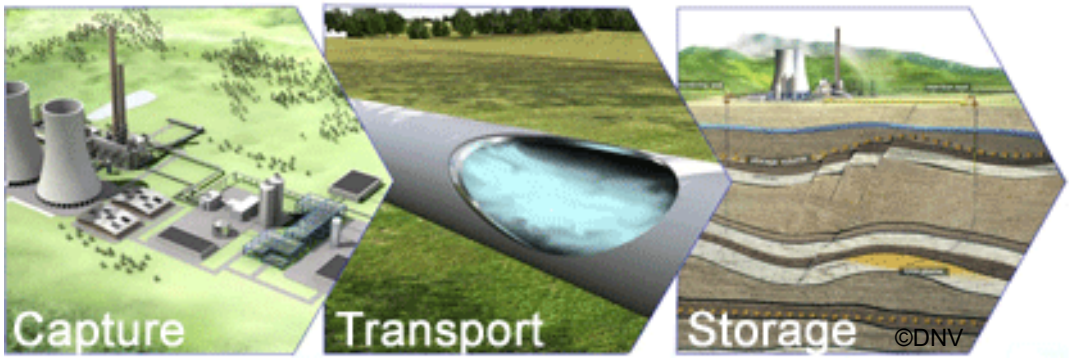
The Agency of R&D for
Energy and Mineral Resources

Assessing CCS Value Chain In Indonesia

A highlight of key findings for moving forward



Utomo P. Iskandar

R&D Centre for Oil and Gas Technology

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DISCLAIMER STATEMENT

Agenda

1. Introduction
2. Key Findings from Study with UK Government
3. Key Findings from Study with TOTAL
4. Key Findings from LEMIGAS Research
5. Conclusion

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Introduction

Background

- Indonesia has committed to reduce its GHG's by adopting the National Action Plan Addressing Climate Change (RAN-PI) through Presidential Decree No.61 / 2011.
- Current efforts are considered still insufficient to achieve 26% CO_2 emissions abatement target by 2020:
  - Energy mix improvements.
  - The switch to less-carbon intensive fuels.
  - Renewable resources deployment.
- Maximizing the national potential of CCS.
- To improve energy security-CCS in conjunction with:
  - Enhanced Oil Recovery (EOR) → 5 from 8 operational projects around the world
  - Coal to Liquid (CTL)
  - Coal to Gas (CTG)
  - Biomass

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Introduction (cont'd)

CCS Milestones in Indonesia

Investigating CO_2 storage potential combined with EOR

Sojitz

Advanced Resources International, Inc.

UK Government

A first comprehensive study to identify CCS potential deployment in Indonesia

WORLD ENERGY COUNCIL
CONSEIL MONDIAL DE L'ÉNERGIE

ADB

PERTAMINA

BAPPENAS

GLOBAL CCS INSTITUTE

Pre-FS Pilot Project in Merbau (South Sumatera)

2003-2005 | **2007-2008** | **2009-2010** | **2011-2012**

- Multiyears joint research at TOTAL field
- Jointly develop detailed scopes for CCS Project's proposals

TOTAL

- Various cooperation with:

International Energy Agency

ieaghg

JCOAL Japan Coal Energy Center

RITE Research Institute of Innovative Technology for the Earth

KIGAM

UK Government

Understanding Carbon Capture and Storage (CCS) Potential In Indonesia

R&D Centre for Oil and Gas Technology

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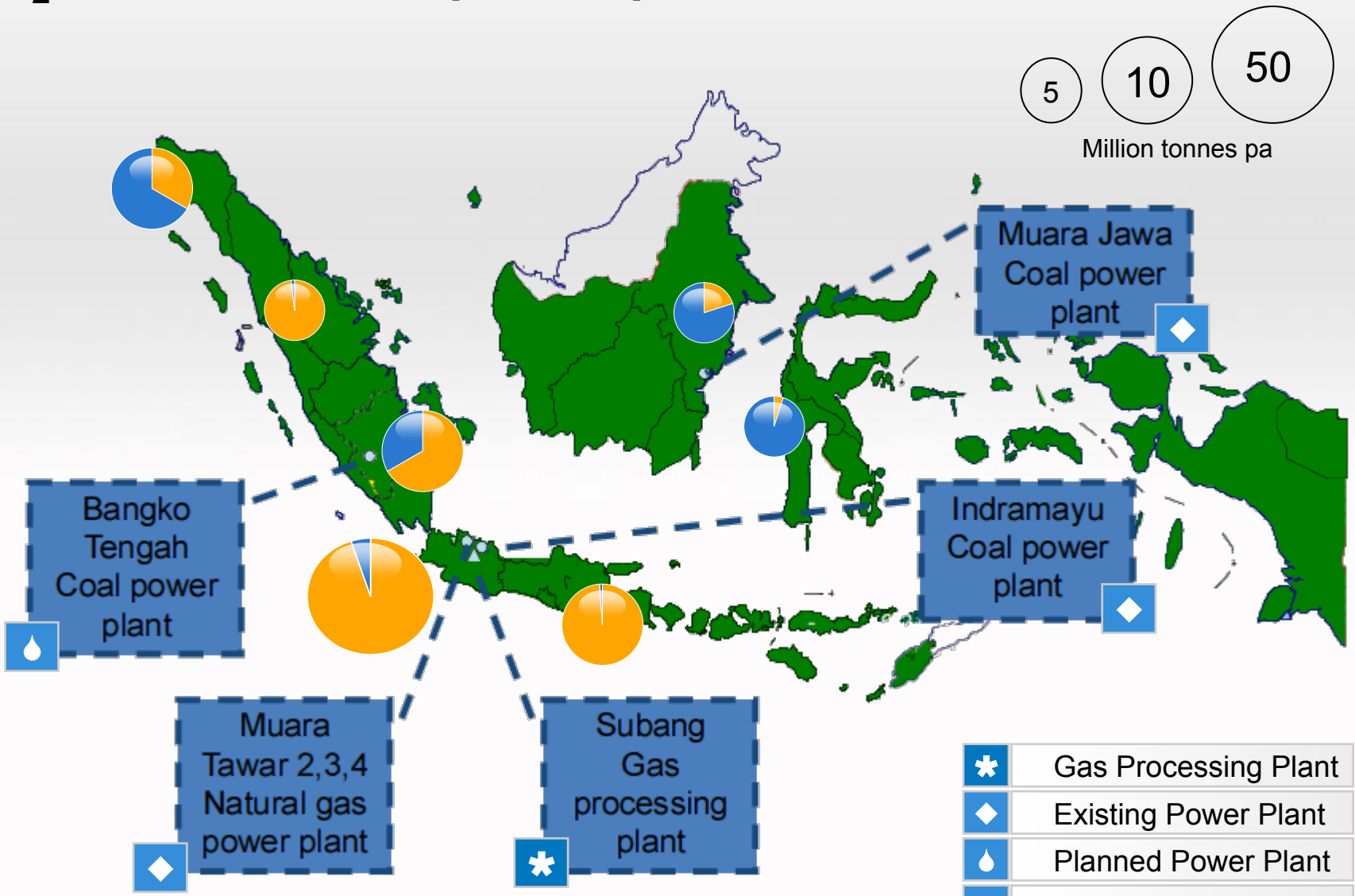
CO_2 Sources and Capture Options in Indonesia



