PhD RESEARCH PROPOSAL

PICO HYDROPOWER
AT TIDAL CANALS IN
TELANG II – BANYUASIN

DISSERTATION PROPOSAL
As one of conditions to earn doctorate
in field of Environment Sciences Study Program
The Pascasarjana of Sriwijaya University

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SANDWICH PROGRAM THE YEAR 2011

Pascasarjana Unsri **Ditjen Dikti**
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APPROVAL PAGE

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AT TELANG II – KABUPATEN BANYUASIN

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As One Of Terms To Acquire
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SUMMARY

Population growth, the economic development, global issue of CO_2 emissions as the cause of global warming and the depletion of oil and gas in the near future in Indonesia have gone through in the past decade. Many attempts have been done in finding clean energy and environmentally friendship power. The program of Desa Mandiri Energy has been launched by the Indonesian government to support the energy fulfillment at villages , ascending the social welfare and alleviate rural poverty.

This study is trying to harness the energy of water flowing in and out of tidal canals at Desa Bangun Sari in Kabupaten Banyuasin on the east coast of South Sumatra. There are 2,136 tidal canals lying in South Sumatra with the potential of tidal power which, pushes us to investigate. This study is evaluating the possibility of harnessing the power contained in water flow by applying Pico Hydropower in the water control structures of tidal canals and evaluating the impacts on the environment around. This study includes observations, measuring the flow of water, designing the waterwheel suitable to the passage in the water control structures and recording the shaft horse power produced by the waterwheel.

Power obtained from the water wheel rotations and then used for irrigation or drainage dependent on the public interest. The utilization of energy derived from the water wheel is dependent on need and availability of power. In general, the water wheel is used for the purposes of water aeration, water pumping and small scale electricity generation.

The impacts of pico hydropower on the social life will also be evaluated, such as the needs of energy, the influence of energy to people. The analyses of impacts will also extended to the influence of water wheel to irrigation and drainage.

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CHAPTER I
INTRODUCTION

Hydropower is an energy comes out from the flowing water. The energy is produced by the kinetic energy contained in the flow of water or by the potential energy produced by the difference of water level. The water turbine or waterwheel, is the equipment consist of wheel and blades arranged on the circumference of the wheel used to convert the flow of water become the mecahnical energy. Waterwheel is the kind of oldest hydropower technology in the world. Waterwheel has firstly applied in Yunani the year 300 BC. Waterwheel, Wind Energy has became the main source of energy besides the steam engine and animal power generating the First Industry Revolution in England and Frech in the year 1760 – 1830 (Fritz, 1984).

The first large hydropower plant in the world was built in 1882 in Apleton, U.S. Wisconsin, generating electrical power of 12.5 kW to meet the needs of two paper mills and a house. (Green-Trust, 2010). Then along with advances in technology, a shift occurred after the found of the Internal Combustion Engineering by Nikolaus Otto in 1861 and the discovery of Diesel engine by Rudolf Diesel in 1897.

In the time after, internal combustion engines is considered more efficient, resulting in greater power, more simple size and shape and can be located anywhere because they do not have near water sources, more technologically advanced and better reflect modern circumstances at the time. Most books write that the discovery of the Combustion Engine by Otto and Rudolf Diesel to be one factor contributing to the Second Industrial Revolution in Europe in 1850.

Since then hydropower is becoming obsolete and left, mainly because it is less efficient in generating mechanical power, technologically behind the time, not practical in use mainly because it requires a specific location and wide area and expensive cost of installations. The world slowly began to leave the Waterwheel and continue to switch to the use the new energy source,i.e. Otto engines, Diesel engines and Nuclear power.

Nowadays, the wideworld are aware of global warming, the Earth's is threatened by the increment of atmospheric temperature. The global warming is allegedly began to occur significantly in the mid-twentieth century due to increased concentrations of

greenhouse gases in the atmosphere as a result of CO_2 gas emissions produced by fossil fuel burning at industries and deforestation. (ICCP, 2007). The efforts to reduce greenhouse gas emissions is done shortly and in international scale. Utilizing the alternative energy is one of choice in order to minimize the CO_2 emissions. The safe source of energy such as solar energy, wind energy, wave energy, tidal energy, geothermal energy and ocean thermal energy conversion are among the interests Hydropower is one of the safe renewable energy resource. The wave energy, tidal energy and ocean thermal energy are intensively encouraged. International agreements and treaties are made among the world leaders as a political commitment to reduce greenhouse gas emissions to the atmosphere. Among the treaty is the 1985 Vienna Convention, Montreal Protocol in 1987 and the Copenhagen Amendment in 1992 and the 1997 Kyoto Protocol on reducing greenhouse gas emissions in the developed and developing countries, all of which aim to reduce greenhouse gas emissions in order to slowdown the depletion and the thinning of ozone layer which convinced cause global warming. (Sukwati, 2010). Energy crisis of the 70's and the later appearance of the 'greenhouse' effect led the European energy policy makers to considers the development of renewables and especially small hydropower, a cheap, secure and clean energy source with minor environmental impacts. (Baguenier, 1994) The depletion of world oil reserves and the significant environmental degradation have revived the interest on renewable energy resource. The exploitation of wind and solar energy, success remarkably. However, hydropower is still the most widely renewable energy source worldwide. It takes 18 % of the whole world electricity generation. (Kadellis, 2007).

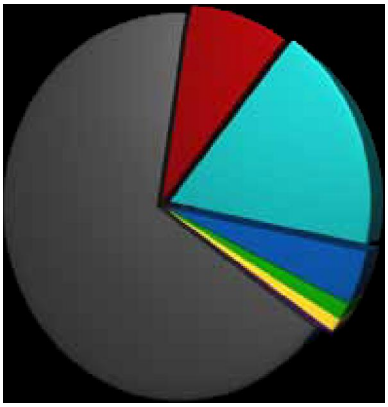


Figure I.1: Estimated Global Installed Electrical Power Capacity 2010 (GW)*
Coal Gas & Oil 68%, Nuclear 9%, Hydropower 17%,
Wind 4%, the rest are Bio energy, Solar and Geothermal
(International Hydropower Association, 2010)

In the energy sector, Indonesia is a developing country which ever experiencing economic difficulties due to the rising oil prices. Indonesia is a country which half of the national energy consumption is oil. The oil price in Indonesia is sets fixed. It previously determined on the base of assumptions and predictions of national economic trends and its correlation to international economic situation. On that base, the Indonesian government set the oil price. The net price gap to the international oil price is subsidized by the government. On the base of this policy, the world oil price raise will disturb Indonesian economic regarding the larger portion of subsidize for every litre of oil will be. The more the oil price raise, the more the subsidy should bore.

Several attempts have been made to anticipate the oil price fluctuation and to strengthen the state economic base. The specified attempts are classified into three categories:
- Energy Conservation,
- Energy Saving and
- Energy Diversification.

The above three categories are carried out simultaneously and specifically in order to support sustainable development in Indonesia. Legally, the Indonesian government has set a reach out for Energy Elasticity smaller than one in the year 2025. (Perpres, 2006). The Presidential Regulation Number: 5 The year 2006 also mandating the government of Indonesia to achieve the of energy consumption diversify, called the Energy Mix with the composition of consumption as shown in the Table I.1 below.

Table I.1: The portion of Indonesia Energy Consumption, the Current Energy Consumption and the projected in the year 2025

No:	Energy Kind	Present Energy Consumption *)	Energy Consumption Projections in 2025 **)
1	Minyak Bumi	47.5%	20%
2	Gas Bumi	26.5%	30%
3	Batubara	24.3%	33%
4	Biofuel	-	> 5%
5	Panas Bumi	2.45%	> 5%
6	Energi Baru Terbarukan	1.7%	> 5%
7	Energi lain	-	> 2%

*) Sumber: BP Tahun 2008.
**) Perpres No5 Th.2006.

Table 1 above showing the sharp descending on the consumption of oil, from 47.5% at present to 20% in the year 2025. On the other side, the table show a sharp ascending on the projected of Gas, Coal and New and Renewable energy consumption.

This dissertation is standing on the attempts to achieve the increment of renewable consumption from 1.7% at present become more than 5% in the year 2025. The mandate of legislations become important from the technical standpoint. We are coming to the time where the sea wave and tidal energy are competitive to conventional thermal generating plants. Its when the fuel cost and the environmental being concerned as remind by Shaw. (Shaw, 1994)

Regarding the waters territory of Indonesia as wide as 2.8 million square kilometers, hydropower became one of Indonesia energy source hope in the near coming years. Hydro energy become the most promising energy when the non-oil, non-CO_2 emissions is considered. Hydropower is also considered as secure alternative energy, compared to nuclear energy. Nuclear energy tend to left behind, realizing the danger of nuclear reactor failure reporting takes many lives in Chernobyl - Russia 1986, Three Miles Island - USA in 1979 and the latest in Fukushima, Japan in 2011 . Hydropower is considered a number of advantages compared with fossil-fueled power plants, among others, do not emit greenhouse gases, uses no fossil fuels, no noise and produces no waste and can be made in small scale. (Fritz, 1984). Hydropower also advantage in operating costs compared with fossil-fueled power plant, its cheaper because water is free in nature. In addition, hydropower has a long service life and does not require a lot of operators for the operation. It is estimated that potential hydropower in Indonesia is 75.000 MW, which is one of the largest hydroelectric reserve in Asia. (Hayes, 2004; Abdullah, 2005)

CHAPTER II
BACKGROUND AND OBJECTIVES

II.1. Background

Indonesia is the worlds largest archipelago state and has the fourth largest population of about 240 million people. Current annual Growth Domestic Product (GDP) growth is between 5% and 6% and it is a net oil importer country, leading in coal and Liquefied Natural Gas (LNG) exporter. In 2008 oil was the dominant energy source with approximately 48% share of the energy mix, coal with 30% and natural gas with 19%. Primary energy consumption was approximately 0.62 TOE/Capita in 2008 and it is growing about 5% per year.(Best, 2011). Indonesia emmitted about 2.1 Gt CO_2 equivalent in 2005, which is equivalent to 4.97% of global green house gas emissions. An increasing from 2.4% of the world emissions or equivalen to 140 million tons of CO_2 in 1993 (Petrich, 1993). Most of Indonesian emissions are not from industrial activity like India, China and Japan but are mainly due to peat fires and deforestation.(Indonesia National Climate Change Commision, 2010; Jupesta, 2011; Brockhaus, 2011).

Indonesia has committed to reduce CO_2 emissions as much as 26% until the year 2020. The statement was spoke by the President of Republic Indonesia, Susilo Bambang Yudhoyono on 25 September 2009 in Bangkok at a meeting of leaders of the G-20. The same statement expressed again on the Summit on Climate Change in Copenhagen, Germany on 15 December, 2009 (Reuters, 2009; Environment News, 2009) This commitment will extend to 41% reducing if there is adequate international support.(Jupesta, 2011; Best, 2011). Realizing this commitment is hard to achieve, the government take a number of ways including increasing the investment in Renewable Energy, Reducing the level of 'deforestation' and Review the Draft Land Use.

Indonesia's commitment to reduce CO_2 emissions by 26% is certainly hard to achieve, with no supporting from all parties linked. Domestic efforts undertook should related to accelerate the energy diversification effort, non-fuel energy utilization and the use of new and renewable energy such as micro hydro, geothermal and biofuels. (State Speech, 2007).

Research on hydro energy that would do this we consider to support government efforts in the utilization of alternative energy sources that are free of CO_2 emissions and fuel-free to support the government program creates the formation of the Energy Self-sufficient Village (DME) throughout Indonesia proclaimed by the President of Indonesia since 2007 (State Speech, 2007) as part of efforts to improve the welfare of the people.

II.2. The Urgency of Research

This study will constitute a scientific study which documented and implemented that are ready to be propagated and studied further for similar applications elsewhere. Marsh land area in Indonesia to 2006 is estimated at 33,393,570 hectares consisting of 20,096 hectares (60.2%) tidal land and 13,296 hectares (39.8%) of land of non-tidal marshes (lowlands).

Table II.1. Indonesia lowland distribution and developed area (Dept PU, 1996)

Locations	**Lowland available (ha)**			**Already developed (ha)**		
	Tidal (million	Non- tidal	Total	Pasang surut	non-pasang surut	Total
Sumatera	6.6	2.7	9.3	0.6	0.26	0.8
Kalimantan	8.1	3.5	11.7	0.2	0.2	0.4
Irian Jaya	4.2	6.3	10.5	0	0.06	0.06
Sulawesi	1.1	0.6	1.8	0	0.02	0.02
Total	**20**	**13.3**	**33.4**	**0.8**	**0.47**	**1.314.8**

Out of 0.8 million hectares of already developed lowland in the four major islands in Indonesia, 0.61 million hectares (± 75%) are situated in the region of South Sumatra, which is concentrated in eastern coastal areas of South Sumatra.

Data from the South Sumatra Region VIII (BWSS VIII) is an area of 615,00 hectares in several locations terebar eastern shore of South Sumatra, among others: Telang I, II Telang, Upang Delta, Delta Saleh, Sugihan Left, Right Sugihan, Padang Sugihan, Karang Agung Downstream, Karang Agung Tengah, Hulu Karang Agung, the island Rimau, Air Rengit. Table I.1. The following data show a large irrigation canals at several locations.

Tabel II.2. Tidal irrigation canal in South Sumatera *)

Location	Area Square	Primary Canal	Secondary Canal	Canal length **)

	(ha)			
Delta Telang I	26,600	5	100	100 x 3,85 = 385 km
Delta Telang II	13,200	4	60	60 x 3,85 = 231 km
Sugihan Kiri	45,557	8	96	96 x 3,85 = 369 km
Sugihan Kanan	29,835	6	58	58 x 3,85 = 223,3 km
Delta saleh	19,760	3		
Padang Sugihan	51,000			
Delta Upang	8,423			
Air Rengit	2,411			
Air Limau	2,576			
Gasing Partian	6,900			
Air Senda	6,730			
Tenggalang	8,794			
Karang Agung Hulu	9,000			
Karang Agung Tengah	30,000			
Karang Agung Hilir	20,317			
Bertak I	4,600			
Bertak II	5,100			
Kumbang Padang	14,227			
Cinta Manis	9,257			

*) Departemen PU-Direktorat Jenderal Pengairan, 2011.
**) Including Saluran Sekunder Pedesaan (SPD) and Saluran Sekunder Drain Utama (SDU)

Primary canals has the following sizes:

- Width of canals: 23 meters
- Bottom width: 6-8 meters
- Depth: 5 meters

Secondary canals has the following size:

Top Width : 7 meters

Bottom width: 3 meters

Depth: 2 meters

The data show in the area of Telang II there are 4 Primary Canals and 231 Secondary tidal irrigation canals. Secondary canal that is used to this study is situated in the Bangun Sari village and positioned at 2.381 South Latitude and 104.42 East Longitude. Each secondary canals serves an area of 288 hectares, which consists of 256 hectares of rice fields and 32 hectares of residential

areas. So with an area of tidal irrigation of 615,250 hectares, the number of secondary canals existed in the area of tidal irrigation in the east coast of South Sumatra are 2136 units.

Suppose, all the secondary canals in South Sumatra can be harnessed to generate electricity through micro hydro drive, then we harvest a considerable mechanical energy that can be extracted from the irrigation canals.

Utilization of water energy in the secondary irrigation canals will related to the efforts of government to create jobs and poverty alleviation. In the state speech in 2007 President of the Republic of Indonesia, Susilo Bambang Yudhoyono explicitly states that "... poverty is not just a man and his household, but also the facilities and the environment ...." Among the programs carried out to realizing the aim is the launched of the Energy Self-sufficient Village (Desa Mandiri Energy) Program throughout Indonesia since 2007.

DME Program in Indonesia was developed with two basic, i.e:

- *Firstly*: non-fuel energy such as micro hydropower, solar energy, wind energy and biogas ;
- *Secondly*: the energy from plantation, such as palm oil, Jarak Pagar, etc.

The aim of DME Program endorsed by the government is mainly to release people's dependence on oil fuel, opening the job vacations for local people and poverty alleviation in rural areas. Micro-hydro energy in irrigation canals are included in the first base of the DME Program. (Topik Pilihan, 2007; Purnomo Yusgiantoro, 2007) The study and academic research in hydropower, solar energy, wind energy and biogas took much attention in universities in Indonesia. At the beginning, Indonesia tend to exploit the energy from plantations, such as Palm Oil and Jarak Pagar. During the past few decades areas of conversion forest have increasingly converted for oil palm and other commercial crops. Oil palm has become one of the most important estate for Indonesian economy. It growth tremendously, from merely 106.000 ha in the late 1960s, oil palm estate had expanded to cover 8 million ha by 2010, concentrated in Sumatra and Kalimantan(Kemtan, 2010; Brockhaus, 2011) The government plans to develop between 2010 and 2015, an additional of 1.5 million ha of new oil palm plantations for food and biofuel. For 2015 – 2025

there is a target for additional 4 million ha.(Indonesias Roadmap For Biofuel Developments in 2025; Brockhaus, 2011). These plans are now to be re-evaluated by the strong repulsion from communities and NGO groups, regarding the loss of biodiversity, deforestation, community lands right and orangutan distinction.

The alternative way to get more energy is from renewable energy such as wind energy, water energy, solar energy and biomass. Total hydropower potential of Indonesia is 75.000 MW is one of the largest hydroelectric reserves in Asia. These potential is spreading across 1315 locations with different size and predicted power. A large amount of the capacity could be developed by mini and micro hydropower. A target of 59.5 MW has been set for commercial microhydropower by the end of 2003 and rising to 153.4 MW by 2020. Villages requiring less than 100 kW will be encourage to build off micro hydro where the water resource existed. Micro hydro schemes of 25 kW or larger will be used to replace the diesel-fired plants. (Hayes, 2004) Indonesian government have developed 633 Self Sufficient Energy Village by 2010 out of 2000 villages targeted by 2014. In Indonesia, there are 80,000 villages, which 45% is located on undeveloped areas. 6500 villages out of it are not yet getting electricity. [Krisnamurthi, 2010)

From the economical point of view, when the water energy in the secondary irrigation canals can be utilized and not reducing the main function of it to irrigate rice fields, the electrical power generated will be a new value added from irrigation canals and economic value for local communities.

Costs incurred by the government to build irrigation systems in Indonesia is very large. Care costs each year to cope with the problem of sedimentation, erosion of the irrigation wall, vegetation that thrives on the edge of the canals and so on, are very large, so it push us to seek the benefits of irrigation canals not only to irrigate the rice fields but also to generate energy to support the daily needs of people in rural areas.

