

# City of Champaign Greenhouse Gas Inventory Report



## 2010 Stationary, Point And Mobile-Source Pollutant Emissions Inventory

**September 2011**

Prepared by:

Champaign Urbana Urbanized Area Transportation Study  
Champaign County Regional Planning Commission  
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September 2011

Prepared for:

The City of Champaign, IL

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Champaign Urbana Urbanized Area Transportation Study (CUUATS)

A Program of the Champaign County Regional Planning Commission (CCRPC)



## Summary

This report summarizes the results of a preliminary study quantifying 2010 greenhouse gas emissions for defined sectors in Champaign, IL.

### **Land Use**

The land use analysis quantifies the estimated emissions resulting from Residential, Commercial and Industrial energy consumption within the City of Champaign based on 2010 Ameren IP reporting data accessed through the Illinois Commerce Commission website. <http://www.icc.illinois.gov/publicutility/salesstatistics.aspx?t=e>.

### **Mobile Source**

Mobile source emissions were quantified using the 2010 Mobile Vehicle Emissions Simulator (MOVES2010a) mobile source emissions model developed by US EPA and FHWA. Separate inventories were created for the City of Champaign municipal fleet and community-wide vehicle population derived from IL Secretary of State vehicle registration data for Champaign County.

### **Municipal Facilities**

Emissions from Municipal facilities were calculated using energy consumption data provided by the City of Champaign for municipal buildings, traffic signals and street lights. The signal and street lights data were from the FY 2009 - FY 2010 assuming usage held constant for the remaining portion of FY 2010.

### **Abbott Power Plant**

Abbott power plant emissions were derived from the University of Illinois iCAP Climate Action Plan (2010) and 2007 Emissions & Generation Resource Integrated Database (eGRID) energy generation and emissions data, assuming fuel mix and generation rates continued to 2010.  
<http://sustainability.illinois.edu/Climate%20Action%20Plan.Final.pdf>

The results indicate that energy generation and fossil fuel combustion at Abbott Power Plant are a significant source of GHG emissions in the City (28%). Residential, commercial and industrial energy consumption follow, at 26%, 17% and 6% respectively. On-road community vehicles contribute 22% of the total GHG emissions. Municipal facilities, street lights and traffic signals, and vehicle fleet contribute a combined 1% of total community-wide GHGs.



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## 1. Introduction

This study was completed in order to develop a Greenhouse Gas (GHG) emissions inventory for the City of Champaign, IL. Using 2010 as the baseline year, the GHG Inventory quantifies the 2010 Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), and Nitrous Oxide (N<sub>2</sub>O) emissions resulting from the following City of Champaign community attributes and expresses total emissions in metric tonnes of Carbon Dioxide Equivalents (mtCO<sub>2</sub>e). It is important to note that municipal solid waste, agricultural land, and waste water are not currently included in this analysis. The sole major point source emitter in the City of Champaign is Abbott Power Plant.

### 2010 Champaign, IL (pop. 81,055) - 1,273,513.33 mtCO<sub>2</sub>e (1.27 MtCO<sub>2</sub>e)

Emissions Inventories for three comparable cities were used to validate the inventory results against.

- 2005 Bellingham, WA (pop 78,905) - 1,018,005 tCO<sub>2</sub>e (923,518.60 mtCO<sub>2</sub>e)
- 2005 Evanston, Illinois (pop. 77,693) - 996,672 mtCO<sub>2</sub>e
- 2009 Bloomington, Indiana (pop. 71,819) - 943,480 tCO<sub>2</sub>e (838,673.24 mtCO<sub>2</sub>e)

Results of this analysis indicate that Abbott Power Plant is the major contributor to GHG emissions for the City of Champaign (359,100 mtCO<sub>2</sub>e), followed closely by residential electricity and natural gas consumption (332,137 mtCO<sub>2</sub>e), and community vehicles (284,239 mtCO<sub>2</sub>e). Figure 1 provides the shares of emissions by sector for the City of Champaign in 2010. The disparity between the City of Champaign's emissions and the comparable cities can be attributed to a slightly higher population and the presence of Abbott Power Plant; none of the comparison studies included a power plant within the city limits.

