

Arup Carbon Calculator

- On 10th September 2010, the Secretary for the Environment announced Hong Kong's latest plan for tackling Climate Change. This long-awaited plan consists of a clear target in terms of both absolute and intensity, the corresponding strategies to achieve this target were listed. However, to facilitate public debate and to arrive at fact-based decisions, we feel that there is a need for Hong Kong to adopt a comprehensive framework that considers the combined effects of the different strategies.
- We introduce a Carbon Calculator that allows users to quickly build low carbon plans and assess their impact. The aim of this calculator is to provide useful estimations to inform discussions on mitigating emissions in Hong Kong, it illustrates the impact of various strategies based on physical assumptions but not economic considerations.
- Given the uncertainties when considering scenarios 10 years away, the calculator is designed to be extremely flexible to accommodate a wide range of assumptions. Users are encouraged to explore the assumptions to modify the scenarios. In fact we will like to express an important caveat at this point – the calculator is intended to help manage our uncertainties and estimate the magnitude of our task ahead, it is not a detailed economics-energy-emission model.
- In its current form, the assumptions behind the calculations are based on data published by EPD, EMSD, PlanD and various other Government sources listed at the end of this document.
- This beta test version is a precursor of the final product without full functionality and documentation. It is intended for users with some understanding of Hong Kong's climate change action plan to experiment with different scenarios. Users are encouraged to report bugs and feedback to trevor.ng@arup.com.

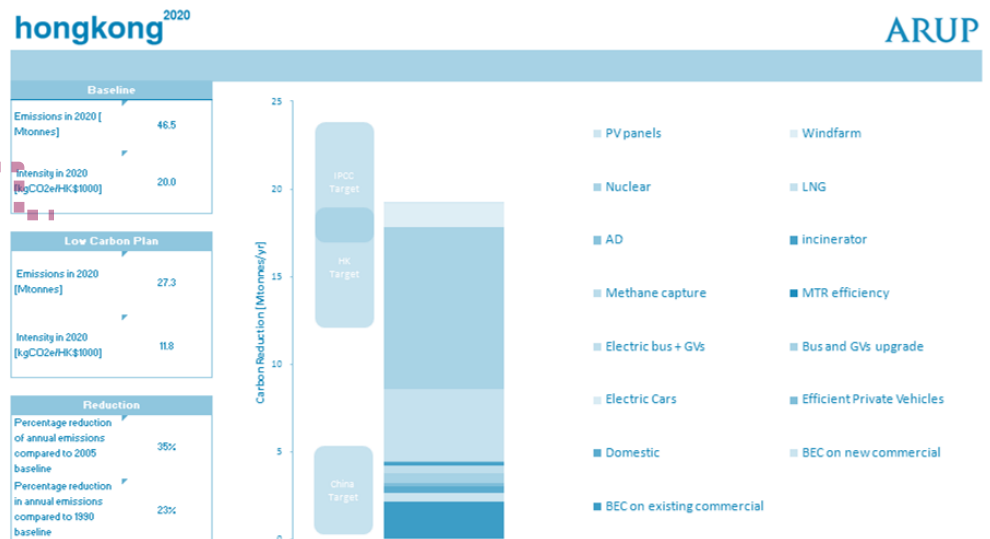
Output

- Output is displayed in boxes on top left

Baseline	
Emissions in 2020 [Mtonnes]	46.5
Intensity in 2020 [kgCO ₂ e/HK\$1000]	20.0

Low Carbon Plan	
Emissions in 2020 [Mtonnes]	26.5
Intensity in 2020 [kgCO ₂ e/HK\$1000]	11.4

Reduction	
Percentage reduction of annual emissions compared to 2005 baseline	37%
Percentage reduction in annual emissions compared to 1990 baseline	25%



