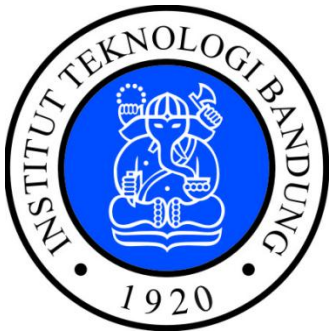
COLLABORATION

GEOCAP

Geothermal Capacity Building Program Indonesia - Netherlands



WOULD YOU LIKE TO SEE OPPORTUNITIES IN GEOTHERMAL RESOURCE?

MENANGKAP PELUANG PEMANFAATAN PANAS BUMI UNTUK INDUSTRI SKALA KECIL-MENENGAH-BESAR

Geothermal Program of Institut Teknologi Bandung

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Presented in The ITB Geothermal Workshop on Low-Medium Enthalpy Use

Thursday, April 7, 2016

Open-air BATHING (Onsen – Japan)

Open-air BATHING (Onsen – Japan)

Onsen have always been important to the Japanese people.

the act of cleansing and purifying the body - Buddhism

Dogo Onsen in Ehime Prefecture on the island of Shikoku is said to be the first recorded in Japanese history - dating back to around the year 712.

Open-air BATHING (Onsen – Japan)

And it isn't just humans who are attracted to open-air bathing

Open-air BATHING (Onsen – Japan)

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Home > Japan In-depth > > Seasonal Rhythm > Japan's Famous Hot Springs > Hokkaido - Tohoku

Japan's Famous Hot Springs

Ginzan-onsen Hot Spring

On both sides of the Ginzan-gawa River which runs through the town of Ginzan-onsen, you can find inns comprising three to four levels, with wooden balconies.

Jozankei-onsen Hot Spring

located in Shikotsu-Toya National Park. Jozan-gensen-koen Park is located in the center of town. There, you can enjoy forest bathing and a stroll on the promenade along the Toyohira-gawa River, which has hot water springing from its bottom

Zao-onsen Hot Spring

very popular among people as "water to nurture the health in children" and "water for making skin light, smooth and beautiful."

AN ONSEN MAP!

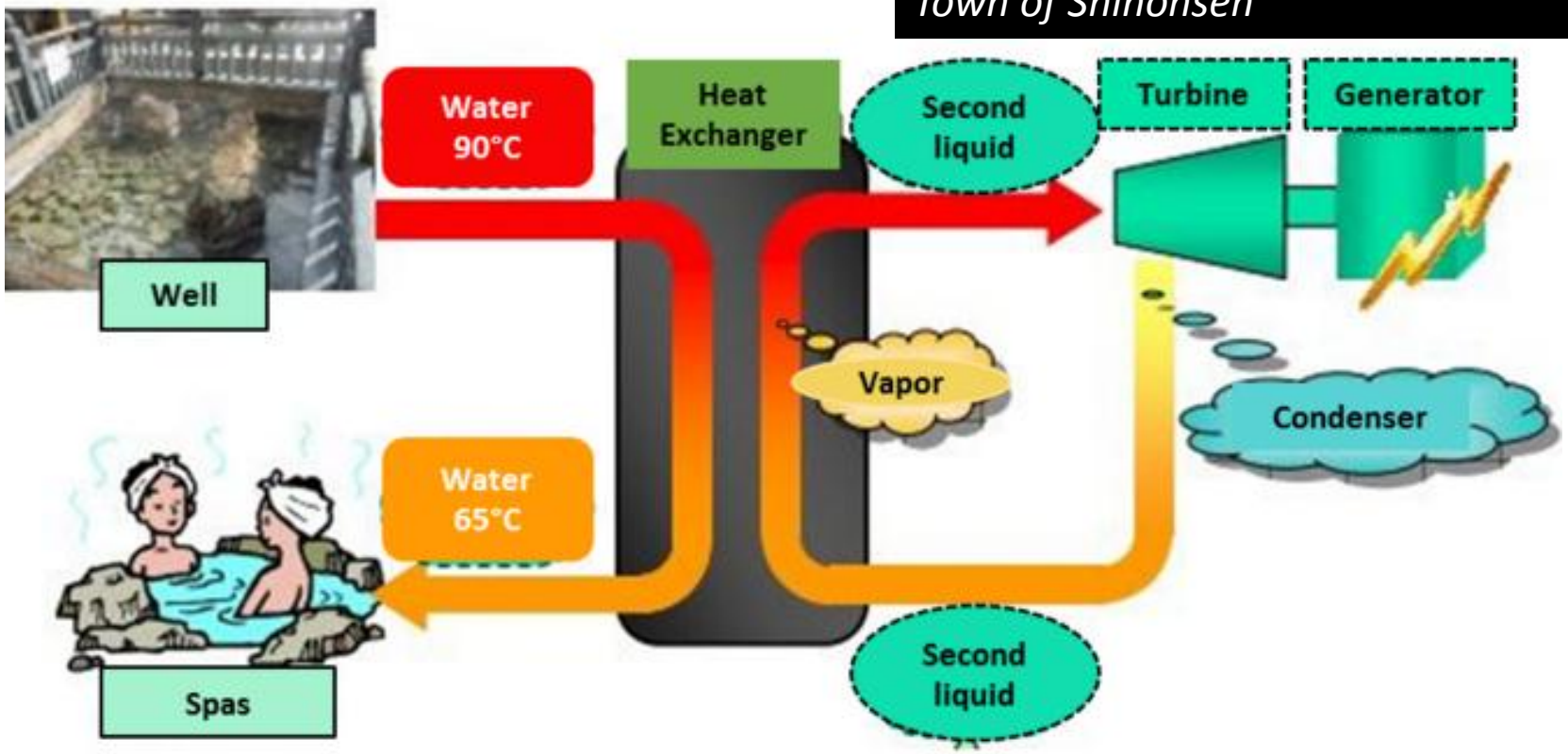
AND NOT A

MANIFESTATION AREA MAP

hot spring resorts

Onsen Binary Systems

Simplified diagram of a "Onsen" binary geothermal plant at Yumura Onsen, Credit: The Town of Shinonsen



"Since we didn't plan to make steam or flash cycle geothermal plants – which require very high temperature geothermal fluids – we didn't need to find and dig new wells," Kaoru Taniguchi, a worker at Department of Local Deployment, Town of Shinonsen, said. "We just installed a geothermal system at a spa where abundant hot water existed."

Onsen Binary Systems

Binary geothermal power plants, or “Onsen” Binary plants, use chemical fluids known as a second liquid (e.g., Isobutene and n-Pentane) that boils at a lower temperature than water.

2 x 20 kW

Onsen Binary Systems

400-KW Onsen Binary Geothermal Power Plant at Tsuchiyu, Fukushima Prefecture, Credit: Genki Up Tsuchiyu Company

Onsen Binary Systems – Yumura Onsen

"At the very beginning, some community members worried that we would lose our spring water," Taniguchi said. "We explained that we don't lose water. To generate electricity, we only lose some heat from spring water, which is already available at the ground surface. Once they understood that we don't dig new wells and draw extra water from the underground, we got their blessings."

The system generated about 140 MWh of electricity, out of which about 72 MWh is used at Yakushiyu spa and charge an energy storage (10 kW)

ICELAND

Open-air BATHING

In Iceland **70%** of primary energy consumption is from geothermal energy, and **100% of primary energy in the country is renewable**.

Open-air BATHING (ICELAND)

Open-air BATHING (ICELAND)

Blue Lagoon Geothermal Spa in Iceland

INDUSTRIAL USERS (ICELAND)

Geothermal energy has been used in Iceland for drying fish for about 25 years. The main appllication has been the indoor drying of salted fish, cod heads, small fish, stockfish, and other products. The annual export of dried cod heads is about 15,000 tons.

INDUSTRIAL USERS (ICELAND)

Seaweed Drying

Once landed, the seaweed is chopped and dried on a band dryer that uses large quantities of clean, dry air heated to 85°C by geothermal water in heat exchangers. The plant has been in operation since 1976, and produces between 2,000 and 4,000 tons of rockweed and kelp meal annually using 34 l/sec of 107°C water for drying.

manufacturing carbonated beverages, and in other food industries

Since 1986, a facility at Hædarendi in Grímsnes, South Iceland, has produced commercially liquid carbon dioxide (CO_2) from geothermal fluid.

Snow Melting (ICELAND)

In downtown Reykjavik, a snow-melting system has been installed under the sidewalks and streets over an area of 50,000 m^2

Iceland's total area of snow melting systems was about 920,000 m^2 in 2008, of which about 690,000 m^2 are in Reykjavik.

The annual energy consumption depends on the weather conditions, but the average is estimated to be 430 kWh/m^2.

Green Houses (ICELAND)

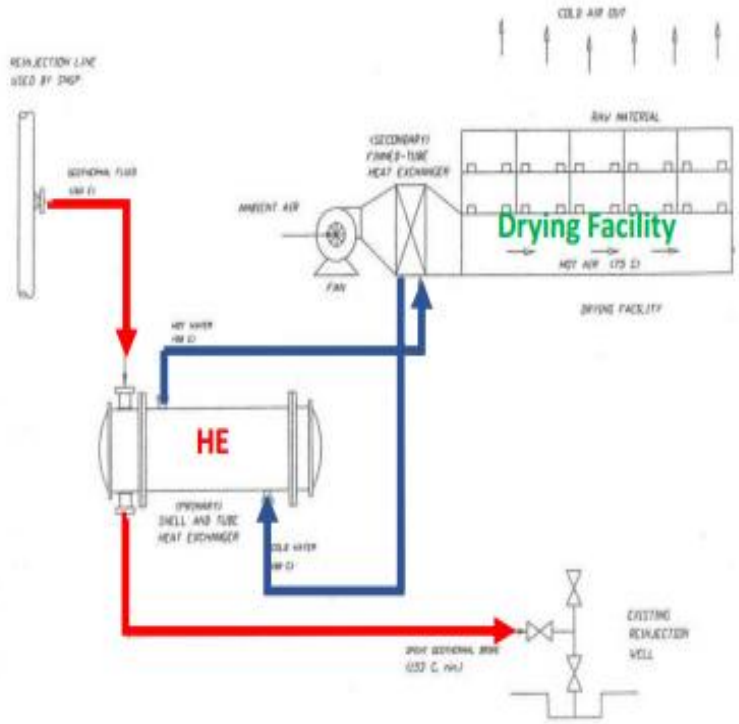
Apart from space heating, one of Iceland's oldest and most important usages of geothermal energy is for heating greenhouses. For years, naturally warm soil has been used for growing potatoes and other vegetables. Heating greenhouses using geothermal energy began in Iceland in **1924**.

Fish (Salmon & Trout) Farming - ICELAND

Geothermal water, commonly at 20-50°C, is used to heat fresh water in heat exchangers, typically from 5 to 12°C.