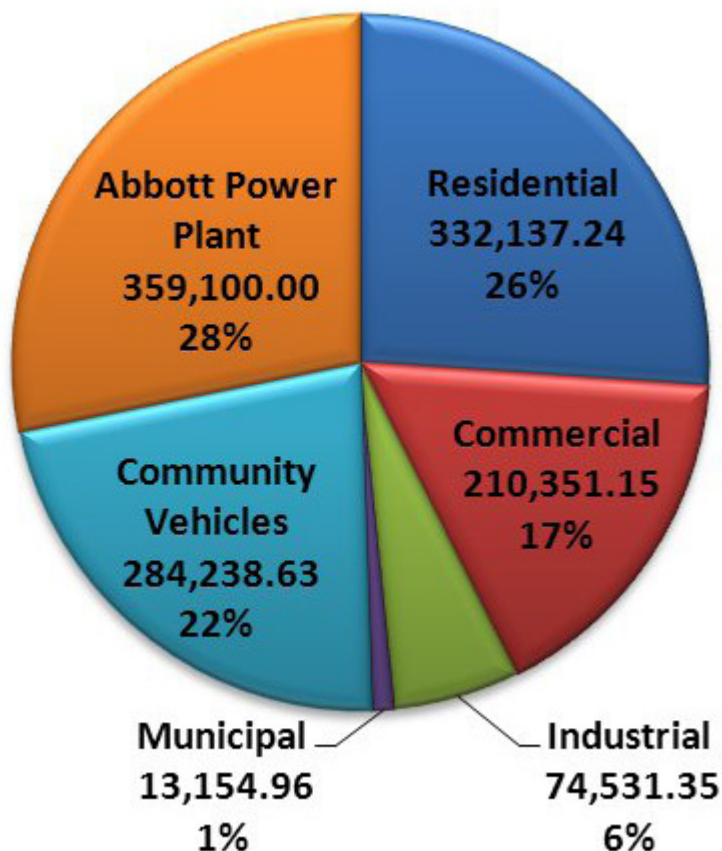


Figure 1. Emission Shares by Sector (mtCO<sub>2</sub>e)



## 2. Energy Generation Emissions by Land Use

Residential, Commercial, and Industrial energy use were estimated separately by multiplying the number of customers of each type in the City of Champaign by the average electricity (kWh) and natural gas (Therms) consumption per customer by type for the region. The electricity consumption estimates were then multiplied by 2007 Emissions & Generation Resource Integrated Database (eGRID) emissions factors for the SRMW (SERC Midwest) subregion for Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), and Nitrous Oxide (N<sub>2</sub>O). These emissions factors account for the region-specific mix of sources of electricity generation (coal, nuclear, wind, natural gas, etc.).

Emissions resulting from direct use of natural gas were estimated using the Intergovernmental Panel on Climate Change's (IPCC) AR4 assessment report emissions factors. Emissions were then converted to metric tonnes of Carbon Dioxide Equivalents (mtCO<sub>2</sub>e) by multiplying Methane and Nitrous Oxide by their Global Warming Potentials (GWPs) 21 and 298, respectively, and summing the totals for all three.

According to the analysis total residential, commercial, and industrial emissions resulting from energy consumption are 617,019.74 mtCO<sub>2</sub>e, the vast majority of which is generated by residential energy consumption. Most Industrial emissions were generated by the direct use of natural gas; most residential and commercial emissions were generated from electricity consumption.

