John Daley's "Carbon Markets and Carbon Pricing: Competitiveness Implications for LNG Exporters and Importers" A Review

and

Possible Implications for LNG Investment Requirements Resulting from Implementation of Carbon Emissions Constraints: A Hypothetical Case

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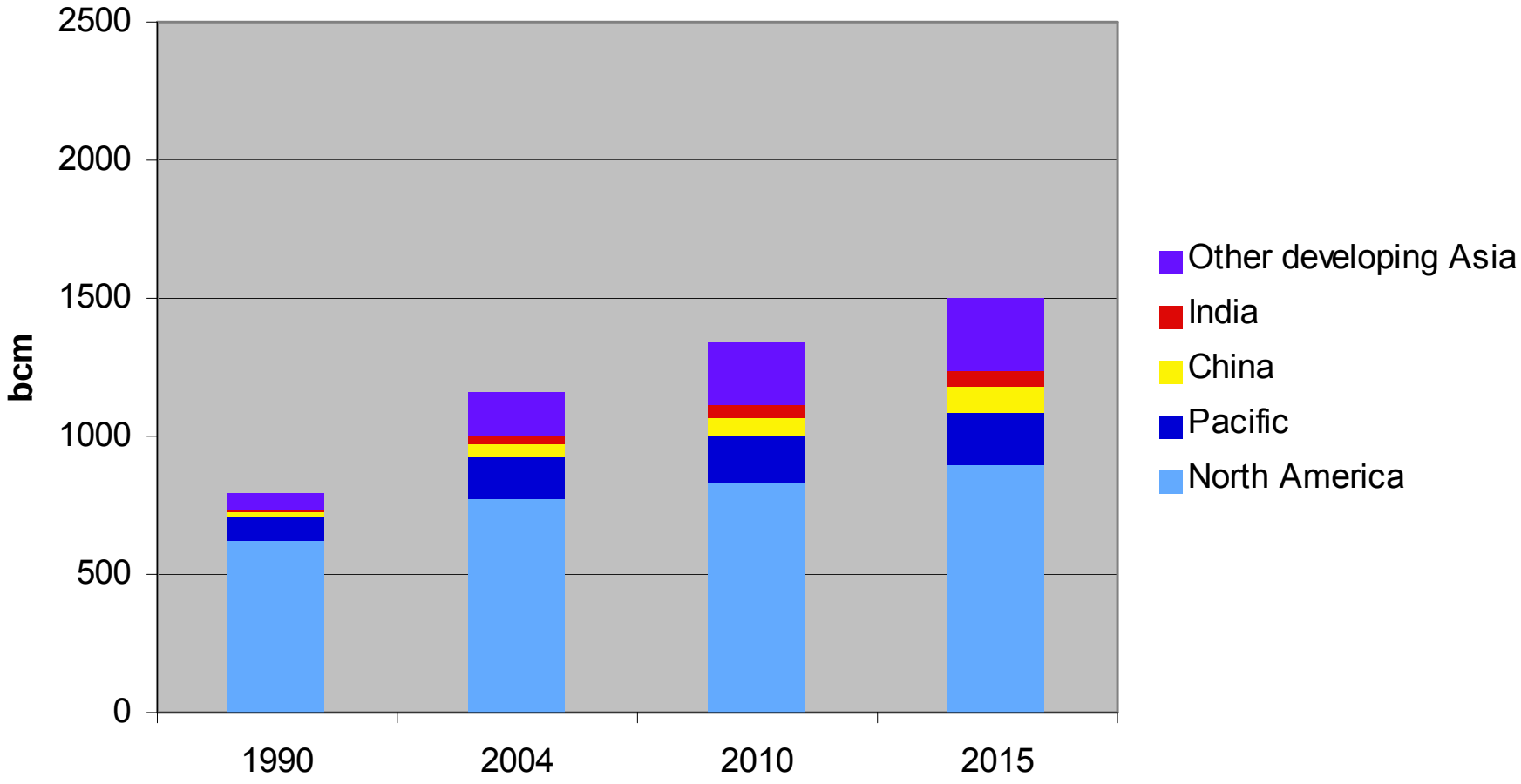
John Daley's "Carbon Markets and Carbon Pricing: Competitiveness Implications for LNG Exporters and Importers" A Review