Contoh Pemanfaatan Langsung

Pengeringan Kelapa di Southern Negros, Filipina
Mampu menghasilkan 6,6 – 7,7 ton kopra dengan tingkat kelembapan 7 – 10%



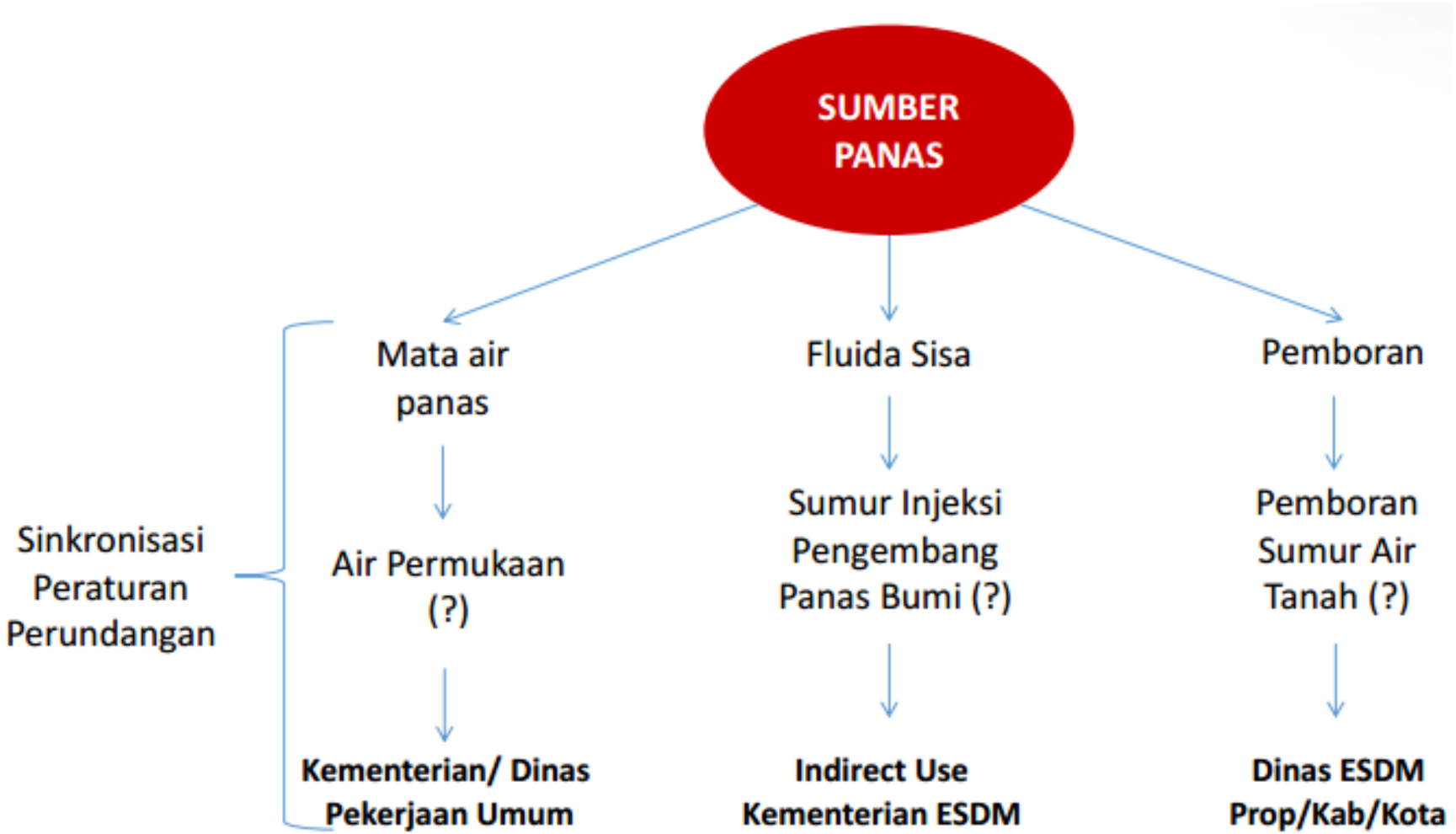
Menggunakan sumber energi panas bumi dari *brine* yang berasal dari PLTP Palipinon

Prinsip kerja :

- 160 °C *brine* dilewatkan sebuah HE
- Kalor dari brine akan mamanaskan fluida air yang dilewatkan HE, yang kemudian kalor tersebut akan dibawa menuju faslitias pengeringan.
- Kalor yang dibawa oleh air akan dipindahkan ke dalam ruangan pengeringan melalui perantara udara yang dialirkan oleh kipas

Sumber: Geothermal Center of Excellence

Tantangan – Kebijakan/Regulasi



Sumber: Geothermal Center of Excellence

Kebijakan/Regulasi – Take Action

NO	NEGARA	KEBIJAKAN
1	PERANCIS	Penyediaan anggaran bagi pemanfaatan energi panas bumi. Contoh: pemanfaatan fluida bertemperatur rendah untuk pemanas dan pendingin ruangan, didukung oleh pemerintah dengan mensubsidi pembangunan instalasi agar kompetitif dengan gas alam. Budget tahunan berkisar 200 juta Euro yang dianggarkan untuk menyokong operasi pemboran sumur yang lebih dalam dari 200 m, dimana sumur tersebut diaplikasikan untuk pemanas ruangan, pengembangbiakan ikan dan pertanian menggunakan rumah kaca.
2	JERMAN	Dukungan pemerintah: penyediaan dana bagi riset, insentif market, program penawaran kredit dan pendanaan melalui bank. Dengan besarnya penggunaan energi untuk keperluan penghangat ruangan, maka *Renewable Energy Heat Act* mewajibkan pemilik gedung untuk menggunakan energi terbarukan bagi keperluan heating/cooling.
3	ISLANDIA	Penyediaan hibah bagi survey pendahuluan dan pemboran eksplorasi. Menjadikan energi panas bumi sebagai energi yang sangat penting dalam pembangunan, baik dari aspek ekonomi maupun sosial melalui Master Plan for Geothermal and Hydropower Development in Iceland

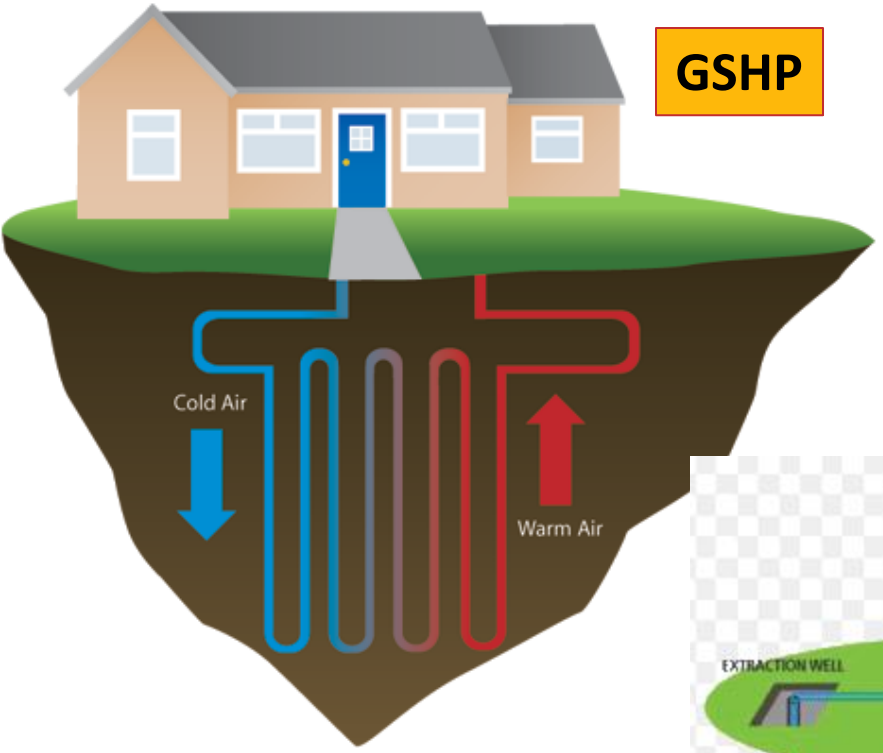
Sumber: Geothermal Center of Excellence

Take Action - Initiatives

- Indonesia terletak di daerah tropis
  - Kebutuhan akan pendinginan ruangan sangat tinggi
- Porsi terbesar dalam konsumsi energi di kota-kota besar Indonesia adalah untuk pendinginan ruangan
- Dinas Energi dan Sumberdaya Mineral Provinsi Jawa Barat berinisiatif membuat penelitian untuk memanfaatkan pompa panas geotermal untuk pendinginan ruangan
  - Bekerja sama dengan pihak Indonesia Geothermal Center of Excellence dan ITB
  - Diharapkan dapat diterapkan di industri-industri yang berada di Jawa Barat

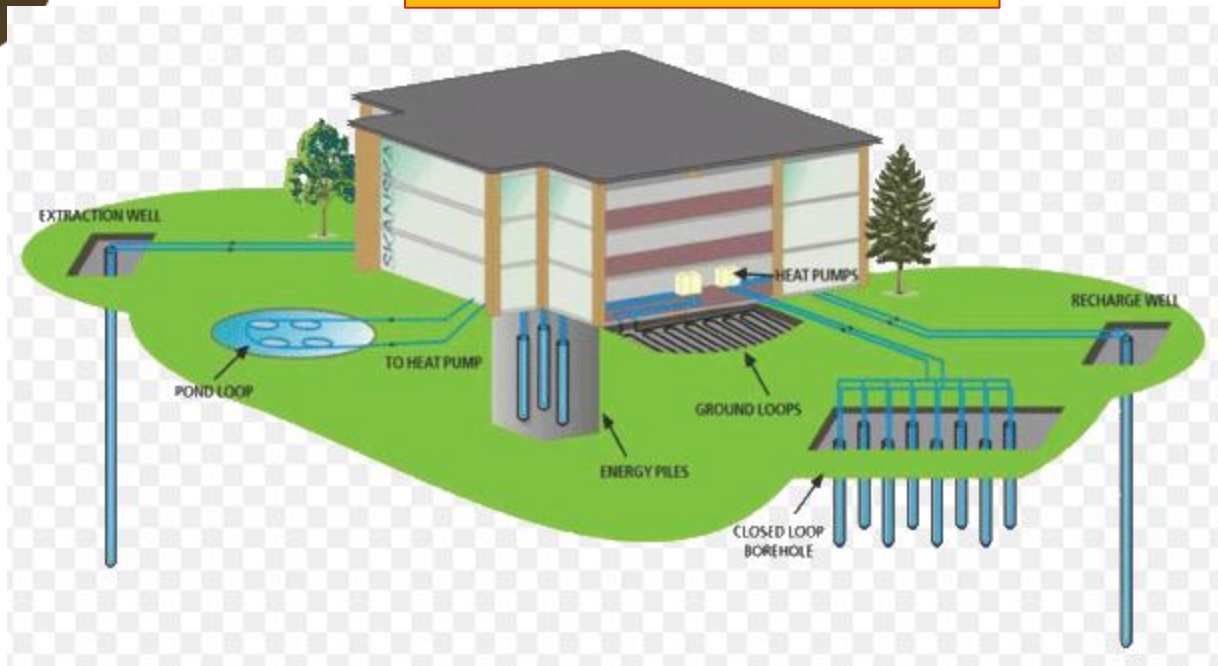
Sumber: Geothermal Center of Excellence

Take Action – Initiatives – Research on Ground Source Heat Pump (GSHP)



