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APPENDICES

Appendix A Carbon Footprint of Electricity

Table A1 Calculation of carbon footprint from electricity (Oct'10 – Sep'11)

Month	Energy Consumption (kWh)	Emissions ($kgCO_2e$)
October 2010	80,780	46,957.41
November 2010	82,020	47,678.23
December 2010	96,140	55,886.18
January 2011	79,150	46,009.9
February 2011	79,150	46,009.9
March 2011	87,700	50,980.01
April 2011	88,180	51,259.03
May 2011	60,220	35,005.89
June 2011	84,960	49,387.25
July 2011	80,080	46,550.5
August 2011	90,740	52,747.16
September 2011	84,080	48,875.7
Total	993,200	577,347.2

Table A2 Calculation of carbon footprint from electricity (Oct'11 – Sep'12)

Month	**Energy Consumption (kWh)**	**Emissions ($kgCO_2e$)**
October 2011	65,596	38,130.95
November 2011	98,340	57,165.04
December 2011	87,891	51,091.04
January 2012	54,349	31,593.07
February 2012	86,160	50,084.81
March 2012	102,780	59,746.01
April 2012	72,280	42,016.36
May 2012	104,100	60,513.33
June 2012	67,560	39,272.63
July 2012	105,720	61,455.04
August 2012	100,300	58,304.39
September 2012	66,360	38,575.07
Total	1,011,436	58,7947.7

Table A3 Calculation of carbon footprint from electricity (Oct'12 – Sep'13)

Month	**Energy Consumption (kWh)**	**Emissions ($kgCO_2e$)**
October 2012	84,080	48,875.7
November 2012	104,640	60,827.23
December 2012	79,800	46,387.74
January 2013	87,680	50,968.38
February 2013	80,240	46,643.51
March 2013	79,960	46,480.75
April 2013	93,400	54,293.42
May 2013	82,680	48,061.88
June 2013	76,840	44,667.09
July 2013	72,220	41,981.49
August 2013	92,600	53,828.38
September 2013	79,260	46,073.84
Total	1,013,400	589,089.4

Carbon footprint of Electricity of Office of the President, Chulalongkorn University

Table A4 Calculation of carbon footprint from electricity (Oct'10 – Sep'11)

Month	**Energy Consumption (kWh)**	**Emissions ($kgCO_2e$)**
October 2010	31,400	18,252.82
November 2010	19,800	11,509.74
December 2010	32,200	18,717.86
January 2011	29,600	17,206.48
February 2011	13,400	7,789.42
March 2011	38,800	22,554.44
April 2011	16,000	9,300.8
May 2011	25,600	14,881.28
June 2011	41,800	24,298.34
July 2011	42,000	24,414.6
August 2011	42,000	24,414.6
September 2011	22,400	13,021.12
Total	355,000	206,361.5

Table A5 Calculation of carbon footprint from electricity (Oct'11 – Sep'12)

Month	**Energy Consumption (kWh)**	**Emissions ($kgCO_2e$)**
October 2011	21,000	12,207.3.
November 2011	20.400	11.858.52
December 2011	21.400	12,439.82
January 2012	31.600	18.369.08
February 2012	16.200	9,417.06
March 2012	38.400	22.321.92
April 2012	26.800	15,578.84
May 2012	21,800	12,672.34
June 2012	36,222	21,055.85
July 2012	29,000	16.857.7
August 2012	25,400	14,765.02
September 2012	26,600	15,462.58
Total	314,822	183,006

Table A6 Calculation of carbon footprint from electricity (Oct'12 – Sep'13)

Month	**Energy Consumption (kWh)**	**Emissions ($kgCO_2e$)**
October 2012	30,400	17,671.52
November 2012	36,400	21,159.32
December 2012	40,040	23,275.25
January 2013	33,400	19,415.42
February 2013	39,200	22,786.96
March 2013	19,600	11,393.48
April 2013	35,800	20,810.54
May 2013	37,600	21,856.88
June 2013	39,200	22,786.96
July 2013	39,200	22,786.96
August 2013	15,900	9,242.67
September 2013	47,600	27,669.88
Total	414,340	240,855.8

Appendix B Carbon Footprint of Energy Use

Table B1 BTU size of air-conditioner at the PPC (Cont.)

Floor	Rooms	Air-conditioner	BTU Size
1	104/1	4	60,000
	106	1	32,000
	104/3(TEM)	2	36,000
	104/4(SEM)	1	25,000
	105	1	36,000
	Craftsman Office	1	18,000
2	204/1	2	38,000
	204/2	1	18,000
	204/3	1	18,000
	204/4	1	18,000
	204/5	1	18,000
	Academic leader	1	18,000
	205	2	32,000
	207/1	4	36,000
			38,000
			45,000
	207/4	1	18,000
	207/6	1	18,000
	210/1	1	18,000
3	304	2	38,000
	305	2	18,000
	307	2	25,000
	308	3	24,000
			36,000
	309	6	38,000
	314	2	36,000
	315	3	25,000
			36,000
	317	1	32,000
	318	2	38,000
4	404/1	2	38,000
	404/2	1	26,000
	404/3	2	25,000
	404/4	2	38,000

Table B1 BTU size of air-conditioner at the PPC (Cont.)

