

DATA ARTIKEL ILMIAH

Judul	: Design Planning of Micro-hydro Power Plant in Hink River
Penulis	: Yulianus RombePasalli, Adelhard Beni Rehiara
Abstrak	: Micro-hydro power plant is a type of renewable power plant that is environment friendly, easy to be operated and low operation cost. Hink River is a river in Manokwari, Indonesia. The result of initial survey shows that the river has hydraulic potency about 29.5 kW. According to the result, a micro-hydro power plant has been planned to this location. The power plant will use 25.2 kW of the hydraulic potency based on flow rate 0.3 m ³ /s and head height 8.6 m. Turbine for the power plant is cross flow turbine type T-14 D-300 and the turbine will be coupled with a 3 phases synchronous generator to produce electrical energy about 17.32 kW. The energy will be transferred via 3 phase distribution lines to some villages around the power plant in radius of 4 km. According to economic analysis, payback period of this power plant is about 17.32 years at benefit factor 1.94; therefore the power plant has feasibility to be built.
Keywords	: micro-hydro; power plant; Hink river
Judul Prosiding	: Procedia Environmental Sciences
Tahun Terbit	: 2014 (Volume 20)
Tempat Pelaksanaan	: Kyoto, Japan
Alamat web	: https://www.sciencedirect.com/science/article/pii/S1878029614000103
Kategori	: Konferensi Internasional
SJR	: -

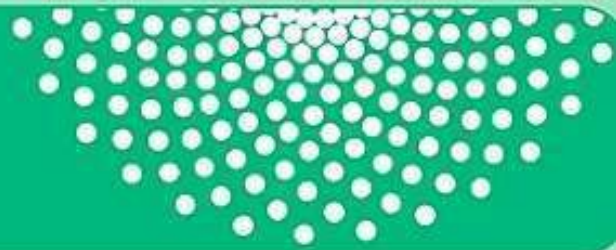


Volume 20 2014

ISSN 1878-0296

Procedia

Environmental Sciences



The 4th International Conference on Sustainable Future for Human Security, Sustain 2013

Guest Editor

N. Agya Utama, Ben Mclellan, Suharman Hamzah, Agus Trihartono, Apip,
Hatma Suryatmojo, Slamet Widodo, M. Ery Wijaya, S. Khoirul Himmi,
Miguel Esteban, Hooman Farzaneh, Niken Prilandita, Novri Susan,
Haryono Huboyo, Makruf Nurudin, Yulianto Prihatmaji

Available online at www.sciencedirect.com

ScienceDirect



4th International Conference on Sustainable Future for Human Security, Sustain 2013

Editorial



The 4th International Conference on a Sustainable Future for Human Security (SUSTAIN 2013) was held at Kyoto University (Japan) on 19-21 October, 2013. The conference was organized by Sustain Society and the Indonesian Students Associations of Kyoto, with the support of the Organization for the Promotion of International Relations (OPIR) Kyoto University, Research Institute for Sustainable Humanosphere (RISH), Global Center for Education and Research on Human Security Engineering (HSE), Global COE Program for Sustainability / Survivability Science for a Resilient Society Adaptable to Extreme Weather Conditions (GCOE-ARS), and Inter-Graduate School Program for Sustainable Development and Survivable Societies (GSS).

The conference originated from the need to provide an inter-disciplinary forum where the most serious problems affecting a sustainable future for human security could be discussed, in recognition of the fact that many future problems cannot be solved by a “siloeed” approach. The emphasis on sustainable futures is in response to the general awareness of the need to solve numerous human-related problems resulting from the rapid growth of modern society. The topic of sustainable futures for human security needs to be discussed in an integrated way, in accordance with the principles of sustainability, considering energy and materials supply, economies and trade, technology, cities, agriculture, social and environmental aspects.

To continue providing adequate technology to cope with the demands of human quality of life requires intensive research and development with multidisciplinary perspectives. Research and development towards achieving future human security should embrace sustainability perspectives, to avoid negatively impacting the environment and necessitating or exacerbating inefficient use of natural reserves, increasing emissions and hazardous wastes and jeopardizing human health and society.

The conference covered a wide range of issues with the aim of highlighting potential issues and paths towards a sustainable future. It attracted a high level of attendance from countries of the global North and South, with a wide geographical coverage. Overall, 160 participants were involved, with 120 presentations over the course of the conference. The quality of papers received was a testament to the reputation that the conference has been building over the past 3 years.

Papers presented at SUSTAIN 2013 were divided into five thematic areas: (1) Energy and Environment (EnE); (2) Sustainable Forestry and Agriculture (FA); (3) Sustainable Built Environment in Tropical Hemisphere Countries (BE); (4) River Basin and Disaster Management (RnD); (5) Social Science and Economics (SE). Under these broad areas, a wide-ranging series of presentations was given, which elaborated on current research across Asia and the world. Being held in Kyoto, a city of great cultural heritage, the participants also took part in a tour of some of the main sights and experiences that link modern and ancient Japan.

The two programmed days of the conference each commenced with keynote presentations which, like the conference itself, were wide-ranging. In the first session on day one, Dr. Ir. Edi Effendi Tedjakusuma, delivered an address on issues of a sustainable future for human security in the context of Indonesia. Dr. Puppim de Oliveira, Assistant Director and Senior Research Fellow at the United Nations University Institute of Advanced Studies (UNU-IAS), then discussed the future sustainability of cities in Asian nations. In the last keynote, Professor Satoshi Fujii, a Japanese cabinet adviser on Disaster Prevention and Reduction, introduced Japanese policy towards a more resilient country.

More than 230 participants attended the conference from 23 countries in Asia, North America and Europe. Around 161 papers were presented in the two days of conference. Only selected papers will be published in the *Procedia Environmental Science* and a special issue of the *International Journal for Sustainable Futures for Human Security (J-SUSTAIN)*.

The organizers appreciate the support and assistance of the co-operating organizations, the participants, presenters and staff. The next SUSTAIN conference is highly anticipated by all the attendees of SUSTAIN 2013 and the committee expect to further build on the success of this year's event.