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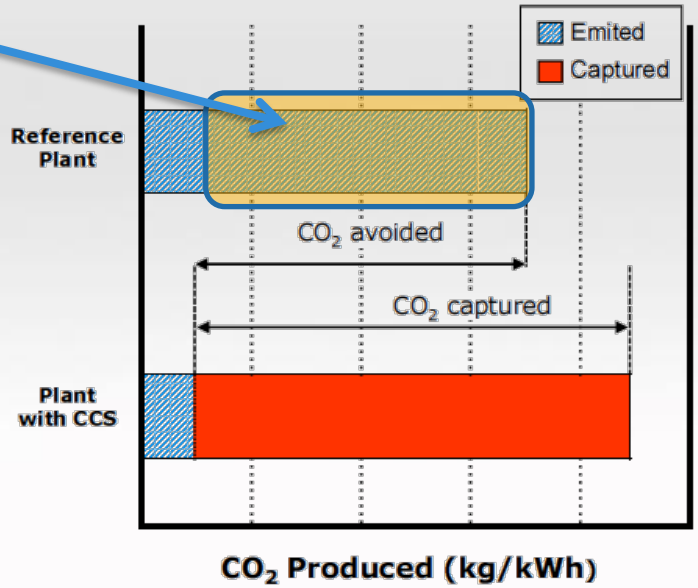
CO_2 Capture Assessments on PLN Power Plants

Plant Location	Type of plant	Plant Size	CO_2 Avoided (kg CO_2/MWh)	
		MW	Without Capture	With Capture
Indramayu West Java	Supercritical steam-cycle pulverised fuel (SC PF)	1000	803	115
Muara Tawar West Java	Natural gas-fired combined cycle (NGCC)	750	340	40
Bangko Tengah South Sumatera	Sub-critical steam cycle	600	1061	149
Muara Jawa, East Kalimantan	Sub-critical steam cycle	100	1037	145

Capture Systems: Post Combustion



Key Findings

- Adds substantially to the cost of electricity generation
- Reduces the output of the plant to which it is fitted
- Energy Penalty

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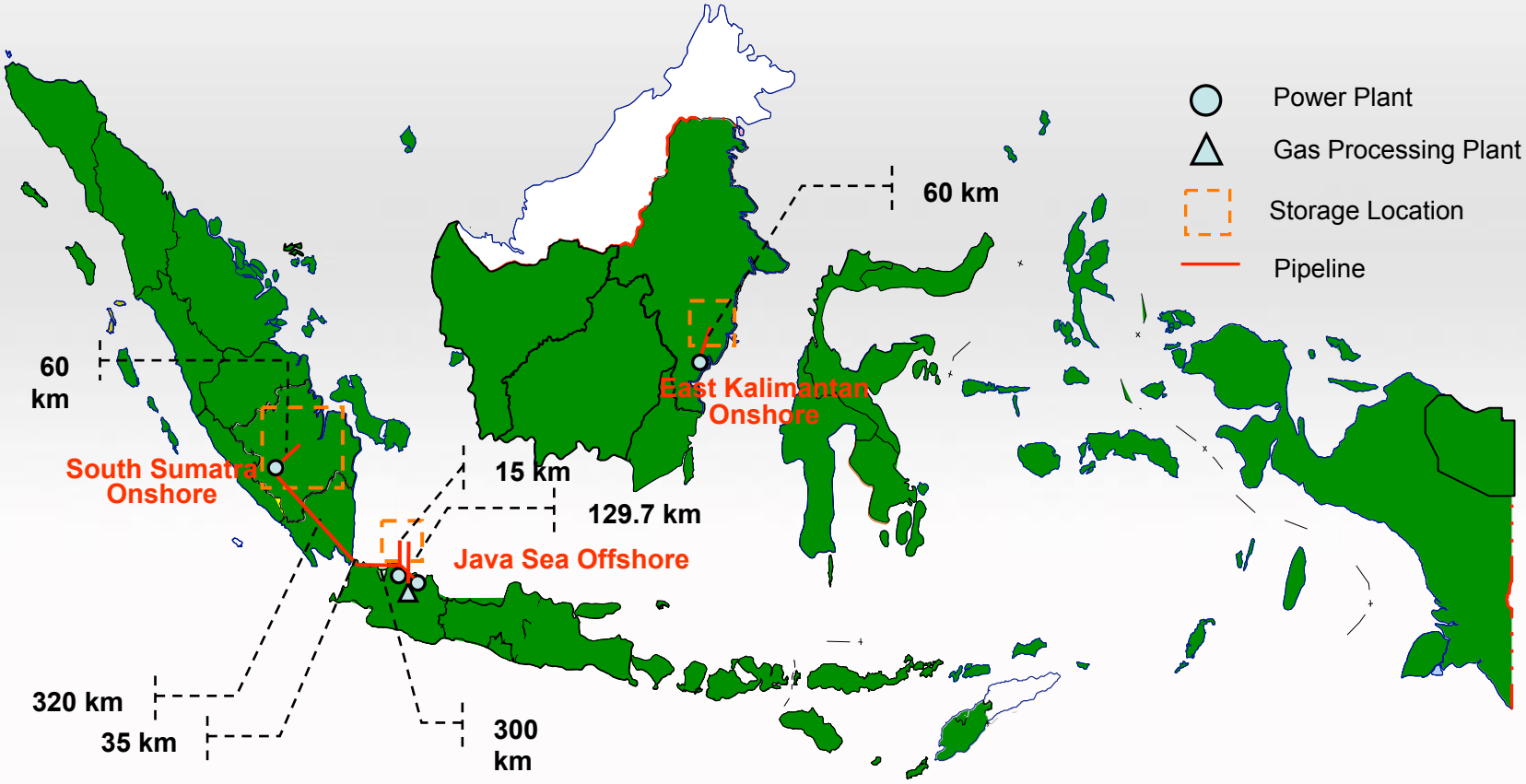
Illustrative Case Studies of CO_2 Transport in Indonesia



Pipeline Route	Location	Distance (km)	CO_2 Volume (Mt/yr)	Capacity Factor (%)	Average cost / tonne ($/t CO_2)	
					Full Capacity	Corresponded Capacity Factor
West Jawa-South Sumatera	Combined onshore and offshore pipelines	655	6.4	70	6.6	9.4
West Jawa	Offshore pipelines	15	1.6	70	1.0	1.4
South Sumatera	Onshore pipelines	60	4.6	65	0.5	0.8