Floor	Rooms	Air-conditioner	BTU Size
	404/5	2	18,000
	404/6	1	26,000
	404/7	1	26,000
	405/1	2	32,000
	406	2	24,000
			25,000
	407	1	12,000
	408	3	15,000
			28,000
	409	1	36,000
	410	2	24,000
5	504	2	48,000
			50,000
	505	2	45,000
	506	2	50,000
	507	2	48,000
	509	2	18,000
	510	1	26,000
	511	1	24,000
	512	1	24,000
	513	1	26,000
	514	1	26,000
	515	1	32,000
6	604	2	50,000
	605	2	38,000
			50,000
	606	4	42,000
			50,000
	607	1	26,000
	608	1	24,000
	609	1	18,000
	610	1	24,000
	611	2	18,000
	612	1	26,000
	613	1	26,000
	614	1	32,000

Table B1 BTU size of air-conditioner at the PPC (Cont.)

7	704	2	48,000
	705	2	38,000
	706	2	48,000
			50,000
	707	1	26,000
	708	1	24,000
	709	1	18,000
	710	1	26,000
	711	2	18,000
			24,000
	712	2	26,000
	713	1	26,000
	714	1	26,000
	715	1	32,000
8	Library	17	12,000
			24,000
			25,000
			28,000
			32,000
			36,000
	Discuss	1	36,000

Table B2 Light's data from the PPC

Floor	**Rooms**	**Light**	**Note**
1	104/1	24	3 lamp series
	106	3	
	TEM	4	Bulb
	SEM	2	Bulb
	1019	16	3 lamp series
	111	2	3 lamp series
	110	2	3 lamp series
2	204/1	9	
	204/2	1	
	204/3	1	
	204/4	3	
	204/5	2	
	Academic head	2	

Table B2 Light's data from the PPC

Floor	Rooms	Light	Note
	205	9	
	207/1	16	
	207/2	1	
	207/3	1	
	207/4	1	
	207/6	1	
	207/7	1	
	206	2	
	208	2	
3	304	21	
	305	2	
	307	2	
	308	4	
	309	25	
	314	12	
	315	15	
	317	3	
	318	9	
4	404/1	6	
	404/2	2	
	404/3	2	
	404/4	5(2)	(x) = T8 short
	404/5	3	
	404/6	5	
	404/7	4	
	405/1	10	
	405/2	1	
	405/3	1	
	406	5	
	407	1	
	408	6	
	409	8	
	410	6	
5	504	12	
	505	12	
	506	12	
	507	12	
	509	4	
	510	4	
	511	4	

Table B2 Light's data from the PPC

Floor	Rooms	Light	Note
6	604	12	
	605	12	
	606	20	
	Prof.Sumate	5	
	607	4	
	608	4	
	609	4	
	610	4	
	611	4	
	612	4	
	613	4	
	614	6	
7	704	12	
	705	12	
	706	12	
	707	6	
	708	4	
	709	4	
	710	4	
	711	4	
	712	4	
	713	4	
	715	6	
8	Library	74(10)	(x) = T8 short
	Discussion rooms	15(15)	(x) = T8 short

Table B3 Electric appliances data from the PPC

Floor	Rooms	Computer	LCD	Fan	Projector	Copiers	Printer
1	104/1						
	106						
	TEM						
	SEM						
	1019						
	111						
	110						
2	204/1	5					5
	204/2	1					
	204/3	1					
	204/4	1					
	204/5	1					
	Academic leader	1					
	205				1		
	207/1	13					8
	207/2						
	207/3						
	207/4	1					
	207/6	1					
	207/7						
	206						
	208			1		1	
3	304	30			1		6
	305	3					2
	307	2				1	2
	308	5					2
	309		2		1		
	314				1		
	315				1		
	317						
	318				1		
4	404/1						
	404/2						
	404/3						
	404/4						
	404/5						
	404/6						
	404/7						
	405/1						

Table B3 Electric appliances data from the PPC (Cont.)

Floor	Rooms	Computer	LCD	Fan	Projector	Copiers	Printer
	405/2						
	405/3						
	406						
	407						
	408						
	409						
	410						
5	504						
	505						
	506						
	507						
	509						
	510						
	511						
	512						
	513						
	514						
	515						
6	604						
	605						
	606						
	Prof.Sumate						
	607						
	608						
	609						
	610						
	611						
	612	2					
	613						
	614						

Table B3 Electric appliances data from the PPC (Cont.)

