Capacity building for geothermal electricity generation in Indonesia

Evaluation of activities supported by the Dutch Promoting Renewable Energy Programme

Source: HLN.be Eruption Krakatau

Rotterdam, March 2015.

This working paper forms part of a series of evaluative assignments commissioned by the Policy and Operations Evaluation Department (IOB) of the Netherlands Ministry of Foreign Affairs to Erasmus Research and Business Support (ERBS) in the area of the Dutch support to Renewable Energy and Development. The report serves as one of the input documents to the policy assessment of the Promoting Renewable Energy Programme (PREP).

Preface

Since 1968, the Netherlands development cooperation has been investing in renewable energy in developing countries, initially in the context of the appropriate technology movement, later as component of environmental protection in combination to poverty alleviation. Over the last decade the support to renewable energy is increasingly motivated by the global effort to reduce carbon dioxide emissions and the green growth agenda. In 2004, during the conference *Energy for Development*, the Dutch Minister for Development Cooperation committed the Dutch government to providing access to energy to 10 million people by 2015. In 2008, with the launch of the Promoting Renewable Energy Programme, efforts intensified to achieve the following (related) objectives: direct investment in renewable energy and biomass; the mobilisation of international awareness and resources to improve access to energy; and the strengthening of the knowledge base of national governments concerning the linkages between poverty, renewable energy and climate change.

Between 2010 and 2014, the Policy and Operations Evaluation Department (IOB) of the Dutch Ministry of Foreign Affairs evaluated the impact at household and community level of different interventions in the area of renewable energy in Rwanda, Burkina Faso and Indonesia. In Indonesia interventions related to domestic biogas, micro-hydro electricity generation and the capacity building in the area of geothermal energy generation were subject to evaluation. These subjects were selected based on pre-established criteria concerning diversity in energy sources.

The working paper presents the evaluation of Dutch funded capacity building in geothermal energy as delivered by both bilateral and multilateral programmes, in particular by the World Bank and the International Finance Corporation (IFC). These programmes shared the common characteristic of being 'upstream' interventions, aimed at eliminating structural constraints such as feed-in tariff hurdles for electricity generated by geothermal sources. Other constraints were the complex legislation that obstructed the exploration and exploitation of geothermal energy, and the capacity flaws within different levels of government to adequately deal with the technical, administrative and financial complexities of geothermal exploitation.

This paper describes the Dutch funded interventions in the area of geothermal energy development in Indonesia, and assesses whether the results of these interventions have contributed to renewed public and private sector interest to invest in geothermal energy.

IOB commissioned Erasmus Research and Business Support (ERBS B.V.), Erasmus University Rotterdam to conduct the study, which was elaborated by Willem Cornelissen. Hester Mourik assisted with web-search.

ERBS is grateful for the assistance provided by the IOB researcher Rafaëla Rijken-Feddes. ERBS assumes full responsibility over the contents of this report.

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Acronyms and abbreviations

ASTAE	Asia Sustainable and Alternative Energy Programme
BAPPENAS	State Ministry for National Development Planning
BECIN	Bilateral Energy Cooperation Indonesia Netherlands
BMZ	*Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung* (German Federal Ministry for Economic Cooperation and Development)
CIF	Climate Investment Fund
CO_2	Carbon dioxide
CTF	Clean Technology Fund (component of CIF)
DGIS	Directorate General for International Cooperation
EC	European Commission
EIA	Environmental Impact Assessment (in Dutch MER, Milieu Effect Rapportage)
EKN	Embassy of the Kingdom of the Netherlands
EnDev	Energising Development
ESMAP	Energy Sector Management Assistance Programme
EUR	Euro
FiT	Feed-in Tariff
FMO	Entrepreneurial Development Bank (*Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden*)
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GEOCAP	Geothermal Capacity Building Programme Indonesia Netherlands
GIZ	*Gesellschaft für Internationale Zusammenarbeit* (prior to 2011 GTZ)
GNP	Gross National Product
GW (h)	Gigawatt (hour)
IBRD	International Bank for Reconstruction and Development
ICS	Improved Cooking Stoves
IDR	Indonesian Rupiah
IFC	International Finance Corporation
IMF	International Monetary Fund
INAGA	Indonesia Geothermal Association
IPP	Independent Power Producer
ITC	International Training Centre (Faculty of Geo-Information Science and Earth Observation, University of Enschede)
IOB	Policy and Operations Evaluation Department of the Netherlands Ministry of Foreign Affairs
JOC	Joint Operation Contract
Ktoe	Kilogramme of oil equivalent
kWh	Kilo Watt hour
MASP	Multi-Annual Strategic Plan
MDGs	Millennium Development Goals
MEMR	Ministry of Energy and Mineral Resources
MW	Megawatt
NGCBP	National Geothermal Capacity Building Programme
NGO	Non-Governmental Organisation
PGE	Pertamina Geothermal Energy
PLN	Persero (state company) Perusahaan Listrik Negara, electricity utility company
PPA	Power Purchasing Agreement
PPP	Public-Private Partnership
PREP	Promoting Renewable Energy Programme
REEEP	Renewable Energy and Energy Efficiency Partnership
REFIT	Renewable Energy Feed-in Tariff

RVO.nl	Netherlands Enterprise Agency
SE4All	Sustainable Energy for All initiative
ToR	Terms of Reference
USD	United States Dollars
WWF	World Wildlife Fund

Currency	EUR 1 = IDR 9,433 as per 1st January 2008 IDR 12,171 as per 1st January 2014

Indonesia facts

Energy

GDP growth 2013	5.8% (Asian Development Bank)
GDP per capita 2013	USD 3,509 (IMF, 2014)
Electricity use per capita	680 kWh (MEMR, 2012)
Electricity access rate	72.5% (MEMR, 2012)
Electricity from renewable sources (not hydro)	4.8% (MEMR, 2010)
Carbon dioxide (CO_2) emission 2013	307 million metric tons (US Energy Information Administration)
Per capita CO_2 emission	1.3 metric tons (US Energy Information Administration)
Geothermal potential (estimated)	27-29 GW

1 Introduction

1.1 Purpose and status of the report

In September 2009, the Policy and Operations Evaluation Department (IOB) of the Ministry of Foreign Affairs of the Netherlands embarked upon the evaluation of programmes in the area of Energy and Development Cooperation as overarching framework for a series of impact studies of activities funded by the Promoting Renewable Energy Programme.[1] The *central research question* for the 10 impact evaluations was: 'What have been the effects – positive or negative, intended or not – on living conditions of target groups of the energy and development cooperation programmes and projects supported by the Netherlands, and how sustainable are the results achieved?'

Between 2010 and 2014, impact studies were conducted in Burkina Faso, Rwanda and Indonesia on selected activities, such as solar energy systems, biogas, improved cooking stoves (ICS) and rural electrification through micro hydro plants. In Indonesia rigorous analysis was conducted on interventions related to micro-hydro electricity generation and biogas. The present report refers to another set of support interventions in the energy sector in Indonesia, being 'upstream' interventions aimed at removing constraints that over decades impeded the exploration and exploitation of geothermal resources (see Annex 1 for a description of geothermal resources).

This study has the status of working paper and serves as background information to the IOB policy analysis of Dutch interventions in renewable energy. Contrary to the rigorous quantitative methods with extensive field research applied to study micro-hydro electricity generation and biogas, the interventions referred to in this report are evaluated based on qualitative research only (see the section on methodology below).

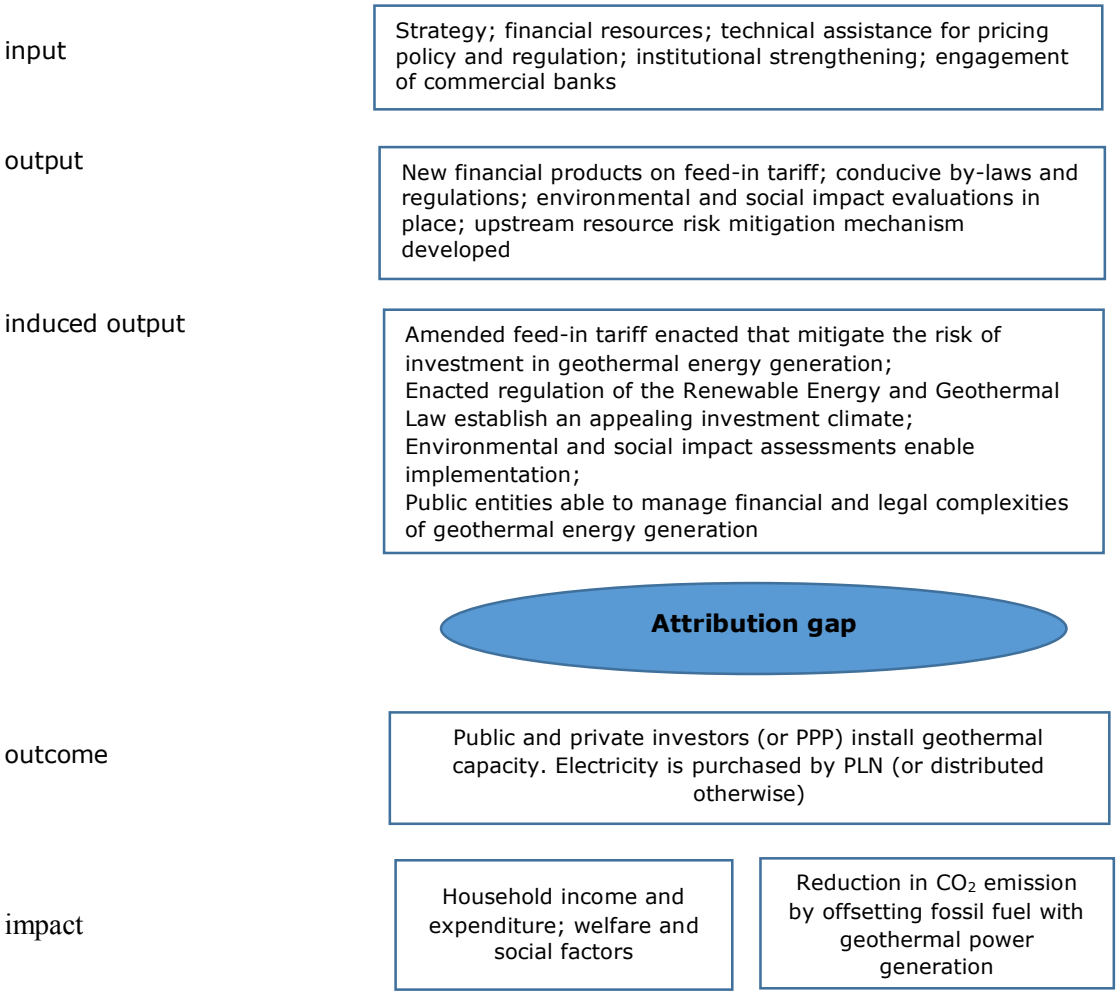
1.2 Objective of the evaluation

During the late 1990s, the exploration and exploitation of geothermal resources had come to a standstill in Indonesia. The Government of Indonesia, with the support of the World Bank and other international organisations undertook various studies to analyse the constraints to geothermal energy development. The subject also formed part of the Netherlands' support to the energy sector in Indonesia. Proposals for improvement pointed all, directly or indirectly, to 'upstream' changes required to establish a more appealing environment for both public and private investment (electricity companies, equity capital providers, international investment banks).

