind	3 – 6 m/s	1.87 MW	-
Ocean	49 GW	0.01 MW	0%

Source：MEMR "Country Report: Renewable Energy in Indonesia (2012)"

2-2. Present Conditions and Challenges Facing the Electricity Sector and Future Development Plans with Some Focus on Renewable Energy of Sumatra

As of October 2011, according to the announcement of PLN, the electrification rate of Indonesia is 71.2%. Depending on the region, the electrification rate in and around the main urban areas such as Java and Sumatra is high, while there are still many under-developed regions, remote place of the mountains or the eastern Nusa Tenggara/ Papua area which have not been electrified. Although, originally, it was the deemed the responsibility of PLN to construct and maintain the electric infrastructure of these rural areas, due to the implementation of the Electricity Act in 2009, under the direction of the central and local governments, governmental/private enterprises and cooperatives were allowed to enter the market.

As of 2010, the electrification rate of Sumatra Island is about 62.5%. Its rate is higher than other areas except Java Island and Bali Island. The Sumatra grid system is a developed one which is synchronized by linking northern and southern grid systems with 150 kV power transmission line.[5] It is planned to further develop 275kV and 500kV grid system by PLN as shown in Figure 2-4.

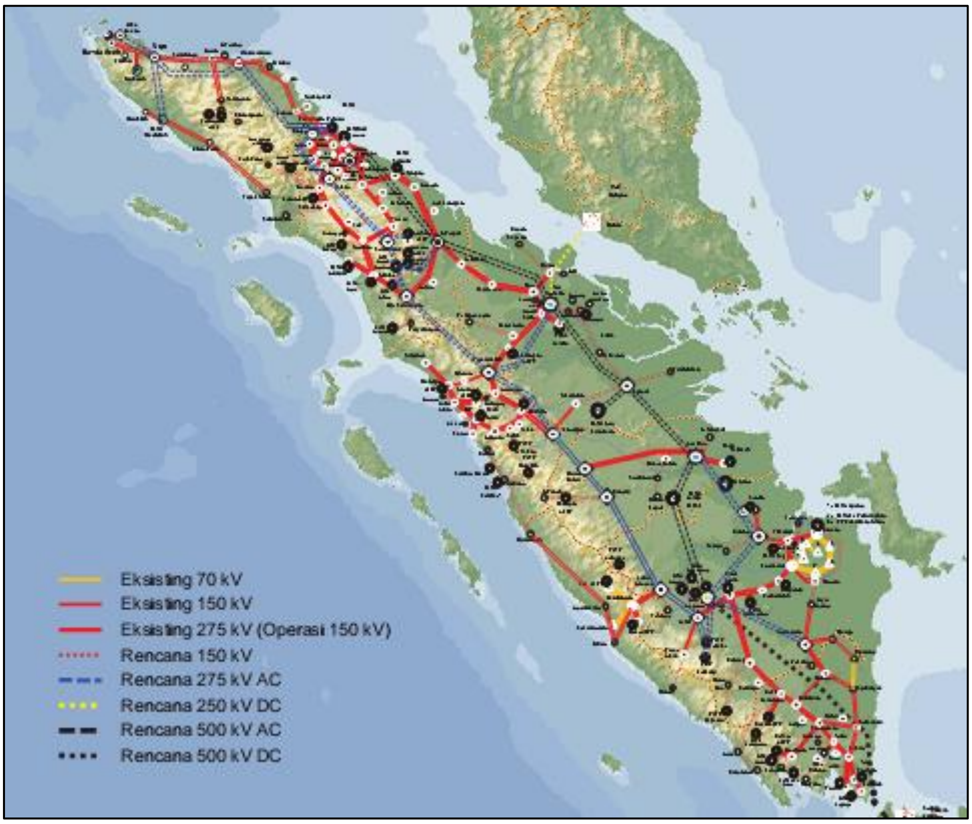

Figure 2-4 Sumatra Grid System Development Plan

Source: PLN "2012-2021 Power Development Plan (RUPTL)" Dec 2012

5 Ministry of Energy and Mineral Resource, "2008-2027 National Electricity Global Planning 2008-2027"

For this reason, to construct and maintain the electric infrastructure of its rural areas show sound progress. North Sumatra Province and Bengkulu Province, the places where target projects are located, record 77.8% and 54.6% at electrification rate. On the other hand, Riau Province and Jambi Province record 40.2% and 31.7% respectively, and they still have many unelectrified areas.

Table 2-4 Each Province's Electrification Rate in Sumatra Island（2012）

Name of Province	Population (Thousand)	Household （Thousand）	Electrification Rate （%）
Ache	4,693.9	1,105.1	88.55
North Sumatra	13,215.4	3,112.5	84.61
West Sumatra	4,957.7	1,182.5	72.98
South Sumatra	7,701.5	1,870.2	63.09
Bengkulu	1,766.8	445.5	71.02
Riau Islands	811.5	192.1	72.13
Lampung	7,767.3	1,985.0	65.29
Bangka Belitung	1,298.2	324.6	73.94
Riau	5,929.2	1,394.7	56.52
Jambi	3,242.8	800.4	58.05
Total	51,384.3	12,412.6	71.69

Source: PLN. "PLN Statistics 2012" Mar 2013

According to 2012-2021 Power Development Plan (RUPTL) stated by PLN, the electricity demand in Sumatra is projected to increase to 65.4TWh by 2021 along with 7.1% annual average economic growth and an annual average increase of 8.2% in electric demand.

Moreover, this plan sets out a target of 97.6% electrification rate by 2021.

Table 2-5 Average Indexes in Sumatra

Population Growth Rate	Annual Average Economic Growth Rate	Annual Average Electricity Demand Growth	Electricity Demand As of 2021 (MW)	Electricity Demand As of 2021 (GWh)
1.8%	7.1%	10%	10,516MW	55,272GWh

Source: PLN "2012-2021 Power Development Plan (RUPTL)" Dec 2012

According to PLN's 2012-2021 Power Development Plan (RUPTL), its baseline plans that while coal-fired thermal power remains as the nucleus of future development of power sources in Sumatra, 1.6 GW of hydro power is expected to be generated by 2021 and total hydro power installed capacity will be 2.6GW and shared 15.7%. Therefore, it is forecast that there will be certain hydro power development in Indonesia.

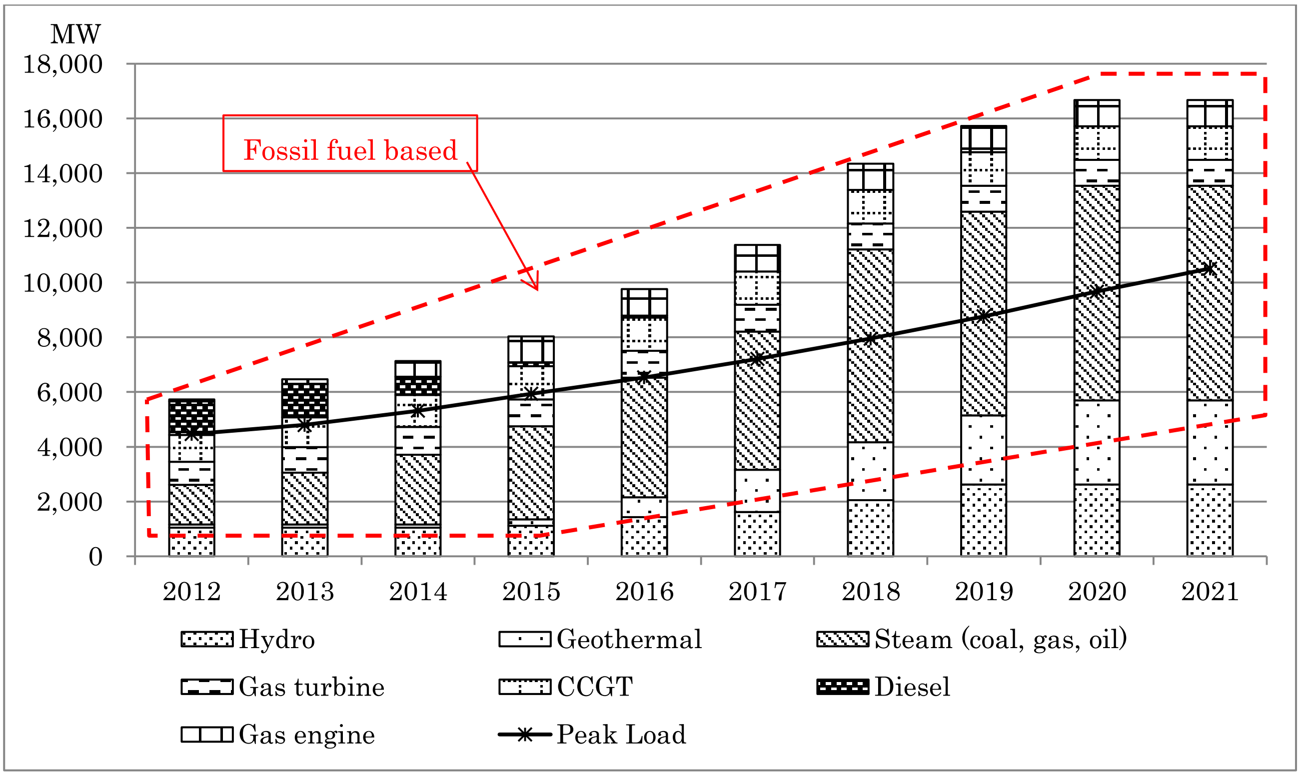

Figure 2-5 Forecast of Generation Capacity and Peak Load

Source: PLN "2012-2021 Power Development Plan (RUPTL)" Dec 2012

However, as shown in the figure below, generation cost of fossil fuel based power plants, given increased fuel cost, is much higher than hydro. Therefore, small hydro power is supposed to be prioritized for generation as it has competitive advantage in generation cost, over other plants.[6]

[6] PLN, as an off-taker of the electricity produced by small hydro power plants, is obligated to purchase all electricity during the contract period. Thus, regardless of the cost comparison with other power plants, electricity produced by small hydro will be purchased.

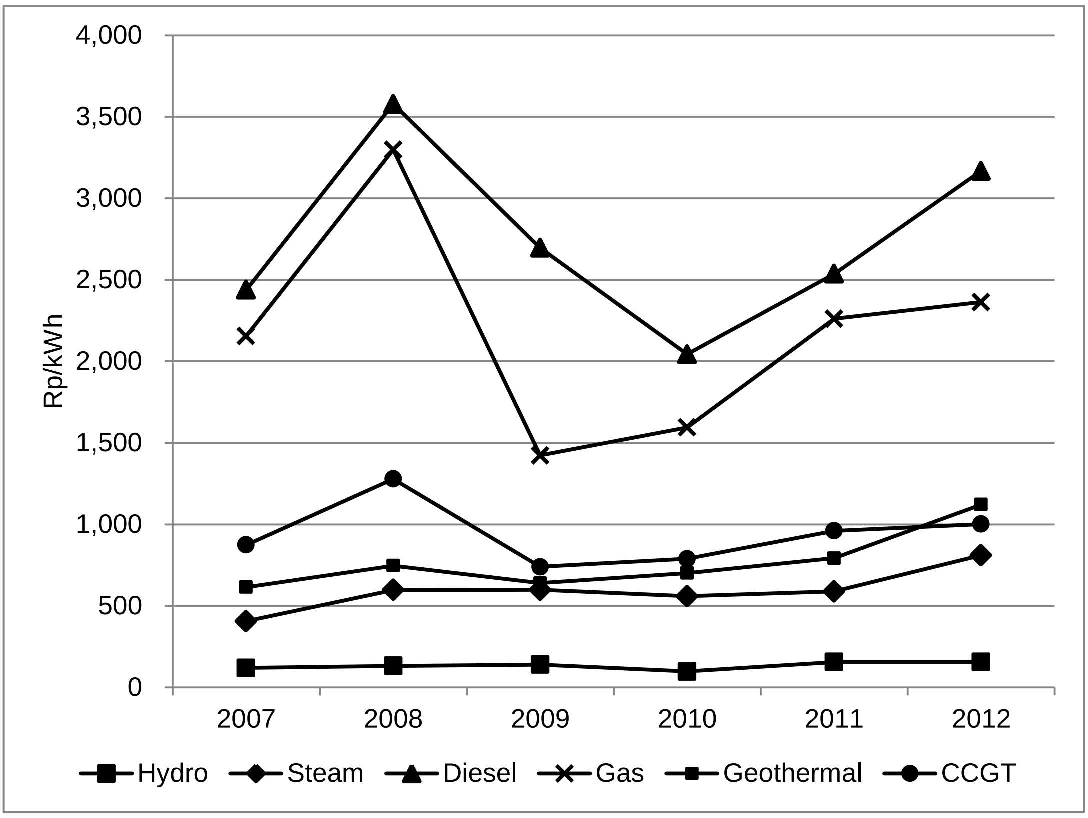

Figure 2-6 Generation Cost Comparison

Source: PLN “PLN Statistics 2012” Mar 2013

According to RUPTL, the following table is the power development plan in Bengkulu.

Table 2-6 Power Development Plan in Bengkulu (2012 – 2021)

Plant Name	Fuel	Capacity	Scheduled commencement of operations	Owner
Ipuh	Coal	6 MW	2013	PLN
Muko Muko	Coal	8 MW	2013	IPP
Simpang Aur	Hydro	23 MW	2015	IPP
Hululais	Geothermal	110 MW	2016	PLN
Ketahun-3	Hydro	61 MW	2019	PLN
Kepahiyang	Geothermal	220 MW	2020	PLN

Source: PLN “2012-2021 Power Development Plan (RUPTL)” Dec 2012

2-3. Summary of the Indonesian Laws Regulations, Policy and Structure Relating to Electricity Focusing on Renewable Energy and Public-Private Partnerships (PPP)

2-3-1. Background and summary of PPP structure and policy in Indonesia[7]

When the Yudhoyono administration was established, the Indonesian government was in a tight economic situation. To promote the growth of the national economy and the furtherance of infrastructure development, the government implemented PPP policies. By opening the areas previously controlled by the public sector such as 1) transport 2)high way 3)irrigation 4)water-works 5)refuse disposal 6)communication 7)electricity 8)oil and natural gas infrastructure to private investments, through the PPP scheme, the Indonesian government hopes to attract both the capital and expertise of foreign companies.

In January 2005, President Yudhoyono invited domestic and overseas investors to 'the Infrastructure Summit 2005'. In November of the same year, Presidential Regulation (PR) number 67/2005 concerning Public Private Partnership in Infrastructure Development was issued to promote PPPs. The objective of the PR 67/2005 was to develop the national infrastructure by utilizing the PPP system. Yet, despite having published 91 candidates for PPPs and selecting 10 model projects, due to the ambiguity of the government's responsibilities under the PR 67/2005, foreign investors failed to show interest and consequently feasibility studies of many of the PPP projects were not conducted. Subsequently, during the first Yudhoyono regime, no PPPs were formed.

However during Yudhoyono's second term of office (October 2009 to September 2014), PR 67/2005 was revised and PR 13/2010 was issued, which clearly defined the Indonesian government's responsibility with regard to PPP projects, including terms regarding the acquisition of land, government subsidies, governmental guarantee on loans. Consequently, the private sector's risks in entering the PPP projects have been greatly reduced.

Table 2-7 Modification from PR67th / 2005 to PR13th / 2010

Modification	PR 67/2005	PR 13/2010
Contracting Agent/Office	No designation regarding Contracting Agent Executing Agent limited to respective ministers, commissioners, the local government chairman	Executing Agent is also designated as the Contracting Agent (which includes provincial/state governments' development authorities)
Share Transfer	➢ No transferal of shares before commercial operation	➢ All or a part of shares are permitted to be transferred
Form and Range of the	Ambiguous terms of government support for projects	Defined the terms of government: ① Government responsibility:

[7] Mizuho Research Institute Ltd, "Indonesia, accelerating the investments for infrastructures with PPP", Oct.18th 2011.

Government Support		(e.g. expropriation of land, approval and license, provision of basic infrastructure) ② Government subsidies (e.g. operating cost) ③ Government guarantee for contingent liabilities
Funding procedures	No particular provisions	The project owner must complete funding within 12 months after the signing of the agreement If one of the following conditions are met, funding shall be deemed complete. ① All documents of all funding for this business are signed. ② The pre-determined amount specified in the finance contract has been spent.

Source：Engineering & Consulting Firms Association

In April 2011, Indonesian Infrastructure Guarantee Fund (IIGF) was established as a solely owned subsidiary of Indonesian Department of Finance with the aim of strengthening government guarantee. IIGF aims to cover government risks that private company cannot control, such as delay in decision making, default of contract and occurrence of events that lie outside the jurisdictions of existing ministries.

As a result of the implementation of policies and framework for the promotion of PPPs, combined with the economic growth driven by the domestic demand and the political stability, the Indonesian market has begun to attract more attention as a potential investment target.. In January 2012, Indonesia's investment rating was raised to BBB-.

2-3-2. Outline of Legal System Related to Electric Power in Indonesia

Regulations related to the electric power business in Indonesia are mainly defined in the Electricity Act of 2009 that was published in September 2009.

The Act defines the electricity supply business as power procurement through power generation, transmission, distribution, and sale to consumers[8]. Indonesian Government assumes principal

[8] The Electricity Act 30/2009, Article 1.

responsibility of power supply[9], but local government is also involved in making various plans and responsible for issuing certain permits necessary for the IPP developers. Under the act, National Electricity General Plan (RUKN) is developed based on the national energy policy through the process participated by the local government as well. In addition, based on the RUKN, local government makes Regional Electricity General Plan after discussion with local parliament.

PLN lost its complete exclusive rights over power supply by the Electricity Act 30/2009, and government owned company, publicly owned company, private company, cooperative, or NGO with power supply business permit (IUPTL) are allowed to conduct generation, transmission, distribution, and retail businesses. However, PLN has the priority to supply electricity to the public[10]. In transmission and distribution sector, the entry barrior could be high because PLN has dominated the market developing infrastructures.

As to the electrification of rural area, it is defined that central government and local government establish the fund for the people in poverty and develop power facilities, power supply to remote and rural area, and rural electrification facilities.

For the renewable energy projects with certain capacity size, Feed in Tariff system where it is possible to sign PPA with PLN for long term fixed price without price negotiation is installed by the MEMR Ministerial Regulation 31/2009 and 04/2012 (see 2-4-1 for details). FIT is based on the Electricity Act of 2009, which allows government owned company, publicly owned company, private company, cooperative, or NGO to conduct electricity supply business, and obligate PLN to purchase electricity produced by the renewable energy source of up to 10MW, developed by the project owners mentioned above.

Foreign investment in power generation sector is regulated by Negative Investment List (Presidential Regulation 36/2010) shown as the following. It is necessary to pay attention to the on-going discussion on its revision.

Table 2-8 Negative Investment List in Power Sector

Business Sector	Conditions
Generation (< 1MW)	Closed; Only for UMKMK[11]
Generation (1-10MW)	Partnership; no limitation for foregin investment but cooperation with UMKMK required (investment, outsourcing, rental or any kind of participation)

[9] The Electricity Act 30/2009, Article 3
[10] The Electricity Act 30/2009, Article 11
[11] UMKMK is a private or company satisfied with low No. 20/2008 concerning micro, small and medium enterprises and low No. 25/1992 concerning cooperatives.

Generation (> 10MW)	Foreign capital raito is up to 90%
Gepthermal plant operation and maintenance	Foreign capital raito is up to95%
Geothermal power	Foreign capital raito is up to 95%

Source：Presidential Regulation 36/2010

2-4. The Objectives, Policies and Institutions of the Central and the Local Government for Financial Resource and Subsidy System of Renewable Energy Development with a focus on Small Hydro Power

2-4-1. Summary of the government objectives for hydroelectric power

As noted earlier, the second Fast Track Program aimed to develop 1204MW by hydroelectric power and to introduce Feed-in-Tariff (FIT) for renewable energy of 10MW or less including small hydro.

The term for power purchase is not defined in the regulation, but about 10-20 years can be seen in the power purchase agreement generally, providing long-term stable power sales expectations. The FIT is applied to all renewable energy of 10MW or less, excluding geo-thermal which could be bigger to be qualified. Power plants over 10MW must negotiate directly with PLN for a PPA price. As the negotiation is often protracted, the risk of the project failing for those over 10MW is larger than those of 10MW and less. It is said that the size to be qualified for FIT may expand up to 15MW from 10MW.

At the conference held in September 2013, senior official of MEMR explained that FIT price for small hydro is being reviewed to be revised soon. The discussion is continued between MEMR and PLN where MEMR shoots for about 20% increase while PLN hopes to minimize the level of increase. Consequently, there is a need to seek timely information from the government and authorities concerned.

Table 2-9 FIT Pricing Structure

System	Hydro Wind Solar Power etc. (<10MW)		Biomass (<10MW) (*)		Thermal
	Medium Voltage (Rp/kWh)	Low Voltage (Rp/kWh)	Medium Voltage (Rp/kWh)	Low Voltage (Rp/kWh)	High Voltage (USD/kWh)
Java, Maudra, Bali	656	1,004	975	1,325	9.7cent ⇒11～15cent
Sumatera, Sulawesi	787	1,205	1,170	1,590	
Kalimantan, Nusa Tenggara	853	1,305	1,268	1,723	
Maluku, Papua	984	1,506	1,463	1,988	

Source: The Regulation of Ministry of Energy and Mineral Resources No. 4 Year 2012

(*) The price varies if final disposal technology is used.

2-4-2. Preferential Tax Treatment

In order to promote the second Fast Track Program, which focuses on renewable energy, the Indonesian government issued preferential tax treatments for renewable energy power producers through the regulation of the Minister of Finance number 24/PMK.011/2011 dated January 29th 2010. The target businesses were those of geo-thermal, wind, biomass, solar PV, hydro, ocean current and ocean thermal generation. The preferential treatments are defined as a deduction of 30% of investment amount from taxable income, the shortening of the depreciation period of assets, exemption of value-added tax and import duties for imported machinery and equipment.

Table 2-10 Preferential Tax Treatment

Income Tax Credit	Deduction from taxable amount which is 30% of investments (Each year 5% deduction for 6 years)
	Shortening of amortization period of fixed assets
	Lower 10% of withholding tax against overseas profit transfer
	The period of carry-over of losses extends up to 10 years.
Exemption from Value-Added Tax	Exemption from Value-Added Tax when strategic related machines and equipment are imported
Exemption from Customs Duty	Exemption from customs duty of related machines and equipment

Source: JETRO Website[12]

The tax rate on the fund transfer is defined as the following by the Tax Treaty between Japan and Indonesia.

Table 2-11 Tax Treaty between Japan and Indonesia

Interest Tax		10%
Distribution Tax	Investment ratio over 25%	10%
	Investment ratio under 25%	15%
Royalty Tax on Transfer		10%

Source: JETRO Website[13]

In the Economic Partnership Agreement between Japan and Indonesia, elimination of tariffs in the power sector was put on hold, but it stated that 1) there will be no tightening of the regulation in the future and 2) there will be revisit to the regulation every three years.

[12] JETRO Website http://www.jetro.go.jp/jfile/report/07000456/indonesia_kankyo_seisaku.pdf (Jan 21st 2014)
[13] JETRO Website http://www.jetro.go.jp/world/asia/idn/invest_04/ (Jan 21st 2014)

2-5. Interests and Trends of Domestic and Foreign Investors in Renewable Energy Development, Especially in the Small Hydroelectricity Sector

It has been confirmed that Pusat Investasi Pemerintah (PIP - the Indonesian Investment Agency) whose main task is to invest infrastructures and PLN are currently supporting constructions of renewable energy power plants in Indonesia. Among the various renewable energy sources, they place a strong emphasis on small hydro and biomass projects in addition to geothermal. PIP can consider providing loans to IPP projects having PPAs with PLN[14]. However, PIP's area of focus for project support may change every year. Up to December 2013, PIP has not made any investment into renewable energy power project including small hydro.

There are some local energy companies in fossil fuel related business that plan to come into the renewable energy business including small hydro for corporate social responsibility or portfolio diversification. PT Sumberdaya Sewatama, which is one of the major local energy companies and subsidiary of PT ABM Investama Tbk, a public listed company with coal value chain from coal mining concession to coal fired IPP, is one example of local energy company planning to penetrate into renewable energy business[15].

On the other hand, although some support programs for renewable energy are being developed as explained above, the development of small hydro power projects by local companies has not necessarily seen much of the progress. There are mainly two issues behind this situation. Firstly, as explained in 1-2, project finance scheme is not regularly utilized, and local banks look at credit of the project owner rather than the project itself, creating difficult environment for small and medium size companies. There are local banks financing to small scale project owners for around 8 years with about 13% interest. However, some it is difficult for the project owner to pay back the debt immediately after commencement of commercial operation. Therefore, it is necessary for the project to be financed with balloon type loan in order not to go default.

Secondly, because small hydro power business became open for private company recently, many of the project owners are new entrants without good understanding of the importance of the engineering in the project. In order to meet the formal requirements, some project owners assign local technical consulting companies who can provide a report very quickly regardless of quality. Proceeding with this kind of FS is likely to create problems such as re-doing surveys, changing layouts, or acquiring additional land, resulting in longer time to actually develop it the project. As such, the financial and technical issues are there while some support programs and investments from overseas have been deployed.

The United States Department of Energy has indicated their intention to invest 1.2 million U.S.

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[14] Kabar24 HP, Access Aug,16th 2012
[15] ABM Investama. "Annual Report 2012"

dollars in the renewable energy sector through the Sustainable Energy for Remote Indonesia Grids (SERIG), and is planning to cooperate with the Indonesian government in this field[16]. United States Agency for International Development (USAID) also agreed with the National Development Planning Agency (BAPPENAS) that they would invest renewable energy sectors in USD 332 million through the Green Prosperity Project by Millenium Challenge Corporation.[17]

In Germany, one of the leading countries in the field of renewable energy, 8 companies (EnBW AG, Ribelga Deutschland GmbH, Schnell Motoren AG, Suma GmbH, Consulectra GmbH, Maxxtec AG, Putmeister Solid Pumps GmbH, Pto2 Anlagentechnik GmbH) participated in German-Indonesia renewable energy conference in 2011, with many showing a strong interest in this field for investments in Indonesia[18].

As examples of foreign investments into Indonesian renewable energy projects, some state owned companies including following countries have made investments in IPP business. From China, China Power Investment, a Chinese state-owned company, announced its plan to invest about Rp. 17 billion together with the Chinese cement company into some hydro IPP projects in North Kalimantan totaling about 7GW[19]. From Korea, Korea Midland Power, a state owned generation company, is developing 284MW hydro power plant, Muara Juloi hydro power project, and signed MOU with PLN in April 2013.

As for Multilateral Development Bank, Asian Development Bank (ADB) is planning to actively become involved in the power sector in Indonesia by providing loans. ADB is planning to give USD 250 million loan to Sarulla geothermal power project (330MW) in North Sumatra developed by the Japanese companies and US plant manufacturer and also USD 2 million technical support grant to three hydro power repowering projects in West Papua in East Indonesia. ADB also approved providing a loan of USD 4.95 million to 220km 500kV transmission line in the Java-Bali grid along with substations, as well as 145km transmission line in West Kalimantan which enables electricity supply from hydro power plants in Malaysia. Other trend includes IFC's investment into Indonesian and foreign private equity funds so as to support renewable energy development[20] and IFC also announced its plan to support wind IPP last year.

As described above, the field of renewable energy in Indonesia is becoming recognized as having a high potentially both government agencies and private companies worldwide.

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[16] Eco-Business. http://www.eco-business.com/news/indonesia-aims-boost-electricity-capacity-renewable-energy/ 24th Jan 2014

[17] US Department of State. Website. http://www.state.gov/r/pa/prs/ps/2012/09/197980.htm 24th Jan 2014

[18] The Jakarta Post, Oct, 25th 2011

[19] The Jakarta Glove, May 29th 2013

[20] IFC Website, Accessed 2013

Chapter.3　Selection of the Project

In the survey, Tornauli project which PT. Northsum Hydro develops in North Sumatra is one of the targeted projects. This project already acquired Izin Prinsip (Research Permit) and Izin Lokasi (Location Permit) from Bupati (Governor)[21], entered into PPA with PLN. It was chosen due to above condition that the project has high possibility of being implemented in comparison with other potential projects in Indonesia.

Table 3-1 Researched Project Outline

No.	Name of Project	Location	Generating Method	Output	Maximum Discharge	Effective Head Differences	Electricity Generation
				MW	m^3/s	m	MWh/y
1	Tornauli	North Sumatra	Intake Method	8.0	11.50	85.21	61.928

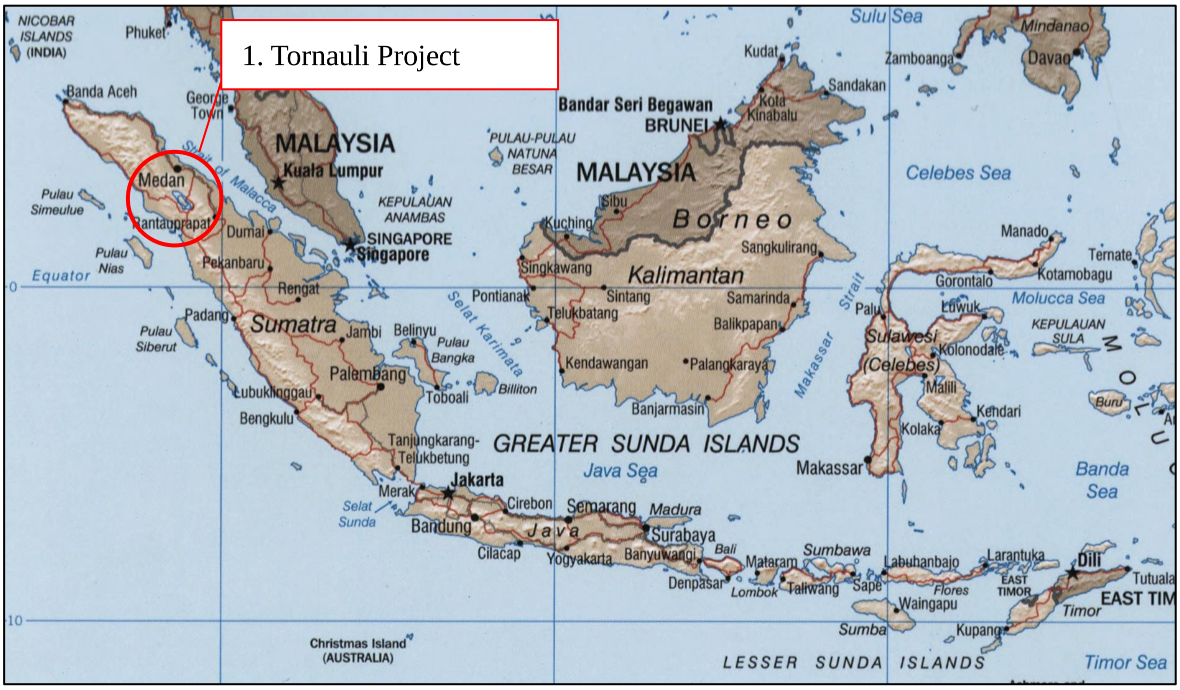

Figure 3-1 Location of Tornauli Project

[21] Bupati is the Governor of Kabupaten that is under the Provinci. The project is located in the Kabupaten Humbang Hasundutan that is in the Provinci Sumatera Utara (North Sumatra).

Chapter.4 Tornauli Project

4-1. Planning of Business and Funding Scheme

In order to identify and solve the challenges facing the realization of candidate projects, this section aims to evaluate the business scheme of the candidate projects and the validity of the funding schemes available to them, including Japan International Cooperation Agency (JICA) Private Sector Investment Finance Scheme.

4-1-1. Business Scheme Evaluation

4-1-1-1. Identifying the Optimum Project Structure

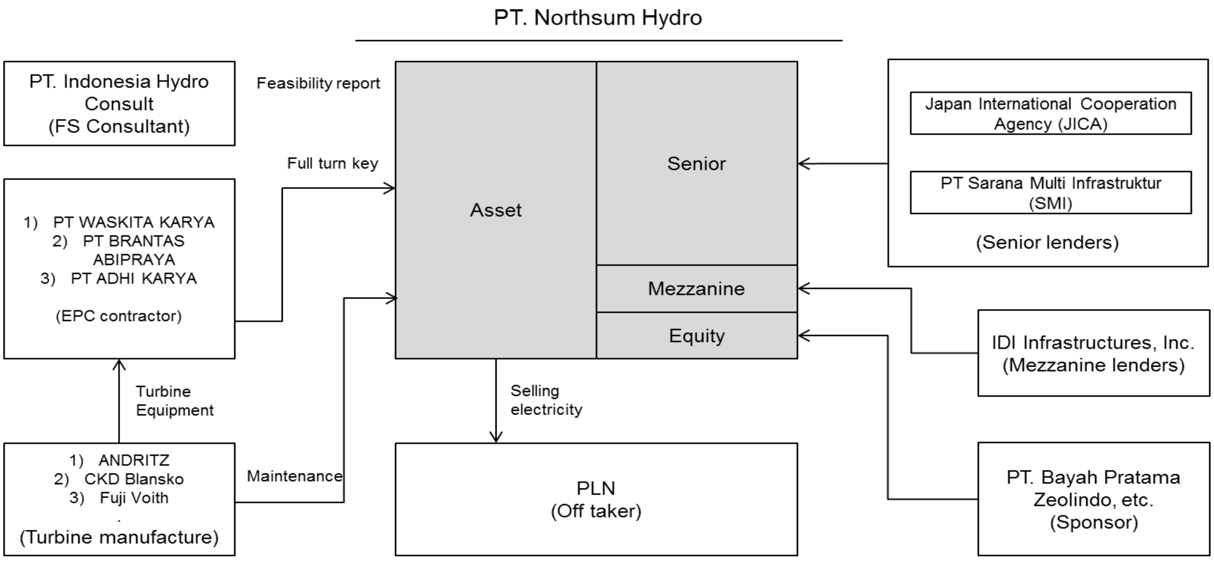

Figure 4-1 Finance Scheme

The Tornauli Project is the hydro power project with its installed capacity of 8MW located in North Sumatra in Indonesia. PT. Northsum Hydro (Northsum), the project company specializes in small hydro power generation development. The management of the company has, in the past, developed large scale hydro power generation plants in Indonesia. Highlighted features of the project are that: 1) Northsum has obtained a 20 year fixed price PPA with PLN. 2) the construction is planned to be undertaken under a full-turnkey contract by a large Indonesian EPC Contractor. 3) the turbine manufacturer will be either European or Japanese manufacturer. 4) the financing structure will be with JICA and PT Sarana Multi Infrastruktur (SMI) as the senior lenders and IDI Infrastructures Inc. (IDI-I) as the mezzanine lender under a current circumstance. Northsum management already had a meeting with a department head of the department of Finance and Investment at SMI, a candidate of senior lender. However, there are no official conference minutes, and SMI is currently in the process to review the project. In terms of equity, Northsum is looking for new investors, and with new investors Northsum will cover 20% of the total project cost.