Floor	Rooms	Computer	LCD	Fan	Projector	Copiers	Printer
7	704						
	705						
	706						
	707	6					
	708						1
	709						
	710						
	711						
	712						
	713						
	715						
8	Library	17	5		1	1	
	Discussion rooms						

Table B4 BTU size of air-conditioner at Office of the President, Chulalongkorn University

Places	Brand	BTU Size
Floor 2		
A1	Central Air	16200
A2	York	120000
A3	York	120000
A4	York	39000
A5	TASAKI	111600
A6	Uni-air	90000
A7	York	22300
A8	York	32000
A9	Uni-air	33000
Floor 3		
A10	York	106000
A11	York	106000
A12	Engineer	25600
Floor4		
A13	York	106000
A14	York	106000
A15	Trane	25000

Table B4 BTU size of air-conditioner at Office of the President, Chulalongkorn University (Cont.)

Places	Brand	BTU Size
Floor5		
A16	York	106000
A17	York	106000
A18	TASAKI	18800
A19	CARRIER	18000
A20	CARRIER	12000
A21	Central Air	12000
A22	MITSUBISHI	12000
A23	CARRIER	9000
A24	CARRIER	12000
Floor6		
A25	TASAKI	20300
A26	TASAKI	26000
A27	TASAKI	26000
A28	TASAKI	22300
A29	TASAKI	14000
A30	TASAKI	14000
A31	TASAKI	39000
A32	TASAKI	26000
A33	Engineer	29400
A34	TASAKI	26000
A35	TASAKI	26000
Floor7		
A36	TASAKI	60000
A37	TASAKI	22000
A38	TASAKI	32000
A39	Uni-air	60000
A40	TASAKI	22000
A41	TASAKI	22000
A42	Uni-air	32000
A43	York	36000
A44	TASAKI	32000

Table B5 Light's data from Office of the President, Chulalongkorn University

Floors	Type of Lighting	Quantity
1	bulb	35
	T8 (long)	1
	T8 (short)	6
2	bulb	121
	T8 (long)	9
	T5 (long)	50
	T8 (short)	20
3	bulb	91
	T8 (long)	46
	T8 (short)	14
4	bulb	137
	T8 (long)	0
	T8 (short)	8
5	bulb	70
	T8 (long)	66
	T8 (short)	8
6	bulb	29
	T8 (long)	64
	T8 (short)	8
7	bulb	48
	T8 (long)	0
	T8 (short)	8

Table B6 Electric appliances from Office of the President, Chulalongkorn University

Floors	Type of Lighting	Quantity
1	Computer	0
	Printer	0
	Copy machine	0
	Projector	0
	Televition	0
2	Computer	70
	Printer	0
	Copy machine	0
	Projector	2
	Televition	5
	Fridge	2
	Microwave	1

Table B6 Electric appliances from Office of the President, Chulalongkorn University (Cont.)

Floors	Type of Lighting	Quantity
3	Computer	7
	Printer	2
	Copy machine	1
	Projector	1
	Televition	1
	Fridge	2
	Microwave	1
4	Computer	33
	Printer	13
	Copy machine	1
	Projector	0
	Televition	0
	Fridge	1
	Microwave	1
5	Computer	13
	Printer	8
	Copy machine	1
	Projector	0
	Televition	0
	Fridge	1
	Microwave	1
6	Computer	10
	Printer	8
	Copy machine	0
	Projector	0
	Televition	0
	Fridge	1
	Microwave	1
7	Computer	4
	Printer	4
	Copy machine	1
	Projector	0
	Televition	0
	Fridge	1
	Microwave	1

Appendix C Carbon Footprint of Transportation

Table C1 Carbon footprint of vehicles fleet

Cars	Vehicle Type	Size Class	Registration Date	Collected Date	Overall Distance (km)	Used (day)
Toyota vios	Car	1500 cc	1/8/51	13/9/2557	94,904	1525
Nissan Van	Van	3000 cc	20/4/2547	13/9/2557	198,116	2511

Cars	Distance/Day (km/d)	Distance/Month (Km/month)	Fuel Consumption (km/l)	Fuel Used (l/d)
Toyota vios	62.23	1,866.96	17.77	3.50
Nissan Van	78.90	2,366.98	10.204	7.73

Table C2 General data of car

Cars	Vehicle Type	Size Class	Registration Date	Collected Data Date	Overall Distance (km)	Used (day)
Toyota Ventury	Van	3,000	17/10/51	20/2/2558	58,498	1,526
Toyota Ventury	Van	3,000	17/10/51	20/2/2558	113,304	1,526
Toyota Ventury	Van	3,000	21/7/52	20/2/2558	44,167	1,345
Toyota Ventury	Van	3,000	21/7/52	20/2/2558	82,492	1,345
Toyota Altis	Car	1,800	18/7/57	20/2/2558	9,287	145
Toyota Altis	Car	1,800	18/7/57	20/2/2558	1,442	145
Toyota Altis	Car	1,800	14/10/56	20/2/2558	9,341	329
Toyota Altis	Car	1,800	14/10/56	20/2/2558	7,913	329
Toyota Altis	Car	1,800	14/10/56	20/2/2558	10,063	329
Toyota Vios	Car	1,600	2/6/52	20/2/2558	15,757	1,376
Toyota Vios	Car	1,600	23/6/52	20/2/2558	23,251	1,361
Toyota Vios	Car	1,600	23/6/52	20/2/2558	82,977	1,361
Toyota Vios	Car	1,600	4/11/47	20/2/2558	40,127	2,474
Toyota Camry	Car	1,800	5/11/47	20/2/2558	27,586	2,473

Table C2 General data of car (Cont.)