II.3. Research Questions

Based on the previous problem description, many thing could be the matters of research. From the nature behaviour at the site to the social matters of local people. Some questions related to this research have been formulated as follows:

1. Can the flowing water through water control structures be used in a feasible way to generate mechanical energy without decreasing significantly the function of tidal canal to supply water or drain water from fields?
2. How is in tidal areas the relationship between the energy generated and the daily tide behaviour at the local site ?.
3. How is the relationship between the energy generated and the availability of water related to the season along the year?
4. Is it possible to construct a waterwheel system at the passage with no significant effect to irrigate or drain the fields?
5. How does the energy utilization impacts to the stakeholders in the neighbourhood?

II.4. Hypothesis

The observations in the field and the measurements taken at the site will give a primary data reflecting the behaviour of tidal and the behaviour of flowing water through the passage. From the field data we can analyze and estimate theoritically, how big is the power that could produced by the flowing water through the passage. This power will change from time to time regarding the increment and the decrement of the tide level. From theoritical estimation, we could construct a waterwheel considering some space limitations existing at the passage. Then the power generated could be evaluated and recorded.

The hypotheses of this study are as follows:

- The water flowing at the water control structures can be converted into mechanical energy by using a waterwheel with no significant influence to the main function of irrigation to and/or drainage from the fields.
- The power generated is related to the quantity of flowing water.
- The aplication of pico hydropower at Desa bangun Sari create impacts on the community..

II.5. Research Objectives

Under such circumstances, the proposed research will studied the behaviour of the water entering and leaving the canals related to the movement of tide current at

low and high tide. The measurements will be taken to the flow of water entering and exiting the water control structures at the wet season and at the dry season. From the measurements, we can clearly find the behaviour of water flowing and its relations to the tide movements and the season. From the measurements we will find the quantity of flow in 24 hours/day, and the speed of flow in 24 hrs/day. From the data taken, we can estimate theoritically how big is the energy contained in the flowing water from time to time.

The detailed objectives of this study are as follows:

- Finding the behaviour of water flow at the site and carry out measurements of flow through the water control structures at Desa Bangun Sari – Telang II, Banyuasin;
- Analyzing the data and estimating the mechanical power contained in the passage;
- Designing a waterwheel by considering the space available in the passage.
- Recording the shaft horse power generated by the waterwheel at maximum water level in the wet season and in the dry season;
- Analyzing the impacts of pico hydropower on the stakeholders.
- Formulation of reccomendations on the applicability of pico hydropower in tidal canals.

CHAPTER III
THE FRAME OF THOUGHT

III.1. Literature Review

During the last 800 years watermills have been in operation all over Europe covering the needs of local habitant for mechanical power (Kaldellis,2007). Watermills also have been used since thousands years ago in India, China and Egypt where the energy of water used in daily life for various purposes such as pounding grain, sawing timber and stone, blacksmiths and extracting the metals from the rocks. Waterwheel is the oldest form of equipment converting the water into mechanical energy in the planet. It is not clear since when the water energy was first used in the world, but it is known waterwheel has existed since 2000 years BC. Doomsday Book in 1086 noted the presence of more than 5000 water-powered mill in Britain, there are 60,000 water mills in France in 1820. (Denny, 2004). Recorded in China, India, ancient Egypt, Paraguay, Brazil, Congo and African countries, the energy used for pumping water into the irrigation and irrigated agricultural areas.

In modern life, the people developed some form of equipment of hydropower. Some of them produce mechanical energy, and several others produce electrical energy. Water energy can be harnessed become energy in some manner i.e:

- Dam (Barrages), where the water potentials convert into mechanical energy by the difference in height of water level or called Potential Energy;
- Stream, where the flow energy is converted into mechanical energy through the water flow velocity or called Kinetic Energy;
- Tidal Power, where the devices utilize the water energy might by the difference height or by the stream of tidal water came in and out of a river or canals;
- Wave Power, which are the devices that use waves as a driving source of energy;
- Ocean Thermal Energy Conversion (OTEC), which is the power that works by exploiting the temperature difference between sea surface and the deep water to be useful energy;

Tidal power could convert into mechanical energy on the base of kinetic energy or potential energy, depending on which base is more advantage. Regarding the tidal

irrigation canals, where the energy conversion is must not obstruct the rice fields watering, the kinetic energy is the only choice.

Hydropower currently take accounts for 715,000 MW or 17% of the world's electrical energy. (BP ,2009). Table 1 below is showing the world's energy generation data derived from the energy of water.

Table III.1: The tenth large scale Water Energy Electricity operated in the world by 2009.

Negara	Produksi energi hidro per tahun (TWh)	Kapasitas Terpasang (GW)	Faktor Kapasitas	Persen dari keseluruhan kapasitas
Cina	585,2	171,52	0,37	17,18
Canada	369,5	88,974	0,59	61,12
Brazil	363,8	69,080	0,56	85,56
USA	250,6	79,511	0,42	17,64
Rusia	167,0	45,000	0,42	5,74
Norwegia	140.5	27,528	0,49	98,25
India	115,6	33,600	0,43	15,80
Venezuela	86,8	-	-	67,17
Jepang	69,2	27,229	0,37	7,21
Swedia	65,5	16,209	0,46	44,34
Paraguay	64,0	-	-	-
Francis	63,4	25,335	0,25	11,23

Source: Wikipedia, 2009
(http://en.wikipedia.org/wiki/Hydroelectricity)

The amount of power could generated by hydropower is thoroughly depending upon the quantity of flow and the different heights of water level. The greater the quantity of flow and the bigger the difference of water level will the greater the power developed. Based on the availability of water flow quantity and the difference of water level. Quantity of water flow is determined by the magnitude of flow rate, and the difference will determine the altitude of the momentum generated at the blade of water turbine that works based on different heights. Based on the availability of water resources, many types of water turbines have been developed and many different power can be generated.

Hydropower could classified in several classes depending on the power produced. Classification can be seen in the following table:

Table III.2: Hydropower classification based on the power produced

No:	Scale	Power output

1	Large Hydropower	> 100 MW
2	Medium Hydropower	15 – 100 MW
3	Mini Hydropower	> 100 KW < 1 MW
4	Micro Hydropower	> 5 KW < 100 KW
5	Pico Hydropower	Up to 5 KW

Source: Practical Answers,2010
http://practicalaction.org/practicalanswers/product_info.php?products_id=41
http://www.reein.org/microhydro/

The classification of hydropower tends to differ from one standard to another. According to the International Hydropower Association (IHA), the rate power of a Small Hydropower Station is usually less than 10 MW, while all stations with rated power less than 1 MW are characterized as mini hydropower. For very small applications, one may also use the expression 'micro hydropower station' (Kaldellis, 2007) Regarding the latest published paper on hydropower there are the same classification for pico hydropower, i.e. up to 5 KW. (Haidar, 2011). On the base of this classification, the title of this study is called Pico Hydropower. This kind of hydropower find the spread attention because of low cost and friendly to environment and potential source of power. Pico hydropower is viewed as a good solution to electrification of the remote sites and small villages in rural areas where the national power-grid system is comparatively uneconomical to extend.

Tidal energy has been used in Francis, Canada and Russia since 1966. Tidal power could developed in areas with large tidal ranging. Tide that is trapped in the canals can be used to turn turbines to generate electricity by the differences in elevation. Limitations of tidal energy is not the water level fluctuations can be tailored to the needs of electrical energy in the community. The one problem in tidal energy is likely one pass utilize. By the way, the energy will only available for twelve hours each day. Some countries have taken efforts to ensure the constant energy through connections with other energy systems such as diesel engines, wind energy and wave energy. By doing so, the systems are coupled and work successively.(Kaldellis, 2006)

This study will try to apply a concept of reversion waterwheel. This waterwheel have double coupling system, which accommodate the forward and backward turning of the wheel. The wheel is put on the screw shaft which will bring the wheel to the left when turn clockwise, and bring the wheel to the right when turn unclockwise. When the wheel is on the left it will connect to the left rachet gear which will transmit the power to the left alternator, and when the wheel is on the right it will connect to

the right rachet gear which will transmit the power to the right alternator. This reversion system will possible to apply with minimum impacts to the stream of water when the wheel blade is flat. This concept of power transmission will enable the waterwheel to gain the energy conversion reversibly, no need of installing two waterwheels to gain energy when exiting and when entering the canal.

This study will try to observe and measuring the real phenomenon of tide at the location of studied canal and analyzing the possibility of converting the flowing water into mechanical energy. If theoritically it is possible, the next step is designing the machine by considering the space available in the sluice. The concept is obtaining the energy by utilizing the energy of flow water when entering and when exiting the sluice. This data is evaluated to convince wheter or not the flow of water feasible to convert into mechanical energy.

This is done to ensure a constant supply of energy, where one of the weaknesses of the energy derived from tidal power production is not constant and is not continuous due to the difference in height. To obtain this constant energy in several countries carried the water energy system alloys connection with other energy sources to create constant energy output. but in this dissertation, we try to make the concept of sustainable energy use so that approaches a const ant energy supply and stable. Small scale hydro energy or micro-hydropower has been widely used as a renewable energy resource, especially in areas where scarce energy. For example in areas far from power and out of reach of electricity distribution networks, remote and rural areas. In these conditions, hydropower can be used especially because one of the properties of hydropower that can be mounted on a small river canals or a canals with a continuous flow of water with a relatively small impact on water biota that exist in the canals.

To convert water energy into power can be done using an instrument called a water turbine. Based on how it works, the water turbine can be classified into two categories, namely:

- Reaction Turbine
- Impulse Turbine

Both types of turbines are distinguished by the shape of turbine blades, how it convert the water power into energy and the capacity of power generated.

In reaction turbines, water media works by changing the pressure on as it passes through the turbine blades and produce energy. Turbine should be given a skin

reaction (encased) to accommodate the water pressure and fully immersed in water flow. Most water turbines and reaction turbines are used at low head (<30m/98ft) and medium (30-300m/98-984ft). In a reaction turbine pressure drop occurs in both the fixed blade and the moving blade.

Reaction turbines change the velocity of water jet. Jet is hitting the turbine blades that alter the direction of flow thus causing a change momentum (impulse) that give rise to forces on the turbine blades. Before hitting the turbine blades, water pressure (potential energy) is changed into kinetic energy and concentrate it through a nozzle to the turbine. Includes the type of reaction turbines are: Francis, Kaplan, Propeller, Bulb, Tube, Straflo, Tyson, Gorlov, Water Mill, Turbine Archimedes screw.

Impulse turbines work on the basis of water flow rate. Energy momentum of the water hitting the turbine blades and turbine wheel. Small impulse turbines require a small amount of water but requires a great height. The type of the impulse turbines are: Pelton, Turgo, Michell-Banki (also known as the Crossflow or Ossberger turbine).

III.2.Turbine Selection

Experience and technical studies have been conducted in various parts of the world have made use of checklists based turbine 'head' and the volume of flow available. In general, the selection of the turbine can be done by referring to the chart below.

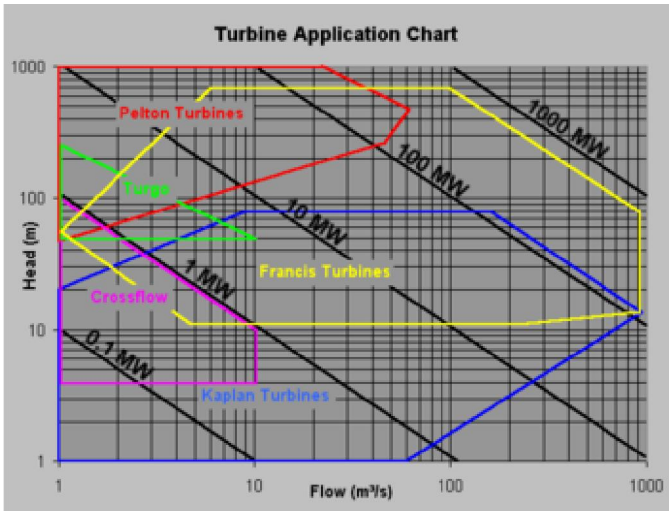


Figure III.1. Turbine selection on the base of Head and Mass flow. (Wikipedia,2010)
http://en.wikipedia.org/wiki/Water_turbine
http://www.copperwiki.org/index.php/Mini-Micro_Hydro_Power_Plants

Selection of turbines is generally based on the available water head and volume of flow available. In general, impulse turbines are used to place the 'head' is large and reaction turbines are used for a small head. Kaplan turbine is one type of reaction turbine with an adjustable blade that can be used for volume flow and 'head' with a large range of values, where the efficiency remains high

Small turbines with a power below 10 MW can be made with the horizontal axis and for large turbines with power up to 100 MW can pivot vertically .. Francis and Kaplan turbines are generally made of vertical pivot, because the consideration of ease of use head available and make the installation of a generator more economical. While it can be made vertical Pelton turbines horizontal because the smaller engine size of the 'head' is available. Some impulse turbines use multiple water jets (multiple water jets) per-runner to increase specific speed and balance of forces 'thrust' on the shaft

Typically ranging Head for a variety of water turbine

- Hydraulic wheel turbine $0.2 < H < 4$ (H = head dalam meter)
- Archimedes' screw turbine $1 < H < 10$
- Kaplan $2 < H < 40$
- Francis $10 < H < 350$
- Pelton $50 < H < 1300$
- Turgo $50 < H < 250$
- Michell-Banki $3 < H < 250$

(Azad Engineering India, 2010) http://www.copperwiki.org/index.php/Mini-Micro
(Wikipedia,2009) http://en.wikipedia.org/wiki/Water_Turbine
(Alpensteel,2010) http://alpensteel.com/article/50-104-energi-sungai-pltmh

Regarding the flow of water that is being the object of study is of low head , theoritically the feasible kind of turbine applied is Hydraulic wheel turbine.

III.3. Waterwheel

In the past, the general form of water wheel was made from wood that installed blades (bucket) surround it which also made of wood. Water turbines can operate with a vertical axis or horizontal axis. In the mid-20th century water mill in Britain and the United States is a waterwheel with a horizontal axis, while the vertical axis waterwheel located in the highlands of Scotland and Southern Europe. The water mill is a type of water turbine suitable to operate on the 'head' as low as two meters below. Water mill operates the largest ever in the world is the Laxey Wheel, with a diameter of 22.1 meters wide by 1.83 meters located in the village of Laxey, Isle of Man.

Generally, hydro-power uses the potential energy of dammed water to drive turbines and generators. The energy generated depends on the volume and the different heights of water in and out. This height difference is called 'head'. The amount of potential energy in water is directly proportional to the 'head'. It is used to concentrate the flow of 'penstock' towards turbine blades.

The following figure shows the mechanism of the utilization of tidal energy to the dam to turn turbines and generators

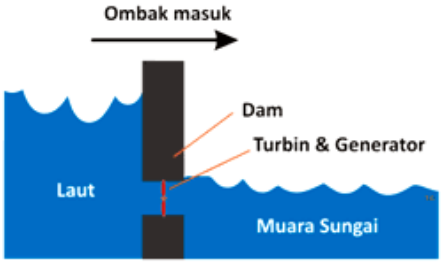


Figure III.2:The water flow into dam when the tide come in (Thicon Gunawan, 2008)
http://majarimagazine.com/2008/01/energi-laut-2-pasang-surut

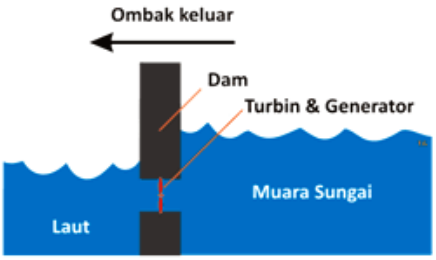
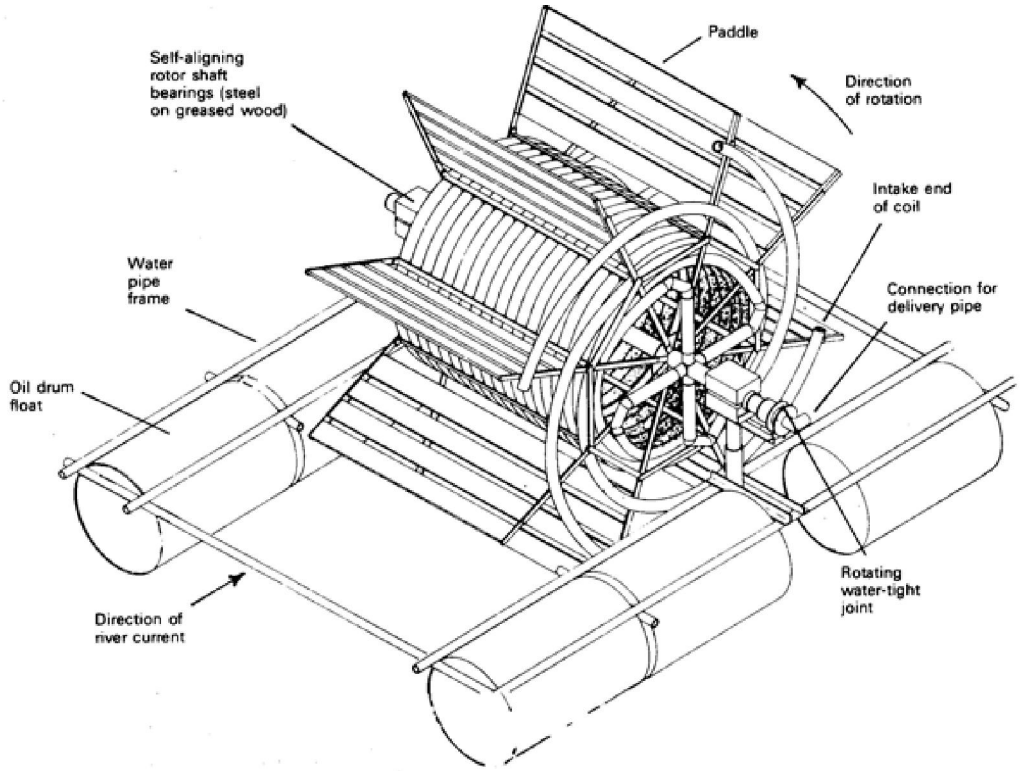


Figure III.3:The water flowing out of dam when ebb (Thicon Gunawan,2008)
http://majarimagazine.com/2008/01/energi-laut-2-pasang-surut

Small-scale electricity generation is needed, especially to remote areas where electrical connections are not easy to do. Small-scale plant for production is classified under 10 megawatts. Small-scale power plants do not require a large installation cost, sophisticated technologies and huge costs on the project as a great power. Micro-hydropower plant can be installed simultaneously with irrigation projects, flood control projects. Small-scale power plants can be divided into mini-hydropower to power about 1 MW and micro-hydropower under 100 kW



Gambar III.4 : Waterwheel as pump generator.
Source: Water power, http://www.otherpower.com/otherpower_hydro.html

Water mill (Waterwheel) is one of the devices used to alter the flow of water into mechanical energy in a small scale. Based on its position against the flow, the water wheel can be divided into two parts, namely the Horizontal Waterwheel and Vertical Waterwheel. Vertical axis windmill Water is the oldest type of water turbine in the world, while the horizontal axis water wheel is a type of development that comes after it and most widely used until late 20th century. (Monition, 1986). Water mills first appeared with Vertical axis made of wood and called Norse Mill. Water is a horizontal axis windmill development after that. Similar windmill better and made of metal starting from the early twentieth century. Water has a vertical axis windmill efficiency low. Water vertical axis windmill with efficiency of 20% was the best performance, a vertical windmill is generally not more than 15%. (Monition, 1986). Water turbines horizontal axis has a better performance than the vertical mill, which is approximately 30%. Water turbines horizontal axis can be divided into three types. Based on water jetting position against windmills, water mills horizontal axis can be divided into three kinds, namely:

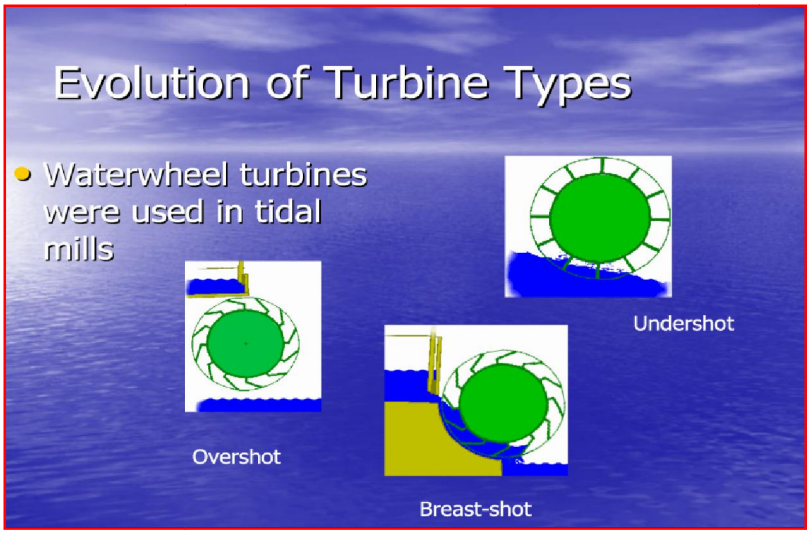


Figure III.5: Waterwheel types.

