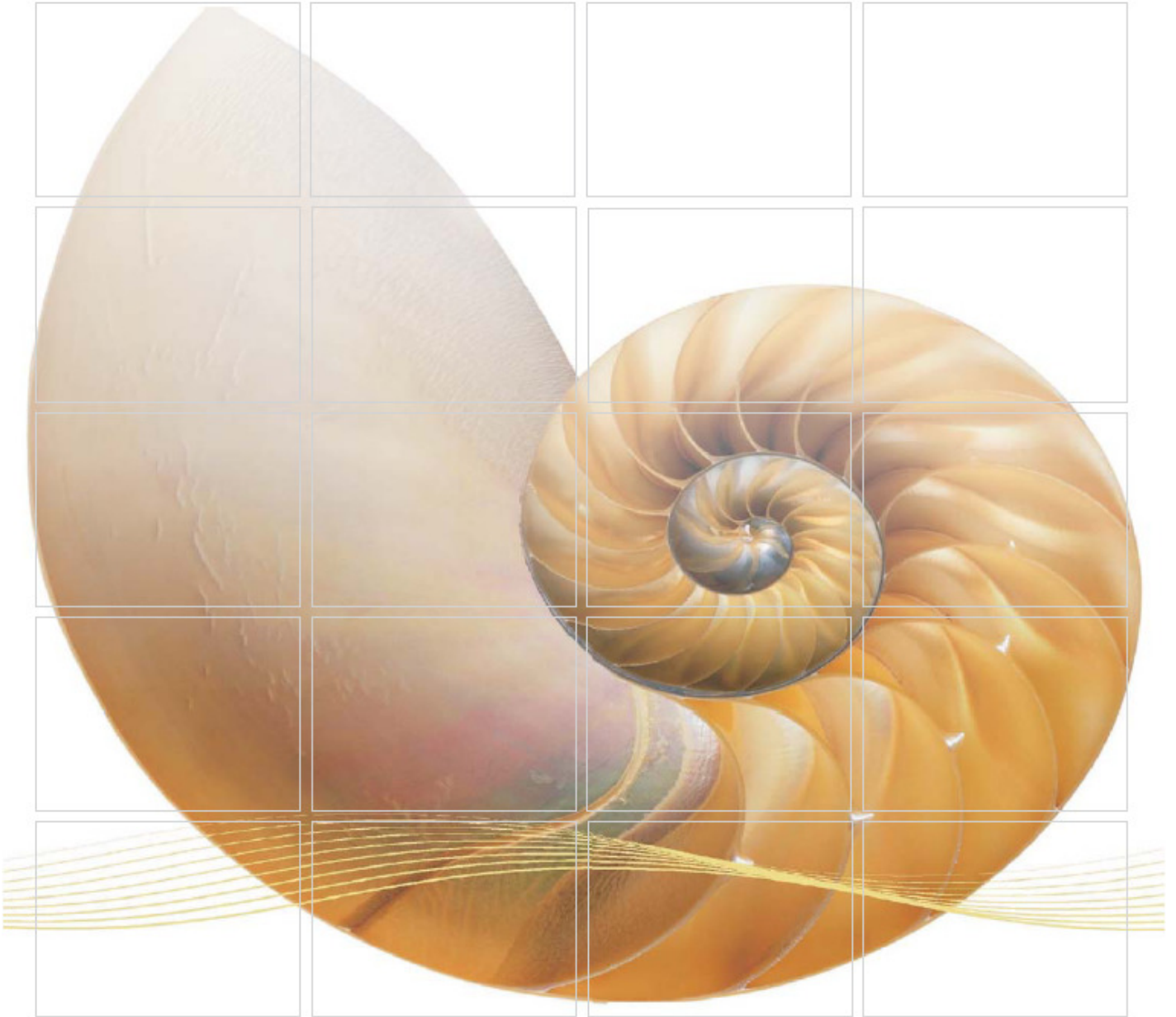


EXECUTIVE SUMMARY



Contract P153 HKIA Carbon Emissions Study

Airport Emissions Management Report

December 2014

Environmental Resources Management

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Contract P153 HKIA Carbon Emissions Study