GSHP

Sources of Ground Heat



Take Action - Initiatives

Unit Pompa Panas

Sumber: Geothermal Center of Excellence

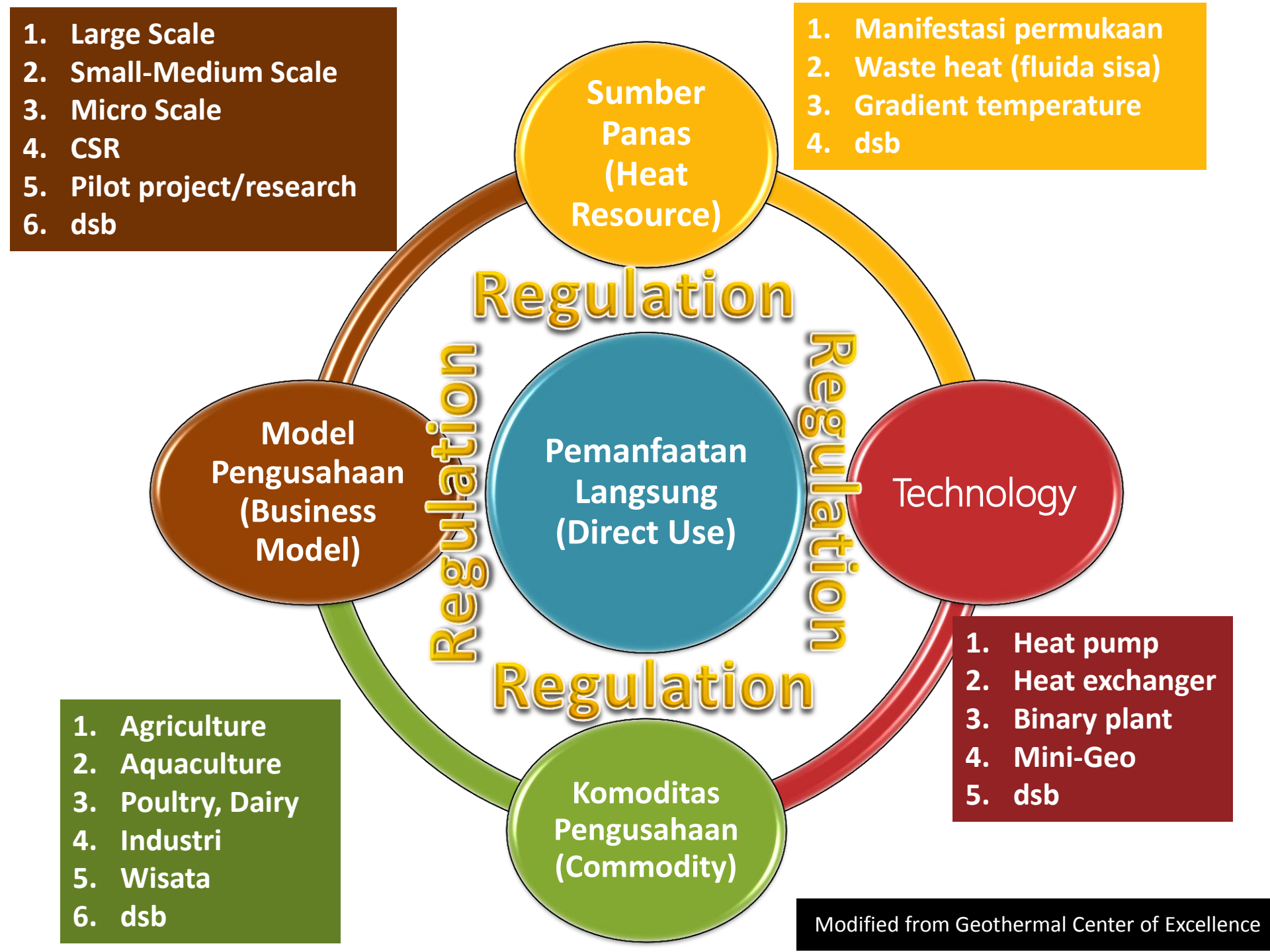
Take Action – Initiatives – Doing Research - Improve

- Sistem *Ground Source Heat Pump* (GSHP) terbukti efektif dalam menurunkan temperatur ruangan
  - Terbukti dari hasil pengukuran temperatur ruangan
- Mengenai efisiensi dari sistem *Ground Source Heat Pump* (GSHP), perlu adanya penelitian lebih lanjut terkait hal ini karena masih adanya inkonsistensi data konsumsi listrik
  - Hal ini terkait adanya perbedaan tipe pendingin ruangan yang dipergunakan dalam kaji terap

Sumber: Geothermal Center of Excellence

MAIN FOCUS AREAS

HOW CAN YOU CONTRIBUTE?


1. Large Scale
2. Small-Medium Scale
3. Micro Scale
4. CSR
5. Pilot project/research
6. dsb
1. Manifestasi permukaan
2. Waste heat (fluida sisa)
3. Gradient temperature
4. dsb
Sumber Panas (Heat Resource)
Regulation
Regulation
Regulation
Regulation
Model Pengusahaan (Business Model)
Pemanfaatan Langsung (Direct Use)
Technology
Komoditas Pengusahaan (Commodity)
1. Heat pump
2. Heat exchanger
3. Binary plant
4. Mini-Geo
5. dsb
1. Agriculture
2. Aquaculture
3. Poultry, Dairy
4. Industri
5. Wisata
6. dsb
Modified from Geothermal Center of Excellence

Keterangan	Darajat Pass	Sari Awit	Puncak Darajat	Puncak Jaya Darajat	BRI (Bukit Rejeng Indah)
Produk yang dihasilkan	Pemandian air panas, terapi belerang,	Pemandian air panas dan penginapan	Pemandian air panas dan penginapan	Pemandian air panas dan penginapan	Pemandian air panas, penginapan, dan terapi batuan
Bahan baku	Air dingin	Air panas	Air dingin	Air dingin yang dipanasi kawah	Air panas
Pasokan bahan baku	Dari Pengunungan	Mata air panas Cibeureum	Dari pegunungan	Mata air dingin	Mata air panas Toblong 1
Proses pengolahan	Air dingin dari pegunungan di alirakan ke kawah yang panas sehingga terbentuk air panas	Mengalirkan air panas yang berasal dari mata air panas Cibeureum	Air dingin dari pengunungan dialirkan ke kawah yang panas dan menghasilkan air panas	Air dingin dari pegunungan di alirakan ke kawah yang panas sehingga terbentuk air panas	Air panas dari Toblong 1 dialirkan dengan pompa dan di filter sebelum menuju kolam pemandian dan penginapan
Pengolahan limbah	Hasil pengurasan kolam dibuang ke sungai	Hasil pengurasan kolam dibuang ke sungai	Selama 2 hari sekali kolam di kuras, air sisa akan digunakan untuk menyiram kebun	-	Air pemandian yang dikuras 1 minggu sekali akan dialirkan ke selokan menuju sungai besar
Harga jual produk (Harga tiket)	Tiket pemandian : 22.000 - 25.000	Tiket pemandian : 14.000-25.000. Biaya penginapan : 600.000 -750.000 per hari	Tiket pemandian : 20.000-25.000. Biaya penginapan : 450.000-500.000 per malam. Biaya penginapan 1.250.000-1.500.000.	Harga tiket 15.000 - 20.000	Harga tiket dewasa 20.000 dan anak 15.000, untuk warga sekitar tidak dikenakan biaya. Biaya penginapan : 450.000 untuk akhir pekan dan 350.000 untuk hari kerja.
Omset	3000 pengunjung/ bulan	2500 - 3000 pengunjung/ bulan	1.2 M per bulan	Baru buka 5 bulan yang lalu	-
Jumlah pekerja	120 orang	20 orang	43 orang	10 orang	4 orang
Tingkat pendidikan	Lulusan SD, SMP, dan SMA	Lulusan SD, SMP dan SMA	Lulusan SD dan SMA	Lulusan SD, SMP dan SMA	Lulusan SD, SMP dan SMA
Daerah asal	Daerah sekitarnya (Garut)	Daerah sekitarnya (Garut)	Garut, khususnya kecamatan Pasirwangi	Daerah sekitar	Kecamatan Pasirwangi
Working hours	08.00 - 16.00 (sistem shift), pariwisata 24 jam	07.00 - 17.00, sabtu-minggu buka 24 jam	8 jam per shift untuk semua karyawan kecuali manajer dan teknisi air	-	12 jam per hari, dengan piket kecuali akhir pekan semua pekerja harus hadir
Jarak ke sumber daya panas bumi	3 km	300 m (mata air panas Cibeureum/ Awit)	2,5 km	5 km	1 km

Sumber: Geothermal Center of Excellence

Produk Industri Kecil dan Menengah di Sekitar Area Darajat

Sumber: Geothermal Center of Excellence

Manifestasi Permukaan Area Darajat

Kawah Manuk

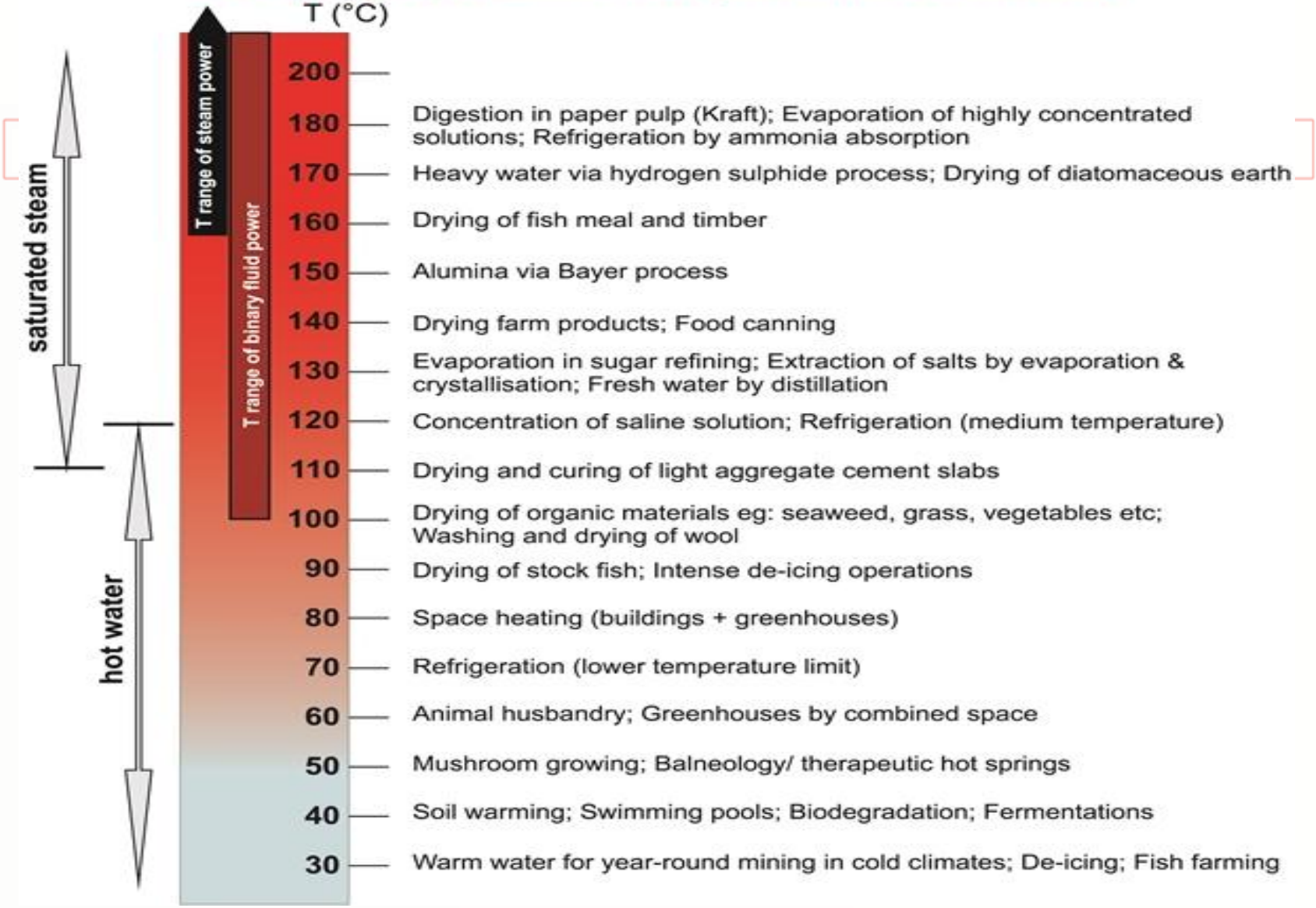
Temperatur fluida	:	86.4°C
pH fluida	:	3.24