Source: Tidal Power, Cause 2003 Final Project, Pete Clark, Rebecca Closner, Lauren Cologe
htttp://www.ems.psu.edu/~elsworth/courses/cause2003/finalprojects/canutepresentation.pdf

1. Upper flow (overshot), namely the water wheel with a flow of water through the top side.
2. Central Flow (Breast-shot), namely the water wheel with a central flow (chest)
3. Down stream (undershot), which is below the water wheel with the flow.

Good planning and careful experiments conducted by John Smeaton (1724 - 1792) shows that the efficiency of the water wheel type Flow Up to 60% or two times greater than the horizontal water wheel type with Flow Down (undershot). Middle Windmill Water flow is more efficient than the stream bottom, but less efficient than the flow top. Windmill Water Flow Top benefited from the force of gravity to the volume of water entering the turbine blade, so that power is generated not only from the kinetic energy comes from water runoff but also from the potential energy derived from the difference in height. Top Flow windmill suitable for use when there is a 'head' of approximately 2 meters. For the 'head' under the mill scale flow is less suitable for use Top, but more suited to the Middle while the Wheel Flow to Head of less than one meter used is the Lower Mill Stream.

The results of research conducted at the Francis by Jean-Victor Poncelet (1788-1867) suggests that two conditions must be met for maximum energy produced. Both these conditions are, first: Water entering the turbine blades should not experience turbulence and the second: Water must be losing speed he had at the time leaving the turbine blades. With reference to both these requirements then the flow of water

turbines Bottom (undershot) can reach and have an efficiency of up to 60-70%. (Monition, 1986) This is the maximum efficiency can be achieved at the Lower Mill Water Flow based on research results.

Figure III.6: Waterwheel is used for water aeration.

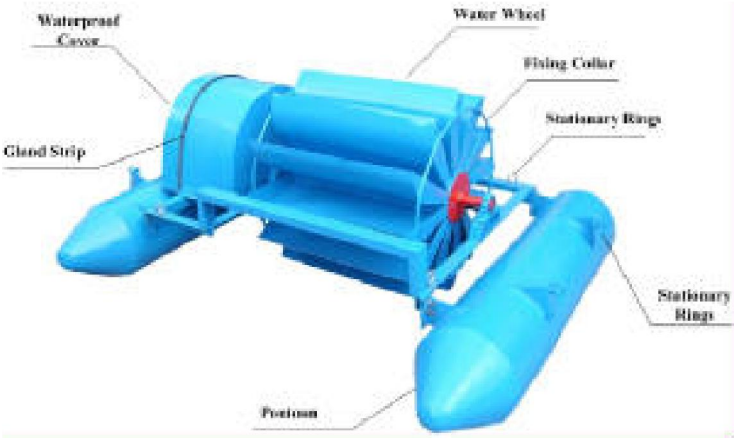


Figure III.7: Waterwheel as electricity generator.

III.4. Tide and Tide Type

There are two high tides and two low tide around the world every time. High tide line is at one with the moon and low tide is at line 900 of the earth-moon line. The difference in height between high tide and low tide is called ranging Plug (Tidal Range). Pairs in the middle of the ocean ranging between 0.5 to 1.0 meters. Ranging

these pairs will be enlarged on the strait and the bay area. For example in the UK Bristol Canals, can reach 13 meters.

The main cause is the effect of pairs of the Moon, while the effects of the sun is half thereof. Tidal energy generated by relative motion of water that interacts with the force of gravity. Water level changes that occur periodically is related to the gravitational pull of the Moon and the Sun. Magnitude pairs at a location on earth is determined by the change in relative position to the earth moon and sun,

Earth's rotation and the effect of local shape of the seafloor and the coastline .. The second factor that controls the plug on the surface of the earth is the sun's gravity. The average height of the sun's tidal effect is half of the tide due to moon. At one time, because the moon rotates to the earth, then there will be times when the moon, the earth and the sun will be on one line, where the gravitational pull the moon will cooperate with the gravitational force of the sun. At the time it will happen Replace Purnama (Spring Tides), which occurs when the highest tide in the earth's axis is aligned with the Earth-Moon-Sun and the lowest tide on the vertical axis of the earth surface. Put these occurred at new moon and 14-15 days after that.

Time pairs associated with the rotation of the earth and the moon to the earth's rotation. If the moon is a celestial body at rest, then the tide cycle is 24 hours. In fact the moon to the earth rotates about 27 days per cycle, so adding 50 minutes to the tidal period. So long a period of tide is 24 hours 50 minutes.

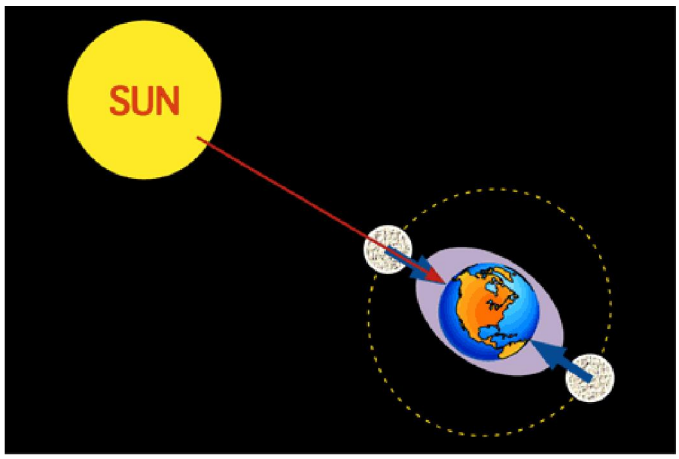
Because the tide in the earth's surface is a style associated with the interaction of the Sun and the Moon's gravity and Earth's rotation, then the tidal power can not be destroyed or removed, and because of tidal power is categorized as a renewable energy source.

A tidal power plant will utilize this phenomenon to get the water to turn a generator of energy. The greater the tidal ranging, both altitude and speed of tidal currents, the greater the potential energy to generate electricity ..

This tidal movement has caused a continuous loss of energy in the Earth-Moon system with respect to pumping water through natural boundaries around the coastline as well regarding the energy lost due to viscosity on the seabed and in turbulence. This energy loss has caused the Earth's rotation slows down uniformly in 4.5 billion years since Earth's formation. During the period of rotation of the earth 620 million years old has increased from 21.9 hours to 24 hours per-day and night. We see that in this period the Earth has lost 17% of the rotational energy. Tidal power while

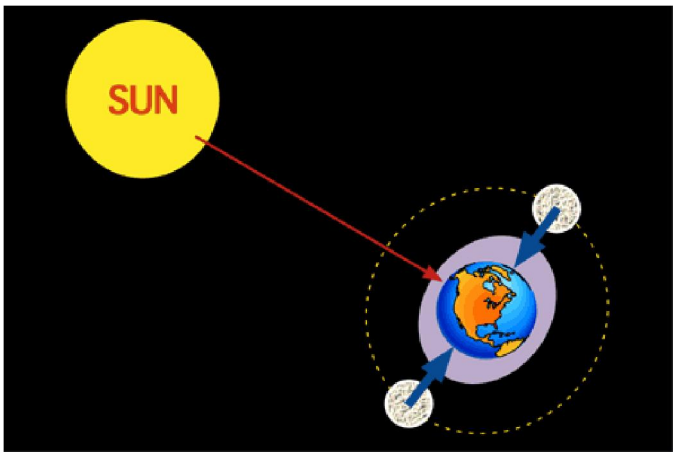
increasing its energy from the Earth-Moon system. Loss of power rotation can only be evaluated in the number of millions of years, so it can be ignored.

There are two forms of the tides, the first Spring Tide (Pasang Purnama). Pasang Purnama occurs when the Moon, Earth and Sun are in a line. This occurred in the early months and on the fourteenth day of the calendar month. At this time the tide is at its lowest and highest positions throughout the year.



Gambar III.8 : Pasang Purnama (Spring Tide)
Source: http://www.physicalgeography.net/fundamentals/8r.html

. Pairs form the second is a Neap Tide (Pasang Perbani), where the position is to attach the sun, earth and moon form a perpendicular angle. At this time, high tide is at its lowest position. This phenomenon occurs on day seven and day 21 of the calendar month

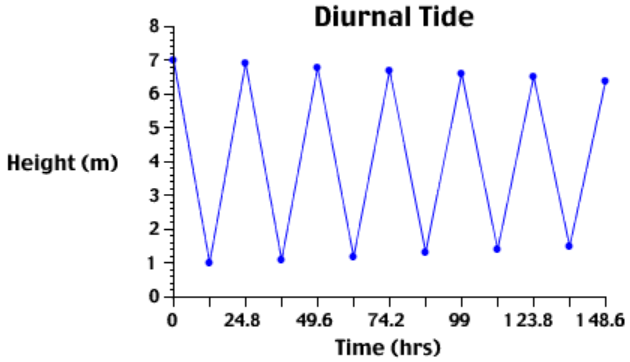


Gambar III.9: Pasang Perbani, occur when the position of Earth, Moon and Sun Form an angel of 90 degrees.
Source: http://www.physicalgeography.net/fundamentals/8r.html

The timing of the tides associated with the Earth's rotation and revolution of moon around the earth. If the moon is still room air, tidal cycle will be 24 hours long. But the moon rotates around the earth. Once the rotation takes 27 hours plus 50 minutes of tidal cycles, so the length of the tidal period is 24 hours 50 minutes and 28 second. (Rourke,2009)

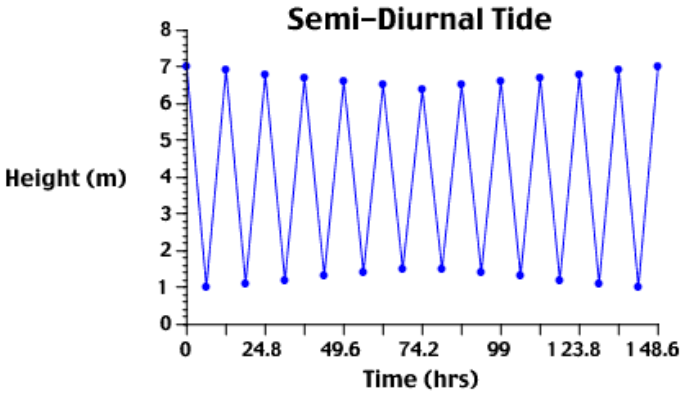
There are three types of tides, namely: Attach Diurnal (Diurnal Tide), Place Semi-Diurnal (Semi-diurnal Tide), and Post Mixed (Mixed Tide). These three pairs of different types are determined by the geometric relationship of the Moon and Sun locations on the surface of the earth.

In the Gulf of Mexico and Southeast Asia, is one high tide and one low per day. These pairs are called Post Diurnal (Diurnal tides).



Gambar III.10 : Grafik Pasang Diurnal dalam sehari
Source: http://www.physicalgeography.net/fundamentals/8r.html

Semi-Diurnal tide (Semi-diurnal tides) has two levels of altitude and two low-level pairs per day. This phenomenon is usually in the Atlantic Coast of the United States and Europe.



Gambar III.11: Grafik Pasang Semi-Diurnal
Sumber: http://www.physicalgeography.net/fundamentals/8r.html

Many parts of the world experiencing Post Mixed (Mixed Tides) where the turnover of high water and low water is different at each location. In pairs of this type, we find the highest high water and high water sec-also the lowest low water we found the highest and lowest low water. This type of tide is found in the Regulations and the West Coast of the United States.

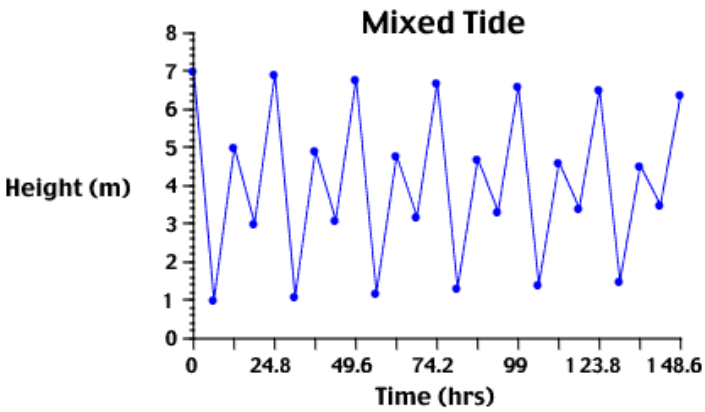


Figure III.12: The graph of Mix Tide
Source: http://www.physicalgeography.net/fundamentals/8r.html

According to Physical Geography. Net, Southeast Asia has type Diurnal tide, where there is one highest and one lowest tide of each tidal day (calendar month).

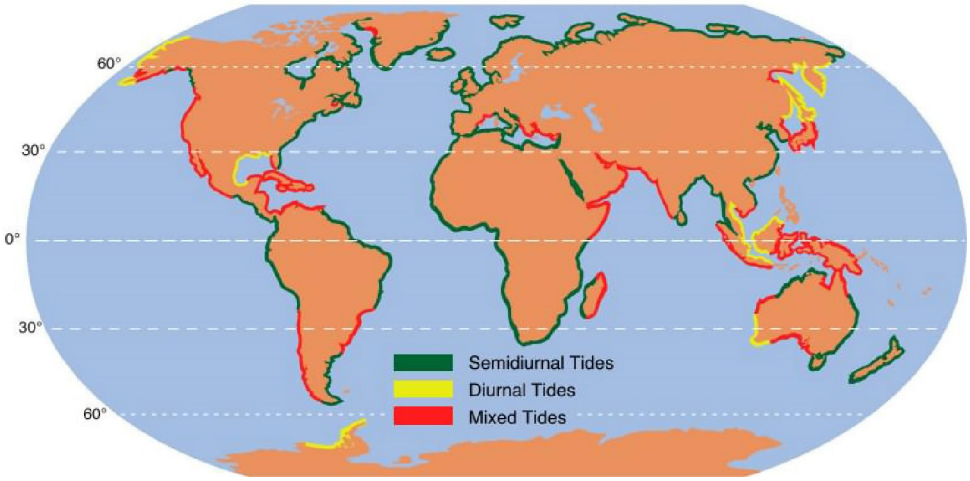


Figure III.13: Global distribution of tides on shores on earth, where most of beaches have semi-diurnal type.
http://www.physicalgeography.net/fundamentals/8r.html

III.5. Telang II – Banyuasin

Geographically located at the position Banyuasin regency between 1.30 ° - 4.0 ° South Latitude (LS) and 104 ° 00 '- 105 ° 35' East Longitude (BT) which extend from and the central part of South Sumatra Province to the East with a total area of 11,832,99 km2 or 1,183,299 hectares.

Table III.3. Number of People in Villages in the Region Survey Year 2007

No	Kelurahan/ Desa	Jiwa			Jumlah
		Laki-laki	Perempuan	Jumlah	KK
1	Purwosari	687	719	1.406	341
2	Telangsari	1.078	1.122	2.200	534
3	Mulayasari	1.390	1.448	2.838	689
4	Banyuurip	1.889	1.953	3.842	933
5	Bangunsari	1.515	1.585	3.100	752
6	Sumbermekarmukti	1.130	1.170	2.300	558
Jumlah		**7.689**	**7.997**	**15.686**	**3.807**

Source : Monografi Desa Masing-masing Tahun 2008

Table III.4. Average Area per Head of the Family in Villages of Region Year 2007

No	Kelurahan	Luas Wilayah	Jumlah KK	Rata-rata
		(Km^2)		Luas (Ha) Per KK
1	Purwosari	14.00	341	4,1
2	Telangsari	28.40	534	5,3
3	Mulayasari	20.00	689	2,9
4	Banyuurip	16.00	933	1,7
5	Bangunsari	14.40	752	1,9
6	Sumbermekarmukti	17.00	558	3,0
Jumlah		**109.80**	**3.807**	**2,9**

Source : Monografi Desa Masing-masing Tahun 2008

Based on the data area and the number of households in each village / village, it can be estimated average area for each family head. Based on these parameters, it appears that the Village Telangsari, indicate the number / value large enough between the villages of the other, that is 5.3 hectares per family. Meanwhile, with characteristics similar to village Bangunsari and Banyuurip is much smaller, each of the numbers of 1.9 and 1.7 hectares per family.