Cars	Vehicle Type	Size Class	Registration Date	Collected Data Date	Overall Distance (km)	Used (day)
Volkswagen Caravelle	Van	2,000	9/9/48	20/2/2558	162,751	2,271

Table C3 Car's fuel used

Cars	Vehicle Type	Distance/Day (km/d)	Fuel consumption (km/l)	Fuel Used (l/d)
Toyota Ventury	Van	38.33	10.204	3.76
Toyota Ventury	Van	74.25	10.204	7.28
Toyota Ventury	Van	32.84	10.204	3.22
Toyota Ventury	Van	61.33	10.204	6.01
Toyota Altis	Car	64.05	13.796	4.64
Toyota Altis	Car	9.94	13.796	0.72
Toyota Altis	Car	28.39	13.796	2.06
Toyota Altis	Car	24.05	13.796	1.74
Toyota Altis	Car	30.59	13.796	2.22
Toyota Vios	Car	11.45	15.238	0.75

Table C3 Car's fuel used (Cont.)

Cars	Vehicle Type	Distance/Day (km/d)	Fuel Consumption (km/l)	Fuel Used (l/d)
Toyota Vios	Car	17.08	15.238	1.12
Toyota Vios	Car	60.97	15.238	4.00
Toyota Vios	Car	16.22	15.238	1.06
Toyota Camry	Car	11.15	13.796	0.81
Volkswagen Caravelle	Van	71.66	10.204	7.02

Table C4 GHG emissions from vehicles fleet in FY 2013

Cars	Vehicle Type	Fuel Consumption (L/d)	Emission Factor ($kgCO_2eq$ /L)	Emission ($kgCO_2eq$ /d)	Total Emission in 1 year
Toyota Ventury	Van	3.76	2.7446	10.31	2,474.61
Toyota Ventury	Van	7.28	2.7446	19.97	4,793.03
Toyota Ventury	Van	3.22	2.7446	8.83	2,119.80
Toyota Ventury	Van	6.01	2.7446	16.50	3,959.22
Toyota Altis	Car	4.64	2.2376	10.39	2,493.15
Toyota Altis	Car	0.72	2.2376	1.61	387.11

Table C4 GHG emissions from vehicles fleet in FY 2013 (Cont.)

Cars	Vehicle Type	Fuel Consumption (L/d)	Emission Factor ($kgCO_2eq$ /L)	Emission ($kgCO_2eq$ /d)	Total Emission in 1 year
Toyota Altis	Car	2.06	2.2376	4.60	1,105.19
Toyota Altis	Car	1.74	2.2376	3.90	936.24
Toyota Altis	Car	2.22	2.2376	4.96	1,190.62
Toyota Vios	Car	0.75	2.2376	1.68	403.57
Toyota Vios	Car	1.12	2.2376	2.51	602.07
Toyota Vios	Car	4.00	2.2376	8.95	2,148.65
Toyota Vios	Car	1.06	2.2376	2.38	571.61
Toyota Camry	Car	0.81	2.2376	1.81	434.22
Volkswagen Caravelle	Van	7.02	2.7446	19.28	4,626.22

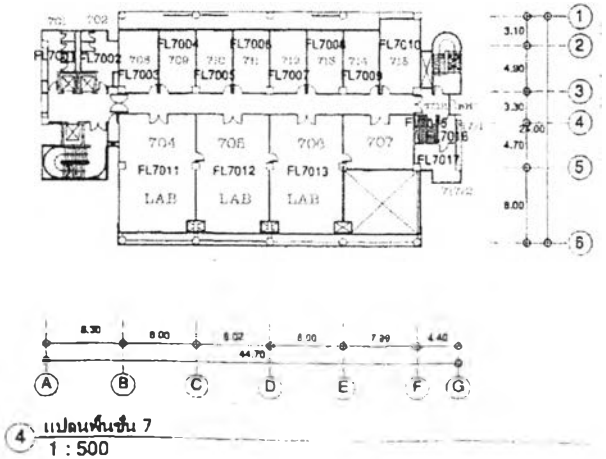
Table C5 Carbon footprint of Daily commuting from student

Type of Transportation	Distance (km/d)	Distance (mile/d)	Emission Factor ($kgCO_2e$/mile)	Emissions (kg CO_2)	Emission Factor (kg CH_4/mile)	Emission Factor (kg N_2O/mile)	Total Emissions ($kgCO_2eq$/day)
MRT	34	0	0.344	0	0.000	0.000	0
BTS	645	0	0.344	0	0.000	0.000	0
Taxi	13.5	8	0.276	2	0.037	0.067	3
Motorcycle	61.5	38	0.150	6	0.073	0.007	9
Public Transport(diesel)	281	4	1.450	6	0.005	0.005	6
1600 cc	328.5	204	0.304	62	0.034	0.036	76
1800 cc	148	92	0.383	35	0.040	0.051	44
3000 cc	0	0	0.464	0	0.183	0.098	0