Chief Editor

N. Agya Utama
Environmental Engineering, Surya University
Summarecon Serpong, Tangerang 15810, Indonesia

Editors

Ben Mclellan, Graduate School of Energy Science, Kyoto University
Suharman Hamzah, Civil Engineering Department, Hasanuddin University
Agus Trihartono, Faculty of Social and Political Sciences, Jember University
Apip, Indonesian Institute of Sciences (LIPI), Indonesia
Hatma Suryatmojo, Faculty of Forestry, Universitas Gadjah Mada, Indonesia
Slamet Widodo, Kyoto University, Japan
M. Ery Wijaya, Surya University, Indonesia
S. Khoirul Himmi, Research Center for Biomaterials, LIPI, Indonesia & RISH, Kyoto University, Japan
Miguel Esteban, University of Tokyo, Japan
Hooman Farzaneh, Asaad University, Iran
Niken Prilandita, Kyoto University, Japan
Novri Susan, Doshisa University, Japan
Haryono Huboyo, Universitas Diponegoro, Indonesia
Makruf Nurudin, Universitas Gadjah Mada, Indonesia
Yulianto Prihatmaji, Universitas Islam Indonesia, Indonesia

Committee and Secretariat

Wignyo Adiyoso, Ritsumeikan University, Japan
Nino Viartasiwi, Ritsumeikan University
Cindy Valentine, Kyoto University, Japan
Bhakti Eko Nugroho, Ritsumeikan University, Japan
Prawira F. Belgiawan, Kyoto University, Japan
Ari Rahman, Ryukoku University, Japan
Hendy Setiawan, Kyoto University, Japan
Gerry Tri Satya Daru, Kyoto University, Japan

© 2014 N. Agya Utama. Published by Elsevier B.V. Open access under [CC BY-NC-ND license](#).

Selection and peer-review under responsibility of the Sustain conference committee and supported by Kyoto University; (RISH), (OPIR), (GCOE-ARS) and (GSS) as co-hosts

Contents

Editorial	
N.A. Utama	1
Low carbon society	
The Evaluation of the Sustainable Human Development: A Cross-country Analysis Employing Slack-based DEA	
S. Chansarn	3
Assessing Sustainable Regional Energy Systems: A Case Study of Kansai, Japan	
B.C. McLellan, Y. Kishita, G. Yoshizawa, Y. Yamaguchi, K. Aoki, I.C. Handoh	12
Lessons Learnt from the Energy Needs Assessment Carried out for the Biogas Program for Rural Development in Yogyakarta, Indonesia	
S.A.P. Rosyidi, T. Bole-Rentel, S.B. Lesmana, J. Ikhsan	20
Evaluation of Energy Self-sufficient Village by Means of Emergy Indices	
R.N. Listyawati, C. Meidiana, M. Anggraeni	30
The End of Fossil Fuel Era: Supply–demand Measures through Energy Efficiency	
N.A. Utama, A.M. Fathoni, M.A. Kristianto, B.C. McLellan	40
Renewable energy	
Upgrading of Palm Oil Empty Fruit Bunch Employing Hydrothermal Treatment in Lab-scale and Pilot Scale	
S. Novianti, M.K. Biddinika, P. Prawisudha, K. Yoshikawa	46
Design Planning of Micro-hydro Power Plant in Hink River	
Y.R. Pasalli, A.B. Rehiara	55
Transformation of Agricultural Market Waste Disposal to Biochar Soil Amendments	
P. Takolpuckdee	64
The Influence of Hydrothermal Temperature on CaO-based Adsorbents Synthesized by Sol–Gel-Hydrothermal Method	
N. Ni Hlaing, R. Othman, H. Hinode, W. Kurniawan, A.A. Thant, A.R. Mohamed, C. Salim, S. Sreekantan	71
Energy system analysis	
Comprehensive Evaluation of the Feasibility to Develop a Renewable Energy Technology System and Waste Treatment Plant in Kupang City, Indonesia based on a Kupang Input Output Table	
A. Amheka, Y. Higano, T. Mizunoya, H. Yabar	79
A Technical and Economic Potential of Solar Energy Application with Feed-in Tariff Policy in Indonesia	
A.M. Fathoni, N.A. Utama, M.A. Kristianto	89
Developing a Tool to Analyze Climate Co-benefits of the Urban Energy System	
H. Farzaneh, A. Suwa, C.N.H. Dolla, J.A.P. de Oliveira	97
Sustainable green building	
Green Assessment Criteria for Public Hospital Building Development in Malaysia	
S.R. Sahamir, R. Zakaria	106
Performance-based Fire Safety Evacuation in High-rise Building Flats in Indonesia – A Case Study in Bandung	
W. Sujatmiko, H.K. Dipojono, F.X.N. Soelami, Soegijanto	116
Passive Application through Solar Induce Ventilation on Sustainable Building in Equatorial Hemisphere	
N.A. Utama, A.M. Fathoni, M.A. Kristianto	126
Malaysia’s Existing Green Homes Compliance with LEED for Homes	
M.A. Ismail, F.A. Rashid	131
Housing structure and environment	
Vertical Landscape for Passive Cooling in Tropical House	
A.M. Nugroho	141
The Elderly Friendly High-Rise Housing: A Comparison Study between Indonesia & Japan	
E.E. Pandelaki, Wijayanti, S.B. Pribadi	146
Rotation Performance of Javanese Traditional Timber Joint	
Y.P. Prihatmaji, A. Kitamori, K. Komatsu	154
Typology of Malay Traditional House <i>Rumah Lontioik</i> and its Response to the Thermal Environment	
Y.H. Prasetyo, M.N.F. Alfata, A.R. Pasaribu	162

