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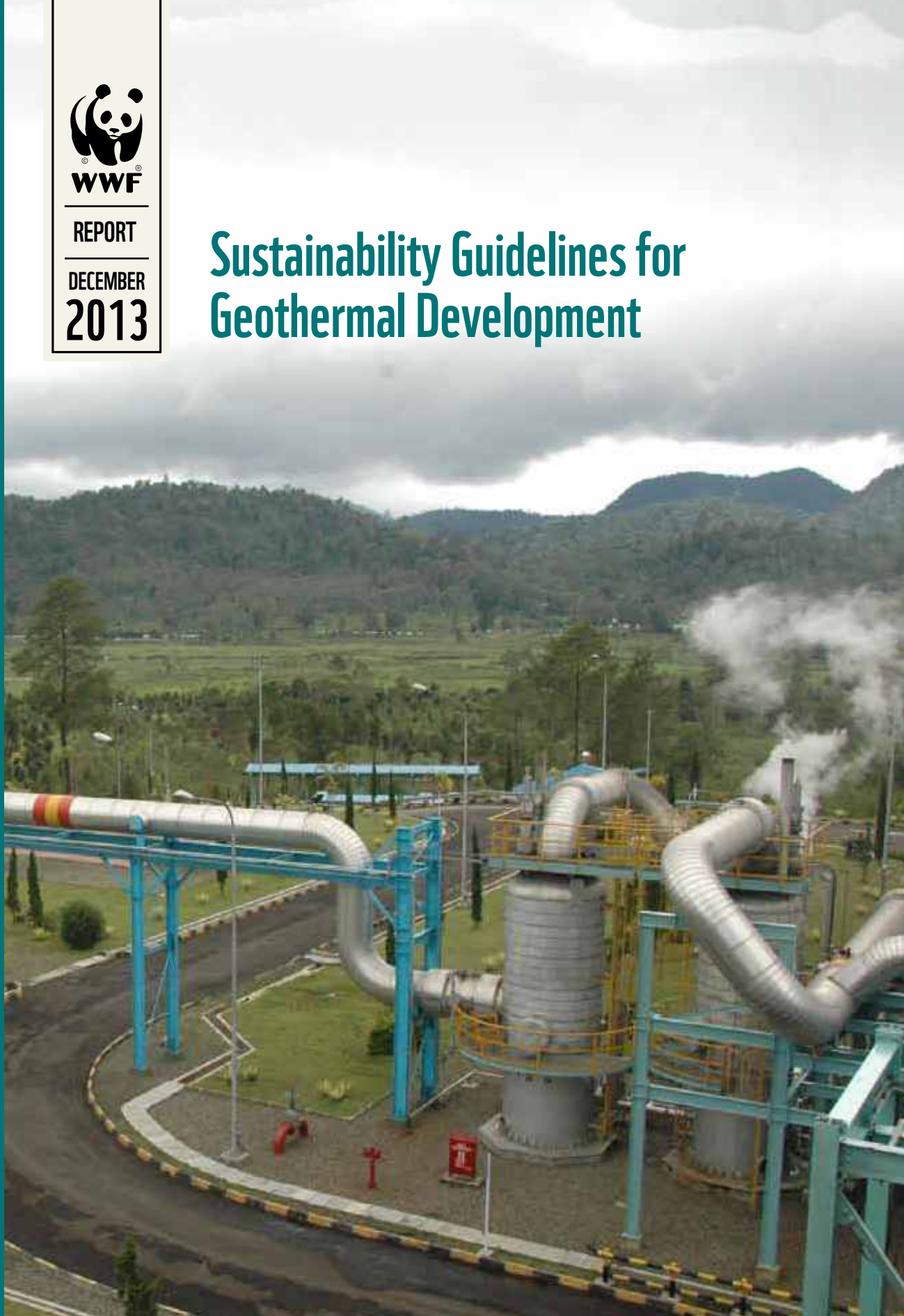
Sustainability Guidelines for Geothermal Development



Sustainability Guidelines for Geothermal Development

WWF Indonesia
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Sustainability Guidelines for Geothermal Development

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Foreword

Energy has become one of the benchmarks of the development of a country and even become a political economic power including Indonesia. Along with the growth of population and economy, it is undeniable that the energy needs of Indonesia also continues to increase rapidly. Most of the source of this energy needs are from non-renewable/ fossil energy such as petroleum, natural gas and coal, and the utilization of it will produce greenhouse gas emissions (GHG) that contribute to global warming and climate change. To improve national energy security in the long term and contribute to global efforts to put a half to climate change, energy conservation and energy diversification through the development of sustainable renewable energy is a necessity.

WWF's vision in the energy sector is to encourage the achievement of 100% Renewable Energy in 2050 globally. For Indonesia, this time is an important period for the transition and transformation of the energy sector towards the development of more environmentally friendly and sustainable. The potential for renewable energy in Indonesia is very large and has not been optimally used. One of these is geothermal energy. Through the program "Ring of Fire", WWF supports the sustainable development of geothermal energy.

Geothermal development in Indonesia is relatively slow with a dynamics and complex problems. One of the concern is the location of the geothermal potential that mostly located in forest area where the biodiversity needs to be protected, providing ecosystem services such as water sources, has the function as the guardian to balance the climate as well as a source of economic income for the community and countries. Geothermal and forest is a natural resource that has great benefits for human survival. Geothermal development in forest areas should always pay attention to sustainability of ecosystem aspects. "Sustainability Guidelines for Geothermal Development" is an idea of WWF-Indonesia's efforts to synergize the development of sustainable renewable energy and support the conservation of forests in Indonesia.

This guide identifies essential criteria and indicators that need to be applied in maintaining the sustainability of geothermal utilization in the forest by paying attention to the stability of forest, the sustainability of the ecological function of forest ecosystems and the sustainability of socio-economic and cultural functions of the forest ecosystem. The preparation of this guide has been through a series of discussion and consultation process with stakeholders. I hope this guidelines can serve as a reference for the government, geothermal developers, academia and also the community.

The preservation of the earth is our responsibility.

Dr. Efransyah, CEO WWF-Indonesia

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List of Abbreviations

AMDAL	:	Analisis Mengenai Dampak Lingkunganx1x (Environmental Impact Analysis)
ANDAL	:	Analisis Dampak Lingkungan (Environmental Impact Analysis)
APL	:	Areal Penggunaan Lain (Area for Other Uses)
CITES	:	Convention on International Trade of Endangered Species
CSA	:	Canada's National Sustainable Forest Management Standard
FPIC	:	Free, Prior, and Informed Consent
FPP	:	Forest People Program
FSC	:	Forest Stewardship Council
GRI	:	Global Reporting Initiative
GRK	:	Gas Rumah Kaca (Greenhouse Gases)
HCVF	:	High Conservation Value Forest
HK	:	Hutan Konservasi (Conservation Forest)
HL	:	Hutan Lindung (Protected Forest)
HP	:	Hutan Produksi (Production Forest)
HPT	:	Hutan Produksi Terbatas (Limited Production Forest)
IBSAP	:	Indonesian Biodiversity Strategy and Action Plan
INP	:	Indeks Nilai Penting (Important Value Index)
IPCC	:	Intergovernmental Panel on Climate Change
ITTO	:	International Tropical Timber Organization
IUCN	:	International Union for Conservation of Nature
IUPHHK	:	Izin Usaha Pemanfaatan Hasil Hutan Kayu (License for Timber Product Utilisation)
KESDM	:	Kementerian Energi dan Sumber Daya Mineral (Ministry of Energy and Mineral Resources)
KPA	:	Kawasan Pelestarian Alam (Conservation Areas)
KSA	:	Kawasan Suaka Alam (Nature Reserve Areas)
KSDAHE	:	Konservasi Sumber Daya Alam Hayati dan Ekosistemnya (Conservation of Natural Resources and its Ecosystems)
LEI	:	Lembaga Ekolabel Indonesia (Indonesian Ecolabeling Agency)
MEA	:	Millennium Ecosystem Assessment
PDB	:	Produk Domestik Bruto (Gross Domestic Product)
PEFC	:	Pan-European Forest Certification
PGE	:	Pertamina Geothermal Energy
PHPL	:	Pengelolaan Hutan Produksi Lestari (Sustainable Production Forest Management)
PKI	:	Prinsip, Kriteria, dan Indikator (Principle, Criteria, and Indicator)
PLTP	:	Pembangkit Listrik Tenaga Panas Bumi (Geothermal Power Plant)
RKL	:	Rencana Pengelolaan Lingkungan (Environmental Management Plan)
RPL	:	Rencana Pemantauan Lingkungan (Environmental Monitoring Plan)
SFI	:	Sustainable Forest Initiative
SNI	:	Standar Nasional Indonesia (Indonesian National Standard)
TBL	:	Triple Bottom Line
TNGHS	:	Taman Nasional Gunung Halimun Salak (Gunung Halimun Salak National Park)
TPI	:	Tebang Pilih Indonesia (Indonesian Selective Logging)
TPTI	:	Tebang Pilih Tanam Indonesia (Indonesian Selective Logging and Planting)
TPTJ	:	Tebang Pilih Tanam Jalur (Selective Logging and Line Planting)
UKL	:	Upaya Pengelolaan Lingkungan (Environmental Management Effort)
UPL	:	Upaya Pemantauan Lingkungan (Environmental Monitoring Effort)
WWF	:	World Wildlife Fund

Glossary

Biodiversity	The term used to describe the diversity of life forms on earth, the interaction between the various living beings as well as between them and the environment.
Geothermal	Source of heat energy contained in the hot water, water vapour, and rocks with associated minerals and other gases that genetically all of it cannot be separated in a geothermal system and its utilisation requires mining process.
Geothermal Resources	The amount of geothermal potential which determined on the basis of the limited estimation parameter that needs to be proven into potential reserves.
Geothermal Utilisation	Activity of locating geothermal resources up to its utilisation either direct or indirect utilisation.
Reservoir	Subsurface rock formations that can store and stream the thermal fluid (steam and or hot water). Reservoir usually is a rock that has a good porosity and permeability.
Geothermal Systems	Heat delivery systems in the upper mantle and crust of the earth where heat is delivered from a heat source to a heat sink.
Direct Utilisation	The utilisation of energy and/or geothermal fluid for non-electrical purposes, either for public interest or personal interests.
Indirect Utilisation	Indirect utilisation for electric power are business activities Geothermal energy utilisation for power generation, either for public interest or personal interest.
Geothermal Surface Manifestation	Geothermal manifestations at the surface which indicates the presence of a hydrothermal system beneath the earth's surface, such as hot springs, geysers, and so on.
Baseline	Tendencies that would occur without any policy intervention or activities. This baseline usually associated with a particular year and used as the basis for calculating rise and drop trends.
Deforestation	A land change from initially forested into land without any trees.
Forest Degradation	Changes in forest cover which originally had dense forest cover into sparse forest cover.
Preliminary Studies	Activities which include the collection, analysis, and presentation of data related to information of geological, geophysical, and geochemical state to estimate the location and existence of geothermal resources and working area.
Exploration	Series of activities of geological, geophysical, and geochemical investigation, drilling test, and drilling exploration wells aimed at obtaining and add information of subsurface geological conditions in order to locate and obtain estimates of geothermal energy.

Glossary

Feasibility Studies	The stages of geothermal mining activities to obtain detailed information on all aspects of the mining business in order to determining the feasibility of geothermal energy utilisation, including investigations or studies acoutthe amount of reserves that can be exploited.
Exploitation	The series of activities in a particular work area which includes the drilling of development wells and reinjection wells, field facilities construction, and production operation of geothermal resources.
Geothermal Reserves	Total heat content stored in the subsurface and is estimated by geoscience and electricity science that can be utilised within a certain time.
Speculative Reserves	Reserve class which potential energy estimation based on a literature study and preliminary investigation.
Probable Reserves	Reserve class which potential energy reserves estimates are based on the results of a detailed investigation and has been identified by exploration (wildcat) and the results of pre-feasibility study.
Presumed Reserves	Reserve class which potential energy reserves estimates are based on the results of a detailed investigation.
Proven Reserves	Reserve class which potential energy reserves estimates are based on the results of a detailed investigation, tested with exploratory wells, delineation and development, as well as a feasibility study.
Land Degradation	The reduced ability of forest land to provide ecosystem services and forest products, due to the negative effects on forest structure.
Forest	A unitary form of landscape ecosystems of biological resources, dominated by trees in their natural environment, which cannot be separated from one to another.
Forest Area	Certain areas designated by the government and/or to be protected as permanent forest.
State Forest	Forests on land that is not liable for land rights.
Claimed Forest	Forests on land that is liable for land rights.
Indigenous Forest	State forests within the territory of indigenous peoples.
Production Forest	Forest areas which primary function is producing forest products.
Protected Forest	Forest provide a basic function as a life support protection system for controlling water system, preventing floods, controlling erosion, preventing sea water intrusion, and maintaining soil fertility.

Glossary

Conservation Forest	Forest areas with certain characteristics which primary functions are to preserving the diversity of plants, animals, and ecosystems.
Nature Reserve Forest Area	Forest areas with particular characteristic which has primary function as preservation areas of plant and animal diversity along with its ecosystem, which also serves as the region's life support system.
Nature Conservation Forest Area	Forests with particular characteristic which has primary function as life support protection systems, the preservation of diversity of plants, animals, and the sustainable use of natural resources and its ecosystems.
Land Use, Land-UseChange and Forestry (LULUCF)	Greenhouse gas inventory sector that covers emissions and removals of greenhouse gases from land use, land use change, and forestry activities which carried out directly by humans.
National Park	Nature conservation area which has native ecosystem, managed by the zoning system which is utilized for the purpose of research, science, education, support aquaculture, tourism, and recreation.
Industrial Plant Forest (HTI)	Forest plants in a production forest that are built by forestry industry groups to improve the potency and quality of production forests by applying silviculture in order to meet the raw material needs of the forest products industry.
Habitat	Environment where a plant or animal lives and grows naturally.
Alpha Diversity	The average number of plant species found in a community/ecosystem, which is called the wealth of ecosystems. Alpha diversity values indicate geographic diversity on a scale that is local and can be determined by calculating the average number of plant species in a community or ecosystem of a forest ecosystem units.
Beta Diversity	The number of plant species in wider regional scale. Beta diversity values determined by counting the number of plant species which is combined from the same community in the region. Beta diversity link alpha and gamma diversity, calculated by dividing the value of gamma to alpha values diversity.
Gamma Diversity	Diversity value that describes the changes in species composition within a broad area of the landscape scale. For the application of ecosystem management in a forest ecosystem units, gamma diversity is the number of plants owned by a particular ecosystem which is a combination of a few parts in a forest management unit.
Sustained Yield Principle	At a certain level of intensity of forest management, timber produced by forest continues over time.
Sustainability of Multiple Use	The understanding that wood is not the only forest products and human needs for forest products is very diverse.

Glossary

Reference Ecosystem	Forest ecosystem that is referred as healthy forest ecosystems for comparison to other forest unit that will be monitored.
Resilience	The capacity of a system to absorb disturbance and knew when to change so that it can maintain its functionality and basic structure.
Adaptability	Capacity of actors within the system to affect the resistance.
Transformability	The ability to create a fundamentally new system, when the current structure of ecological, economic, and social cannot be maintained
Maximum Disturbance	This situation will only occur if the received disturbance exceeds the threshold of ecosystem's ability to maintain and renew itself.
Carrying Capacity	The maximum number of individual biological elements that can be guaranteed a good life in a certain environment condition. In ecological systems, each species means as an environment for other species so the environment itself is a relationship of interdependence between species that were added to the physical element.
Greenhouse Gases Effect	The effects of greenhouse gases, when CO2 gases withstand the radiation emitted by the sun to earth in the form of heat which warm earth's atmosphere.
Greenhouse Gases	The atmospheric gases that are liable for causing global warming and climate change. Type the main greenhouse gas is carbon dioxide (CO2), methane (Ch4), and nitrous oxide (N20).
Ecosystem	Systems that consist of life factors (biotic) and nonliving (abiotic) that has reached a steady balance. Ecological system formed by the interrelationship between living organisms with their environment.
Primary Forest	Land with tree species and woody plants that grow naturally and largely unspoiled by human activities so its ecological processes are not disrupted.
Secondary Forest	Forest that revives naturally after logging or cleared for various activities.
Crop Forest	Wooded land where trees have been established through seeding and planting saplings.
Intergovernmental Panel on Climate Change (IPCC)	Agency which surveyed technical and scientific literature throughout the world and publish reports that become source of reliable information and the basis Climate Change Convention negotiations. More than 2,500 scientists and 800 authors from 130 countries contributed to the IPCC's Fourth Assessment Report in 2007, which confirmed that human activities cause climate change. The IPCC is an independent institution that is not related to the structure of the Convention.

Glossary

Ecosystem Services	Services that are supported, organized, and made available by ecosystem to the human. Forests, for example, providing food, water, wood and fiber, as well as regulating the climate and water system. These ecosystems also provide benefits to recreational, aesthetic, and spiritual satisfaction.
Clean Development Mechanism	Mechanism under the Kyoto Protocol in which developed countries may finance the project of greenhouse gas emissions reduction in developing countries and receive carbon credits that can be used to meet emission reduction obligations.
Mitigation	The action to reduce greenhouse gas emissions caused by human activities and increase carbon storage to combat climate change.
Climate Change	Changes in climatic conditions due to human activity that alters the composition of global atmosphere. Measurement conditions and variability based on the long-term average meteorological parameters such as air temperature, rainfall, and wind speed.
Kyoto Protocol	International agreement that acknowledge industrialized countries to reduce greenhouse gas emissions that they produced by 5.2 percent from 1990 emissions levels during the period 2008-2012.
Global Warming	The rise in average temperature of Earth's atmosphere from year to year due to increased concentrations of greenhouse gases, mainly due to human activities such as industrialization and deforestation.
Carbon Absorption	The process of binding of CO_2 in atmosphere by plants, which have light-capturing pigment, chlorophyll, through the process of photosynthesis.
Restoration	Recovery of natural forest to rebuild its structure and function, protect and restore critical habitat, riparian areas, watersheds, and other attributes.
Sustainable Forest Management	Forest management and utilization to maintain biodiversity, productivity, regeneration capacity, and socioeconomic functions.
United Nations Framework Convention on Climate Change (UNFCCC)	Agreement made at the Earth Summit in 1992, which urged all countries concerned to stabilize greenhouse gas concentrations in the atmosphere at a level that would not harm the earth's climate. UNFCCC Secretariat more generally refers to the United Nations assigned to support the implementation of the agreement.

Foto: ©Moving Images/ NL Agency

I. INTRODUCTION

1.1. Background

Indonesia is one of the countries that are known with the highest biodiversity in the world. Indonesian biodiversity are stated by Indonesian Vice President in his speech during Hari Cinta Puspa dan Satwa Nasional 2012, Indonesia consist of 90 types of ecosystem, 40,000 species of plant, and 300,000 species of animal. To protect its biodiversity, in the end of 2010 the Ministry of Forestry have stated the protected animals and plants consisting of mammals (127 types), aves (382 types), reptiles (31 types), fish (9 types), insects (20 types), crustaceans (2 types), entozoan (1 type) and bivalves (12 types). One of Indonesia's effort to control its flora and fauna trading that's heading towards extinction, Indonesia signed the CITES convention and listed several of its flora and fauna into Appendix I and II

[1] http://wapresri.go.id/index/preview/pidato/180
[2] Type of protected flora and fauna can be seen at Apendix of preservation of Flora and Fauna, Government Regulation no. 7 Year of 1999
[3] Forestry Statistic, Ministry of Forestry 2011

The economic value of the biodiversity is potential to become the backbone for industry, agriculture, trade, forestry, health, and tourism. Ministry of Environment, refers to a number of academic studies mentioned, the value of genetic resources and traditional knowledge each year can reach up to 500 – 800 USD, or more than twice the value of timber products. This potential is greater as the approval of Nagoya Protocol will provide protection to biodiversity and ensure a sharing benefit for Indonesia. In this context, the ecological importance of biological wealth will give an economical benefit. Along with the development of science and technology, it is believed that the discovery of many new types of biodiversity and its uses will continues to be discovered. At the same time, the economic value of biodiversity will continue to rise

On the other hand, Indonesia also contain natural resources such as minerals and rather high energy, like geothermal. Indonesian geothermal resources are generally located on the volcanic trail, extending from Sumatera Island, along the island of Java, Bali, Nusa Tenggara, Sulawesi, and Maluku. It stretches for 7,500 kilometer with a width of 50 – 200 kilometer. This condition position Indonesia as the owner of the largest potential geothermal energy in the world, reaching up to 28,617 megawatts (MW), or about 40% of the total potential of the world that is spread over 299 location. Geographically, the largest geothermal reserves are located in Sumatera (12, 760 MW), Java (9,717 MW), Sulawesi (3,044 MW), Nusa Tenggara (1,451 MW), Maluku (1,071 MW), Bali (354 MW), as well as other area (220 MW)

Globally, the use of geothermal energy for power generating can reach up to 9,900 MW in the world. In Indonesia, based on the data of the Ministry of Geology and Mineral Resources, the utilization of geothermal energy by December 2012 are 1,341 MW located in Java (1,134 MW), Sumatera (122 MW), Sulawesi (80 MW) and Nusa Tenggara (5 MW)

This puts Indonesia as the world's third largest producer of geothermal power after United States (2,687 MW) and Philippines (1,968 MW). With the existing potential, the use of electricity from geothermal energy in Indonesia can still be improved. In addition to power generation, geothermal energy can also be used for non-electrical activity such as hot water bath, agricultural and fishery dryer product and room heater and others.

4 http://www.menlh.go.id/peringatan-hari-cinta-puspa-dan-satwa-nasional-hcpsn-2011
5 Profile of Geothermal Potential, Ministry of Energy and Mineral Resources 2012
6 Indonesian Institute of Science/ Lembaga Ilmu Pengetahuan Indonesia (LIPI)
7 Agency of Geology, Ministry of Energy and Mineral Resources 2012
8 Indonesia as a center of geothermal, Ministry of Energy and Mineral Resources, April 2010

Table 1. Installed Capacity Geothermal Power Plant

No	Location	Permit Holder	Developer	Name of Power Plant	Installed Capacity
1	Sibayak - Sinabung North Sumatera	PT. Pertamina Geothermal Energy (PGE)	PT. Pertamina Geothermal Energy (PGE)	Sibayak	12
2	Cibereum Parabakti, West Java	PT. Pertamina Geothermal Energy (PGE)	KOB – Chevron Geothermal Salak,Ltd (CGS)	Salak	377
3	Pangalengan, West Java	PT. Pertamina Geothermal Energy (PGE)	KOB – Star Energy Geothermal Wayang Windu, Ltd (SEDWWL)	Wayang Windu	227
4	Kamojang – Darajat, West Java	PT. Pertamina Geothermal Energy (PGE)	PT. Pertamina Geothermal Energy (PGE)	Kamojang	200
5	Kamojang – Darajat, West Java	PT. Pertamina Geothermal Energy (PGE)	KON – Chevron Geothermal Indonesia, Ltd (CGI)	Darajat	270
6	Dieng Plateau, West Java	PT Geo Dipa Energi (GDE)	PT Geo Dipa Energi (GDE)	Dieng	60
7	Lahendong – Tompaso, North Sulawesi	PT. Pertamina Geothermal Energy (PGE)	PT. Pertamina Geothermal Energy (PGE)	Lahendong	80
8	Ulubelu, Lampung	PT. Pertamina Geothermal Energy (PGE)	PT. Pertamina Geothermal Energy (PGE)	Ulubelu	110
					1.336

Source : Ministry of Energy and Mineral Resources, december 2012

The geothermal system in Indonesia is generally a hydrothermal system that has a high temperature (>2250 c), located in several areas in Sumatera, Java, Sulawesi and parts of eastern Indonesia. The hydrothermal system beneath the earth's surface is often indicated by the geothermal surface manifestation, such as hot springs, geysers, and others. Based on experience on high and moderate temperature geothermal systems for power generation.

The location for potential geothermal in volcanic are usually associated with forest. Datas from Directorate General of New Renewable Energy and Energy conservation Ministry of Energy and Mineral Resources in 2010 stated, that there are 41 points of potential geothermal in conservation forest with the capacity of 5.935 MW, in protected forest area (46 points) with the capacity of 6,623 MW, and in the production forest are (37 points) with the capacity of 3,670 MW

PLTP Ulubelu, Lampung.
Foto: ©Moving Images/ NL Agency

[9]Geothermal Energy in Indonesia, Nenny Saptadji, ITB

Today, geothermal development in forest are still faces many obstacles, especially sync in government regulation between the energy and forestry sector. Several attempts to overcome this policy constrains that have been and are doing by the governments are supported by several geothermal players. KESDM are still trying to revise Law 27/2003 on Geothermal, while the Ministry of Forestry trying to revise the Law 5/1990 on Conservation of Natural Resources and Ecosystem

Along with that, The Ministry of Energy and Mineral Resources and the Ministry of Forestry signed a Memorandum of Understanding No. 7662/05/MEM.S/2011 and No. Nk.16/Menhut-II/2011 on Acceleration Geothermal Concessions Permit in Production Forest, Protected Forest and Conservation Forest. The memorandum of understanding was to speed up the permitting process of geothermal utilization in production forest and protected forest area, as well as preparing the steps for the utilization of geothermal activities so that it can be done in conservation forest area and still considering the principles of conservation.

