



SARULLA GEOTHERMAL PROJECT

Developing The Largest
Geothermal Fields in the World

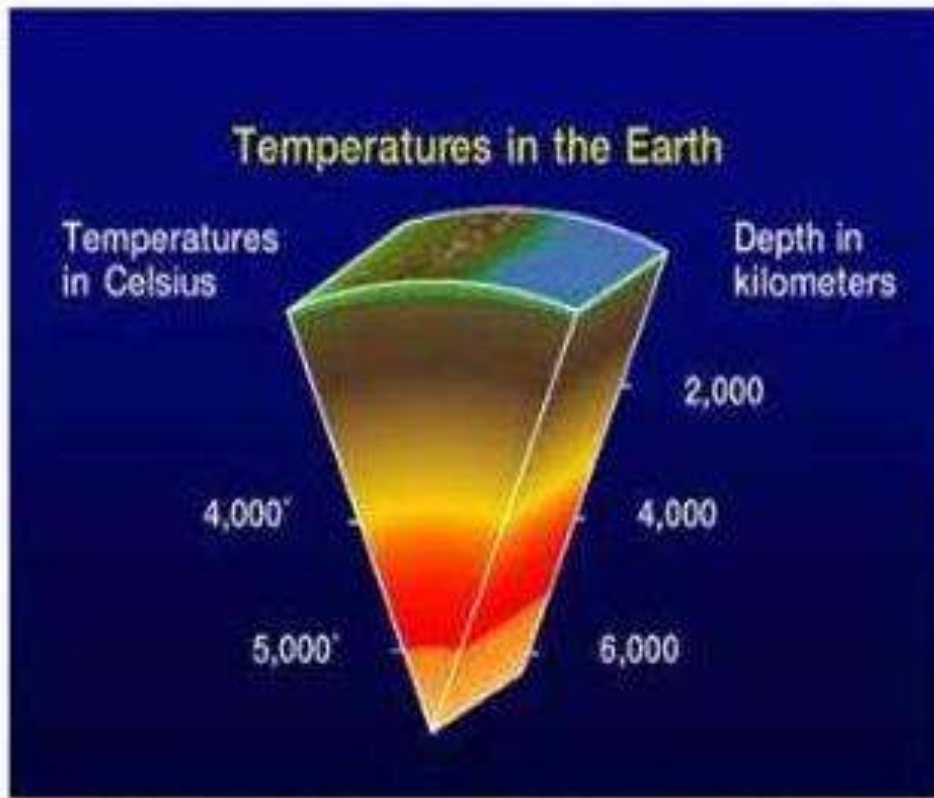
October 2017

PT Medco Power
Indonesia

OUTLINES

- Introduction
- Geothermal in Indonesia
- Sarulla Geothermal
 - Developing the Largest Geothermal Fields in the World

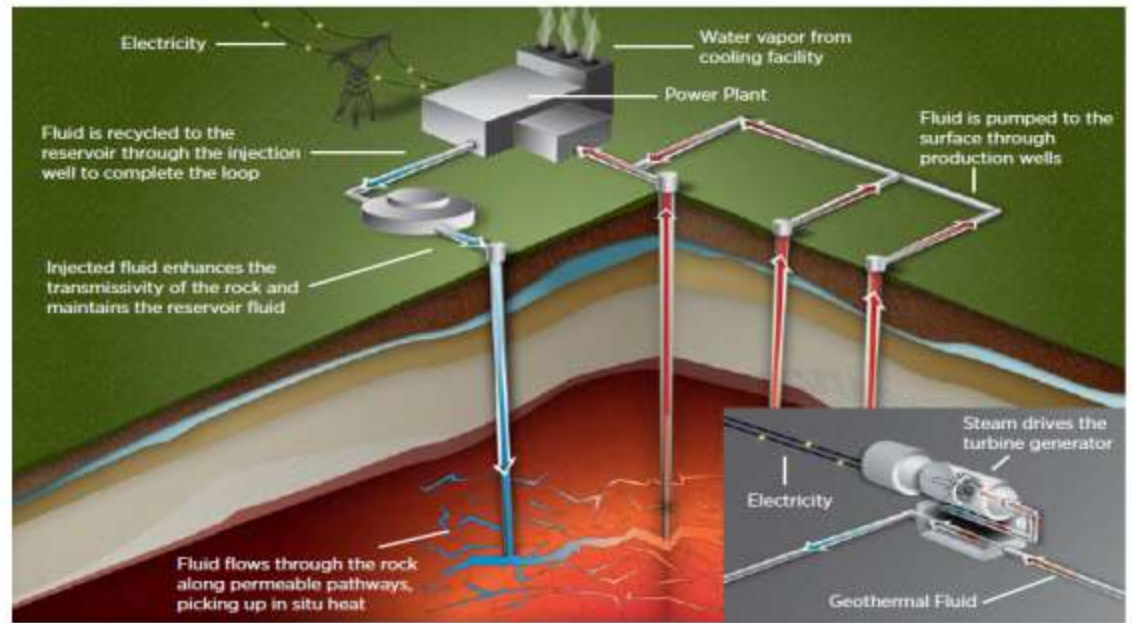
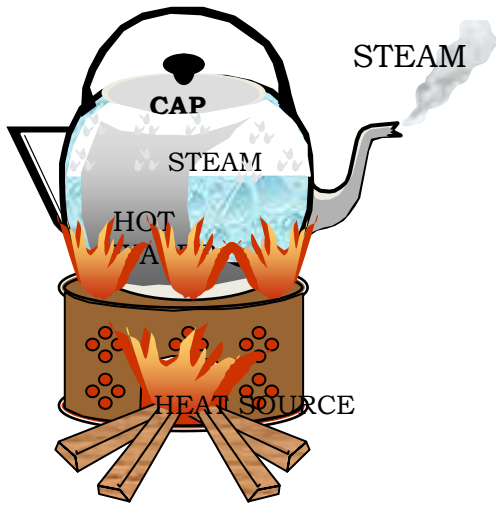
What is Geothermal ?



The deeper you go, the hotter it is!