4-1-1-2. Confirmation of Approval, License and PPA Acquisition Status

Generally, project owners of a small hydro power generation select a candidate site through their networks which is frequently introduced through local influential persons, local office of PLN and

Governor affiliates. After the candidate site is identified, they have to apply for the Research Permit to Governor to officially conduct a field research. If the relevant requirements are fulfilled, the Research Permit is issued by the Governor within one to two months. In addition, the project owner also has to apply for Location Permit to the Governor a permit to conduct small hydro power generation operations.

As Research Permit and Location Permit cannot be issued for the same candidate site for several project owners, in order to secure the land and prevent the other project owners from taking the candidate site, it is important to obtain the candidate site quickly. Once the Research Permit and the Location Permit are obtained, it is possible to conclude a PPA with PLN. The final step before commencing construction works, the project owner must obtain an IMB (Izin Mindirikan Banyunan Bupati), the Indonesian building permit.

Table 4-1 List of Northsum's Obtaining Progress of Approval and License

Types of Approval and License	Progress
Research Permit	Already Obtained
Location Permit	Already Obtained
PPA	Already Obtained
IMB (Izin Mendirikan Bangunan - Building Permit)	To Be Obtained

4-1-2. Evaluation of the Project Owner

4-1-2-1. Company Overview

Table 4-2 Company Overview of Northsum Hydro

1	Company Name	✓ PT. Northsum Hydro
2	Date of Establishment	✓ May 2011
3	Type of Business	✓ Development and operation of hydro power generation
4	Shareholder Composition	✓ PT. Bayah Pratama Zeolindo and 2 other individuals (August 2012) *PT. Bayah Pratama Zeolindo is an investment company held by individuals (including the members of Northsum's management）. Other investment track records on PT. Bayah Pratama Zeolindo will be confirmed later.
5	Numbers of Employee	✓ Several People
6	Location of Head Office	✓ Jakarta, Indonesia

4-1-2-2. Financial Status

Northsum is a SPC which is established for this project, so there is no financial information at this point. Detail financial status will be confirmed later on.

4-1-2-3. Track record

Tornauli Project is the first small hydro power generation project for Northsum. It is understood that the managers of Northsum have sufficient experience in development, construction, and operations of power generation plants through not only the development of large-scale hydro power generation in Indonesia, but also coal-fired thermal power IPP. A small hydro power business has similar characteristics and high relevance to the IPP business development that Northsum management experienced. It is also expected that around 20% of necessary equity amount out of total project cost will be covered by current existing shareholders and additional new investors; hence, it is necessary to confirm that there will be the sponsor taking a responsibility for this project in terms of financial aspects.

Although the Northsum management has experience in operating power plants before, it is necessary to check the ability to perform well when hiring internal engineers in terms of technical aspects.

4-1-2-4. Medium-term strategy and Business plan

Northsum currently develops multiple small hydro projects besides Tornauli one and is planning to develop medium-sized hydro power plants in the future.

4-1-3. Evaluation of the Off-taker

In this project, the off-taker is PLN, the State Electric Power Company of Indonesia. The following is the outline of the company.

- Date of Establishment: October 27, 1945
- Shareholder Composition: 100% Indonesian Government
- Numbers of employees: 47,615 (December 2011)
- Management profile: Composed of seven directors. The president commissioner is from MEMR. Other commissioners are from the former vice-president of the International Monetary Fund (IMF) to the head of the Jakarta Police Department, showing the wide variety of personnel from various backgrounds.
- Business overview: PLN is legally authorized to have power generation, transmission and distribution line in a vertical integration business structure dominating the power market of Indonesia. Power generation is managed by its subsidiary companies and IPPs whereas it is a monopoly over power transmission and power distribution. PLN's market share for the capacity out of total power generation capacity in Indonesia is 85% (4,934MW) and its share in power transmission is 100% (36,741km of transmission network) and power distribution is also 100% (685,785km network). Currently, in order to promote private investment, Indonesian Government is supporting investment for IPPs by implementing a long term PPA.
- Financial status as of 2011 fiscal year: Sales – approximately IDR 208 trillion, net income approximately IDR 7 trillion (approximately JPY 1.9 trillion and JPY 62.9 billion, respectively under the exchange rate of December 31 2012).

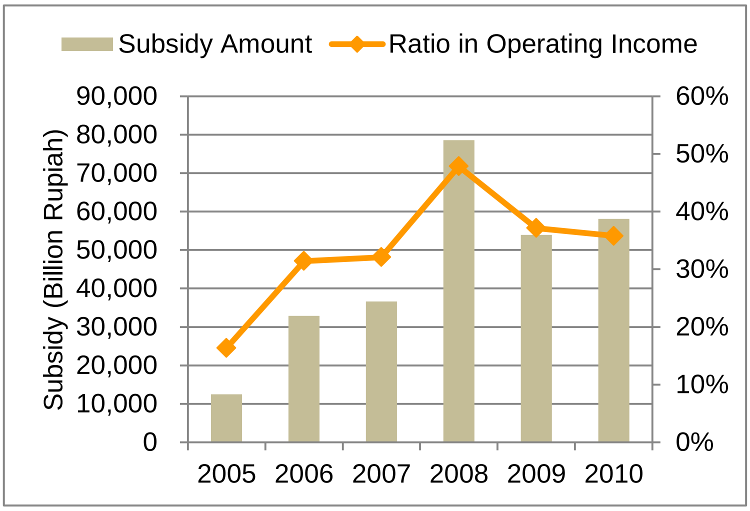

Figure 4-2 Subsidy PLN Receive from Government and its Ratio in Operating Income

The credit rating of the Indonesian government bond has been raised to investment grade by multiple rating agencies. Macroeconomics indicators such as government debt and foreign exchange reserves have shown improvements in recent years. The Indonesian government has increased the price of fuel in order to decrease the fuel subsidy, which had been a major policy issue for many years. On the other hand, FIT was established by law, obligating the sole state-owned power company, PLN, to buy electricity, therefore it is difficult to imagine a situation where the government will ignore PLN breaching PPA signed under FIT scheme.

Table 4-3 Credit Rating of Indonesian Government Bond

Rating Company	Rating	Forecast
Standard & Poor's	BB + (Investment Grade -1)	Stable
Moody's	Baa 3 (Investment Grade)	Stable
Fitch	BBB - (Investment Grade)	Stable

Source: Websites of Rating Companies

4-1-4. Evaluation of the Current Project's EPC Contractor and Turbine Manufacturer

The EPC contractor and turbine manufacturer candidates of this project are as follows:

4-1-4-1. EPC Contractor

(1) PT WASKITA KARYA[22]

- Company Overview: the company was established in 1964. In 1990s, it engaged in constructions of a multi-story building such as BNI City Indonesian Office Building, Graha Niaga Tower, Mandiri Planza Tower, and Shangri-La Hotel. Its expertise has been applied to bridgework such as Raja Mandala, Rantau Berangin, and Barelang IV. The company also has undertaken approximately 30 dam constructions and over 10 power plant construction projects such as Pondok, Grogkak, Tilong, Gapit, and Sumi. It obtained ISO9002 in 1995 and ISO9001 in 2003. The company has expanded in overseas since 2006, and it opened a branch office in the main cities of Middle East such as Dubai, Abu Dhabi, and Jidda. The company has a record of implementing the "Solo Lower Valley River Improvement Business", financed by the JICA ODA Loans scheme.
- Shareholder composition: Not disclosed (however, over 50% is owned by the Indonesian Government)
- Financial Status as of 2010 fiscal year: Revenue – IDR 585 billion. Net operating profit – IDR 38 billion. Total assets: IDR 407 billion. (Approximately JPY 79.2 billion, JPY 4.1 billion and JPY 75.2 billion respectively, according the exchange rate of December 31 2012)

(2) PT BRANTAS ABIPRAYA[23]

- Company Overview: 100% government-owned company established in 1980. Their core business

[22] PT WASKITA KARYA HP, http://www.waskita.co.id
[23] PT BRANTAS ABIPRAYA HP, http://www.brantas-abipraya.co.id/

is construction of dams, airports, bridges and irrigation facilities. They have obtained ISO9000 in 1998.

- Shareholder Composition: 100% government-owned.
- Financial Status: No Disclosure

(3) PT ADHI KARYA[24]

- Company Overview: the company was established through the nationalization of the Dutch company, Associate N.V. in 1960. Since 1999, it has become the biggest construction company in Indonesia. In 2004, it became listed on IDX as the first construction company. In 2009, it obtained ISO9001, and was elected as one of the Indonesian largest company 100 in 2010 in Fortune magazine. The company has 3 subsidiaries: 1) PT Adhi Persada Properti (real-estate development, 97.93% ownership), 2) PT Adhi Persada Realti (real estate, 99.00% ownership) , 3) Adhi Multipower, Pte Ltd (trading, 100% ownership).
- Shareholder Composition: 52.28% owned by the Indonesian government. Indonesian and foreign investors own the remaining share.
- Financial Status as of 2010 Fiscal Year: Revenue – approximately IDR 6.695 trillion. Operating profits – IDR 55.5 billion. (Approximately JPY 60.2 billion and JPY 5 billion, according to the exchange rate of December 31 2012)

In this project, three EPC contractors above are chosen as candidates and one of them will be chosen to conduct detailed conference for the project. For that purpose, the further discussion shall be conducted. In this process, it is important to confirm the background of engineers in the project team and track record of small hydro projects in addition to the information above.

4-1-4-2. Turbine Manufacturer

(1) ANDRITZ[25]

- Company Overview: An Austrian company established in 1852. Their core businesses are in generator supply for hydro power plants, delivery and maintenance of production facility for metal and paper-pulp factory. ANDRITZ HYDRO, one of the ANDRITZ group, has developed their businesses in more than 20 countries and 50 business sites around the world. Their products range from large and small size hydro power generators, irrigation facilities, to pumps. By now, this company has delivered in total 30 thousands turbines (Total installed capacity is 400,000MW). At the end of 2012, their products share in hydro power plants market in the world is more than 40%. ANDRITZ HYDRO has firm business foundation in this domain with storage of turbine design know-how in more than 170 years. In addition, this company has been listed on the stock exchange since 2001.
- Shareholder Composition: The chairman of ANDRITS, Mr. Wolfgang Leitner and managing

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[24] PT ADHI KARYA HP, http://www.adhi.co.id/adhi2012/front/
[25] ANDRITZ HP, http://www.andritz.com/

director Mr. Certus Beteiligungs-Gmbh,, have approximately 30% of its stocks. The rest 70% stocks are held by American and English institutional investors and Austrian and German individual investors

- Numbers of Employees: Approximately 17,900 (As of April. 2013: Excerpted from HP)
- Management Profile: The executive committee is composed of 5 members, and 4 of them have worked at ANDRITZ for more than 16 years. Wolfgang Leitner, the chairman, has held positions of CEO and the chairman for more than 19 years.
- Financial Status as of 2012 year: Sales – Approximately 5,100 million euros, net profit－approximately 242 million euros, and total assets- approximately 5,100 million euros. (Approximately JPY 592 billion, JPY 27 billion, and JPY 590 billion according to the exchange rate of December 31 2012)

(2) CKD Blansko[26]

- Company Overview: Czech company was established in 1950 as a state-owned company. Their core business is in the production of hydro power turbines. They also have an original network in the world and already have ISO 9001.
- Shareholder: TYAZHMASH Group is the parent company.
- Number of Employees: Not disclosed
- Management Profile: Not disclosed.
- Financial Status: Not disclosed.

(3) Fuji-Voith Hydro

- Company Overview: Established in 1997, as a joint venture between Voith Siemens and Fuji Electric. This company widely handles 50kW-Micro water turbine, and also handles 500MW scale large water turbine and power generator including main body of water turbine, that of power generator, and peripheral equipment. Fuji-Voith Hydro purchased the hydro power equipment business of EBARA Corporation in June 2011. Also, they have an intention to reinforce their sales in Asia, aiming at the annual sales scale of 10 billion yen.
- Shareholder Composition: Fuji Electric and Voith Hydro, each owns half of the stocks.
- Employee: No Disclosure
- Management Profile: No Disclosure
- Financial Status: Sales－Approximately 6 billion JPY(No Disclosure regarding other financial status)

In this project, above three EPC contractors are chosen as candidates and one of them will be chosen to conduct detailed conference for the project. It is necessary to confirm on background of engineers in project teams and track record in small hydro project of each company in addition to above

[26] CKD Blansko HP, http://www.ckdblansko.cz/

company summary.

4-1-5. Analysis of Financials and Investment Effect

4-1-5-1. Analysis of Cash flow of the Business

(1) Financial Arrangements

Northsum currently assumes that the total project cost is approximately IDR 193,870 million. In the financial structure, SMI and JICA are potential candidates for senior lenders. Responsible officials from SMI and Northsum already had a meeting and commented that SMI would like to consider the investment opportunity of Tornauli project along with the progress of new potential investors' participation. For the senior and mezzanine finance, the prospective lender's terms are: 2 year grace period, 7 year repayment period after the commercial operation. Interest During Construction (IDC) is provided by the senior and mezzanine lenders. The type of mezzanine finance is to have a convertible right with subordinated bonds. In other words, Northsum issues the convertible bonds, and IDI-I underwrites them all.

Overall capital structure at this stage comprise with around 70% of total project cost that comes from the senior lenders; the potential candidates are JICA and SMI providing same amount of principle to the project, and around 10% of total project cost will be covered by IDI-I as mezzanine finance, and around 20% of total project cost will be injected by current existing shareholders.

Detail information regarding financial structure is listed below.

Table 4-4 Details of Financial Arrangement

PT. Northsum - Financial Arrangement for Tornauli project

Unit: million IDR

Asset		Liabilities	
EPC Cost & Others	168,000	Senior Loan (Principal)	
Interests during Construction		SMI	60,000
SMI	8,138	JICA	60,000
JICA	7,326	Senior Loan (Interests)	
IDI-I	3,839	SMI	7,260
		JICA	6,600
		Mezzanine Finance (Principle)	
		IDI-I	16,184
		Mezzanine Finance (Interests)	
		IDI-I	3,204
Compensate Balance (D	3,650	Net Assets	
Others	2,916	Net Assets	40,621
Total Assets	193,870	Liabilities & Net Assets	193,870

Unit: million IDR

Investors	Amounts	%
SMI	67,260	34.69%
JICA	66,600	34.35%
IDI-I	19,389	10.00%
Sponsor	40,621	20.95%
Total	193,870	100.00%

単位：百万ルピア

Funding Method	Amounts	%
Senior Loan	133,860	69.05%
Mezzanine Finance	19,389	10.00%
Equity	40,621	20.95%
Total	193,870	100.00%

The total project cost breakdown will be confirmed later. Noted is that the EPC cost is calculated above Northsum applying the cost based on local standard.

(2) Detailed Conditions

Basic assumptions are listed below. Since some of the details are yet to be confirmed, it should be noted that the assumptions are based on information provided by the owner or estimation from reasonable projection at this moment.

Table 4-5 Detailed Conditions

Base Item	Details	Unit	Value	Detail
Basic Specification				
	Installed capacity	kW	8,000	based on informaton provided by the owner
	Annual power production	kWh	56,654,000	reference by conducted study *table4-22 Annual Available Power Energy
	Power selling Price	IDR / kWh	787	based on informaton provided by the owner
	Power selling years	Year	20	based on informaton provided by the owner
	Annual power selling revenues	million IDR	44,598	
Loan Condition				
	Senior Loan (SMI)			
	The Amount of Loan	million IDR	68,885	*detail shall be discussed (suppose that JICA and SMI provide same amount of principle)
	Interest	% / year	11.00%	*detail shall be discussed
	Period of deferment for Principle	Year	2	expected construction period
	Repayment Period	Year	7	usual repayment period
	Senior Loan (JICA)			
	The Amount of Loan	million IDR	68,210	*detail shall be discussed (suppose that JICA and SMI provide same amount of principle)
	Interest (Yen Rate 3%+SWAP rate7% addition)	% / year	10.00%	*detail shall be discussed
	Period of deferment for Principle	Year	2	expected construction period
	Repayment Period	Year	7	usual repayment period
	Mezzanine Loan (IDI-I)			
	The Amount of Loan	million IDR	19,588	*detail shall be discussed (suppose that IDI-I provids 10% amount out of total project cost)
	Interest	% / year	18.00%	*detail shall be discussed
	Period of deferment for Principle	Year	2	expected construction period
	Repayment Period	Year	7	usual repayment period
Opearational Cost				
	Cost of water-use	IDR / kWh	5	based on informaton provided by the owner
	Opearational Cost	million IDR	3,500	referece by other similar project cost
	Insurance Cost	million IDR	650	referece by other similar project cost

(3) Business Plan（Financial Statements）

The 10 year business forecasts of the project after the commercial operation consisting of an income statement, a balance statement, and a cash flow statement are shown below. If the operation of the plant runs well according to the predication, the repayment of senior and mezzanine would be made throughout the periods by the source of stable income by selling electricity to PLN, and its selling price is agreed on PPA which is determined by FIT.

Table 4-6 Business Plan(Financial Statements)

Income Statement		Y 2013	Y 2014	Y 2015	Y 2016	Y 2017	Y 2018	Y 2019	Y 2020	Y 2021	Y 2022	Y 2023	Y 2024
Unit: million IDR		-2 nd	-1 st	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
Income	Revenue	0	0	44,598	44,598	44,598	44,598	44,598	44,598	44,598	44,598	44,598	44,598
	Expenses	0	0	23,306	23,508	23,721	23,944	24,178	24,425	24,683	24,954	25,239	25,536
	Gross Profit	0	0	21,292	21,090	20,877	20,654	20,420	20,173	19,915	19,644	19,359	19,062
	Sales Administrative Expense	100	100	100	105	110	116	122	128	134	141	148	155
	Operational Profit	-100	-100	21,192	20,985	20,767	20,538	20,298	20,046	19,781	19,503	19,211	18,906
	Non-Operating Expense	0	0	18,959	17,063	15,167	13,271	11,375	8,531	4,740	0	0	0
	current earnings	-100	-100	2,234	3,922	5,600	7,267	8,923	11,514	15,041	19,503	19,211	18,906
	Corporate Tax	0	0	0	0	0	0	0	2,879	3,760	4,876	4,803	4,727
	After-tax Income	-100	-100	2,234	3,922	5,600	7,267	8,923	8,636	11,281	14,627	14,408	14,180

Balance Sheet		Y 2013	Y 2014	Y 2015	Y 2016	Y 2017	Y 2018	Y 2019	Y 2020	Y 2021	Y 2022	Y 2023	Y 2024
Unit: million IDR		-2 nd	-1 st	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
Assets	Total Assets	54,737	195,651	182,217	170,471	160,402	152,001	137,422	114,721	86,831	48,961	48,961	48,961
Liabilities	Long-term Debts (Senior)	13,709	137,095	123,385	109,676	95,966	82,257	61,693	34,274	0	0	0	0
	Long-term Debts (Mezzanine)	1,959	19,588	17,629	15,670	13,711	11,753	8,814	4,897	0	0	0	0
	Fixed Liabilities	15,668	156,682	141,014	125,346	109,678	94,009	70,507	39,171	0	0	0	0
Capital	Total Capital	39,069	38,969	41,203	45,125	50,725	57,992	66,915	75,550	86,831	48,961	48,961	48,961
	Liabilities and Capital	54,737	195,651	182,217	170,471	160,402	152,001	137,422	114,721	86,831	48,961	48,961	48,961

Cash Flow Statements		Y 2013	Y 2014	Y 2015	Y 2016	Y 2017	Y 2018	Y 2019	Y 2020	Y 2021	Y 2022	Y 2023	Y 2024
Unit: million IDR		-2 nd	-1 st	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
Operational Cash Flow		-100	-100	21,206	22,894	24,572	26,239	27,895	27,608	30,253	33,600	33,381	33,150
Investment Cash Flow		-35,496	-154,227	0	0	0	0	0	0	0	0	0	0
	EPC Cost	-33,600	-134,400	0	0	0	0	0	0	0	0	0	0
	IDC (Senior)	-1,440	-14,398	0	0	0	0	0	0	0	0	0	0
	IDC (Mezzanine)	-353	-3,526	0	0	0	0	0	0	0	0	0	0
	Others	-103	-1,903	0	0	0	0	0	0	0	0	0	0
Financial Cash Flow		54,837	135,586	-15,279	-15,279	-15,279	-16,047	-23,687	-31,326	-34,357	-52,497	-14,408	-14,180
	Long-term Debts (Senior)	13,709	123,385	-13,709	-13,709	-13,709	-13,709	-20,564	-27,419	-34,274	0	-0	0
	Long-term Debts (Mezzanine)	1,959	17,629	-1,959	-1,959	-1,959	-1,959	-2,938	-3,918	-4,897	0	0	0
	Others	0	-5,428	389	389	389	-379	-184	10	4,814	0	0	0
	Capital	39,169	0	0	0	0	0	0	0	0	0	0	0
	Dividend Payment	0	0	0	0	0	0	0	0	0	52,497	14,408	14,180
Changes in Cash		19,241	-18,741	5,927	7,615	9,293	10,192	4,208	-3,718	-4,104	-18,898	18,972	18,970
Cash at the beginning		0	19,241	500	6,427	14,042	23,336	33,528	37,736	34,018	29,914	11,017	29,989
Cash at the end		19,241	500	6,427	14,042	23,336	33,528	37,736	34,018	29,914	11,017	29,989	48,959

(4) Investment return and sensitivity analysis

Based on the business plan as the base case, Equity IRR, average DSCR (senior) and Financial IRR will be calculated with conducting of sensitivity analysis shown as follows:

Table 4-7 Investment return and sensitivity analysis

Case	Equity IRR	Average DSCR (senior)	Financial IRR
Base case	18.06%	1.39	17.77%
EPC cost increased by 10%	15.59%	1.39	15.70%
Price increased by 10%	16.54%	1.37	16.82%
SWAP rate increased by 10%	17.85%	1.37	17.71%
Power production decreased by	15.45%	1.24	15.39%

Even in the event of power production decreased by 10%, Equity IRR still remains above 15%; average DSCR is over 1.2 and Financial IRR is more than 15%; hence, it is considered as attractive project from the stand point of investors.

(5) Economic analysis (Economic IRR calculation)

Economic IRR is an indicator to analyze the performance of efficiency in allocating the national economic resources. In Economic IRR, expenses are considered as something that decreases the national income; revenues are, on the other hand, considered as something that increases the national income. First of all, the Standard Conversion Factor (SCF), a factor that applies when converting non tradable commodities into international standardized price, shall be calculated:

$$SCF = (I+E) / [(I+Id) + (E+Ed)]$$

I：Total import amounts (CIF)

E：Total export amounts (FOB)

Id：Total import duties

Ed：Total export duties

Table 4-8 Standard Conversion Factor (SCF)

Unit: billion IDR

Items	Y 2007	Y 2008	Y 2009	Y 2010	Y 2011	5 years ave.
Total import	3,961	22,764	18,105	19,759	28,856	18,689
Total export	16,976	0	0	0	25,266	8,448
Total import duties	942,431	1,032,278	932,249	1,074,569	1,221,229	1,040,551
Total export duties	756,895	833,342	708,529	831,418	942,297	814,496
SCF	0.99	0.99	0.99	0.99	0.98	0.99

Source: JETRO and World Bank, World Development Indicators

Economic expenses are calculated as follows. Civil costs are local currency expenses, and turbines and electrical equipment are foreign currency expenses. In economic expense, tax and interest expense are not considered as a decrease of national resources; hence, it can be ignored.

Table 4-9 Economic expenses

＜Economic expenses＞ Unit: million IDR

No.	Cost items	Foreign currency	Economic expense (1)	Local currency	SCF	Economic expense (2)	Total (1)+(2)
1	Civil cost	-	-	140,000	0.99	138,600	138,600
2	Electrical and turbine cost	28,000	28,000			0	28,000
3	Others (lawyers, etc.)	700	700			0	700
4:1+2+3	Total economic expenses	28,700	28,700	140,000		138,600	167,300

Economic revenues are based on the replacement reduction values of diesel engines and small hydro selling price.

Table 4-10 Economic revenues

＜Economic revenues＞

No.	Items	Unit	Value
1	Diesel engine cost	IDR / kWh	3,470
2	PPA price of small hydro	IDR / kWh	787.2
3:1-2	Replacement deduction unit revenue	IDR / kWh	2,683
4	Transmitted power generation	kWh / Year	56,654,000
5:3*4	Replacement deduction value	MM IDR / Year	151,995

Source: PLN. “PLN Statistics 2010”

The cash flow statement including Economic expenses and Economic revenues is as follows. Operational costs are based on costs in other similar projects and price escalation shall not be considered as it is not affect resource consumption.

Table 4-11 Cash Flow

<Economic expenses> Unit: million IDR

No.	Cost items	Foreign currency	Economic expense (1)	Local currency	SCF	Economic expense (2)	Total (1)+(2)
1	Civil cost	-	-	140,000	0.99	138,600	138,600
2	Electrical and turbine cost	28,000	28,000			0	28,000
3	Others (lawyers, etc.)	700	700			0	700
4:1+2+3	Total economic expenses	28,700	28,700	140,000		138,600	167,300

<Economic revenues>

No.	Items	Unit	Value
1	Diesel engine cost	IDR / kWh	3,470
2	PPA price of small hydro	IDR / kWh	787.2
3:1-2	Replacement deduction unit revenue	IDR / kWh	2,683
4	Transmitted power generation	kWh / Year	56,654,000
5:3*4	Replacement deduction value	MM IDR / Year	151,995

<Cash flow statement> Unit: million IDR

Year	Initial cost	Operation cost	Total cost	Revenue
1	33,460		33,460	
2	133,840		133,840	
3		2,720	2,720	151,995
4		2,720	2,720	151,995
5		2,720	2,720	151,995
6		2,720	2,720	151,995
7		2,720	2,720	151,995
8		2,720	2,720	151,995
9		2,720	2,720	151,995
10		2,720	2,720	151,995
11		2,720	2,720	151,995
12		2,720	2,720	151,995
13		2,720	2,720	151,995
14		2,720	2,720	151,995
15		2,720	2,720	151,995
16		2,720	2,720	151,995
17		2,720	2,720	151,995
18		2,720	2,720	151,995
19		2,720	2,720	151,995
20		2,720	2,720	151,995
21		2,720	2,720	151,995
22		2,720	2,720	151,995
Total	167,300	54,400	221,700	3,039,903

Economic IRR calculated by the above cash flow is 78.5%, and the average social discount rate is considered as 12%; therefore, this project shall bring add value to the nation.

(6) Operational Performance Indicator

The following is the operational performance indicator to monitor the power plant. The down time ratio and transmission loss etc. are estimates as well as capacity factor and power generation. After the commercial operation, monthly monitoring these indicators shall be conducted.

Table 4-12 Operational Performance Indicator

Indicators	Value
Down time ratio by trouble shooting, etc.	5% of expected power generation
Transmission loss and self consumption, etc.	2% of expected power generation
Capacity factor	80.84%
Transmitted power generation (kWh)	56,654,000
Installed capacity (kW)	8,000

4-1-6. Review on Business Risks and Contract Conditions

4-1-6-1. Risks associated with projects and considerations on a security package

The general business risks and evaluations on project finance are as follows:

Table 4-13 Outline of Business Risk and Evaluation

1	Sponsor risk (evaluation of sponsor)	✓ The current majority of shareholder is PT. Bayah Pratama Zeolindo but Northsum is looking for new investors and it may change the composition of share percentage of the equity; therefore, it is necessary to confirm the final shareholder structures later on. ✓ There are not confirmed of the conflict of interest and role sharing among shareholders of this project. ✓ It is expected that around 20% of equity amount will be covered by existing shareholders and new investors. ✓ It is expected to have a corporate guarantee to PT. Bayah Pratama Zeolindo during the construction period so as the sponsor to be responsible for this project in case unexpected cost overrun happens. ✓ For supplemental information, one of the candidates in senior lender of this project, SMI, has experience to provide loans to a 7.5MW small hydro project in West Sumatra while the developer does not have experience in developing IPP business. SMI sees the developer from the aspect of being capable of contractor and ask the developer to utilize international consulting company to review hydrology and FS report and EPC management to minimize the risk of the project.
2	Construction / technical risks (evaluation of EPC contractor)	✓ At this moment, there are a couple of candidates for a potential EPC contractor but detail discussion has not yet conducted. The EPC contactor's detail in technical, financial and contracting, will be confirmed and evaluated in the selection timing.
3	Operational risk	✓ Operation in small hydro is simple unlike thermal plants. Northsum

	(evaluation of operators)	plans to utilize local stuff for security and basic operation, and will also hire some of the skilled engineers internally to come to the site a couple of time monthly. ✓ It is common that in other small hydro projects, the company hire local stuff as much as possible while hire skill engineers to come to the site to confirm but usually evaluation on operators is just before the commercial operation begins. ✓ It is therefore this project will be expected to be the Sponsor Support type, it is necessary to confirm the price and work of scope carefully and to evaluate the ability to carry out the communication, countermeasures in emergency situations, safety management in a sudden accident.
4	Sale, transaction and revenue risk	✓ This project is based on 20 years PPA, obligating PLN, the off-taker, to purchase all electricity it could produce. The evaluation of capability of PLN as an off-taker is examined in the section 4-1-3. ✓ There is no provision on the adaptation of the revised tariff, for the existing project in case there is any such revision, written in the FIT related regulations. In general, when there is a new regulation introduced, then it will be reflected on the new project. Therefore, the risk of decreasing FIT price for this project can be quite limited. The standard PPA defines the tariff can be revised in case the cost for water-use is adjusted based on the new regulation. Thus, if the cost for water-use is increased, then the tariff for this project can also be increased.
5	Supply and fuel risk	✓ This project is a run of river type of small hydro, and the risk of supply and fuel is limited to the flowing river. Around the project site, it has not confirmed that there is any development plan; therefore, the risk of supply and fuel is limited to the reduction of the catchment area of this project.
6	Other risks	✓ There are not seen any valuable species and animals around the site, and not seen any local community going against this project. The land agreements with land onwers are still in the process to complete. ✓ Related to the utility risk, the plant needs a new sub-station that accepts generated electricity from the plant. Current situation, there is no sub-station that can accept the electricity from the plant; therefore, it needs to carefully monitor that PLN will build the sub-station. ✓ The price escalation will affect construction cost, operational cost including maintenance and managing costs. With the construction cost, it is possible to minimize the price escalation risk by making an agreement with EPC contractor with a fix lamp sum. With the

	operational cost, supply and fuel are flow that comes from the river with no costs, and maintenance cost could be fixed for long term or to maintenance by own to minimize the risk.

Detail risks of the project are as follows:

(1) Power Purchase Agreement (PPA)

In concluding PPA, PLN tests technical acceptability of the power grid by conducting feasibility study called Kata Kerja Operational (KKO). The study not only covers technical aspect but also validates the financial aspect by checking the credit of the project owner whether or not they are able to start up the project at the same time. Generally in PPA, there is a name of the project owner, generation capacity, name of substation and conditions for connection, power purchase price, duration of contract, planned date for power purchase, and so on. It is important to confirm if the PLN-owned substation has excess capacity for accepting power from the plant. In case substation capacity needs to be enhanced, it is necessary to check the construction period and planned start date of the construction.

In Tornauli project, PPA is already signed, and details of the above matter are currently being confirmed. However, the copy of contracts has not been received and power substation is not constructed yet. PLN plans to construct it in the future. For this reason, it is necessary to check the construction schedule of power substation against PLN along with checking the original document of PPA.

(2) Acquisition of the land

Regarding the site for small hydro power generation, the cost to acquire the land is relatively inexpensive in Indonesia**.** Therefore, it is common to acquire, not lease, the land for the project in Indonesia. Sometimes local people live in the area for a long time though the land is actually owned by the Governor of Kabupaten (province), Kecamatan (county), Ministry of Forest, etc. It is necessary to have the certification of ownership transfer of the land transferred from the current owner while compensating local residents for moving and agricultural crops. In case the acquisition of the land is not completed at the time of granting the loan, it is common to define conditions precedent for the complete acquisition of the land in the loan agreement.