Analyzing Indoor Environment of Minahasa Traditional House Using CFD M.A. Kristianto, N.A. Utama, A.M. Fathoni	172
Transportation and infrastructure	
An Evaluation of Sustainable Design and Construction Criteria for Green Highway R.R.R.M. Rooshdi, N. Ab Rahman, N.Z.U. Baki, M.Z.A. Majid, F. Ismail	180
Private Involvement in Sustainable Management of Indonesian Port: Need and Strategy with PPP Scheme S. Hamzah, S.A. Adismita, T. Harianto, M.S. Pallu	187
An Assessment of Commuters' Perceptions of Safety and Comfort Levels of 'Women-Only Coach': The Case Study of KTM Komuter Malaysia S. Bachok, M.M. Osman, M. Murad, M. Ibrahim	197
Environmental and waste management	
Feasibility Study on Reuse of Washed Water in Electronic Industry: Case Study for Flexible Printed Circuit Board Manufacturing in Thailand T. Eksangsri, T. Jaiwang	206
Fuel Production from LDPE Plastic Waste over Natural Zeolite Supported Ni, Ni-Mo, Co and Co-Mo Metals W. Sriningsih, M.G. Saerodji, W. Trisunaryanti, Triyono, R. Armunanto, I.I. Falah	215
Study of Waste Lubricant Hydrocracking into Fuel Fraction over the Combination of Y-Zeolite and ZnO Catalyst F.A. Khowatimy, Y. Priastomo, E. Febriyanti, H. Riyantoko, W. Trisunaryanti	225
Biodecolorization of Textile Dyes by Immobilized Enzymes in a Vertical Bioreactor System D.H.Y. Yanto, S. Tachibana, K. Itoh	235
Eco-building Material of Styrofoam Waste and Sugar Industry Fly-ash based on Nano-technology E. Setyowati	245
Potential Use of <i>Aspergillus flavus</i> Strain KRP1 in Utilization of Mercury Contaminant E. Kurniati, N. Arfarita, T. Imai	254
Sustainable consumption	
Green Attitude and Behavior of Local Tourists towards Hotels and Restaurants in West Sumatra, Indonesia R.P. Lita, S. Surya, M. Ma'ruf, L. Syahrul	261
Toward Paperless Public Announcement on Environmental Impact Assessment (EIA) through SMS Gateway in Indonesia S.F. Persada, M. Razif, S.C. Lin, R. Nadlifatin	271
Sustainability of the Rare Earths Industry B.C. McLellan, G.D. Corder, A. Golev, S.H. Ali	280
Greening University Campus Buildings to Reduce Consumption and Emission while Fostering Hands-on Inquiry-based Education N. Chalfoun	288
Water quality	
Determination of Chromium and Iron Using Digital Image-based Colorimetry M.L. Firdaus, W. Alwi, F. Trinoveldi, I. Rahayu, L. Rahmidar, K. Warsito	298
Design and Development of an Integrated Web-based System for Tropical Rainfall Monitoring E.M. Trono, M.L. Guico, R. Labuguen, A. Navarro, N.J. Libatique, G. Tangonan	305
Agriculture and forest product utilization	
Utilization of High-density Raw Materials for Panel Production and its Performance M.N. Rofii, S. Yumigeta, Y. Kojima, S. Suzuki	315
Exploration of Unutilized Fast Growing Wood Species from Secondary Forest in Central Kalimantan: Study on the Fiber Characteristic and Wood Density D.S. Adi, L. Risanto, R. Damayanti, S. Rullyati, L.M. Dewi, R. Susanti, W. Dwianto, E. Hermiati, T. Watanabe	321
The Effect of Various Pretreatment Methods on Oil Palm Empty Fruit Bunch (EFB) and Kenaf Core Fibers for Sugar Production T.Y. Ying, L.K. Teong, W.N.W. Abdullah, L.C. Peng	328
Characterization of Biomass Pellet Made from Solid Waste Oil Palm Industry S.S. Munawar, B. Subiyanto	336
Porous Carbon Spheres from Hydrothermal Carbonization and KOH Activation on Cassava and Tapioca Flour Raw Material G. Pari, S. Darmawan, B. Prihandoko	342
Breeding, feed and agriculture technology	
Physicochemical and Microbiological Properties of Fermented Lamb Sausages Using Probiotic <i>Lactobacillus Plantarum</i> IIA-2C12 as Starter Culture I.I. Arief, Z. Wulandari, E.L. Aditia, M. Baihaqi, Noraimah, Hendrawan	352
Plant DrgProteins are Cytoplasmic Small GTPase-ObgHomologue I.N. Suwastika, R.L. Ohniwa, K. Takeyasu, T. Shiina	357
Analysis of DNA Polymorphism in SRY Gene of Madura Cattle Populations T. Hartatik, T.S.M. Widi, S.D. Volkandari, D. Maharani, Sumadi	365

Agriculture and food security

Maize Response at Three Levels of Shade and its Improvement with Intensive Agro Forestry Regimes in Gunung Kidul, Java, Indonesia P. Suryanto, E.T.S. Putra, S. Kurniawan, B. Suwignyo, D.A.P. Sukirno	370
Food and Human Security in Sub-Saharan Africa H.M. Rajaonarison	377
Assessment of Heavy Metals Tolerance in Leaves, Stems and Flowers of <i>Stevia Rebaudiana</i> Plant E.W.I. Hajar, A.Z.B. Sulaiman, A.M.M. Sakinah	386
Crop Selection Strategies of Squatters at Early Stage of Settlement in Lower Amazon K. Ishimaru, S. Kobayashi, S. Yoshikawa	394
The Effect of Humic Acid and Silicic Acid on P Adsorption by Amorphous Minerals E. Hanudin, S.T. Sukmawati, B. Radjagukguk, N.W. Yuwono	402
Soil Microbial Biomass and Diversity Amended with Bagasse Mulch in Tillage and No-tillage Practices in the Sugarcane Plantation S. Silvia, T. Miura, K. Nobuhiro, K. Fujie, U. Hasanuddin, A. Niswati, S. Haryani	410
Adoption of Improved Varieties of Vegetable Crops with Pesticide Use in Chiang Mai Province, Northern Thailand J. Chalermphol, G.B. Bastakoti, R.C. Bastakoti	418
The Impact of Food Safety Standard on Indonesia's Coffee Exports A. Nugroho	425

Human security

Anti-Korean Sentiment and Hate Speech in the Current Japan: A Report from the Street K. Ito	434
Conflict Management of Renewable Natural Resources in the Border of Indonesia-Malaysia: Sustainable Environmental Approach H. Herdiansyah, B.S. Soepandji, F. SSE Seda, O. Dewi	444
The Mass-media Role in Conflict Resolution (A Case Study of Kompas Daily Coverage on Aceh Conflict 2003–2005) N. Imtihani	451
Land Tenure Conflict in the Middle of Africa van Java (Baluran National Park) K.F. Wianti	459

Politics and democracy

Reconstructing Social Identity for Sustainable Future of Lumpur Lapindo Victims A. Farida	468
Political Identity and Election in Indonesian Democracy: A Case Study in Karang Pandan Village – Malang, Indonesia A.B. Barrul Fuad	477
Political Ideology Meaning and Patriarchal Ideology of Female Politicians in Indonesia: A Case in Malang V.S.D. Soedarwo	486
Ethnicity, Democracy and Decentralization: Explaining the Ethnic Political Participation of Direct Election in Medan 2010 I.K. Nasution	496
Local Elites and Public Space Sustainability: The Local Elite Roles in the Presence and Usage of Public Space in Malang Raya, Indonesia R. Kurniaty	506