In respond of that condition, WWF – Indonesia conducted series of preliminary studies that in general were intended to ensure the sustainability of forest ecosystems that has been and will be the location of geothermal concession operation, especially forest with high conservation value. Among them are forest that has been assigned as conservation areas, protected forest, and areas of high conservation value forest (HCVF) located within the production landscape

Systematically, this study includes the identification of the numbers and distribution of geothermal potential in forests, both in which that have been exploited and is still a potential; framework identification for activities and operation of geothermal development; identify the effects of each activity in geothermal exploitation stage of the forest ecosystems; clarify the economic value of forest ecosystems that can be compared to the economic value of geothermal concession in forest areas; and develop recommendations in the form of forest ecosystem sustainability guide for the location of geothermal utilization

Forest ecosystem sustainability guide within geothermal area is to ensure the sustainability of the forest ecosystem that can affect every level of decision in geothermal exploitation in forest areas.

PLTP Kamojang, Jawa Barat. Foto: ©WWF-Philippines/ Christopher Ng.

1.2. Purpose

The development of Standard Geothermal Energy Utilization in Sustainable Forest area is one of the main activities in“Ring of Fire” WWF program.This program aims to accelerate he development and utilization of geothermal energy that is sustainable in Indonesia and Philippines,which is in line with the vision of WWF’s Global Energy Sector 100 Percent Renewable Energy by 2050

In general,the development of this guide is to help forest managers andgeothermal developers,and other parties to formulate and establish the benchmark for forest ecosystem sustainability based on specific criteria and indicators.These sets of criteria and indicators can then be used as a framework to monitor the development of ecosystem sustainability

- Minimize or avoid negative impacts to the environment and the preservation of forest with high value conservation as well as social impact
- Maintaining of increasing the wisdom value of the local communities for managing the natural resources and the environment as well as high conservation value identified in the are of geothermal development
- Build broad support from stakeholder through a more advance sustainability profile and better social acceptance by protecting the society and ecosystem,as well as enhancing the role of the geothermal industry in conservation forest and biodiversity
- Provide input for the policy and regulation development as well as advocacy activities to accelerate the development and utilization of geothermal energy,and being one of the options considered for central and local government in giving permission for geothermal development,especially in the Indonesian forest.

1.3. Scope of Guide

Overall, the purpose for ecosystem includes ecological, economical, and social. Forest ecosystem sustainability guide within geothermal area is focused on the ecological purpose from forest ecosystem that includes biological and physical components. The scope of discussion for this guide includes:

1. Forest ecosystem typology based on forest ecological aspect
2. Principal, criteria, and indicators for forest ecosystem sustainability within geothermal area
3. Forest ecosystem monitoring within geothermal area

Ecosystem's social and economical purposes are important. In fact, the management of social aspect became an enabling condition for natural resources management success. Therefore, this guide can be effectively applied when the social aspects have been previously managed.

Currently, there are many management tools for social issues that have been developed by various parties, and WWF – Indonesia encourage several competent element in this issues to formulate a more specific social issues management. This is to guard the geothermal exploitation in the forest area to be

1.4. Methodology for Guide Development

This Guide is developed through various activities carried out systematically by involving relevant parties. The stages includes:

1. Preparation

a. Guide for framework development
b. Identification of the parties involved (government, geothermal developers, NGOs, universities, etc)
c. Data identification and information about potential as well as geothermal utilization profile in forest area
d. Literature study about forest ecosystem and geothermal
e. Forestry policy assessment and utilization for geothermal
f. Focus Group Discussion about framework guide development

2. Draft Guide Development

a. Determining and harmonizing a framework that will be used to organize information
b. Field observation in several geothermal utilization location that has been operating
c. Baseline framework development forest ecological typology
d. Selection and development for the definition of Principles, Criteria, and Indicator for Forest Ecosystem Sustainability indicator for geothermal exploitation
e. Development of the draft for Principles, Criteria, and Indicator for Forest Ecosystem Sustainability within geothermal area
f. Public consultation through FGD to draft Principles, Criteria, and Indicator for Forest Ecosystem Sustainability
g. Development for verifier and method for testing the indicator
h. Development of grading framework for overseeing the ecosystem sustainability within geothermal work area
I. Development of comprehensive draft guide

3. Final Guide Development

a. Guide for public consultation
b. Adjustment for guide based on input by the parties
c. Final guide launch

1.5. Systematics Writing Guide

Part one :background description, objective, methodology, and scope of field

Part two :briefly explain the concept of ecosystem and ecosystem sustainability, Indonesian forest management framework, operational geothermal framework, potential geothermal in forest areas, the operational geothermal affect to sustainability for forest ecosystems, policy condition for geothermal in forest, geothermal policy mindset in forest, and several form of environmental management tools in Indonesia

Part three :explain framework for developing typology of forest ecosystem and about typology of forest ecosystem itself

Part four :explain framework for developing the guide, hierarchy of principles, criteria, and indicator for forest ecosystem sustainability comprehensively especially about principles, criteria and indicator of forest ecosystem

Foto: ©Moving Images/ NL Agency

II. GEOTHERMAL AND FOREST

Geothermal utilization role for sources of clean energy that is also environmentally friendly is very important to support national energy and reduce carbon emission, which is a major contributor to global warming and climate change. The same thing goes for forest as the largest carbon storage and habitat for biodiversity therefore its presence should be maintained and preserved. Two considerations that seem contradictory, can it be complementary to each other? What is the purpose of forest are that have to adapt to the operation of geothermal concession? Or the other way around, geothermal exploitation must adapt to every purpose of forest are where the operation area done?

2.1. Forest Ecosystem and the Concept of Sustainability

A simple definition of ecosystem is a system formed by the ecological interrelationships of living things with it environment. Forest as an ecosystem includes: (1) plants; (2) animals; (3) soil as substrate to grow; (4) microorganisms; and (5) the atmosphere. Therefore, forest is a complex physical and biological system, in which there are a lot of interaction and interdependence between each components (Supriyadi, 2009)

Naturally, the interaction between components of forest ecosystem varies, in which a different environmental condition will resulted a different type of forest. Variations of forest are then classified into several types depending on the classification system. According to Spurr and Barnes (1980), the world's forests are grouped into two, tropical and subtropical forest. Forest in Indonesia, Van Steenis categorizes the forest into tropical forest and monsoon. Both of those types are then categorizes into a more detail type of forest. Among them are mountain rainforest, swamp forest, mangrove forest, and heath forest

To determine the response of forest community to its environment, the ecosystem components are grouped into six ecosystem attributes, such as (1) composition. (2) structure, (3) pattern, (4) heterogeneity, (5) purpose, and (6) the dynamics and resilience (Hobbs and Norton, 1996). Heterogeneity as one of the attributes of ecosystems generally knows as biodiversity. The definition of biodiversity is very diverse but more importantly is a variation of the structure and biodiversity of organisms purpose in genes level, population, communities, or ecosystems (Cox, 1997; Fielder and Jain, 1992; Hunter, 1996; Hurbelt, 1971; ICBP, 1992; Johson, 1993; Magurran, 1988; McAllister, 1991; Peet, 1974; Reid and Miller, 1989; Sandlund et al, 1992 and Wilson, 1992). In measurability dimensions, biodiversity can be categorized into three levels, such as (1) alpha diversity; (2) beta diversity; (3) gamma diversity (Dykeet al, 2008)

[10] http://id.wikipedia.org/wiki/ekosistem

In the evolution of forest ecosystem management, the problem of disruption and damage to forest ecosystems remains a major topic among scientist, activists, and policy makers around the worlds. Forest ecosystem became the focus of about the earth's ecosystem damage problem.

Normatively, forest management has set standards or benchmarks of good forest management, which is known as the concept of sustainability or forest sustainability. This concept refers to the forest preservation for indefinite future with no quality loss. The concept of sustainability is needed, because forest management aims at providing goods and services for current and future generations.

The concept of sustainability evolved into three stages, which is the preservation of timber production, sustainability of multiple uses, and ecosystem preservation (Bettinger, 2009). First, the sustainable timber yield (sustained yield principles) or defined as “at a certain level of intensity of forest management, there are continuous timber produced by forest” This concept emphasizes on forest planning that relies on the balance of growth and tree harvesting. The tree growth itself is not something that can be identified easily. The concept of timber yield sustainability is translated into forest yield regulation. The implementations of this concept are implemented through several sulvicultural systems, such as Selective Logging, Selective Logging Line, and last is Intensive Silviculture, which is still being tested in several forest management units. Meanwhile, the silvicultural system for forest is Clear Cutting Artificial Regeneration

Second, the concept of sustainability of multiple uses comes from the understanding that woods are not the only forest product and human needs for forest are varied. In Millennium Ecosystem Assessment there are four categories of forest ecosystem services that forest may provide, such as provisioning services, regulating services, cultural services, and supporting services.

[11] Bettinger P, Boston K, Siry JP, Grebner DL. 2009. Forest Mangement and Planning. Amsterdam: Elsevier.

Forms of benefit of each ecosystem services are shown in the following figure:

Image 1. Various Benefits of Forest Ecosystem

Provisioning Services	Regulating Services	Cultural Services
Product obtained from ecosystem	Benefits obtained from regulation of ecosystem processes	Nonmaterial benefits obtained from ecosystem
• Food • Fresh water • Fuel wood • Fiber • Bio-chemical • Genetic resources	• Climate regulation • Desease regulation • Water regulation • Water purification • Pollination	• Spiritual and religious • Recreation and eco-tourism • Aesthetic • Inspirational • Educational • Sense of place • Cultural heritage
Supporting Services		
Service necessary for the production of all other ecosytem sevices		
• Soil formation	• Nutrient cycling	• Primary production

·Source : Ecosystem and Human Well-being: Synthesis (2005)

Foto: ©WWF-Indonesia/ PHKA

Third, the concept of sustainability ecosystem that emerges from the concept of ecosystem-based management. This concept explained that the flow of goods and services from forest depends on the processes that preserve the ecosystem. If the concept of sustainable timber yield and multiple uses stressed the importance of the results or benefit of the forest as a factory of goods and services, then the sustainability of the ecosystem will be focused on the factory

The concept of forest ecosystem sustainability are often mentioned as the concept of sustainability that is most needed right now, given that the damage to the ecosystem is in alarming stage. In the context of sustainability of forest ecosystems, experts linked it to the concept of forest ecosystem health. The concept of ecosystem health is promoted as a concept that helps clarify, evaluate, and implement ecological policy. Viewed from the perspective of system analysis, the concept of forest ecosystem health can be defined as the process of how a forest ecosystem conditions is created that are capable of supporting the ecosystem to re-new themselves naturally, maintain vegetation diversity, ensuring habitat stability for flora and fauna, as well as forming a functional connection between the community of plants, animals, and the environment.

Kolbet al (1994) propose, a healthy forest are distinguished by four qualitative attributes:

1. The physical environment, biotic resources, and the network of food or nutrients to support productive forest for at least a few transition in succession of forest ecosystems.

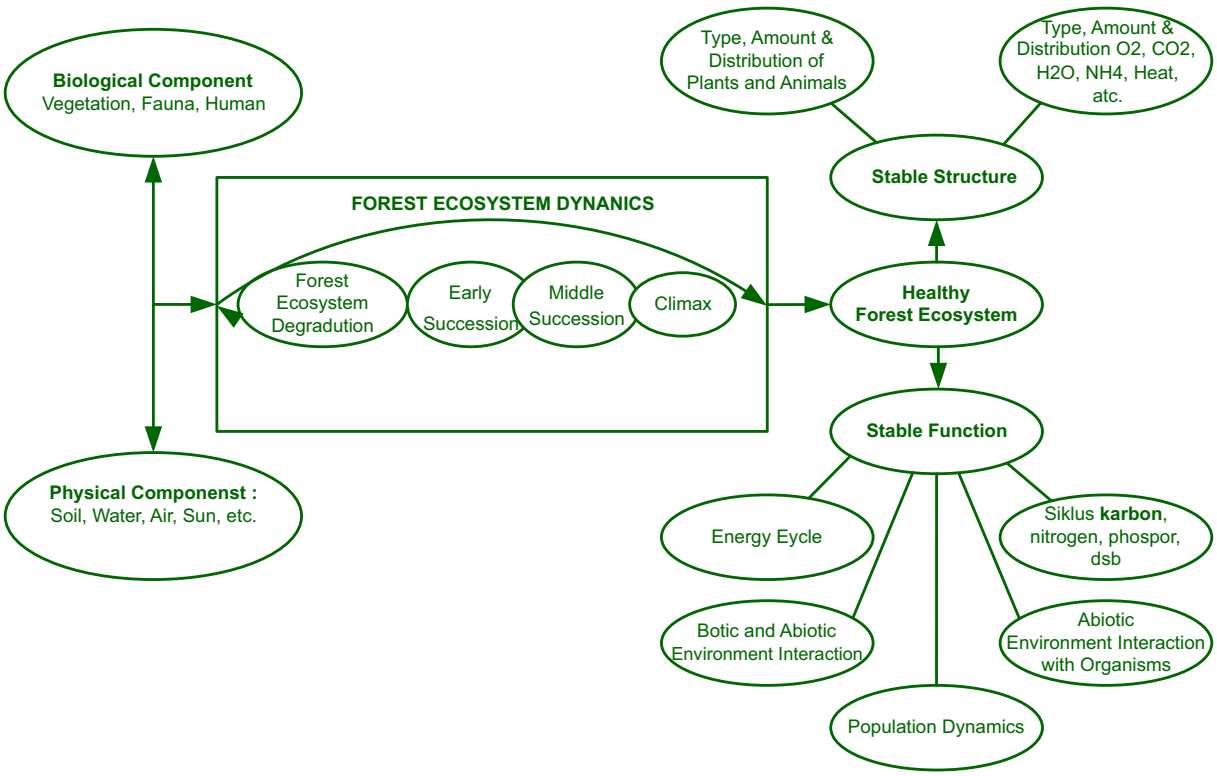
2. Resistance to catastrophic change and/or the ability to recover from catastrophic changes in landscape level

3. Functional balance between supply and demand needs for essential resources (water, nutrients, light, space to grow, etc) for major parts of Nvegetation

4. Diversity of transition stage and stand structure that provides a viable habitat for many native species and the entire essential ecosystem processes.

Measurement of ecosystem health for the benefit of supervision is a complex and difficult job, even more so every unit of forest ecosystem they each have their own characteristic. Experts suggest that the measurement of monitoring of ecosystem health is approached by baseline study of the ecosystem structure and propose, history of ecosystem assessment, and the ecosystem reference as a baseline for healthy forest for a forest ecosystem unit that will be monitored.

Image 2. System Flowcharts in Forest Ecosystem Concept



Human position in ecosystem has always been an interesting discussion. At concept level, human existence is mapped as an inseparable part of ecosystem. Therefore, the sustainability of ecosystem concept evolves to the concept of sustainability of ecosystem and social values. Studies on how is human relationship with ecosystem or often referred as social-ecological system are viewed from three attributes, resilience, adaptability, and transformability

Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing changes so that it can still maintain its basic structure and purpose. Adaptability is the capacity of actors in the system to influence resistance. While transformability is the capacity to create a new system fundamentally, when the structure of ecology, economic, and social cannot be maintain. This situation will only happen there's a disruption to the ecosystem that exceed the ecosystem's ability to maintain and renew itself (maximum disturbance)

The application of sustainability concept in forest management is influenced by the value and goals of forest management. The implementation for those three sustainability concepts in Indonesian forest management is as follows:

[12] Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. Ecology and Society 9(2): 5. http://www.ecologyandsociety.org/vol9/iss2/art5

Table 2. Implementation of Forest Sustainability Concept

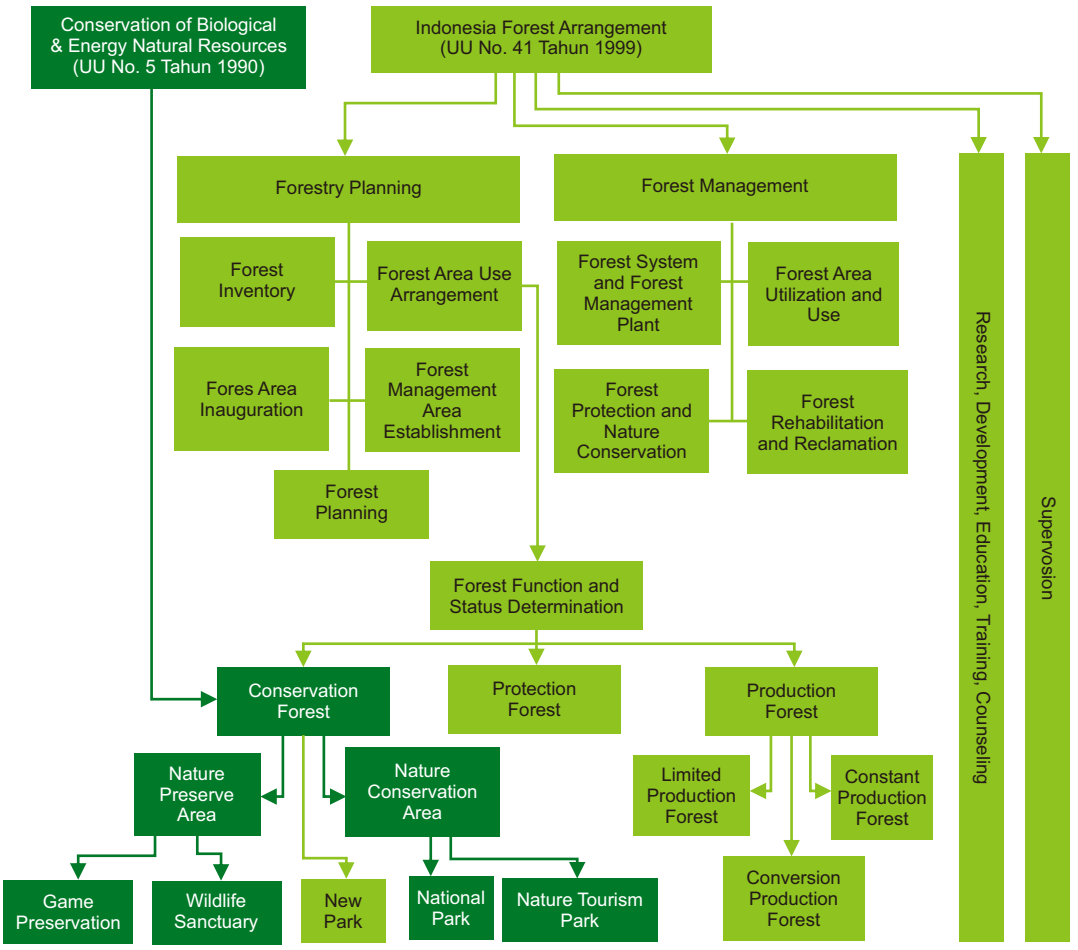
Sustainability Concept	Forest Purpose		
	Production	Protection	Conservation
Sustainability Timber Product			
Sustainability multi-function forest			
Sustainability Ecosystem			
Keterangan :			
: Dominant			
: Applicable but not dominant			
: Not applicable			

**ecosystem conservation of production forest is implemented by high conservation value forest (HCVF) instrument*

2.2. Indonesian Forestry Framework

In Act No. 41 of 1999 about Forestry, forest is defined as an entity of ecosystem in the form of lands comprising of biological resources, dominated by trees in their natural environment, which cannot be separated with each other. The forest are is a are designated area
Appointed by the government to be protected as permanent forest. Development in forestry sector in Indonesia is organized through a series of forest management activities, which include forest planning, forest management, research and development, education and training, forest counseling, and monitoring as shown in the following chart.

Image 3. Framework of Forest Arrangement in Indonesia

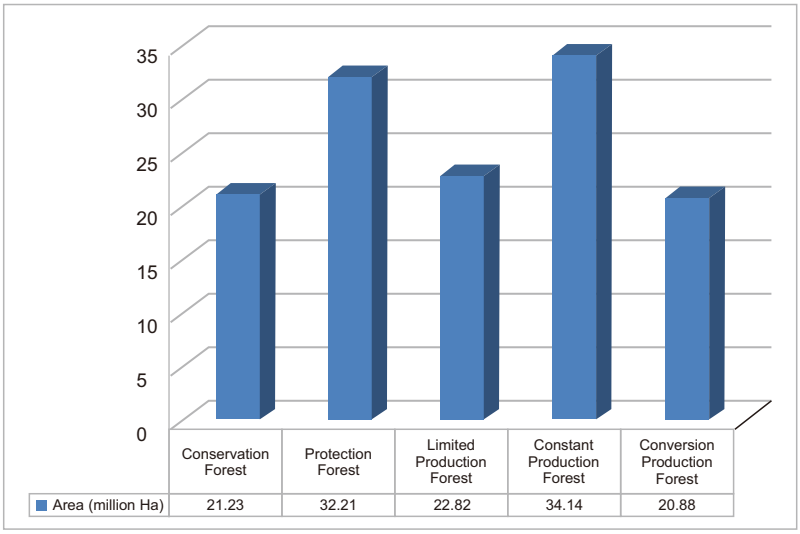


Source : Compilation from Law no 41 year 1999 and Law no 5 year 1990

On of the main activities of forestry planning is to establish forest stewardship and to establish the forest purpose and utilization. Based on its purpose, Indonesian forest are grouped into three categories:

1. **Conservation forest** is a forest with certain characteristics that have the principal function of preserving the diversity of plants, animals, and ecosystems. Conservation area includes natural reserves, conservation areas, and hunting parks

Image 4. Forest Area Based on Their Purposes



Source : Forestry Statistic 2011

2. Protected forest is a forest that have a main purpose of protecting the life support system by managing the water, preventing floods, controlling erosion, preventing sea water intrusion, and maintaining soil fertility

3. Production Forest is a forest area that has a main purpose of producing forest products. Production forest includes limited production forest, permanent production forest, and conversion production forest as a reserve for the benefit of

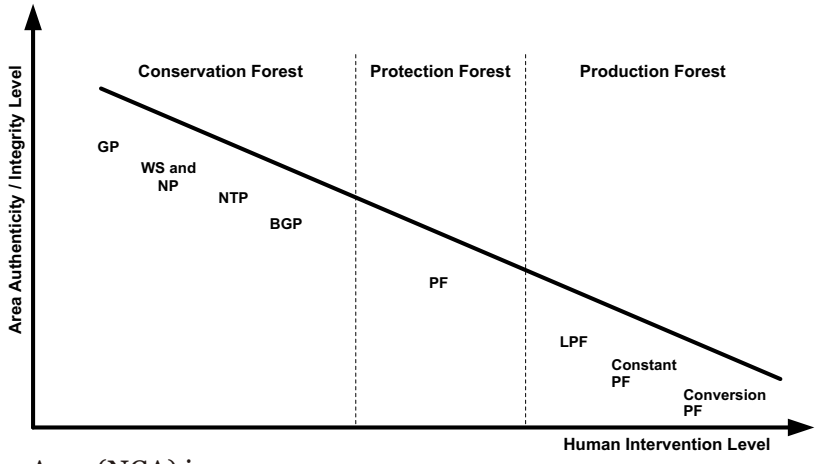
Purpose distribution for this forest shows in the form and the level of management intervention for each forest. The span ranging from natural reserves (one of the categories for conservation forest that must protect its authenticity by avoiding human intervention) to production forest that can be converted, which is one of the categories in production forest that are reserve for development outside of forestry sector

Taman Nasional Tesso Nilo.
Foto: ©WWF-Indonesia/ Zulfahmi.