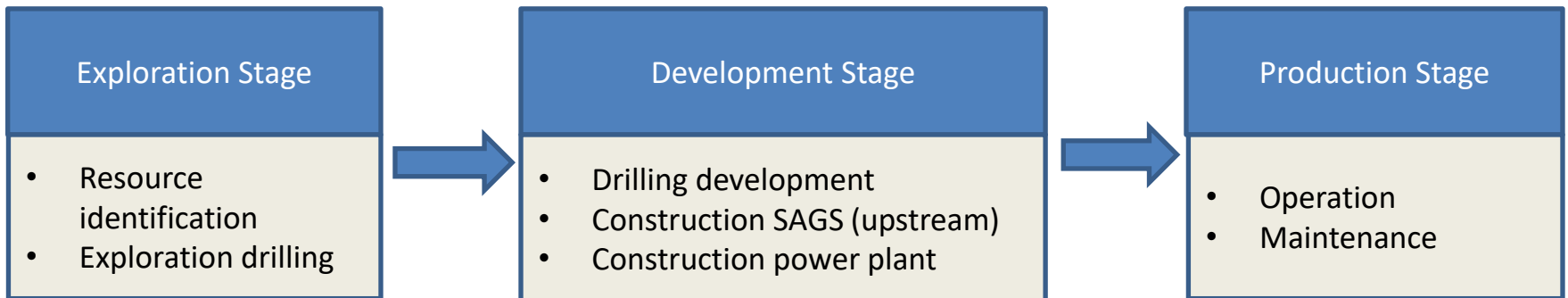
It's simply the heat energy of the earth, generated by various natural processes, such as :

1. Heat from when the planet formed and accreted, which has not yet been lost
2. Decay of radioactive elements
3. Friction
4. Etc...

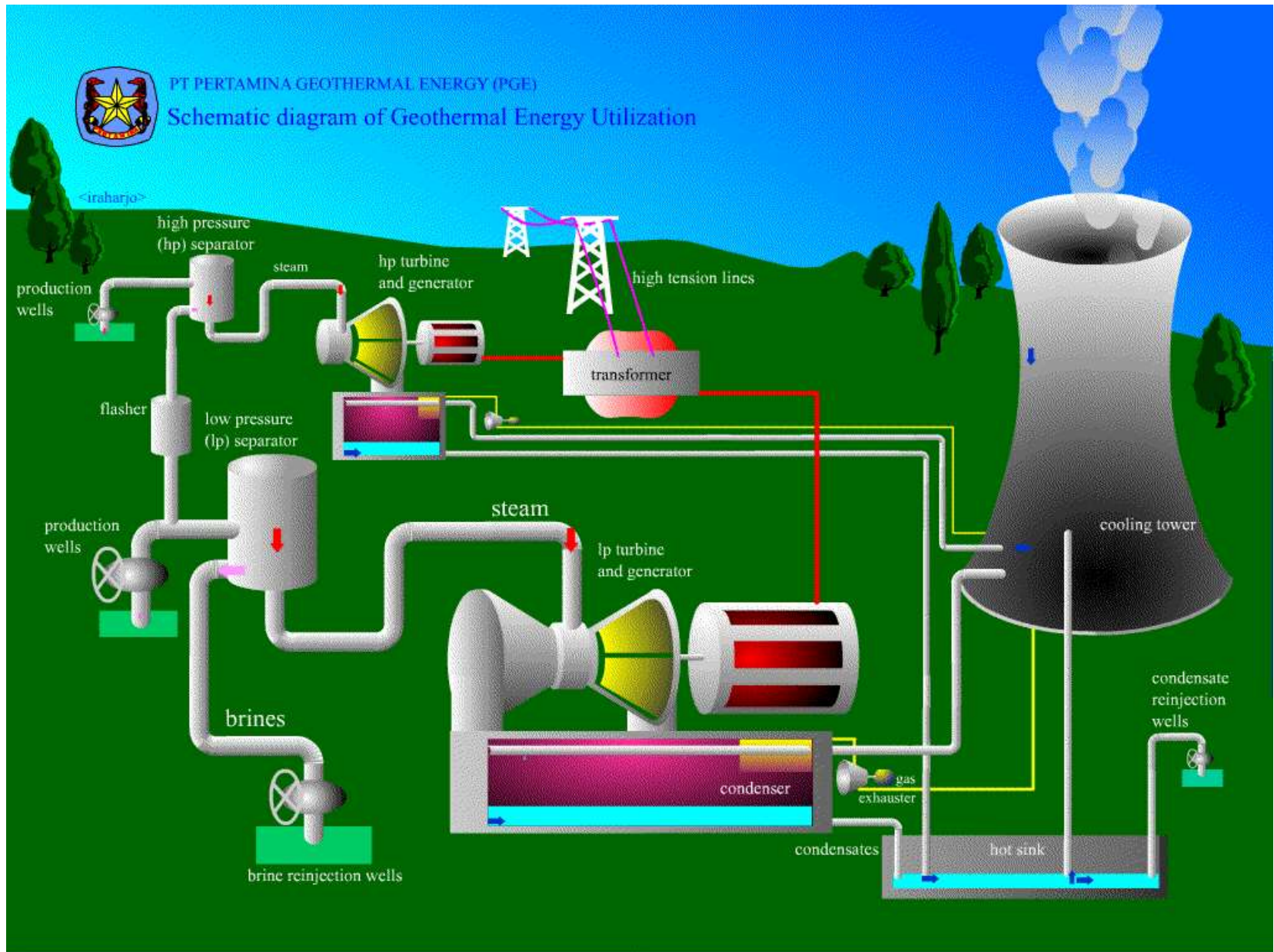


How Geothermal Resource is Located: Surface Manifestations

Stage in Geothermal Project :