For Tornauli project, it is assumed to acquire the land, not to lease the land. It is necessary to confirm the detailed information such as the required acquisition area and the negotiation status with each local land owners. Though most of the site has already been acquired, the rest is under continuous negotiation.

(3) River flow rate

There are two approaches to forecast river flow rate; 1) forecast based on rainfall rate in the neighboring gauging stations, 2) forecast based on actual river flow rate at gauging stations in the target river. Depending on the Governor, it may be required to sluice maintenance flow. Therefore, it needs to be factored in when calculating the annual power generation. If the forecast river flow rate is different from the actual rate, the power generation would be lower than the predicted value. Stress test assuming risk scenario of lower-than-forecasted river flow rate leading to lower power generation needs to be conducted. By identifying acceptable range of risk, examination on the feasibility of this project with reasonable capital structure needs to be conducted.

In Tornauli project, the forecasted river flow rate based on the rainfall data from the nearest rain-gauge station is adopted in order to forecast flow rate of the target river because there is no gauging station in the same river. According to Northsum, PT. Indonesia Hydro Consult who has much experience made FS report and calculated water flow data and generation data. The calculation of power of this test uses the discharge estimated from data of the rainfall measurement observation station according to local materials (NRECA model), but it is necessary to make a comparison based on the discharge of simple basin conversion from actual discharge. It has been confirmed that the numbers were appropriate. The maintenance flow is taken into account in the planning with consideration of effective head loss, self-consumption, and transmission loss, and annual electricity sales at the receiving terminal are calculated.

(4) Consensus with the local residents

Because a small hydro power generation project is a long-term project with PPA of about 20 years using local resources such as river, it is important to obtain consent and to build a consensus with local residents. It is already confirmed that Northsum had already held a public hearing in Tornauli project. When the site visit was conducted, no action of opposition was observed. Northsum seemed like dealing with local residents politely to care for a local consensus.

(5) Engineering

Prior to signing PPA, a technical consulting company conducts basic design for hydrology and master plan designing, and an EPC contractor or an engineering company conducts detailed engineering after signing PPA. It is necessary to check the status of the construction work whether or not it is being conducted according to the detailed engineering design. A third party engineering company or members who are familiar with engineering tasks are expected to be in charge of this task.

Tornauli project plans to use an EPC contractor with a full turnkey contract. It is planned to hire some engineering experts as internal stuff to manage the progress of construction; however appropriateness of the proposed engineers in terms of their track record and experience needs to be checked upon.

(6) EPC contractor

In choosing an EPC contractor for a small hydro power project in Indonesia, it is important to review their track record, particularly on construction of hydro power facilities in order to determine their capability to keep to the schedule and execute the contract. However, small hydro power projects are usually not a full turnkey, and thus there are few EPC contractors with the experience. Moreover, there are some cases where large national construction company with rich experience in large scale hydro delays its construction. Therefore, it is necessary to confirm how to handle the risk of delay, nonperforming risk, and risk of guarantee against defects, when discussing the contracts.

There are three candidates for EPC contractor for Tornauli project; PT Waskita Karya, PT Brantas Abipraya and PT Adhi Karya. For the company information, please see the section 4-1-4.

(7) Turbine manufacturer / maintenance

Selection of turbine falls into 2 categories; 1) widely used yet relatively expensive turbines made in EU or Japan, 2) limitedly used yet less expensive ones made in China. The selection depends on preference of owners but it is highly preferred to meet certain quality standard as the turbine is expected to be used for a long period in small hydro power projects. Since it is possible to have turbine trouble just after start of commercial operation, it often requires the turbine manufacturer to guarantee spare parts. For several years after the end of guarantee period, one idea is to sign a maintenance contract with the turbine manufacturer until maintenance capability can be internalized.

In selection of the turbine manufacturer, maintenance framework for supporting the project needs to be confirmed. Especially, it is important to clarify risks related to the local maintenance support system for trouble shooting and to identify the out of scope services.

There are 3 candidates for turbine manufacture for Tornauli project; ANDRITZ, CKD Blansko and Fuji Voith Hydro. For the company information, please see the section 4-1-4.

(8) Operation

The daily operation and maintenance work is usually conducted either by internally hired employees or by outsourced personnel. The main operation works consist of monitoring the operational progress, maintaining equipment and managing, making daily or weekly reports, and preparing the necessary documents at the site in the case of insurance claims.

In Tornauli Project, Northsum plans to hire several local staff for operation work and to send their own engineers to the site to coordinate maintenance work for a few times a month. Daily work is not complicated compared to thermal power plants. However, it is necessary to confirm their capability for carrying out communication, conducting countermeasures in emergency situations, implementing safety management in a sudden accident.

(9) Insurance Contract

The most commonly used insurances in a small hydro power generation are marine transit insurance, assembling insurance, and third party liability insurance during the construction phase. It is usually the case that EPC contractor covers marine insurance, assembling insurance and third party liability insurance. After the construction is complete, there are property insurance, business interruption insurance, and third party liability insurance, but some project owners do not contract for business interruption insurance. In some cases, some financial institutions require them to do so. It would be a problem if the insurance firm would be incapable of paying the sum insured. Therefore it is needed to select the insurance firm by checking their financial strength, ratings and solvency margin. Sometimes the lenders may have the requirement to enter into a contract with an insurance firm which has the rating above certain level.

First of all, it is necessary to confirm which original insurance firm project owner is selecting and the contents of the insurance. Assembling insurance during the construction period is for making compensation for the property losses caused by sudden accidents in the site and natural disaster. It is necessary to confirm what are the risks not being covered by the policy clause. Also, the coverage of property insurance contracted after the completion of the construction should be confirmed likewise.

It is desirable that the sum insured for physical damage is basically Full Replacement Value which enables reconstruction of a power plant. However if the sum insured is enlarged, the premium would be higher. Therefore the project owner sometimes does not choose Full Replacement Value to restrain the premium cost. For the lender, if it is possible to prove that the expected damage is limited in the scope based on Maximum Probable Loss calculated by the Trusted Third Party, it may be acceptable to apply Maximum Probable Loss as the sum insured.

Among other important matters, it is necessary to confirm the deductible amount within an accident. If the exemption from responsibility is quite large within an accident**,** physical damage amount becomes less than the amount of the exemption from responsibility. Then, the insurance cannot be claimed. If the exemption from responsibility is decreased, the premium tends to be increased. Therefore it is important to consult with the project owner about the optimum exemption from responsibility.

In Tornauli project no insurance has been contracted, and at the moment there is no candidate. Thus, this matter shall be closely followed up.

4-1-6-2. Outline of Various Contracts (Off-take, EPC, O&M, etc)

(1) PPA（Off-take Agreement）

In Tornauli project, PPA has been already entered into according to the business operator. However, confirmation of its original documents has not been conducted yet. Details of contracts need to be confirmed later. For that reason, below summary lists main items which need confirmations.

Table 4-14 Items for Confirmation on PPA

1	Party in Charge	✓ PLN and Northsum
2	Plant Generation	✓ To Be Confirmed

	Capacity	✓ Tornauli has the potential of more than 10MW but the FIT currently limits the generation capacity to be up to 10MW.
3	Selling Price	✓ Selling price varies depending on places of power plants. Sometimes the price deviates from the pre-determined FIT price. So it is necessary to confirm whether there is discrepancy between selling price in PPA and stipulated price in FIT.
4	Selling Term	✓ Twenty years are the typical term for the commercial operation. However, it needs to be confirmed because there are some anomalies depending on projects that usually range from 15 to 25 years.
5	Expected Commercial Operation Date	✓ In general, it is required to set the start day of operation within two years after completing financial arrangements and to complete financial arrangements within one year after entering into PPA.
6	System Connection Conditions	✓ It is usually the case to connect to PLN substation of 20kV or directly connect to the 20kV transmission line. The project owner has to pay the cost to connect to the grid.
7	Other Conditions	✓ It may define other payment items and conditions on cancelling contracts, thus it is necessary to confirm.

(2) EPC Contracts

In Tornauli project, ECP contract has not been discussed in details yet. Details of contracts need to be confirmed later. For that reason, below summary lists main items which need confirmations.

Table 4-15 Items for Confirmation on EPC Contract

1.	Party in Charge	✓ Ordering Party : Northsum ✓ Contractor: Name of EPC contractor (To Be Confirmed)
2.	Scope of Contractor Service	✓ It's necessary to list a range of jurisdiction so that every item is covered as a full turnkey contract consisting of procurement, construction, trial run duties, the training, machine parts necessary for the completion of this generation facilities. ✓ More specifically, the work of assisting all business approvals, report generation facilities, electrical equipment, and related construction, civil works, installation of equipment, procurement of spare parts, training of operating personnel, all the other necessary tasks to fulfill the contract.
3.	Contract Amount	✓ Needs to be confirmed, it is desirable for (fixed price) fix lump-sum.
4.	Payment	✓ Payment based on the construction progress or the payment

Conditions	based on the set date is common. The refund bond (guarantee of repayment of advanced payment) in the form of bank guarantee is seen by a large-scale international bid project, but it is not common in a small hydro project in Indonesia.
5. Delivery Conditions	✓ Define the date of delivery and the final completion date (Warranty period starts from the time of completion of construction).
6. Reporting Requirement	✓ It is desirable that the contractor makes a progress report monthly.
7. Insurance	✓ Policy holder：Contractor ✓ Insured: the project owner, the contractor, subcontractors, lenders, etc. ✓ Type of Insurance ➢ Transport Insurance ➢ Assembling Insurance ➢ Third Party Compensation Insurance
8. Guarantee Against Defects	✓ Necessary to set the term of the insurance
9. Performance Guarantee	✓ Necessary to have a guarantee for generation capacity (MW) of the generator
10. Liquidated Damages	✓ Liquidated Damages（Set the amount of compensation per day delay. The amount of compensation per day is expected to be calculated on the basis of expected annual sales ÷ annual operational days, however, it is necessary to confirm.）

(3) Maintenance Contract

In Tornauli project, maintenance contract has not been discussed in details yet. Details of contracts need to be confirmed later. For that reason, below summary lists main items which need confirmations.

Table 4-16 Items for Confirmation on Maintenance Contract

1. Party in Charge	✓ Generally, consignor is the project operator. ✓ Consignee is the maintenance company.
2. Term of Contract	✓ Generally speaking, turbine manufacturers guarantee necessary materials and parts for maintenance for one year after the start of commercial operation and it is expected to have the contract for the maintenance for several years after the end of the warranty period. Then it is expected to reduce the cost by establishing its own maintenance structure afterward. It is necessary to confirm that project operator actually follow above scenario.

3. Expense for Commission	✓ Total annual payment is divided by 12 and the payment is commonly made monthly.
4. Scope of Service and Obligation	✓ The periodical maintenance is assumed as regular maintenance to the project related facilities in line with the maintenance manual provided by the manufacture (including the making necessary documents, commissioning and supervising outside supplier and so on). Scope of maintenance needs to be confirmed. ✓ Large-scale maintenance duties are a large-scale maintenance work planned in a long-term operation maintenance plan. It is expected to inform the details of work, schedule and additional cost in advance. It is common to create a set of documents to report the results.
5. Acceptance	✓ It has to be accepted by the project owner. It is necessary to check the results with the consignor within the several days after the completion of the periodical and the large-scale maintenance.
6. Guarantee for Service	✓ The warranty against defects guarantees that there are no defects in the products offered. ✓ Usually, warranty period is about 12 months after the completion of the work ✓ At the time of violation of the guarantee, the trustee pays the cost at his own expense, and it is common to carry out the following necessary repairs.The damage to generation facilities due to the violation of guarantee ✓ The maintenance of product in conjunction with the violation of guarantee ✓ The performance warranty has to be set to compensate the amount to cover the damage caused by failing to achieve the insured output capacity to the consignor.

4-1-7. Conditions and Issues toward Building Financial Scheme

4-1-7-1. Confirmation of Available Equity Amount for the Project Owner

Firstly, it needs to be confirmed what kind of scheme the project owner intends to pursue. Generally, a Holding Company (HD) is established, and SPC is also established for each project. It is often the case that the equity is injected from the HD. This is because it is difficult to sign PPA for several projects under the same project company name with PLN. From PLN's point of view, there are many failed projects due to funding issues in a small hydro power, and thus PLN thinks it should be difficult for the same company to finance multiple projects at the same time. Therefore, project owner is required to take above scheme.

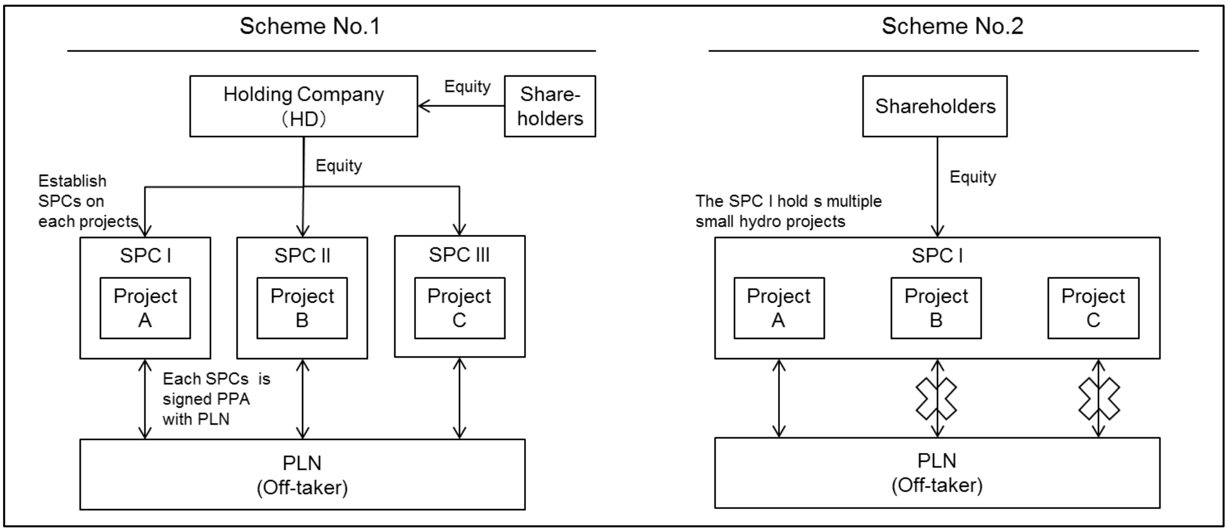


Figure 4-3 Project Schemes

However, there are some cases where project owners attain permits and develop with the same SPC name in the multiple projects without establishing HD (See above scheme(2)). Therefore it needs to be confirmed that the project owner raises the capital for SPC through HD or the equity holders provide the capital directly without HD if it is the first project for the project owner. In addition, it also needs to be confirmed how much equity the project owner can provide for the project. Even though the project owners have sufficient capital, in case they have several projects in the pipeline, they may intend to leverage by reducing equity amount and increasing the debt amount. On the other hand, the project owners who do not have enough funding ability may have their limitations, and then the equity amount should be determined accordingly.

In Tornauli project, it is the first project for Northsum, the project owner. At present, it is the case of scheme (2) where equity holders invest directly to SPC without HD. Northsum is inviting strategic investors in the project and to increase the equity capital.

4-1-7-2. Confirmation of available debt amount from senior lenders

It is extremely important to confirm whether local, governmental and foreign-affiliated financial institutions in Indonesia can provide loans during construction period of a small hydro power generation project. After introduction of FIT, small hydro power generation business has started to expand as a base power source, but there are only a few financial institutions which have provided loans for small hydro power projects. Therefore, many institutions generally provide loans as a corporate finance depending on the credit of the project owners, or private guarantees and collateral. In fact, financial institutions which can evaluate the project risk, create the security package and provide project finance type loan by taking the risk during the construction are quite limited.

The financial institutions which can take risks during the construction period mention that their internal regulation permits to provide only up to 80% of total project cost. Thus project owners with high credit also have to provide equity for at least 20%. However in case that they have to allocate the limited capital to other projects in pipeline, or they cannot provide their own equity for 20% of total project cost, they have to call up mezzanine lenders which are subordinated lenders. At present, Northsum is in discussion with several local and governmental financial institutions. It is necessary to continuously confirm the status and stances of senior lenders, specific conditions and the financing amount on the projects. They have already had a meeting with the department head of PT.SMI Financing and Investment section, the detailed discussion has not done under the current situation of not having strategic investor's participation to the project.

4-1-7-3. Possibility of inviting mezzanine lenders

There is a financing method called mezzanine other than equity and senior loan mentioned above. Though mezzanine financing is given a low-priority to senior financing, it has a priority to equity finance. Therefore, it stands in the middle between the two as a financing method. When the project owner have limitation in their equity amount they can provide and so do senior lenders, in the case where the total sum of both parties does not cover the total project cost, the project owner needs to consider inviting mezzanine lenders. In other words, when there is financing need from both project owner and senior lenders, the mezzanine financing becomes the possibility.

The typical way of mezzanine is an investment by mezzanine loans and class shares. Both instruments are inferior to senior lenders in the ranking of repayment. That means that repayment for senior lender has a priority from the sales of electricity after tax or necessary expenses. Therefore, from the senior lender's point of view, inviting mezzanine lenders is equivalent to capital enhancement. On the other hand, from the project owner's point of view, as it is not an investment by ordinary share, the project owner can avoid lowering the return on equity, dilution of voting share, and at the same time, is able to keep the flexibility in the management of the business.

Candidates for mezzanine lenders are local governmental financial institutions such as securities company type or investment bank type, or mezzanine section of foreign-affiliated financial institutions. However, such financial institutions that take risks aggressively during the construction period are quite limited.

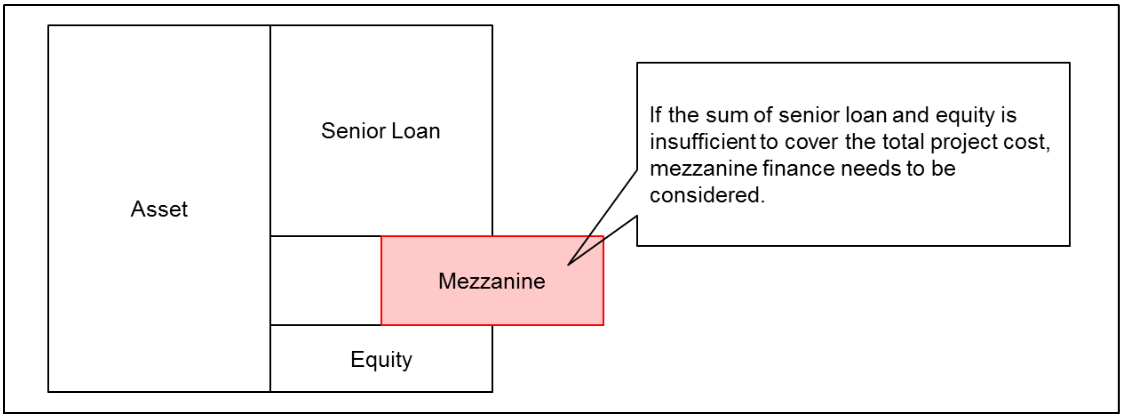


Figure 4-4 Structure of Mezzanine Financing

While Northsum spoke with the financial arrangements with IDI-I as a mezzanine lender, they have not effectively communicated in explaining the progress of inviting the strategic investors and the progress has not be made with financial institutions which offer loans. It seems that they have not discussed in details with other parties.

4-1-7-4. Terms and Conditions of Possible Loans from Local Financial Institutions / Governmental Financial Institutions

In Tornauli project, discussion with senior lenders has not advanced in details yet. Details of contracts need to be confirmed later. For that reason, below summary lists main items which need confirmations.

Table 4-17 Outline of Conditions on Possible Loans by Local Financial Institutions

1. Party in Charge	✓ Lessor : Senior Lender ✓ Lessee : Northsum
2. Loan Amount	✓ Necessary to confirm whether interest amounts (Interest during Construction) can be added to the loan amount.
3. Period of Repayment	✓ During the construction period (2-3 years), the repayment is deferred. The repayment on principal will begin after the start of commercial operation. The repayment period is usually between 7 years and 9 years.
4. Interest	✓ It varies depending on the creditworthiness of the project owners and projects.
5. Drawdown timing	✓ Phased payment along with the progress of the construction is common; however the conditions on payment should be clarified.
6. Up-Front Fee and Agent Fee	✓ There are some financial institutions which require upfront fee or agent fee for their financing. The fee amounts need to be clarified.
7. Prepayment prior to the maturity date	✓ There are cases where the penalties may be required for repayment (total amount or a part of the loan) prior to the maturity date of the loan..
8. Default Charge	✓ Generally, when payment of the interest or the principal is delayed, the late payment charges are charged.
9. Cash water fall mechanism	✓ In case of Project Finance, Cash waterfall mechanism is adopted and priority of payment is decided beforehand. Dedicated account is opened, managed and operated by the agent (General accounts are as follows). ➢ Account for Project ➢ Account for tax payment ➢ Account for Payment Expenses ➢ Account for Repayment Senior Debt ➢ Account for Debt Service Reserved

	➢ Account for Repayment Mezzanine ➢ Account for Sponsor Release ➢ Deposit Account for taxes and insurance fund It is necessary to confirm how the accounts are managed.
10. Covenants	✓ Generally speaking, covenants are categorized into 2 parts, one is the responsibility that the project owners have to follow according to the clauses in the contract, and the other is a set of acts which are prohibited in the contract. In Indonesia, general responsibilities include the maintenance of necessary permits and license, financial covenants such as submission of audited financial statement, DSCR etc. All of these will have to be confirmed. The prohibited acts are sales or leasing of power generation assets without the approval of lenders, contracting a new loan, transfer of ownership, and dividends payment during the loan payment period. Again, these will have to be confirmed. .
11. Forfeiture of benefit of time	✓ If the violations of covenants are not corrected, the above situation continues for a certain period of time, the operator is prompted for a lump-sum repayment from the lender.
12. Mortgage	✓ Senior lenders usually get the first priority on security interest in the set of assets such as land and equipment needed to operate a small hydro project. It is necessary to confirm if additional collaterals are required.

4-1-7-5. Outline of terms and conditions in executing loans

Financial institutions generally enter into a loan agreement with stipulating Conditional Precedent (CP), and if the CP is not satisfied in advance, the loan is not executed. The concerned contracts are a complete set of the project related contracts, such as acquisition of land, EPC, contract to purchase turbines, PPA, and insurances.

Table 4-18 Outline of Conditions on Possible Investment Execution

1. Contracts of Project	✓ A set of project related contracts to operate and maintain the small hydro power generation business is required. It is necessary to confirm the range of contracts required.
2. Guarantee	✓ Personal guarantees oby representatives or sponsor companies may be required depending on lenders. This needs to be confirmed.
3. Mortgage	✓ It is necessary to confirm what kind of mortgages financial institutions require. (a land sales certificate, additional deposits)
4. Environmental impact assessment	✓ For small hydro projects below 10MW, environmental impact assessment called AMDAL is not required. However, the approval of UKL / UPL (Environmental Management Efforts and Environmental Monitoring Efforts) from governor is required by

	lenders in many cases. It needs to be confirmed.
5. Review by a third party	✓ Generally, the lenders appoint a third party consulting firm to check the progress of the construction, and the payment is coordinated according to the progress. It is necessary to confirm whether a third party is involved in the process.
6. Director	✓ In the case of mezzanine lenders, it may be required to appoint directors.

4-1-7-6. Outline of terms and condition of loans for JICA Private Sector Investment Finance Scheme

In the case of utilizing JICA Private Sector Investment Finance Scheme, above terms and conditions of loans from the local commercial banks and government financial institutions may be required as well. Since a form of loan by project finance is assumed, the terms and the way of repayment should be examined under the consideration of the project. In the case of loan from JICA independently, it is anticipated that there will be quite some efforts required in negotiating with the project owners such as monitoring after the execution of the loan and resolving troubles. Therefore one idea is to co-finance with local financial institutions, or to offer a packaged proposal by inviting mezzanine lenders who are having a good relationship with the project owners in the view of reducing the burden.

However, it is necessary to see if the project owner is able to build proper relationship with potential new investors as development partner as it is required to invite potential investors to increase equity capital.

Table 4-19 Outline of the Specific Conditions on Investment and Loans (Assumption)

1. Party in Charge	✓ Lessor：Independent Administrative Corporation Japan International Cooperation Agency (JICA) ✓ Lessee：Northsum
2. Loan Amount	✓ It is desirable to add the-based average interest rate (Interest During Construction) to the total financing amounts.
3. Repayment Period	✓ The repayment of the principal is deferred for 2 years during the construction period, while the repayment period is assumed to be 7 years.
4. Interest	✓ Discussion with the project owner is necessary
5. Financing Payment	✓ It is assumed that the financing is done progressively along with the construction progress.
6. Up Front Fees and Agent Fees	✓ It is assumed that agent work is assigned to a local financial institution or governmental financial institution
7. Repayment Before Maturity	✓ Planning for a co-financing, therefore it is necessary to coordinate terms and conditions with the local financial institutions or

	government-affiliated financial institutions
8. Late Payment Charges	✓ See above
9. Cash Waterfall Mechanism	✓ See above
10. Covenants	✓ See above
11. Acceleration	✓ See above
12. Mortgage	✓ See above

4-2. Tornauli Location

4-2-1. Overview of the candidate project

4-2-1-1. Location of the planned project site

The planned site of Tornauli is in Simongo river in Tornauli Village, Parlilitan Commune, Humbang Hasundutan District, North Sumatra Province. (Figure of planned location : Figure 4-5) Geographically, Humbang Hasundutan District is at 2.01 -2.28 North latitude, 98.10 - 98.58 east longitude, located in the North Sumatra central part. The area is 2,335.33 square kilometers, the largest commune is Parlitian with 598.70 square kilometers (accounting for about 26% of total area of commune), and the smallest commune is Bhakti Raja with 50.36 square kilometers (accounting for about 2% of total area of commune).　Humbang Hasundutan District is bounded by four other districts as below:

- Bounded on the North by Samosir District
- Bounded on the East by Tapanuli District
- Bounded on the West by Pakpak Bharat District
- Bounded on the South by Tapanuli District

Figure 4-5 Location Map of the Planned Project Site

Source: Google map

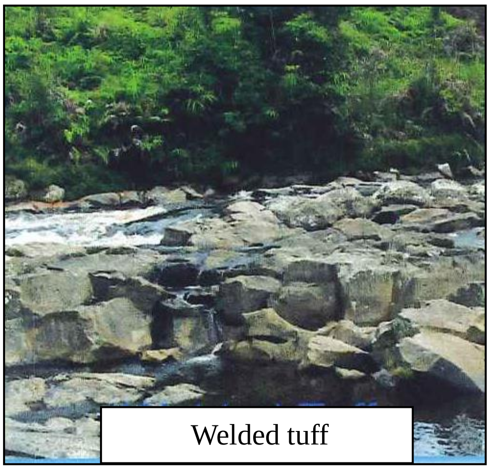
4-2-1-2. Topography

Humbang Hasundutan district is located higher above the sea level of 330 ~ 2075m. The followings are its rate of slopes in detail.

- Delta（0~2%）: 11%
- Slope area（2~15%）: 20%
- Slope ground (15~40%): 42%
- Steep area (40~44%): 27%

4-2-1-3. Geology

It is welded tuff at intake weir and powerhouse and pumice tuff at intake, settling basin, headrace, headtank and penstock.



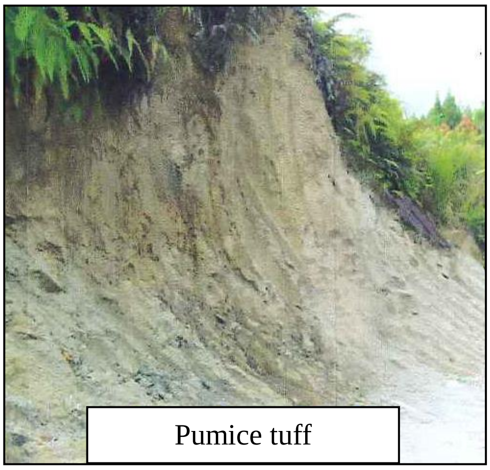


Figure 4-6 Welded Tuff and Pumice Tuff

4-2-1-4. Hydrology

The basin of Simonggo river, which is the candidate for small hydro power project of Shimonggo river is located from 2 degrees 17 minutes 43 seconds to 2 degrees 29 minutes 15 seconds of northern latitude and 98 degrees 28 minutes 43 seconds to 98 degrees 39 minutes 30 seconds of east longitude. The river goes through Humbang Hasundutan district to North Tapanuli district.

The catchment area at intake weir of the project is 273.66km^2. Simongo River has many branches on the right bank of the upper of intake weir (Aek Sihulihap, AekTarabintang, Aek Sitotio).

Rainfall in this area is very much so that it is very favorable for this project.

4-2-1-5. Climate

The climate in the project site is the same as that of other sites in Indonesia which is the rainforest climate, with rainy season and dry season. (Dry season: February through July, Rainy season: August through January). The average amount of water per year around the project site is about 2300mm, and classified as the site with high rainfall on the ISOHYET rainfall map (2000 ~ 2500mm). In addition, the annual average temperature is 22℃,the mean humidity is 80%, the average wind speed is 4.3 not (2.3m/s).

4-2-2. Overview of power generation plan

4-2-2-1. Overview of the plan

It is a generating project in the form of run - of - river using the head change of the flow running into the end of Simonggo River. The maximum amount of water of 11.5 m^3/s is collected from the intake weir. The water runs from the intake weir to the head tank where is at the downstream 2.6km far from the weir, and then it runs from the headrace of the open air or closed channel to the head tank, the penstock about 640m long and then to the generating station with the effective head of 85m. After producing the maximum generating power of 8MW, it will run to Shimonggo River again. Table 4-20 shows estimated data of this generating project in detail.

Table 4-20 Description of Electric Power Planning (Location of Tornauli)

Contents			Features (Japanese method)	Features (local method)	Summary
Name of river			Shimonggo river		
Basin area			273.66km^3		
River flow (m^3/s)			Conversion flow by NRECA model of Dolok Sunggul rain-gauge station (average from 1977~1999)		
			Maximum 88.79 35 days 34.01 High water 20.01 Average water 13.02		
			Low water 8.44 Dry weather water 4.88 Minimum 4.27 Annual average 16.96		
Electric power planning	type of power generation		Run – of - river		
	intake water level		879.00 m		
	tailwater level		788.50 m		
	Gross head		90.50 m		
	Effective head		85.21m		
	Maximum water discharge		11.5m^3/s		
	Output		8,400kW	8,000kW	
	Output L5		5,809kW	-	
	Annually electricity		60,853 MWh	61,928 MWh	
General equipment	Intake weir		Height 7.0m, dike peak length 40.9 m		
	Intake		Lateral intake method		
	Settling basin		Open-air , length 56.87m, width 12.00m		
	head tank		Open-air, length 77.59m, width 10.50m		
	waterway	Headrace	Open-air or subterranean Length 2,608m, width 2.50 ~ 4.59m, height 3.16m		
		Penstock	Length 640.61m, Inner diameter 2.4 m,		
		spillway channel	Length 370m		
	Power plant		Semi-subterranean type		
	Turbine type		Francis horizontal shaft 2 turbines		
	Generator type		2 synchronous generators		
River utilization	water for river maintenanece		0.82m^3/s		
	Plant factor		82.70%	88,4%	
	River utilization rate		61.80%		
Total cost			9, 096 million yen	1,174 million yen	Japanese method: calculation standard NEF Local schedule: supplied document
Unit price of construction cost per kW			1, 083 thousand Yen	147 thousand yen	
Unit price of construction cost per kWh			149. 5 Yen/kWh	19.0 Yen/kWh	

4-2-2-2. Generating capacity and power output L_5

The following is the generating capacity calculated by the local enterprises and the calculating results of generating capacity by the Japanese method adopted in this survey. When the generating capacity is compared of the results of this survey and calculation by the local enterprises, the figure of this survey is less than the local calculation, the difference is about 1,000 MWh. The following reasons are assumed.

- Difference in the efficiency of generating equipment
- Difference in the maximum output
- Difference in the method of establishing the maintenance flow discharge

① Generating capacity by local enterprises
Annually available electricity generation = 61,928MWh/year

② Generating capacity based on the Japanese method.