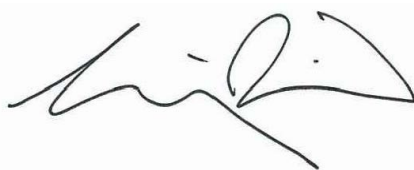


Executive Summary of Airport Emissions Management Report

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Client: Airport Authority Hong Kong		Project No: 0199279			
Summary: This document summarises the key findings on greenhouse gas (GHG) projection and the associated carbon pricing studies.		Date: 8 th December 2014			
		Approved by:  Craig A Reid Partner			
0	Technical Report	Var	CAR	CAR	8/12/2014
Revision	Description	By	Checked	Approved	Date
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1 EXECUTIVE SUMMARY

1.1 BACKGROUND

The Airport Authority Hong Kong (hereafter referred to as the “AAHK”) has been demonstrating a commitment to carbon reduction for many years including carrying out airport-wide annual carbon audits since 2008, pledging to reduce airport-wide carbon emissions by 25% per workload unit (WLU)⁽¹⁾ from 2008 levels by 2015 in 2010 and taking actions to reduce emissions across the airport community. AAHK achieved Airports Council International’s (ACI) Level 3 Optimisation accreditation in late 2012, successfully renewing the certificate in 2013.

In 2013, AAHK commissioned ERM-Hong Kong, Limited (ERM) to project future greenhouse gas (GHG) emissions and associated carbon cost expected to arise from the planned three-runway system (3RS); the future two-runway system (2RS) should the 3RS not be pursued; and to compare the findings with the baseline GHG emissions calculated for the 2011 operating year (hereafter referred to as the “Carbon Emissions Study”). This report summarises the key findings of the Study.

1.2 GHG EMISSIONS STUDY

A GHG emissions study has been carried out under the Carbon Emissions Study to project the GHG emissions associated with the operations of the planned 3RS, and the future 2RS should the 3RS not be pursued. The assessment adopted two approaches, namely

- **Approach 1:** Full Landing and Take-off (LTO), and Full Cruise for Departing Flights; and
- **Approach 2:** LTO and Cruise within the HKSAR geographical boundary for both departing and arriving flights, plus ground emissions.

Approach 1 was adopted because this method is widely used for assessment of GHG emissions from international aviation and follows Intergovernmental Panel on Climate Change (IPCC) guidelines whereby ‘national jurisdictions’ only report GHG emissions from departing flights, to avoid double counting between jurisdictions. GHG emissions projected using Approach 1 were used to derive a “global” carbon cost for the emissions. Approach 2 was developed in order to provide an estimate for GHG emissions from aircraft and non-aircraft aviation activities within the HKSAR geographical boundary. The methodology developed follows relevant GHG measuring and reporting protocols and aligns with requirements in guidance documents for ACI’s Airport Carbon Accreditation scheme, which accounts for GHG emissions from aircraft emissions as well as non-aircraft emissions (e.g. emissions from other airport activities). Under Approach 2, further assessment is made on identifying those GHG

⁽¹⁾ One workload unit is equal to one passenger or 100kg of cargo.

emissions emitted within the HKSAR geographical boundary which AAHK/Hong Kong International Airport (HKIA) may control, guide or influence. It should be noted that the “local” carbon cost of GHG emissions estimated using Approach 2 is more appropriate for making comparisons with the economic benefits attributed to the third runway in Hong Kong.

Quantification of GHG emissions using both approaches was carried out for year 2011, and five future assessment years (i.e. 2018, 2023, 2031, 2035 and 2038) based on the review of the IATA Consulting projection of CO₂ emissions due to LTO. The rationale for selecting the five future assessment years is as follows:

- 2018 (the year with air traffic movements (ATM) hitting 2RS’ practical maximum capacity of 420,000);
- 2023 (the planned first year of 3RS operation);
- 2031 (the year when peak aviation CO₂ emissions due to LTO are projected, hence also defined as the “worst year”);
- 2035 (the mid-point between 2031 and 2038);
- 2038 (15 years after the commencement of 3RS operations in 2023).

The findings were then extrapolated to estimate the GHG emissions for a 50-year period, (i.e. 2012 to 2061) in order to estimate the additional GHG emissions due to the operation of the 3RS. The key assessment findings are presented in the following sections.

1.2.1 GHG Emissions of the Five Assessment Years under Approach 1 and Approach 2

Figure 1.1 and *Figure 1.2* show the comparison of GHG emissions of the 3RS scenario with those in the 2RS scenario under Approach 1 and Approach 2.