In addition to the interest of forestry, forest are can also be allocated for activities outside of forestry sector. For this purpose a forest term is used, which is using as a part of forest for development purposes outside of forestry sector without changing the purpose of the forest. The utilization of the forest can only be done in the protected forest and production forest. While on conservation forest the utilization have a certain limitations as stipulated in Act no. 5/1990 about KSDAHE and its utilization regulation in Government Regulation No.28/2011 about Management of Area Reserves and Conservation Area

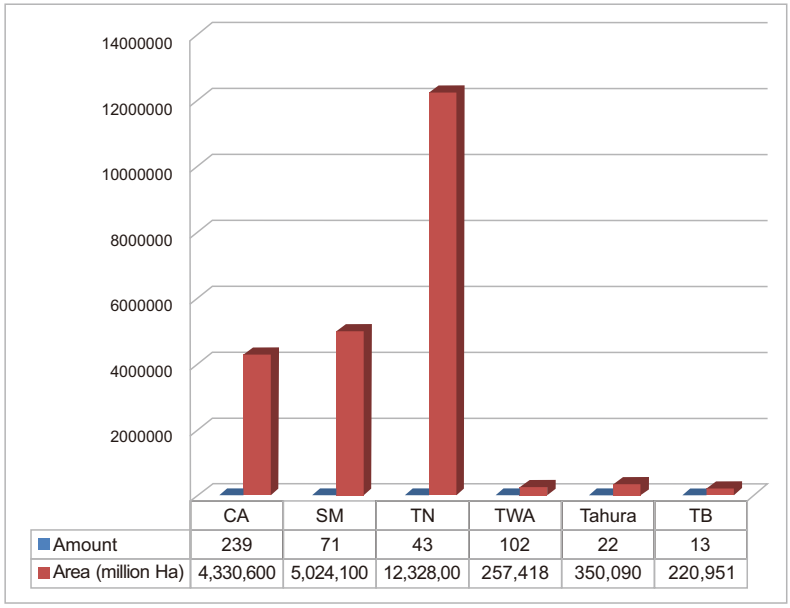
Conservation forest may include Conservation Area, Natural Sanctuary Area or Hunting Park. Natural Sanctuary Area (NSA) is a region with certain characteristics, both on land and water with the main purpose of preserving the diversity of plants and animals area as well as ecosystem that act as the area's life support system.

Image 5. Forest Purpose Gradation Based on Authenticity and Human Intervention Level



Meanwhile, Natural Conservation Area (NCA) is an area with certain characteristic, both in land and water with the main purpose of preserving the diversity of plants and animals, as well as the sustainable use of natural resources and its ecosystem. Nature preserve consists of natural sanctuary and wildlife sanctuary, while nature conservation area includes national parks, nature parks, and forest parks.

Image 6. Total And Area of Conservation Area Based on Their Categories



	CA	SM	TN	TWA	Tahura	TB
Amount	239	71	43	102	22	13
Area (million Ha)	4,330,600	5,024,100	12,328,00	257,418	350,090	220,951

Source : Forestry Statistic 2011

In general, conservation management activities include the protection of life support systems, the preservation of plants and animal diversity as well as their ecosystems. The basic principle of the forest conservation management is to differentiate it from other forest management activities especially about its precautionary principle in order to avoid changes to its original condition

The precautionary principle was to maintain the nature carrying capacity as a life support and to maintain the biodiversity of natural capital stock. Therefore, the rules in conservation area management more or less mention about the restrictions to as little of modification as possible.

In practical terms, conservation area management uses a space division approach or area division known as the concept of zoning and block. Every zone reflects the purpose and the condition of ecological, social, economic, and cultural communities. Special attention is given to areas that are considered to have exceptional ecological condition, especially due to the existence of flora and fauna that is endemic, rare, protected, and endangered. Consideration of physical condition that is also a concern is morphology (height, slope, etc), uniqueness, landscape, and others. From that identification process with the emphasis on that specific area, the area is divided into several zones or block, each have one or more sub-objectives, definitions, descriptions, and management principles. Zoning will direct forms of action and investment activity according to the zones.

Therefore, it can be said that the zoning or blocking division in conservation area is a translation of the concept and objective of management action to become a guide of conservation management activities.

Based on recent data, 521 conservation area units, there are 47 conservation area units that are still not establishing the zoning arrangement. References for zones or block arrangement for new conservation are in Indonesia are only available for national parks (Ministry Law P.56/Menhut-II/2006 about Park Zoning Guidelines). For other conservation areas, until now it refers to PHKA Director General No.2.688/IV-KK/2007 on July 16th 2007 about Zone Management and NSA/NCA. In the letter, it stated:

1. The term block in natural recreational parks and the botanical garden is replaced with the term zone
2. Natural Reserve and Wildlife Preserve organized into a core zone, protection zone, and other zones if needed
3. Natural recreational parks are organized into protection zone and other zone if needed
4. Botanical garden are organized into the protection zone, utilization zone, collection zone, and other zone if needed

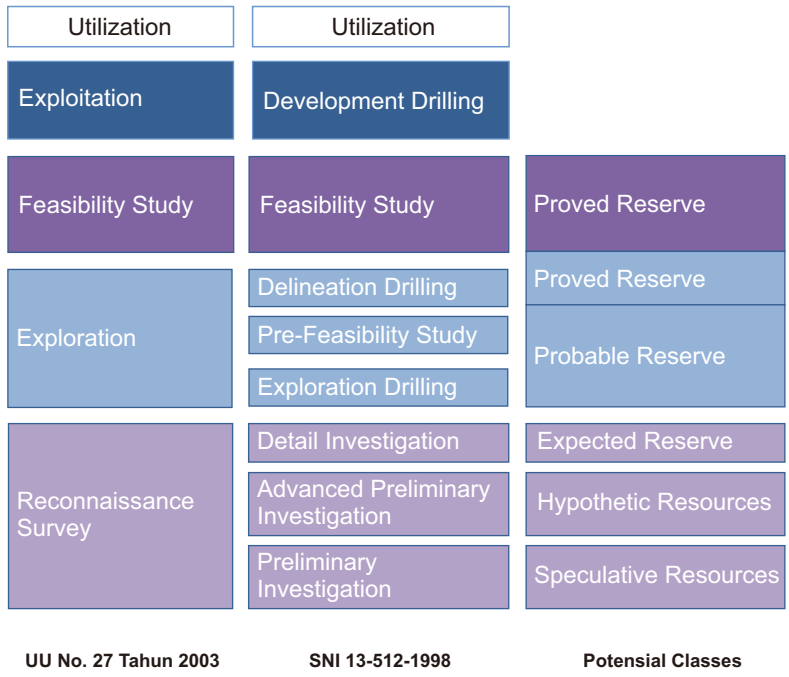
[13]Carrying capacity in ecology is defined by Colinvaoux (1986) as the maximum number of individual elements of biodiversity that can still be guaranteed a good life in a certain environment. In each species ecology means the system as an environment for other species, so that the environment itself is a relationship of interdependence between species were added to the physical element.

2.3. Geothermal Exploitation Framework

Geothermal in Law No.27/2003 is defined as a source of heat energy contained in the hot water, water vapor and rocks with minerals and other gases, which are genetically all can not be separated in a geothermal system and for it utilization mining is required. The utilization of geothermal energy is a series of activities from finding the source of geothermal to utilizing it, either directly or indirectly.

The development of area that have a geothermal potential into a geothermal field that produces electrical energy need to go through several stages of activity. Based on law No.27/2003, stages for geothermal operational activities consist of: Preliminary Survey, Exploration, Feasibility Study, Exploitation and Utilization. Furthermore, most of the geothermal operations are stated as geothermal exploitation activities, such as: Exploration, Feasibility Study, and Utilization.

Image 7. Stages of Geothermal Development Activity



Source : Irsamukthi, 2012

In PP No.59/2003 about Geothermal Business Activity described in more detail about geothermal activities, which includes: Preliminary Survey, Determination and Auctions Work Area, Exploration, Feasibility Study, Exploitation, and Utilization. Meanwhile, in the Indonesian National Standard (SNI) are mentioned that the stages of geothermal development activities include: Preliminary Investigation (Reconnaissance Survey), Advance Investigation, Detailed Investigation. Drilling Exploration (Wildcat), Pre-Feasibility Study, Delineation Drilling, Feasibility Study, Geothermal Drilling Development and Utilization.[14]

[14] http://irsamukhti.blogspot.com/2012/09/tahapan-kegiatan-pengembangan-geothermal.html

Referring to SNI 12-5012-1998 output of each phase of geothermal activity is as follows :

Table 3. Geothermal Development Activities Output

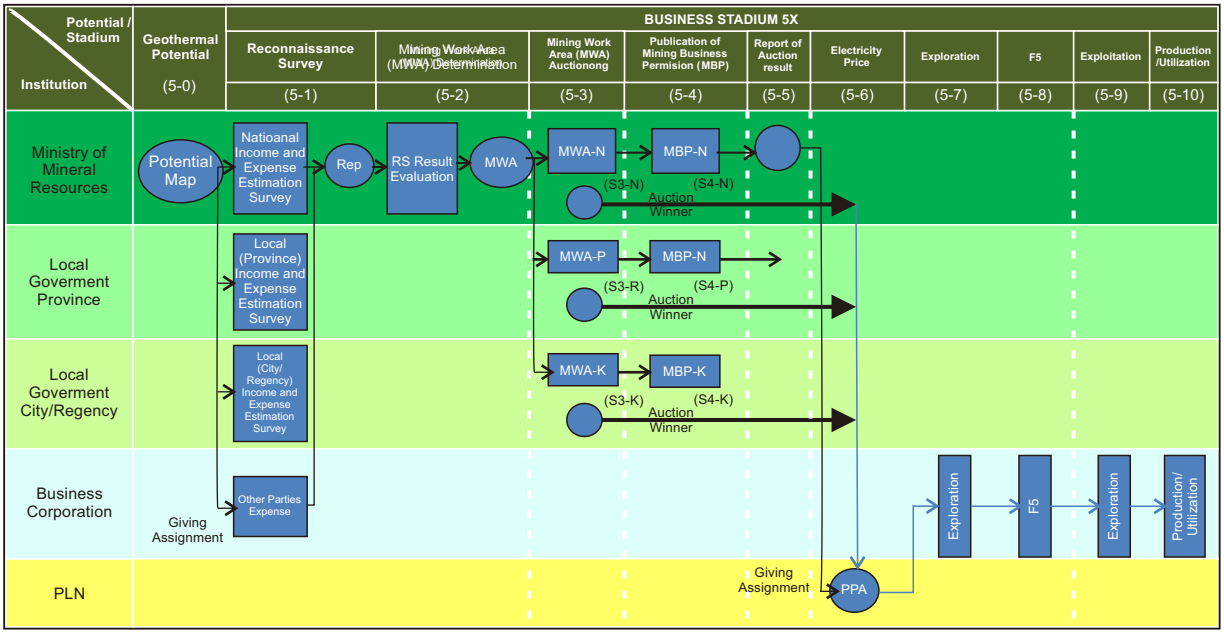
Phases of Activity	*Output*
Reconnainse Survey	1. Review Geilogical Map and Manifestation Distribution 2. Fluid Temperature at Surface 3. Sub-surface Temperature (estimation) 4. Speculative Resource Potential
Advanced Investigation	1. Preliminary Geolocal Map 2. a) Chemistry element anomaly Map b) Fluid Type c) Geothermal System 3. Geophysical map 4. Hydrogeological map 5. Hypothesis Resource map
Detail Investigation	1. a) Detail Geological map b) Alterlation zona map c) Geolocal structure map d) Geolocal hazard inditification map 2. a) Chemistry anomaly map b) Hydrologi model 3. a) Anomaly map and vertical section of rock physical characteristic b) Rock Physical Characteristic & fluid from thermal gradient well 4. Thermal Gradient well 5. Tentative geothermal model 6. Recommendation for Exporation Drilling location spot 7. "Expected reserve" potential
Eksploration Drilling (*Wildcat*)	1. Eksploration Drilling 2. a) Sub-surFace Geolocal model b) Alteration zona 3. Physical and chemical characteristic of well 4. Tentative geotermal model 5. Exploration well potential
Pre-Feasibility Study	1. a) "probable reserve" protentail b) direct or indirect use 2. Development Planning
Delinaetion Drilling	1. Delinaetion well 2. Geothermal model 3. Well potential 4. Reservior Characteristic
Feasibility Study	1. "Proved reserve" potential 2. a) Production and injectionwell disign b) Production well piping disign c) Power plant system disign 3. Feasible or infeasible to develop
Devolopment Drilling	1. Development well 2. Geothermal field production capacity

Source : Irsamukthi, 2012

[15] http://irsamukhti.blogspot.com/2012/09/tahapan-kegiatan-pengembangan-geothermal.html

In the current regulation, the geothermal exploitation involves various parties, from the central government, provincial, and local governments, developers, and other parties. In that process, the role or involvement of local communities in the process of the geothermal exploitation is not seen.

Image 8. Several Parties Involvement in Geothermal Business Process



Source : Directorate General of New and Renewable Energy and Energy Conservation, 2010

Foto: ©Moving Images/ NL Agency

2.4. Potential Geothermal Resources in Forest Area

Geothermal potential in the forest area in 2010 was 16,228 MW in 124 points. In detail, 41 potential points are in the area of Conservation Forest with a potential of 5,935 MW, 46 potential points in Protected Forest (6,623 MW), and 37 potential points in Production Forest (3,670 MW). Overall, the potential geothermal in forest area reaches 57 percent of the total of potential geothermal in Indonesia.

Table 4. Geothermal Potential Distributions in Indonesian Forest Area

No	Area Inauguration Process	GP	WS	NP	NTP	HP	BFP	Total
1	After Determination	61	17	16	26	3	13	136
2	After B5N5	44	20		20	4	2	90
3	After agreement, B5N5 not yet finished	41	12	6	27	3	1	90
4	In the process of boundary system determination	45	9	24	9	2		89
5	Boundary system determination not yet created	54	17	4	34	1	6	116
		245	75	50	116	13	22	521

Information :
BSNS : Boundary System News Events
GP : Game Preservation
WS : Wildlife Sanctuary
NP : National Park
NTP : Nature Tourism park
HP : Hunting park
BFP : Botanical Garden Park

Source : Directorate General of New and Renewable Energy and Energy Conservation, 2010

Until now, geothermal development operations that have in production are in 5 regions with the total of 566,333.74 hectares of land uses, which include 340,803.38 ha (60.18 percent) in other area, 51,768.99 ha (9,14 ha) in Conservation Forest 127,166.67 ha (22.45 percent) in the Protected Forest, 3,758 ha (0.66 percent) in Production Forest and 42,836.21 ha (7.56 percent) in Limited Production Forest.

Table 5. Producing Geothermal Mining Work Areas in Indonesia

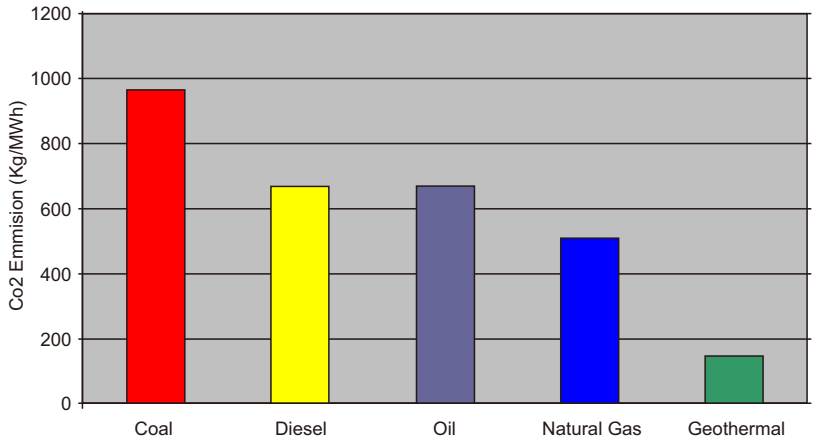
No.	Name of mining work area MWA	Location	LAND USE (Ha)					
			Other	Conservation Forest	Protection Forest	Production Forest	Limited Prodution Forest	Water Body
1	Gunung Salak	G. Salak, Sukabumi, Jabar	6,326.11	17,242.60	19,077.20	2,399.62	1,431.48	310.31
2	PGE DTT Dieng	G. Prahu Dieng, Jateng	70,878.14	58.51	7,522.81	854.86	33,553.13	
3	PGE Kamojang/Darajat/ Papandayan	Papandayan, Cikuray, Jabar	105,987.29	14,222.39	32,474.83	246.43		
4	PGE Lahendong	Tompaso, Tomohon, Sulut	80,695.96	1,658.36	12,124.43		7,033.91	4,789.35
5	PGE Pangalengan/ Wayang Windu	Patuha, Papandayan, Malabar, Jabar	76,915.88	18,587.13	55,967.40	257.57	817.69	184.86

2.5. The Effect of Geothermal Operation to Forest

Geothermal energy is a renewable energy source that is environmentally friendly, because carbon emissions produced are very low with smaller openings area when compared to other fossil fuel type, such as coal, oil, and gas

Meskipun fakta panas bumi

Image 9. Co2 Emission Comparisons from Several Source of Energy



Source : Intergovernmental Panel on Climate Change (IPCC) Report and Indonesia First Communication on Climate Change Convention, Presentation of Dr. Ir. Nenny Miryani Saptadji, "Environmental Issues form Geothermal Development".

Despite the fact that geothermal produces lower emissions, there are different opinions about the exploitation of geothermal energy. Proponents of geothermal assume no serious implications on the development of geothermal energy to the preservation of forest ecosystem or biodiversity. The reason, geothermal plants only need a small area to put some well. One well need open space of no more than 0.2 ha of land with 4-5 wells in it. Disturbing activities are during the drilling of new wells that need less than 1 ha of land clearing and opening the access road to the drilling location for the mobilization of equipment. Drilling a well could take 20-30 days. After that, the cleared land can be restored instantly.

Meanwhile, conservationists still see geothermal activity in forest areas are risking the sustainability of forest ecosystems for various reasons. Namely:

1. Installing drilling rig and all equipment requiring the construction of access roads and drilling pads. This operation will change the surface morphology (platform) and may damage vegetation and affect wildlife structures habitat.
2. Uncontrolled release of steam (blowout) can contaminate surface water.
3. Installation of geothermal carrier pipe and construction of geothermal power plants also require land clearing, which will affect the structure of the vegetation and wildlife habitat, as well as the surface morphology.

4. The geothermal fluid (steam or hot water) usually contains gases such as carbon dioxide (CO_2), hydrogen sulphide (H_2S), ammonia (NH_3), methane (CH_4), and a number of other gases, as well as dissolved chemicals. For example, sodium chloride (NaCl), boron (B), arsenic (As), and mercury (Hg), is a source of pollution when discharged into the environment.
5. Wastewater from a geothermal plant is also higher than the environmental temperature. Plant and animal organisms which sensitive to temperature variations could gradually disappear, and lead fish species without a food source. Increased water temperature can also interfere with the development of the eggs of other fish species. If the fish is eaten and utilised by fisherman communities, the loss of the fish will have a significant impact on the society.
6. Extraction of large amounts of fluid from geothermal reservoirs can cause land subsidence phenomenon slowly.
7. Reinjection of geothermal fluid can trigger or increase the frequency of earthquakes in particular areas. The threat of earthquakes associated with geothermal operations can cause landslides, such as occurred in the area of the River Full, Kerinci District, Jambi Province in January 2013.
8. Noise that exceeds the threshold due to geothermal plants operation could be a problem at the time of drilling and production.

From the larger scale and long term development perspective, taking into account the ever-increasing energy needs and significant impacts from the use of fossil energy, the effort to utilise geothermal energy can be regarded as a strategic alternative. However, on a local scale, especially if the exploitation of geothermal energy is done in locations classified as ecologically important, then a number of requirements must be applied to ensure the ecological disturbance still under the threshold. It can be done as long as geothermal exploitation able to internalise the ecological considerations in its operations.

2.6 The Situation about Geothermal Business Policy Issues in Indonesian Forest Area

Problems discussion in the utilisation of geothermal focus in forest conservation forests area. It caused five interlocked conditions, namely: 1) Most of the geothermal potential, either have not been explored, have been explored, will be exploited, has been exploited and exploited is in the conservation area; 2) Geothermal energy is seen as a commodity is obtained through mining activities; 3) Mining activities in forestry perspective categorised as area use outside the forestry sector interests that cannot be done within conservation area; 4) Utilisation in the conservation area are very limited which avoid clearing the area; and 5) The exploitation of geothermal resources led to the land clearing which is feared to affect the stability of the ecosystem.

In the sphere of government policy in the today's politics context, exploitation of geothermal resources in conservation forests will probably be done by a change in regulation level. Policy and regulatory constraints that has been the "obstacle" will likely be addressed through two options. First, change the laws and regulations in the energy sector, which directed to change the definition of geothermal energy as a non-commodity of mining. Second, categorize geothermal as a commodity of environmental services that can be internalised as one of the forestry commodities sector.

On the other hand, in the sphere of policy as an object of study, the formulation of policies for geothermal development in the forest area is fairly complex. In terms of substance, forest management covering many aspects, such as ecology, economics, engineering, management, and social. In terms of linkages and dependencies, including the allocation of spatial and inter-generative allocation, whereas in terms of actors include local communities, businesses, government, the public, consumers, communities and even the world (benefits beyond the boundary). In such complexity, the effectiveness of the policy will be determined by the interaction between policy makers and stakeholders. The interaction occurs correctly only in a participatory political culture. The involvement of stakeholders in policy formulation is essential to reduce the risk of conflict due to the negative impact of the implementation of the policy. If the policy itself has a consensus value, then the impact of emerging policy would be relatively simple to deal with.

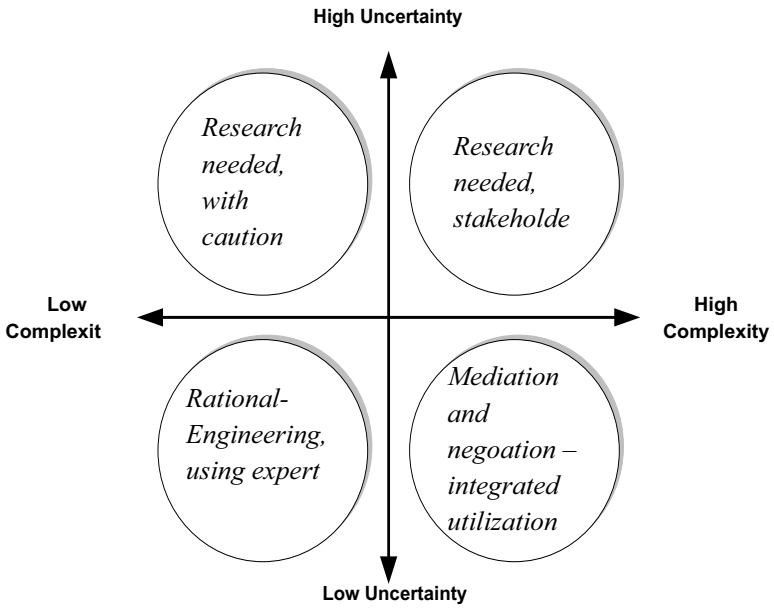
[16] Law no. 27 of 2003, Article 1, Paragraph 1, Geothermal energy is the source of heat contained in hot water, water vapor, and rocks with minerals and other gases that genetically can not be separated in a geothermal system and its utilization is required for the mining process. Law no. 27 of 2003, Article 1, Paragraph 7, Geothermal Mining Enterprises is a business that includes exploration activities, feasibility studies, and exploitation.

[17] Law no 41 of 1999, Article 24, Forest area utilization can be made to all forest areas except natural conservation forest as well as core zone and forest zone in national park. Article 38, Paragraph 1, Use of forest area use in the interest of development beyond forestry activities can only be made in production forest area and protected forest area. Government Regulation no 24 of 2010, Paragraph 2, The Regulation specifies non-forestry development activities, which include mining, water resource facilities and infrastructures, water installation networks, public facilities and clean water and waste water channels.

[18] Law No. 27 of 2003 about Geothermal has been included in National Legislation Program 2013.

In addition to the complexity of the problem, geothermal policy formulation in the forest area has an element of uncertainty due to limited data, information, and relevant knowledge. In fact, the effectiveness of one policy depends on access to the stock of knowledge, because the policy itself is knowledge that can be applied in the context of specific space and time. The level of availability of data, information, and knowledge shows the uncertainty situation faced in the policy formulation process. Some environmental experts said that this uncertainty is one of the characters in the environmental resource management policies. Data, information, and knowledge about the whole environmental resources cannot be obtained at once, but it will always appear after the management proceed. On the other hand, policies can often be made without waiting for necessary data, information, and knowledge to complete. The solution is, environmentalists and natural resources promote the application of the concept of adaptive management of environmental resources.

Image 10. Situations in Geothermal Policy Formulation in Forest Areas and Guide Approach in Policy Making



Judging from above conditions, the problems in the policy-making process is a combination of the level of complexity of the problems and the uncertainty faced. The combination determines the situation encountered in the formulation of policies as well as directing how policy formulation should be done, including in the policy-making process of geothermal exploitation in forest area.

