The effects of shale gas development in the U.S., & the status of developing unconventional gas in the world

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The Future of Energy, Resources and Materials

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Presentation Outline

1. Current status of developing unconventional gas
2. Development of shale gas in the U.S. and its effects
3. Development of shale gas outside the U.S.
4. Development of CBM in Asian Pacific

Status of Developing Unconventional Gas

United States

- **CBM**: **Commercial production**
- **shale gas**: **Commercial production**, LNG export-planned

Australia

- **CBM: Commercial production, LNG export-under construction**
- Shale gas: development

Europe

- Shale gas: development

China, India, Indonesia

- CBM: commercial production in small quantity
- Shale gas: development

Effects of shale gas boom in the U.S.

Cheap supply of natural gas

- **Vitalize the US energy consuming industries ←manufacturer's return to US**
- **Create energy related employment**

Structural Change to the world LNG markets

- Disappearance of the U.S. LNG market
- Exports of US LNG could give an impact to the world LNG market

Increase of production of tight oil, NGL

- **Activate petrochemical industries: ethane cracker, propane dehydrate**
- US LPG exports is increasing
- Investment in infrastructure such as pipeline & storage
- US could become the largest oil producer by 2017 (IEA)

others

- North America has been the hot target for E&P investments
- Increase of coal exports ←decrease of domestic coal consumption

Shale Gas Plays in North America

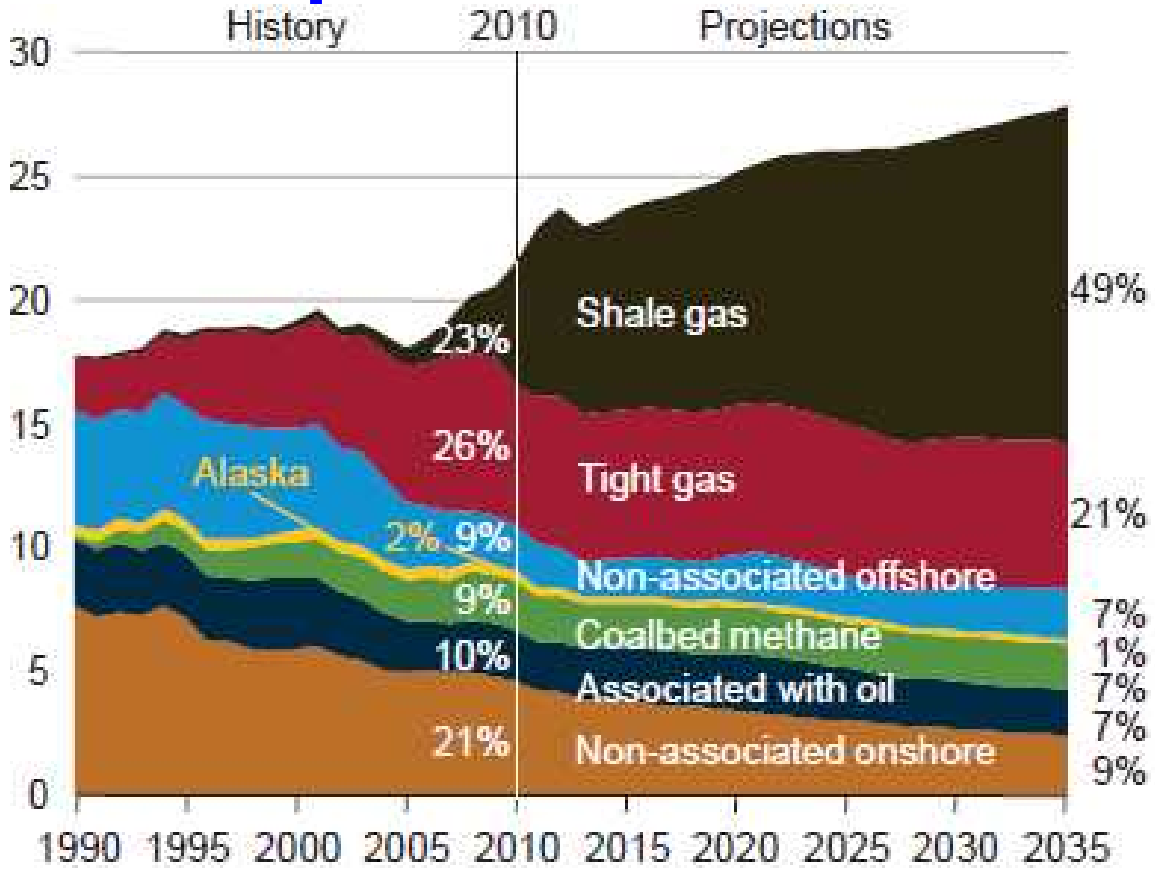
出所：U.S.A Energy Information Administration based on data from various published studsies. Canada and Mexico plays from ARI.

Trend ①Texas, Rocky mountains⇒ North East (Marcellus), Mid-west in Canada

②gas production⇒ development in liquids-rich shale

ConocoPhillips & Chesapeake deduced gas production due to low price in Jan. 2012

Gas production forecast in U.S.



Source: AEO2012

DOE, Jan. 2012

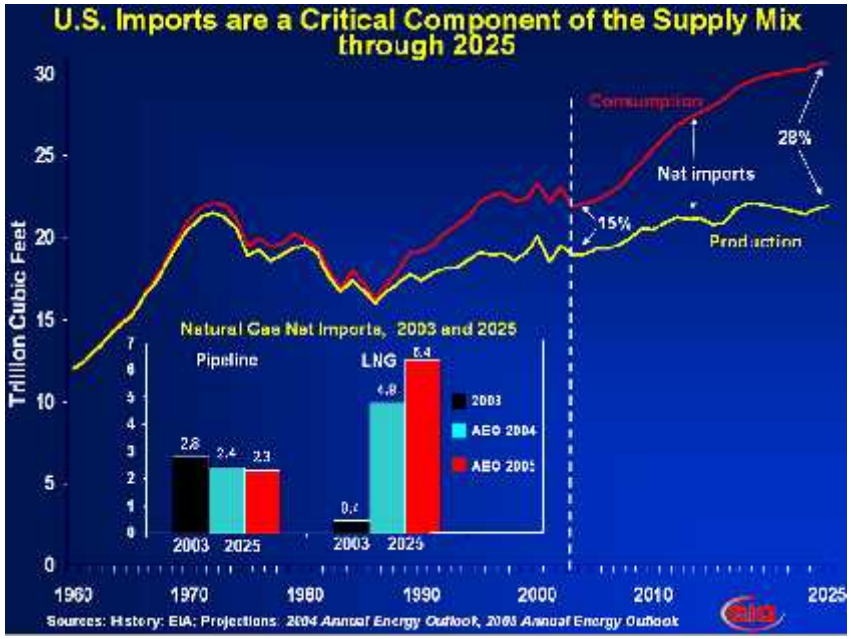
Stable increase in unconventional gas ＋ energy efficiency