Residents in the survey area is a community transmigrants from areas of West Java, Central Java, East Java and DI. Yogyakarta, which is placed in this area around 1983. Condition of the community's business survey area is currently classified as already quite advanced, with the rice commodity as its superior. Although only one crop in one year, but the productivity of land is quite high, reaching 4-7 tonnes /

hectare. Transmigration program in accordance with the existing average land ownership society in this area is 2 hectares per head of the Family.

Telang II Delta swamp locations where the work performed design review located strategically across the region because it is not too far from the city of Palembang. The distance of about 45 km to the old role of about 1 hours drive and intermediate region between the cities with the port of Tanjung Api-Api. With the location of such a population growth and changes in the area happened so very quickly. As a result of this strategic cross the region has ever built before megalami changes. Information about the picture of the land, the channel network systems and existing buildings in this area is the area of the proposed concept is the basis for further planning

More than 17% of gross domestic product (GDP) was obtained from pertania sector with a growth rate around 3%. Status of food crops in the agricultural sector is very prominent because it is the largest contributor, which is about 62% in 1990. In addition, the agricultural sector is also the largest absorber of labor. Approximately 35.45 also workforce or 72% of the total available labor absorbed by the agricultural sector.

Topography

District Area Banyuasin around 11832.99 km^2, lies between 1.3 o - 4o south latitude and 104O 40 ', 105O 15' east longitude. Most of the district is lowland Banyuasin located at the downstream flow of rivers and river Musi Banyuasin. Almost 80% are low-lying areas of tidal marsh and lowlands, while the remaining 20% is dry land with flat to undulating topography and rolling hills with a height of 20-140 meters above sea level. Slope ranges from 0% to a maximum of 2%. Topography measurement results show that the condition of the land area of 5,000 hectares of relatively flat with an average elevation of +6.60 m, the lowest land elevation + 5.90 m and +7.34 m. The highest land Job sites are in rural areas Telang Sari, Sari Mulya, and partly in the Banyu Urip.

Hydrology

In the area of tidal marsh, hydrology analysis emphasis on analysis of rainfall, water balance (water balance) between the availability of rain water for plant needs, the amount of disposal to reduce the discharge of excess water, and tidal influence on

job sites.

Rainfall data used as the basis for the analysis of rainfall data recorded at Sultan Mahmud Airport rainfall station Badaruddin II, Palembang, with the length of the data for 12 years (Year 1997 to 2008). The results of the analysis show that the maximum annual rainfall of 3542.50 mm, occurred in 2007, while the lowest 2089.50 mm, occurred in 1997. The highest maximum daily rain is 278.30 mm, while the highest average daily rainfall is 9.40 mm throughout the event. The highest monthly average of rain is 344.61 mm, occurred in March, while the lowest was 81.23 mm occurred in August. Climatological data, yielding the value of long sun shines an average of 66.9% varied between 52.4% in January and 80.0% in July. The maximum air temperature was 32.6 ° C and minimum temperature of 22.4 ° C. humidity hádala average annual 83.2% with a range of 80.0% (September) and 85.3% (December). The wind speed varies between 1.6 km / h (November) and 2.7 km / h (January) with an average of 2.1 km / h, and according to Baufort scale, wind speeds classified in the "weak wind-being".

Projected water deficit is likely to occur in June, July, August and September. Frequency analysis of maximum daily rain to get some extreme daily rainfall values when repeated 5, 10, 25 and 50 years as shown in 170.62; 200.53; 238.33, and 266.37 mm respectively.

Water requirements for crops

Consumptive water requirements for plants are the water requirements for the continuity of life that no other crop is the amount of crop evapotranspiration (ETC). ETC values are influenced by: temperature (air temperature), sunlight, humidity, and wind speed. Crop evapotranspiration can be calculated by the equation:

ETC = kcETo, ...(3.1)

By kc is the crop coefficient and ETo is evapotranspiration constants (mm / day). Kc and ETo values changed between the time according to changes in local climatology, more specific crop coefficient kc, influenced by the types and varieties of plants. Crop coefficients for the based on research conducted by FAO and Nedeco.

Constant evapotranspiration (ETo) is calculated by means of empirical data based on evaporation. When evaporation is measured at the station agrometeorolgi, then it is

usually used pan evaporation Class A. The prices of pan evaporation (Epan) converted into the value of ETo to introduce a pan coefficient (Kp) whose value ranges between 0.65 and 0.85 depending on wind speed, relative humidity and elevation, with the following equation:

ETo = Kp. Epan, ... (3.2)

Nila ETo from Penman evaporation formula on the basis of the reference crop albedo 0.25; so that crop coefficients used to calculate ETo etc, should be based on this with albedo of 0.25 as well. The results according to FAO kc values varied between 0.95 to 1.10, while according Nedeco kc values vary between 1.20 to 1.33. By taking the value of kc at 1.33, then based on ETo values that have been calculated, then the obtained value of ETC consultants calculated monthly as shown in Table 3.1.

Based on the results of a calculation of rainfall data collected, the balance between water availability (average monthly rainfall, Rbln) with the water requirements for crops (crop evapotranspiration, etc) can be seen in Table 3.1 and Figure 2.1 below. Water deficit occurred in June, July, August and September, while other months have a surplus. On the basis of this analysis, the cultivation of rice (once a year) can be started in November. If patterned to plant rice 2 times a year, should be planted rice varieties of short-lived (105 days).

Bulan	R_{bln}	$ET_{c\ bln}$	ΔS	Ket
Jan	287.67	182.28	105.39	surplus
Peb	213.59	179.95	33.64	surplus
Maret	344.61	177.82	166.79	surplus
April	308.83	159.92	148.91	surplus
Mei	172.08	161.73	10.36	surplus
Juni	120.23	146.09	-25.86	defisit
Juli	122.31	158.00	-35.70	defisit
Agust	81.23	193.74	-112.51	defisit
Sept	90.60	205.35	-114.75	defisit
Okt	247.85	202.72	45.13	surplus
Nop	320.68	185.88	134.79	surplus
Des	328.34	174.48	153.86	surplus

Table III.5. Water Balance the between Rain value provided by the water requirements for Plants

Water Quality

Water quality in the tidal swamp area is determined by:

a. Soil properties, especially the depth and state of pyrite, as well as the thickness and

state of peat,

b. Drainage and irrigation systems,
c. Sluice arrangement, and
d. The frequency of flushing water in the land and channel.

Pyrite is the only substance found on the ground at any tidal area, which formed at the time of land flooded by sea water entering the dry season. At the time of wetlands or stagnant conditions, pyrite is not harmful to plants. However, when exposed to air (oxidized), pyrite transformed into iron and sulfuric acid which can be toxic to plants. Pyrite can be exposed to the air if: raised to the surface of the ground (eg at the time to cultivate the land, making the channel, or create surjan) or when the surface of the ground water falls (eg during the dry season). Thus the system of water management in the tidal swamp land is done by one-way flow system. One channel used as channel revenue tertiary irrigation and drainage channels to be a quarter of tertiary drainage channels. Shallow channel is also required around the mapped fields. These channels serve as a conduit dealer near quarter, irrigation channels and collecting ducts as a quarter near the drainage channel. In the plot of paddy field also made intensive shallow channel which serves to wash the acid substances and toxic substances from the land. Inter-channel spacing varies depending on the constraints of land that can be set as follows:

a. Land with a pyrite content in the channel created with a distance of 9 m or 12 m,
b. Land with pyrite content of shallow channels made with a distance of 6 m or 9 m,
c. In acid sulfate land created a channel with a distance of 3 m or 6 m,
d. On land the channel bed is made within 3 m.

Balance that exists between the oxidation and leaching sufficient to maintain the soil becomes sour. It is important to finalize the ground with a low density of immature to implement a system of shallow water settings. To accelerate the maturation process of this type of soil, the soil water during the dry season to be lowered 60 cm below the soil surface. On land that has been cooked quite possible the use of irrigation pumps and tractors combined with the creation of "plow-layer" (immature soils can not maintain a pool of water on the land).

The results of water quality, water pH of 6.28, while the quality of the permitted between 6.5 ~ 8.5, so that the location of the work enables the development of

agricultural areas to plant rice during the rainy season and planting palawijo on the outside of the rainy time.

Socio-Economic

Location of work is quite close to the city of Palembang, is only + 45 km towards the direction of Tanjung Api-api, and can be reached by four wheel drive vehicles. Private vehicles can go directly to the location, with a smooth asphalt road conditions, so a trip to the location can be reached with a time of 1 hour. Based on the work, the study area includes 8 villages namely administrative Mekarsari Village, Village Bangunsari, Banyuurip Village, Village Muliasari, Village Telangsari, Sukadamai Village, Village and Village Sukatani Muarasugih, all of which belong to the Cape Lago District, District Banyuasin. Banyuasin Regency is a district that has the potential expansion of human resources is quite large in South Sumatra. In mid 2006, the population of District Banyuasin 757.3 thousand inhabitants. While in 2007 there was an increase to Rp 778.6 thousand inhabitants. The increase also occurred in 2008. In mid 2008 the number of conditions.

District population of 790,360 souls Banyuasin. In 2008 also increased the number of residents. In that year recorded a population District Banyuasin in pertangahan year approximately 798,360 inhabitants. The population is large enough it may indicate that there is a potential human resources are quite large.

Equal distribution of the general population may help in efforts to increase prosperity, therefore in the population distribution business ideally in line with the composition of the population of a wide spatial area. In the municipality there are 15 districts Banyuasin in total area is about 11,832.99 Km^2, so the average population density in 2007 amounted to 65.80 jiwa/km^2. Along with the increase of population, population density in Banyuasin also increased. In 2006 the population density of 64.01 jiwa/km2, whereas in 2005 amounted to 62.02 jiwa/km2.

The rate of population growth in the period 2005 to 2008, fairly stable. In 2006 the district population growth Banyuasin amounted 1.69%, whereas in 2007 has decreased from the previous year, amounting to 1.58%, although nominally experiencing population growth as described above, whereas in 2008 the population growth in District Banyuasin amounted to 2.58 percent. In conclusion Banyuasin District's population from 2006 to 2008 have continued to rise sufficiently low. If

connected to wide area, in 2008 District Banyuasin still a sparsely populated area, with a population density of 67.47 jiwa/Km^2.

Banyuasin diverse livelihoods, but the dominance of the type of work are: industrial / processing, agricultural, and civic buildings. Gross Regional Domestic Product (GDP) is a key indicator in measuring the growth of the economy of a region. Regency GRDP Banyuasin with oil at current prices during the last three years are as follows: in 2006 at 7,029,269 million dollars, in 2007 amounted to 8,158,813 million dollars, and the year 2008 amounted to 9,884,371 million dollars.

Banyuasin economic growth with oil and gas in 2008 reached 5.42 percent. This figure is slower than in 2007 amounted to 6.17 percent. Meanwhile, economic growth Banyuasin without oil and gas grew by 5.78 percent. This value is also slower than in 2007 amounted to 6.53 percent.

The inflation rate by including oil and gas by 14.93 percent in 2008. If inflation is calculated without entering the oil and gas, inflation of 11.03 percent. Income per capita is the Gross Regional Domestic Product (GDP) on the basis of factor cost divided by the population mid-year. Banyuasin per capita income growth rates showed a rise in the period 2006-2008, the Gross Regional Domestic Product Per Capita of Rp. 4,308,229, while the Regional Per Capita Income of Rp. 3,554,289. Associated with design review, socio-economic surveys provide data on the results of the current farming per hectare amounted to Rp. 3.384.00,00 whereas if the project is carried out based on the analysis of income per hectare will be increased to Rp. 8,315,000.00.

Table III.6. Distribution of Land Area

No	Village Name	Area square (Ha)	Area condition
1	Tegal Sari	1787,27	• Kelapa planted 48,17 Ha • Sawit planted 135,43 Ha • Padi planted 1603,40 Ha • Luas rata-rata petak tersier 44Ha
2	Mulya Sari	1057,70	• Throughout Paddy planted • Luas rata-rata petak tersier 44Ha
3	Banyu Urip	1431,85	• Tertanami Padi seluruhnya • Luas rata-rata petak tersier 44Ha
4	Bangun Sari	1431,85	• Paddy planted througout • Luas rata-rata petak tersier 44Ha
5	Sumber Mekar	785,93	• Paddy planted throughout • Luas rata-rata petak tersier 44Ha

Sumber : Data hasil pengukuran, 2009

Primary Canal

To illustrate the following visual field survey included photographs in Figure 2.3. while the inventory of available channels 9567.33 m total line length of 5000 Ha area efekktif plan, and these channels can be seen in the following table.

Tabel III.7: Primary Canal

No	Nama Saluran	Nomenklatur	Panjang (m)	Jenis Saluran
1	Primer	Primer 17.1	477,00	Tanah
2	Primer	Primer 17.2	1009,14	Tanah
3	Primer	Primer 17.3	246,34	Tanah
4	Primer	Primer 17.4	959,59	Tanah
5	Primer	Primer 17.5	148,06	Tanah
6	Primer	Primer 17.6	950,52	Tanah
7	Primer	Primer 17.7	289,12	Tanah
8	Primer	Primer 17. 8	925,10	Tanah
9	Primer	Primer 17.9	146,97	Tanah
10	Primer	Primer 17.10	962,22	Tanah
11	Primer	Primer 17.11	216,89	Tanah
12	Primer	Primer 17.12	930,51	Tanah
13	Primer	Primer 17.13	152,35	Tanah
14	Primer	Primer 17.14	953,28	Tanah
15	Primer	Primer 17.15	249,39	Tanah
16	Primer	Primer 17.16	950,85	Tanah
17	Primer	Primer 17.17	894,95	Tanah
18	Primer	Primer 17.18	116,08	Tanah
19	Primer	Primer 17.19	919.56	Tanah

Sumber : Data hasil pengukuran, 2009

• Secondary Channels

Secondary channel conditions have largely been experiencing a lot of silt on the bottom line, but viewed in terms of form still has the look of the channel geometry which forms as a channel. In some of the channels has occurred avalanches Here some photos of the survey results presented as a general description Primary channel

conditions, as well as a list of 101,291.81 m along the secondary channel available in Table 2.10 and Figure 2.4.

Figure III.14: Secondary Channel

Figure III.15: Meeting of the Secondary and Primary Channels

Tabel III.8: Secondary Channel

No.	Saluran	Nomenklatur	Panjang (m)
1	Sekunder Utara	SDU 1 Utara	3850,57
		SDU 2 Utara	3852,03
		SDU 3 Utara	3841,82
		SDU 4 Utara	3861,24
		SDU 5 Utara	3860,61
		SDU 6 Utara	2001,85
		SDU 7 Utara	2004,83
		SDU 8 Utara	2103,83
		SDU 9 Utara	1971.55
2	Sekunder Selatan	SDU 1 Selatan	2037,90
		SDU 2 Selatan	2009,95
		SDU 3 Selatan	2025,58
		SDU 4 Selatan	3854,51
		SDU 5 Selatan	3854,10
		SDU 6 Selatan	3850,15
		SDU 7 Selatan	3801,46
		SDU 8 Selatan	3853,46
		SDU 9 Selatan	3858.0

Livelihood and Income Communities.

In connection with the continuation of agricultural development, structuring potential and untapped land use needs to be done. This situation is closely related to the effort that should be encouraged to increase agricultural production due to the development of socio-economic circumstances and cultural societies.
Condition of the Delta Wetlands project area Telang has the potential to be cultivated productive agricultural areas. Generally, residents in the survey area are subsistence farmers have, some other minor work as, entrepreneurs, carpentry, civil servants and services.

As farmers in the agricultural population of activity is by using rain-fed rice, beans, and cucumbers. The last two plants are only planted in the dike, or high ground, around the rice field. Its range is relatively small because it is only a sideline business only., While employers' annual plants (perennials), the main one is oil, then lanseh, durian, rambutan, and coconuts. The plants are grown outside the area of swamp rice fields which is a high land in the vicinity of rice cultivation.

To meet the needs of fat and animal protein, ordinary people catch fish in rivers and channels - channels contained in the survey area. Besides, some people raise cattle, buffaloes, goats, chickens and ducks.

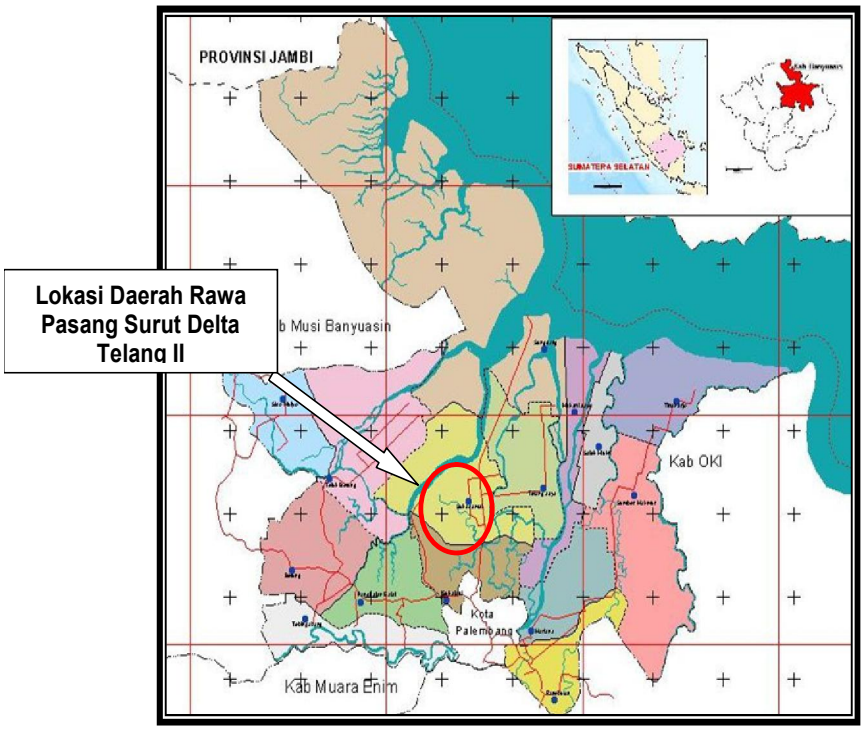
From interviews in mind that the income of the average - average farmer today is about Rp. 19,860,000, - per year. This income is net income from farm crops and have not been reduced by the cost of a day - the day that range between Rp. 35.000, - per day up to Rp. 50.000, - per day. Another farmer incomes, derived from the results of other farm including breeding, which generally reaches 50% of the income of rice farming.

