Rising Costs, Complex Challenges, and No Silver Bullets: Why Technology and Better Analysis Matter More than Ever for the Utilities Industry

Mike Thomas
mthomas@lantaugroup.com

THE LANTAU GROUP
strategy & economic consulting

Observation

- Asia faces **unprecedented** energy cost **challenges** due to **high cost** of natural **gas**
- Compounded by growing **environmental concerns**
- Exacerbated by **overly simplistic** regulation and policy
- Complicated by **insufficient use of analysis** to highlight the key issues and risks
- And constrained by **limited human resources** in critical areas

Too many decisions reflect poor information, limited state awareness, or excessive simplicity

The challenge

Albert Cheng says the government and legislators should have opposed CLP's bid to raise charges as inflation is hitting reside

U.S. Electric Power Industry Reputation Weakens Amid Challenges, Rating Research LLC Studies Show

Taiwan's Severe Energy Security Challenges
By: Huei-Chu Liao and Sih Ti Chou

MALAYSIA
More electricity rate 'shocks' on horizon, ANZ warns

Electricity bills to rise 35% in Thailand
Government blames costly liquefied natural gas for tariff hike.

Passing Lane Etiquette

Build a better bond with customers

Empower with information & choices

Manage large accounts carefully

Proactively identify and meet needs

Make better decisions about fuel and capital

Incentives for better integration

Enhance awareness of cost-effectiveness implications

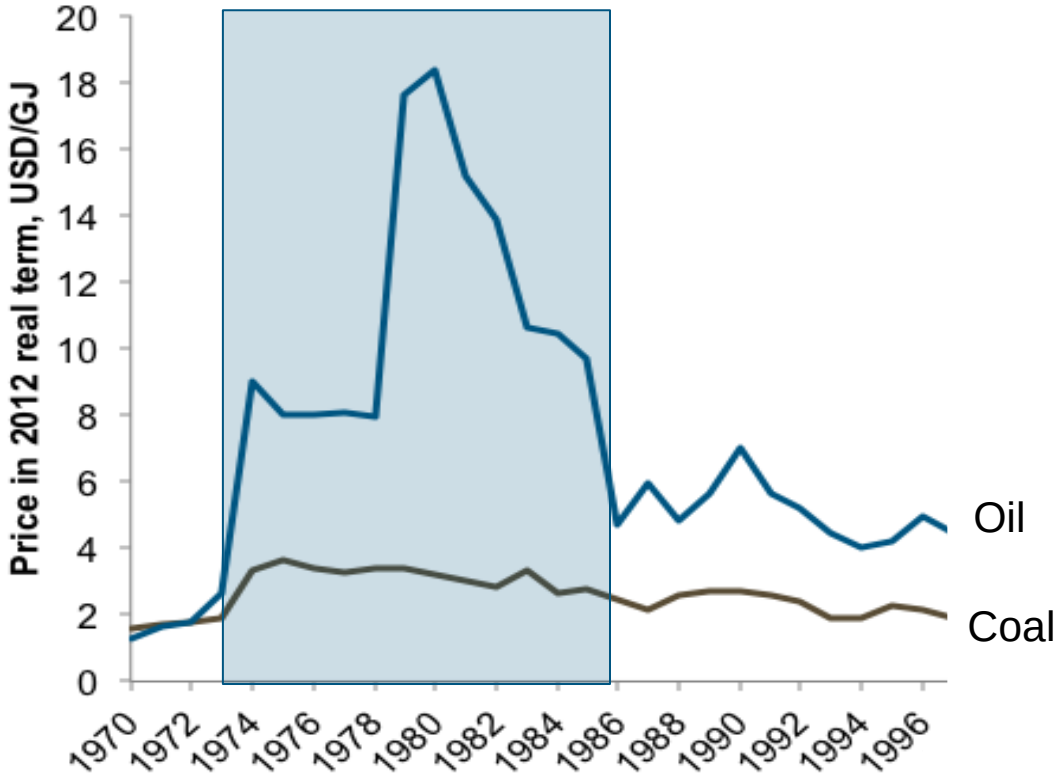
THE BEGINNING

The White Rabbit put on his spectacles. “Where shall I begin, please your Majesty?” he asked.

“Begin at the beginning,” the King said very gravely, “and go on till you come to the end: then stop.”

– Lewis Carroll (*Alice in Wonderland*)

In the 1970s, oil prices shot up, creating a “coal window”

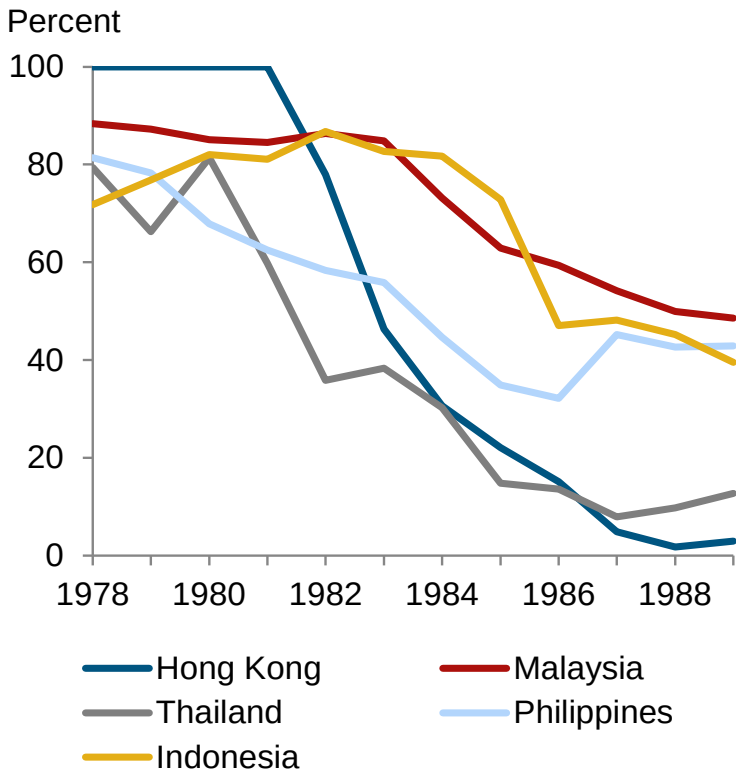


Note: Crude price: 1970 - 1987:Arab Light Crude prices ; 1988 - 2012: Brent price (historical Brent price only starts from May 1987)
Coal price: 1970 - 1982: average coal prices in the US from EIA; 1983 - 2012: Newcastle FOB price

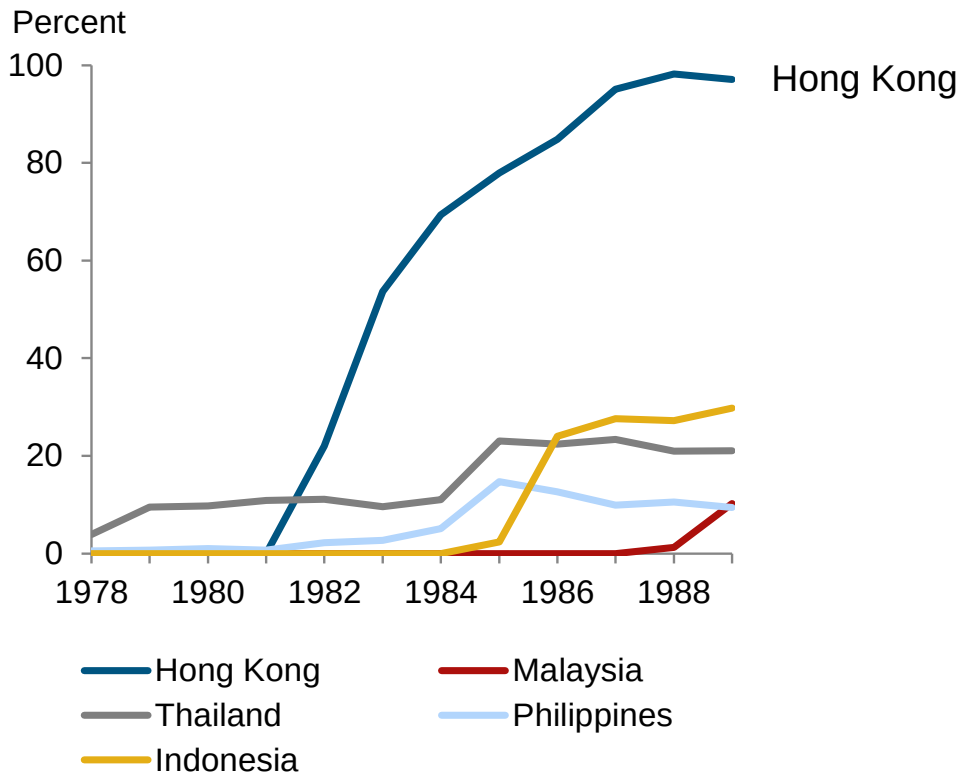
Up to that point, many Asian countries were using oil for power generation

Almost all of Asia shifted away from oil

Almost everyone moved away from oil



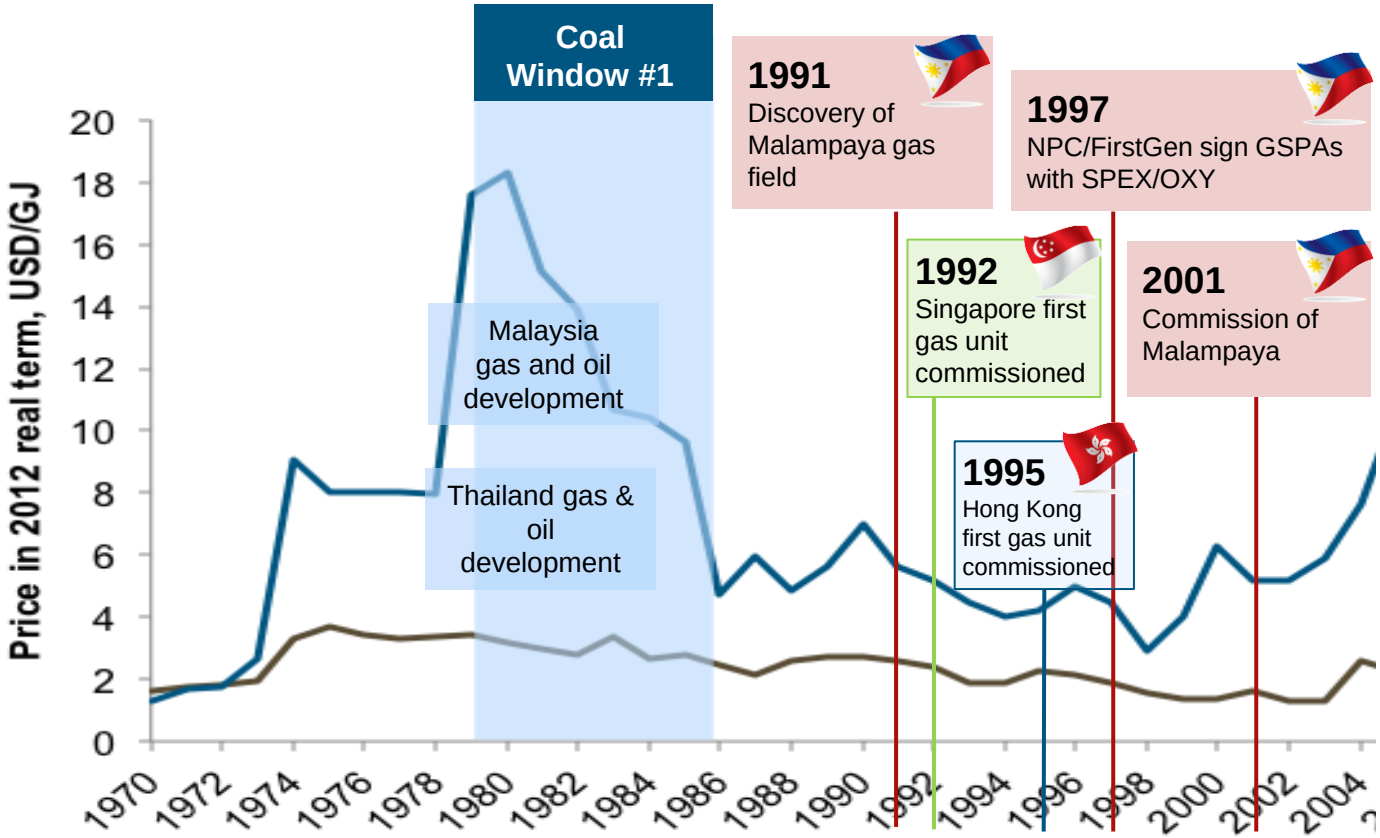
If you had no other choices, you moved quickly towards coal



It was a simple world ➔ from something *expensive* towards something *cheaper*

Source: World Bank

The opening and closing of the coal window was followed by a period of growth in use of natural gas



Note: Crude price: 1970 - 1987:Arab Light Crude prices ; 1988 - 2012: Brent price (historical Brent price only starts from May 1987)
Coal price: 1970 - 1982: average coal prices in the US from EIA; 1983 - 2012: Newcastle FOB price

Decisions are easy when the same choice gives you: “green”, “cheaper”, and “local”

Keep up with growth

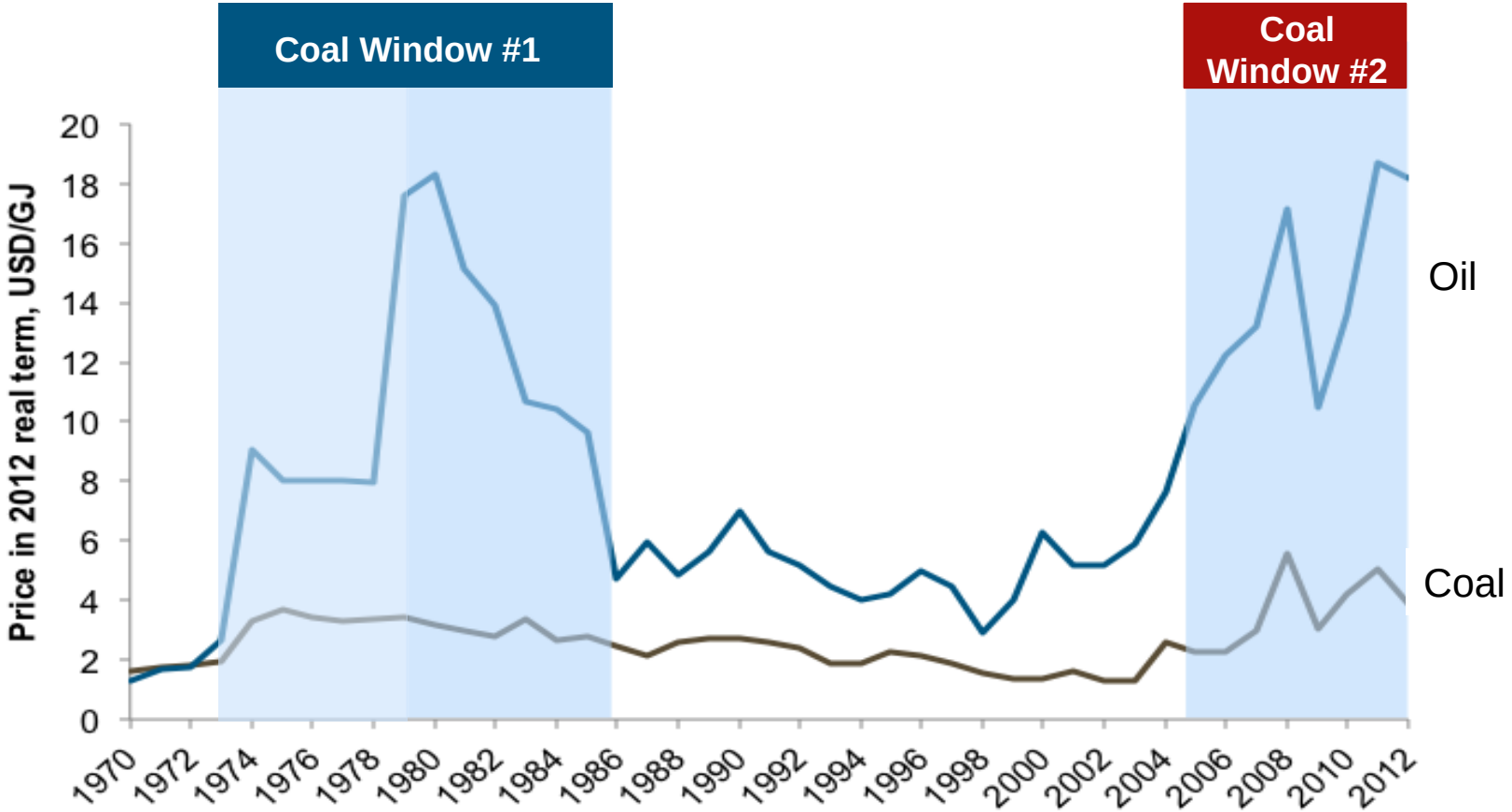
Respond to fuel availability and cost

Up to then….life was pretty straightforward….