For both approaches, with the commencement of the third runway operation in 2023, the difference between GHG emissions under the 3RS and 2RS scenarios increases from 2023 to 2031. However, this difference stabilises towards 2038 which is attributed to both the 3RS reaching saturation, and to improvements in aircraft technology.

Figure 1.1 Comparison of GHG Emissions under 3RS and 2RS Scenario for Approach 1

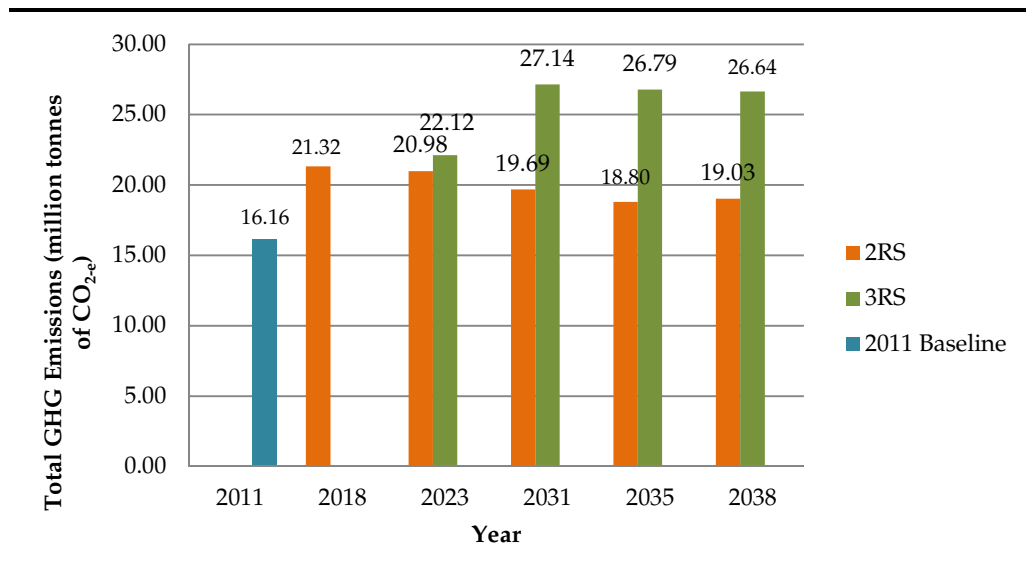
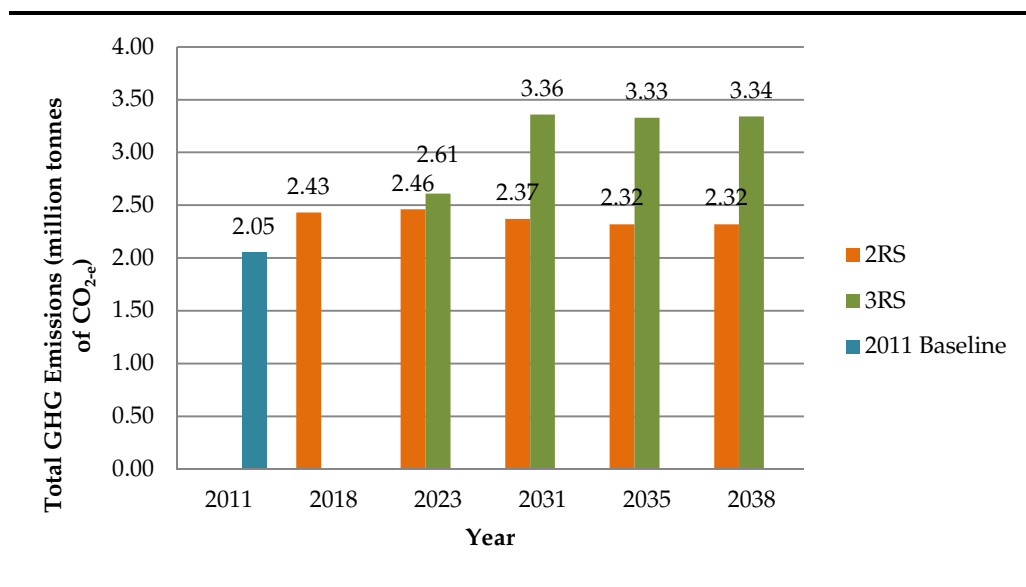


