Our take on an issue of the day ...

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In this edition

More and more countries in Asia are developing green-house gas emissions reduction strategies.

In this Chinese New Year edition of Lantau Pique, we look at a recent proposal to reduce coal-fired generation substantially in Hong Kong using a combination of natural gas and nuclear power.

The "50:40:10" proposal may be politically acceptable and technically feasible, but it is nothing like the type of regulation and market-based initiatives that are needed to truly deliver lower cost greenhouse gas emission reduction solutions.

May you enjoy good health and prosperity in the Year of the Rabbit!

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Lantau **Pique**

From Hong Kong to Texas, With Love

The Government of the Hong Kong SAR (GOHK) recently released a consultation document: "Hong Kong's Climate Change Strategy and Action Agenda" (Agenda).[1] The Agenda proposes that Hong Kong reduce greenhouse gas emissions substantially by, among other things, reducing the coal-fired proportion of Hong Kong's electricity generation output from 54% in 2009 to no more than 10% by 2020.

To achieve this reduction in coal-fired generation, Hong Kong's share of generation from nuclear power would increase to around 50% and its share of generation from natural gas would increase to around 40%.[2] The Mainland has assured Hong Kong of nuclear generation capacity and natural gas sufficient to meet this target, making it technically feasible for this "50:40:10" proposal to be a key part of Hong Kong's overall climate change strategy.

Feasible and affordable, but not necessarily cost-effective…

The Agenda focuses on the need for emission reduction, the sources where emissions could be reduced and on whether achieving those reductions is affordable, casting the cost of greenhouse gases emission reduction as something to be measured in terms of its impact on Hong Kong's GDP.

The GOHK's Agenda, however, does not set out a clear analysis of the cost effectiveness of the 50:40:10 target in conventional economic terms.

Because we can, or because it makes sense?

The focus on feasibility and affordability, but not cost-effectiveness, constitutes a big departure from sound policy analysis. Good analysis focuses on benefits as well as costs. Imagine a study which suggests that a large new government office building should be built simply because taxpayers can afford it. Imagine a property developer building an apartment building and charging only half-price for each apartment simply because the developer is already wealthy. Good investors focus on whether the next investment makes good business sense; they do not spend money just because they have it.

1. And in December 2010, the GOHK released a study entitled: "A Study of Climate Change in Hong Kong – Feasibility Study" by Environmental Resources Management.

2. The percentages reflect actual generation output shares, not installed generation capacity shares.

Regulating inputs rather than output…

The 50:40:10 proposal is also unusual in that it represents an attempt to regulate the input fuel mix for electricity generation, rather than set limits on emissions or establish cost-effectiveness thresholds. Output-based regulation provides much greater scope for flexibility and innovation in determining how best to meet the overall objective. Invariably more flexibility leads to greater value by lowering cost or increasing reduction potential.

If Hong Kong seeks to lead by example, then the way the GOHK constructed, evaluated and presented the 50:40:10 target is not a strong platform for doing so. In fact, though it may be technically feasible and reasonably affordable, the economic costs of the 50:40:10 are still very high when properly put in context. And for power sector investors, the extensive long-dated investments and contractual commitments will require a supportive regulatory arrangement beyond the end of the current Scheme of Control.

In light of these concerns, we review the 50:40:10 proposal from a different perspective. The results may surprise you.

A manageable tariff path, but a significant hidden cost…

The 50:40:10 proposal will require significant, long-dated investments in new generation capacity and power and fuel purchase contracts. Even so, we project only a modest increase in the average power tariff between now and 2020, an increase less than the inflation rate.[3] So, superficially at least, the 50:40:10 proposal appears reasonable. And Hong Kong's air quality has reached a point where just about any policy that can be described using terms like "reasonable" and "emission reduction" in the same sentence will probably find a great deal of support.

But the visible tariff impact is not the real story. The real cost of the 50:40:10 proposal is about what happens to future tariffs if the 50:40:10 proposal is adopted relative to what would have happened to future tariffs if the 50:40:10 proposal is not adopted, as shown in Figure 1.