Core generation technologies

Few complicating issues

Around 2005, a second Asian coal window opened and continues to this day

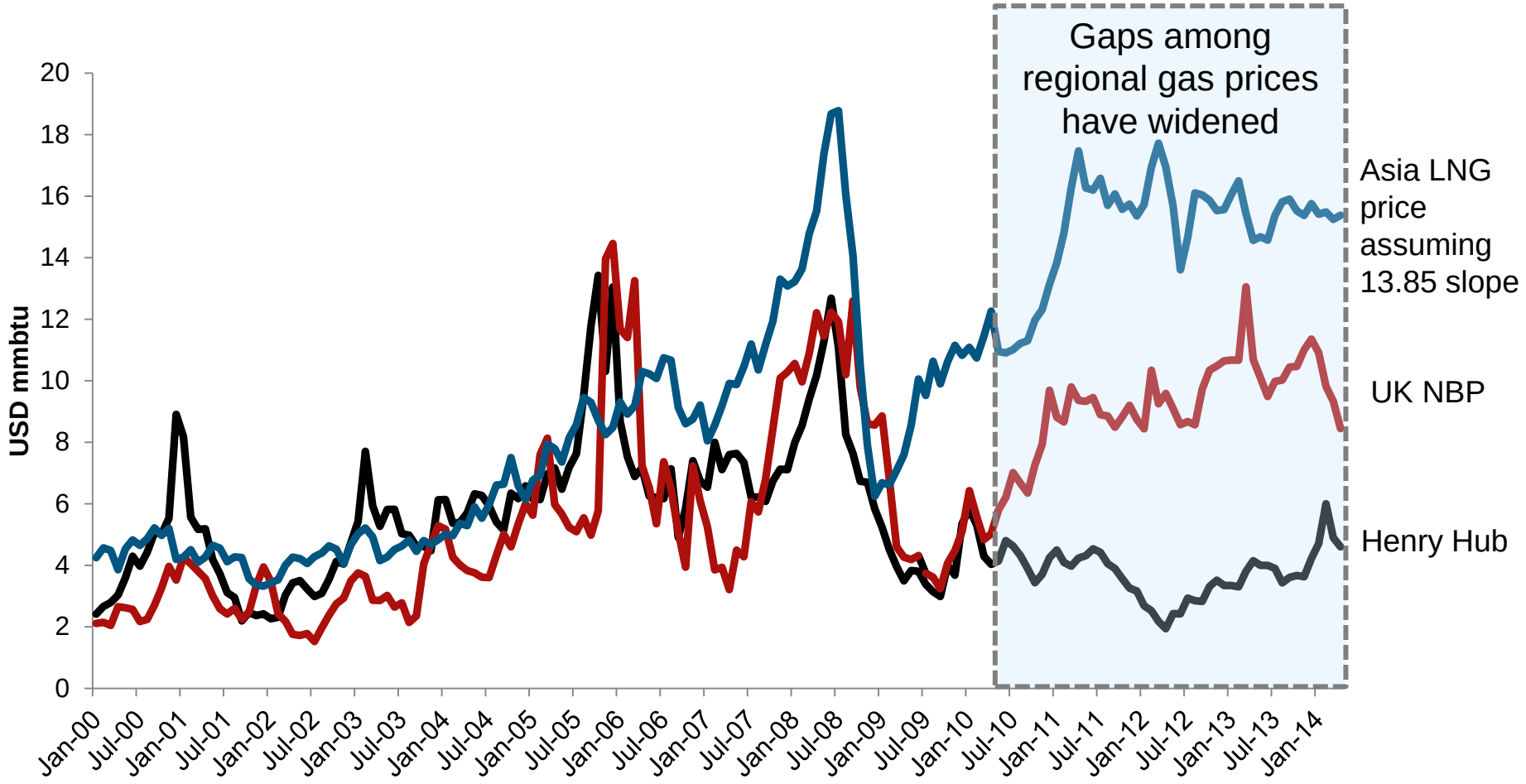


Note: Crude price: 1970 - 1987:Arab Light Crude prices ; 1988 - 2012: Brent price (historical Brent price only starts from May 1987)
Coal price: 1970 - 1982: average coal prices in the US from EIA; 1983 - 2012: Newcastle FOB price

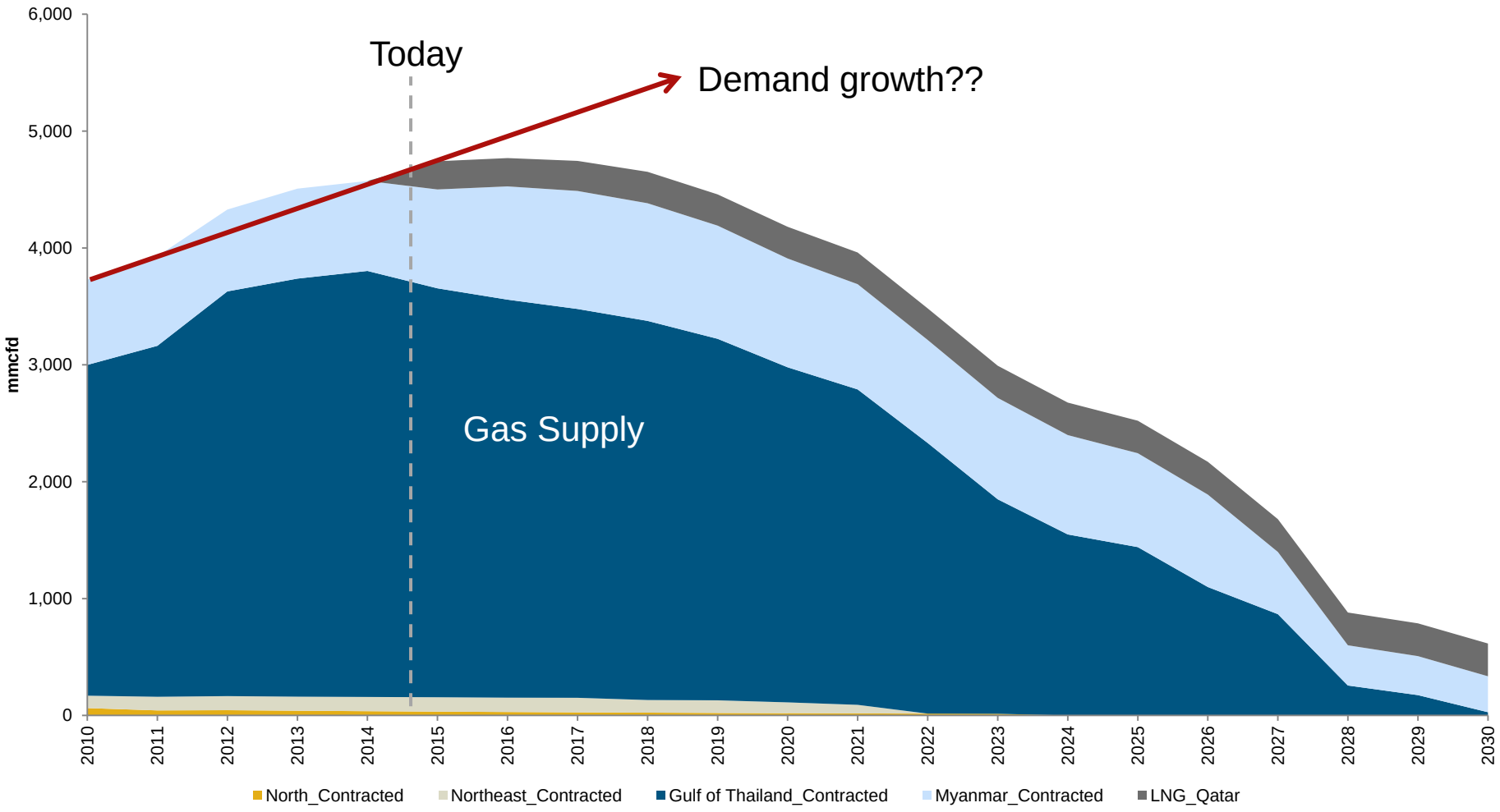
And so here we are….much of that gas is linked to the price of oil

Gas: Asia's Confounding Challenge

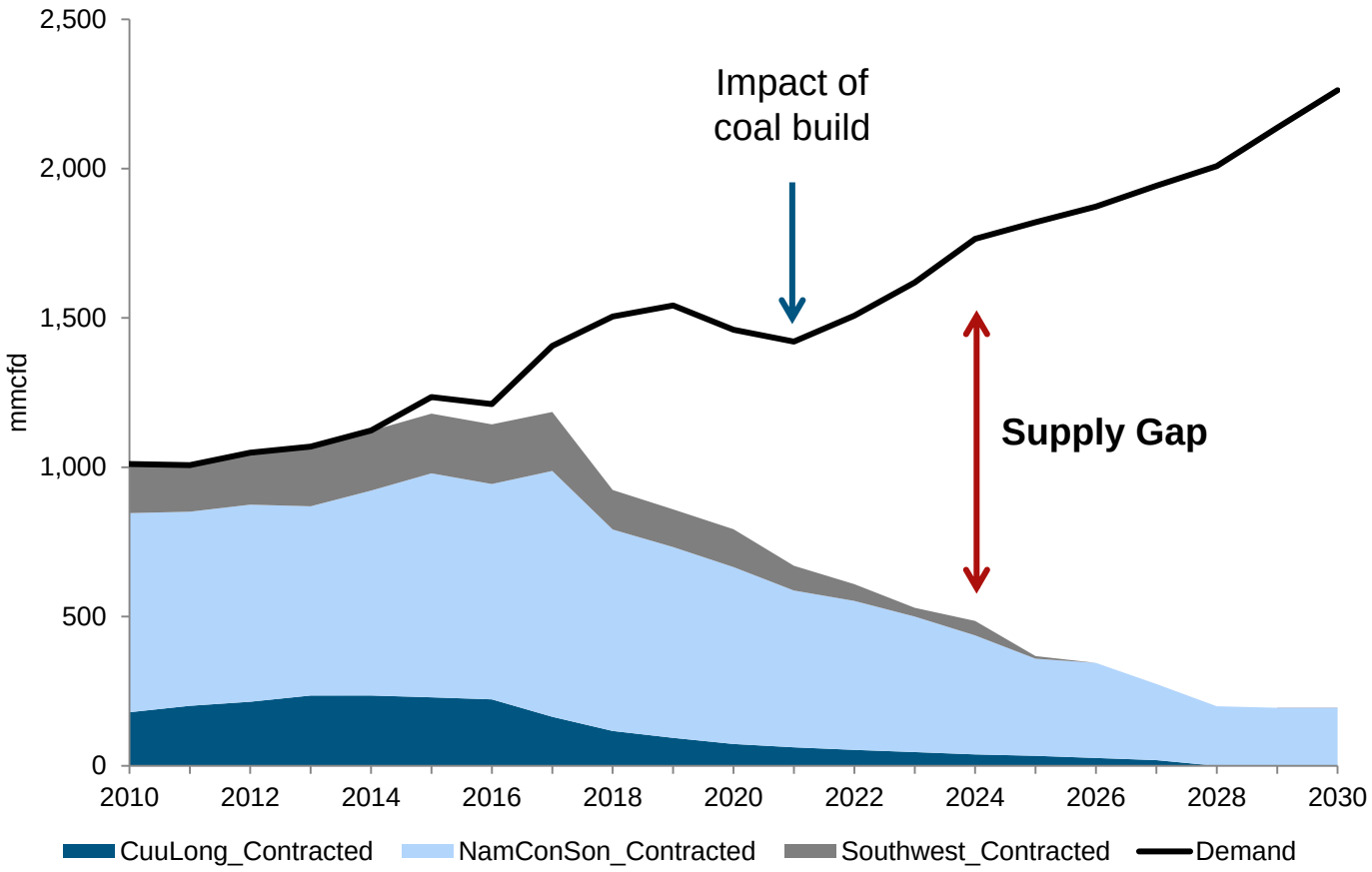
Asia's higher gas prices are a significant, differentiating, challenge



Thailand's emerging gas supply "gap"