- ➪ US is to become net gas exporter as of 2021, with LNG export starting in 2016
- ➪ decrease in world LNG demand

  Change of LNG producers' marketing strategies

⇒（Qatar etc.）Original market = USA → developing other **markets as Asia**

Change of Gas supply/demand, USA



Forecast in 2004

⇒2025

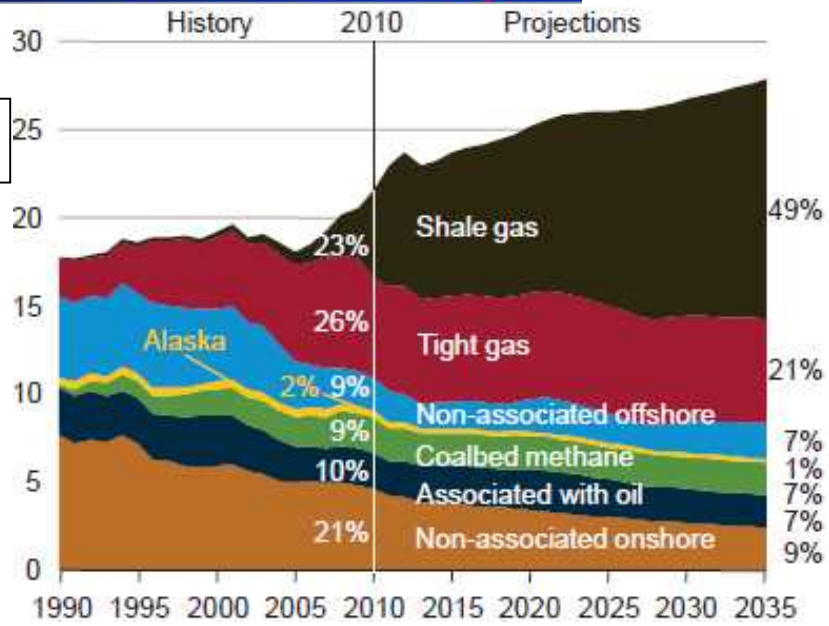
28% of gas consumed will be imported

⇒2035

US will become gas net exporter

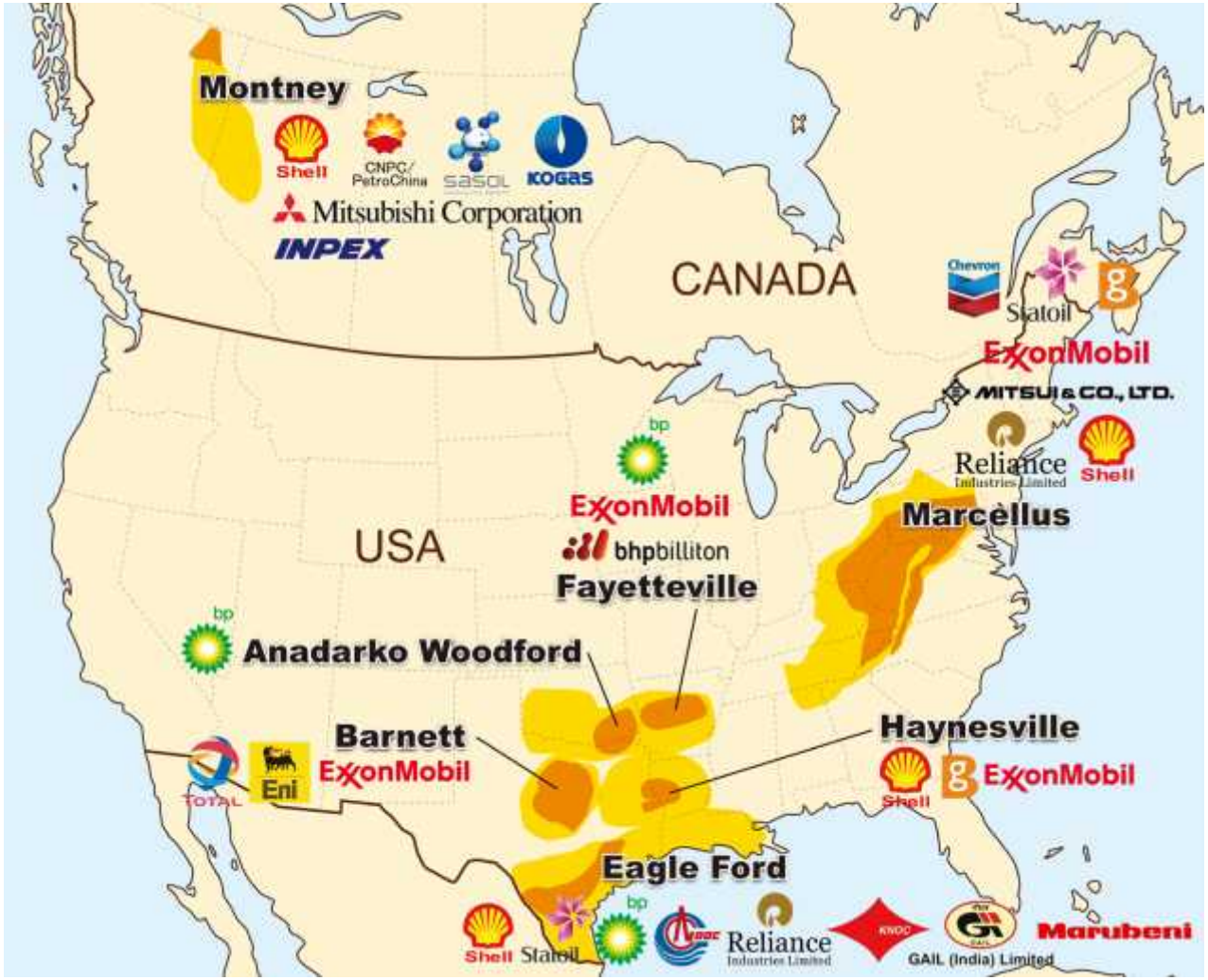
Latest forecast

(Jan., 2012）



Source: DOE EIA

Investors in shale gas/oil development in North America



Investment in shale gas and tight oil assets in North America has been a boom since 2009 by both IOCs and NOCs.

Emerging LNG Export Projects: North America

- 17 US liquefaction projects submitted applications to export LNG. Total capacity=170 million tons
- Around 40 million tons will be realized?
- So far, Cheniere's Sabine Pass got the approval of export and construction of the facilities.
- Asian buyers look for US LNG exports for cheaper source of LNG.