1. The complexity of Geothermal Business in Forest Area from Several Interest Perspective

Considering the variation of interest and maps of sectorial actors, exploitation of geothermal resources in the forest area is fairly complex. Observations of several multi-stakeholder meeting obtained some findings as follows:

a. Interest of Forestry Sector Development

Despite policy constraints, the forestry sector turned out has great hopes on geothermal exploitation in forest areas. The authorities in the forestry sector have projected geothermal utilisation as part of the operations under the forestry sector authority. In the Crop Forest-Based Forest Development Road Map and National Park 2011-2030 mentioned, geothermal will be one of the "booster" forestry sector's contributions to national GDP. Correspondingly, the National Forestry Plan 2011-2030, geothermal is a commodity of environmental service that will be an important part in the development of forestry scenario the next 20 years.

b. Interest of Natural Resources Conservation

The complexity of the problem in the policy formulation of geothermal resources utilisation in the Indonesian forests is the differences of interest. The utilisations of geothermal resources as a source of clean energy and environmentally friendly perceived has an important role in supporting national energy security and reduce carbon emissions that lead to global warming and climate change. The largest forest carbon storage and biodiversity habitat also become the reason why its existence needs to be maintained and preserved.

c. Interest of Energy Sector Development

Based on Presidential Regulation No. 5/2006, the National Energy Policy aims to realize the security of energy supply in the country, where one goal is to achieve an optimal energy mix in 2025. Role of geothermal energy is projected to more than 5 percent of the total national (primary) energy supply. Then, in the framework of the Accelerated Development Programme of 10,000 MW Power Plant Phase II, as per Presidential Decree No. 4/2010, the planned development of geothermal energy by the year 2014 amounted for 4,925 MW. In this regard, the Ministry of Energy and Mineral Resources has full authority and responsibility to achieve that target. Geothermal potential is mostly associated with forest areas that clearly need coordination between sectors in its utilisation.

IPCC Report about Land use, change of Land use and forestry calculate more than 1 Ha forest area in good condition can absorb more than 8 ton Carbon and prevent emission 29.36 t CO_2.

d. Interest of Regional Development

In the context of regional autonomy, in accordance with Law No. 32/2004 on Regional Autonomy, the authority of local government, one of which is to improve the welfare of society according to the conditions, peculiarities, and the potential in the regions involved. Local governments are also required to take care of environmental issues. In this case, any local government should ensures that geothermal energy utilisation in the administrative region may contribute significantly to the increase in local revenues in order to improve the welfare of local societies. Simultaneously, local governments are also required to control the environment to avoid the harmful environmental impacts of development activities.

e. Business Interest in Geothermal Resources Development

From the perspective of the geothermal developers and practitioners, geothermal are neither environmental services commodities nor mining, but the energy commodities. In terms of regulation, geothermal employers encourage the legal status clarity of geothermal working areas in forest conservation, the smoothness of permit procedures, clarity of rules regarding the obligations that must be met, and other issues related to governance in relation to business certainty based on geothermal energy development in forest areas.

f. Socioeconomic and Culture Interest

Local people will always be the group that potentially most affected by an investment program or project, both positive and negative impacts. The presence of geothermal concessions in forest areas will certainly affect the relationship between people and forests that have been take place. This relationship not only socio-economic nature, but often also a spiritual relationship, which is characterized by a local cultural phenomenon. One important issue is the "tenure", that land ownership is based on a formal claim is not always in line with the tenure system prevailing in a society, particularly the indigenous communities that live long or hereditary in a region.

[20]Law no 32 of 2004 about Regional Autonomy, Article 13 and 14.

2. The Uncertainty of Geothermal Utilization in Forest Area

Uncertainty geothermal concessions in forest areas emerged from the two sides, both in terms of operational of geothermal energy utilisation as well as the forest management. Characteristics of activities from geothermal resources utilisation are not static, but dynamic. In the long run there is always a need to drill additional wells to maintain steam supply. Experience in Indonesia, a decrease in the supply of geothermal steam (steam depletion) in the geothermal field that has been operating within the range of 5-7 percent each year. It may happen; because of the geothermal reservoir conditions can change. It could also be due to geological conditions or reduction in reservoir management.

The understanding of geothermal experts towards a prospect or geothermal reservoirs is not obtained at once, but continually evolves over time and level of operations or exploration. The more accurate the data of sub-surface quality survey is known, the more accurate the information of geothermal reservoir location. It is then greatly influence the development of geothermal energy plans further. In that condition, the experts and developers of geothermal energy requires that the function of forests to be continuously evaluated and the changes of function should continue to at a point where the characteristics of the geothermal resources have been known as a whole. This is obviously inversely related to the logic of conservation (conservation management) that puts restrictions as a form of precautionary principle. Geothermal development in a forest area was should be stopped at one point where it considered at high risk for forest preservation. The question then, is the function of forests should adapt to the geothermal utilisation activities? Or conversely, geothermal exploitation must adapt to every function of forest area where the operation will be done?

The best-case example observed is in the operation of geothermal exploitation in the Taman Nasional Gunung Halimun Salak (TNGHS). Development of geothermal systems in TNGHS is water dominated geothermal systems,

PLTP di kawasan TNGHS.
Foto: ©Moving Images/ NL Agency.

in TNGHS is water dominated geothermal systems, which are the most common development system in Indonesia. On the other hand, TNGHS is a national park, one of the categories of protected areas and the most advanced in terms of management concepts and practices. Geothermal exploration wells in TNGHS first began in 1983, and then Units 1 and 2 began production in 1994. Upon operation of geothermal development in TNGHS started, understanding the characteristics of the geothermal reservoir (subsurface) of TNGHS continues to increase, and it is crucial for determining the optimisation strategy of geothermal resources in TNGHS, where the next wells will be drilled, which production facilities and where that will be built, where the power plant will be put, and others.

A similar case occurred in Kamojang Nature Reservation and Nature Recreational Park and its surrounding protected forests. There, the geothermal development operations are steam dominated geothermal systems which relatively rare, or perhaps the only one in Indonesia. Geothermal exploration in the conservation area is keep moving and it is unknown when it will meet its mature point. Everything that explained before affects the land clearing.

Construction of facilities to support the operational of geothermal resources utilisation in forest areas requiring land clearing that potentially disrupt habitat for many species of plants and animals. The disturbance does not occur only at a single point location, but scattered at several points in the forest, including the construction of access roads, steam pipes, electrical networks, and other infrastructure for the construction of geothermal power plants.

Construction of new roads and infrastructure are often abused by land seekers, illegal loggers, and forest encroachers to enter into a protected forest area. Opening up access frequently led to the emergence of regional exotic species that deliberately or accidentally introduced into the region, could even become dominant because of its invasive nature (invasive alien species). The incident has the potential to cause habitat fragmentation, raises barriers to the migration process

[21] Exotic species, in the Encyclopedia of Forestry Indonesia mentioned that a tree is considered exotic when the tree grows outside the native range. Exotic species may be detrimental to native flora or fauna. Most of the exotic plants which cause environmental problems is a plant that is introduced inadvertently. In the new habitat may be few predators or diseases that uncontrolled population growth are often called exotic invasive. Invasive exotic plant roots are extensive dominate over moisture and nutrient content of the soil so that plants grow faster and faster canopy closes vegetation underneath. Also because there are exotic plants that produce "allelopati" that are toxic to other vegetation thereby reducing biological diversity.

and cut the space for animal roaming, degrade and break the food supply chain (trophic network), reducing the ability of reproduction and survival of various protected, rare, and endangered species, as well reduce genetic inventory reserves, and so forth.

In terms of forest management, the uncertainty comes from three main aspects, namely 1) the legal status and procedures for geothermal exploitation permit in forest areas is still unclear; 2) the legal status and the actual area that is still not determined; and 3) Performance management is still weak. Legality of the entire forest area constituted by the Minister of Forestry Appointment Map. Some units, especially Perhutani and company, which has forest utilisation, rights (HPH) or Timber Forest Management Permit (IUPHHK) has translated the map into a larger-scale map. Meanwhile, conservation of forest management units under the Directorate General of Protection and Nature Conservation supervisory not implement the rules and have not had adequate direction for it. Protected areas still use partial designation/determination map and forest maps and small-scale water per province. Then, from the aspect of preconditions, there are many areas that have not completed the inaugural (read: delimitation). In actual, physical signs of the forest boundary on the ground is often unclear, the risk of claimed interest often lead to conflicts of land ownership.

Table 6. Area Inauguration progress of Indonesia Conservation Areas 2011

No	Area Inauguration Process	GP	WS	NP	NTP	HP	BFP	Total
1	After Datermination	61	17	16	26	3	13	136
2	After BSNS	44	20		20	4	2	90
3	After Agreement, BSNS Not Yet Finished	41	12	6	27	3	1	90
4	In the Process Boundary System Datermination	45	9	24	9	2		89
5	Boundary System Datermination Not Yet Created	54	17	4	34	1	6	116
		245	75	50	116	13	22	521

Information :
BSNS : Bourdary System News Event
GP : Game Preservation
WS : willlife Sunctuary
NP : National Park
NTP : Nature Tourism Park
HP : Hunting Park
BFP : Botalical Garden park

From the aspect of forest management performance, is not uncommon found in a forest area unit that did not reflect its function, due to ineffective management. Examples of cases in Bukit Barisan Selatan National Park, precisely in South Resort and Sekincau where the location was also chosen as one of the geothermal mining working area. The total area of both resorts was covering an area of 50,975 ha, and 29,707 ha turned into coffee plantations, cocoa, and a variety of other crops in which there are also public facilities such as schools, village offices, and others. It shows that status and functions of officially determined area may be different from the actual conditions.

2.7. Mindset about Geothermal Policy In Forest Area

Geothermal development policy in conservation forest area should be laid on two goals: 1) Preservation of functions in conservation forest area includes the conservation of genetic, species, and ecosystems; 2) Certainty of business development of geothermal resources. In policy formula, this goal is a policy outcome that must be achieved through a series of activities. In this effort there is always a delivery system in which policy is translated into policy programs with instruments designed to ensure the implementation of programs that simultaneously contribute to the achievement of objectives. One of the instrument needed is a practical guide or a complete guidelines that are technically reliable to ensure the entire series of geothermal operations in forest area give its eye to forest ecosystems.

For that purpose, WWF-Indonesia tries to concretely encourage the emergence of such instruments through the study of forest ecosystem sustainability in geothermal working areas in the form of a set of criteria and indicators. The final results of the study would be in the form of a guide to the forest ecosystem sustainability. Assessment process to produce a guide done by involving the parties through a series of activities, including focus group discussions, public consultation, discussions with experts, forestry practitioners, geothermal practitioners, and others.

Ecosystem sustainability guide for geothermal utilisation focused on biophysical aspects as a source indicator. Other aspects are also important in the geothermal energy utilisation in forest area is the legal and social aspects of an enabling condition or prerequisites that must be met first. Legal aspects include the legality of geothermal operations existence and the legality of its forest area. Meanwhile, the social aspects can be met with the application of the principle of free, prior and informed consent (FPIC), which is the principle that the public has the right to give or withhold consent to the proposed project that could have an impact on lands they owned, occupied, or used.

[22] The legality of forest area refers to the strengthening of the forest area which includes the designation of forest areas, mapping, boundary marking, and official report of boundaries, and the establishment of forest area.

FPIC principle has been long proposed by Forest Peoples Programme (FPP) and now has become the main principle in international law and jurisprudence related to indigenous peoples. Another problem in the social aspects that must be resolved first is the public acknowledgment regarding the limits, status, and function of forest area. In some places are often found in cases where a unit of forest area has been legally established, but in fact claims from society is still happens.

[23] FPP. Free, Prior and Informed Consent. http://www.forestpeoples.org/guiding-principles/free-prior-and-informed-consent-fpic.

Table 7. Synergy of Forest Ecosystem Sustainability Interest and Geothermal Activity in Forest Area

Phases of Activity		Output	
UU No. 27 Tahun 2003	SNI 13-5012-1998	Geothermal Development Interests	Forest Ecology Preservation Interests
Preliminary	*Reconnainse Survey*	1. Review geological map and manisfestation distribution 2. Fluid temparature at surface 3. Sub-surface temperature (estimation) 4. Speculative Resource Potensial	1. Forest Area Map 2. Forest management zonation/block 3. Forest resource potensial (spatial and non-spatial) 4. Classes of forest area coverage
	Advanced Investigation	1. Preliminary geological map 2. a) Chemistry element anomaly map b) Fluid Type c) Geothermal system 3. Geophysical map 4. Hydrogeological map 5. Hypothesis Resource Map	1. Forest land physiography map 2. Forest area hydrology map 3. Land map 4. Complete list and distribution of biodiversity 5. Significant species list 6. Distribution and population of significant species 7. Significant species habitat
	Detail Investigation	1. a) Detail geological map b) Alteration zone map c) Geological structure map d) Geological hazard identification map 2. a) Chemistry anomaly map b) Hydrology model 3. a) Anomaly map and vertical section of rock physical characteristic b) Rock physical characteristic & fluid from thermal gradient well 4. Thermal gradient well 5. Tentative geothermal model 6. Recommendation for exprolation drilling location spot 7. "Expected reserve" potential	1. Classes of land area physical sensitive(spatial and non-spatial) 2. Classes of land area biological sensitive (spatial and non-spatial) 3. Distribution of forest ecosystem typology variation according to ecological aspect based on ecosystem bio-physical characteristic (spatial and non-spatial). 4. Geothermal exploration activities position on forest area based on zone/block and forest ecosystem bio-physical typology 5. Forest protection plan based on ecosystem from geothermal exploration activity

(Next) **Table 7.**

Phases of Activity		Output	
UU No. 27 Tahun 2003	SNI 13-5012-1998	Geothermal Development Interests	Forest Ecology Preservation Interests
Exploration	Exploration Drilling *Wildcat*	1. Exploration drilling 2. a) Sub-surface geological model b) Alteration zone 3. Physical and chemical characteristic of well 4. Tentative geothermal model 5. Exploration well potential	1. Monitoring result of exploration activity effect towards area physical condition 2. Monitoring result of exploration activity effect towards area biological condition 3. Exploration activity effect towards forest ecosystem ecology function
	Pre-Feasibilty Study	1. a) "Probable Reserve" Potential b) Direct or indirect use 2. Development Planning	1. Level of geothermal exploitation and utilization activity effect 2. Forest protection pland based on ecosystem
	Delineation Drilling	1. Delineation well 2. Geothermal model 3. Well potential 4. Reservoir characteristic	1. Site plan of geothermal exploitation and utilization activty effect 2. Geothermal exploration activities position on forest area based on zone/block and forest ecosystem bio-physical typology
(Feasibility Study)	(Feasibility Study)	1. "Proved Reserve" potensial 2. a) Production and injection well design b) Production well piping design c) Power plant system design 3. Feasible or infeasible to develop	1. Feasibilty of geothermal business activity (feasible or infeasible) is implemeted in forest area from forest ecological aspect 2. If feasible : Ecosystem management activity design (ecosystem protection that is still good condition, protection of on-progress succesion process restoration in order to accelerate nature succesion and degradated area recovery 3. "Extraordinary activity" design, such as: development of wildlife adventure corridor, second habitat establishment, relocation, restoration,etc.
Exploitation	Development Drilling	1. Development well 2. Geothermal field production capacity	Construction of all main and supporting facilities for exploitation and utilization not create ecosystem ecology function degradation.
Utilization		1. Construction of Geothermal Power Plant, (GPP) main facilities (wellpad, piping, separator, switchyard, etc. 2. Construction of production supporting facilities (road, office, etc.)	

2.8 Several Environmental Sustainability Framework

Before entering the guide formulation stage, first note that some instruments are often used for various purposes, which essentially lead on ensuring environmental sustainability. Where the position of the guide to the instruments? Some of these are as follows:

1. Environmental Impact Analysis (AMDAL)

Environmental Impact Assessment or EIA is categorised into three types according the intensity and level of development proposed, namely:
·Integrated EIA Activity/multisector, significant impacts of a business or integrated activities on the environment in which a project plan/activities located in a single ecosystem and also involve more than one government authorities.
·Areal EIA, significant impacts of a project plan/integrated activity in a single ecosystem type, under the authority of a government agency.
·Regional EIA, significant impacts of a project plan/integrated activities proposed in a single ecosystem types in the area of development planning, which involves more than one authorised agency as part of the decision-making process.

In this instrument, a significant impact is defined as a fundamental change to the environment due to a business or activity. The significance of the impact is determined 7 parameters, namely:
·The number of people affected,
·The extent of the impact,
·Duration of the impact,
·The intensity of the impact,
·How many environmental components affected,
·The cumulative nature of the impact,
·The impact that can be recovered or cannot be recovered.

Types of businesses and activities that can have significant impact on the environment are grouped into 14 sectors and 84 activities. Details of activities and scale are announced in Minister of Environment Decree No. Kep-11/Menlh/3/1994 on the types of businesses or activities that require an environmental impact assessment which was then revised by Decree of the Minister of Environment No. 17/2001 on the types of businesses or activities that require an environmental impact

assessment. Environmental Impact Report is referred to ANDAL, which is a detailed, and in-depth research studies on the impact of a project or activity is important. Then, management and monitoring plan must be prepared to manage and monitor the significant impact of the project plan and activities. Environmental Management Plan referred to as RKL and Environmental Monitoring Plan called RPL.

Based on Minister of Environment Regulation No. 05 of 2012 on Business and/or activities that must have EIA, geothermal exploitation activities which are obliged to have EIA is activities with a working area more than 200 ha, open space area of over 50 hectares, the development of geothermal steam and/or development of power plant bigger than 55 MW, or the construction of electricity transmission lines over 150 kV. For the operation of geothermal activity below the threshold does not require an EIA, but still have to make Environmental Management Program (UKL) and Environmental Monitoring Plan (UPL) according to the procedures set forth in the Decree of the Minister of the Environment No. 86/2002 on Guidelines for UKL and UPL.

EIA instrument is more positioned as a requirement for licensing, but give less attention to aspects of performance assessment, when the activities have been proceeding. Nevertheless, the EIA results are very useful as a baseline that can be used by other instruments that are made in the context of performance appraisal.

2. High Conservation Values Forest Assessment

Assessment to identify areas of high conservation value forests, known as HCVFs (High Conservation Value Forests) developed by the Forest Stewardship Council (FSC) and published in 1999. Key to the concept of HCVFs is to identify high conservation values (HCVs). In the guide on how to identify, manage, and monitor forests with high conservation value forests is explained that high conservation value forest areas have one or more characteristics of the definition as follows:

- HCV1: Forest areas that have concentrations of biodiversity values that are important globally, regionally, and locally, such as endemic species, endangered species, places to save themselves (refugee), etc.

[24] Principal and Criteria of FSC (2003) in toolkit for forest management and related stakeholders to identify, manage and monitor the High Conservation Value (HCF) Forest.

- HCV2: Forest areas that have a broad landscape level that is important globally, regionally, and locally which are in or have a management unit, where most or all of the species that naturally exist in the region are in the patterns of natural distribution and abundance.
- HCV3: Forest areas that are in or have rare, threatened, or endangered ecosystems.
- HCV4: Forests that serves as a natural regulator in critical situations, such as watershed protection, erosion control, etc.

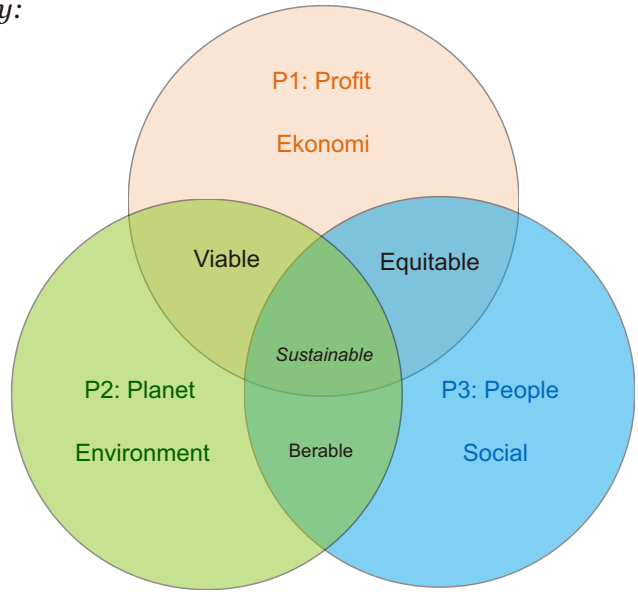
  HCV5: Forest areas that are essential to meeting basic needs of local communities, e.g. basic needs, health, etc.
- HCV6: Forest areas that are critical to local communities' traditional cultural identity, such as cultural, ecological, economic, and religious areas which significance are identified with the local communities involved.

3. Certification of Sustainable Forest Management

There are several forest certification schemes that are currently running and can be grouped in mandatory and voluntary schemes, as follows:
a)Mandatory forest management certification schemes for Sustainable Forest Management (SFM) are regulated through Minister of Forestry Regulation No.38/Menhut-II/2009, Financial Monitory Agency Directorate General Regulation No. P.6/VI-Set/2009, and Financial Monitory Agency Directorate General Regulation No.P.02/VI-BPPHH/2010. Mandatory scheme developed in Indonesia was established together with the International Tropical Timber Organisation (ITTO).
b)Voluntary forest certification schemes that have been recognised and implemented in the field is quite diverse, either developed as national, regional, and international levels initiative. Some forest certification schemes include:
·FSC (Forest Stewardship Council)
·PEFC (Pan-European Forest Certification)
·CSA (Canada's National Sustainable Forest Management Standard)
·SFI (Sustainable Forest Initiative)
·American Tree Farm System
·LEI (Lembaga Ekolabel Indonesia/Indonesian Ecolabel Agency)

4. Triple Bottom Line Sustainability Framework and Sustainability Reporting

The concept of the Triple Bottom Line (TBL) is a framework for calculating performance measurements carried out in three dimensions, namely social, environmental, and financial. The dimensions of the TBL are also popularly known as 3P: People, Planet, and Profit. Performance measurement on the profit dimension can be made relatively simpler by looking at an investment rate of profit in the monetary size. However, measurement of performance to social and environmental (ecology) dimensions will be more difficult, due to variations in conditions and social and environmental situation in each place where the measurements will be performed. That led to the absence of a universal standard for the measurement of TBL. The views are just the same experts on two principles, namely:



1) How the activities of an organization affect the "social welfare" for measuring the social dimension

2) How does it affect the activities of "environmental health" for measuring performance on the environmental dimension? Meanwhile, further performance analysis will require a set of indicators for each dimension, and these indicators are specific

Accuracy of the indicator establishment is very dependent on the determination of stakeholders and experts involved, as well as the ability to develop baseline data. From the baseline then environmental quality standards approach is developed (for environmental dimensions) and the comparison index (for the social dimension) to corresponding social environment variables and that is considered important to a location and case.

TBL framework is further developed for sustainability reporting, which is a framework for reporting on economic, environmental, and social policies, as well as the impact and performance of an organization and the results in the context of sustainable development. Sustainable Reporting are promoted and developed by the Global Reporting Initiative (GRI).

In general, sustainability reporting provides a framework that can be used by many organizations in the world to measure and report their sustainability performance in a transparent and accountable ways. It was seen from the four key criteria of sustainability, namely economic, environmental, social, and governance.

The guide of forest ecosystem sustainability in geothermal working areas has close links with these instruments. This guide will adapt some of the parameters used in other appropriate instruments. However, unlike the others, this guide is specifically designed to be an integrated part of the operational management of geothermal utilisation and forest management. Furthermore, this guide will also promote environmental management scenarios that can be measured, reported and verified.

[25] Non-Profit Organization that work for sustainable economic development with providing a guidance for sustainable reporting.