Geothermal Power Plant Schematic

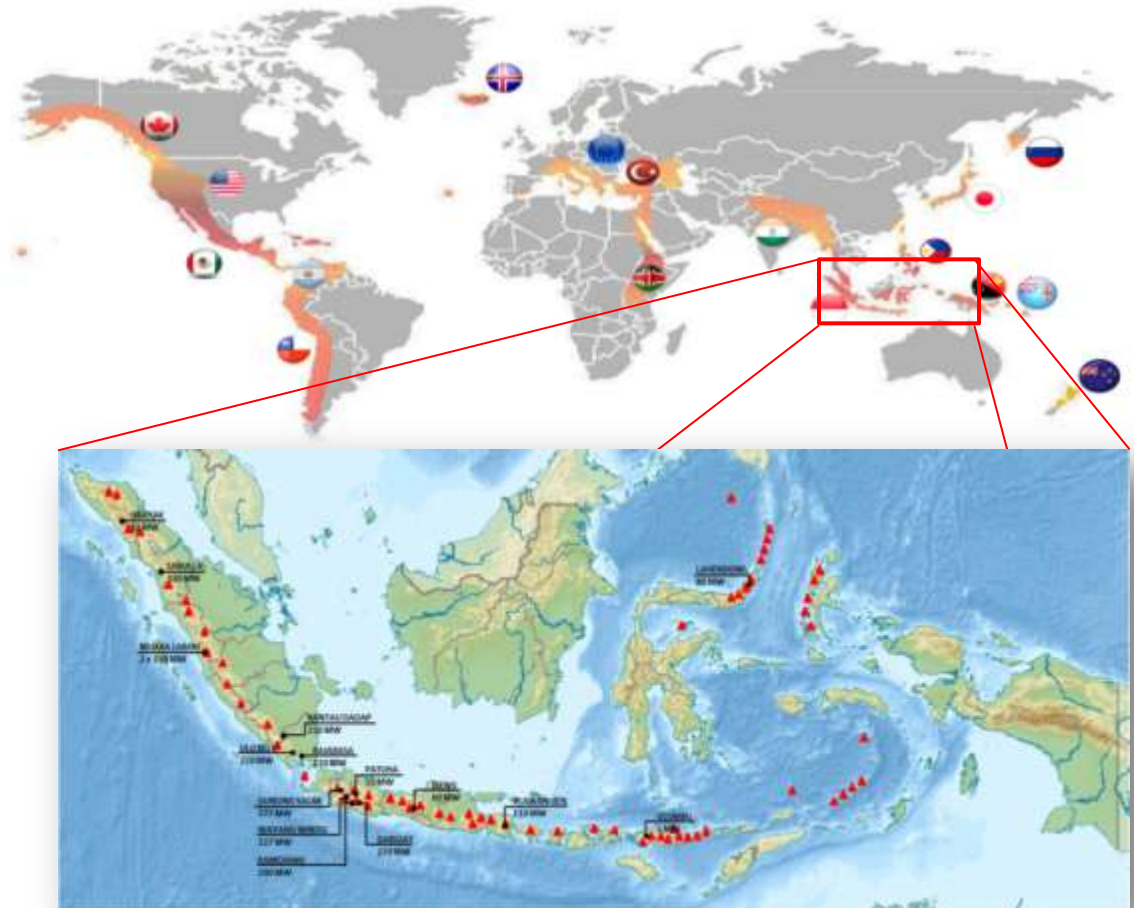


Indonesia sits above 40% of world's geothermal resources, or an equivalent of 29 GW potential resources. Out of which, less than 5% are currently utilized (fully developed). Indonesia is the third largest installed capacity in the world, after the USA and the Philippine. ***So far Indonesia is the largest un-developed geothermal potential in the world***

Indonesia Geothermal Resources

No.	Island	Number of Location	Potential (MW)	Installed Capacity (MW)
1	Sumatera	90	12,778	122
2	Java	71	9,717	1,134
3	Bali & Nusa Tenggara	28	1,805	5
4	Kalimantan	12	145	
5	Sulawesi	65	3,044	80
6	Maluku	30	1,071	
7	Papua	3	75	
Total		299	28,635	1,341

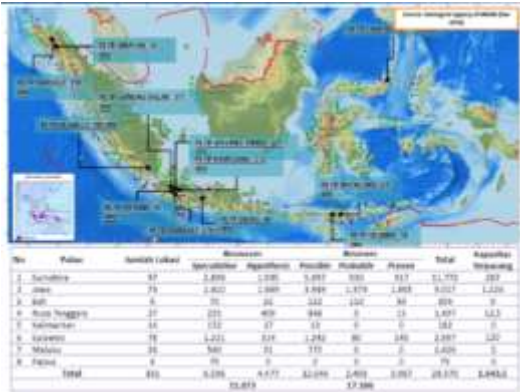
Geothermal technology has been utilized and proven. Kamojang operations is now entering its second 30-year period.





No	Location	Location Number	Potential Energy (Mwe)					Installed
			Resource		Reserve			
			Speculative	Hypotetic	Probable	Possible	Proven	
1	Sumatera	97	2.893	1.935	5.097	930	917	342
2	Java	73	1.410	1.689	3.949	1.373	1.865	1.224
3	Bali	6	70	22	122	110	30	0
4	Nusa Tenggara	27	225	409	848	-	15	12,5
5	Kalimantan	14	152	17	13	-	-	0
6	Sulawesi	78	1.221	314	1.242	80	140	120
7	Maluku	33	560	91	775	-	-	0
8	Papua	3	75	-	-	-	-	0
Total		331	6.596	4.477	12.046	2.493	2.967	1.698,5
			11.073		17.506			

INDONESIA GEOTHERMAL POTENTIAL



28.5 GW

Resources 11,073 MW

Reserves 17,506 MW

Geological Dept. Dec 2016



1698.5 MW

12 Power Plant at 10 Concession area

9.7% geothermal reserves utilized

GEOTHERMAL CONCESSION



71 WKP *

19 existing WKP

52 New WKP

*WKP = Geothermal Working Area



1.01 GWh

8.66% of 2017 target (11.66 GWh)

