2018 Accounting Report on Carbon Emission Consumption for International Campus, Zhejiang University

January 2019

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1 Preface

What humans can do to make contribution to influence global climate is to change ratios of greenhouse gas, aerosol (fine particulate matter) and cloud in the atmosphere. Greenhouse gas and aerosol will impact the amounts of inward solar radiation and outward infrared (thermal) radiation—part of Earth energy balance, which means global climate system can be interfered by controlling proportion and features of greenhouse gas and aerosol. Fossil fuels burning, one of human activities, is the biggest greenhouse gas source to release CO_2 into the atmosphere. Influence on global warming by humans has been much worse than any nature movements such as solar activity and volcanic eruption since industrial age (1750).

CO_2 concentration in the atmosphere has been increased from 280ppm in the industrial age to 379ppm in 2005, according to *Climate Change 2007 Synthesis Report*. However, the concentration was increased just about 20ppm during the 8000 years ahead of industrialization, less than 10ppm shift in decades even in a century, mostly likely to be caused by natural processes. Unfortunately, CO_2 has been boomed in nearly 100ppm since 1750, which is mainly caused by deforestation and fossil fuels use in transportation, air-conditioning and cement production and so on.

International Campus Zhejiang University is always committed into pilot tasks to lead the green campus construction in China. This report will directly show International Campus carbon emission and carbon intensity through accounting on both indirect and indirect greenhouse gas emissions and energy consumption to encourage more people to pay attention to climate change, and to join this green campaign.

2 Introduction of International Campus, Zhejiang Jiang University

International Campus, Zhejiang University (International Campus for short) located in Haining, Zhejiang Province, with covering area of 666,667m^2 (1000mu) and building area of 399,300m^2. It was officially opening in November 2016, and by January of 2019, it has 364 faculties and staff and 755 full-time students, including 517 undergraduate students, 180 graduate students, 58 doctoral students and 212 degree international students.

The University of Edinburg and University of Illinois at Urbana-Champaign have been brought into International Campus to jointly establish two institutes, Zhejiang University-University of Edinburgh Institute, ZJU and Zhejiang University-University of Illinois at Urbana-Champaign Institute, ZJU providing the following majors, including Biomedical Sciences, Biomedical Informatics, Electrical Engineering, Computer Engineering, Civil Engineering and so on. International Business School, ZJU is speeding up its process and is offering professions such as China Studies, Philosophy, Mathematics and Economics and Master Program in Innovation, Entrepreneurship and Global Leadership. Also, International Campus was cooperated with Imperial College London to set up the Joint Lab for Applied Data Science.

3 Report Year & Period

This report is for 2018, from January to December.

4 Accounting Boundaries

Campus carbon emissions accounting is based on two boundaries, organizational boundaries and operational boundaries. The organizational boundaries on International Campus are consistent with its geographical boundaries; the operational boundaries include making estimates to direct or indirect carbon emissions about International Campus. Explanations are as follows:

- Scope 1
  It accounts for direct greenhouse gas (GHG) emissions from sources that are owed or controlled by International Campus, principally the result of production of heat by boilers.
- Scope 2
  It accounts for indirect GHG emissions associated with generation of purchased electricity caused by activities such as teaching and academic research.
- Scope 3
  It allows for the treatment of other indirect GHG emissions that are a consequence of activities of International Campus but occur from sources not owned or controlled by the campus, such as materials purchasing, employee commuting, business travel and so on.

This report will not calculate GHG emissions of hydrofluorocarbons (HFCs) of scope 1 and scope 3, only scope 2 because of inadequate equipment and incomplete statistics approaches. GHG emissions identification form is as below:

GHG Emission Sources Identification Form 4-1

Operational Boundaries	Emission Source Types	Main Emission Sources	Energy Consumption	GHG	Accounting
Scope 1: direct GHG emissions	Stationary combustion sources	Boiler	Natural gas	CO_2, CH_4, N_2O	Yes
	Stationary combustion sources	Canteen	Natural gas	CO_2, CH_4, N_2O	Yes
	non-stationary combustion sources	Shuttle Buses	Diesel	CO_2, CH_4, N_2O	Yes
	non-stationary combustion sources	Official business vehicle	gasoline	CO_2, CH_4, N_2O	Yes
		Air-conditioning and extinguisher	Refrigerant	HFCs	No
Scope 2: indirect GHG emissions	Purchased electricity	Lighting, air-conditioning and related facilities	Power	CO_2	Yes

Scope 3: other indirect GHG emissions	non-stationary combustion sources	On and off campus commuting transportation excluding shuttle bus and official business vehicle	gasoline	CO_2, CH_4, N_2O	No
	non-stationary combustion sources	Airplane, train, bus and ship (business travel)	Gasoline, diesel and power	CO_2, CH_4, N_2O	No

5 Energy Consumption Activity Level Calculation

Calculation range: all buildings of phase-one campus construction, and parts of phase-two construction, including ZJU-UIUC Institute and ZJU-UoE Institute, Serviced apartment and Academic Exchange Center. The calculating period for all phase-one buildings, Serviced Apartment and Academic Exchange Center in phase-two are from January to December in 2018 and for the other phase-two construction is from June to December in 2018.