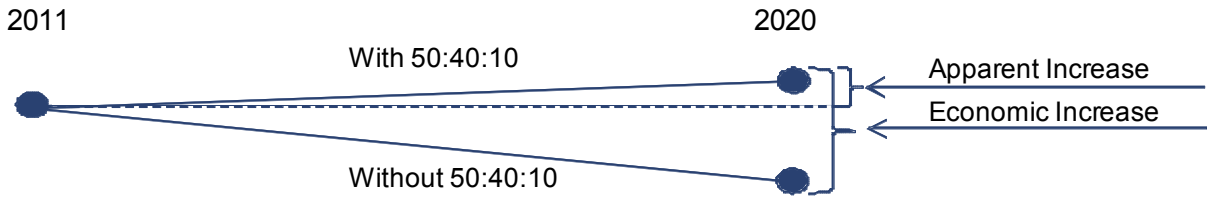


Figure 1: Illustration of economic cost versus apparent cost

Viewed in this way, we calculate an "economic" tariff increase on the order of 20 to 25%, implying that 20 to 25 cents of every dollar spent on electricity in Hong Kong will be spent ***only*** because of the commitment to 50:40:10.[4] And that is a pretty large cost. With the possible exception of Spain, we are not aware of any country that has intentionally dedicated such a large proportion of its electricity tariff to a specific greenhouse gas emission reduction policy.

3. Special thanks to Adam Worthington, Head of Regional Utilities, Renewables and Coal, Asia; and Zhi Aik Yeo of Macquarie Securities for their kind assistance.

4. We projected the target generation capacity mix necessary to support achievement of the 50:40:10 proposal. We also projected the generation capacity and fuel mix that would make sense without the 50:40:10 proposal. We looked at nuclear and gas-related costs separately in order to understand the specific impact of each component of the 50:40:10 proposal. We estimated the associated costs from various public sources, including the CLP's and HKE's 2009 Annual Report and, with respect to nuclear power and other generation technology costs, various public reports from McKinsey & Company.

Over a thousand dollars per Hong Kong resident each year

The costs of implementing 50:40:10 versus what the cost of producing electricity *might otherwise have been* is projected to be around HKD9 billion each year by 2020.[5] Assuming Hong Kong's 2020 population is 7.7 million[6], the 50:40:10 proposal represents an average cost of over HKD 1,200 per person each year.[7]

Nuclear power is mostly a zero-sum transfer from the Mainland

According to publicly available McKinsey & Company research, the all-in cost of nuclear power within the Mainland is nearly the same as the cost of coal-fired generation.[8] Building nuclear power instead of building coal-fired generation reduces greenhouse gas emissions at an almost trivial cost of USD5 per tonne[9], a figure substantially less than the costs associated with most wind, solar or other renewable energy projects, and below the cost of most of the carbon credits that have been sold to date. If the Mainland could build and operate as many nuclear power stations as were needed, it could stop building coal plants, and the world would make enormous progress towards controlling and reducing greenhouse gas emissions at an exceptionally low cost.

It is not surprising, therefore, to see nuclear power feature prominently in the 50:40:10 proposal. The electricity generated from nuclear power results in nearly zero greenhouse gas emissions. By increasing the proportion of Hong Kong's electricity that is generated using nuclear power, Hong Kong can reduce its greenhouse gas emissions.

The problem is that the Mainland power sector has been unable, to date, to build nuclear power generating capacity in line with growing demand. If nuclear construction is running flat out, then Hong Kong's participation in a nuclear project simply means there is less nuclear available for the Mainland. The Mainland will need to offset the transfer of nuclear energy to Hong Kong by increasing generation from its own coal plants.

If Hong Kong could contribute to speeding up the pace of nuclear development in the Mainland, then that would be a tangible and positive contribution. But it has been 20 years since CLP Power was directly involved in the construction of the Daya Bay power station. And while Hong Kong could provide financial capital, the Mainland has become one of the biggest economic forces in the world today and by all accounts can easily afford to build whatever infrastructure it wants. The reality is that if Hong Kong can do something to "expand" the Mainland's nuclear development programme, the net impact would still be small. If so, then substantially all of the nuclear power that could be made available to Hong Kong would simply reduce the nuclear power available to the Mainland.

Alas, Hong Kong may claim to enjoy the benefits of contributing to emission reductions through investment in nuclear power, but in reality overall greenhouse gas emissions within the broader Pearl River Delta region, or within greater China, will probably be the same no matter what Hong Kong does. This fact highlights the importance of extra-regional accounting. Tracking power system related greenhouse gas emissions within Hong Kong alone is not particularly meaningful given Hong Kong's level of economic, electrical and fuel-related integration with the Mainland.