Governance and development

“Theologization” of Psychology and “Psychologization” of Religion: How Do Psychology and Religion Supposedly Contribute to Prevent and Overcome Social Conflicts? J. Abraham, A. Rufaedah	516
Analytic Hierarchy Process of Academic Scholars for Promoting Energy Saving and Carbon Reduction in Taiwan Y.-T. Tung, T.-Y. Pai, S.-H. Lin, C.-H. Chih, H.-Y. Lee, H.-W. Hsu, Z.-D. Tong, H.-F. Lu, L.-H. Shih	526
Adopting Industrial Organizational Psychology for Eco Sustainability K. Rose	533
Social Capital and Migration in Rural Area Development G. Prayitno, K. Matsushima, H. Jeong, K. Kobayashi	543
Model of Environmental Communication with Gender Perspective in Resolving Environmental Conflict in Urban Area (<i>Study on the Role of Women's Activist in Sustainable Environmental Conflict Management</i>) D. Asteria, E. Suyanti, D. Utari, D. Wisnu	553
Evaluation of Fiscal Policy on Agropolitan Development to Raise Sustainable Food Security (A Study Case in Bangli Regency, Kuningan Regency and Batu Municipality, Indonesia) H. Rosdiana, Inayati, Murwendah	563
Recognizing Indigenous Knowledge for Disaster Management: <i>Smong</i> , Early Warning System from Simeulue Island, Aceh Syafwina	573

Community development

City Skyline Conservation: Sustaining the Premier Image of Kuala Lumpur N.A.H. Yusoff, A.M. Noor, R. Ghazali	583
---	-----

Model of Community-based Housing Development (CBHD) of Bedah Kampung Program in Surakarta Indonesia W. Astuti, D.A. Prasetyo	593
Disaster Risk and Adaptation of Settlement along the River Brantas in the Context of Sustainable Development, Malang, Indonesia S. Utami, Soemarno, Surjono, M. Bisri	602
An Analysis on Transmission of Ethnic Languages in Selected Communities in the World Heritage Site of Malacca, Malaysia A.A. Bakar, M.M. Osman, S. Bachok, M. Ibrahim	612
Urban management	
The Role of Transit Oriented Development in Constructing Urban Environment Sustainability, the Case of Jabodetabek, Indonesia H.S. Hasibuan, T.P. Soemardi, R. Koestoer, S. Moersidik	622
Understanding the Role of Education Facilities in Sustainable Urban Development: A Case Study of KSRP, Kitakyushu, Japan F.A. Nuzir, B.J. Dewancker	632
Disaster management	
Study on Reducing Tsunami Inundation Energy by the Modification of Topography based on Local Wisdom F. Usman, K. Murakami, E.B. Kurniawan	642
The Evaluation of the Result of Post-Processing Envisat Satellite Altimetry Data Used for Coastal Area Potential Flood Mapping (Case Study: Coastal Area of Buleleng Regency, Bali, Indonesia) L.S. Heliani, I.W.K.E. Putra, Subaryono	651
Government-communities Collaboration in Disaster Management Activity: Investigation in the Current Flood Disaster Management Policy in Thailand I.-s. Raungratanaamporn, P. Pakdeeburee, A. Kamiko, C. Denpaiboon	658
Disaster Prevention Education in Merapi Volcano Area Primary Schools: Focusing on Students' Perception and Teachers' Performance Tuswadi, T. Hayashi	668
Multi-epoch GNSS Data Analysis on Geodynamics Study of Central Java L.S. Heliani, Danardono, N. Widjajanti, H. Panuntun	678
Sustainable Disaster Risk Reduction through Effective Risk Communication Media in Parangtritis Tourism Area, Yogyakarta I.M. Susmayadi, Sudibyakto, H. Kanagae, W. Adiyoso, E.D. Suryanti	684
Climate Change and Water Scarcity Adaptation Strategies in the Area of Pacitan, Java Indonesia W. Widiyanti, A. Dittmann	693
River basin management	
Climate Change & Home Location Preferences in Flood Prone Areas of Bojonegoro Regency M. Anggraeni, I.R.D. Ari, E.B. Santosa, R. Widayanti	703
Chemical Characteristics of Surface Water and Groundwater in Coastal Watershed, Mekong Delta, Vietnam T.D. An, M. Tsujimura, V. Le Phu, A. Kawachi, D.T. Ha	712
Sustainability Assessment of Humid Tropical Watershed: A Case of Batang Merao Watershed, Indonesia R. Firdaus, N. Nakagoshi, A. Idris	722
Soil Erodibility of Several Types of Green Open Space Areas in Yogyakarta City, Indonesia A. Kusumandari	732
Urban Lakes in Megacity Jakarta: Risk and Management Plan for Future Sustainability C. Henny, A.A. Meutia	737
Assessment of Paleo-hydrology and Paleo-inundation Conditions: The Process P. Luo, K. Takara, B. He, W. Duan, Apip, D. Nover, W. Tsugihiro, K. Nakagami, I. Takamiya	747
Pest management	
Disruption of <i>gspD</i> and its Effects on Endoglucanase and Filamentous Phage Secretion in <i>Ralstonia Solanacearum</i> H.S. Addy, A. Askora, T. Kawasaki, M. Fujie, T. Yamada	753
Host Range for Bacteriophages that Infect Bacterial Blight Pathogen on Soybean G. Susianto, M.M. Farid, N.R. Dhany, H.S. Addy	760
Termite Resistance of Medium Density Fibreboard Produced from Renewable Biomass of Agricultural Fibre Y. Indrayani, D. Setyawati, T. Yoshimura, K. Umemura	767
The Efficacy of the Oleic Acid Isolated from <i>Cerbera manghas</i> L. Seed Against a Subterranean Termite, <i>Coptotermes Gestroi</i> Wasmann and a Drywood Termite, <i>Cryptotermes Cynocephalus</i> Light D. Tarmadi, S.K. Himmi, S. Yusuf	772
New Bio Preservatives from Lignocelluloses Biomass Bio-oil for Anti termites <i>Coptotermes Curvignathus</i> Holmgren H.A. Oramahi, F. Diba, Nurhaida	778
Biodiversity, forest ecology and management	
Environmental Ethics in Local Knowledge Responding to Climate Change: An Understanding of Seasonal Traditional Calendar <i>PranotoMongso</i> and its Phenology in Karst Area of GunungKidul, Yogyakarta, Indonesia A. Retnowati, E. Anantasari, M.A. Marfai, A. Dittmann	785