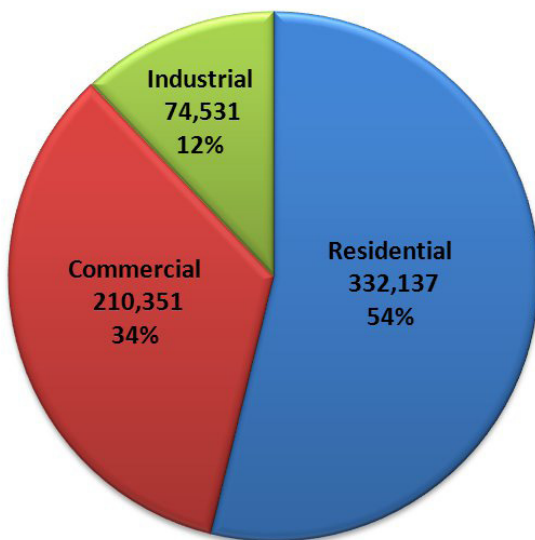


Figure 2. Emission Shares by Land Use Type (mtCO<sub>2</sub>e)

Table 1. Estimated Energy Usage and Emissions by Land Use Type

	Estimated Average annual kWh	Estimated Average Natural Gas Therms	mtCO <sub>2</sub> e
<b>Residential Customers</b>			
33,759	397,007	18,914,493	332,137
<b>Commercial Customers</b>			
2,795	252,935	9,690,265	210,351
<b>Industrial Customers</b>			
355	33,285	89,489,820	74,531

The 2010 mix of sources for electricity generation provided by AmerenIL indicates that the majority of electricity produced in our region is done so through coal combustion (77%)<sup>1</sup>.

<sup>1</sup> <http://www.icc.illinois.gov/downloads/public/en/a%20m%20erenillinois.pdf>

### 3. Mobile Source Emissions

Mobile source emissions for the City of Champaign municipal and community fleets were estimated using the US Environmental Protection Agency's Office of Transportation and Air Quality's (OTAQ) Motor Vehicle Emission Simulator (MOVES2010a). The MOVES model estimates emissions based on local inputs such as annual vehicle miles travelled (VMT), hourly temperature and relative humidity, vehicle population and age mix, roadway mix, average speeds, and fuel formulation.

Total 2010 estimated mobile source GHG emissions for the City of Champaign, including the municipal and community fleets are 20,636.14 mtCO<sub>2</sub>e.

#### Community Fleet

City of Champaign vehicle population data was derived from current Illinois Secretary of State vehicle registration data for Champaign County. The vast majority of vehicles in the City are passenger cars. Heavy equipment such as backhoes, front-end loaders, and graders are not included in the community wide mobile source emissions analysis. Municipal vehicles were subtracted from the community vehicle population. Additional inputs were added to the model to account for the mix of hybrid buses in the CU-MTD fleet and the addition of diesel particulate filters on the remaining buses.