5. We assume the cost of natural gas to Hong Kong is on par with the cost of LNG delivered to other Asian countries such as Korea, Japan, Taiwan and Singapore. Historically, the price of LNG to Asia Pacific countries has been linked formulaically to the price of crude oil. We assume 85% of crude oil parity as the basis for LNG pricing. We assume gas sourced by the Mainland from Central Asia or from domestic sources will not be sufficient to offset the Mainland's need to import LNG. Consequently, the value of gas is set by the LNG price. Use of a lower value would benefit Hong Kong, but at the Mainland's expense.

6. See: "Hong Kong's Population Projections 2010-2039", Census and Statistical Department Hong Kong Special Administrative Region, People's Republic of China, Table 1.7.

7. Per customer costs would be higher, but would also include businesses which will be hit disproportionately as they use much more electricity than residential customers.

8. See: "China Green Revolution: Prioritizing Technologies to Achieve Energy and Environmental Sustainability", McKinsey & Company, 2008, p. 109.

9. Based on the current Euro to US dollar exchange rate (approximately 1.3 Euros per US Dollar).

50:40:10 is therefore fundamentally a story about natural gas

The main thrust of emission reductions specifically attributable to 50:40:10 is the emission reduction associated with the proposed increase in the use of natural gas. If nuclear power is mainly a zero sum transfer from the Mainland to Hong Kong, then virtually all of the net regional emission reductions that arise from 50:40:10 do so because natural gas is used aggressively to displace coal-fired generation.

Worldwide, natural gas is seen as a clean fuel that is part of the solution to greenhouse gas emissions. While such perception is not untrue, it is imprecise, and ignores the reality that gas-fired generation is also a source of greenhouse gas emissions and that the price of gas differs widely around the world. Some regions, like Texas in the United States, have access to gas at much lower prices than other regions of the world. Looking forward, the gas available to Hong Kong and China is likely to be at the higher end of the pricing spectrum.

Of course, the cost of the 50:40:10 proposal to Hong Kong could be reduced if the Mainland were to make natural gas available to Hong Kong at a sufficiently low price. But any "cheap" gas that the Mainland offers to Hong Kong will need to be replaced from more expensive sources. After all, the Mainland still needs more gas. If anything, the Mainland is paying increasingly high prices to import natural gas in the form of LNG.

The Mainland has no reason to offer Hong Kong gas priced less than what the Mainland itself must pay unless the Mainland intends to offer Hong Kong a hidden subsidy. Surely it is the intention of Hong Kong—China's most developed city—to make a contribution to global emissions reduction without need of a subsidy from a developing country.

And natural gas in China is a bad deal for greenhouse gas reduction…

The cost of switching from coal to natural gas at existing power stations in Hong Kong is just about three times the cost to make the same switch in Texas, as shown in Figure 2.

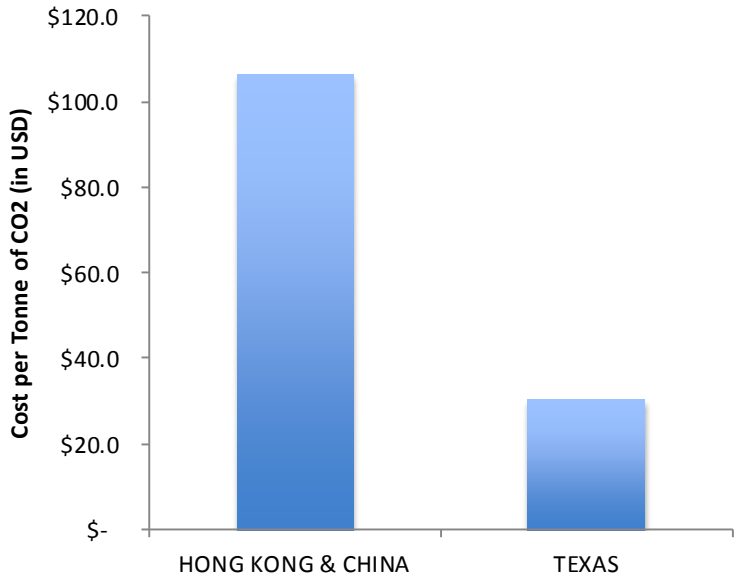


Figure 2: Cost of switching to gas in Hong Kong versus Texas[10]

Texas is a very large economic region with its own wholesale electricity market. Texas generates a total 404 GWhs of electricity per annum, nearly ten times more than Hong Kong, mostly from natural gas and nuclear power. Of that total approximately 60 GWhs of electricity is generated from coal-fired power stations totaling 9 GW of installed capacity (approximately 50% more than is installed in Hong Kong).

