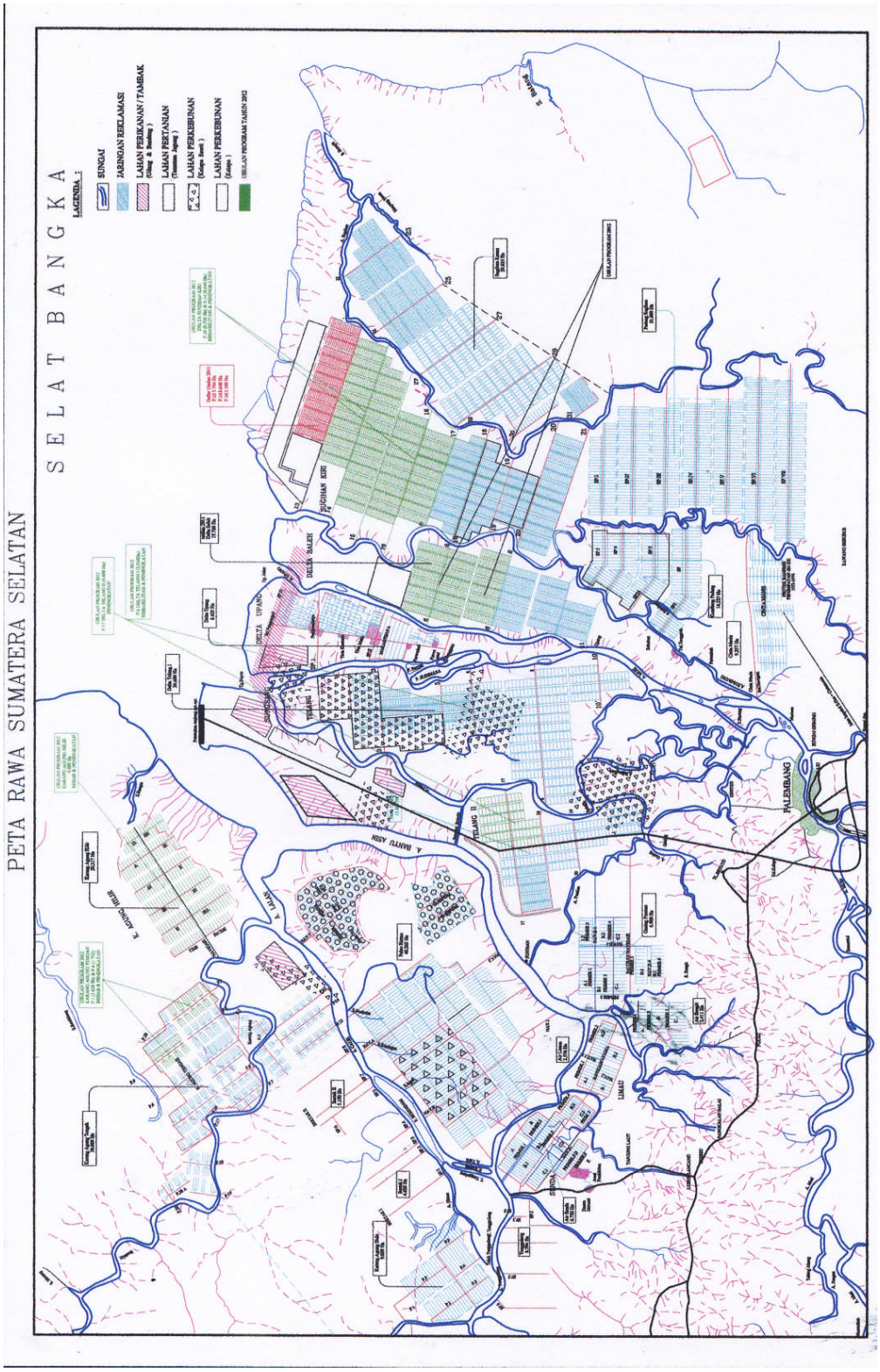
Lampiran 1: Peta Rawa dan Saluran Irigasi Pasang Surut Sumatera Selatan



Lampiran 2: Peta Saluran Irigasi Delta Telang II – Sumatera Selatan

Lampiran 3:

Tabel Data Keinggian air, Kecepatan dan Debit Aliran
Pada Selang Antara Musim Hujan dan Musim Kemarau Januari 2011

Jam	Tinggi (cm)	Kecepatan (cm/det)	TinggixLebar (cm^2)	Debit (dm^3/det)
1.00	15	128	1261	16
2.00	13	128,8	970	125
3.00	13	0	970	0
3.30	40	16,8	3880	65
4.30	56	35,5	5432	193
5.30	67	62,1	6499	403
6.30	80	70,1	7760	543
7.30	88	75,5	8536	644
8.30	93	72,8	9021	659
9.00	96	62,1	9312	577
9.30	97	51,5	9409	485
10.00	99	40,2	9603	384
11.00	101	35,5	9797	348
11.50	95	22	9215	203
12.00	86	22	8342	184
13.00	85	19,5	8245	161
14.00	82	27,5	7954	219
15.00	81	40,8	7857	321
16.00	75	46,1	7275	335
17.00	67	70,1	6499	455
18.00	58	78,1	5626	439
19.00	45	92,1	4365	402
20.00	36	112,8	3492	395
21.00	25	120,8	2425	293
22.00	20	128,8	1940	250
23.00	18	128,8	1746	225
24.00	16	128,8	1455	188

Lampiran 4:

Tabel Data Keinggian air, Kecepatan dan Debit Aliran
Pada Musim Kemarau 12 September 2011

Kecepatan (cm/detik)	Tinggi Permukaan Air (cm)	Lebar saluran (cm)	Debit (dm^3/det)
67	62	97	402,938
70	55	97	374,85
118	49	97	560,854
121	42	97	521,472
124	36	97	460,944
90	29	97	253,17
38	19	97	73,72
0	20	97	0
8	20	97	15,52
26	28	97	65,572
46	35	97	156,17
76	41	97	302,252
112	46	97	499,744
123	52	97	635,544
82	58	97	461,332
68	60	97	395,76
40	62	97	240,56
30	63	97	183,33
16	64	97	97,776
0	64	97	0

Tabel Data Ketinggian air , Kecepatan dan Debit Aliran
Pada Musim Hujan 6 Agustus 2011

Jam	Kecepatan (cm/det)	Tinggi (cm)	Lebar pintu air (cm)	Debit (dm^3/det)
13	94	28	97	255,304
14	40	28	97	112,52
14.35	0	28	97	0
15	75	26	97	189,15
16	83	26	97	209,326
17	54	25	97	130,95
18	30	40	97	116,4
19	62	40	97	240,56
20	110	35	97	373,45
21	99	32	97	307,296
23	97	30	97	282,27
3.00	72	29	97	202,536
6.00	70	29	97	196,91
9.00	54	29	97	146,664
10	40	28	97	104,76
11	0	27	97	0
12	38	25	97	194

Lampiran 5:

Tabel Data Pengamatan Terhadap Tinggi Permukaan air dan Kecepatan Aliran pada 15 Desember 2012

Jam pengamatan	Transisi aliran	Tinggi permukaan air (cm)	Kecepatan (cm/detik)
12.30		99	61
13.30		103	59,8
13.40		104	56
13.50			55
14.00		105	
14.30		105	55
15.00		107	54
15.30		109	48
16.00		110	36,4
17.00		113	12,6
17.30	Aliran transisi dari arus masuk ke arus keluar	113	0
17.45		111	14,5
18.00		110	22,6
19.00		103	33,7
20.00		97	55,7
20.15		96	
20.30		95	63,9
21.00		92	67,9
21.30		87	74,3
22.00		82	78,1
23.00		76	83,2
24.00		70	101,1
01.00		65	107,2
02.00		59	113,4
03.00		52	119,7
04.00		47	123,6
05.00		41	124,2

Lampiran 6:

Tabel Data Pengamatan Kecepatan Aliran dan Output daya pada Alternator Pada Pengujian Musim Hujan
16 Desember 2012

Jam Pengamatan	Kecepatan Aliran (Cm/detik)	Voltage yang dihasilkan (Volt x 10^{-1})
7.30	11	-
8.00	18,2	-
9.15	28,7	-
10.00	36,2	-
11.00	48,6	15
12.30	64,7	40
13.30	66,1	73
13.40	64,2	62
13.50	60,5	49
14.00	57	41
14.30	56	38
15.00	54	28
15.30	48	16
16.00	36,4	-
17.00	12,6	-
17.15	0	-
17.30	14,5	-
18.00	22,6	-
19.00	33,7	-
20.00	55,7	-
20.15		26
20.30	63,9	31
21.00	68,7	46
21.30	74,3	68
22.00	82,6	92
23.00	91,5	107
24.00	95,6	116
01.00	92,7	112
02.00	90,3	98
03.00	71,8	40
04.00	56,2	23
05.00	32,1	-
05.30	18,9	-
06.15	1,2	-

Lampiran 7 :

Estimasi Daya Berdasarkan Data Tinggi dan Kecepatan Aliran Air
Pada Pintu Air Bangun Sari Pada Musim Kemarau 21 Juli 2012

Waktu pengamatan (Jam)	Tinggi permukaan air (Cm)	Kecepatan aliran air (Cm/det)	Output alternator (Volt x 0,1)	
1	62	58	-	
2	55	70	46	
3	52	88	71	
4	50	98	86	
5	47	106	112	
6	45	110	128	
7	40	97	88	
8	36	60	22	
9	32	38	-	
10	29	0	-	
11	31	8	-	
12	34	26	-	
13	35	46	-	
14	38	76	24	
15	39	92	86	
16	41	106	112	
17	43	98	98	
18	45	90	78	
19	50	82	66	
20	53	68	32	
21	56	41	-	
22	59	30	-	
23	60	16	-	
24	62	0	-	

Lampiran 8:

Tabel Data Output Voltage Alternator Pada Musim Hujan
Pada Saat Arus Masuk Saluran
Berdasarkan Pengukuran pada bulan Desember 2012

Jam	Output Voltage (Volt x 0,1)	Kuat Arus (Amp)	Daya (Watt)
11.00	15	7,27	10,9
12.30	40	7,27	29
13.30	73	7,27	53
13.40	62	7,27	45
13.50	49	7,27	35,6
14.00	41	7,27	29,8
14.30	38	7,27	27,6
15.00	28	7,27	20,3
15.30	16	7,27	11,63

Tabel Data Output Voltage Alternator Pada Musim Hujan
Pada Saat Arus Keluar Saluran
Derdasarkan Pengukuran pada bulan Desember 2012

Jam	Output Voltage (Volt x 0,1)	Kuat Arus (Amp)	Daya (Watt)
20.15	26	7,27	18,9
20.30	31	7,27	22,53
21.09	46	7,27	33,44
21.30	68	7,27	49,43
22.0	92	7,27	66,88
23.0	107	7,27	77,78
24.0	116	7,27	84,33
1.0	112	7,27	81,42
2.0	98	7,27	71,24
3.0	40	7,27	29,08
4.0	23	7,27	16,72

Lampiran 9 :

Tabel Data Output Voltage Alternator Pada Musim Kemarau
Pada Saat Arus Masuk Saluran
Berdasarkan Data Pengukuran pada bulan Juli 2012

Jam	Output Voltage (Volt x 0,1)	Kuat Arus (Ampere)	Daya (Watt)
2.0	46	7,27	33,44
3.0	71	7,27	51,61
4.0	86	7,27	62,51
5.0	112	7,27	81,42
6.0	128	7,27	93,05
7.0	88	7,27	63,97
8.0	22	7,27	15,99

Tabel Data Output Voltage Alternator Pada Musim Kemarau
Pada Saat Arus Keluar Saluran
Berdasarkan Data Pengukuran pada bulan Juli 2012

Jam	Output Voltage (Volt x 0,1)	Kuat Arus (Ampere)	Daya (Watt)
14.0	24	7,27	17,44
15.0	86	7,27	62,52
16.0	112	7,27	81,42
17.0	98	7,27	71,24
18.0	78	7,27	56,7
19.0	66	7,27	47,98
20.0	32	7,27	23,26

Lampiran 10: Alternator Putaran Rendah NaiEr 100 Watt, 12 Volt.