<u>Status of SPA & negotiation</u>

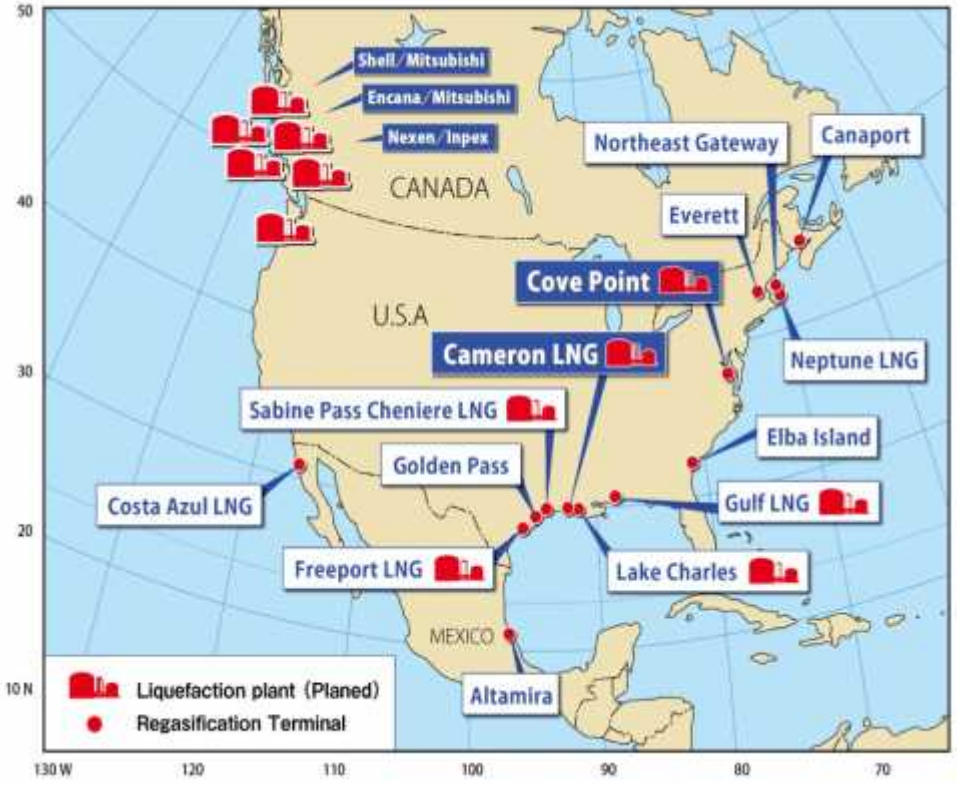
・BG, Gas Natural, Kogas, GAIL: SPA with Sabine Pass

・Chubu・Osaka gas with Freeport LNG

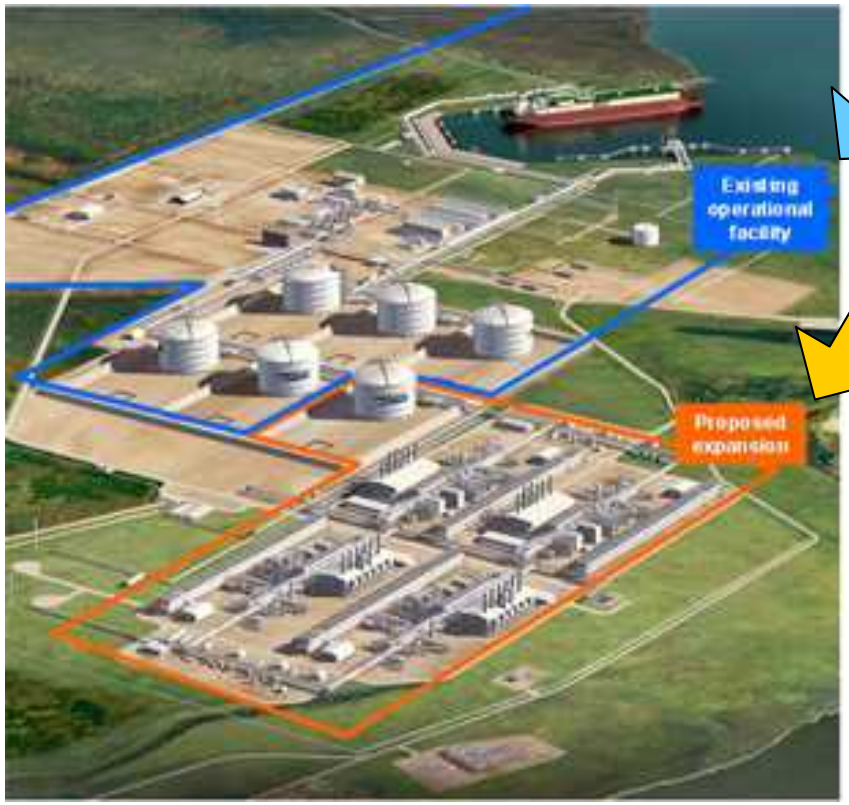
・Mitsubishi・Mitsui：in negotiation joining in Cameron LNG

・Tokyo Gas・Sumitomo： in negotiation with Cove Point

・Several gas developing projects are formed in Canada with prospect of exporting LNG.



Cheniere Energy-Sabine Pass LNG



（source）Cheniere Energy HP

・**existing tanks, port faciliteis**

・**will build liquefaction facilities,18 mm tons**
Phase 1=9mm tons（Trains 1 & 2）
Phase 2=9mm tons（Trains 3 & 4）

・**Oct. 2011-Jan.2012**
executed LNG SPAs with BG,GN,GAIL, Kogas
・ **Oct. 2011　placed EPC-order to Bechtel**
・ **2012/Q1　　plan FID for Phase 1**

・**<u>Business model</u>**
purchase feed gas ⇒liquefy ⇒ sell on FOB basis

<u>Challenges to Cheniere</u>：　small-mid sized gas trader（**re-gas terminal, gas PL**）
・ **weak financing base（no profit for the past 15 years, Debt-ridden）**
→has a concern in financing for building liquefaction facilities
・**no experience in LNG chain business→doubtful ability of operatorship**
（⇒These challenges are common to the all US liquefaction projects）