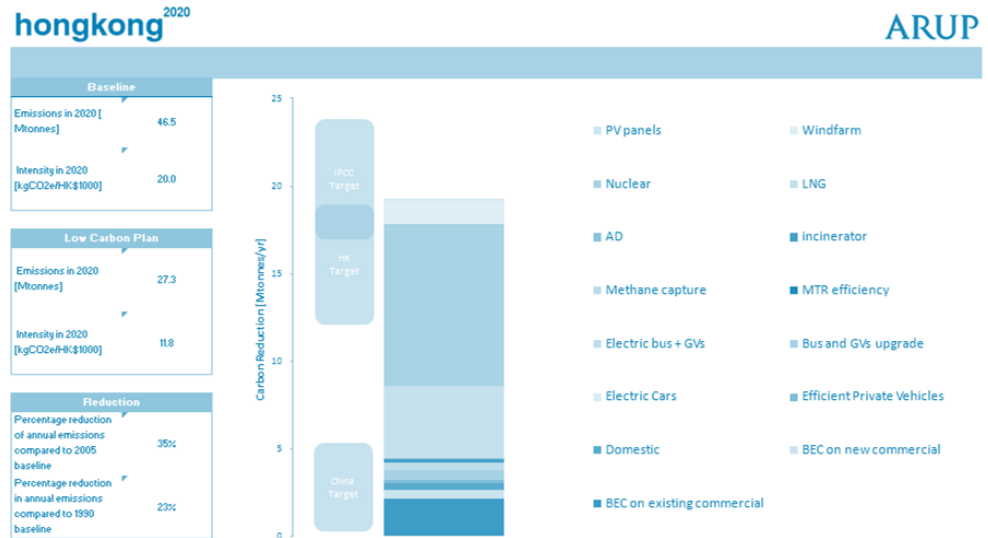
	Action by 2020	Change these values to form your plan	Error Check
Energy Efficiency	1 Penetration of BEC (%)	25.00	< >
	2 Effectiveness of BEC % reduction	45.00	< >
	3 Improved efficiency of new buildings	50.00	< >
	4 Penetration of EE appliances	30.00	< >
	5 Efficiency of Grade A appliance	25.00	< >
Transport	6 Penetration of High Eff Cars	50.00	< >
	7 Efficiency improvement of cars	20.00	< >
	8 Penetration of Elec cars	5.00	< >
	9 % of buses LGV etc Upgraded	50.00	< >

	Action by 2020	Change these values to form your plan	Error Check
Transport	10 Efficiency of upgraded buses HGV etc	20.00	< >
	11 % of Electric Bus HGV etc	10.00	< >
	12 MTR efficiency improvement	0.00	< >
Waste	13 % methane capture	60.00	< >
	14 Incinerator size [tonnes/day]	3000.00	< >
Electricity Generation	15 Anaerobic Digester size [tonnes/day]	400.00	< >
	16 LNG % displacing coal	40.00	< >
	17 Nuclear % to displace coal	50.00	< >
	18 Wind farm (MW)	200.00	< >
	19 Percentage of HK area	0.01	< >

Input 1 – Efficiency and Transport

- Input level of implementation for each strategy by either typing it directly into the number box or dragging the sliders

		Action by 2020	Change these values to form your plan	
Energy Efficiency	1	Penetration of BEC (%)	66.00	<input type="text" value="66.00"/>
	2	Effectiveness of BEC % reduction	40.00	<input type="text" value="40.00"/>
	3	Improved efficiency of new buildings	60.00	<input type="text" value="60.00"/>
	4	Penetration of EE appliances	30.00	<input type="text" value="30.00"/>
	5	Efficiency of Grade A appliance	50.00	<input type="text" value="50.00"/>
Transport	6	Penetration of High Eff Cars	40.00	<input type="text" value="40.00"/>
	7	Efficiency improvement of cars	30.00	<input type="text" value="30.00"/>
	8	Penetration of Elec cars	20.00	<input type="text" value="20.00"/>
	9	% of buses LGV etc Upgraded	40.00	<input type="text" value="40.00"/>
	10	Efficiency of upgraded buses HGV etc	20.00	<input type="text" value="20.00"/>