Kawah Darajat

Temperatur fluida	:	79.8°C
pH fluida	:	4.20

Sumber: Geothermal Center of Excellence

Direct-use applications for geothermal resources



POTENTIAL OF HEAT
FROM HOT SPRINGS (MANIFESTATION)

No.	Surface Manifestation	Surface Temperature (°C)	Flowrate (L/s)	Heat Load (MW)
1	Ciracas Hot Springs	41.6-46	0.2	0.04
2	Batu Gede Hot Springs	42.1-45.5	0.2-1	0.11
3	Kawah Domas Hot Springs	85.5 -91.1	0.3-2	0.41
4	Kancah Hot Springs	31.1-34.5	3.3-5.1	0.57
5	Cimanggu Hot Springs	34.1-35.2	2.3-2.85	0.37
6	Maribaya Hot Springs	45.1-46.6	0.23-1.1	0.13
7	Patuha Hot Springs	35-83	2-15	2.07
8	Cimanggu Hot Springs	40-55	7.82-15.87	2.33
9	Rancawalini Hot Springs	40-55	7.17-15.87	2.27
10	Cibuni Crater Hot Springs	85-90	>3	1.06
11	Ciwidey Hot Springs	70-90	>4	1.30
12	Wayang Windu Hot Springs	39-66	15	3.25
13	Kawah Kamojang Hot Springs	90-93	2	0.74
14	Kawah Hujan Hot Springs	94	2	0.76
15	Citepus Hot Springs	55-60	2	0.47
16	Ciseeng Warm Springs	44.3	0.5	0.09
17	Cibodas Hot Springs	65.7	0.13	0.04
18	Ciherang Hot Springs 1	39.3	0.03	0.00
19	Ciherang Hot Springs 2	35.3	0.17	0.02
20	Cisaketi Hot Springs 3	42.1	0.33	0.06

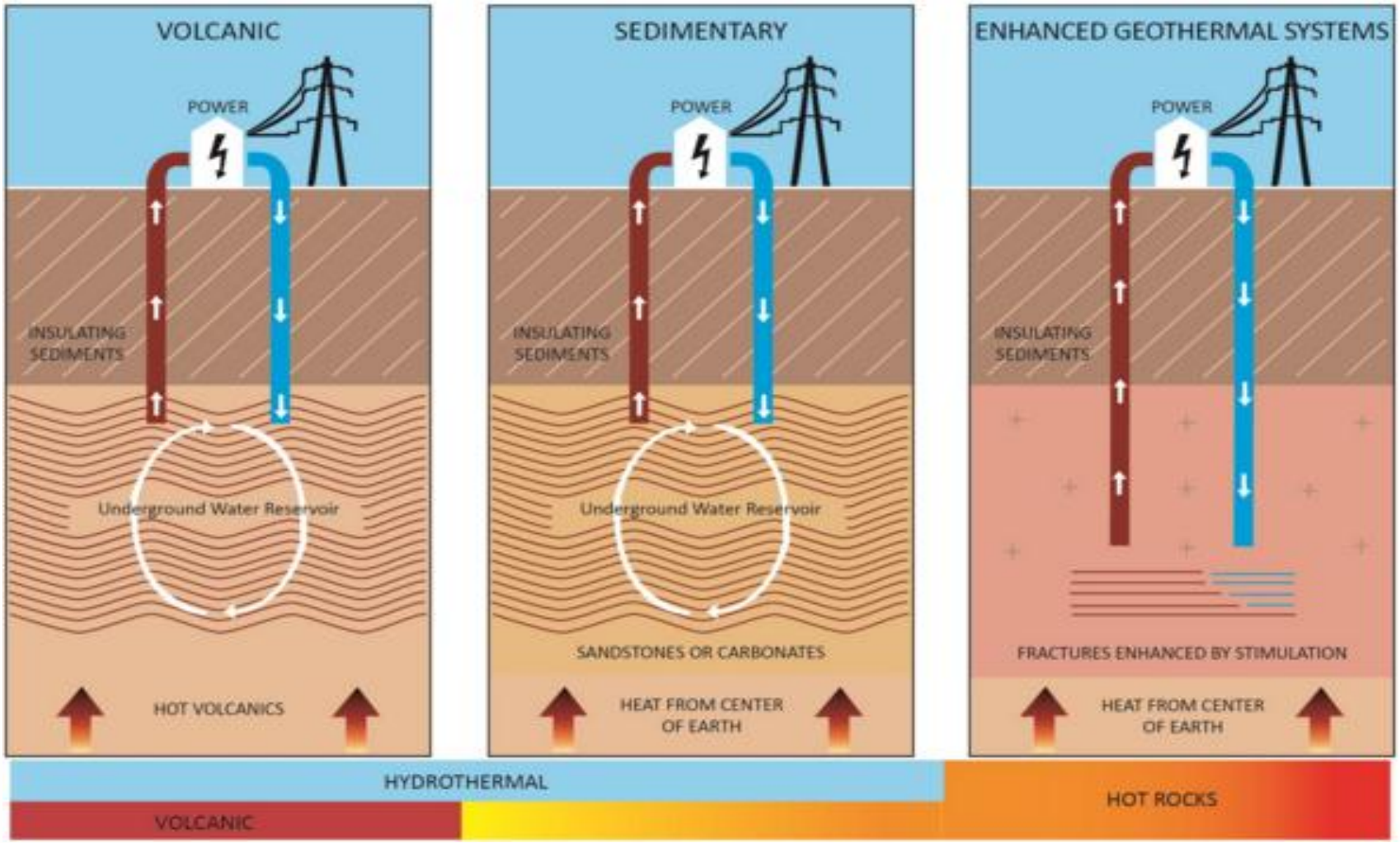
No.	Surface Manifestation	Surface Temperature (°C)	Flowrate (L/s)	Heat Load (MW)
21	Cipanas Karang Hot Springs	71.2	0.07	0.02
22	Muhinin Hot Springs	40	0.03	0.00
23	Sarimaya Hot Springs	61.2	0.08	0.02
24	Cipanas Cikuluwung Hot Springs	47.2	0.15	0.03
25	Cihideung Hot Springs	46	0.18	0.03
26	Kawah Ratu-G.Salak Hot Springs 1	45.9	2	0.38
27	Kawah Ratu-G.Salak Hot Springs 2	40.3	1	0.17
28	Panulisan Warm Springs	44-52	2	0.40
29	Tanggeung-Cibungur-Cibuni Hot Spring 1	70.5	2	0.58
30	Cipanas-Pacet Warm Springs	40	0.8	0.13
31	G.Kromong Hot Springs	57	4	0.94
32	Talaga Bodas Hot Springs	68.1	7	1.95
33	Kawah Mas Hot Springs	79	0.17	0.05
34	Kawah Manuk Hot Springs	65	0.17	0.05
35	Cibeureum Leutik Hot Springs	32	0.25	0.03
36	G. Masigit-Guntur Hot Springs	45	2	0.37
37	Cilayu Hot Springs	61	1	0.25
38	Subang Hot Springs 1	60.5	2	0.50
39	Subang Hot Springs 2	60.8	0.5	0.13
40	Subang Hot Springs 3	60.9	0.5	0.13

No.	Surface Manifestation	Surface Temperature (°C)	Flowrate (L/s)	Heat Load (MW)
41	Subang Hot Springs 4	60.7	0.5	0.12
42	Cibingin Hot Springs	54.2	3	0.67
43	Ciater Hot Springs	44-46.9	2 – 15	1.60
44	Batu Kapur Hot Springs	39.4-40.1	2.2 – 3.9	0.50
45	Cisolok Hot Springs 1	103	10	4.13
46	Cisolok Hot Springs 2	99	10	3.98
47	Cisolok Hot Springs 3	82	10	3.33
48	Cisolok Hot Springs 4	101	10	4.05
49	Cisolok Hot Springs 5	96	10	3.87
50	Kawah Karaha Hot Springs	91	1.6	0.59
51	Galunggung Hot Springs 1	50	2	0.41
52	Galunggung Hot Springs 2	60	3	0.74
53	Galunggung Hot Springs 3	60	3	0.74
54	Galunggung Hot Springs 4	61	3	0.75

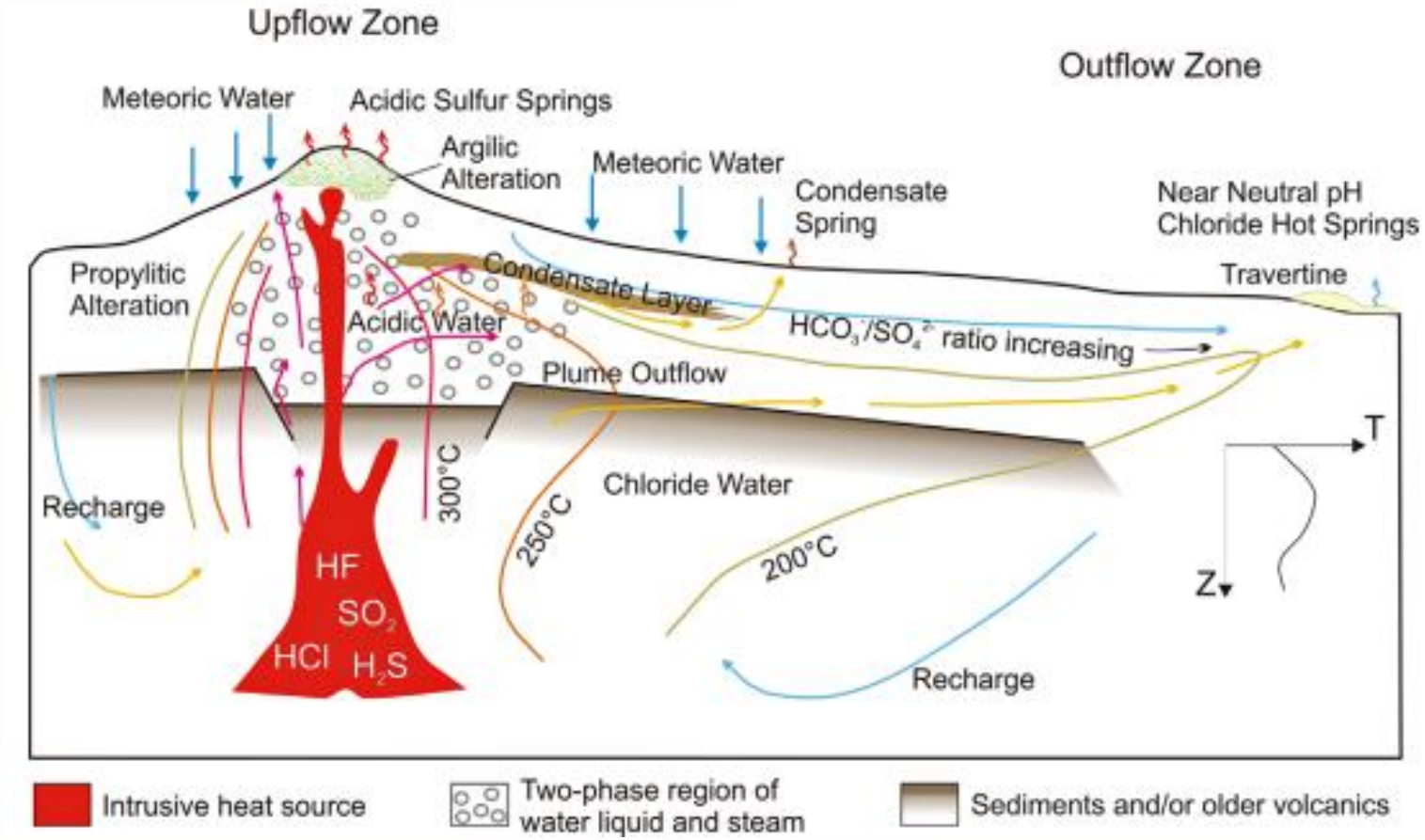

(1)
(2)
(3)
(4)