The objective of the present evaluation is to analyse the effects of these interventions aimed at redeploying investment in geothermal energy in Indonesia. Figure 1 summarises the perceived results chain and describes how financial resources and strategy as input lead to output in terms of new financial instruments, regulation and capacity building. At the moment of evaluation (2014) there was no geothermal energy used to produce electricity to feed into the grid that could time-wise be related to the interventions referred to in the results chain. In consequence, the study focused at the question whether the changes in the financial and regulation environment have triggered both public and private investment in geothermal capacity.

[1] See: www.iob-evaluatie.nl/node/331. Terms of Reference impact evaluation of Energy and Development Cooperation supported by the Netherlands, Sept 2009.

Figure 1: Results chain of support to geothermal energy



The questions addressed in this working paper are derived from Terms of Reference elaborated for evaluation studies to be conducted in Indonesia[2] encompassing (a) g*eneral and contextual questions concerning the energy sector and its institutions and (b) questions concerning the renewable energy activities in Indonesia funded by the Netherlands*.

The questions at output level relate to the following aspects:

- Which government entities received technical assistance in the area of price policy and formulation of regulations in the area of geothermal energy generation?
- What kind of new financial products were developed, in particular those related to risk mitigation?
- Were the proposed and drafted regulations related to the Geothermal Law approved and enacted?
- Were there any additional regulations or codes developed and enacted in the area of the exploration licenses?

And the questions at induced output and outcome level are:

- Which and how many private enterprises made use of the financial instruments developed?

[2] Terms of Reference impact evaluation of Netherlands supported programmes in the area of Energy and Development Cooperation in Indonesia. 09 February, 2011.

- What kind of public-private arrangements have been put in place?
- How many new investors, both national and international, have started to make investments, either individually or in public-private partnership in geothermal energy generation? If positive, can this investment either in total or in part being attributed to the improvements in pricing policy, regulations and codes?

Induced output indicators refer to new feed-in tariffs and pricing mechanisms, legal regulations and procedures. At outcome level, the indicators are direct investment (either by the public or private sector) in geothermal exploration and exploitation. It is noted that attribution is hard to prove for two reasons: (i) the Dutch interventions were almost all embedded in larger programmes of the Indonesian government, the World Bank, the International Financing Corporation (IFC) or the Asian Development Bank (AsDB); (ii) an array of other factors play a role in investment decisions.

1.3 Evaluation methodology

The evaluation of interventions in the area of geothermal energy was restricted to those ones that were either funded directly by the embassy of the Kingdom of the Netherlands in Jakarta or indirectly with Dutch resources through (additions to) funds established within international organisations, like the World Bank.

The general and contextual questions concerning the energy sector and its institutions in Indonesia have been addressed using qualitative techniques only (documentation research, web search).

Baseline information regarding the interventions was gathered during a field mission in October 2010. Reports concerning the interventions were collected and reviewed over the period 2010-2014. As follow-up, in 2014 additional desk research was conducted. Web search was combined with semi-structured interviews held with stakeholders in the Netherlands and with international organisations (2014). Due to logistical and financial constraints, the results of this evaluative analysis have not been verified by a field visit to Indonesia.

Due to logistical and financial constraints there has been a time lapse between the field visit to Indonesia and the interviews hold at the time (2010) and the follow up (2014) without further verification in Indonesia.

2 The energy context in Indonesia

2.1 Economic development and energy

In 2008, Indonesia formally became a lower middle income country and has experienced annual growth rates of over 5 percent[3] since then. Domestic private consumption is the major driver of growth and relies on domestic private investment. This implies that the economy was hardly affected by the 2008-2013 global economic crisis (EIU, 2014). The economic growth is distributed dissimilar over the archipelago, leading to a rising disparity among islands and inequality among population groups.

The relation between economic growth and energy in Indonesia is complex. About 10% of the Gross Domestic Product depends on mining of energy carriers like coal, oil and gas (the GDP is roughly composed of 50% services, 25% manufacturing, 15% agriculture and 10% mining[4]) and Indonesia is the world's second largest exporter of coal. The annual increase in energy demand is approximately 8% (or 2,000 MW) per year (van der Meer, 2013). Historically, Indonesia has relied on heavily subsidized oil-fuelled power plants (88.1% in 2008) to meet electricity demand, but the policy to diversify the fuel sources led to an expanding number of coal plants. Since 2011, international coal prices are declining, implying that the contaminating coal plants became economically more advantageous. In 2008, Indonesia was among top ten countries when it comes to greenhouse gas emission. Subsidies on energy (fuel, electricity) together require 17% of public spending (EIU, 2014). The policy of the government under President Joko Widodo (2014) is to gradually phase out the subsidies on fuel, but the State Budget over the fiscal year 2015 still shows an increase in spending on fuel and electricity subsidies. The state energy monopoly, Pertamina, tightened daily quota's on purchased diesel and petrol in several instances, but had to lift these again after massive protests. Table 1 shows a breakdown of total energy use and electricity use in relation to domestic energy sources.

Table 1 Breakdown of energy use, electricity and heat generation in Indonesia, 2010

Year 2010	Primary energy sourced within country	Energy imports minus exports	Primary energy used within the country (1)			Electricity generation source
	Ktoe	Ktoe	Ktoe	GWh	percentage	percentage
Coal, brown coal and peat	186,328	-155,845	30,483	354,517	15	40
Oil fuels	48,442	19,482	66,930	778,392	32	20
Natural gas	74,741	-35,952	38,789	451,114	19	24
Hydroelectric	1,520		1,520	17,679	1	10
Biofuels and waste (2)	54,326	-290	54,039	628,474	26	
Geothermal	16,088		16,088	187,104	8	6
Totals	381,446	-172,605	207,849	2,417,279	100	100
Renewables as % of totals	19	0	34	34	34	16

Source: Based on World Energy Statistics and Balances. Database 2012 'World Energy Balances', IEA, 2012.
Note: (1) Sum of energy sources within the country, energy imports minus exports, international marine and aviation bunkers. (2) The database considers the category 'biofuels and waste' as 'renewable energy'.
Standard conversion 1 kilogramme of oil equivalent (Ktoe) = 11.63 GigaWatt hour (GWh).

[3] The average pace of GDP growth over the period 2008-2013 was 5.2% The Economist Intelligence Unit, 2010 and 2014. Although only 12% of the population is officially classified as poor, about 100 million out of the total population of 240 million (2014) live around or below the poverty line of USD 2 per capita per day.
[4] Indonesië: energievoorziening. Ministerie van Economische Zaken, Sept. 2009.

Over the last decade the average electrification rate in Indonesia has improved quickly: while in 2004 some 55% of the households had access to electricity, in 2011 this was already 73%, with the highest levels in Jakarta (98%) and the lowest ratio (29%) in Papua.[5]

2.2 National policy and strategy on renewable energy

The State Ministry for National Development Planning has indicated that Indonesia's energy demand will grow exponentially up to 2050. In order to match the economic growth, 5 GW of new generating capacity each year would be required (Rickerson & Beukering, 2012). A more modest target of 2 GW annually was set in Indonesia's first Fast-track programme (2006), that was designed to rapidly develop 10,000 MW of generation capacity in order to address the peak demand in particular (Rickerson & Beukering, 2012). This first plan, largely based on the diversification from oil fuelled plans to coal fuelled plants was questioned soon after its launch, amongst others by the former Head Research at PLN, criticizing the focus on coal, while the country counts with the highest potential for geothermal generation in the world. Indonesia possesses probably some 40% of the world's geothermal resources[6] what is equivalent to an estimated 27-29 GW[7]. Indonesia is located in the so-called 'ring of fire', a large magmatic arc of active volcanoes that also embraces the Philippines. In 2008 however, Indonesia generated only 2.8% of its electricity from geothermal and other renewable sources (Resources, 2009).

The plea for more attention to 'new and renewable' energy sources was expressed by the Law no. 30/2007 (New Energy and Renewable Energy Law) that distinguishes between sources of 'new' energy (nuclear, hydrogen, coal bed methane, liquefied coal and gasified coal) and 'renewable' energy (geothermal, bioenergy, wind, solar, hydropower, and oceanic power). The updated version of the Fast-track Programme, presented in December 2008, focused more on diversified energy sources, amongst them geothermal energy. The corresponding energy investment programme of Government (2008) envisaged to generate 4,733 MW from geothermal resources over the period 2009-2014. Geothermal energy would be used for the expansion of the grid in the first place, primarily in Java, Sumatra and Sulawesi (the target was updated to 4,952 MW in 2012). In 2009, the Ministry of Finance of Indonesia argued that geothermal energy would attract innovate investors and innovative financing,[8] a view also expressed in the National Energy Policy Plan 2010-2015. The 4,733 MW to be generated by geothermal resources was unprecedented[9] and the responsibility for its achievement rested with Pertamina Geothermal Energy (PGE). The National Energy Policy Plan considered renewable energy as a special 'species' of energy aimed at explicit functions and target groups, being:

- electricity supply to remote rural areas;
- electricity supply for higher and middle income classes, commercial buildings and hotels in urban areas; and
- for frontier islands, targeting at communities that otherwise remain deprived from electricity.

Since the 2011 amendment of the Fast Track programme and the publication of the Vision 25/25 report 'new and renewable' energy sources are considered as 'one among all'. In the Vision 25/25 the geothermal target was further increased to 9,500 MW (Sanyal, Morrow, Jayawardena, Berrah, Fei Li, & Suryadarma, 2014) by 2025.[10] The Vision also expresses Indonesia's commitment to international agreements on greenhouse gas emission. Thereto Government launched the Inisiatif Energi Berish ('more energy, less carbon'), indicating that geothermal electricity generation would reduce 69.5 million tons of CO_2 annually by 2025.

[5] Dr.Hasrul Laksmana Azahari. *New and Renewable Energy*. Ministry of Energy and Mineral Resources. Directorate General New Renewable Energy and Energy Conservation. Jakarta, 2012.
[6] Dr.Antonie de Wilde. *Accelerating Geothermal Development in Indonesia*. Briefing note 2010.
[7] Marubeni. *Marubeni and Toshiba win order for Indonesia's Parytuha Unit 1 Geothermal Power Plant*. June 2013
[8] United Nations Environment Programme. *Unleashing Power from Geothermal in Southeast Asia*: WWF-Philippines, WWF Indonesia, WWF Global Climate and Energy Initiative. 2012
[9] Nicholas Keyes. *A Deep Well of Experience: Supporting Indonesia's Geothermal Development*. The World Bank. Blog on Sustainable Energy for All 12 May 2012.
[10] Fidelis E. Satriastanti. Thomas Reiters Foundation. *Indonesian push for geothermal energy faces bureaucratic hurdles*. 25th July 2013.

Of the potential 27-29 GW in geothermal resources, 16 GW is proven in 102 known fields, estimated to be economically viable (Sanyal, Morrow, Jayawardena, Berrah, Fei Li, & Suryadarma, 2014). By 2014, the installed capacity (7 installations on Java, Sulawesi and Sumatra) exploits 1.3 GW[11], being less than 5% of the potential of the sites identified as financially feasible. So far, the commercial wells in Indonesia are still rather small and vary in capacity from 3 MW to 40 MW. Over 70% of the known Indonesian fields have a resource base greater than 50 MW and at least half offer a resource base of 100 MW or more (Sanyal, Morrow, Jayawardena, Berrah, Fei Li, & Suryadarma, 2014).

For the installation of the 4,952 MW (2012), a capital investment of some USD 750 million annually or USD 12 billion in total is required. Of that amount, about 70% is supposed to come from independent power producers (IPPs). Main investors are supposed to come from China, the United States, Germany and Japan. To support the development of geothermal power, Indonesia has accessed USD 315 million in loans, at lower than usual interest rates, through the Clean Technology Fund (CTF), part of the Climate Investment Funds (a USD 7.6 billion international financing mechanism to support low-carbon development and adaptation to climate change in developing countries).