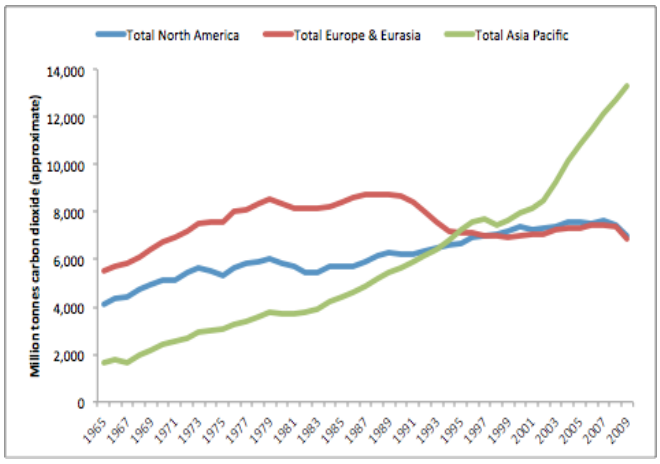
10. Supporting calculations are shown at the end of this report.

The price of natural gas in Texas is largely determined by gas sales and purchase at the Henry Hub pricing point. Henry Hub is a point at which nine interstate and four intrastate pipelines converge. The Henry Hub price is the key gas pricing point for most of North America. Texas is geographically close to Henry Hub and so pays relatively less in delivery charges, making Texas one of the least expensive places to purchase natural gas in the United States. Recently, the price of natural gas in the United States has fallen dramatically due to a combination of reduced demand (due to the recession) and a significant increase in supply (due to the commercialization of shale gas extraction).

Global gas markets do not yet converge around a single common reference price across the various markets in North America, Europe and the Asia Pacific region. Until they do, one can achieve the maximum greenhouse gas emission reduction per dollar spent by targeting those markets where natural gas is most favorably priced and pursuing different options in those markets where natural gas is more expensive.

Asia is the real loser when international carbon markets fail

As shown in Figure 3, Asia's growth is driving a massive increase in greenhouse gas emissions. An attempt to reduce those emissions using natural gas purchased in the Asia Pacific region will be much more expensive than a similar effort to use more natural gas in North America or Europe. Asia is a big loser if there are limited international emission reduction opportunities. The West is a big loser if it conceptualizes the solution as massive investment in natural gas-fired projects in Asia.



Source: BP Statistical Review of World Energy 2010

Figure 3: Greenhouse gas emissions by region

Given that greenhouse gas emission reduction is a global challenge, an ideal world would first see reductions occurring in those regions and in those ways that involve the lowest costs, gradually moving to other regions and other approaches that involve higher costs until the cumulative total of necessary reductions has been achieved. In the ideal world, Hong Kong would *not* implement 50:40:10 unless or until all the coal in Texas had already been displaced by gas and it was clear that further reductions were still required to meet the global emission reduction target. In the ideal world, Hong Kong would most likely be a net *financial* contributor, helping others in other places achieve cost-effective emission reductions that Hong Kong, itself, has no direct access to.

Results such as these show the clear value of international cooperation in the development of solutions to the challenge of reducing global greenhouse gas emissions. Unfortunately, real opportunities for such cooperation have been limited. Carbon credit trading is one mechanism intended to bridge these gaps. Most carbon markets allow purchases of carbon credits at prices one-fourth to one-tenth the cost that Hong Kong would pay to increase natural gas usage. Other programmes, such as the Clean Development Mechanism, are focused on channeling money from developed countries into developing countries. Ironically, that may be the least efficient direction for funds to flow! In a more efficient economic world, Asia would do well to invest in the developed world where far more options already exist with which to reduce greenhouse gas emissions cost effectively.