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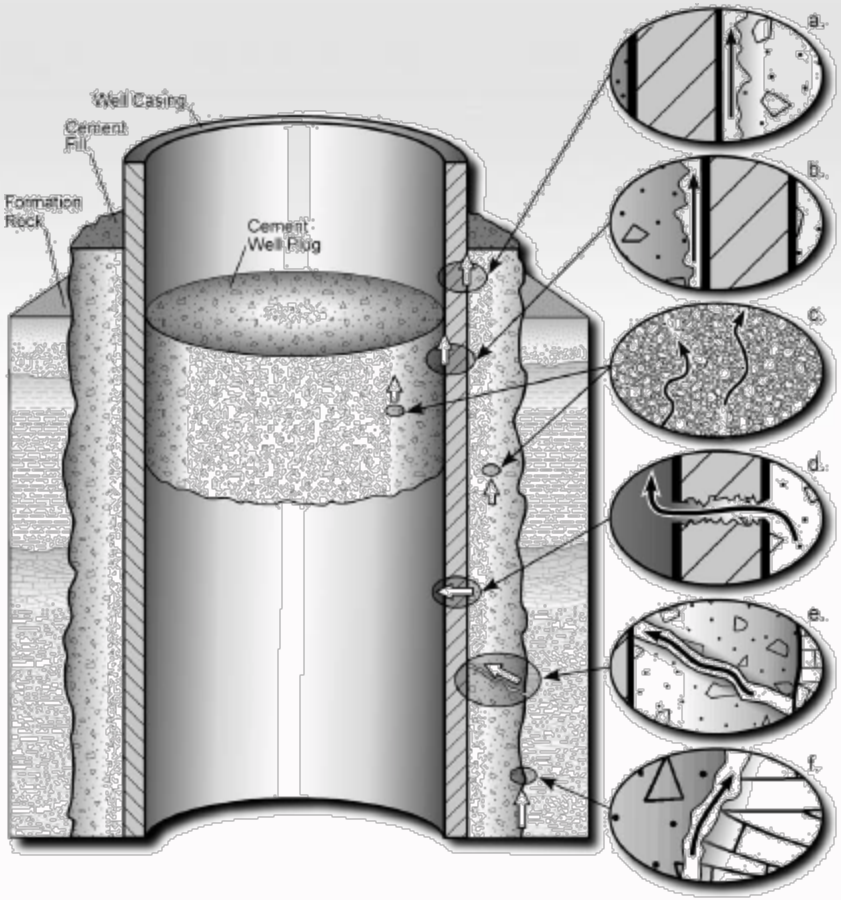
Inventory of CO_2 Emission and Possibility of CO_2 Storage in East Kalimantan Geological Formations

Non-Geological Containment Risks



Wellbore Integrity Assessment

- CBL Evaluation
- Casing Leaks Assessment

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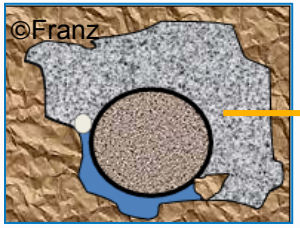
Cement Bond Log Evaluation

Good CBL 5 – 10 mV

Zones	/ Layers		CBL (mV)	Remarks
D	Depleted	Layer-D1	> 10	1 well < 5; from 8 wells
	Saline	Saline-D	>10	1 well < 10; from 22 wells
E	Depleted	Layer-E1	>10	2 wells < 10; from 10 wells
	Saline	Saline-E	>10	2 wells
F	Depleted	Layer-F1	>10	3 wells < 10; from 18 wells
	Saline	Saline-F	>10	9 wells
G	Depleted	Layer-G1	< 8	9 wells
	Saline	Saline-G	>10	2 wells < 10; from 13 wells

Theory, Measurement, and Interpretation of Well Logs



Cross-section of poorly cemented well

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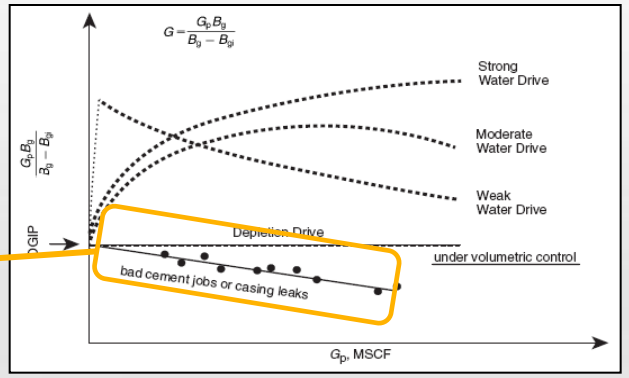
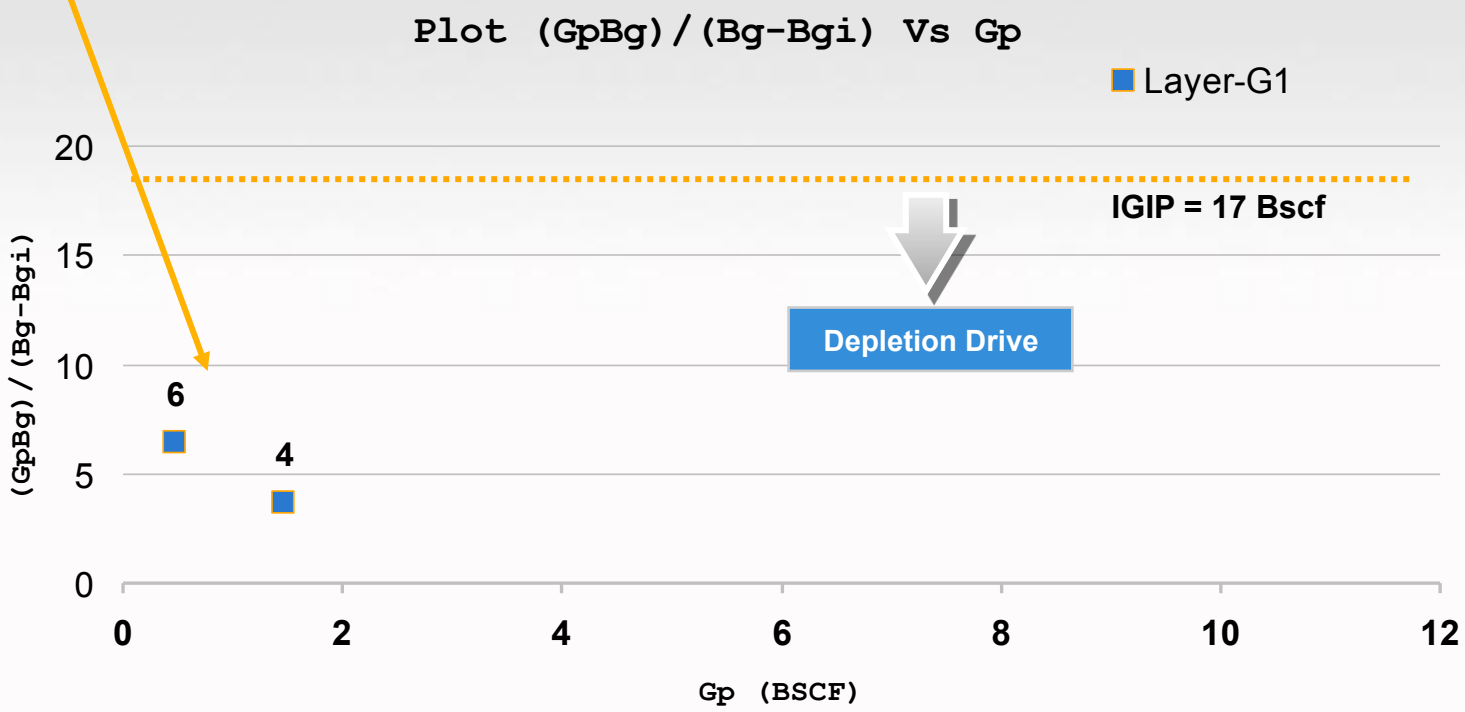
Casing Leaks Assessment

e.g. Layer-G1



bad cement job



Source: Advanced Res.Eng T.Ahmed, 205-206

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Determining the Potential for Carbon Capture and Storage (CCS) in South East Asia:

Indonesia Case Study

R&D Centre for Oil and Gas Technology

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Key Focus Area of Assessment

Regional area

- South Sumatera

Specific Area for Pilot Project

- Source: Merbau Gas Gathering Station (GGS)
- Storage: Depleted oil and gas reservoirs surrounding Merbau GGS

Rationale

- Based on outcome and recommendation from previous study with UK Government.
- Large presence of the industrial and power sector.
- Large and various CO_2 sinks (depleted hydrocarbon reservoirs, and coal seams).
- Attractive for CO_2-EOR development
- South Sumatera has low density population.
- Existing infrastructure.