While investment in generation may come from private investors, the transmission and large part of the distribution remains the responsibility of the state utility company PT PLN that has to make sizeable investments in the expansion of the grid for distributing and selling the additional power.

2.3 Main actors in geothermal energy

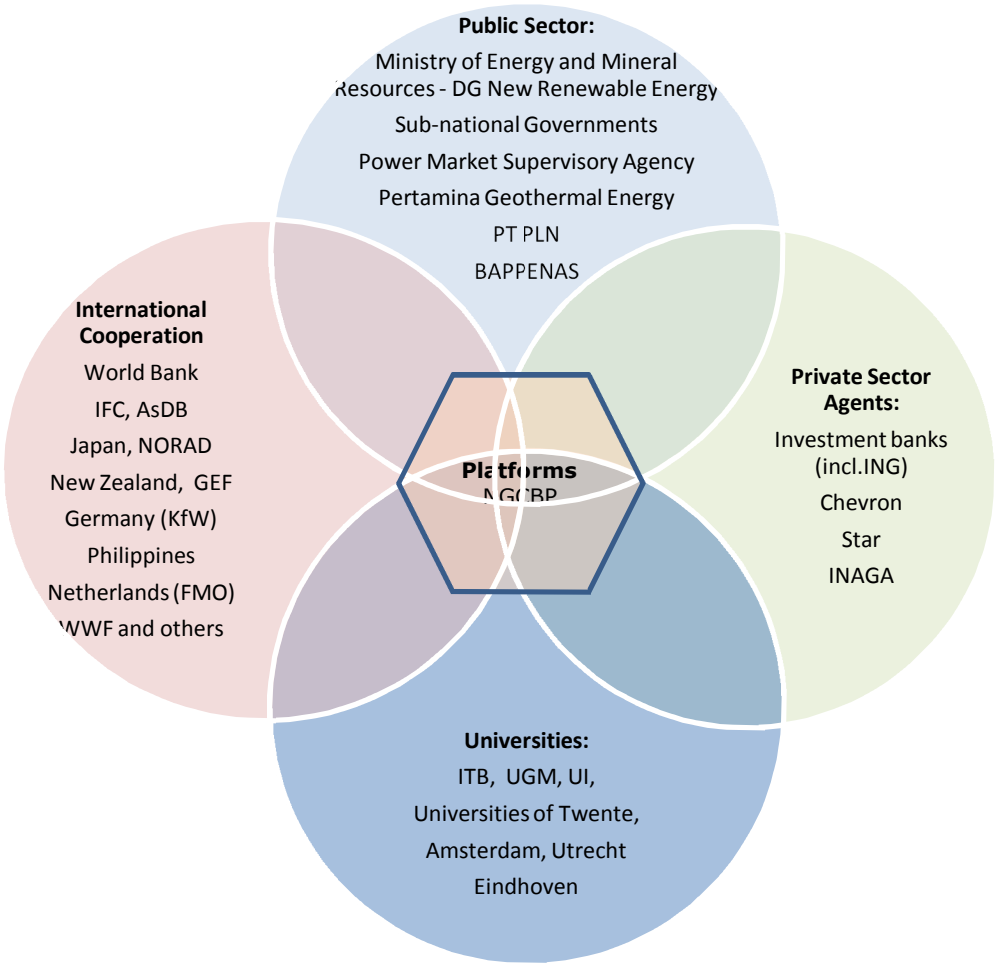
The energy sector counts with a large number of private and public stakeholders. The Central Government through the Ministry of Mines and Energy (MEMR) determines, in coordination with the State Ministry for National Development Planning BAPPENAS, the national energy policy and strategy. MEMR sets the regulatory framework and procedures related to energy generation, transmission and distribution. The implementation of the strategy rests in the first place with the Indonesian State Electricity Company (*Persero*) *Perusahaan Lositrik Nasional* (PT PLN). PT PLN owns well over 45 major power plants, 5,000 power stations and roughly two-thirds of the country's generating capacity. It is the largest actor for transmission and distribution for which it held up to 2012 a monopoly. The generation of energy is responsibility of the State Company PT Pertamina, established in 1957 for the oil and gas exploration and exploitation. Pertamina's business is conducted both in Indonesia and abroad and encompasses activities in the fields of exploration, production, and oil and gas distribution. Pertamina also pursues drilling service businesses to develop geothermal energy. The daughter company Pertamina Geothermal Energy (PGE) is the world's largest company in geothermal energy. MEMR has full authority to foster and supervise geothermal projects, being with either investment by Pertamina or by private investors.

Important national stakeholders are also the sub-national governments, who have to deal with geothermal exploration in relation to the Forestry Law and the issuance of licenses.

Stakeholders related to international cooperation and financing (see section 2.5) are the World Bank, IFC, the Asian Development Bank and some bilateral actors, amongst them the Netherlands. Currently (2014), the Netherlands' stakeholders are mainly academic networks, investment banks and some private companies. From an investment perspective, the association of national investors in geothermal energy (INAGA), as well as international investment banks and energy companies are important actors. Figure 2 summarizes the main stakeholders of importance from the perspective of the Dutch support to geothermal energy activities. From the Indonesian Pertamina perspective there are obviously more and different stakeholders.

[11] Fidelis E. Satriastanti. *ibid*.

Figure 2 Summary of main stakeholders in geothermal development in Indonesia from the perspective of the Dutch support



Source: IOB

AsDB	Asian Development bank
GEF	Global Environment Facility
IFC	International Finance Corporation
INAGA	Indonesia Geothermal Association
ITB	Technical University of Bandung
NGCBP	National Geothermal Capacity Building Programme (NGCBP)
NORAD	Development Cooperation Agency of Norway
PT PLN	Indonesian State Electricity Company (*Persero*) *Perusahaan Lositrik Nasional*
UGM	Gadjah Mada University (Yogyakarta)
UI	University of Indonesia
WWF	World Wildlife Fund

2.4 Key problems in the energy sector

To the Government of Indonesia in general and to MEMR in particular, the main problem in the energy sector is to generate and distribute sufficient power to keep up with the population increase and economic growth. Apart from the technical challenge, it is a financial problem since energy is heavily subsidized. Even minor reductions in the subsidy level caused social unrest and political pressure by 'cronies' in the manufacturing sector and transport sector. To a large extent the increase in demand originates from the urban areas on Java. A related challenge is posed by the inter-linked factors of low access to electricity and a spatially dispersed population on outer islands and rural communities, combined with the high cost of generation from diesel fuel. Although over 70% of the households do have access to electricity, still 14-15 million households do not.[12] The

[12] Fabby Tumiwa. Institute for Essential Services Reform. *Mekanisme Pendanaan. Energi Berkelanjutan di Indonesia*. WWF, NORAD, 2013.

Government's '1000 island electrification programme' intends to improve electricity access in the outer islands through renewable energy sources. Another national energy challenge is the increasing greenhouse gases emission caused by coal and oil fuelled electricity plants.

Due to the Asian crisis of 1997, international capital flows for investment diminished quickly and since that time hardly any new investment in geothermal energy had materialized in Indonesia. Apart from the lack of investment capital, potential investors were also reluctant since the official price offered by the sole buyer of electricity, PLN, was too low to expect a positive internal rate of return on investment, while the 1999 democratization process had introduced legal dimness. By late 2010, the constraints that hampered investment in geothermal exploration and exploitation, were predominantly:

1) the feed-in tariff paid by PLN (legally responsible for the transmission and distribution of electricity) was unattractive;
2) inaccuracy and insufficiently developed legal framework and corresponding regulations concerning authority over the geothermal sources, licensing rights and fiscal obligations. This also referred to the fact that most geothermal energy sites are located in protected forest areas (van der Meer, 2013, p. 16);
3) the initial investment costs were very high;
4) lack of know-how and expertise in the public sector at the level of decision making as well as the level of implementation.

1) Feed-in tariff

One of the major obstacles to private investment in energy generation was the feed-in tariff structure. PT PLN purchased electricity from independent power providers (IPP) at a 'cap price' determined by the generation costs of electricity in coal fuelled plants. Indonesia is rich in coal, of which the mining is relatively easy (surface exploitation). Since PLN is the single buyer of electricity generated, it is the price-setter. This price is also determined by the electricity rate (the sales price) which is determined by Government. This sales price does not cover all transmission and distribution costs. In consequence, banks and private investors require a Government guarantee that PLN will pay them in time, so they can comply with their amortization obligations to their financiers. Such a guarantee system was put in place by Presidential Decree 2005/67 (de Wilde, 2010). The implication is that subsidies are required to maintain the difference between production costs and payers' rate, while to PLN this is no performance incentive, since for every kWh purchased (and sold) it loses money. Regulation no.32/2009 of MEMR indicated that the price for electricity bought by PLN was capped at USD 0.097 per kWh, applied pan-territorial (MEMR Regulation no. 2/2011).

2) Legal Framework and regulations

Prior to 2003, geothermal energy was the responsibility of the Ministry for Coal and Mining at national level and the Presidential Decree no.22 (PD22/1981)[13] basically contemplated that geothermal business was the authority of Pertamina with monopoly rights to explore, exploit and develop geothermal resources. But to understand the origin of the problem of lack of investment in geothermal energy, one has to go back to 1999, when the national Parliament of Indonesia approved two laws on decentralization: law 22/1999 concerning administrative decentralization, and law 25/1999 concerning financial administration. The legislation implied the transfer of rights over mineral resources, including geothermal resources, to the provincial governments. The complexities in mandates in a multi-layer governance structure caused regulatory and bureaucratic barriers to the development of geothermal resources.[14] The 1999 legislation showed deficiencies and contradictions and between 2001 and 2004 various amendments and additions were introduced, resulting in a 2004 update (Law no.32/2004 and Law no. 33/2004) and the amendment of the 1945 Constitution (Holtzappel & Ramstedt, 2009).

[13] Information of legal framework: Pudji W.Purbo, Fanny Kurniawan, Prtita Nazarudin. *Indonesia's Geothermal Business Legal Framework*. Makarim & Taira S. July 2010.
[14] Fidelis E. Satriastanti. *ibid*.

The decentralised structure in which subnational government had obtained the mandate over natural resources made it necessary to formulate a law on renewable energy. The Renewable Energy and Geothermal law 2003 made the roles and functions of the provincial and sub-provincial governments more explicit. However, not all problems were solved, since geothermal resources were considered a mining component, and the geothermal sites are frequently located in forestry reserves. The provincial governments had to deal with both the Geothermal Law and the Forestry Law and the latter law put constraints to mining activities and the exploration and exploitation of mineral resources, including geothermal energy. In consequence, the potential of geothermal development could not be fully explored in areas under forest conservation. Of the 58 concessions for geothermal development issued (December 2013), 49 could not be put in practice, since the sites are located in areas of forest conservation.

The positive aspect of the Renewable Energy and Geothermal law 2003 however was that it opened up opportunities for private investment, with a focus on 'joint operations' with Pertamina. The involvement of private enterprises was restricted to subcontracting, since Pertamina was the license holder (*Kuasa Pengusahaan).* It implied a two-pronged approach: Pertamina was to develop and exploit geothermal energy using its own resources, whilst simultaneously Pertamina liaised with private companies in joint operations to develop and exploit other geothermal resources. The latter could be either to develop the steam fields for sales of steam to PLN for electricity generation, or photo-voltaic generation companies, who in turn had to sell the electricity to PLN against a fixed feed-in tariff. The legislation also established a regulatory body, the Power Market Supervisory Agency.

