



## History of the Sigura Gura Hydropower Plant (PLTA) 1976-1982

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### ABSTRACT

This study explores the history of the Siguragura Hydroelectric Power Plant (PLTA) from 1976 to 1982, focusing on its role in renewable energy development under the Asahan Authority Project in North Sumatra. Using heuristic historical methods, this research examines primary sources such as archives, newspapers, photos, YouTube, and interviews, along with secondary sources. The study highlights the significance of the Asahan River in local history for transportation, trade, and nature. It also discusses the collaboration between Indonesia and Japan in harnessing the river's potential for hydroelectric power generation, part of an integrated project that includes the construction of an Aluminum Factory and the Tangga Hydroelectric Power Plant.

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## INTRODUCTION

Energy is a basic human need that is inherent in everyday life. Basically, energy is already available in nature including renewable energy sources and non-renewable energy sources. Electricity as one of the energies plays an important role in various human activities. Electrical energy is a basic need starting from household matters, schools, offices, places of worship, social places, companies and the state. Almost all equipment and supporting materials in people's lives use electrical energy as their driving force (Tanjung and Setiawan, 2021). As a result, there has been an increase in electricity consumption from year to year (Oktaviani and Noveriyanti, 2019). Quoted in 2018, the total final energy consumption increased by 114.9 million Barrels of Oil Equivalent (BOE).

The Indonesian government needs to make a transition to fossil energy and conserve energy, especially in the energy use sector. This is in accordance with the statement of the Head of the Agency for the Assessment and Application of Technology (BPPT) Unggul Priyanto who said that Indonesia is in an energy emergency. Fossil energy is still Indonesia's main energy source, especially petroleum. From the consumption of 1.6 million barrels of oil per day, Indonesia only produces 700,000-800,000 barrels per day. The rest or more than half is imported.

Energy needs in Indonesia are one of the important concerns in increasing domestic sector growth. In the Business as Usual (BAU) scenario, it is estimated that national energy needs in 2019-2050 will continue to increase in accordance with population economic growth, energy prices and government policies. Based on data from the Agency for the Assessment and Application of Technology (BPPT), the total final energy consumption in 2019 of 989.9 million Barrels of Oil Equivalent (SBM) is still dominated by fuel oil (BBM). Energy needs in 2020, around 89% of final energy consumption in Indonesia still depends on fossil energy resources. The mix of renewable energy in Indonesia's final energy consumption is 10.71%. Meanwhile, renewable energy from the use of geothermal, water, wind, and solar energy is only 2.43% (Abubakar Lubis, 2007).

The energy crisis is a problem that exists in almost all countries in the world, including Indonesia. The issue of Climate Change is marked by the commitment of countries in the world through the Paris Agreement on the annual agenda of the United Nations (UN). Indonesia's meeting at the United Nations Conference of the Parties 28 United Arab Emirates (UN COP 28 UAE) in Dubai in 2023, showed that Indonesia is committed to participating in achieving the net zero emission target of 30%-40% by 2060 or the previous year by making a transition from conventional energy to environmentally friendly energy or in Indonesia called New Renewable Energy (EBT) (Wisnu Aji, 2019).

There are various types of energy sources that can be utilized in Indonesia, one of which is energy sourced from water for the development of hydroelectric power plants. This is because Indonesia's topography is mountainous and hilly and is crossed by many rivers and certain areas have lakes/reservoirs that are quite potential as sources of water energy.

The Ministry of Energy and Mineral Resources (ESDM) is encouraging efforts to accelerate the development of new renewable energy, in this case water

energy. Indonesia's hydropower potential is quite large, reaching 75,000 Megawatts (MW). However, currently its utilization through the provision of national electricity has only reached 1% of its total potential. The total hydropower potential owned by the Indonesian nation is 75,000 MW and currently only 10.1% or 7,572 MW is utilized.

The large water potential in Indonesia is 74,976 MW, 70,776 MW is outside Java, of which 3,105.76 MW has been utilized, most of which is on the island of Java. The construction of each type of power plant is based on the technical and economic feasibility of the power plant and the results of environmental impact analysis studies. The considerations are the availability of certain energy sources, the need (demand) for electrical energy, low generation costs, and the specific characteristics of each type of power plant to support base load or peak load.

The types of power plants in Indonesia include:

Steam Power Plant (PLTU), Hydroelectric Power Plant (PLTA), Gas Power Plant (PLTG), Gas and Steam Power Plant (PLTGU), Diesel Power Plant (PLTD), Wind Power Plant (PLTB), Solar Power Plant (PLTS), Wave Power Plant (PLTO), Nuclear Power Plant (PLTN). PT Perusahaan Listrik Negara (Persero) or PLN reported that the number of Hydroelectric Power Plant (PLTA) units in Indonesia was 162 units as of the end of 2021. This number is around 2.64% of the total 6,143 power plants. The North Sumatra region has 45 PLTD power plants.