POTENTIAL OF GROUND HEAT

TYPES OF GEOTHERMAL SYSTEM

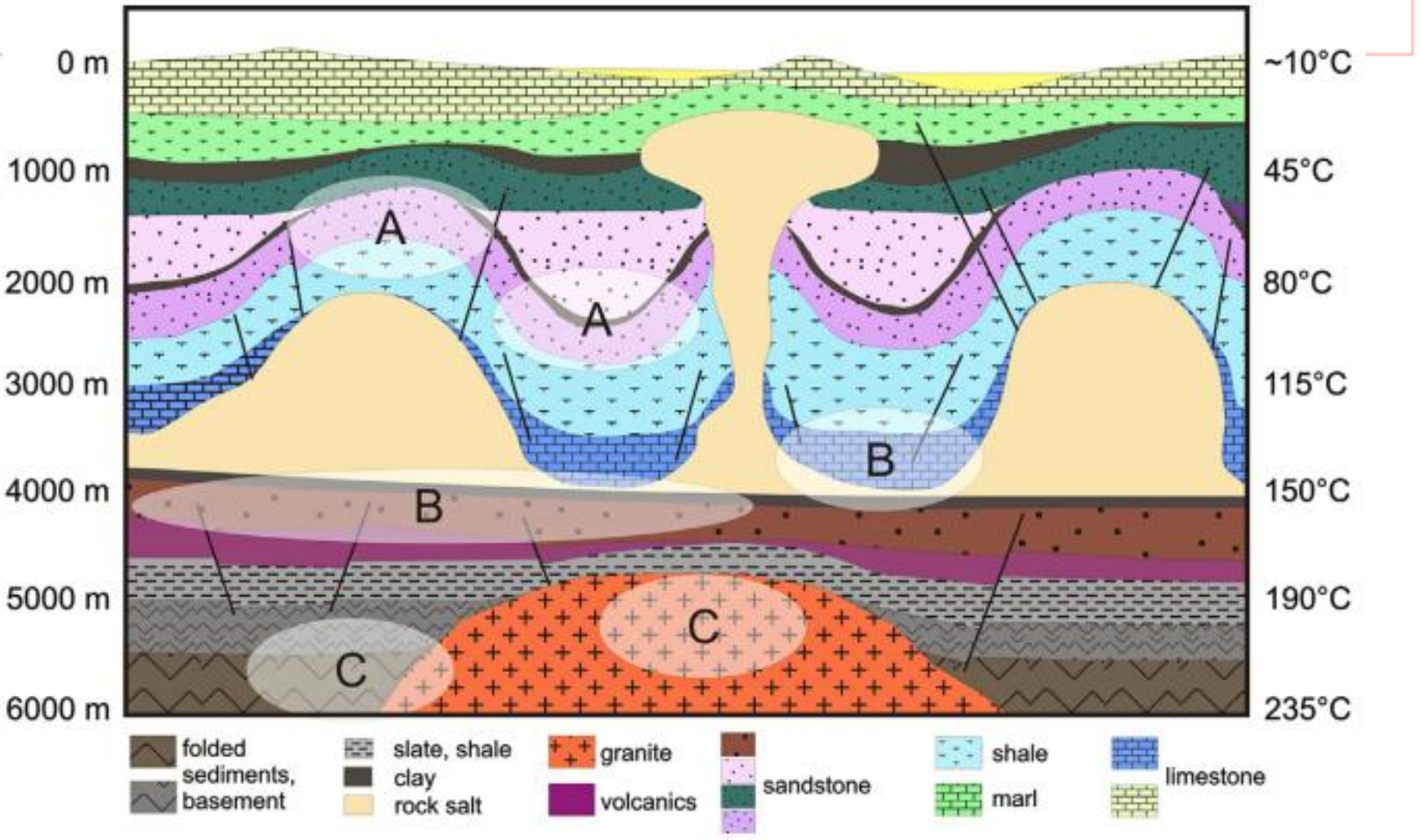


AREA PANAS BUMI YANG TERKAIT DENGAN AKTIVITAS VULKANIK

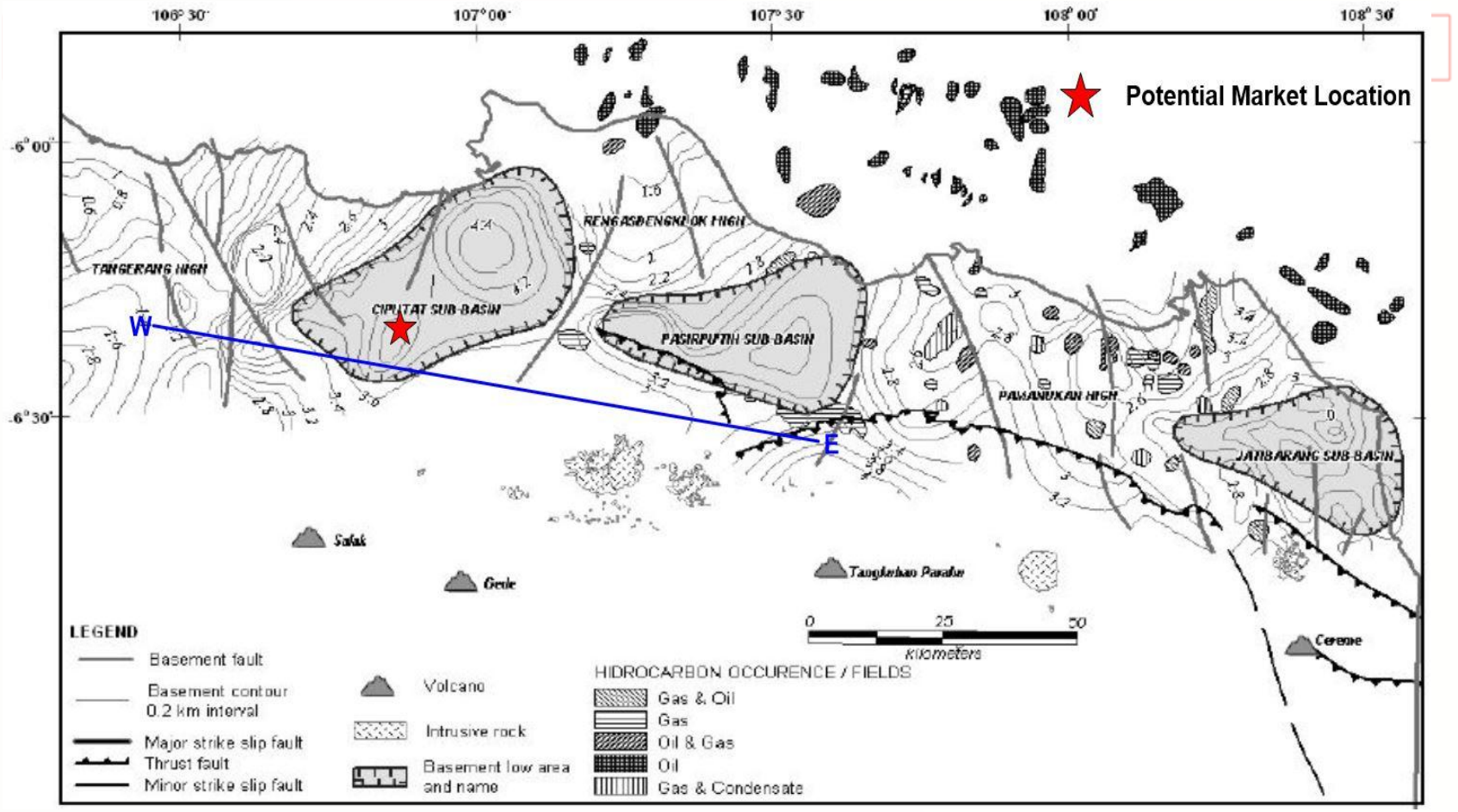


AREA PANAS BUMI YANG TIDAK TERKAIT DENGAN AKTIVITAS VULKANIK

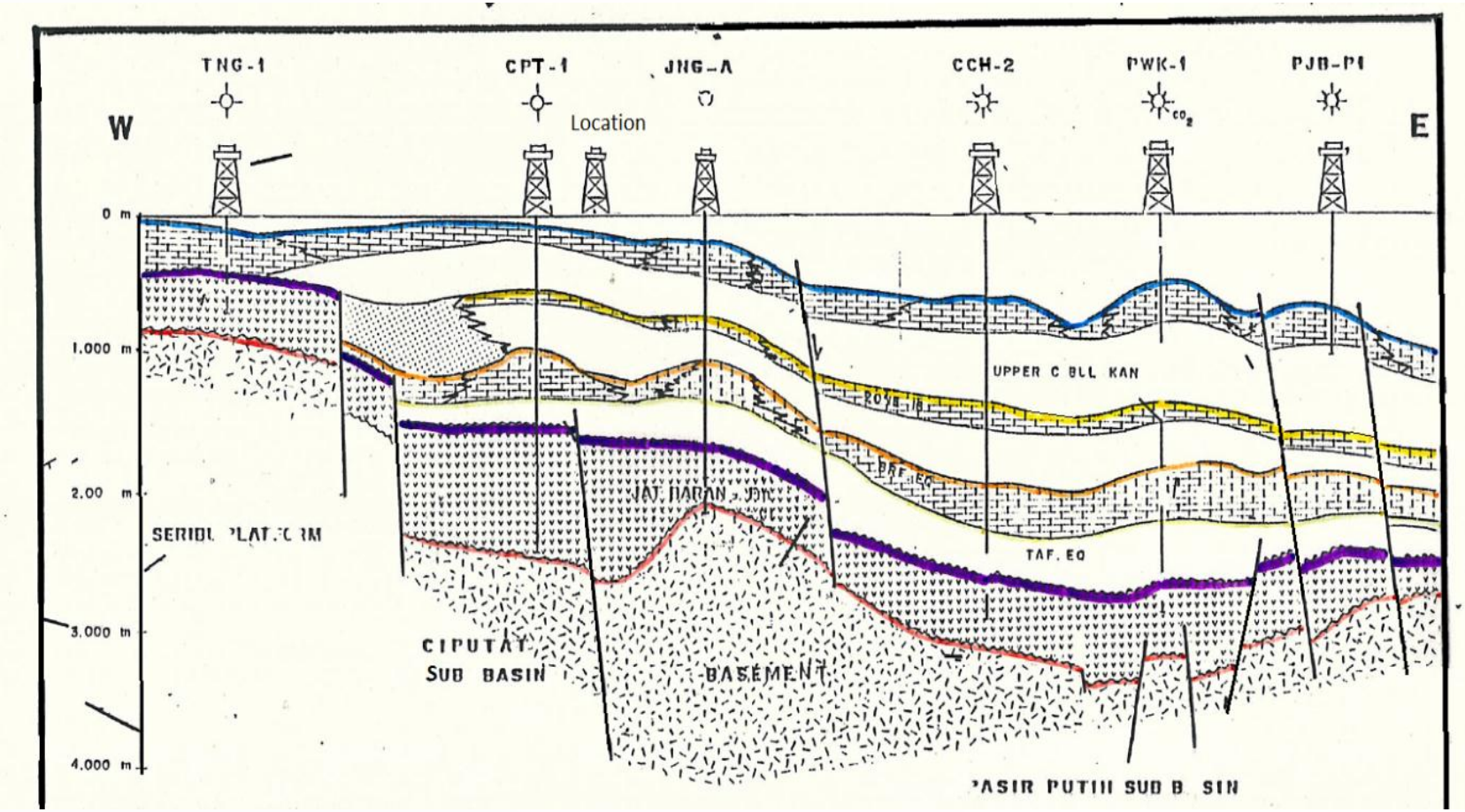
e.g. Sedimentary Basin-Hosted



HOT SEDIMENTARY BASIN IN NORTH WEST JAVA BASIN