While the subnational governments were 'owner' of the geothermal field, they could not do much with them, since on the fiscal side most of the local governments remained highly dependent on transfers from the central government. The tight fiscal situation left little room to initiate programmes for development and if they had the opportunity, sub-national governments invested in health and education, not in energy (Holtzappel & Ramstedt, 2009). There was another reason as well: while potential investors faced the problem that not all Provincial Governments applied the regulations in the same way, these sub-national governments faced the problem that the Indonesian bidding processes for obtaining exploration licenses did not encompass a performance bond or the obligation to come to a Power Purchase Agreement (PPA). That allowed private companies to bid at a low price and to speculate that licenses could be sold at a later moment in time, when conditions were more favourable. Since these licenses had a life-time of 10 years, it also implied that –in absence of use of the license- the local government did not receive income out of the license, while in the meantime no geothermal activities developed.

A modification to the absolute monopoly of PLN was introduced by the enactment of Law no. 30/2009 that stated that the supply of electric power is organized by the state and carried out by state-owned enterprises, regional government–owned enterprises, private business entities and self-supporting social organisations. This implied that from 2009 onwards PLN was no longer the sole responsible, but still the first responsible, for the supply of electricity. With the intention of reducing dependence on fossil fuels, Government established fiscal incentives to attract investors in renewable resources through Decrees by the Ministry of Finance in 2010[15] and 2011.[16]

3) High exploration and investment costs

For greenfield exploration in geothermal resources, both initial costs and initial risks are high. In part this is due to constraints in the availability of geological data. Existing data bases have not been centralized and are not publicly available to private enterprises.[17] The drilling success rate ranges from 63% to 73%, substantially less than in the United States or Iceland. In Indonesia, the

[15] Ministry of Finance Regulation No. 21/PMK.011/2010 Concerning on Tax and Custom Facilities for Renewable Energy Utilization.
[16] Ministry of Finance Regulation Number 130/PMK.011/2011 Concerning on Provision of Exemption Facilities or Reduction of Income Tax.
[17] In the Netherlands the geological data are available to interested parties (in part free of charge, in part against a fee). TNO manages the database.

per MW well capacity cost ranges from USD 300,000-400,000, so for a 20 MW installation the drilling costs sum to USD 12 million. Next to the drilling risk, the investment costs of a geothermal plant are 2 to 3 times higher than that of a fossil fuel plant. However, the running costs are lower, since no energy carriers (coal, oil, gas) are needed. Once in operation, the running costs are mainly debt service of the financing for the initial investment (de Wilde, 2010). A related problem of the high initial costs and risk is the financial engineering required. Complex structures are required to accumulate sufficient capital for investment. To an investor, this implies a 'capacity risk': are the implementing parties able to manage technically and financially complex undertakings?

4) Constraints in know-how

Both the Legislative and Executive power are supposed to have sufficient knowledge to fulfil the function of legislation, of policy maker, of controlling entity or of oversight body. In 2003, government was aware that for the implementation of New Renewable Energy and Geothermal Law not all stakeholders possessed the required capacities to deal with geothermal matters. Also the international financiers such as the World Bank observed shortcomings in capacity at different levels: a) the technical capacity to judge requests for licenses and/or quality of technical proposals; b) the management capacity over natural resources by sub-national governments; c) the capacity to impose compliance to laws and regulations in the areas of environmental management and social safety.[18]

2.5 International support to geothermal energy development

In 2013, the Institute for Essential Services Reform (IESR) together with World Wildlife Fund (WWF) Indonesia and with the support of Norway (NORAD) conducted an inventory on Sustainable Energy Financing in Indonesia (Tumiwa, 2013). The report concluded that sustainable energy financing in Indonesia had been highly depending on grants from the international donor community and soft-loans from the multilateral and bilateral development financiers, such as World Bank, GEF, UNDP, Germany, Netherlands and others. While loans from multilateral and grants from bilateral sources are used for medium to large scale projects, like hydro-energy generation, NGOs destine their resources to small localized projects. Commercial funding of renewable energy has been largely restricted to projects with medium scale, for example 1-10 MW mini-hydro centrals. For example, the German GIZ implements (on behalf of a group of partners, including the Netherlands) the Energising Development (EnDev) programme.[19]

The World Bank has coordinated the international support for geothermal development. Since 2007, with the aim to overcome the capacity limitations and legal hurdles, the World Bank supported the government through a grant from the Global Environmental Facility (GEF) to undertake key reforms aimed at enhancing the investment climate for geothermal development. Simultaneously, the World Bank assisted PGE kick-start its ambitious geothermal expansion programme through a USD 175 million IBRD loan[20], along with concessional finance of USD 125 million from the Clean Technology Fund (CTF). In addition, the World Bank had secured over USD 10 million in grants from bilateral donors (including the Netherlands) destined to strengthen PGE's technical capabilities in line with international standards. The World Bank leads the 'Scaling-Up Renewable Geothermal Energy Development in Indonesia'[21], a partnership in support to PGE for steam field development through Pertamina and encompasses a USD 50 million Steam Gathering programme (SAGS). In 2012, the partners in the programme were ESMAP, ASTAE, Aus Aid,

[18] Source: interviews World Bank and IFC, 2010. In 2008, at PGE only one –already retired- expert determined the drilling and exploration component. The World Bank considered this as a high risk factor and stressed the need for capacity building. This triggered the project implemented by RVO.nl.
[19] IOB evaluated this EnDev component. Jörg Peters and Maximiliane Sievert. Impact evaluation of Netherlands supported programmes in the area of Energy and Development Cooperation in Indonesia. *The provision of electricity to rural communities through Micro-Hydro Power*. July 2014.
[20] The Netherlands funded the Environmental Impact Assessment.
[21] Migara Jayawardena. Senior Infrastructure Specialist. EAP Infrastructure Unit. *Scaling –up Renewable Geothermal Energy Development in Indonesia: leveraging International Partnerships for Maximum Impact*. May 2012. Consultative Group Meeting. ASTEA.

Government of the Netherlands, Government of New Zealand, CIF, Carbon Partnership Facility, the World Bank Carbon Finance Unit, the Public-Private Infrastructure Advisory Facility (PPIAF), and GEF. Fields are developed at Ulubelu in South Sumatra and Lahendongh in North Sulawesi. These two fields together add 150 MW of new power energy, enough to bring electricity to up to one million households.

While the World Bank focused on the public sector investment through Pertamina and PGE, IFC developed a programme to improve the investment climate to private investors through four components: 1) the promotion of sustainable regulatory and pricing policies for renewable energy projects (2) advice in the preparation of geothermal projects (3) Support of early stage risk capital and (4) the development of small-scale biomass co-generation projects. The Netherlands supported the first two of these four components (see chapter 3).[22]

The WWF has been active in promoting geothermal energy through various publications. After series of studies WWF concluded that the development of geothermal energy in forest areas[23] is hardly harming the reserves, while it brings financial resources to the sub-national governments through local taxes and royalties, enabling them to invest in the protection of the reserves in accordance to the Forestry Law.

[22] IFC. *Indonesia Renewable Energy Program*. November 2009.
[23] WWF Indonesia. *Igniting the Ring of Fire*, 2012. WWF. Sustainability Guidelines for Geothermal Development in Forest Areas, 2013.

3 Dutch supported interventions in geothermal energy generation

The overarching principles of the Dutch development cooperation have been poverty alleviation and the promotion of sustainable development, while striving for human rights, gender equity and taking care for the natural environment. From 2000 onwards, these principles were framed by the Millennium Development Goals (MDG). Access to energy was considered a precondition to the achievement of the MDGs.

The ratification of the Kyoto Protocol (United Nations, 1997) and the World Summit on Sustainable Development (United Nations, September 2002) underpinned the Dutch policy on renewable energy, where the Netherlands' representation announced output targets for the year 2015. This became more explicit when in 2004 the Dutch Minister for Development Cooperation formulated the output target of supplying 10 million persons with access to energy by the year 2015. The internal policy note *Bridging the Energy Gap* of 2004 referred to the preference for sustainable energy from renewable sources and the establishment of a level playing field for renewable energy vis-à-vis fossil fuels.

In October 2007, the then Minister for Development Cooperation issued the White Paper '*Een Zaak van Iedereen*' (Ministry of Foreign Affairs, 2007) that zoomed in on four areas of policy attention: peace and security; growth and distribution; equal rights and opportunities for women; and environment and energy.

3.1 Energy in Dutch development cooperation

Since the late 1960s, Dutch development cooperation has paid attention to renewable sources of energy, initially in the context of the appropriate technology movement, later more in relation to environmental concerns. In 1993, the first policy document on energy and development cooperation 'Sustainable Energy Economy' developed an explicit policy regarding the relation between poverty alleviation and renewable energy in developing countries. In 1998, the budget of the Netherlands Ministry of Foreign Affairs explicitly designated funds amounting to 0.1% of GNP for environmental programmes, including climate and energy programmes[24] – areas deemed indispensable for achieving the Millennium Development Goals.

The Sustainable Energy and Development Strategy (2007) was specifically devoted to the promotion of renewable energy options in developing countries as component of a large national Dutch energy transition programme. The policy was outlined in a letter to Parliament,[25] in which the ministry's sustainable energy policy was described in terms of incentive to the use of renewable energy within the frame of the attainment to the MDGs. The then Minister for Development Cooperation announced that the Netherlands would make EUR 500 million[26] available for renewable energy in developing countries. The overarching objective of this Promoting Renewable Energy Programme (PREP, 2008-2013), was 'to promote the use of renewable energy in developing countries, which will propel poverty reduction, gender equality and a mitigation of the negative effects of the use of energy on the climate' (Ministry of Foreign Affairs, 2008). To achieve this, governments would be supported in jointly developing and implementing with private and public organisations 'good and coherent' policies with regard to renewable energy and poverty reduction.

[24] Letter from the Minister of Development Cooperation to Parliament, Determining Budget for 1998, TK 25 600 V, nr 78, May 1998.
[25] DGIS. *Beleidsbrief Duurzame Energie*, May 2008.
[26] Approximately EUR 125 million was already included in the budget and corresponded to the ODA commitment. EUR 375 million can be considered as 'additional' financial resources on top of the Dutch ODA commitment.

The core of the Dutch approach was to build on existing channels of implementation, using available capacity and knowledge, covering the entire spectrum of actors in energy and enabling the governments of developing countries. The general objective was made operational through four interrelated specific objectives:

1. Direct investment in the production of and access to renewable energy in priority countries and regions;
2. Sustainable production of biomass for energy;
3. Influencing the policies of partners responsible for investment in energy;
4. Developing capacity and knowledge in developing countries with regard to renewable energy.

PREP has a *container structure* that accommodates an array of sub-funds, programmes, projects and activities. The bilateral flows were to a large extent delegated to the *Bundesministerium für Wirtschafliche Zusammenarbeit und Entwicklung / Gesellschaft für Internationale Zusammenarbeit* (BMZ / GIZ) for funding of the Energising Development programme (EnDev). Only a minor part was implemented directly or indirectly through RVO.nl or delegated to the embassies of the Kingdom of the Netherlands (mainly Rwanda and Indonesia). The private sector was involved through public-private partnerships and through the Dutch Entrepreneurial Development Bank FMO and Non-Governmental Organisations, preferably with a market-oriented approach; the multilateral channel was used through the World Bank and Regional Development Banks, such as the African Development Bank. PREP funds have supported energy-related activities and interventions in over 30 countries, but the geographical focus of the programme was on the African Great Lakes region, Sub Saharan Africa and Indonesia.