Item specifics

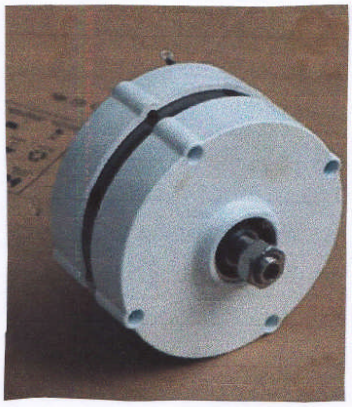
Place of Origin: Jiangsu China (Mainland)
is_customized: Yes
Brand Name: NaiEr
Type: Wind Power Generator
Model Number: NE-100
generator: Three-phase permanet magnet synchronous alternator
type: radial flux/brushless
rated power: 100w
max power: 150w
rated volatge: 12v / 24v
net weight: 3.5kg(8.4 lb)
diameter: 150mm
height: 65mm
shell: alunimum alloy

Product Description

Features:
1, Starting with low wind speed, wind energy utilization high; small size, beautiful appearance, low vibration operation.
2, Installed by human design, easy installation, maintenance and repair.
3, Using a new set of ring power output devices, to overcome the traditional small-scale wind turbine wind when the cable winding.
4. Permanent magnet generator rotor using patented alternator, together with the special stator design, effectively reduce the generation of resistance torque, while allowing more wind turbines and generator has good matching characteristics, the unit runs reliability.

Technical parameters

rated power	100w
max power	150w
rated voltage	12v/24v
rated speed	450 r/m
net weight	3.8kg(8.4Lb)
dimension(height*shaft*diameter)	65*30*150mm
woring temperature	-40°F to 176 °F



100w ac 12v low rpm permanent magnet alternator

Lampiran 11: Pengukuran Kinerja Alternator dalam satuan Voltage

Tabel Data Pengujian Simulatif Alternator *)

No	Putaran Alternator (RPM)	Output Voltage (Volt)
1	65,6	1,6
2	145	1,7
3	156	2,2
4	182	2,5
5	200	2,9
6	274	3,0
7	300	3,6
8	349	6
9	416	8,8
10	452	11,2
11	660	14
12	745	16
13	860	18,7
14	906	19,1
15	1108	20,8
16	1210	22,1

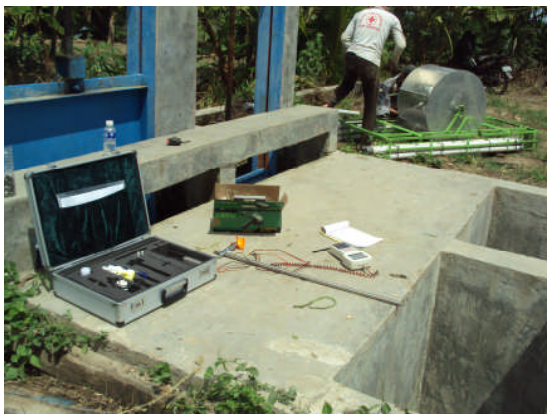
*) Putaran kekiri atau kekanan pada alternator menghasilkan daya yang sama.

Lampiran 12: Pengukuran Kuat Arus Alternator dalam satuan mili-Amper (mA).

Data Pengukuran Kuat Arus Alternator
Dalam mili-Amper (mA)

No:	Putaran Alternator (RPM)	Kuat Arus (Ampere)
1	200	5,5
2	300	6,8
3	314	16,4
4	400	14,3
5	678	13,1
6	583	12,5
7	460	11,7
8	509	11,3
9	468	1,94
10	441	4,8
11	482	3,4
12	455	2,6
13	380	0,8
14	575	6,12
16	789	1,8
17	520	2,1
18	600	2,6
19	700	0,8
20	300	2
21	1000	2,6
22	600	0,6
23	366	0,4
24	267	3,7
25	614	9,9
26	475	10,6
27	498	13,8
28	511	16,4
29	533	18,6

Lampiran 13:



(a)

(b)

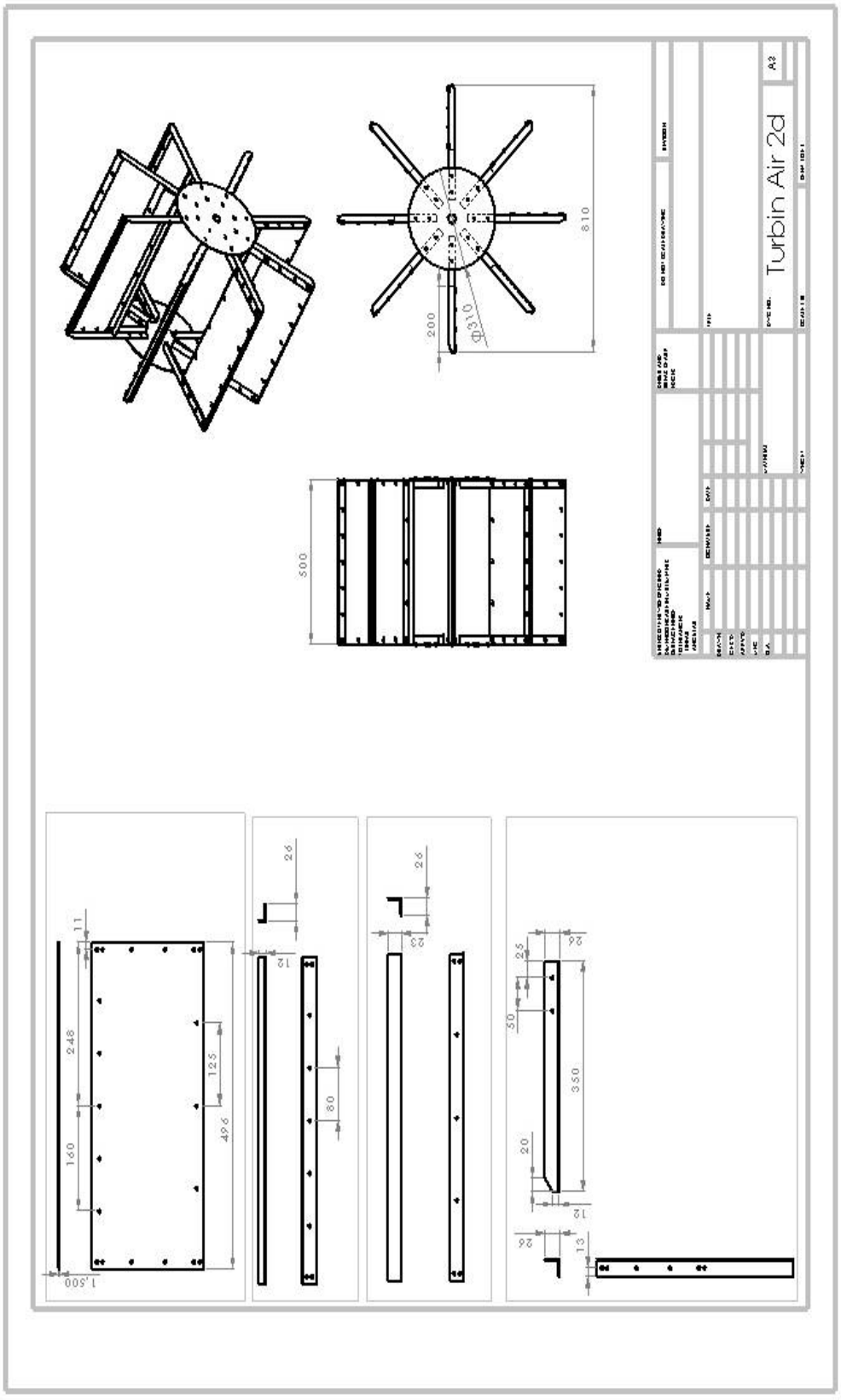
(c)

(d)

(e)

Aktifitas Penelitian Kincir Air Apung di Desa Bangun Sari Telang II – Banyuasin pada bulan Desember 2012

Lampiran 14: Gambar Detail Roda Kincir



Lampiran 15: Spesifikasi Teknis Material Aluminium Alloy 6063

GENERAL INFORMATION

Alloy 6063 is a heat-treatable aluminium alloy having good combination of extrudability and mechanical properties, also responding well to polishing, anodising, chemical brightening and dyeing.
Thin walled hollow and intricate solid shapes could be produced more readily and easily with this alloy

ALLOY 6063
Aluminium-Magnesium-Silicon alloy (AlMgSiO)

Chemical composition

%Si	%Fe	%Cu	%Mn	%Mg	%Cr	%Zn	%Ti	%Other	%Aluminium
0,35 - 0,50	0,10 - 0,30	0,10	0,10	0,35 - 0,55	0,05	0,1	0,1	0,05	Remainder

Mechanical Properties

Temper	Ultimate Tensile Strength (MPa)	0,2% Proof Stress (MPa)	% Elongation
T4	130	69	14
T5	150	110	7
T6	185	160	7

Physical properties

Density	2,71 x 10^{-6} kg/mm^3
Melting range	600 - 650 deg C
Specific heat between 0 - 100° C	879 J/kg deg C
Coefficient of linear expansion between 20 - 100° C	23 x 10^{-6} / deg C
Thermal conductivity at 25° C	0.033 u m
Electrical Resistivity at 20° C	69 x 103 MPa
Modulus of Elasticity	

Temper designation

- F- Indicates the as-fabricated condition where no control has been exercised over the temper of the alloy.
- T- Indicates a heat-treated alloy.
- T4 Solution heat treatment followed by natural aging at room temperature to a substansial stable condition.
- T5 Artificial aging after an elevated temperature, rapid cool fabrication process such as casting or extusion
- T6 Solution heat treatment followed by artificial aging

For subsequent severe forming process as in bending, please opt for softer tempers.

Mill Finish
Natural aluminium finish off the extrusion-press with no further anodising or colouring process.