Table 4-21 Power Generation and Output L5

Power generation — Unit: MWh

Year	Ian	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total
1977	5, 219	2, 781	1, 504	1, 243	1, 433	320	2, 207	1, 598	1, 039	3, 837	4, 594	4, 470	30, 245
1978	2, 667	2, 826	3, 535	5, 703	5, 193	2, 954	4, 388	4, 055	5, 922	6, 239	6, 038	6, 030	55, 549
1979	3, 046	2, 230	4, 228	5, 889	5, 823	4, 976	5, 249	2, 828	4, 015	5, 925	6, 038	6, 239	56, 485
1980	6, 229	4, 823	5, 132	5, 902	5, 896	4, 456	2, 461	2, 283	2, 822	5, 371	5, 941	6, 239	57, 556
1981	6, 235	5, 686	4, 539	5, 100	5, 068	3, 842	1, 248	5, 529	6, 038	6, 174	6, 038	6, 239	61, 736
1983	6, 239	5, 828	4, 835	5, 193	4, 601	4, 124	5, 782	6, 029	6, 038	6, 177	5, 646	6, 239	66, 733
1984	6, 239	5, 754	4, 618	5, 308	6, 239	6, 038	6, 145	6, 152	6, 038	6, 225	6, 038	6, 239	71, 034
1985	5, 862	4, 085	4, 736	5, 866	5, 565	4, 609	5, 935	6, 069	6, 038	6, 239	6, 038	6, 239	67, 281
1986	6, 239	5, 632	4, 242	5, 260	4, 878	4, 323	5, 927	3, 593	4, 033	5, 849	6, 038	6, 239	62, 253
1987	5, 868	4, 744	3, 433	4, 823	6, 239	5, 128	3, 835	5, 193	4, 936	6, 181	6, 038	4, 227	60, 645
1989	6, 239	5, 318	3, 724	4, 918	6, 010	4, 911	4, 114	3, 637	4, 138	5, 826	6, 017	6, 239	61, 092
1991	6, 239	5, 600	6, 035	6, 038	6, 239	6, 038	5, 852	4, 306	3, 863	4, 268	5, 869	6, 239	66, 586
1992	6, 239	5, 754	6, 239	6, 038	5, 936	3, 889	1, 645	257	3, 666	5, 214	5, 716	6, 239	56, 834
1993	6, 239	5, 783	4, 532	5, 267	6, 239	6, 038	5, 774	2, 784	5, 726	6, 239	6, 038	5, 790	66, 449
1994	5, 752	4, 840	5, 633	5, 699	4, 830	3, 715	2, 649	2, 755	5, 808	6, 239	6, 038	6, 239	60, 198
1995	5, 768	4, 687	5, 928	5, 885	5, 229	3, 027	3, 407	3, 250	3, 799	4, 887	5, 891	6, 239	57, 997
1996	6, 239	5, 758	6, 191	5, 957	5, 265	2, 838	3, 074	3, 059	3, 029	4, 532	5, 888	6, 239	58, 070
1997	5, 896	3, 588	4, 563	4, 452	5, 798	6, 021	4, 551	5, 859	6, 038	6, 125	6, 038	6, 204	65, 135
1998	4, 367	4, 233	4, 112	3, 109	1, 336	2, 664	3, 178	5, 787	6, 038	6, 212	6, 038	6, 239	53, 314
1999	6, 239	5, 837	5, 847	3, 856	5, 403	6, 035	5, 500	4, 073	3, 761	4, 198	5, 866	6, 239	62, 853
Total	59. 219	51. 399	52. 804	51. 220	52. 287	45. 176	39. 743	35. 768	45. 866	53. 739	59. 400	61. 907	608. 528
Average	5. 922	5. 140	5. 280	5. 122	5. 229	4. 518	3. 974	3. 577	4. 587	5. 374	5. 940	6. 191	60. 853

Output L5 — Unit: kW

Year	Ian	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Total
1977	4, 983	2, 576	0	0	0	0	641	0	0	3, 064	4, 108	4, 243	1, 635
1978	2, 569	2, 206	2, 618	5, 701	5, 110	2, 739	3, 217	3, 861	7, 421	8, 386	8, 386	6, 926	4, 928
1979	2, 659	917	2, 450	7, 157	6, 370	5, 673	5, 071	2, 540	3, 166	6, 376	8, 386	8, 386	4, 929
1980	8, 302	5, 302	4, 719	7, 255	6, 634	4, 276	2, 095	1, 666	1, 692	4, 231	7, 581	8, 386	5, 178
1981	8, 348	7, 565	4, 133	4, 187	4, 553	3, 738	0	2, 801	8, 386	7, 845	8, 386	8, 386	5, 694
1983	8, 386	8, 316	4, 445	4, 383	4, 868	4, 129	6, 168	6, 638	8, 386	7, 889	6, 550	8, 386	6, 545
1984	8, 386	7, 812	4, 278	4, 990	8, 386	8, 386	7, 629	7, 662	8, 386	8, 265	8, 386	8, 386	7, 579
1985	6, 689	4, 353	4, 331	7, 568	6, 623	4, 922	6, 628	6, 966	8, 386	8, 386	8, 386	8, 386	6, 802
1986	8, 386	7, 335	4, 428	4, 699	5, 210	4, 355	6, 582	3, 093	3, 523	6, 437	8, 386	8, 386	5, 902
1987	6, 547	5, 780	3, 642	4, 371	8, 386	5, 303	3, 161	5, 345	5, 440	7, 898	8, 386	8, 386	6, 054
1989	8, 386	6, 158	3, 988	4, 559	6, 882	4, 902	4, 253	3, 474	3, 899	6, 945	8, 211	8, 386	5, 837
1991	8, 386	6, 944	7, 048	8, 386	8, 386	8, 386	6, 587	4, 106	3, 999	4, 032	6, 982	8, 386	6, 802
1992	8, 386	7, 711	8, 386	8, 386	6, 614	3, 634	0	0	0	5, 057	6, 406	8, 386	5, 247
1993	8, 386	7, 938	4, 745	5, 274	8, 386	8, 386	6, 208	2, 385	5, 839	8, 386	8, 386	6, 157	6, 706
1994	6, 342	5, 132	5, 859	6, 791	4, 522	3, 888	2, 377	1, 961	6, 473	8, 386	8, 386	8, 386	5, 709
1995	6, 489	4, 537	6, 774	7, 485	5, 219	2, 685	2, 248	2, 648	3, 378	5, 190	7, 311	8, 386	5, 196
1996	8, 386	7, 741	7, 983	7, 780	5, 318	2, 554	1, 917	2, 430	2, 757	2, 682	7, 274	8, 386	5, 434
1997	6, 930	4, 062	4, 040	4, 774	5, 706	8, 247	4, 224	5, 219	8, 386	7, 545	8, 386	8, 093	6, 301
1998	4, 021	3, 888	3, 893	2, 915	0	2, 304	2, 321	4, 629	8, 386	8, 160	8, 386	8, 386	4, 774
1999	8, 386	8, 386	6, 531	4, 052	4, 206	8, 363	5, 922	4, 058	3, 868	3, 953	6, 951	8, 386	6, 088
Total	74. 099	62. 498	59. 247	60. 402	55. 239	53. 349	36. 059	30. 911	46. 984	60. 336	76. 679	81. 338	58. 095
Average	7. 410	6. 250	5. 925	6. 040	5. 524	5. 335	3. 606	3. 091	4. 698	6. 034	7. 668	8. 134	5. 809

4-2-2-3. Estimated cost of construction

The following is the details of construction cost calculated by the local enterprises and the estimated construction cost calculated in this survey. The local construction cost is cheaper by 1/8 compared to the assumption of the cost in Japan. The variance can be attributed to the difference of labor costs and prices in Japan and Indonesia.

① Labor costs provided by the local enterprises
Estimated construction cost: 1,040.9 million yen (= 117.370 million IDR)
Construction price / kWh: 16.8 yen / kWh

② Estimated construction cost based on the Japanese method.

Table 4-22 Estimated Construction Cost

Contents		Estimated cost (million yen)	Remarks
1)	Land compensation expense	10	
2)	Relating to building power house	137.0	Semi-subterranean type
3)	Relating to civil construction	4,557.10	
	1. conduit	3,835.8	
	a. intake weir	218.5	Height 7,0m, dam length 40, 9m
	b. Intake	110.5	
	c, sedimentation basin	157.9	
	d, headrace	2,019.2	Open-air or subterranean L=2608m
	e, head tank	134.1	Head-tank
	f, spill way	99.8	L=370m
	g, penstock	728.0	L=640.61m
	h. tailrace	0.0	L=0m
	i, outlet	19.1	
	j. others	348.7	10% execution expense of above headrace (headrace bridge, intake reconstruction excluded)
	2. r eservoir	–	
	3. equipment and machine	721.3	
	k, foundation	307.0	Semi-subterranean type
	l, Some equipment	414.3	(①+②-+ jack)x10,0%
4)	Relating to electricity equipment	2,085.2	
	o, turbine	742.7	Francis
	p, generator	602.6	Synchronous
	q, surplus water reducer	0.0	
	r, other equipment	739.9	Expense for main transformer and electric switchgear (55% of turbine + generator)
5)	Temporary equipment expense	768.0	Temporary road: L=2019m (access road of intake weir : 1143m, access road of power plant: 966m.)
6)	Construction cost in progress	498.3	{ 2) +3) +4) +5) } ×0, 07
7)	(Sub total)	8,055.6	{1)~5) }
8)	Interest rate in construction period	0	Not added
9)	Relevant dispersal expense	80.6	Sub total ×0,01
10)	Electricity transmission and distribution equipment	960.0	L=12km
11)	(Total)	9,096.2	
Unit price of construction cost per kWh (yen/kWh)		149.5	

4-2-3. Investigation of power generation plan

In this survey, we examine the appropriateness of the power generation in accordance with the method used in Japan. We have focused on inspecting the items listed below.

- River flow condition at the intake site
- Water discharge for generating
- Effective head
- Theoretical water power and output capacity
- Generating capacity
- Generating scale

4-2-3-1. Waterway route

The drawing of Tornauli waterway route is shown in Figure 4-7. Tornauli is a small hydro power project in the form of run-of–river and the conduit type power generation.

Intake Weir (872m high above sea level) is located far from the neighborhood by a few hundred meters but there are few trees and it is a grazing area with a sloping terrain, so the road construction to access the area will be easy.

The water which is taken from intake weir for generating runs into the head tank through the headrace with length of 2.608m (with slope of 1/2,545), settling basin, Parshall Flume[27], then the water runs from the tank to the power house through penstock with length of 640m (divided into two branches in front of the power house).

[27] A diaphragm part is installed in the middle of headrace, then the flow of the river will examined be by critical discharge

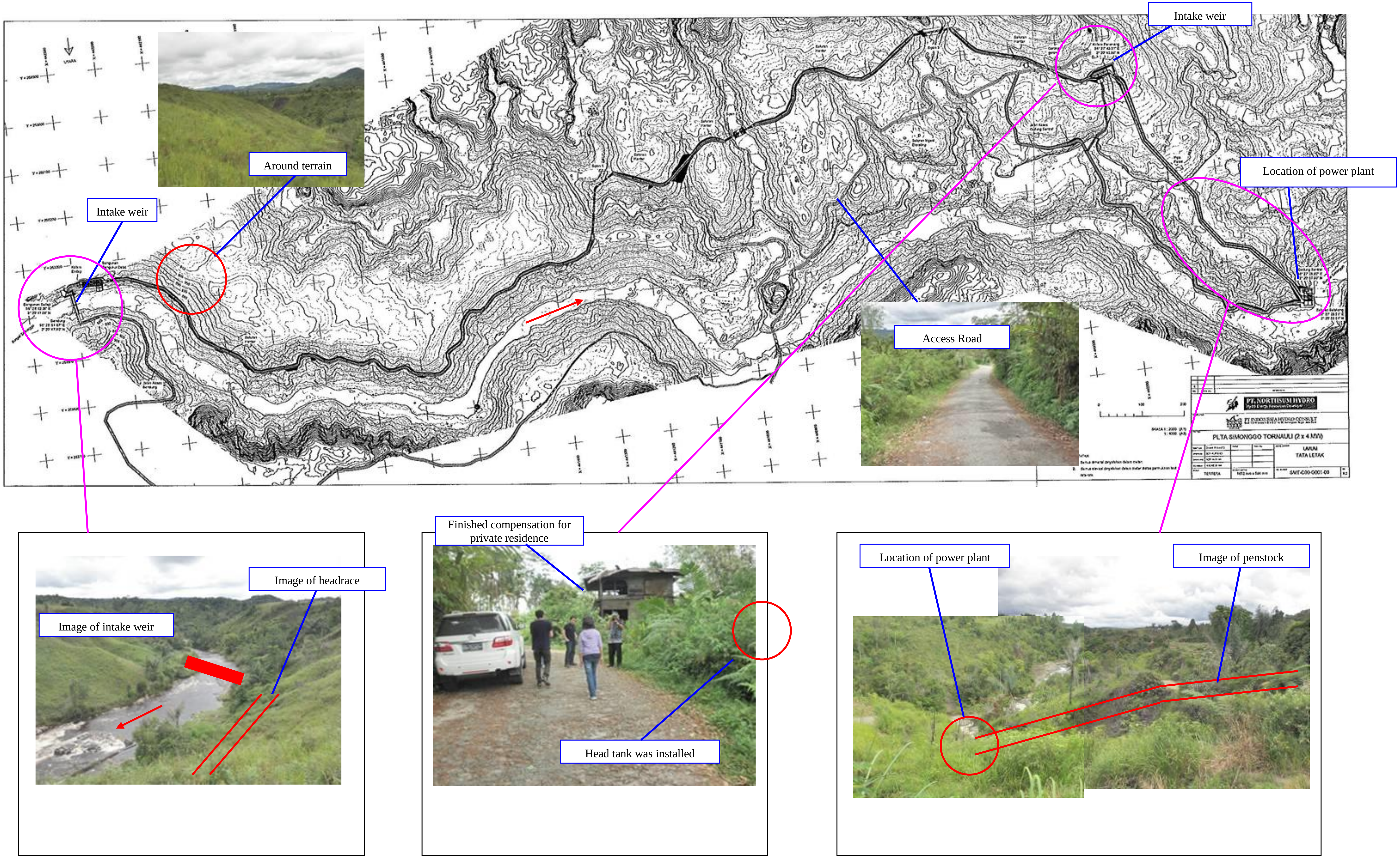
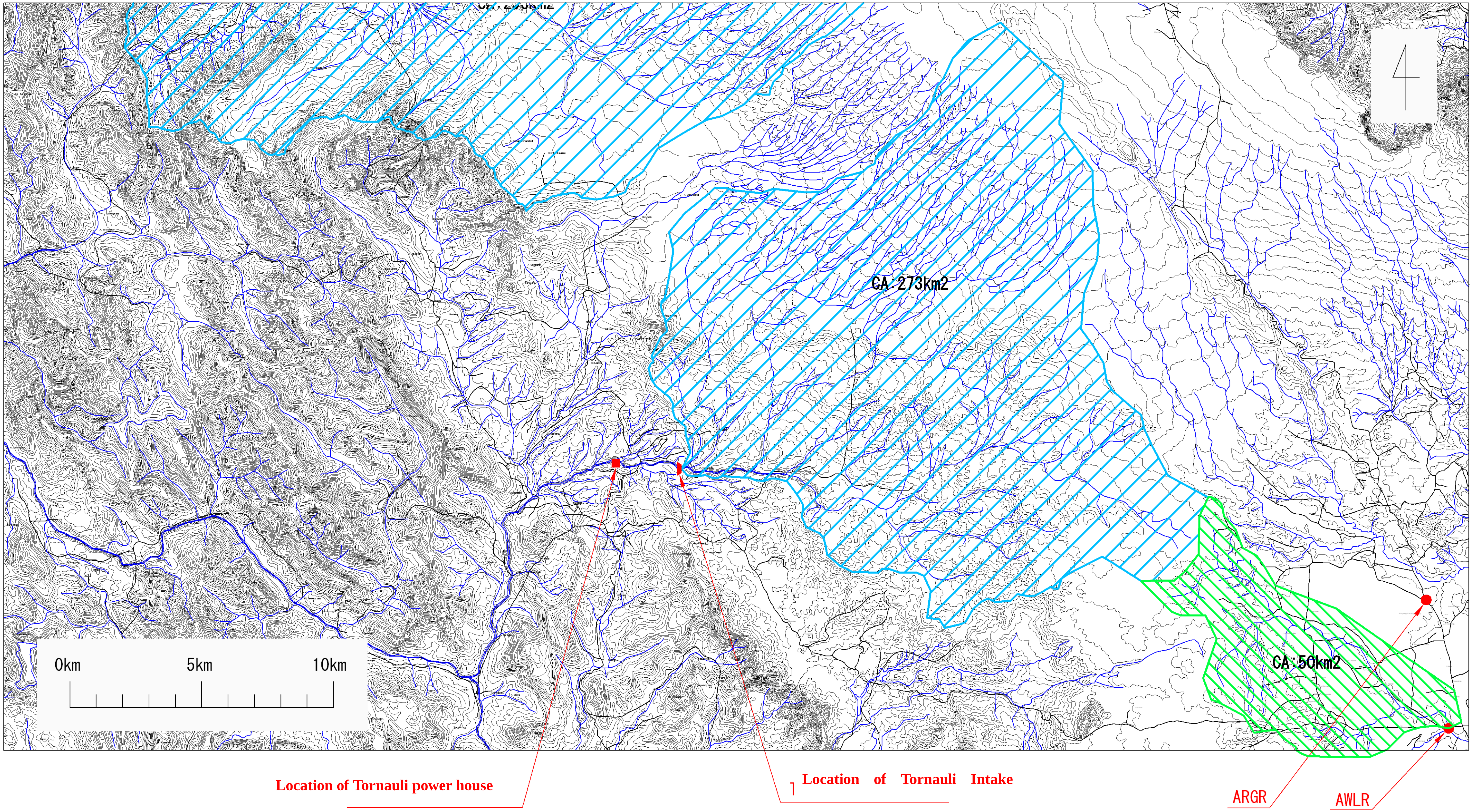


Figure 4-7 Drawing of Waterway Route



ARGR (Automatic Rain Gauge Recorder)
AWLR (Automatic Water Level Recorder)

Figure 4-8 Location of the Plan and Water - gauging station

4-2-3-2. Flow condition at the location of water intake site

The survey provides information about locations associated with the volume of used water and control of gained information on adjustment methods of flow condition at these locations.

(1) Flow data

1) Local measures

The data on flow discharge of the plan of building hydro power plants in Indonesia, and the data of water-gauging stations in the surrounding regions at that time are used. Usually, Automatic Water Level Recorder using water-level-measuring buoys is installed at the water-gauging stations; the data-recording paper will be changed once two weeks. In addition, in case of no water-gauging stations in the surrounding regions or no measured data in the long run, the rainfall data of rainfall measurement observation stations will be used.

The water-gauging station closest to the location of this plan is located in Humbang Hasundutan province, Doloksanggul district, Purba Turuan village, Sibundong river downstream with basin area of 50km^2.

In addition, the rainfall measurement observation station is also placed in Humbang Hasundutan province, Doloksanggul district, and its data were recorded from 1977 to 1999. The location of this plan along with location map of the water-gauging station and the rainfall measurement observation station are shown in Figure 4-8.

.

Table 4-23 Water-gauging Station and Rainfall Measurement Observation Station in Location of the Plan

	Name of river	Basin area	Period of obtaining data	Remark
Sibundong water gauging station	Sibundong River	50km^2	1992～2002	Missing data in 1999
Doloksanggul Rainfall measurement observation station	—	—	1977～1999	Missing data in 1982,1988 and 1990

Based on this survey, the long term rainfall data from the observatory are converted into the water discharge for use. There are many models of converting rainfall data into water discharge, but this survey uses NRECA model developed by Norman H.Crawfort. This model is widely used in research centers for irrigation of Public Professional Department of Indonesia, and also used in the plan of building hydro power plants.

2) Japan's domestic measure

According to "Guide to discharge calculation in the location of the plan of building hydroelectric powerhouse: (Legal entity Group) New Energy Foundation" in Japan, in case of absence of discharge data at the location of the plan, discharge dada of the water-gauging station in the neighboring or adjacent region will be used.

(Identifying the neighboring or adjacent region)

- Adjacent region: The rate of basin area of both upstream and downstream of the river within 0.5~0.2
- Neighboring region: The rate of basin area of both upstream and downstream of the river beyond 0.5~ 0.2 or the rate of basin area within 0.5 ~ 0.2 in contiguous basin

The location of the plan and water-gauging station Sibundong are adjacent basin with area of 5 times higher in the rate, so it is identified to be “out of the neighboring and adjacent region".

Therefore, in this case, there is no water-gauging station in the neighboring and adjacent region to the planned location; it is advisable to simply survey and measure at the location of the plan (within 1 year). Then the correlation and recurrence relation between the measured discharge and discharge of the water-gauging station of the adjacent river water (in this plan it is water-gauging station Sibundong) is examined, from which deciding whether it is necessary to supplement or not and calculate the discharge in 10 years based on circulation flow.

However, according to steps above, it is a must to take into account of potential limitations for avoiding large errors, to calculate the discharge in accordance with the simple basin rate in a short time, and to consider the discharge in accordance with the feasibility of results based on the economy in the late stage of the plan, from which considering whether it is necessary to establish a new water-gauging station or not.

The calculation of power of this test uses the discharge estimated from data of the rainfall measurement observation station according to local materials (NRECA model), but it is necessary to make a comparison based on the discharge of simple basin conversion from actual discharge, accordingly the appropriate figure will be determined.

(2) Flow condition

Mapping the flow duration curve of intake location is made based on local measures. The flow duration curve is adjusted with the potential probability in accordance with average daily discharge attained by the local measures. Accordingly, it is necessary to only change the date by which the probability arises that can outline the Figure of the flow duration curve of Japan's domestic measure.

However, in order to compare to the discharge data used in the location (data is estimated by NRECA model from the data of rainfall measurement observation station Doloksanggul), there should be adjustments to the data of basin conversion based on actual measuring results in the water-gauging station Sibundong.

Table 4-24 and Figure 4-9 show the map and table of flow duration curve pursuant to the local measure. This result gives a small value when the discharge data estimated by NRECA model in this survey is compared to the discharge data of basin calculation based on actual measurements at the water-gauging station Sibundong. Therefore, in case of power calculations based on this discharge data, available power energy will be smaller. Since then, under the consideration of doing business, these data are considered to be conservative.

Table 4-25 and Figure 4-10 show the map and table of flow duration curve pursuant to Japan’s domestic measures. Adjusting the flow condition with potential probability is made in accordance with the average daily discharge gained by the local measure. Accordingly, the date of arising probability is changed to outline the Figure of flow condition of Japan's domestic measures. For example, Japan's rainy season (95 days) would correspond to Q26% (95 days ÷ 365 days).

Table 4-24 Flow Duration Curve – Local Method (Tornauli)

probabirity	Doloksanggul rainfall measurement observation station	Sibundong water gauging station
Q 5%	45.22	61.01
Q 10%	32.91	43.19
Q 15%	27.05	35.21
Q 20%	23.09	30.27
Q 25%	20.56	27.04
Q 30%	18.63	25.07
Q 35%	17.16	23.37
Q 40%	15.68	21.89
Q 45%	14.41	20.46
Q 50%	13.07	19.42
Q 55%	11.96	18.28
Q 60%	11.01	16.91
Q 65%	10.02	15.71
Q 70%	9.09	14.61
Q 75%	8.23	13.63
Q 80%	7.36	13.30
Q 85%	6.56	12.81
Q 90%	5.60	10.78
Q 95%	4.18	7.12

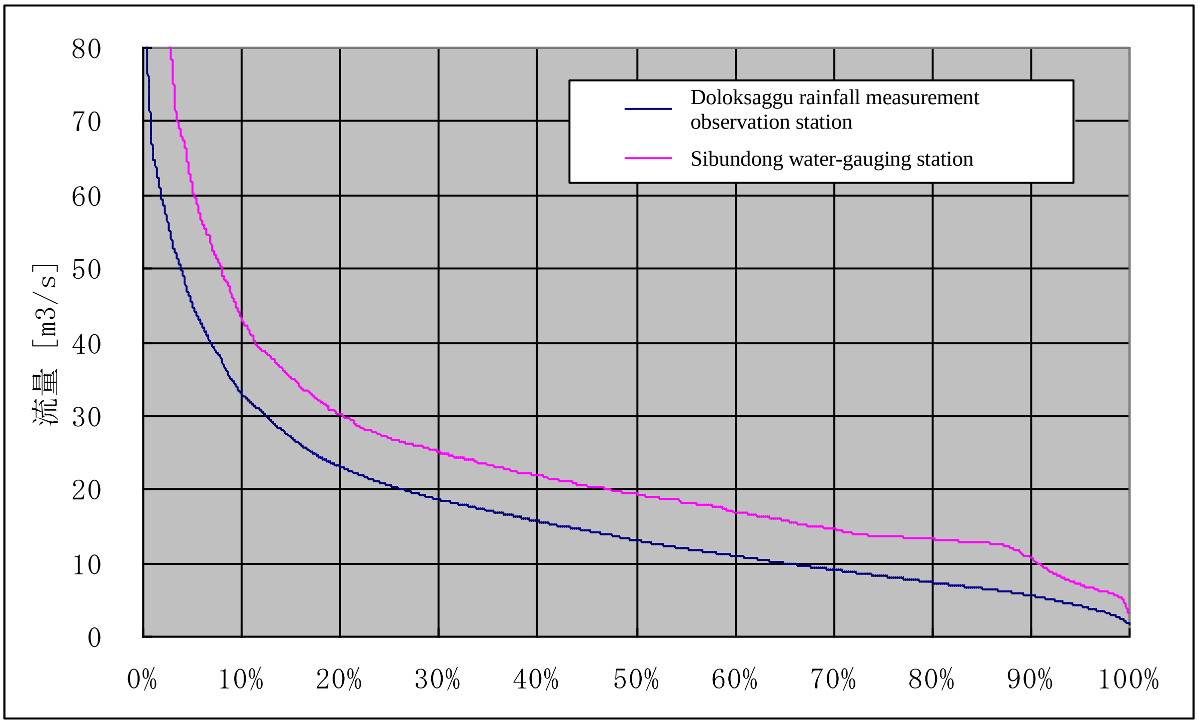


Figure 4-9 Flow Duration Curve Pursuant to Local Measures (Tornauli)

Table 4-25 Table of Flow Duration Curve Pursuant to Japan's Domestic Measures (Tornauli)

[From the year 1977]～ 【CA=273.660km2】 (Unit : m^3/s)

	Max flow	Flow 35day	High water 95day	Average water 185day	Low water 275day	Dry weather water 355day	Min flow	Total annual water	Annually average
[1977]	77.14	36.53	20.36	11.89	7.97	5.73	5.38	6,183.72	16.94
[1978]	90.45	50.27	24.53	17.44	10.81	6.53	5.96	7,973.71	21.85
[1979]	88.56	37.62	21.73	14.85	7.70	1.97	1.66	6,533.16	17.85
[1980]	66.52	34.16	20.74	15.27	10.90	4.87	3.87	6,775.29	18.56
Data from the year 1977 to the year 1990 is organized (Missing data in the year 1982, 1988, 1990).									
average	88.79	34.01	20.01	13.02	8.44	4.88	4.27	6,195.23	16.96

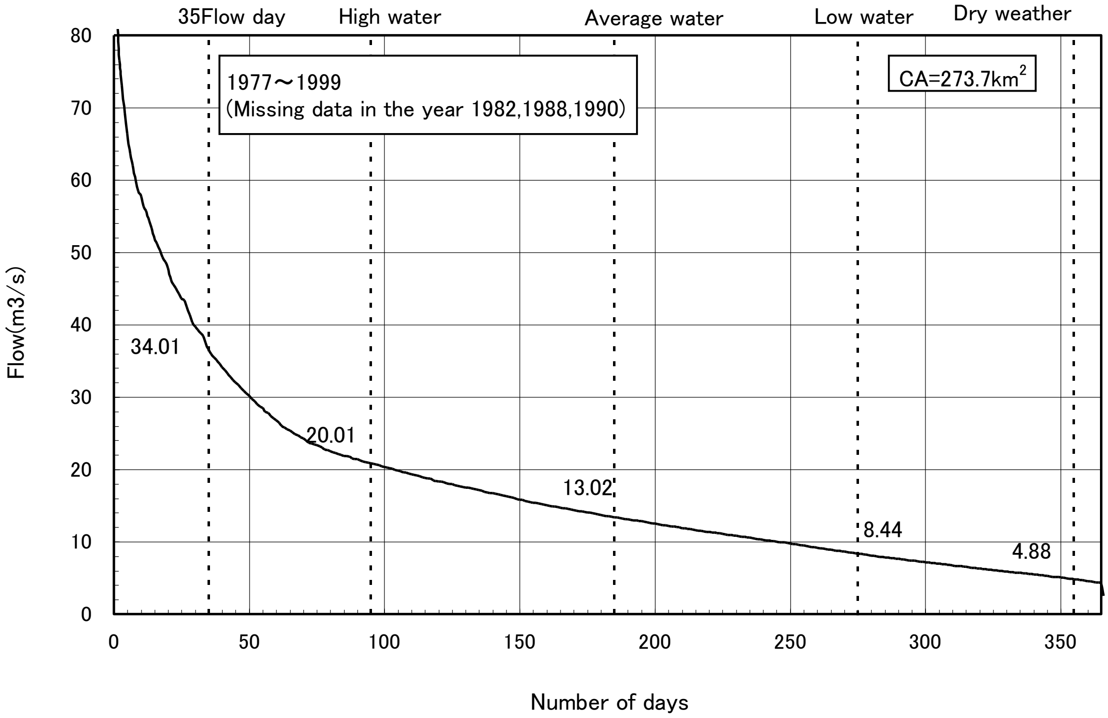


Figure 4-10 Diagram of Flow Duration Curve Pursuant to Japan's Domestic Measures (Tornauli)

4-2-3-3. Inspection of generating scale

Generating scale of relevant location has the utilizable discharge of 11.5m^3/s, and the peak output power of 8MW. It is necessary to research the generating scale using alternative inspection method of Japan's generating scale. In addition, in such case, it is necessary to confirm the appropriateness of factors.

(1) Intake level –Tail water level– Effective head

1) Intake level

Figure 4-11 represents the plan chart and cross-section drawing of the intake weir. At height of 872.00m compared to the river bed, there will be installed an intake weir at a height of 7m, therefore, the height of spillway is 879.00 m which is the intake level. This location is regarded to be suitable according to the plan drawing.

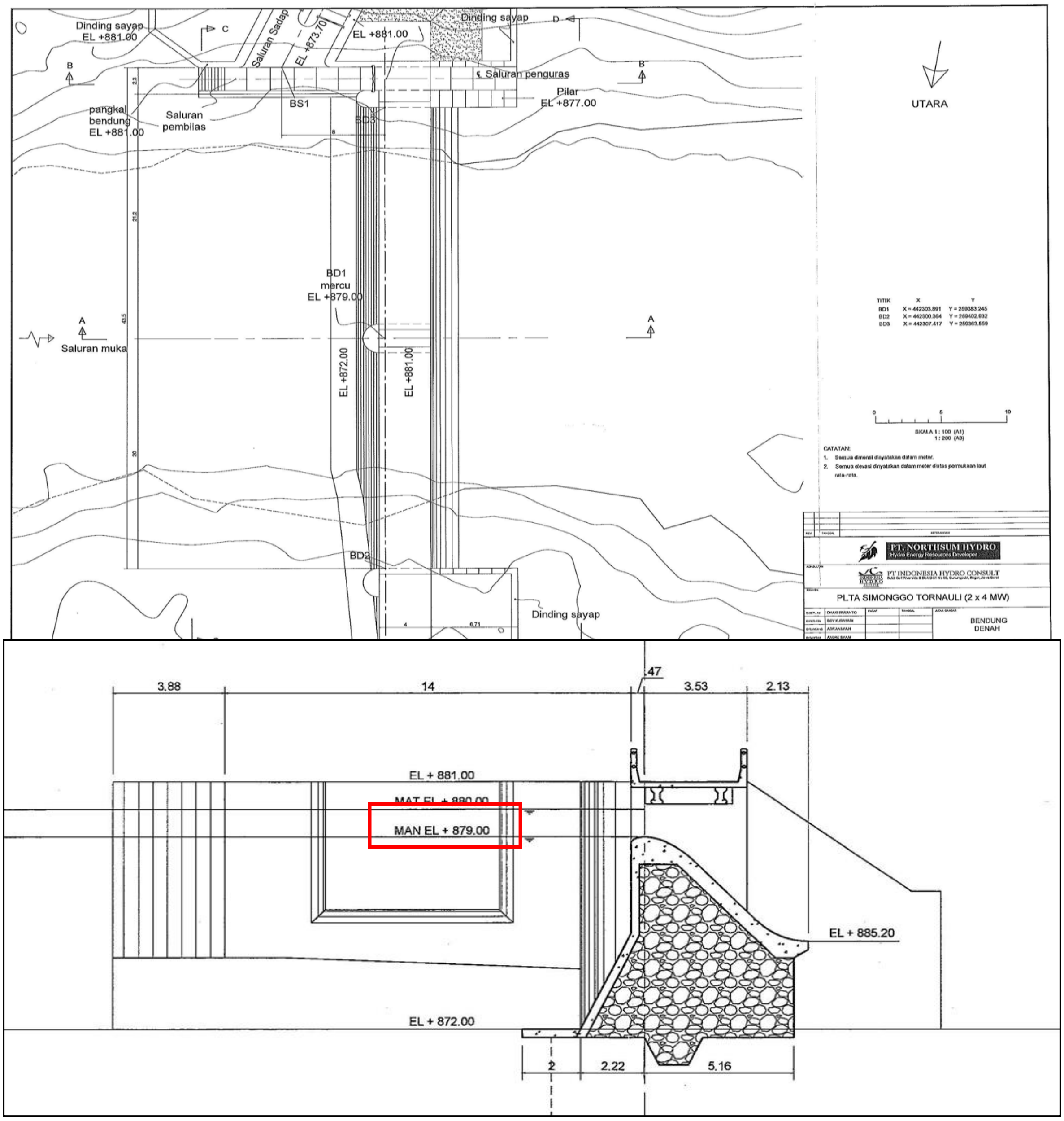


Figure 4-11 Intake Weir at the Location of Tornauli

(Above figure : Plan drawing、below figure : cross – section drawing)

2) Tail water level

Data received from the local enterprises are listed below.

- Tailrace level：788.50m

Figure 4-12 shows the cross-section drawing of the powerhouse. River's outlet gate is located adjacent to the powerhouse, and the walls are built in prevention of possible floods. The tail water level is equal to the river water level. It is established in the region near the center of variation range of river water level in the plan drawing, and is considered as an appropriate tail water level.