Income of smallholders in the study area is generally much higher when compared with the results usahtani crops. In addition to the commodity price of oil

palm fruit is currently high enough in the market, the average oil palm plantation land ownership is also relatively wider. This condition brings the trend shift pattern society bog Delta Telang farm from farm to farm food crops into oil palm plantations.

Health

Judging from the state of the environment in the survey area, it appears that the people there are concerned about health. This can be seen from the health center and IHC who received positive response from local residents to take advantage of existing health facilities. Population health improvement efforts that have been done of health education through integrated health and the PKK which has been running pretty good. In the survey area of health-related problem is the availability of family latrines and clean water source for washing bathroom toilet (MCK). To meet the needs of drinking water a day - the day, residents in the survey area using well water and rain water bin. Based on visual observation of the water wells of the population indicates that the water is clear and odorless. But if the rain continued well water tends to become turbid, so that residents use rain water.



Gambar 1.1 Peta Lokasi Daerah Rawa Pasang Surut Delta Telang II

Tidal

Tidal observations are conducted on July 28, 2009 to August 12, 2009 in two places at the first location downstream of the primary channel at coordinates X = 475,956.332 Y = 708,924.726 and coordinates while the second location is at the upper primary channel at coordinates X = 464,578.604 = 707,266.036 and Y coordinates. Observations made by taking two different locations upstream and downstream of the primary channel with consideration to see the influence of tidal fluctuations of the channel and land from downstream to upstream channel at the site of work. The following Figure 2.1 is a tidal fluctuations that occur at both locations of observation.

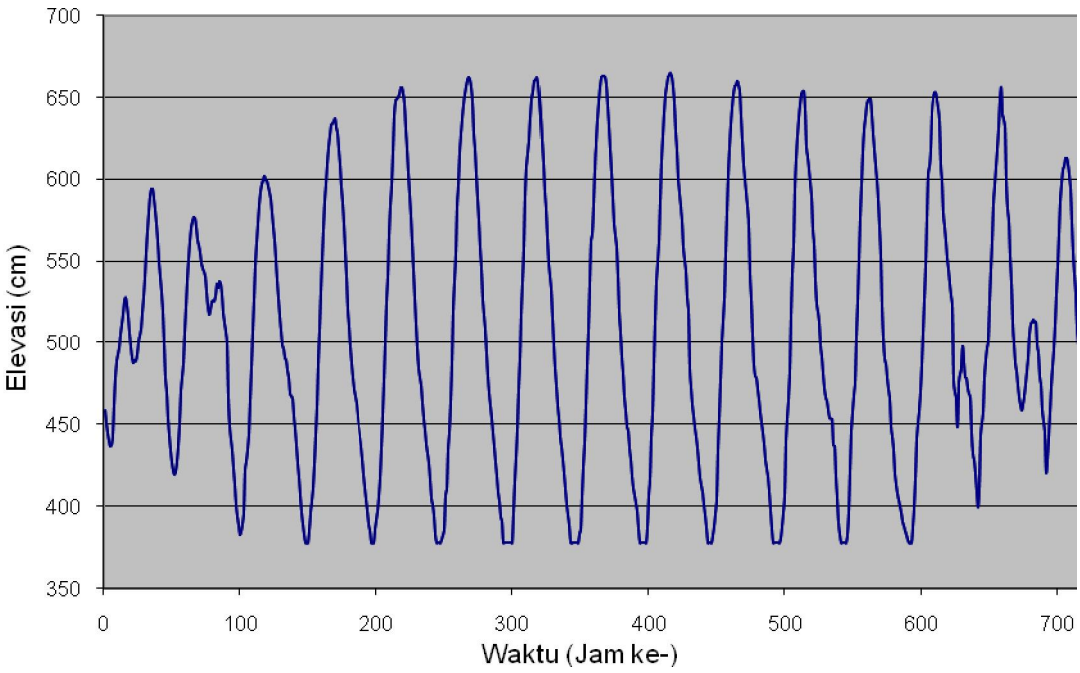
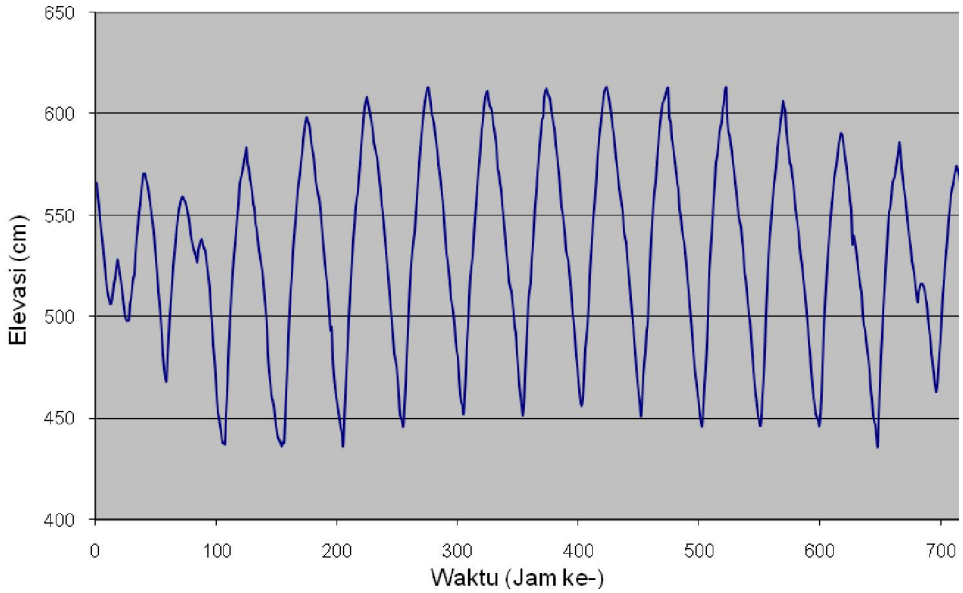


Figure III.16: Tidal fluctuations based on the elevation at Location 1

Tidal fluctuations are shown in Figure 2.1 shows the influence of tidal observations at the site of primary channel 1 with the highest elevation on the influence of tidal elevation hight +6.649 m and the mean water level (mean high tide) at +5.932 m elevation while elevation of the influence of low tide +3.779 m at the lowest elevation and the mean low water level (mean high tide) at an elevation of +4.497 m. Tidal conditions in Figure 2.2 shows the influence of tidal observations at the site of primary channel 2 with a height of tidal influence at the highest elevation hight

+6.132 m and the mean water level (mean high tide) at +5.689 m elevation while elevation effect at low tide +4.362 m elevation and the mean low water level (mean high tide) at an elevation of +4.805 m. Based on tidal height data in the primary channel and land topography, it may be concluded no effect of tidal water to inundate the land, but the effect on the channel. Tidal Predictions based on the book in 2008 from the Coordinating Agency for Surveys and Mapping Agency, 2007 tide stations that occurred in the Pacific tides (tidal stations nearest the project site) in July of 3.80 meters and the highest tide in December, the highest tide 4.20 meters. Analysis of the analog data on the Pacific station in 2008, then in December at the job site the highest tide occurs at an elevation of 3.27 meters or yards +7.049, if in July obtained the results of field measurements at an elevation of 2.87 meters or yards +6.649 on the location of measurement 1 (downstream).

This prediction shows that the area most of the area review disasin basih above the highest tide, only a small portion in the downstream area of the submerged tide.



Gambar III.17: Fluktuasi Pasang Surut berdasar elevasi di Lokasi 2

CHAPTER IV
METHODOLOGY

The canals are generally viewed as to irrigate the rice fields, drink water source, flood control, fishing, agriculture, tourism and education. Utilizing the tidal power at the irrigation canals will add the benefit of canals and will significantly contribute the social welfare and step-up productivity. The electricity may facilitate the people to activate at night, put on the radio and watching television.

Figure IV.1: The water control structures at Bangun Sari Village in Wet Season

Figure IV.2: The water control structures at Bangun Sari in Dry Season

With respect to the methodology this study will include the following phase:

Figure IV.3: A hut at the channel side with no electricity

IV.1. Beginning Phase

The Beginning, reviewing the previous studies on Waterwheel, finding the data related to Telang II – Banyuasin. Visiting the site location at Desa Bangun Sari, Studying the matters related to the tide and waterwheel; Collecting the book and journal related to energy generation and potential of tide in Telang area. Legally, this study is also known by the Local official and Public Work Ministry.

. The research begin with a discussion about visiting the site. The site is located at Kecamatan Tanjung Lago, Banyuasin district, about 45 kilometers from Palembang city. The location could reach by boat of three hours travelling or by car of two hours driving. Telang area is divided by Tanjung Api-api road, where Telang I is at the right of the road, and Telang II is at the left side, when we drive to Tanjung Api-api. The site is about one kilometer from the main road Tanjung Api-api. It is accessible by bike, motorcycle or by car, even sometimes it hard to access in rainy season. There are seven sluices have been developed in Telang II, all are at the secondary canals. The sluice is situated at 50 meters from the primary canal. The sluice choose is at 2.381 South Latitude and 104.42 East Longitude by considering the inhabited site and simplifying the data taking.

The research also begins with the small discussion and opinion exchange with officials from Public Works Ministry. The agreement from Public Works Ministry is then continued to ask permit to Camat Tanjung Lago and Desa Bangun Sari Head to

perform research on the location at the village. Some preliminary research is taken afterwards,i.e:

- Photoing the location and the surround of it.
- Videoing the flow of water at the water control structures.
- Positioning the location by using GPS (Global Positioning System).
- Measuring the real sluice sizes, mainly the passage of water and the space available on it.
- Measuring the flow of water by using current meter and recording the level of water by each passing hours regarding the increment and decrement of tide.

IV.2. Data Collection and Analysis

Data Collection and Analysis, includes:

- Finding the physical data of Desa Bangun Sari.
- Contact the local Farmer Group,
- Take photo surround the location and carry out measurements at water control structures.
- Finding the relevant references and write down the data.

The data collected by direct visit to the site of research location. The physic data taken by measurements, interviewing the people around the location and ask questions to the local officials. Social data taken from the Head of Village and Staff.

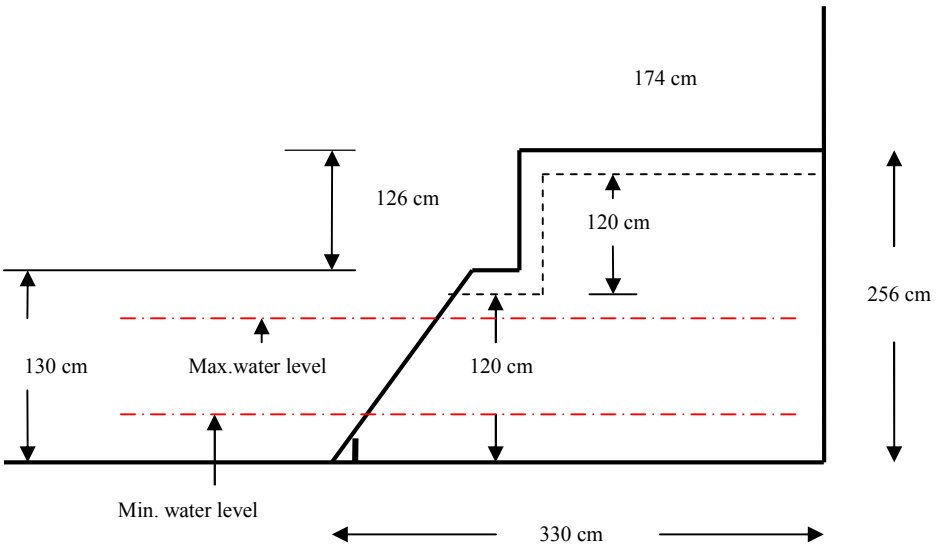


Figure IV.4: Schematic of the water control structures.

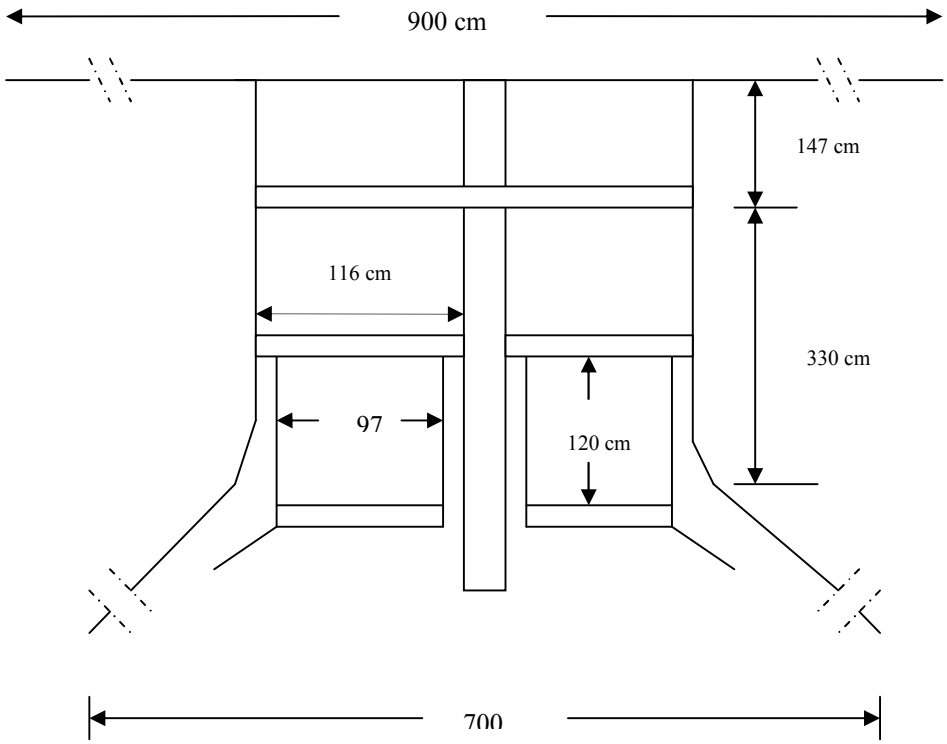


Figure IV.5: Top view of the water control structures.

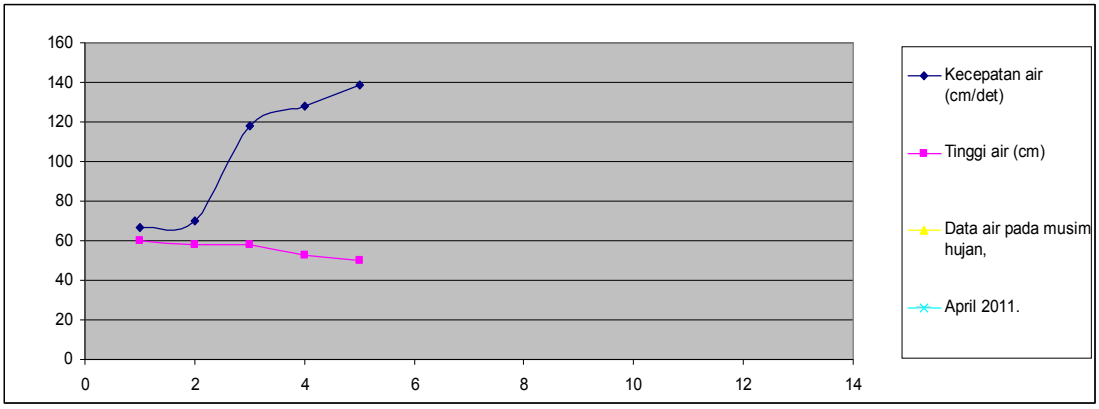


Figure IV.6: Diagram of water level and the velocity of flow at the water control structures

at wet season.

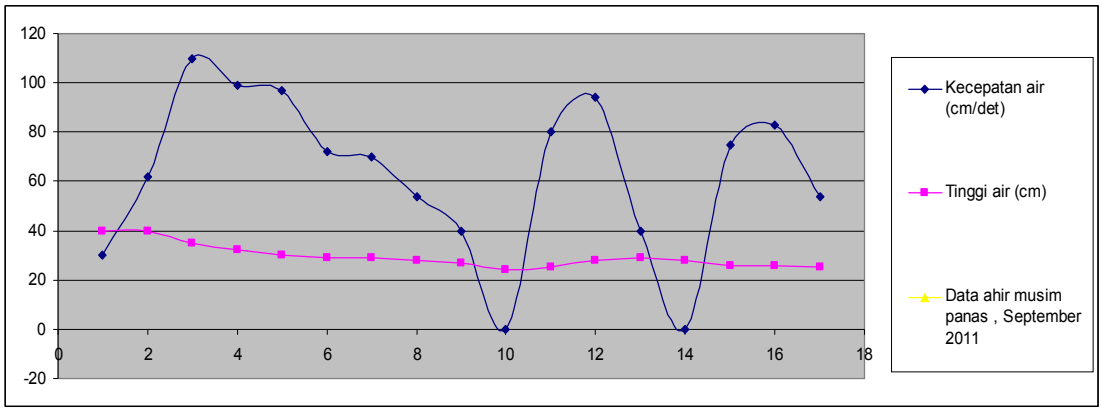


Figure IV.7: Diagram of water level and velocity of flow water at the water control structures in dry season.

IV.3. Designing The Waterwheel

Developing the idea by designing the waterwheel on the base of water control structures space and manufacturing the waterwheel as designed. The power harnessed from the flowing water will measured directly at the water control structures. The waterwheel will developed in three forms of the same size of in diameters and in blade area, but difference in sum of blades,i.e: 6 bladed 9 bladed and 12 bladed. The performance of the waterwheels are tested directly at the site, by measuring the shaft horse power at the peak of wet season and at the end of dry season. From the tests and the measurements, the performance is recorded and the choice is taken for the best performance, but the minimum blade required is likely. It refers to the intention to get a good performance with little disturbance to the main irrigation function to watering the rice fields.

The diameter of the wheel can not made freely in size, mainly because of limits to the water control structures. The diameter of the wheel is consist of the wheel core diameter and the length of blade attached surround it. The diameter of the waterwheel will determined on the base of the availability of sluice space when the water level is at maximum level in wet season.

Material is an important factor in order to get an optimum lifetime of the device. The material became important consideration regarding the environment where it works is water which at dry season, it normally seawater with high chloride concentration entering the canal. Seawater is highly corrosive compared to river fresh water. For this purpose, material is selected from some consideratios as the base of decisions concerning the lifetime of the device, the effectiveness of the work and the

resistance to corrosion attack, it is intended to have materials with following properties:

1. Resistance to corrosion.
2. Light metals and easy to joined by any means of thermal or mechanical.
3. Easy to form and any other manufacturing processes.

For the above purpose, the following materials are sufficiently fullfill the requirements:

a. Alluminum base alloy.

b. Stainless steel of austenitic type. This material resistance to corrosion, but relatively heavy and hard to formed.

c. Non-metal materials, such as Fibreglass, Poly Vinyl Chloride, Plastic, Acrylic, Asbestos and Wood.