Natural Anodised Finish
By means of electro-chemical process natural oxide-film will be formed and thickened considerably on the meta surface. The alumunium extrusion is then sealed in hot deionised-water which closes off the pores and permanentl seals the oxide film imparting to the metal surface the extreme hardness, corrosion and wear resistance of the oxid Alexindo natural anodise finish conform to International Standard and is available in nominal film-thickness of 5, 1 18 and 25 microns.
For normal and severe atmospheric condition, film thickness of 10 and 25 microns respectively should be recommende

Colour Finish
In the Alexindo colour process, inorganic metal colour particles are deposited and fixed electrolytically at the va base of the pores of anodic film allowing virtually full thickness off the anodic film to protect them.
The aluminium extrusion is then sealed in hot deinoised water which closes off the pores and permanently seals in th colour particles.
The colouring process in combination with anodising is to yield a finish which is lightfast, abrasion and corrosi resistance and unchanging colour intensity.
For normal and severe atmospheric condition, film thickness of 18 and 25 microns respectively should be recommende

Lampiran 16: Analisis Mutu Bada Air Sebelum Kincir Air Apung

KEMENTERIAN KESEHATAN RI
DIREKTORAT JENDERAL PP & PL
BALAI TEKNIK KESEHATAN LINGKUNGAN & PENGENDALIAN PENYAKIT
P A L E M B A N G

Komite Akreditasi Nasional
Laboratorium Penguji
LP - 449 - IDN

Jln. Jend. Sudirman Km. 2,5 No. 7490
Telp. 0711 - 351278 Fax. 0711-351278

SERTIFIKAT HASIL PENGUJIAN
IR.02.02/VIII.8/65~~6~~ /12

UMUM

Laboratorium	: Kimia Air
Jenis Sampel	: Air Permukaan
Kondisi Sampel/Abnormalitas	: Sedikit Berendapan
No. Urut Sampel	: 650
Kode Sampel	: Sampel I
Berasal dari	: Darmawi
Diambil oleh	: Darmawi (Pengambilan Sampel Tanggung jawab Konsumen)
Diambil/Diterima tanggal	: 16 Desember 2012/18 Desember 2012
Tgl. Pengujian di Lab	: 18 Desember 2012
No. Lab	: 3956/S-A/XII/2012

HASIL UJI

No	Parameter	Satuan	Kadar maksimum Air Sungai Kelas I	Hasil	Metode Pemeriksaan
	FISIKA				
1	Zat padat terlarut	mg/L	1500	407	SNI 06-6989.27-2004
2	Zat padat tersuspensi	mg/L	50	21	SNI 06-6989.3-2004
	Kimia Anorganik				
1	pH * *(di Laboratorium)*	#	6 - 9	**2,56**	SNI 06-6989.11-2004
2	Kebutuhan Oksigen Biokimia *(BOD_5)*	mg/L	2	0,90	SNI 6989.72.2009
3	Kebutuhan Oksigen Kimia *(COD)*	mg/L	10	1	SNI 6989.2-2009
4	Dissolved Oxygen *(DO)*	mg/L	6	4,58	SNI 06-6989.14-2004
	Kimia Organik				
1	Minyak & Lemak	mg/L	1	0,126	SNI 06-6989.10-2004

*) : Terakreditasi #) : Tidak ada satuan

Catatan : pH Asam berdasarkan Peraturan Gubernur Sumsel No. 16 Th 2005

Palembang, 28 Desember 2012

Manajer Mutu

Ir. Megawati, M.Kes
NIP. 19581211 197912 2001

Manajer Teknis Kimia Air

Nurul Fadillah, S.Si
NIP. 19800908 200312 2003

Lampiran 17: Analisis Baku Mutu Badan Air sesudah Kincir Air Apung

KEMENTERIAN KESEHATAN RI
DIREKTORAT JENDERAL PP & PL
BALAI TEKNIK KESEHATAN LINGKUNGAN & PENGENDALIAN PENYAKIT
P A L E M B A N G

KAN Komite Akreditasi Nasional Laboratorium Penguji LP - 449 - IDN

Jln. Jend. Sudirman Km. 2,5 No. 7490 Telp. 0711 - 351278 Fax. 0711-351278

SERTIFIKAT HASIL PENGUJIAN
IR.02.02/VIII.8/656/12

UMUM

Laboratorium	: Kimia Air
Jenis Sampel	: Air Permukaan
Kondisi Sampel/Abnormalitas	: Sedikit Berendapan
No. Urut Sampel	: 650
Kode Sampel	: Sampel II
Berasal dari	: Darmawi
Diambil oleh	: Darmawi (Pengambilan Sampel Tanggung jawab Konsumen)
Diambil/Diterima tanggal	: 16 Desember 2012/18 Desember 2012
Tgl. Pengujian di Lab	: 18 Desember 2012
No. Lab	: 3957/S-A/XII/2012

HASIL UJI

No	Parameter	Satuan	Kadar maksimum Air Sungai Kelas I	Hasil	Metode Pemeriksaan
	FISIKA				
1	Zat padat terlarut	mg/L	1500	112	SNI 06-6989.27-2004
2	Zat padat tersuspensi	mg/L	50	18	SNI 06-6989.3-2004
	Kimia Anorganik				
1	pH * *(di Laboratorium)*	#	6 – 9	**3,60**	SNI 06-6989.11-2004
2	Kebutuhan Oksigen Biokimia *(BOD_5)*	mg/L	2	1,80	SNI 6989.72.2009
3	Kebutuhan Oksigen Kimia *(COD)*	mg/L	10	2	SNI 6989.2-2009
4	Dissolved Oxygen *(DO)*	mg/L	6	4,48	SNI 06-6989.14-2004
	Kimia Organik				
1	Minyak & Lemak	mg/L	1	0,163	SNI 06-6989.10-2004

*) : Terakreditasi #) : Tidak ada satuan

Catatan : pH Asam berdasarkan Peraturan Gubernur Sumsel No. 16 Th 2005

Palembang, 28 Desember 2012

Manajer Mutu

Ir. Megawati, M.Kes
NIP. 19581211 197912 2001

Manajer Teknis Kimia Air

Nurul Fadillah, S.Si
NIP. 19800908 200312 2003

Lampiran 18:

KEMENTERIAN PENDIDIKAN NASIONAL
UNIVERSITAS SRIWIJAYA
PROGRAM PASCASARJANA
Jl. Padang Selasa No.524, Bukit Besar Palembang 30139
Tel: (0711)354222, 352132 Fax:(0711) 317202, 320310
Email: ppsunsri@mail.pps.unsri.ac.id Homepage: www.pps.unsri.ac.id

Nomor : 283 .20/H9.1.10/PP/2011 Palembang, 31 Januari 2011
Lampiran : -
Perihal : Permohonan izin Penggunaan Lokasi Penelitian

Kepada Yth Bapak Camat Tanjung Lago, kecamatan Tanjung Lago

Di Kabupaten Banyuasin

Dalam rangka penyusunan tugas akhir/ Disertasi menghadap Bapak/Ibu, mahasiswa Program Pascasarjana Universitas Sriwijaya di bawah ini :

Nama	:	Darmawi
NIM	:	20093602002
Program Studi	:	Doktor (S3) Ilmu-ilmu Lingkungan
Judul Disertasi	:	Mikro Hidro pada Saluran Irigasi Psang Surut Telang II-Kabupaten Banyuasin.
Promotor	:	Prof. Dr. Ir. Edi Armanto.
Co-promotor I	:	Dr.Ir. Siti Masreah Bernas, MSc
Co-promotor II	:	Dr. Ir. Riman Sipahutar, MSc

Sehubungan dengan itu mohon perkenan Bapak/Ibu kiranya dapat memberikan izin penggunaan Saluran Sekunder di Desa Bangun Sari Kecamatan Tanjung Lago Kabupaten Banyuasin kepada mahasiswa kami tersebut dalam rangka penyusunan tugas akhir/Disertasi yang dimaksud.

Demikianlah atas perhatian dan kerjasamanya diucapkan terima kasih.

Direktur,

Prof. Dr.dr. HMT. Kamaluddin, M.Sc, Sp.FK
NIP 195209301982011001

Tembusan :
- Kepala Desa Bangun Sari

Lampiran 19:

KEMENTERIAN PEKERJAAN UMUM
DIREKTORAT JENDERAL SUMBER DAYA AIR
BALAI BESAR WILAYAH SUNGAI SUMATERA VIII
SNVT PELAKSANAAN JARINGAN PEMANFAATAN AIR SUMATERA VIII PROP.SUMSEL
Jl. Kapten Anwar Sastro No.1251 Telp.(0711) 362720 Fax.(0711) 312272 - Palembang

Nomor : UM 01 03/BBWSS.VIII/463 Palembang, 16 Februari 2010
Lampiran :

Kepada Yth,
Direktur Program Pasca Sarjana
Unversitas Sriwijaya
di
Palembang

TO : Darmawi
(Mhs S3 IC

Perihal : **Izin Penggunaan Lokasi Penelitian**

Sehubungan dengan Surat Saudara Nomor :283.20/H9.1.10/PP/2011 Tanggal 31 Januari 2011 Perihal : Permohonan Izin Penggunaan Lokasi Penelitian, setelah kami pelajari pada prinsipnya kami dapat mengizinkan saudara untuk penggunaan lokasi penelitian pada saluran sekunder di desa Bangun Sari Kecamatan Tanjung Lago Kabupaten Banyuasin, untuk pengaturan lebih lanjut agar dapat menghubungi PPK Irigasi dan Rawa IV (Sdr. Ir. Ricky Nelson).

Demikian atas perhatiannya diucapkan terimakasih.

Kepala Balai Besar
Wilayah Sungai Sumatera VIII
Propinsi Sumatera Selatan

Ir. Soekotjo Trisulistyo, Dipl, HE
NIP. 110 035 044

Tembusan kepada Yth :
1. Kabag Tata Usaha BBWSS. VIII
2. Kabid Pelaksanaan Jaringan Pemanfaatan Air Sumatera VIII
3. PPK Irigasi dan Rawa IV
4. Pertinggal