KONDISI SAAT INI

Potensi Panas Bumi



28,5 GW

Resources 11.073 MW
Reserve 17.506 MW
Badan Geologi, Desember 2016

Kapasitas Terpasang



1698,5 MW

- 12 PLTP pada 10 WKP
- Pemanfaatan 9,7% dari cadangan panas bumi Indonesia

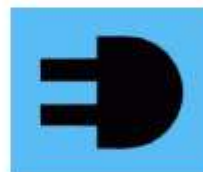
Wilayah Kerja Panas Bumi



71 WKP

- Eksisting 19 WKP
- Baru 52 WKP

Produksi Listrik



1,01 GWh

- 8,66 % dari target 11,66 GWh di tahun 2017

Regulasi



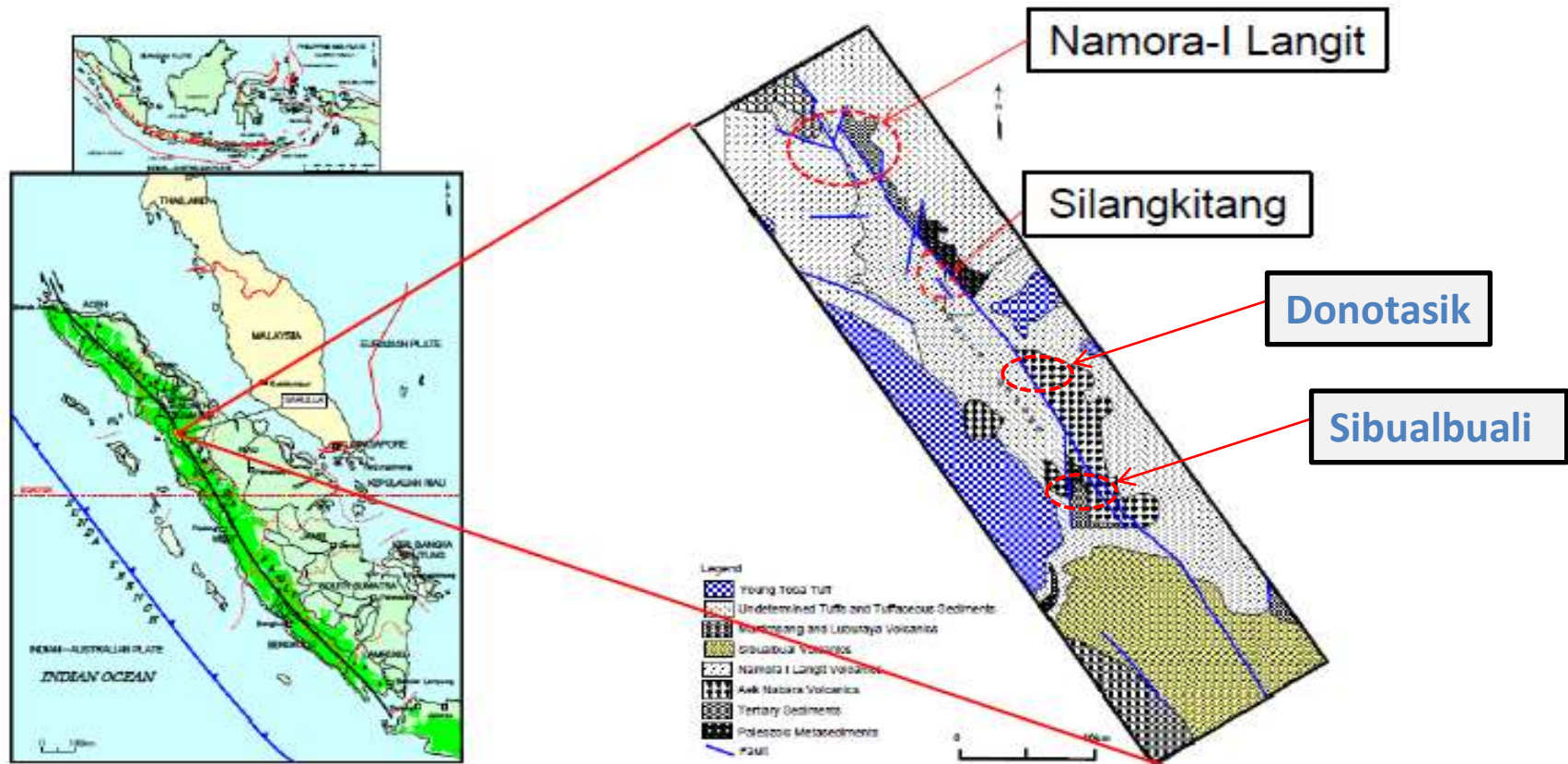
- UU No. 21/2014
- PP 59/2007 jo. PP 75/2015
- PP 28/2016
- PP 9/2012
- PP 79/2014
- PP 7/2017
- Perpres 4/2010
- Permen ESDM, PMK terkait & Permen LHK terkait