Elements of success in shale gas development

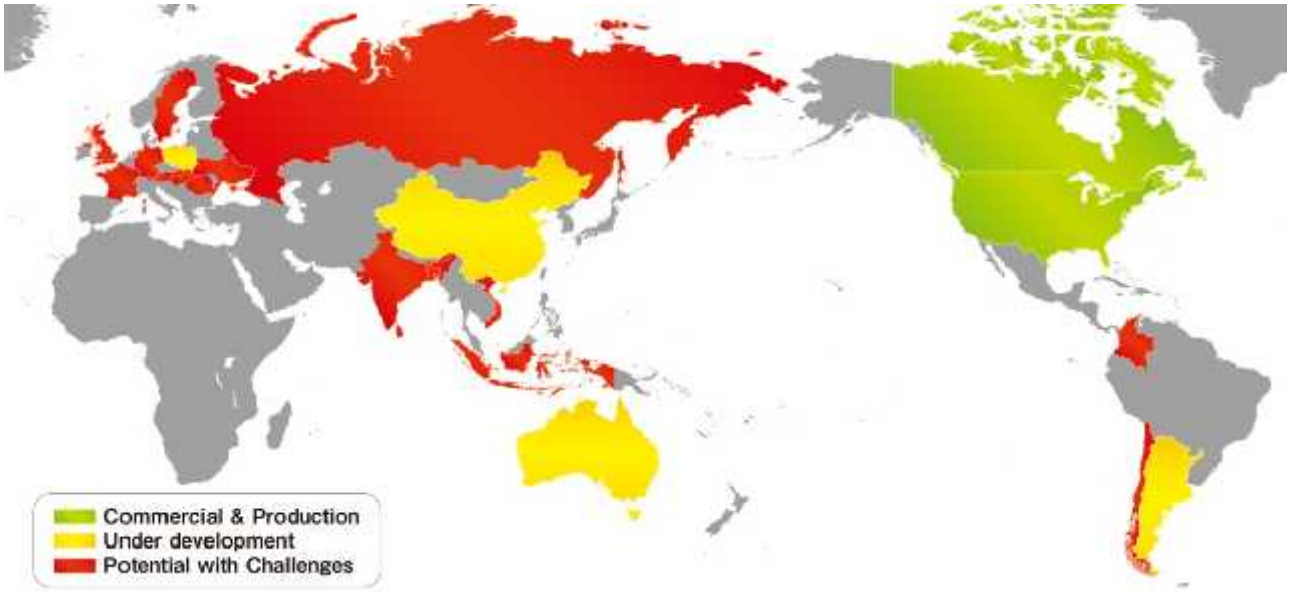
The elements of success in the USA

- **existence of gas markets**（applicable both to US/Europe）
- collaboration between gas producers/service companies

（USA＝gas producer＋consumer、Continental Europe= no producer）

- Natural resources belong to land owners in USA（belong to a country in Europe）
- existence of transport infrastructure
- existence of enough drilling rigs
- water for hydraulic fracturing
- favourable gas prices to lead to production incentive
- incentives by the government, legal framework, securing lands, royalty

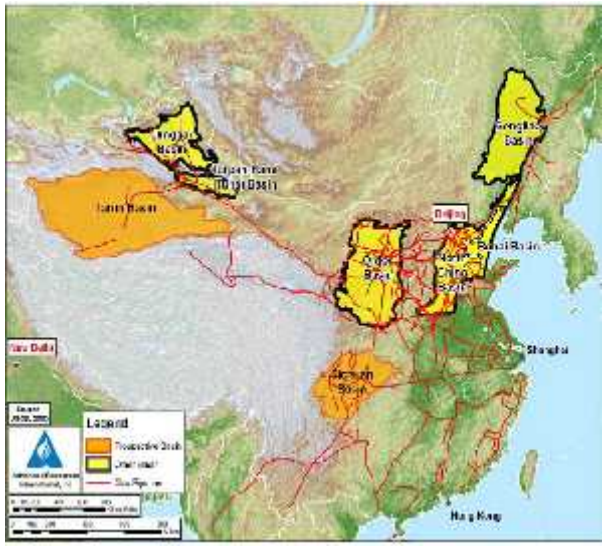
Status of Shale gas development outside US



- Major IOCs, first joined in shale gas projects in the U.S., then looked for opportunities in developing shale gas outside the U.S.
- **Europe:**
  - **Several developing activities, so far with no major success**
  - **Concern on environmental issues →No fracturing in France & others**
- **Argentina: success of developing tight oil**
- **Asian Pacific: development activities are quite in early stage**

➪**More time is needed before commercial production of shale gas commence.**

Status of Shale gas development in China



(DOE)

- US DOE “the potential of the world shale gas resources in April 2011”

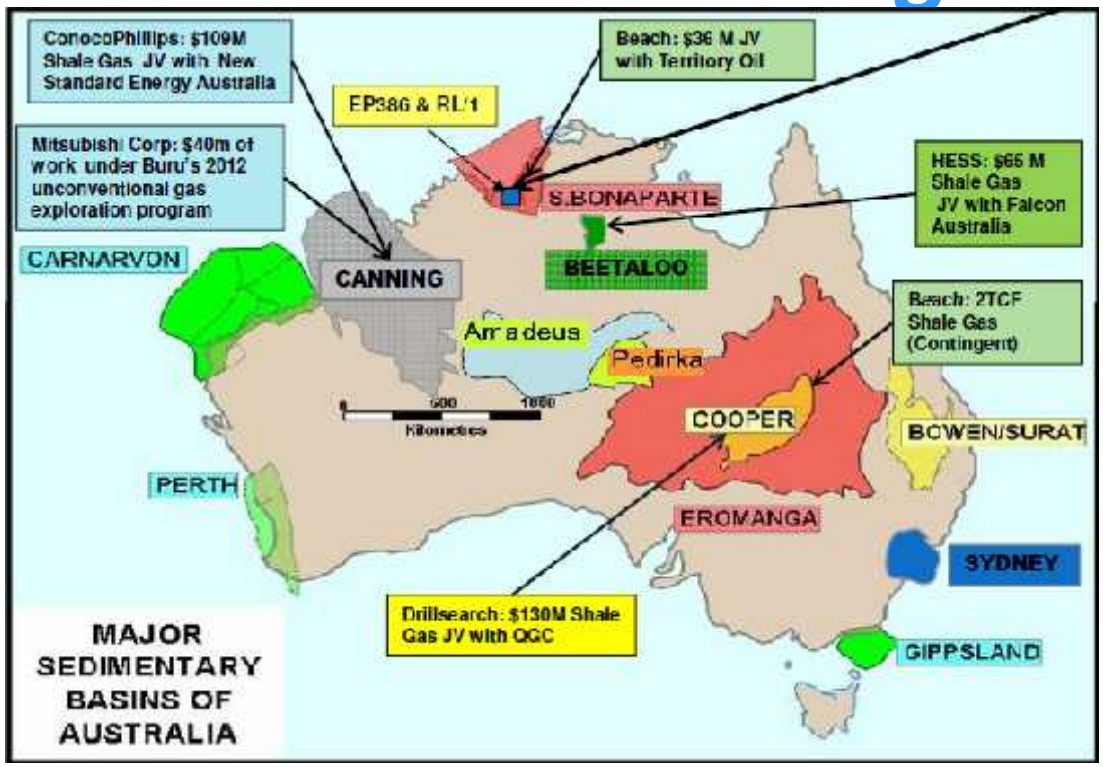
“China has the largest shale gas potential of 1,275 tcf followed by U.S.”

