Supplementary Information

Levelized Cost Analysis of Indirect Evaporative Cooling in Data Centre

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Table S1. Summary of part of literature for IEC Application

Reference	Cooling systems	Application	COP	Climate Zones Considered	Location	Cost analysis
1	Single to multi/ hybrid evaporative coolers	Building	0.1-7	Arid, Semi-Arid, Humid Subtropical, Tropical Wet and Dry, Tropical Wet	India	LCC
2	Hybrid IEC-MVC	Building	Not indicated	Hot and dry, hot and humid	Saudi Arabia	LCC
3	direct contact evaporative coolers	Building	7.8-29.2	Tropical, Arid, Temperature, Cold	Various countries	LCC
4	Dew point cooling	Data Centre	Avg.29.7	Mild and humid	UK	N/A
5	IEC systems	Data Centre	3.15-9.26	Dry, medium humidity, high humidity	China	N/A
6	Dew-Point indirect evaporative cooler and Direct evaporative cooler	Poultry house	Not indicated	hot and humid	Qatar	LCC

Table S2. Configurations of the target data centre[7]

Floor Area	2,250 m² × 9 stories
Number of Servers	720 units/floor × 9 stories
Heat gains from Server Computers	2,880 kW/floor × 9 stories
Lighting	49.5 kW/floor × 9 stories
Others heat resources: Lightening People	Sensible heat: 60W/person × 20persons/floor × 9 stories Latent heat: 40W/person × 20persons/floor × 9 stories

Table S3. The thermal output timetable for server computers[7, 8]

Time	Weekday (%)	Weekend (%)
00:00-09:00	90	80
09:00-21:00	100	90
21:00-24:00	90	80

Table S4. Interpreting symbols for various climates in the Köppen-Geiger Classification System[3, 9-11]

Symbol meaning for Climate Description		
1st Symbol	2nd Symbol	3rd Symbol
A_tropical		
	f_Rainforest	
	m_Monsoon	
	w_Savannah	
B_Arid		
	W_Desert	
	S_Steppe	
		h_Hot
		k_Cold
C_Temperate		
	s_Dry summer	
	w_Dry winter	
	f_Without dry season	
		a_Hot summer
		b_Warm summer
		c_Cold summer
D_Cold		
	s_Dry summer	
	W_Dry winter	
	f_Without dry season	
		a_Hot summer
		b_Warm summer
		c_Cold summer
		d_Very cold summer
E_Polar		
	T_Tundra	
	F_Frost	

Table S5. Worldwide weather stations considered in this study[9, 12]

Climate Classification	Cities	Latitude	Jan-Mar		Apr-Jun		Jul-Sep		Oct-Dec	
			average D.B.T(°C)	**average Humidity ratio(g/kg)**	**average D.B.T(°C)**	**average Humidity ratio(g/kg)**	**average D.B.T(°C)**	**average Humidity ratio(g/kg)**	**average D.B.T(°C)**	**average Humidity ratio(g/kg)**
BWh	Jeddah	21.48	24.5	9.7	31.3	14.0	33.9	16.7	28.5	14.1
BWh	Riyadh	24.68	18.4	4.4	32.5	5.4	36.1	6.4	23.0	6.2
BWh	Dubai	25.27	23.2	9.4	32.5	13.2	35.9	17.1	27.8	13.2
Cfa	Atlanta	33.75	9.9	4.9	21.9	10.6	24.9	14.6	12.0	6.4
Cfa	New York	40.71	3.5	3.2	17.0	7.7	24.5	11.9	9.5	5.0
Csa	Madrid	40.42	8.7	4.4	18.8	6.1	25.9	7.2	12.7	6.8
Cfb	London	51.51	7.9	5.1	14.4	6.7	19.5	8.7	10.2	6.7
Dwa	Seoul	37.56	1.6	2.7	19.0	8.8	25.2	15.3	7.3	4.7
Dwa	Beijing	39.91	1.0	1.9	20.7	8.0	25.0	14.0	4.8	3.3
Dfa	Windsor	42.32	-1.5	2.5	15.7	7.3	22.2	11.2	6.4	4.2