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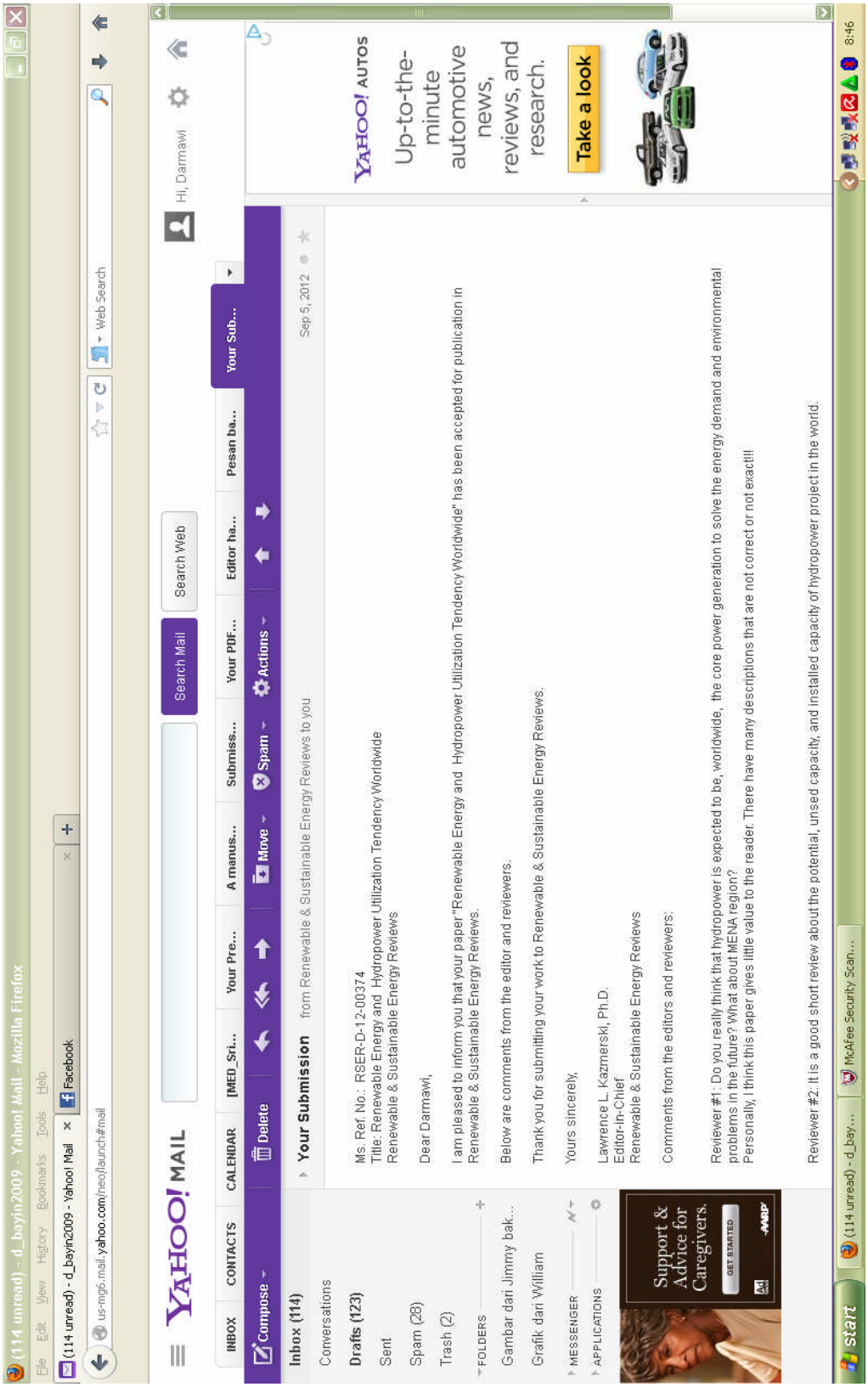

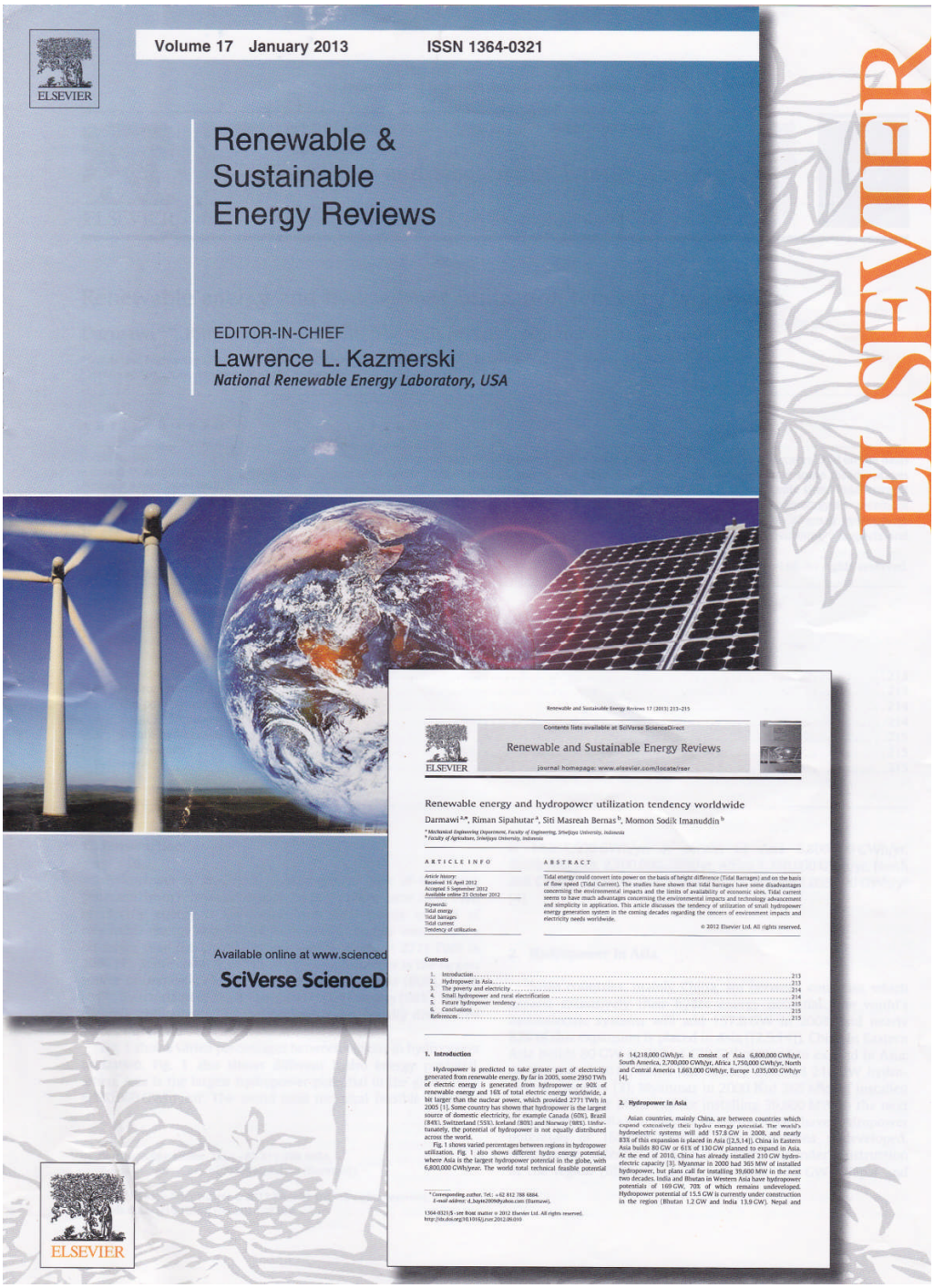
Volume 17 January 2013
ISSN 1364-0321
Renewable & Sustainable Energy Reviews
EDITOR-IN-CHIEF
Lawrence L. Kazmerski
National Renewable Energy Laboratory, USA
ELSEVIER
Renewable and Sustainable Energy Reviews 17 (2013) 213–215
Contents lists available at SciVerse ScienceDirect
Renewable and Sustainable Energy Reviews
journal homepage: www.elsevier.com/locate/rser
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ARTICLE INFO
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Renewable energy and hydropower utilization tendency worldwide

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ARTICLE INFO

Article history:
Received 16 April 2012
Accepted 5 September 2012
Available online 23 October 2012

Keywords:
Tidal energy
Tidal barrages
Tidal current
Tendency of utilization

ABSTRACT

Tidal energy could convert into power on the basis of height difference (Tidal Barrages) and on the basis of flow speed (Tidal Current). The studies have shown that tidal barrages have some disadvantages concerning the environmental impacts and the limits of availability of economic sites. Tidal current seems to have much advantages concerning the environmental impacts and technology advancement and simplicity in application. This article discusses the tendency of utilization of small hydropower energy generation system in the coming decades regarding the concern of environment impacts and electricity needs worldwide.

Contents

1. Introduction

Hydropower is predicted to take greater part of electricity generated from renewable energy. By far in 2005, some 2950 TWh of electric energy is generated from hydropower or 90% of renewable energy and 16% of total electric energy worldwide, a bit larger than the nuclear power, which provided 2771 TWh in 2005 [1]. Some country has shown that hydropower is the largest source of domestic electricity, for example Canada (60%), Brazil (84%), Switzerland (55%), Iceland (80%) and Norway (98%). Unfortunately, the potential of hydropower is not equally distributed across the world.

Fig. 1 shows varied percentages between regions in hydropower utilization. Fig. 1 also shows different hydro energy potential, where Asia is the largest hydropower potential in the globe, with 6,800,000 GWh/year. The world total technical feasible potential is 14,218,000 GWh/yr. It consist of Asia 6,800,000 GWh/yr, South America, 2,700,000 GWh/yr, Africa 1,750,000 GWh/yr, North and Central America 1,663,000 GWh/yr, Europe 1,035,000 GWh/yr [4].

2. Hydropower in Asia

Asian countries, mainly China, are between countries which expand extensively their hydro energy potential. The world's hydroelectric systems will add 157.8 GW in 2008, and nearly 83% of this expansion is placed in Asia ([2,5,14]). China in Eastern Asia builds 80 GW or 61% of 130 GW planned to expand in Asia. At the end of 2010, China has already installed 210 GW hydroelectric capacity [3]. Myanmar in 2000 had 365 MW of installed hydropower, but plans call for installing 39,600 MW in the next two decades. India and Bhutan in Western Asia have hydropower potentials of 169 GW, 70% of which remains undeveloped. Hydropower potential of 15.5 GW is currently under construction in the region (Bhutan 1.2 GW and India 13.9 GW). Nepal and

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http://dx.doi.org/10.1016/j.rser.2012.09.010

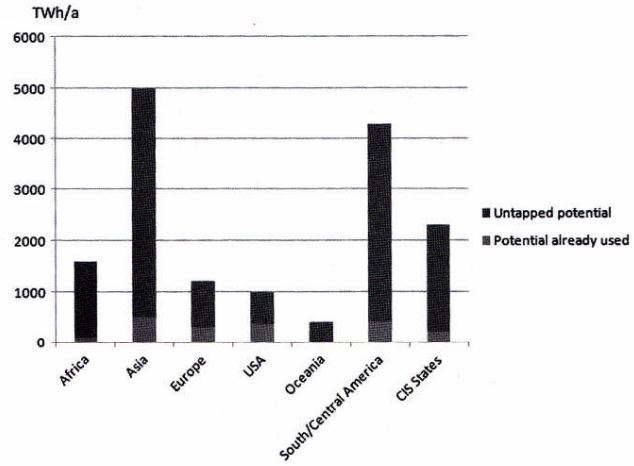

Fig. 1. Hydropower potential, untapped and already used power.
Source: Seifried [1]

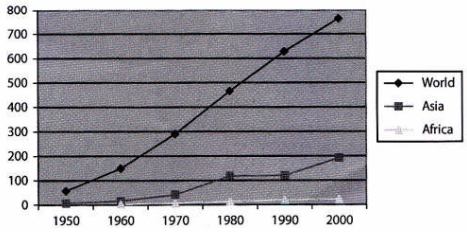

Fig. 2. World hydroelectricity system installation increment in decades in kWh/p/y. Developed from: Sternberg [2].

Bhutan are rich in hydropower resources. Pakistan in South Asia, has hydropower potential more than 38,000 MW. In Middle East, there are limited sites for hydropower, only Iran and Iraq have project under development. Iran is seeking to develop some 2.6 GW and Iraq 0.3 GW [3]. ASEAN countries' total hydro potential is 202417 MW. According to IEA and ESCAP report, installed hydro capacity in ASEAN region in 2000 is 17.913 MW [16]. It is now more than 105.000 MW of hydro capacity under construction in the world.