Primeval Forest in the Period of Human Cultural History on Gunungsewu Karst Indonesia L.R.W. Faida	795
Tropical Forest Biodiversity to Provide Food, Health and Energy Solution of the Rapid Growth of Modern Society E. Sukara	803
Evaluation of Four Years Old Progeny Test of Shoreamacrophylla in PT Sari Bumi Kusuma, Central Kalimantan Widiyatno, M. Naiem, S. Purnomo, Jatmoko	809
Progeny Test of <i>Shorea leprosula</i> as Key Point to Increase Productivity of Secondary Forest in Pt Balik Papan Forest Industries, East Kalimantan, Indonesia M. Naiem, Widiyatno, M.Z. Al-Fauzi	816
Climate Change Adaptation for Agro-forestry Industries: Sustainability Challenges in Uji Tea Cultivation F. Ashardiono, M. Cassim	823
Recovery of Forest Soil Disturbance in the Intensive Forest Management System H. Suryatmojo	832
Ethnobiological Study of the Plants Used in the Healing Practices of an Indigenous People <i>Tau Taa Wana</i> in Central Sulawesi, Indonesia S.K. Himmi, M.A. Humaedi, S. Astutik	841



4th International Conference on Sustainable Future for Human Security, Sustain 2013

Design Planning of Micro-hydro Power Plant in Hink River

Yulianus Rombe Pasalli*, Adelhard Beni Rehiara

Engineering Department, University of Papua, Jl. Gunung Salju Amban, Manokwari, 98314, Indonesia

Abstract

Micro-hydro power plant is a type of renewable power plant that is environment friendly, easy to be operated and low operation cost. Hink River is a river in Manokwari, Indonesia. The result of initial survey shows that the river has hydraulic potency about 29.5 kW. According to the result, a micro-hydro power plant has been planned to this location. The power plant will use 25.2 kW of the hydraulic potency based on flow rate 0.3 m³/s and head height 8.6 m. Turbine for the power plant is cross flow turbine type T-14 D-300 and the turbine will be coupled with a 3 phases synchronous generator to produce electrical energy about 17.32 kW. The energy will be transferred via 3 phase distribution lines to some villages around the power plant in radius of 4 km. According to economic analysis, payback period of this power plant is about 17.32 years at benefit factor 1.94; therefore the power plant has feasibility to be built.

© 2014 Yulianus Rombe Pasalli. Published by Elsevier B.V. Open access under [CC BY-NC-ND license](#).

Selection and peer-review under responsibility of the Sustain conference committee and supported by Kyoto University; (RISH), (OPIR), (GCOE-ARS) and (GSS) as co-hosts

Keywords: micro-hydro; power plant; Hink river;

1. Introduction

On contrary to electronic technology that is going to nano-technology, the usage of electrical energy starts to giga-watt. This contradiction also happens in Indonesia. The consumption of electrical energy is increasing by the

* Corresponding author. Tel.: +62-986-214739; fax: +62-986-211455.

E-mail address: j.rombe@fmipa.unipa.ac.id

time. PLN, as an Indonesian government company that handles electrical energy production, has responsibility to fulfill the essential power of the people in the country.

As an island in Indonesia that has biggest rain forest, Papua Island has many districts and villages separated by cities and forest. This condition gives limitation of accessibility and high investment of power lines. Therefore, not all area in Papua Island can be served by PLN and standalone power plant will be the best solution to solve the problem in Papua.

Hink River is a river in district Hink, Manokwari, Indonesia. Located in between of $1^{\circ}13' 10.7''$ S and $133^{\circ} 56' 05.5''$ E, the district can be reached from Manokwari local transportation. Hink River has good water supply to be used as micro-hydro power plant. This paper will explain the design planning of a micro-hydro power plant in Hink River and also its power lines distribution.

Nomenclature

PLN	Electrical Company of Indonesian government
S	South Latitude
E	East Longitude
Wh	Watt hour
kWh	Kilowatt hour
MW	Megawatt
km	Kilometre
m	Meter
m/s	Meter per second

2. Micro-hydro System

Hydropower is based on the principle that flowing and falling water has a certain amount of kinetic energy potential associated with it. Hydropower comes from converting the energy in flowing water, by means of a water wheel or a turbine, into useful mechanical energy. This energy can then be converted into electricity through means of an electric generator. The energy from the flowing/falling water can also be used directly by suitable machines to avoid the efficiency losses of the generator. Recently, small-scale hydropower systems receive a great deal of public interest as a promising, renewable source of electrical power for homes, farms, and remote communities. Micro-hydro systems refer specifically to systems generating power on the scale of 5 kW to 100 kW [1].

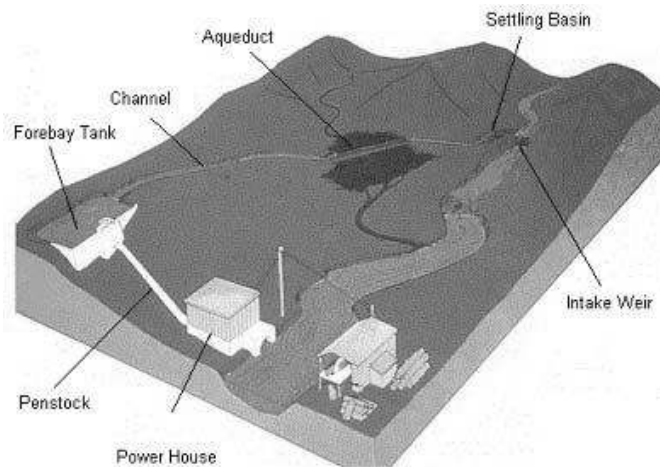


Fig. 1. General components of micro-hydro power plant[1]

The micro-hydro system includes a water turbine that converts the energy of flowing water into mechanical energy. This mechanical energy drives a generator which produces electrical power. The efficiency of the overall system, given the pipe friction losses and turbine deficiencies, is generally on the range of 50% of theoretical power associated with the energy of the flowing water. Micro-hydro has been in use for many years in many applications. The turbine varies from site to site according to the given pressure head and design flow at each site [1].

Fig. 1 shows a typical system and details components generally found at a micro-hydro facility. Water flow in upstream will be diverted in intake weir and it will flow into the channel. The channel transports the water to forebay tank before going to penstock pipe. In the tank, debris will be filtered and prevented from being drawn to the turbine by means of penstock. Power conversion is done inside the power house, and turbine will transfer mechanic energy to generator, then generator produces electric energy.