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Scope of Work

A comprehensive assessment of CCS chain and broad variety of disciplines and expertise involved

Public Awareness

Bambang Wahyudi

Economic Analysis

Yusep C. Karyana
Ika Kaifah
Rick Hasselback

Roadmap

Usman
Utomo P.I.
Hardiv Situmeang
Bill Gunter
Doug Mcdonald
Kelly Thambimuthu

Legal & Regulatory

P. L. Coutrier
Craig Hart

CO_2 Sources

Utomo P.I.
Agustini
Doug Mcdonald
Kelly Thambimuthu

CO_2 Storage (sink)

Bill Gunter
Usman
Sugihardjo
Sudarman S.
Herru L.
Utomo P.I.

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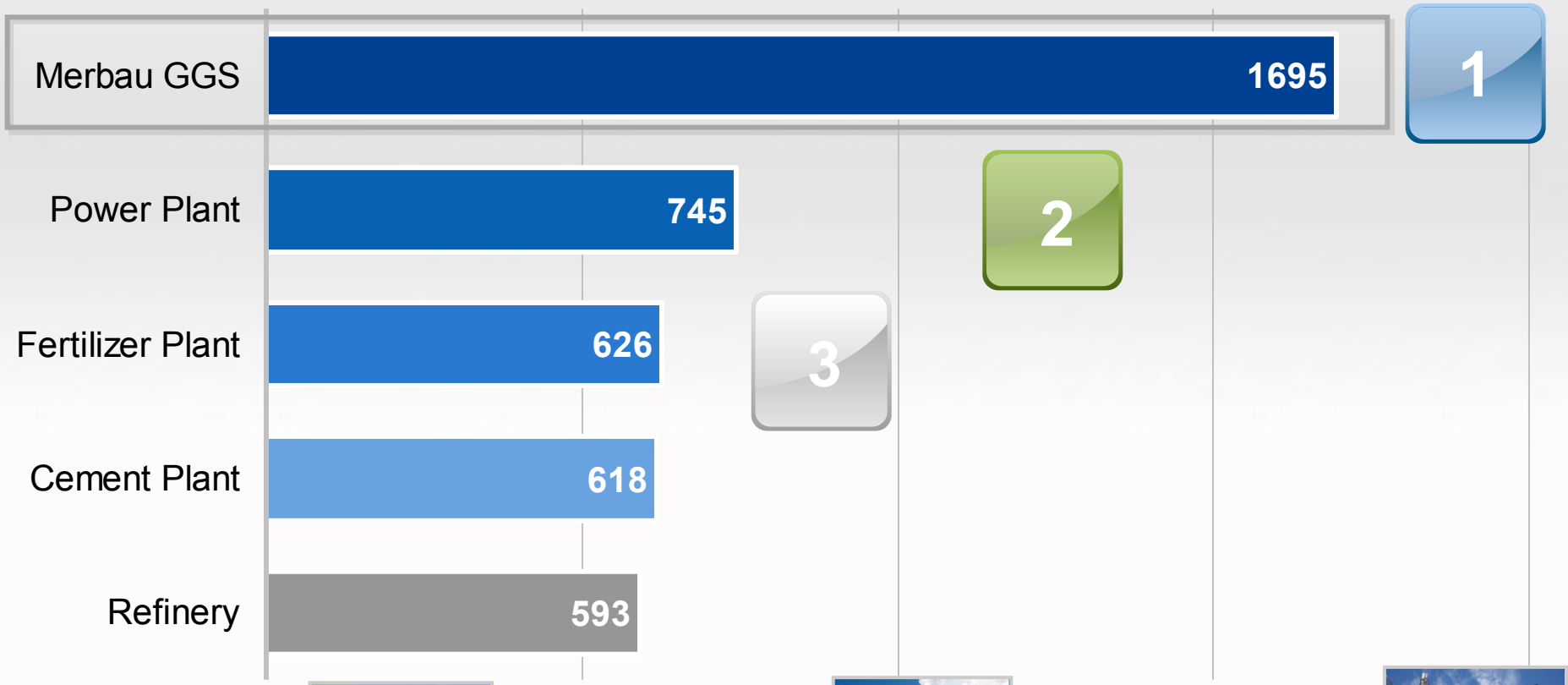
Identified Major CO_2 Sources in South Sumatera

Scoring and Ranking Results



1. Merbau GGS

- High purity CO_2 content
- Proximity to CO_2 storage
- New facility

2. Power Plant

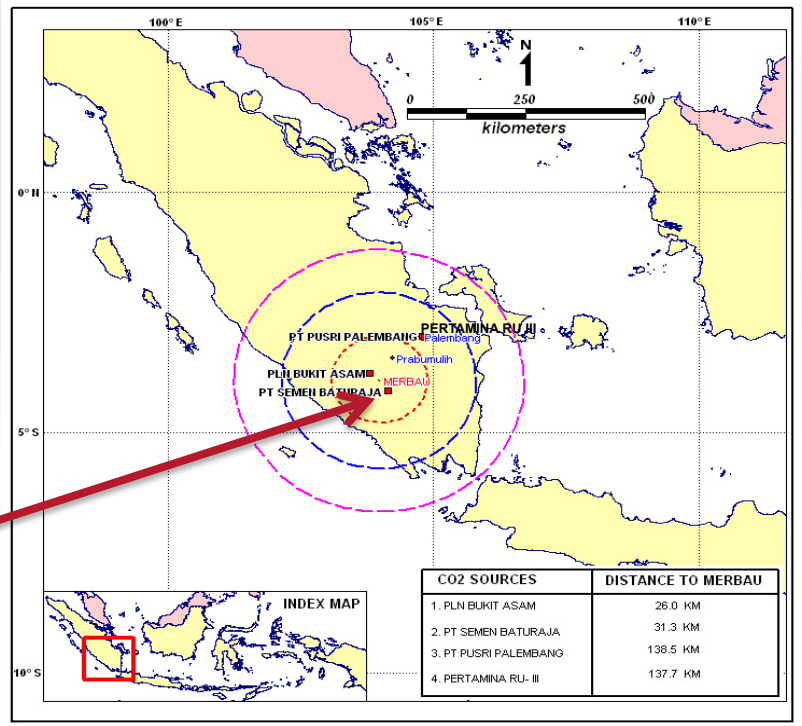
- Large CO_2 volume per year
- Supply of fresh water for future retrofitting CO_2 capture

3. Fertilizer Plant

- No impurities from the flue gas
- Moderate amount of CO_2 supply
- Future excess of pure CO_2 supply

Consideration for Merbau Gas Gathering Station as CO_2 Source

CO_2 absober unit discharges 363t/d CO_2



Extra facilities need to be built for:

- drying: glycol contactor
- compressing: compressor
- power generation: gas turbines
- transport: pipeline or truck

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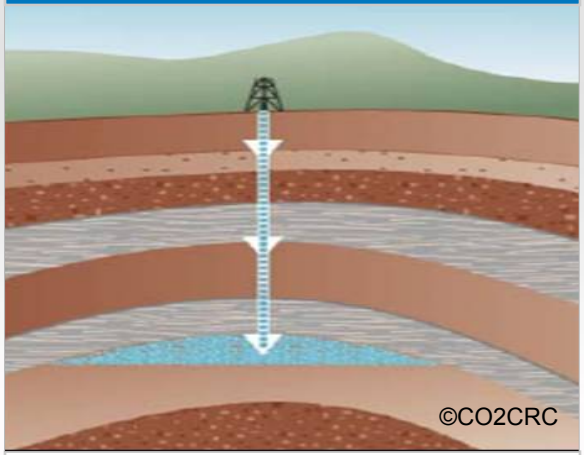
Identified Major CO_2 Sources in South Sumatera