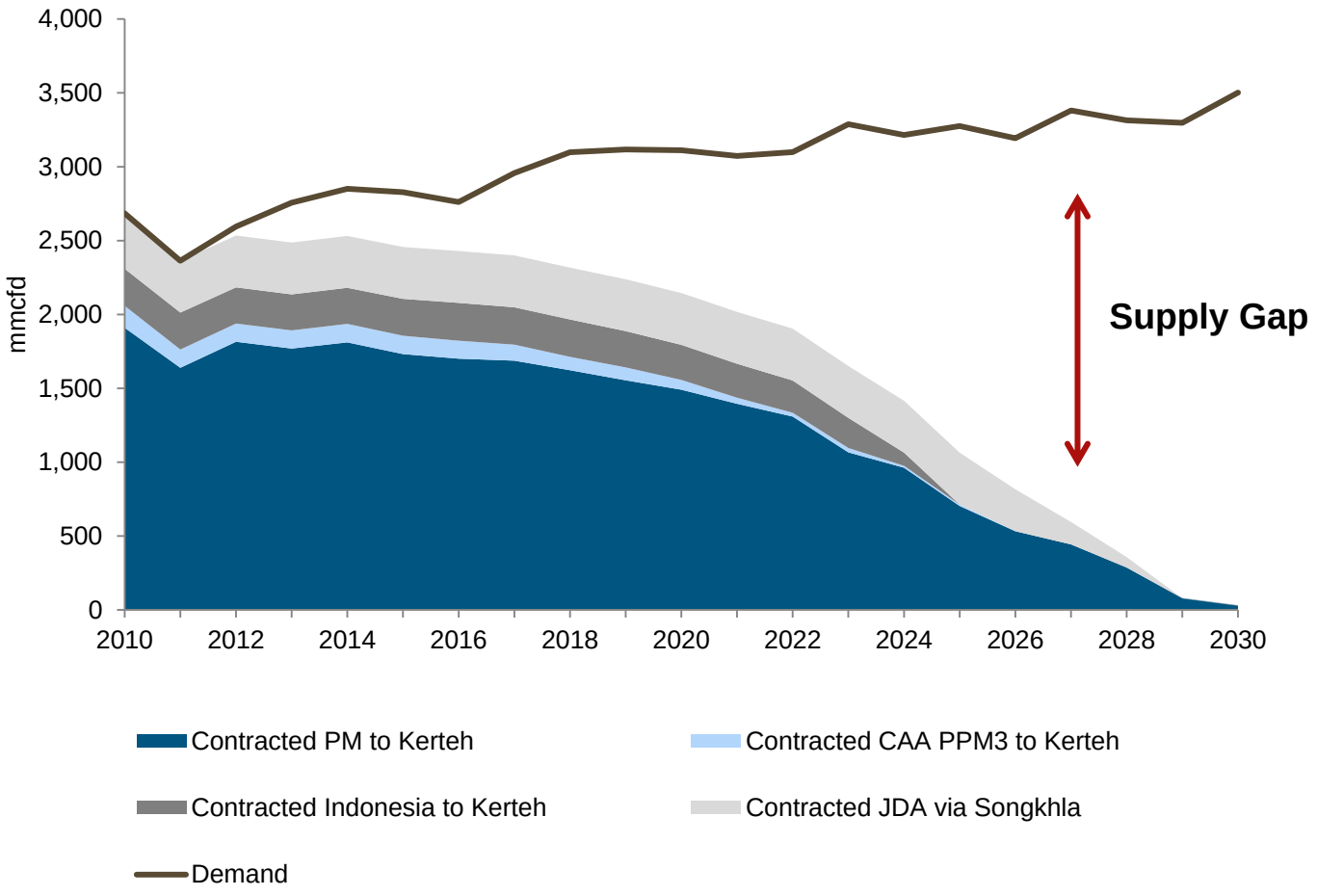


Vietnam's emerging gas supply gap



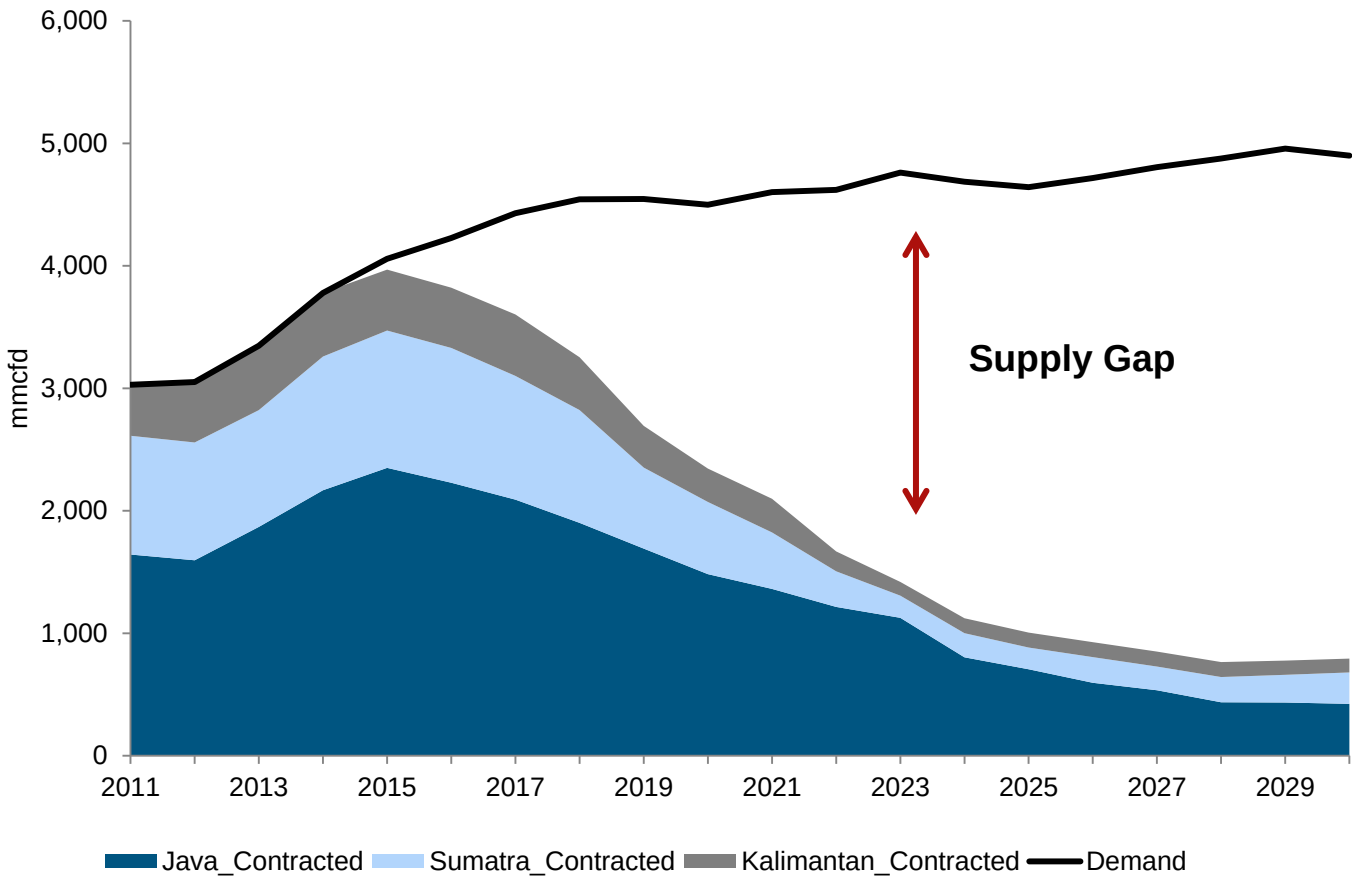
Source: TLG forecasts

Peninsular Malaysia's emerging gas supply gap



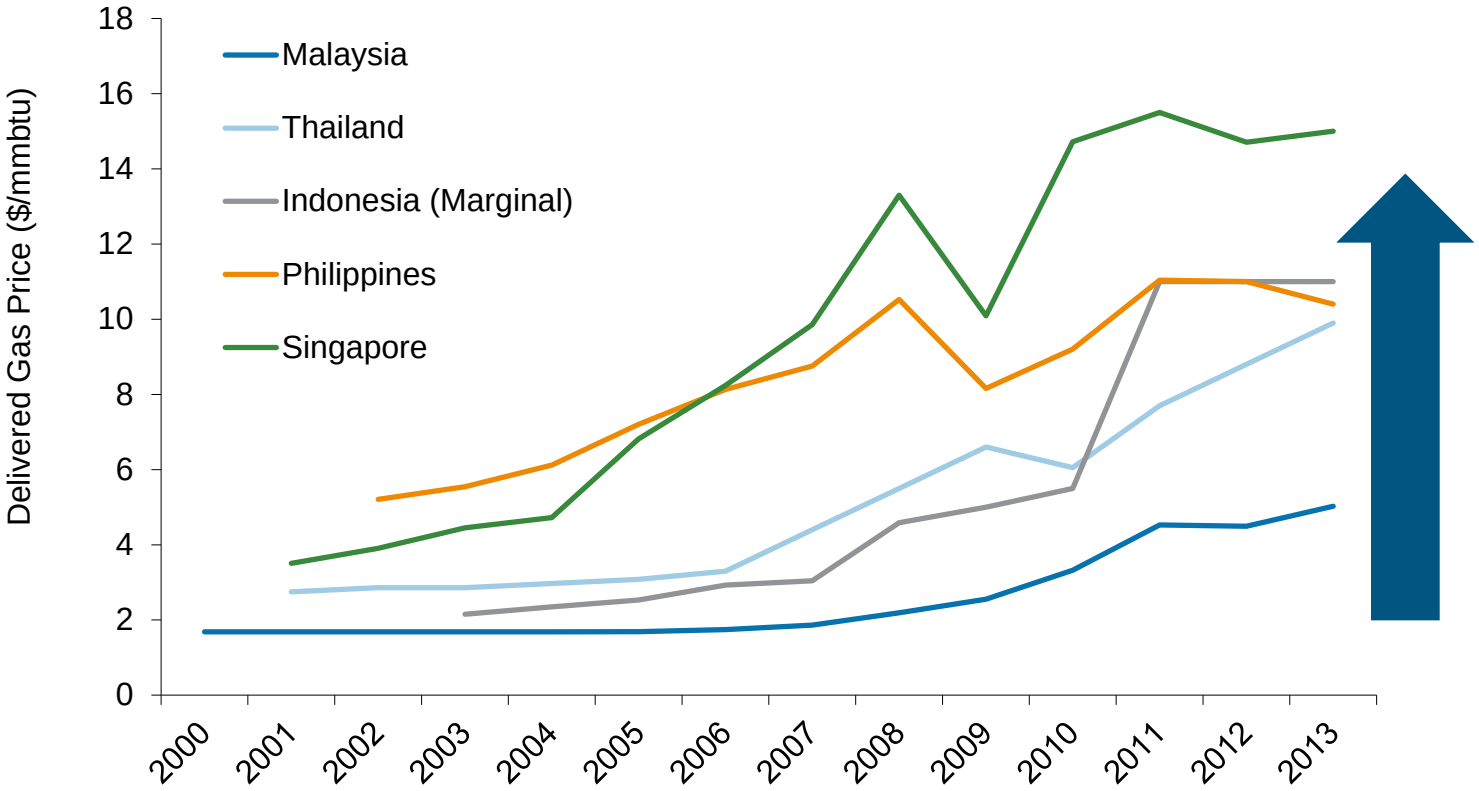
Source: TLG forecasts

Indonesia's emerging gas supply gap



Source: TLG estimates

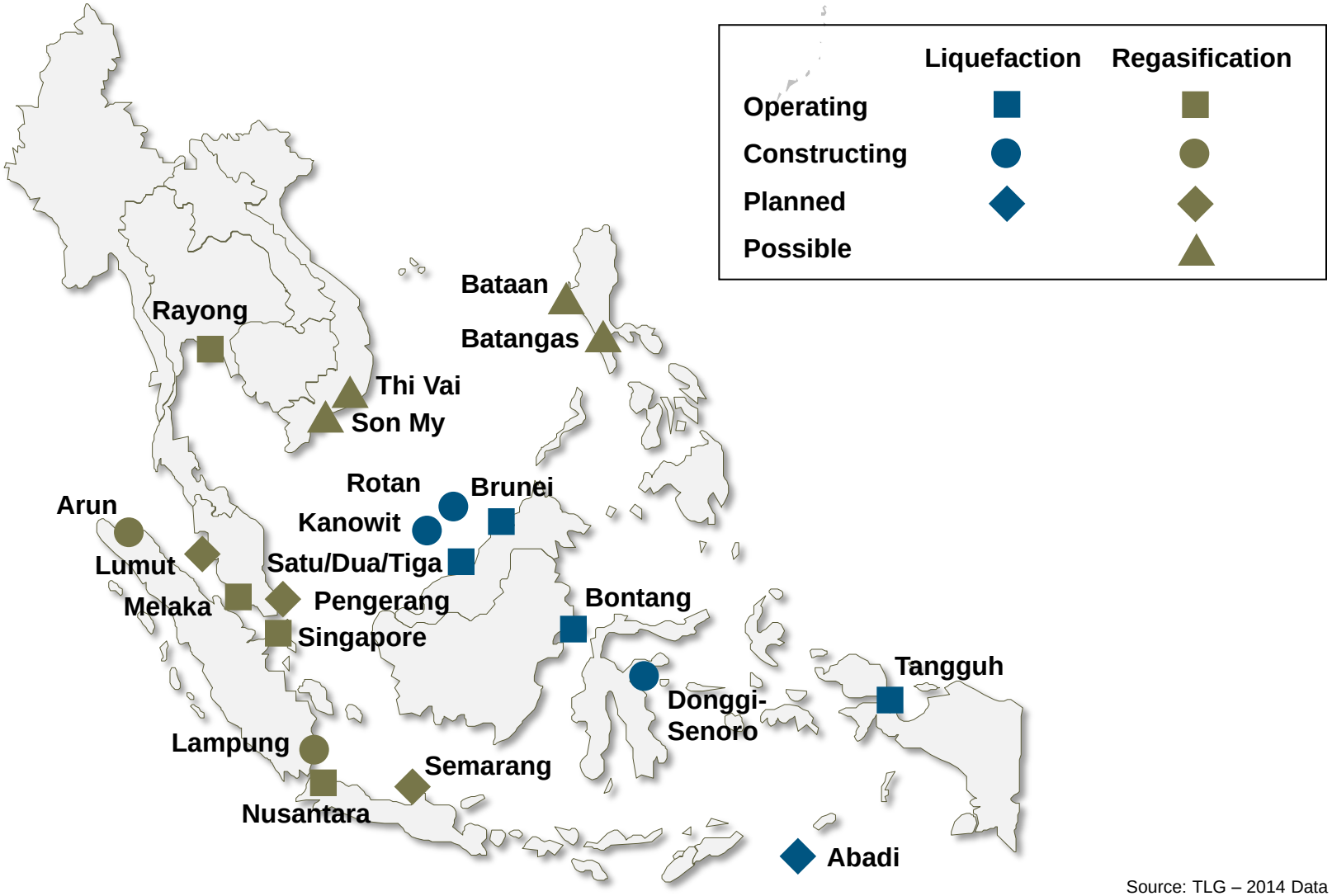
The gap puts upward pressure on the pricing of new domestic resources….



Note: Indonesia marginal jumps in 2011 due to domestic LNG at Nusantara Regas

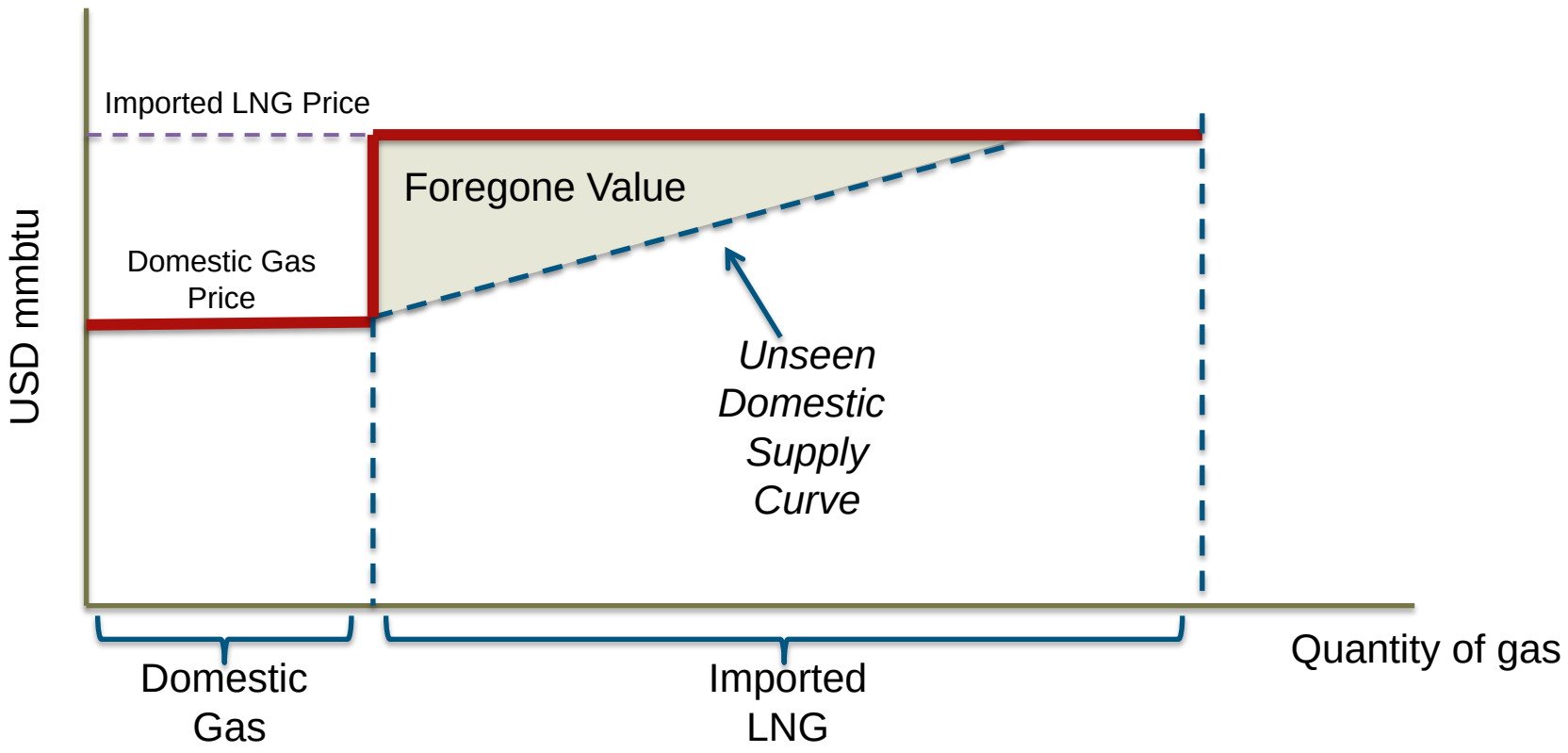
Source: TLG compilation from various online sources and associated analysis, mostly ex platform prices before transmission

And leads to many decisions to import or export LNG….



Source: TLG – 2014 Data
www.globalnginfo.com

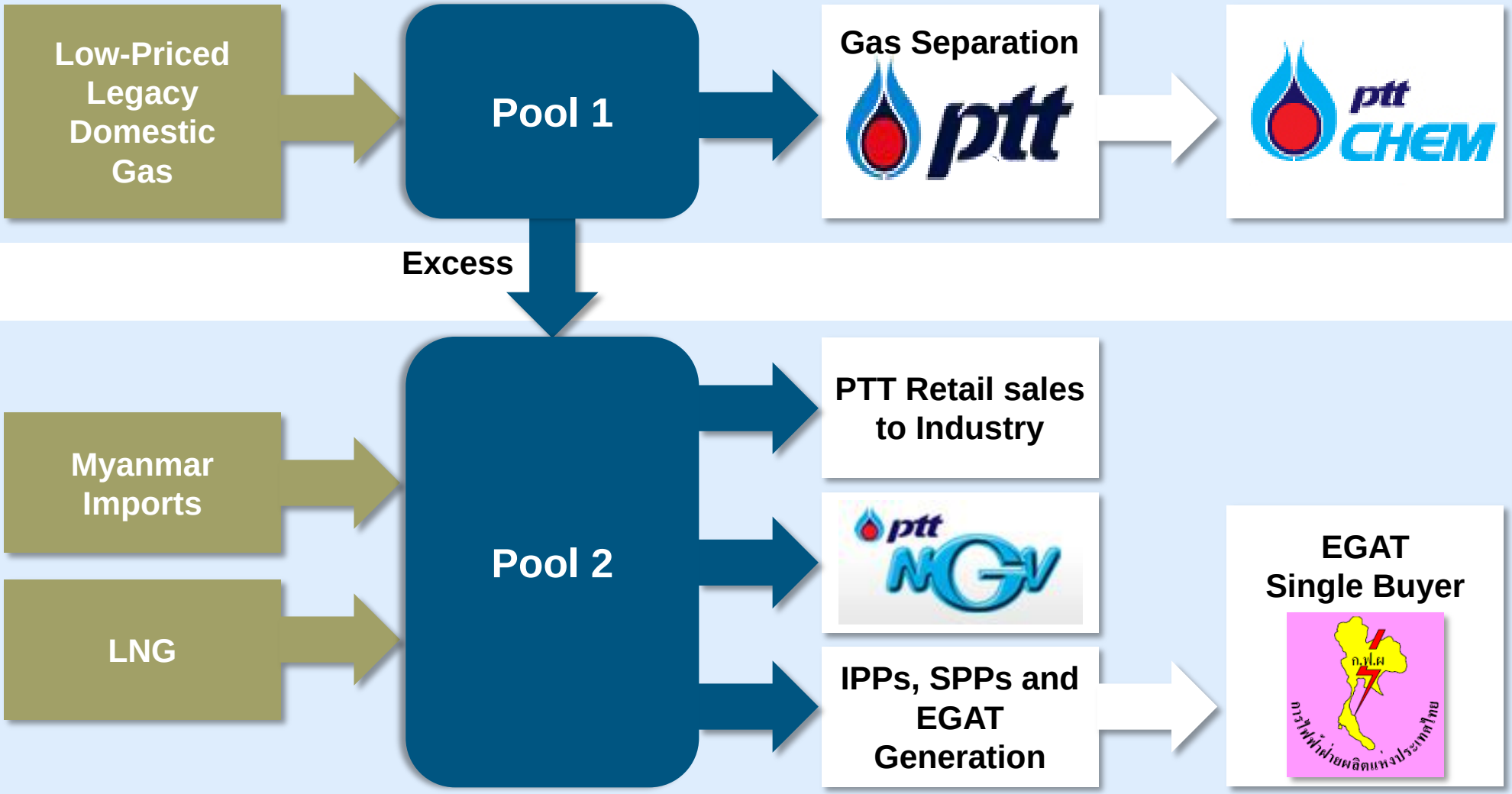
Imported LNG usually comes in at the "market price", and local (domestic gas) is priced differently – leading to a kinked gas supply curve



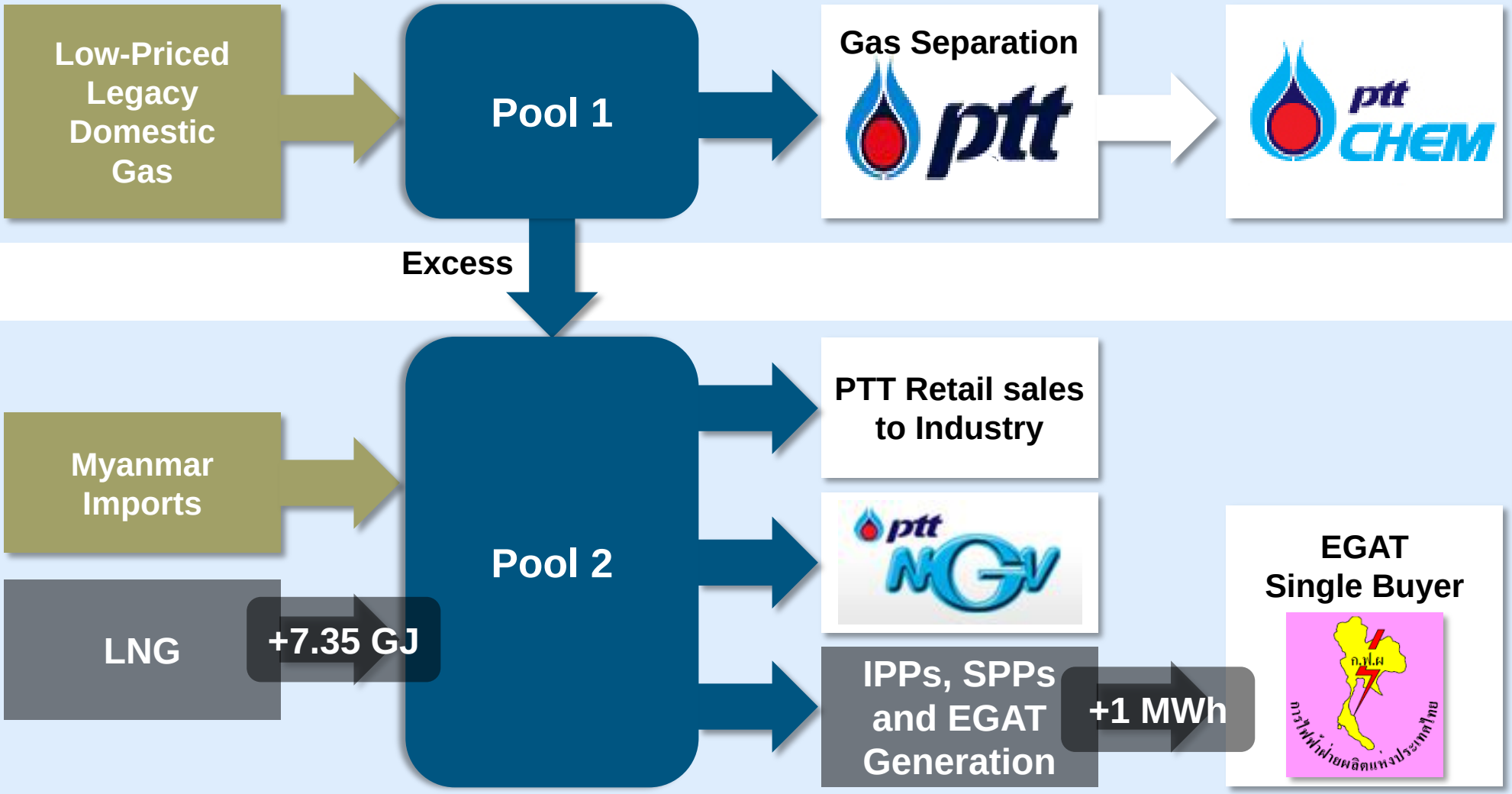
Domestic gas price regulation creates artificial shortage of domestic gas, but also creates the illusion that domestic gas is cheaper…

Poor information leads to poor decisions….