Once power estimates have been made, one can select the appropriate turbine for the site. In general, there are two types of turbines to choose from (though there are more, and hybrids are common): impulse turbines and reaction turbines. Impulse turbines are most common for high head, low flow sites, while reaction turbines are most common with low head, high flow sites. The two most common types of impulse turbines are the Turgo and the Pelton. In the Turgo, a jet of water from the nozzle strikes the turbine runners at an angle. Significant power can be generated with relatively little head. Like the Turgo, Pelton turbines are particularly suited to low flow, high head sites. Water jets from the nozzle strike along the circumference of the turbine blades. Nozzle selection is also important in microhydro systems. Nozzle size is limited by the size of the turbine runners (blades), flow rates, and penstock diameter. Many turbines on today's market are capable of utilizing more than one nozzle. In these situations, it is common to use nozzles with different diameters that can be turned on or off depending on the time of year and the flow rates. Nozzle diameter greatly impacts the jet flow rate of the system and should be matched with the stream flow rates [1].

3. Methodology

3.1. Hydro Potency

Hydro energy potency in Indonesia can reach 75000 MW and only 8% or about 3700 MW has been used in hydro and mycrohydro power plant. The development of hydro power plants depends much on geographic location, rainfall and chatchement area. This condition has involved the variation of power plant capacity. Indonesian government has an action to upgrade the micro-hydro capacity until 2846 MW in year 2025 [2].

3.2. Measuring Flow and Head

Flow is the quantity of water moving past a given point over a set time period which is expressed as volume in gallons per minute (gpm) or cubic meters per second (m^3/s), and head is the vertical distance that water descends in altitude as a result of gravity.

Water flow can be measured by some simple methods. Bucket method and area and speed method are two methods commonly used in measuring flow rate. Bucket method can be used in measuring flow rate especially in measuring flow rate in low flow streams or in a small river. The method is used to count the time needed to fulfill a bucket and flow rate is calculated by dividing water volume in the bucket with time consuming. On the other hand, area and speed method is used in streams with a higher flow. Water flow can be measured by constructing a weir of known dimensions and measuring the time necessary for the pooled water to rise to a known height. An object can be placed and timed to float from the upstream to the downstream line. Flow rate is the product of water volume, water movement and friction coefficient (0.6 for rocky stream bottoms).

In case where it is hard to construct a weir, the area and speed method can be used. This method will calculate the cross section area (S) as the product of width and average deep of the river. Then, flow rate can be found by multiplying cross section area with water speed flow. Flow rate (Q) is equal to average speed of water flow (V_{avg}) and the cross section area of the media (S). This method can be formulated as follows [3].

$$Q = V_{avg} \times S \text{ (L/s)} \quad (1)$$

3.3. Hydro Power

The theoretical power produced by a micro-hydro system depends entirely on the flow rate of the water, vertical height (or head) that the water falls and the acceleration of water due to gravity through following equation [1-10].

$$P_T = \rho g Q H \quad (2)$$

$$P_T = c Q H \quad (3)$$

Where P_T is theoretical power in units of watts, ρ is density of water that equal to 1000 kg/m^3 , Q is the flow rate in m^3/sec , H is the head in meters and g is gravity in 9.81 m/s^2 . Because water density and gravity are constant, the equation can be simplified as in eq. 3 with c is the product of both constant parameter.

The theoretical power is rough calculation of hydro power in a river. There are some losses that reduce power while conversion process. Therefore, electrical power produced by a micro-hydro should be multiplied with total efficiencies of the system, including efficiencies of penstock η_p , generator η_g , and turbine η_t . Then, the output of electrical power can be formulated as follows [3-11].

$$P_g = \rho g Q H \eta_o \quad (4)$$

Where P_g is the generated power in units of watts and η_o is overall efficiencies in percent that will be in between 50-70% [9]. Normally, head is decreased after the installation of the micro-hydro equipment, and then generated power will be lower than theoretical power.

3.4. Economic Analysis

Economic analysis of a micro-hydro power plant is important to evaluate the eligibility of the plant. The analysis includes cost, benefit and benefit cost ratio, and payback period to build the plant.

a. Cost

Cost in developing a micro-hydro power plant will be investment and operational cost. Investment cost is the cost to build the plant, including cost for civil, electrical and mechanical, and distribution line works, for taxes, contingencies cost and engineering cost. The last two costs are indirect cost and others are direct cost for the work. Contingencies cost is the cost for over predicting payment while engineering cost is the cost for engineering activity including survey, detail design, supervision, etc.

Operation cost is the cost for operating the power plant. This cost can be the cost for bank interest, operators, management, and maintenance. Deviation of civil buildings, distribution wires, and electrical mechanical equipments are the other operation costs of a micro-hydro power plant. By using flat system of annual cash flow, the deviation of equipments for 25 and 30 years operation in 3% of interest rate is determined about 0.0274 and 0.0210 [12].

b. Benefit

Daily benefit of micro-hydro power plant operation will be the product of power production and fixed price of the power. By multiplying daily benefit within 30 days, it will give monthly benefit value. Annual benefit is 12 times higher than monthly benefit.

Benefit cost ratio (BCR) is sometimes the simple way to evaluate feasibility of an investment. BCR is a comparison between benefit and cost of an investment. The investment is feasible if BCR is equal to or higher than 1; on the other hand, it is not feasible for the BCR value lower than 1 [12].

c. Payback Period

Payback period is the time period for paying back all of the cost. The payback period is calculated by counting the number of years taken to recover the cash invested in a project. The investment is feasible if the payback period is lower than investment period [12].

4. Result and Discussion

4.1. Social Condition

The development of microhydro power plant took place in the capital of the Hink district. The district is 40 km away from Manokwari city and it lies from 1° 13' 10.7" S to 133° 56' 05.5" E at position 2100 m high from sea level. The district is a district of 29th district in Manokwari regency and it can be reached by land vehicle.

There are five villages in the capital of Hink district located close each other and furthestmost the distance is about 3 km. Official resource has mention that 650 people live in the villages and it has been provided in table 1.

Table 1. Population data of Hink district.

Name of village	Family head	Population	House
Demunti	25	141	12
Menyememut	23	81	20
Mbeigau	29	89	25
Leihak	50	154	44
Kisab	39	185	16
Total	166	650	117

It can be seen from the table that in a house can contain more than a family head. This is caused by the local tradition that men can marry in very young and they can live in the house with their big family. Local people work as farmer, but the harvest is only for self consumption since there is no local market.