Table C6 Carbon footprint of Daily commuting from faculty members and staff

Type of Transportation	Distance (km/d)	Distance (mile/d)	Emission Factor ($kgCO_2eq$/mile)	Emissions (kg CO_2)	Emission Factor (kg CH_4/mile)	Emission Factor (kg N_2O/mile)	Total Emissions ($kgCO_2eq$/day)
BTS	104	0	0.344	0	0.000	0.000	0
Taxi	0	0	0.276	0	0.037	0.067	0
Motorcycle	45	28	0.150	4	0.073	0.007	6
Public Transport(diesel)	254	4	1.450	5	0.005	0.005	5
1600 cc	292	181	0.304	55	0.034	0.036	68
1800 cc	324	201	0.383	77	0.040	0.051	96
3000 cc	130	81	0.464	37	0.183	0.098	60

Figure C1 Blue print of the PPC floor 5-8



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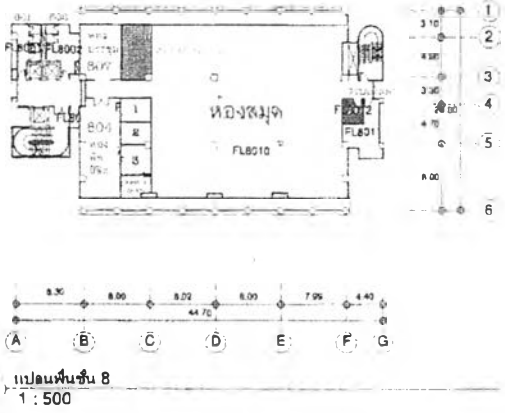

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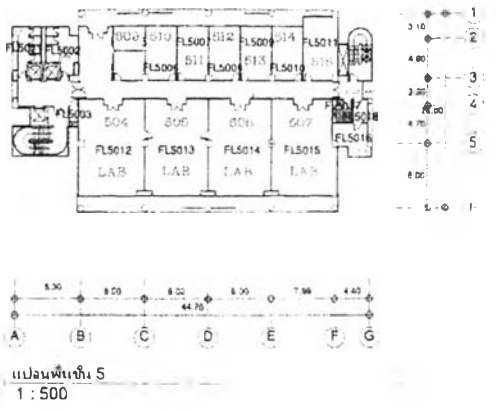

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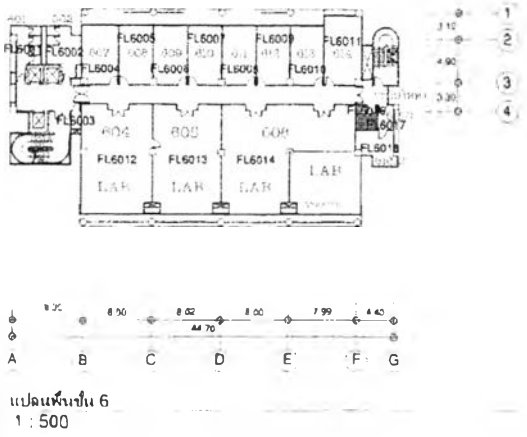

3 แปลนพื้นชั้น 6
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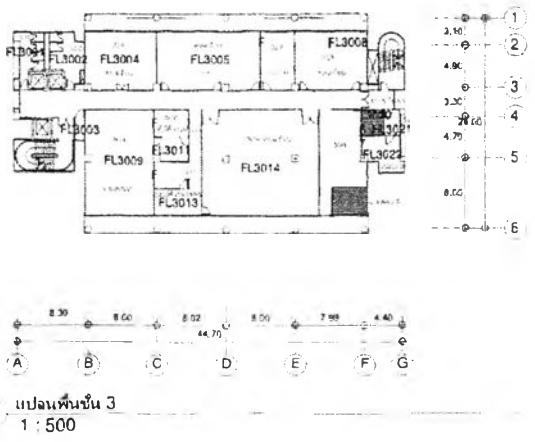
Figure C2 Blue print the PPC floor 1-4



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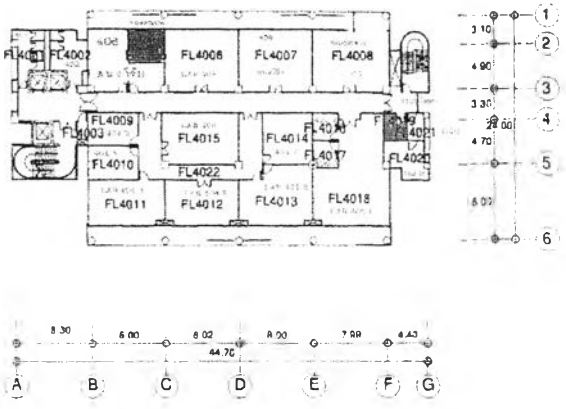