Kendala Utama

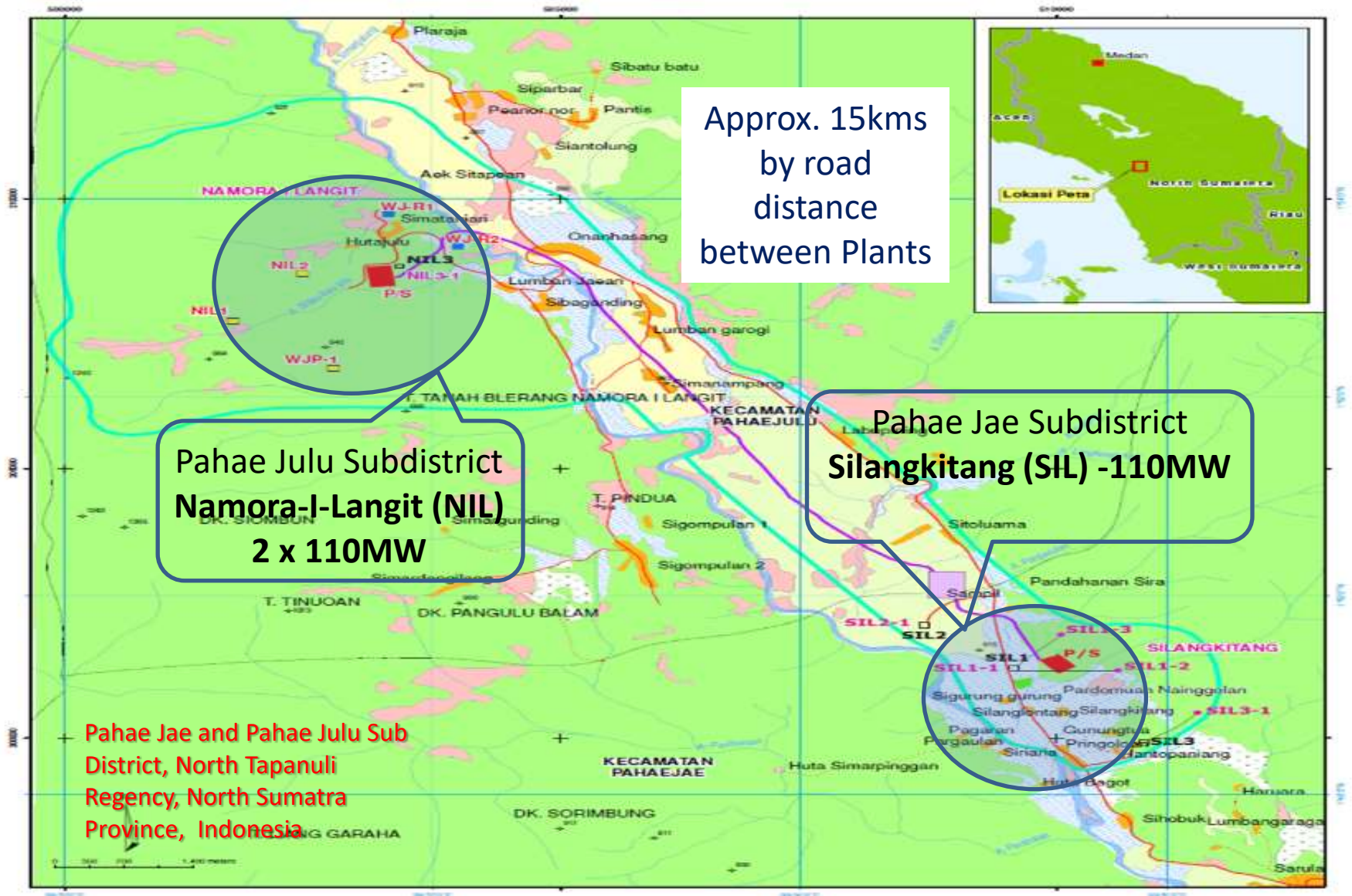


- Tumpang tindih lahan
- Harga dan pendanaan
- Keterbatasan SDM dan Teknologi
- Isu Sosial

SARULLA GEO THERMAL



- Location: North Sumatra, Indonesia
- Geologic Setting: Great Sumatra Fault Zone
- Simultaneous development of two resources in a single concession area
 1. SIL – One unit of 110 MW
 2. NIL – Two units of 110 MW each
- Potential development in Donotasik and Sibualbuali



**Pahae Julu Subdistrict
Namora-I-Langit (NIL)
2 x 110MW**

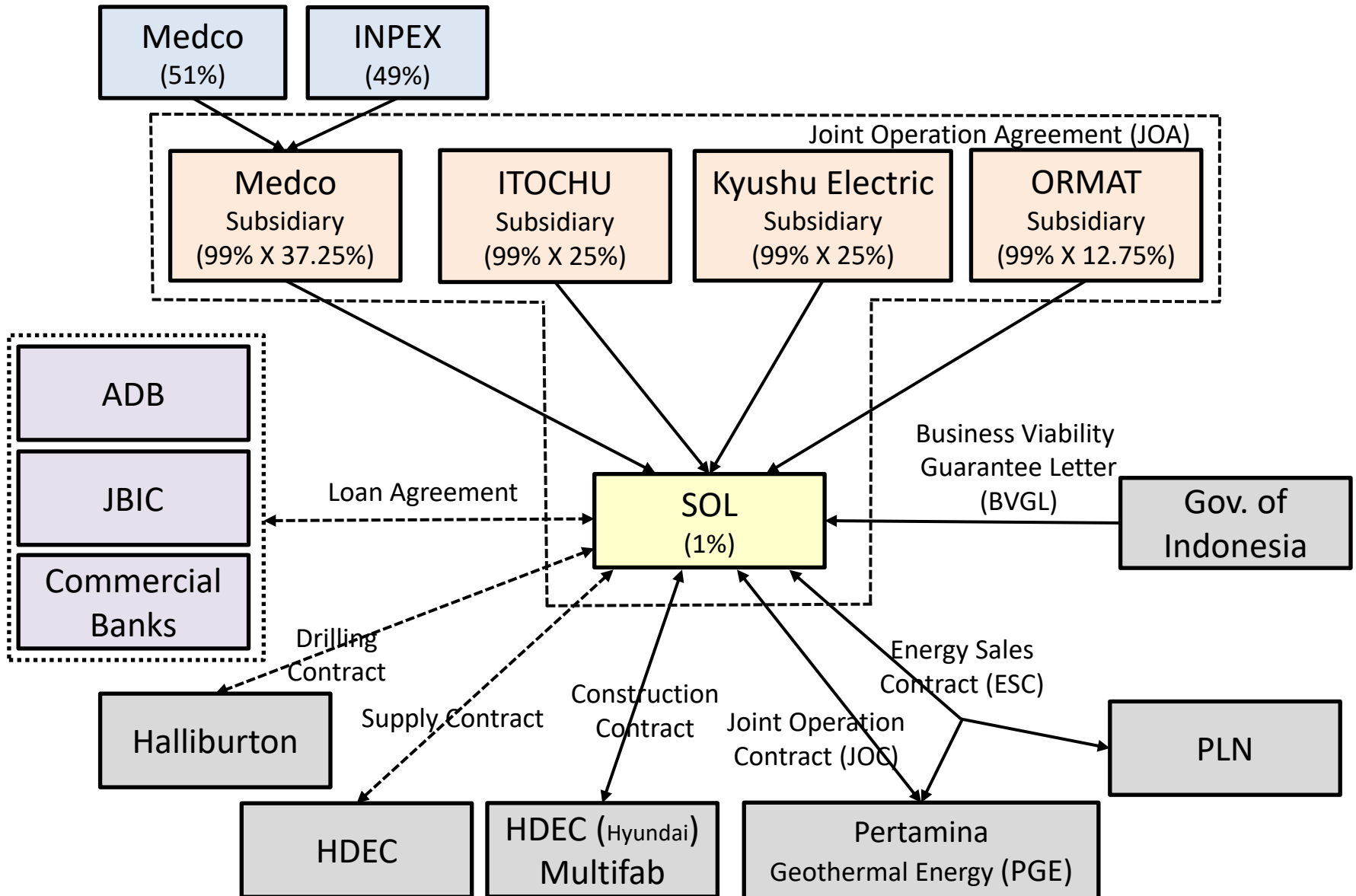
Approx. 15kms
by road
distance
between Plants