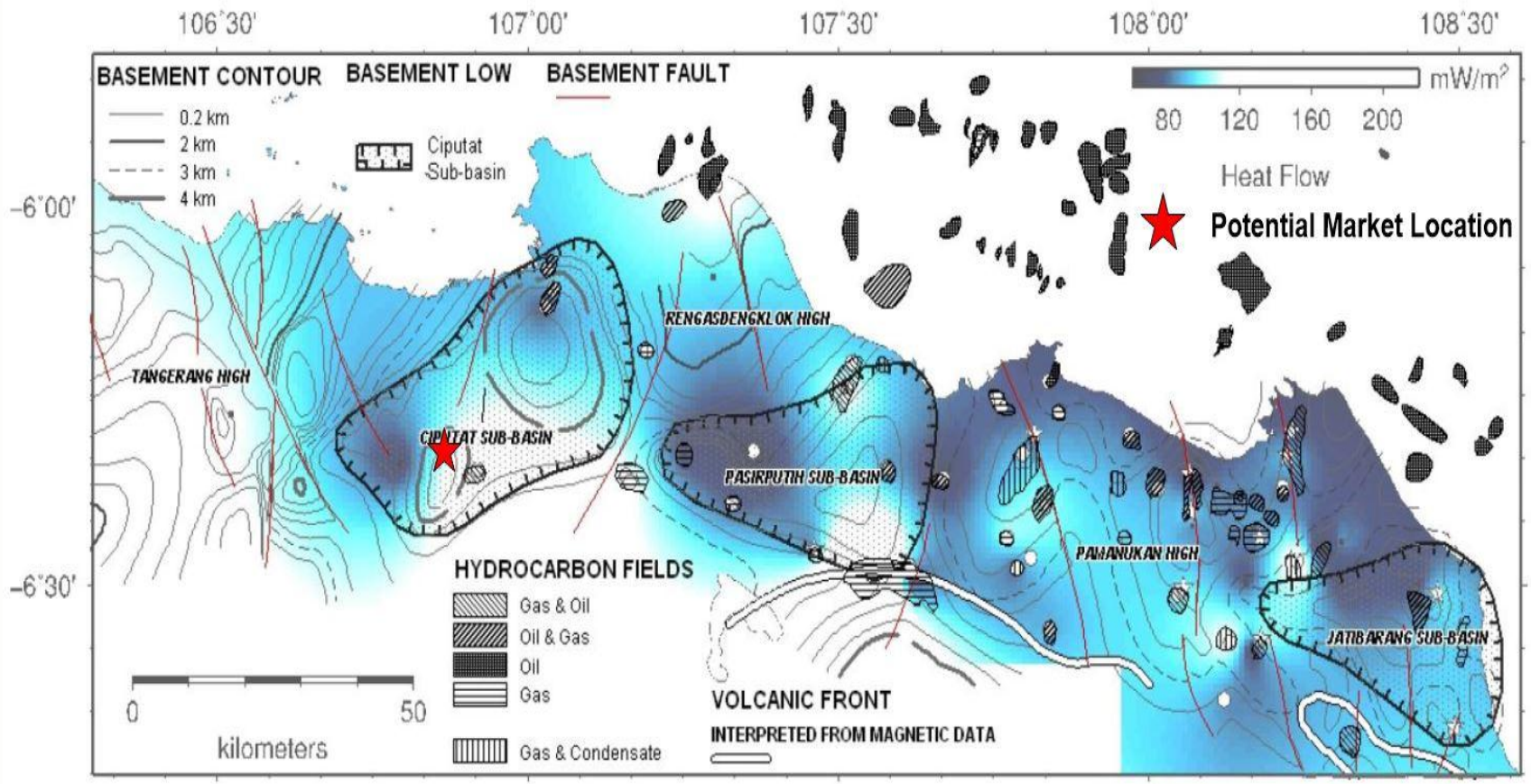


PROFIL TEMPERATUR SUMUR-SUMUR HASIL PENGEBORAN OIL MENUNJUKAN ADANYA GRADIEN TEMPERATUR



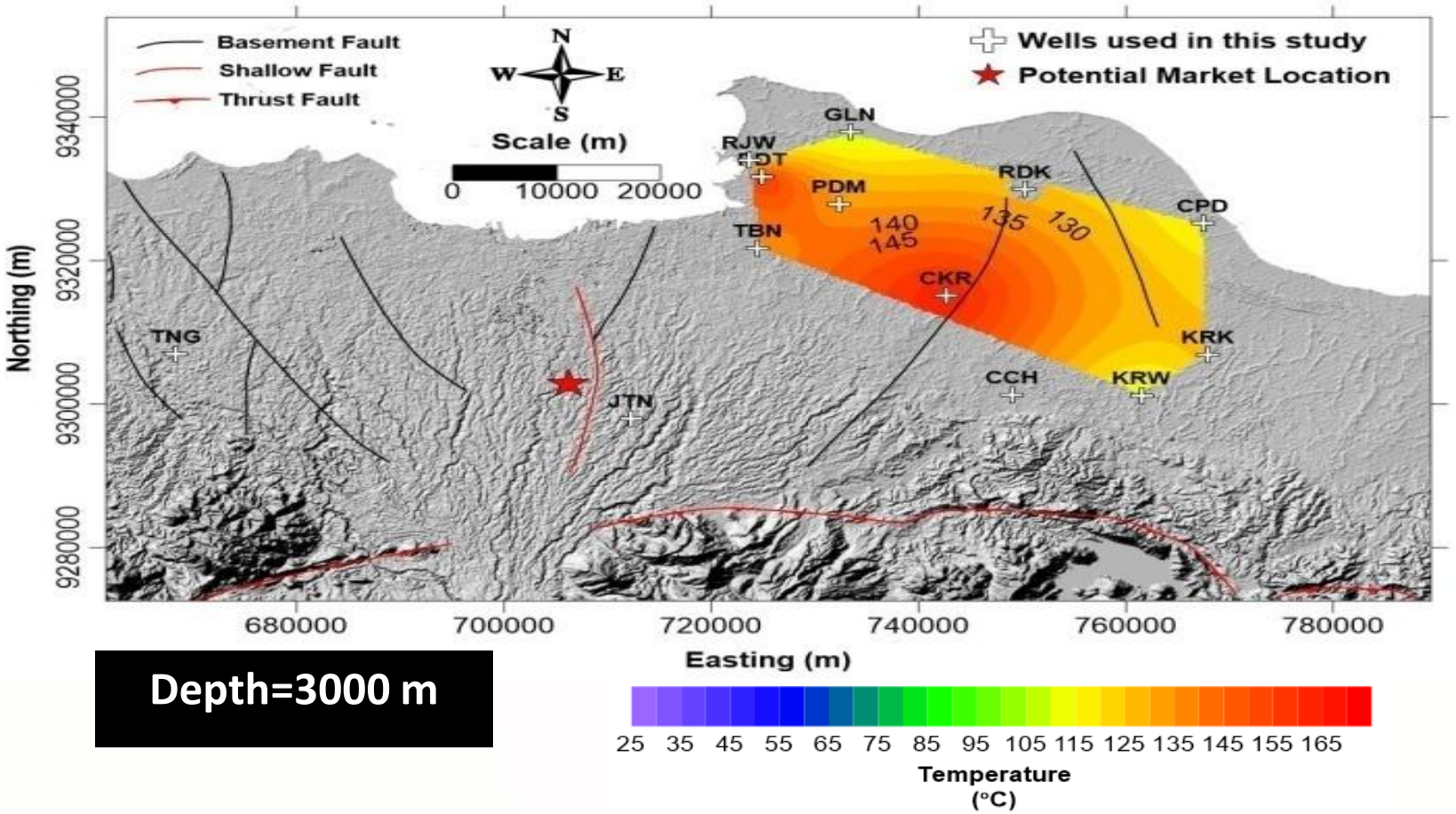
PROFIL TEMPERATUR SUMUR-SUMUR HASIL PENGEBORAN OIL MENUNJUKAN ADANYA GRADIEN TEMPERATUR

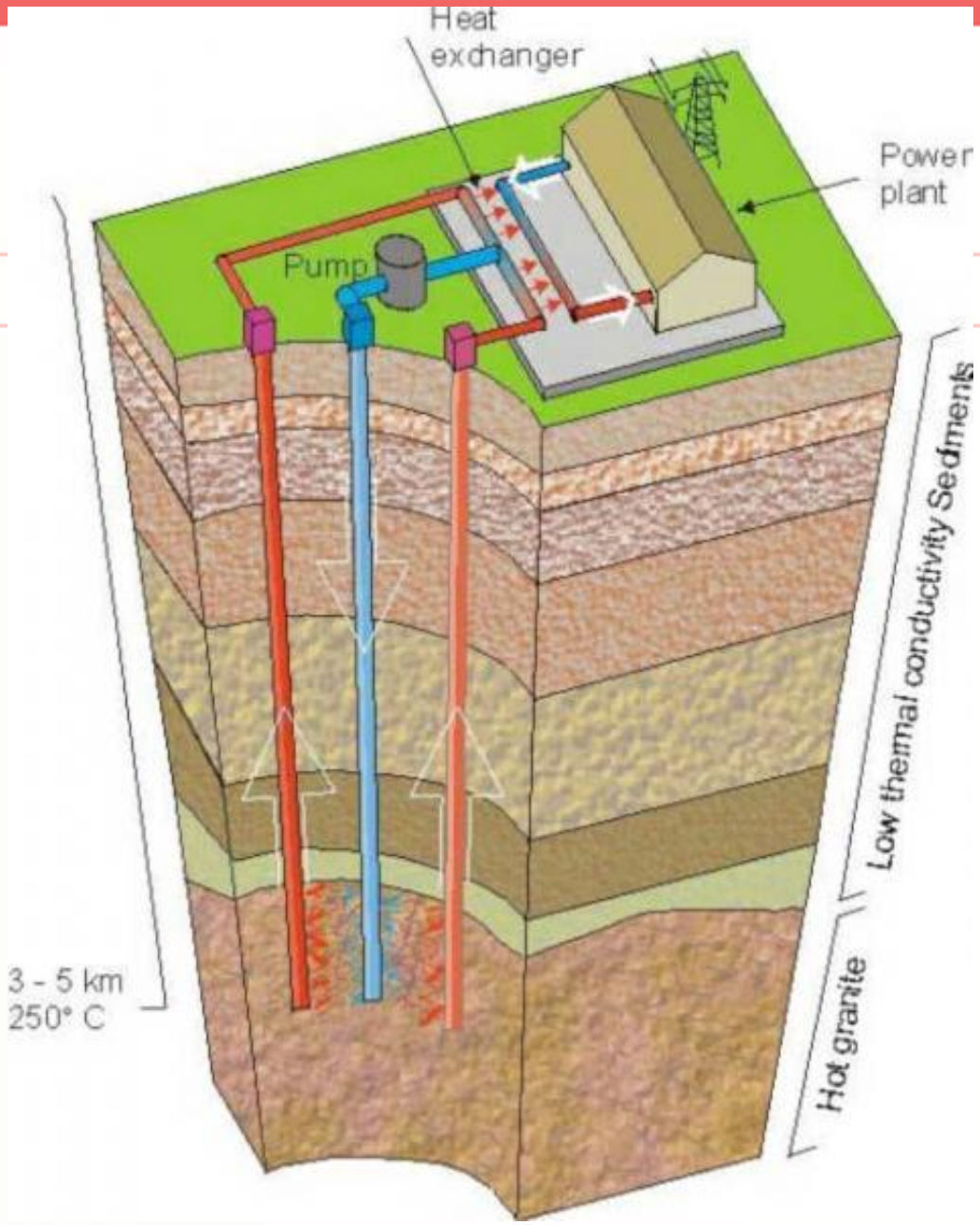
Contour map of heat flow of Onshore NW Java Basin (Suryantini, 2007)