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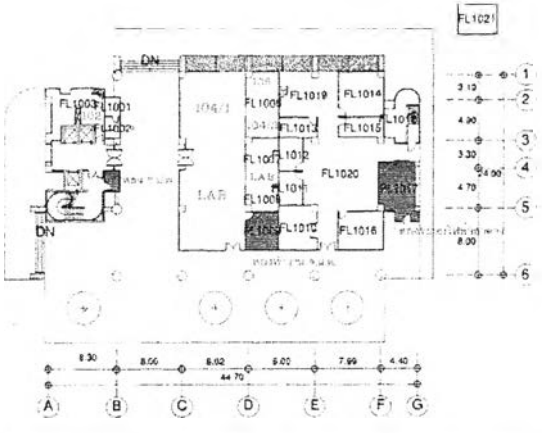

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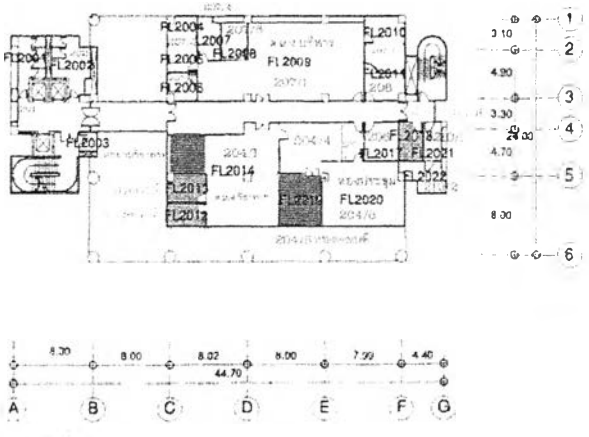

2 แปลนพื้นชั้น 2
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Appendix D Carbon Footprint of Tap Water Used

Table D1 Calculation of carbon footprint from tap water used (Oct'10 – Sep'11)

Month	Quantity(m^3)	GHG Emissions ($kgCO_2e$)
Jan	1,092	28.83
Feb	1,309	34.56
Mar	1,086	28.67
Apr	1,203	31.76
May	957	25.26
June	1,319	34.82
Jul	1,580	41.71
Aug	1,334	35.22
Sept	1,327	35.03
Oct	929	24.53
Nov	671	17.71
Dec	908	23.97
Sum	13,715	362.08

Table D2 Calculation of carbon footprint from tap water used (Oct'11 – Sep'12)

Month	**Quantity(m^3)**	**GHG Emissions ($kgCO_2e$)**
Jan	805	21.25
Feb	1025	27.06
Mar	944	24.92
Apr	849	22.41
May	887	23.42
June	1,140	30.10
Jul	913	24.10
Aug	1,410	37.22
Sept	1,089	28.75
Oct	870	22.97
Nov	784	20.70
Dec	797	21.04
Sum	11,513	303.94

Table D3 Calculation of carbon footprint from tap water used (Oct'12 – Sep'13)

Month	**Quantity(m^3)**	**GHG Emissions ($kgCO_2e$)**
Jan	759	20.04
Feb	955	25.21
Mar	773	20.41
Apr	758	20.01
May	683	18.03
June	1160	30.62
Jul	1520	40.13
Aug	1207	31.86
Sept	870	22.97
Oct	724	19.11
Nov	793	20.94
Dec	710	18.74
Sum	10,912	288.08

Carbon footprint of tap water used of Office of the President, Chulalongkorn Universit

Table D4 Calculation of carbon footprint from tap water used (Oct'10 – Sep'11)

Month	**Quantity(m^3)**	**GHG Emissions ($kgCO_2e$)**
Jan	1,176	31.05
Feb	1,265	33.40
Mar	1,064	28.09
Apr	762	20.12
May	671	17.71
June	448	11.83
Jul	631	16.66
Aug	494	13.04
Sept	552	14.57
Oct	580	15.31
Nov	601	15.87
Dec	1,007	26.58
Sum	9,251	244.23

Table D5 Calculation of carbon footprint from tap water used (Oct'11 – Sep'12)

Month	**Quantity(m^3)**	**GHG Emissions ($kgCO_2e$)**
Jan	978	25.82
Feb	650	17.16
Mar	961	25.37
Apr	946	24.97
May	1,097	28.96
June	783	20.67
Jul	584	15.42
Aug	530	13.99
Sept	419	11.06
Oct	511	13.49
Nov	492	12.99
Dec	464	12.25
Sum	8415	222.16

Table D6 Calculation of carbon footprint from tap water used (Oct'12 – Sep'13)

Month	**Quantity(m^3)**	**GHG Emissions ($kgCO_2e$)**
Jan	500	13.20
Feb	1,001	26.43
Mar	772	20.38
Apr	732	19.32
May	585	15.44
June	244	6.44
Jul	649	17.13
Aug	628	16.58
Sept	649	17.13
Oct	628	16.58
Nov	642	16.95
Dec	626	16.53
Sum	7,656	202.12