		Action by 2020	Change these values to form your plan	Error Check
Energy Efficiency	1	Penetration of BEC (%)	25.00	<input type="text" value="25.00"/>
	2	Effectiveness of BEC % reduction	45.00	<input type="text" value="45.00"/>
	3	Improved efficiency of new buildings	50.00	<input type="text" value="50.00"/>
	4	Penetration of EE appliances	30.00	<input type="text" value="30.00"/>
	5	Efficiency of Grade A appliance	25.00	<input type="text" value="25.00"/>
Transport	6	Penetration of High Eff Cars	50.00	<input type="text" value="50.00"/>
	7	Efficiency improvement of cars	20.00	<input type="text" value="20.00"/>
	8	Penetration of Elec cars	5.00	<input type="text" value="5.00"/>
	9	% of buses LGV etc Upgraded	50.00	<input type="text" value="50.00"/>

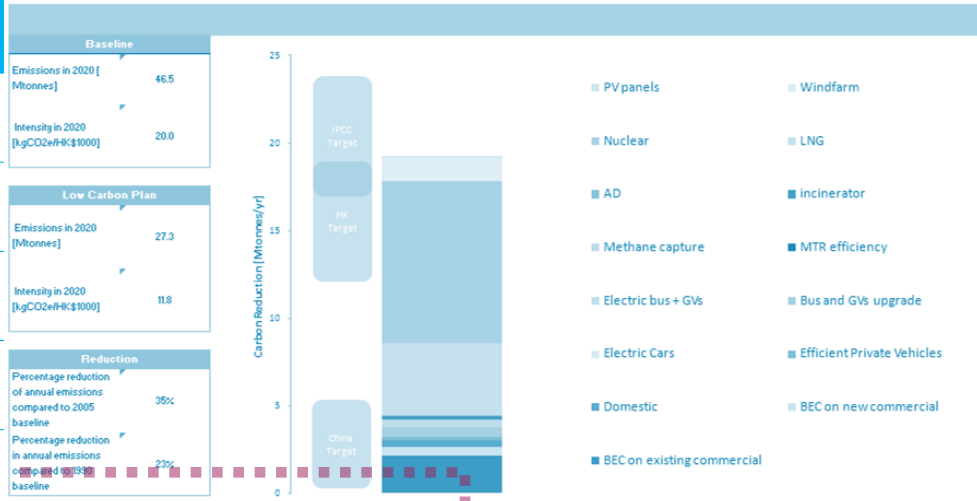
		Action by 2020	Change these values to form your plan	Error Check
Transport	10	Efficiency of upgraded buses HGV etc	20.00	<input type="text" value="20.00"/>
	11	% of Electric Bus HGV etc	10.00	<input type="text" value="10.00"/>
	12	MTR efficiency improvement	0.00	<input type="text" value="0.00"/>
Waste	13	% methane capture	60.00	<input type="text" value="60.00"/>
	14	Incinerator size [tonnes/day]	3000.00	<input type="text" value="3000.00"/>
Electricity Generation	15	Anaerobic Digester size [tonnes/day]	400.00	<input type="text" value="400.00"/>
	16	LNG % displacing coal	40.00	<input type="text" value="40.00"/>
	17	Nuclear % to displace coal	50.00	<input type="text" value="50.00"/>
	18	Wind farm (MW)	200.00	<input type="text" value="200.00"/>
	19	Percentage of HK area	0.01	<input type="text" value="0.01"/>