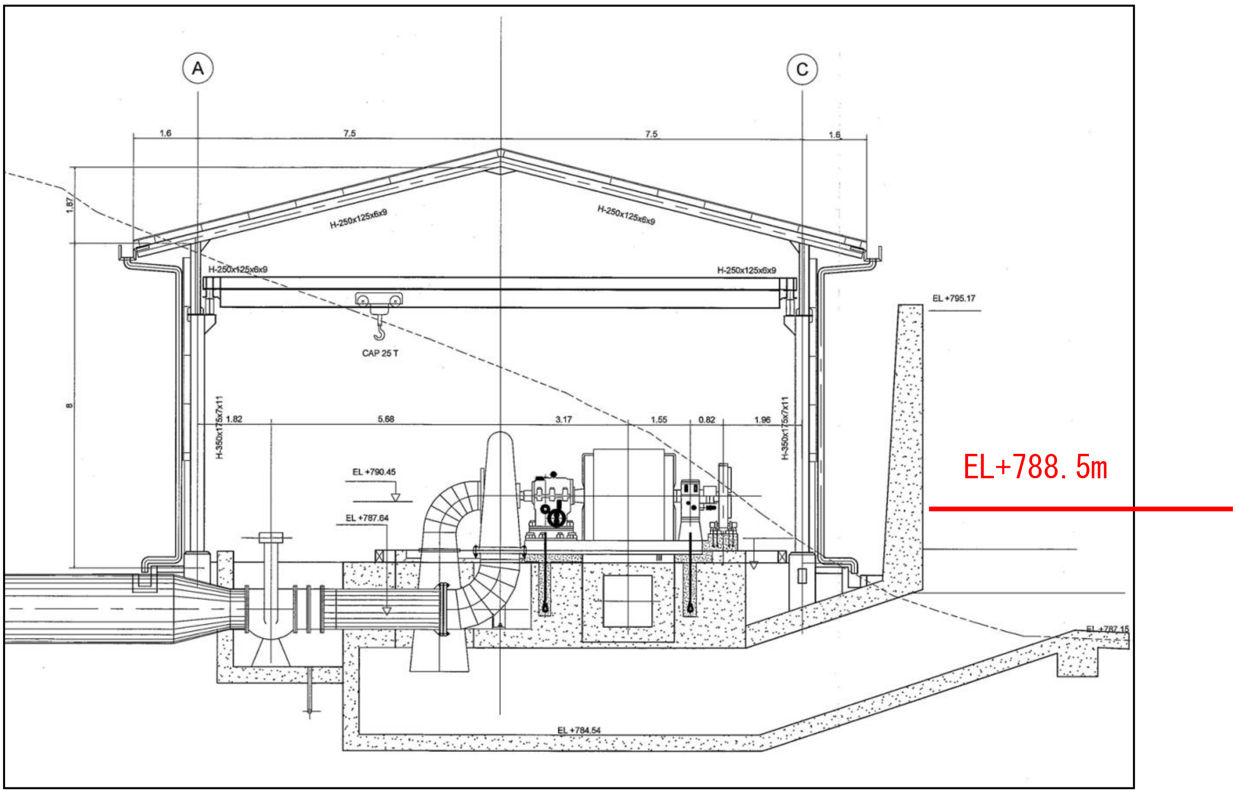


Figure 4-12 Powerhouse – Location of Tornauli

3) Effective head

(A) Method of determining the appropriateness of effective head

The effective head in Japan is calculated by "intake water level – tail water level– loss head". The data received from the local enterprises are listed below accordingly the effective head is 85.21m.

Japan's loss head calculating method is used to determine the appropriate effective head.

- Intake water level : 879.00m
- Head tank level : 875.30m
- Tail water level : 788.50m
- Gross head : 90.50m
- Loss head : 5.29m
- Effective head : 85.21m

(B) Calculation of head loss

Table 4-26 represents the calculation result of loss head of this survey and the local consultant calculation, while Table 4-27 represents the calculation result of effective head. In the calculation of loss head, maximum water discharge data in the design value of the region which is $11.5m^3/s$ is used to calculate.

The flow as mentioned earlier will be rotated in order as follows; "Intake weir → Intake gate → Settling basin → Parshall Meter flume → Headrace → Head tank → Penstock →Powerhouse". The loss head of river upstream against the tank is from the tank's water level for calculations of the rest. Here, the Parshall meter flume which narrows the flow is located on the headrace to generate critical discharge, the entire water level difference between the Parshall meter flume upstream and downstream water level falls. According to the calculating results of this survey, downstream water level difference of Parshall flume is 1.219m, fully consistent with the irrigation capacity.

In addition, the loss head from the tank to the river downstream has been included in the loss of penstock. With this result, the loss head of penstock is 0.056m different from the result of calculation by the local consultant 1.590m.

Details of the calculation can be found in the Appendix T4-1.

Table 4-26 Calculation of the Head Loss (Tornauli) (Unit :m)

Item		Local enterprises	This survey	
Intake gate	Flow	0.250	0.018	0.035
	pier		0.017	
Settling basin	Change the cross section	0.050	0.000	0.061
	Inflow		0.061	
Parshall Meter flume		0.800	1.219	1.219
Headrace	Open channel No1	1.950	0.912	2.385
	Shiphon No 1		0.310	
	Open channel No2		0.185	
	Shiphon No2		0.183	
	Open channel No3		0.322	
	Shiphon No3		0.196	
	Open channel No4		0.277	
headtank	Expansion the cross section	0.650	0.000	0.000
Penstock	Inflow	1.590	0.017	1.590
	friction (Before divide branches)		1.180	
	Divide branch		0.164	
	friction (After divided branches)		0.057	
	Shrink cross section		0.116	
	Surplus		0.056	
Total		5.290	5.290	5.290

Table 4-27 Calculation of Effective Head (Tornauli)

Item	Unit	MAX
Plant discharge	m^3/s	11.500
Intake level	m	879.000
Tailrace level	m	788.500
Gross head	m	90.500
Head loss	m	5.290
Effective head	m	85.210

(2) Integrated performance of water turbine – generator

1) Selection of types of water-turbine

The water-turbine type will be selected suitable to the effective head and water discharge.

In Japan, in the planning phase, the water-turbine type is determined by using the table of water-turbine selection as in Figure 4-13. In addition, in the implementation design phase, manufacturer's information such as water-turbine type and load-bearing efficiency may be obtained and reflected in the calculation of consumed power.

In Tornauli, Francis horizontal shaft turbine is used for planning. The effective head and water discharge at the location in this plan is as follows:

Effective head: 85.21m

Water discharge: 11.50m^3/s

And based on Japan's Figure of water-turbine selection, the Francis horizontal shaft turbine is selected to use for the project.

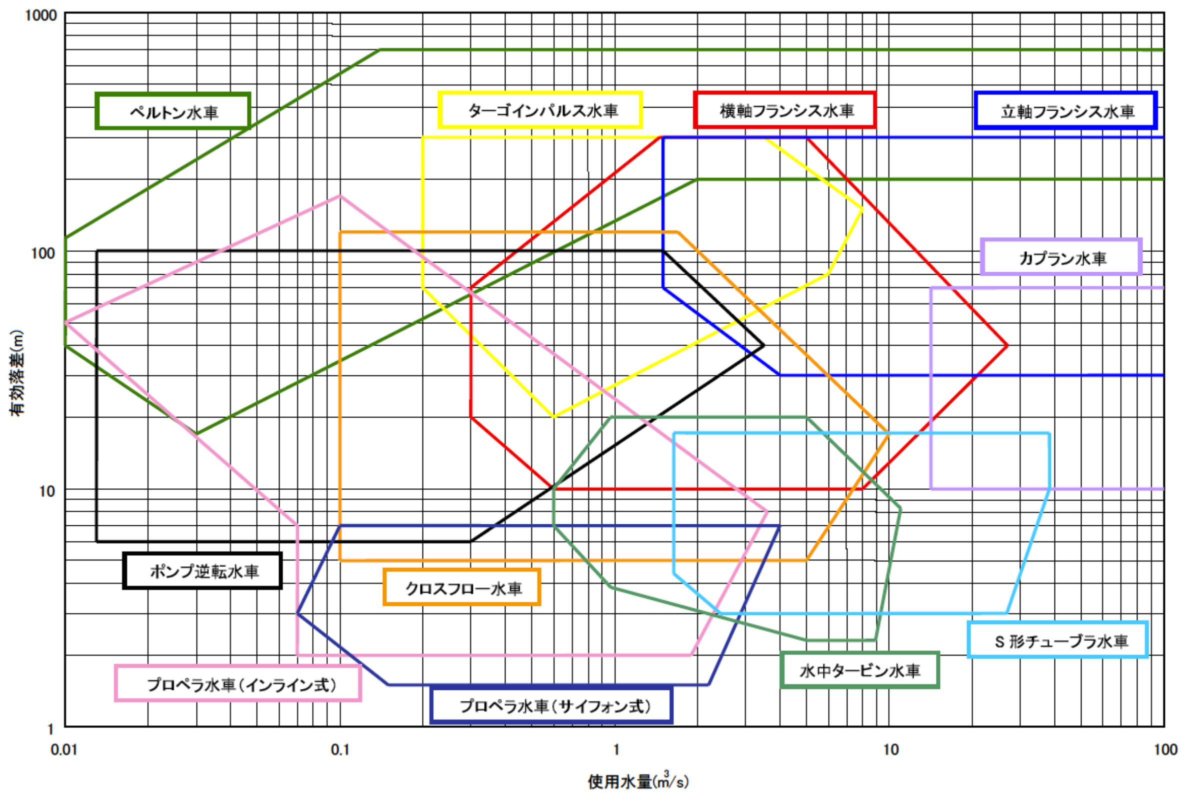


Figure 4-13 Diagram of Turbine Selection

Source："Hydro Valley plan guidebook" (New Energy Foundation)

2) Performance of turbine – generator

The general performance of water-turbine and generator is used to calculate the available power energy by the value provided by the turbine manufacturer. Figure 4-14 shows the general performance curve based on the turbine manufacturer's value and steps of "Small and medium hydroelectric guidebook (Version 5): (Legal entity Group) New Energy Foundation" (approximated values are shown in the Figure: the manufacturer's value).

The performance given by the manufacturer is higher than the value designed by NEF. In this survey, it is assumed that the general performance curve is used in accordance with the manufacturer's value.

In addition, the minimal generating power based on the previous actual data is 40%, compared to the maximum water discharge.

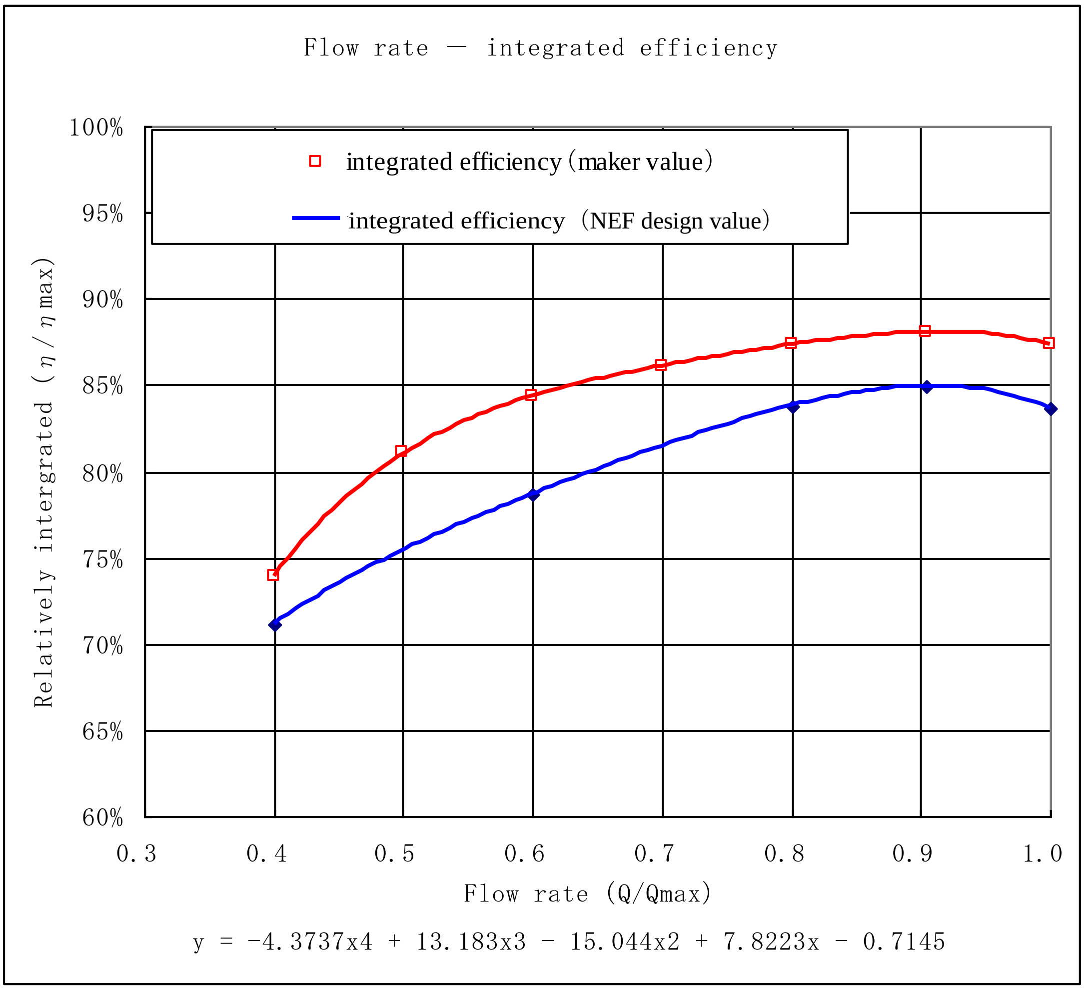


Figure 4-14 Integrated Efficiency Curve Diagram of Turbine Generator

(3) Cases of inspection of generating scale

According to the Japanese inspection method, it is a must to inspect the generating scale of the power generation plan and provide calculations for generation capacity (MW), power generation (MWh) and overall cost of the works based on a review of the river flow characteristics by changing the maximum amount of water discharge

Table 4-28 shows the cases of generating scale inspection. With water discharge of 11.5m^3/s in plan 2 of this plan, the maximum power is 8.4MW, compared to the current plan of 8MW, greater than 400kW. The generating performance of this plan uses the Japanese manufacturer's value, compared to the current value to enhance performance.

The generating performance calculated according to this survey is 87.3%
The generating performance calculated according to the survey in use is 83.3%

Table 4-28 Content of Generating Scale Consideration

Content	Feature					Local feature
Name of river system, name of river	Shimonggo River					
Basin area	273.66 km ^{2}					
Intake elevation	EL. 879.00 m					
Tailrace elevation	EL. 788.50 m					
Gross head difference	90.50 m					
Effective head difference	85.21 m					
Max use water	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Local feature
	8.24 m^3/s	11.50 m^3/s	13.72 m^3/s	16.46 m^3/s	19.20 m^3/s	11.50 m^3/s
Maximum output	6,000 kW	8,400 kW	10,000 kW	12,000 kW	14,000 kW	8,000 kW
River maintaining flow	0.82 m^3/s (0.30 m^3/s/100km^2)					N/A

※The above yellow column in the table shows the case that the water discharge volume is similar to the current plan.

(4) Power generation

1) Annual available power generation

The available power generation is calculated based on the content of generating scale consideration given above.

According to the local information, relevant plans do not need irrigation in the downstream, thus the discharge maintenance is not required. However, after considering the environment, it is recommended that the discharge remains as before.

In the "Assurance of the maintenance discharge of river pursuant to changes in each period, so called generating guideline, statement S63.7.14" in Japan, the standard of maintenance discharge for each $100km^2$ basin area is $0.1\sim0.3m^3/s$. In the Survey, this value is regarded as the reference value, and the maintenance discharge is set as below.

Maintenance discharge＝Basin area $273.66km^2$ x $0.3m^3/s/100km^2$ x 100 = $0.82m^3/s$.

Annual available power generation and power output L5 are represented in Table 4-29. In case 2, the maximum water discharge of this plan is $11.5m^3/s$, although there is difference from the calculation condition below, it is 1,000MWh in comparison with the available power generation in local documents, so the value is almost the same.

(Differences in principal calculating conditions)
Generating performance
Peak output power
Method of establishing maintenance discharge
(Reference)
Available power energy which does not take into account the maintenance discharge (Proposal case 2) 63,191MWh

Table 4-29 Annual Available Power Generation

Annually available power energy Unit:MWh

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Case 1	4,411	4,026	4,222	4,054	4,113	3,660	3,446	3,113	3,666	4,260	4,310	4,464	47,746
Case 2	5,922	5,140	5,280	5,122	5,229	4,518	3,974	3,577	4,587	5,374	5,940	6,191	60,853
Case 3	6,751	5,671	5,787	5,676	5,750	4,984	4,133	3,849	5,139	5,894	6,971	7,280	67,885
Case 4	7,651	6,076	6,250	6,210	6,296	5,351	4,162	4,063	5,676	6,414	8,170	8,483	74,800
Case 5	8,351	6,344	6,600	6,592	6,745	5,494	4,133	4,169	6,038	6,722	9,237	9,479	79,903
Local document	－												61,928

Output L5 Unit:kW

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Case 1	5,777	5,378	5,249	5,201	5,062	4,413	3,740	3,039	3,938	5,111	5,919	5,997	4,902
Case 2	7,410	6,250	5,925	6,040	5,524	5,335	3,606	3,091	4,698	6,034	7,668	8,134	5,809
Case 3	8,320	6,361	6,058	6,352	5,808	5,600	3,509	3,105	4,924	6,236	8,577	9,309	6,180
Case 4	9,139	6,306	6,054	6,523	6,242	5,498	3,002	2,717	4,997	6,338	9,477	10,416	6,393
Case 5	9,330	6,254	6,080	6,439	6,389	4,904	2,775	2,114	4,775	6,120	10,000	11,214	6,366

2) Annual power generation

According to the local FS report, the power consumption of power plant accounts for 2% of the annually available power generation. In addition, time of power cut due to causes such as incidents, inspection and maintenance is 4%. In the Japan's "Small and Medium Hydroelectric Guidebook", the rate of suspension of power supply is 5% (generating terminal). Based on the domestic results, the rate of plant consumption and wastage on the line is similar to the local materials, the rate is 2% (receiving terminal).

The annual available power generation of the case is shown in Table 4-30. At the receiving terminal, result of the case 2 that is similar scale of local materials is 1,600MWh lower than calculation result of local materials.

Annual available power generation (generating terminal) =Annual available power generation x 0.95

Annual available power generation (receiving terminal) = Annual available power generation x 0.95 x 0.98

Table 4-30 Annual Available Power Generation

Unit:MWh

	Annual available power generation	Annual power generation (generating terminal)	Annual power generation (receiving terminal)
Plan 1	47,746	45,359	44,452
Plan 2	60,853	57,810	56,654
Plan 3	67,885	64,491	63,201
Plan 4	74,800	71,060	69,639
Plan 5	79,903	75,908	74,390
Local document	61,928	59,451	58,262

(5) Overall cost of the works

Overall cost of the works is calculated by the domestic method, based on standard of cost estimate for the generation planning of "Standard of cost estimate for the hydroelectric plant (March, 2005): New Energy Foundation" (unit price, calculation sheet...).

This cost is changed in accordance with the price adjustment factor ("related to construction" and "related to civil" will be + 12.4%, "in relation to power" + 6.1%) after considering price volatility in recent years (Fiscal year 2003 → 2010).

In comparison between the local document and the Plan 2 in the equivalent generating scale, the cost of the works is 9 times higher than the cost calculated locally with Japan's estimate method as shown below table. This is due to the difference between labor costs and prices in Japan and Indonesia.

The construction cost from local document is an estimated by the local consulting company based on other similar small hydro projects in Indonesia. Although it does not show much difference compare to the cost of other projects, Tornauli will be little lower. It is necessary to consider design of the structure and construction schedule for more accurate estimate of the construction cost.

Table 4-31 Overall Cost of the Works (Unit: Million JPY)

	Contents	Case of study						Summary
		Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Local document	
1)	Land compensation expense	10.0	10.0	10.0	10.0	10.0		
2)	Relating to housing works	115.9	137.0	152.4	170.0	185.2		Semi-subterranean type
3)	Relating to construction	3,906.0	4,557.1	4,937.2	5,466.8	5,973.1		
	① Waterway	3,318.6	3,835.8	4,132.6	4,555.1	4,957.7		
	a. Intake weir	218.5	218.5	218.5	218.5	218.5		Height7.0m, Crest length of weir40.9m
	b. Intake	82.9	110.5	129.6	151.6	174.1		
	c. Settling basin	115.4	157.9	187.3	223.1	258.7		
	d. Headrace	1,692.6	2,019.2	2,214.1	2,434.9	2,639.4		Opened or closed channel L＝2,608m
	e. Head tank	99.1	134.1	157.5	185.6	213.6		Head tank
	f. Spillway channel	89.8	99.8	106.3	115.7	121.8		L＝370m
	g. Penstock	702.6	728.0	722.1	787.8	854.8		L＝641m (Separate into 2 tubes at 11m)
	h. Tailrace channel	0.0	0.0	0.0	0.0	0.0		
	i. Outlet	16.0	19.1	21.5	23.8	26.1		
	j. Miscellaneous execution	301.7	348.7	375.7	414.1	450.7		10.0% execution expense of above headrace
	② Regulating pond	—	—	—	—	—		
	③ Equipment and machine	587.4	721.3	804.6	911.7	1,015.4	—	
	k. Jack	232.3	307.0	355.8	414.7	472.4		Semi-subterranean type
	l. Some equipment	355.1	414.3	448.8	497.0	543.0		(①+②+jack)×10.0%
4)	Relating to electricity	1,680.7	2,085.2	2,325.3	2,614.9	2,887.8		
	o. Turbine	609.0	742.7	821.2	914.6	1,001.6		Horizontal shaft Francis
	p. Generator	475.3	602.6	679.0	772.4	861.5		Synchronous
	q. Surplus water reducer	0.0	0.0	0.0	0.0	0.0		
	r. Other equipment	596.4	739.9	825.1	927.9	1,024.7		Expense for main transformer and electric switchgear
5)	Temporary equpment expense	714.1	768.0	799.7	841.6	881.3		Temporary road : L=2109m
④	Total expense	419.1	498.3	545.0	606.5	664.9		{2)+3)+4)+5)}×0.07
6)	(Sub Total)	6,845.8	8,055.6	8,769.7	9,709.7	10,602.3		{1)～6)}
7)	Dam dispersal expense	—	—	—	—	—		Not calculated
8)	Interest rate in construction period	0	0	0	0	0		Not added
9)	Relevant dispersal expense	68.5	80.6	87.7	97.1	106.0		Sub Total×0.01
10)	Expense for electricity cable	960.0	960.0	960.0	960.0	960.0		20kV、12km
11)	(TOTAL)	7,874.3	9,096.2	9,817.4	10,766.8	11,668.3	1,040.9	

※ Exchange rate for local document: IDR 1 = JPY 0.01

(6) Test results of generating scale

Table 4-32 shows the test results of generating scale by Japan's domestic measures. The most appropriate generating scale is the case of low prices as in plan 4, the construction unit price for each kWh is 143.9 yen, and peak output power is 12MW (maximum water discharge is 16.46 m^3/s). However, the fixed purchase price is applied in Indonesia, only for the power under 10MW, thus, peak power of 10MW (maximum water discharge of 14.72 m^3/s) in plan 3 (construction price for each kWh is 144.6 yen) is considered the most appropriate scale.

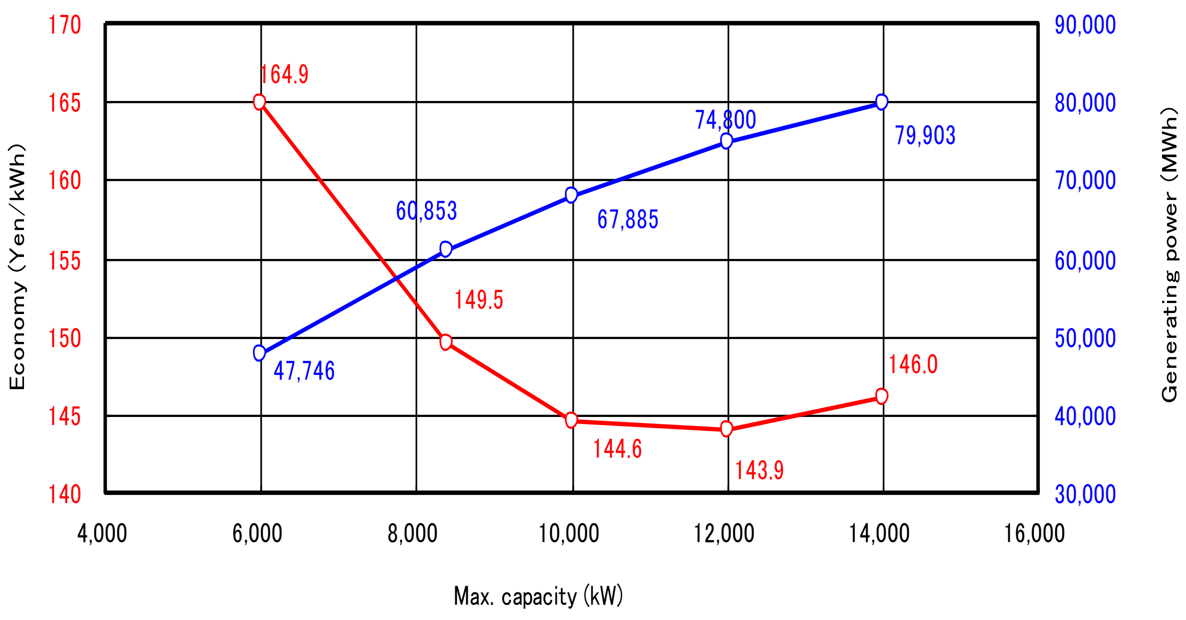
Local enterprises choose the maximum amount of water in the Plan 2 (capacity factor is 83% and the utility factor of river flow is 62%), and it shows the unit price for each kWh is 149.5 yen/kWh which is higher than that in Plan 3.

The causes of difference from the locally selected generating scale are as follows:

- The construction cost of hydro power equipment as mentioned above, due to the large difference in labor costs between Japan and Indonesia. Thus, in case of using local construction costs, the unit price for each MWh will be different.
- The scale of the plan is determined by possible budget scope of the local developer.

Table 4-32 Comparison and Analysis Results of Generation Scale

	Items	Case of study					Local document
		Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	
	Name of river system and river	Shimongg river					
	Basin area	273.66 km²					
	Discharge of river (m³/s)	Conversion discharge by NRECA model of DolokSunggul rainfall measurement observation station(Average 1997-1999)					
		Maximum 88.79 35 days high water 20.1 Medium water 13.02					
		Low water 8.44 Dry weather water 4.88 Minimum 4.27 Annual average 16.96					
Generation plan	Type of power generation	Run-off-river					
Generation plan	Intake water level	879.00 m	879.00 m	879.00 m	879.00 m	879.00 m	879.00 m
Generation plan	Tail water level	788.50 m	788.50 m	788.50 m	788.50 m	788.50 m	788.50 m
Generation plan	Gross head	90.50 m	90.50 m	90.50 m	90.50 m	90.50 m	90.50 m
Generation plan	Effective head	85.21 m	85.21 m	85.21 m	85.21 m	85.21 m	85.21 m
Generation plan	Maximum water discharge	8.24 m³/s	11.50 m³/s	13.72 m³/s	16.46 m³/s	19.20 m³/s	11.50 m³/s
Generation plan	Output	6,000 kW	8,400 kW	10,000 kW	12,000 kW	14,000 kW	8,000 kW
Generation plan	Output L_5	5,002 kW	5,421 kW	5,809 kW	6,064 kW	6,269 kW	-
Generation plan	Annual electricity generation	47,746 MWh	60,853 MWh	67,885 MWh	74,800 MWh	79,903 MWh	61,928 MWh
General equipment	Intake weir	Height 7.0m, Crest length of weir 40.9m					
General equipment	Intake	Intake type from lateral face					
General equipment	Settling basin	Open channel, Length 56.87m, Width 12.00m					
General equipment	Head tank	Open channel, Length 77.59m, Width 10.50m					
General equipment / Waterway	Headrace	Open channel or close channel L=2608m					
General equipment / Waterway	Penstock	Inner diameter 2.4m, L=640.61m					
General equipment / Waterway	Spillway channel	L=370m					
General equipment	Power house	Semi-underground type					
General equipment	Turbine type	Francis horizontal shaft turbine× 2					
General equipment	Generator type	Synchronous generator, 2 generator					
River Utilizati	Water for river maintenance	0.82 m³/s (0.30m³/s/100km²)					N/A
River Utilizati	Plant factor	90.8%	82.7%	77.5%	71.2%	65.2%	88.4%
River Utilizati	River utilization rate	50.9%	61.8%	67.3%	72.5%	76.5%	N/A
	Total cost of the project	7,874 million yen	9,096 million yen	9,817 million yen	10,767 million yen	11,668 million yen	1,041 million yen
	Construction cost equivalent to kW	1,312 million yen	1,083 million yen	982 million yen	897 thousand yen	833 thousand yen	130 thousand yen
	Construction cost equivalent to kWh	164.9 yen/kWh	149.5 yen/kWh	144.6 yen/kWh	143.9 yen/kWh	146.0 yen/kWh	16.8 yen/kWh



4-2-4. Safety inspection of key civil works

4-2-4-1. Intake weir

(1) Overview

1) Detail of inspection

Intake weir of concrete gravity dam is located on upstream of powerhouse. Based on Japan's technical standards, the stability of water intake equipment (slides, overturn, bearing capacity) shall be verified.

Determination of cross-sections and construction conditions of intake weir are based on data derived from the local documents such as design. In case of unclear condition, Japanese documents on standards are referred.

Calculation condition and result of calculation are shown below, and other details of calculation are attached in Appendix T4-2.

2) Cross-section of intake weir

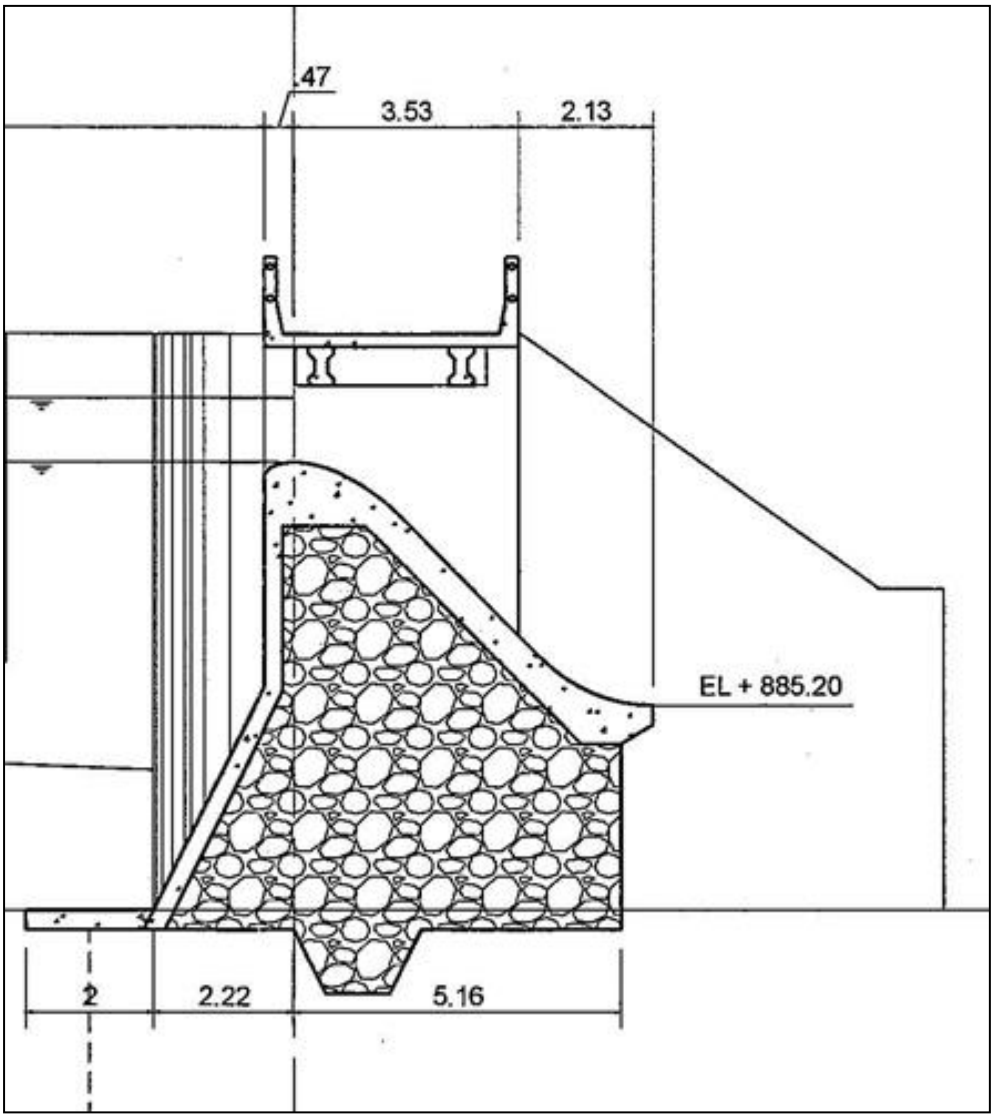


Figure 4-15 Cross-Section of Intake Weir for Stability Calculation (Tornauli)

(2) Calculation condition

1) Reference and standard

Reference and standard for design of this survey are shown in Table4-33.