Geological Formations Available in South Sumatera

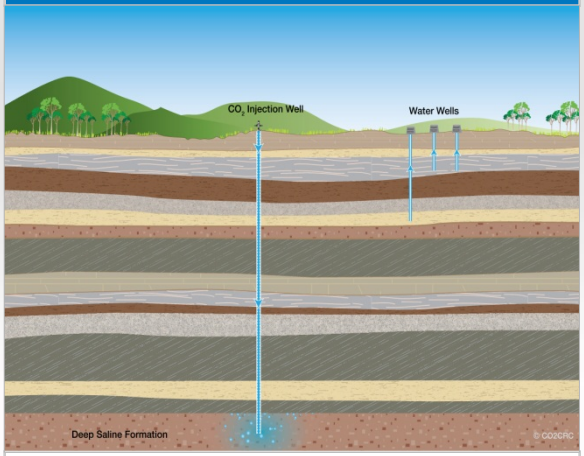
Depleted Oil & Gas Reservoirs



Total effective storage capacity:

- Oil reservoirs (98 fields) = 22 $MtCO_2$ (EOR) = 70 $MtCO_2$ (CCS)
- Gas reservoirs (35 fields) = 831 $MtCO_2$.

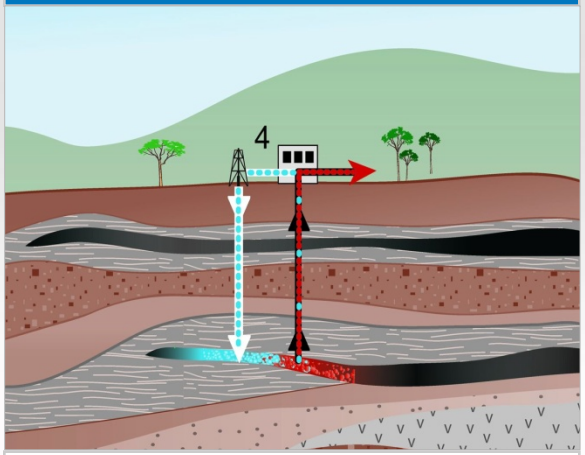
Saline Formations



Total theoretical storage capacity:

- Saline aquifers = 7.65 $GtCO_2$.
- Assuming % Efficiency of storage (E) = 0.12%

Coal Seams



Total theoretical storage capacity in Muaraenim Formation:

- Coal seams = 2.7 $GtCO_2$
- Assuming % Efficiency of storage (EF) = 0.21.

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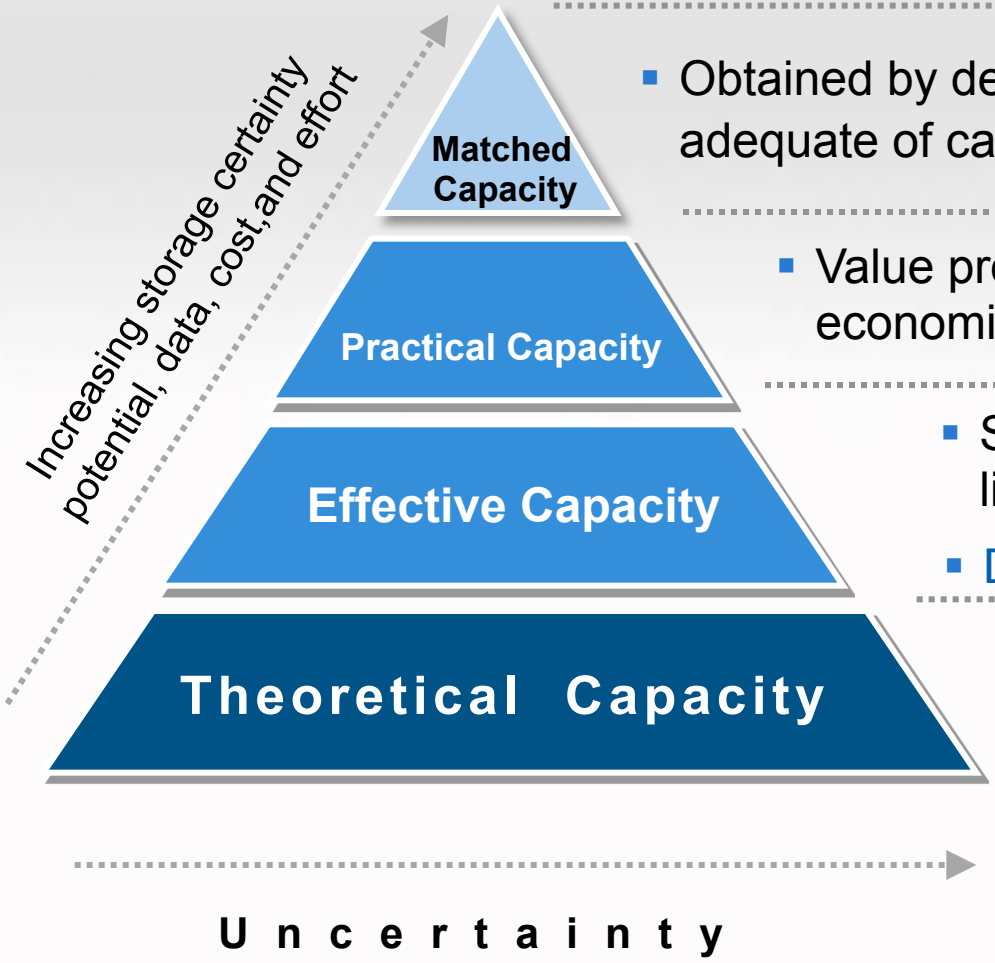
CO_2 Storage Capacity Classification

Techno-Economic Resource-Reserve Pyramid for CO_2 Storage Capacity



- Obtained by detailed sources with storage sites and adequate of capacity and supply rate & injectivity
- Value prone to changes as technology, policy, economics & etc. change
- Subset total PV by applying technical limits (geology and engineering limits)
- Depleted Oil and Gas Reservoirs
- Assumes entire volume is accessible to store CO_2 in the pore space
- Saline Formations and Coal Seams