The increase in production and consumption of electrical energy at the State Electricity Company (PT. PLN) in North Sumatra from 2018 to 2022 has increased. If viewed in 2022, electricity consumption will exceed the amount of electricity production. PLN has estimated that with the relatively high level of electricity consumption in North Sumatra, the presence of the Asahan 3 Hydroelectric Power Plant will be a solution to the electricity problem in North Sumatra, so that future electricity supply needs can be met properly. Currently, the electricity system for the North Sumatra region is supplied from a number of available power plants with an average power capacity of around 1,517 MW. Meanwhile, the peak load condition on the same electricity system is 1,365 MW.

So with this very limited power reserve, it is estimated that it will not be able to avoid blackouts if one of the main power plants undergoes maintenance, so efforts are needed to further increase the power reserve by adding new power plants. Hydroelectric Power Plants (PLTA) are one of the environmentally friendly and solution-oriented technologies to support energy diversification by utilizing renewable energy, supporting the program to reduce the use of fuel oil (BBM) and mostly using local content (Bisuk, Siahaan, 1986).

The history of the construction of the Siguragura Hydroelectric Power Plant (PLTA) through a series of quite long events. The plan to build the Siguragura Asahan PLTA has existed since the Dutch Colonial era in Asahan. During the Dutch colonial era in the 19th century, the Asahan River was indeed quite popular. A number of Dutch and local newspapers continuously reported on the beauty of the Asahan River and the plan to build a power plant chaired by Ir. Romeling. This discourse was proven by sending Dutch envoys such as surveyors or experts to research the large project. From the beginning of the 20th century to the middle of the 20th century, the Dutch mentioned that the project

to be built included 3 factories, namely the hydroelectric power plant at the Wilhelmina waterfall, an alumina factory, and an aluminum factory

However, as it developed, the project did not run until the Dutch left Indonesian soil, during the Japanese era this project was abandoned until the Indonesian independence revolution. Entering the New Order era, the Asahan Authority Project re-emerged as a national project. The Asahan Authority Project was directly under the Ministry of Industry. However, several obstacles caused the project to only be implemented during the New Order Government under the Leadership of President Soeharto, precisely during the Development Cabinet III. The development of the Asahan Authority Project was based on Presidential Decree No. 5 of 1976 concerning the Establishment of the Development Authority and the Asahan Hydroelectric Power and Aluminum Smelting Center Supervisory Agency. The Aluminum Smelting Company managed by PT. Indonesia Asahan Aluminum (Inalum) requires a large supply of electricity, so a Hydroelectric Power Plant (PLTA) was built in the upper reaches of the river. There are three electricity generating cycles before reaching Kuala Tanjung, namely having to pass through 3 dams which are used for the purpose of generating electricity in the power plants it owns. The dams are the Regulator Dam, the Sigura-gura Water Reservoir Dam, and the Tangga Water Reservoir Dam (Bisuk, Siahaan, 1986).serves to dam the water that has been used by the Siguragura Hydroelectric Power Plant (PLTA) to be reused in the Tangga Hydroelectric Power Plant (PLTA). This dam is the first arch dam in Indonesia. Tangga Power Station has 4 generators. The total fixed capacity of the four generators is 223 MW. This type of dam is an arch-shaped mass concrete with a height of 82 meters.

Construction in the Asahan PLTA area was carried out on June 9, 1978. A year later on July 6, 1979 the first pile driving at the Kuala Tanjung aluminum smelter construction site began. work in the field progressed very rapidly, shoulder to shoulder between Indonesian and Japanese implementers.

The Siguragura Hydroelectric Power Plant (PLTA) was built because there was a need for electricity supply for aluminum smelting, indicating that the orientation of the construction of the Siguragura Hydroelectric Power Plant (PLTA) from the start was not to meet the electricity needs of the people of North Sumatra. But the Siguragura Hydroelectric Power Plant (PLTA) is an important part of the aluminum production process of the PT. Indonesia Asahan Aluminum (Inalum) Company which is a manifestation of the friendship between the two countries between Indonesia and Japan. However, the Siguragura Hydroelectric Power Plant (PLTA) also plays a role in the development of North Sumatra, especially in the area around the PT Indonesia Asahan Aluminum (Inalum) company. PLTA Asahan 2 which consists of PLTA Siguragura and PLTA Tangga in 2021 recorded that the electricity produced reached 4,041,774 MWh with a usage rate of 4,027,118 MWh.

Studies on Hydroelectric Power Plants are quite numerous and adequate studies. These studies include those from Diponegoro University, Polban, UIN Suka, IPB Journal, UMY and various other campuses in Indonesia that discuss the perspective of PLTA with exact sciences. However, among these studies,

none have discussed the study of PLTA from a historical perspective. The study of the Siguragura Hydroelectric Power Plant (PLTA) has previously been conducted by E Lumbantoruan, from the perspective of Civil Engineering at HKBP Nommensen University. Meanwhile, there has been no study of the Siguragura Hydroelectric Power Plant (PLTA) from a historical perspective. Based on the reality above, the researcher is interested in researching and studying further so that he can write a complete History of the Siguragura Hydroelectric Power Plant (PLTA) in 1976-1982. An important period considering that the construction of the Siguragura Hydroelectric Power Plant coincided with the Asahan Authority project which was planned since the Dutch Colonial era in the 19th century. However, in reality it was only realized in 1976 and completed in 1982. The author sees the dynamics in various aspects and historical perspectives related to the Siguragura Hydroelectric Power Plant (PLTA). In addition, the researcher sees that the construction of the Siguragura Hydroelectric Power Plant (PLTA) is one of the real manifestations as a modern giant project that pioneered the development of the first aluminum smelting company in Indonesia. The concept of building an aluminum smelting plant accompanied by the construction of the Siguragura Hydroelectric Power Plant (PLTA) as a source of electrical energy for the operation of the aluminum smelting plant is a complete package that is rarely found.