3.2 Dutch policy and strategy on energy in Indonesia

The Netherlands and Indonesia have a long-standing relationship when it comes to energy; the Indonesian – Netherlands' Energy Working Group exists since the 1980s. Formal bilateral agreements on the cooperation in the area of energy dates back to 1996.[27] Between 1995 and 2012 annual meetings on energy took place. During that period the embassy of the Netherlands allocated a budget to exchange of knowledge, vocational training and the implications of decentralisation to the energy sector. The focus was on the access to energy and hence transmission and distribution programmes were being pushed forward, but after 2004 the reorientation of the policy of the ministry of Foreign Affairs towards renewable energy implied a shift from distribution to generation. When the PREP resources became available (2008), the embassy disentangled the energy component from the environmental one and made it a separate component in the multi-annual planning.

In 2006, the Indonesian Ministry for Planning BAPPENAS had requested the Netherlands to provide support for its implementation of the Paris Agenda, while there were high expectations for the implementation of the Schokland Agreements, including those for the environmental sector and two related to energy and climate. The general policies for the relations between the two countries over the period 2006-2010 were described in the 2006 Indonesia Note[28]: participatory democracy, internal stability, human safety, rule of law, qualitative high quality and accessible public services (mainly education), an inviting investment climate and sustainable water and energy management. Both countries strived for intensification of the trade relations and the reduction the CO_2 emission as a common interest. To that end the Netherlands would make the knowledge available in the Netherlands accessible to the Indonesian government.

[27] Ministry of Energy and Mineral Resources of the Republic of Indonesia. Workshop on Energy Efficiency and Conservation. 12th Joint Energy Working Group Meeting Indonesia –The Netherlands. Palembang, 26-28 November 2007.
[28] Beleidsnotitie Indonesië. Vormgeving van een bilaterale samenwerkingsrelatie met Indonesia voor de periode 2006-2010. Tweede Kamer, vergaderjaar 2005-2006, 26049, nr.51. June 2006.

The embassy of the Kingdom of the Netherlands in Jakarta determined its strategy with respect to renewable energy in the multiannual strategic plans over time. The Multi-annual Strategic Plan for Indonesia over the period 2008-2011 envisaged a broad-based support programme covering the sectors mentioned in the 2006 policy note. Within the component 'climate and energy' of EUR 54 million, EUR 50 million was envisaged for renewable energy activities. The Strategic Plan was endorsed by the ratification of the Comprehensive Partnership Agreement between the Netherlands and Indonesia (2009) with –next to strategic results as improved democracy, stability, human rights and governance- also 'improved environmental an climate policies, resulting in an increase in the use of renewable energy, sustainable management of natural resources and the reduction of greenhouse gas emission'.

Based on the positive experience gained in the Bilateral Energy Cooperation Indonesia – Netherlands (BECIN) working group, plans would be developed to invest EUR 50 million out of the EUR 500 million PREP resource envelope for sustainable energy in the form of biogas, hydro power, biomass and geothermal energy.

The Multiannual Strategic Plan (2012-2015) modified the priorities in accordance to the Government Agreement ('regeerakkoord') of 2011 and the subsequent Focal Letter on Development Cooperation (Ministry of Foreign Affairs, 2011) that implied a gradual phasing out of energy as theme in development cooperation. The subsection 'agro-food, food security and sustainability' mentions that the promotion of renewable energy would be continued[29] (Embassy of the Kingdom of the Netherlands in Jakarta, 2011). One year later, in 2012, the embassy decided to focus its programme further and renewable energy was no longer considered within the bilateral cooperation. Indonesia was classified as a 'transitional' partner county, what implies that the development cooperation will be phased out gradually and replaced by a relation based on economic cooperation (Multi annual Strategic Plan 2014-2017 p.3).[30] The Multi-Annual Plan 2014-2017 does not refer to energy anymore.

3.3 Dutch support to interventions in the area of geothermal energy in Indonesia

An overview of the Dutch support to renewable energy in Indonesia is provided in Annex 3, table 1. Within this resource envelope four activities were explicitly in support of capacity building for the exploration and exploitation of geothermal energy (see table 2).

Table 2 Dutch support to interventions in the area of geothermal energy development

Programme or activity	Main subject	Starting year	Implementing Agency	Expenditure in `000 EUR
Geothermal power preparation support	Preparatory conditions to enable power generation	2009	World Bank	1,950.0
Renewable Energy Development programme	Improving the investment climate to private investors in renewable energy	2009	IFC	510.0
Asia Sustainable and Alternative Energy (ASTAE) III	Capacity building in energy policy and administrative management	2011	World Bank	1,400.0*
PPP Geothermal GEOCAP	Energy Education and training, networking	2013	Twente University (consortium)	846.1**

Notes: * Budget to ASTAE Indonesia EUR 9.4 million, of which EUR 1.4 million for geothermal energy.
** Budget corresponding to the year 2013.

[29] Through the civi-lateral channel activities would be continued as the Ecosystem Alliance (IUCN NL), Partners for Resilience Alliance (Climate–proof disaster risk reduction programme); HIVOS Green entrepreneurship programme and the ICCO Food and Nutrition security programme.
[30] Kingdom of the Netherlands. *Multi-Annual Strategic Plan*. Update development cooperation of the Multi-Annual Policy Framework, 2014-2017. Indonesia. October 2013.

The Dutch funded components consisted of technical assistance and capacity building mainly and can be classified into two groups. A first group of activities was related to, or complementary to activities implemented by the World Bank. The World Bank had set aside a substantial portfolio for loans to the Government of Indonesia but could not allocate these resources prior to a reform of the sector and the elimination of structural constraints. Since the World Bank provides loans to governments, the focus was on the public utility company Pertamina, in particular PGE.

(1) Indonesia Geothermal Power Preparation Grant (World Bank). The Netherlands made EUR 1.95 million available for social and environmental impact studies related to three geothermal fields by PGE, as well as for institutional capacity building in PGE concerning geothermal energy.

(2) Indonesia Geothermal capacity building (Ministry of Energy and Mineral Resources and World Bank/GEF). The World Bank/GEF elaborated a proposal for a start of its geothermal programme, whereby capacity building at different levels of government was pivotal. The embassy of the Netherlands allocated additional (grant) funding through ASTAE.[31]

A second group of activities aimed at removing constraints for private sector involvement in geothermal energy. Although the objectives of this group of activities are highly comparable to those of the World Bank, they are not the same. The activities in this group were supported by funds delegated to the embassy of the Kingdom of the Netherlands in Jakarta.

(3) IFC Indonesia Renewable Energy Programme Development.[32] In line with the decentralisation of the responsibilities for energy delivery to the subnational governments, IFC started a programme to strengthen the capacities at that level in the area of (tendering for, taxing of) geothermal energy. The Netherlands contributed EUR 0.5 million to an IFC Trust Fund (together with Finland and the Clean Energy Fund) to promote private sector development in renewable energy. The Netherlands' contribution was earmarked for (1) the promotion of sustainable regulatory and pricing policies and (2) advise on preparation of geothermal and hydro projects, with the aim to involve private sector in the provision of renewable energy. This was done through: (i) engagement with local governments, which had exploitation rights of geothermal fields, and (ii) assistance to tendering by capacity building (iii) energy efficiency. RVO.nl was contracted to provide the technical assistance and training to support the implementation through BAPPENAS[33] (permanent technical assistance by an advisor and a small trust fund for short term expertise; the technical assistance had a broad mandate and was not restricted to the IFC programme). An important component of the IFC programme was the strategy development for pricing policy. IFC also developed monitoring and evaluation indicators on energy efficiency.

(4) GEOCAP. GEOCAP's history is related to the technical assistance to BAPPENAS. One of the proposals was that the Directorate for Energy, Mineral Resources and Mining of BAPPENAS would develop a National Geothermal Capacity Building programme (NGCBP). A fact finding mission was launched in 2009, with involvement of TNO, when BAPPENAS requested for Dutch support to geothermal activities. The objective formulated at the time was to increase the capacity of Indonesia's ministries, local government agencies, public and private companies and knowledge institutions in developing, exploring and utilizing geothermal sources, and to assess and monitor its effects on the economy and environment. The NGCBP was formally established in 2011 and proposals for GEOCAP were

[31] ASTAE's three pillars of activity are: Renewable Energy, Energy Efficiency and Access to Energy. There are 'direct' activities (World Bank-funded projects) and 'indirect' ones, where the Bank provides advice or technical support on grant base rather than on lending. The embassy supported the 'indirect' component.
[32] The IFC Indonesia Renewable Energy Program (Nov 2009) was not exclusively aimed at geothermal energy, but encompassed also show case projects in the area of biomass, biogas and innovations in hybrid technologies.
[33] Although the 'central planning' by BAPPENAS does not exist anymore, it plays a fundamental role in setting the national targets for electricity supply and harmonization between the central government, regions and approximately 400 districts concerning energy matters. The latter is important, since under the Decentralisation act, the districts have gotten a responsibility in energy supply they have had never before.

elaborated. Since in the same year 2011, the Dutch minister of Foreign Affairs issued the Focal Letter on Development Cooperation (Ministry of Foreign Affairs, 2011) in which energy was no longer an eligible sector, the embassy was very reluctant to allocate 'fresh' resources to energy. Finally in 2013,[34] the NGCBP obtained the support from the Geothermal Capacity Building Programme Indonesia Netherlands (GEOCAP) for a period of 3.5 years. The department of Earth Systems Analysis of the Faculty ITC of the University of Twente is the coordinating partner of a large consortium comprising: Indonesian partners (Technical University Bandung, University of Indonesia, Gadjah Mada University, the Indonesia Geothermal Association - INAGA,[35] WWF Indonesia and geothermal companies PGE, Chevron, OTP, Star Energy and Supreme Energy) and Dutch partners (IF Technology, Well Engineering Partners, TNO, DNV-KEMA, Delft University of Technology, Utrecht University and University of Twente). GEOCAP[36] will develop linked programmes for education and training, research and databases. It also contains an 'out-of-the box' thinking component 'geothermal energy 2050' aimed at unconventional geothermal resources that at present are undiscovered or technically not (yet) feasible. The programme also serves as gateway for Netherlands companies to liaise with the Indonesian geothermal sector to develop business to business case studies and corporation. The budget committed is EUR 6,130,000 (of which EUR 846,000 for the year 2013).

Indirectly, also another project funded by the embassy of the Netherlands in Jakarta, CASINDO (2008-2011), supported to the geothermal sector by shifting the focus from existing 'exchange' programmes into a 'capacity building' from the national and province level to lower subnational levels (*kabupaten* and *kota* levels). In each province an energy team[37] was established and linked to one of the seven Indonesian universities that joined the programme. Geothermal energy was among the topics of the various courses delivered by CASINDO to MEMR and BAPPENAS. To a large extent the model was adopted by the Government of Indonesia and some of the Indonesian universities involved are partner in GEOCAP.

Private investment

The Netherlands has promoted private investment in renewable energy through the Bilateral Energy Cooperation Indonesia Netherlands (BECIN)[38], supported by RVO.nl. The aim was to come to a self-sustaining structure to strengthen human capacity with respect to energy planning, renewable energy development and energy access to the poor through three subsectors: mini/micro hydro power, biogas and geothermal energy. BECIN was closed in 2012. Joint activities of Indonesian and Dutch businesses are coordinated though the Bilateral Energy Working Group Indonesia Netherlands. The private stakeholders active in geothermal activities have their own association: the Indonesia Geothermal Association (INAGA).