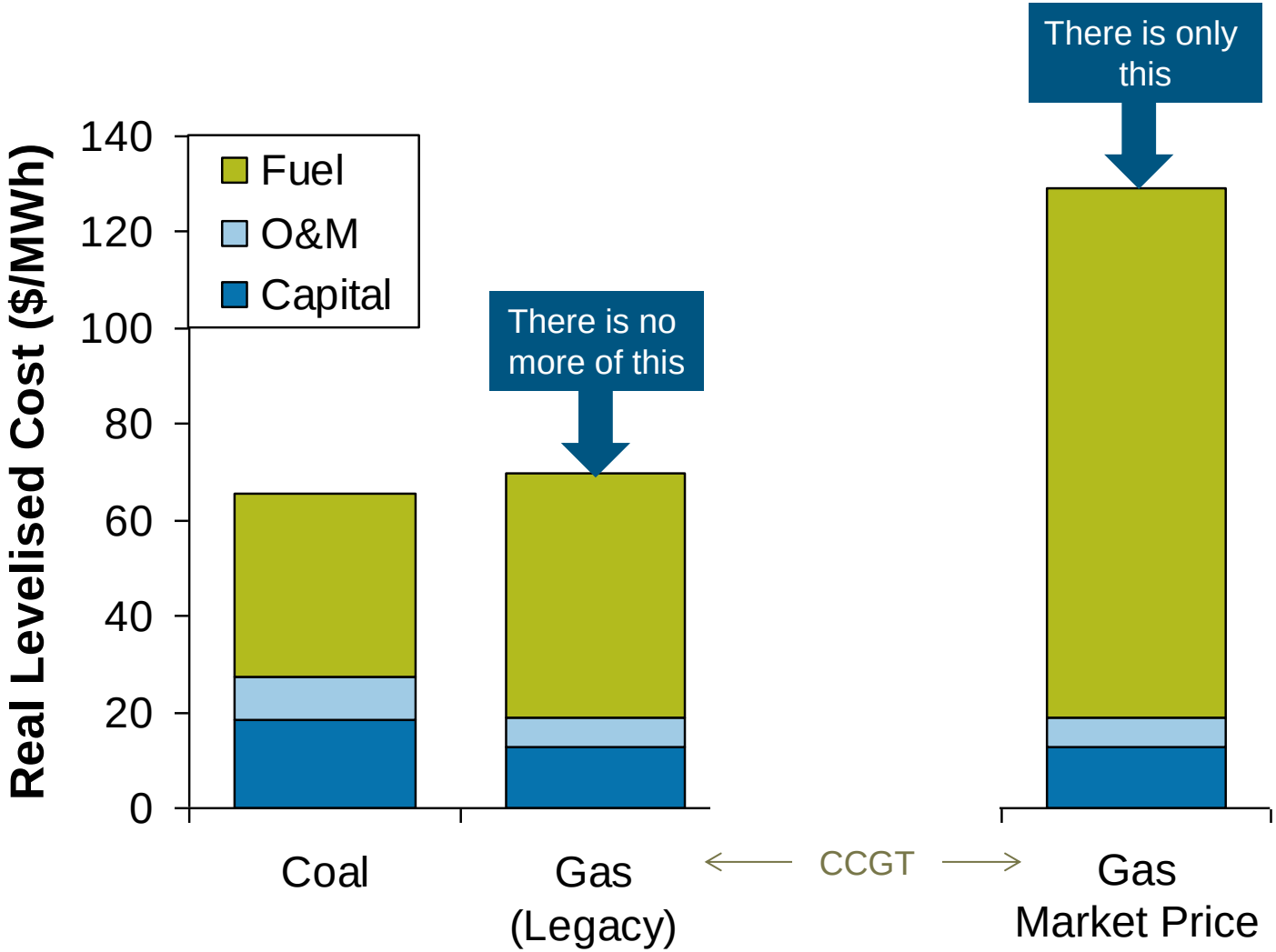
Gas “pooling” mitigates impact of LNG prices – Thailand example



Gas “pooling” mitigates impact of LNG prices – Thailand example



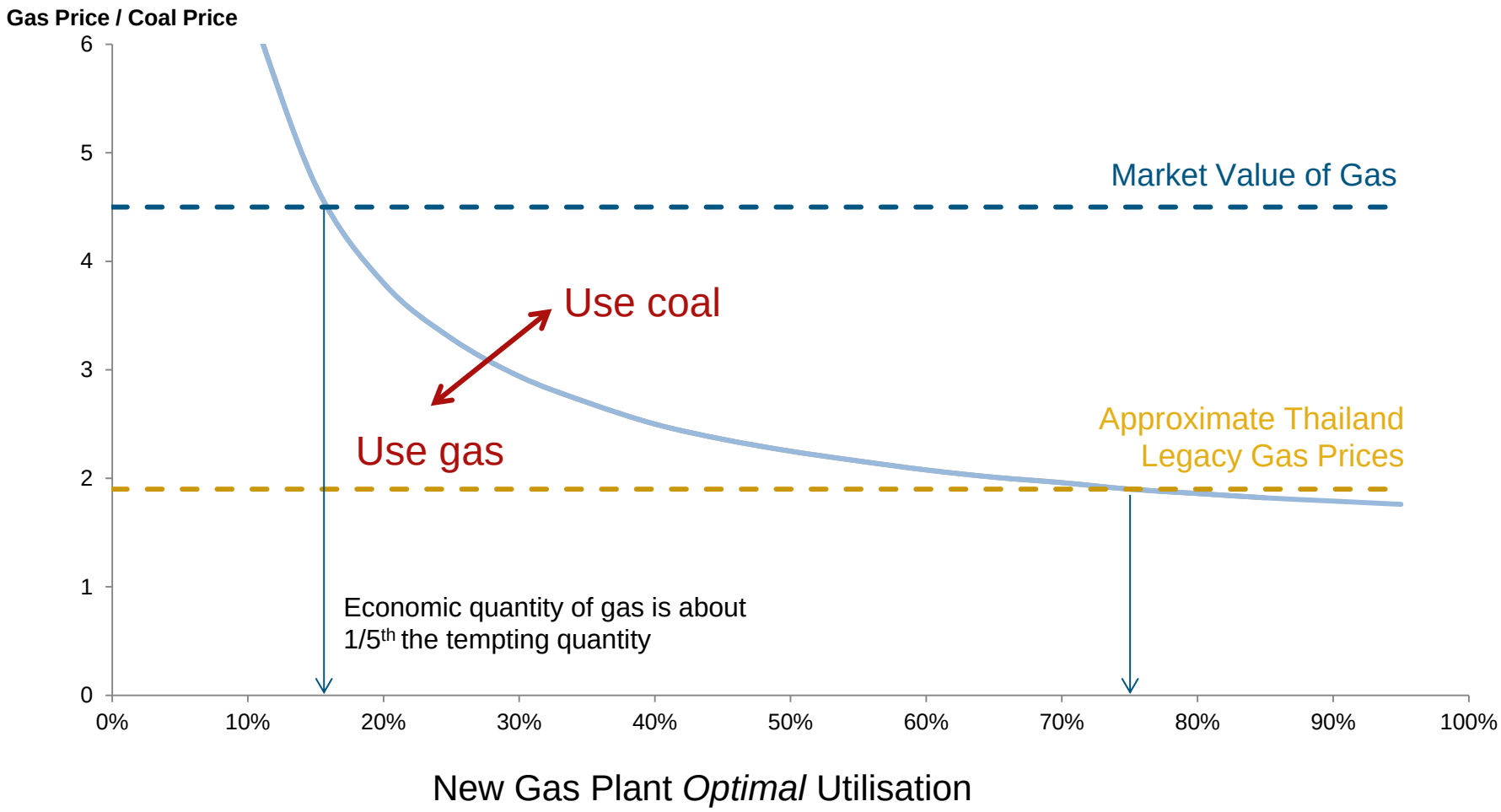
Planning, investment, policy, and operations all need to get the marginal economics right, or risk expensive bad decisions….



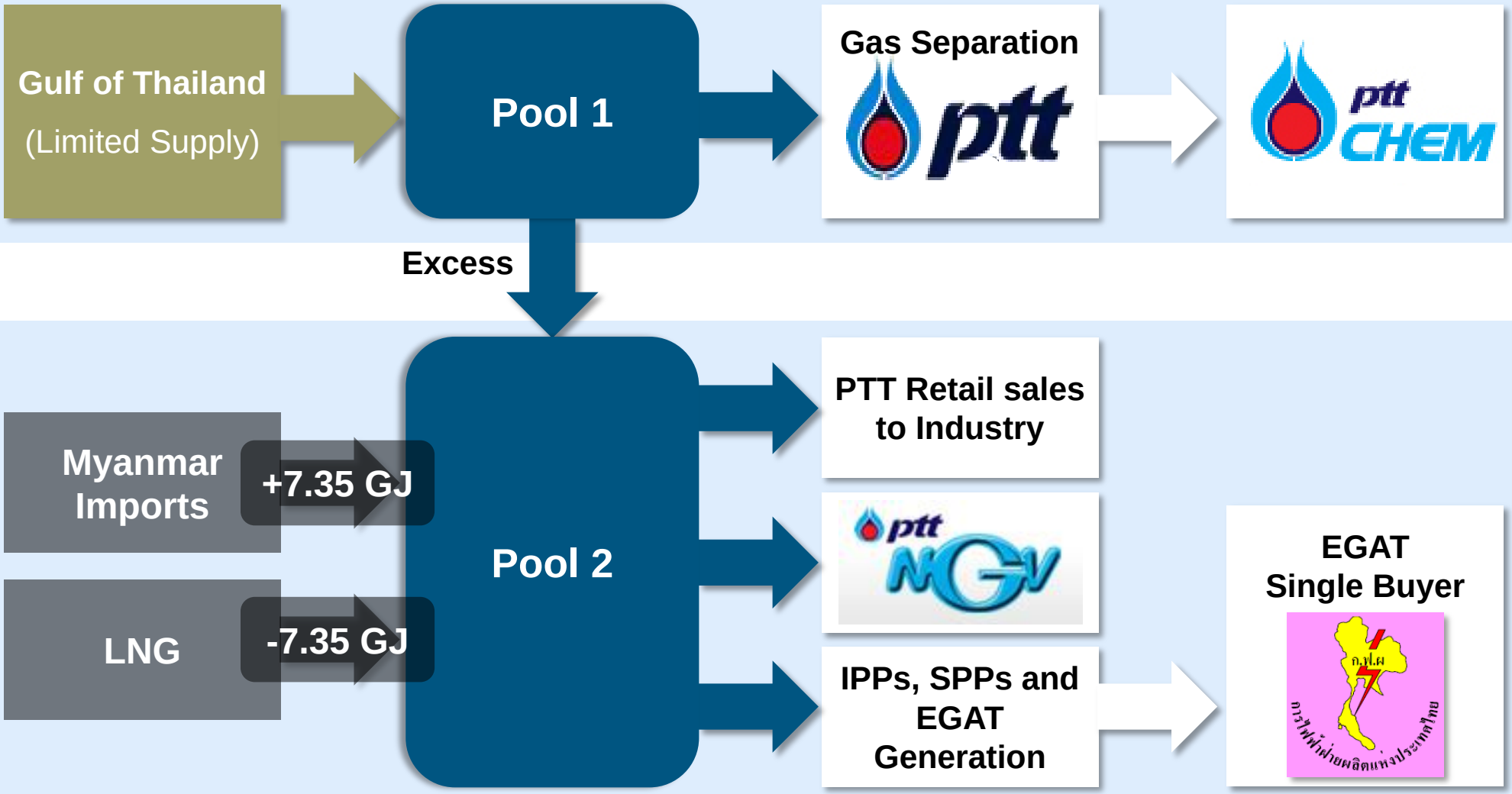
Source: TLG analysis

Using valuable gas wisely

The Terrible No Good Very Bad Economics of Gas for Baseload Power in Asia

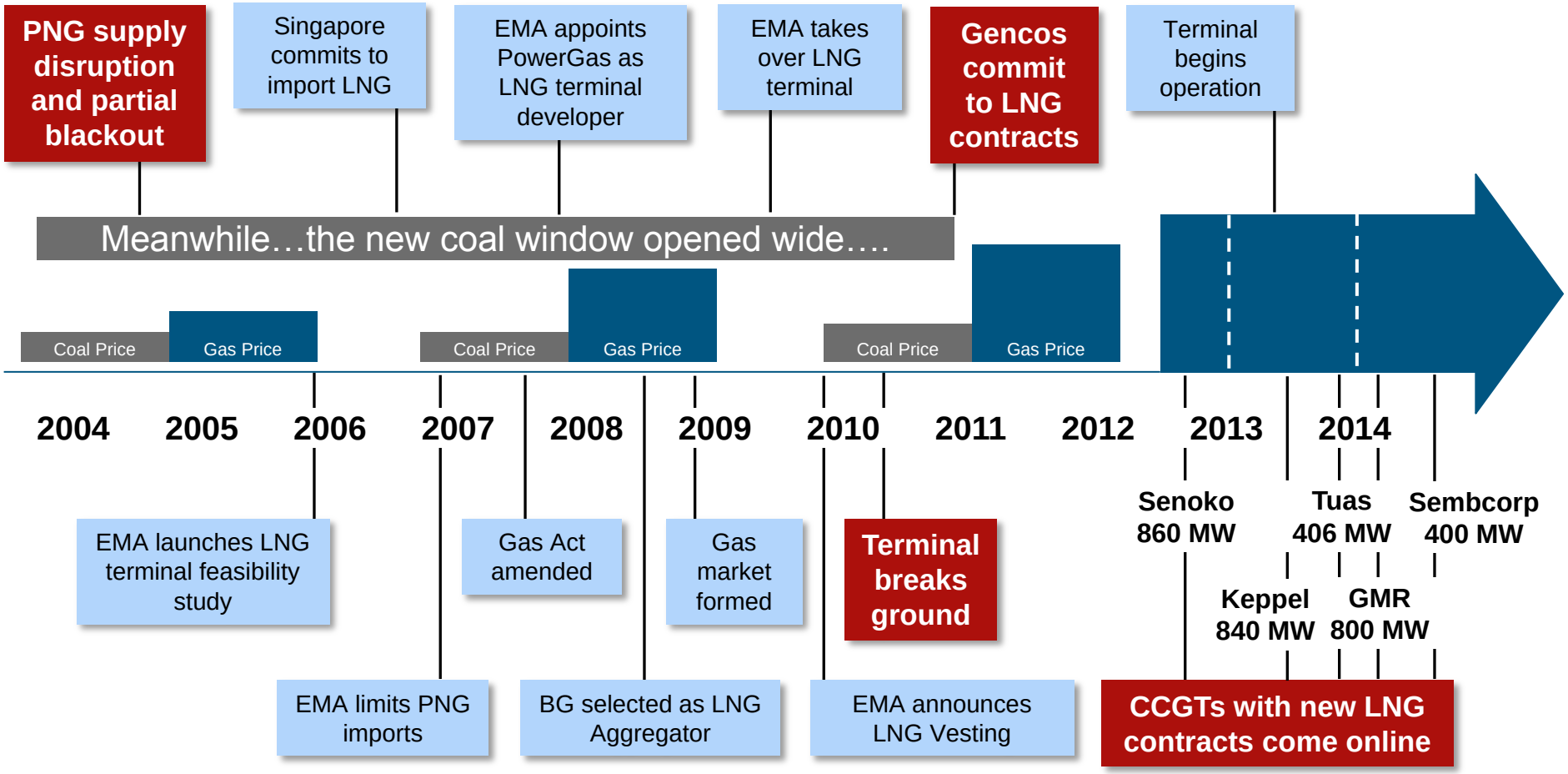


Understanding marginal value enhances value of local resources when sold….



Better Understanding of Fuel Markets and Marginal Economics → Better Infrastructure Decisions

Development of Singapore's LNG terminal ignored the latest coal window



Singapore focused on LNG as a solution to energy security – paying a premium

Singapore's LNG terminal feasibility study included a cost-benefit analysis that was immediately out of date and never revised as things changed further

Levelized electricity generation costs ($/MWh), from "Integrated Summary Report for Proposed Singapore LNG Termina" report in August 2006

	Oil Price US$25/bbl	Oil Price US$30/bbl	Oil Price US$40/bbl
LNG – Low ^	84.59	87.68	93.86
LNG – Base ^	87.99	91.82	99.48
LNG – High ^	91.39	95.96	105.11
Coal – US$35/ton	85.55	85.55	85.55
Coal – US$45/ton	89.82	89.82	89.82
Coal – US$55/ton	97.54	97.54	97.54
Coal – US$65/ton	103.53	103.53	103.53
IGCC – US$35/ton	103.36	103.36	103.36
IGCC – US$45/ton	108.80	108.80	108.80
IGCC – US$55/ton	114.24	114.24	114.24
IGCC – US$65/ton	119.68	119.68	119.68
PNG #	79.24	90.23	112.21
Orimulsion	56.26	64.52	81.04
Fuel Oil	97.97	111.74	139.27
CNG-LNG Formula	86.30	90.13	97.80
CNG-PNG Formula	84.28	95.27	117.26

- The average Brent price in 2005 was US$54/barrel—already over 20 percent higher than the *high* oil price case in the feasibility study released in 2006.
- Crude prices continued to increase, reaching more than US$100/barrel in 2008, but the LNG economics are not re-visited.

If an investment is exposed to market dynamics, then the analysis needs to reflect risk in more insightful ways

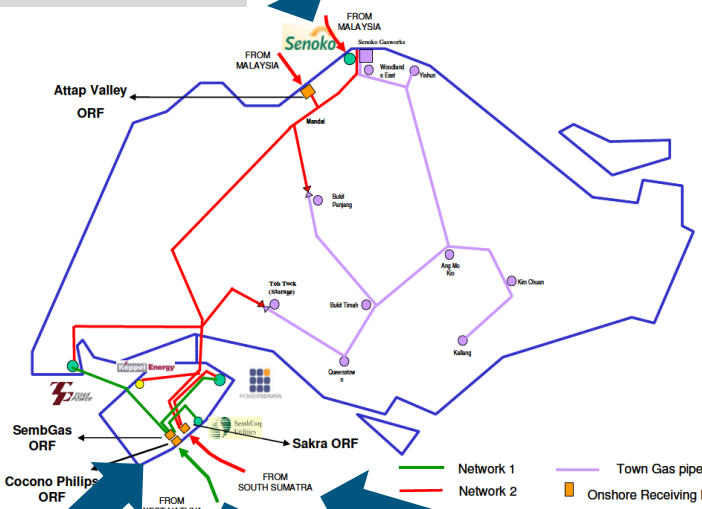
Source: EMA website (Integrated Summary Report for Proposed Singapore LNG Terminal, August 2006)

Of course, the LNG terminal *does* provide Singapore with flexibility and enhanced energy security?

- Enables *access* global natural gas markets for purchasing and trading spot LNG cargos
- Supplements access to piped natural gas from pipelines from Malaysia and Indonesia
- Provides support for dealing with gas supply disruption
- Enhances Singapore's negotiating position for other sources of gas or fuels
- It opens the possibility for Singapore to become a gas trading hub

14 TWh (28% of 2013 demand)

Piped gas from Malaysia



18 TWh (37% of 2013 demand)

Piped gas from South Sumatra (ID)

~100% of 2013 demand

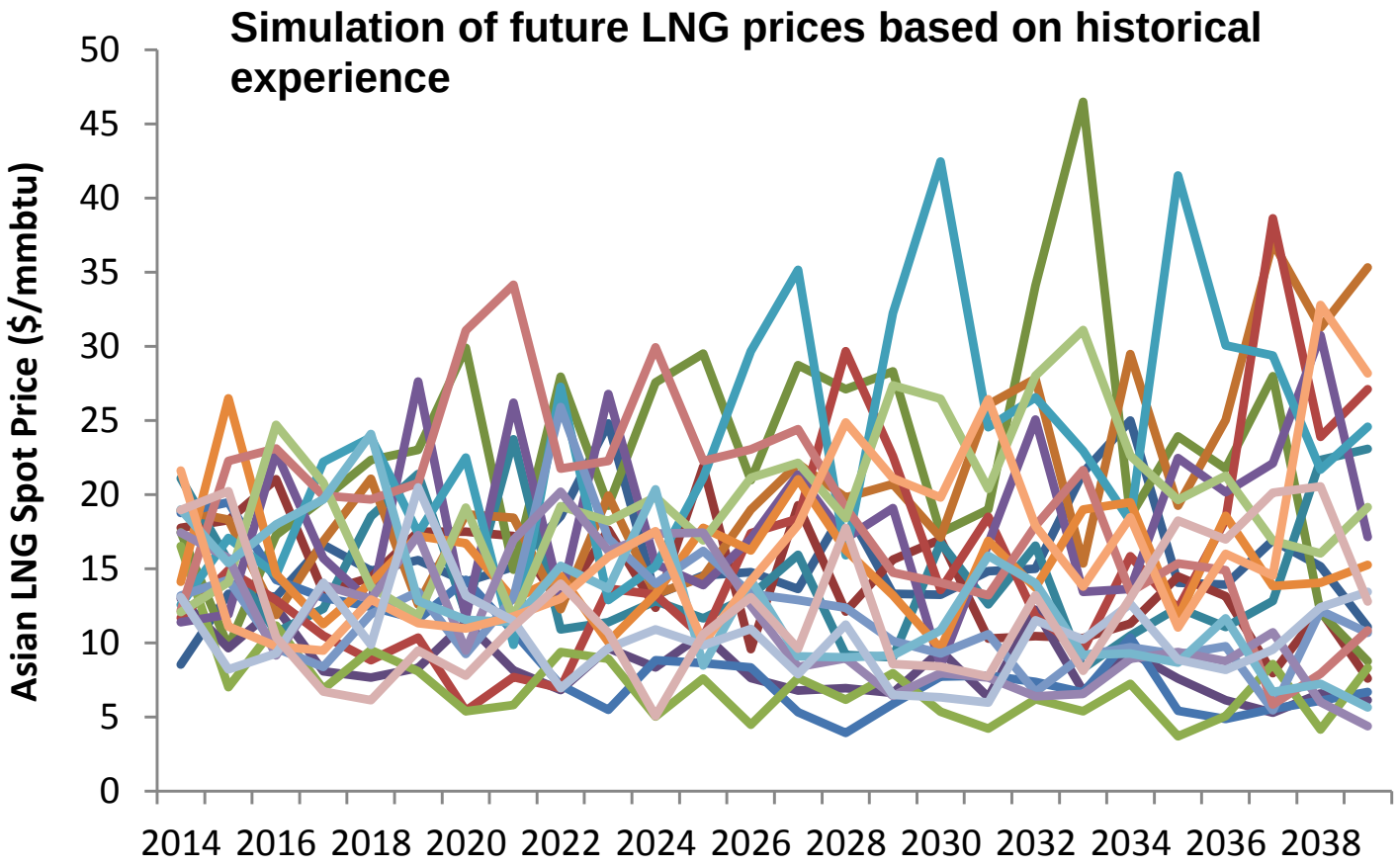
Singapore 6 Mtpa LNG terminal
(Total gas demand is ~ 6 Mt in 2013)

36 TWh (75% of 2013 demand)

Piped gas from West Natuna (ID)

How much of a premium is LNG worth compared to other options that enhance security?