Input 2 – Waste and Electricity Generation

- Input level of implementation for each strategy by either typing it directly into the number box or dragging the sliders

hongkong 2020

		Action by 2020	Change these values to form your plan	
Transport	11	% of Electric Bus HGV etc	30.00	<input type="text"/>
	12	MTR efficiency improvement	0.00	<input type="text"/>
Waste	13	% methane capture	65.00	<input type="text"/>
	14	Incinerator size [tonnes/day]	3500.00	<input type="text"/>
	15	Anaerobic Digester size [tonnes/day]	1500.00	<input type="text"/>
Electricity Generation	16	LNG X% displacing coal	22.00	<input type="text"/>
	17	Nuclear Y% to displace coal	51.00	<input type="text"/>
	18	Wind farm (MW)	200.00	<input type="text"/>
	19	Percentage of HK area	1.00	<input type="text"/>
	20	Others [Mtonnes]	0.00	<input type="text"/>



		Action by 2020	Change these values to form your plan	Error Check
Energy Efficiency	1	Penetration of BEC (%)	25.00	<input type="text"/>
	2	Effectiveness of BEC % reduction	45.00	<input type="text"/>
	3	Improved efficiency of new buildings	50.00	<input type="text"/>
	4	Penetration of EE appliances	30.00	<input type="text"/>
	5	Efficiency of Grade A appliance	25.00	<input type="text"/>
Transport	6	Penetration of High Eff Cars	50.00	<input type="text"/>
	7	Efficiency improvement of cars	20.00	<input type="text"/>
	8	Penetration of Elec cars	5.00	<input type="text"/>
	9	% of buses LGV etc Upgraded	50.00	<input type="text"/>

		Action by 2020	Change these values to form your plan	Error Check
Transport	10	Efficiency of upgraded buses HGV etc	20.00	<input type="text"/>
	11	% of Electric Bus HGV etc	10.00	<input type="text"/>
Waste	12	MTR efficiency improvement	0.00	<input type="text"/>
	13	% methane capture	60.00	<input type="text"/>
Electricity Generation	14	Incinerator size [tonnes/day]	3000.00	<input type="text"/>
	15	Anaerobic Digester size [tonnes/day]	400.00	<input type="text"/>
	16	LNG % displacing coal	40.00	<input type="text"/>
	17	Nuclear Y% to displace coal	50.00	<input type="text"/>
	18	Wind farm (MW)	200.00	<input type="text"/>
	19	Percentage of HK area	0.01	<input type="text"/>

Details and assumptions

- Mouse over actions to see details and default values

	Action by 2020	Change these values to form your plan	Error Check
Energy Efficiency	1 Penetration of BEC (%)	0.00	<input type="text" value="0.00"/>
	2 Effectiveness of BEC % reduction	0.00	<input type="text" value="0.00"/>
	3 Improved efficiency of new buildings	0.00	<input type="text" value="0.00"/>
	4 Penetration of EE appliances	0.00	<input type="text" value="0.00"/>
	5 Efficiency of Grade A appliance	0.00	<input type="text" value="0.00"/>
Transport	6 Penetration of High Eff Cars	0.00	<input type="text" value="0.00"/>
	7 Efficiency improvement of cars	0.00	<input type="text" value="0.00"/>
	8 Penetration of Elec cars	0.00	<input type="text" value="0.00"/>
	9 % of buses GV etc Upgraded	0.00	<input type="text" value="0.00"/>
	10 Efficiency of upgraded buses GV etc	0.00	<input type="text" value="0.00"/>

Specify the level of energy performance of Grade A appliance standard - % reduction in energy consumption compared to the average stock (EMSD estimates impact at 25%)

hongkong 2020

Baseline	
Emissions in 2020 [Mtonnes]	46.5
Intensity in 2020 [kgCO ₂ e/HK\$1000]	20.0

Low Carbon Plan	
Emissions in 2020 [Mtonnes]	27.3
Intensity in 2020 [kgCO ₂ e/HK\$1000]	11.8

Reduction	
Percentage reduction of annual emissions compared to 2005 baseline	35%
Percentage reduction in annual emissions compared to 1990 baseline	23%

Carbon Reduction [Mtonnes/yr]

