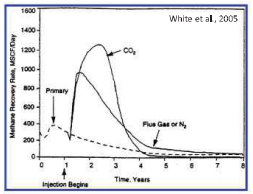
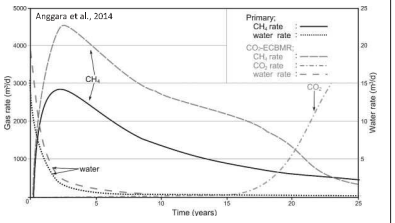
Tipikal kurva produksi CBM dan ECBM





Coal Bed Methane (CBM) dan Shale gas

- Produksi komersial
- Mendukung penyediaan energi di Indonesia

Regulasi

Kondisi saat ini (2013):
- CBM: 54 PSC (Mei, 2013)
- Shale gas: 1 PSC (2013)

- Keekonomian
- Isu sosial

Perencanaan produksi

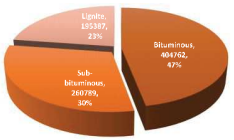
Karakterisasi CBM/Shale gas *play*

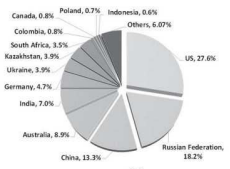
Reservoir Management

Enhanced CBM Recovery

Ferian Anggara

Sumber daya dan cadangan batubara





- Low rank coal (Lignite&Sub-bituminous) = 53%
- High rank coal (Bituminous&Antracite) = 47%

Percepatan pengembangan CBM/Shale gas

Karakterisasi → **Pengembangan** → **Produksi**

- Peningkatan produksi (CO_2-Enhance Recovery)
- Perlindungan lingkungan global
- Isu sosial

Database: *Perlunya suatu database "play" CBM/Shale gas di Indonesia*

POD: *Rumusan POD masih didiskusikan secara intensif*

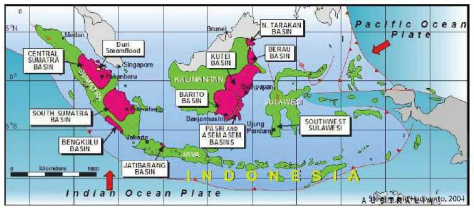
- Injeksi CO_2 untuk meningkatkan produksi methane dan *geological storage*
- Social Risk Managements (SriMAS)

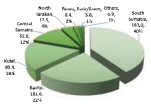
"boosting" pemenuhan energi dari CBM/Shale gas

Schedule

- Introduction (20/2)
- Group presentation (27/2)
- Unconventional (CBM) Reservoir Management (6/3)
- Unconventional (CBM) Reservoir Management (13/3)
- Unconventional (Shale gas) Reservoir Management (20/3)
- Unconventional (Oil shale) Reservoir Management (31/3)
- Unconventional (Methane hydrate) Reservoir Management (2/4)

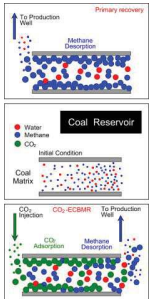
Coal and CBM resources in Indonesia





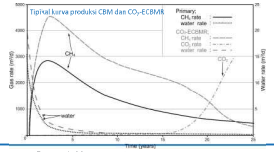
Coal bed methane (CBM): **337-453 Trillion cubic feet**

Handbook of Energy and Economic Statistics of Indonesia, 2012
- Coal resources: 120 billion tones
- Coal reserves: 28,017 million tones

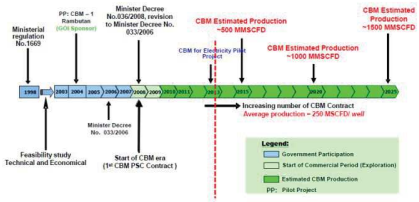


CBM Production

- **Proses "*dewatering*"**
  → Prosedur standar yang dilakukan
- **Injeksi CO_2 ke reservoir CBM**
  - ✓ Meningkatkan produksi methane: CO_2 *enhanced coal bed methane recovery* (CO_2-*ECBMR*)
  - ✓ Sebagai salah satu opsi menyimpan CO_2 di formasi geologi: CO_2-*geological storage*

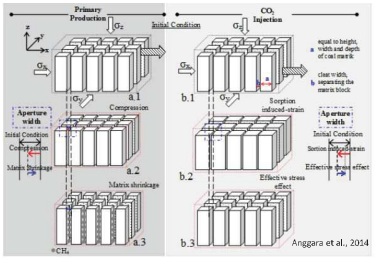


Road map pengembangan CBM di Indonesia



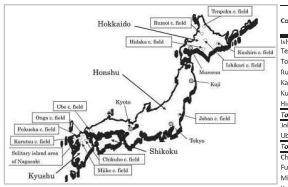
Bagaimanakah realisasinya?