Table4-33 References for Stability Analysis of Dam

No	Title	Issued year	Issuing Organization
1	Design document from local consulting company	2011.	－
2	Document for technical standards and application process for government program for hydro power generating installations	2011. Mar	Electric power civil engineering association
3	River management facilities and processes	2000. Jan	Japan rivers association
4	River erosion control technical standards by the Ministry of Construction	1997. Oct	Japan rivers association
5	Concrete standards, structural Performance	2008. Mar	Japan society of civil engineer
6	Rules on structural dynamics	1986. June	Japan society of civil engineer
7	Road bridge	2012. Mar	Japan road association
8	Road earthmoving – retaining structure standards	2012. July	Japan road association

2) Design water level

Elevations and water levels referred from document of local company are shown below.

- Dam top height : EL＝879.00m
- Design flood level : EL＝880.00m
- Normal water level : WL＝879.00m
- Sedimentation level : EL＝879.00m
- Elevation of dam foundation rock : EL＝872.00m

3) Material condition

Calculation conditions for each material are shown below.

(A) Concrete

Table 4-34 Conditions on Concrete Calculation

Items	Symbol	Unit	Value	Reference No.
Unit weight (Concrete)	γ_c	kN/m^3	24.0	1
Unit weight (Masonry block)	γ_b	kN/m^3	22.0	1
Design strength	σ_{ck}	N/mm^2	—	—
Allowable bending compressive stress intensity	σ_{ca}	N/mm^2	—	—
Allowable shearing stress intensity	τ_a	N/mm^2	—	—

4) Natural condition

Basic information and geographic condition for this construction is shown below.

(A) Soil condition (sedimentation)

Table 4-35 Soil Condition

Items	Symbol	Unit	Value	Reference No.
Unit weight (wet)	γ_t	kN/m^3	17.65	4
Unit weight (underwater)	γ_s	kN/m^3	9.81	4
Unit weight of water (underwater)	γ_w	kN/m^3	9.81	4

(B) Foundation ground

For the physical properties of foundation ground, figures are taken from the Ministry of Construction, "Draft Technical Standard for River Erosion Control" document from Japan. Geological feature at location of intake weir is "welded tuff" according to the "Design from local company". In this survey, it is referred as "hard rock with cracks" to verify the allowable bearing capacity while considering safety work.

Table 4-36 Foundation Ground Conditions

Items	Symbol	Unit	Value	Reference No.
Compressive strength	qu	kN/m^2	9810	4
Allowable bearing capacity(At normal)	σ	kN/m^2	588	4
Allowable bearing capacity(During earthquake)	〃	kN/m^2	883	4

Table 4-37 Allowance Bearing Capacity and Friction Factor for Type of Geology

基礎地盤の種類		許容支持力度 (tf/m²) {kN/m²} 常時	地震時	摩擦係数 場所打ちコンクリートの場合の堰等の底面の滑動安定計算に用いるすべり	備考 qu (tf/m²) {kN/m²}	N 値
岩盤	亀裂の少ない均一な硬岩	100 {981}	150 {1470}	0.7	1 000 以上 {9 810 以上}	—
	亀裂の多い硬岩 Hard rock with cracks	60 {558}	90 {883}	0.7	1 000 以上 {9 810 以上}	—
	軟岩，土丹	30 {294}	45 {441}	0.7	100 以上 {981 以上}	—
礫層	密なもの	60 {588}	90 {883}	0.6	—	—
	密でないもの	30 {294}	45 {441}	—	—	
砂質地震	密なもの	30 {294}	45 {441}	0.6	—	30～50
	中位なもの	20 {196}	30 {294}	0.5	—	15～30
粘性土地盤	非常に堅いもの	20 {196}	30 {294}	0.5	20～40 {196～392}	15～30
	堅いもの	10 {98.1}	15 {147}	0.45	10～ 20 {98.1～196}	8～15
	中位なもの	5 {49}	7.5 {73.5}		5～ 10 {49～ 98.1}	4～ 8

5) Loading condition

(A) Dead load

Total weight of dam is considered as dead load.

(B) Soil and water weight

Soil and water weight on upper side of fillet is included.

(C) Seismic inertia force

Seismic inertia force Pf is calculated by multiplying dead load W and design horizontal seismic coefficient K_h, and it effect horizontal direction through center of gravity of dam.

Design horizontal coefficient K_h is calculated by following equation. In addition, r1 and r2 are determined considering seismic strength and ground classification. However, the value that is considered more safety is applied here since information of ground is unidentified.

$Pf = K_h \times W$

$K_h = \gamma_1 \times \gamma_2 \times \gamma_3 \times K_0$

where,

K_h : Design seismic coefficient ($K_h = 1.0 \times 1.2 \times 1.0 \times 0.2 = 0.24$)

K_0 : Standard seismic coefficient ($K_0 = 0.2$)

γ_1 : Zoning factor ($\gamma_1 = 1.0$ from Table 4-38)

γ_2 : Ground condition factor ($\gamma_2 = 1.2$ from Table 4-39)

γ_3 : Importance factor ($\gamma_3 = 1.0$)

Table 4-38 Zoning Factor

Zone	Strong earthquake region	Medium earthquake region	Weak earthquake region
Factor r_1	1.0	0.85	0.7

Table 4-39 Ground Condition Factor

Ground classification	Type Ⅰ	Type Ⅱ	Type Ⅲ
Factor c_2	0.8	1.0	1.2

(D) Static water pressure

On water level at upstream and downstream of dam, external and internal water pressure which is acting to the wall are considered as static water pressure and calculated by following equation. Seismic inertia force, seismic dynamic water pressure and water pressure at planned high water are not act at same time.

$P_w = (1/2) \times \gamma_w \times h^2$

where,

P_w : Total of static water pressure from water surface to depth h (kN/m^2)

γ_w : Unit weight of water ($\gamma w = 9.8 kN/m^3$)

h : Depth from surface

(E) Uplift pressure

Uplift pressure due to water level differences between upstream and downstream of dam axis is considered.

Uplift pressure on upstream end : $\{(h_1-h_2)\times\mu+h_2\}\times\gamma_w$

Uplift pressure on downstream end : $h_2\times\gamma_w$

where,

μ : Uplift coefficient (=1/3)

h_1 : Depth of upstream end

h_2 : Depth of downstream end

(F) Mud pressure

Mud pressure of horizontal direction due to sediments in reservoir is calculated by following equation.

$$Pe=(1/2)\times Ce\times\gamma_s\times d^2$$

where,

Pe : Total of horizontal direction mud earth pressure from seddiment surface to depth d

Ce : Mud pressure coefficient (=0.5)

γ_s : Unit weight of sedimentation(underwater)

d : Depth from sediment surface

(G) Dynamic water pressure

Dynamic water pressure is calculated by Westergaard's approximation formula.

$$Pd=(7/12)\times\gamma_w\times K_h\times H^{1/2}\times h^{3/2}$$

where,

Pd : Total dynamic water pressure from water surface to depth h (kN/m^2)

γ_w : Unit weight of water

K_h : Design horizontal seismic coefficient

H : Depth from water surface to foundation ground

H : Depth from surface

(H) Wave pressure

Wave pressure is generally calculated considering wave height due to wind and earthquake. However, it is not necessary to consider wave height due to wind because of standard of dam. Wave height due to earthquake is calculated by following equation.

$$h_e=(K_h\cdot\tau/\pi)\times\sqrt{(g\times H)}$$

where,

h_e : Total of wave height

K_h : Design seismic coefficient

τ : Earthquake frequency (1 second generally)

H : Depth from design water level to bottom sill level

6) Stability condition

It is necessary to analyze stability calculation of sliding, overturning, and bearing capacity.
Stability condition of concrete gravity dam referred from “Ministry of construction River erosion control technical standard” is shown below.

Stability condition：

① Sliding : Safety factor has to be 1.5 by Henny’s formula

② Overturning : Resultant force of external force has to be in 1/3 of horizontal section of dam body

③ Bearing capacity : Stress effects to rock surface and dam body does not exceed the allowable stress intensity.

Items and details to analyze are shown below;

(A) Stability against sliding

According to the Ministry of Construction, “Draft Technical Standard for River Erosion Control” document from Japan, stability against sliding is calculated by following equation that satisfy safety factor N by Henny’s equation.

$$N=\frac{\text{Resistant force against sliding}}{\text{Sliding force}}=\frac{f\cdot\Sigma V+\tau\cdot L}{\Sigma H}\geqq 4$$

where,

ΣV : Vertical load on dam base bottom (kN/m)

ΣH : Horizontal load on dam base bottom (kN/m)

f : Friction factor between dam bottom and bearing ground

As natural condition mentioned above, $f=\tan\phi_B=0.7$

ϕ_B : Friction angle between dam bottom and bearing ground(°)

τ : Shearing strength of rock mass(kN/m^2)

Coulomb’s equation is used since there is no result of examination

$\tau=C_B+\sigma\cdot\tan\phi_B$

C_B : Cohesion between dam bottom and bearing ground(kN/m^2)

As natural condition mentioned above, $C_B=196$(kN/m^2)

When there is no test result of Japan’s domestic stability calculation example, internal friction angle and cohesion are not considered at same time, thus,

$C_B=0$(kN/m^2)

σ : Normal stress acting to failure surface

Allowable bearing capacity as mentioned in natural condition is applied in this inspection

Normal $\sigma=588$(kN/m^2)

During earthquake $\sigma=882$(kN/m^2)

L : dam bottom width(m)

(B) Stability against overturning

Total of external force (= resultant force R) has to be in 1/3 of dam bottom width for stability condition against overturning. In addition, eccentric throw e from center of dam bottom of resultant force need to satisfy following equation.

Normal : $|e| \leqq B/6$

During earthquake : $|e| \leqq B/3$

Eccentric throw e from center of dam bottom of resultant force is calculated by following equation.

$$e = (L/2) - d$$

where,

d : Distance from point of application of resultant force R to around toe of dam bottom (m)

$$d = \frac{\Sigma M_r - \Sigma M_0}{\Sigma V} = \frac{\Sigma V_i \cdot a_i - \Sigma H_j \cdot b_i}{\Sigma V_i}$$

ΣM_r : Resisting moment around toe of dam base(kN・m)

ΣM_o : Overturning moment around toe of dam base(kN・m)

V_i : Vertical component of load acting to dam(kN/m)

a_i : Horizental distance from toe of dam base to point of application of V_i(m)

H_j : horizontal component of load acting to dam(kN/m)

b_j : Height of point application of H_j from dam base(m)

L : Bottom width of dam (m)(under this design)

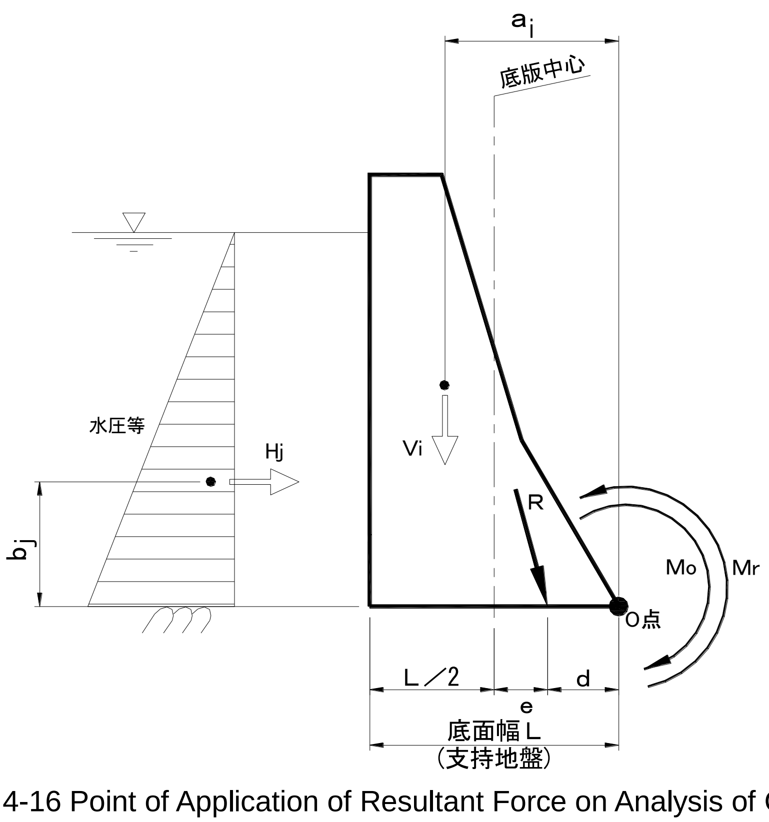


Figure 4-16 Point of Application of Resultant Force on Analysis of Overturning

(C) Stability against bearing capacity of foundation ground

According to “Road earth work ‘Retaining wall construction guideline’ ”, stability against bearing capacity of foundation ground is calculated by following equation that satisfy modulus of subgrade reaction q_1, q_2.

$$\left.\begin{array}{l} q_1 \\ q_2 \end{array}\right\} \leqq q_a$$

where,

q_a : Allowable bearing capacity of ground (kN/m^2)

In this design, as mentioned in「4) Natural condition (B) Foundation ground」,

Normal : 588 kN/m^2

During earthquake : 882 kN/m^2

Modulus of subgrade reaction q_1、q_2 are shown by following equations.

Case 1: Point of application is in 1/3 of width from bottom center

$$q_1 = \frac{\Sigma V}{L} \cdot \left(1 + \frac{6e}{L}\right)$$

$$q_2 = \frac{\Sigma V}{L} \cdot \left(1 - \frac{6e}{L}\right)$$

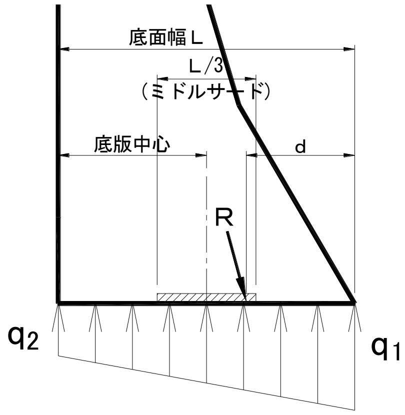


Figure 4-17 Modulus of Subgrade Reaction (Trapezoidal Distribution)

Case 2: Point of application is in 2/3 of width from bottom center
(point of application is out of 1/3 of width from bottom center)

$$q_1 = \frac{2\Sigma V}{3d}$$

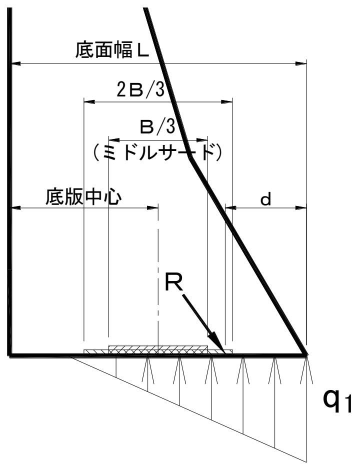


Figure 4-18 Modulus of Subgrade Reaction (Triangle Distribution)

7) Cases of study

As the loading condition as mentioned, cases of study and basic loading item are shown in Table 4-40.

Table 4-40 Cases of Study for Stability Calculation of Intake Weir (Tornauli)

<table>
<tr><td colspan="2" rowspan="2">Condition</td><td>Sedimentation</td><td colspan="2">No sedimentation</td><td colspan="2">Fully sedimentation</td><td rowspan="2">Remark</td></tr>
<tr><td>Water level</td><td>High water level (during earthquake)</td><td>Design flood level (Normal)</td><td>High water level (during earthquake)</td><td>Design flood level (Normal)</td></tr>
<tr><td rowspan="8">Primary load</td><td colspan="2">Dead load</td><td>○</td><td>○</td><td>○</td><td>○</td><td>—</td></tr>
<tr><td rowspan="2">Mud pressure</td><td>vertical</td><td>—</td><td>—</td><td>○</td><td>○</td><td>—</td></tr>
<tr><td>Horizontal</td><td>—</td><td>—</td><td>○</td><td>○</td><td>—</td></tr>
<tr><td colspan="2">Weight of water (upstream)</td><td>○</td><td>○</td><td>○</td><td>○</td><td>—</td></tr>
<tr><td rowspan="3">Static water pressure</td><td>Upstream</td><td>○</td><td>○</td><td>○</td><td>○</td><td>—</td></tr>
<tr><td>Downstream</td><td>—</td><td>—</td><td>—</td><td>—</td><td>Water level at downstream is 0</td></tr>
<tr><td>Uplift force</td><td>○</td><td>○</td><td>○</td><td>○</td><td>—</td></tr>
<tr><td colspan="2">Vertical load</td><td>—</td><td>—</td><td>—</td><td>—</td><td>Vertical load on Dam top is not considered.</td></tr>
<tr><td rowspan="3">Secondary load</td><td colspan="2">Seismic inertia force</td><td>○</td><td>—</td><td>○</td><td>—</td><td rowspan="3">Seismic force of horizontal direction is considered.</td></tr>
<tr><td colspan="2">Seismic dynamic water pressure</td><td>○</td><td>—</td><td>○</td><td>—</td></tr>
<tr><td colspan="2">Seismic dynamic earth pressure</td><td>○</td><td>—</td><td>○</td><td>—</td></tr>
</table>

(3) Results of stability calculation

Results of stability calculation of intake weir is shown in Table 4-41 and

Table4-42. The results completely satisfied stability condition under the conditions of the Survey. However, since expected value is partially used for physical property of ground, it is necessary to examine soil condition at the site and verify proper physical property again.

Table 4-41 Result of Stability Calculation of Intake Weir (Tornauli－No sedimentation)

Cross section				At top water level	At design flood level
				During earthquake	Normal
Overflow section	Active force	Vertical force	(kN)	902.070	901.613
		Horizontal force	(kN)	562.625	309.015
		Resisting moment	(kN·m)	3,476.107	3,474.983
		Overturning moment	(kN·m)	1,489.098	801.257
	Sliding	Safety factor		9.220	11.860
		Required safety factor		1.200	1.500
		Result		OK	OK
	Overturning	Eccentric throw	(m)	1.487	0.725
		Standard value	(m)	2.460	1.230
		Result		OK	OK
	Bearing capacity	Applied stress coefficient	(kN/m^2)	272.982	194.180
		Allowable bearing capacity	(kN/m^2)	882.000	588.000
		Result		OK	OK

Table4-42 Result of Stability Calculation of Intake Weir (Tornauli－Fully sedimentation)

Cross section				At top water level	At design flood level
				During earthquake	Normal
Overflow section	Active force	Vertical force	(kN)	968.132	967.675
		Horizontal force	(kN)	682.798	429.188
		Resisting moment	(kN·m)	3,912.264	3,911.140
		Overturning moment	(kN·m)	1,769.462	1,081.621
	Sliding	Safety factor		7.660	8.650
		Required safety factor		1.200	1.500
		Result		OK	OK
	Overturning	Eccentric throw	(m)	1.477	0.766
		Standard value	(m)	2.460	1.230
		Result		OK	OK
	Bearing capacity	Applied stress coefficient	(kN/m^2)	291.650	212.779
		Allowable bearing capacity	(kN/m^2)	882.000	588.000
		Result		OK	OK

4-2-4-2. Dust and waste filter

The dust and waste filter is installed to prevent wood from drifting and waste from running into the headrace. In the current design, installation of the dust and waste filter was not confirmed in the current design, thus it is highly recommended to re-examine the existence of the filter.

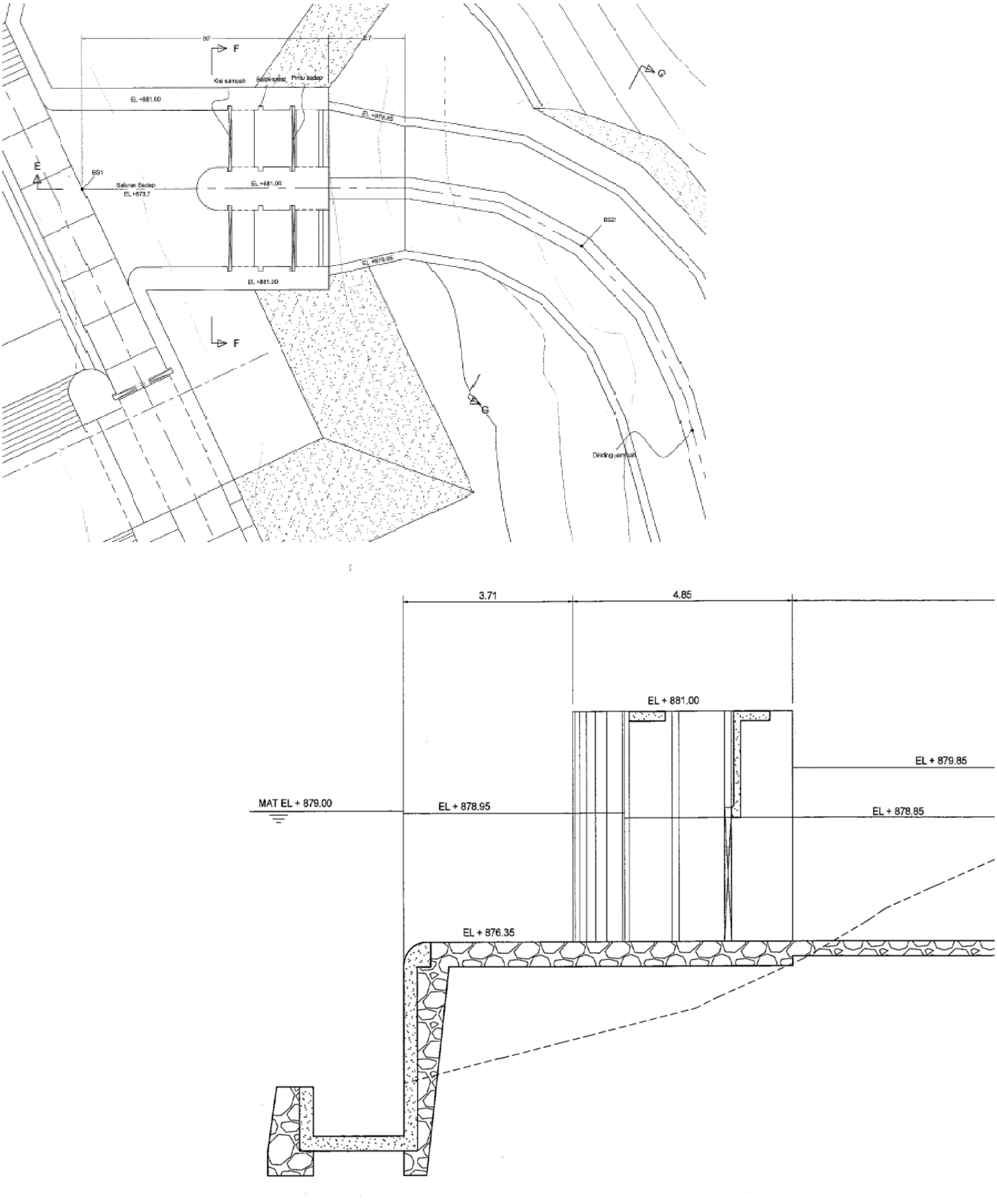


Figure 4-19 Ground Plan and Cross-Section of Intake

4-2-4-3. Headrace

Based on the design, it is necessary to redefine the structure of planned headrace and measure the possibility of water flow by hydraulic accounting.

(1) Elements of object headrace

According to the local design, the headrace length is 2.608 m with 0.04% sloping in the open channel, and there are three locations of overflow pipe (siphon pipe) on the whole headrace. The extended and enhanced ranges are shown in Table 4-43. In addition, the cross-section Figure of headrace is shown in Figure 4-20.

Table 4-43 Extended and Enhanced Points of Headrace

Name	Station point SP.m	Length of interval m	Slope of headrace		Starting point EL.m	Finish point EL.m
Starting point of headrace	115.60	1266.51	2544.51	0.0393%	875.230	874.730
Siphon 1	1382.11	170.89			874.730	874.149
	1553.00	251.86	2544.51	0.0393%	874.149	874.050
Siphon2	1804.86	99.14			874.050	873.791
	1904.00	408.10	2544.51	0.0393%	873.791	873.630
Siphon3	2312.10	106.30			873.630	873.350
	2418.40	305.51	2544.51	0.0393%	873.350	873.230
Starting point of water tank	2723.91				873.230	
Total		2608.31				

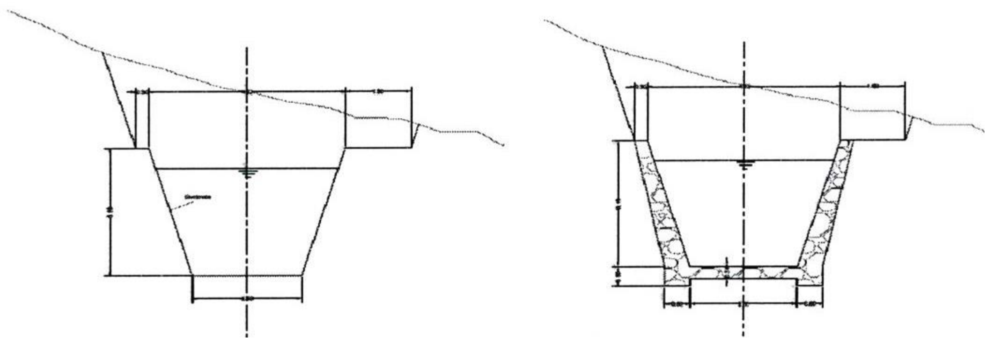


Figure 4-20 Section of Standard Headrace (drawings received in-site)

(2) Calculation of uniform flow

Manning equation is used to calculate the depth of uniform flow. As a result , the uniform flow depth is 2.70m for maximum water discharge of 11.5m^3/s, with the headrace height of 3.16m, attaining 85% depth (2.70m ÷ 3.16m). It is considered as appropriate possibility of water flow.

<Uniform flow depth is calculated by Manning equation>

$$AR^{2/3} = \frac{Qn}{\sqrt{I}} \quad \cdots \text{①}$$

uniform flow depth	$:h_o$		(m)
Plant discharge	$:Q$		(m^3/s)
Slope of headrace	$:I=$	0.00039	
Manning roughness coefficient	$:n=$	0.017	
Width of headrace	$:B=$	2.500	(m)
Slope of sidewall	$:m=$	0.330	
cross-sectional area	$:A=(B+mh)h$		(m^2)
wetted perimeter	$:S=B+2h\ (1+m^2)^{0.5}$		(m)
hydraulic radius	$:R=A/S$		(m)

Item	Flow $Q\ (m^3/s)$	Right side $Q \cdot n/I^{0.5}$	uniform flow depth $h_0\ (m)$	cross-sectional area $A\ (m^2)$	wetted perimeter $S\ (m)$	Hydraulic radius $R\ (m)$	Left side $AR^{2/3}$	Left side - right side
MAX	11.500	9.862	2.699	9.153	8.185	1.118	9.862	0.000
Regular	1.730	1.484	0.814	2.252	4.213	0.535	1.484	0.000

(3) Calculation of non-uniform flow

The standard sequence method is used to calculate the non-uniform flow, and then estimate the water surface profile of raceway. Basic equation for calculating the non-uniform flow is shown below (set of spring formula, equation 2.4). The following equation applies Manning equation and Bernoulli equation. This result is shown in Figure 4-21. For more detail on the calculation, please refer to the Appendix T4-1.

Water surface profile gradually reduces towards downstream, and it is 2.46m at the point of deeper water level of the raceway. As a result, the raceway is 3.16m high, and there is a redundant space of about 0.70m.

According to the results above, the possibility of the raceway flow is fully guaranteed. The depth of 2.07m at the end of raceway of tank level is used for calculation. It is lower by 0.63m compared to the depth of uniform flow. Thus, it is possible to heighten the installation location for the tank and lengthen the effective head (0.63m).

$$\left(\frac{\alpha_2 Q^2}{2gA_2^2}+h_2+z_2\right)-\left(\frac{\alpha_1 Q^2}{2gA_1^2}+h_1+z_1\right)=-\frac{1}{2}\left(\frac{Q^2}{K_1^2}+\frac{Q^2}{K_2^2}\right)(L_2-L_1)$$

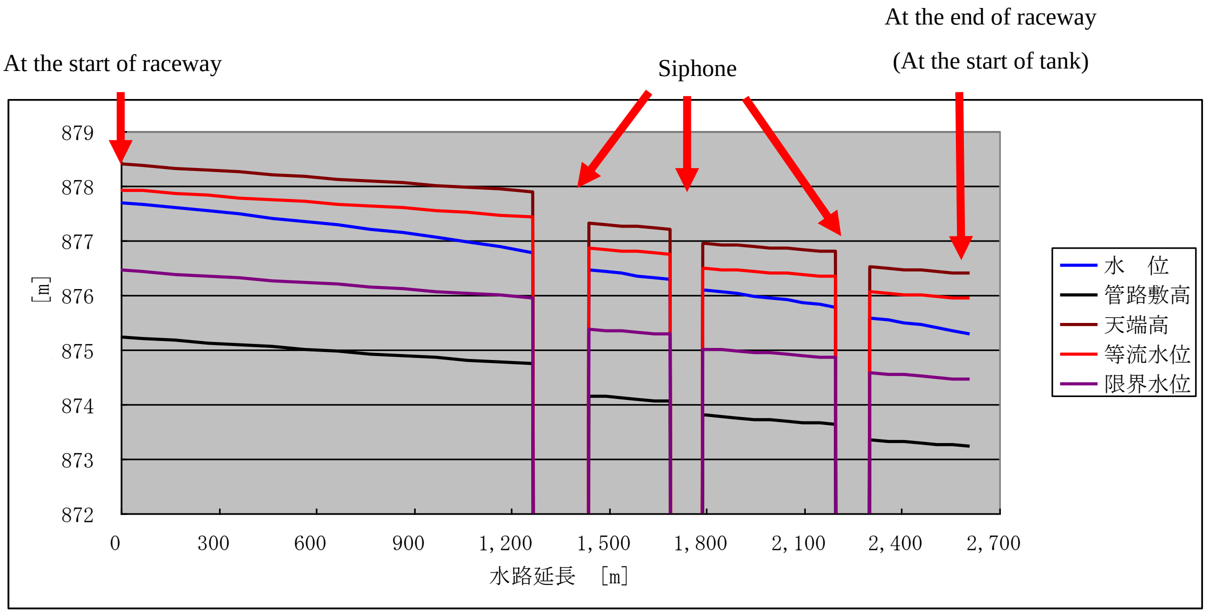


Figure 4-21 Standard Figure of Raceway (drawings received in-site)

(4) Case of 10MW

Using Japan's domestic method, the test result of scale determines the peak power of 10MW as the most economical generation capacity. This figure is used as a reference to determine the possibility of water flow with generation capacity of 10MW (maximum utilizable amount of water is 13.7m^3/s).

The depth of uniform flow is estimated by Manning equation. Uniform flow depth is 3.00m for maximum water of 13.7m^3/s, and attaining 95% of depth for raceway height of 3.16m, (3.00m ÷3.16m). Thus, the result does not show redundant space.

This result indicates that if the current condition remains, the assurance of water flow possibility will be difficult and need to expand the cross-section width or raise the raceway slope. The slope of this plan is I = 1/2,545, while Japan standard is I = 1/1,000.

<Depth of uniform flow is calculated by Manning equation>

$$AR^{2/3} = \frac{Qn}{\sqrt{I}} \quad \cdots ①$$

uniform flow depth	:h_o		(m)
Plant discharge	:Q		(m^3/s)
Slope of headrace	:I=	0.00039	
Manning roughness coefficient	:n=	0.017	
Width of headrace	:B=	2.500	(m)
Slope of sidewall	:m=	0.330	
cross-sectional area	:A=(B+mh)h		(m^2)
wetted perimeter	:$S=B+2h\,(1+m^2)^{0.5}$		(m)
hydraulic radius	:R=A/S		(m)

Item	Flow $Q(M^3/s)$	Right side $Q\,n/I^{0.5}$	Uniform flow $h_{o(m)}$	Cross section $A(m^2)$	Wetted perimeter $S_{(m)}$	Hydraulic radius $R_{(m)}$	Left side $AR^{2/3}$	Left side – right side
Max	13.720	11.765	3.004	10.488	8.827	1.188	11.765	0.000

4-2-4-4. Head tank

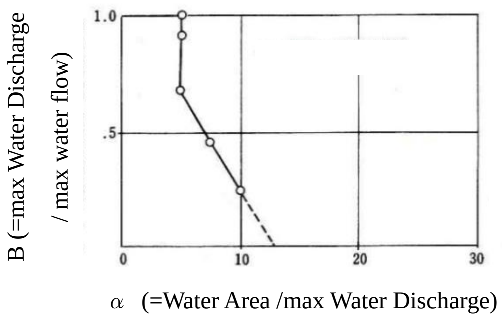
Head tank of the generating station usually used has the capacity equal to 2 ~ 3 volume of peak water discharge (120Qmax ~ 180Qmax), as a result, the structure has redundant hydraulically. Therefore, re-designing the head tank with appropriate capacity can help minimize the scale. It was referred to Japan's Small and medium hydro power guidebook (Legal entity Group) New Energy Foundation" to determine the necessary conditions suitable hydraulically.

The scale required for head tank should have the following elements:

- Water area that is enough not to cause hunting phenomenon to the water level regulator.
- Operating capacity is required for startup or periodical operation.
- "Capacity for confirming of water level down" and "capacity for emergency breaking" that have surplus to the water level for starting emergency stop when the level is lower than normal.