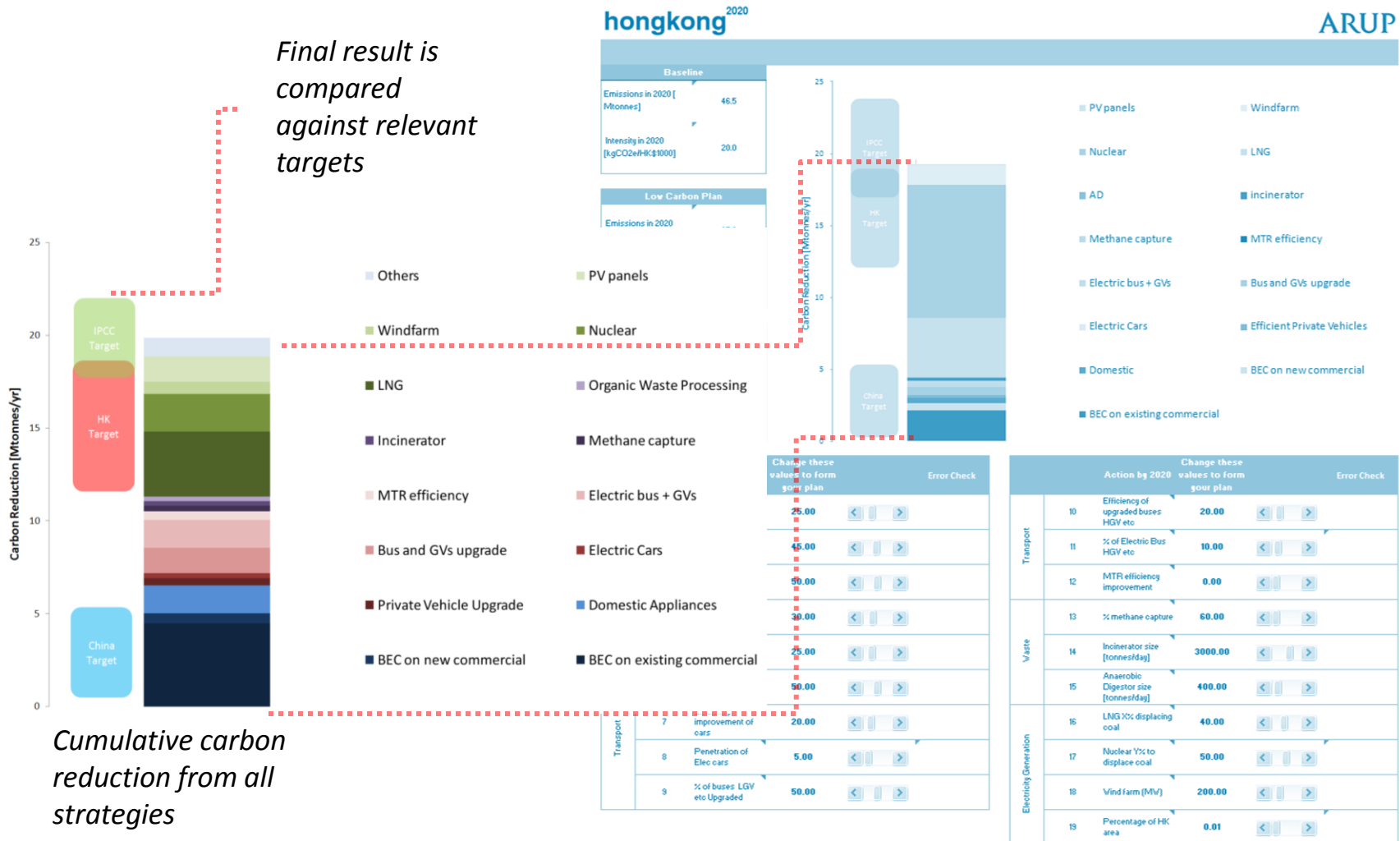
- PV panels
- Nuclear
- AD
- Methane capture
- Electric bus + GVs
- Electric Cars
- Domestic
- BEC on existing commercial
- Windfarm
- LNG
- Incinerator
- MTR efficiency
- Bus and GVs upgrade
- Efficient Private Vehicles
- BEC on new commercial