5.1 Emission Sources and Energy Consumption Activity Level Calculation

2018 International Campus Main Emission Sources Calculation Form 5-1

Operational Boundaries	Main Emission Sources	Types of Energy	Unit	Consumption Amount	Record Approach
Scope 1: direct GHG emissions	Boiler	Natural gas	NM^3	200,400	Gauge table
	Canteen	Natural gas	NM^3	28,400	Gauge table
	Shuttle bus	Diesel	L	21,500	Recorded by the supplier
	Official business vehicle	Gasoline	L	19,600	Recorded by the supplier
Scope 2: indirect GHG emissions	Lighting, air-conditioning and related facilities	Power	kWh	6,251,500	Gauge table

5.2 Main Emission Sources and Energy Consumption in Key Buildings

In this report, we will calculate carbon emissions in detail on the following buildings to provide a strong data gist for the future measures in lowering carbon emissions.

2018 International Campus Energy Consumption Activity Level Calculation on Major Functional Buildings Form 5-2

No.	Building	Function	Area (m^2)	Power (kWh/a)	Natural Gas (m^3/a)
1	No.1 Residential College	Student accommodation	27,408	1,190,684	18,953
2	Academic Exchange Center	Hotel	25,296	1,325,010	——
3	Gymnasium	Sports	14,669	356,165	8,285
4	Student Service Center	Canteen	12,748	986,066	30,812
5	Learning and Teaching Building North B	Teaching	10,750	198,458	11,761
6	Arts and Science Building	Administration	10,648	291,364	35,221
7	Learning and Teaching Building North A	Teaching	10,440	487,639	59,304
8	Library	Library	9,840	443,806	54,988
9	ZJU-UoE Institute	Science and research	8,174	731,980	——
10	ZJU-UIUC Institute	Science and research	7,238	115,138	——
11	Serviced Apartment	Faculty accommodation	5,824	122,827	——
12	Hospital	Clinic	2,130	75,554	——

6 Emission Factor (EF), Global Warming Potential (GWP), CO_2 Equivalent Method (CO_2e)

6.1 Emission Factor (EF)

Emission factor is used in greenhouse gas inventories to estimate emissions from materials in a certain measurement, which links the activity level data with GHG emissions. Power EF is based on *Announcement of Emission Factor for China's Reginal Power Grid Baseline in 2015* by Climate Change Department subordinated to National Development and Reform Commission; coal EF is based on *Evaluation Guide Rules of Recycle Energy Buildings Model Application Projects*; other EF data are guided by energy heat values from the page 283 of *China Energy Statistical Yearbook of 2008* and calculation values from GHG default emission coefficient of 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2.

Typical Emission Factors and Related Introduction Form 6-6-1

Type	EF			Guideline
	CO_2	CH_4	N_2O	
Power	81,120 tCO_2/（kWh）	--	--	EF value form re Reginal Power Grid Power EF in East China in the Page 4 of *Announcement of Emission Factor for China's Reginal Power Grid Baseline in 2015* by Climate Change

				Department subordinated to National Development and Reform Commission
Coal	2.47 tCO_2/t	--	--	*Evaluation Guide Rules of Recycle Energy Buildings Model Application Projects*
Natural gas	209,000 tCO_2/m^3	3.73×10^{-4} tCH_4/ten thousand m^3	3.73×10^{-5} tN_2O /ten thousand m^3	Chapter 3 of GHG default emission coefficient of 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2
Vehicle gas	226,000 tCO_2/L	8.16×10^{-3} tCH_4/ten thousand L	2.61×10^{-3} tN_2O /ten thousand L	GHG default emission coefficient of 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2
Vehicle diesel	273,000 tCO_2/L	1.44×10^{-3} tCH_4/ten thousand L	1.44×10^{-3} tN_2O /ten thousand L	GHG default emission coefficient of 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2
Liquefied petroleum gas (stationary)	175,000 tCO_2/L	0.278 tCH_4/ten thousand L	0.0278 tN_2O /ten thousand L	GHG default emission coefficient of 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2
Vehicle	3.641×10^{-5} tCO_2/km	--	--	2010 Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting: Annex 6 Passenger Transport Conversion Tables:22 of 35,Table 6k
Train	3.641×10^{-5} tCO_2/km	--	--	2010 Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting: Annex 6 Passenger Transport Conversion Tables:22 of 35,Table 6k
Airplane	2.052×10^{-4} tCO_2/km	--	--	2010 Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting: Annex 6 Passenger Transport Conversion Tables:22 of 35,Table 6l

6.2 Global Warming Potential (GWP)

Global warming potential (GWP) is a measure of how much heat a greenhouse gas traps in the atmosphere up to a specific time horizon, relative to CO_2. The GWP of CO_2 is 1. The GWP in this report is from *2007 IPCC Guidelines for National Greenhouse Gas Inventories*.