Matchstick geometry representation of a coal seam



a. CH_4 primary production scheme: a.1 initial condition; a.2 increasing effective stress caused by drawdown pressure and it's resulting decreasing aperture width thus permeability is decreasing; a.3 CH_4 is desorbed during drawdown pressure resulting matrix shrinkage and finally permeability is rebound at certain pressure. b. ECBMR by CO_2 injection scheme: b.1 initial condition; b.2 permeability reduction caused by CO_2 sorption induced-strain; b.3 when CO_2 is injected into coal reservoir, push back phenomenon is occurred and resulting rebound permeability (model was drawn based on Seidle et al. (1992); Shi and Durucan (2005).

Coal & CBM resources and CO_2 injectivity in Japan



5.58 Trillion cubic feet

Coalfield	Reserves Coal (1000 t)	Reserves CH_4 (10^6 m^3)	CO_2 Seq. (10^6 t)
Ishikari	6,352,677	80,844	8.07
Tenpoku	999,253	2088.4	8.26
Tomamae	92,329	492.1	1.95
Rumoi	480,592	1624.4	5.42
Kayanuma	67,279	240.6	0.95
Kushiro	1,857,387	8098.2	32.02
Hidaka	22,052	99.9	0.40
Total of Hokkaido	9,871,879	93,488.0	369.66
Ishizu	1,000,819	2760.9	10.91
Ube	619,126	928.7	3.67
Total of Honshu	1,619,199	3688.7	14.58
Chikuho Onga	2,334,089	12,924.0	48.73
Fukuoka	175,522	840.8	3.32
Miike	1,646,955	20,488.1	81.01
Karatsu	855,801	4210.5	16.65
Hokusho	158,985	475.4	1.88
Solitary Island area	1,571,509	22,335.4	88.31
Total of Kyushu	6,742,861	60,874.2	240.70
Total of Japan	18,033,879	158,050.9	624.54

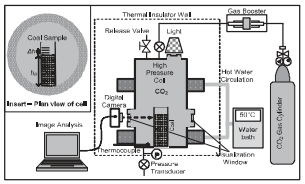
Yamazaki et al., 2006

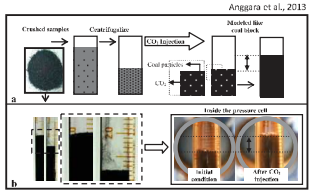
Coal seams as CO_2 geological storage

- ❑ **Primary CBM production**
- ❑ **Injection of CO_2 into coal seams:**
  - ✓ Give added value of enhanced coal bed methane recovery (CO_2-ECBMR)
  - ✓ Safe and permanently storing CO_2 over geologic time
- ❑ **Geological storage** (GS): an option to store CO_2 storage in *large enough quantities over long geological periods of time*

Development of stable, affordable and environmentally friendly in term of natural resources

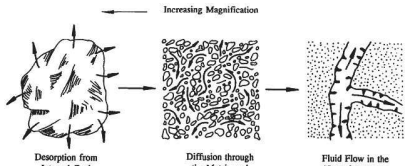
Swelling measurement-1





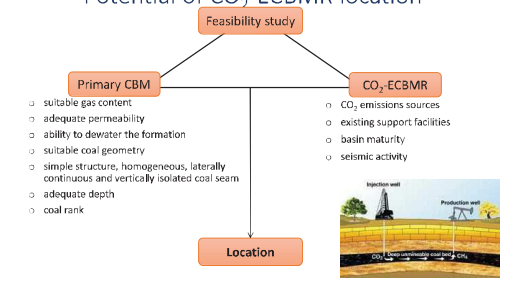
Anggara et al., 2013

Mechanism of gas transport in coal



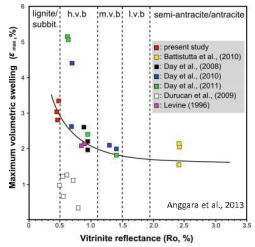
King et al., 1986

Potential of CO_2-ECBMR location



(IPCC, 2005; Anggara et al, 2010)

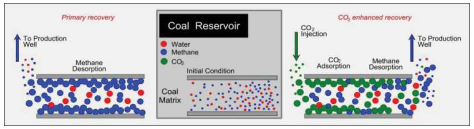
Dependence of CO_2 swelling on coal properties



- shows slightly linear decreasing trend with increasing rank
- h.v.b → scatter data→ in some rank ranges, the maceral composition seems to be dominant (Busch and Gensterblum, 2011)
- vitrinite and liptinite→ decrease density → tend to swell
- inertinite & clay → increase density → tend to shrink
- different lithotypes
- ash and TOC should be considered

Individual sample → different components of the coal swelled to varying extents

Problem identification

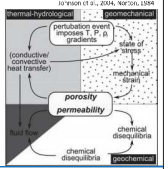


- ❑ CO_2 adsorption is higher compare to CH_4 at given pressure

--> to displace CH_4 (+++)