Appendix E Data Requirement Calculation of Emission Factor

Table E1 Car's fuel consumption rate for vehicles fleet

Type	Fuel	Unit	Fuel Consumption Rate	Reference
Small Gasoline Automobiles (1600 cc)	Gasoline	km/L	15.238	Pollution Control Department, 2008
Medium Gasoline Automobiles (1800 cc)	Gasoline	km/L	13.796	Pollution Control Department, 2008
Large Gasoline Automobiles (2000 cc)	Gasoline	km/L	12.248	Pollution Control Department, 2008
All Average Size of Gasoline Automobliles	Gasoline	km/L	14.763	Pollution Control Department, 2008
Van	Diesel	km/L	10.204	American Petroleum Institute, 2004

Table E2 Emission factor of vehicles fleet's fuel and electricity

Type	Unit	Greenhouse Gases Emissions				Reference
		CO_2	CH_4	N_2O	Overall GHG	
		kg/unit	kg/unit	kg/unit	$kgCO_2e$/unit	
Diesel	Liter	2.698722E+00	1.092600E-04	2.185200E-05	2.7080	IPCC Vol.2 table 2.2, DEDE
Gasoline-uncontrolled	Liter	2.181564E+00	1.038840E-03	1.007360E-04	2.2376	IPCC Vol.2 table 3.2.1, 3.2.2, DEDE
Purchased electricity	kWh	N/A	N/A	N/A	0.5813	MTEC, G2G, 2009

Table E3 Default maximum CH_4 producing capacity (B_0) for domestic wastewater. (IPCC, 2006 Vol.6)

DEFAULT MAXIMUM CH_4 PRODUCING CAPACITY (B_O) FOR DOMESTIC WASTEWATER
0.6 kg CH_4/kg BOD
0.25 kg CH_4/kg COD
Based on expert judgment by lead authors and on Doorn *et al.*, (1997)

Table E4 Default MCF values. (IPCC, 2006 Vol.6)

DEFAULT MCF VALUES FOR DOMESTIC WASTEWATER			
Type of Treatment and Discharge Pathway or System	**Comments**	**MCF 1**	**Range**
Untreated System			
Sea, River and Lake	Rivers with high organics loadings can turn	0.1	0 – 0.2
Stagnant Sewer	Open and warm	0.5	0.4 – 0.8
Flowing Sewer (open or closed)	Fast moving, clean. (Insignificant amounts of CH_4 from pump stations, etc)	0	0
Treated System			
Centralized, Aerobic	Must be well managed. Some CH_4 can be emitted from settling basins and other pockets.	0	0 – 0.1
Centralized, Aerobic Treatment Plant	Not well managed. Overloaded.	0.3	0.2 – 0.4
Anaerobic Digester for Sludge	CH_4 recovery is not considered here.	0.8	0.8 – 1.0

Table E4 Default MCF values (Cont.) (IPCC, 2006 Vol.6)

Type of Treatment and Discharge Pathway or System	**Comments**	**MCF 1**	**Range**
Anaerobic reactor	CH_4 recovery is not considered here.	0.8	0.8 – 1.0
Anaerobic shallow lagoon	Depth less than 2 metres, use expert judgment.	0.2	0 – 0.3
Anaerobic deep lagoon	Depth more than 2 metres	0.8	0.8 – 1.0
Septic system	Half of BOD settles in anaerobic tank.	0.5	0.5
Latrine	Dry climate, ground water table lower than latrine, small family (3-5 persons)	0.1	0.05 – 0.15
Latrine	Dry climate, ground water table lower than latrine, communal (many users)	0.5	0.4 – 0.6
Latrine	Wet climate/flush water use, ground water table higher than latrine	0.7	0.7 – 1.0
Latrine	Regular sediment removal for fertilizer	0.1	0.1
1 Based on expert judgment by lead authors of this section.			

Table E5 Fuel emission factor of daily commuting

Transportation Activity				**CO_2 Emissions**
				Default
Transport description			**Activity Unit**	**kg CO_2/mile**
Road Transportation	**mpg**	**kgCO_2/ gallon**		
Hybrid Automobiles	34		vehicle miles	0.1610
Small Gasoline Automobiles	29	8.810	vehicle miles	0.3038
Medium Gasoline Automobiles	23	8.810	vehicle miles	0.3830
Large Gasoline Automobiles	19	8.810	vehicle miles	0.4637
LPG Automobile	21	5.79	vehicle miles	0.2757
Diesel Automobiles	24	10.15	vehicle miles	0.4229
Gasoline Light Truck	14	8.810	vehicle miles	0.6293
Gasoline Heavy Truck	6	8.810	vehicle miles	1.4683
Diesel Light Truck	15	10.15	vehicle miles	0.6767
Diesel Heavy Truck	7	10.15	vehicle miles	1.4500
Light Motorcycle	60		vehicle miles	0.1503
Rail Transportation			**Activity Unit**	**kgCO_2/ passenger mile**
Diesel Locomotive			passenger miles	0.17187324
Electric Locomotive			passenger miles	0.34374648
Coal Locomotive			passenger miles	0.223775555
US Intercity Rail (e.g. Amtrak)			passenger miles	0.185
US Transit Rail (e.g subway, tram)			passenger miles	0.163
US Commuter Rail			passenger miles	0.172