[34] GEOCAP was approved, not at least since RVO.nl convinced the embassy of the opportunities for the Dutch private sector and academic research in the area of geothermal energy.
[35] INAGA is the association of private actors involved in geothermal activities.
[36] http://www.utwente.nl/en/newsevents/2014/1/225693/itc-coordinating-partner-of-the-geothermal-capacity-building-programme.
[37] Each team established an Energy Forum comprising both public and private actors in the energy sector. CASINDO looked in the first place at small-scale activities that could contribute to the achievement of the MDGs.
[38] Support to capacity building was provided at the national level and in five provinces: North Sumatra, Yogyakarta, Central Java, West Nussa Tenggara and Papua.

4 Induced Output

As shown by the results chain (figure 1), the expected output of the combination of different activities was envisaged to be:

- financial products that mitigate the risk of investing in geothermal energy to the state and state enterprises;
- a better investment climate to the private sector by improvements in legislation and procedures;
- feasibility studies and environmental and social impact assessments in place.

This output was expected to be applied or to be enacted by the Indonesian government (the induced output) and serve as enabling environment for actual investments in geothermal energy generation (the outcome).

4.1 Financial products and engineering

Exploratory and pilot investments in geothermal energy were made up to 1997, but for over a decade since then investments were financially not feasible neither to PGE, nor to the private sector. The reason was that independent power producers could sell electricity to the state utility PLN only. PLN had no freedom to determine the sales price of electricity to customers (electricity rate), since that price is determined by government. PLN purchases electricity from energy producers using a Power Purchasing Agreement. Since PLN had the monopoly, it was (and still is) the price setter. And this price was based on the economically most advantageous form of electricity generation, being coal fuelled generation.[39] Renewable energy was financially not feasible at the pan-territorial feed-in tariff of USD 0.097 per kWh, the price used up to 2011. This price blocked the development of geothermal resources since its exploration costs are high, while many of the geothermal sites are located outside Java, where the geographical conditions are difficult and the demand for electricity is less.

Both the World Bank (IBRD) and the Netherlands worked with the Indonesian authorities, PLN and PGE to find feasible solutions. IBRD did so through technical assistance in the frame of a USD 35 million loan for the construction of geothermal plants in Lampung and North Sulawesi. The Netherlands did so through the technical advisor attached to BAPPENAS and in coordination with the Dutch Entrepreneurial Bank FMO[40] and the Netherlands Enterprise Agency RVO.nl.

The output produced of the Dutch intervention was a proposal to launch a Feed-in-Tariff (FiT) Fund (Rickerson & Beukering, 2012). The FiT fund was designed to close the gap between the rate the investments require for development of a geothermal project and the purchase price used by PLN, a 'topping up' for electricity delivered would be paid from a Fund. The topping up varies over time and depends on changes in fuel prices, but the power producer would receive a fixed price over a longer period of time (say 20 years). Assuming a gradual increase in prices for fossil fuels, the price for the fossil fuels will reach a stage of break–even with the fixed geothermal electricity price and afterwards will become more expensive. As long as the price paid by the Fund decreases and eventually will become negative, the start-up period would be paid by earning back during the period after the break-even.[41] This essentially implies that the Fund is a hedge against rising fossil fuel prices allowing the government to accelerate renewable power uptake. Both the Indonesian ratepayer and taxpayer would benefit from such a Fund since it would unlock geothermal projects that might otherwise not move forward. Obviously, the primary risk of such a Fund is that prices

[39] Indonesia is rich in coal, of which the mining is relatively easy (surface exploitation). The quality of coal is however poor and its use as fuel is highly polluting

[40] According to FMO the geothermal sector could attract foreign direct investment, in particular from Dutch medium-sized enterprises. In 2011, FMO was prepared to support investments, but has withdrawn afterwards.

[41] The assumption was that the coal price would increase with some 3% per year as a result of expanding demand from China and India. The investment and exploration costs for geothermal would increase at a slower pace.

for fossil fuel decline instead of increase.[42] The financial means for the initial period required for the Fund could be supplied by development banks (like the FMO) and private investment funds.[43] The concept is not exclusive[44] and has the interest of investment funds, since on a global scale, the annual investment requirements to achieve an energy transition towards renewable energy requires billions of dollars and FiT Funds may play an important role to cover the initial financial needs.

The Dutch technical advisor in BAPPENAS (supported by FMO and RVO.nl) provoked an extensive dialogue with PLN, MEMR and other Indonesian stakeholders to explore the opportunities for launching such a feed-in tariff fund. To the Indonesian authorities it was unknown that private capital suppliers were interested to invest in such an undertaking speculating on long term rewards. The importance of this dialogue rests in the fact that at various levels of government one became aware of the pricing mechanism as a major bottleneck, but also as an option for future financial gains to capital suppliers. The Indonesian authorities preferred that profits would not end up in private capital funds. Although the FiT Fund was never implemented, the discussions contributed to the development of new regulations and tariff systems (induced output in the results chain). It triggered the elaboration of a system with regionally differentiated price floors (Rickerson & Beukering, 2012) and with price preference to renewable energy supply with even preferential prices for geothermal energy. Getting the feed-in tariff high on the political agenda can be attributed to the Dutch technical advisor and his BAPPENAS colleagues.

The induced output was that MEMR issued Decree 04/2012[45] in 2012 which established a regionally differentiated feed-in-tariff system for geothermal energy ranging from USD 0.10/kWh in Sumatra to USD 0.18/kWh in Papua (Rickerson & Beukering, 2012). This Decree was explicitly aimed at attracting more investment to the geothermal power industry. Later that year, the feed-in tariff for geothermal energy was further increased to USD 0.197 /kWh for remote areas (MEMR No. 22 of 2012). From that time onwards PLN and PGE made different price commitments to independent power providers. The increase triggered the start-up of projects that had been shelved for various years. However, the increase was still insufficient to attract investment to remote islands, reason why a further differentiated approach was declared in 2014 to a maximum of USD 0.296 /kWh.[46]

4.2 Legislation and regulation

As indicated in section 2.4, imprecise legislation was among the key constraints to geothermal energy development. Competing claims and rights impeded the issuance of licenses for various stages of geothermal exploration and exploitation.

Next to the legislation referring to exploration and exploitation rights, existed the monopoly position of PT PLN. Since 2009 however (Law no 30/2009) independent power producers are entitled to sell electricity directly to customers rather than through PT PLN. This modification responded only to needs of small grids on the outer islands and facilitated for example micro hydro generation for agricultural production or processing. But in Indonesia no 'market' exists for the distribution of electricity or other forms of energy. This opening of the market is not the first priority to geothermal producers, since the investments are high and can be earned back only if large volumes of electricity are sold to the grid over a longer period of time. The issuance of Law

[42] Between 2011 and late 2014 this has been the case as result of the shale gas revolution in the United States and declining crude oil prices.
[43] The option of commercial bank participation (ING, Rabo) with loans based on 'future put' (as if it were equity) was cumbersome. Bank laws require a cash flow on loans, so the idea is that the initial flow (up to the break even point) would have to be covered by a development bank or development aid.
[44] The concept is used in several commodity markets. In energy a comparable fund is operative in Uganda.
[45] Ministry of Energy and Mineral Resources Regulation Number 04 Year 2012 Electricity Power Purchased Price from Renewable Generations (small and medium scale) and Excess Power.
[46] Source: Raras Cahyafitri in: Jakarta Post, 27th August 2014. http://www.thejakartapost.com/news/2014/08/27/legal-barrier-geothermal-development-removed.html.

no 30/2009 cannot be considered as an induced output of one of the interventions supported by the Netherlands.

The problems related to legislation and regulation can be grouped into:

- multi-layer legislation and regulation;
- the capacity at sub-national level (mainly) to apply the existing laws and regulation.

Multi-layer legislation and regulation

The World Bank was directly involved in the modifications of legal aspects of geothermal exploration and exploitation through the Geothermal power preparation support programme, as well the Indonesia Geothermal capacity building programme. This encompasses an array of aspects and regulations since the Law 27/2003 had split upstream exploitation from downstream utilization, in which the law distinguishes six phases of geothermal upstream activities, of which five required permits or licenses: preliminary survey; determination of work area; exploration; feasibility study (no permit required); exploitation; and utilization. The Law 27/2003 did not provide regulation for the direct use of geothermal energy, for example for heating in agro-business or hot spring facilities.

The Dutch advisor to BAPPENAS, jointly with his direct counterparts at BAPPENAS, was important to analyse the bottlenecks in the legislative multi-layer building and to raise awareness about the critical points at various levels of government (output), but was not directly involved in the elaboration of proposals to structural reforms to the legal structure (induced output).[47]

The World Bank however, did suggest modifications in regulations by facilitating the services of consultants contracted with Dutch grant money through ASTAE. The output here is the consultancy advice issued to the Government of Indonesia, in particular MEMR and BAPPENAS that finally led to two more detailed legislations, adopted in order to provide incentives to private sector investments:

- Ministry of Finance Regulation No. 21/PMK.011/2010 Concerning on Tax and Custom Facilities for Renewable Energy Utilization; and
- Ministry of Finance Regulation Number 130/PMK.011/2011 Concerning on Provision of Exemption Facilities or Reduction of Income Tax.

It is unlikely that these two legislations can be considered as (part of an) induced output of the Dutch supported interventions.

The main change however, took place in August 2014, when the House of Representatives approved the new Geothermal Law that replaced Law 27/2003. Taking into consideration the contents of this new law, it can be considered as an induced output of the interventions supported. The 2014 Geothermal Law no longer considers geothermal energy generation a mining activity, and in consequence the exploration of geothermal fields located in forest conservation areas is no longer prohibited. Tenders concerning the exploration of geothermal sources will now be issued by the central government (and no longer by local administrations) in order to smoothen the bureaucratic process. The local administrations will receive a share of the revenues derived from geothermal exploitation under a so-called production bonus scheme.[48] This bonus on production has also reduced the risk of speculation with licenses, since the sub-national governments have now a direct interest in the exploitation of the geothermal resources. At the same time the single feed-in tariff was replaced by a differentiated system in which PLN sets special prices for geothermal energy. For the most remote areas the geothermal prices paid will be 250% over the tariff paid for coal generated electricity (USD 0.296 vs 0.118 /kWh).

[47] An exception was the amendment proposed for the strengthening of the Power Market Supervisory Agency (regulatory body established in 2002).
[48] Source: Raras Cahyafitri in: Jakarta Post, 27th August 2014. http://www.thejakartapost.com/news/2014/08/27/legal-barrier-geothermal-development-removed.html.

4.3 Feasibility studies, environmental impact assessments and other capacities

All interventions aimed at raising awareness and increasing the capacity to manage geothermal energy matters at different levels of government; from BAPPENAS to the *kota* – level.

Most sub-national governments were not fully acquainted with the laws and regulations concerning geothermal energy exploration and exploitation, and if they were they either lacked the financial means to explore the geothermal resources or the human capacity to manage the exploitation. Local governments, happened to be cautious and afraid for eventual disasters occurring as result from exploration (the mud stream incident) even if such a fear is not justified (Sidoarjo, Surabaya, 2006). Overall, there was a limited number of qualified staff both within Central Government and within the local governments able to deal with the complexities of managing geothermal resources. It is in this area that the Netherlands supported interventions produced sizeable output through the organization of seminars, courses, and knowledge networks. Contributions were made at academic level by the networking of Indonesian and Dutch universities and knowledge institutes (Casindo, GEOCAP), by technical assistance provided to the highest levels of Government (RVO.nl) and by capacity building to sub-national governments (Casindo).