1) **discussing in the US-China oil & Gas industries’ forum**
2) **NOC（PetroChina、Sinopec）’s JVs with Shell, BP**

- **Areas for exploitation: Sichuan, Guizhou, Jiangsu**
- **Government made aggressive target of production: 60-100 Bcm by 2020**
- **The 1st and 2nd bidding were conducted in 2011- 2012→ blocks awarded to Chinese companies（JV with IOC can apply for the 2nd bidding）**

➪**Several challenges for development**

Potential of Shale gas in Australia



(source) Advent Energy Ltd., Shale Gas World Asia, July 2012

- **Shale gas development is quite in early stage in Australia.**
- **Potential is in Cooper basin, Canning basin and onshore Northern Territory.**
- **Exploration is conducted by Beach, Buru, Senex, Santos etc.**
- **Santos announced they commenced first shale gas commercial production with its Moomba-191 shale gas well in the Cooper Basin in August 2012.**
- **ConocoPhillips and BG secured blocks for future shale gas development.**

How much does unconventional gas grow?

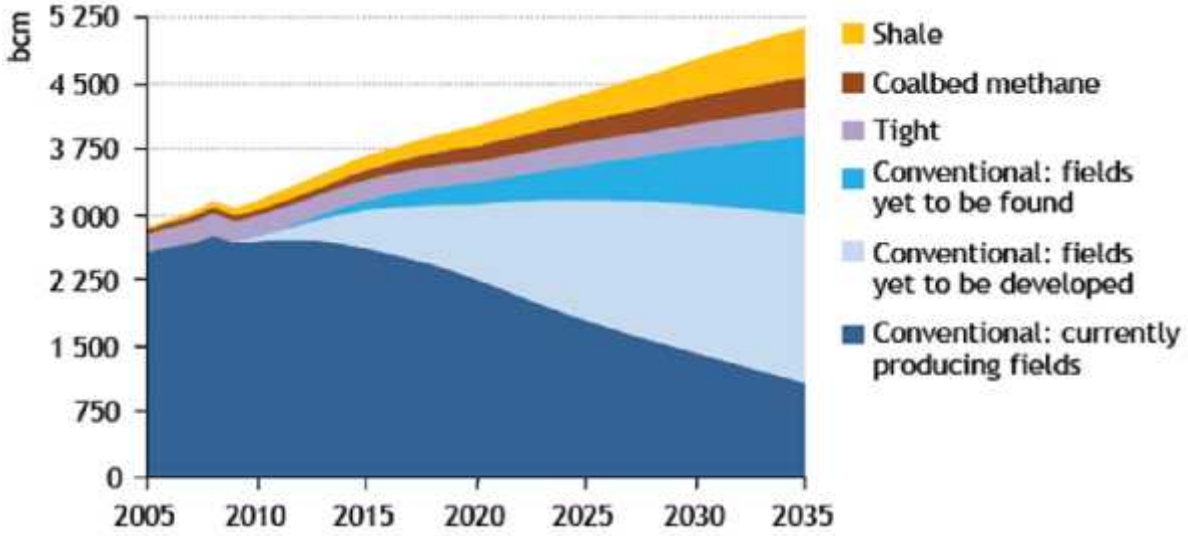
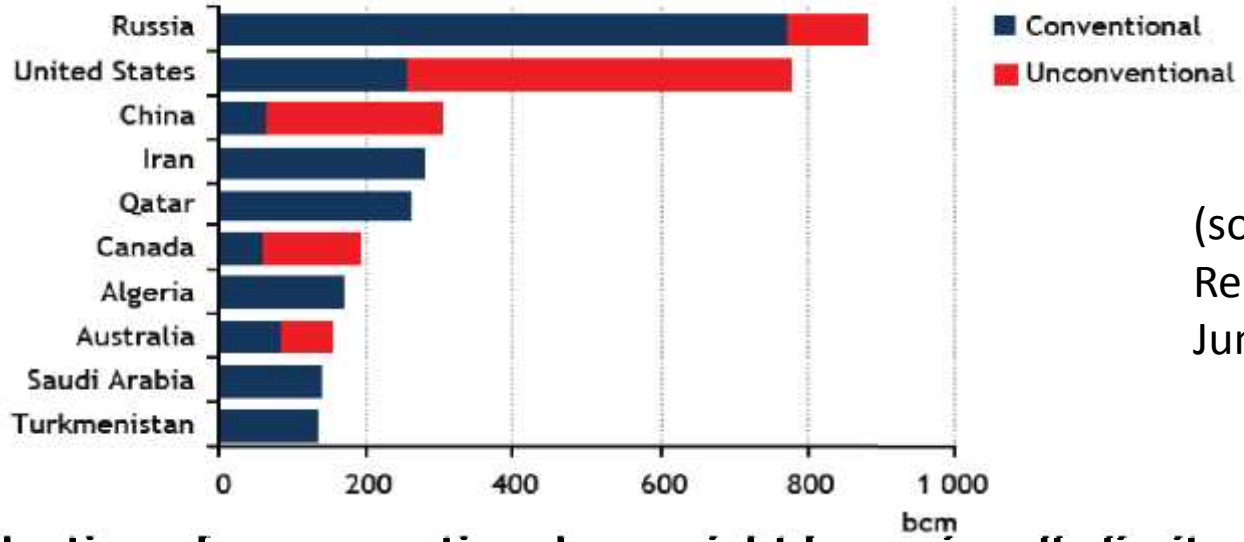


Figure 1.8 ▻ Largest gas producers by type in the GAS scenario, 2035



(source) IEA Special Report ”Gas Golden Age” June, 2011

Production of unconventional gas might be regionally limited to North America, Australia (and China) even in 2035.

Development of CBM in Asian Pacific

Queensland, Australia

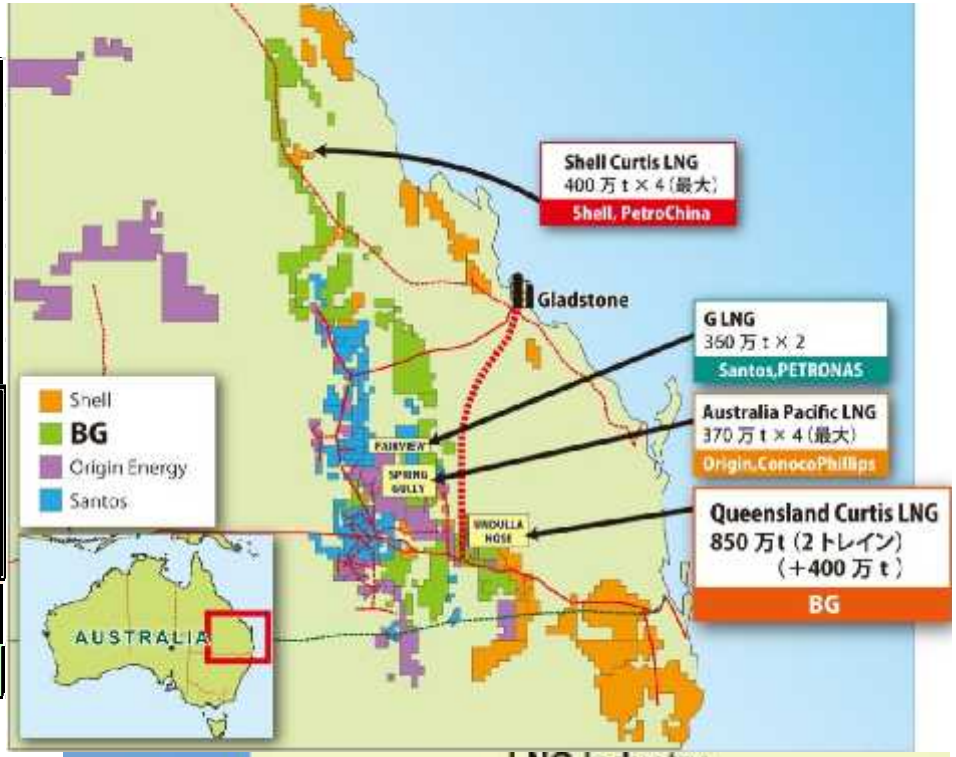
- Status; Commercial production for domestic markets, CBM-LNG projects are under construction
- The status; well advanced
- Challenges; Cost overrun, concern of project delay, concern of environmental issues