Figure 1.2 Comparison of GHG Emissions under 3RS and 2RS Scenario for Approach 2



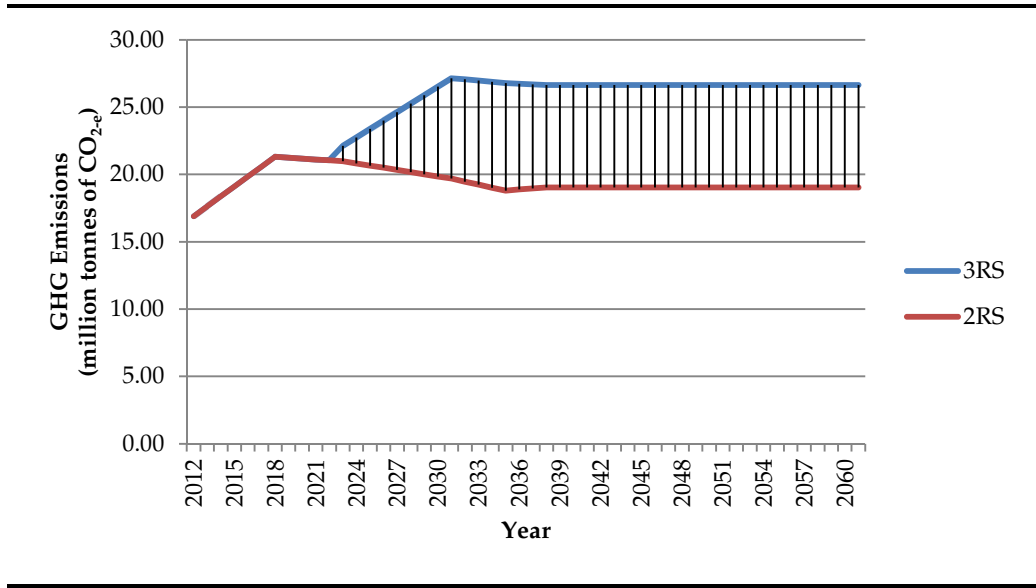
1.2.2 50-Year Projection of GHG Emissions under Approach 1 and Approach 2

The trend of total GHG emissions under the 3RS and 2RS scenarios over the 50-year period under Approach 1 and Approach 2 are presented in *Figure 1.3* and *Figure 1.4* respectively.

Under Approach 1, annual total GHG emissions for the 2RS scenario increase from 2012 to 2018 when ATMs hit a practical maximum capacity of 420,000. After 2018, total GHG emissions for the 2RS scenario show a decreasing trend up to 2035 after which emissions increase slightly to 2038 and then level off for the remainder of the 50-year period. After 3RS becomes operational in 2023, annual total GHG emissions for the 3RS scenario increase over the period to around 2032 as ATMs increase with the 3 runway operation. From 2032, 3RS GHG emissions

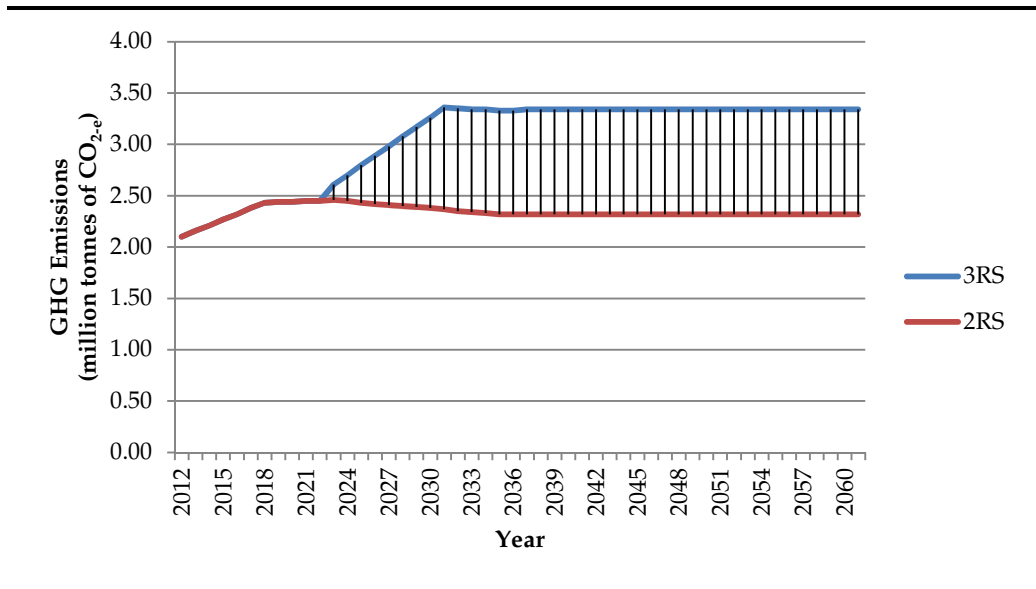
show a slightly decreasing trend, levelling off for the remainder of the 50-year period.