Global Warming Potential Form 6-2

GHG	Molecular Formula	GWP
Carbon dioxide	CO_2	1

Methane	CH_4	25
Nitrous oxide	N_2O	298

Data from the 4th 2007 IPCC Evaluation Report

6.3 Carbon Dioxide Equivalence (CO_2e)

CO_2e is an abbreviation of 'carbon dioxide equivalence' and is the internationally recognized measure of greenhouse emissions.
International Campus CO_2e equation: $CO_2e = GHG_i \times GWP_i$
GHG_i means the emission amount of greenhouse gas type i and the measurement unit is ton;
GWP_i means the GWP of greenhouse gas type i.

7 Campus Carbon Emissions (Greenhouse Gas Emissions) List

7.1 Campus Carbon Emissions (Greenhouse Gas Emissions) List

1 Total Campus Carbon Emissions (Greenhouse Gas Emissions)
GHG emissions on International Campus in 2018: CO_2 6,816.82 tons, CH_4 0.5565 tons, N_2O 0.0584 tons, equivalent to CO_2e 6,848.15 tons. The direct GHG CO_2e is 602.43 tons, including sources such as natural gas of canteen and heat for teaching, learning and academic buildings in winter, diesel of shuttle bus and oil of official business vehicles; the indirect GHG CO_2e is mainly from purchased electricity, about 6,245.72 tons.

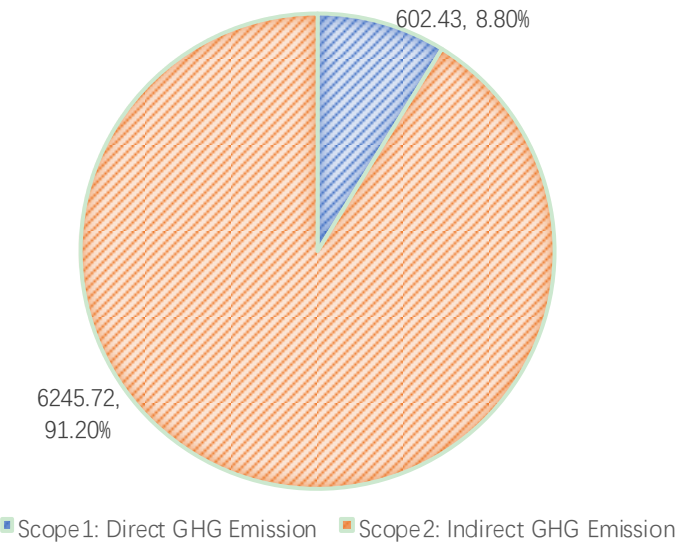
Details are listed as the blow forms:

International Campus GHG Emission Graph 7-1

International Campus GHG Emission Form 7-1

Operational Boundaries	Sources	Type	Unit	Annual Consumption Reported	CO_2	CH_4	N_2O
Scope 1 Direct GHG Emission	Boiler	Natural gas	NM^3	200,400	4,187,800	75	7
	Canteen	Natural gas	NM^3	28,400	594,500	11	1
	Shuttle bus	Diesel	L	21,500	585,700	31	31
	Official business vehicles	Oil	L	19,600	343,100	5,449	545
Scope 2 Indirect GHG Emission	Lighting, air-conditioning and related facilities	Purchased electricity	kWh	7,699,400	62,457,200	0	0

International Campus GHG Emission List Form 7-2 (Scope)



Emission Scope	Scope 1 Direct GHG Emission	Scope 2 Indirect GHG Emission	Total Emission
Amount (t)	602.43	6,245.72	6,848.15
Percentage %	8.8	91.2	100

International Campus GHG Emission List Form 7-3

GHG / Emission	CO_2	CH_4	N_2O	Total Emission
Emission (t)	6,816.82	0.5565	0.0584	--
GWP	1	25	298	--
CO_2e (t)	6,816.82	13.9133	17.4132	6,848.15
Percentage %	99.54%	0.2%	0.25%	100%