Modified from CSLF, 2007

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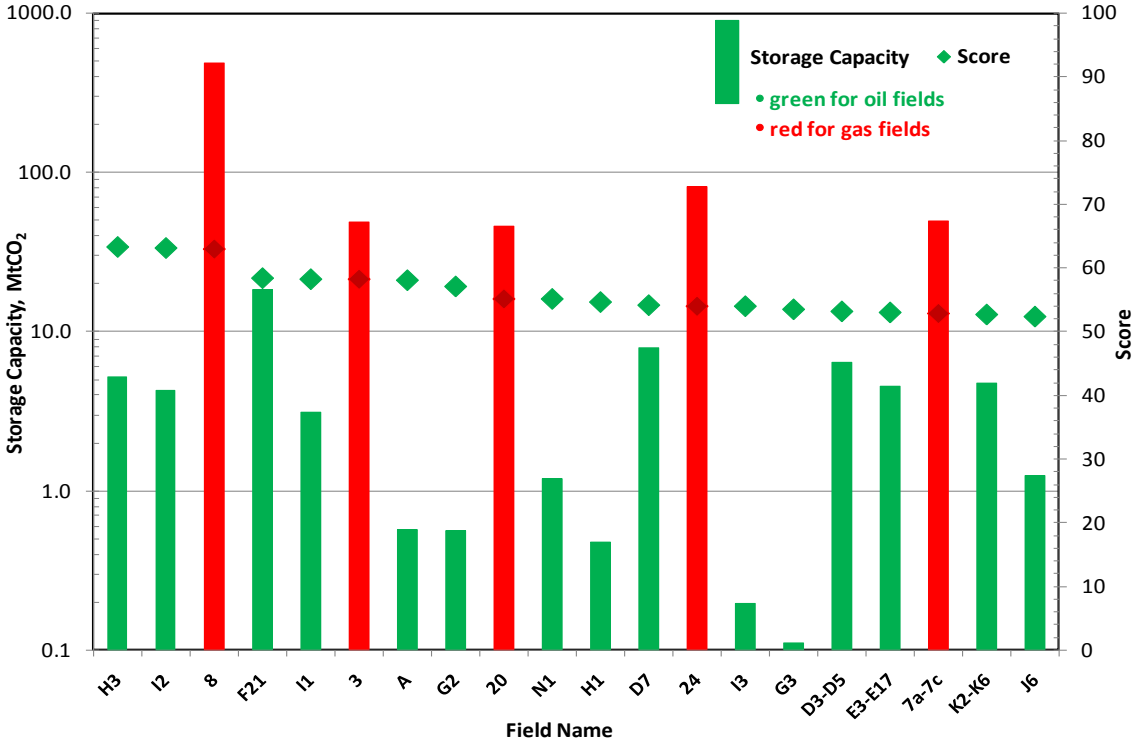
Scoring and Ranking for the Top 20 Depleted Oil and Gas Fields



Rank	Field Name	Distance from CO_2 Source
1	8	165
2	I2	12
3	H3	98
4	3	205
5	I1	118
6	A	26
7	G2	85
8	F21	76
9	20	179
10	N1	221
11	H1	95
12	24	183
13	I3	128
14	D7	59
15	G3	88
16	D1	53
17	7a-7c	58
18	E3-E17	68
19	K2-K6	145
20	J6	139

Methods

- Based on criteria established incorporating capacity, containment, injectivity, added value and timing.

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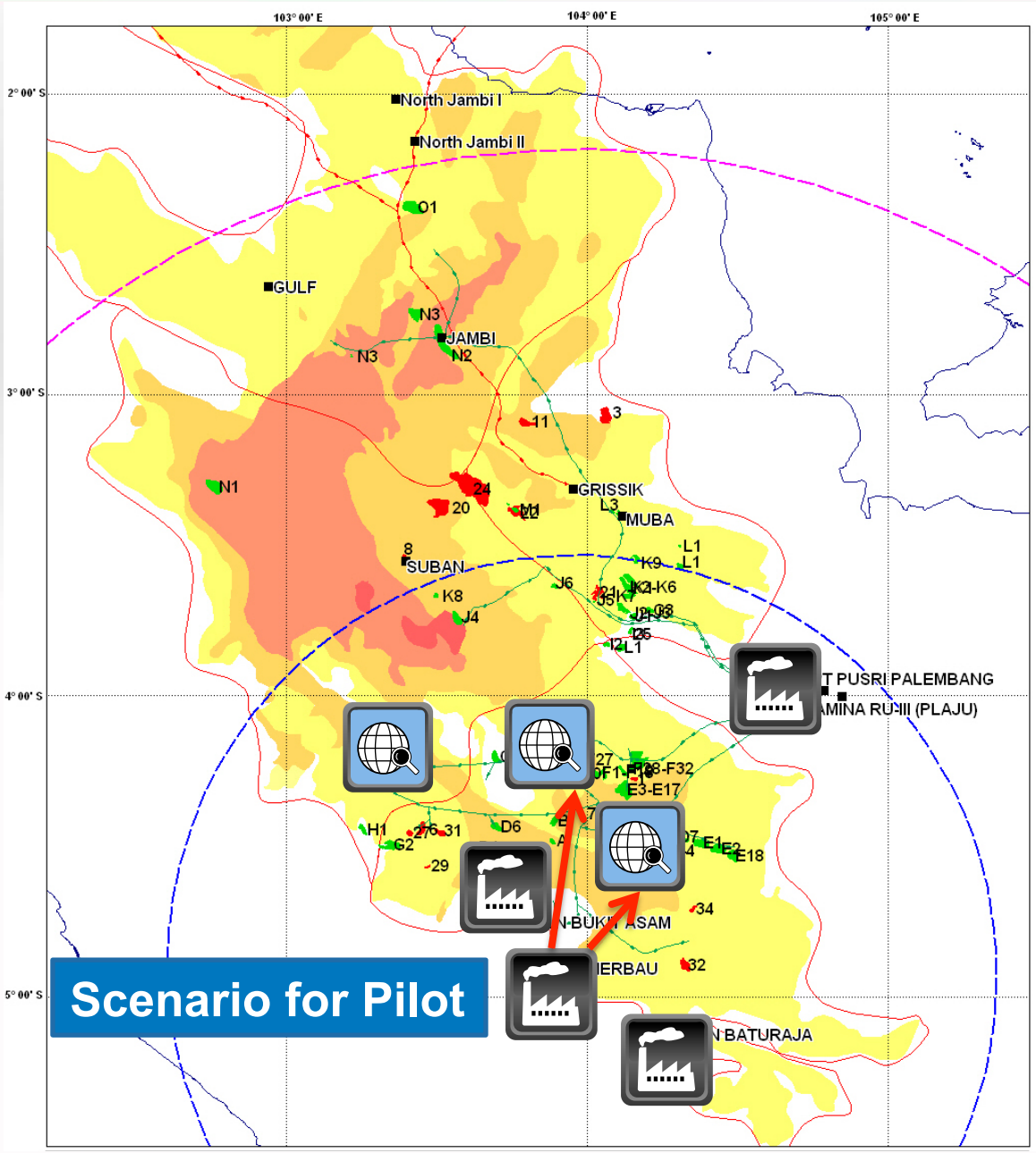
Source – Sink Matching for the Oil and Gas Fields



Methods

- 150 & 300 km circles around best sources
- Contain attractive sink(s)?
- Rank identified possibilities by proximity
- If several available, rank by infrastructure

Scenario for Pilot

- CO_2 Source:
  Merbau Gas Gathering Station
- CO_2 Sinks:
  a. Oil Field F21
  b. Gas Field 7c

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CCS Deployment Strategy in Indonesia

STAGE 1

Pilot

- 50-100 tonnes per day of CO_2 over several months
- Knowledge of reservoir performance to support financing and designing a Demo project.