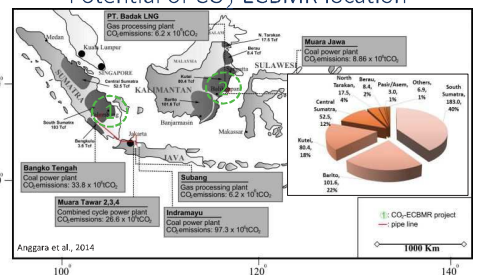
--> to induce coal swelling; permeability reduction

Changes in permeability

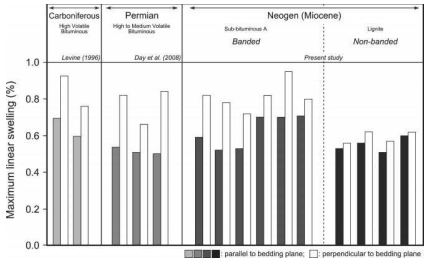


Johnson et al., 2004; Norton, 1984

Potential of CO_2-ECBMR location



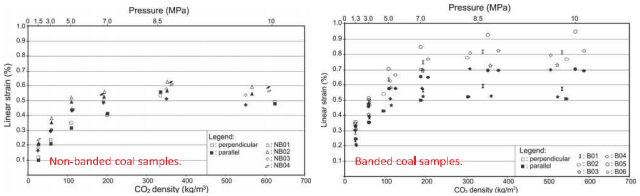
Comparison of swelling behavior as function of coal megascopic texture and ages



Anggara et al., 2014

Coal swelling

Linear strain of coal sample block for perpendicular and parallel to bedding plane as function of CO_2 injection pressure

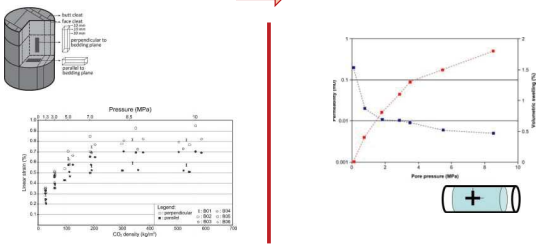


Anggara et al., 2014

Coal lithotype

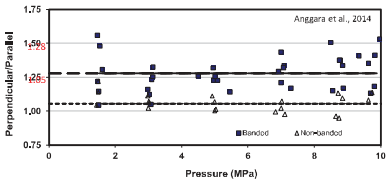
Next meeting: Permeability reduction

Swelling data → Permeability reduction

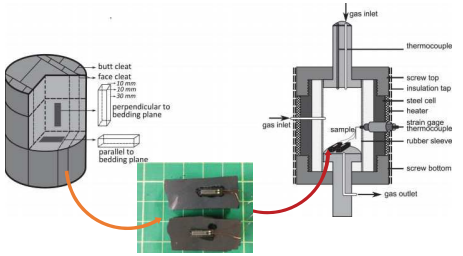


Ratio of perpendicular/parallel linear strain

- Non-banded: 1.05
- Banded: 1.28

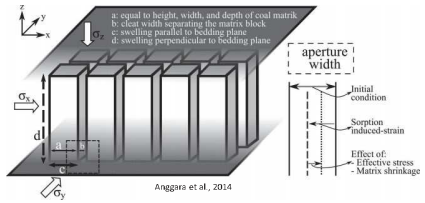


Swelling measurement-2



End

Effect on CO_2-ECBMR



Swelling parallel to bedding plane→ directly effect cleat aperture→ permeability change

Coal type and petrography analysis of coal samples

Samples										
Group	Group I					Group II				
Megascopic texture	Dull luster, non-banded					Bright luster, banded				
Rank	Lignite*					Sub-bituminous A*				
Depth interval (m)	100.56-101.93	101.94-103.68	121.75-122.80	122.81-125.05	34.25-35.95	57.10-58.40	58.41-60.05	108.06-110.05	133.80-135.60	135.61-137.45
Sample code	NB01	NB02	NB03	NB04	B01	B02	B03	B04	B05	B06
Petrographic composition										
Total huminite	83.8	83.0	81.4	80.2	82.0	79.6	83.4	80.8	79.8	81.4
Total inertinite	7.0	8.2	9.6	8.8	10.5	10.6	6.6	9.4	12.2	9.8
Total liptinite	7.4	6.6	6.6	8.6	6.7	8.0	8.0	6.2	6.8	7.4
Mineral matter	1.8	2.2	2.4	2.4	0.7	1.8	2.0	3.6	1.2	1.4
Huminite reflectance	0.37	0.38	0.37	0.37	0.47	0.47	0.47	0.46	0.50	0.50