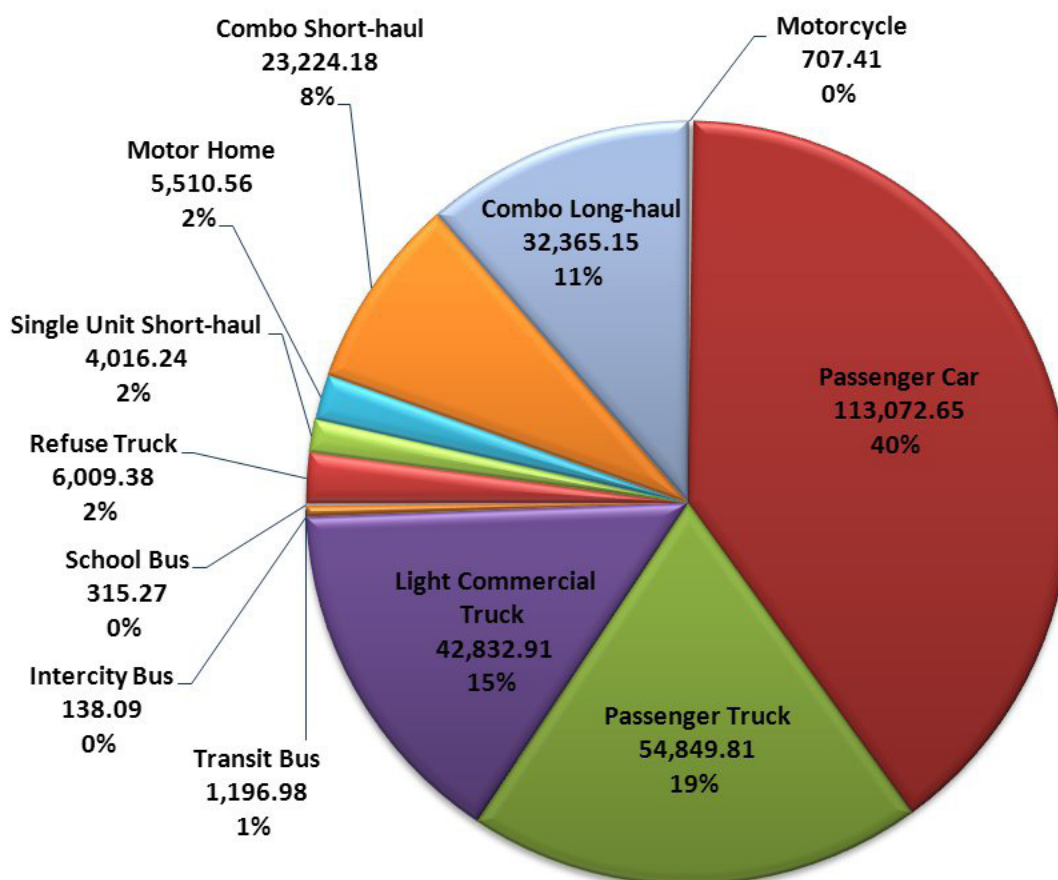


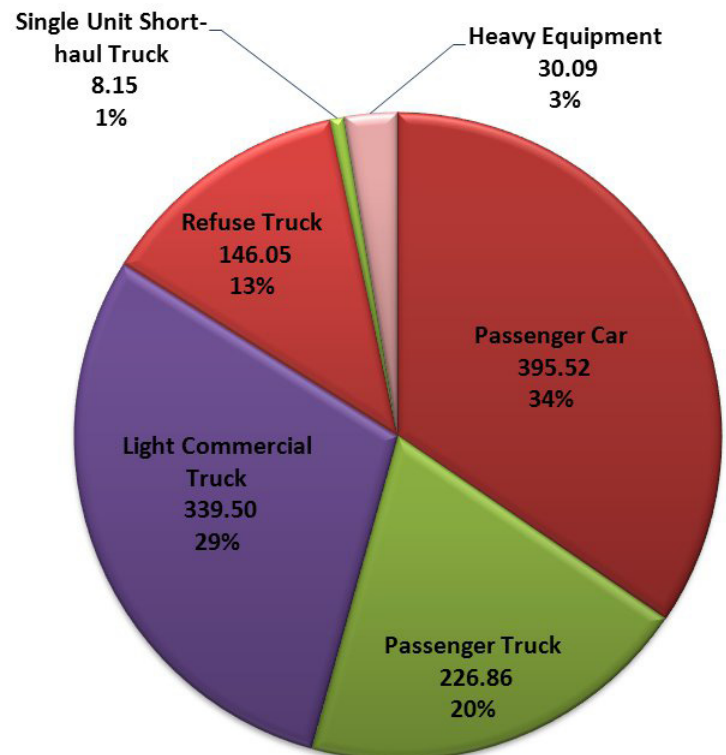
Figure 3. 2010 Community Fleet Emissions Shares