	Action by 2020	Change these values to form your plan	Error Check
Energy Efficiency	1 Penetration of BEC (%)	25.00	<input type="text" value="25.00"/>
	2 Effectiveness of BEC % reduction	45.00	<input type="text" value="45.00"/>
	3 Improved efficiency of new buildings	50.00	<input type="text" value="50.00"/>
	4 Penetration of EE appliances	30.00	<input type="text" value="30.00"/>
	5 Efficiency of Grade A appliance	25.00	<input type="text" value="25.00"/>
Transport	6 Penetration of High Eff Cars	50.00	<input type="text" value="50.00"/>
	7 Efficiency improvement of cars	20.00	<input type="text" value="20.00"/>
	8 Penetration of Elec cars	5.00	<input type="text" value="5.00"/>
	9 % of buses LGV etc Upgraded	50.00	<input type="text" value="50.00"/>

	Action by 2020	Change these values to form your plan	Error Check
Transport	10 Efficiency of upgraded buses HGV etc	20.00	<input type="text" value="20.00"/>
	11 % of Electric Bus HGV etc	10.00	<input type="text" value="10.00"/>
	12 MTR efficiency improvement	0.00	<input type="text" value="0.00"/>
Waste	13 % methane capture	60.00	<input type="text" value="60.00"/>
	14 Incinerator size [tonnes/day]	3000.00	<input type="text" value="3000.00"/>
Electricity Generation	15 Anaerobic Digester size [tonnes/day]	400.00	<input type="text" value="400.00"/>
	16 LNG % to displace coal	40.00	<input type="text" value="40.00"/>
	17 Nuclear % to displace coal	50.00	<input type="text" value="50.00"/>
	18 Wind farm (MW)	200.00	<input type="text" value="200.00"/>
	19 Percentage of HK area	0.01	<input type="text" value="0.01"/>

Graphical Output

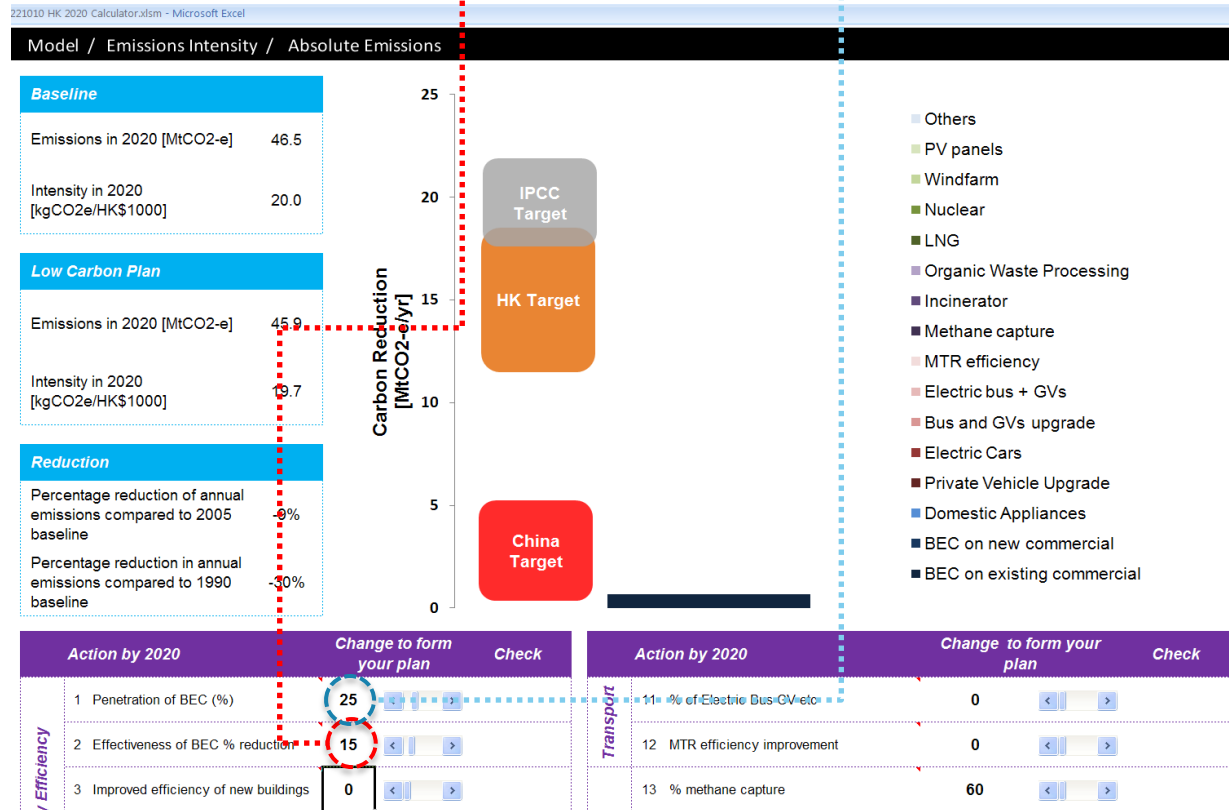
- Carbon reductions from strategies are represented graphically on a bar graph