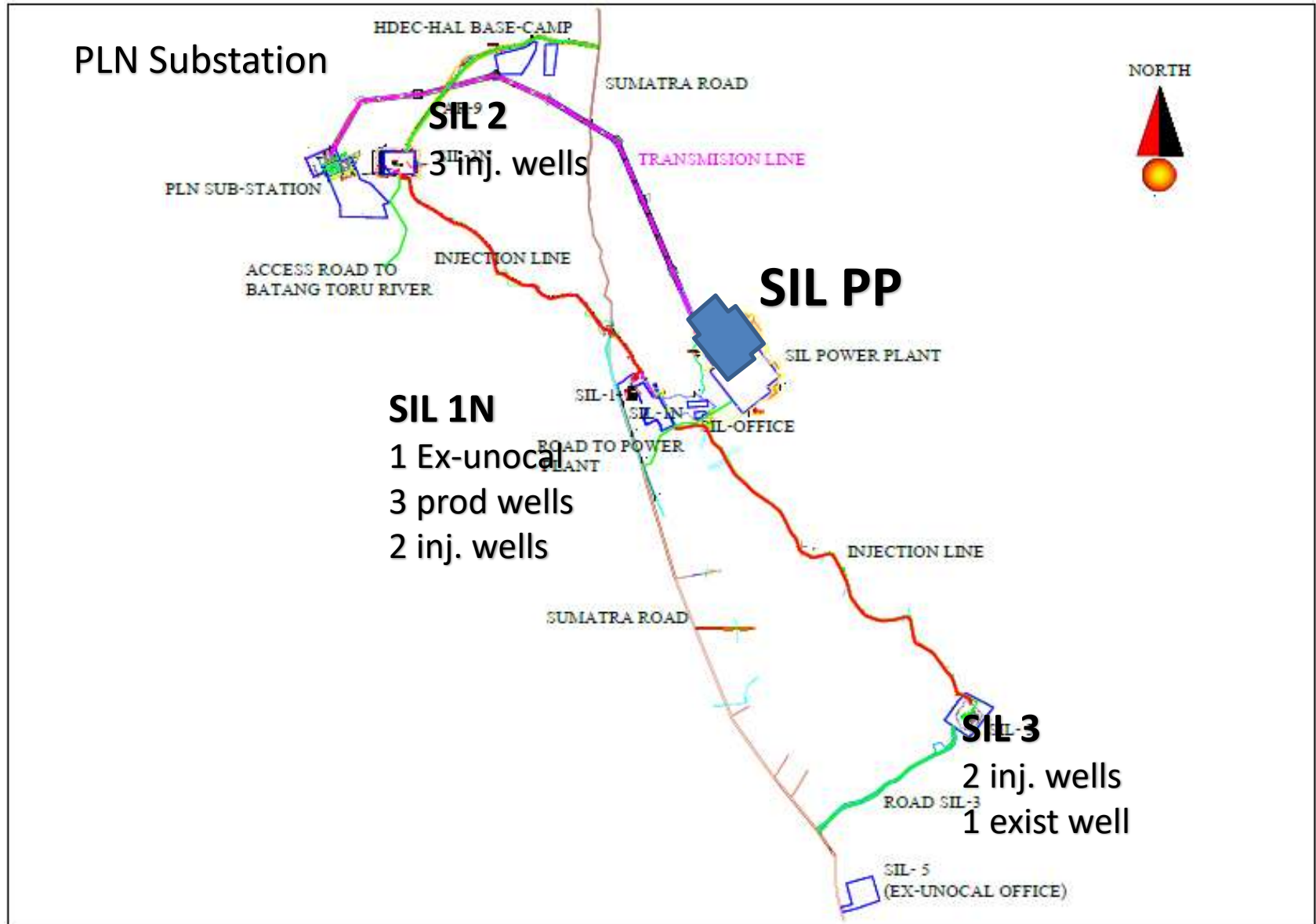
**Pahae Jae Subdistrict
Silangkitang (SIL) -110MW**

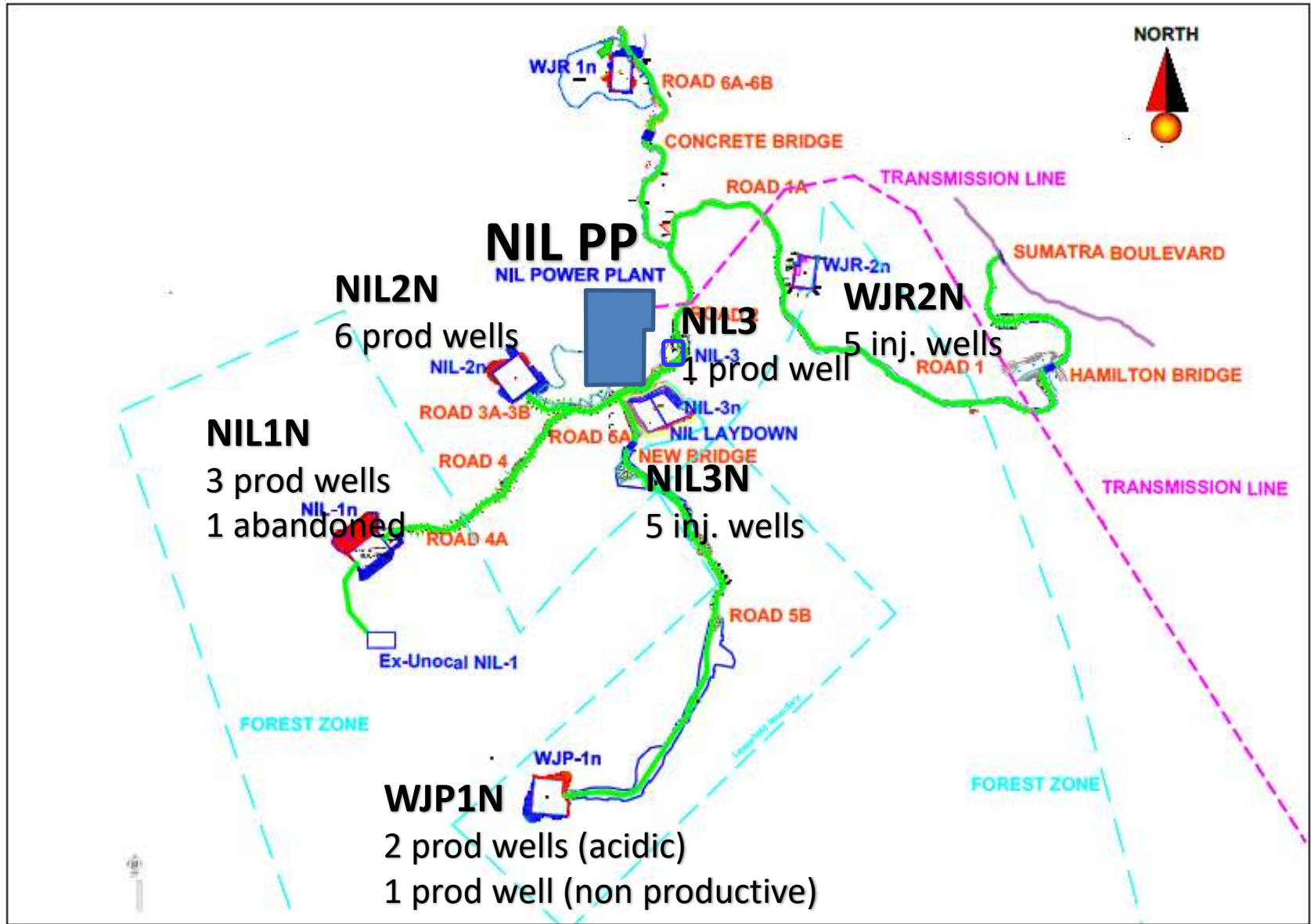
**Pahae Jae and Pahae Julu Sub
District, North Tapanuli
Regency, North Sumatra
Province, Indonesia**