3. The poverty and electricity

According to International Hydropower Association (2011), it is estimated that 1.4 billion people live without electricity around the globe. Some other says 1.6–2.0 billion people live in the dark and smoke filled home [7,6]. Electricity is one of the pillars on which education and health lie on. Electricity is strongly related to the policy to step-up the economic sustainability and a better quality of life, reducing the poverty and diminishing the inequality.

In Bangladesh, India and Pakistan 570 million people have no access to electricity. Millions of people worldwide have no access to electricity. According to Kaygususz [6], it is approximately 589 million people in Africa, 587 million people in Sub-Saharan Africa, 809 millions in developing Asia, 614 million in South Asia and 1453 million in all developing countries. Data show the interrelation between the poverty and the electricity availability. Energy consumption of African people especially sub-Saharan Africa is 248 Kgoe or half of the world average, while the population in sub-Saharan Africa in 1999 is estimated to be 642 million people or over 80% of the African total population [9] (Fig. 2).

4. Small hydropower and rural electrification

According to Giles [10], some hydropower schemes cause global warming as much as fossil fuel plants as the previous forested areas emit greenhouse gases in the form of methane and nitrous oxide which have global warming effect 25 and 300 times greater than carbon dioxide respectively. Other environmental concerns are highlighted by Harrison et al. [12] on the problem of sediment transport and river ecology. The International Energy Agency has also reported several other negative impacts of major and medium scales that are being associated with large hydropower projects. Many large hydropower projects create social problems worldwide. High Aswan Dam as the one that has 6000 km^2 surface area and water volume of 162 km^3 creates downstream and up-stream effects, methylmercury bioaccumulation, emission of greenhouse gases and limitation of biodiversity. High Aswan Dam hydro-electric development resulted in the relocation of more than 100,000 people to make way for reservoir. Migration of large number of people resulted in harmful social effects [13].

Very small hydro plants do not suffer from such environmental and social problems, not only because the scale of the technology but also due to the insignificant storage of water. Mostly mini-, micro- and pico-hydropower do not form a barrier of aquatic life. Small hydropower plants are now recognized as important technology to rural populations, many of which do not have access to electric power.

Ocean covers approximately 71% of earth surface and holds a large amount of energy more than 2×10^3 TW, which is mostly

untapped renewable energy on the planet. Ocean energy is available in some forms, including tide, wave, tidal current, thermal energy conversion. Among them hydro energy is the most highlighted because of the advantages including the long-time predictability, large potential resource and high energy density which is about 832 times greater than that of wind. On the basis of large potential, clean energy necessities of the world and low operating cost, the hydro energy will probably take an important role in coming decades in electricity generation specifically in remote areas and rural areas where electricity grid is unable to reach. Laos in South East Asia with population of 6.5 millions spread across mountainous terrain which covers three quarters of the land area uses pico-hydropower as do the countries with small hydropower.

5. Future hydropower tendency

Renewable energy is of interest to all energy communities to cover the increasing energy deficit, where hydropower, wind energy and photovoltaic seem to be optimum choices among the renewables available today. Hydro energy can be harnessed from the water current by simply utilizing the velocity of the water stream. The power can be extracted from the ocean and river current by using submerged turbine, which are similar to wind turbine, capturing the energy through the process of hydrodynamic. The use of kinetic energy of stream is considered to be a strong alternative in accordance with the large potential and clean energy. The technology of submerged turbine is fit to the requirements of free greenhouse gases emission, low operating cost and low noise transmission systems and nearly existed in most sites in the globe. With these reasons, the use of kinetic energy predicted tends to increase in the domain of kinetic energy conversion in coming decades rather than potential energy conversion worldwide. Mukrimin Sevket [15] expected that the world renewable energy generation will reach 5.8 trillion kWh by 2020, where hydroelectricity will share 4.4 trillion kWh from total or 76%.

Some countries which have numerous water energy resources use hydropower to fulfill their electric domestic needs, such as Norway (98.25%), Brazil (85.56%), Venezuela (67.17%) of installed capacity in 2009. Sternberg [17] reported that installed hydropower worldwide raise significantly from the year 1950 to 2000. In Africa, there is an increment of 4461 percent from 1950 to 2000, in Asia 2418 percent, in Europe 782 percent, in North America 234 percent, Oceania 1307 percent, South America 4954 percent. The world total increment of installed hydropower from the year 1950 to year 2000 is 721 percent or from 92,105 MW to 756,000 MW. These data represent a great tendency to utilize the hydro energy for electricity in coming decades worldwide.

6. Conclusions

Small hydropower which converts the kinetic energy of river stream or ocean current into electrical energy seems a promising alternative source of energy generation to fulfill electric necessity in remote areas. The choice of small hydropower is also backed up by the international effort to reduce greenhouse gas emission in the atmosphere.

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Lampiran 21: Akseptasi Makalah Ilmiah pada Konferensi Internasional Padang 2013

Fakultas Teknologi Pertanian
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SAFE 2013 International Conference Sustainable Agriculture, Food, and Energy

15th March 2013

DARMAWI[1], RIMAN SIPAHUTAR[1], SITI MASREAH BERNAS[2], MOMON SODIK IMANUDDIN[2]

[1] Mechanical engineering lecturer of Sriwijaya University-Palembang
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INDONESIA

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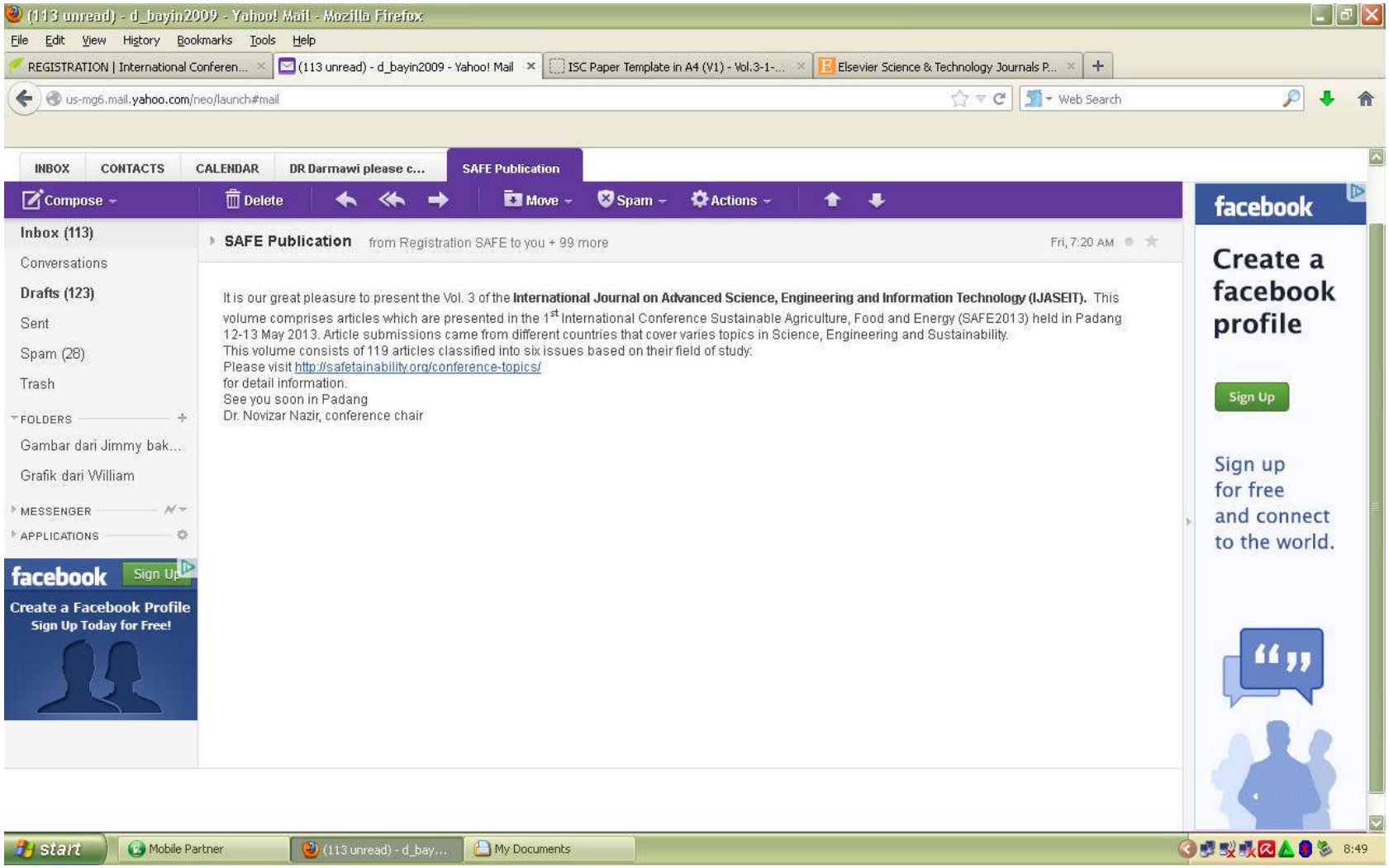
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Pico Hydropower Application on Tidal Irrigation Canal Supporting The Indonesian Agricultural Activities Case Study: Telang II - Banyuasin

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Abstract

A review of waterwheel history has conducted to evaluate the possibility and the technology development in its relation to harvest the energy from the flowing water in and out of irrigation canal regarding the tidal movement. The study has conducted at the east shore of South Sumatra. Hydro energy became a promising renewable energy in order to achieve at least 5% of total Indonesian national energy mix consumption in 2025. Tidal turbine energy is technologically potential for Indonesian future regarding the beach of 81,000 kilometers long and 20 millions hectares of tidal swamp area out of 33 millions hectares available. Mechanical torque of 30 Nm is produced by a waterwheel of 0.38 meter radius. An estimation of 60 watt at the peak of rain season could harvested from each tidal irrigation canal in Telang II. This mechanical energy is applicable to generate small quantity water pump, water aeration injector and small electric energy energy appliances.

Keyword: Hydropower, renewable energy, tidal energy, irrigation canal.

Introduction

The world electric energy production become doubled in the last decade, from 9.5 MTOe in 2001 to 19 MTOe in 2010 (Abbasi, 2011). 17% out of it comes from hydropower or about 715.000 MW (BP, 2009). Some countries with lean fossil fuel resources, fulfill their national energy necessity with hydropower.e.g. Brazil with 85.5% of its national capacity , Norwegia with 98.25% of national capacity and Canada with 61.12% of national capacity. (Wikipedia,2009) Hydro energy is an interesting energy resource regarding the clean and safe impact on the environment.

Indonesia is trying hard to diversify the energy consumption, concerning the pain experiences of state economic disturbances when the oil price raise. The higher the portion of oil in national energy consumption, the more the dependency of state economic on oil price. The government take some policies on the base of energy conservation, energy saving and energy diversification. In order to achieve the energy diversification target successfully, it is projected to consume energy mix as presented in Table 1, as a compulsory target. Renewable energy resources as solar energy, wave energy, tidal energy, wind energy are abundance in Indonesia regarding the geographic position across the tropic area and archipelagic islands of the country.

