# Feedbacks on the consultancy document for HK's climate change strategy and action agenda.

## Background

The Hong Kong MARKAL-MARCO (HKMM) model was used to examine three scenarios for the mitigation analysis quantitatively. Hence, the suggestions in the Consultation Document are based on the results of HKMM. From the document (Agreement No. CE 45/2007 EP) released in December 2010, we found that there were one reference scenario and three proposed scenarios "run" with HKMM for the scenario selections and reported that only Scenario 3 can reach the emissions reduction target. The proposed scenarios mean that different policies were imposed for emissions reduction and use of new energy saving technologies. One of the important policies is "energy-mix" in the power generation sector. In p.B-54, it was mentioned that the mitigation policies and measures proposed in this study are defined with **fixed market penetration**, energy targets, or market shares.

## Feedbacks

### (1) Abnormal result: the more emissions reduction we achieve, the more energy we use.

Table 1 is the summary of the results of all scenarios in 2010. The second column is the emissions reduction amount and the third to fifth columns are the energy demand and electricity output respectively.

***Electricity demand is abnormally overestimated!***

In Scenario 2, when we are going to reduce 4.2MtCO2-e with using 211274 TJ electricity.

In Scenario 3, when we are going to reduce 16.6MtCO2-e with using 231747 TJ electricity.

That is, **if we are going to reduce 12.4MtCO2-e (16.4 - 4.2), we need to use more electricity, 20,437 TJ (231747 – 211274) which is greater than all the electricity consumption of the private household segment in 2007!**

| | Table 3.2 Million Tonnes CO2-e reduction | Table 3.5 Final Energy Demand (TJ) | Table 3.6 Primary Energy Demand (TJ) | Table 3.9 Electricity Output (TJ) |
|---|---|---|---|---|
| **Base Case** | 46.1 | 396,211 | 744,786 | 232,152 |
| **Scenario 1** | 3.1 | 374,187 | 697,134 | 209,169 |
| **Scenario 2** | 4.2 | 375,817 | 700,716 | ***211,274*** |
| **Scenario 3** | 16.6 | 401,857 | 725,402 | ***231,747*** |

Table 1. Summary of 2010's results

## (2) Unreliable results - Price elasticity of electricity demand

From page 42 of the Consultation Document, we have the cost ranges of electricity generation by fuel type. Since the only difference between Scenario 2 and 3 is the percentage of fixed fuel-mix of the electricity generation sector, we can use this percentage to calculate the average costs of the electricity generation for Scenario 2 and 3. Moreover, since the costs are given in range, Average and High scenarios are used and the results are shown in Table 2.

| | Average Cost of electricity (cents/kWh) | |
|---|---|---|
| | Average | High |
| Scenario 2 | 64.21031 | 71.96579 |
| Scenario 3 | 62.5807 | 67.52976 |
| ***Elasticity*** | ***-3.59552*** | ***-1.45319*** |

Table 2. Price elasticity of electricity demand in 2020.

With using the fifth column of Table 1 and the average costs of electricity in Table 2, we can easily calculate the price elasticity of electricity demand in 2020 which are also the results of the HKMM model.

Note that it is well-known that elasticity of demand is generally inelastic (elasticity > -1) for electricity especially when the power company is a monopoly (government regulated monopoly). However, the above **elasticity results are contradicting the reality! The results of the report are totally unreliable.**

## (3) Hugh Marginal Abatement Cost

From Figure 3.13 showed that with Scenario 3 (the proposed one in the consultation document), the highest marginal abatement cost (5000HK$/Tonne Carbon) CANNOT help us to reach the emission reduction level found in Scenario 3 (18 MtCO2-e in 2030 from Table 3.2)

That is, **the estimated marginal abatement cost should be over 5000HK$/Tonne Carbon which is higher than the range of historical and projected records of the marginal abatement cost (or prices of carbon credits) traded in the international market. It does not make sense while we are proposed to use "cheap" and "clean" energy.**

## (4) Why we have these unreliable results?

**An analogy (using a wrong approach with a right tool to resolve the problem):** We are going to use a claw hammer for pounding nails. However, we use the

extracting-nails end of the hammer to pound nails. The nails (our results) were screwed up! The results are totally unreliable.

To answer the above question, we need to understand the foundation of the HKMM model which may be too harsh to readers. Instead, I will sum up some important features as below.

The first **M** of HKMM is the MARKAL model (a type of bottom-up engineering model) which allows a detailed description of existing and alternative energy technologies and of existing and alternative paths of energy carriers from their source -- through different conversion technologies - until the point of final energy use.

The second **M** of HKMM is the MACRO model which is a macroeconomic model with an aggregated view of long-term economic growth. The basic input factors of production are capital, labor and individual forms of energy. The economy's outputs are used for investment, consumption and inter-industry payments for the ***cost of energy***. Investment is used to build up the stock of capital. The model clearly distinguishes between autonomous and price-driven conservation.

Hence, HK MARKAL-MACRO is a synthesis between the bottom-up engineering model MARKAL and a top-down macroeconomic model called Macro described above.

***The original purpose of the integration of M and M:***
One of the important features is price-induced conservation by lowering the marginal productivity of capital and labor. That is, if there is a rise in energy costs, the production function allows us to adapt by substituting more capital like more energy efficiency machines in place of energy. In short, we have a single and asymmetric price elasticity of energy demand.

***Wrong use of fixed fuel-mix as an input to HKMM while fuel-mix should be an output of the model:***
Since the fixed fuel-mix was used as an input, it provides a false signal to the model that the energy price is reduced (under the fuel-mix strategies for different scenarios, it is expected that the energy cost of Scenario 3 is cheaper than that of Scenario 2, from p.B-46 of the document). According to the single and asymmetric price elasticity of energy demand, we “would” use more energy to maintain the overall “production” output.

## (7) Conclusion and suggestions

ENB should **really** made use of the HKMM models for different scenario settings. According to the M-M document, for CO2-e emissions studies, M-M can provide as primary results a ranking of the mitigation scenarios, as well as the cost of reducing

CO2-e (value of carbon rights) and implications for the economy. M-M should NOT be used to select the scenarios by try-and-error.

Since the proposed Scenario 3 highly rely on the imported nuclear power (~50% of electricity demand), a multi-regional model is required as mentioned on p.B-57. It is because more emissions in other Pearl River Delta (PRD) regions and finally the overall emissions in PRD is increased.

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Date: 30 December 2010