2 International Campus Carbon Emission Intensity

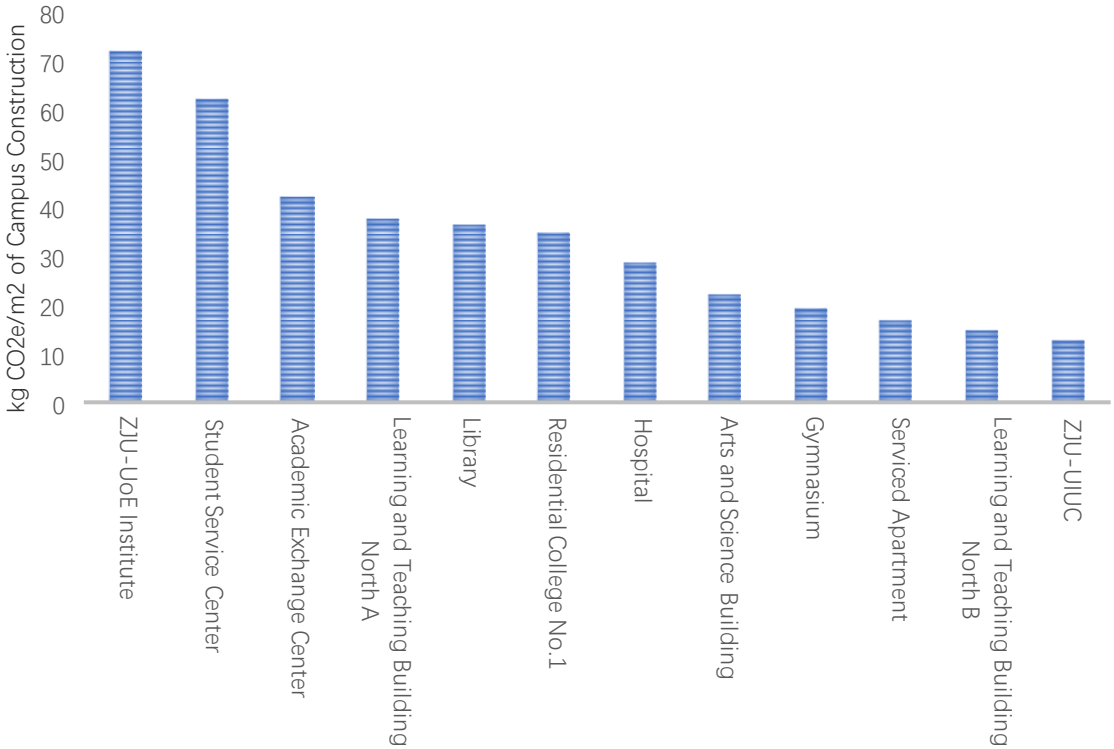
In 2018, the average CO_2e is 9.03t accounted on students, 6.09t on faculty and students, 42.93kg per square meter of campus construction and 25.45kg per square meter of floor area. Details are as blow:

International Campus GHG Emission List Form 7-4 (per unit)

GHG / Emission	CO_2	CH_4	N_2O	Total Emission
CO_2e Emission (t)	6,816.82	13.9133	17.4132	6,119.4
Student's average CO_2e (t)	9.03	0.0007	0.0001	8.06
CO_2e (t) on faculty and students	6.09	0.0005	0.0001	5.44
CO_2e (t) /m^2 of campus construction	42.93	0.1090	0.1364	47.94
CO_2e /m^2 of floor area	25.45	0.0520	0.0650	22.85

7.2 Greenhouse Gas Emissions List of Key Buildings

Buildings contributed most to total energy consumption and average carbon emission of campus construction has been reported. Key accounting construction area is 145,165m^2, which includes 91.43% of construction area that put in use and 75.26% of total carbon emission. The maximum average carbon emission intensity of campus construction is from ZJU-UoE Institute, about 73kg CO_2e/m^2. Detail forms are as below:



Key Buildings' Average Carbon Emission Bar Graph 7-2

2018 Carbon Emission List of Key Buildings on International Campus Form 7-5

No.	Building	Construction Area (m^2)	Power （kWh/a）	Total CO_2 Emission (t)	Per Construction Area (kg CO_{2e}/m^2）
1	ZJU-UoE Institute	8,174	731,980	594	73
2	Student Service Center	12,748	986,066	800	63
3	Academic Exchange Center	25,296	1,325,010	1,075	42
4	Learning and Teaching Building North A	10,440	487,639	396	38
5	Library	9,840	443,806	360	37
6	No.1 Residential College	27,408	1,190,684	966	35
7	Hospital	2,130	75,555	61	29
8	Arts and Science Building	10,648	291,364	236	22
9	Gymnasium	14,669	356,165	289	20
10	Serviced Apartment	5,824	122,827	100	17
11	Learning and Teaching Building B	10,750	198,458	161	15
12	ZJU-UIUC Institute	7,238	115,138	93	13
	Total	145,165	6,324,692	5,131	34