Exposure to fuel price uncertainty is greater for gas than coal – and tends to increase as the fuel mix becomes less diverse



Coal is also subject to market price fluctuations,
but coal is a smaller part of total costs than gas for the same amount of generation

Exposure to fuel risk is still something a bit new – given how many Asian countries have enjoyed subsidised or controlled local fuel pricing for many years

Some Observations

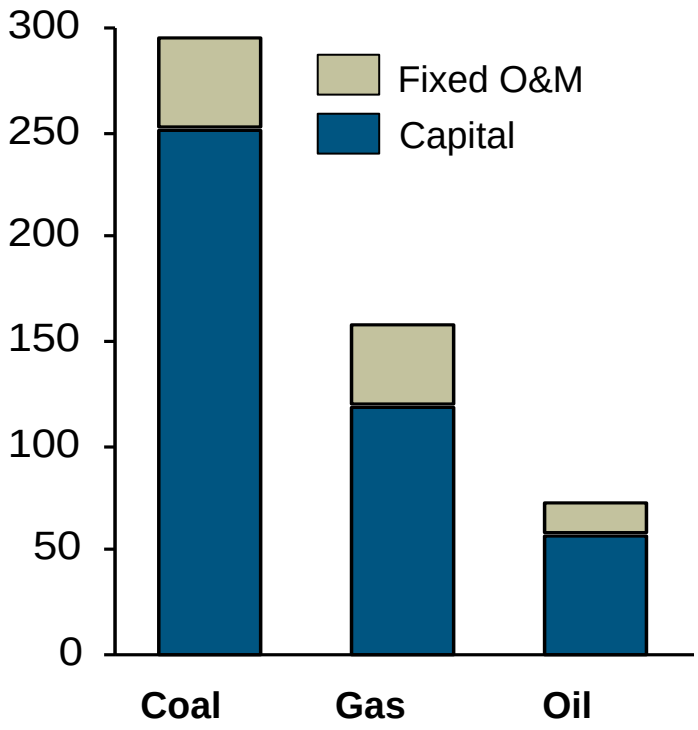
- Gas in a coal window is much more challenging
  - Substantial cost pressures
- Getting marginal price signals wrong is expensive
  - Using expensive gas without even knowing
  - Missing opportunities to export power or gas at higher prices
  - Creating industries and making investments that are not supported by economic fundamentals
- The analysis required is more complex as fuel markets become more relevant to costs
  - Dispatch and planning have access to the information needed to avoid these problems
  - But often the information is either ignored or poorly presented
  - Meaningful risk analysis is compromised by overly simplified scenarios

Proper, timely, decision support is an enormous source of value

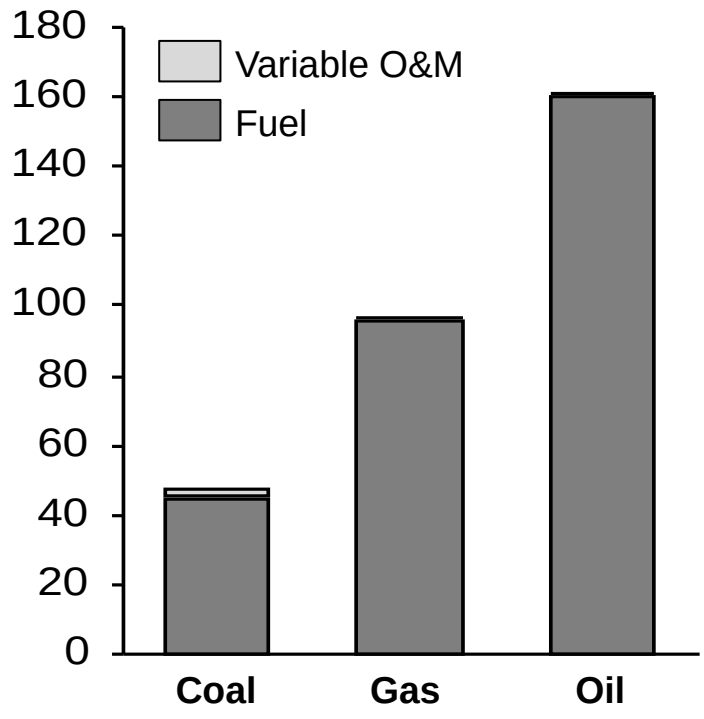
The Increasingly Relevant Value of Flexibility

Each type of unit has a different structure of fixed and variable costs

Fixed costs - $/kW per year



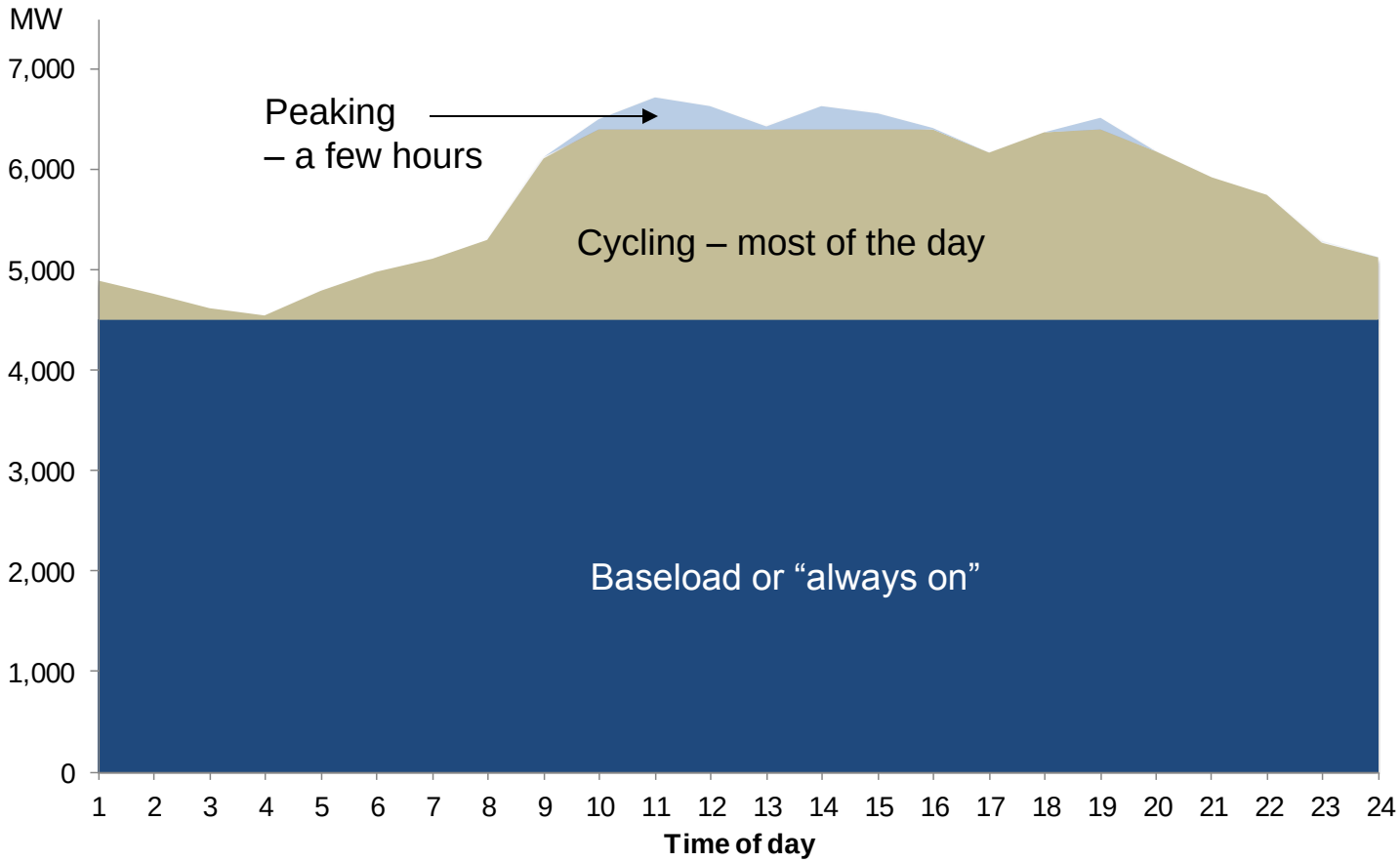
Variable costs - $/MWh



So many choices, and these are just the easy ones…

The ideal electricity system has a mix of different technologies to meet the varying load across the hours of the day

Electricity demand in Luzon on an illustrative day (Friday, 10 Jan 2014)



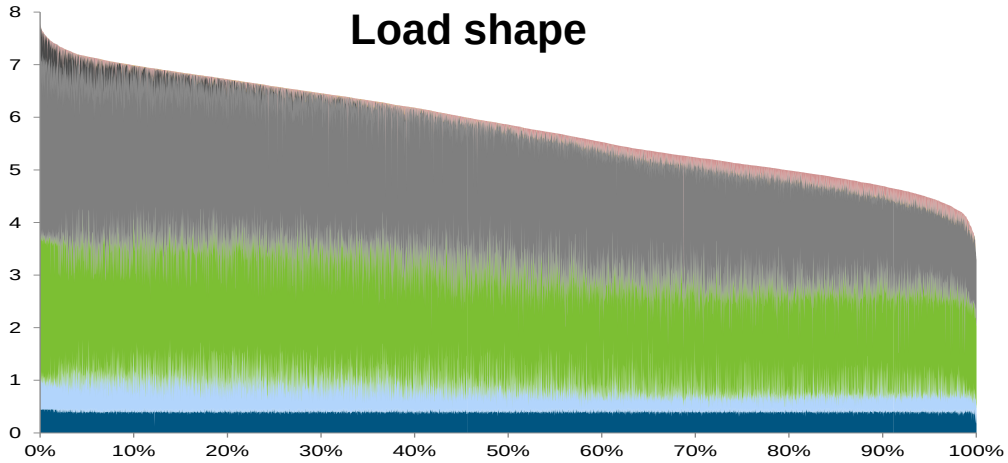
We can divide the demand up into three kinds of demand:

- **Baseload**: Which is always needed
- **Cycling**: Which is mostly needed during the day
- **Peaking**: For which just a small amount is needed in a few hours

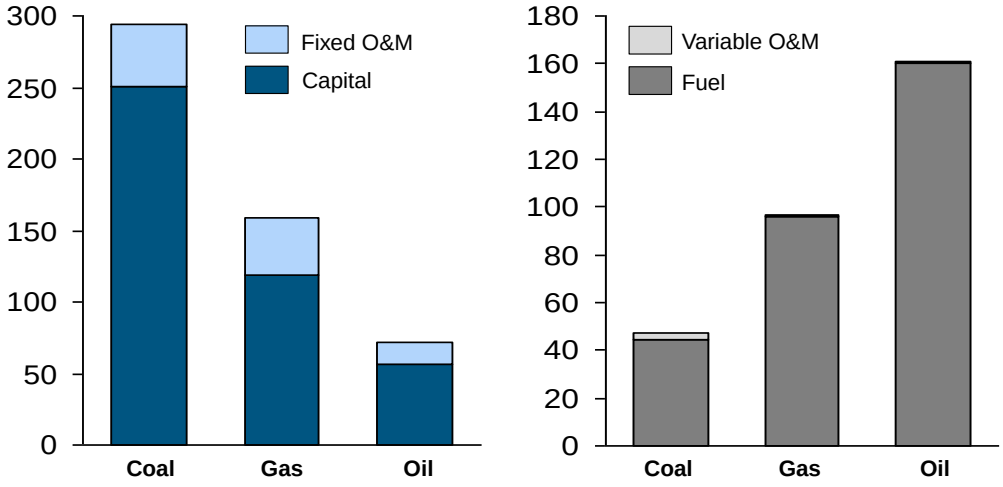
Source: PEMC

The portfolio aggregation problem – given a load shape and cost structure – is how to determine the optimal capacity and generation mix

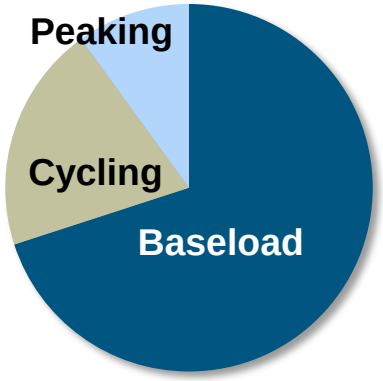
Load shape



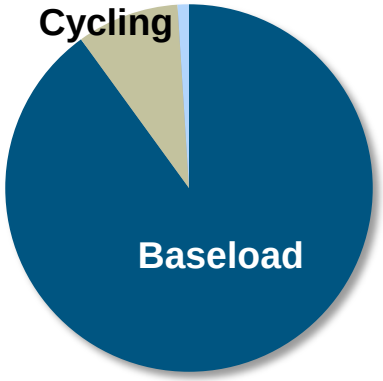
Fixed and variable cost structure



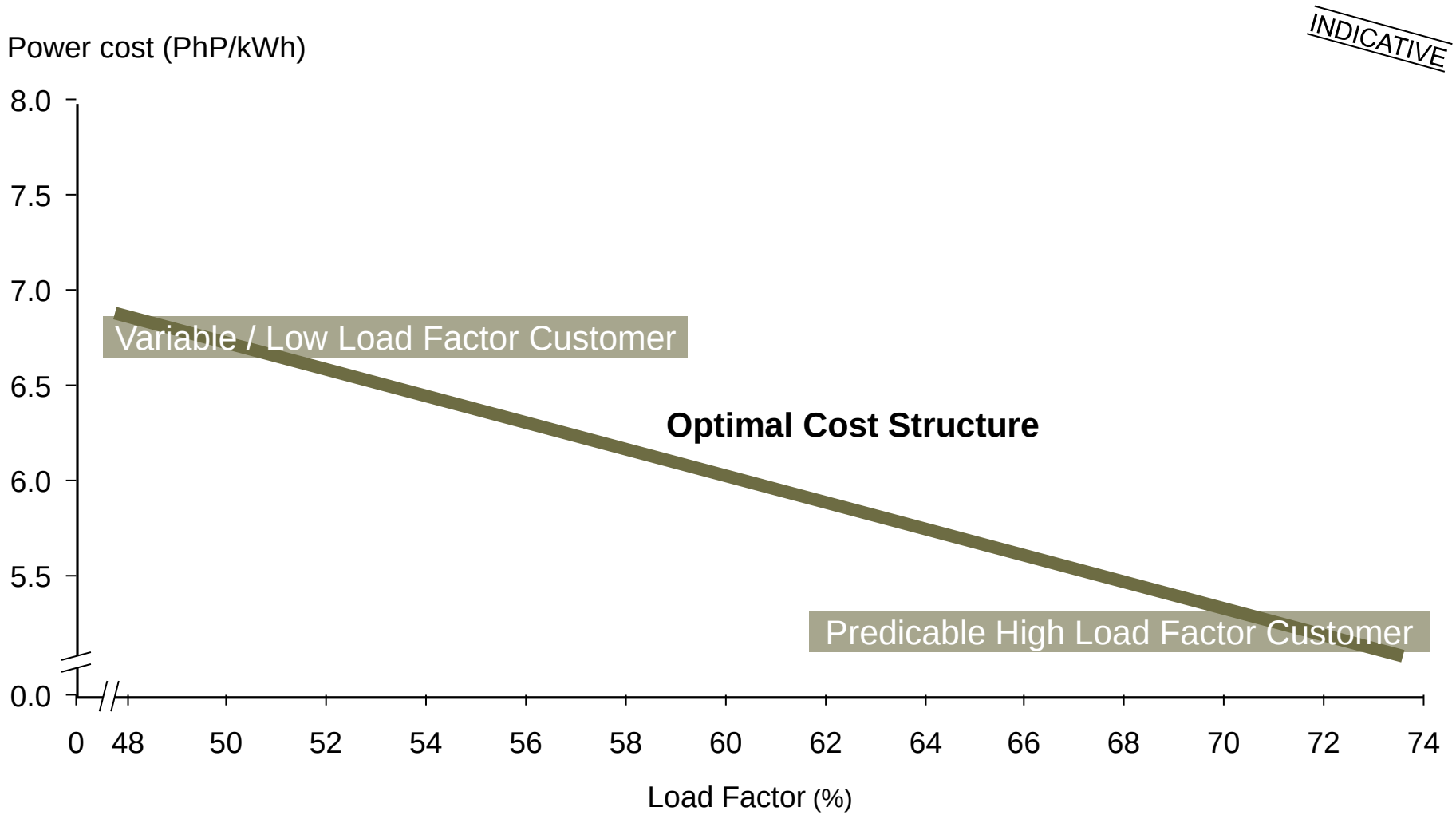
Optimal Capacity Mix



Optimal Generation Mix

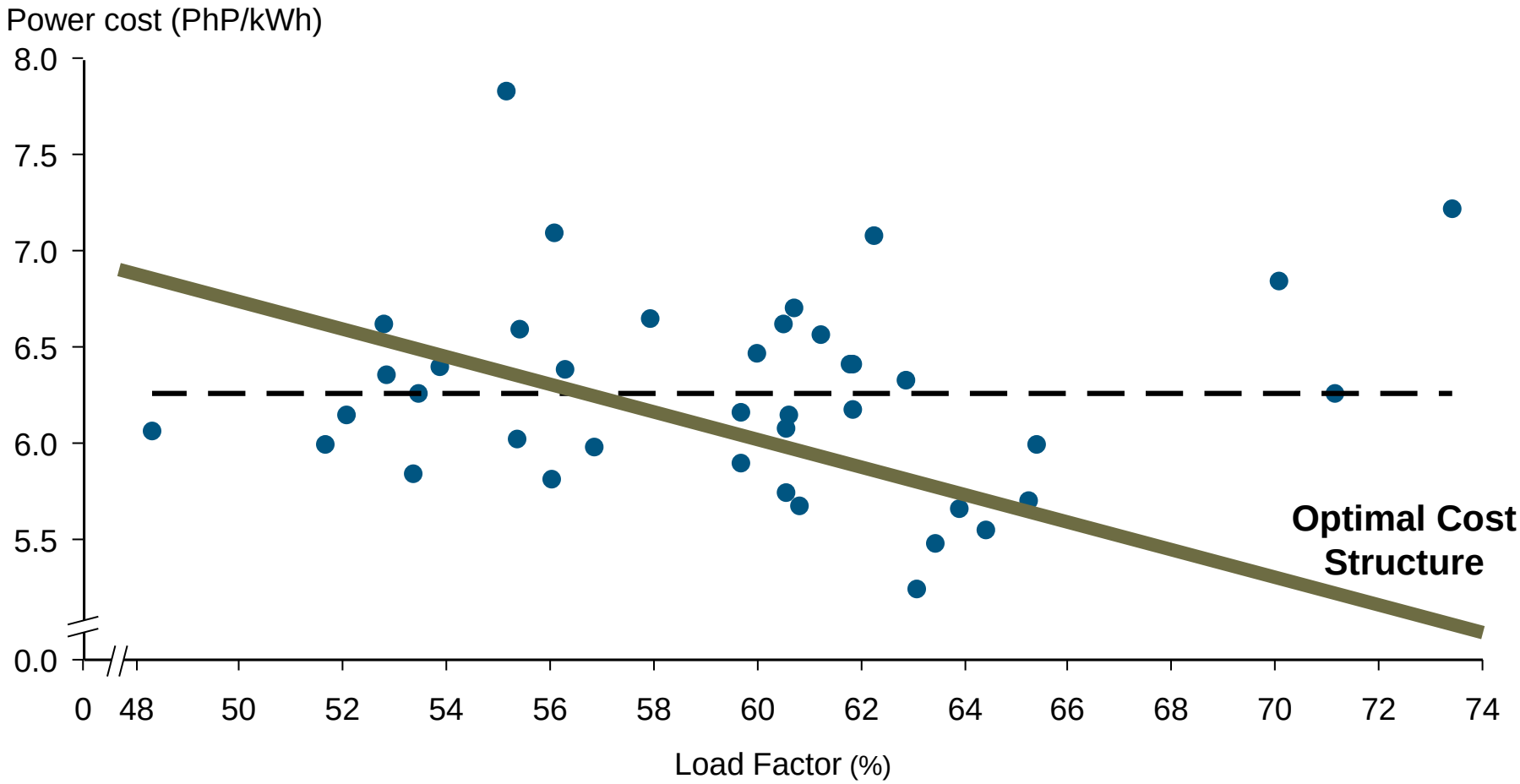


How much should a retailer charge each customer for a power sales contract? (getting this right helps you recover your costs at least risk)