Figure 1.3 *Estimation of GHG Emissions over the 50-Year Period under Approach 1*



Under Approach 2, GHG emissions show a similar pattern given the same forecasts on airport activity.

Figure 1.4 *Estimation of GHG Emissions over the 50-Year Period under Approach 2*



Four possible approaches were identified for the carbon pricing for the development of the 3RS at HKIA. These approaches are:

- **Emissions Trading Schemes (ETS)** - A national or international market-based approach to control GHG through economic incentives, i.e. emitters comply via investment in own reductions or buying traded allowances. Carbon pricing under ETS is usually referred as “traded price of carbon”;
- **Marginal Abatement Cost (MAC)** - The MAC reflects the cost of one unit of emissions reduction to meet a specific emissions target. An alternative to buying carbon credits from trading platform, countries or companies can obtain carbon credit through sponsoring carbon reduction projects, e.g. under Clean Development Mechanism (CDM), Joint Implementation (JI), etc. Such carbon pricing is usually referred to as “non-traded price of carbon”;
- **Carbon Taxation** - A carbon tax is a price charged on units of carbon emissions that a facility emits. Tax is applied within national boundaries, sometimes complementing the ETS; and
- **Social Cost of Carbon (SCC)** - SCC represents the marginal cost of global damage from climate change. This is an approach used predominantly in countries where ETS and/or Carbon Tax do not apply and hence no specific reduction targets are set/ available.

The HKSAR has not subscribed to any international obligations on GHG emissions, and no national emissions target for the aviation industry is adopted in the HKSAR or PRC. It is, therefore, not appropriate to adopt ETS or MAC approach in Hong Kong. The social cost of carbon was the selected approach as it reflects the latest science on climate change impacts and the most current, leading peer-reviewed scientific information. It is also applicable on a global basis and less influenced by other factors such as market interference or government rule changes. In addition, SCC values are available from the US Environmental Protection Agency (EPA)⁽¹⁾ which are directly applied in the regulation of CO₂.

1.3.1

Future Values and Net Present Values (NPV)

The carbon cost in future values under Approach 1 and Approach 2 were calculated based on the annual SCC values in 2011 dollars⁽²⁾ and the annual total GHG Emissions. The annual carbon costs in future values were subsequently discounted back to the annual present values using a 3% discount rate. The 3% discount rate is the middle case in the US EPA work and is commonly adopted in GHG emissions cost related estimates. Furthermore, the 3% discount rate would provide a more conservative estimate compared to the 4% discount rate typically

⁽¹⁾ Based on Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis, 2013, Interagency Working Group, United States Government.

⁽²⁾ Annual SCC values in 2007 dollars from US EPA were adjusted by the Price Indexes of GDP provided on the webpage of the Bureau of Economic Analysis of the US Department of Commerce to annual SCC values in 2011 dollars on pro rata basis.

used in Government infrastructure projects in Hong Kong. By summing the carbon cost in present values, carbon costs in Net Present Values (NPV) were estimated under the corresponding approaches.

1.3.2 Result Summary on Carbon Pricing for 50 Years

Figure 1.5 shows the trend of the total carbon cost in future values for 50 years based on Approach 1. The total carbon costs in NPV associated with the 3RS and 2RS scenarios were US\$ 34.30 billion and US\$ 27.45 billion in 2011 dollars or US\$ 35.36 billion and US\$ 28.30 billion in 2013 dollars respectively (using SCC at the 3% discount rate). The carbon cost associated with the *Additional GHG Emissions* due to a third runway at HKIA during the study period is thus US\$ 6.85 billion in 2011 dollars or US\$ 7.06 billion in 2013 dollars (about HK\$ 55 billion in 2013 dollars).