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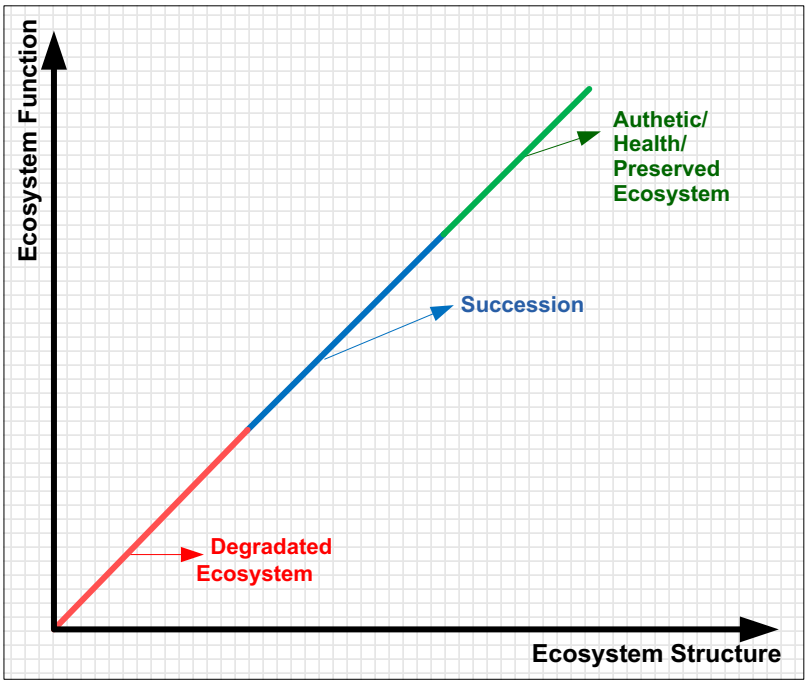
III. BASELINE AND TYPOLOGY OF FOREST ECOSYSTEMS

3.1 Framework of Baseline Preparation and Typology of Forest Ecosystem

Geothermal working areas or so-called WKP usually cover quite a broad area, which is very likely consist of land mosaics with different biophysical characteristics. Despite its broad area, the actual utilized are for geothermal operations is generally only about 1 percent of its WKP area. A unit of geothermal working areas can operate in areas with varying biophysical conditions. The actual conditions of forest ecosystems that will become geothermal working areas were not always in good condition or not reflect its original condition. It could be that the location is in a degraded state or in a successional stage, having previously disturbed naturally or due to human activities. Information on the biophysical variations, actual conditions, and original condition ecosystem profile (reference ecosystem) is required as a source of knowledge to make a decision on how geothermal project should be implemented in a location.

These considerations also serve as a guide in the preparation of this guide, which preservation guide of forest ecosystems in geothermal working areas should be applicable to variety of forest conditions. Thus, it requires the stipulation of the typology of the forest ecosystems that targets geothermal resources utilization to classify forest based on ecosystem components. Typology must be able to represent the entire state of forest ecosystems, but in the preparation it should be made as simple as possible to be easily understood.

Image 11. Diagram of the Possibility of Ecosystem Condition in Forest in Geothermal Working Area



Stipulation of forest ecosystem typology based on ecological aspects performed using a baseline approach that is placed on ecosystem health and function of the ecosystem structure. Baseline health of the ecosystem is the basic condition of the forest ecosystem information collected before the geothermal project begins and will be used as a comparison for defining the actual conditions, as well as projecting or estimating the effects of any geothermal project activities on the condition of the forest ecosystem.

In general, there will be three possible directions of ecosystem management, namely

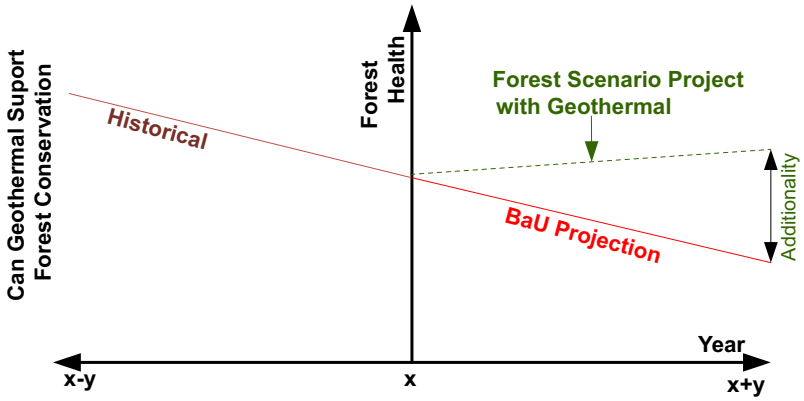
1) Ecosystem management that lead to the efforts of maintain the actual condition if the actual condition of the ecosystem is healthy.

2) Ecosystem management efforts directed at maintaining or accelerating current succession process if the actual condition of the ecosystem is under natural succession.

3) Management of the ecosystem that is geared to the rehabilitation or restoration if the actual state of the ecosystem is degraded.

The presence of geothermal utilization unit in forest area is expected to improve the performance of ecosystem management. It deals with aspects of additionality, i.e. how the existence of geothermal utilization can contribute to the efforts of maintaining sustainability of forest ecosystems in good condition, repair degraded forest ecosystems, and or maintain the current succession process. This additionality aspect is an additional benefit compared to forest management in the business as usual (BAU) schemes in the absence of geothermal exploitation.

Image 12. **Illustrations for Preparation of Forest Ecosystem Management Baseline**



3.2 Forest Ecological Aspects

Forest as an ecosystem can be perceived as a community of diverse types of organisms in an ecosystem. Which community does the physical environment affect, which together form the ecosystem. Communities in the relatively stable physical environment, such as in tropical forests have higher species diversity than the communities affected by the unstable physical environment or frequently disturbed. Stable environment ensure the success of an organism's adaptation and enabling sustainable evolution compared to unstable or disturbed environment (Odum, 1985).

Therefore, efforts to understand the characteristics of ecosystem's ecological aspects can simply be seen from the biological and physical characteristics. Biological characteristics of ecosystem are usually seen from its biodiversity as well as the existence of important fauna and flora (endemic, rare, and endangered). The physical characteristics of the ecosystem can be seen from land cover, land physiographic (landform, altitude, slope, and land systems), land, water, and air.

3.2.1. Ecosystem Biological Characteristics

Biological characteristics of an ecosystem unit indicated by variety of things. For example, the level of biological diversity and the existence of certain species, habitat types, and others, which is one of important measure of sustainability.

1. Biodiversity

In the document of "Indonesian Biodiversity Strategy and Action Plan 2003", the meaning or definition of biodiversity includes the following aspects

- Biodiversity is the term used to describe the diversity of life forms on earth, the interactions between the various living beings as well as between them and the environment
- Biodiversity encompasses all forms of life on earth, ranging from simple creatures such as fungi and bacteria up to being who able to think like humans
- Biodiversity is the ecological functions or natural service, a service that generated by one species and/or ecosystem (living space) that provide benefits to other species, including humans (McAllister, 1998); Biodiversity refers to the overall aspect of the life support systems, which include social, economic and environmental, and ethical aspects of knowledge systems, and the relation between the various aspects of this
- Knowledge systems and cultural diversity of society is also closely linked to biodiversity.
  There are three levels of biodiversity are often used, the level of genetic diversity, the type (species), and the ecosystem. Here is the definition for each level

- Genetical diversity
  The diversity among individuals of one another, which is still within one species. It is due to variations in the composition or structure of the gene (DNA) in each individual, even though they are a single species in the world so that no living being exactly the same. For example, the variation in the species of chicken (Gallus gallus), which includes black chicken cemani, white bangkok, arabic, and ayam kampung.
- Species diversity
  The diversity of different individual species. It shows the variation of the shape, appearance, and other properties of the variation between species with each other. For example, variations in various species of birds such as chickens, ducks, ducks, geese, and others.

[26] Summarize from Indonesia Biodiversity Strategy and Action Plan (IBSAP) 2003

[27] http://biology-community.blogspot.com/2012/09/keanekaragaman-hayati.html

- Ecosystem diversity
  Organism is diverse in shape, appearance, and its other properties interact with the abiotic environment and with other types of organisms. The interaction will form a wide variety of ecosystems that make up the diversity of ecosystems. In Indonesia, the diversity of the ecosystem reaches 47 different ecosystems.

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This guide will put species diversity as a focus of attention in measuring biodiversity on the grounds that species diversity can be an indicator of ecosystem health. Information about the biodiversity of an area is usually the comparison of species diversity from one place to another place. Quantitative index of biodiversity can be analyzed in several ways, namely:

- Alpha diversity (α), the average number of plant species in a community or ecosystem, which often referred as ecosystem species richness. Alpha diversity values indicate geographic diversity on a scale that is local and can be determined by calculating the average number of plant species in a community or ecosystem of a forest ecosystem unit.
- Gamma diversity (γ), the number of plant species in a wider regional scale. For the application of ecosystem management in a forest ecosystem unit, gamma diversity is the number of plant species in an ecosystem that combined from few parts in a forest management unit.

- Beta diversity (β), the value of diversity that describes the level of change in species composition that includes a wide area in the landscape scale. Beta diversity values determined by counting the number of plant species which a combination of some of the same community in the region. Bet diversity linking alpha and gamma diversity, calculated by dividing the value of gamma to alpha diversity values.

Measurement of species diversity generally uses an index, a single value that describes a situation in a simple way. Practically, if we did a survey at several locations, then the index value can be compared to determine how differences in diversity at each location. Some species diversity indices are commonly used, such as species richness index (Margalef's index), Shannon's index, and Simpson index.

Although there are several indices concerning species richness, Margalef's index is the simplest. However, this index is not taken into account the proportion of species abundance.

Table 8. Diversity Index

Species Indeks	Formula	Information
Margalef's index	$D_m=(S-1)/\ln N$	• Dm: *Diversity*, • S: Species amount, • N: Individual total amounts of all species in sample
Shannon's index	$H' = -\sum pi \ln p1$	• H': Index Value of Shannon-Wiener • *Pi* : Proportion of every species i • H': is all pi ln pi amount for all species in community • If community only has 1 species , so H'=0 • The higher of H' value indicates the higher of species amount and the higher of it's relativity abundance Shannon index value is usually rangee between 1.5-3.5 and rarely get closed to 4.5
	$E= H'/H_{max}=H'/Ln\ S$	• Although Shannon-Wiener's index already involves evenness in it's calculation, evennesscan be calculated using H max value (maximum diversity) • E= Evenness
Simpson index	$D= \sum \frac{(n_i\ (ni-_1)}{N(N-1)}$	• ni: Individu amount in one species • N: Individu total amounts of all species in sample

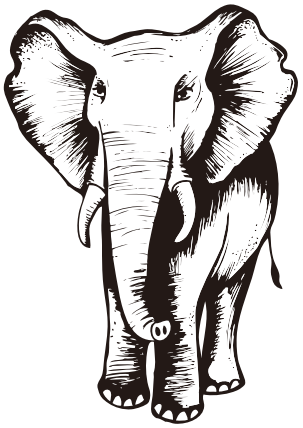
Source : compiled from various sources

2. Species conservation status

Status of a species can be categorized based on the distribution, abundance, and status of protection, as follows:

- Based on its distribution, the species can be interpreted as a native species, endemic species, and introduced species. All three frequently mentioned for the same meaning, although each term is very different. Native species that is also called indigenous species are species that inhabit a region or ecosystem naturally without human intervention. Endemic species is a natural phenomenon of an organism to be unique to a particular geographic region. A species can be called endemic if the species is native species that can only be found in a particular place and not found in other regions. The area here can be an island, a country, or any particular zone.

  Meanwhile, the introduced species are species that thrive outside the original habitat due to human intervention, either intentionally or not. There are several species of destructive and invasive. However, others did not have a negative impact, instead beneficial for ecosystems and humans.

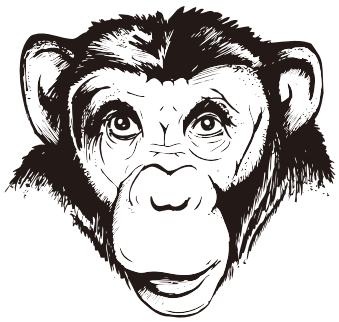


- By its existence, a species at risk of extinction associated earth in the future. In IUCN Red List Categoriesthere are several levels of species based extinction risk globally, namely:

  - Extinct (EX)
    Species in this category in the IUCN List are species that no longer existed. The last species proved to be truly dead.

  - Extinct in the Wild (EW)
    The existence of the species category does not exist in the wild or natural habitat. Only exist in captivity.

  - Critically Endangered (CE)
    Species that highly at risk to become extinct in the wild in their natural habitat or in the near future.



- Endangered (EN)
  In this category, the high-risk species will be extinct in the wild or in their natural habitat.

- Vulnerable (VU)
  Species at high risk for endangered status in the wild.

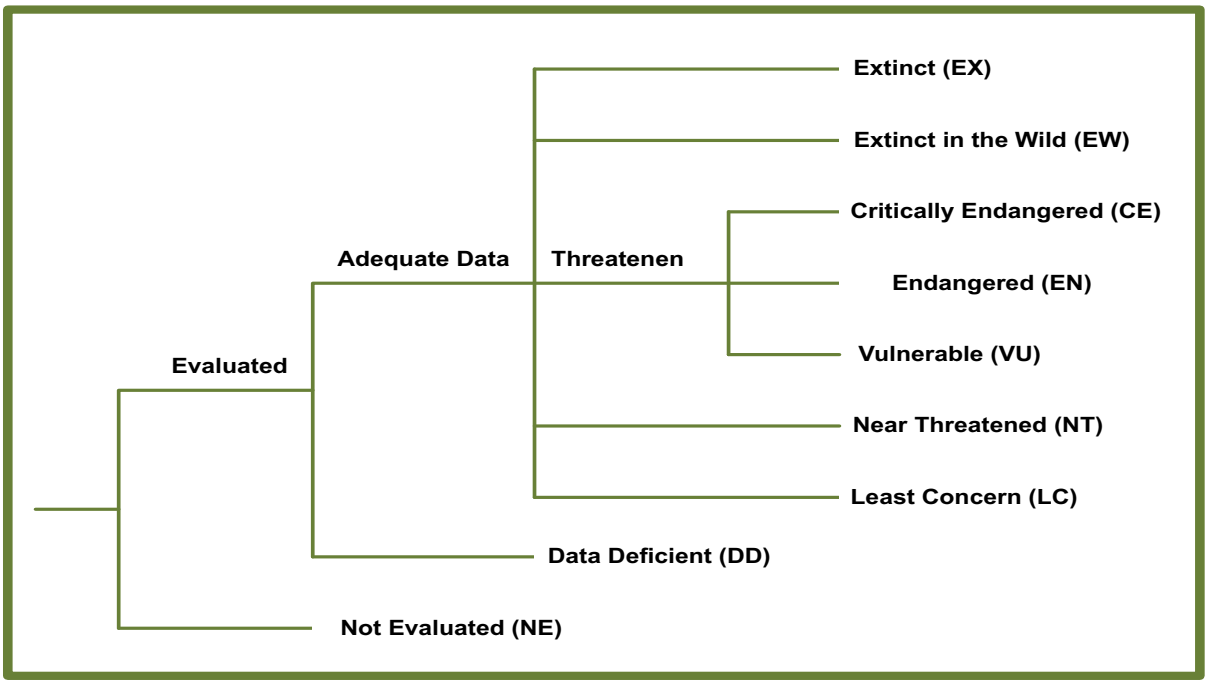
- Near Threatened (NT)
  Species that should get attention because the approaching threat of extinction in the future.

- Least Concerned (LC)
  Species categorized here are safe and away from the threat of extinction.

- Data Deficient (DD)

- Not Evaluated (NE)

Image 13. Relationship Structures of Every Category of Species in Risk



3.2.2. Physical Characteristics of Ecosystem

The physical characteristics of the ecosystem in this guide will focus on some aspects that are considered important, as follows:

1. Forest Cover Class Stratification

Based on the interpretation of high-resolution satellite imagery, land cover in Indonesia is divided into 23 land cover classes, which in turn are grouped into 3 groups based on the closing level of land cover vegetation:

a. Closure Group I: consisted of closure of open land, bush / shrub, agricultural, mixed dry land bush.
b. Closure Group II: consists of closure of dry forest, secondary swamp forest.
c. Closure Group III: consists of closure of savanna, agricultural land, rice fields, mining and settlement.

Interpretation data of satellite imagery was then checked into the field to correct some errors of interpretation so corresponding to the real conditions and recent changes in the field.

2. Climate Type and Rainfall

Climate type analyzed according to climate classification by Schmidt and Ferguson. Monthly rainfall data for the last 10 years are grouped in the dry months (monthly rainfall <60 mm), humid months (monthly rainfall between 60-100 mm), and a wet month (monthly rainfall> 100 mm). Determination of the type of climate is based on the value of Q is calculated using the formula:

$$Q = (\text{Dry Month}/\text{Wet Month}) \times 100\%$$

Next, climate classification based on the criteria of Schmidt & Ferguson. Rainfall intensity (I) is calculated based on the average rainfall in a year and a day of rain. As follows:

$$I = \frac{\text{Rainfall}}{\text{Average Raining Days in a Year}}$$

Table 9. Rainfall Intensity Classifications

Class of Rainfall Intensity	Rainfall Intensity (mm/day)	Rainfall Classification
1	< 13,6	Very Low
2	13,6 – 20,7	Low
3	20,7 – 27,7	Medium
4	27,7 – 34,8	High
5	> 34,8	Very High

3. Water Springs

Observations include data collection of water springs in the forest area. The information that should be noted, the location of springs, spring discharge, altitude around springs location, and description of land cover around the water spring.

4. Land Physiography

Landform and altitude were analyzed descriptively based on topographic maps by observing the pattern and height of contour lines. Slope class classified according to contour lines density. In the hilly/mountainous, in addition to the analysis of contours density, slope class determination is also carried out by systematically looking at the peak or ridge/mountain. The length of the slope is determined based on field observations by predicting the average in each slope class and location. Slope classes used as follows:

Table 10. Slope Class Classifications

Slope Class	Condotion		Slope Classification
	On the map	On the field	
1	Contour distance > 6,25 mm	0 % - 8 %	Flat
2	Contour distance 3,33 - 6,25 mm	8 % - 15 %	Slope Slightly
3	Contour distance 2,00 - 3,32 mm	15 % - 25 %	Somewhat Steep
4	Contour distance 1,25 – 1,99 mm	25 % - 40 %	Sleep
5	Contour distance < 1,25 mm	> 40 %	very Sleep

·Source : Decree of Ministry of agriculture no 873/Kpts/UM/11/1980

5. Land

The physical condition that is important to note in this guide is the sensitivity of the soil to erosion. Data sensitivity of soil erosion is needed to determine which type of treatment that can be performed on a unit of land. Sensitivity of soil against erosion by soil type is as follows:

Table 11. Soil Sensitivity to Erosion

Soil Class	Soil Type	Sensitivity
1	Aluvial, Glei Planosol, Grey Hidromorf , groundwater Laterits	Not sensitive
2	Latosol	Less sensitive
3	Brown forest soil, noncalsic brown, meditern	Somewhat sensitive
4	Andosol, Laterits, Grumusol, Podsol, Podoslic	sensitive
5	Regosol, Litosol, Organosol, Renzine	Very sensitive

3.3. Typology of Forest Ecosystem Based on Ecological Aspects

Creation of the ecological aspects of this typology is a form in data analysis of ecosystem ecological aspects. The analysis can be used for various purposes, including a look at the level of ecological sensitivity for predicting ecosystem responses that may occur from possible disturbances in ecological systems. Sensitivity is also interpreted as the ratio between the external forces that will changes the ecosystem original condition with internal forces in maintaining its balance.

Areas that are usually considered sensitive areas that biologically have high levels of biodiversity or a place to live for many kinds of flora and significant fauna (endemic, rare, and endangered). From the various efforts in order to measure the level of ecological sensitivity of a forest ecosystem, we can apply some parameters on the biological and physical elements of the forest area, which is as follows:

Table 12. Biophysical Characteristics in Determining Ecosystem Sensitivity

Ecological Component	Sensitivity		
	High	Medium	Low
Biological of Area			
Biodiversity	High	Medium	low
The existence of endemic palnts	More than one species	One species	None
The existence of endagered plants			
The existence of endemic animals	More than one species	One species	None
The existence of endagered animals			
Physical of Area			
land coverage	Primary forest	Secondary Forest	Non-forest
Slope	Steep-Very Steep (>25%)	Somewhat Steep (15-25%)	Slope Slightly-Flat (0-15%)
Rainfall Intensity	Very High-high (>27,7)	Medium (20,7-27,7)	Low-very low (<20,7)
Soil (based on erodibility by level)[28]	Very High-high (0,44-0,64)	Somewhat high-medium (0,21-0,43)	Low-very low (0,00-0,10)

[28] Wischmeier and Smith (1978) has developed the concept of soil erodibility are quite popular, in this case soil erodibility (K) is defined as the amount of rainfall erosion index of erosion for soil in standar condition, ie continuous fallow land located on the slopes of over 22 m, slopes 9% with a uniform slope.

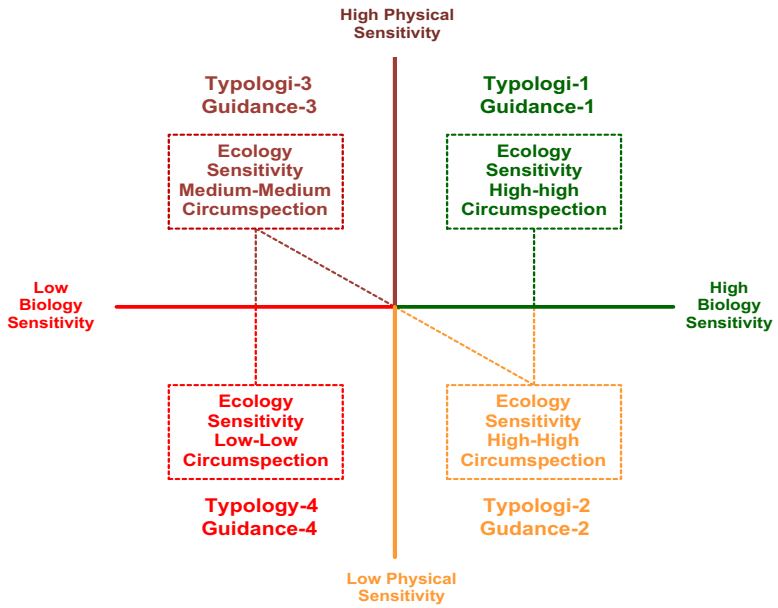
Typology of ecological aspects in a forest area can be obtained by combining biological and physical parameters of the elements in a matrix. Biological parameters placed on the column, while the physical parameters of the matrix on the row. From this combination can be obtained three gradation levels of ecological sensitivity of a forest, which are forest with a high, medium, and low degree of ecological sensitivity.

Table 13. Typology of Ecological Aspect

Biological Aspect	Physical Aspect		
	High	Medium	Low
High	High ecology sensitivity	High ecology sensitivity	High ecology sensitivity
Medium	High ecology sensitivity	Medium ecology sensitivity	Medium ecology sensitivity
Low	Medium ecology sensitivity	Medium ecology sensitivity	Low ecology sensitivity

Based on the ecological aspects, the final typology of forest ecosystems is a combination of biological and physical characteristics that reflect consideration of domination from one component to the other components. The results can be used to drive ecosystem management scenarios that must be done in every geothermal operation within forest ecosystems, especially geothermal operational that potentially changes the ecosystem.

Image 14. Final Typology Grouping of Earth Exploitation in Forest Area



From the final typology can be classified four types of typologies utilization of geothermal resources. Later, it can be used as guidelines to decide whether or not and to know what technical requirements it takes for each stage geothermal resourcesutilization in forest areas. Those four typology of the forest ecosystem are as follows:

Table 14. Definition of Forest Ecosystem Typology Based on Ecological Aspects

Typology	Biological Characteristic	Physical Characteristic
Typologi 1	• Medium to high biodiversity • One or more than one significant plant species (endemic, scarce, endangered) • One or more than one significant animal species (endemic, scarce, endangered)	• Primary or secondary forest • Medium to high land physiography susceptibility • Medium to high land erodibility level
Typologi 2	• Medium to high biodiversity • One or more than one significant plant species (endemic, scarce, endangered) • One or more than one significant animal species (endemic, scarce, endangered)	• Primary or secondary forest • Low to Medium land physiography susceptibility • Low to Medium land erodibility level
Typologi 3	• Low to medium biodiversity • One or none significant plant species (endemic, scarce, endangered) • One or none significant animal species (endemic, scarce, endangered)	• Primary or secondary forest • Medium to high land physiography susceptibility • Medium to high land erodibility level
Tipologi 4	• Low to medium biodiversity • One or none significant plant species (endemic, scarce, endangered) • One or none significant animal species (endemic, scarce, endangered)	• Primary or secondary forest • Low to Medium land physiography susceptibility • Low to Medium land erodibility level

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IV. FOREST ECOSYSTEM SUSTAINABILITY GUIDE

4.1. Framework of Formulation Guide

Various frameworks have been developed by a number of parties to develop guidelines for environmental management. One of the most appropriate and relatively often used in an effort ongoing activities in the forest area is the "*logical framework*", which is often referred in the literature as a frame of *input-process-output-outcome-impact*. In the formulation of forest ecosystem sustainability guide utilization of geothermal working areas, the use of the *logical framework* will be modified to simplify the process of analysis and understanding.