27 Feb 1993	Unocal North Sumatra Geothermal (“UNSG”) signed JOC (with Pertamina) and ESC (with PLN)
1993 – 1997	UNOCAL conducted drilling exploration in Silangkitang, Namora I Langit and Sibual Buali, acquired some part of lands and built office/warehouse.
1998	Economic crisis occurred in Asia, project was halted
23 Jan 2004	Project assigned to PLN (effective February 24, 2004) by UNSG through Deed of Assignment
01 Dec 2004	Bid Submission for taking over of Project
25 July 2006	Letter of Award to Consortium
14 Dec 2007	ESC Amendment (among PLN, Pertamina Geothermal Energy (“PGE”) and Consortium) and JOC Amendment (between PGE and Consortium) were signed. Tariff – US¢ 4.642/kWh.
10 Mar 2011	New Tariff (staged tariff) Approval by Ministry of Energy and Mineral Resources. Tariff – 3-stage tariff; US¢6.79/kWh on levelized basis
04 Apr 2013	Second ESC/JOC Amendments were signed
28 Mar 2014	Loan agreements were signed
23 May 2014	Project Notice to Proceed (NTP)
18 Mar 2017	<u>Achieved the Date of Commercial Generation of Unit 1 (SIL) with Unit Rated Capacity (URC) of 105.974 MW</u>
02 Oct 2017	<u>Achieved the Date of Commercial Generation of Unit 2 (NIL phase 1) with URC of 108.796 MW</u>

Project Name	Sarulla Geothermal Power Project
Location	Pahae Jae and Pahae Julu Sub District, North Tapanuli Regency, North Sumatra Province, Indonesia
Capacity	3 X 110 MW
Sponsors	PT Medco Power Indonesia (In June 2015, INPEX acquired 49% of Medco's interest) Itochu Corporation Kyushu Electric Power Co., Inc. Ormat International, Inc.
Project Co.	Sarulla Operations Ltd ("SOL")
Financial Close	23 May 2014
Total Project Cost	USD 1.6 Billion (original budget)
Scheduled Date of Commercial Generation	SIL : November 2016 NIL-1 : November 2017 NIL-2 : May 2018
Contract Period	30 years after NIL-2 COD







Power Plant Technology – IGCCU

(Integrated Geothermal Combined Cycle Units)

- Proven technology in Geothermal; used in countries of USA, New Zealand, Japan, Philippines, Turkey, etc.
 - Utilizes both geothermal steam & brine to make electricity
 - Reinjects 100% of the geothermal fluid (net of NCG)
 - Uses air-cooling instead of water
 - Multiple modular units
- **THE FIRST IN INDONESIA**

The process

2-phase geo fluid is separated at the Separator station

Steam enters back-pressure turbine at higher pressure and exhaust at lower pressure/still steam state. It then goes to the OEC bottoming binary units

Brine enters the brine binary units

Condensate and brine injected back to wells



Combined Cycle (Binary)



Condensing System

Air cooling enhances 100% reinjection and eliminates mists from water cooling towers