Table 2. 2010 Community Vehicle Population and Emissions

Vehicle Type	Population	CO <sub>2</sub> e (g/mi)	Est. DVMT	Daily Emissions (mtCO <sub>2</sub> e)	Annual Emissions (mtCO <sub>2</sub> e)
Motorcycle	338	380	5,642	2.14	707.41
Passenger Car	37,634	434	788,701	342.64	113,072.65
Passenger Truck	7,915	643	258,357	166.21	54,849.81
Light Commercial Truck	5,318	654	198,357	129.8	42,832.91
Intercity Bus	5	1,928	217	0.42	138.09
Transit Bus	99	1,306	2,778	3.63	1,196.98
School Bus	130	1,020	937	0.96	315.27
Refuse Truck	40	1,805	10,091	18.21	6,009.38
Single Unit Short-haul	33	1,148	10,603	12.17	4,016.24
Single Unit Long-haul	-	-	-	-	-
Motor Home	163	1,153	14,487	16.70	5,510.56
Combo Short-haul	95	2,204	31,927	70.38	23,224.18
Combo Long-haul	61	2,797	35,060	98.08	32,365.15
<b>Total</b>	<b>51,831</b>	<b>15,472</b>	<b>1,357,156</b>	<b>861.33</b>	<b>284,238.63</b>

### Municipal Fleet

The City of Champaign municipal vehicle fleet data was provided by the Fleet Services division of Public Works. Average annual vehicle miles travelled (VMT) for the municipal fleet were calculated for each vehicle type based on actual mileage data and used as inputs into the MOVES mobile source emissions model. The municipal fleet contains sixty six (66) pieces of heavy equipment whose efficiencies were derived from average monthly vmt/hours and estimated fuel efficiency<sup>1</sup>.



<sup>1</sup> Lewis, Michael Phil. Estimating Fuel Use and Emissions Rates of Nonroad Diesel Construction Equipment Performing Representative Duty Cycles.

Figure 4. 2010 Municipal Fleet Emissions Shares

Table 3. 2010 Municipal Vehicle Population and Emissions

Vehicle Type	Population	CO <sub>2</sub> e (g/mi)	Est. DVMT	Daily Emissions (mtCO <sub>2</sub> e)	Annual Emissions (mtCO <sub>2</sub> e)
<b>Motorcycle</b>	<b>0</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Passenger Car</b>	<b>61</b>	<b>418</b>	<b>3,771</b>	<b>1.58</b>	<b>395.52</b>
<b>Passenger Truck</b>	<b>31</b>	<b>687</b>	<b>1,315</b>	<b>0.90</b>	<b>226.86</b>
<b>Light Commercial Truck</b>	<b>63</b>	<b>660</b>	<b>2,048</b>	<b>1.35</b>	<b>339.50</b>
<b>Intercity Bus</b>	<b>0</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Transit Bus</b>	<b>0</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>School Bus</b>	<b>0</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Refuse Truck</b>	<b>14</b>	<b>1,825</b>	<b>319</b>	<b>0.58</b>	<b>146.05</b>
<b>Single Unit Short-haul Truck</b>	<b>2</b>	<b>1,153</b>	<b>28</b>	<b>0.03</b>	<b>8.15</b>
<b>Single Unit Long-haul Truck</b>	<b>0</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Motor Home</b>	<b>0</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Combination Short-haul Truck</b>	<b>0</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Combination Long-haul Truck</b>	<b>0</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Heavy Equipment</b>	<b>66</b>				<b>30.09</b>
<b>Total</b>	<b>171</b>	<b>4,743</b>	<b>7,481</b>	<b>4.45</b>	<b>1,146.17</b>

## 4. Municipal Facilities

The City of Champaign's municipal facilities, along with traffic signals and street lights, account for approximately 1.3% of the GHG emissions for the community. Approximately 42% of the City's electricity use, as of FY 2009/2010, was consumed by traffic signals and street lights. Since then the City has replaced all traffic lights with LEDs, reducing energy consumption, and therefore emissions, exponentially. Direct natural gas consumption accounted for approximately 14% of the City's CO<sub>2</sub>e emissions and 42% of the City's total energy use.