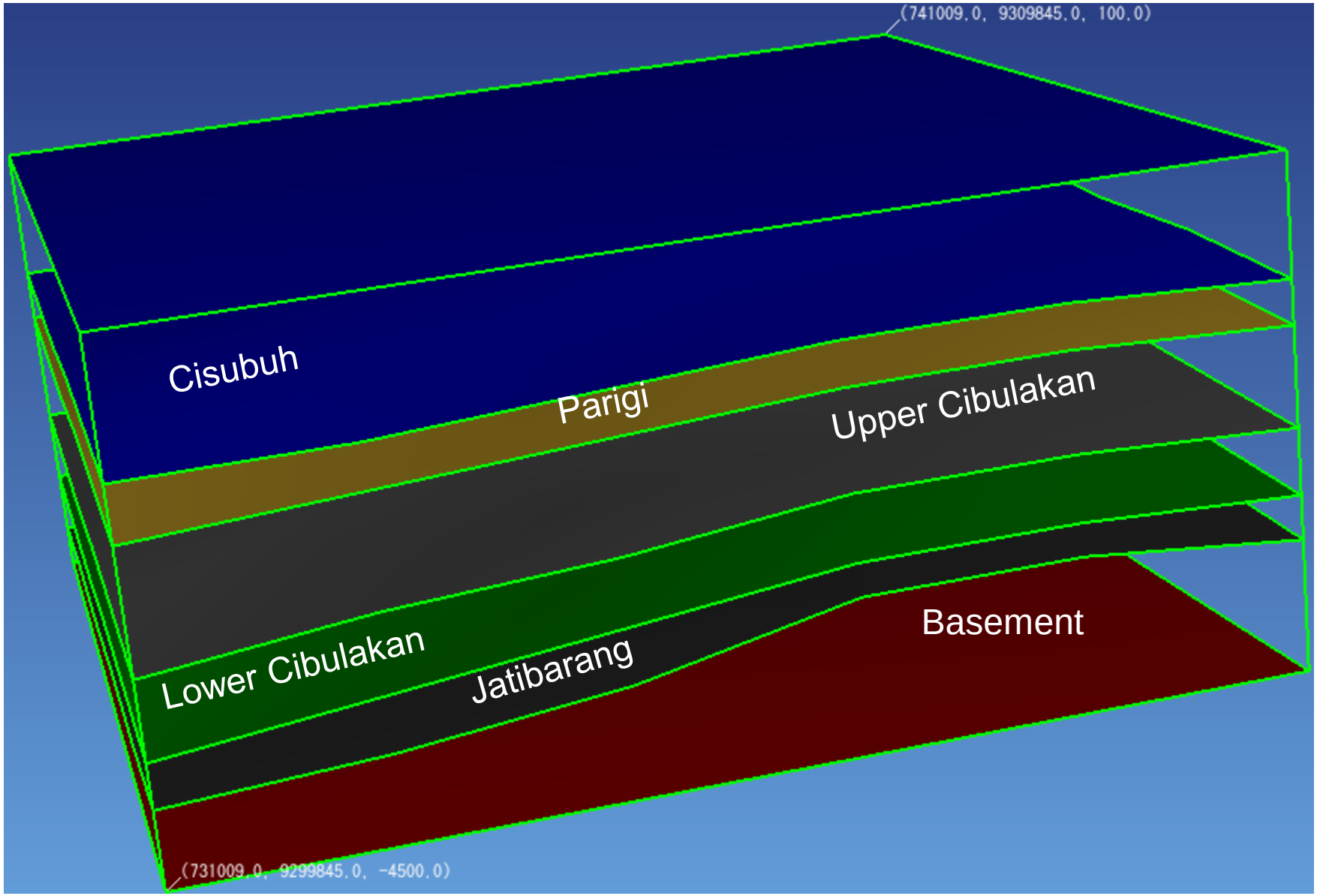
PROFIL TEMPERATUR SUMUR-SUMUR HASIL PENGEBORAN OIL MENUNJUKAN ADANYA GRADIEN TEMPERATUR

Contour map of temperature of Onshore NW Java Basin (LAPI ITB, 2014)

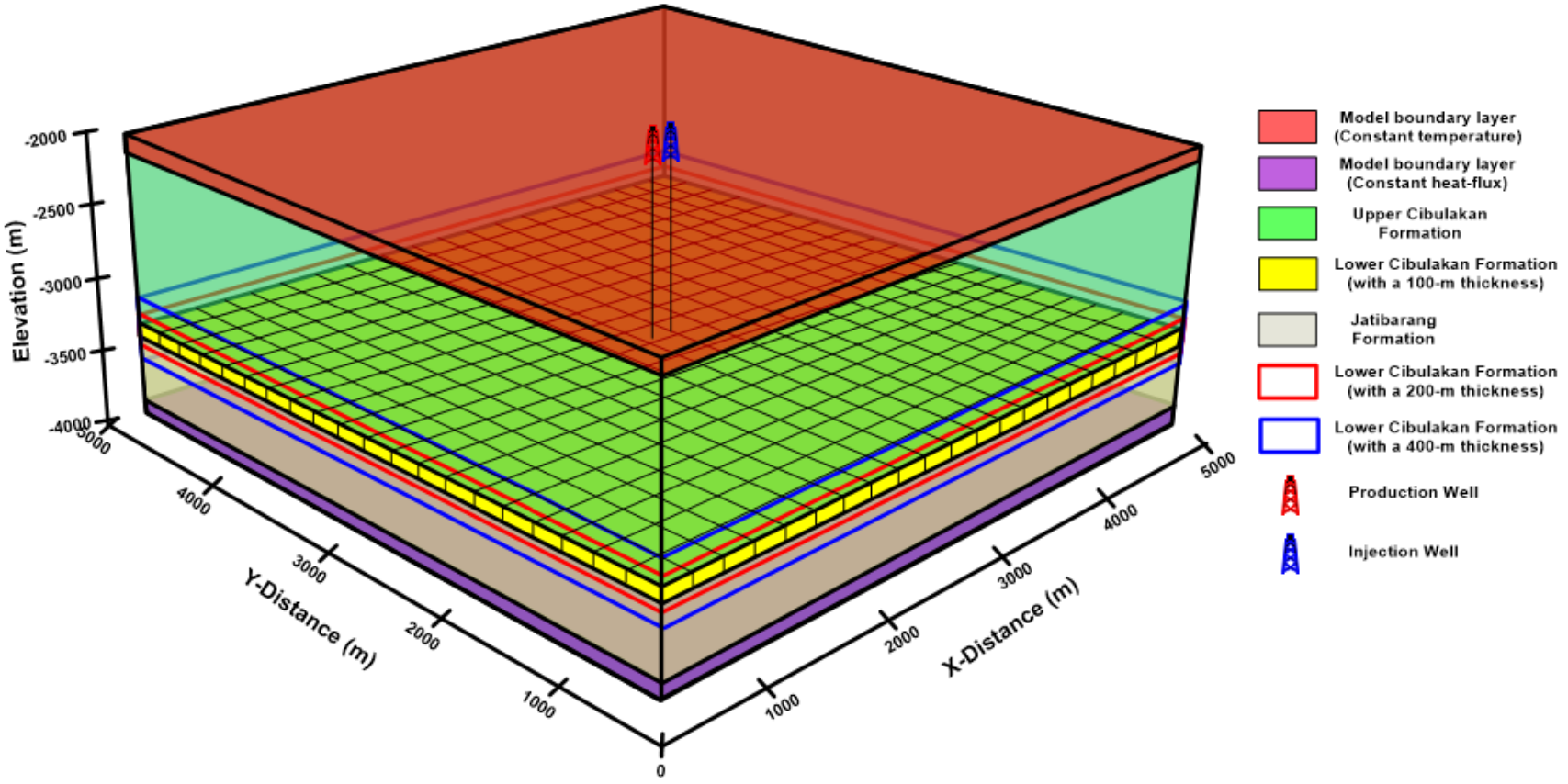



Heat
exchanger
Power
plant
Pump
3 - 5 km
250° C
Low thermal conductivity Sediments
Hot granite

THE SUBSURFACE FORMATION LAYER IN THE VICINITY OF JABABEKA (10X10 KM²)



THE MODEL DOMAIN (SIMPLIFIED, 5 KM X 5 KM)



The conceptual, low-enthalpy, geothermal reservoir extends 5km × 5km horizontally