Guide formulation begins with the selection of a framework that will be used to deliver the guide. The framework is intended as a logical reference when theguide is set. Creation of framework begins with goal setting, and then followed hierarchy with the sequence starting from the Principles, Criteria and Indicators. The tools that will be used to construct this hierarchy are the *analytic hierarchy process*. Once Principles, Criteria and Indicators of forest ecosystem sustainability utilization in geothermal working areas are formulated, there is a public consultation involving at least forest managers, developers and practitioners of geothermal utilization, academics, and other parties relevant for feedback and improvement for this framework to be more acceptable and easier to implement. Principles, Criteria and Indicators agreed upon are basicassets of a guide that will be applied in the field.

The agreed guides need to be verified through the application test in several forest locations. Tests conducted on each typology of forests state in order to obtain a guide model for each typology. Furthermore, the guide model applied in certain forest areas that have been and are utilizing geothermal resources.

The guide models on each forest typology obtained need to be described in the manual form of internal and external audit. The goal is so it is easy to use or apply by the actors in the field and independent party as assessor. Thus, the guide model that has been built should be disseminated to stakeholders.

From previous explanation, in general the formulation stages of sustainability guide of geothermal utilization in forest areas are as follows:

1. Compilation and harmonization of frameworks used to organize information.
2. Observations of geothermal utilization at several locations that have been in operation.
3. Selection and creating definition of Principles, Criteria and Indicators to be used for analytical methods tools.
4. Expert assessment to Principles, Criteria and Indicators.
5. Public consultation to Principles, Criteria and Indicators.
6. Data collection and database creation for the purposes of the indicators.
7. Use of visualization tools for analyzing the information obtained and its causal relationship.

8. Preparation of draft model from sustainability guide of geothermal energy utilization in the forest area.
9. Validation of models built on each forest typology.
10. The public consultation model that has been field-tested.
11. Prepare manual draft for Internal and External Audit.

4.2. Principles, Criteria, and Indicator

Sustainability of forest ecosystems in geothermal working areas can be parsed accordingthe hierarchical logical framework, starting from the most abstract level to the concrete level/operations that can be measured. The hierarchy starts from the goal elements or the objectives of national park management, followed by elements of principles, criteria and indicators.

Information classification of Goals (G), Principle (P), Criteria (C), and the indicator (I)) in the assessment of the sustainability of forest ecosystems utilization in geothermal working areas is made to ensure consistency of thought in developing a coherent guide. Classification of P, C, and I facilitate the formulation of a sustainability parameters assessment of geothermal resources utilization in the forest area in a consistent and coherent manner. Each level of information explains its function according to its relevant level and identifies the characteristics of the parameters that appear in certain levels.

In classifying information, the horizontal and vertical consistency should be concerned. Horizontal consistency means that the parameters that appear in the same level do not overlap, while the vertical consistency means parameters at lower levels describes a clear relationship to the level above it. In addition, the parameter should lies in the correct hierarchy and use the correct term.

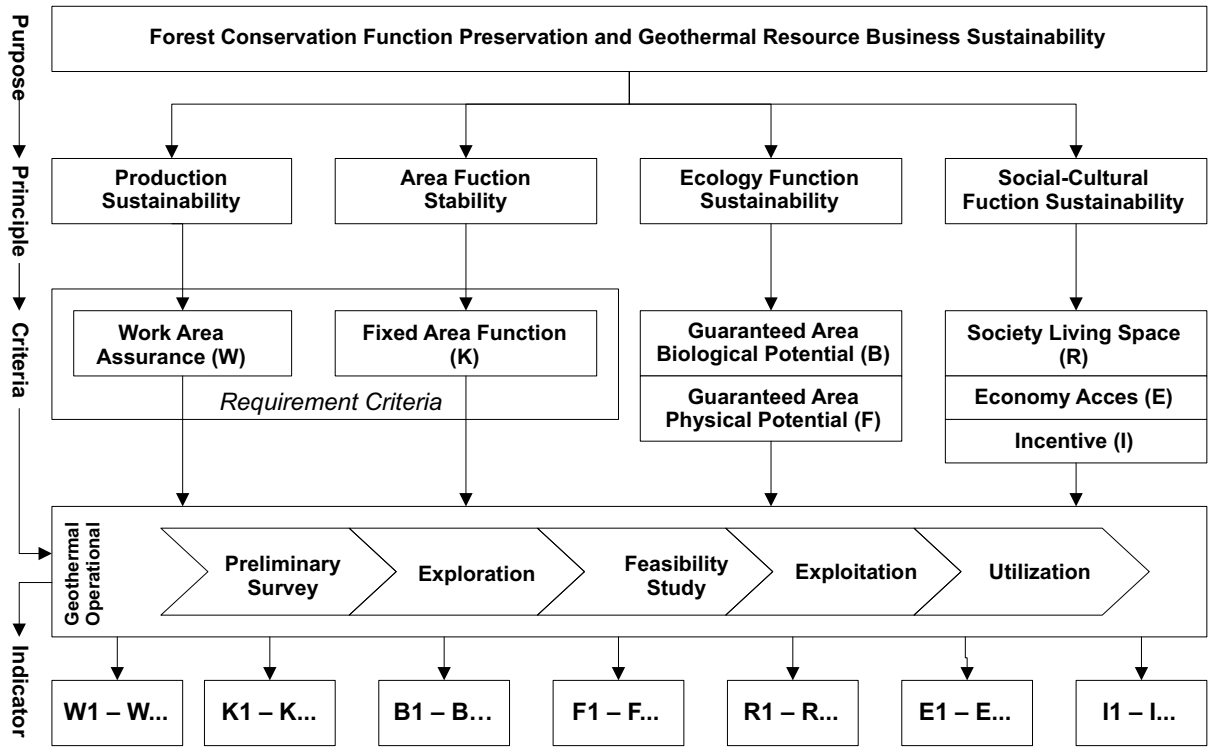
In the development of P, C, & I, the overall hierarchy information is categorized as a result dimension of a process or series of geothermal operations. In this case, the principle as an explicit part of the goal is seen as a dimension of the result to be achieved by a series of geothermal operations in forest areas, through a series of criteria and an assessment of each indicator.

Overall, the sustainability of geothermal utilization in forest areas should include the principles or dimensions of the following results:

1. Sustainability of geothermal production,
2. Stability of forests functions,
3. Sustainability of ecological functions in forest ecosystem,
4. Sustainability of socio-economic functions in forest ecosystems culture.

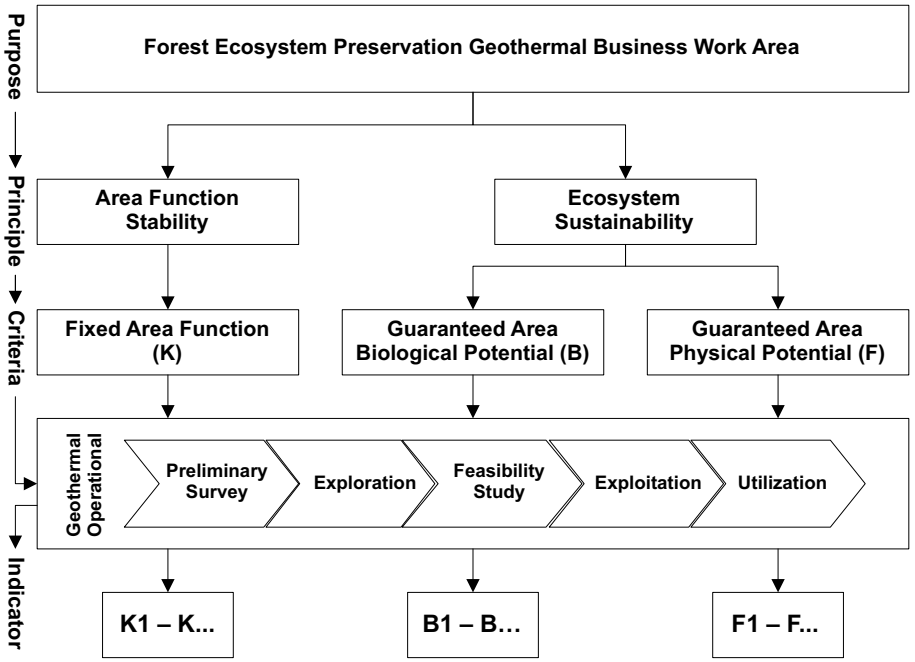
Hierarchical model of sustainable geothermal utilization, following the logic of the overall objectives, principles, criteria and indicators are as follow:

Image 15. Hierarchical Model of Sustainable Geothermal Utilization in Forest Area



The framework of P, C, & I of sustainable forest in geothermal working area is part of the framework of P, C, & I geothermal utilization as overall. Sustainable forest ecosystems besides can be seen from the ecological functions based on its biophysical characteristics, it also can be determined from its function stability based on legality and legitimacy or acknowledgment of the parties. Thus, sustainability of forest ecosystems of ecological aspects must satisfy the principle of regional stability and the sustainability of ecological functions.

Image 16. Hierarchical Model of Sustainable Forest Ecosystem in Geothermal Working Area



If the dimension of the result were placed in the row of a matrix and geothermal operations placed on the column matrix, then it would see a regularity of corresponding relationships and dependencies between results dimensions with the geothermal operations. Indicators were then developed in the cross matrix between criteria of geothermal operations that are deemed as the most influential on the sustainability of forest ecosystem

Table 15. **Matrix of Criteria and Indicator of Forest Ecosystem Sustainability Geothermal Working Area**

Geothermal Operational Activity	Forest Area Function Stability Fixed Area Function (K)	
Reconnaissance Survey and Work Area Determination	K1. Geothermal model, expected reserve, and exploration drilling location objective in forest area K2. Geothermal work area is established without be accompanied by proposal of forest area function change	
Exploration	K3. Exploration activities effect towards forest area function	
Feasibility Study	K4. Geothermal business plan feasibility from forest area function and forest management unit purpose-related aspect	
Exploitation	K5. Exploitation and development drilling not interfering area function and forest management purpose.	
Utilization	K6. Tools and infrastructure of utilization development (piping installation from production well to power plant, power plant building, electrical grid installation, office, etc.) according to forest management zone/block.	

	Ecology Function Preservation	
	Biological Area Potential (B)	Physical Area Potential (F)
	B1. Biodiversity potential of forest area includes complete lists of forest area animals & plants species, significant animals and plants, also distribution and population of those significant species. B2. Behavior andhabitat map of significant animals and plants species.	F1. Newest land coverage condition, historical land coverage change, and land coverage projection to the future. F2. Other forest area physical characteristic includes slope, soil, and rainfall factor.
	B3. Disturbance that's caused by exploration activities toward forest area biological condition.	F3. Disturbance that's caused by exploration activities toward forest area biological condition
	B4. Exploitation effect potential and geothermal utilization towards forest ecosystem biological condition.	F4. Exploitation effect potential and geothermal utilization towards forest ecosystem physical condition.
	B5. Control and maintenance effort of area biological potential based on future effect potential because of exploitation and utilization activities.	F5. Control and maintenance effort of area physical condition based on future effect potential.
	B6. Exploitation effect towards forest area biological condition and its treatment efforts.	F6. Exploitation effect towards forest area physical condition.
	B7. Geothermal energy utilization effect towards forest area biological condition.	F7. Geothermal energy utilization effect towards forest area physical condition.
	B8. Geothermal utilization contribution towards forest biological potential management quality.	F8. Geothermal utilization contribution towards forest biological potential management quality.

Table 16. Intensity Scale Indicator Stability Function Principal in Forest Area (Criteria: Function Fixed Region)

Indicator	Definition	Score	Information
F1. Existing land coverage, historical land coverage change, and land coverage projection.	Land coverage condition is the simplest indicator to see ecosystem physical condition. To improve the accuracy of analysis, land coverage that is studied must be data series to see change tendency, both in history or in the future projection. It is very useful to prepare baseline of land coverage physical condition before and after geothermal business operation.	Good	Land coverage data existing, land coverage in the former period, and land coverage projection in the future with reference year that has been decided. It can be identified by newest cover story high resolution of satellite image interpretation and field check, cover story of past period, and projection analysis based on business as usual activity.
		Medium	Land coverage data existing can be identified by newest cover story high resolution of satellite image interpretation and field check.
		Buruk	Land coverage data existing can be identified by newest cover story low resolution of satellite image interpretation without any field check.
F2. Forestland physical characteristic includes slope, land, and rainfall intensity factors.	Other important land physical condition to determine land ability level must be identified and studied to assess type and treatment level that can be obtained in the land unit.	Good	Slope, land erosion level, and rainfall data in forest area that become geothermal work area objective can be discovered by direct observation, measurement, and research, followed by advanced analysis about land capability to accept some treatments.
		Sedang	Slope, land erosion level, and rainfall data in forest area that become geothermal work area objective is discovered by secondary data, however the analysis about land capability to accept some treatments is only done by using secondary data.
		Buruk	Slope, land erosion level, and rainfall data in forest area that become geothermal work area objective is only discovered by secondary data. There is no analysis about land capability to accept some treatments.

F3. Interference because of exploration activitytowards forest area physical condition	Exploration drilling can create many influences toward topography, such as land opening for well and other supporting facilities, local vibration when drilling, etc. All physical effects occurred must be identified, both their types and scale, and they must be handled soon so they don't decrease land physical support ability to support living.	Good	Interference scale and types that created because exploration activity to area physical condition are identified and can be handled by area physical recovery so physical support ability towards ecosystem function can hold out.
		Medium	Interference scale and types that created because exploration activity to area physical condition are identified and can be handled by area physical recovery so physical support ability towards ecosystem function can hold out.
		Bad	Interference scale and types that created because exploration activity to area physical condition is not identified and there is no treatment for the effects so it can risk to the decreasing of physical support ability towards ecosystem function.
F4. Geothermal exploitation and utilization effect potential towards forest ecosystem physical condition.	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem physical condition must be identified, so it can be reviewed whether those types and scales of interference not exceed the limit of forest ecosystem tolerance. This is an important information source to determine the feasibility of geothermal utilization exploitation activity from ecology aspect.	Good	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem physical condition are identified well. Those types and scales of interference are still under control and do not arise any significant impact for degradation of ecosystem function.
		Medium	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem physical condition are identified well. Those types and scales of interference are still under control although the treatment needs relatively long time. Furthermore, ecosystem function recovery takes quite long time as well.
		Buruk	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem physical condition are not identified. It causes difficulties the treatment efforts in order to maintain ecosystem function maintenance.

Next Table 16

Indicator	Definition	Score	Information
F5. Control and maintenance efforts of area physical potential based on effect potential that will happen because all exploitation and utilization activities.	Estimation of interferences that arise from all geothermal utilization and exploitation are expected to be under control, by well-planned efforts. In this case, there must be detail plan for treatment of every type of interferences that predicted.	Good	There is adequate technical design of ecosystem protection and recovery activities to ensure there is no degradation risk of ecosystem function from geothermal utilization and exploitation. The technical design also includes activities design that directly contributing to forest management quality improvement.
		Medium	There is adequate technical design of ecosystem protection and recovery activities to ensure there is no degradation risk of ecosystem function from geothermal utilization and exploitation.
		Bad	There is no technical design of ecosystem protection and recovery activities that can be used to handle the risks of ecosystem function from geothermal utilization and exploitation
F6. Exploitation effects toward forest area physical condition and their treatment efforts	Geothermal exploitation activity effects in forest area toward forest area ecosystem function and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assessed to ensure there is no permanent ecosystem function degradation.	Good	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. Additional effects that arise and are not yet predicted can be handled soon so they do not cause permanent degradation ecosystem function in the area.
		Sedang	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. However, there are additional effects that arise and not yet predicted that cannot be handled so they cause permanent degradation ecosystem function in the area.
		Bad	Geothermal exploitation activity effects in forest area cannot be managed by protection and recovery that have been designed, because implementation of activities design is not optimum.

F7. Geothermal utilization effects toward forest area physical condition	Geothermal exploitation activity effects in forest area toward forest area ecosystem function and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assesse to ensure there is no permanen ecosystem function degradation.	Good	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. Additional effects that arise and are not yet predicted can be handled soon so they do not cause permanent degradation ecosystem function.
		Sedang	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. However, there are additional effects that arise and not yet predicted that cannot be handled so they cause permanent degradationecosystem function.
		Bad	Geothermal exploitation activity effects in forest area cannot be managed by protection and recovery that have been designed, because implementation of activities design is not optimum.
B8. Geothermal utilization contribution towards forest physical condition management quality.	Physical condition of forest area where geothermal work area exists is not always in good condition. That condition is caused by the amount of pressure toward forest, because the \management is not effective all this time so ecosystem function keeps decreasing. Additional role of geothermal business in the forest can be directed to handle ecosystem physical degradation, such as ecosystem restoration and land rehabilitation, society empowerment to reduce dependability of society to forest, etc.	Good	Geothermal business in forest area is proven too contribute in the improvement of ecosystem function that already damaged before geothermal operation, such as rehabilitation and operation.
		Sedang	Geothermal business in forest area has made efforts to contribute in the improvement of ecosystem function that already damaged before geothermal operation, but they are not significant yet.
		Bad	Geothermal business in forest area does not have additional efforts to contribute in the improvement of ecosystem function that already damaged before geothermal operation.

Tabel 17. Intensity Scale Sustainability Ecological Function Principal (Criteria: Potential Biological Secured Forest Area)

Indicator	Definition	Score	Information
B1. Biodiversity potential of forest area includes complete lists of plants and animals species in forest area, significant plants and animals species, and distribution and population of those significant species.	Biodiversity potential of the simplest forest area unit is being observed in species level. Study of biodiversity potential in species level includes complete lists of plants and animals species in forest area, significant plants and animals species, and distribution and population of those significant species. Category of these significant species is determined by endemicity, scarcity, and endangered potency level based on Red List Data Book IUCN. Preliminary survey phase in geothermal business besides directed to get geothermal technical information and data, it also has to validate and update those biodiversity potential. Even more, there shall be population trend/series for significant species. It can be used to prepare baseline in area biological potential.	Good	Preliminary survey is able to produce complete lists of plants and animals species in forest area, significant species list based on their endemicity, risk of their extinction and scarcity, also distribution and population trend/series of those significant species.
		Medium	Preliminary survey is able to produce complete lists of plants and animals species in forest area, significant species list based on their endemicity, risk of their extinction and scarcity. But it does not produce distribution and population trend/series of those significant species.
		Bad	Preliminary survey only produces complete lists of plants and animals species in forest area.

B2. Significant animals and plants species habitat map and behavior.	Every species has its own different and unique behavior. Some animal species lives in solitary or colony; some can share space with their own species but some tend to dominate by themselves; some can reproduce fast, others reproduce quite slow; some can hold on against interference, some easily die when nterfered; some can live in certain height and temperature, but some cannot; etc. Reaction of every animal species toward interference is different. Same goes to plant species, some need sunlight while others don't, etc. Study about species behavior and habitat characteristic is very important. Therefore, insitu conservation of wildlife is obtained by habitat management approach, practical activity which organizing ecosystem biotic and physical condition so optimal condition for population development can be obtained.	Goog Medium Bad	Preliminary study can produce data, information, and knowledge about significant species behavior, their characteristics, and habitat map. Preliminary study only produces data, information, and knowledge about significant species behavior. Preliminary study does not produce data, information, and know ledge about significant species behavior, their characteristics, and habitat map.

[29] Yoakum dan Dasmann (1971) dalam Alikodra (1989): "Teknik Pengelolaan Satwa Liar Dalam Rangka Mempertahankan Keanekaragaman Hayati Indonesia". IPB Press. Bogor

Next Table 17

Indicator	Definition	Score	Information
B3. Interference because of exploration activity towards forest area biological condition	Geothermal exploration in forest area needs land opening for exploration well, road access construction, basecamp, etc. Direct effect that possibly happens is habitat fragmentation, etc. Interference/disturbance toward ecosystem biotic condition must be surely discovered, and how much the influence of every disturbance towards every significant species living in the forest area. All disturbance/interference effect should be able to be controlled so they do not exceed the limit of ecosystem biotic elements to defense themselves.	Good	Interference scale and type that created because exploration activity is under limit of ecosystem biotic element ability to defense or renew their stability in relatively fast time.
		Medium	Interference scale and type that created because exploration activity is under limit of ecosystem biotic element ability to defense or renew their stability, but it needs relatively long time.
		Bad	Interference scale and type that created because exploration activity exceeds the limit of ecosystem biotic element ability to defense or renew their stability.

PLTP Kamojang, Jawa Barat. Foto: ©WWF-Philippines/ Christopher Ng.

B4. Geothermal exploitation and utilization effect potential towards forest ecosystem biological condition.	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem biotic condition must be identified, so it can be reviewed whether those types and scales of interference not exceed the ability of forest ecosystem biotic elements limit to defense/reproduce themselves. This is an important information source to determine the feasibility of geothermal utilization exploitation activity from ecology aspect.	Good	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem biotic condition are identified well. Those types and scales of interference not exceed the ability of forest ecosystem biotic elements limit to defense/ reproduce themselves.
		Medium	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem biotic condition are identified well. However, those types and scales of interference exceed the ability of forest ecosystem biotic elements limit to defense/ reproduce themselves.
		Bad	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem biotic condition are not identified.

Next Table 17

Indicator	Definition	Score	Information
B5. Control and maintenance efforts of area biological potential based on effect potential that will happen because all exploitation and utilization activities.	Estimation of interferences that arise from all geothermal utilization and exploitation are expected to be under \control, so they do not threaten forest area biological potential. Therefore, it is needed to prepare control and maintenance plan for area biological potential according to future effect potential. In this case, special activities plan must be created to handle significant effect potential that can threaten endemic, scarce, and endangered species living which live inside geothermal work area in the forest.	Good	There is adequate technical design of ecosystem protection and recovery activities to ensure there is no degradation risk of area biological potential from geothermal utilization and exploitation. The technical design also includes activities design that directly contributing to forest management quality improvement.
		Medium	There is adequate technical design of ecosystem protection and recovery activities to ensure there is no degradation risk of area biological potential from geothermal utilization and exploitation.
		Bad	There is no technical design of ecosystem protection and recovery activities that can be used to handle the risks of area biological potential from geothermal utilization and exploitation.

B6. Exploitation effects toward forest area biological condition and their treatment efforts	Geothermal exploitation activity effects in forest area toward forest area biological potential and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assessed to ensure there is no permanent biological potential degradation.	Good	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. Additional effects that arise and are not yet predicted can be handled soon so they do not cause permanent degradation biotic elements in the area.
		Medium	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. However, there are additional effects that arise and not yet predicted that cannot be handled so they cause permanent degradation biotic elements in the area.
		Bad	Geothermal exploitation activity effects in forest area cannot be managed by protection and recovery that have been designed, because implementation of activities design is not optimum.

Next Table 17

Indikator	Pengertian	Nilai	Keterangan
B7. Geothermal utilization effects toward forest area biological condition	Geothermal exploitation activity effects in forest area toward forest area biological potential and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assessed to ensure there is no permanent biological potential degradation.	Good	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. Additional effects that arise and are not yet predicted can be handled soon so they do not cause permanent degradation biotic elements in the area.
		Medium	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. However, there are additional effects that arise and not yet predicted that cannot be handled so they cause permanent degradation biotic elements in the area.
		Bad	Geothermal exploitation activity effects in forest area cannot be managed by protection and recovery that have been designed, because implementation of activities design is not optimum.

B8. Geothermal utilization contribution towards forest biological potential management quality.	Habitat condition is not always in good condition. That condition is caused by the height of pressure to forest, because the management is not effective all this time so ecosystem biological potential in the state of degradated. Additional role of geothermal business in the forest can be directed to improve forest management quality, such as forest management tools and infrastructures management quality improvement, conservation institute development, society empowerment for biodiversity conservation, etc	Good	Geothermal business in forest area is proven too contribute in the improvement of significant species population viability. It is done within some activities that directly decrease the activities that cause the degradation of ecosystem biotic elements.
		Medium	Geothermal business in forest area has made efforts to contribute in the improvement of significant species by insitu, but they are not significant yet.
		Bad	Geothermal business in forest area does not have additional efforts to contribute in the improvement of significant species by insitu.

Table 18. Intensity Scale Sustainability Ecological Function Principal (Criteria: Physical Condition Secured Forest Area)

Indicator	Definition	Score	Information
F1. Existing land coverage, historical land coverage change, and land coverage projection.	Land coverage condition is the simplest indicator to see ecosystem physical condition. To improve the accuracy of analysis, land coverage that is studied must be data series to see change tendency, both in history or in the future projection. It is very useful to prepare baseline of land coverage physical condition before and after geothermal business operation.	Good	Land coverage data existing, land coverage in the former period, and land coverage projection in the future with reference year that has been decided. It can be identified by newest cover story high resolution of satellite image interpretation and field check, cover story of past period, and projection analysis based on business as usual activity.
		Medium	Land coverage data existing can be identified by newest cover story high resolution of satellite image interpretation and field check.
		Bad	Land coverage data existing can be identified by newest cover story low resolution of satellite image interpretation without any field check.