Actual achieved results appear to reflect widespread poor information or analysis

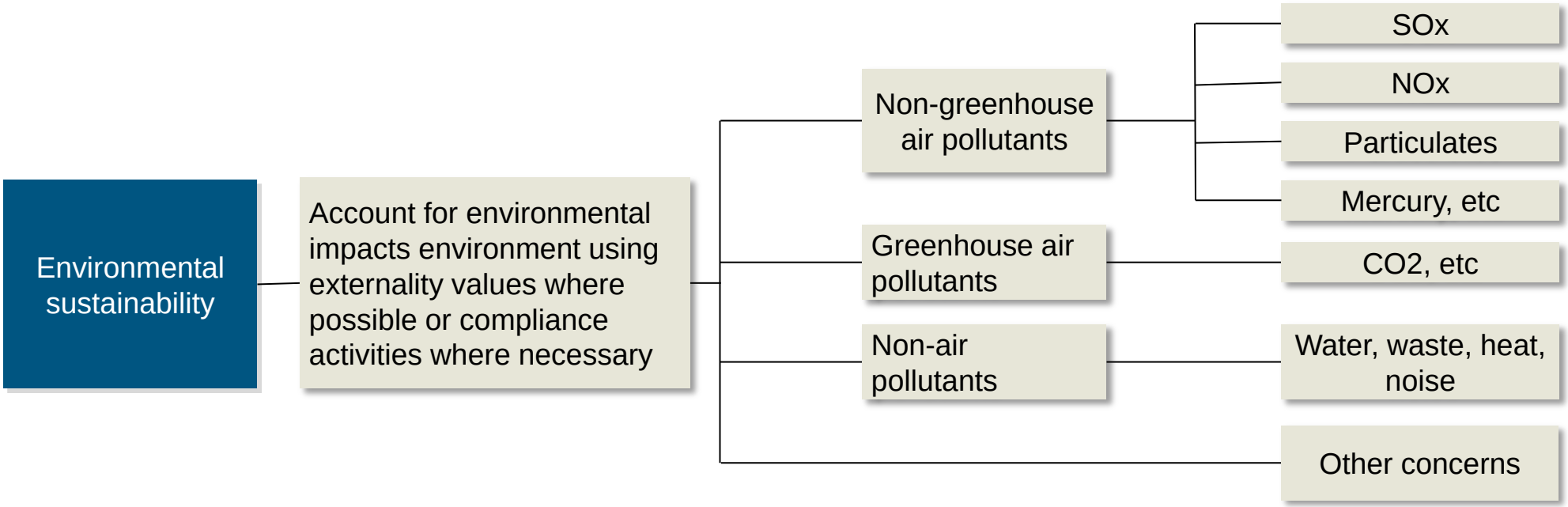
Average power cost vs. load factor for Luzon grid ECs (2012)



Source: NEA

Environmental challenges are particularly challenging (and non-intuitive)

Few Asian countries have used value-based emissions regulation….



It's more complicated – but that does not make it wrong

We did some analysis…..

Carbon Emissions

$$\underbrace{(\$/\text{tonne})}_{\text{Carbon price}} * \underbrace{(\text{tonnes/GJ})}_{\text{Carbon content by fuel}} * \underbrace{(\text{GJ/MWh})}_{\text{Heat rate by unit}} = \$/\text{MWh}$$

Non-Carbon Emissions

$$\underbrace{(\$/\text{emission})}_{\text{Emission price}} * \underbrace{(\text{emissions/MWh})}_{\text{Emission rate by unit}} = \$/\text{MWh}$$

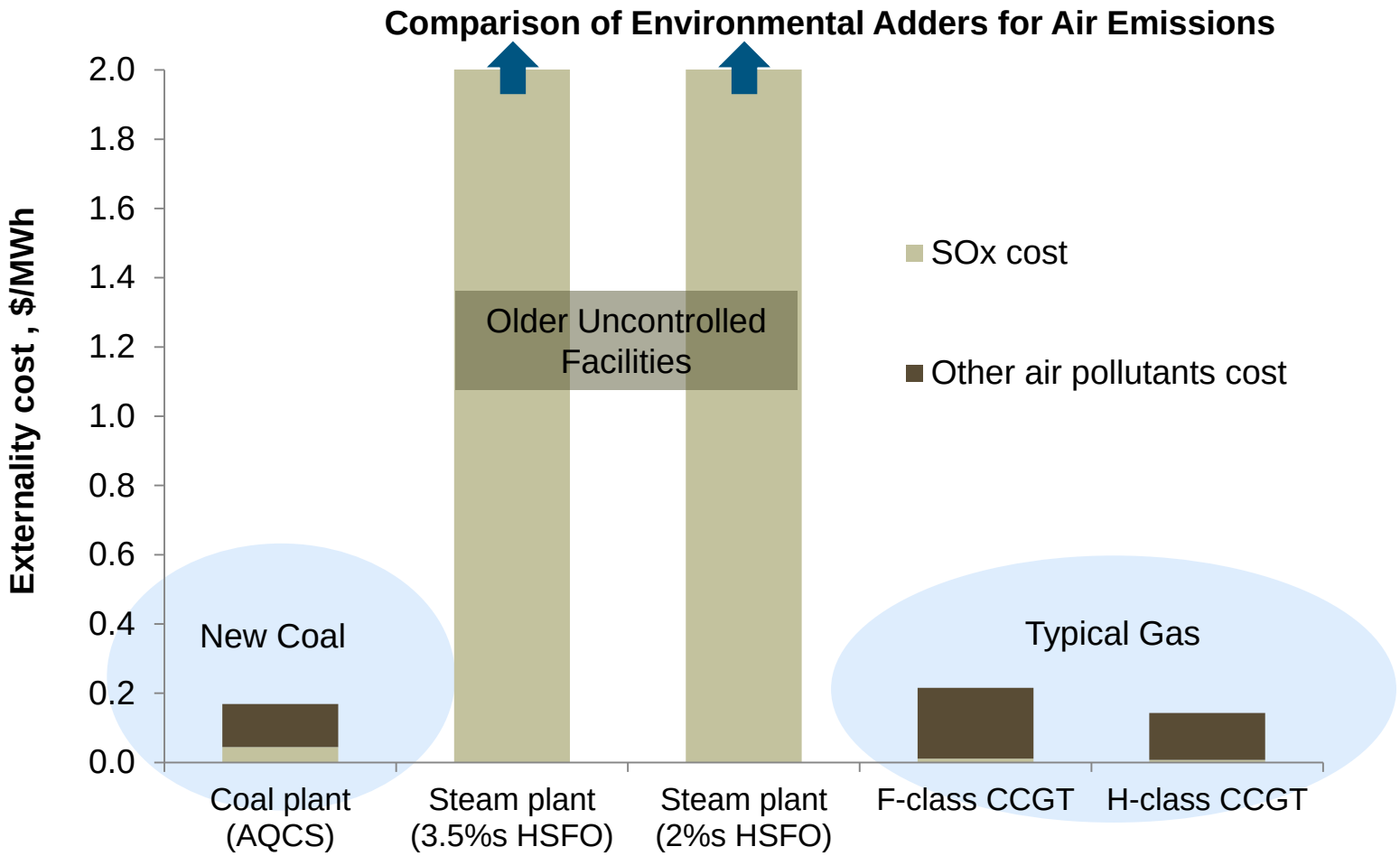
Even if we don't know the best value to use, we can solve for the break-even value associated with choosing one option over another….

Using some representative values….

Pollutants	Working value for externality price	Rationale
SO_x	SGD 500/ton	Based on the average additional switching cost from 3.5% HSFO to 2% HSFO in 2011
NO_x	SGD 400/ton	Based on the US Federal Energy Regulatory Commission NOx allowance spot prices in Q2 2011 – Q3 2012
PM	SGD 1,000/ton	Estimated from EIA externality studies
Hg	SGD 10,000/ton	Estimated from EIA externality studies

Any value can be tested….

And compared the non-carbon emissions costs of coal vs gas vs existing generation



The right technology renders non-carbon emissions largely irrelevant to the decision….

Yet cost-effectiveness analysis is largely ignored, despite dramatic insights

Implied price of emissions based upon coal-gas switching due to emissions cap (2015)

	Implied price of emissions (HK$/tonne)	Benchmark price (HK$/tonne)	Excess Cost Ratio	Basis for Benchmark
SO2	340,000	3,300	100x	Average additional switching cost from 3.5% HSFO to 2% HSFO in 2011 in Singapore
NOx	1,050,000	2,600	400x	Federal Energy Regulatory Commission NOx allowance spot prices in Q2 2011 – Q3 2012
RSP	41,600,000	6,600	6,300x	EIA Externality Study

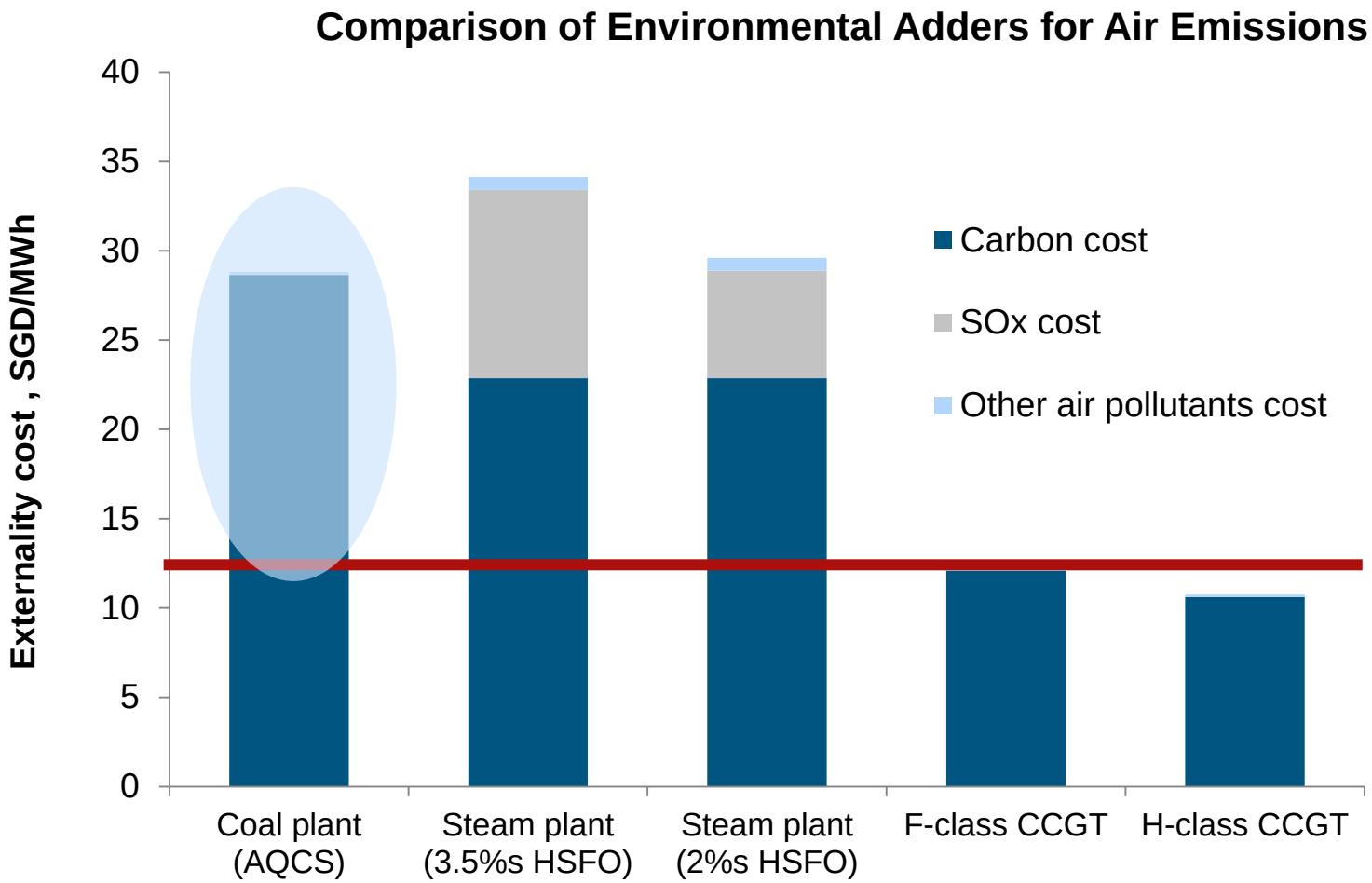
Assumptions

- SO2 emissions rate (kg/MWh): 0.10 vs. 0.02 for coal vs. gas
- NOX emissions rate (kg/MWh): 1.02 vs. 0.22 for coal vs. gas
- RSP emissions rate (kg/MWh): 0.03 vs. 0.01 for coal vs. gas
- Indicative marginal generation cost (HK$/MWh): 400 vs. 1,200 for coal vs. gas

What is the best way to spend money to improve environmental outcomes?

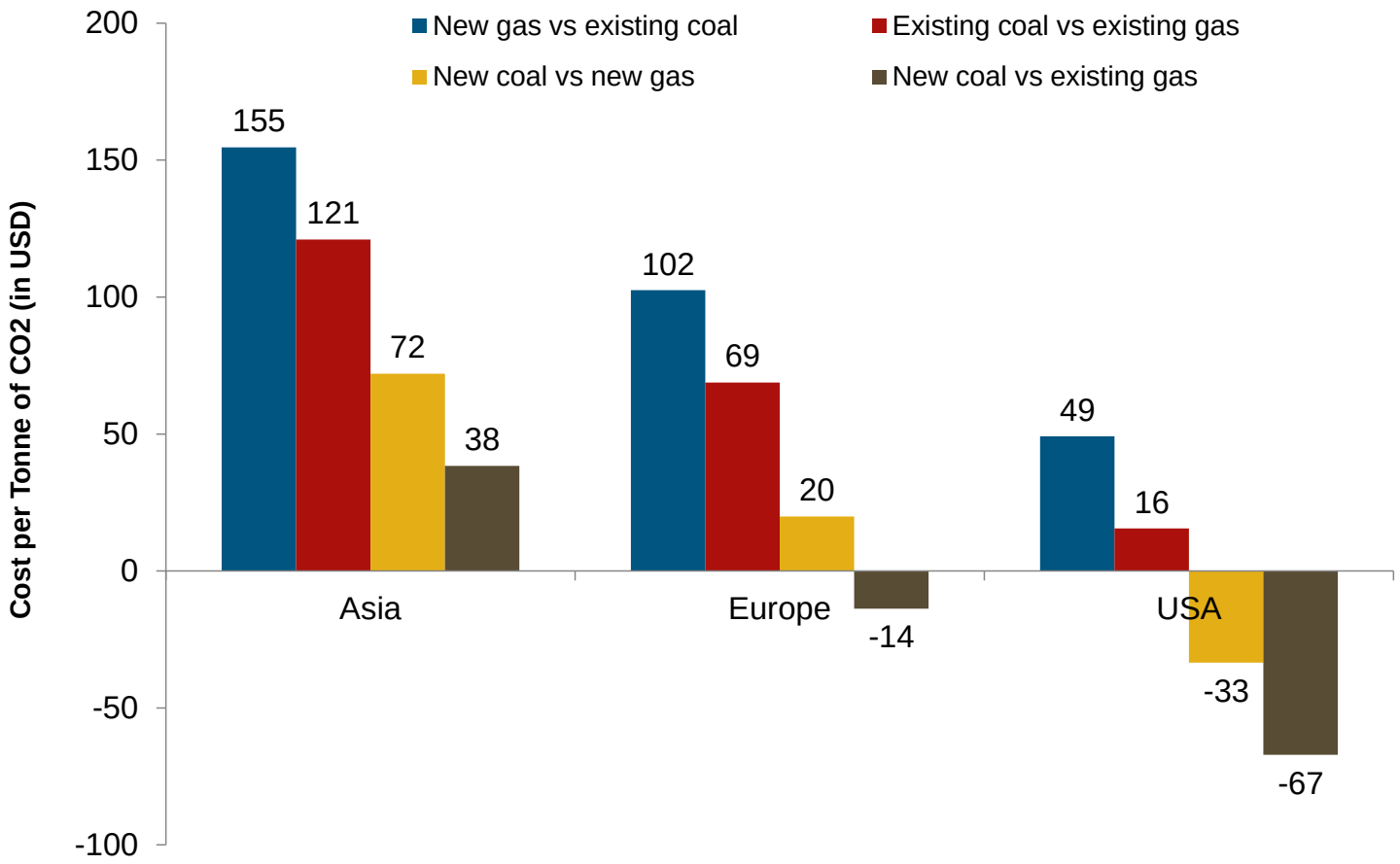
Source: CLP Sustainability Reports; EIA; TLG analysis

On an apples-to-apples basis—the elephant issue is carbon



No question: coal emits more than twice the CO2 than gas-based generation

But….using more natural gas in Asia to reduce carbon is much more expensive than doing the same thing elsewhere in the world…



Carbon is a serious global problem – why focus only on local solutions?