Example 1



improving energy efficiency in commercial buildings through good housekeeping, information technology products and intelligent building environmental management system, such that by 2020, 25% of existing commercial buildings can be 15% more energy efficient compared with 2005; and



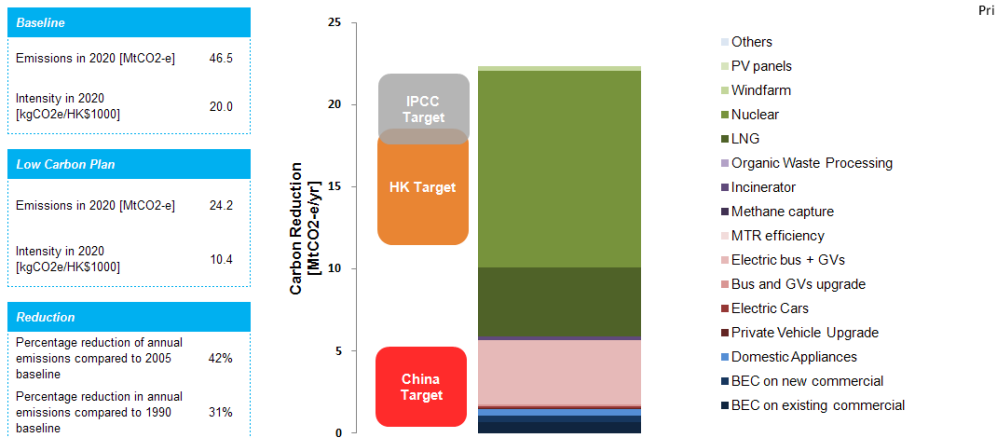
Exercise 1

- Estimate the emission reduction through the list of measures suggested in the Climate Change Strategy and Action Agenda
- Input the effort levels by typing values directly or moving the sliders
- The values below are suggested as a reference.