Asian coal producers: China, Indonesia, India

- Status; Production in small quantities, development
- Governments have aggressive targets of increasing CBM production, which has not been realized.
- The status; far behind.
- Challenges; lack of enough markets & pipelines, regulations, suitable technology

Australia : CBM-LNG projects under construction

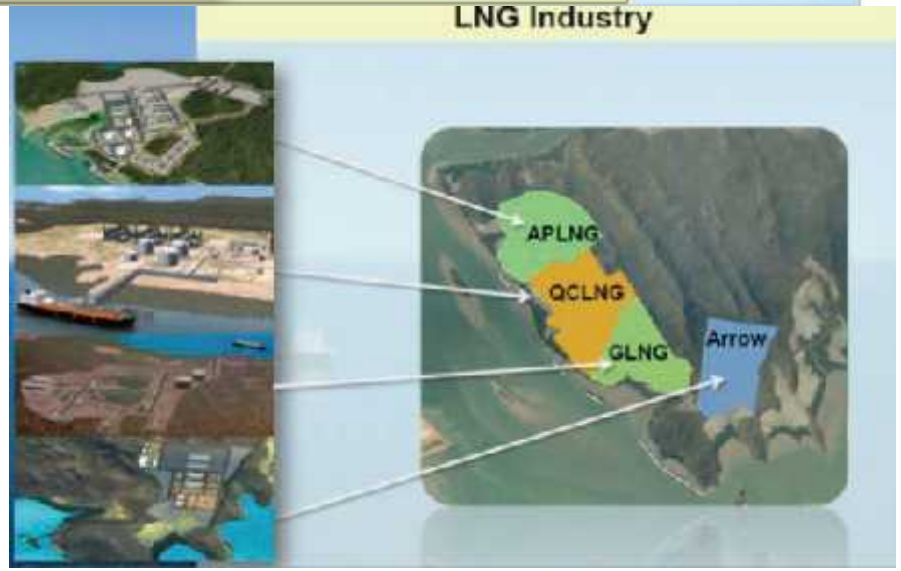
Project	FID	Capacity	
		M. tons	ratio
Gorgon 1-3	2009	15	
Wheatstone	2011	8.9	
Prelude	2011	3.6	
Ichthys	2012	8.4	
offshore W.Australia		35.9	59%
Queensland Curtis LNG	2010	8.5	
Gladstone LNG	2011	7.8	
Australia Pacific LNG-1	2011	4.5	
Australia Pacific LNG-2	2012	4.5	
CBM in QLD		25.3	41%
Total under construction		61.2	100%



Among 7 Australian new LNG projects, 3 are CBM-LNG projects.

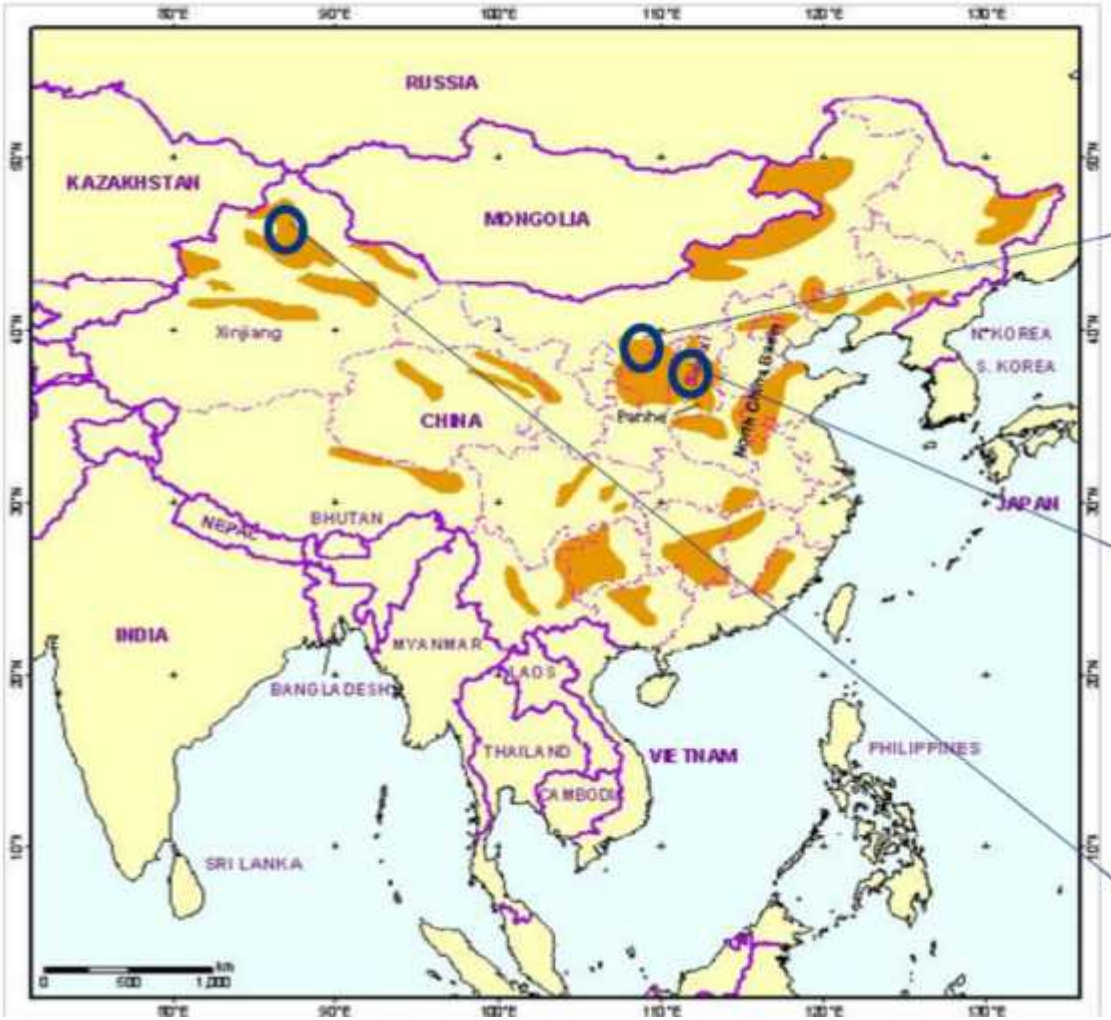
the CBM-LNG's ratio of the total new capacities = 41%

➪CBM has a significant impact on Australian LNG projects.