NIL3 – Drilling NIL3-3



Completed 1st well on 9 Sept;
Drilling of 2nd well in progress

NIL1n – Flow test NIL1N-8



Early September 2017

SIL 1n – Drilling SIL1n-2



NIL 3n – Drilling NIL3n-1



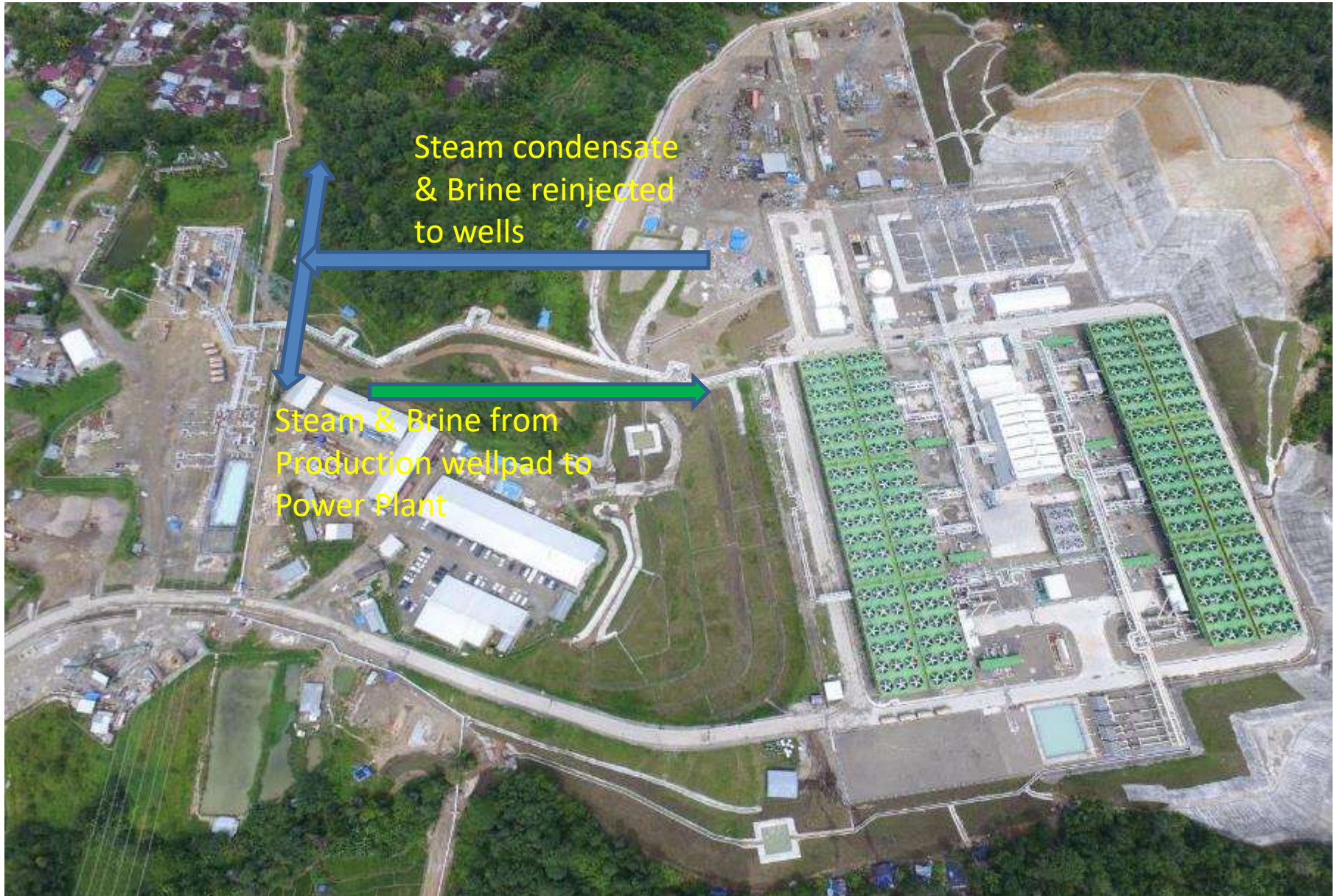
SIL 3 – Rig up



NIL 2n – Well testing NIL2n-2



Early January 2016





Completed the tests and started commercial operation on 18 March 2017 at 00:00HRS with 105.974MW capacity

STG ~ 60MWg / Bott OECs ~ 29MWg / Brine OECs ~ 27MWg

SIL POWER PLANT



URC test – Discussion with PLN



URC test – Power output



URC test – Monitoring with PLN



URC test completed



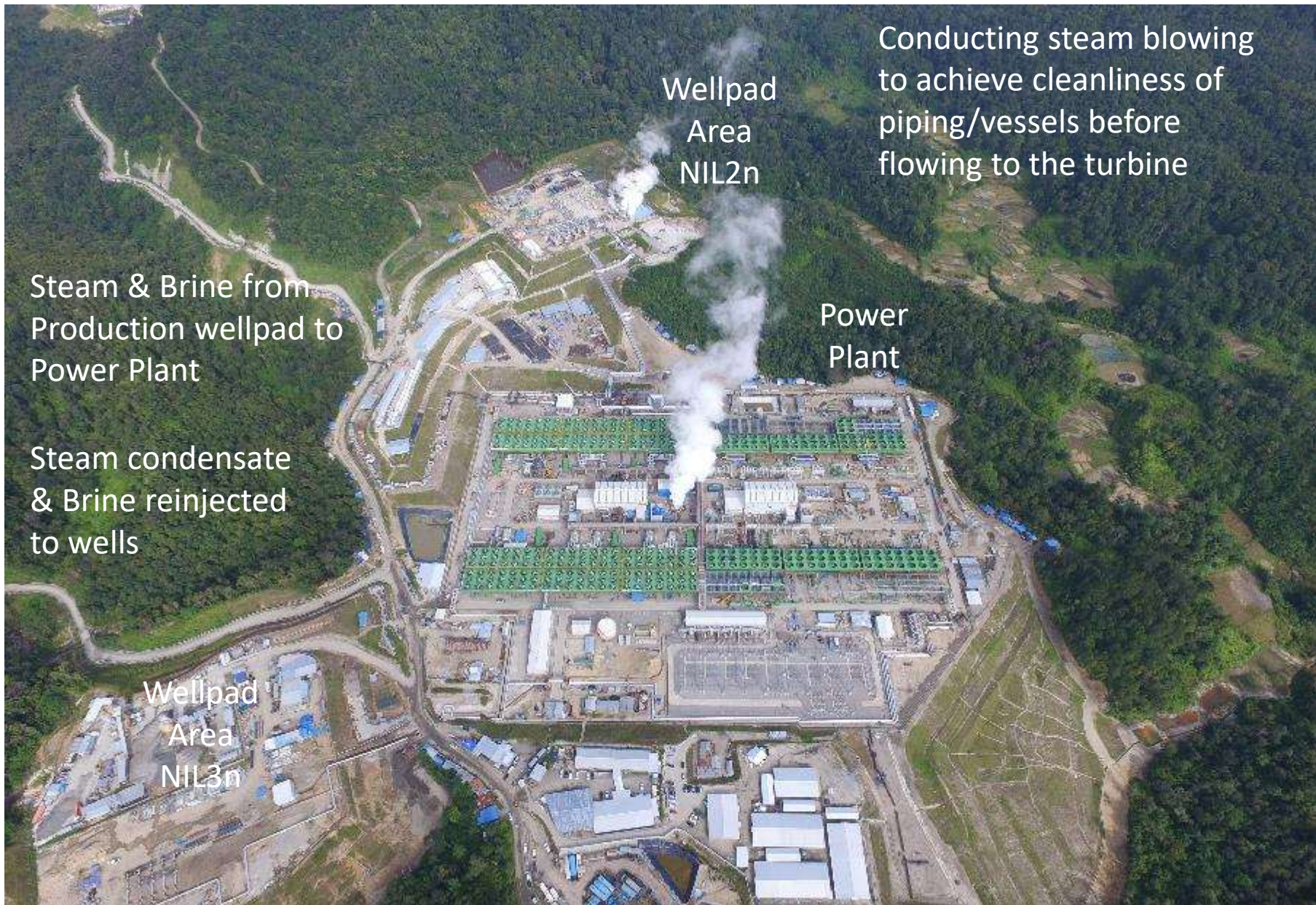
Operating using 4 production wells & 6 injection wells in service

NIL Power Plant – Excavation, backfilling and disposal



NIL Site in May 2015

Power Plant Construction Status - NIL



Steam & Brine from
Production wellpad to
Power Plant

Steam condensate
& Brine reinjected
to wells

Wellpad
Area
NIL3n

Wellpad
Area
NIL2n

Power
Plant

Conducting steam blowing
to achieve cleanliness of
piping/vessels before
flowing to the turbine



NIL2N



NIL Phase 1
on commercial
generation on 2
October 2017

NIL Phase 2
(89,5%)

Switchyard

NIL POWER PLANT (NIL 1)

URC test completed with total nett capacity 108.796 MW on 1 October 1230hrs (witness by PLN and PGE)



Steam blowing for NIL ph 1



Load acid for ph Control



Load pentane - OEC

Thank you