Then also if we pay attention to the deadline for the establishment of the Siguragura Hydroelectric Power Plant (PLTA) which is part of the Asahan Authority Project, it can be seen that it was very rare in the 1970s to build a factory and power plant using fairly high technology. In addition, the location which is quite far from the city and is located on the Bukit Barisan route that connects three districts at once in North Sumatra is a challenge in itself from the process of being established to operating until now. Therefore, due to the breadth of the problems being studied and researched, the research problems must be limited. The researcher conducted a study only related to the "History of the Siguragura Hydroelectric Power Plant (PLTA) in 1976-1982". The spatial scope of the area in Asahan Regency, North Sumatra Province. While the temporal scope is 1976-1982. 1976 as the beginning of the year of work on the utilization of the Asahan River in the Asahan Authority Project under the responsibility of PT. Indonesia Asahan Aluminium (Inalum) including the construction of the Siguragura Hydroelectric Power Plant (PLTA). Meanwhile, 1982 was the year the Asahan Authority Project was completed.

## LITERATURE REVIEW

### *Development Theory*

Through the book *Development Politics (Paradox, Theory, Actors, and Ideology)* by Warjio, it can be seen that development is basically the result of a political process carried out by the actors in it; by the government with other devices such as institutions, political parties or even community groups. The development of the Siguragura Hydroelectric Power Plant (PLTA) is the result of a political process involving actors, both government and other devices.

According to Warjio, important variables in development politics include: the existence of development actors, power, system, ideology, and foreign

intervention. These variables will be a reference for the author to help analyze the actors in the development of the Siguragura Hydroelectric Power Plant (PLTA) who take a central and determining role in the development process. They can be individuals, groups, or countries. As actors of development, they have instincts and political interests in development through certain methods or strategies to achieve goals (Warjio, 2023).

The existence of power is an important requirement in development. Without power, it is difficult for individuals, groups, or countries to intervene in development. With power, development goals can be implemented. Power is what is owned by development actors to realize the goals of development, either in the form of hard power or soft power. The variable of power when connected to the construction of the Siguragura Hydroelectric Power Plant (PLTA) is certainly inseparable from the power of the development actors (Sartono Kartodirdjo, 2017).

The variable of a system is needed in development because the system can drive a desired pattern in development. One or more systems will influence how development is carried out and achieves its goals, in this case the system or mechanism for the construction of the Siguragura Hydroelectric Power Plant (PLTA) is carried out and achieves its goals.

The next variable is the existence of ideology. Ideology is an absolute requirement in development politics that can drive development because it contains spirit or ideals. Ideology is the spirit that drives development actors to achieve goals. Ideology is the spirit of all activities carried out by development actors in achieving their goals. The construction of the Siguragura Hydroelectric Power Plant (PLTA) is certainly based on ideology as the spirit of the implementation of the development.

The last variable is the existence of foreign intervention. Foreign intervention is a central requirement for the work of development politics. Something intervention that comes from a particular group, system or country that functions to control. They have a special relationship and mutually beneficial interests and on the one hand there may be dependency. This variable is needed by the author to see foreign intervention or influence in the development of the Siguragura Hydroelectric Power Plant (PLTA) which is behind the scenes and played by development actors who are in front of the screen.

### ***Company Management Theory***

According to George R. Terry, 1958 in his book *Principles of Management*, management in a company is a process consisting of planning, organizing, directing, and controlling which is carried out to achieve the main objectives of the company by involving humans and other resources.

Planning means including the act of selecting and connecting facts and making and using assumptions about the future in terms of visualizing and formulating proposed activities to achieve desired results. Organizing is determining, grouping, and arranging the various activities needed to achieve goals. Placement of people (employees), to these activities, provision of physical factors suitable for work needs and designation of the relationship of authority

delegated to each person in relation to the implementation of each expected activity.

Directing (actuating) is to arouse and encourage all members of the group to have the will and strive hard to achieve goals sincerely and in harmony with the planning and organizational efforts of the leadership. Supervision (Controlling) can be formulated as the process of determining what must be achieved, namely the standard so that implementation is in accordance with the plan. This theory is a reference for the author to see the management structure of the Siguragura Hydroelectric Power Plant (PLTA) by involving human resources in the management of natural resources from the initial stage to the final stage (George R Terry, 1993).

## **METHODOLOGY**

The method used in this study is the historical method. The historical method is the process of critically examining and analyzing historical records and traces. The method is a systematic way used to conduct research. This study uses a historical research method that emphasizes human, temporal, and spatial aspects. In the historical method, there are four stages that must be carried out, including the following:

### ***Heuristics***

In historical studies, the use of sources as an understanding of past events is absolute. Heuristics is an activity of collecting traces of the past known as historical data. The data collected must be in accordance with the type of history written. Heuristics aims to ensure that the framework of understanding obtained is based on relevant sources, which can be arranged clearly, completely, and comprehensively (Sartono Kartodirdjo, 1982).