STAGE 2

Demonstration

- Larger quantities of CO_2 injected into many wells continuously over many years
- 500-1,000 tonnes per day or more of CO_2 injected over 10 + years.
- Confirmation of long-term successful CO_2 storage to support financing and construction of at least one full scale commercial operation

STAGE 3

Commercial

- Very large quantities of CO_2 captured from one or more sources injected into one or more locations for a very long time period
- 2,500 -5,000 tonnes per day CO_2 captured and injected over 20+ years.
- Capture and store sufficient quantities of CO_2 to substantially reduce Indonesia's CO_2 emissions

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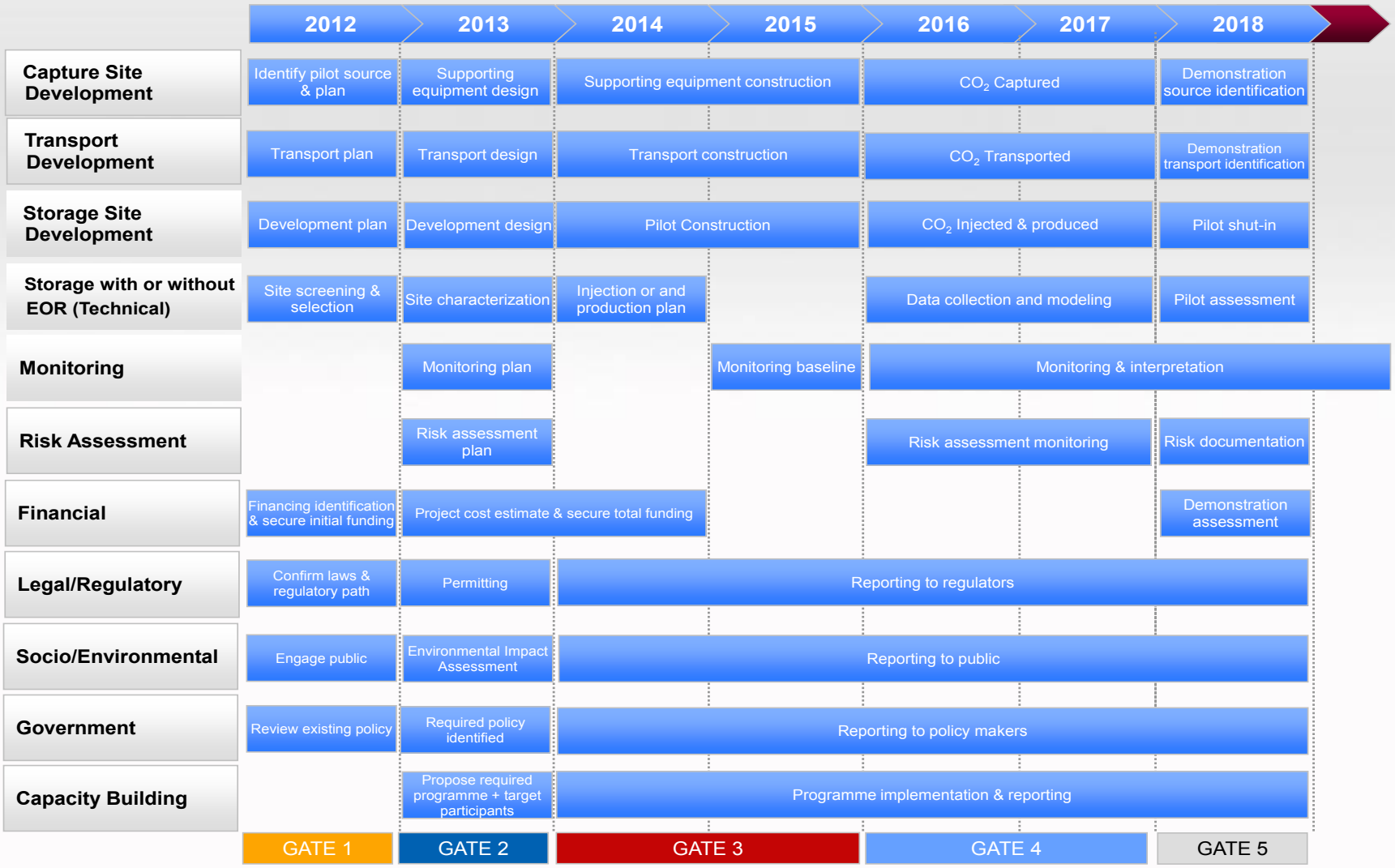
Roadmap for CCS Pilot Project

With emphasis to improve energy security through EOR / CTL / CTG / Biomass



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Indonesia Regulatory Assessment

Key Findings

- At present no law on CCS available in Indonesia but several regulations under oil & gas reflect similarity for CCS arrangements.
- e.g. Minister Regulation No.13 /2007 "*Requirements and procedures of waste water treatment for upstream oil and gas and geothermal activities using injection method into the subsurface*"

- CCS project will involve interest of multi-ministers and agencies at central government. e.g Ministry of Environment and Ministry of Energy and Mineral Resources

- Laws and regulation applicable to CCS covers environmental regulation, national constitution, pipeline regulation, transportation regulation, health & safety regulation, oil & gas mining laws.

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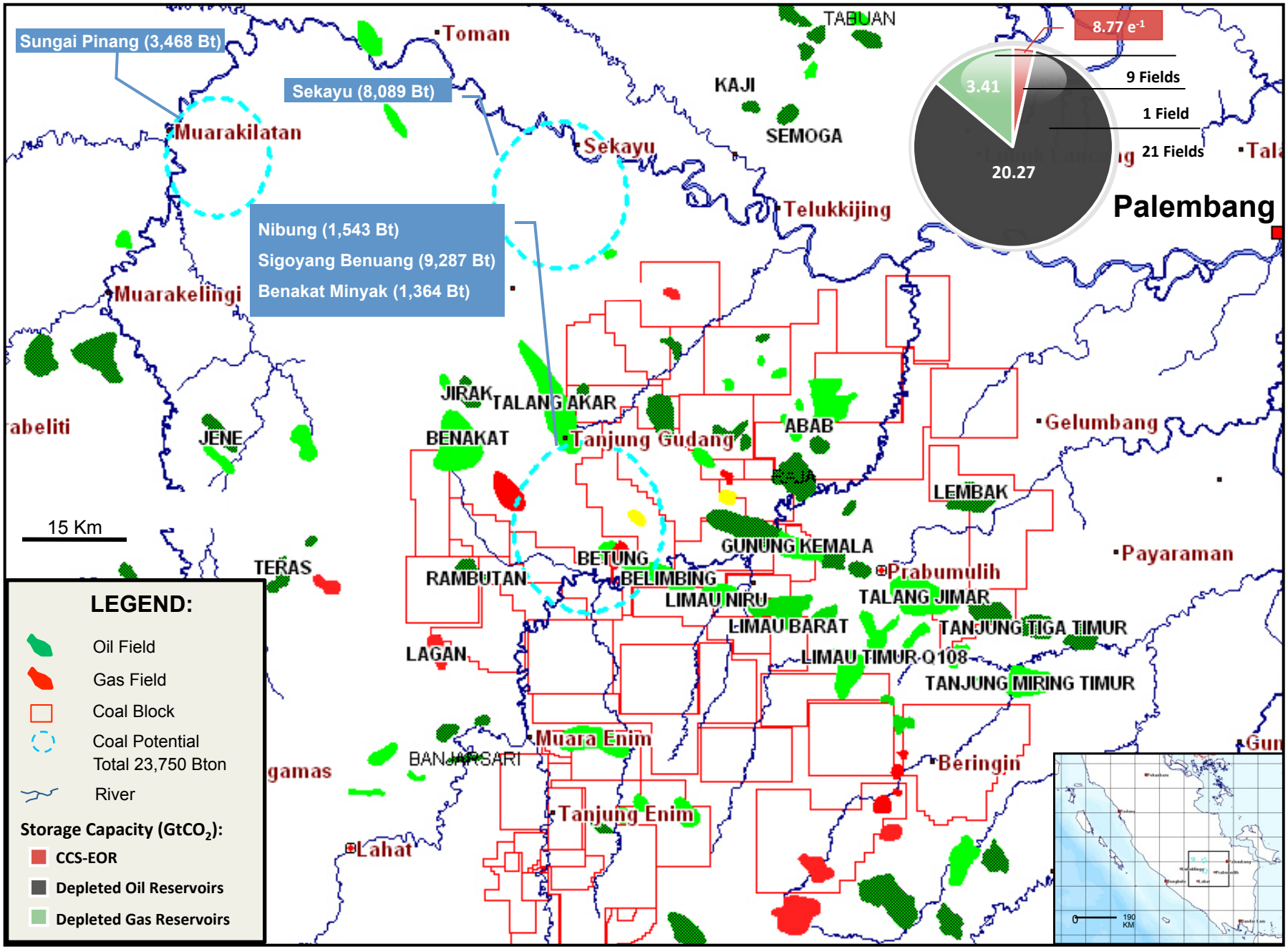
CCS as CO_2 Management on Low-rank Coal Utilization in South Sumatera