(Gladstone Port Authority)

China: CBM development



Shaanxi province

Inner Mongolia

Shanxi province

(most advanced)

Xinjiang

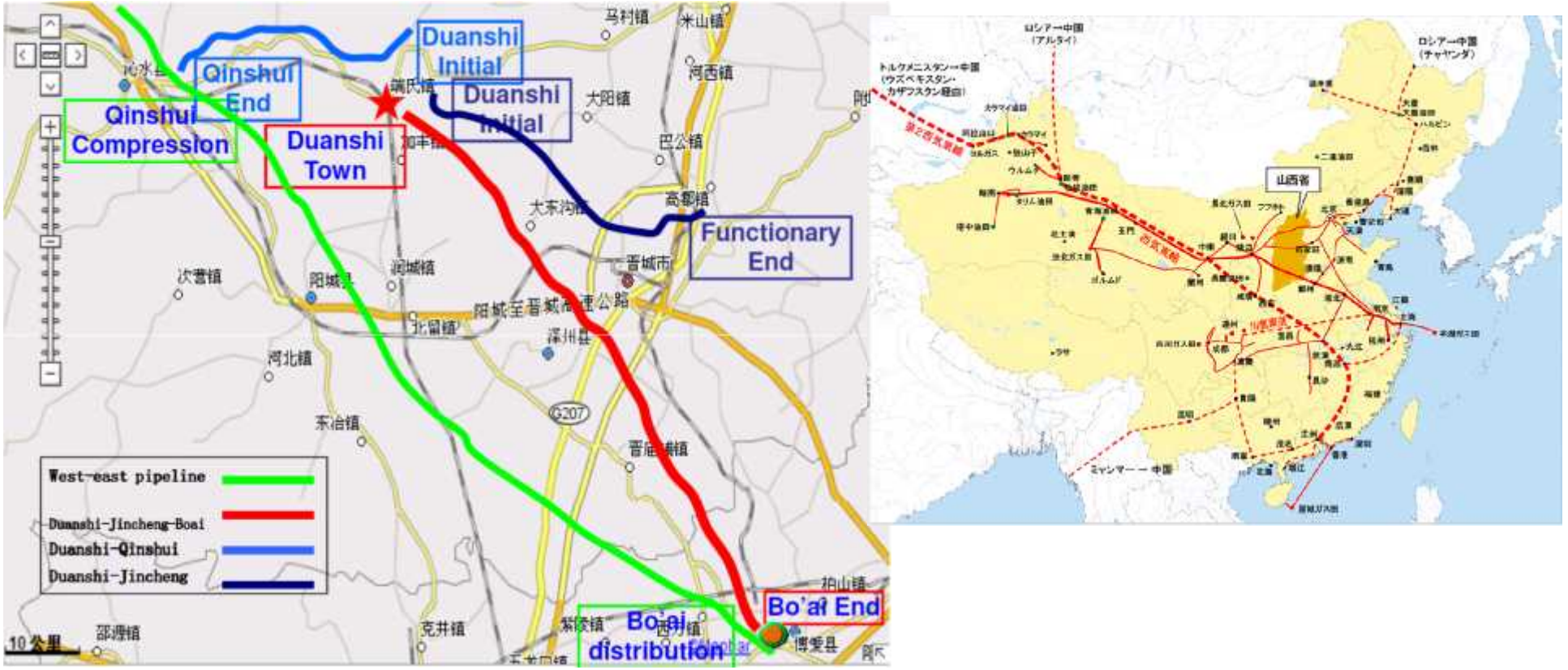
Wood Mackenzie & JOGMEC 2009

There are several small scale production and development of CBM.

Production is far behind the government's target.

Challenges include: lack of connecting pipeline, the rule of 3rd party access to the trunkline, suitable technology

Qinshui Basin, Shanxi province: plan for CBM pipelines



（China United Coalbed Methane Corp Ltd. 2009）

Commercial production in Shanxi province is most advanced, still mainly for regional use, due to lack of connecting pipeline systems.

The first connecting pipeline from the CBM field to West-East main pipeline was completed in September 2009.

Green Dragon completed connecting line from its Shizhuang blockt to West-East pipeline in April 2012.

China: Business models for CBM commercialization

Lack of long-distance transportation

→CBM is mainly consumed locally near CBM fields.