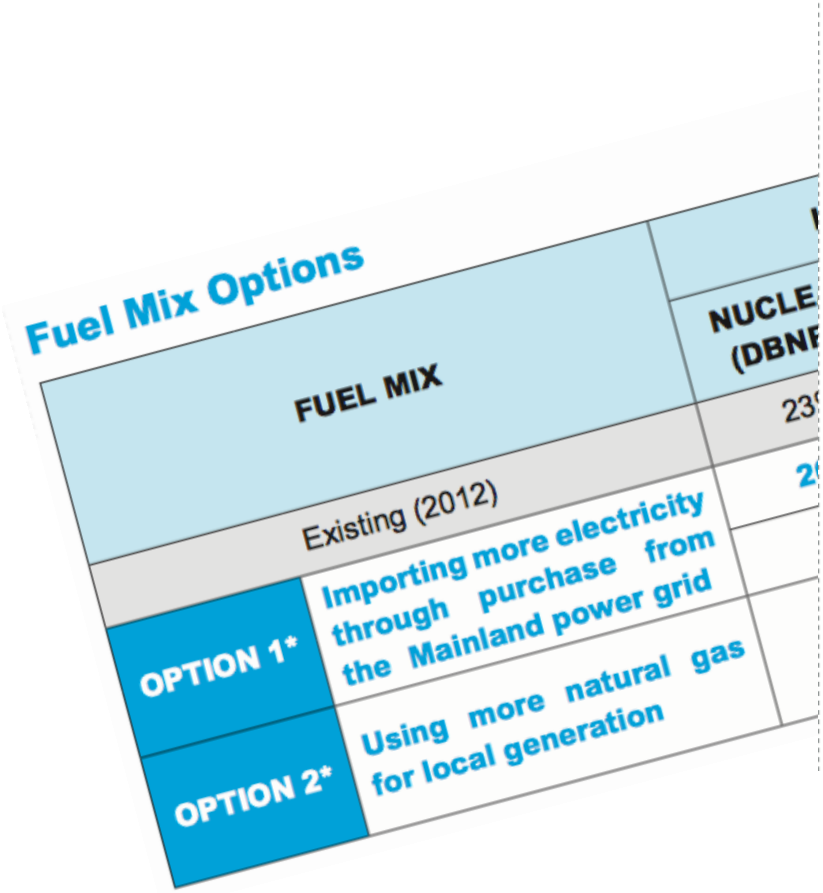
Source: TLG analysis

The challenges are getting more complex

- Simplifying problems so that non-technical experts can grasp the core issues correctly is extremely difficult and easily done badly
- Dynamic markets (fuel, emissions) produce information that is often ignored, confusingly presented, or misleadingly averaged
- Asia is in a coal window – the questions are simple:
  - What is the cost of ignoring it? and
  - How do you manage the carbon consequences of it?

Better information, timely delivered, can help prevent bad ideas from becoming bad commitments

The absence of better information leads to strange policy behaviour….



Q1: How do you view each of the two fuel mix options with regard to safety, reliability, cost, environmental performance and other relevant considerations? (Please indicate your view on **EACH** of the two options.)

Option	Support	Not Support	Reason for NOT supporting (You can tick more than one box)
1	☐	☐	☐ **Safety** ☐ **Reliability** ☐ **Affordability** ☐ **Environmental performance** ☐ **Others (please specify):** _____
2	☐	☐	☐ **Safety** ☐ **Reliability** ☐ **Affordability** ☐ **Environmental performance** ☐ **Others (please specify):** _____

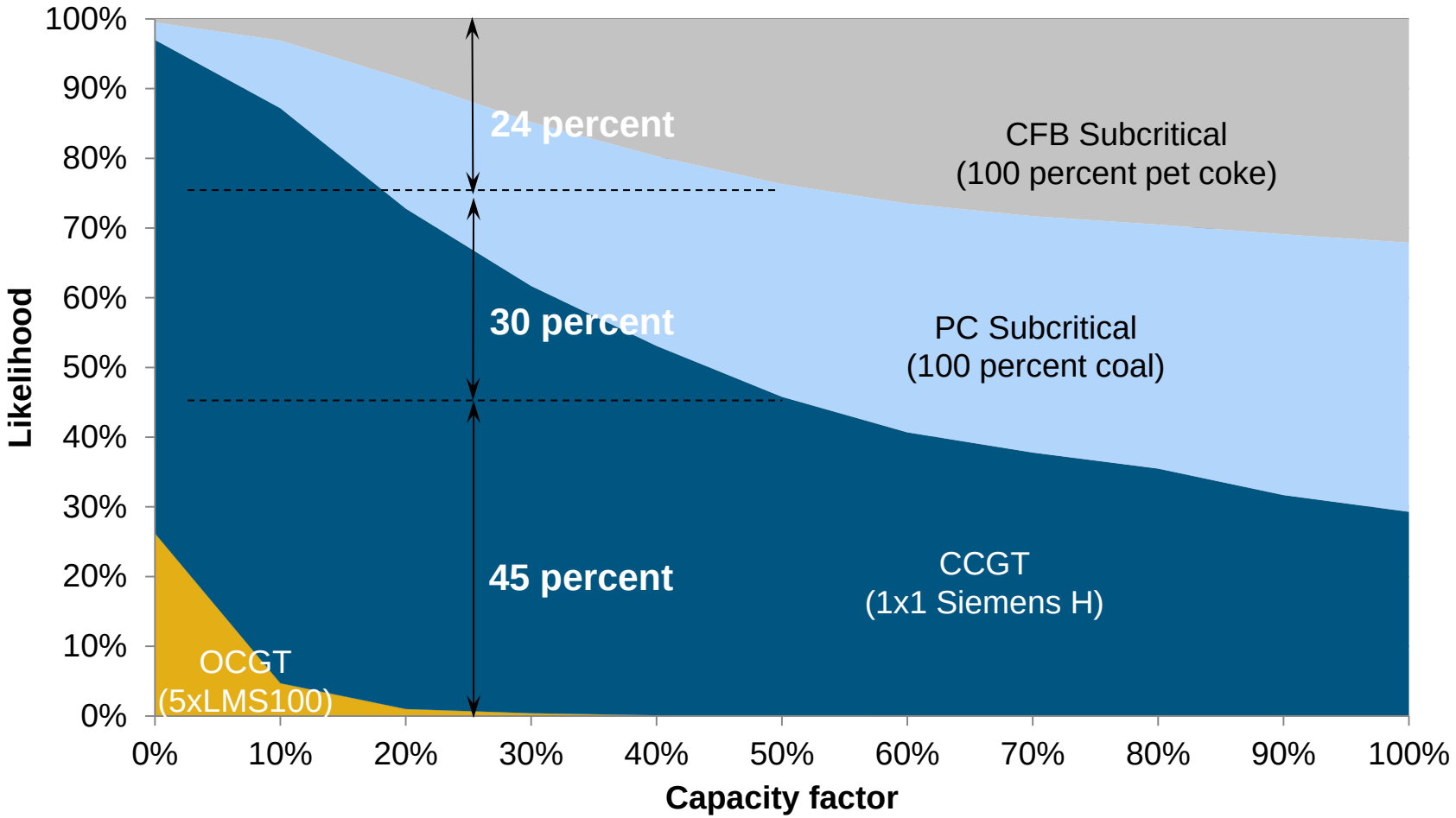
Lack of information or analysis leads to odd approaches to making tough decisions

How to improve things?

There's a completely different gas "future" awaiting for Asia – time to make it happen

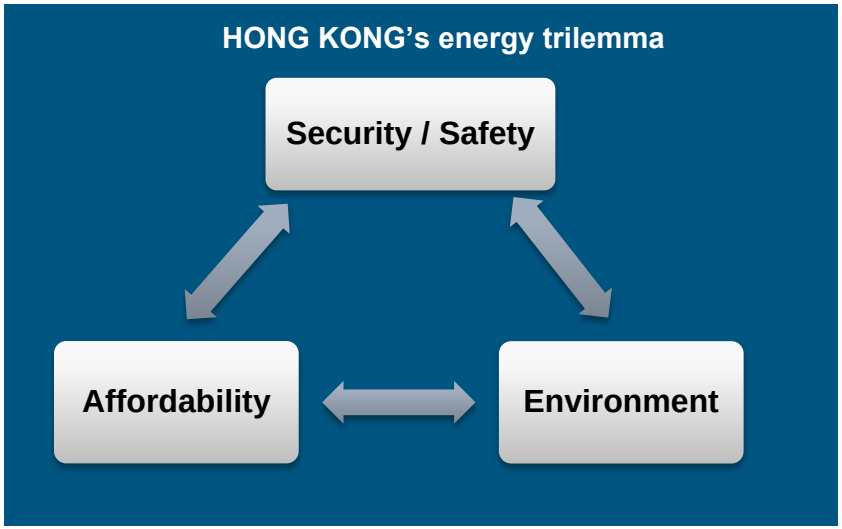
- Coal, nuclear, and renewables will edge out gas as a baseload generation resource
- Mid-merit LNG-fired generation will be subject to daily load variation, seasonal swings, and long-term capacity factor uncertainty
  - Cannot support high load factor for LNG terminals or inflexible take-or-pay commitments
  - Cannot sign bankable long-term supply contracts
- LNG terminals will be forced to recover their costs primarily via capacity reservation charges, rather than throughput charges
  - Throughput capacity will vary with circumstances / sizing of storage will be a key design variable
  - Break-bulk shipping and LNG trucking – both inherently more flexible – will supplant gas pipelines
- LNG aggregators will act as financial intermediaries between LNG liquefaction projects and downstream customers (e.g., mid-merit CCGTs)
  - Buying shares in liquefaction projects / Taking positions in LNG tankers
  - Securing LNG storage capacity

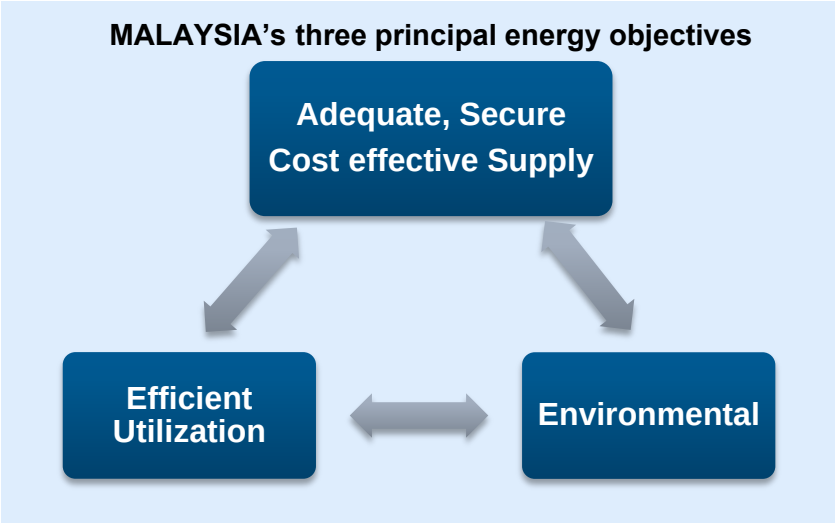
Risk needs to be more explicit in policy and regulatory decisions

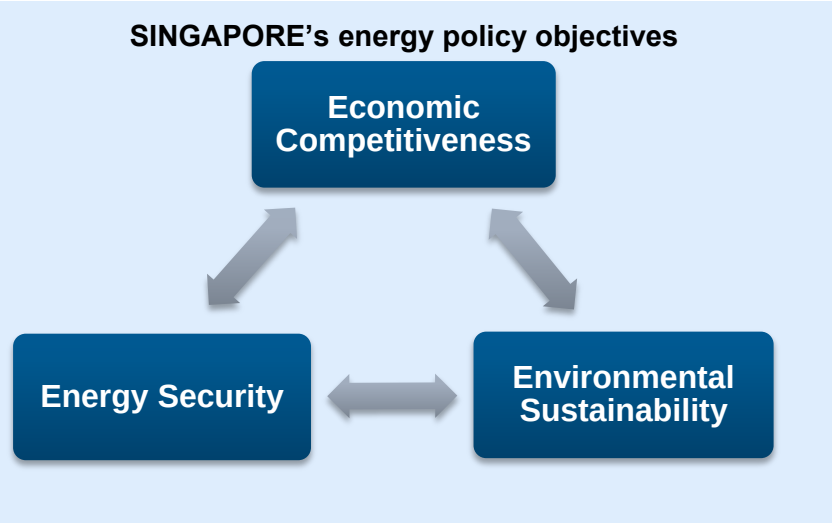


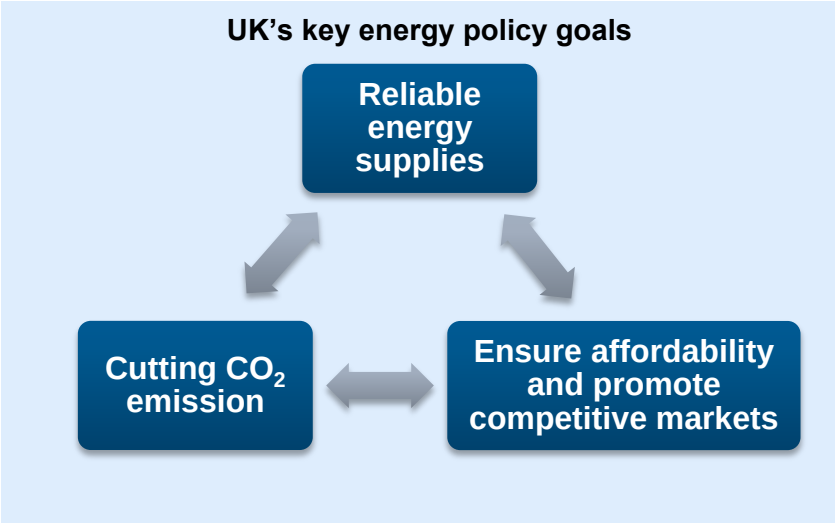
Greater focus on simulation and integration of market risks into infrastructure planning

The “energy trilemma” that everyone talks about needs to be given rigor….





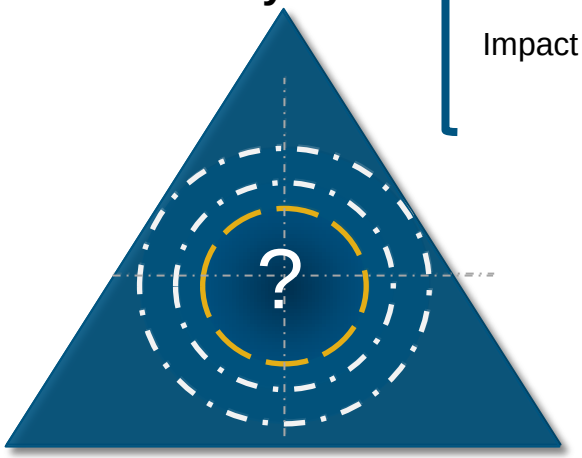




Ideally, complex problems would be evaluated within a structured framework informed by deep analysis of available or accessible information

Money Costs

- New capital and fixed costs
- Impact on fuel costs
- Impact on other variable costs



Environmental Costs

- Cost of air / water / ground emissions
- Other environmental costs

Security Costs

- Cost of losing load
- Cost of being exposed to price risk
- Cost of missed opportunities for learning or improving negotiating leverage

Don't rule out anything arbitrarily

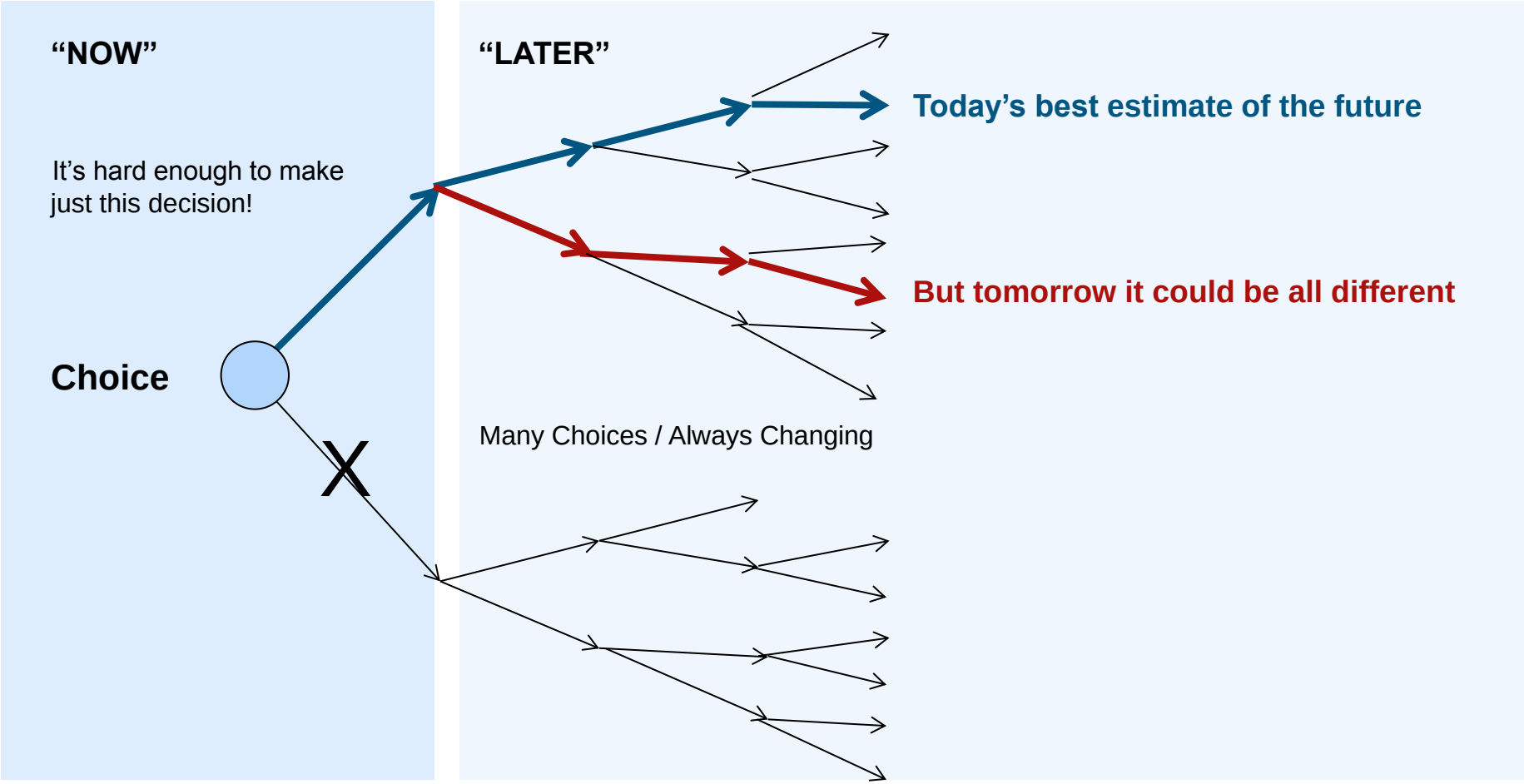
Don't impose constraints that are not based on a value assessment

Be clear about the choices

Focus on identifying actual impacts

Measure what you can; and be open about what you can't measure

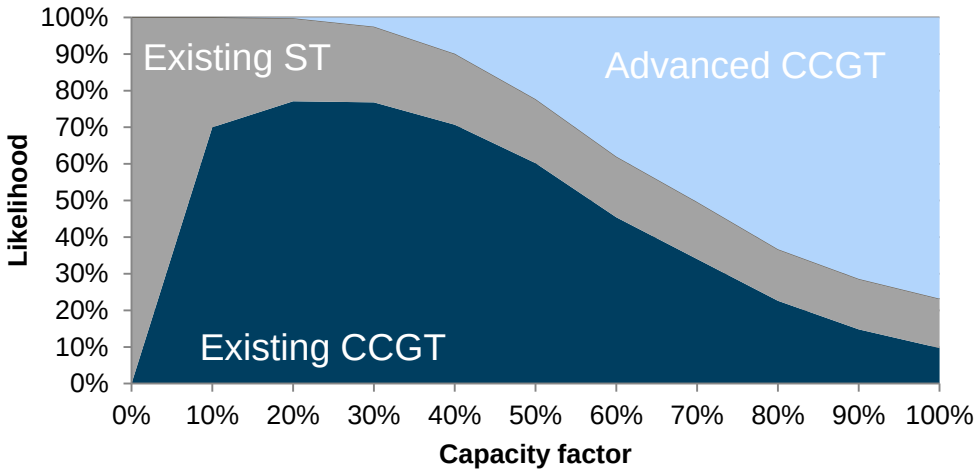
The value of flexibility needs to become a more central focus in planning