IV.4. Shaft Horse Power Measurements

Measuring Shaft Horse Power generated by waterwheel by using the moment balance to find power at relevant revolution per-minute of the wheel.

The calculation is as followas: $Mt = 71620\ N/n$

Where: Mt = Torque (Kg-cm)

N = Power (HP or equal to 7500 Kgcm/Sec)

n = revoultion perminute (RPM).

Power can also be calculated based on the measurement of flow velocity on the water passage door. Betz formula, power can be calculated as follows:

$$P = rho.A.\ (V1 - V2)\ 3.$$

where: P = Power generated (HP)

rho = Water density (kg/m3)

A = surface area of the turbine blades (m2)

V1 = speed of water flow plow blade (m / sec)

V2 = speed of water flows out the blade (m / sec)

As an element of comparison, the flow rate at different water levels, the calculation used by Duflow Program. Duflow program used to record tidal data at a maximum height of rainy season and minimum tidal height in the summer.

IV.5. Analyzing The Impacts

Evaluating the impacts on the community and on the environment around the canal at relevant time and some hopes on the future.

CHAPTER V
POTENTIALS AND RECOMMENDATION

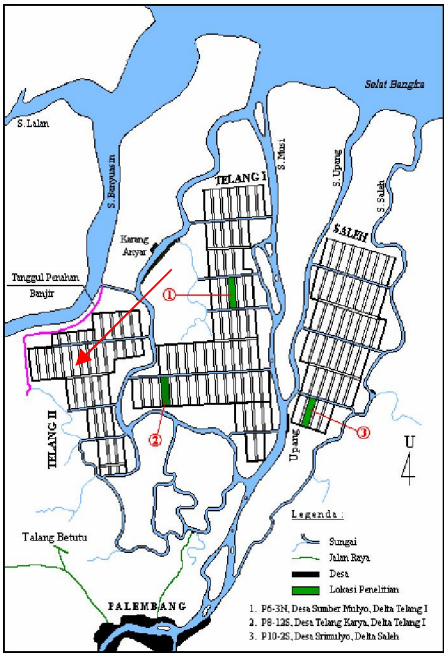
V.a. Potentials

From the local point of view, the needs of hydropower generating in Bangun Sari village is quite high, regarding some reasons: firstly, the electricity is expensive to install, meanwhile the hydropower is free of charge; secondly, the hydropower is possibly could help the farmers to generate the small agriculture engine such as paddy separators, corn shedder etc. and thirdly, supporting the effort of Indonesian government to ascend the people prosperity and the walfare. The utilization of irrigation channel for energy purpose could fastly change the social culture of the local people. Irrigation channel could viewed as not only for farmings but also for the daily life. Slowly, the people will step up their life activity, especially at night, for reading, learning, watching television etc.

In the point of view of nationality, the hydropower is a way to bring the country out of oil dependence and protect the state economy from the influence of world oil price raise.

The study of hydropower is focused on the utilization of water flow at the gate of irrigation channel in Bangun Sari Village which located at the position of 2.381 South Latitude and 104.42 East Longitude.

The observation conducted in march the year 2011 showing the water level at rain season is maximum at 95 cm from the baseline of watergate and the observation conducted in August the year 2011, the minimum water level at the dry season (summer) is at 30 cm, means that the cross section of flowing water at the irrigation watergate is 75 cm x 97 cm at the wet season and 10 cm x 97 cm at the dry season. The speed of flowing water in wet season measured by current meter is varying from zero at the beginning of tide and 1.12 m/sec at the end of tide at wet season and 0.76 m/sec at dry season. The maximum water level at dry season is 40 cm..



Picture V.1: Map of KTM Telang. Telang II at the left side. (Pusdatarawa,2006)

The maximum power contained in the flowing water at wet season is:

$P = T \times \omega$

where: P is the power contained in water (Watt)

T is the torque produce by flowing water at the shaft of wheel (Nm).

ω is the circumferential speed of the wheel (rad/sec).

Torque $T = F \times r$, where F = Force acting on the wheel blade (Newton) and r is the distance between the shaft and the blade center point.

The amount of the force acting on the blade is the total mass of water acting on the blade times the velocity of flowing water. ω is the angular speed of the wheel.

In case, we assume that all of the water power could accomodated by the device we use to converts the flowing water into mechanical energy , the power will be maximum at the wet season where the quantity of flowing water is maximum and the minimum power will be at at the dry season where quantity of flowing water through the gate is minimum. If the radius of waterwheel is assumed 0,75 meter, the circumfrential speed of the wheel does the same with the velocity of water hence the angular speed of the wheel is 1.49 rad/sec and the rotation of the wheel is about 14.4 rpm. The force of water acting on the blade of (0.75 x 0.97) m^2 will equal to: $\rho.m.V$

which is equal to: ρ.A.V.V. where ρ is density of water 998,2 kg/m^3. A is the area of blade and V is the velocity of flowing water. The force acting on the blade will be 998.2kg/m^3 x (0.75x0.97)m^2 x 1.12 m/sec x 1.12 m/sec = 90.938 Newton. The torque at the center of the wheel shaft will be 90.938 N x 0.75 m = 68.203 Nm. Hence the total power harnessed from the water flowing through the gate will equal to 68.203 Nm x 1.49 rad/sec = 102,304 Watt.

By the same way, the power contained in water in the dry season could estimated as follows. From the preliminary measurements, the average velocity of water flowing out through the gate is 0.76 m/sec and the quantity of water acting on the blade is 998.2 kg/m^3 x (0.1x0.97)m^2 x 0.76 m/sec x 0.76 m/sec = 5.5926 Newton. Torque produced is 5.6 x 0.75 = 4.2 Nm. If the circumferential speed of the wheel is the same as the velocity of water, U = 0.76 m/sec and the angular velocity will be 1.01 rad/sec. The power produced is P = 4.2 x 1.01 = 4.24 Watt.

Realizing that the irrigation channel in South Sumatra is at the moment as much as 2136 channels, Indonesia also have a huge waters territory which have tide and wave energy all the day, hydro energy has become the most promising energy in the future to apply. As stated in the early of this article, the independence of Indonesia from the oil energy is absolutely required. Indonesia should soonly diversivy the national energy consumption, and the law has come into force that the consumption of renewable energy should ascending from 1.7% at present to 5% in the year 2025. In this case the hydropower is a possible and seems feasible.

IV. b. RECOMMENDATIONS

From the above analyzing, we could take some conclusions and likely recommendation such as follows:

1. From the priliminary measurements and primary observations to the flow of tidal in Bangun Sari irrigation channel Telang II - Banyuasin, we arrive to conclude that micro hydropower is theoritically feasible to apply.
2. The local people in Bangun Sari and Banyuasin people in general, needs a cheap or free hydro electricity to support their life, in order to improve the quality of living and to ascend the prosperity and welfare.
3. From the point of view of nationality, Indonesia has soonly escape from the oil dependence in order to protect the state economy from the oil price raise and to divert the national energy consumption.

WORKPLAN
Detailed work schedule for the research project

No	Activities	Location	Year							
			2011				2012			
1	**Preliminary Phase**		**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
1.1.	Site visit	Telang II								
1.2.	Permission letter from related officials	Telang II								
1.3.	Photoing, Videoing and Village data collection	Telang II								
1.4.	Flow and water level measurements	Telang II								
2	**Secondary Phase**									
2.1.	Proposal Seminar	Pasca Unsri - Plg								
3	**Third Phase**									
3.1.	Designing The Waterwheel	Telang II								
3.2.	Manufacturing the Floating waterwheel	Telang II								
3.3.	Field experiments and Records	Telang II								
3.4.	Data analysis & Conclusions	Telang II								
4	**Research Results Seminar**	Telang II								
5	**Final Examination**	Telang II								

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Annex III

INTERNATIONAL JOURNALS HIGHLIGHTS RELATED TO HYDROPOWER

1. **Utilization of pico hydro generation in domestic and commercial loads**
   Ahmed MA Haidar dkk, 2011.
   -Pico hydro utk menunjukkan output generation below 5KW.
   -Pico cocok utk providing elevtricity to the off-grid remote and isolated region that suffer energy deficit.
   -Penggunaan pertama moving water to produce electricity was a waterwheel on the Fox River in Wisconsin 1882.
   -Hydropower is the most widely used renewable energy worldwide as it contributes 19% of the worlds electricity power.
   -Micro or pico hydropower will provide a good solution for energy supply in remote and hilly areas.
   -Pico hydropower generate electricity for hpusehold level and micro hydro at village level.
   -India, China, Brazil dan Kenya diantara negara hydropower untu off-grid decentralized village hydro scheme.
   -Di Asia hydropower menggantikan diesel dimana hydro di-hybrid dgn solar and wind powers.
   -Hydro generation classification Large>100MW,Small≤25MW,Mini≤1MW, Micro 6-100KW,Pico<5KW
   -Impulse turbine for high head sites and reaction turbineused for low head sites.

2. **Indonesia and Global climate change Negotiations**
   Carl H Petrich, 1993
   -With extensive coastal areas, it is clearly vulnerable to any sea level rise that might result from global warming.
   -Indonesia ranks ninth among all countries in total GHG emissions.
   -It is responsible to 2.4% of world GHG emissions, releasing of 140 million tonnes O_2 to the atmosphere each year.29 million tonnes are generated from fossil fuel combustion. The remaining are produced by biomass combustion and non-energy activities such as agriculture.
   -Indonesia is also the site of 10% of worlds remaining tropical rain forest.

3. **Pico Hydro- Reducing Technical Risk for Rural Electrification**
   AA.Williams, R Simpson, 2009
   -Pico hydro could cost-effective option for the electrification of remote rural communities.
   -World Bank Energy Unit Report shows that pico hydro is likely to have the lowest cost for off-grid generation.

4. **Small hydro and the environmental implications of its expensive utilization**
   Tasneem Abbasi, S.A.Abbasi, 2011
   a. Small Hydropower System (SHS) includes mini, micro and pica hydro system.
   b. SHS is a source of clean energy with little or no adverse impacts on the environment.
   c. Unlike thermal power plants there are no gaseous or flyash emissions seen coming out of hydropower during the process. And, unlike nuclear power plants, there are no radioactive wastes to contend with.
   d. Hydropower seems to provide 'side-benefits'. Reservoir can be used for recreation and fish culture. The water coming off the turbine can be used for domestic water supply and irrigation.
   e. High Aswan Dam (HAD) commissioned in Egypt in 1970, ever since then has become an iconic symbol of multi purpose hydropower-cum-irrigation projects.
   f. The International Energy Agency has reported several negatif impacts of major and medium scales that are now widely accepted as being associated with large hydropower projects.
   g. Among the most diconcerting of the adverse impacts of hydropower projects is the emissions of greenhouse gases methane and nitrous oxide. These two gases have respectively global warming potential 25 and 300 times greater than carbon dioxide.
   h. It belief widely prevalent at present is that small hydro is a clean substitute for large hydro.
   i. Broadly small hydro schemes are of two types, i.e. small discharges high head, and large discharge small head.
   j. In the UK water mills are known to have been in use over 900 years ago. By the 19th century there were over 20.000 watermills in operation in England alone. The invention of water turbine in France in 1827 led to the development of modern hydropower.
   k. In Europe turbine replaced the waterwheel almost completely by the end of the 19th century.
   l. In USA, the first hydroelectric scheme was installed in Wisconsin in 1882. Only three years after, the light bulb had been invented by Edison.
   m. In India the first ever small hydro unit for generating electricity was commissioned in 1897 at Darjeeling, the capacity 130 kW and operational up to now. Another small hydropower of 4.5 MW capacity came at Sivasamudram in 1902. Another hydropower of small and medium unit of 508 MW installed in the pre-independence India.
   n. The global installed capacity for electrical power generation by small hydro was 30.000 MW in 2000 and is expected to rise by 40% by the end of 2010.
   o. In Europe, small hydro is contributing 47.000 MW at present the second biggest utilizer of small hydro just behind Asia.
   p. In terms of power generation equivalent to a million ton of oil, shows an increase contributionof twofold of small hydro from 9.5 in 2001 to 19 in 2010.

q. The world at present is utilizing a very small fraction of the small hydropower potential (SHP). For example, India use only about tenth of its estimated 15.000 MW SHP , Indonesia has an estimated SHP of 5000 MW but only 5 MW installed, and just 1 MW actually used. Bangladesh, has SHP close to 10.000 MW but almost zero utilization.
r. Asia leads the world as the biggest small hydropower generating continent.
s. China is already the biggest user of its SHP with over a hundred system currently in operation.
t. There are two type of beliefs about environment friendliness of small hydro. Both are widely prevalent:
   -It has no adverse environmental impact at all (30,31,33,52-55)
   -Have some negative impcts but the impact are too small to be of any concern (8,29,32,36,46,56)
u. Hydro installations have some beneficial effects on river systems, in particular:
   -They collect and remove large amount of water-borne debris during operations.
   -Water flow is slower leading to less erosion of river bank
   -Upstream water level can be raised

5. Remote community electrification in Serawak, Malaysia
Martin Anyi, Brian Kirke,Sam Ali,. 2010

a. On the other hand remote peoples dependency on rivers as source of water supply,food and transport result in most remote villages being situated in close proximity to rivers.
b. It is serious problem with floating debris such as trees, grass, wild vines, leaves, seaweed, rubbish etc.
c. Without government funding, villages struggle to meet the cost of operating their own diesel generator. The village people have to work out how to operate and how to maintain their sets.
d. Electricity also enable to set up village industry. Such rice milling, corn, coffee, cocoa etc. In fact remote villages could produce products of value to urban population.
e. Therefore providing the electricity in an appropriate and sustainable manner will eventually improve the socio economic standard of remote communities.
f. A water gate is used to regulate and to cut water supply to the wheel.
g. Regular greasing to the chain and sprockets is needed in order to reduce friction. The system could simplified by using helical speed reducer.
h. Dedicated research and development on a selected hydrokinetic turbine which is robust, debris resistance and less site specific is now underway at the University of South Australia. The intended system will harness the energy from free flowing water current as low as 1 m/det or in straits where many remote communities are located. The system requires no civil works, transmission line will be short and no pipe work will be required.

6. **Environmental-impact assessment of hydropower in Egypt**
S.M.Rashad, M.A.Ismail, 2000

- In between 1985-1995 hydropower had contributed between 22% of egypt energy.
- Aswan High Dam, Surface area 6000 km^2, Volume 162 km^3, Max depth 110 m, mean depth 70 m. Max discharge 130 -120 m^3/day , Min discharge 108 m^3/day.
- Beneficial and detrimental effects, recent review focused on four large scale impacts:
  a. Methylmercry bioaccumulation b. Emissions of green house gases
  c. Downstream effects d. Limitation of biodiversity
- Environmental effects of the dam:
  a. Drop in water level downstream of the dam, cause of down level of river bed.
  b. Rise in water levels, by deposition of eroded materials at up-stream
  c. Bank erosion and meandering. The main reason for erosion of Nile banks are:
    - meandering of the river
    - groundwater seepage from the bank
    - seepage of water from adjecent lands towards the river
    - wave action due to navigation
    - reduction of water levels after construction of Aswan Dam
    - reduction of the river slope due to degradation
- Kualitas air diukur dari: Temperatur, pH, Dissolved oxygen, biochemical oxygen demand, total dissolved solids, suspended matter, phosphates, nitrates, ammonia and faecal coliforms
- By the electricity industries appear around the dam. Industry such as fertilizer, iron and steel, sugar,plywood, milk industries, pulp and paper and kaoline, new population centers have emerged around the dam. The population increase from 280.000 in 1960 to around 1 million in 1998.
- Large hydro-electric development often necessitates the relocation of a large number of people and results in harmful social effects. International attention is focused on the involuntary resettlements, not only as major of social impact of dams, but perhaps as the single serious issue of large scale hydroelectric develoment. The construction of Aswan Dam resulted in the relocation of more than 100 000 people to make way for reservoir.
- The presence of phytoplankton increased from 160 to 250 mg/l.. Shrimp catches declined after the closure of the dam. Accelerated migration of sea fish into the mediteranian.
- The hydropower plant give rise to GHG emissions from the various links of its energy chain, such as those associated with transportation, plant construction, storage of dismantling waste. Hydropower also release GHG gases mainly CH2 and CH4 from anaerobic degradation of organic material that was flooded by the water reservoir. CH4 is a powerful greenhouse gas with a much higher infra-red trapping capability than CO2.
- Other sources of GHG emissions associated with the construction materials, concrete and steel.

- The amount of plant biomass and soil carbon flooded. Plant biomass varies in different ecosystem,e.g., 0.7 kg of C/m2 in grasslands to 20 kg/C/m2 in tropical rain forest.

7. **Hydropower: Dimensions of social and environmental coexistence**
   R. Sternberg, 2008
   -Tucurui 330 MW turbine that operates using 584 m3/det in 24 hrs, this comes to 50,457,600 m3/day/unit. 0.6 m3/day is needed for 12 unit.
   - Tabel 2 halaman 1597: Hydropower: installed,percent change, potential-1950,2000.
   (Data penting kemajuan hydropower dunia diberbagai kawasan).
   - Tabel 4 halaman 1613: World electricity production – total in 10^9 kWh.
   (Data penting produksi listrik di berbagai kawasan dunia hingga tahun 2000).
   - Tabel 6 halaman 1516: Perubahan konsumsi listrik di berbagai kawasan dunia)

8. **Energy services and Energy poverty for sustainable rural areas**
   K.Kaygusuz, 2011
   - Kayu dan biomasa lain masih menjadi sumber energi utk household of poor people.
   - Susahnya mengumpulkan dan habis waktu utk itu dianggap tanggung jawab wanita di daerah yang terbelakang.
   - There is a general belief that, with the arrival of electricity, such societies might acquire a higher degree of economic sustainability and a better quality of life.
   - It is estimated that one-third of the worlds population, amounting about 2 billions people around the world, have no access to electric energy. Electricity is one of the pillars on which education and heatlh lie on. Electricity is related to the policy to reduce the poverty and inequality.
   - In Bangladesh, India and Pakistan 570 millions people have no access to electricity.
   - Tabel 1 halaman 938: Daftar jumlah penduduk tanpa listrik di dunia.
   - Tabel 2 halaman 939: Konsumsi energi perkapita di dunia berdasarkan kawasan.
   - Tabel 3 halaman 939: Macam energi dan kegunaannya di rumah tangga negara berkembang.
   - According to World Energy Council (WEC), a total of 1039MJ of useful energy per capita per year is assumed to be required at the household level to meet the three basic services such as cooking, lighting and space heating.
   - Energy for income generation, Rural industri, Rural electrification and Rural development.