### Municipal Emissions

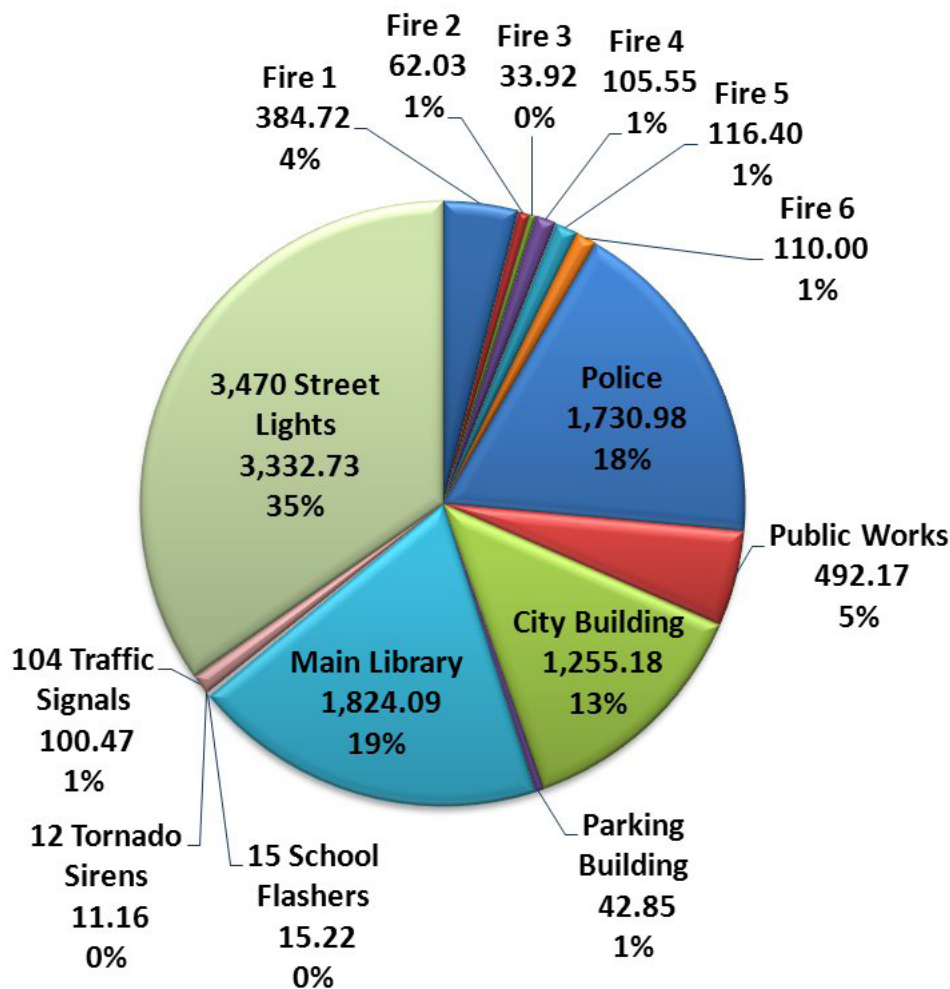


Figure 5. 2010 Municipal Facilities Emissions Shares (mtCO<sub>2</sub>e)

Table 4. 2010 Emissions from Electricity Consumption by Facility (mtCO<sub>2</sub>e).

Facility	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
Fire 1	263.7	0.003	0.004
Fire 2	44.5	0.001	0.001
Fire 3	22.1	0.000	0.000
Fire 4	66.6	0.001	0.001
Fire 5	75.9	0.001	0.001
Fire 6	70.1	0.001	0.001
Police	1,330.4	0.015	0.022
Public Works	355.1	0.004	0.006
City Building	987.3	0.011	0.016
Parking Building	22.2	0.000	0.000
Main Library	1,550.0	0.018	0.026
15 School Flashers	15.1	0.000	0.000
12 Tornado Sirens	11.1	0.000	0.000
104 Traffic Signals	99.9	0.001	0.002
3470 Street Lights	3,315.5	0.038	0.055
<b>Total</b>	<b>8,229.7</b>	<b>0.0951</b>	<b>0.1369</b>
<b>mtCO<sub>2</sub>e</b>	<b>8,229.7</b>	<b>2.00</b>	<b>40.80</b>
<b>Total mtCO<sub>2</sub>e</b>			<b>8,272.5</b>

Table 5. 2010 Emissions from Natural Gas Consumption by Facility (mtCO<sub>2</sub>e).