Flexible strategies are more complex, but often better

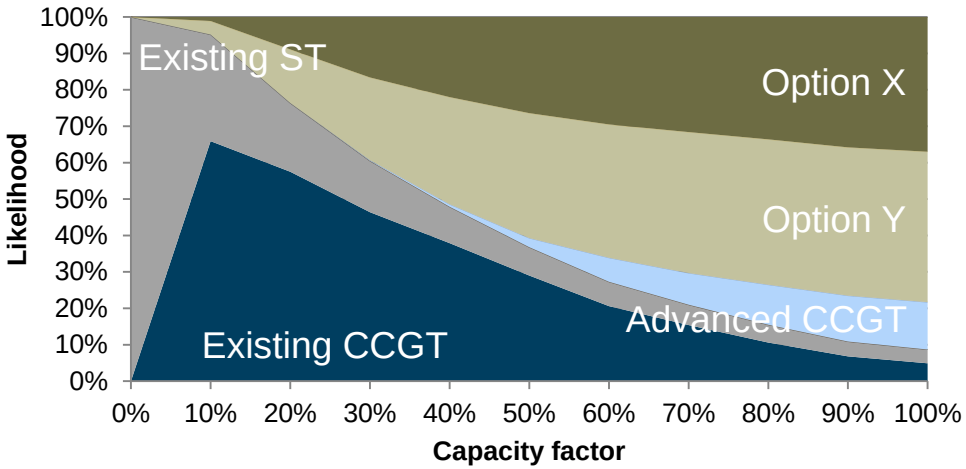
Arbitrary exclusion of options needs to be avoided—it raises costs and risk

Constrained to be mostly natural gas



	System Average Cost (SGD/MWh)
Mean	128
Std deviation	33
10th percentile	89
90th percentile	171

Wide open consideration of all options



	System Average Cost (SGD/MWh)
Mean	107
Std deviation	13
10th percentile	89
90th percentile	123

More focus on how to optimise a portfolio of options to reduce cost

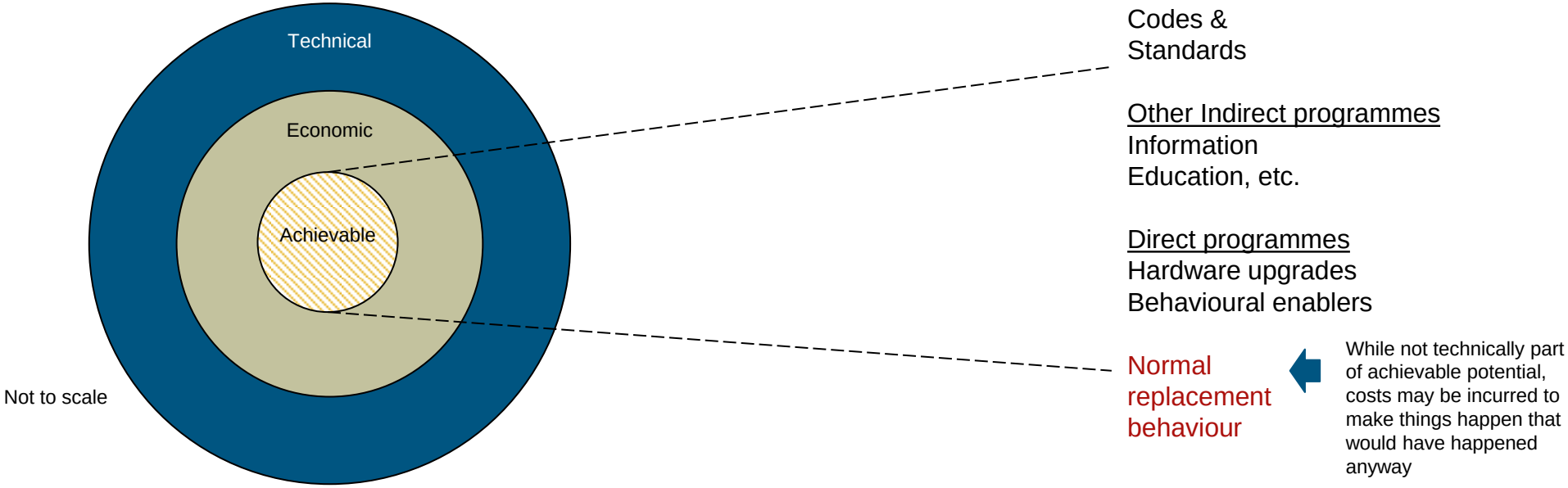
Smarter emissions regulations are needed to extract more value from what is possible with boiler and fleet optimisation

- Project module descriptions:
  - Using big data and analytics to formulates nonlinear control models and precise phase transition simulation models with real-time data of coal quality and characteristics, oxygen content in flue gas, heat signal, heat surface, fouling and slagging, etc.
  - Ultra-supercritical boiler smart control technologies based on combustion, nonlinear control theory, optimization, etc
  - Integration of equipment and smart control technologies

- Implementation power stations:
  - First 2x1000 MW in Guodian Group's Jianbi Power Station in Jiangsu Province, commissioned in late 2011
  - And more than 10 other 1000 MW USC plants in China

Optimisation requires an objective function

More attention should be devoted to understanding energy usage and efficiency potential



	Instantaneous Technical	Total savings potential assuming all non-EE units are replaced with EE units at once
	Phase-in Technical	Technical savings potential assuming non-EE units are replaced according to their lifetime
	Economic	Phase in technical savings potential of measures that are cost-effective from a societal perspective
	Achievable	Amount of economic potential likely to be achieved given a level of customer acceptance
	• **Indirect**	What might occur due to replacement trends, codes & standards, information, education or other indirect measures
	• **Direct**	Attributable to direct programs

Asia remains behind in studies and policies related to EE achievement

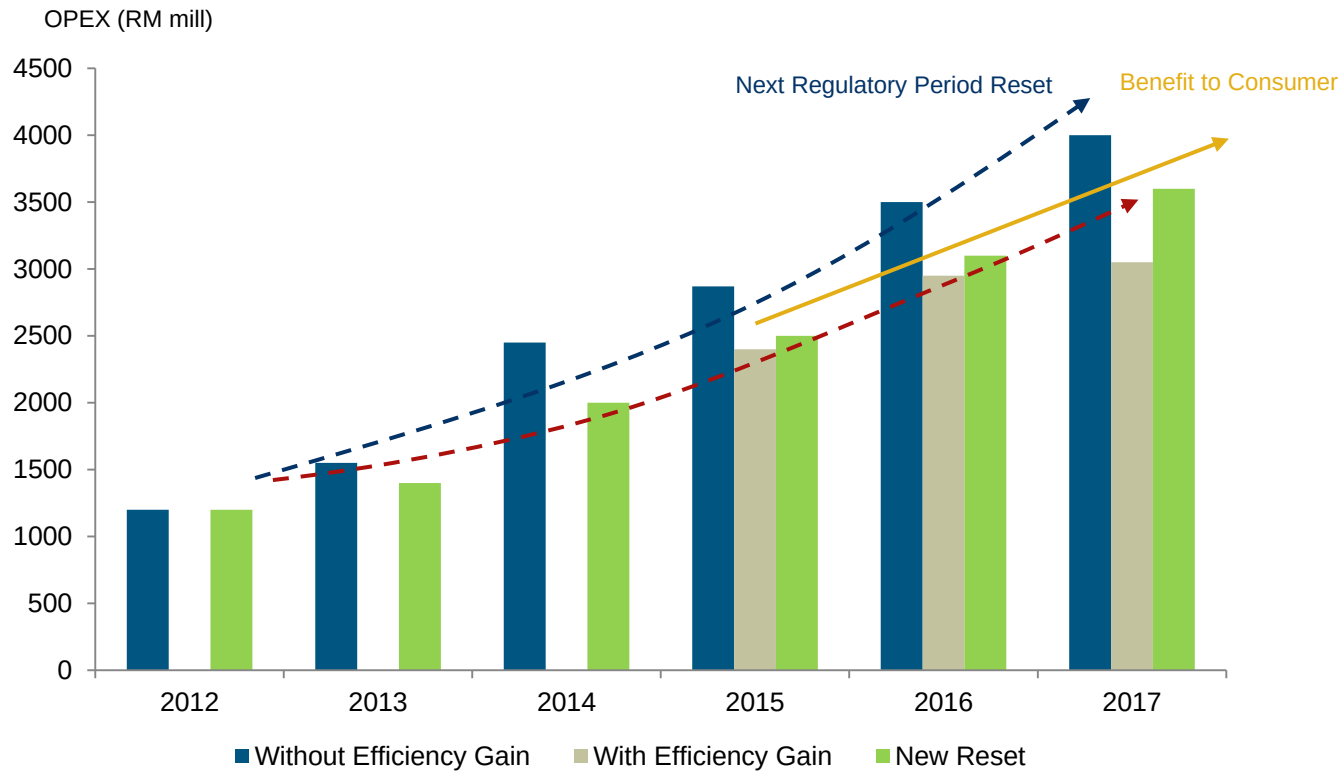
As Asian energy growth slows, more focus on incentive regulation is needed to improve performance and justify costs

IBR regimes have been relatively less common and relatively less intrusive in Asia, but with rising fuel prices and tariffs, more pressure is likely to be placed on reducing other costs or enhancing performance

If so, then:

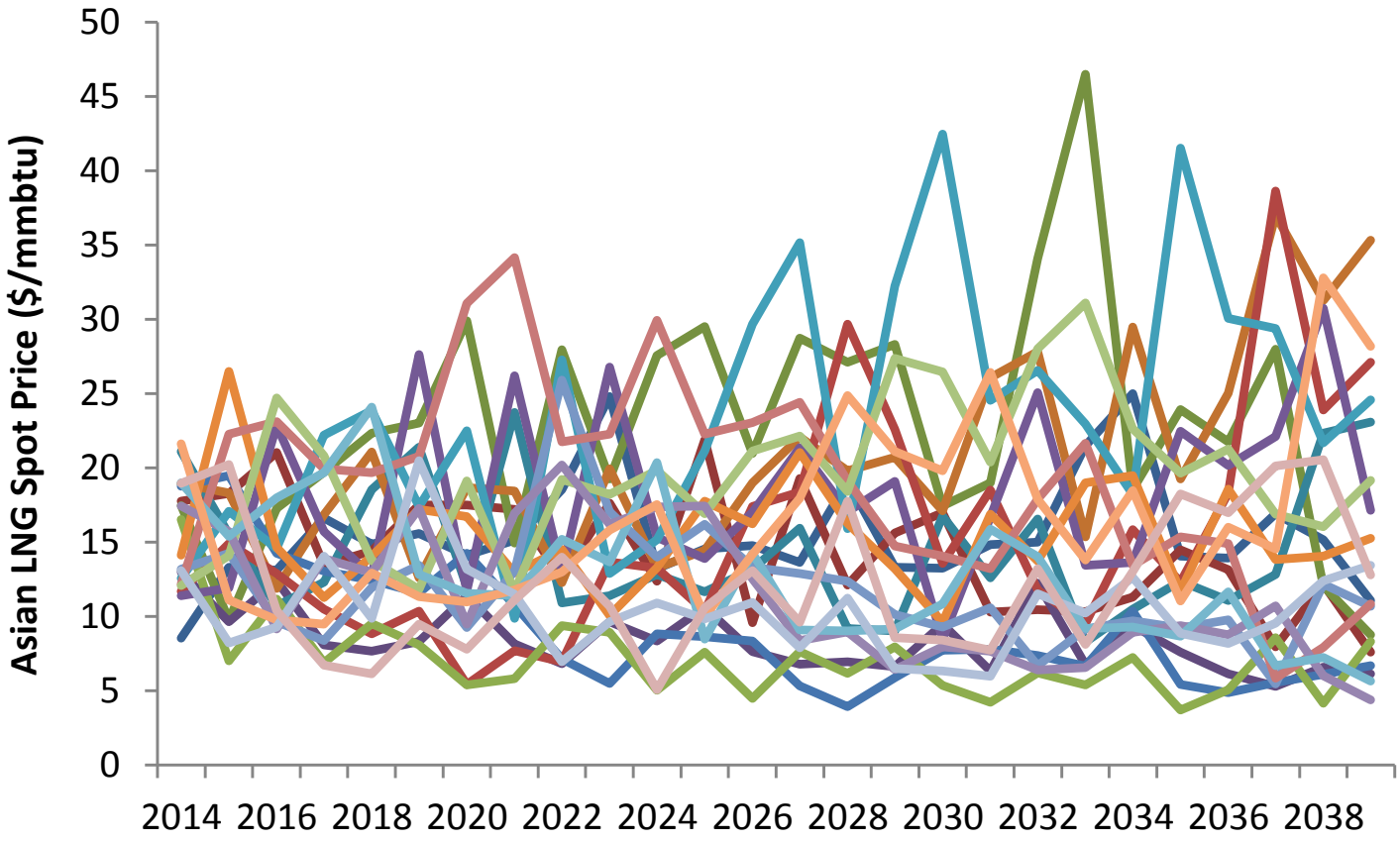
Measurement and identification of opportunities to reduce costs

Measurement and reporting for regulatory defense or offense



Forcing utilities to pay more attention to the link between cost and performance

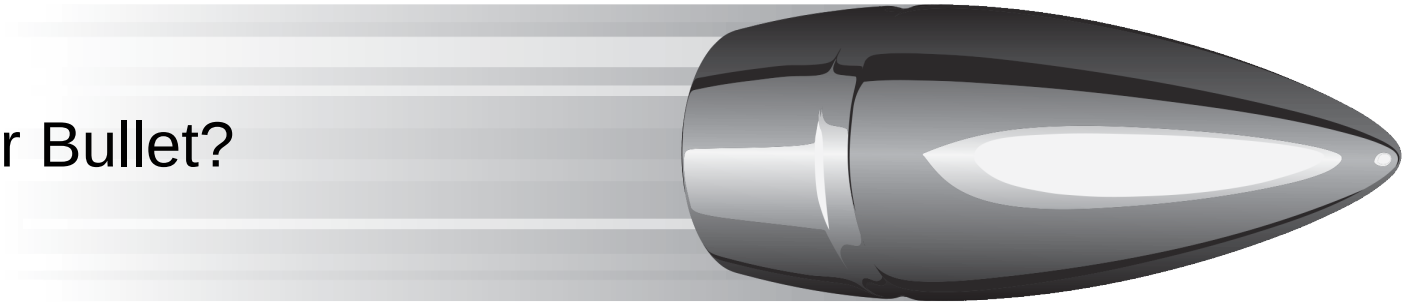
Tariff management will need to address the risk of exposure to global fuel markets and whether customers will pay a premium for protection



Coal is also subject to market price fluctuations,
but coal is a smaller part of total costs than gas for the same amount of generation

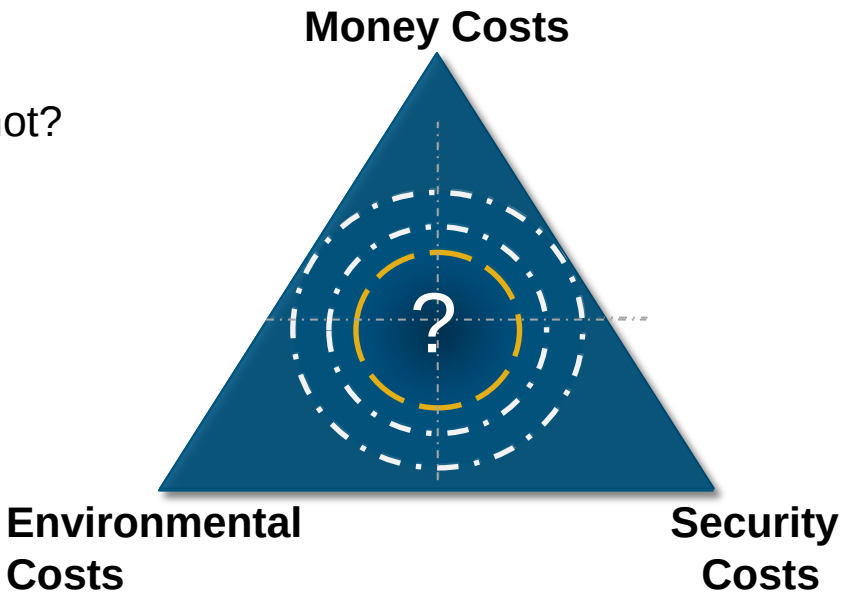
Renewables offer greater insulation from fuel markets – a sometimes overlooked value proposition

The Silver Bullet?



Nope: the answer lies in the details and incentives

- ***Who*** cares about the outcome?
- What ***aspects*** do they care about?
- What aspects ***should*** they care about but currently do not?
- Who ***believes*** something can be done?
- How do you make the argument to ***motivate*** change?
- What costs and benefits do you need to ***measure***?
- ***How*** do you measure or estimate them?
- Who bears the ***risk*** of decisions vs outcomes?
- How do you implement, execute, and ***manage*** it?
- What do you ***learn*** from the experience?



Excellence is defined not by keeping the lights on, but by keeping the lights on while continuously answering and responding to these questions

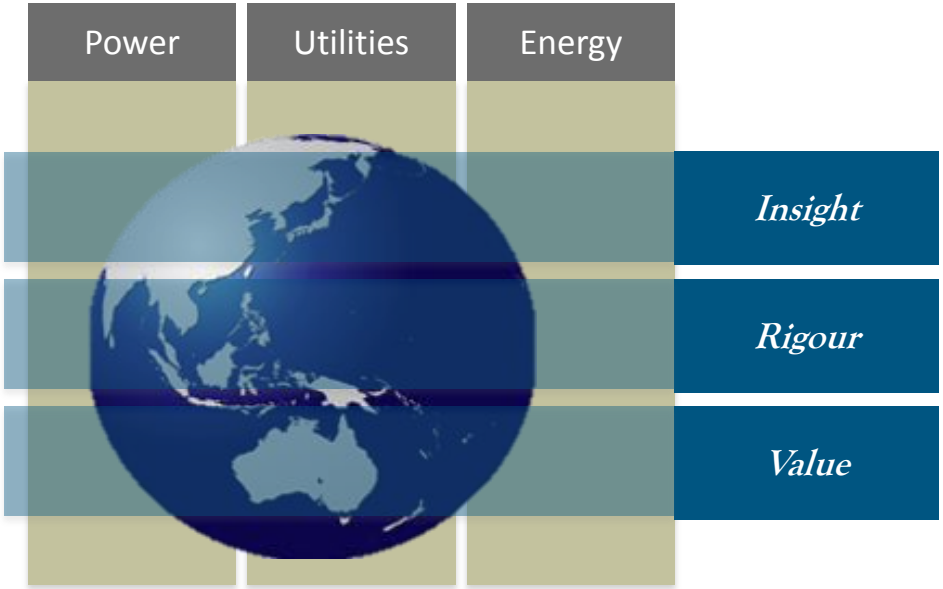
THE END

`Wake up, Alice dear!' said her sister; `Why, what a long sleep you've had!'

`Oh, I've had such a curious dream!' said Alice, and she told her sister, as well as she could remember them, all these strange Adventures of hers that you have just been reading about; and when she had finished, her sister kissed her, and said, `It was a curious dream, dear, certainly: but now run in to your tea; it's getting late.'

So Alice got up and ran off, thinking while she ran, as well she might, what a wonderful dream it had been.

– Lewis Carroll (*Alice in Wonderland*)



www.lantaugroup.com

For more information please contact us:

Mike Thomas
mthomas@lantaugroup.com
+852 2521 5115 (office)
+852 9226 2513 (mobile)

The Lantau Group (HK) Limited

4602-4606 Tower 1, Metroplaza

223 Hing Fong Road

Kwai Fong, Hong Kong

Hong Kong

Tel: +852 2521 5501