9. **Renewable energy conversion and utilization in ASEAN countries**
   Kamarudin Abdullah, 2005
   - Penduduk dunia telah melewati 6 miliar.
   - IPCC study on climate change 2001 predicted that average global temperature due to
   GHG emissions will rise by 5.8^0C by 2100.

- Current findings indicated that total oil reserve in Indonesia comprised of 5.2 billion
barrel of proven and 4.6 billion barrels of potential reserve.
- If the rate of production is maintain at 0.54 billion barrels per year, meaning that in 18 years Indonesia oil will be exhausted.
- Tabel 1: Data potensi berbagai sumber daya energi diberbagai negara anggota
ASEAN.
-The primary energy consumption in ASEAN had increase from 121.3 Mtoe in 1995 to 248.7 Mtoe in 1997, but indicated a decline to 133.9 Mtoe in 1998. Electricity demand during the same period shown gradual increase from 19.0 Mtoe in 1995 to 24.46 Mtoe in 1998.
- About 20.000 Mwe or 40% of the world geothermal energy resources are found in Indonesia, but only small portion had been developed for power generation.
- Tabel 4: Kapasitas terpasang berbagai sumber energy terbarukan di Asean.
- kapasitas terpasang energi terbarukan di Asean dk termasuk geothermal, diperkirakan toatl 2866.8 Mwe comprising 1862 MW fromBiomass, 965.4 GW of mini/micro hydro, 39.3 MW from solar, and 0.29 MW from wind energy.

10. **Scenario planning for the electricity generation in Indonesia.**
C. Rahmatullah, Lu Aye, R.J.Fuller, 2007.
- (Tidak dipakai, karena tdk nasionalis)

11. **Hydropower potential and Development Activities**
Alison Bartle, 2002
- Inherent benefit of hydropower:
1.The resources are widely spread geographically, about 70% of the economically
feasible potential remains to be developed, mostly in developing country.
2. Well advance technology with more than a century of experience.
3. Although the initial investment can be relatively high, hydro has the lowest
operating cost and longest plant life.
4. Hydro can contribute to other fuctions such as irrigation water supply, navigation, recreation facilities, flood control, industy and drinking water.

-There is now more than 105 000 MW of hydro capacity under construction in the
world. The greatest amount of current development is in Asia (84 400 MW), followed by South America (14 800 MW), Africa (2403 MW), Europe 2211 MW and North & Central America 1236 MW.
- Tabel1: Data penduduk dan konsumsi listrik per-capita di beberpa negara Afrika.
- Isi mencerminkan data terpasang dan under construction of the world hydropower plant, di semua bagian dunia.
- Tabel 2: Daftar World Hydropower development and Potential

12.Energy use and carbon dioxide emission of Indonesian small and medium scale industry

Architrandi Priambodo, 2001

-The overall contribution by the small industrial sector is about 366 000 ton in 1993 compared to 46 million tons generated by all industrial sector.
-Tabel 1: Emisi CO2 from fossil fuel burning and cement manufacturing 1995.
-In the third conference of the UNFCCC (United Nation Framework Convention on Climate Change), in Kyoto December 1997 , the developed country committed themselves to reduce the emissions of CO2,CH4 and N2O by 6-8% in the period of 2008-2012 as compared to the 1990 emissions levels.
-It is reported that in Indonesia in 1994, the CO2 emissions was about 748.607 Gg of which 265 was due to the enrgy sector and industrial processes.
-CO2 emissions due to all energy use in the country amounted to about 170,000 Gg.

13.Fctors affecting CO2 emissions from the power sector of selected countries in Asia and the Pacific.

Ram M Shresta, Gabrial Anandarajah, Migara H Liyanage, 2009.

- The study shows that the economic growth was the dominant factor behind the increase in CO2 emissions in ten of the selected counties in Asia and the Pacific.

14. Poverty and Energy in Africa – A brief review

Stephen Karekezi, 2002.

- Penduduk Afrika diperkirakan 780 juta pd than 1999 atau equivalent to 80% dari penduduk India.
- Menurut World Bank pada tahun 1998, sekitar separuh dari penduduk Afrika berpendapatan kurang dari satu dollar per-hari.
- Konsumsi energi Afrika tak termasuk Afrika Utara dan Afsel, adalah 248 kgoe, yaitu 50% dari rata2 dunia. Konsumsi listrik er-kapita turun dari 447 menjadi 126 kWh pada thn 2001.(Data World bank).
- Gambar 1: GNP per kapita negara2 Afrika VS Konsumsi energi per-kapita.
- Tabel 2: Konsumsi listrik rata2 masing2 negara Afrika.
- Tabel 3: Elektrifikasi di pedesaan di negara2 Afrika.

15. Advancing Sustainable Hydropower IHA Activity Report 2011

IHA, 2011

- Globally, an estimated 1.4 billion people live without electricity.
- According to IEA (2010), only 31% of population in sub-saharan Africa have access to electricity.
- Economic growth, accompanied by rapid urbanisation, increasing demand in energy and water in the region.
- China is already the region leader in term of installed capcity at 210 GW at the end of 2010.
- Overall, Asia 64.5% share of the world current planned hydropower capacity.

- Data kapasitas terpasang hydropower termutakhir di seluruh belahan dunia.

16. Hydropower and The world Energy Future
IHA, 2000

-The International Energy Outlook 2000 forecast that global consumption of electricity will be 76% higher in 2020 than in 1997. Consumption will increase from 12 000 TWh (1977) to 22,000 TWh (2020).

- Global energy picture.
- Benefits of hydropower
- Caharacteristic of hydropower
- Electrical system benefits
- Avoided emissions
- Social and environmental impacts of hydropower: sedimentation, fish protection.

17. An Overview of Renewable energy in Spain, The Small Hydropower Case
German Martinez Montes,dkk 2005

- Gambar 2 halaman 528: Daftar pembangkit >10 MW di berbagai negara Eropa.
- Gambar 3 halaman 529: Evolusi hydro electric power di Spanyol.

18. The 21st Century Power: Tendencies and Prospects
N.P.Zapivalov

- Tabel 1 halaman 140: Kondisi energi dunia dan ramalan hingga thn.2030.
- Tabel 2 halaman 141: Penggunaan energi primer dibanding hydroelectric power di berbagai negara di dunia.

19. Palm oil and The emissions of Carbon Based Greenhouse Gases
L. Reijnders, M.A.J.Huijbregts, 2008

- Emissions of CO_2 due to the use of fossil fuels and the anaerobic conversion of palm oil mill effluent currently in South Asia correspond to an emission of about 2.8
  - 19.7 kg CO_2 equivalent per kg of palm oil.
- Calorific value of palm oil is estimated at 40 GJ/ton.
- Malaysia, Brazil and Indonesia are among the countries utilize the palm oil in the production of biodiesel. In Malaysia the absence of Sulfur and Nitrogen is stressed.
- The use of palm oil is also advocated because it is dramatically reduce CO_2 emissions.
- Emisi CO_2 palm oil lebih rendah dari biodiesel, tetapi NOx lebih tinggi dibanding minyak Diesel biasa.
- With rspect to hazardous particles no significant difference has been found between Diesel and Biodiesel.

20. A hystory of renewable energy technology
Bent Sorensen, 1991

- The average energy conversion of a human being is 60 – 90 watt for maintenance and 40 – 70 watt for work and other activities.
- Fuelwood provided fire 350 000 years ago, animal came into use 10 000 years ago, solar energy in the form of fossil fuel 9000 years ago.
- Wind energy used for sailship about 5500 years ago, windmill 2500 years ago in India.
- Water power digunakan dalam skala kecil sekitar 250 Sebelum Masehi untuk Jam Air dan Waterwheel.
- Alat2 teknologi mulai diciptakan pada abad 16, terutama berbasis Tenaga Otot manusia, angin dan hydropower.
- Dapur bertenaga matahari pertamakali diciptakan pada abad 18 yaitu tahun 1747 oleh J.Cassini dgn kemampuan temperatur lebih dari 1000^0C untuk mencairkan logam.
- Photovoltaic effect was discovered by Becqquerel in 1839.

21. The contribution of small hydropower stations to the elctricity generation in Greece: Technical and economic consideration
J.K. Kaldellis, 2007

- Renewable energy contribute with 18.5% of the planet electricity generation.
- Small hydropower usually less than 10 MW, while stations less than 1 MW characterized as mini. For very small applications less than 50 kW, expressed as microhydropower stations.
- Salah satu masalah developing the SHP di Greek adalah birokrasi.

22. Electricity generation and economic growth in Indonesia
Seung-Hoon Yoo, Yeonbae Kim, 2006

- The findings show that there is a strong relationship between electricity consumption and economic growth. The relationship may very well run from electricity generation to economic, and/or from economic growth to electricity generation.
- Energy consumption in ASEAN countries is estimated to increase from 280 MTOE in 2000 to about 583 MTOE by 2020.
- Fig 1: Data GDP, Konsumsi listrik dan Listrik yg Dibangkitkan di Indonesia 1971-2001.

23. Renewable Energy Education For Asean
Mohd Yusof Othman and Kamaruzzaman Sopian, 1999

- Total ASEAN population s about 350 million with total area of 3,155,000 km2. Consist of nine countries, where Vietnam, Laos and Myanmar became newest member since 1996.
- The growth of Asean economic growth tremendously, resulting in the increases in energy demand.

- Tabel 1: Asean energy indicator 1993 (luas wilayah,pdd, konsumsi energi primer total dan perkapita (toe), konsumsi energi final (ktoe).
- Tabel 2: Total energi yg digunakan utk beberapa negara asean 1994 dan 1980
- Tabel 3: Konsumsi nergi per-kapita dibbrp negara asean.
- Tabel 4: Produksi minyak dan gas dibeberapa negara asean 1994 dan 1980
- 5 Faktor penghambat dalam penggunaan renewable energy di negara2 Asean

a.The reluctance of the developed countries to promote the use of energy.

b.The international politics and monopoly by multinational oil companies in global energy business.

c. Lack of funds and funding mechanism for the application of renewable energy technology.

d. The lack of policy in the countries to apply the renewable energy

e. The needs of expertise and technology know how to exploit ren. Energy.

24. How much energy can be extracted from moving water with a free surface: A question of importance in the field of tidal current energy?
Ian G Bryden, Scott J Couch, 2007

- Halaman 1964, Grafik hubungan antara extracted power at varies flow speed at channel length 4000 m, width=500 m, depth=40 meter, n=Manning coeficient=0,025 $sm^{-1/3}$ and U_o=3 m/sec.

25. A light left in the dark: The practice and politics of pico-hydropower in the Lao PDR
Mattijs Smits, Simon R Bush, 2010

- Pico-hydro technology (≤1 kW) operating at individual household level, has until now received scant attention.
- More than 10.000 MW of electricity is already contracted out through export to Thailand and Vietnam and should be delivered by 2020.
- Tabel 1: Kapasitas energi terpasang di Laos dari berbagai sumber renewable energy.
- Laos is one of the fiscally poorest countries of Southeast Asia, with a population of 6.5 millions spread across a largely mountainous terrain which covers three quarters of the total land area (UNDP,2009).
- Only 10% of the electricity generated from the large dams currently in place is made available for domestic consumption.
- Gambar 3: The relation between The power generated and The times it broken/damaged.

26. Benefits from a renewable energy village electrification system
Alex Zahnd, Haddix McKay Kimber, 2009

- More than 100 years after Edison dicovery, 1.6-2 billion people around the globe still live without light, dark and smoke filled home.

- There is a strong relationship between between prosperity and access to electricity
- 80% of Nepals 28.5 million people live in rural areas, with around half of this so remote, that neither the road, nor the grid is ever likely to reach them, 5-18 days walk. Neither the road nor the electricity grid will reach them for decades to come.
- Electricity energy can provide appropriate and sustainable lighting which brings potential health, education,social and economic benefit to the people who lived previously in homes with severe indoor air pollution. These cause respiratory diseases, asthma, blindness and hearth disease, resulting in low life expectancy for women and high dead rate of children under five years in Nepal.
- During the year 2003-2004, Nepal national average per-capita electricity consumption was 68.5 kWh/yr. The national average GDP was 1000-1370 US$. In Humla, it was only 72 US$, with 42% of the people living below the poverty line. Nepal is one of the poorest and most needy country in the world today.
- Nepal is a country rich in renewable energy such as hydro, wind and sunlight.
- With annual average runoff of 225 billion m^3 from over 6000 river, Nepal theoritical potential hydropower capacity is estimated around 83.000 MW. Technically and economically feasible is estimated around 43.000 MW.
- Until July 2005 only 546 MW or 1.3% of the potentials had been exploited.
- Humla is a district which have no link or connection to a road. Only a 16 day walk or an hour flight with a 25 year old twin otter, landing on a rough earthen and gravel landing strip.
- The lamps used is white LED (WLED) lamps consuming just 1 watt per-light providing enough light to see each other, daily indoor activity and reading.
- A pico hydropower generating 150 watt, provided 30 homes each with three WLED lights.
- Benefits of village electrification system: Health, Eucation, Social life, Income generation, physical condition, environment.
- Millenium Development Goal (MDG):
  a. Reduce by half the proportion of people living less than a dollar a day.
  b. Reduce by half the proportion of people who suffer from hunger.

27. Optimal Installation of small hydropower plant – A review.
Sachin Mishra, SK Singal, DK Khatod, 2011.

- Clean Development Mechanism (CDM), and related economic aspects review of small hydropower.

28. The utilization of short term energy storage with tidal current generation systems.
I.G.Bryden, D.M. Macfarlne, 2000

- The power input in a wind system can fluctuate unpredictably, whilst the power input in a tidal system is cyclical and predictable and hence can be mathematically modelled.

- The ratio between the actual average power output and the rated power is known as
the availability factor and is of vital importance in assessing the costs associated with
the generation of electricity.
- Halaman 894: Persamaan model untuk tidal current speed and the power generated.

29. River current energy conversion systems: Progress, prospects and challenges

M.J.Khan, M.T.Iqbal, J.E.Quaicoe, 2008

- River Current Energy Conversion Systems (RCECS) convert kinetic energy of river
water into other usable form of energy.
- Radkey and Hibbs difine River Current Turbine (RCT) as "Low pressure run-of the river ultra low head turbine that will operate on the equivalent of less than 0,2 m of head"
- A River Turbine may provide a generating power, require a little or no civil work, cause less environmental impact and may possess significant economic value.
- RCECS sometime says as WCT (Water Current Turbine), or Ultra Low Head Hydro Turbine, Hydrokinetic Turbine, Free Flow/Stream Turbine (implying use of no dam, reservoir or augmentation), Zero Head Hydro Turbine are common and employ the same underlying principle of operation.
- The study of tidal energy, marine current energy and wind energy valuable in developing an understanding of the RCECS technology.
- The power extracted by turbine is:
$$P = 1/2\rho A V^3 .Cp$$
Dimana: rho=1000 kg/m3 utk water and 1.223 kg/m3 for wind.
- Gambar 1: Perbandingan Power Density produced at varies speed of water and the wind.
- Intermediate Technology Development Group (ITDG) in 1978 resulted in the so-called Garman Turbine specifically meant for water pumping and irrigation.
- Gambar 2 menunjukkan berbagai posisi turbine terhadap river current.
- The effect of varying blade pitch and shaft inclination angle were also studied in Bangladesh and an average mechanical system efficiency of 30% was reported.
- Another Australian design known as Tyson Turbine consisted of horizontal axis with a submerged 90^0 transmission mechanism that power a generator fitted on a pontoon.(Gambar 2.b).
- Belgian concept (Rutten Company) containing a twin tubular pontoon with floating turbine and a straight bladed waterwheel was tested in Zaire (Gambar 3.a).
- The needs for protection mechanism against debris and severe conditions has also been outlined.
- According to UNDP (United Nation Development Program, 2002) over 2 billion people have zero access to electricity, 1 billion people adopt mundan power sources (dry cell batteries, candles and kerosene) and 2.5

billion people in developing countries mainly in rural areas, have marginal access to national electricity grid.

- It is believed that many developing countries such as China, India and Brazil will appear as the key drivers behind the boost in energy demand in future.
- An effective and low cost mechanism for harnessing energy from the flowing river may revolutionize the scenario of rural power generation.
- Gambar 4: H-Darrieus turbine used as river current energy.(Vertikal axis).
- RCECS technology is probably at its infancy. Recent reports indicate that such devices are slowly entering into the implementation phase.

30. Tidal Energy Update

Fergal O Rourke, Fergal Boyle, Anthony Reynolds, 2010

- Tidal energy has been exploited on a significant scale since the construction of La
  Rance Tidal barrage in France in 1967.
- Kinetic energy can also be harnessed from tidal current to generate electricity and
  involves the use of tidal current turbine.
- Tidal current turbine is still in an early stage of development.
- In 2007, the global share of energy from fossil fuels was 88% of the total primary energy consumption. This primary energy consumption consist of 35.6% oil (3952.8 mtoe), 23.8% natural gas (2637.7mtoe), 28.6% coal (3177.5mtoe), 5.6% nuclear (622 mtoe), 6.4% hydroelectricity(709.2 mtoe).
- Heavy dependence on fossil fuel is becoming increasingly concerning because of limited potentials and the CO2 release into the atmosphere known as GHG effect.
- Renewable energy technologies are becoming an increasingly favourable alternative to assuage fossil fuel reltive issues.
- Water Current Turbine (Tidal Current Turbine) can benefit from the development of wind energy technology.
- Tidal phenomenon occurs twice every 24 hour,50 minutes and 24 second.
- Bulan mengorbit bumi setiap 29,5 hari, dikenal sebagai siklus bulan.
- Bulge of water on the nearest of the moon, terjadi by gravitational pulling force of the moon. Pada sisi bumi terjauh dari bulan terjadi gaya centrifugal yang juga menyebabkan kenaikan permukaan air, sehingga pada kedua sisi bumi yang segaris dengan bulan terjadi kenaikan muka air (pasang naik).
- Tidal Barrages: work on the base of potential energy of the tide.
  Tidal Current Turbine work on the base kinetic energy.
- Tidal barrages consist of embankment, water control structures, turbines and ship lock.
  Tidal barrages can be single basin and double basin.
- The turbine, can be uni-directional and bi-directional.
- Info tentang barrages2 besar dunia La Rance dan Bay of Fundi
- Tabel 1: Tidal barrages besar di dunia (Tempat, tinggi, luas basin and capacity)

- Tidal current technology is similar to wind energy technology, however there are several difference in the operating conditions. Water is 832 times more dense than air.
- Ada tiga macam konstruksi Tidal Current Turbine:
  -Gravity structure, large mass of concrete attach to the river base.
  -Piled structure, pinned to the sea floor using steel or concrete beam
  -Floating structure.
- Tidal Current Turbine is still in its infancy.
- The most promising Tidal Current Turbine:

Evopod Tidal Turbine, berdiameter 15 meter dipasang pada tiga tiang pancang. UK

Free flow turbine, diameter 4.68 meter, three bladed, individual beam. NY

Gorlov Helical Turbine, vertical axis, three twisted bladed, helix, 1 m dia. USA

Lunar Energy Tidal Turbine, horizontal axis, gravity base, bi-directional, 11.5m dia, a duct of length 19.2 m and dia 15 m. UK

Neptune Tidal Stream Device, twin three bladed horizontal axis, monopole structure, bi-directional, apply in coast of Korea. Based in UK.