Facility	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
Fire 1	119.3	0.0	0.0
Fire 2	17.3	0.0	0.0
Fire 3	11.7	0.0	0.0
Fire 4	38.5	0.0	0.0
Fire 5	40.0	0.0	0.0
Fire 6	39.4	0.0	0.0
Police	392.7	0.0	0.0
Public Works	134.8	0.0	0.0
City Building	262.1	0.0	0.0
Parking Building	20.4	0.0	0.0
Main Library	265.3	0.0	0.0
<b>Total</b>	<b>1,341.6</b>	<b>0.1264</b>	<b>0.0025</b>
<b>mtCO<sub>2</sub>e</b>	<b>1,341.6</b>	<b>2.65</b>	<b>0.75</b>
<b>Total mtCO<sub>2</sub>e</b>			<b>1,345.0</b>

Table 6. 2010 Electricity Consumption by Facility.

Facility	Share of Electricity Consumed	Electricity (kWh)
Fire 1	3%	326,800
Fire 2	1%	55,117
Fire 3	0%	27,404
Fire 4	1%	82,479
Fire 5	1%	94,070
Fire 6	1%	86,880
Police	16%	1,648,400
Public Works	4%	440,040
City Building	12%	1,223,280
Parking Building	0%	27,553
Main Library	19%	1,920,574
15 School Flashers	0.2%	18,764
12 Tornado Sirens	0.1%	13,760
104 Traffic Signals	1.2%	123,843
3470 Street Lights	40.3%	4,108,095
<b>Total</b>	<b>100.0%</b>	<b>10,197,060</b>

Table 7. 2010 Natural Gas Consumption by Facility.

Facility	Share of NG Consumed	Natural Gas (Therms)
Fire 1	9%	22,483
Fire 2	1%	3,255
Fire 3	0.9%	2,198
Fire 4	3%	7,263
Fire 5	3%	7,535
Fire 6	3%	7,428
Police	29%	74,010
Public Works	10%	25,412
City Building	20%	49,399
Parking Building	1.5%	3,854
Main Library	20%	50,006
<b>Total</b>	<b>100%</b>	<b>252,843</b>

## 5. Abbott Power Plant

Abbott Power Plant is the only point source emitter in the City of Champaign with available data, and the largest. Information used for this analysis was derived from the University of Illinois iCAP Climate Action Plan report (2010), verified against 2007 Emissions & Generation Resource Integrated Database (eGRID) generation and emissions data.

Assuming a continuation of both amount of electricity generated and fuel mix, Abbott's 2010 emissions are estimated to be 359,100 mtCO<sub>2</sub>e.



## 6.0 Summary

The City of Champaign's total estimated GHG emission for 2010 are approximately 1,006,325.76 mtCO<sub>2</sub>e based on available data and the analyses conducted for this study. Although municipal solid waste, agricultural land, and waste water are not currently included in this analysis, the results indicate that the City emissions per person (12.41 mtCO<sub>2</sub>e/person/year), are just over the average (12.15 mtCO<sub>2</sub>e/person/year) for the comparison cities of Bellingham, WA, Evanston, IL, and Bloomington, IN referred to in the introduction.

While the inventory methodologies were not identical, the results indicate that they were similar enough to provide accurate estimates of emissions for comparison. Utilization of the MOVES mobile source emissions model for the City of Champaign inventory is expected to provide much more accurate emissions results than other methods and provide total emissions estimates by fuel type, vehicle type, as well as rates per mile or vehicle to be used in further analyses.

It is believed that the results of this inventory provide an accurate and reasonable estimation of 2010 emissions for the City of Champaign. The inventory results and this report will be updated upon completion of new analyses of the above sectors and their contribution to community-wide GHG emissions.