Hydropower is a possible energy to be developed in Indonesia regarding the huge amount of hydro energy potential. It is estimated that Indonesian hydropower potential about 75,000 MW one-third of Asian hydropower potential. (Hayes, 2004; Kamarudin, 2005). Hydropower, especially Tidal Current Turbine take special attentions for development in recent years. Tidal Current Turbines are classified as small hydropower regarding the energy produced mostly below 50 MW.

1. Greenhouse Gas Emission and Global Warming

Global warming is faced by the earth and threaten all nations on the globe. It is predicted that no nations and no countries will safe on earth when the temperature rise and climate change affected by the global warming is out of control.

Table 1: Indonesian Energy Consumption Rate at Present and Consumption Projections in The Year 2025

No:	Energy Specifications	Present Consumption Rate *)	Consumption Rate Projection in the Year 2025 **)
1	Oil	47.5%	20%
2	Gas	26.5%	30%
3	Coal	24.3%	33%
4	Biofuel	-	> 5%
5	Geothermal	2.45%	> 5%
6	New and Renewable Energy	1.7%	> 5%
7	Others	-	> 2%

*) British Petroleum, Year 2008.
**) Perpres No5, Year.2006.

The greenhouse effect is the process of absorption and emission of infrared radiation by gases in the atmosphere and warm the planet's lower atmosphere and surface. It was proposed by Joseph Fourier in 1824. (Weart, 2008).
The major greenhouse gases are water vapor, which causes about 36–70% of the greenhouse effect (Schmidt, 2005) ; carbon dioxide (CO_2), which causes 9–26%; methane (CH_4), which causes 4–9%; and ozone (O_3), which causes 3–7%. (Russell, 2007). Clouds also affect the radiation balance through

cloud forcings similar to greenhouse gases.

. Indonesia produce emission of about 2,1 Gt CO_2 equivalent in 2005, which is equivalent to 4.97% of world greenhouse production. An increment has occured up to 2,4% of world emission in year 1993 or equivalent to 140 millions ton of CO_2 (Petrich,1993). Most of Indonesian emission was not from industrial activities such as India, China and Japan, but from peat burnt and deforestation. (Indonesia National Climate Change Commision, 2010; Jupesta, 2011; Brockhaus, 2011).

2. Waterwheel

Waterwheel has established since 2000 BC. Doomsday Book reported in the year 1086 there are 5000 waterwheels in England and 60.000 waterwheels in France in the year 1820 (Denny, 2004). It is reported that in China, India, olden Egypt, Paraguay, Brazil, Congo and African countries, waterwheels are used to pump the water into rice fields.

At the beginning most of the waterwheel operated with vertical shaft. Vertical shaft waterwheel is considered as much simplified the transmission system where the mechanical energy could directly connected to the equipment wanted to the device such as milling machine, pumps etc. Some decades after, waterwheel is constructed with horizontal shaft, regarding the high efficiency and the development of transmission system. Waterwheel has operated in Europe since 800 years ago to meet the mechanical energy the people need that time.(Kaldellis, 2007).

2.Telang II – Banyuasin

Muara Telang is a Kecamatan in Kabupaten Banyuasin, Sumatera Selatan, Indonesia. This area is now being developed as a Kawasan Terpadu Mandiri (Integrated Self Sufficient Area) or abbreviated by KTM-Telang. This area includes Delta Telang I and Delta Telang II which is separated by Telang River. Delta Telang I and Delta Telang II is surrounded by four main rivers, Musi River on East, Banyuasin River on the West, Sebalik River and Gasing River on the the south, while on the north bordered by Terusan PU and Banka Strait.

Delta Telang I has an area of 26.680 hectares involving three Kecamatans,i.e. Kecamatan Muara Telang, Kecamatan Banyuasin II and Kecamatan Makarti Jaya. Delta Telang II has an area of 13,800 hectares including Kecamatan Tanjung Lago, Kecamatan Talang Kelapa and Kecamatan Muara Telang. Delta Telang II has 12 villages, i.e. Desa Telang Sari, Desa Purwosari, Desa Mulya Sari, Desa Banyu Urip, Desa Bangun Sari, Desa Sumber Mekar Mukti, Desa Suka Damai, Desa Suka Tani, Desa Tanjung Lago, Desa Sri Menanti and Desa Kuala Puntian.

I.2.a.Climate and Hydrology

The climate of KTM Telang is categorized as tropical rain where warm and moist is existed all the year. Average monthly temperature is 27 C dan relative humidity is 87%. The area of KTM Telang categorized as agroklimat C1 zone. In wet season (rain season) with period of 5-6 months the average rainfall is >200 mm per-month and in dry season (summer), of equal period the average rainfall is <100 mm per-month. Dry season does on October-April, and rain season does on May-September.

Tidal irrigation canals are fully developed in KTM Telang concerning the needs to watering the area of rice fields around it. Primary canals are stretching connecting between rivers

and Secondary canals are stretching connecting between primary canals. In general, the drainage system in KTM Telang is double-grid system. Mostly the distance between primary canals are 8.000 m. Secondary canals are perpendicular and directly connected to primary canals. The distance between secondary canals are 1,150 meters each and 3,850 meters long. Most of KTM Telang area topographically are tidal swamp area with the elevation of 0,5 m - 2,25 m above the sea level. The water moving in and out of the canals all day long.

I.3. Bangun Sari Village

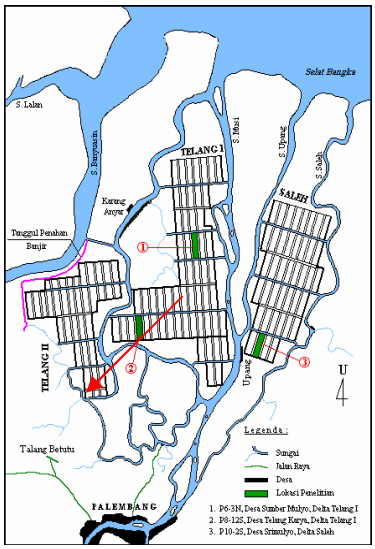
Bangun Sari is a village where the study of micro hydro power is focused on. Bangun Sari village is situated in Telang II and located at about one kilometers at the side of Jalan Raya Tanjung Api-api. Bangun Sari is an area of 1650 hectares square. This area is inhabitted by 3,390 people, consist of 1,786 man and 1,604 women or about 681 Family Heads. Most of the people or about 60 % of the population are farmers and some other informal jobs. Small community with public facility is at the center of the village where the people do trading and their daily activities. (Darmawi, 2011)

From the local point of view, the needs of hydro power generating in Bangun Sari village is quite high, regarding the following reasons: firstly, the electricity is expensive to install, meanwhile the hydro power is free of charge; secondly, the hydro power is strongly possible to generate the small farming engine such as paddy separators, corn shedder etc. and thirdly, supporting the Indonesian government program to ascend the people prosperous and the walfare by Desa Mandiri Energi (Energy Self-sustainable Village) program. The utilization of irrigation canal for energy purpose could hopely change the culture of the local people from only water culture to techno-water culture. In the point of view of nationality, the hydro power is a way to bring the country out of oil dependence and protect the state economy from the influence of world oil price fluctuation.

II. Theoritical Energy Study

The study of hydro power is focused on the sluice of irrigation canal in Bangun Sari Village which is situated at 2.381 South Latitude and 104.42 East Longitude.

The observation conducted in March, 2011 noting that the water level at rain season is maximum at 95 cm from the baseline of sluice 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 sluice 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



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

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

Torque T = F x 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 rad/sec.

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: ρ.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. (Darmawi, 2011)

III. Floating Waterwheel and Energy Harnessed

Waterwheel is constructed on the base of sluice gate sizes existed in Bangun Sari village on Telang II – Banyuasin.

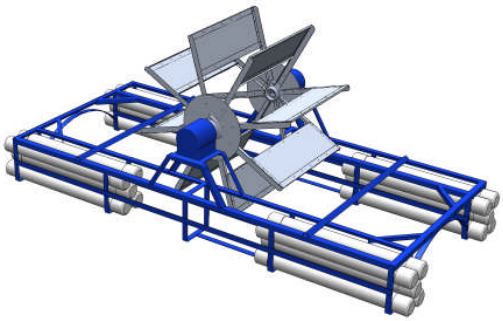
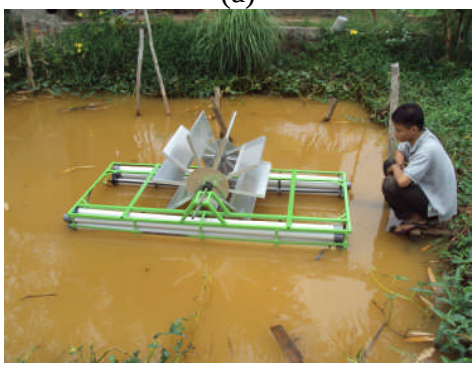


Figure 2: Floating waterwheel with supporting PVC pipes on sides.

The wheel is made of Alluminium Alloy in the form of flat and L-profile. Connections are alluminium rivets. The overall sizes are 200 centimeters long and 90 centimeters wide. The wheel diameter is 79 centimeters with eight flat blades of 50 x 20 centimeters in size.

(a)



(b)

Figure 3: (a) The wheel and supporting frame in constructions. (b) The floating test is conducted with PVC pipes at the left and right sides.

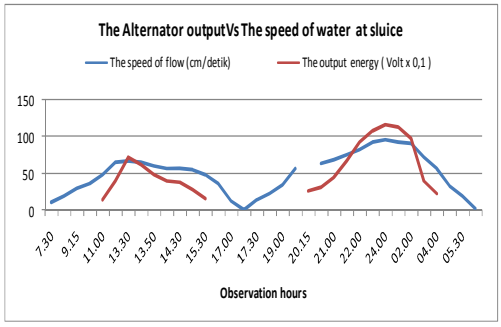
(a)

.(b)

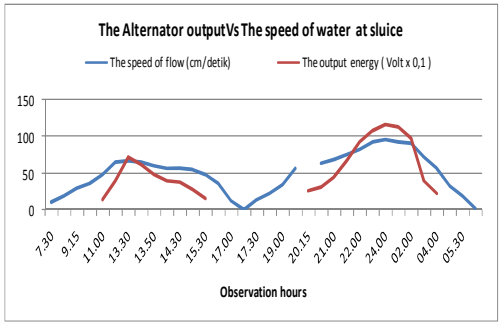
Figure 4: (a) Floating waterwheel is on test on Musi River in December 2012 (b)Floating waterwheel is on test at sluice gate at Bangun Sari Village.in January 2013.

IV. Results of test

The actual onsite test and measurements at the end of the year is shows the profile of water level and the speed of water flow on sluice as Figure 5. Figure 5a, shows the relation between the water level and the speed of water current at the sluice. Figure 5b shows the relation between the speed of water at sluice and the electric energy produced by the alternator.



(a)



(b)

Figure 5: The water level at tidal irrigation canal sluice and related speed of water flow. (b) The electric energy harnessed from the tidal current at sluice by applying the floating waterwheel.