The activities (co-) funded by the Netherlands did not directly lead to either new or better elaborated feasibility studies (output). A relatively large number of eligible project proposals existed since the late 1990s, but had been shelved after 1997. New feasibility studies were elaborated, but not by the Dutch supported programmes, but by the Japanese JICA and Japanese consultancy firms. JICA did not want to be involved in the policy dialogue, as pursued by the World Bank and BAPPENAS, and instead it financed a relatively large number of (pre-) feasibility studies. This enabled Japanese consultancy and construction companies to gain knowledge and experience. So, once the conditions improved and tenders were launched, the Japanese companies had a comparative advantage over their competitors. This, in combination with a low interest credit line made available by the Japanese Government, made the Japanese companies successful in the area of geothermal energy exploration.

Since 1997, it is a legal requirement that all infrastructure projects that count with a financing plan are legally bound to conduct environmental and social impact assessments. Local governments in Indonesia are handicapped when addressing the social, economic and environmental impacts of mining because they do not receive support from the national government for the funding of studies.[49] Projects funded with resources from either the World Bank or the Asian Development Bank (or both) have to adhere to a comprehensive environmental and social due diligence clause that implies that any existing or potential environmental and social impact has to be identified in advance according to the national regulatory requirements. This is done through the Environmental and Social Assessment (AMDAL) that requires also an Environmental and Social Impact Analysis (ANDAL), and an Environmental and Social Impact Management Plan (RKL), and Environmental and Social Impact Monitoring Plan (RPL).[50] The Dutch resources to the World Bank enabled the contracting of consultants to conduct these studies. The studies produced are an output of the Dutch funded interventions.[51] Environmental and Social Impact Analysis is among the key areas of attention of the National Geothermal Capacity Building Programme (NGCBP), since 2013 supported by GEOCAP, although it is not a specific field of attention to GEOCAP.

Being a legal obligation for infrastructure projects, the availability of environmental and social impact assessments cannot be attributed to the Dutch interventions. The existence is not an induced output of the interventions. The Dutch capacity building programmes however, have

[49] http://www.resourcegovernance.org/grants/improving-subnational-revenue-management-and-budget-planning-indonesia.
[50] Source: ADB 42916-014: Sarulla Geothermal Power Generation Project. 2014.
[51] Casindo had a down to earth approach where workshops were organised to inform lower level governments about the role, functions and methodologies applied in environmental and social impact assessment.

contributed to improving the technical quality of these assessments and have enabled the government of Indonesia to contract these studies.

Capacity building

Capacity building focused on the improvement of skills in the area of geothermal energy within the public sector; the exchange of knowledge among universities; and the dissemination of knowledge to subnational governments.

The capacity building programmes and trainings of both the World Bank, the RVO.nl advisory services to BAPPENAS and GEOCAP have contributed to human capability development. One induced output that can be –at least partially- attributed to the Dutch interventions is the establishment of the Geothermal Centre of Excellence within BAPPENAS. The technical knowledge required for that centre is largely the result of the presence of the technical advisor, in combination to network relations between universities in Indonesia and the Netherlands (started with Casindo and continued by GEOCAP). GEOCAP is a direct product of the support to capacity building provided to BAPPENAS and the 2011 Geothermal Capacity Building programme (NGCBP).

An important component in geothermal development is the knowledge on subterranean data management. The Netherlands (TNO) has leading expertise in that field.[52] Availability of data to private investors leads to efficiency gains (reduce risks in investment for drilling). Pertamina Geothermal Energy has drilling information on 80 sites and productivity data on 251 wells in the country in the GeothermEx archive; these wells compromise some 80% of the total production wells drilled (Sanyal, Morrow, Jayawardena, Berrah, Fei Li, & Suryadarma, 2014).

The contacts among universities, have had – and still have- lasting effects by the exchange of students, teachers, PhD candidates and the flourishing alumni associations.

[52] In the Netherlands within the public domain (dinoloket.nl).

5 Outcome

The induced output is expected to produce outcome (see figure 1) that in this case would be that both public and private sector companies have started investing in geothermal exploration and exploitation. Obviously, this outcome cannot be entirely or exclusively be attributed to the Dutch interventions (the attribution gap), although RVO.nl used this outcome as performance indicator.[53] For attribution, these new investments are assumed to be enhanced by or triggered by the modifications in pricing policy, regulations and management capacity.

There are over 200 sites in Indonesia with geothermal resource development potential. By 2014, the Ministry for Energy and Mineral Resources had offered 58 geothermal concession areas for development. Since 2012, significant investments have been made in geothermal power generation, with or without soft loan backing by international financing institutes, regional development banks or blended facilities from bilateral donors (Japan). By May 2014, nine of these were either in production, or construction activities had started to exploit the resources. Public lending can support private investment in geothermal activities, for example by using low interest loans for exploration or by guarantee arrangements. Commercial banks do provide debt finance for a geothermal field if at least 50 percent of the resources are granted or guaranteed. For a greenfield private entrepreneur this not easy to obtain. The World Bank and IFC can provide financing via instruments such as the Clean Technology Fund. The CTF programme in Indonesia makes long-term finance available for private investors at subsidized interest rates of one to three percent.

Investment in geothermal energy is made by both the public and the private sector, as detailed in continuation:

Public investment through Pertamina

Pertamina Geothermal Energy invests in geothermal energy by using public money. The strategy of Pertamina is that it taps the international capital markets for the commercially viable parts of its operations, while the IBRD and AsDB, as well as CTF resources are used in blended constructions for the higher-risk (and in the short run less viable) geothermal activities.

In 2013, the MEMR announced[54] that it achieved 'debottlenecking' the plans for the Sarulla Geothermal Plant. The financing of the project has been heralded as a breakthrough, since the project was initiated in 1990 but ground to a halt during the Asian financial crisis in 1997. In 2013, the vice-president of the Republic of Indonesia approved handed over the Business Viability Guarantee Letter from the Ministry of Finance to the consortium Sarulla Operations Limited (SOL). SOL obtained the rights to use the geothermal field with PGE as concession holder. With three phases of 110 MW each[55] is the Sarulla (northern Sumatra) is the biggest power plant of the Fast Track Programme[56] and the world's largest 'greenfield' geothermal operation. The commercial operation of phase 1 is expected to start in 2016. In May 2014, SOL[57] concluded a USD 1.17 billion financing deal with international lenders, led by Societé Generale Corporate & Investment

[53] One of the performance indicators of the contract of the Dutch advisor to BAPPENAS was: "investment agreements signed between Pertamina and private investors."
[54] MEMR. Republic of Indonesia. Press Release no. 17/PR-MEMR/2013, 10th April 2013. *Debottlenecking of Sarulla Geothermal Plant – Largest in the World*, Subsidy savings of USD 1 million / day and environmentally friendly.
[55] The units will be powered by steam from production and injection facilities at the Silangkitang and Namora-I-Langit reservoirs, located in North Sumatra. The project will be developed and implemented under a 30-year Energy Sales Contract and Joint Operating Contract with PGE under a 20-year business guarantee from the Ministry of Finance.
[56] The IBRD and AsDB issued loans up to USD 315 million (of which USD 125 million concessional from CTF) for a blended capital mix for two geothermal sites: Ulubelu in Lampung and Lahendong, North Sulawesi. Together these plants will produce 1,200 MW and reduce greenhouse gas emissions by the equivalent of 194 million tonnes of CO_2 over the project lifetime.
[57] Established by Japanese Itochu Corporation (25%), Kyushu Electric Power Company (25%), PT Medco Power Indonesia (37.5%), and US-based Ormat International (Ormat Technologies Inc) (12.5%).

Banking[58] (among them ING Commercial Banking).[59] Once completed in 2018, the plant is supposed to reduce the CO_2 emissions by 1.3 million tonnes a year.

Private investment

Private investment in geothermal energy takes place. Private capital investment over the period 2012-2014 in geothermal activities sums some USD 300 million. In 2012, the Indonesian power supply company PT Geo Dipa Energi obtained the license for the Patuha 1 geothermal plant, a 55 MW plant in West Java in the suburbs of Bandung. Two Japanese companies, Marubeni and Toshiba, construct the installation on a turn-key contract. The plant is scheduled to start its operations late 2014, early 2015. The Japanese Government supports the companies through its yen loan programme.[60]

Spin-off to Dutch private sector

The new geothermal projects are all tendered to commercial companies. A few Dutch enterprises (amongst them Fugro) are involved in technical design, construction and financing. The Sarulla power plant is financed by a consortium that also encompasses the Dutch ING. The ING head Utilities, Power and Renewables at ING Structured Finance explained the participation by 'the shift in INGs portfolio of power plant financings towards more renewable energy projects'.[61]

There has been a longstanding commitment to link Indonesian universities and students to the Dutch Technical Universities (Twente, Utrecht, Eindhoven and Delft). Indonesian alumni associations are very active and maintain linkages to Dutch companies and research institutes such as TNO and KEMA. Dutch enterprises that participate in GEOCAP are: IF Technology, Well Engineering Partners, and DNV-KEMA.

Efficiency

The two-pronged approach as pursued by the Dutch development cooperation, with attention to both the public and the private sector, can be understood as both effective and efficient. In absence of a normative view on whether electricity generation and distribution pertain to either the public or the private sector, the Dutch support was widely accepted by both public and private stakeholders. A similar comment cannot be made for all multilateral partners involved and although the Netherlands was a small actor, in many occasions it was considered a lead partner.

The total Dutch development investment in geothermal interventions did not exceed EUR 5 million. It is believed that at least part of the IBRD and AsDB loan investment resource envelope would never have been employed in absence of the Dutch efforts to find solutions to the feed-in tariff bottleneck. The World Bank Indonesia Geothermal programme has helped to mainstream geothermal development as a priority area within the Government's low carbon growth strategy with IBRD and Clean Technology Fund loans[62], added to the Government of Indonesia own investment of USD 275 million. In consequence, it is reasonable to assume a substantial leverage over the relatively modest financial input by the Netherlands.

[58] The lender group includes the Asian Development Bank and Japan Bank International Corporation (for USD 492 million). The six major commercial banks involved are Societé Generale, Bank of Tokyo-Mitsubishi UFJ, ING Bank NV, Mizuho Bank, National Australia Bank and Sumitomo Mitsui Banking Corporation.
[59] Sources: the Star website, September 2014; and Thomson Reuters 28th May 2014.
[60] Marubeni. *ibid.*
[61] ING Structured Finance. *New geothermal power plant for Indonesia*. August 2014.
[62] The first CTF operation in East Asia.

6 Findings

Indonesia, located in 'the ring of fire' has an enormous potential for the exploitation of geothermal energy. Government considers geothermal energy as the most promising source of renewable energy; the electricity generated from it is cost-competitive and with base-load capacity (i.e. capable of generating electricity without any interruption) and hence a convenient source to feed the national grid. To Indonesia geothermal energy is not only meant to respond to the increasing demand for electricity, but also a manner to attract innovative technology and to avoid additional investment in fossil-based electricity generation. Since many geothermal sites are located on the outer islands, installation costs are high, but they do have the potential to replace many of the aging diesel propelled installations.

With the 1997 Asian crisis, the geothermal power development was put on hold and its further development was complicated by the decentralisation process (1999). For over a decade, the main obstacles to further development of the geothermal sources were:

- to power suppliers the feed-in tariff paid by the state-owned PLN was too low to have a positive return on investment;
- unclear and insufficiently explicit legal framework and regulations concerning different stages of exploration and exploitation within a multi-layer governance system;
- the high initial investment costs (and drilling risk);
- the shortfall of technical know-how and managerial expertise at the level of policy-, and decision making, as well as the level of technical implementation.

Input

Prior to the launch of the PREP, the embassy in Jakarta managed a relatively small portfolio of energy projects intertwined with the environmental programme. When PREP resources became available, the embassy disentangled the energy component from the environmental one and made it a separate programme in its multi-annual planning. However, there was no continuity in the provision of input, due to the general shifts in development policy as introduced in 2011. Soon after its scaling-up, energy as (sub-) sector was down-sized again in 2011 and was eliminated entirely in 2012. The financing of GEOCAP in 2013 for a period of 3.5 years was reluctantly accepted by the embassy.