4.2. Potency of Hink River

A survey had been done to investigate hydrolic potency of the Hink River in earth coordinate of 1° 14' 08.9" S and 133° 57' 14.2" E. The potency could be determined by measuring the flow rate of the river and the measurement was done by using the method of speed and area. Digital current meter was used to measure water speed flow and the result was multiplied by the cross section area of the river. The multiplication gave flow rate of the river about 0.3 to 0.4 m³/s.

Fig.2 shows the map and the nature of survey location and in around this location intake was placed. The intake for the power plant had been chosen in around the survey location while the power house was placed about 140 m from the intake. Measured by a GPS, the height of the head was about 10 m. Therefore, the hydrolyc potency of the river with flow rate 0.3m³/s was calculated using eq.2 as follows.

$$P_T = (1000 \frac{kg}{m^3})(9.8 \frac{m}{s^2})(0.3 \frac{m^3}{s})(10m) \quad (5)$$

$$= 29.4kW$$

The potency could be reduced by efficiency of the micro-hydro power plant equipment and the head would be lower by placing the equipments into those location. According to JICA [9], overall efficiency will be 50-70%, and then the generated power is in between 14.70-20.58 kW. Therefore, the turbine and generator should be chosen higher than 20.58 kW.



Fig. 2. Map and Location of surveying

4.3. Microhydro Power Plant Equipment

a. Civil Equipment

Waterworks of the planning micro-hydro power plant include weir, intake, forebay and tailrace. Flood gate and trash screen are the complement equipments that are placed in intake and forebay. Flood gate is used to maintain the power plant, and trashrack is used to separate trash from water before it comes to the turbine. Specification of the waterworks is given in tabel 2. Penstock used PVC pipe with diameter 16” class D about 35 unit to fix the distance from intake to power house.

Dimension planning of power house was 3x3 m and it will be semi pemanent building with set forth of gavel stone in bottom side and thick board in upper side. Slove and machine foundation will be reinforced concrete with iron cast type K-225 and the house will be roofed by corrugated iron.

Table 2. Waterworks equipment.

	Weir	Intake	Forebay	Tailrace
Dimension (length, widht, height)	8x1x1 m	1x1x1 m	3x2x1 m	3x0.5x0.5 m
Construction	Gravel stone	Gravel stone	Gravel stone	Gravel stone
Flood gate	-	0.75x0.75 m (sheet metal)	0.75x0.75 m (sheet metal)	-
Trashrack	-	0.75x0.75 m (cast iron 10mm)	0.75x0.75 m (cast iron 10mm)	-

b. Electrical and Mechanical Equipment

According to flow rate and head measurement, this micro-hydro power plant is planned to use cross flow turbine type T-14 D-300 with efficiency about 76%. Power axle of the turbine is 24 kW to handle 300 l/s flow rate at head 8.6 m. Mechanic energy from the turbine is transfered to generator to produce electrical energy. The generator of

micro-hydro power plant is 220V/380V 3 phase synchronous generator with rating power 28kVA/22.4 kW, power factor 0.8, frequency 50 Hz and efficiency 92%.

Energy produced by the micro-hydro power plant is constant hour by hours. To anticipate the damage caused by load variation, a controller is needed to balance the load of the consumer and power produce. The function of this controller is also to protect generator and turbine from run away speed caused by load clearing. The controller is Electronic Load Controller (ELC). While load is decreased and power is excessive, ELC switches the power to ballast load.

4.4. Energy Production and Distribution

Efficiency of turbine, generator and penstock are known about 76%, 92% and 98 % respectively while effective head after installation the equipments is approximately 8.6 m. Therefore, overall efficiency and generated power are calculated as follows.

$$\begin{aligned}\eta_o &= 0.98 \cdot 0.920 \cdot 0.760 \cdot 100\% \\ &= 68.52\%\end{aligned}\quad (6)$$

$$\begin{aligned}P_g &= 1000 \frac{\text{kg}}{\text{m}^3} \cdot 9.8 \frac{\text{m}}{\text{s}^2} \cdot 0.3 \frac{\text{m}^3}{\text{s}} \cdot 8.6\text{m} \cdot 68.52\% \\ &= 17.32\text{kW}\end{aligned}\quad (7)$$

Electrical energy from the micro-hydro power plant will be distributed to seven villages by overhead distribution lines using twisted cable 3x50 mm and 1x35 mm in 4000 m long. Cable stanchion will be from wood with dimension 6 x 0.12 x 0.12 m. Distance between stanchion is about 50 m and therefore it will need 80 sticks to meet 4000 m of distribution cable. Each house will tap the energy from main distribution line using twisted cable 2 x 25 mm and electrical installation each house using NYM cable 2.5mm.

Table 3. Power usage for public facility

Name of village	Location	Lamps (Wh)	Wall plugs (Wh)	Total power (Wh)
Church	Mbeigau	1430	17600	19030
Church and office	Leihak	2860	17600	20460
Junior High School	Leihak	2860	13200	16060
Church	Kisab	1430	13200	14630
Elementary school	Kisab	3289	13200	16489
Pre school	Kisab	1573	4400	5973
District office	Kisab	3718	13200	16918
Clinic	Kisab	2574	8800	11374
District hall	Kisab	1573	8800	10373
House of district head	Kisab	1430	4400	5830
House of district vice head	Kisab	1859	4400	6259
House of school head	Kisab	1716	4400	6116
House of clinic head	Kisab	1859	4400	6259
Street lamps	All villages	14950	0	14950
Total		43121	127600	170721

Energy produce will be spread to 117 houses and each house will consume total 429 Wh for lumination about 11 watt, each in living room, bed room and kitchen. On the other hand, 1150 watt energy will be allocated to street lamp about 23 watt in 50 stanchions and those lamps will use 14950 Wh per day. Public facility buiding in the

capital of Hink district is about 13 buildings including schools, churches, clinic, district office, district hall and street lamps. The electricity used for public facility is planned about 8867 watt or about 170721 Wh per day under assumption that lamps and wall plugs will work 13 and 22 hours respectively. Total energy distribution planning for each village is provided in table 3 and 4.

Table 4. Power usage for houses

Name of village	Lamps (Wh)	Wall plugs (Wh)	Total power (Wh)
Demunti	5148	4400	9548
Menyememut	9152	4400	13552
Mbeigau	11297	4400	15697
Leihak	19162	4400	23562
Kisab	6864	13200	20064
Total	51623	30800	82423

Total power needed in Hink district is about 335567 Wh per day while output of micro-hydro power plant will be 415680 Wh per day. Therefore, power safe from the process conversion is about 80113 Wh per day. The saving energy can be used for the other public facility, and roughly it is enough to illuminate 93 more houses.