Figure 1.5 Total Carbon Cost in Future Values at HKIA under the 3RS and 2RS (2012 – 2061) based on Approach 1

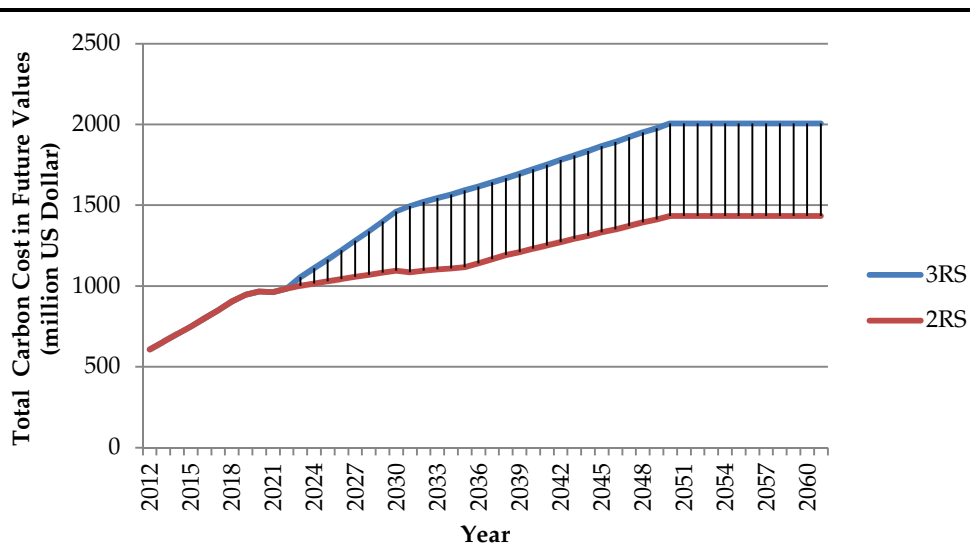
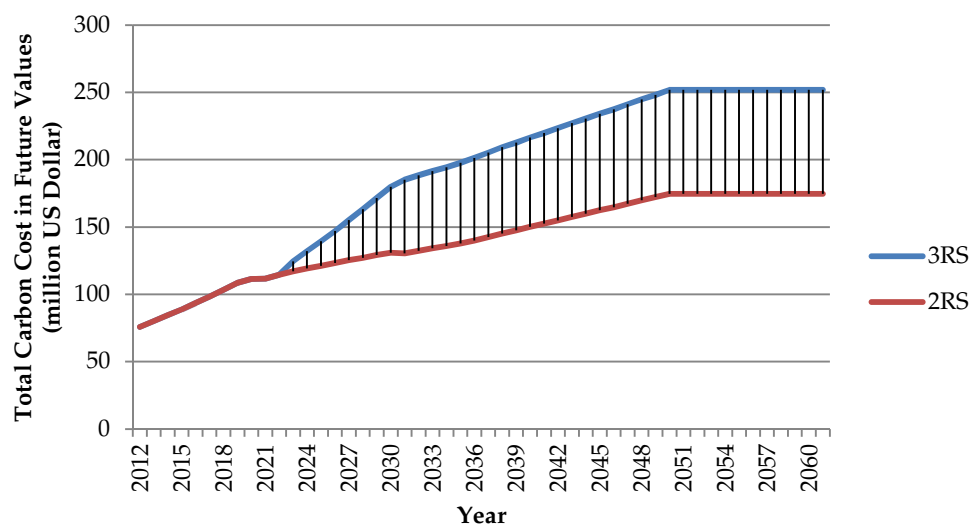


Figure 1.6 shows the trend of the total carbon cost in future values for 50 years based on Approach 2. The total carbon costs in NPV associated with the 3RS and 2RS scenarios were US\$ 4.21 billion and US\$ 3.29 billion in 2011 dollars or US\$ 4.34 billion and US\$ 3.39 billion in 2013 dollars respectively (using SCC at the 3% discount rate). The carbon cost associated with the *Additional GHG Emissions* due to a third runway at HKIA during the study period is thus US\$ 0.92 billion in 2011 dollars or US\$ 0.95 billion in 2013 dollars (about HK\$ 7 billion in 2013 dollars).