The sources used in this study include primary sources obtained from the National Archives of the Republic of Indonesia (ANRI) online. In Medan, the author visited the North Sumatra Regional Library and Archives, the Medan City Public Library, the Community Reading Park and Tengku Luckman Sinar Library, the University of North Sumatra Library, the Asahan Regency Library and Archives Service. The researcher also visited the research site in search of Company Archives, local newspapers such as the Waspada Newspaper, online newspapers and magazines on the Delpher and Gahetna sites related to the research. In addition, secondary sources are also used in the form of books, journals, articles, and other related scientific research. Then, later sources obtained from interviews with the surrounding community, especially in Tangga Village, and others that support the research will be used (Helius Sjamsudin, 2007).

### ***Verification (Source Criticism)***

After going through the stages of collecting historical sources, the next stage is to verify or criticize the sources. In the verification or source criticism stage, there are two methods used, namely external criticism and internal criticism. Starting with the initial stage, namely external criticism. External criticism is carried out with the aim of determining the authenticity of the historical sources

used. External criticism is also carried out to observe the outside of the historical source, such as paper, ink, writing style, and language used.

After that, the next stage is to carry out internal criticism of the historical source, internal criticism is criticism carried out to test the credibility of the historical source used. At this stage, the focus of criticism is on the contents of the historical source. This is done to prove whether the testimony or statement contained in a document or archive can be accounted for or not.

### ***Interpretation***

Next, the stage that must be passed is interpretation, namely interpreting sources that have previously been verified. Interpretation is an interpretive activity that aims to find things that are interconnected between one fact and another. At the interpretation stage, there are two things that are done, namely analysis (describing) and synthesis (unifying). This process begins with the breakdown of historical facts into several possibilities that are selected to be used as sources in the research. Then, the facts are put back together to be arranged into new historical facts.

### ***Historiography***

The last stage carried out is historiography or writing history. Historiography is the writing of history that is carried out by presenting the results that have been obtained through previous steps and will later be made into a scientific work. Quoting Gootschalk, to produce a historiography that can be accounted for, researchers must discuss it analytically and synthetically as if these two parts have their own processes. However, it should be noted that the two processes cannot be separated and must remain juxtaposed (Louis Gottschalk, 2015).

## **RESEARCH RESULT AND DISCUSSION**

### ***New Order and National Industrialization***

Since independence, Indonesia's industrial development in the 1950s to early 1960s was stagnant due to lack of funds and foreign exchange (The Kian Wie, 1994). Industrial placement took into account factors of raw materials, markets, energy, and labor. In the New Order era, the government carried out economic stabilization, rehabilitation, and reconstruction including industrial sectors that had previously not developed. Unlike the Soekarno era, the New Order government opened up opportunities for private ownership, liberalized foreign investment, abolished foreign exchange controls, and reduced the privileges of state-owned enterprises. Foreign direct investment (PMA) is considered important because it brings capital, technology, and knowledge (Sirojuzilam, 2006).

### ***Overview of Siguragura Hydroelectric Power Plant***

Along the Asahan River, 7 hydroelectric power plants can be built so that a constant water discharge is needed throughout the year. In the first stage, it is proposed to build Hydroelectric Power Plant No. 2 which includes the dredging

components of the Asahan River, Regulating Dam, Intake Dam, Headrace Tunnel, Penstock, Power House, Tailrace, and Transmission Wire.



Figure 1. Asahan River in 1964

After PT INALUM was established in 1976, four consultants were appointed to study the development of hydroelectric power plants in the Asahan area. Nippon Koei designed the Siruar dam (107 m<sup>3</sup>/second), Siguragura (111 m<sup>3</sup>/second), and Tangga (118 m<sup>3</sup>/second), and took into account rainfall along the Asahan River. The river flows from Lake Toba and descends 820 m in the first 40 km, passing two major waterfalls: Siguragura (200 m) and Tangga (150 m). Yachiyo Engineering studied the soil conditions in Kuala Tanjung and designed the New City in Tanjung Gading, Asia Aero Survey mapped the development area, and Pacific Consultants designed the port. The water flow from Lake Toba is used to generate electricity through a system of tunnels, damping tanks, turbines, and generators connected to a switchyard and forwarded to PT INALUM.

Asahan Hydroelectric Power Plant Project No. 2 was originally planned as one unit, but was eventually divided into two to ensure the energy needs of the aluminum smelter, namely the Siguragura Hydroelectric Power Plant (286 MW) and Tangga Hydroelectric Power Plant (317 MW), with a total installed capacity of 603 MW and an annual energy production of 3,922 GWh. This project only utilizes part of the total potential of the Asahan River which according to Russian research in 1964 could be developed into five hydroelectric power plants with a total capacity of 1,202 MW and a production of 6,270 GWh per year (Bisuk Siahaan, 1984).