Put differently, *Hong Kong could choose not to implement 50:40:10, but to instead take the resulting savings and spend it so as to retire all coal-fired power stations in Texas. Hong Kong electricity consumers would pay the same as if 50:40:10 had been implemented, but they would likely have reduced global greenhouse gas emissions by 50% more for the same amount of money. How or why is this not a good deal? A greener deal? A better deal?*

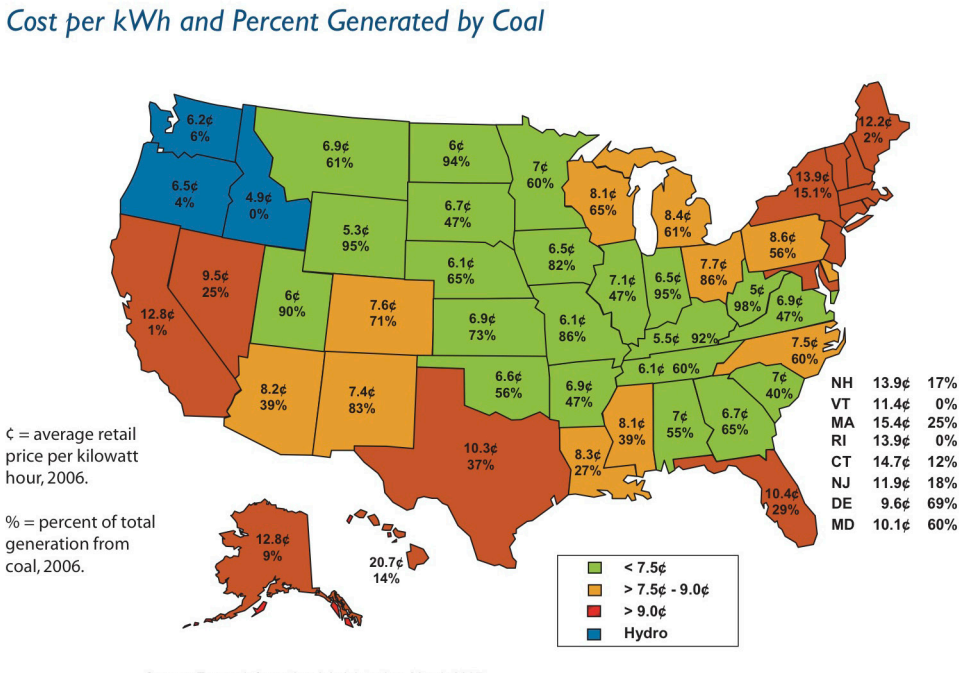
Or, Hong Kong could simply invest to reduce emissions in Texas by the same amount as implementing 50:40:10 would achieve in Hong Kong. In doing so, Hong Kong would still have money left over to do other good works at home or abroad. This may sound silly and it may be infeasible politically, but it is economically sound and it is a pretty good deal for all parties. It would also set a beneficial precedent by supporting international solutions to what is fundamentally a global problem. Indeed, it is a lot cheaper to reduce greenhouse gas emissions using natural gas *throughout* much of the United States and Europe than it is to do so in Hong Kong (or China, Japan, Korea, Taiwan or any Asia Pacific LNG importing country).

You can have coal-fired generation and clean air….

Greenhouse gas emission reduction is sometimes confused with improvement in air quality. A pure reduction in greenhouse gas emissions does little to improve ambient air quality. The Pearl River Delta air quality problem is not a greenhouse gas emission problem, so it is not necessary to restrict available options only to those that reduce greenhouse gas emissions.

The 50:40:10 proposal would reduce a wide range of emissions, but those that are relevant to regional air quality could also have been reduced in less expensive ways. The 50:40:10 proposal may be described as contributing to overall air quality improvement, but it is not fair to the consumer unless the cost of 50:40:10 is compared to the cost of other options that *would reduce those same emissions*.

Second, the level of coal-fired generation in Hong Kong is somewhat higher, but not significantly higher, than that of many areas of the world where air quality is much, much better than in Hong Kong. For example, a very large percentage of the United States derives electricity from utilities with very substantial proportion of coal-fired power generation, as shown in Figure 4. Without question, 50:40:10 would reduce Hong Kong's power sector emissions. But the associated costs are substantial, and out-of-line with the cost of alternatives that work perfectly well throughout most of the developed world.



Source: Energy Information Administration, March 2007.