Table E6 Factor for alternative calculation

Factors for Alternative Calculation			
Vehicle Type	**kg CO_2/mile**	**g CH_4/mile**	**g N_2O/mile**
Hybrid Automobiles	0.16		
Small Gasoline Automobiles	0.30	0.0336	0.0357
Medium Gasoline Automobiles	0.38	0.0404	0.0511
Large Gasoline Automobiles	0.46	0.1828	0.0982
LPG Automobile	0.28	0.037	0.067
Diesel Automobiles	0.42	0.0005	0.0010
Gasoline Light Truck	0.63	0.0010	0.0015
Gasoline Heavy Truck	1.47	0.1828	0.0982
Diesel Light Truck	0.68	0.0010	0.0015
Diesel Heavy Truck	1.45	0.0051	0.0048
Light Motorcycle	0.15	0.0729	0.0074
Diesel Locomotive	0.17		
Electric Locomotive	0.34		
Coal Locomotive	0.22		
US Intercity Rail (e.g. Amtrak)	0.19	0.002	0.001
US Transit Rail (e.g subway, tram)	0.16	0.004	0.002
US Commuter Rail	0.17	0.002	0.001

Table E7 Emissions factor for paper and tap water used

Type	**Unit**	**Factor ($kgCO_2e$/Unit)**	**Reference**	**Remarks**
Paper	kg	2.93	IPCC, 2006	
Water	m^3	0.0264	Metropolitan Waterworks Authority (Thailand)	File: LCI data source

Table E8 Mix solid waste composition (2006 IPCC Guidelines for National Greenhouse Gas Inventories)

TABLE 2.3
MSW COMPOSITION DATA BY PERCENT - REGIONAL DEFAULTS

Region	Food waste	Paper cardboard	Wood	Textiles	Rubber leather	Plastic	Metal	Glass	Other
Asia									
Eastern Asia	26.2	18.8	3.5	3.5	1.0	14.3	2.7	3.1	7.4
South-Central Asia	10.3	11.3	7.9	2.5	0.8	6.4	3.8	3.5	21.9
South-Eastern Asia	43.5	12.9	9.9	2.7	0.9	7.2	3.3	4.0	16.3
Western Asia & Middle East	41.1	18.0	9.8	2.9	0.6	6.3	1.3	2.2	5.4
Africa									
Eastern Africa	53.9	7.7	7.0	1.7	1.1	5.5	1.8	2.3	11.6
Middle Africa	43.4	16.8	6.5	2.5		4.5	3.5	2.0	1.5
Northern Africa	51.1	16.5	2	2.5		4.5	3.5	2	1.5
Southern Africa	23	25	15						
Western Africa	40.4	9.8	4.4	1.0		3.0	1.0		
Europe									
Eastern Europe	30.1	21.8	7.5	4.7	1.4	6.2	3.6	10.0	14.6
Northern Europe	23.8	30.6	10.0	2.0		13.0	7.0	8.0	
Southern Europe	36.9	17.0	10.6						
Western Europe	24.2	27.5	11.0						
Oceania									
Australia and New Zealand	36.0	30.0	24.0						
Rest of Oceania	67.5	6.0	2.5						
America									
North America	33.9	23.2	6.2	3.9	1.4	8.5	4.6	6.5	9.8
Central America	43.8	13.7	13.5	2.6	1.8	6.7	2.6	3.7	12.3
South America	44.9	17.1	4.7	2.6	0.7	10.8	2.9	3.3	13.0
Caribbean	46.9	17.0	2.4	5.1	1.9	9.9	5.0	5.7	3.5

Table E9 Emissions factor for each solid waste.

Waste Compositions	**Greenhouse Gases Emissions (tCO_2e/ ton)**	**References**
Paper/Cardboard	2.93	2006 IPCC Guideline for National Greenhouse Gas Inventories- Volume 5: Waste
Textiles	2.00	
Food Waste	2.53	
Wood	3.33	
Garden/Yard and Park Waste	3.27	
Nappies	4.00	
Rubber/Leather	3.13	
Other	2.32	

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Proceedings:

1. Kaewprom, J; Malakul, P.; and Charoensaeng, A. (2015, April 21) Carbon footprint of organization: Case studies of the Petroleum and Petrochemical and Office of the President, Chulalongkorn University. Proceedings of the 6th Research Symposium on Petroleum, Petrochemicals, and Advanced Materials and the 21th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.
2. Kaewprom, J.; Malakul, P.; and Charoensaeng, A. (2015, June 6) Carbon footprint of organization: Case studies of the Petroleum and Petrochemical and Office of the President, Chulalongkorn University. 3rd International Conference on Sustainable Development, Rome, Italy.