### *Hydrology and Meteorology*

This research has been conducted since 1976, for a period of 35 years. The examination is based on previous research. In addition, it also observed rainfall in the rain-fed valley of Lake Toba and the Asahan River watershed up to the Tangga Dam. Evaporation of water from the surface of Lake Toba was calculated from evaporation measurements in Simangkuk. This investigation aims to be able to determine with certainty the water flow available for power generation purposes and determine the optimum installed capacity for the Siguragura and Tangga power stations. Based on observations of the water flow overflowing from Lake Toba since 1916, the Low Water Level (MAR) and highwater level

(MAT) in Lake Toba were determined which were needed to utilize the Asahan River flow optimally. These observations and investigations continued until December 1977, when the hydrological data were considered sufficient to determine the final design for the construction of the hydroelectric power plant.



Figure 2. Traffic view crossing the Asahan valley (1979)

### ***Topography***

Topographic survey of the project was conducted through aerial photography (July–December 1975) and direct ground measurement (November 1976–August 1977) covering the entire project area, river channels, dam locations, power stations, 120 km of transmission lines, and 271 tower pole locations. The survey aimed to obtain an accurate map of the land surface shape to determine the building volume and the best construction pattern. Based on the results, the location and shape of the Siruar diversion tunnel were selected on the left side of the cliff as the cheapest and safest option, and the axis of the Siguragura Dam was moved to facilitate construction and reduce the risk of accidents even though the cost increased by 6%. Geological research was carried out since the Dutch era, continued by Russian experts (1962–1963), and Nippon Koei (1970–1971), with further investigations until 1978 to deepen the geological conditions in the dam and regulator areas.

### ***Geology***

Geological investigations have been carried out extensively in the Siguragura area. Dutch researchers had conducted investigations in this area long before World War II. Russian experts conducted research in 1962–1963. Nippon Koei conducted additional research in 1970–1971 covering the Organizer Dam area in Siruar and the Siguragura Dam area. The investigations were carried out in two stages. The first stage was carried out between May and September 1976 and the second stage between September and October 1977. Laboratory investigations were completed in January 1978 and the final report was completed in mid-1978.



Figure 3. Siruar and the Siguragura Dam area

### *Preparatory Work and Infrastructure*

1. Repair and Strengthening of Public Roads between Tebing Tinggi – Porsea
2. Construction of Access Roads to all project fields
3. Construction of Permanent Housing for PT. INALUM employees
4. Installation of Diesel Power Plant
5. Installation of Telecommunications Connections between Pematang Siantar and the Project
6. Provision of Crushed Stone and Sand

Before the main construction begins, facilities are built first to facilitate construction work. The construction of these facilities is preparatory work. At the Asahan Hydroelectric Power Plant, preparatory work includes:

1. Repair of public roads
2. Construction of access roads
3. Construction of permanent housing
4. Construction of temporary electricity centers for construction
5. Installation of telecommunications connections

The equipment and building materials for the Asahan Hydroelectric Power Plant project were mostly transported through Belawan Port and brought overland to the project site. To accommodate heavy transport, roads and bridges were repaired, including road widening, bridge strengthening, and emergency bridge construction. PT Inalum repaired the public road from Pematang Siantar to Porsea. The project access road was also widened and paved, especially the Siguragura-Parhitean route, and five access roads and two new bridges were built. The total cost of repairing roads and bridges reached Rp 2.5 billion, completed between 1977-1978. PT Inalum built an 80-hectare employee settlement in Paritohan complete with offices, clinics, mosques, churches, and a diesel power plant for electricity supply. The 8,900 kW diesel power plant was installed near the Siguragura Dam and served six construction areas. After the Siguragura Hydroelectric Power Plant was completed, one of the diesel power plant units was moved as an emergency reserve. A telecommunications system

was also built using a UHF radio network and PABX connecting the entire project site to the national network, operating since February 1979.

Because local stone did not meet construction standards, stone sources were found in the Sampuran Si Harimau valley. This paleozoic stone has high strength and is used as a concrete material. A crushed stone plant was built simultaneously with the work on Package A and began operating in January 1979. This plant produces crushed stone and sand in various sizes using jaw and cone crushers and sand grinding machines.

The stone production results were initially stored in the valley and then transported using a 544.5-meter-long cable line to the stockpile in Bulusoma. This system allows the transportation of 180 tons of stone per hour. The stone and sand are then transported by truck to the project area. The need for stone increased as the project progressed, with peak usage in September 1980 reaching 43,411 tons. In addition to packages A, B, and C, around 10% of the stone was used for road repairs, housing, and additional projects such as transmission lines.