Figure 1.6 *Trend of Total Carbon Cost in Future Values at HKIA under the 3RS and 2RS (2012 – 2061) based on Approach 2*



GHG emissions from HKIA operations under a 3RS and a 2RS scenario for five future assessment years were quantified based on two approaches. Actual GHG emissions data for 2011 along with projected GHG emissions calculated for five assessment years were then used as the basis for linear extrapolation of GHG emissions for a 50-year period from 2012 to 2061 under both scenarios.

Total GHG emissions for Approach 1 under the 3RS and 2RS scenarios for 50 years were estimated to be 1,241 and 972 million tonnes of CO_{2-e}, respectively. The *Additional GHG Emissions* due to the operation of the third runway at HKIA were estimated to be 269 million tonnes of CO_{2-e}.

Similarly, the total GHG emissions for Approach 2 under the 3RS and 2RS scenarios for 50 years were estimated to be 153 and 117 million tonnes of CO_{2-e}, respectively. The *Additional GHG Emissions* due to the operation of the third runway at HKIA were estimated to be 36 million tonnes of CO_{2-e}.

Based on the assessment of different carbon pricing approaches, SCC was recommended for the estimation of the carbon cost in this study because SCC is non region/ state specific and is applicable globally. Also, it reflects the most current leading peer-reviewed scientific information and the latest science on climate change impacts. The most up-to-date SCC values are available from the US EPA which are widely adopted in the US. There are many different carbon pricing schemes worldwide and the unit price per tonne of CO₂ (tCO₂) can vary from US\$ 1 in places like Mexico/ New Zealand to US\$ 168 in Sweden. However, almost 90% of the existing carbon pricing schemes worldwide are below US\$ 35/ tCO₂ published by the US Interagency Working Group (IWG) on Social Cost of Carbon, as stated in the 2014 World Bank report⁽¹⁾.

Based on the results obtained from the 50-year projection, SCC in 2011 US dollars from the US EPA was adopted to calculate the annual carbon cost in future values. The annual carbon costs were then discounted back to present values based on the discount rate of 3%. Subsequently, annual carbon costs in present values were summed to estimate the carbon cost in net present values (NPV).

The total carbon costs of the 50-year GHG emissions in NPV under the 3RS and 2RS scenarios of Approach 1 were estimated to be US\$ 35.36 billion and US\$ 28.30 billion respectively (in 2013 dollars)⁽²⁾. The total carbon cost of the *Additional GHG Emissions* in NPV due to the operation of the third runway at HKIA was thus estimated to be US\$ 7.06 billion (about HK\$ 55 billion in 2013 dollars). It should be noted that emissions and costs from aircraft activities calculated under Approach 1 are not the responsibility of the airport (or the jurisdiction). The global aviation sector is developing a global sectoral approach to aviation GHG emissions/ cost management. The airport (or even a national jurisdiction) has very limited responsibility on such emissions.

(1) State and Trends of Carbon Pricing, World Bank Group 88284, May 2014

(2) NPV in 2011 dollars were adjusted by the Price Indexes of GDP provided on the webpage of the Bureau of Economic Analysis of the US Department of Commerce to NPV in 2013 dollars on pro rata basis

Similarly, the total carbon costs of the 50-year GHG emissions in NPV under the 3RS and 2RS scenarios of Approach 2 were estimated to be US\$ 4.34 billion and US\$ 3.39 billion respectively (in 2013 dollars). The total carbon cost of the *Additional GHG Emissions* in NPV due to the operation of the third runway at HKIA was thus estimated to be US\$ 0.95 billion (about HK\$ 7 billion in 2013 dollars). It should be noted that the cost of GHG emissions estimated using Approach 2 is more appropriate for making comparisons with the local economic benefits attributed to the third runway at HKIA.

Under Approach 2, the relative proportion of GHG emissions for the assessment years under AAHK control/guide/influence is about 1:2:7. Hence, the GHG emissions (and associated cost) under AAHK control contributes only a small fraction of total GHG emissions under Approach 2.

Nonetheless, AAHK has commitments and proactive actions to reduce GHG emissions that are possible for an airport to control or guide. These actions include ongoing joint efforts with AAHK business partners to monitor and reduce carbon emissions.