The Dutch approach was to invest in knowledge and capacity building programmes with the aim to eliminate pertinent bottlenecks and to contribute to a better investment climate for both public and private investment in geothermal energy. This strategy implied complementary activities with the public sector (through the World Bank), with the private sector (through IFC) and with knowledge centres (universities in Indonesia and the Netherlands). The Dutch support to the geothermal development comprised two projects implemented by the World Bank within the context of loan preparatory activities by the Bank. These activities were focused on the national utility company Pertamina and in particular the Pertamina Geothermal Energy. A third activity was aimed at improving the investment climate to private sector actors through a programme with IFC. Technical assistance was provided to the State Ministry for National Development Planning BAPPENAS. A fourth support was of a more technical nature through the network programme GEOCAP, led by the University of Twente. The total investment from PREP resources in geothermal activities did not exceed EUR 5 million.

Output and induced output

The output of Dutch funded activities is intertwined with activities deployed by the broad pre-investment programmes managed by World Bank and IFC. The output of the Dutch technical assistance to BAPPENAS can be determined with more precision and contemplates the analysis of, and awareness raising about, the main constraints to the development of the geothermal subsector. These bottlenecks were made subject of discussion, dialogue and negotiation at all levels in government and among an array of public and private stakeholders, including the state utility company, private sector companies, investment banks and academic centres. The Dutch

interventions produced output in human capabilities, proposals for changes in tariff-structure and its financing and in knowledge networking. The output related to the legislative framework and operational procedures is less ascertainable. Nevertheless, the Dutch contribution can be considered as operationally and institutionally additional.[63]

Induced output can be observed for the (i) feed-in tariff structure (ii) strengthening of technical and managerial capacities, and (iii) the establishment of multi-stakeholder platforms through public sector- academic- private networking.

(i) The interventions triggered significant amendments of the feed-in tariff structure (price differentiation in terms of geographical location and energy source).

(ii) The 'targeted' capacity building contributed to an increased knowledge and expertise of the Indonesian authorities at different levels of government. The induced output is a public policy on geothermal energy, a flow of regulatory innovations and the establishment of an enabling environment for investment.

(iii) The programmes in knowledge development and exchange on technical and managerial issues produced as induced output more or less stable knowledge exchange networks, amongst others between Indonesian and Dutch universities.

Outcome

Since 2011 and 2012, investment in geothermal energy generation has been impressive. The state has contracted sizeable loans, both from concessional lenders and from commercial capital providers to invest in geothermal development. The successful financing of the large Sarulla project is result of amendments in the legislation and the various revisits of the feed-in tariff with a geographical differentiation and a source differentiation. The Sarulla project is expected to become a catalyst for further development of Indonesia's geothermal resources.

The amendments in the feed-in tariff structure and the clearer legal requirements have also appealed independent power producers to invest in geothermal energy, as evidenced by a number of Japanese investments in cooperation with an Indonesian license holder. These investments have been enhanced by the amendments to the Renewable Energy and Geothermal law, while regional price differentiation and increases in the feed-in tariff structure convinced private financiers.

Neither energy in general, nor geothermal development in particular is among the priority areas of the embassy of the Kingdom of the Netherlands in Jakarta and do not receive particular attention for commercial enhancement between the countries. Dutch private investment is made by the ING bank, while a few Dutch companies are commercially involved.

[63] IEG (2008, p.25) Three dimensions of additionality can be distinguished: *Financial* – providing funding on terms otherwise not available from private sources, and mobilizing funds from other financiers (direct or indirect by changing the risk perception); *Operational* – seeking through specialist advice and knowledge to improve a venture's or intervention design or functioning; *Institutional* – improving standards of governance and environmental and social sustainability.

Annexes

Annex 1 Geothermal energy

Geothermal energy is energy generated and stored in the earth. The geothermal energy of the earth's crust originates from the original formation of the planet (20% approximately) and from radioactive decay of minerals (80%). The first origin implies that the planet is slowly cooling down on geologic timescales and the latter is a natural form of nuclear energy. The geothermal gradient is the difference in temperature between the core of the planet and its crust. This geothermal gradient is 25–30°C per kilometre of depth in most of the world, but values are higher in areas where the crust is thinner, such as near volcanoes. The gradient drives a continuous conduction of thermal energy in the form of heat from the core to the surface, which may be further augmented by fluid circulation (hot springs, for example). Temperatures at the core–mantle boundary may reach over 4,000°C. The deeper one drills into the earth crust, the higher the temperature, so a distinction is made between high enthalpy and low enthalpy thermal exploitation. The high enthalpy areas are mostly related to volcanic areas, in particular where opportunities for exploitation are enhanced by the presence of subterranean water resources. This is mostly the case in Indonesia. Water heated in the crust may take the form of a supercritical fluid. A supercritical fluid is any substance at a temperature and pressure above its critical point, where distinct liquid and gas phases do not exist. Close to the critical point, small changes in pressure or temperature result in large changes in density, allowing properties of a supercritical fluid to be 'fine-tuned'. Since there is no liquid/gas phase boundary, changing the pressure and temperature of the fluid, allow to 'tune' the substance to be more liquid- or more gas-like. This characteristic makes it a suitable 'vapour fuel' to propel turbines.

Geothermal power is considered to be *renewable* because any projected heat extraction is small compared to the earth's heat content. Even though geothermal power is globally sustainable, extraction must still be monitored to avoid local depletion, usually not of temperature but of water resources. Geothermal energy is also considered to be a *green* form of energy and CO_2 emissions from geothermal electricity generation are negligible. Nevertheless, wells may release greenhouse gases trapped within the earth. In the past these emissions where discharged in the air, but increasingly these gases are being re-injected to avoid negative environmental effects, as well as to maintain pressure in the earth crust. Geothermal energy is independent of weather conditions contrary to solar, wind or hydro applications. It has an inherent storage capability and in consequence can be used for both base load and peak power.

Theoretically, the earth's geothermal resources are more than abundant to supply humanity's energy needs, but only a small fraction may be exploited in a financially feasible manner. Drilling and exploration for deep resources is very expensive; in Indonesia the cost ranges from USD 300,000-400,000 per MW (de Wilde, 2010). Forecasts for the future of geothermal power depend on assumptions about technology, energy prices, subsidies, and interest rates. In principle, geothermal power is immune to fuel cost fluctuations. However, capital costs are significant. Drilling accounts for over half the costs, and exploration of deep resources entails significant (financial) risks. Some of the legal issues raised by geothermal energy resources include questions of ownership and allocation of the resource, exploitation rights and sales obligations, royalties, and social and environmental impact.

After The Geysers, a geothermal field in California, the Philippines is the second highest producer, where geothermal energy caters for 17% of the national production (Georgsson & Fridleifsson, 2013). Iceland is the world leader in direct applications: some 92.5% of its homes are heated with geothermal energy. By 2012, approximately 12% of the world's capacity was installed in Indonesia.

Annex 2 Access to energy

In the policy document on environment and renewable energy, the Ministry of Foreign Affairs underlines the direct relation between the lack of access to energy and poverty (Ministry of Foreign Affairs, 2008). The term 'energy poverty' is used, but in the literature this notion has various connotations (IOB, 2013, p. 57). In general, it can be understood as the bare minimum of energy required to cook as well as the bare minimum of lighting to be able to read or to carry out productive activities after sunset. Described as such it matches well the distinction made for the analysis of the energy transition process from traditional towards modern forms of energy (Madubansi & Shackleton, 2006; Fall, Sarr, Dafrallah, & Ndour, 2008):

(i) energy for thermal applications (space heating, cooking, water heating);
(ii) energy for lighting, safety, communication and entertainment; and
(iii) productive use.

These three categories are not mutually exclusive, since some forms of energy for heating (for example, biogas) can be used for lighting as well, or even for productive purposes, such as to dry crops, cure tobacco and fire bricks. But in general, energy for productive purposes is in the form of a constant supply of electricity of sufficient power to drive equipment and machinery. This report focusses on electricity generation and restricts considerations of consumption to price only.
The use of electricity depends on whether (new) opportunities come within reach of the potential user, i.e. becomes physically accessible or financially affordable.

This paper concerns geothermal energy, mostly used to generate electricity to be sold to the electricity distributors. Geothermal energy is strictly spoken not a real renewable in all its utilisation forms, but at least it is a clean form of energy. The exploration and installation costs are high, but once in operation, the operational costs are low. It is a higher-end, non-polluting form of energy that enables heating and cooling, but also the production of electricity for the services level 5 according to the Sustainable Energy for All Global Tracking Framework (2013, p. 79) as shown in table 1.

Table A2.1 Levels of electricity services

Tier	Description
5	Use of devices that typically require several kilowatts, such as air conditioners, industrial equipment
4	Use of devices that typically require a kilowatt, such as water heaters, irons, vacuum cleaners. At this level domestic solar systems are usually no longer sufficient
3	Use of devices that typically require 100 W or more, such as rice cookers, refrigerators, freezers
2	Bright light, use of radio and telephone and other devices requiring several tens of watts, such as small television, fan, or computer
1	Pico-PV and battery charging stations

Source: Sustainable Energy for All Global Tracking Framework, 2013.

Annex 3 Allocations from PREP resources to Indonesia

Table A3.1 Expenditure from PREP resources in Indonesia

Programme or activity	Main subject	Starting year	Implementing Agency	Expenditure in '000 EUR
Energy Working Group	Energy Education and training	2006	RVO.nl	9,318.1
Indonesia Palmoil certification	Energy Education and training	2008	CREM	272.6
National programme for Community Empowerment (PNPM) micro-hydro	Hydro electrical power plants	2008	World Bank	11,200.0
Geothermal power support	Power generation	2009	World Bank	1,950.0
Biogas programme	Installation of domestic biogas digesters	2009	HIVOS	5,878.0
Renewable Energy programme	Power generation from renewable sources	2009	IFC	510.0
PPP Geothermal GEOCAP	Energy Education and training	2013	Twente University	846.1*
Total expenditure				**29,974.8**
Regional or Worldwide Funds and programme of which activities were implemented in Indonesia				
SNV Asia Biogas	Biomass - biogas	2010	SNV	
Access to Energy Fund	Transmission of electricity	2006, 2012	FMO	
Daey Ouwens Fund	Renewable energy	2008	RVO.nl	
BMZ Partnership	Energizing development	2010	GIZ	
SALIN Global Village Energy partnerships	Power generation	2009	GVEP International	
Biofuel sustainability	Biomass	2008	RVO.nl	
Climate Investment Fund Trust Fund CEIF-MDTF	Renewable sources	2008	World Bank	
Fair Carbon Fund	Renewable sources	2009	ICCO	
Scaling up renewable Energy (SREP)	Energy policy, renewable energy access	2010	World Bank	
Energy Sector Management Assistance Programme (ESMAP) 2011-2014	Energy policy and administrative management	2011	World Bank	
Asia Sustainable and Alternative Energy (ASTAE) III	Energy policy and administrative management	2011	World Bank	
Global Alliance for Clean Cookstoves (GACC)	Energy research and energy efficiency	2012	United Nations Foundation	
IFC Renewable Energy	Environmental research	2013	IFC	

* The committed budget over the project period of 3.5 years is EUR 6.13 million.

Included are activities that were funded from PREP resources, be it specific allocations to Indonesia or through general funds (of which the expenditures in Indonesia form part of broader programmes and cannot be precisely indicated).

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