	Action by 2020	Change to form your plan	Check	
Energy Efficiency	1 Penetration of BEC (%)	25		
	2 Effectiveness of BEC % reduction	15		
	3 Improved efficiency of new buildings	50		
	4 Penetration of EE appliances	25		
	5 Efficiency of Grade A appliance	25		
Transport	6 Penetration of High Eff Cars	15		
	7 Efficiency improvement of cars	20		
	8 Penetration of Elec cars	15		
	9 % of buses GV etc Upgraded	8		
	10 Efficiency of upgraded buses GV etc	20		
Transport	11 % of Electric Bus GV etc	7		
	12 MTR efficiency improvement	0		
	Waste	13 % methane capture	60	
		14 Incinerator size [tonnes/day]	3000	
		15 Anaerobic Digester size [tonnes/day]	400	
	Electricity Generation	16 LNG X% displacing coal	40	
		17 Nuclear Y% to displace coal	50	
		18 Wind farm (MW)	200	
		19 PV Coverage %	0	
		20 Others [ktonnes]	0	

Example 2

- Continues from Exercise 1
- What if we upgrade all the buses and Goods Vehicles to Electric Vehicles?
- Error indicated because % of upgraded vehicles EV + High Efficiency Vehicles cannot exceed 100%



	Action by 2020	Change to form your plan	Check		Action by 2020	Change to form your plan	Check
Energy Efficiency	1 Penetration of BEC (%)	25	< >	Transport	11 % of Electric Bus GV etc	100	< > <small>% of electric + high eff must be < 100</small>
	2 Effectiveness of BEC % reduction	15	< >		12 MTR efficiency improvement	0	< >
	3 Improved efficiency of new buildings	50	< >		13 % methane capture	60	< >
	4 Penetration of EE appliances	25	< >		14 Incinerator size [tonnes/day]	3000	< >
	5 Efficiency of Grade A appliance	25	< >		15 Anaerobic Digester size [tonnes/day]	400	< >
Transport	6 Penetration of High Eff Cars	15	< >	Waste	16 LNG X% displacing coal	40	< >
	7 Efficiency improvement of cars	20	< >		17 Nuclear Y% to displace coal	50	< >
	8 Penetration of Elec cars	15	< >		18 Wind farm (MW)	200	< >
	9 % of buses GV etc Upgraded	8	< >		19 PV Coverage %	0	< >
	10 Efficiency of upgraded buses GV etc	20	< >		20 Others [ktonnes]	0	< >

Reduce this value to 0% to clear the error

Exercise 2

- Continues from Example 2
- Suppose we find that increasing the proportion of electricity generated through nuclear power is not a feasible option
- Reduce the proportion from nuclear generation back to the 2010 value: 25%
- Note the impact of this modification on other sectors



Note that the higher grid emission factor also leads to a smaller reduction from adopting electric vehicles

Proportion of electricity generated through nuclear reduced from 50 to 25%

References

- **Hong Kong's Climate Change Strategy and Action Agenda – Consultation Document.** Environment Bureau, HKSAR Government. Available online from: http://www.epd.gov.hk/epd/english/climate_change/consult.html
- **Energy End-use Data and Consumption Indicators/Benchmarks : Hong Kong Energy End-use Data.** Electrical and Mechanical Services Department, HKSAR Government. Available online from: <http://www.emsd.gov.hk/emsd/eng/pee/edata.shtml>
- **Study on the Potential Applications of Renewable Energy in Hong Kong - Stage 1 Study Report.** Electrical and Mechanical Services Department, HKSAR Government. Available online from: http://www.emsd.gov.hk/emsd/e_download/wnew/stage1_report.pdf
- **Greenhouse Gas Emission Control Study,** Environment Protection Department, HKSAR Government. Available online from: http://www.epd.gov.hk/epd/english/climate_change/greenhouse_gas_study.html
- **Hong Kong 2030 Planning Vision and Strategy.** Planning Department, HKSAR Government. Available online from: http://www.pland.gov.hk/pland_en/p_study/comp_s/hk2030/eng/home/index.htm
- **Study on Enhanced Promotion of Building Energy Codes in Hong Kong,** Electrical and Mechanical Services Department, HKSAR Government. Available online from: http://www.emsd.gov.hk/emsd/e_download/pee/BEC_Development_Report_2007.pdf
- **Sustainable Energy - without the hot air.** UIT Cambridge, 2008. Available free online from www.withouthotair.com