- Daley provides a series of graphs, and I will briefly discuss several of them.
- One significant aspect of Daley's paper deals with the life-cycle cost of LNG-supplied electricity generation relative to coal.
- A recent paper by Jaramillo, et al., in the September 1 issue of *Environmental Science and Technology*, suggests that LNG imported into the USA will have life-cycle emissions of CO_2e equal to, and possibly exceed, that of coal. There appear to be many instances in their paper where LNG seems to be systematically disadvantaged in the analysis.

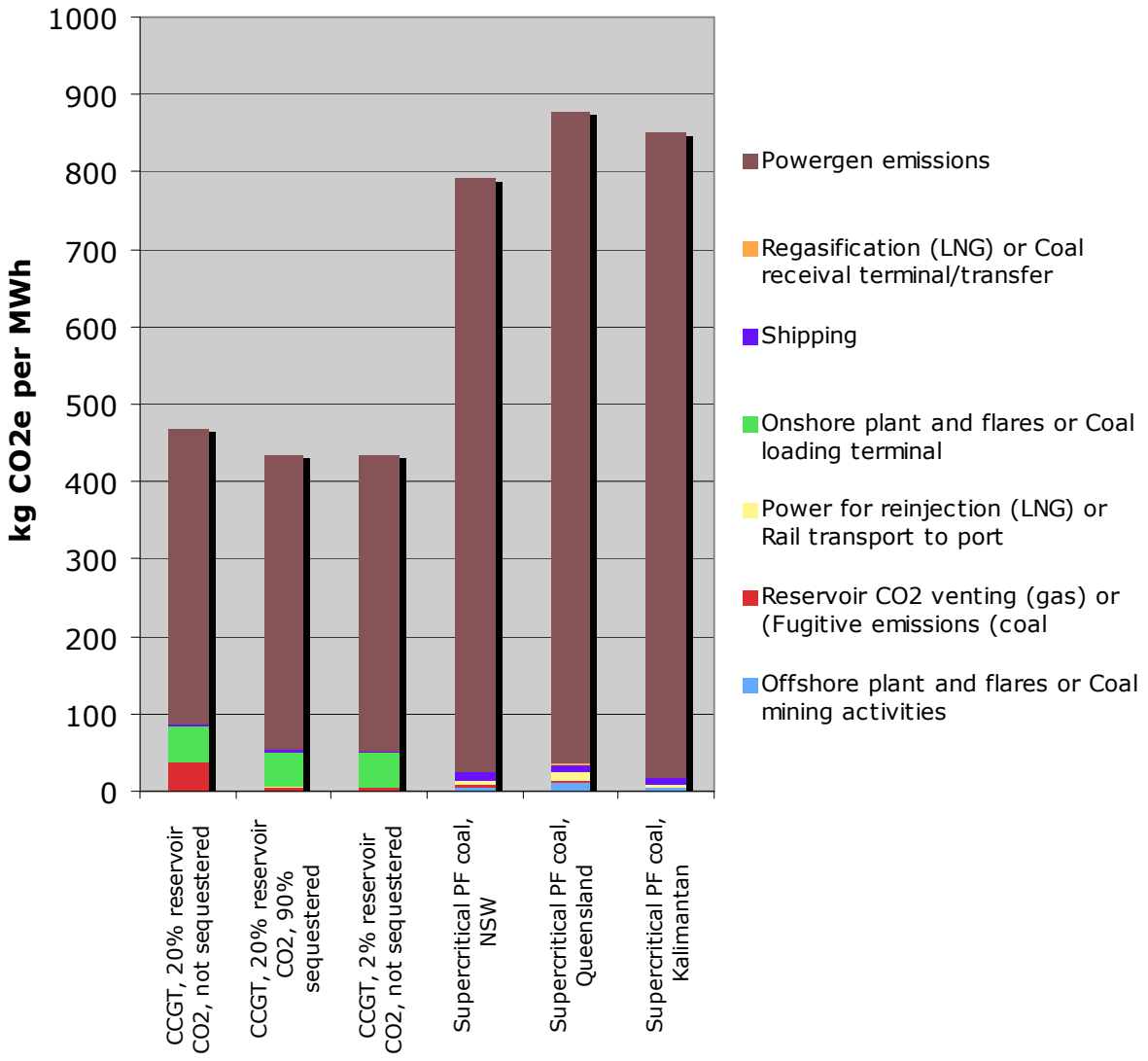
Daley's Charts

- Primary natural gas demand: Asia-Pacific
- 'Life cycle' CO_2e emissions: Fuel source to power station in North Asia
- Levelised Power Generation Cost Comparisons, with and without CCS ,and with and without emissions charges
- Effect of emissions charges on the cost of baseload power: Illustrated case 2

Primary natural gas demand: Asia Pacific



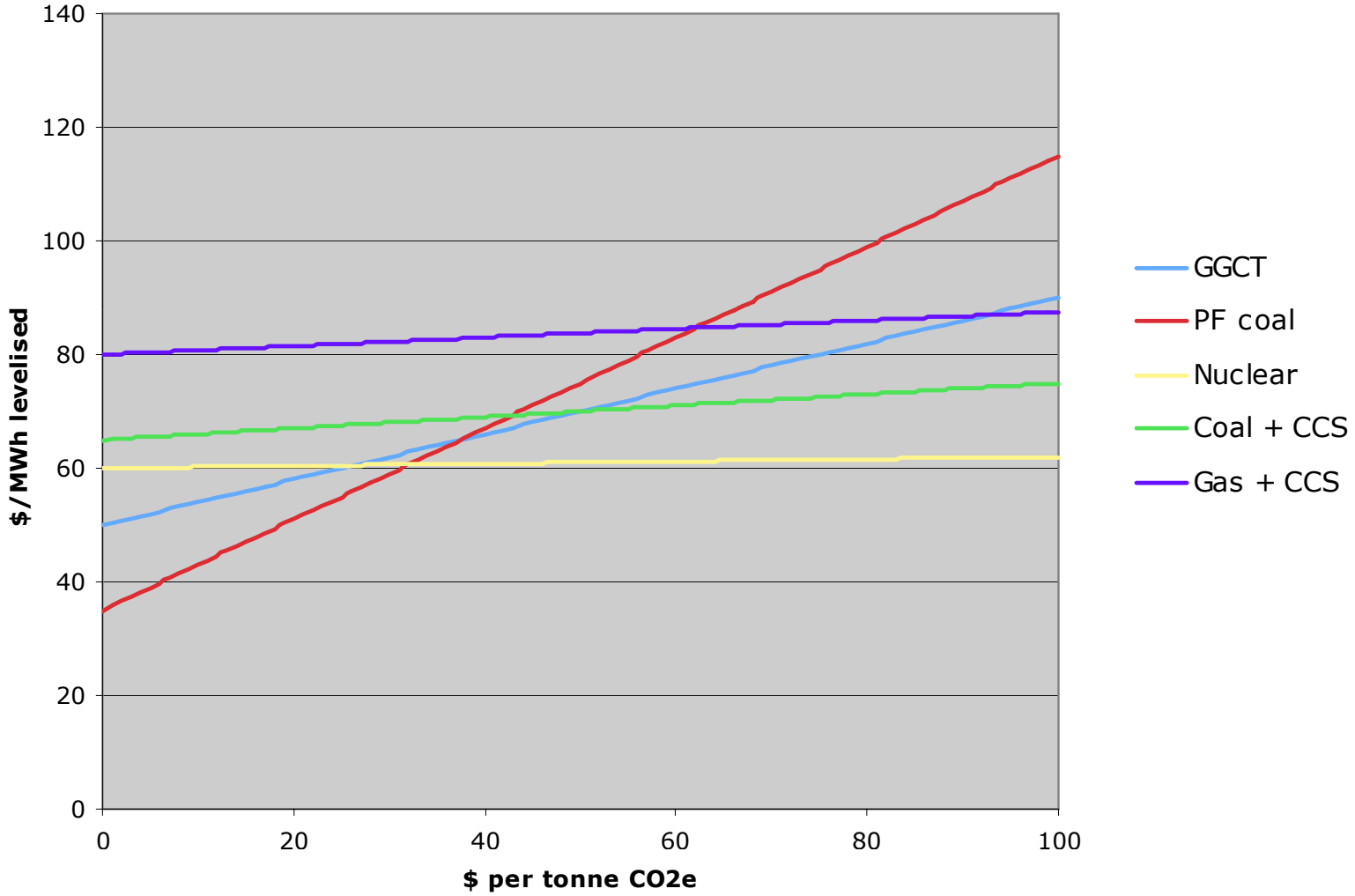
'Life-cycle' CO2e emissions: fuel source to power station in North Asia