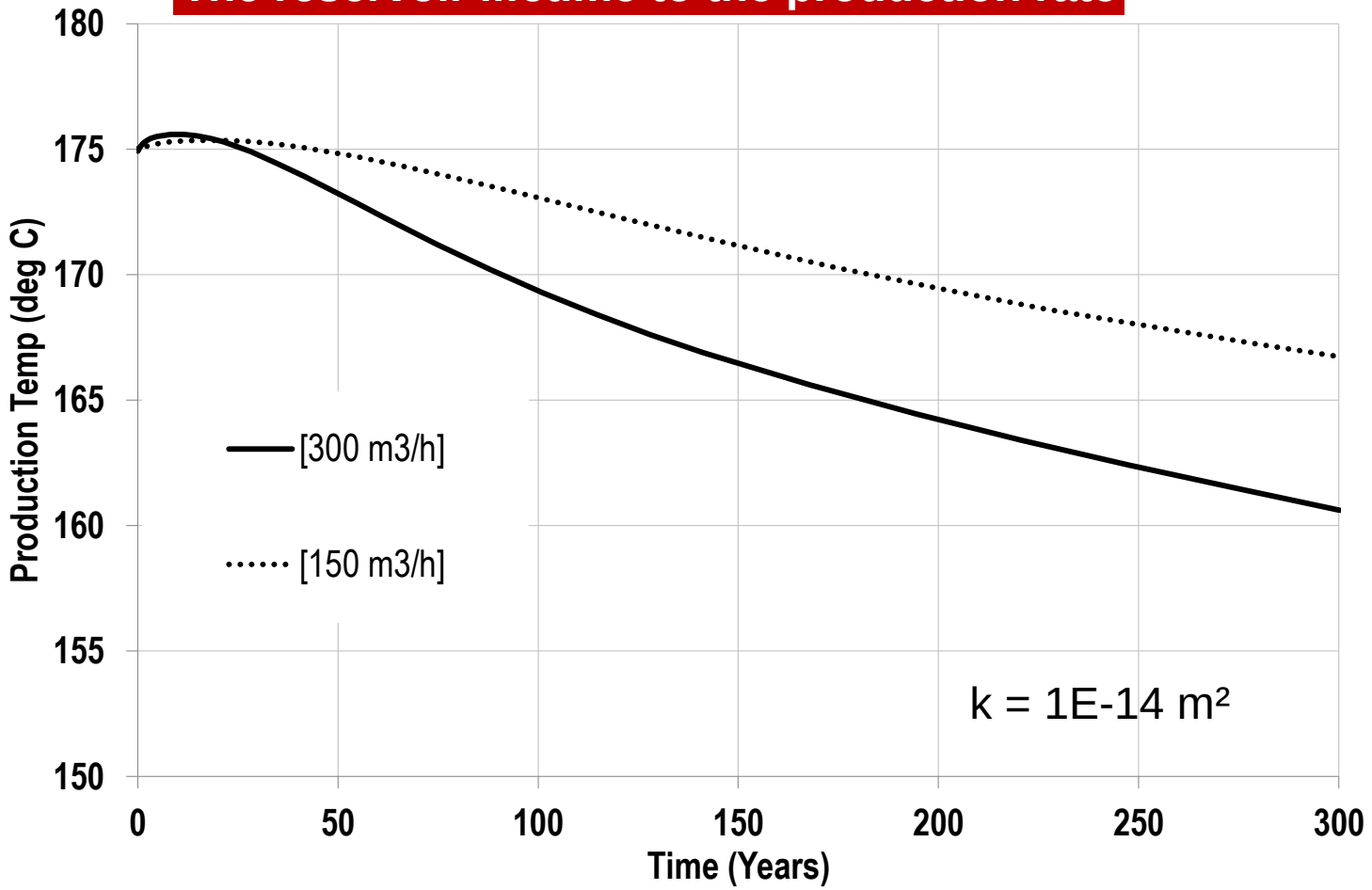
THE MODEL PARAMETERS

	Case 1 Production rate (m^3/h)	Case 2 Re-injection temperature (°C)	Case 3 Reservoir thickness (m)	Case 4 Reservoir permeability (m^2)	Case 5 Well Spacing (m)	Case 6 Porosity (Fraction)
A	75	28[a]	100[a]	1E-13 (0.1D)	600	0.05
B	150[a]	40	200	1E-14[a]	1200[a]	0.1[a]
C	300	70	400	1E-15	2000	0.2

[a] Denotes reference parameter values
(i.e parameter values when other parameters are being varied)

Simulation	Case 1 Worst Case	Case 2 Best Estimate
Production flow rate (m^3h)	300	150

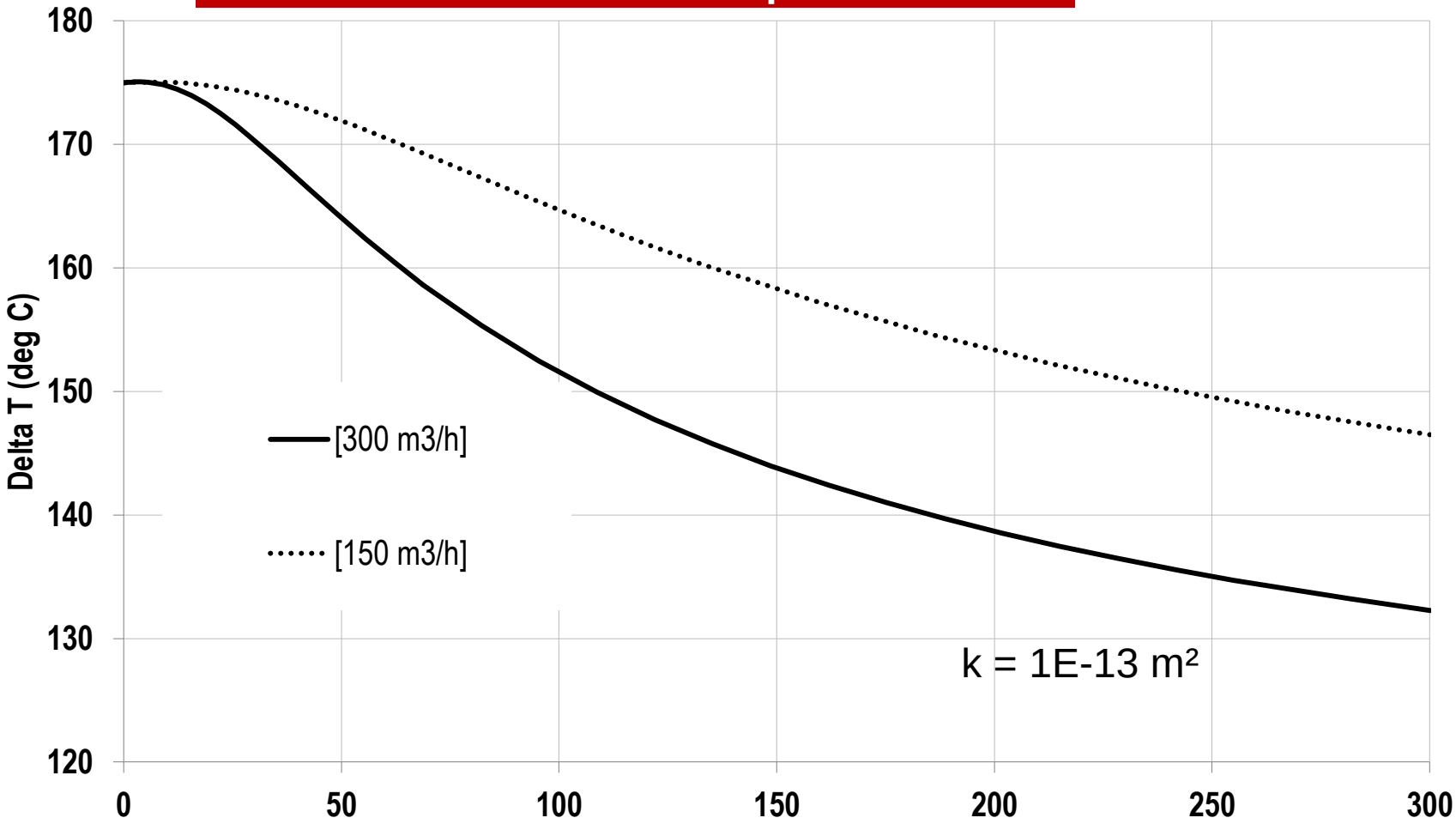
The reservoir lifetime to the production rate



THE SCENARIOS

Simulation	Case 1 Worst Case	Case 2 Best Estimate
Production flow rate (m^3h)	300	150

The reservoir lifetime to the production rate



THE SCENARIOS

POTENTIAL OF HEAT
FROM WASTE FLUID FROM POWER PLANT

TYPE OF RESOURCE	NO	REGENCY/ KABUPATEN	GEOTHERMAL PROSPECT	COMPANY	TYPE OF FLUID	INSTALLED CAPACITY (MW)		POWER PLANT CYCLE	P SEPARATOR (bara)		P TURBINE (bara)		P CONDENSOR (bara)	
WASTE HEAT	1	BANDUNG	Kamojang	PERTAMINA GEOTHERMAL ENERGY AREA KAMOJANG	Vapor dominated	UNIT I	30	Direct Dry Steam-Single Flash	UNIT I	10	UNIT I	6.5	UNIT I	0.133
						UNIT II	55		UNIT II	10	UNIT II	6.5	UNIT II	0.1
						UNIT III	55		UNIT III	10	UNIT III	6.5	UNIT III	0.1
						UNIT VI	60		UNIT VI	11.3	UNIT VI	11	UNIT VI	0.14
	2		Wayang Windu	STAR ENERGY WAYANG WINDU	Two phase-vapor dominated	UNIT I	110	Separated Steam-Single Flash	UNIT I	10.43	UNIT I	10.2	UNIT I	0.12
						UNIT II	117		UNIT II	10.45	UNIT II	10.7	UNIT II	0.12
	3		Patuha	GEO DIPA ENERGI	Two phase-vapor dominated	UNIT I	60	Separated Steam-Single Flash	UNIT I	7 (Demister)	UNIT I	7	UNIT I	0.1
	4	BOGOR	Awibengkok-G. Salak	CHEVRON GEOTHERMAL SALAK	Liquid dominated	UNIT I	60	Separated Steam-Single Flash	UNIT I	-	UNIT I	6.2	UNIT I	0.09
						UNIT II	60		UNIT II	-	UNIT II	6.2	UNIT II	
						UNIT III	60		UNIT III	-	UNIT III	6.2	UNIT III	
						UNIT IV	65.6		UNIT IV	-	UNIT IV	6.9	UNIT IV	0.1
						UNIT V	65.6		UNIT V	-	UNIT V	6.9	UNIT V	
						UNIT VI	65.6		UNIT VI	-	UNIT VI	6.9	UNIT VI	
	5	GARUT	Darajat	CHEVRON GEOTHERMAL INDONESIA	Vapor dominated	UNIT I	55	Direct Dry Steam-Single Flash	UNIT I	-	UNIT I	10	UNIT I	0.1
						UNIT II	95		UNIT II	-	UNIT II	13	UNIT II	0.1
						UNIT III	121		UNIT III	-	UNIT III	16.6	UNIT III	0.1
						1134.8								

TYPE OF RESOURCE	NO	REGENCY/ KABUPATEN	GEOTHERMAL PROSPECT	COMPANY	Number of Brine Wells (No of Wellpad)	Number of Condensate Wells (No of Wellpad)	Total Flowrate of Brine Wells	Temp of Brine Wells (deg C)	Minimum Temp of Injection	Pressure of Brine Wells (bar)	Total Flowrate of Condensate Wells	Pressure of Condensate Wells (bar)
WASTE HEAT	1	BANDUNG	Kamojang	PERTAMINA GEOTHERMAL ENERGY AREA KAMOJANG	-	4 (15; 20; 35; 55)	-	-	40	-	6000 (L/m)	-
	2		Wayang Windu	STAR ENERGY WAYANG WINDU	1	3	50-60 kg/s	180	-	5.6	80-100	5.3; -0.9; -0.7
	3		Patuha	GEO DIPA ENERGI	1		89-111 ton/hour					-
	4	BOGOR	Awibengkok-G. Salak	CHEVRON GEOTHERMAL SALAK	2 (pad 14)	7(6)	± 2000 kph (total) kilopounds per hour or 252 kg/s	173.4	-	-	6966 (ton/h)	-
	5	GARUT	Darajat	CHEVRON GEOTHERMAL INDONESIA	-	1	-	-	40	-	135 liter/s	-

THANK YOU

INNOVATE, INITIATIVE, COLLABORATE,
TAKE AN ACTION,
MAKE A CHANGE