### ***Public Hydroelectric Works***

1. Improvement of Asahan River Channel
2. Construction of Siruar Regulating Dam
  - a. Civil construction of Dam
  - b. Ironwork of Dam Water Gate
3. Construction of Siguragura Reservoir Dam
  - a. Civil construction of Dam
  - b. Ironwork of Dam Water Gate and Waterway
4. Construction of Siguragura Power Station
  - a. Civil work of Power Room and Underground Transformer Room
  - b. Electrical work, installation of Turbine, Generator, Main Transformer, Main Cable and Supporting Equipment
5. Construction of Stair Reservoir Dam
  - a. Civil work of Dam
  - b. Ironwork of Dam Water Gate and Waterway
6. Construction of Stair Power Station
  - a. Civil work of Power House
  - b. Electrical work of installation of Turbine, Generator, Main Transformer, Main Cable and Supporting Equipment

The Asahan Hydroelectric Power Plant is designed to utilize a continuous water flow of 105.8 m<sup>3</sup>/second obtained based on observations made between 1964-1975. Observations recorded between 1920-1932 and 1957-1975 showed an average water flow of 106.8 m<sup>3</sup>/second. By continuously releasing 105.8 m<sup>3</sup>/second of water from Lake Toba, the lake surface can decrease to El. 902.40 m. This decrease may occur once in 10 years, if the rainfall is the same as in the observation year above. To obtain a constant water flow for the needs of the Asahan Hydroelectric Power Plant, the design is based on regulating the water level of Lake Toba between the Low Water Level (MAR) El. 902.40 m and the highwater level (MAT) El. 905.00 m.

The construction of Asahan Hydroelectric Power Station is divided into four main parts, namely civil work, mechanical metal work, electrical work and installation of high voltage electric wires. The main work is divided into several components, each carried out by one contractor or a combination of several contractors in the form of a joint venture. To carry out a component such as a dam or power station, a civil contractor is appointed who must work together with other contractors (suppliers) who are tasked with providing hydroelectric power plant equipment or supplies.

The civil contractor first begins the excavation work, installing the foundation or concreting. Followed by other contractors or suppliers who are tasked with installing hydroelectric power plant equipment such as water gates on the dam, turbines or generators on the power station. After the equipment has been installed, the final work is continued by the civil contractor to complete the concreting or other work.

The synchronization of the work is very dependent on the accuracy of the implementation schedule. Therefore, each job is supervised very carefully by a consultant who is also tasked with providing a schedule or work time, which will result in wasted time and money, because the work of the next contractor will be hampered by waiting until the previous work is completed. This synchronization not only concerns the construction work of the hydroelectric power plant, but also relates to the construction schedule of the Aluminum Smelter in Kuala Tanjung.

When rainfall is very high in the rain-fed valley, the surface of Lake Toba is allowed to rise to a maximum height of El. 905.50 m. This water surface is called the Flood Water Level (FWL). If there is very high rainfall, which may occur once in 100 years, then 400 m<sup>3</sup>/second of water needs to be released from Lake Toba, called flood water flow.

When the peak load is reached, the Siguragura hydroelectric power plant requires a water flow of 146.8 m<sup>3</sup>/second and the Tangga hydroelectric power plant 152.8 m<sup>3</sup>/second. If rain does not fall between Siruar and Tangga, then all the water flow for the Tangga hydroelectric power plant must be provided from Lake Toba. Therefore, the regulation of water from Lake Toba is limited by two extreme conditions, namely:

1. Must be able to drain flood water with a flow of 400 m<sup>3</sup>/second. When the lake water level is at FWL.
2. Must be able to drain water for the peak load needs of the Tangga hydroelectric power plant with a flow of 152.8 m<sup>3</sup>/second. When the lake water level is at MAR.

To increase the flow capacity of the Asahan River, dredging and widening were carried out along 13.6 km with a base slope of 1:8000. The river cross-section is trapezoidal with a sloping side ratio of 1:2, an upstream base width of 30 m and a downstream base width of 20 m. Dredging lowered the river bed by an average of 4 m with the excavation results in the form of mud, soil, river stones, and hard rocks totaling 2,300,000 m<sup>3</sup> of soil and 263,000 m<sup>3</sup> of stone.

The dredged material was piled on the riverbank to form a 38,000 m long embankment, with a back width of 3 m and a height of 1 m above the water

surface. A 19,400 m long drainage channel was dug to drain water from the mainland and embankment back into the river. Dredging was carried out from upstream to downstream so that sediment would not settle again.

The dredging of muddy soil used two dredger ships with a capacity of 100,000 m<sup>3</sup>/month. The rocky section uses heavy equipment such as backhoes and crane dredgers. Four bridges were affected by the project, one provincial bridge in Porsea was reinforced, three others were dismantled and rebuilt, one became a vehicle bridge (3.5 m wide), the remaining two pedestrians (1.5 m wide) with a span of 75–85 m.

This dam is a 47 m high and 154 m long concrete gravity type, with an effective capacity of 750,000 m<sup>3</sup>. Water discharge is guaranteed from Lake Toba (105.8 m<sup>3</sup>/second) and rain flow (1.2 m<sup>3</sup>/second). There are two spillways (capacity 645 m<sup>3</sup>/second) and one control channel (40 m<sup>3</sup>/second). A 72.5 m trapezoidal stilling basin was built downstream of the dam.

Before the construction of the main dam, the river was diverted to a 305 m long diversion tunnel. The 983 m long upper channel tunnel was dug from two directions with a diameter of 6 m, lined with 50 cm of concrete. Water from the dam flows into the upper damping tank, then enters the turbine through a four-branched pressure pipe. The underground turbine room is built 220 m below ground level, consisting of a turbine room and a main transformer room. Water exits through a 447.86 m long underpass to the Asahan River. The road and transport tunnel to the turbine room are built down a 1 km cliff, the construction of which takes up to 1 year. Excavation and casting are carried out in stages so that the structure remains stable.