Levelised Power Generation Cost Comparisons, with and without CCS ,and with and without emissions charges

	Emissions	Levelised powergen costs, without emissions charge		case 2 vs case 1
	kg CO2e/MWh	Illustrative case 1	Illustrative case 2	
LNG/CCGT	400	$40	$50	dearer gas
LNG/CCGT+CCS	75	$60	$80	CCS costs higher
Coal/Supercritical PF	800	$35	$35	
Coal + CCS	100	$55	$65	CCS costs higher
Nuclear	20	$60	$60	

Effect of emissions charges on cost of baseload power: illustrative case 2



Possible Implications for LNG Investment Requirements Resulting from Implementation of Carbon Emissions Constraints: A Hypothetical Case

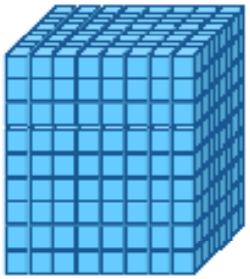
- The question I am asking is what would be the investment requirements in the LNG industry if China chose to shift a significant share of its electricity generation capacity *growth* to natural gas, from coal, and if this was to be supplied by LNG.
- It has been suggested that China's generation capacity is growing at 1,000 MW per week.
- What if China chose to make 25% of that *growth* natural gas fired that is fed by LNG?
- This 250 MW of capacity per week would be incremental to current expected calls on LNG supplies.

Table 1: 25% of potential 1,000 MW per week electricity capacity growth in China
250 MW per week => 13,000 MW per year
90% load factor => 11,700 MW running 24/7
@ 8,760 hrs/yr => 102,492,000 MWh of electricity per year
@ 3,412 Btu / kWh => 349.7 x 10^{12} Btu of electricity per year
@ 50% thermal efficiency => 699.4 x 10^{12} Btu of natural gas per year
@ 1,050 Btu / ft^3 => 666.1 x 10^9 ft^3/y (or 666.1 Bcf/y or 18.9 Bcm/y)
Divide by 600 to convert to LNG form => 1,110,167,314 ft^3/y of LNG (or ≈ 1.1 Bcf/y of LNG or 31.1 million cm/y of LNG)
Divide by 87.2 to convert from ft^3 to tonnes => **12.73 million tonnes of LNG per year**

What may this cost?

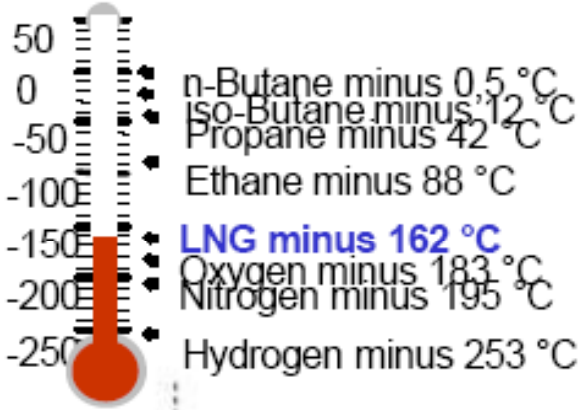
- The 12.73 mtpa will have to be added each year for a decade to keep up with the expected *growth* in generation capacity.
- The following chart provides an estimate of the cost of two alternative supply chains, neither exactly matching the 12.73 mtpa volume, and the estimates are a couple years old.
- It may, however, be somewhat instructive to look at these older estimates and consider what has happened to construction costs in the oil and gas sector in the intervening period.