Screening Criteria for Specific Indonesian Sedimentary Basins

CRITERIA	Increasing CO_2 Storage Potential →				
	CLASSES				
	1	2	3	4	5
On/Off Shore	Deep Offshore	Shallow Offshore	Onshore		
Geothermal	Warm (>400C/ km)	Moderate	Cold (<300C/ km)		
Maturity	Unexploration	Exploration	Development	Production Basin	
Fault Intensity	Extensive Faulted and fracture	Moderately Faulted and fracture	Limited Faulting and fracturing		
Tectonic Setting	For Arc	Back Arc	Platform	Deltaic	Rift Vally
Depth (meter)	Shallow (<1,500m)	Intermediate (1,500-3,500 m)	Deep (>3,500 m)		
Size	Small	Medium	Large	Giant	
Hydrocarbon Potential	None	Small	Medium	Large	Giant
Accessibility	Inaccessible	Difficult	Acceptable	Easy	
Infrastructure	None	Minor	Moderate	Extensive	

Modified from Bachu, 2003 and CO2CRC, 2009

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10 Most Suitable Sedimentary Basins for CO_2 Storage

No.	Basin Name	Region	Suitability Score (1-0)
1	Kutai	East Kalimantan	0.913
2	Tarakan	East Kalimantan	0.777
3	South Sumatera	South Sumatera	0.756
4	Seram	Maluku	0.735
5	North West Java	West Java	0.723
6	Barito	Central-South Kalimantan	0.722
7	Central Sumatera	Riau	0.715
8	North Sumatera	North Sumatera	0.702
9	Salawati	Papua	0.690
10	North East Java	East Java	0.683

Main Factor

- Well characterized reservoirs
- Favorable and well-known geological structure
- There is potential to reuse existing infrastructure

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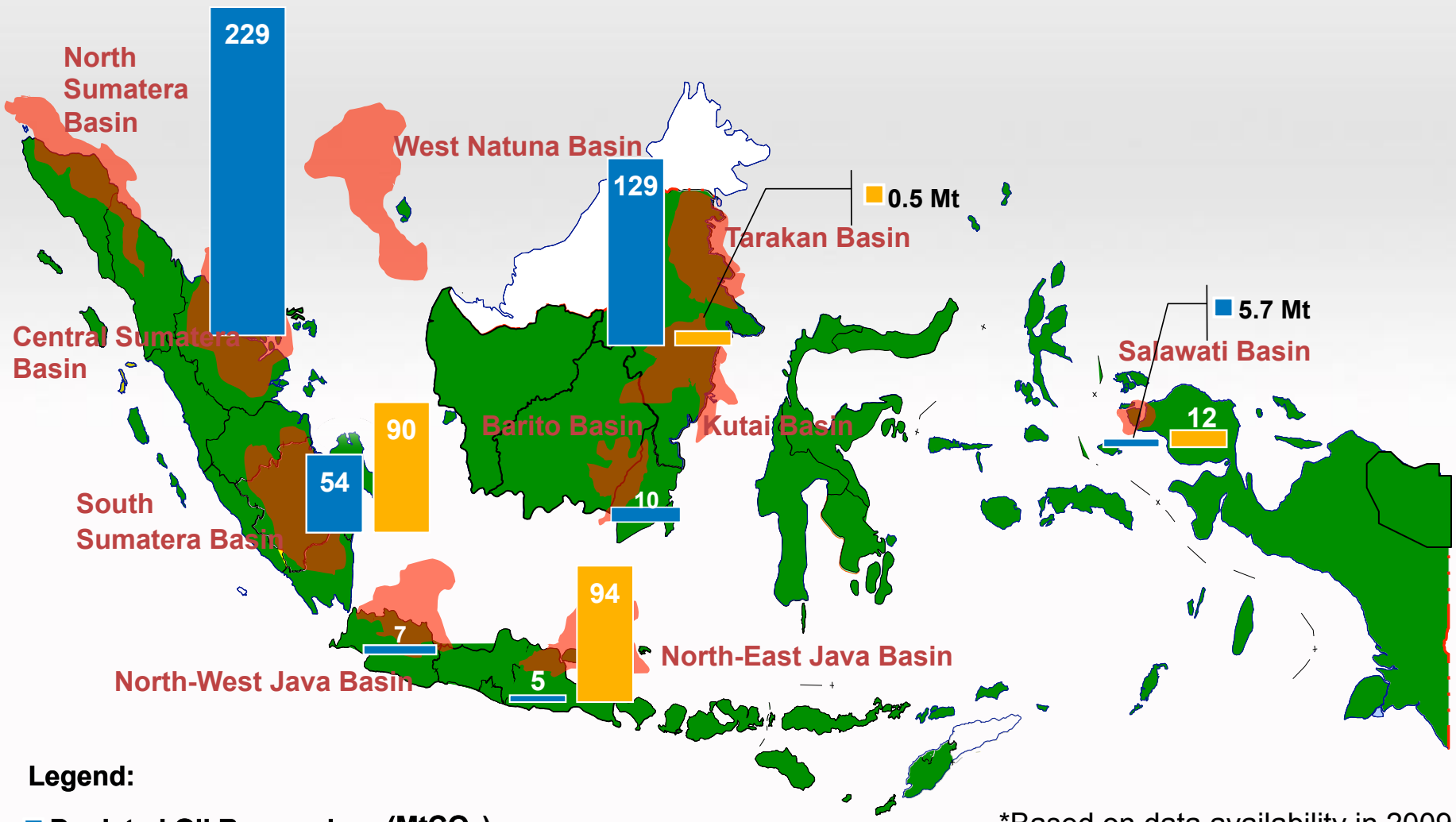
CO_2 Storage Capacity Estimates in Depleted Oil and Gas Field*



Legend:

- **Depleted Oil Reservoirs ($MtCO_2$)**
- **Depleted Gas Reservoirs ($MtCO_2$)**

*Based on data availability in 2009

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Conclusion

- The most suitable near-term deployment of CCS in Indonesia will be in the oil and gas upstream sector. The use of CO_2 for EOR provides a driver and early mover for deploying CCS particularly for Indonesia.
- More than 600 Mt of CO_2 is able to store at the depleted oil and gas reservoirs in Indonesia while the latest study indicates South Sumatera offers various of geological formation with capacities more than 10 $GtCO_2$.
- Low hanging fruit of CO_2 source will be supplied from gas processing plant.
- Possible entry point for legislation for CCS pilot project:
  a) As part of EOR : through Ministry of Energy
  b) As an experimental project: first Indonesian CBM pilot project
- To move forward CCS in Indonesia should be based on the roadmap developed.
- The CCS roadmap developed provides an analytical footing that enables:
  - Stakeholders to move forward on specific actions,
  - Address unidentified key issues, and
  - Take timely action

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takk

terima kasih | thanks | merci | gracias | obrigado | спасибо | 谢谢 | شكر

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