4.5. Economic Analysis

Investment of the micro-hydro power plant is approximately Rp. 778224202.02, including direct cost and indirect cost. Contingencies cost is predicted about 5% of direct cost and engineering cost is about 7% of direct cost for survey, supervision cost, detail design and planning as shown in table 5.

Table 5. Investment cost

Items	Prize (Rp)
Direct cost	
1. Civil works	382388690.18
2. Electrical and Mechanical	198000000.00
3. Distribution lines	57500000.00
4. Taxes (10%)	63788869.02
Sub total	701677559.20
Indirect cost	
1. Contingencies cost (5%)	31894434.51
2. Engineering cost (7%)	44652208.31
Sub total	76546642.82
Total	778224202.02

Annual generator output is about 149644.8 kWh; therefore annual benefit is about Rp. 92543126.40 at power price Rp. 720.00/kWh and monthly load benefit is chosen about Rp. 32000.00 per month kWh or in this case about Rp. 5468160.00 per month. Cost which includes deviation of civil building (30 years), deviation of electrical and mechanical (25 years), deviation of distribution lines (30 years), operation and maintenance cost, and 3% of bank interest are shown in table 6.

Profit of annual operation is the benefit minus cost and it will cost Rp. 44933537.85. Benefit factor build by the micro-hydro power plant in Hink district is about 1.94 and payback periode will be 17.32 years or about 17 years and 4 month. Electrical and mechanical equipment can reach 25 years and the building can life until 30 years. According to the criterion of benefit cost ratio and payback period, the development of micro-hydro power plant in Hink district is feasible.

Table 6. Annual cost and benefit

Items	Prize (Rp)
Benefit	
1. Annual Load benefit	5564160.00
2. Annual benefit	86978966.40
Total benefit	92543126.40
Cost	
1. Bank interest (3%)	23346726.06
2. Deviation of civil building	8030162.49
3. Deviation of electrical and mechanical	5425200.00
4. Deviation of distribution lines	1207500.00
5. Operation and maintenance cost	9600000.00
Total cost	47609588.55
Profit	44933537.85

5. Conclusion

The result of water supply measurement in Hink River shows that maximum flow rate is 0.4 m³/s. With head about 10m, the hydraulic potency is equal to 29.5 kW. Design planning of micro-hydro in Hink River includes hydraulic potency, generator and turbine, power house, and overhead distribution lines. Hydraulic potency of planned micro-hydro power plant for Hink River is 0.3 m³/s and with 8.6 m of head, the maximum potency is about 25.2 kW. Turbine cross flow type Flow T-14 D-300 is chosen to be coupled with 3 phase synchronous generators to produce electrical energy about 17.32 kW. The energy can be transferred to some villages around Hink District in about 4 km from power house using overhead distribution lines.

Electrical energy from the micro-hydro power plant is planned to be transferred to 5 villages that will consume 335567 Wh per day. Saving energy from the power plant is about 80113 Wh per day and it can be used for other public facilities or houses around the villages.

Annual benefit is Rp. 92543126.40, while annual cost can reach Rp. 47609588.55; therefore annual profit operation will be Rp. 44933537.85 and total investment of the micro-hydro is Rp. 778224202.02. Benefit cost ratio and payback period are about 1.94 and 17.32 years. Both benefit cost ratio and payback period have indicated that the micro-hydro power plant in Hink district is feasible to be built.

Environment and social impacts of developing and operating of the micro-hydro power plant in Hink River are not studied yet. This research will continue to investigate those impacts.

References

1. Anonymous. *Micro-Hydro Power*. Cited on 28 July 2013 at http://www.rowan.edu/colleges/engineering/clinics/cleanenergy/rowan_university_clean_energy_program/Energy_Efficiency_Audits/Energy_Technology_Case_Studies/files/Micro_Hydro_Power.pdf
2. Anonymous. *ESDMAG Edisi 2*. Dinas ESDM 2012 Cited on 28 July 2013 at prokum.esdm.go.id/ESDMAG/ESDM_Edisi_2.pdf
3. Anonymous. *Laporan Survey Potensi PLTMH di Kabupaten Teluk Wondama*. BP3D Kab. Teluk Wondama. 2007.
4. Deepak Kumar Lal, Bibhuti Bhusan Dash, A. K. Akella. Optimization of PV/Wind/Micro-Hydro/Diesel Hybrid Power System in HOMER for the Study Area. *International Journal on Electrical Engineering and Informatics*, 2011 2011;3:3. P. 307-325.
5. Vineesh V., A. Immanuel Selvakumar. Design of Micro Hydrel Power Plant. *International Journal of Engineering and Advanced Technology (IJEAT)* 2012;2-2. P. 136-140.
6. Khizir Mahmud, Md. Abu Taher Tanbir, Md. Ashraful Islam. Feasible Micro Hydro Potentiality Exploration in Hill Tracts of Bangladesh. *Global Journal of Researches in Engineering* 2012; 12: 9-1.
7. Abdul Azis Hoesein, Lily Montarcih. Design of Micro Hydro Electrical Power at Brang Rea River in West Sumbawa of Indonesia. *Journal of Applied Technology in Environmental Sanitation* 2011, 1-2. p. 177-183.
8. Soedibyo, Heri Suryoatmojo, Imam Robandi, Mochamad Ashari. Optimal Design of Fuel-cell, Wind and Micro-hydro Hybrid System using Genetic Algorithm. *Journal of TELKOMNIKA* 2012, 10:4. p. 695-702.
9. JICA. *Panduan untuk Pembangunan PLTMH* (Edisi Bahasa Indonesia). Japan: Tokyo electric Power Services Co. Ltd; 2003.
10. Balitbang ESDM. *Laporan Akhir Studi Kelayakan Pembangkit Listrik Tenaga Mikrohidro Kabupaten Teluk Wondama PLTMH Kaliati*, Departemen Energi dan Sumber Daya Mineral. 2006.
11. BC hydro. *Handbook for Developing Micro Hydro in British Columbia*. 2004. Cited on 10 August 2013 at http://www.bchydro.com/content/dam/hydro/medialib/internet/documents/environment/pdf/environment_handbook_for_developing_micro_hydro_in_bc.pdf
12. Arson Aliudin, *Ekonomi Teknik*. PT. RajaGrafindo Persada. Jakarta. 2006.