The excavation volume for the underground power room reached 59,530 m<sup>3</sup>, namely for the tunnel 246 m<sup>3</sup>, for the upper part 14,800 m<sup>3</sup> and the excavation down 44,493 m<sup>3</sup>. The blasted rocks were first transported out through the conductor tunnel and then piled in the switch field. However, at the same time as the excavation of the conductor tunnel, a vertical well was also dug, from the switch field penetrating into the underground main transformer room adjacent to the power room. This vertical well became the place for the electric cable channel from the main transformer room to the switch field, as well as the elevator place to transport people from the control building to the power room.

During the construction period, this vertical well was used to transport excavated rocks from the power room and the main transformer room to the switch field, to fill and level the field. Through this well, 59,293 m<sup>3</sup> of rocks were removed from the power room and 41,311 m<sup>3</sup> from the main transformer room. To dig a vertical well 214.5 m deep and 6.5 m in diameter, a large hole drilling tool called a big man was used. First, a hole with a diameter of 13.5 cm was made from top to bottom until it penetrated the temporary tunnel. In this tunnel, the drill bit was replaced with a grinder or reamer with a diameter of 1.15 m. This grinder, while rotating to grind the rocks, was pulled up. Because of this grinding, the hole was widened from 13.5 cm to 115 cm. After a 115 cm hole was formed, the rocks around the hole were blasted until they reached 6.5 m. The broken rocks from the blast were dropped down through the 115 cm hole, into the temporary tunnel, and from there transported out.

The following details the land area required for the construction of the Asahan Hydroelectric Power Plant, based on the Asahan Master Project Agreement.

Detailed Bagian Proyek	Diperlukan secara Permanen	Tambahan selama Pembangunan
<b>1. Waduk</b>		
a. Waduk Bendungan Sempur	640	—
b. Waduk Bendungan Perahu, Air, Sempur	25	—
c. Waduk Bendungan Perahu, Siguragura	16	—
<b>2. Bendungan Pengantar (termasuk Jalan Pengantar)</b>	7	8
<b>3. Saluran Tenaga Siguragura</b>		
a. Bendungan, Perendah dan Saluran Atas	3	9
b. Tangki Perantara	1	1
c. Saluran Tenaga	6	21
<b>4. Saluran Tenaga Tarung</b>		
a. Bendungan dan Saluran Atas	1	2
b. Saluran Tenaga	1	2
<b>5. Tempat Memara Mikro-wave (termasuk Jalan Pengantar)</b>	17	—
<b>6. Jalan Pengantar antara Perumahan dan Tempat</b>		
a. Di Bawah Saluran	770	—
b. Tangki Memara	16	—
c. Gang Pengantar	15	—
d. Dampak Kena dan Lapangan Perumahan Barung	—	24
<b>7. Perumahan Perumahan Perumahan</b>	80	—
<b>8. Perumahan dan Bawah Tanah dari semua Tanggungan dan Saluran Tenaga</b>	16	—
<b>10. Daerah Sumbu Asahan yang Dilindungi dari Bendungan Pengantar sampai Pembuang Saluran Bawah Tarung</b>	***	—
<b>11. Jalan Proyek dari Perumahan sampai Pulau Raja termasuk Pelebaran Jalan yang telah ada</b>	—	40
<b>12. Lapangan Perumahan Perumahan dan Bawah Bangunan di Pulau Raja</b>	—	4
<b>13. Lapangan Perumahan Perumahan (quality)</b>	—	***
<b>14. Daerah Perumahan bagi Karyawan Pembangunan</b>	—	33
	1.614	195
		1.809

Figure 4. Personal Documentation of Bisuk Siahaan

Based on the Asahan Hydroelectric Power Plant Project Schedule diagram above, it can be seen that the realization of the construction is generally in accordance with the plan. Although there are components that are somewhat late, several components can be completed earlier than planned. The first electricity distribution to the Aluminum Smelting Plant in Kuala Tanjung can be carried out on time on January 1, 1982, along with the ignition of the first reduction furnace. At that time, the Siguragura Hydroelectric Power Plant had only completed 2 power generating units, namely Units No. 1 and No. 2, while the construction of other units continued. In May 1982, Units No. 3 and No. 4 were ready to be tested to generate additional power.

The implementation time depicted in the diagram above is the actual time used for implementation and not the contract period. For hydromechanical metal work and electrical work, the contract period also includes the time required for engineering, factory work, transportation and installation in the field. The time stated in the diagram is the actual installation time in the field, starting from when the equipment arrives in the field until it is ready to be operated.

It is seen that the implementation of the Kuala Tanjung Substation takes quite a long time, even though the work is relatively small. This is because the work is very closely related to the completion of the Aluminum Smelting Factory building consisting of 3 buildings. The construction schedule of the Project can be carried out according to plan, thanks to the land acquisition which is the responsibility of the government, it can be completed smoothly on time.