V. Conclusions

By utilizing the floating waterwheel at the sluice, the electric energy harnessed at sluice as long as eleven hours in one day at rain season. The

energy stored in the battery is small but could support the daily life activity. The mechanical energy harnessed from the tidal irrigation sluice could also utilized for other agricultural activities such as water aeration of fish ponds and couple the spiral pumps to lift the water from canal to the rice fields. .

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Lampiran 22: Makalah Terkait Hydropower di Telang II - Banyuasin

ISBN: 978-979-8420-12-2

HAMBATAN DAN TANTANGAN PEMANFAATAN ALIRAN AIR PADA SALURAN IRIGASI SEKUNDER UNTUK MEMOMPAKAN AIR KE LAHAN PERSAWAHAN SEBAGAI DUKUNGAN BAGI PENGELOLAAN LAHAN SUB-OPTIMAL DI DESA BANGUN SARI TELANG II - KABUPATEN BANYUASIN

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Abstrak. Telang II adalah wilayah lahan basah yang berlokasi di sekitar 40 km dari pusat kota Palembang, di Kecamatan Tanjung Lago, Kabupaten Banyuasin dengan irigasi pasang surut. Desa Bangun Sari merupakan salah satu desa yang berada dalam Kecamatan Tanjung Lago-Kabupaten Banyuasin dimana terdapat setidaknya delapan Saluran Sekunder dan empat diantaranya sudah memiliki pintu air. Pasang surut yang keluar masuk pintu air dapat dimanfaatkan untuk memompakan air ke areal persawahan yang berada kurang lebih 1-3 meter diatas level air pada saluran sekunder. Untuk ini digunakan Kincir Air Apung (Floating-waterwheel) sebagai alat penggerak mula yang dikopel dengan sistem Pompa Spiral (Spiral Pump) untuk mengangkat air dari dalam saluran sekunder ke areal persawahan yang berada diatasnya.

Kata Kunci: Saluran Sekunder, Pasang surut, Kincir Air Apung, Pompa Spiral

1. PENDAHULUAN

Kabupaten Banyuasin terletak pada posisi antara 1,30° - 4,0° Lintang Selatan (LS) dan 104° 00' - 105° 35' Bujur Timur (BT) yang terbentang mulai dan bagian tengah Propinsi Sumatera Selatan sampai dengan bagian Timur dengan luas wilayah seluruhnya 11.832,99 Km^2 atau 1.183.299 Ha. Kabupaten Banyuasin merupakan kabupaten hasil pemekaran dari Kabupaten Musi Banyuasin yang terbentuk berdasarkan UU No. 6 Tahun 2002.

Lokasi ini cukup dekat dengan kota Palembang, hanya berjarak $\pm$ 45 km menuju ke arah Tanjung Api-api, dan dapat ditempuh dengan kendaraan roda empat. Kendaraan pribadi dapat langsung menuju lokasi, dengan kondisi jalan tanah dengan perkerasan batu pasir, sehingga perjalanan ke lokasi dapat ditempuh dalam waktu 1 jam. Berdasarkan peta, daerah studi secara administratif meliputi 8 desa yaitu Desa Mekarsari, Desa Bangunsari, Desa Banyu Urip, Desa Muliasari, Desa Telangsari, Desa Sukadamai, Desa Sukatani dan Desa Muarasugih, yang seluruhnya termasuk ke dalam Kecamatan Tanjung Lago, Kabupaten Banyuasin.

2. KEPENDUDUKAN DAN MATA PENCAHARIAN

Kecamatan Tanjung Lago, berdasarkan data hasil survey tahun 2008. Jumlah penduduk di daerah ini adalah sebanyak 24.270 jiwa, yang tercakup ke dalam kurang lebih 5.891 kepala keluarga dengan rata-rata anggota keluarga 4 (empat) jiwa. Komposisi penduduk jika dilihat dari jenis kelaminnya adalah terdiri dari laki-laki sebanyak 12.058 jiwa dan perempuan sebanyak 12.212 jiwa. Jumlah Selengkapnya data kependudukan di kecamatan Tanjung Lago pada tahun 2007 dapat dilihat pada tabel di bawah ini.

Tabel 1. Jumlah Penduduk di Desa-desa di Telang II Kecamatan Tanjung Lago Tahun 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	Banyu Urip	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**

Sumber: Data survey tahun 2008 (Intimulia Multikencana, 2009)

Berdasarkan data diatas, dapat dilihat bahwa Desa Banyu Urip yang merupakan daerah rawa, jumlah penduduknya mencapai 3.842 jiwa, di Desa Bangunsari jumlah penduduknya mencapai 3.100 jiwa. Keduanya merupakan desa dengan jumlah penduduk terbesar di Sedangkan desa Purwosari hanya sebanyak

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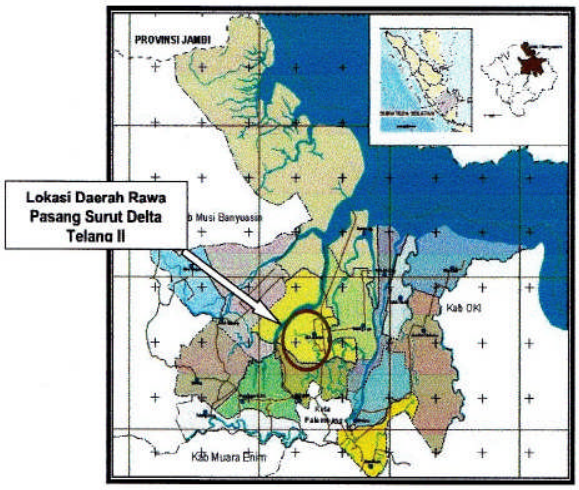

Gambar 1.1 Peta Lokasi Daerah Rawa Pasang Surut Delta Telang II
Sumber: Intimulia Multikencana,2009

Pemerataan penduduk secara umum dapat membantu dalam usaha meningkatkan kesejahteraan, oleh karena itu dalam usaha pemerataan penduduk idealnya komposisi jumlah penduduk sejalan dengan luas keruangan suatu wilayah. Di Kabupaten Banyuasin terdapat 15 kecamatan yang secara total luasnya adalah sekitar 11.832,99 Km^2, jadi secara rata-rata kepadatan penduduk pada tahun 2007 adalah sebesar 65,80 jiwa/km^2. Seiring dengan peningkatan jumlah penduduk, kepadatan penduduk di Banyuasin juga meningkat. Pada tahun 2006 kepadatan penduduk sebesar 64,01 jiwa/km^2, sedangkan pada tahun 2005 adalah sebesar 62,02 jiwa/km^2.

Laju Pertumbuhan penduduk dalam kurun waktu tahun 2005 hingga 2008, cukup stabil. Pada tahun 2006 pertumbuhan penduduk Kabupaten Banyuasin adalah sebesar 1,69%, sedangkan pada tahun 2007 mengalami penurunan dari tahun sebelumnya, yaitu sebesar 1,58%, walaupun secara nominal mengalami pertambahan jumlah penduduk sebagaimana tersebut di atas, sedangkan pada tahun 2008 pertumbuhan penduduk Kabupaten Banyuasin adalah sebesar 2,58 persen. Dapat dikatakan jumlah penduduk Kabupaten Banyuasin dari tahun 2006 hingga tahun 2008 terus bertambah dengan laju rendah. Jika dihubungkan dengan luas wilayah, pada tahun 2008 Kabupaten Banyuasin masih merupakan daerah yang berpenduduk jarang, dengan kepadatan penduduk 67,47 jiwa/Km^2. Tabel berikut menunjukkan distribusi luas lahan pertanian dan jenis tanaman yang dibudidayakan masyarakat.

Tabel 4. Distribusi Luas Lahan Pertanian untuk Telang II.

No	Nama desa	Luas lahan Pertanian (Ha)	Jenis Tanaman
1	Tegal Sari	1787,27	• Kelapa 48,17 Ha • Kelapa Sawit 135,43 Ha • Padi 1603,40 Ha • Luas rata-rata petak tersier 44Ha
2	Mulya Sari	1057,70	• Semua padi • 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	• Semua padi • Luas rata-rata petak tersier 44Ha
5	Sumber Mekar	785,93	• Semua padi • Luas rata-rata petak tersier 44Ha

Sumber : Data survey tahun 2008 (Intimulia Multikencana,2009)

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Data pada tabel diatas menunjukkan luas lahan pertanian di desa Bangun Sari adalah 1431,85 hektar dengan jenis tanaman semua padi. Jika jumlah KK adalah 752, maka rata-rata kepemilikan lahan pertanian di desa bangunsari adalah 1,9 hektar per-KK, sedangkan kepemilikan lahan pertanian terbesar terdapat pada desa Tegal Sari yaitu 5,24 hektar per-KK. Angka-angka ini menunjukkan betapa makin vitalnya fungsi tanah bagi penduduk desa Bangun Sari dalam kaitannya dengan upaya menciptakan kesejahteraan penduduk. Jika dikaitkan dengan data diatas, dimana semua lahan ditanami padi, maka merupakan suatu tantangan bagi semua pihak terkait untuk mengupayakan agar tanaman padi tersebut tetap produktif dan tetap mampu mendukung kebutuhan hidup masyarakat desa Bangunsari selanjutnya. Seandainya usaha ini tidak dilakukan maka besar kemungkinan terjadi penurunan taraf kesejahteraan masyarakat karena menyempitnya lahan pertanian yang mereka miliki akan berdampak pada meningkatnya biaya produksi karena makin menurunnya kualitas tanah sehingga 'net-income' petani makin kecil. Fenomena ini akan berlanjut pada usaha petani untuk menanam komoditi lainnya. Dalam hal ini jika hasil pertanian padi dipandang tidak memuaskan oleh masyarakat maka terbuka peluang terjadinya hal-hal yang kurang menguntungkan pemerintah antara lain:

- Terjadi konversi lahan pertanian ke bidang lain misalnya menjadi lahan perkebunan atau lahan industri atau bahkan menjadi lahan pemukiman.
- Target produksi padi dari pemerintah untuk tingkat lokal maupun domestik tidak tercapai yang berarti akan meningkatkan pangsa impor beras nasional.

Untuk meminimalisir kemungkinan ini, maka tiada pilihan lain kecuali semua pihak terkait harus berupaya mendukung agar lahan yang ada di Bangunsari tetap produktif dengan biaya produksi tetap rendah.

3. DUKUNGAN TEKNOLOGI BAGI OPTIMALISASI PENGELOLAAN LAHAN SUB-OPTIMAL

Data pada tabel diatas menunjukkan jenis tanaman yang dibudidayakan di desa Bangun Sari adalah padi. Dari hasil dialog kami dengan kelompok tani setempat, salah satu masalah yang mereka hadapi adalah membawa air dari saluran irigasi ke areal persawahan yang relatif lebih tinggi kurang lebih 1-3 meter. Mengangkat air ke areal persawahan ini dianggap menjadi permasalahan, karena jika dilakukan dengan menggunakan mesin Diesel atau diangkat secara manual, maka akan meningkatkan biaya produksi, karena kebutuhan air tersebut setiap hari dan dalam jumlah yang cukup besar karena luasnya areal persawahan. Akibatnya, masalah mengangkat air dari dalam saluran keareal persawahan ini menjadi faktor penting dalam meningkatkan penghasilan petani khususnya dan menambah kesejahteraan masyarakat pada umumnya..