Indicator	Definition	Score	Information
F2. Forestland physical characteristic includes slope, land, and rainfall intensity factors.	Other important land physical condition to determine land ability level must be identified and studied to assess type and treatment level that can be obtained in the land unit.	Good	Slope, land erosion level, and rainfall data in forest area that become geothermal work area objective can be discovered by direct observation, measurement, and research, followed by advanced analysis about land capability to accept some treatments.
		Medium	Slope, land erosion level, and rainfall data in forest area that become geothermal work area objective is discovered by secondary data, however the analysis about land capability to accept some treatments is only done by using secondary data.
		Bad	Slope, land erosion level, and rainfall data in forest area that become geothermal work area objective is only discovered by secondary data. There is no analysis about land capability to accept some treatments.
F3. Interference because of exploration activity towards forest area physical condition	Exploration drilling can create many influences toward topography, such as land opening for well and other supporting facilities, local vibration when drilling, etc. All physical effects occurred must be identified, both their types and scale, and they must be handled soon so they don't decrease land physical support ability to support living.	Good	Interference scale and types that created because exploration activity to area physical condition are identified and can be handled by area physical recovery so physical support ability towards ecosystem function can hold out.
		Medium	Interference scale and types that created because exploration activity to area physical condition are identified and can be handled by area physical recovery so physical support ability towards ecosystem function can hold out.
		Bad	Interference scale and types that created because exploration activity to area physical condition is not identified and there is no treatment for the effects so it can risk to the decreasing of physical support ability towards ecosystem function.

Indicator	Definition	Score	Information
F4. Geothermal exploitation and utilization effect potential towards forest ecosystem physical condition.	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem physical condition must be identified, so it can be reviewed whether those types and scales of interference not exceed the limit of forest ecosystem tolerance. This is an important information source to determine the feasibility of geothermal utilization exploitation activity from ecology aspect.	Good	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem physical condition are identified well. Those types and scales of interference are still under control and do not arise any significant impact for degradation of ecosystem function.
		Medium	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem physical condition are identified well. Those types and scales of interference are still under control although the treatment needs relatively long time. Furthermore, ecosystem function recovery takes quite long time as well.
		Bad	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem physical condition are not identified. It causes difficulties the treatment efforts in order to maintain ecosystem function maintenance.

Foto: ©Moving Images/ NL Agency

Indicator	Definition	Score	Information
F5. Control and maintenance efforts of area physical potential based on effect potential that will happen because all exploitation and utilization activities.	Estimation of interferences that arise from all geothermal utilization and exploitation are expected to be under control, by well-planned efforts. In this case, there must be detail plan for treatment of every type of interferences that predicted.	Good	There is adequate technical design of ecosystem protection and recovery activities to ensure there is no degradation risk of ecosystem function from geothermal utilization and exploitation. The technical design also includes activities design that directly contributing to forest management quality improvement.
		Medium	There is adequate technical design of ecosystem protection and recovery activities to ensure there is no degradation risk of ecosystem function from geothermal utilization and exploitation.
		Bad	There is no technical design of ecosystem protection and recovery activities that can be used to handle the risks of ecosystem function from geothermal utilization and exploitation.

Indicator	Definition	Score	Information
F6. Exploitation effects toward forest area physical condition and their treatment efforts	Geothermal exploitation activity effects in forest area toward forest area ecosystem function and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assessed to ensure there is no permanent ecosystem function degradation.	Good	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. Additional effects that arise and are not yet predicted can be handled soon so they do not cause permanent degradation ecosystem function in the area.
		Medium	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. However, there are additional effects that arise and not yet predicted that cannot be handled so they cause permanent degradation ecosystem function in the area.
		Bad	Geothermal exploitation activity effects in forest area cannot be managed by protection and recovery that have been designed, because implementation of activities design is not optimum.

Indicator	Definition	Score	Information
F7. Geothermal utilization effects toward forest area physical condition	Geothermal exploitation activity effects in forest area toward forest area ecosystem function and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assessed to ensure there is no permanent ecosystem function degradation.	Good	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. Additional effects that arise and are not yet predicted can be handled soon so they do not cause permanent degradation ecosystem function.
		Medium	Geothermal exploitation activity effects in forest area can be managed by protection and recovery that have been designed. However, there are additional effects that arise and not yet predicted that cannot be handled so they cause permanent degradation ecosystem function.
		Bad	Geothermal exploitation activity effects in forest area cannot be managed by protection and recovery that have been designed, because implementation of activities design is not optimum.
F8. Geothermal utilization contribution towards forest physical condition management quality.	Physical condition of forest area where geothermal work area exists is not always in good condition. That condition is caused by the amount of pressure toward forest, because the management is not effective all this time so ecosystem ecosystem function keeps decreasing. Additional role of geothermal business in the forest can be directed to handle ecosystem physical degradation, such as ecosystem restoration and land rehabilitation, society empowerment to reduce dependability of society to forest, etc.	Good	Geothermal business in forest area is proven too contribute in the improvement of ecosystem function that already damaged before geothermal operation, such as rehabilitation and operation.
		Medium	Geothermal business in forest area has made efforts to contribute in the improvement of ecosystem function that already damaged before geothermal operation, but they are not significant yet.
		Bad	Geothermal business in forest area does not have additional efforts to contribute in the improvement of ecosystem function that already damaged before geothermal operation.

Table 19. Verifier and Verification Method Indicator Forest Area Purpose Stability Principal

Indicator	Definition	Verifier
K1. Geothermal model, unexpected reserves and exploration drilling location in forest area	Geothermal model, predictable potential geothermal reserves, and location target for drilling location are the three main outputs of the preliminary study phase. All three will provide information on where and how the exploration activities that would/should be done. From the preliminary information it can consider how the potential effect on the function of the are of exploration activities and forest management objectives that have been set so that the plans for controlled exploration can be prepared in order for the area function and objection of forest management are not disturbed	1. Geothermal models, unexpected resources of geothermal, and the propose exploration sites in forest area that are reported by preliminary study 2. Forest boundaries 3. Zone/block forest management 4. Potential impact of exploration to the area purpose and forest management 5. Control exploration plan to focus for maintain the area purpose and forest management objective
K1. Geothermal working areas specified without a proposed changes in forest area	Geothermal working areas surrounding or located in the forest are without proposed changes for the purpose of forest area. To be sure, all the stages in the assigning the geothermal working areas, several things needs to be considered such as, the purpose of the are, management objective, and zone/block forest management	1. Appropriate procedures for Geothermal Working Area 2. Proses/treaties for appropriate Geothermal Working Areas that have been done 3. Determined Geothermal Working Area 4. Forest Area Purpose and forest management objective have not changes

	Data and Information		Verification Method
	Secondary	Primary	
	1. Reports containing the result of a preliminary study of potential geothermal and proposed exploration location complete with map (map of surface distribution manifestation, maps of potential exploration wells, maps of exploration infrastructure) 2. SK document about designation/ establish of forest area 3. Forest area map 4. zone/block forest management map 5. Forest management plan document 6. Design Engineering Document (DED) for exploration about to be performed, including maps and site plan	1. Ground check on the proposed locations for exploration and all supporting activities according to the exploration technical plan made by preliminary study 2. Ground check for forest boundaries 3. Ground check for zone/block forest managemen 4. Report of assessment study about activity exploration impact to the area purpose and forest management	1. Map overlay for potential geothermal expected in forest area and zone/ block forest management 2. Map overlay of forest area with maps of planned exploration and all supporting activities (exploration infrastructure) 3. Map overlay zone/block forest management with exploration activities with all supporting activities (exploration infrastructure) 4. Search of area document legality and forest management document 5. Assessing the potential impact of exploration and all supporting activities to area purpose and forest management objectives
	1. Documents about policy guidelines/ manual/procedure for determining the geothermal working areas 2. Documents about process/treaties for settlement and maps of geothermal working areas 3. SK document for determining of geothermal working areas and its decree 4. SK document for designation/ establishment of forest area	1. Delineation of geothermal working areas	1. Map overall of geothermal working areas with forest maps 2. Information search about whiter there is any proposed changes to the purpose of the forest area

Indicator	Definition	Verifier
K3. Impact of exploration to forest area function	Exploration activities in forest area need clearing, not only on the drilling location, but also for the supporting infrastructure (access roads, basecamp, etc.) that will affect forest conditions. Substantively, forest purpose is based on the conditions (forest potential) so that changes in the forest conditions due to exploration might affect the forest purpose. Therefore, exploration needs to be effective and to avoid technical errors during drilling. Technical error may cause disturbance that exceed the estimation and new unexpected affect may appear. In principle, all exploration impact should be controlled so that the purpose of the forest and purpose of forest management can be maintained	1. Exploration potential impact 2. Exploration implementation 3. Impacts throughout exploration to forest conditions 4. Handling exploration impact
K4. Feasibility of geothermal utilization plan in terms of forest purpose and objectives of forest management units	The final result of exploration is a geothermal model, a potential wells (proven reserves), and the characteristic of the reservoir. Therefore it can be known where and how the development activities should be done and what is the impact to the forest ecosystem. By doing so, there are several impacts that we	1. Geothermal model, potential wells (proven reserves) and reservoir characteristics 2. Engineering design (DED site plan) for construction of major facilities and geothermal development (exploitation and utilization) 3. Zoning/block forest management 4. Feasibility for all development activities according to their forest management zone/block 5. If zone/block need adjustment, it should be certain that it does not affect the forest function and forest management objective specified before

	Data and Information		Verification Method
	Secondary	Primary	
	1. Document about study of potential exploration impact report 2. Document about technical design of handling exploration impact 3. Document about exploration impact report 4. Document about exploration impact assessment report 5. Document about exploration impact handling on forest condition report	1. Field assessment of changes in forest condition before and after exploration 2. Field assessment about exploration impact treatment 3. Assessment about the effectives in exploration impact to the forest condition	1. Search for exploration planning document 2. Search for study report on exploration impact document 3. Search for exploration impact plan document 4. Field rapid assessment for exploration, the impact occurs, and handling effort done
	1. Documents of exploration result about geothermal model, proven reserves, and characteristic reservoir 2. Geothermal planning documents with spatial direction (map and site plan) infrastructure development plan throughout the geothermal development in forest areas 3. SK document about determining zoning/block forest management and its maps 4. Document about the result of conformity assessment of development activities (exploitation and utilization) of zone/block forest management 5. Document about proposed changes on zone/block forest development (if any)	1. Ground check on the location of geothermal development which will be implemented in the forest area according the map and the development site plan (exploitation and utilization)	1. Map overlay of the location of geothermal development that will be done with maps of forest management zone/block

Indicator	Definition	Verifier	
K5. Exploitation or drilling development that do no interfere with the purpose and function of forest management areas	Drilling development to exploit "proven geothermal potential" (production and injection wells) carried out in accordance with zoning/block management forest. It must be ensured that the production capacity of production wells to be correspond with the assumption to avoid opening new land to search new production wells in order to meet the production capacity economically	1. Exploration/drilling development 2. Impact of exploration/drilling development 3. Handling the impact of exploration/ drilling development	
K6. Utilization of facilities and infrastructure (pipe installation from production wells to the power plant, plant/power plant building, electrical works, offices, etc.) in accordance zone/block of forest management	The entire utilization infrastructure (piping installation of production wells to the power plant, plant/power plant building, electrical works, offices, etc.) must in accordance with the zoning/block forest management	1. Infrastructure development activities 2. Impact of infrastructure development of using geothermal to electricity 3. Handling the impact of infrastructure development of using geothermal to electricity	

Foto: ©Moving Images/ NL Agency

	Data and Information		Verification Method
	Secondary	Primary	
	1. Document about the implementation of exploitation/drilling development report 2. Document about impact assessment of exploitation/drilling development report 3. Document about the effect of exploitation/drilling development report	1. Field observation in the location of exploitation/drilling development 2. Rapid assessment in the field to the exploitation impact/drilling development and its handling	1. Search planning and execution exploitation document 2. Search forest condition change before and after exploitation document 3. analysis of change in forest condition before and after the exploitation
	1. Document about infrastructure development for the utilization of geothermal energy into electricity report 2. Document about result of an impact assessment of infrastructure development geothermal energy into electricity report 3. Document about the handling of the impact of infrastructure development for utilization of geothermal energy into electrical energy report	1. Observation on the location of facilities and infrastructure utilization of geothermal energy into electricity energy 2. Rapid assessment in the field to see the impact of infrastructure development for the utilization of geothermal energy into electrical energy and its handling	1. Search for planning and implementation of geothermal utilization into electricity document 2. Search for assessment report of geothermal utilization into electricity document 3. Analysis of change in forest conditions before and after the geothermal utilization into electricity

Table 20. Verifier and Verification Method for Sustainability Ecological Function in Forest Area Indicator

Indicator	Definition	Verifier	
B1. Biodiversity potential of forest area includes complete lists of plants and animals species in forest area, significant plants and animals species, and distribution and population of those significant species.	Biodiversity potential of the simplest forest area unit is being observed in species level. Study of biodiversity potential in species level includes complete lists of plants and animals species in forest area, significant plants and animals species, and distribution and population of those significant species. Category of these significant species is determined by endemicity, scarcity, and endangered potency level based on Red List Data Book IUCN. Preliminary survey phase in geothermal business besides directed to get geothermal technical information and data, it also has to validate and update those biodiversity potential. Even more, there shall be population trend/series for significant species. It can be used to prepare baseline in area biological potential.	1. Complete lists of animals and plants species in the forest that become geothermal work area. 2. Endemic, scarce, and endangered species lists that live in the forest that becomes geothermal work area. 3. Endemic, scarce, and endangered species distribution and population that live in the forest that become geothermal work area.	
B2. Significant animals and plants species habitat map and behavior.	Every species has its own different and unique behavior. Some animal species lives in solitary or colony; some can share space with their own species but some tend to dominate by themselves; some can reproduce fast, others reproduce quite slow; some can hold on against interference, some easily die when interfered; some can live in certain height and temperature, but some cannot; etc. Reaction of every animal species toward interference is different. Same goes to plant species, some need sunlight while others don't, etc. Study about species behavior and habitat characteristic is very important. Therefore, insitu conservation of wildlife is obtained by habitat management approach, practical activity which organizing ecosystem biotic and physical condition so optimal condition for population development can be obtained.	1. Study result of endemic, scarce, and endangered species that live in the forest that become geothermal work area. 2. Description and habitat map of endemic, scarce, and endangered species that live in the forest that become geothermal work area. Habitat map is based on habitat components.	

Verification (Criteria: Ensuring Potential Biological Region)

	Data and Information		Verification Method/ Sampling
	Secondary	Primary	
	1. Report document of forest area animals and plants species, at least shows complete lists of animals and plants species, which live in forest area that become geothermal work area and their population. 2. Red List Data Book IUCN document and its appendixes. 3. Report document of endemic, scarce, and endangered animals and plants identification result. 4. Report document of special activities (such as: corridor construction), which are created to protect endemic, scarce, and endangered species living that live in the forest that become geothermal work area.	1. Population and distribution survey of endemic, scarce, and endangered species purposively.	1. Preparation of forest area biodiversity index. 2. The making of endermicity, scarcity, and endangerment status of animals and plants species that successfully identified to forest that becomes geothermal work area. 3. Permanent Sampling Plot (PSP) making to monitor population and distribution of endemic, scarce, and endangered species. 4. Monitoring of population and distribution of endemic, scarce, and endangered species. 5. Trend analysis of endemic, scarce, and endangered species population that live in the forest that become geothermal work area.
	1. Study result document of endemic, scarce, and endangered species that live in the forest that become geothermal work area. 2. Habitat map of endemic, scarce, and endangered species that live in the forest that become geothermal work area.	1. Field observation of endemic, scarce, and endangered species that live in the forest that become geothermal work area.	1. Habitat analysis to determine important areas that must be protected for sake of endemic, scarce, and endangered species that live in the forest that become geothermal work area.

Indicator	Definition	Verifier	
B3. Interference because of exploration activity towards forest area biological condition	Geothermal exploration in forest area needs land opening for exploration well, road access construction, basecamp, etc. Direct effect that possibly happens is habitat fragmentation, etc. Interference/disturbance toward ecosystem biotic condition must be surely discovered, and how much the influence of every disturbance towards every significant species living in the forest area. All disturbance/interference effect should be able to be controlled so they do not exceed the limit of ecosystem biotic elements to defense themselves.	1. Location distribution of all activities in order of geothermal exploration. 2. Habitat of endemic, scarce, and endangered species that live in the forest that become geothermal work area. 3. Exploration activities effect toward forest area biotic condition that become geothermal work area. 4. Treatments of exploration activities effect toward forest area biotic condition that becomes geothermal work area.	
B4. Geothermal exploitation and utilization effect potential towards forest ecosystem biological condition.	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem biotic condition must be identified, so it can be reviewed whether those types and scales of interference not exceed the ability of forest ecosystem biotic elements limit to defense/ reproduce themselves. This is an important information source to determine the feasibility of geothermal utilization exploitation activity from ecology aspect.	1. Distribution of well drilling activity location candidates (exploitation). 2. Habitat of endemic, scarce, and endangered species that live in the forest that become geothermal work area. 3. Exploitation activities effect potential toward forest area biotic condition that become geothermal work area, especially toward habitat of endemic, scarce, and endangered species.	

	Data and Information		Verification Method/ Sampling
	Secondary	Primary	
	1. Complete report document of exploration activities. 2. Report document of exploration activities toward forest area biotic condition assessment study that become geothermal work area, especially their effects to habitat condition. 3. Report document of exploration activities toward forest area biotic condition treatment that become geothermal work area, especially their effects to habitat condition. 4. Report document of special activities (such as: corridor constriction) that purposely protect endemic, scarce, and endangered species that live in the forest that become geothermal work area.	1. Field observation to see habitat changes that caused by exploration activities. 2. Field observation to assess effect treatment and special activities implementation that purposely protect endemic, scarce, and endangered species living that live in the forest that become geothermal work area.	1. Interference type and level analysis of any disturbances that can be tolerated by endemic, scarce, and endangered species that live in the forest that become geothermal work area. 2. Effectivity analysis of exploration activities treatment from the perspective of its impact to endemic, scarce, and endangered species living that live in the forest that become geothermal work area.
	1.Location map of geothermal activities in order of exploitation and utilization. 2. Habitat map of endemic, scarce, and endangered species that live in the forest that become geothermal work area. 3. Report document of exploitation activities toward forest area biotic condition potential study that become geothermal work area, especially their effects to habitat condition.	1. Field observation to see habitat changes that caused by exploitation activities.	1. Interference type and level analysis that possibly happen because of geothermal exploitation and utilization activities. 2. Interference type and level analysis of any disturbances that can be tolerated by endemic, scarce, and endangered species that live in the forest that become geothermal work area. 3. Locations overlay that are predicted to get the impacts with habitat map of endemic, scarce, and endangered species living that live in the forest that become geothermal work area.

Indicator	Definition	Verifier	
B5. Control and maintenance efforts of area biological potential based on effect potential that will happen because all exploitation and utilization activities.	Estimation of interferences that arise from all geothermal utilization and exploitation are expected to be under control, so they do not threaten forest area biological potential. Therefore, it is needed to prepare control and maintenance plan for area biological potential according to future effect potential. In this case, special activities plan must be created to handle significant effect potential that can threaten endemic, scarce, and endangered species living which live inside geothermal work area in the forest.	1. Activities planning of area biological potential control and maintenance activities planning based on effect potential that will occur, complete with design map. 2. Technical design of special activities (such as: corridor constriction) that purposely protect endemic, scarce, and endangered species.	
B6. Exploitation effects toward forest area biological condition and their treatment efforts	Geothermal exploitation activity effects in forest area toward forest area biological potential and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assessed to ensure there is no permanent biological potential degradation.	1. Distribution of exploitation activities locations. 2. Habitat of endemic, scarce, and endangered species that live in the forest that become geothermal work area. 3. Exploitation effect toward forest area biological potential that become geothermal work area. 4. Treatment of exploitation activities effect toward forest biological potential that become geothermal work area.	

	Data and Information		Verification Method/ Sampling
	Secondary	Primary	
	1. Document of area biological potential control and maintenance activities planning based on effect potential that will occur, complete with design map. 2. Document of special activities (such as: corridor constriction) that purposely protect endemic, scarce, and endangered species that live in the forest that become geothermal work area.	1. Field observation to observe the compatibility of area biological potential control and maintenance, also special activities plan that purposely protect endemic, scarce, and endangered species that live in the forest that become geothermal work area.	1. Feasibility analysis of area biological potential control and maintenance and special activities obtained. Feasibility is based on type and scale of effects potential assessment result.
	1. Report document of geothermal exploitation activities. 2. Report document of exploitation activities toward forest area biological potential that become geothermal work area, especially their effects to habitat condition. 3. Report document of exploration activities treatment result toward forest area biological that become geothermal work area. 4. Report document of special activities (such as: corridor constriction) that purposely protect endemic, scarce, and endangered species that live in the forest that become geothermal work area	1. Field observation to see habitat changes that caused by geothermal utilization to electrical energy activities. 2. Field observation to assess effect of geothermal power plant activities treatment and special activities implementation that purposely protect endemic, scarce, and endangered species living that live in the forest that become geothermal work area.	1. Interference type and level analysis of any disturbances in order to utilize geothermal for electrical energy activities that can be tolerated by endemic, scarce, and endangered species that live in the forest that become geothermal work area 2. Effectivity analysis of geothermal utilization to electrical energy activities treatment from the perspective of its impact to endemic, scarce, and endangered species living that live in the forest that become geothermal work area.

Indicator	Definition	Verifier	
B7. Geothermal utilization effects toward forest area biological condition	Geothermal exploitation activity effects in forest area toward forest area biological potential and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assessed to ensure there is no permanent biological potential degradation.	1. Distribution of geothermal activities locations in order to utilize geothermal energy. 2. Habitat of endemic, scarce, and endangered species that live in the forest that become geothermal work area. 3. Utilization effect toward forest area biological potential that become geothermal work area.	
B8. Geothermal utilization contribution towards forest biological potential management quality.	Habitat condition is not always in good condition. That condition is caused by the height of pressure to forest, because the management is not effective all this time so ecosystem biological potential in the state of degraded. Additional role of geothermal business in the forest can be directed to improve forest management quality, such as forest management tools and infrastructures management quality improvement, conservation institute development, society empowerment for biodiversity conservation, etc.	1. Special activities that initiated by developer to support forest management quality improvement for insitu biodiversity conservation according to forest mangement function and objectives.	

	Data and Information		Verification Method/ Sampling
	Secondary	Primary	
	1. Report document of utilization activities to convert geothermal energy to electrical energy. 2. Report document of geothermal power plant activities toward forest area biological potential that become geothermal work area, especially their effects to habitat condition. 3. Report document of geothermal power plant activities treatment result toward forest area biological that become geothermal work area. 4. Report document of special activities (such as: corridor constriction) that purposely protect endemic, scarce, and endangered species that live in the forest that become geothermal work area.	1. Field observation to see habitat changes that caused by geothermal utilization to electrical energy activities. 2. Field observation to assess effect of geothermal power plant activities treatment and special activities implementation that purposely protect endemic, scarce, and endangered species living that live in the forest that become geothermal work area.	1. Interference type and level analysis of any disturbances in order to utilize geothermal for electrical energy activities that can be tolerated by endemic, scarce, and endangered species that live in the forest that become geothermal work area. 2. Effectivity analysis of geothermal utilization to electrical energy activities treatment from the perspective of its impact to endemic, scarce, and endangered species living that live in the forest that become geothermal work area.
	1. Document of special activities plan that initiated by developer to support forest management quality improvement for insitu biodiversity conservation according to forest management function and objectives. 2. Document of special activities report that initiated by developer to support forest management quality improvement for insitu biodiversity conservation according to forest management function and objectives.	1. Field observation to see special activities effectivity that initiated by developer toward quality improvement of forest area biodiversity management according to its function and objective.	1. Implementation effectivity analysis of special activities that initiated by developer to support quality improvement of forest area biodiversity management according to its function and objective.

Table 21. Verifier and Verifier Method for Sustainability Ecological Function in Forest Area Indicator

Indicator	Definition	Verifier
F1. Existing land coverage, historical land coverage change, and land coverage projection.	Land coverage condition is the simplest indicator to see ecosystem physical condition. To improve the accuracy of analysis, land coverage that is studied must be data series to see change tendency, both in history or in the future projection. It is very useful to prepare baseline of land coverage physical condition before and after geothermal business operation.	1. Land coverage condition existing. 2. Land coverage data series.
F2. Forestland physical characteristic includes slope, land, and rainfall intensity factors.	Other important land physical condition to determine land ability level must be identified and studied to assess type and treatment level that can be obtained in the land unit.	1. Area slope classes at forest area that become geothermal work area. 2. Rainfall intensity level at the forest that become geothermal work area. 3. Soil sensitivity towards erosion at the forest that becomes geothermal work area. 4. Land susceptibility of the forest that becomes geothermal work area.
F3. Interference because of exploration activity towards forest area physical condition.	Exploration drilling can create many influences toward topography, such as land opening for well and other supporting facilities, local vibration when drilling, etc. All physical effects occurred must be identified, both their types and scale, and they must be handled soon so they don't decrease land physical support ability to support living.	1. Type and scale of interferences toward area physical condition that are caused by exploration activities. 2. Control and maintenance activities of area physical condition that are affected by exploration.