Regarding water area that is enough not to cause hunting phenomenon to the water level regulator, simulation test was implemented while considering hydraulic system of headrace and operation of hydraulic equipment. As a result, 5~10 Qmax of water area is required, and the biggest value 10Qmax of the water area was applied in this plan to confirm its appropriateness.
Accordingly, the required area of the tank (A) is 115.0m^2.

Required area A≧10Qmax
Required area A≧10x11.5= 115.0m^2
Where, Qmax: maximum water discharge = 11.5m^3/s



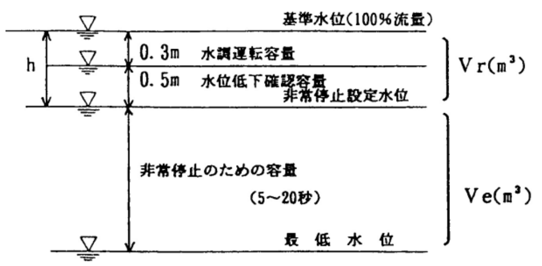
A = Water Area (m^2)
= α × (max Water Discharge)

Necessary capacity of the tank (V) is shown in the Figure below

- Operating capacity
- Capacity for confirming of water level down
- Capacity for emergency breaking

These factors show that it is necessary to ensure the capacity 11Qmax and necessary capacity of 126.5 m^3.

V≧ Vr+Ve
≧ 11Qmax ≧ 11×11.5＝126.5m^3



Head Tank Capacity
V = Vr + Ve
= 11Q or 7Q (m^3)

Condition of Head Tank Capacity

After considering design conditions of minimum water level and necessary conditions above, the tank size can be determined. In conjunction with the current design, the tank size is shown in Table 4-44.

Table 4-44 Tank Size Value by Current Design

Item	Unit	Current design	Remark
Effective length	m	27.00	Distance from finish point of flaring to slope
Width of water tank	m	10.50	
Water tank elevator	m	875.30	
Lowest elevator	m	874.30	Consider to the air-entraining admixture run to penstock and ensure that covering water depth is over 1D(D : inner diameter) 874.3m＞871.2m=Foundation height of slope 868.8m+1D : 2.4m
Effective hydraulic radius	m	1.00	Water level of water tank is 875.3m－lowest level 874.30m
Water surface area	m^2	283.50	＞10Qmax=115.00m^2
Effective storage capacity	m^3	283.50	＞11Qmax=126.50m^2

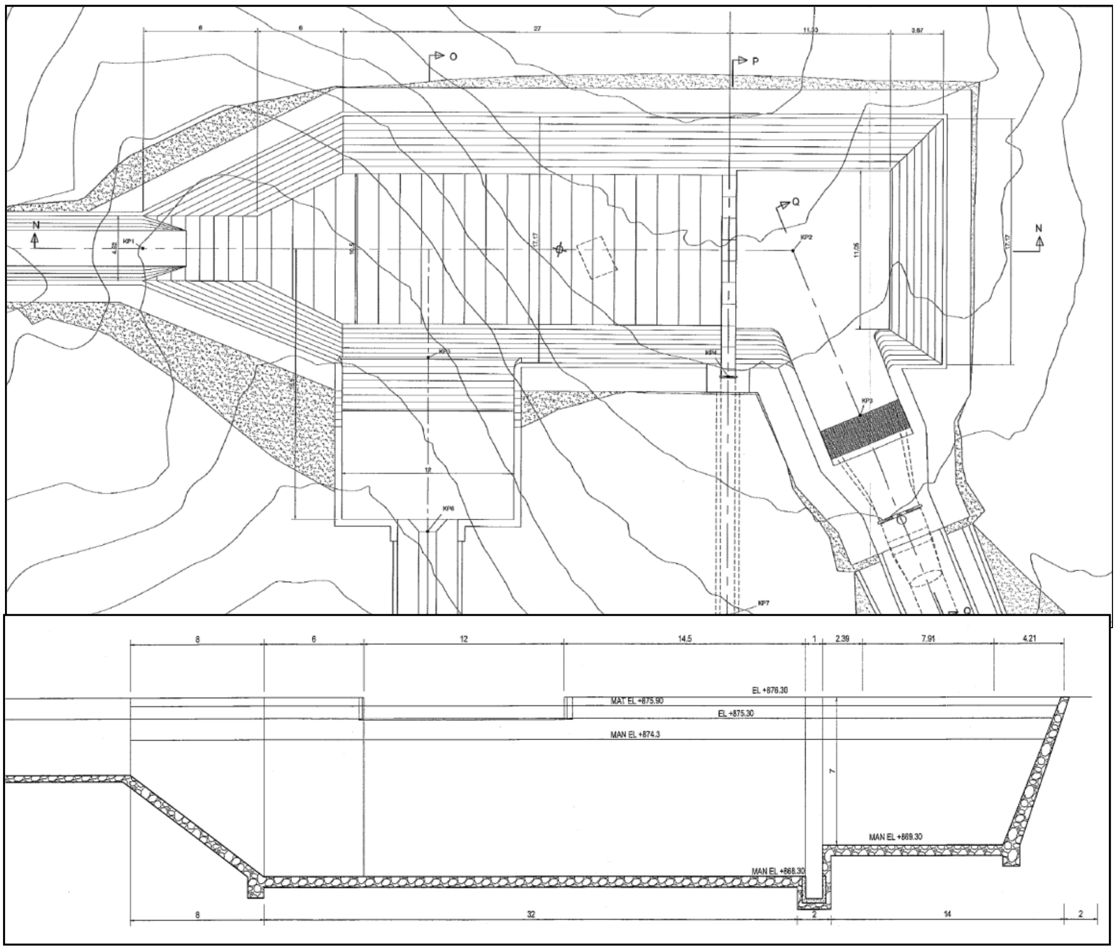


Figure 4-22 Tank Plan Design (upper figure) and Cross-Section Design (lower figure)

Source: local design

Based on above data, water area of the tank and the operating capacity is 28Qmax as calculated below. Thus, the capacity could downsize by 2 to 3 minutes of the maximum water discharge, and it is possible to ensure the required conditions with enough space.

① Water area = tank width x operating length =10.50×27.0=283.50m2（≒28.4Qmax）≧10Qmax

② Operating capacity = water area x tank depth = 283.50 × 1.00 = 283.50 m^3 (≒ 28.4Qmax) ≧ 11Qmax

4-2-4-5. Penstock

(1) Overview

1) Detail of inspection

Based on Japan's technical standard "Technical standard of iron pipe of manhole" by Association of Manhole Iron Pipe, it is necessary to determine the safety of penstock from local design using penstock pressure and structural calculation.

Calculation condition and result of calculation are shown below, and more detail of calculation is attached in the Appendix T4-3.

2) Planned route

Exposed penstock and concrete coated and embedded penstock are planned to use. Penstock is installed as single steel pipe with diameter ϕ2.4m along the natural ground about 640m, and it divides into 3 ways before powerhouse. Figure 4-23 is shown profile of penstock and Figure 4-24 is shown standard drawing.

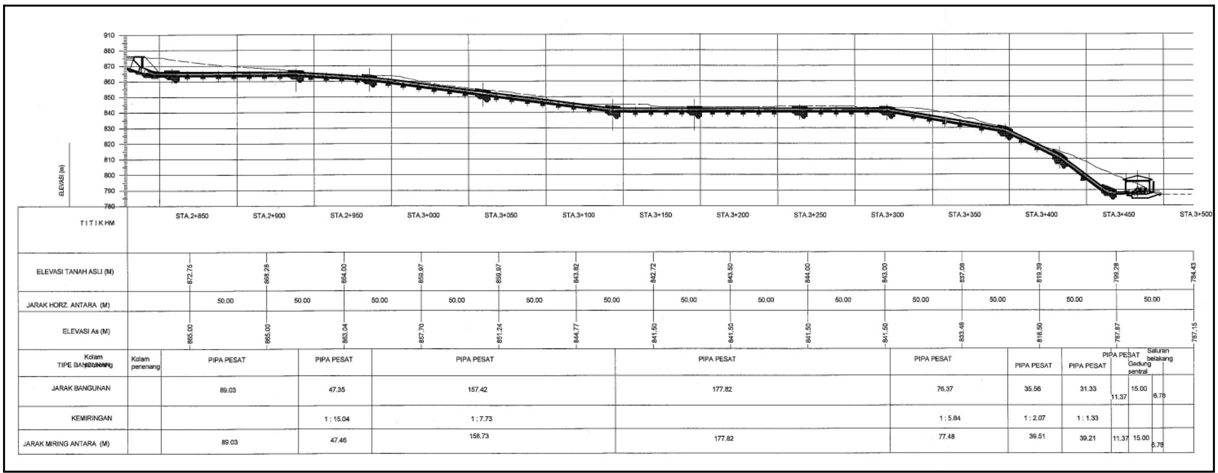


Figure 4-23 Profile of Penstock

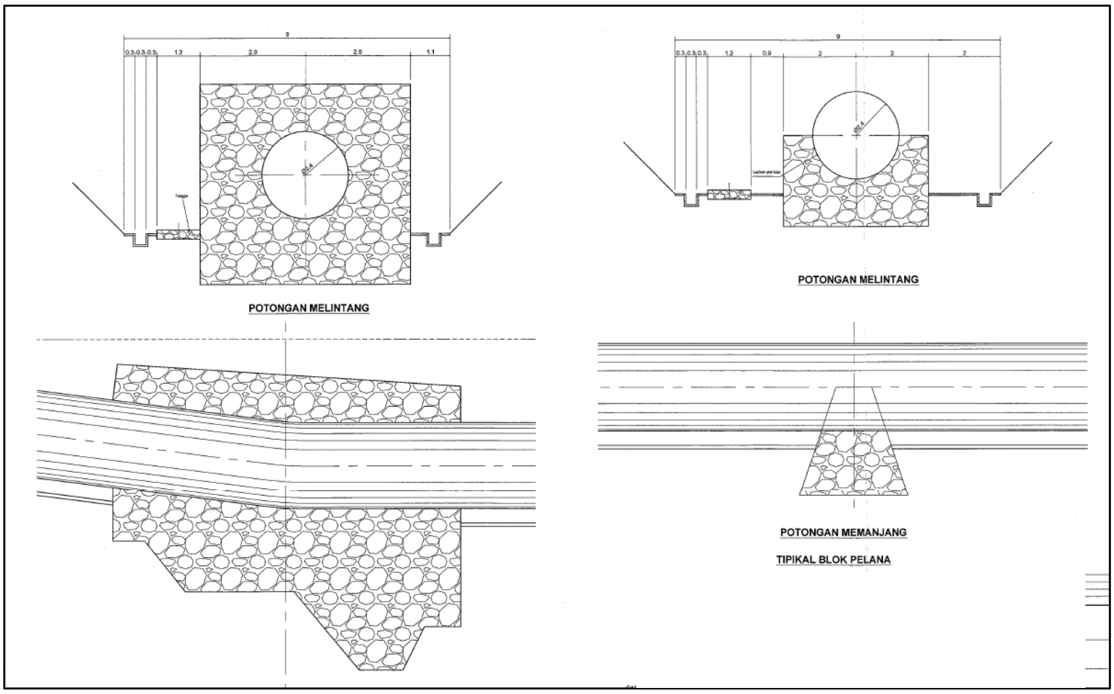


Figure 4-24 Standard Drawing of Penstock

(2) Detail of design

The calculation is besed on technical standard of hydraulic power generating installation and Japan hydraulic gate & penstock association.

Type	:	Exposed penstock and concrete revetted embedded penstock
Number of pipe	:	1 waterway
Inner diameter size	:	2.40～0.94m
Pipe thickness	:	14 mm
Pipe length	:	651.390 m (Curve length from start of penstock to center of inlet valve)
Maximum static head	:	87.660 m (Head from tar 875.3 m to center on inlet 787.64 m)
Maximum water hammer pressure head	:	47.000 m (Center of inlet valve)
Attack wave head	:	0.000 m
Maximum design head	:	144.660 m (Center of inlet valve)
Maximum discharge	:	11.50 m^3/s
Turbin closing time	:	4 sec
Corrosion allowance	:	1.5 mm
Safety factor against external pressure	:	1.5 over
Temperature change	:	20 ℃
Type of material Allowble stress	:	see table below

Material	Thickness (mm)	Tensile stress (N/mm^2)	Compressive stress (N/mm^2)	Shearing stress (N/mm^2)	Bearing stress (N/mm^2)
ISO E275 A-D	t ≦16	150	150	85	255
	16＜ t ≦40	145	145	80	245
	40＜ t ≦63	140	140	80	235

Elastic modules of steel	:	206 kN/mm^2
Linear expansion coefficient of steel	:	1.2×10^{-5} /℃
Poisson's ratio of steel	:	0.3
Weld efficiency	:	Plant 0.85 Site 0.80

(3) Result of analysis

Stress analysis results of penstock are shown in Table4-45. The results show that 14mm of pipe wall thickness for current plan is not appropriate in some sections at downstream.

Table4-45 Stress Analysis Result of Penstock（Tornauli）

No.	Inner diameter	Pipe thickness	Pipe length	Pipe wall thickness			Inner pressure		
				Design head	Allowable head	Result	Circumferential stress	Allowable stress	Result
	D_0	t_0	Ln	H	Ha		σ 1	η・σ a	
	(mm)	(mm)	(m)	(m)	(m)		(N/mm^2)	(N/mm^2)	
①-1	2400	14	150.000	28.33	127.47	OK	26.70	120.00	OK
①-2	2400	14	145.220	59.64	127.47	OK	56.20	120.00	OK
①-3	2400	14	177.820	75.20	127.47	OK	70.80	120.00	OK
①-4	2400	14	116.990	115.70	127.47	OK	108.90	120.00	OK
①-5	2400	14	50.580	143.72	127.47	NG★	135.30	120.00	NG★
②	1680	14	9.380	144.54	182.05	OK	95.20	120.00	OK
③	1163	14	1.400	144.66	262.88	OK	66.00	120.00	OK
④	940	14	0.000	144.66	325.14	OK	53.30	120.00	OK

No.	Inner diameter	Pipe thickness	Pipe length	Axial stress			
				Equivalent stress		Allowable stress	Result
	D_0	t_0	Ln	σ eq	σ eq’	σ a	
	(mm)	(mm)	(m)	(N/mm^2)	(N/mm^2)	(N/mm^2)	
①-1	2400	14	150.000	49.30	60.37	120	OK
①-2	2400	14	145.220	70.10	68.92	120	OK
①-3	2400	14	177.820	81.20	76.64	120	OK
①-4	2400	14	116.990	113.40	101.05	120	OK
①-5	2400	14	50.580	136.70	120.67	120	NG★
②	1680	14	9.380	103.10	90.42	120	OK
③	1163	14	1.400	81.10	70.64	120	OK
④	940	14	0.000	72.60	63.04	120	OK

(4) Suggestion for improvement

Stress analysis results show that pipe wall thickness is not appropriate at downstream. In addition, it is possible to make pipe wall thickness smaller at upstream of pipe as the stress is smaller. Table 4-46 shows suggestion for improvement of penstock wall thickness. Details of calculation are attached in Appendix T4-4.

Table 4-46 Suggestion for Improvement of Penstock Wall Thickness (Tornauli)

No.	Inner diameter	Pipe thickness	Pipe length	Pipe wall thickness			Inner pressure		
				Design head	Allowable head	Result	Circumferential stress	Allowable stress	Result
	D_0	t_0	Ln	H	Ha		σ 1	η・σa	
	(mm)	(mm)	(m)	(m)	(m)		(N/mm^2)	(N/mm^2)	
①-1	2400	8	150.000	29.25	66.29	OK	53.00	120.00	OK
①-2	2400	8	145.220	61.46	66.29	OK	111.30	120.00	OK
①-3	2400	10	177.820	78.11	86.68	OK	108.10	120.00	OK
①-4	2400	16	116.990	119.32	147.87	OK	96.80	120.00	OK
①-5	2400	18	50.580	147.65	168.26	OK	105.30	120.00	OK
②	1680	18	9.380	148.53	240.31	OK	74.10	120.00	OK
③	1163	18	1.400	148.66	347.00	OK	51.30	120.00	OK
④	940	18	0.000	148.66	429.19	OK	41.50	120.00	OK

No.	Inner diameter	Pipe thickness	Pi;e length	Axial stress			
				Equivalent stress		Allowable stress	Result
	D_0	t_0	Ln	σ eq	σ eq'	σ a	
	(mm)	(mm)	(m)	(N/mm^2)	(N/mm^2)	(N/mm^2)	
①-1	2400	8	150.000	60.80	75.50	120	OK
①-2	2400	8	145.220	110.20	107.02	120	OK
①-3	2400	10	177.820	109.40	103.02	120	OK
①-4	2400	16	116.990	104.00	91.90	120	OK
①-5	2400	18	50.580	112.30	97.16	120	OK
②	1680	18	9.380	87.10	75.67	120	OK
③	1163	18	1.400	70.80	62.41	120	OK
④	940	18	0.000	64.80	57.65	120	OK

4-2-4-6. Generator – Turbine

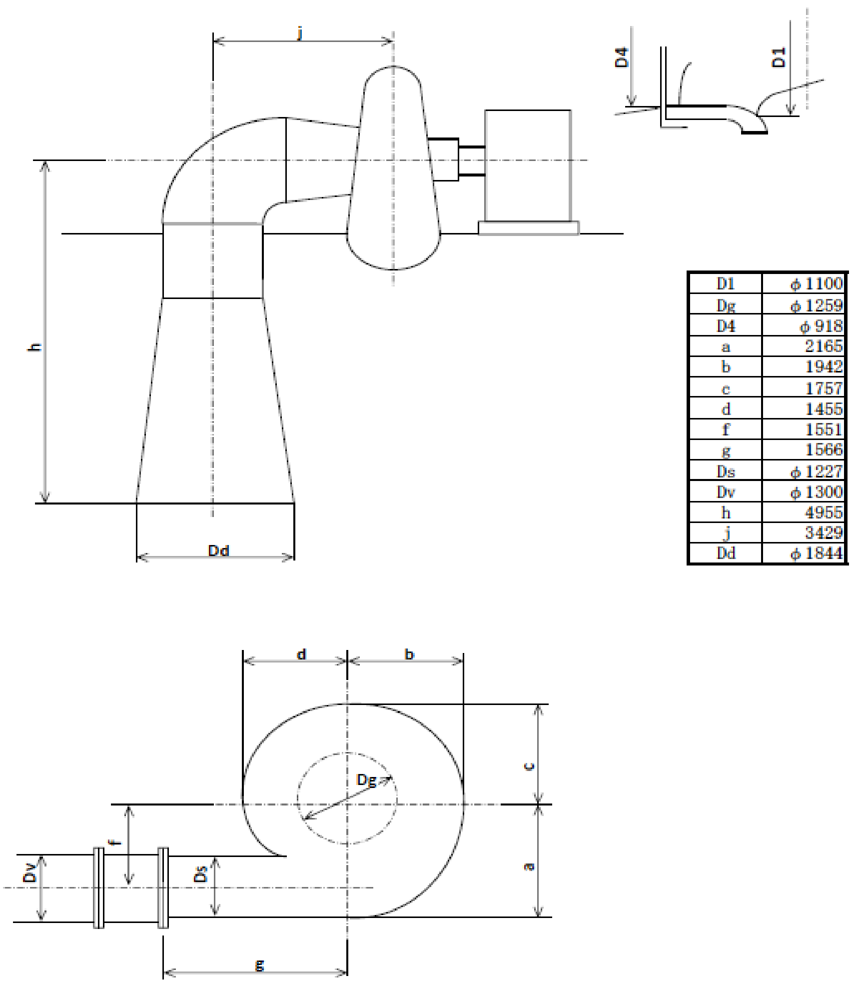
(1) Consideration on layout

In the current design, the flow runs into iron pipe of turbine at the right angle, thus, there will be large wastage in generation. In addition, if it is required to maintain, there is no space to take out rotor blades to horizontal direction in the current design, so it is necessary to move the rotor and stator together.

To solve this problem, Figure 4-25 provides the scheme of modified layout of turbine. If changing in this way, the flow and iron pipe of turbine will be in the same direction, and it is possible to reduce losses. In addition, it will be easy to maintain the equipment by ensuring space for rotor rotation.

(2) Suction head of turbine

When changing the layout of turbine as mentioned above, it is possible to shorten the distance between the turbine central height and turbine inlet iron pipe height. The size of the turbine after changing is represented in the Figure 4-26. This allows the central height of iron pipe to rise to EL.788.899 and minimize the volume of excavation for the iron pipe installation.



D1	ϕ 1100
Dg	ϕ 1259
D4	ϕ 918
a	2165
b	1942
c	1757
d	1455
f	1551
g	1566
Ds	ϕ 1227
Dv	ϕ 1300
h	4955
j	3429
Dd	ϕ 1844

Figure 4-25 Dimension of Water Turbine After Modification

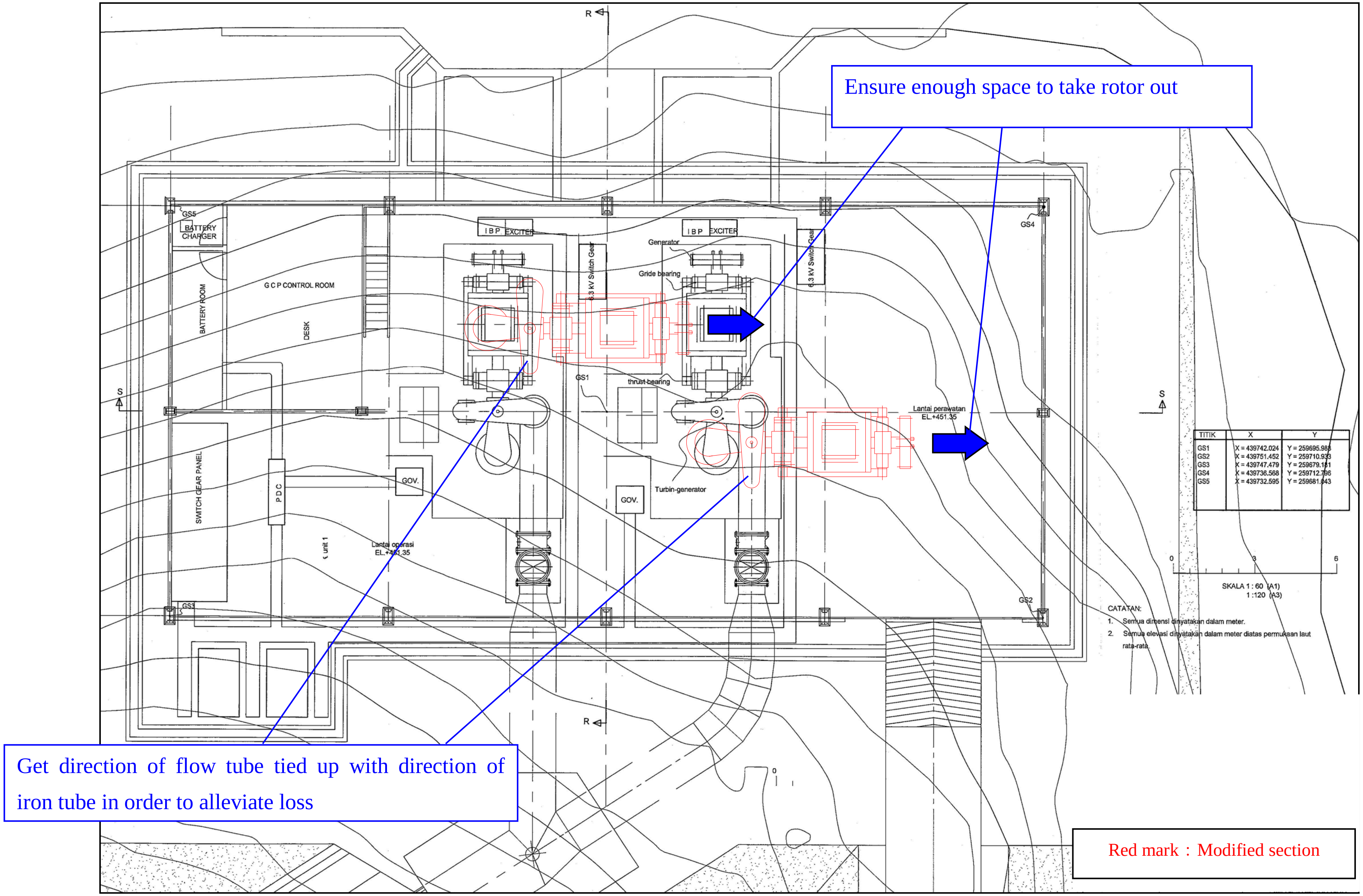


Figure 4-26 Modified Layout of Turbine (As supplied by Local Company)

4-2-4-7. Powerhouse

Flood level in the design is 795.17m, and the current policy is to build the flood wall. It is highly recommended to fully inspect to find the appropriate solution to prevent the generating station from flooding.

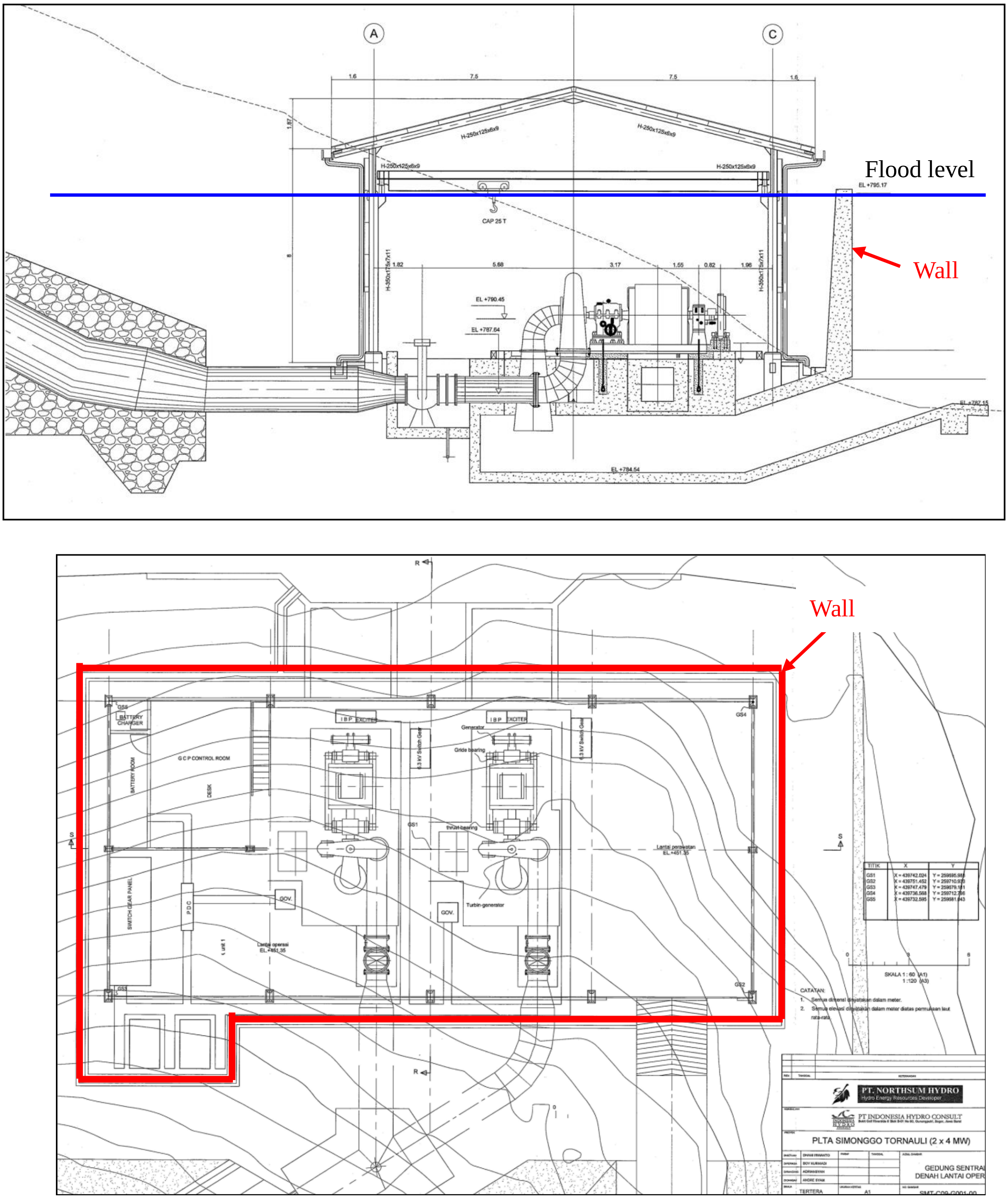


Figure 4-27 Vertical Section of Generating Station (upper figure) - the Plan Design (lower figure)

4-2-5. Discussion of domestic technique and possible implementation of specific know-how

4-2-5-1. Supply of generating equipment and tools by Japanese enterprises

It is necessary to conduct tests on the products and technique of Japanese companies that can be supplied to the local projects.

(1) Compound auxiliary engine

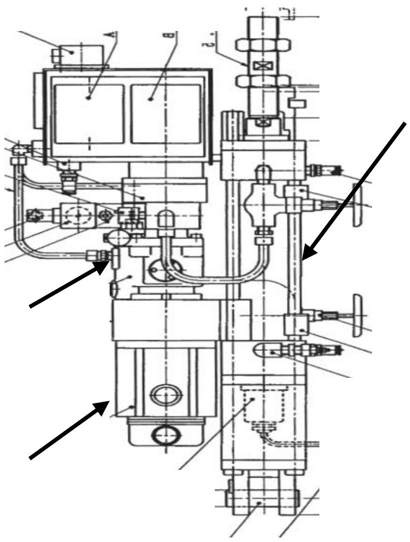
So far, oil pressure have been used for the operation of turbine's guide vane, however electric auxiliary engine was used in Japan to find environmental-friendly solutions to avoid oil spills in the power plant. However, electric auxiliary engine has problems in maintenance of spindle damage or the replacement of regular lubricants. These problems are solved by using compound auxiliary engine combining the strengths of operation by oil pressure and electricity. This method is already applied for turbines with capacity of 10MW, and this technique is fully capable of application in accordance with this station.

The characteristics of this system are listed below.

- It is a uniform and simple device, so it is easy to install with the existing equipment. There is also no additional pipe.
- With a compact design using oil pressure 10Mpa, it minimizes the installation space.
- Because it requires a small amount of oil during operation, it is easy to maintain.

Below is an example of installation of Francis horizontal shaft turbine with the same size and general structure.

<General Structure>



<Example of Application>

Figure 4-28 Compound Auxiliary Engine

(2) Integrated control panel

So far, the device is always composed of many separate control panels such as the main panel, engine speed governor, AVR[28] to improve the performance of PLC[29], the number of control panels is reduced by putting all these features together into a single PLC in Japan. This technique can fully apply to the generating station of the project.

The characteristics of this system are listed below.

- Reducing the number of control panels
- Reducing the cost of installing cable systems by decreasing the number of cables

Here is the design of integrated control panel.

Figure4-29 Design of Integrated Control Panel

28 AVR (Automatic Voltage Regulator)：Automatic Voltage Regulator

29 PLC (Programmable Logic Controller)：Programmable logic controller for the change of relay revolution

4-2-5-2. Research related to efficiency and sophistication of operation and maintenance

(1) Background

Hydro power plants in Japan except the special generating stations are not managed by people. With regard to maintenance of power plant, a large-scale maintenance system which manages several power plants by responsible offices being is in operation. Besides, in recent years, based on data that are continuously stored by machines automatically, we perform effective operating maintenance such as prompt recovery in case of problems, as well as measured life extension and large-scale dismantling and checking cycle of equipment relying on aging diagnosis, etc.

On the other hand, in Indonesia, almost all hydro power plants have maintenance personnel and operators. For equipment maintenance, the replacement timing and maintenance period are judged mainly based on the period after installation. In comparison with the planned maintenance scheme by analyzing the machine conditions, those tasks such as overhauling, checking and repairing hydraulic generator machinery is being done in a shorter cycle in Indonesia

(2) Component of remote monitoring system

Based on the system that is being used by HEPCO, chart below shows the recommended demonstration system and establishment of positive system.