➪ ①power station ②CNG for vehicles ③small-scale LNG

CNG station

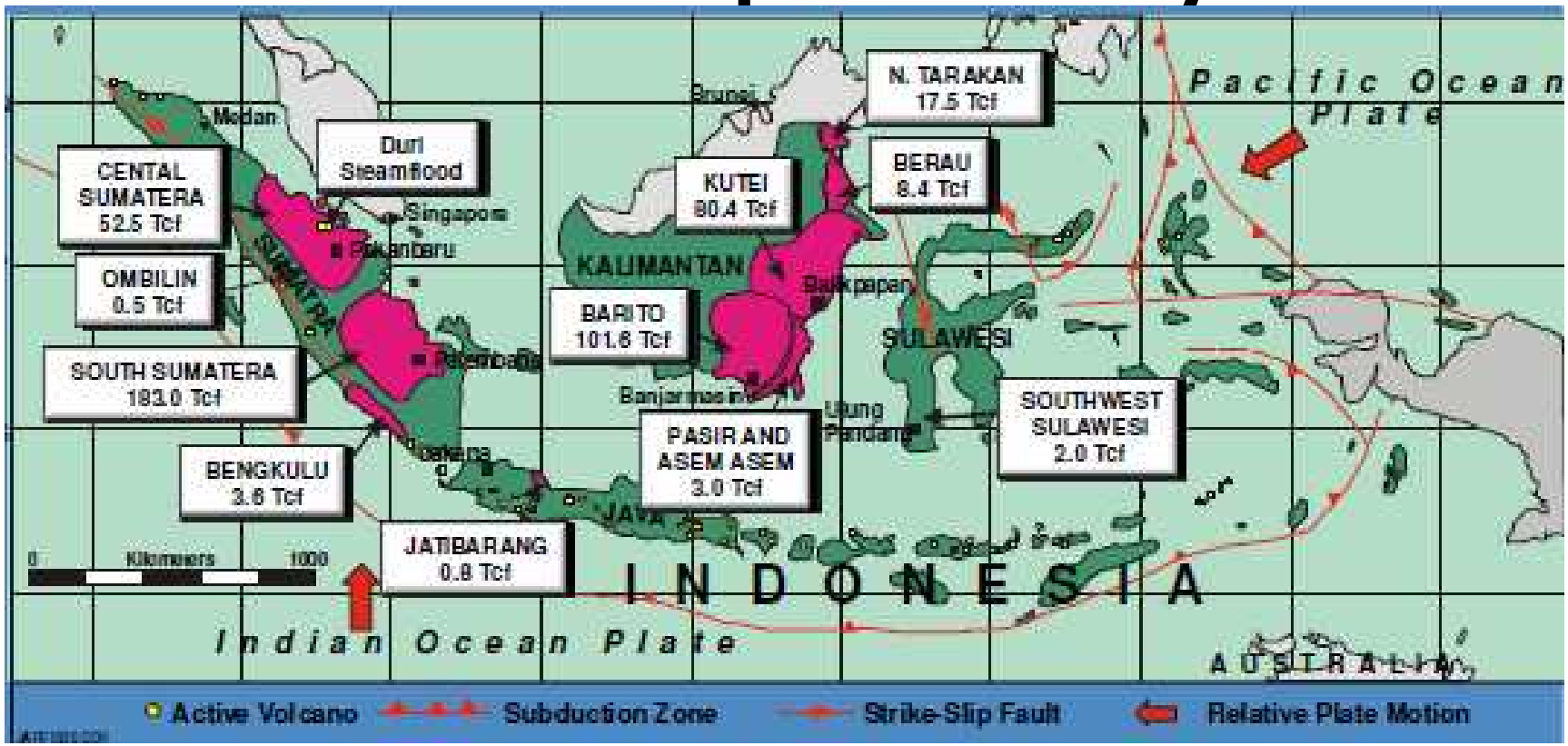
Small LNG plant

（source）China United Coalbed Methane Corp Ltd.

China: business model of small-scale LNG

Small-scale LNG plant in Xinjiang by Guanghui
LNG is supplied with industrial users in affluent coastal provinces by tank lorry.
(pictures) JOGMEC

Indonesia: CBM potential by coal basin



（source）LEMIGAS

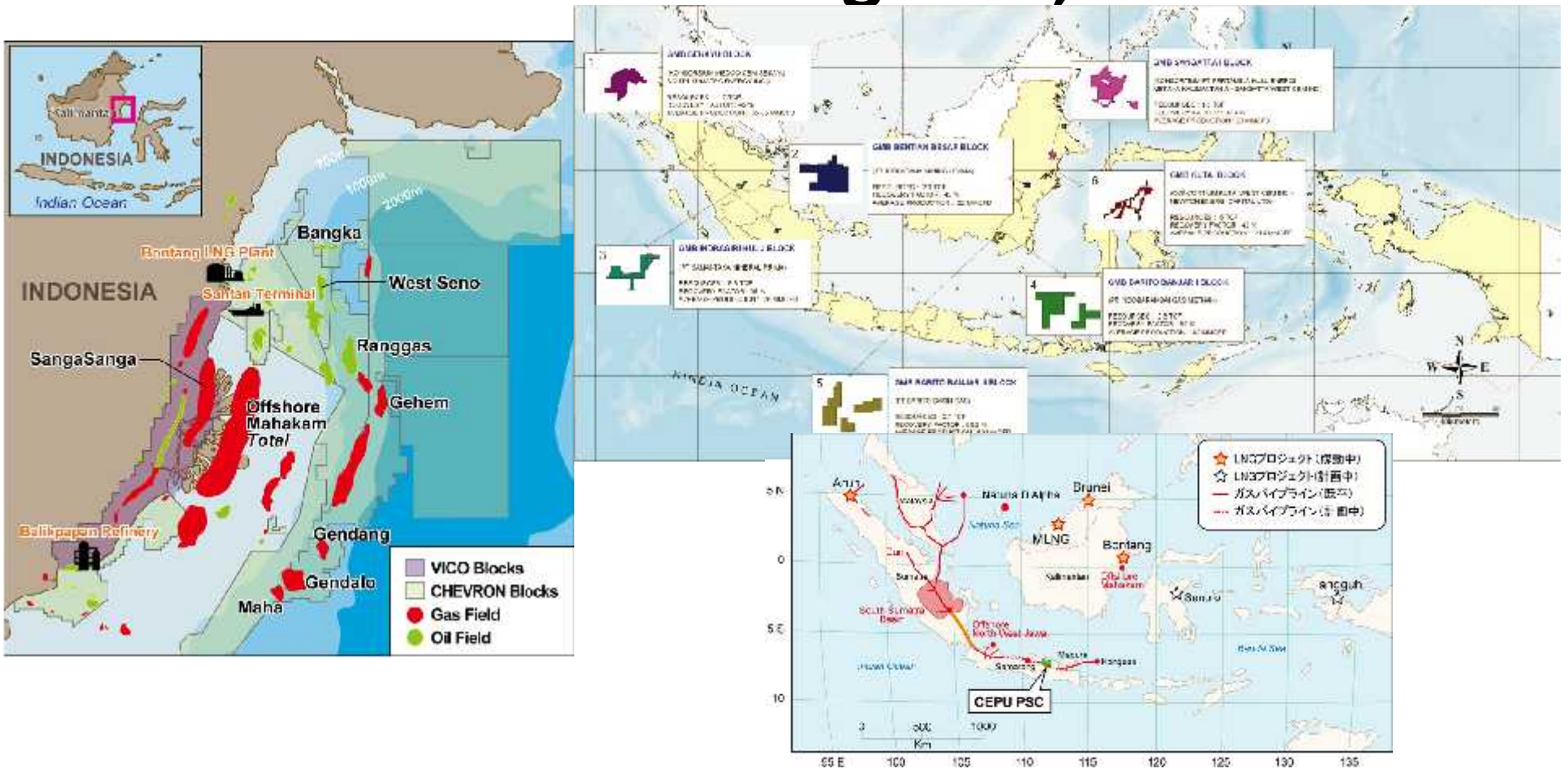
CBM potential=453 tcf (Government)

Basins with high potential :

Sumatra ; South Sumatra, Central Sumatra

Kalimantan ; Kutei (close to Bontan LNG), Barito

Indonesia:Bontang LNG,CBM fields



Major gas markets are focused in Java island, and LNG plant (Bontang).

・VICO and Ephindo blocks near Bontang LNG in Kalimantan have some advantage in commercial production.

・Connecting pipeline system to main pipeline is not enough in South Sumatra.

⇒CBM production is mainly for local use.

India: CBM production in West Bengal

・Coal is produced in Eastern States:

West Bengal, Bihar, Orissa

・Transportation system of Coal by rail is not well developed.

Commercial production of CBM is in Damodar Valley in West Bengal by GEEC since 2007. CBM is used for local industries and CNG vehicles.
Since coal in India contains a lot ash, it is not preferred for CBM production.
Challenges: lack of pipeline from producing areas to main markets (West coast)