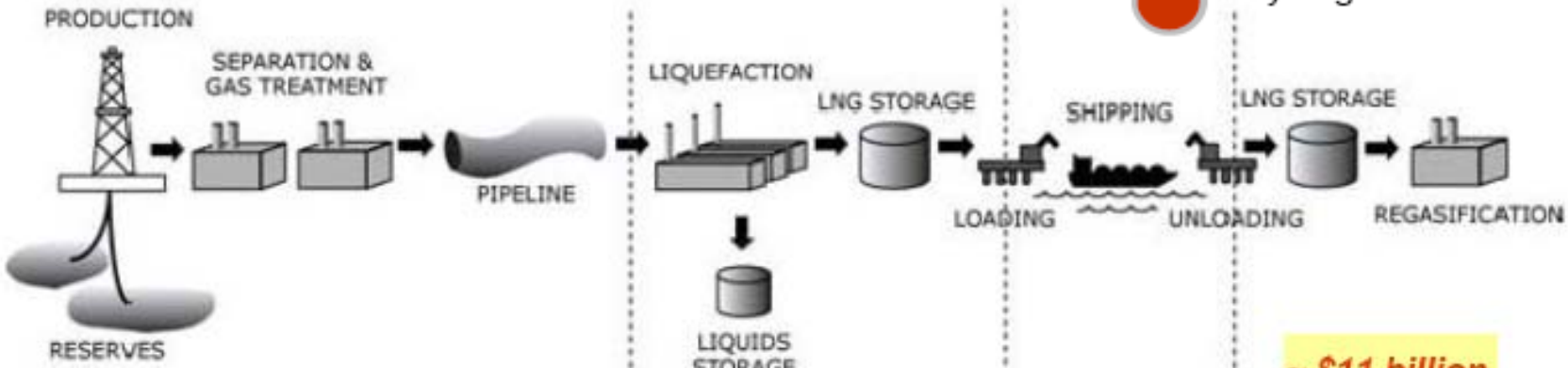
Introduction : LNG Chain is complex and expensive



600 m3 GAS

1 m3 LNG





~ $11 billion

2X 7.5 MMt Trains (~1.9 Bcf/day)

US$ 1.5 B | US$ 2.5 B | US$ 5.5 B (~34 Ships) | US$ 1.5 B

~ $4 billion

1X 4.0 MMt Train (~0.5 Bcf/day)

US$ 1.0 B | US$ 0.8 B | US$ 1.4 B (~9 Ships) | US$ 0.7 B

Construction Cost Increases

- In the past two years construction costs have been estimated to have increased by 50%; there also are estimates that in the past five years costs have tripled.
- Since the estimated costs in the previous chart are from 2004, if we apply the 50% increase, the 2x7.5 mtpa project would be expected to cost between $16 and $17 billion.
- If the industry needed, or wanted, to expand capacity incrementally by 12.73 mtpa, we could probably expect additional upward pressure on construction costs, and the cost of the 12.73 mtpa could be heading to $20 billion, or more.

Summary - Discussion

- This is hypothetical, but… .
- It suggests that huge investments may need to be sustained to either meet the challenge of a government mandated increase in demand or to provide the incentive for a shift from coal to LNG.
- It suggests that the pace of approvals will be important.
- However, in addition to the dollar amounts associated with the pace of approvals discussed at APGAS 2006, we now must also consider the CO_2e emissions differences that will exist if LNG projects are delayed.
- This difference could be in excess of 50 million tonnes of CO_2e per year, for this 250 MW per week example.