Open Center Turbine, Nereus Turbine, Stingray Tidal Energy, SeaGen and TidEL

31. Marine-current power generation by diffuser-augmented floating hydro-turbine

F.L.Fonta, P.M.Jacovkis, 2008

- Among the ocean energy resources, wave and marine current energy emerge as the most promising options in the immediate future.
- Gambar 5: Konsep diffuser augmented floating hydro-turbine consist of two pontoons side by side.
- Gambar 7,8,9: Kegiatan pembuatan diffuser serta diagram hubungan antara :Flow speed Vs Current speed.

32. An overview of development of Tidal current in China: Energy resource, conversion technology and opportunities.

Dong Li, Shujie Wang, Peng Yuan, 2010

- China is the biggest developing country which enjoy prosperity of rapid development, also faces problems caused by the increasing energy consumption.
- Oceans cover approximately 71% of earth surface and hold a large amount of energy more than 2 x10^3 TW [4] Its includes tide, wave, tidal, thermal, salinity gradient and biomass.
- Tidal current energy was highlighted because of the advantages of high energy density (832 times greater than wind). Therefore it receiving more attention from politicians, industrialis and academic all over the world and is expected to play important role in the future energy supplies.
- China has an excellent tidal current energy with a capacity of approximate 13950 MW which has been exploited since 1960.
- Oceanic current is used to describe the motion of the ocean water, which are driven by several factors:

1. First factor is wind.Winds drives current mainly near the surface, near the
   coast and in small scale in an open ocean on a global scale.
2. Second factor is thermohaline circulation, which is difference of water
   density by temperature and salinity.
3. Third factor, is rise and fall of the tides.

- Areas with high tidal current flows commonly occur in narrow straits, between islands and around headlands.
- Keys criteria or principles for tidal current turbine site selection are some listed below: - Max. peak current of 2-3 m/s to achieve economic size of rotor.
  - Uniform flow for long periods
  - Close to coast, channels or between islands and estuaries.
- China situated in the west coast of the Pacific with coastline of 18,000 km (if
  including all the islands the total length of the coast is 32,000 km).
- Thousand of island in the seas, 6500 islands have an area more than 500 (m2 ?).
  Between islands, there hundreds of channels.
- The tidal of Bohai Sea is dominated by regular semi-diurnal and irregular semi-
  diurnal tide with a velocity of about 0.5 – 1 m/s.
- Coast of Yellow Sea, the type of tide is regular semi-diurnal with velocity of about 1
  m/s.
- Data menunjukkan kapasitas energy pada berbagai lokasi laut di China, data
  kecepatan pada beberapa lokasi dan jenis pasang yang ada.
- Berbagai instalasi Water Current Turbine (Tidal Current Conversion) technology
  yang sdh aplikasi di China.
- Opportunities of WCT: Decreasing dependence on fossil fuel, increasing pressure
  on reducing emissions, national policy to accelerate the development of renewable
  energy.
- Tabel 2: Konsumsi berbagai jenis sumber energy China dalam 2000 dan 2005
- Gambar 11: Konsumsi listrik di China dari 2000 – 2009.

33. Limits to tidal current power.
Chris Garrett, Patrick Cummins, 2008

- Analysis has clearly shown that the power potential is not given by the flux of kinetic energy, as has been commonly assumed.
- The attraction of tidal stream energy is that it does not produce GHG and is hence regarded as environmentally benign.

34. The economic of Tidal Energy

Eleanor Denny, 2009.

- Tidal generation is almost perfectly forecastable and as such maybe a viable
  alternative to wind generation.
- Analisis economic dari Tidal energy.

35. Evaluation and measures to increase performance coefficient of Hydrokinetic turbines

Mukrimin Sevket Guney, 2011

- This study presents the valids equations for energy conversion system from water
  currents analogous to wind power system.
- Hydro and wind power seems to be optimum choices among the renewable energy
  today.
- Figure 1: Konsumsi energi pasar dunia (1990-2015)
- Figure 3: World renewable energy generation in 2020 by source.
- Figure 4: Hydrokinetic energy capacity forecast 2009-2015.
- It is reported in 1996 that yearly potential for tidal energy in Europe was 48 TWh, most of which is in UK
- The global tidal range energy potential is estimated to be about 200 TWh/y.
- The potential for Marine Current Turbine in Europe is estimated to exceed 12 GW installed capacity, 4.3 GW out of it is in UK.
- Figure 7,8,9,10: Coef. of Performance of WCT VS Tip speed ratio.
- Figure 11: Perbandingan antara ducted and unducted turbine.

36. Laboratory-scale simulation of energy extraction from tidal currents

X.Sun, J.P.Chick, I.G.Bryden

- This paper decribes the work conducted into determining te size of the resource and
  what the large-scale consequences of extraction might be by using commercial
  Computational Fluid Dynamic (CFD).

37. A review on the development of tidal current energy in China.

Hong-wei Liu, Shun Ma, Wei Li, Hai-gang Gu, Yong-gang Lin, Xiao-jing Sun, 2011

- The total installed wind power capacity has amounted to 5906 MW in 2007 in China, and has reached 12,170 MW in 2008. Chinas goal is of its total installed capacity of wind power is 10,000 MW by 2010.
- Compared to wind and wave energy, tidal energy has some distinct advantage such as predictability and regularity, which make it attractive.
- Outlining the marine current turbine (MCT) being built and tested in the world. SeaGen, Evopod, TidEL, Stingray, Lunar, Solon, Dirrieus, Gorlov.
- The development of Tidal Current Energy in china relatively slow. China began using tidal power in the mids 1950s, and more than 76 plants were built within 1950s and 1980s, all are barrage tidal plants. However only three of those tidal plants are still in operation now.

- The first tidal current turbine in China developed and tested in 1970. Generated 5.8 kW at current velocity 3 m/s. The turbine was similar to ship propeller, three bladed of one meter length.

38. The power generation from tidal currents by Darrieus Turbine
S.Kiho, M.Shiono, K.Suzuki, 1996
- The turbines is vertical axis turbine, three bladed Darrieus type,
- It operate without blocking strait or bay.
- It is belive that an effective tidal range of 5 m is required for effective power generation. Whilst maximum speed of tidal currents exceeds 5 m/sec at some locations of Akasi and Kurushima.
- Darrieus turbine which rotate in the same direction for flows in opposite directions and can take up the energy witout regards the direction of flow.
- Tabel 1:Ukuran2 Turbine Darrieus yang dipakai: 4.2 m height, 3.9 ton weight, dia 1.6m, Generator 525 rpm, 3 phase, 200 volt.
-Gambar1: Konstruksi Turbin Darrieus.
- The **tip speed ratio** λ (lambda) or **TSR** for wind turbines is the ratio between the rotational speed of the tip of a blade and the actual velocity of the wind. If the velocity of the tip is exactly the same as the wind speed the tip speed ratio is 1. The tip speed ratio is related to efficiency, with the optimum varying with blade design.[1] Higher tip speeds result in higher noise levels and require stronger blades due to large centrifugal forces.
- Gambar 2: Karakteristik turbin: Tip speed ratio VS Turbine efficiency.
- Gambar 3: Karakteristik generator: Putaran turbin(rpm) VS Daya yg dihasilkan.
- Findings after long term experiments:
  -The power generation is possible when the flow speed is 1 m/s or higher
  -The highest efficiency of 56% is attained at the Tip Speed Ratio of 2.1 over 1.1 m/s of
  tidal flow speed.
  -For long term of operation it needs to preventing deposition of marine orgnism and
  suspended substances.
- Site selection is required to meet the needs for navigation, fishing and the environment.

39. What makes technology transfer? Small-scale hydropower in Nepal's Public and Private Sectors.
Godfrey Cromwell, 1992.
- Halaman 983: Mechanical end uses, average time requirements of agroprocessing. Milling, Hulling and Expelling (Traditional VS Hydropower)
- Electrical end uses (for daily activity, small scale indsustry, learning etc).

40. Initial evaluation of tidal stream energy resources at Portland Bill, UK
L.S.Blunden, A.S.Bahaj , 2006
- Pemanfaatan tidal barrage dewasa ini mulai dihindari karena high cost dan dampak liungkungan yang besar.
- Riset banyak dilakukan untuk memanfaatkan "Tidal Stream".
- Advantage includes:

-Predictability of tidal stream
-High power density of water flow
-Lack of extreme power speed
-Minimal visual impact
- Obstacles include:
-Expense and risk involved in marine construction, amplified by strong current.
-Cost of cable-laying
- Study ini dihasilkan oleh ESTU 93 (Energy Technology Support Unit):
- Identified suitable sites with peak stream speed approximately 2 m/s.
- Depth greater than 20 m.
- The reports identified 33 sites in the UK with a total surface area of 1450 km^2.
- Total output power was calculated to be 57639 GWh.
- JOULE II report an estimates of 12500 MW of European resource, with UK sites contributing 8900 MW of the total. 42 sites identified in UK with total surface area 1330 km^2. The criterion for site selection was peak stream speed greater than 1.5 m/s
- A UK site potential for tidal stream current is around Portland Bill, Dorset, with tidal stream up to seven knots (3.6 m/s).

41. Hydropower's future, the environment and global electricity systems R.Stenberg

- Tabel 1: World electricity system installed increased by 2100% or 425 per-year from 1950 – 2000
- Faraday menemukan listrik tahun 1831, tetapi baru 20 tahun kemudian dihasilkan listrik dari waterwheel, yang ditemukan oleh Francis tahun 1851.
- BRIC (Brazil,Russia,India and China) adalah countries where hydropower progression can be represented in. BRIC are hydropower rich country.
- Tabel 2: Data luas,volume air,panjang dan aliran rata2 sungai2 di dunia.
- In Brazil, in 1889 at Juiz de Fora one of the first hydroelectric plants powered a textile mill.
- UK, USA and Germany are coal rich states, used hydropower and coal powered thermal plants.
- Coal poor states such as Italy, and France turned to their 'white coal' hydropower resource base.
- China has actively fostered its hydropower sector dating to 1970. Similarly, much of USSR industrialization was hydropowered.
- Hydropower regulates 12% of the world rivers fluvial volume.Such as Hoover Dam (1951 MW), Three Gorges project (22.400 MW), Lake Nasser 160 km^3.
- 88% of the worlds stored river water serve urban water supply system, irrigation (about 70% of the worlds fresh water), flood control, recreational water projects and canal systems.
- Fish life and river transport are variables that need to be addressed.
- The term of 'white coal', comes from Switzerland and Italy, two states without domestic coal resources, which actively used hydropower potential.
- Illustrative estimate of the environment external cost berdasarkan jenis sumber energi.
- Tabel 4: Projected electricity demand for selected states 2004-2015 in%/year.
- Vietnam a rather small country as 17 unit that are in construction. 95 dams of varied stages are in construction in China 50 out of it is large dam, Iran has 16

large projects out of 48 hydropower projects under construction, Turkey has 15 large hydropower projects under construction out of 51 units. Japan has 35 units in varied phases, 8 of it is large hydropower projects.
-Tabel 5: Data pembangunan hydropower dunia selected state)2008 dan setelah 2008.
- Hydropowers future is difficult to insulate from geopolitical streams and interest group.
- Canada and the US resolve their differences on the use of the waters of the Columbia River and The St. Lawrence.
- Uruguay and Argentina considered Salto Grando in 1903, but its construction started in 1974. The pace of change is in good measure powered by the pressure of electricity demand and economic-social requirements.
- Itaipu-Binacional is an idea how geopolitics can be put to productive use for the national interests. In 1973 Brazil and paraguay agree to start construction of Itaipu after studied in 1967.
- In time, Argentina and Paraguay agree to build Yacyreta, west of Posadas.
- Currently, there are three large hydropower projects share by four states in La Plata Basin: Salto Grande (Argentina-Uruguay), Itaipu (Brazil-Paraguay), Yacyreta (Argentina-Paraguay). Here, geopolitics illustrates how to move from contention and conflict to regional cooperation. The hydropower projects change the spatial order of the region in the major spheres of politics and economy.
- Myanmar had 365 MW in 2000 of installed hydropower and plans to call for installing 39,600 MW in next two decades.
- The world hydroelectric systems will add 157.8 GW in 2008, and nearly 83% of this expansion is palced in Asia (Tabel 5). 80 Gw out of 130 GW in Asia is in China.
- Norway and Switzerland turned to hydropower as coal-poor states.
- Electricity consumption in Africa in 2000 is 524 kWh/p/y while the world 2475 kWh/p/y
- Tabel 6: Konsumsi listrik dunia 2004, country grouping based on.

42. Status of CCS Development in Indonesia.
Dennis Best, Rida Mulyana, Brett Jacobs, Utomo P Iskandar, Brendan Beck, 2011

- CCS stand for Carbon Capture and Storage.
- Indonesia is the worlds largest archipelago state, and has the fourth largest population of about 240 million people. Annual GDP growth is between 5% and 6% and it is a leading coal and LNG exporter.
- Primary energy consumption was approximately 0.62 TOE/Capita in 2008 and it is growing at about 5% per year.
- In 2008, oil share 48% of energy mix, coal about 30%,gas about 19%.
- CO_2 sources in Indonesia mainly from industry such as power plants,oil & gas processing plants, steel and ammonia plants, cement factories.
- Total industry CO_2 emissions from industry are estimated to about 17.5 million tonnes per annum.
- The government has pledged to achieved a non-binding commitment to reduce country emissions by 26% in 2020 and has stated that this target would increase to 41% if international financing is available.

- There is some potential for CCS to be funded through other method such as through the Clean Development mechanism (CDM), Enhance Oil Recovery (EOR) and Enhance Gas Recovery (EGR).

43. Energy and environment in the ASEAN: challenges and opportunities
Shankar K. Karki, Michael D. Mann, Hossein Salehfar, 2005

- ASEAN is one of the most dynamic economic regions of the world.
- ASEAN was first officially established in 1967 in Bangkok with the signing of the bangkok Declaration by the five original member nations: Indonesia, Malaysia, Philippines, Singapore and Thailand. Brunei Darussalam, Vietnam, Lao People Republic, Burma/Myanmar and Cambodia joined later.
- Over the period from 1980 to 1999, its economy grew by nearly 5% a year and energy consumption by 7.5% and it is expected to grow at this rate until 2020.
- Table 1: Economic and Social Indicators of Asean Countries. GDP, Population growth, Urban Population and Economic Growth.
- Table 2: Asean energy resources and reserves
- Table 3: Biomass as percentage of total energy mix of the Asean Countries
- Table 4: Commercial primary energy mix in the Asean region (percentage).
- Table 5: Asean countries energy production/total primary energy supply.
- Table 6: Urban air quality in the Asean region.
- Table 9: CO2 emission from fuel combustion 1990-1998 (million ton).
- Table 12: Hydropower Potential in the Asean Region (MW). Installed hydro capacity in 2000, Hydro potential, Total installed capacity in 2000.

44. Asia energy mixes from socio-economic and environment perspectives
V.Thavasi, S.Ramakrishna, 2009

- Strong economic growth in Asia has caused a great demand foe energy which has resulted in an enormous increase in CO2 emissions.
-ASEAN, India, China, Sout Korea and Japan are the most important region in Asia as their economies have been growing steadily.
- It has been projected that energy demand of Asia will increase twice by 2030 due to increase in population and rapid level of urbanization and industrialization, which in turn increase the CO2 emissions level tremendously.
- Energy mix are promising options to mitigate the thread of irrevesible global climate change.
- Hydropower has been abundant in most f the ASEAN countries except Brunai and Singapore.
- Tabel 1: Socio-economic information of countries in Asia.(GDP, total CO2 emission, emissions per capita, Total population, Population by Age in 2010.
- Two third of total carbon in India have been due to burning of coal, mainly in power stations. The renewable sources presently contribute 8% of grid capacity in India.
- Japans energy consumption has been rated the highest in the world, despite its poor energy resource. 83% of Japan primary energy supply has been from fossil fuel.
- Japan targeted to produce more than 60% of its electricity from renewable energy resources in 2050, from 4% at present time.

- China is the largest producer and consumer of coal in the world. 70% of China primary energy consumption is coal. Renewable energy supply in China is account for 7.5%
- Coal and oil have accounted for 25% and 43% of South Korea energy mix consumption.
- Country with large population may contribute to more carbon emissions. India population is being more than a billion. China represents 20% of the world population with over tan 1.3 billion.
- China has been ranked 99 in the world base on its CO2 emissions percapita.
- Japan is the world tenth most populated country with population around 127 million.

Japan has the highest life expectancy in the world, at 81.25 years in 2006.

- South Korea is one of the highest population density in the world.
- Gambar 1: Primary energy mix in major Asian countries.
- Forest can capture and store CO2 because they use CO2 as the building blocks for organic molecules and store it in woody tissue.(Kurz, Scholze)
- Decreasing deforestation and increasing reforestation should leads to increase capacity to absorb carbon.
- Table 3: Population and Population in cities in Asia 2005.

45. Greenhouse Gas Emission from hydropower, The state of research in 1996. Luc Gagnon, 1997

- There are two GHG emissions source: 1. Direct and indirect emissions associated with the construction of the plant. 2. emissions from decaying biomass from land flooded by hydro reservoir. It will produce CO2 and CH4 emissions.
- In cold climate, GHG emissions factor is 15 g CO2 equivalent/kWh, which is 30-60 less than factors of fuel generation. At tropical climate, it will be higher.
- Gas2 penyebab global warming meliputi: CO2, CH4(methane),N2O(nitrous oxide),CF4(carbon tetrafluoride).
- GWP(global warming potential) according to IPCC report 1994 (Intergovernmental Panel on Climate Change), based on perunit weight over 100 years. 24.5 for CH4, 320 for N2O and 6300 for CF4.

46. Hydropower –The politics of water and energy: Introduction and overview Frans H och, 2002

- Social effects of hydropower
- Environmental effects of hydropower
- Ethical and legal issues of hydropower development (Outlining).