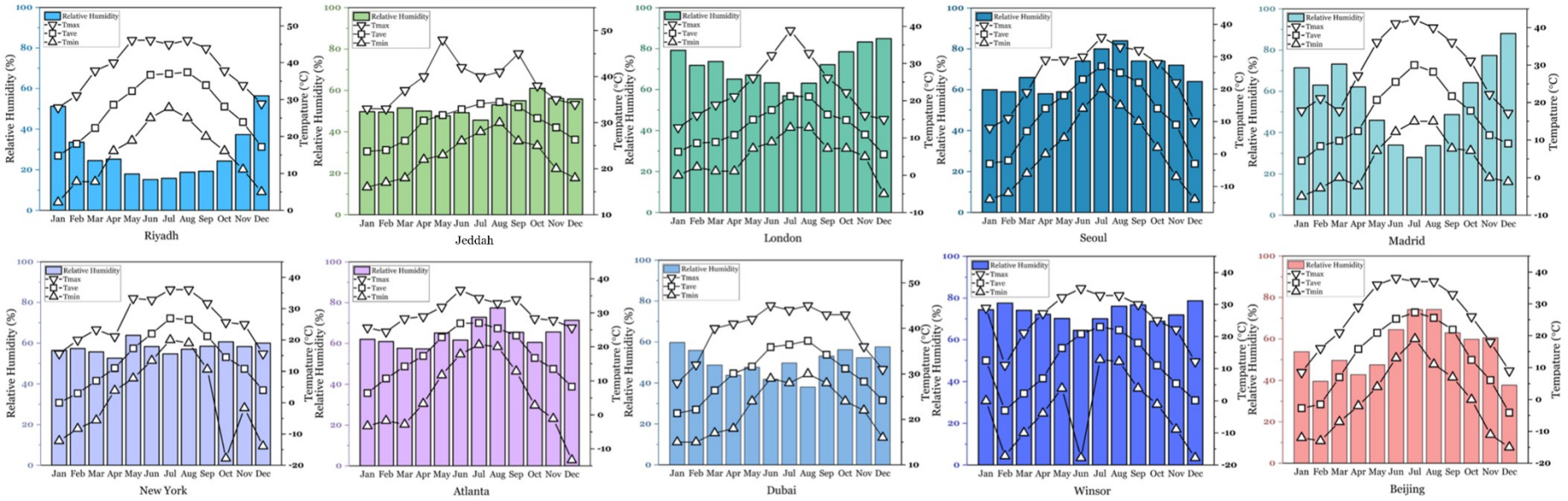

Figure S1. Annual Weather Data for Cities[13]

Table S6. Cost analysis parameters for the selected cities.

City	Average discount rate (%)	Average inflation rate (%)	Average real escalation rate of electricity price (%)	Industry electricity price (USD/MWh)	CO2 index (ton CO2/MWh)	Unit Cost of CO2 emission pollution (USD/ton of CO2)
Jeddah Riyadh	2[2]	1.87[14]	0[15]	47.96[16]	0.57[17]	0
Dubai	1.60[18]	0.78[19]	0.124[20]	62.62[21]	0.40[17]	0
Atlanta New York	0.25[22]	3.63[23]	5.60[24]	83.5[25]	0.37[26]	15.33[27]
Madrid	1.34[28]	2.70[29]	0.85[30, 31]	223.88[32]	0.22[33]	85.28[34]
London	-1.30[35]	3.36[36]	15.4[37]	241.22[38]	0.26[17]	65.01[39]
Seoul	1[40]	2[41]	2.20[42]	87[43]	0.44[26]	18.53[34]
Beijing	2.90[44]	2.01[45]	1.28[46]	64.6[25]	0.53[26]	7.29[47]
Windsor	3.42[48]	3.02[49]	1.43[50]	75.03[51]	0.13[26]	37.69[52]