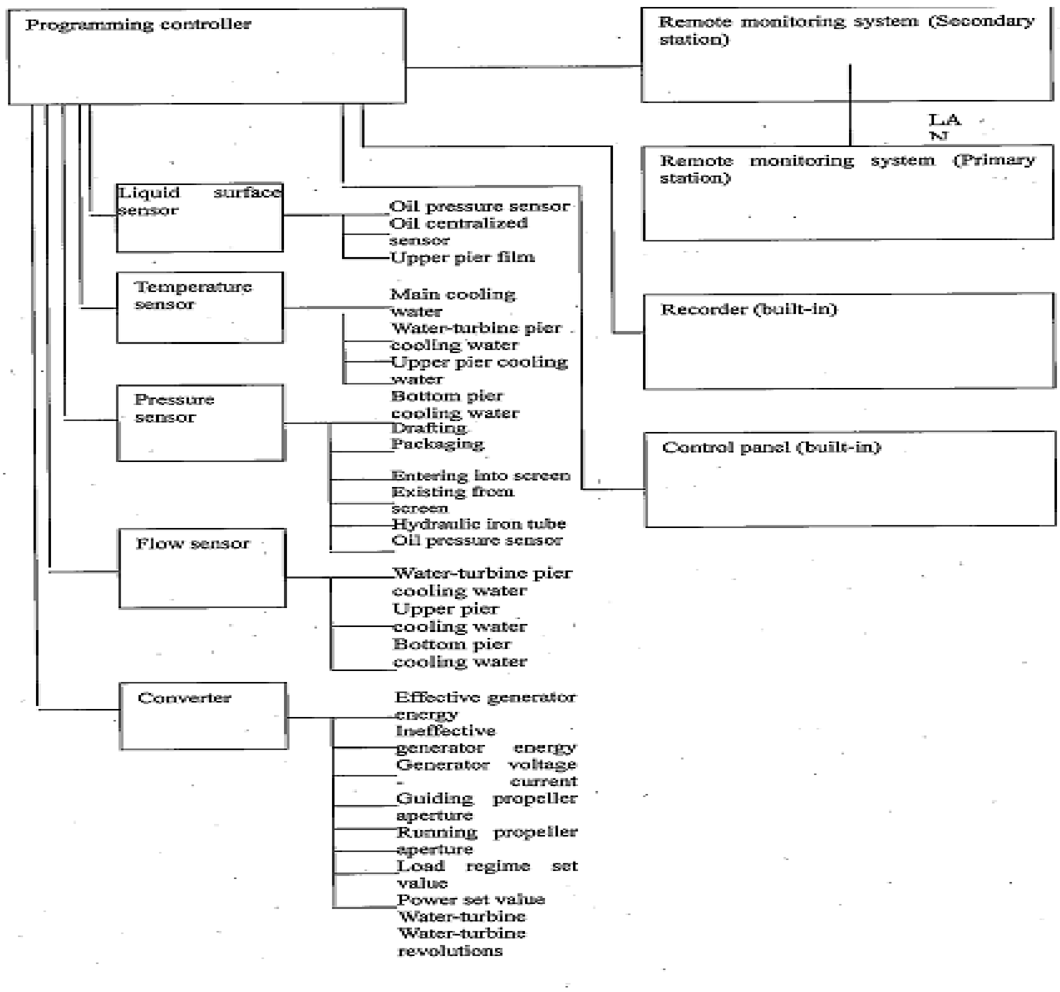


Figure 4-30 Components of Remote Monitoring System

(3) Analysis of maintenance data

In designing a large-scale maintenance structure, it is necessary to confirm the current maintenance structure, and operating and maintenance standards in detail. In order to discuss the expected results by implementing the maintenance structure, necessary information and expected results are indicated below.

1) Maintenance standard

It is possible to study the frequency of walk-around check (visual check), periodical and overhauling maintenance, to simplify the work by data maintenance done by the system, and to extend the replacement period.

2) Update cycle of machinery

Update frequency of slider and power controller can be managed and analyzed based on data received from the system. Therefore, the timing of the machinery update can be optimized.

3) Cycle of periodical inspection and inspection for over hauling

Based on the implementation of maintenance process below, the efficiency of maintenance can be improved.

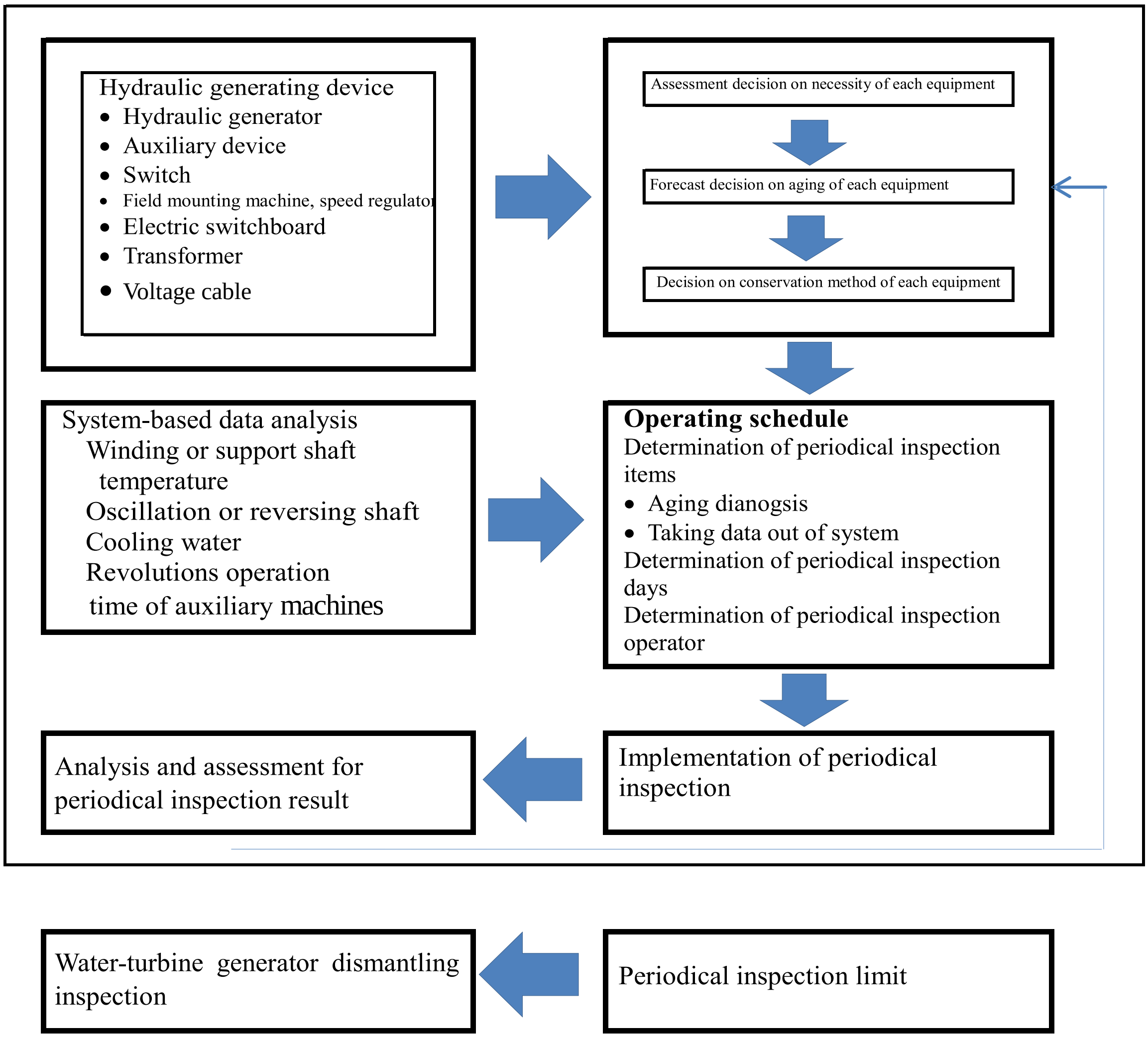


Figure 4-31 Flow of Maintenance

(4) Implementation of a large-scale maintenance structure in a newly operating hydro power plant

By developing small hydro power plants with the assumption that the wide area maintenance structure is in place, it is possible to effectively place the people for maintenance work and perform advanced maintenance duties. In case of developing multiple hydro power plants in the same water system, it is possible to construct a wide area maintenance system and perform consistent maintenance work in the same water system by establishing a base powerhouse to undertake comprehensive maintenance work and by constructing the communication line and setting up the remote monitoring system at the time of power plant design.

Small hydro power development is the field that business characteristics are generally low and, private investment is also slow. However, by improving the long term efficiency of the operation and maintenance after the completion of the construction in advance, it is possible to encourage the development. Particularly, in the case of small hydro power development by financing in loans in JPY, it is considered useful to offer not only the financial support toward designing, procurement and construction, but also the support for implementing a remote monitoring system for a wide area maintenance structure, and technical support for data analysis to the concerned countries.

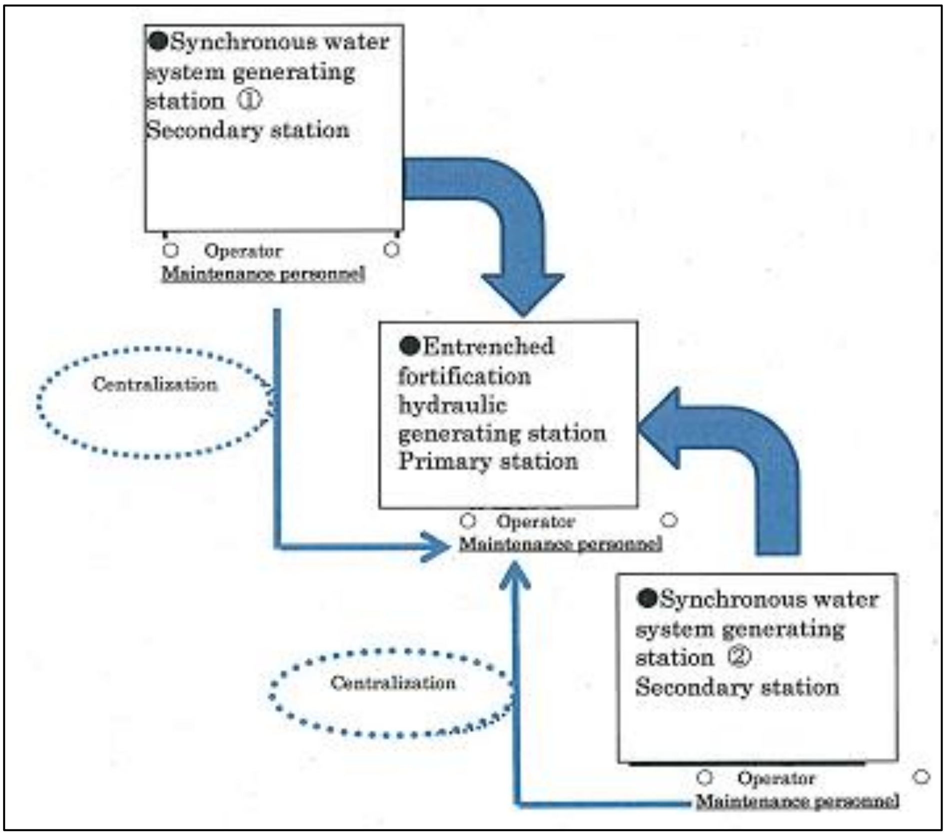


Figure4-32 Image of Wide Area Maintenance System

(5) Expected results

1) Direct effects

(A) The results of construction of effective maintenance system

- Effectively maintaining and operating the power plants with a smaller number of employees.
- Eliminating the lack of manpower for maintenance of power plants in case there are more hydro powerhouses developed in a rapid pace.
- Establishing the maintenance systems in mountainous regions and local area where there is difficulty in ensuring human resources.

(B) The results of the implementation of preventive maintenance while understanding the exact status of equipment

- Optimization by periodic checking, overhauling checking and changing the spare parts
- Reducing operating costs of power plants
- Stable operating of the power plants in the long term

2) Indirect effects

- Increased available power generation by improving the utilization and performance of hydro powerhouses
- Encouraging the development of small hydro powerhouses
- Expanding the opportunity to join the projects in the field of IT by Japanese companies
- Providing added values
- Expanding the predominance by providing a total system capable of minimizing operating costs and ensuring stable operation of power plants in the long run.

4-2-6. Construction schedule

A construction schedule is a comprehensive implementation plan including labor, materials, machinery, engines, water supply devices, building and transportation during the construction period in order to complete the project with required standards in an economic manner without prejudice to the safety and environment. In this section, the construction planning method and important notes implemented in Japan and all the processes in this project will be discussed.

4-2-6-1. Issues in the construction schedule

(1) Construction volume and period

Construction volume is shown by the formula below. When the construction period is defined, the construction volume for a year is determined by minimizing variation of construction volume.
In addition, from meteorological and operating conditions, a number of construction months for a year and construction days for a month will be determined.

- (Construction volume) = (Construction volume unit) x (Construction period)
- (Construction volume per day) = (Construction volume per hour) x (Construction period per day)

Construction volume in an hour and construction time in a day mainly change according to the features of machines, on-site construction condition, rate of operation, shift assignment, and other factors. Notes on the establishment are presented in Table 4-47.

Table 4-47 Notes Regarding the Establishment of Construction Volume and Period

Construction machines	Studying researching machines, their capacity and the condition of site construction, then come up with the best combination.
Rate of operation	It is represented by the rate over total practical working time of actual operating period; however, due to irrationalness of operation steps, machine adjustment is incomplete, and due to operational fault of the operator, the working rate can be reduced. Therefore, it is necessary to manage carefully.
Construction period in day	It is determined by the operating shift of the staff. The working hour is determined by setting up 1, 2 or 3 shifts in a day.

(2) Construction method and project cost

The project cost is divided into a variable cost depending on construction volume and a fixed cost being equivalent to the construction period. Because variable and fixed costs change according to the project scale, construction method and machine capacity, these costs are important in the first cost analysis of the project and construction method selection.

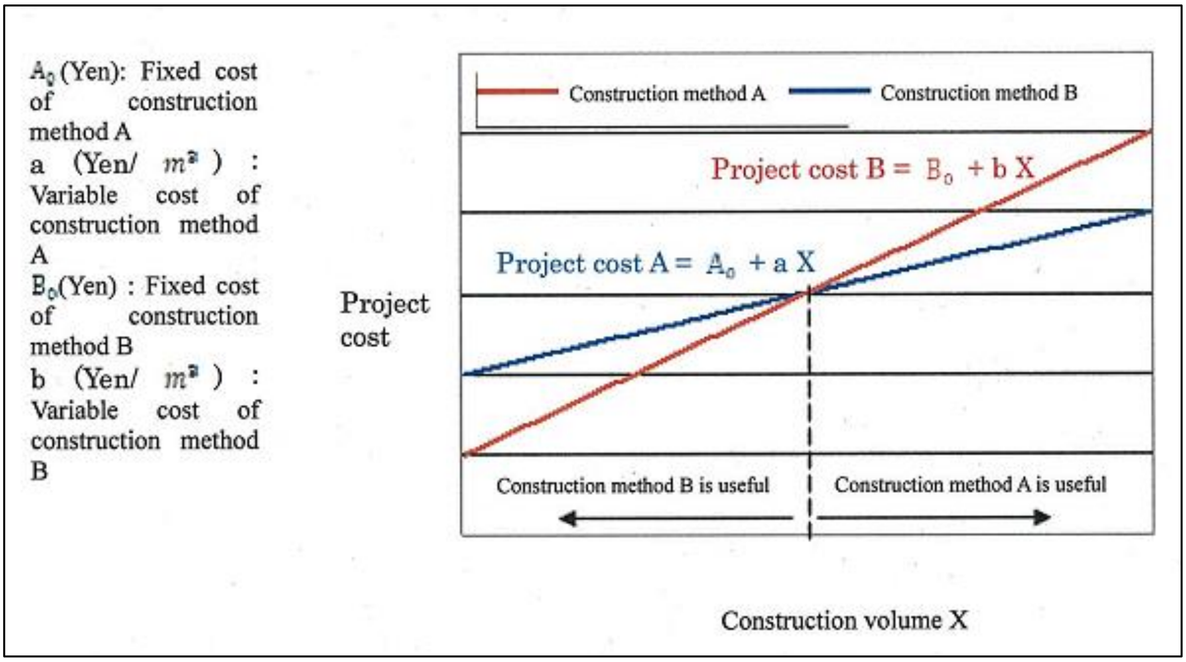


Figure 4-33 Comparison of Construction Methods A & B

4-2-6-2. Issues in planning for the construction method

(1) Balance between the economic speed and project content

Since the total cost of building a powerhouse incurs relatively large interest payments, if the construction period is shorter interest payments and costs such as administrative cost and other costs become less and economical. However, there is a limitation in shortening the construction period. In order to make the construction period shorter by exceeding such limitation, it is necessary to invest a large amount of money in temporary equipment and construction machinery. Moreover, with the extra labor costs, it will bring the total project cost higher.

Among powerhouse projects, there are some other constructions which require a longer construction period such as the construction of dams and large tunnels. These construction periods can have significant impacts on the period for the construction of a powerhouse. In such a case, the stages of constructions should be first studied economically, then the attention should be paid to balance between each project and the comprehensive project plan should be created. (Comparison of project stages, Table 4-48 and Figure 4-34)

Table 4-48 Comparison of Project Stages

Plan 1	・Considering each stage of work independently and arranging to have the same completion time in a most economical way. ・Because a large portion of total quantity of the project work concentrates at the end of project period, it looks as if it is a most economical way from the aspect of interest payment. However, the peak of some stages of work is duplicated; therefore, it is expected to have large work volume of work during certain periods. ・Therefore, to accommodate such large volume of work, required lodging for workers, collecting, transportation, other temporary facilities and machinery is expected to be increase accordingly, thus losing economy.
Plan 2	・By moving the operation period of work of the tunnel, it can reduce the maximum total workload significantly and becomes more economical than plan 1.
Plan 3	・Squeezing the work period of dam A which requires the maximum period and adjusting the work stage of dam B and tunnel along the work of dam A, it balances and streamlines the temporary facilities and usage of machines.
Plan 4	・Taking a comprehensive view over 3 stages of work and without thinking of the completion stage of dam A, by extending total work period, the total economic benefits can be obtained.

Source: Medium and small hydroelectric power manual

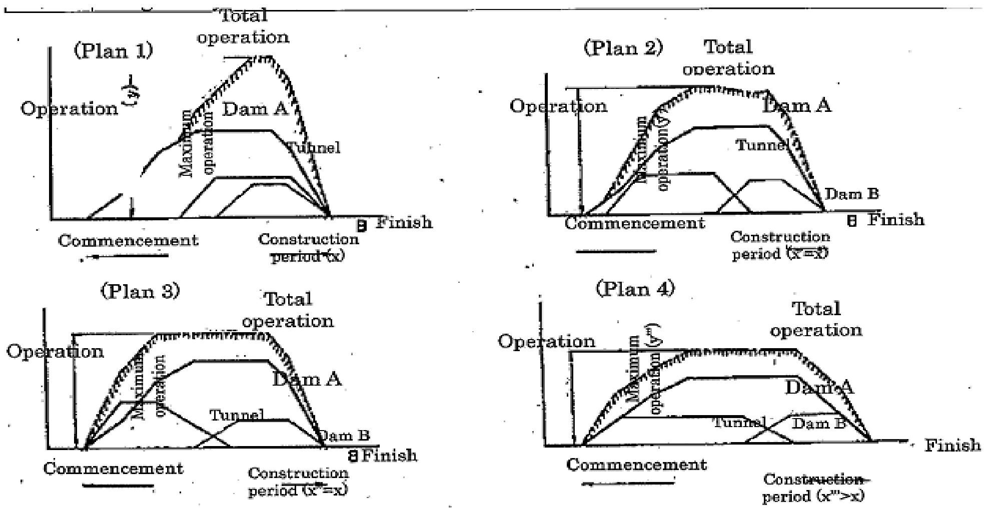


Figure 4-34 Comparison of a Construction Process

(2) Scale of project equipment

In order to execute the project, it is necessary to have a large number of equipment and machines. Under the consideration of the balance between those equipment and machines, the work stages should be determined. .

In general, if the construction facility is expanded, it is possible to shorten the project period. However, if it exceeds a certain level, even though the construction facility is expanded, it is impossible to shorten the period. On the other hand, the economy of such work stages will increase, in other words the cost is reduced, as the construction facility is expanded. After a certain limitation, it will decrease, in other words the cost is increased. This limitation can be seen at a relatively smaller construction facility for work stages of smaller scale, and can be observed at a relatively large construction facility for work stages of larger scale.

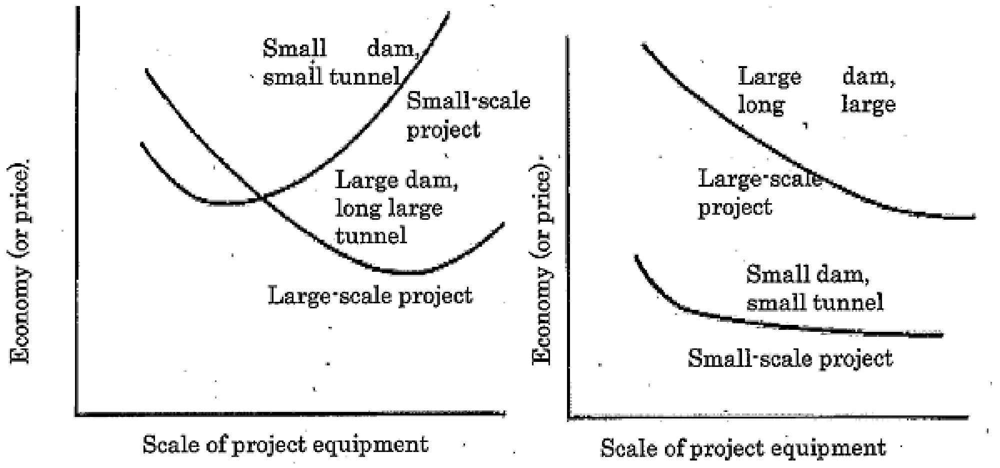


Figure 4-35 Scale of Equipment, Economic Potential and Work Period

Source: Guide book for small hydro power project

(3) Hydrometer logical conditions – Time of the start of the construction work and construction period

Hydrometer logical conditions such as temperature, the amount of rain, heavy snow and flood and others have a great influence on project stages. Therefore, it is necessary to select the most suitable time for the start of the construction work.

(4) Distribution of operation volume

It is necessary to consider monthly salary, a number of workers, quantity of materials and main construction machines for each stage in the project. If there is any imbalance between them, it is necessary to review and the new plan should be put in place.

(5) Extra margin for each stage

Together with the construction process, there are sometimes unexpected incidents in work stages, such as a large quantity of springs in tunnels, abnormal flood of a river, and some others. In such cases, if they are serious matters, it is necessary to review the entire stages of work; however, it is recommended that the planning of work stage is designed in a way to absorb such incidents and to be able to cope with the fluctuation of work volume. In establishing extra margin for the work stages, the past experiences and achievement can be a good indication as they vary depending on the project condition, types of work and the degree of research.

4-2-6-3. Entire stages of construction (Tornauli)

The major processes of the power plant project at Tornauli are the construction of the roads, intake weir, raceway, penstock, and power house. Each process will have its own construction stage, and it is necessary to create a plan for each stage and an entire project plan by considering the total balance of overall stages. The estimated stages of the entire construction work of the power plant are shown in Table 4-49.

Table 4-49 Progress of Entire Process of Construction

No	Structure object \ Number of months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Ⅰ	**Preparatory Works and Mobilization**																						
Ⅱ	**Civil Works Construction**	■	■	■																			
1	Access Roads			■	■	■	■																
2	Weir				■	■	■	■	■	■	■	■	■	■									
3	Intake				■	■	■	■															
4	Sand Trap and Flow Measuring Device																						
5	Headrace Channel				■	■	■	■	■	■	■	■	■	■	■	■							
6	Syphons and Culverts				■	■	■	■															
7	Headpond							■	■	■	■	■	■										
8	Penstock Foundations						■	■	■	■	■	■	■	■	■	■							
9	Powerhouse							■	■	■	■	■	■	■	■	■	■	■	■	■			
10	Transmission Line Poles														■	■	■	■					
Ⅲ	**Fabrication**																						
1	Penstock				■	■	■	■	■	■	■	■	■	■	■	■	■						
2	Gates and Trash Racks						■	■	■	■	■	■											
Ⅳ	**Procurement**																						
1	Hydro Mechanical Equipment				■	■	■	■	■	■	■	■											
2	Mechanical Balance or Plant							■	■	■	■	■	■	■	■	■							
3	Electrical Balance of Plant											■	■	■	■	■							
4	Transmission Line							■	■	■	■												
Ⅴ	**Installation**																						
1	Penstock								■	■	■	■	■	■	■	■	■	■					
2	Gates and Trash Racks													■	■	■	■						
3	Hydro Mechanical Equipment Unit1														■	■	■						
4	Hydro Mechanical Equipment Unit2																■	■	■				
5	Mechanical Balance or Plant													■	■	■	■	■	■	■	■		
6	Electrical Balance of Plant																■	■	■	■	■		
7	Transmission Line															■	■	■	■	■			
Ⅵ	**Commissioning**																						
1	Transmission Line																			■	■	■	
2	Unit1																			■	■		
3	Unit2																				■	■	
Ⅶ	**Commercial Operation**																						
1	Unit1																				■		
2	Unit2																					■	

4-2-7. Summary – Issues

4-2-7-1. Summary – Issues

Primary results, issues and improvement measures of this survey are presenting here and shown in Table 4-50.

(1) Discussion on the planning of electric power generation

1) Primary results

① Discharge data was the data estimated from the rainfall measurement observatory, Doloksanggul by using NRECA model. It is necessary to confirm accuracy of NRECA model.

② In Japan, if there is no water-gauging station in the surrounding and adjacent region to the planned location, it is usually the case to conduct a survey at the planned location (within 1 year), and this data is used for the estimation. It is necessary to examine the correlation and circulation relationship between the measured discharge and the discharge at the water-gauging station of the adjacent river (it is Sibundong in this plan), then deciding whether it is necessary to supplement or not and calculate the discharge for 10 years based on circulation flow.

③ In comparing to the data estimated by NRECA model and actual data of the water-gauging station Sibundong (basin area of 50km^2), the estimated discharge above is lower. Therefore, available power generation will be smaller, and the data is considered to be conservative in the judgment of business evaluation.

④ Effective head which is determined after calculating the loss head is considered appropriate.

⑤ In the case of using the same maximum amount of water as the local plan, the power output will be 8MW compared to 8.4MW of the local plan. Generating efficiency of this survey is higher when using the value provided domestic manufacturers as this figure is higher.

⑥ When the available power generation is compared to the local materials, although the calculations conditions are different such as generating capacity, generating efficiency and method of establishing maintenance discharge, the difference is only 1.000 MWh, so it can be considered almost the same.

⑦ The construction cost which is estimated based on Japanese standards is about 9 times higher compared to the cost of local materials. This is because of the difference in labor costs and material prices.

⑧ The construction cost from the local materials is approximate estimate based on other similar small hydro project in Indonesia by local consulting company. Although it does not show much difference compared to the cost of other project, it will be little lower. It is necessary to consider design of the structure and construction schedule for more accurate estimate of the construction cost.

⑨ The investigation on the generating scale was done based on comparison of the unit price for each MWh. By using the most appropriate scale based on Japan’s domestic method, because the fixed purchase price limits at 10MW, the peak power will be 10MW (maximum amount of water is 13.72 m^3/s), which result is different from the power of 8MW in the local plan.

2) Issues

① Regarding the discharge data, it is highly recommended to conduct simple surveys at the location of the plan and to confirm the reliability of the data.

② Concerning the capacity of power generation calculation, it is advisable to determine the necessity of maintenance discharge and performance setting.

③ It is necessary to confirm the rationality of economic evaluation through the information of construction price as well as labor costs.

④ When comparing to the local materials, because of the difference in the most suitable scale, it is highly recommended to determine the method of selecting the appropriate scale.

(2) Discussion on safety issues of main works

1) Main results

① As a result of stability calculation based on Japanese standard, stability of intake weir is proved.

② Because the dust and waste filter is not confirmed on the design, it is highly recommended to re-examine the existence and necessity of the filter.

③ There is enough water flow of the raceway as a result of the hydraulic accounting. However, it is impossible to circulate the maximum amount of water of $13.72m^3/s$ required for the capacity of 10MW. Therefore, it is necessary to expand the width of cross section or raise the raceway slope.

④ The test result of the tank scale confirms that the output capacity is guaranteed.

⑤ As a result of penstock wall thickness which is calculated by Japanese standard, 14mm thickness of penstock that is applied on local document is not appropriate in some sections at downstream.

⑥ The test result of turbine and generator design shows that the flow runs into iron pipe of turbine at the right angle, which causes large wastage.

⑦ Where it is required to do maintenance work, there is no space for rotor blades turning horizontally, therefore it is necessary to move the rotor and stator at the same time. This layout makes the maintenance work difficult.

⑧ Flood level in the design is 795.17m which makes the power house be flooded. The current policy is to build the flood wall; however, to prevent the power house from flooding, it is highly recommended to fully review the preventive measures.

2) Improvement measures

① Stability of intake weir is proven by calculation of Japanese standard. However, since expected value is partially used for physical property of ground, it is necessary to examine soil condition in site and verify proper physical property again.

② Because the tank water level is lower than 0.63m from the depth of uniform flow, it is expected to lengthen the effective head if the installation location of the tank is placed higher.

③ 14mm of pipe thickness of penstock at downstream is not satisfied for the pressure and required more thickness. Since the pressure at upstream is lower, increasing the size of thickness gradually by some sections toward the downstream could be more economical. The result of calculation shows that thickness of 8mm from upstream to 90m, 10mm to 137m mark, 16mm to 187m mark, and 18mm the rest is appropriate for this plan.

④ According to the design of generator, the flow runs into iron pipe of turbine at the right angle, thus, there will be large wastage in generating. In addition, if it is required to do maintenance work, with the current design, there is no space for rotor blades turning horizontally, so it is necessary to move the rotor and stator at the same time. If the current design is changed, the flow and iron pipe of turbine will be in the same direction, it will reduce wastage. In addition, by ensuring space for rotor rotation, it is easy to do maintenance for equipment.

⑤ When the design of turbine is changed as described above, it can shorten the distance between the turbines central height and turbine iron pipe height. This allows raising the central height of iron pipe, and minimizing the digging for the iron pipe installation.

Table 4-50 Primary Results, Issues and Improvement Measures

		Primary results, issues	Improvement measures
Generating plan	Discharge data	Discharge data was the data estimated from the rainfall measurement observatory, Doloksanggul by using NRECA model.	Regarding the discharge data, it is highly recommended to conduct simple surveys at the location of the plan and to confirm the reliability of the data.
		In Japan, where there is no water-gauging station in the surrounding and adjacent region to the planned location, it is usually the case to conduct a survey at the planned location (within 1 year), and this data is used for the estimation. It is necessary to examine the correlation and circulation relationship between the measured discharge and the discharge at the water-gauging station of the adjacent river (it is Sibundong in this plan), then deciding whether it is necessary to supplement or not and calculate the discharge in 10 years based on circulation flow.	
		In comparing to the data estimated by NRECA model and actual data of the water-gauging station Sibundong (basin area of 50km2), the estimated discharge above is lower. Therefore, available power energy will be smaller, and the data is considered to be conservative in the judgment of business evaluation.	—
	Effective head	Effective head which is determined after calculating the loss head is considered appropriate.	—
	Output	In the case of using the same maximum amount of water as the local plan, the power output will be 8000kW compared to 8400kW of the local plan. Generating efficiency of this survey is higher when using the value provided domestic manufacturers as this figure is higher.	—
	Electric generation	When the available power energy is compared to the local materials, although the calculations conditions are different such as generating capacity, generating efficiency and method of establishing maintenance discharge, the difference is only 1.000 MWh, so it can be considered almost the same.	Concerning the capacity of power energy calculation, it is advisable to determine the necessity of maintenance discharge and performance setting.
	Estimated cost	Construction cost which is estimated based on Japanese standards compared to the construction cost of local materials is about 8 times higher. This is because of the difference in labor costs and material prices.	It is necessary to confirm the rationality of economic evaluation through the information of construction price as well as labor costs.
		The construction cost from the local materials is approximate estimate based on other similar small hydro project in Indonesia by local consulting company. Although it does not show much difference compared to the cost of other project, it will be little lower.	
	Generation scale	The investigation on the generating scale was done based on comparison of the unit price for each kWh. By using the most appropriate scale based on Japan' s domestic method, because the fixed purchase price limits at 10000kW, the peak power will be 10,000 kW (maximum amount of water is 13.72 m3/s), which result is different from the power of 8.000 kW in the local plan.	When comparing to the local materials, because of the difference in the most suitable scale, it is highly recommended to determine the method of selecting the appropriate scale.
Safety issues of main structures	Intake weir	As a result of stability calculation based on Japanese standard, stability of intake weir is proved.	Since expected value is partially used for physical property of ground, it is necessary to examine soil condition in site and verify proper physical property again.
	Dust and waste filter	Because the dust and waste filter is not confirmed on the design, it is highly recommended to re-examine the existence and necessity of the filter.	—
	Headrace	There is enough water flow of the raceway as a result of the hydraulic accounting. However, it is impossible to circulate the maximum amount of water of 13.72m3/s required for the capacity of 10.000 kW. Therefore, it is necessary to expand the width of cross section or raise the raceway slope.	—
	Head tank	The test result of the tank scale confirms that the output capacity is guaranteed.	Because the tank water level is lower than 0.63m from the depth of uniform flow, it is expected to lengthen the effective head if the installation location of the tank is placed higher.
	Penstock	As a result of penstock wall thickness which is calculated by Japanese standard, 14mm thickness of penstock that is applied on local document is not appropriate in some section at downstream.	14mm of pipe thickness of penstock at downstream is not satisfied for the pressure and required more thickness. Since the pressure at upstream is lower, increasing the size of thickness gradually by some sections toward the downstream could be more economical.
	Turbine, Generator	The test result of turbine and generator design shows that the flow runs into iron pipe of turbine at the right angle, which causes large wastage.	If the current design is changed, the flow and iron pipe of turbine will be in the same direction, it will reduce wastage. In addition, by ensuring space for rotor rotation, it is easy to do maintenance for equipment.
		Where it is required to do maintenance work, there is no space for rotor blades turning horizontally, therefore it is necessary to move the rotor and stator at the same time. This layout makes the maintenance work difficult.	When the design of turbine is changed as described above, it can shorten the distance between the turbines central height and turbine iron pipe height. This allows raising the central height of iron pipe, and minimizing the digging for the iron pipe installation.
	Powerhouse	Flood level in the design is 795.17m which makes the generating station be flooded. The current policy is to build the flood wall; however, to prevent the generating station from flooding, it is highly recommended to fully review the preventive measures.	—