Verification (Criteria: Ensuring the Physical Condition of Forest Area)

	Data and Information		Verification Method/ Sampling
	Secondary	Primary	
	1. Cover stories of high resolution satellite images. 2. Past periods cover stories of high-resolution satellite images. 3. Study result document of coverage change tendency projection in the future based on forest business as usual (BaU) scenario.	1. Ground check of land coverage purposively.	1. Present and past period cover stories of high-resolution satellite images interpretation. 2. Projection analysis (extrapolation) of land coverage condition in the future based on historical data series.
	1. Area slope classes map of the forest that become geothermal work area. 2. Rainfall intensity distribution map of the forest that become geothermal work area. 3. Soil sensitivity class distribution map of the forest that become geothermal work area. 4. Land susceptibility level map of the forest that become geothermal work area.	1. Test of soil sampling picking for soil testing in laboratory. 2. Making of rainfall intensity observation station.	1. Physical land unit susceptibility analysis of the forest that become geothermal work area based on slope, rainfall intensity, and soil sensitivity.
	1. Complete report documents of exploration activities the forest that becomes geothermal work area. 2. Report document of exploration activities toward forest area physical condition assessment that become geothermal work area. 3. Report document of forest area physical condition exploration activities treatment that become geothermal work area.	1. Field observation to see exploration activities locations. 2. Field observation to observe physical effects from exploration activities.	1. Comprehensive analysis to get the conclusions about type, level, and location of physical interferences that arise because of exploration activities, along with the boundary limit of interferences that can be tolerated. 2. Effectivity analysis of exploration activities treatment.

Indicator	Definition	Verifier	
F4. Geothermal exploitation and utilization effect potential towards forest ecosystem physical condition.	Interference types and scales that possibly arise because of exploitation and utilization toward ecosystem biotic condition must be identified, so it can be reviewed whether those types and scales of interference not exceed the ability of forest ecosystem biotic elements limit to defense/reproduce themselves. This is an important information source to determine the feasibility of geothermal utilization exploitation activity from ecology aspect.	1. Distribution of well drilling activity location candidates (exploitation) and their tools and infrastructures. 2. Critical locations, which have high physical susceptibility level. 3. Exploitation activities effect potential toward forest is physical condition that becomes geothermal work area, especially critical locations which have high susceptibility level.	
F5. Control and maintenance efforts of area physical potential based on effect potential that will happen because all exploitation and utilization activities.	Estimation of interferences that arise from all geothermal utilization and exploitation are expected to be under control, by well-planned efforts. In this case, there must be detail plan for treatment of every type of interferences that predicted.	1. Activities planning of area physical condition control and maintenance activities planning based on effect that will occur because of geothermal exploitation and utilization. 2. Technical design of special activities that purposely handle significant impacts which influence physically susceptible land.	
F6. Exploitation effects toward forest area physical condition and their treatment efforts.	Geothermal exploitation activity effects in forest area toward forest area ecosystem function and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assessed to ensure there is no permanent ecosystem function degradation.	1. Distribution of exploitation activities locations. Critical locations, which have high physical susceptibility level. 2. Exploitation effect toward forest area physical condition that become geothermal work area. 3. Treatments of exploitation activities effect toward forest physical that become geothermal work area.	

	Data and Information		Verification Method/ Sampling
	Secondary	Primary	
	1. Land unit susceptibility level map of the forest that become geothermal work area. 2. Report document of exploitation activities toward forest area physical condition potential assessment that become geothermal work area, especially their effects to habitat condition.	1. Locations overlay that are predicted to get the impacts with land unit susceptibility level map. 2. Type and level of physical interferences analysis that can be tolerated according to land ability based on susceptibility land unit.	1. Interference type and level analysis that possibly happen because of geothermal exploitation and utilization activities. 2. Interference type and level analysis of any disturbances that can be tolerated by endemic, scarce, and endangered species that live in the forest that become geothermal work area. 3. Locations overlay that are predicted to get the impacts with habitat map of endemic, scarce, and endangered species living that live in the forest that become geothermal work area.
	1. Document of area physical condition control and maintenance activities planning based on effect potential that will occur, complete with design map. 2. Document of special activities that purposely protect area physical condition, which have high susceptibility level.	1. Field observation to observe the compatibility of area biological potential control and maintenance, also special activities plan that purposely protect area physical condition which have high susceptibility level.	1. Feasibility analysis of area physical condition control and maintenance and special activities obtained. Feasibility is based on type and scale of effects potential assessment result.
	1. Report document of geothermal exploitation activities. 2. Report document of exploitation activities toward forest area physical condition that become geothermal work area. 3. Report document of exploitation activities treatment result toward forest area physical condition that become geothermal work area. 4. Report document of special activities that purposely protect forestland function to maintain water and land stability.	1. Field observation to see physical changes that caused by geothermal exploitation, whether they are interferences that can be tolerated or not. 2. Treatment effectivity analysis of exploitation activity effect in the perspective of water and land stability management system.	1. Interference type and level analysis of any disturbances from exploitation activities that can be tolerated or not. 2. Effectivity analysis of exploitation activities treatment from the perspective of its impact to water and land stability management system.

Indicator	Definition	Verifier	
F7. Geothermal utilization effects toward forest area physical condition.	Geothermal exploitation activity effects in forest area toward forest area ecosystem function and their treatment efforts have been studied and prepared before. In the middle and after exploitation activity, effects and treatment efforts must be monitored and effectively assessed to ensure there is no permanent ecosystem function degradation.	1. Distribution of geothermal activities locations in order to utilize geothermal energy. 2. Distribution of locations that physically susceptible. 3. Utilization effect toward forest area physical condition that become geothermal work area.	
F8. Geothermal utilization contribution towards forest physical condition management quality	Physical condition of forest area where geothermal work area exists is not always in good condition. That condition is caused by the amount of pressure toward forest, because the management is not effective all this time so ecosystem ecosystem function keeps decreasing. Additional role of geothermal business in the forest can be directed to handle ecosystem physical degradation, such as ecosystem restoration and land rehabilitation, society empowerment to reduce dependability of society to forest, etc	1. Special activities that initiated by developer to support forest management quality improvement, especially to improve forest area physical condition according to forest management function and objectives.	

	Data and Information		Verification Method/ Sampling
	Secondary	Primary	
	1. Report document of utilization activities to convert geothermal energy to electrical energy. 2. Report document of geothermal power plant activities toward forest area physical condition that become geothermal work area. 3. Report document of geothermal power plant activities treatment result toward forest area physical condition that become geothermal work area. 4. Report document of special activities that purposely protect forestland function to maintain water and land stability.	1. Field observation to see physical changes that caused by geothermal utilization to electrical energy activities. 2. Field observation to assess effect of geothermal power plant activities treatment and special activities implementation that purposely protects physical condition in susceptible locations area.	1. Interference type and level analysis of any disturbances if utilization activities, whether it can be tolerated or not. 2. Effectivity analysis of exploitation activities treatment from the perspective of its impact to water and land stability management system.
	1. Document of special activities plan that initiated by developer to improve forest area physical condition that is damaged because improper management all this time. 2. Document of special activities report that initiated by developer to improve forest physical condition.	1. Field observation to see special activities effectivity that initiated by developer, toward quality improvement of forest area physical condition in order to revitalize area function and existing forest area management objectives.	1. Implementation effectivity analysis of special activities that initiated by developer to improve area physical condition in order to revitalize area function and existing forest area management objectives.

Table 22. Standard Value of each Indicator in each Typology

Indicator	Typology 1	Typology 2	Typology 3	Typology 4
Area Function Stability Principles				
K1. Geothermal model, expected reserve, and exploration drilling location objective in forest area.	good	good	good	good
K2. Geothermal work area is determined without accompanied by proposal of forest area function change	good	good	good	good
K3. Exploration activities effect towards forest area function	good	good	good	good
K4. Feasiblity of geothermal business plan from forest area function and forest management purpose that is related.	good	good	good	good
K5. Exploitation activities or development drilling do not interfere forest area function and forest management purpose	good	good	good	good
K6.Construction of all facilities of GPP is suitable to forest management zone/block.	good	good	good	good

Indicator	Typology 1	Typology 2	Typology 3	Typology 4
Area Function Stability Principles				
B1. Biodiversity potential of forest area includes complete lists of plants and animals species in forest area, significant plants and animals species, and distribution and population of those significant species.	good	good	moderate	moderate
B2. Significant animals and plants species habitat map and behavior.	good	good	moderate	moderate
B3. Interference because of exploration activity towards forest area biological condition	good	good	moderate	moderate
B4.Geothermal exploitation and utilization effect potential towards forest ecosystem biological condition.	good	good	moderate	moderate
B5. Control and maintenance efforts of area biological potential based on effect potential that will happen because all exploitation and utilization activities.	good	good	moderate	moderate
B6. Exploitation effects toward forest area biological condition and their treatment efforts	good	good	moderate	moderate
B7. Geothermal utilization effects toward forest area biological condition	good	good	moderate	moderate
B8. Geothermal utilization contribution towards forest biological potential management quality.	good	good	moderate	moderate

Indicator	Typology 1	Typology 2	Typology 3	Typology 4
Area Function Stability Principles				
F1. Existing land coverage, historical land coverage change, and land coverage projection.	good	moderate	good	moderate
F2. Forestland physical characteristic includes slope, land, and rainfall intensity factors.	good	moderate	good	moderate
F3. Interference because of exploration activity towards forest area physical condition	good	moderate	good	moderate
F4. Geothermal exploitation and utilization effect potential towards forest ecosystem physical condition.	good	moderate	good	moderate
F5. Control and maintenance efforts of area physical potential based on effect potential that will happen because all exploitation and utilization activities.	good	moderate	good	moderate
F6. Exploitation effects toward forest area physical condition and their treatment efforts	good	moderate	good	moderate
F7. Geothermal utilization effects toward forest area physical condition.	good	moderate	good	moderate
F8. Geothermal utilization contribution towards forest physical condition management quality.	good	moderate	good	moderate

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APPENDIX

1. Zoning National Park Management
2. Summary of Non-geothermal Activities in Natural Preservation Areas/Natural Conservation Areas

Appendix 1. Zoning National Park Management

Name	Definition	Criteria
Core Zone	Part of a national park that still have a natural condition, either physical or biota that are still original and has been disturbed by human and absolutely protected. The purpose is for the protection of original and distinctive biodiversity	a) Part of national park that has a diversity of plants and animals and their ecosystems; b) Represents certain formation and biota or its constituent units that are characteristic of ecosystem in the national park with pristine physical condition and not disturbed by human c) Have a natural condition, both physical and biota are still original and has not been disturbed by human d) Have a certain area and certain shape to ensure the survival of certain species to support the effective management and ensuring the natural ecological processes e) Has the characteristic for it potential and is an example that its existence requires conservation f) Has a communities of plant and wildlife and their ecosystem that are rare and gravely threatened g) A wildlife habitat and/or certain prioritized plants that are unique/ endemic. h) An activity of migrant wildlife
Forest Zone	Part of national park due to its location, condition and its potential are able to support the conservation in core zone and utilization zone	a) Area which is a habitat or home range area to protect and to support breeding of wildlife; b) Have ecosystems or species diversity which capable of supporting preservation of the core zone and zone use; c) A place of life for migrant species.
Utilization Zone	Part of national park due to its location, condition and its potential are used for nature tourism and other condition/ environmental services	a) Have a natural attraction in the form of plants, animals or a specific ecosystem formations and its geological formations are beautiful and unique; b) Have sufficient area to ensure potential sustainability and attraction to be used for nature tourism; c) Environmental conditions that favor the use of environmental services, development of nature tourism, research and education; d) An area that allows for the development of infrastructure for utilisation activity of environmental services, eco-tourism, recreation, research and education; e) Not directly bordered to the core zone.

	Purpose	Allowed Activity
	For the protection of ecosystems, unique flora and fauna preservation along with its habitat which are sensitive to disturbance and change, sources of germplasm from species of plants and wildlife for the purpose of research and development of science, education, and as supporting cultivation.	a) Protection and security; b) Inventorying and monitoring of natural resources in the ecosystem; c) Research and development, science, education, and or supporting cultivation; d) Can build non-permanent infrastructure that are not limited to research and management activities
	For preservation activities and the utilization of natural resources and a natural environment for the purpose of research, conservation education, limited travel, wildlife habitat and support the breeding of migrant species as well as supporting the core zone.	a) Protection and security; b) Inventorying and monitoring of natural resources in the ecosystem; c) Research development, education, limited nature tourism, use of environmental services and supporting activities of cultivation; d) Development of habitat and populations in order to increase the nexistence of wildlife populations; e) Construction of facilities and infrastructure for the benefit of research, education, and limited nature tourism.
	For the development of nature tourism and recreation, environmental services, education, research, and development which support utilization of cultivation activities.	a) Protection and security; b) Inventorying and monitoring of natural resources in the ecosystem; c) Research and development education, and support cultivation; d) Development of potential and natural attractions; e) Development of habitat and populations; f) Nature tourism exploitation and utilisation of environmental services; g) Construction facilities and infrastructure of management, research, education, nature, and utilization environmental services.

(Next) Appendix 1. Zoning National Park Management

Name	Definition	Criteria	
Traditio nal Zone	Part of national park that are established for the benefit of traditional use by the locals, who have historically had a dependency with the natural resources	a) The potential and condition of certain non-timber natural resources that have traditionally used by local communities to meet their needs; b) In waters there is a potential and condition of certain natural resources have been exploited through breeding, multiplication, and enlargement by local communities to meet their needs.	
Rehabili tation Zone	Part of the national park, which is due to the damage it is necessary for a community recovery activities for its damaged biodiversity and ecosystem	a) The existence of physical changes, physical properties, and biological changes which ecologically affect the sustainability of ecosystem recovery which recovery requires human intervention; b) The presence of invasive species that interfere with few types or native species in the region; c) Recovery area of (a) and (b) takes a minimum of 5 years.	
Religion, Culture, and Histo-rical Zone	Part of national park that have in them a religious site, relics or historical and cultural heritage which is used for religious activities, and protection of cultural values or history	a) The existence of a location for religious activities are still maintained and used publicly; b) The existence of cultural and historical sites, both reserved and non-reserved by laws.	
Special Zone	Part of national park, which is due to unavoidable condition there has been groups of locals and their supporting properties in the are before it was assigned as a national park, among them are telecommunication, transportation facility, and electricity	a) There have been a group of people and its life supporting infrastructure lived before the area were appointed/designated as national park; b) There have been infrastructure, among other telecommunication, transportation facilities, and electricity, before the region was appointed/ designated as national park; c) Location is bordered with the core zone.	

Foto: ©Moving Images/ NL Agency

	Purpose	Allowed Activity
	To utilise certain potential of national parks by local people in a sustainable manner through regulating the utilization in order to meet their needs.	a) Protection and security; b) Inventorying and monitoring of potential types of resource utilised by the community; c) Development of habitat and populations; d) Research and development; e) Exploiting the potential of natural resources in accordance with the agreement and applicable regulations
	To restore damaged ecosystems damaged areas back into or close to its natural ecosystem conditions.	a) Protection and security; b) Inventorying and monitoring of potential types of resource utilised by the community; c) Development of habitat and populations; d) Research and development; e) Exploiting the potential of natural resources in accordance with the agreement and applicable regulations.
	To demonstrate and protect the work, culture, history, archeology, and religion values as a vehicle for research of; education and nature of history, archeology, and religious.	a) Protection and security; b) Utilisation of nature tourism, research, education and religion; c) Implementation of traditional ceremonies; e) Maintenance of cultural and historical sites, as well as the continuity of existing religious rituals/customs
	Activities for the benefit of communities living in the region before it was appointed/designated as national park. Existing community along with its life support infrastructure and interests that cannot be avoided, such as telecommunications facilities, transportation facilities, and electricity.	a) Protection and security; b) Utilization to support community life; c) Rehabilitation; d) Monitoring the population and community activities, as well as the carrying capacity of the area.

Sumber: Permenhut No. P.56/Menhut-II/2006

Appendix 2. Summary of Non-geothermal Activities in Natural Preservation Areas/Natural Conservation Areas

No	Location	The Third Party	Activity	
1.	Gunung Halimun Salak National Park	PT Chevron Geothermal (previously Unocal Geothermal of Indonesia)	Geothermal field development and Geothermal Power Plant in Mount Salak protected forest for 20 years covering 273.66 ha	
2.	Kawah Kamojang Preservation Area	Pertamina UEP III	Access of steam pipe and drilling installations covering 5.25 ha and 4.25 ha OBJ OBJ OBJ OBJ	
3.	Kawah Kamojang Preservation Area	Pertamina UEP III	Geothermal drilling and steam pipelines covering 21.51 ha	
4.	Kawah Kamojang Preservation Area	Pertamina UEP III	Geothermal drilling phase 2 covering 5.85 ha and 12.4 ha	
5.	Kawah Kamojang Preservation Area	Pertamina UEP III	Field development Phase 2 covering 12 ha	
6.	Kawah Kamojang Preservation Area	PT Latoka Trimas Bina Energi	Geothermal power plant development Unit VI covering 2 ha	

Natural Preservation Areas/Natural Conservation Areas

	Licensing/Approval	Cooperation Agreement	Time Span
	- Minister of Forestry Letter No. 018/Menhut- VII/1995 dated 11 June 1995 - Minister of Forestry Letter No. 1053/Menhut- VII/1995 dated 19 July 1995 - Directorate General of Forest Protection and Nature Conservation Letter No. S.797/IV/ KK/2005 dated 20 December 2005	Lease agreement with compensation ratio 1:2 No. 06/044.3/ III/1996 tgl. 15 Agustus 1996	20 years
	- Directorate General of Forestry Letter No. 2143/Dj/1/74 dated 30 May 1974 - Directorate General of Forestry Letter No. 3059/DJ/1/78 dated 21 September 1978	Lease without compensation	1 August 1995 – 1 August 2000
		Extension through Cooperation Agreement between West Java's Natural Resource Conservation Office with Pertamina GE dated 13 July 2009, addendum 21 December 2009	13 July 2009 – 13 July 2014
	- Directorate General of Forestry Letter No. 204/DJ/1/1983 dated 17 January 1983 - Directorate General of Forestry Letter No. 576/DJ/1/1983 dated 11 February 1983 - Ministry of Forestry Letter No. 022/Kpts-II/1984 dated 17 February 1984	Lease without compensation	1 August 1995 – 1 August 2000
		Extension through Cooperation Agreement between West Java's Natural Resource Conservation Office with Pertamina GE dated 13 July 2009, addendum 21 December 2009	13 July 2009 – 13 July 2014
	- Ministry of Forestry Letter No. 227/Kpts-II/1989 dated 11 February 1989 - Ministry of Forestry Letter No. 927/Menhut-VII/1997 dated 20 August 1997	Lease with compensation covering 12 ha and 14 ha	1 September 1995 – 1 September 2020 and 20 August 1997 – 20 August 2022
		Extension through Cooperation Agreement between West Java's Natural Resource Conservation Office with Pertamina GE dated 13 July 2009, addendum 21 December 2009	13 July 2009 – 13 July 2014
	- Ministry of Forestry Letter No. 341/Menhut-VII/1997 dated 15 March 1997	Lease with compensation covering 24 ha	
		Extension through Cooperation Agreement between West Java's Natural Resource Conservation Office with Pertamina GE dated 13 July 2009, addendum 21 December 2009	13 July 2009 – 13 July 2014
	- Ministry of Forestry Letter No. 242/Menhut-VII/1998 dated 25 February 1998	Lease with compensation covering 4 ha	
		Extension through Cooperation Agreement between West Java's Natural Resource Conservation Office with Pertamina GE dated 13 July 2009, addendum 21 December 2009	13 July 2009 – 13 July 2014

Appendix 2. recapitulation non forestry activities geothermal

No.	Location	The Third Party	Activity
7.	Papandayan Preservation Area	PT Amoseas Indonesia Inc.	Expansion Activity Phase 2 covering 26 ha
8.	Papandayan Preservation Area	PT Amoseas Indonesia Inc.	Geothermal exploration and exploitation; and steam pipe access drilling covering 7 ha
9.	Papandayan Preservation Area	PT Amoseas Indonesia Inc.	Installation of Gas/Steam Supplier Pipes covering 0.095 ha
10.	Bukit Barisan Selatan National Park	Local Government of West Lampung	Development of Sekincau-Suoh Geothermal Power Plant
		Chevron Geothermal Suoh Sekincau	Geothermal Potencial Investigation (Geology, Geophysics, and Geochemistry surveys)
11.	Kelimutu National Park	PT Sokoria	Sokoria Geothermal Power Plant
12.	Gunung Rinjani National Park	PT PLN (Persero)	UKL-UPL (AMDAL) studies; Geology, Geochemistry, and Geophysics survey in Sembalun.

Natural Preservation Areas/Natural Conservation Areas

	Licensing/Approval	Cooperation Agreement	Time Span
	- Ministry of Forestry Letter No. 336/Menhut-VII/1997 dated 26 March 1997	Lease with compensation	1998-2003
		Extension through Cooperation Agreement between West Java's Natural Resource Conservation Office with Chevron Geothermal Indonesia dated 13 July 2009.	
	- Ministry of Forestry Letter No. 520/Menhut-VI/1986 dated 22 October 1986 - Ministry of Forestry Letter No. 126/Menhut-II/1992 dated 10 January 1992 - Ministry of Forestry Letter No. 321/Menhut-V/2001	Lease with compensation covering 7 ha	30 January 1997 - 29 February 2002
		Extension through Cooperation Agreement between West Java's Natural Resource Conservation Office with Chevron Geothermal Indonesia dated 13 July 2009.	13 July 2009 – 13 July 2014
	Ministry of Forestry Letter No. 126/Kpts-II/1992 dated 10 January 1992		5 April 1993 – 5 April 1998
		Extension through Cooperation Agreement between West Java's Natural Resource Conservation Office with Chevron Geothermal Indonesia dated 13 July 2009.	13 July 2009 – 13 July 2014
	Directorate General of Forestry Letter No. S.98/IV-KK/2008 dated 25 February 2008	Cooperation Agreement between Bukit Barisan Selatan National Park with West Lampung Government No. PKS.89/BBTNBBS-1/2009 and No. 549/01/PEMKAB-LB/II.11/2009 dated 29 January 2009	29 January 2009 – 29 January 2014
	- Directorate General of Forestry Letter - No. S.370/IV- KKBHL/2011 dated 8 August 2011	(3G survey phase)	
	No progress		
	Directorate General of Forestry Letter No. S.256/IV- KKBHL/2011 dated 26 May 2011	(3G survey phase)	

Sumber: Direktorat Konservasi Kawasan Ditjen PHKA (2011)

About WWF Ring of Fire Program

With the Ring of Fire Program, WWF has an ambition:
by 2015 there is a significant shift towards the use of renewable energy and particularly in the sustainable production and use of geothermal energy in Indonesia and the Phillipines.

Improved Enabling Environment

By 2015, an improved enabling environment conducive to geothermal energy and other RES will be in place in Indonesia and the Philippines.

WWFs 100% Renewable Vision

By 2015, Indonesia has agreed to national renewable energy targets for 2030 in line with WWF's 100% renewable vision, including a target for ending energy poverty by 2030. By 2015, the targets for the Philippines will be more ambitious than the 2030 target announced by government.

WWFs Sustainability Guidelines

By 2015, WWF's Sustainability Guidelines shall have been accepted by the geothermal industry as a best practice benchmark, has significantly improved geothermal energy's social acceptability and built broad stakeholder support.

WWF strengths of working in partnership with the public and private sector, and combining expertise with on the ground implementation, will form the basis of our approach. Furthermore, WWF has been 50 years of experience in the region. WWF intends to use this program as a catalyst to accelerate geothermal development in other countries within the region - and potentially in other regions with rich geothermal energy potential.

The program will show it is possible to achieve this ambition in a sustainable way, conserving biodiversity, and at the same time support innovation and green economic growth, counter climate change and improve the living conditions of targeted communities. A rightly approached 'Green New Deal' works on energy supply, environment protection, employment creation and economic growth.

WWF

Why we are here
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature

www.wwf.or.id

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