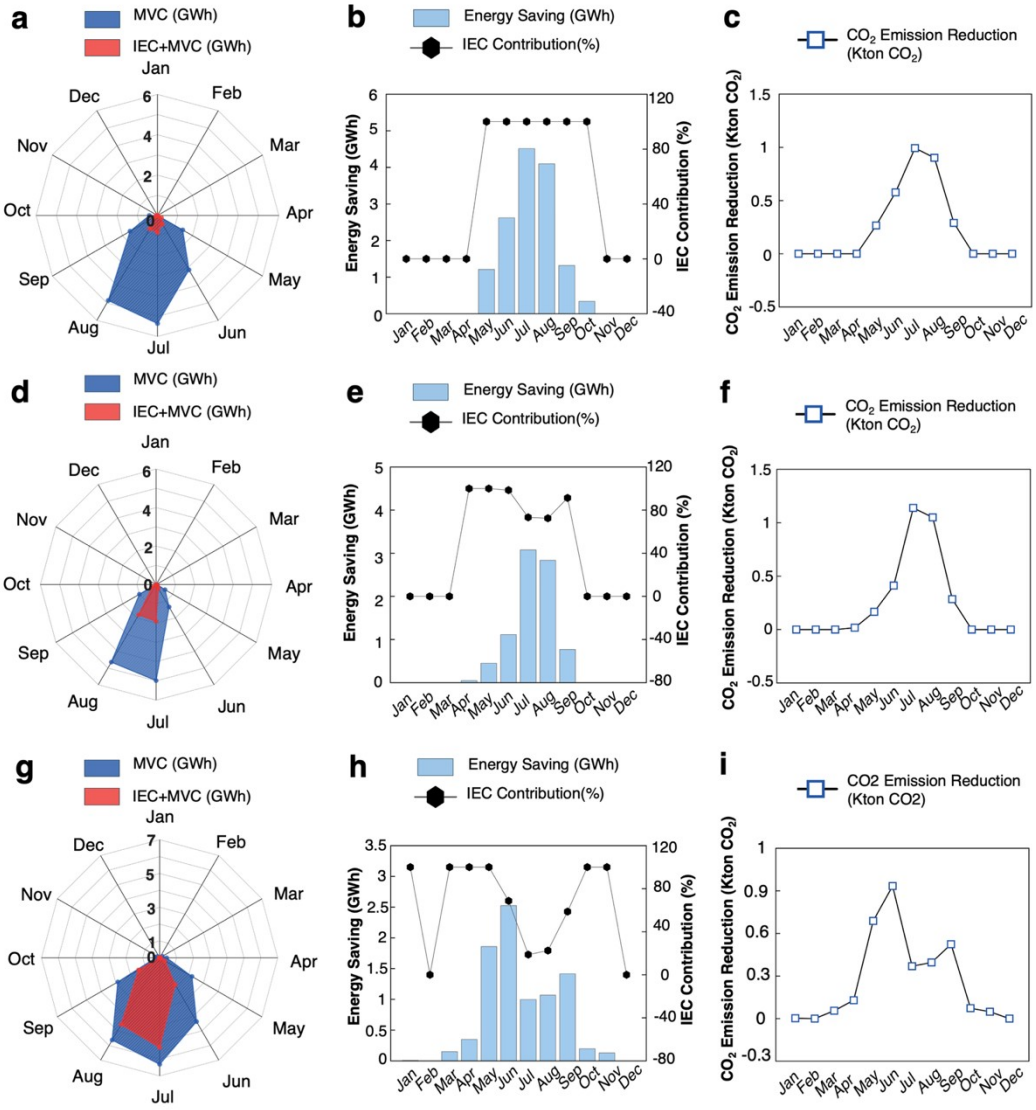

Figure S2. (a) Madrid Comparison of Energy Consumption (b) Madrid Energy Saving (c) Madrid CO2 Emission Reduction (d) New York Comparison of Energy Consumption (e) New York Energy Saving (f) New York CO2 Emission Reduction (g) Atlanta Comparison of Energy Consumption (h)Atlanta Energy Saving (i) Atlanta CO2 Emission Reduction