Figure 4: Coal-fired generation in the United States

To be clear, the point here is not to argue against efforts to improve air quality, but to identify ways to maximize the effectiveness of the money available to tackle the problem. Spending more money on options that contribute less to the eventual solution means having less money later to spend on options that can contribute more.

Conclusion

The 50:40:10 proposal, though affordable, is much less cost-effective than approaches that combine greater flexibility and access to international cooperation. The fundamental reason for this is that natural gas in the Asia Pacific region has long been priced on terms that make it relatively expensive for power generation. To then attempt to extend the use of natural gas to back down coal-fired generation may look like the same strategy that is being pursued in other developed countries, but those countries have very different natural gas resource economics. Asia Pacific countries dependent on LNG will need to develop different greenhouse gas emission reduction strategies. Coal-fired generation may well be the most economic option, but should be combined with offsetting participation in international carbon markets where feasible.

Hong Kong's legitimate interest in contributing positively to global greenhouse gas emission reduction should look beyond 50:40:10 and consider ways to add flexibility into the core design of the 50:40:10 policy. For example, as a next step, the HKG could:

- Identify an acceptable cost per tonne emission reduction threshold and challenge the power companies to develop innovative approaches to achieve those reductions, thereby maintaining control over runaway costs and maximizing the value of flexibility and innovation.
- Identify international partnerships that allow the Hong Kong government to take a leadership position in contributing to international cooperation and a framework whereby individual countries can channel their citizen's interest in doing the right thing more constructively.
- At minimum, ensure that the gas-related portion of the 50:40:10 target be flexibly administered so as to reduce the likelihood and cost associated with entering into long-term, fixed commitments to purchase gas at prices that could prove to be excessive.
- Design an opt-out regime whereby demonstrated alternative reductions or internationally sanctioned credits can be used to displace local fuel switching or capital investment where doing so is less expensive.

An inflexible and uncompromising 50:40:10 policy sits at the extreme high end of the international cost spectrum of efforts to reduce jurisdictional greenhouse emissions. The higher costs arise as a result of the strong commitment to adopt natural gas, which is relatively expensive throughout much of Asia. A stark illustration of this expense shows that it would be less expensive and could also result in even greater global emission reductions were Hong Kong to simply invest so as to implement its 50:40:10 policy in Texas. While such an example may be unrealistic, it shows how the absence of effective international coordinating mechanisms contributes to higher cost local actions than would otherwise be necessary.

Appendix: Comparing the cost-effectiveness of switching from coal to gas: Hong Kong vs. Texas

It costs USD30.8 per tonne of CO2 removed in Texas, but USD106.6 in Hong Kong, as shown below.

HONG KONG & CHINA

COAL		
Cost per Tonne	$	100.0
Conversion Factor: GJ per Tonne		25.0
Result: Cost per GJ	$	4.0
Conversion Factor: GJ to MWh (Coal Plant)		9.5
Result: Cost per MWh	$	38.0
Tonnes of CO2e emitted		1.02

GAS		
Cost of Crude Oil per BBL	$	85.0
Conversion Factor (MMBTU per BBL)		5.8
Result: Cost per MMBTU	$	14.7
Conversion Factor (MMBTU per GJ)		1.05506
Result: Cost per GJ	$	15.5
Conversion Factor: GJ per MWh (Gas Plant)		7.0
Result: Cost per MWh	$	108.2
Conversion Factor: Oil price to LNG price		85%
Result: Cost per MWh	$	92.0
Tonnes of CO2e emitted		0.52
Difference in cost	$	54.0
Difference in tonnes		0.5
Cost per tonne of CO2e	$	106.6

TEXAS

COAL		
Cost per Tonne	$	30.0
Conversion Factor: GJ per Tonne		20.0
Result: Cost per GJ	$	1.5
Conversion Factor: GJ to MWh (Coal Plant)		9.5
Result: Cost per MWh	$	14.3
Tonnes of CO2e emitted		1.0

GAS		
Cost per MMBtU	$	4.0
Conversion Factor (MMBTU per GJ)		1.05506
Result: Cost per GJ	$	4.3
Conversion Factor: GJ per MWh (Gas Plant)		7.0
Result: Cost per MWh	$	29.8
Tonnes of CO2e emitted		0.5
Difference in cost	$	15.6
Difference in tonnes		0.5
Cost per tonne of CO2e	$	30.8