Kita mengetahui bahwa biaya produksi dan hasil panen merupakan dua hal yang memiliki hubungan secara timbal balik yang antagonistik. Yang sangat diharapkan oleh petani dan kita semua sebagai pemangku kepentingan adalah biaya produksi rendah dan hasil panen maksimal, dan sebaliknya yang paling tidak diharapkan adalah biaya produksi tinggi dan hasil panen minimal. Oleh sebab itu persoalan ini menjadi persoalan yang mendesak untuk dipecahkan, dalam rangka mendukung agar petani tetap pada produksi padi pada lahannya. Untuk ini maka kami menyarankan salah satu solusi, yaitu penggunaan pompa spiral dengan memanfaatkan tenaga aliran air pada saluran sekunder.

4. POMPA SPIRAL

Pompa Spiral merupakan suatu alat yang menurut pengamatan penulis dapat digunakan pada pintu air saluran sekunder untuk mengangkat air dari dalam saluran ke areal persawahan. Pompa Spiral dianggap tepat karena memiliki beberapa keistimewaan antara lain dapat mengangkat air hingga suatu ketinggian tanpa harus memiliki putaran yang tinggi.

Pompa Spiral merupakan hasil temuan seseorang berkebangsaan Switzerland yang bernama H.A. Wirtz pada tahun 1746. Berdasarkan hasil pengujian yang dilakukan oleh Peter Tailer pada Windfarm Museum, Massachussets, setelah 240 tahun pompa itu ditemukan, diperoleh hasil dimana sebuah roda (wheel) dengan diameter 6 kaki dan lilitan pipa polyethylene 1,25 inch sepanjang 160 kaki, dengan kecepatan keliling roda sebesar 3 ft/sec atau sekitar 90 cm/detik dihasilkan air sebanyak 3900 gallon air perhari atau 14.742 liter jika 1 gallon = 3,78 liter dengan 'head' sebesar 40 kaki (±13 meter).

Karakteristik ini membuat pompa spiral menjadi layak untuk diaplikasikan pada lokasi persawahan Telang II guna menunjang perencanaan pembangunan dan lingkungan hidup. Uji-coba skala kecil di Telang II ini, berapapun hasil yang dicapai akan bereskalasi pada penggunaan hal serupa dilokasi lain dalam wilayah irigasi khususnya di Kecamatan Tanjung Lago.

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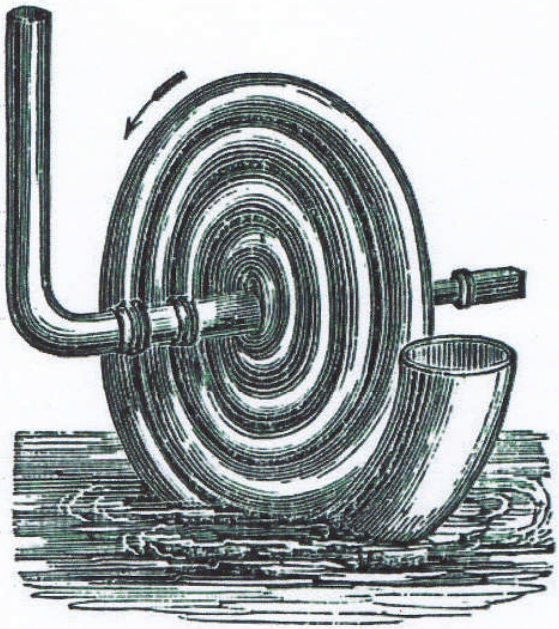
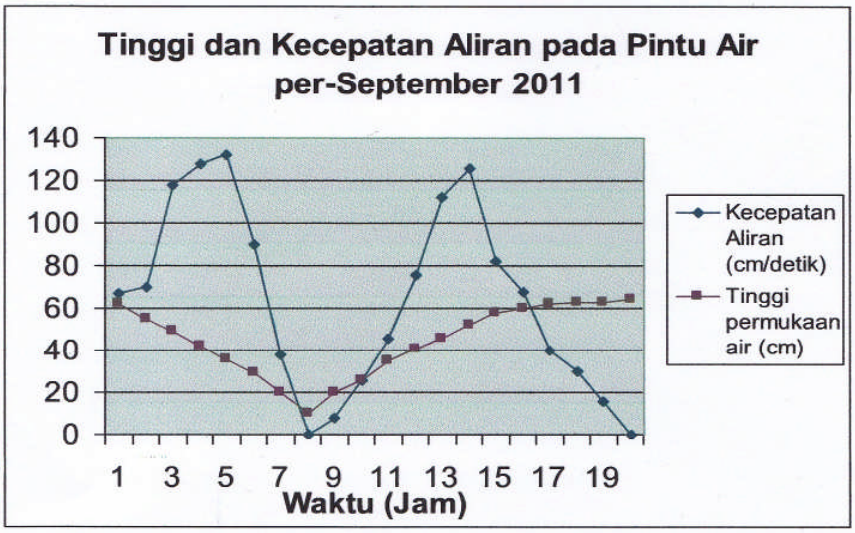


Gambar 2. Pompa Spiral
Sumber: Tailer (2012), http://lurkertech.com/water/pump/tailer/

Dalam kaitannya dengan data lapangan yang diperoleh melalui pengukuran langsung pada pintu air seperti tampak pada Gambar 3. Periode dimana kecepatan aliran diatas 60 cm/detik hanya terdapat dalam kurun waktu kurang lebih 12 jam per-hari.



Gambar 3: Tinggi dan Kecepatan aliran pada pintu air pada musim kemarau tahun 2011
Sumber: Hasil pengukuran pada pintu air desa Bangun Sari pada musim kemarau tahun 2011

5. HAMBATAN DAN TANTANGAN

Persoalan-persoalan yang dihadapi dalam implimentasi Pompa Spiral di daerah irigasi pasang surut Telang II diantaranya adalah sebagai berikut:

a. Jumlah volume air yang dipompakan bervariasi terkait kecepatan aliran air masuk dan keluar saluran.

ISBN: 978-979-8420-12-2

b. Volume total air yang dihasilkan diperkirakan tidak dapat memenuhi kebutuhan semua areal persawahan, sehingga perlu peningkatan kapasitas secara teknis.
c. Lokasi yang dapat digunakan untuk menggerakkan kincir air sebagai pemutar pompa spiral hanya satu buah pada setiap pintu saluran irigasi sekunder.
d. Kecepatan aliran air keluar masuk saluran tidak konstan terhadap waktu sehingga daya pompa juga tidak konstan terhadap waktu.

Tantangan yang harus dihadapi dalam implimentasi Pompa Spiral pada wilayah irigasi pasang surut Telang II diantaranya adalah sebagai berikut:

1. Bagaimana meningkatkan volume air yang dipompakan dalam hubungannya dengan peningkatan efisiensi dan penyesuaian diameter pipa coil yang digunakan.
2. Bagaimana mendistribusikan air ini agar diperoleh manfaat yang optimal dari air yang dipompakan.
3. Ukuran pintu air yang cukup kecil sehingga tidak mungkin membuat 'wheel' dalam ukuran yang lebih besar guna menghasilkan daya dan volume air yang lebih besar.

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Lampiran 23:

Tarif Dasar Listrik PLN
Berdasarkan Permen ESDM No: 30 Tahun 2012

TARIF TENAGA LISTRIK UNTUK KEPERLUAN RUMAH TANGGA
BERLAKU 1 JANUARI 2013 s.d. 31 MARET 2013

NO.	GOL. TARIF	BATAS DAYA	REGULER		PRA BAYAR (Rp/kWh)
			BIAYA BEBAN (Rp/kVA/bulan)	BIAYA PEMAKAIAN (Rp/kWh)	
1.	R-1/TR	s.d. 450 VA	11.000	Blok I : 0 s.d. 30 kWh : 169 Blok II : di atas 30 kWh s.d. 60 kWh : 360 Blok III : di atas 60 kWh : 495	415
2.	R-1/TR	900 VA	20.000	Blok I : 0 s.d. 20 kWh : 275 Blok II : di atas 20 kWh s.d. 60 kWh : 445 Blok III : di atas 60 kWh : 495	605
3.	R-1/TR	1.300 VA	*)	833	833
4.	R-1/TR	2.200 VA	*)	843	843
5.	R-2/TR	3.500 s.d 5.500 VA	*)	948	948
6.	R-3/TR	6.600 VA ke atas	**)	Blok I : 0 s.d 55 jam nyala = 980 Blok II : di atas 55 jam nyala = 1.380	1.336

Catatan :

*) Diterapkan Rekening Minimum (RM):

RM1 = 40 (Jam Nyala) x Daya tersambung (kVA) x Biaya Pemakaian.

**) Diterapkan Rekening Minimum (RM):

RM2 = 40 (Jam Nyala) x Daya tersambung (kVA) x Biaya Pemakaian Blok I.

Jam nyala : kWh per bulan dibagi dengan kVA tersambung.

Lampiran 24:

Rincian Biaya Pembuatan Kincir Air Apung

1. Konstruksi rangka penopang:
   a. Baja siku 1 inch 4 batang……. Rp 108.000,-
   b. Baja strip 1 inch 8 batang……. Rp 96.000,-
   c. Upah kerja + Listrik……. Rp 450.000,-
   Total Rp 656.000,-
2. Roda kincir:
   a. Dua keping flat aluminium
      Ukuran 80 cm x 200 cm, tebal 1 mm …….. Rp 1.600.000,-
   b. Empat batang aluminium profil siku
      1 inch…… Rp 128.000,-
   c. Paku keling dan Riveter……... Rp 225.000,-
   d. Upah kerja…… Rp 500.000,-
   Total Rp 2.453.000,-
3. Sistem transmisi:
   a. Tiga buah kopling tidak tetap……... Rp 150.000,-
   b. Satu pasang roda gigi miring (1 : 5)..…….. Rp 75.000,-
   c. Satu pasang roda gigi lurus (1: 8,5)…….. Rp 250.000,-
   d. Biaya peneyetelan dan upah kerja……..... Rp 750.000,-
   Total Rp 1.225.000,-
4. Alternator:
   a. Alternator AC 100W, 12 Volt
      Merk NaiEr……... Rp 2.500.000,-
   b. Biaya pabean dan Pajak impor…….. Rp 1.100.000,-
   c. Housing……. Rp 200.000,-
   d. Biaya penyetelan dan upah kerja…….. Rp 500.000,-
   Total Rp 4.300.000,-
5. Pipa pengapung:
   a. Delapan buah pipa PVC diameter 10 cm…. Rp 160.000,-
   b. Biaya penyetelan dan upah kerja……. Rp 200.000,-
   Total Rp 360.000,-

Rekapitulasi: Rp 656.000 + Rp 2.453.000 + Rp 1.225.000 +
Rp 4.300.000 + Rp 360.000 = Rp 8.994.000

(Delapan juta sembilan ratus sembilan puluh empat ribu rupiah)