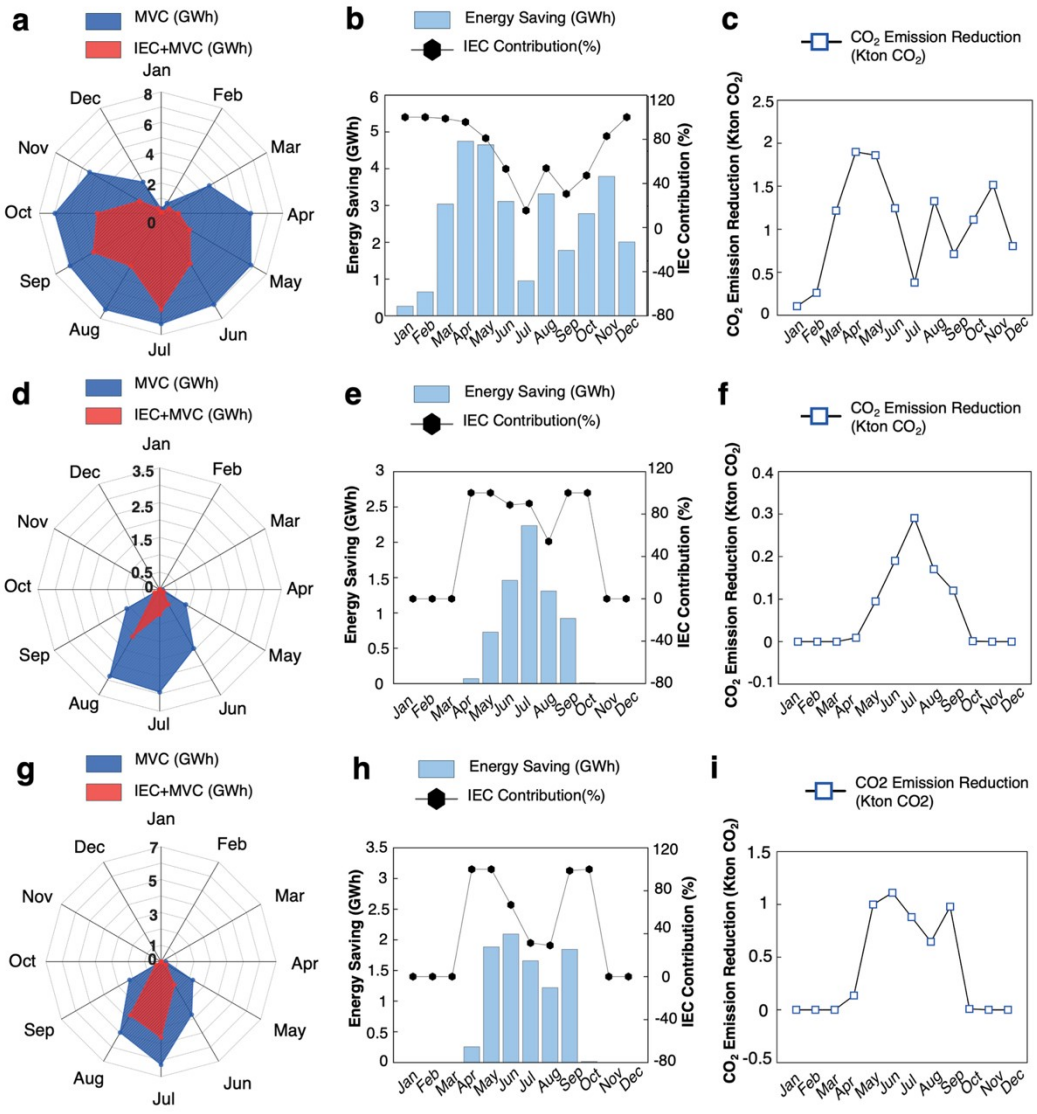

Figure S3. (a) Dubai Comparison of Energy Consumption (b) Dubai Energy Saving (c) Dubai CO2 Emission Reduction (d) Windsor Comparison of Energy Consumption (e) Windsor Energy Saving (f) Windsor CO2 Emission Reduction (g) Beijing Comparison of Energy Consumption (h) Beijing Energy Saving (i) Beijing CO2 Emission Reduction

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