### *Sigura Gura Retaining Dam*

The Siguragura Dam is part of the Siguragura Hydroelectric Power Plant project included in Package B together with the power station and waterway, implemented by two Japanese contractors. The main function of this dam is to ensure high energy for electricity generation and to provide water for daily peak load needs with an effective reservoir capacity of 750,000 m<sup>3</sup>. This concrete

gravity dam is 47 m high, 154 m long, and is equipped with two spillways and one control conduit to channel water to the Tangga Hydroelectric Power Plant when the Siguragura turbine is not operating.

To build the main dam, the river flow was diverted into a 305 m long diversion tunnel dug between September 1978 and April 1979. This tunnel was originally planned to be completely concreted, but only certain parts were concreted due to solid rock conditions. After the flow was successfully diverted in August 1979, excavation of the dam foundation and construction of the main structure began. Concrete for the main dam, as much as 37,870 m<sup>3</sup>, was poured between March 1980 and May 1981, and 11,416 m<sup>3</sup> for the stilling pool until August 1981.

The 983 m long upper channel tunnel that flows water to the turbines was built almost simultaneously with the dam. Excavation was carried out from two directions, including utilizing the former Dutch tunnel which was widened. The concreting of the tunnel began in June 1979 and was completed in 15 months. This tunnel has a circular cross-section with a diameter of 6 m and is lined with 50 cm thick concrete, built almost horizontally with a slope of 1:100.



Figure 5. Worker's shout "Kampai, Horas" in a water tunnel (1980)

The Siguragura Dam was built using a gradual concreting technique like the Siruar Dam, consisting of 13 blocks and 32 layers, each 1.5 m thick. The first layer that is in direct contact with the rock is divided into two layers 0.75 m thick. The concrete for the main dam began to be cast in March 1980 and was completed in May 1981 with a volume of 37,870 m<sup>3</sup>, while the concrete for the stilling pool (11,416 m<sup>3</sup>) was cast between May 1980 and August 1981. Curtain grouting began three months before the concreting was completed, with denser rock conditions than the Siruar Dam.



Figure 6. Tunnel to the center of the earth (1979)

The 983 m long upper channel tunnel with a diameter of 6 m was built horizontally in the river bank, lined with 50 cm thick concrete. Excavation was carried out from two directions and met in the middle on October 8, 1979, at an average speed of 80 m per month. The old tunnel left by the Dutch was reused and widened. The tunnel concreting began in June 1979 and was completed in August 1980. The damping tank was excavated in October 1978 and the reservoir was constructed from May the following year.

#### ***Sigura Gura Hydroelectric Power Plant Management***

The management structure consists of the President Director and Directors. The President Director and Directors under him: Head Office and Construction Division. Under the Head Office: General Affairs Department, Public Relations Department, Personnel Department, Finance and Accounting Department, Procurement and Transportation Department, Tokyo Office. Under the Construction Division: Medan Office, Aluminum Smelter and Infrastructure Construction Department, Power Plant Construction Department. The Director of PLTA in 1976-1983 was Ichiro Miyachi.

#### **CONCLUSIONS AND RECOMMENDATIONS**

The Siguragura Hydroelectric Power Plant (PLTA) is one part of the results of the Asahan Authority Project based on Presidential Decree No. 5 of 1976. The Asahan Authority Project itself is the realization of cooperation between two countries, namely Indonesia and Japan. The Asahan Authority Project consists of the construction of PT. INALUM, the construction of the Siguragura Hydroelectric Power Plant (PLTA), and the construction of the Tangga Hydroelectric Power Plant (PLTA). The history of the construction of the Siguragura Hydroelectric Power Plant (PLTA) has experienced ups and downs but is still said to be a successful and timely project in its 7-9 years of work.

The initial planning of the construction to the beginning of its operation tells a long story. Starting from the exposure of the beauty of Lake Toba and its tributaries, until then the idea of building a Hydroelectric Power Plant (PLTA) emerged which inspired various surveys and research on feasibility studies. This

survey and research process is quite time consuming because it has been proven to take quite a long time. Starting from the Dutch, Japanese, Independence, to the New Order era. It takes ambition, consistency, and perseverance to make it happen in the era of Indonesia which is still young. The construction of the Asahan Authority Project is real proof that at that time, Asahan was quite noticed and sought after by foreign countries because of its enormous natural resource potential. However, it is unfortunate that the construction of the Siguragura Hydroelectric Power Plant (PLTA) was not intended from the start to meet the needs of the people, especially the people of Asahan and North Sumatra. But only to meet the electricity needs of an aluminum company in Kuala Tanjung Batubara.

### ADVANCED RESEARCH

This study advances historical research on infrastructure development by offering a rare historiographical perspective on the Siguragura Hydroelectric Power Plant (PLTA), a strategic energy project rooted in colonial-era planning but realized during Indonesia's New Order. Unlike prior technical or environmental analyses, this research uncovers the political, economic, and foreign policy dimensions behind the Indonesia–Japan cooperation within the Asahan Authority Project. By situating the PLTA's development within broader state-led industrialization and energy transition efforts, it enriches our understanding of how historical infrastructure reflects both geopolitical strategy and local transformation.

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