

APPENDIX D: Greenhouse Gas Emissions Calculations

This appendix calculates the potential greenhouse gas (GHG) reductions for each of the implemented action items included in the Climate Change Action Plan (CCAP). The data and assumptions provided herein were developed from appropriate sources and referenced accordingly. In many cases data were not available and no calculations could be performed but will when data are available in future updates. The GHG emissions reductions are weighed against the targets set by the Mayor's Climate Protection Agreement, Washington State Mandate, and IPCC to show status of the CCAP. Discrepancies will be addressed in future updates of the CCAP as information becomes available.

| | 1990 | 2000 | 2005 | 2009* |
|--|---------|---------|---------|---------|
| City of Edmonds GHG Emissions Inventories - Tonnes | 179,557 | 248,380 | 271,131 | 281,976 |

| Source of Goal >>> | Mayor's Agreem'nt | Wash. State | Wash. State | Wash. State | IPCC |
|---|----------------------|----------------|----------------|----------------|--------|
| Edmonds GHG Emissions Goals - Tonnes | 2012 | 2020 | 2035 | 2050 | 2050 |
| Kyoto Protocol Goal is 7% less 1990 level (1) | 166,988 | | | | |
| Goal for 2020 is to equal 1990 level (2) | | 179,557 | | | |
| Goal for 2035 is 25% less than 1990 (2) | | | 134,668 | | |
| Goal for 2050 is 50% less than 1990 (2) | | | | 89,779 | |
| Goal for 2050 is 80% less than 1990 (3) | | | | | 35,911 |

| | | | | | |
|--------------------------------------|---------|---------|---------|---------|---------|
| Req'd Reductions from 2009 Emissions | 114,988 | 102,419 | 147,308 | 192,198 | 246,065 |
|--------------------------------------|---------|---------|---------|---------|---------|

| | | | | | |
|---|-------|--------|---------|---------|---------|
| Calculated Reductions from Action Items | 8,203 | 36,057 | 103,742 | 171,679 | 171,679 |
|---|-------|--------|---------|---------|---------|

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|-----------------------------|---------|--------|--------|--------|--------|
| Shortfall of GHG Reductions | 106,785 | 66,362 | 43,566 | 20,519 | 74,386 |
|-----------------------------|---------|--------|--------|--------|--------|

* Estimated

(1) Goal established in US Mayor's Climate Protection Agreement signed in 2006

(2) Goals established by Washington State issued 2007

(3) Goal established by United Nations' International Panel on Climate Change (IPCC) issued in 2008

Edmonds Climate Change Action Plan

Our Transportation and Land Use

TR1: Promote the serviceability of commercial and mobility hubs.

| Value | Parameter Text | Symbol | Formula or Reference |
|------------|---|--------|---------------------------------|
| 11.05 | Vehicle Miles Travelled (VMT) per day per person in 2005 | A | Edmonds Inventory Report |
| 39860 | Population in 2005 | B | Edmonds Inventory Report |
| 338.75 | No. of annual travel days used to account for weekdays and weekends | C | Edmonds Inventory Report |
| 149.20 | Annual VMT in million miles | D | $A*B*C/1,000,000$ |
| 14.90 | Average vehicle mileage in mpg | E | Calc. from Inventory Report |
| 10,011,303 | Gallons of fuel consumed in 2005 | F | $D*1,000,000/E$ |
| 0.008891 | Emissions factor for 7% diesel and 93% gasoline vehicles - tonnes/gal | G | EPA emission factors & Inv. Rpt |
| 89,012 | Tonnes of GHG emissions | H | $F*G$ |
| 20% | Estimated percent reduction of miles driven due to creation of hubs | I | SWAG |
| 17,802 | Annual GHG emissions reduction in tonnes | J | $H*I$ |
| | | | |
| | | | |

TR2: Continue to encourage businesses to locate in Edmonds

| Value | Parameter Text | Symbol | Formula or Reference |
|-----------|--|--------|----------------------------|
| 4186 | Number of businesses in Edmonds | A | Quickfacts |
| 40265 | Population of Edmonds 2009 | B | Est. from Inventory Report |
| 10.0% | Percent of population working at local businesses | C | SWAG |
| 4027 | No. of residents employed at local businesses | D | $B*C$ |
| 0.96 | Ratio of residents working per local business | E | D/A |
| 15.0% | Anticipated % increase of new businesses by 2050 | F | SWAG |
| 628 | Number of new businesses | G | $A*F$ |
| 604 | Number of residents with shorter commute distances | H | $E*G$ |
| 4 | Average commute miles within Edmonds | I | SWAG |
| 15 | Average commute miles outside Edmonds | J | See SUM sheet |
| 1,660,931 | Annual reduction of VMT in miles | K | $(J-I)*250*H$ |
| 30.0 | Average vehicle mileage assumed for study | L | SWAG |

Edmonds Climate Change Action Plan

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|----------|---|---|----------------------|
| 55,364 | Gallons of fuel saved | M | K/L |
| 0.008891 | Emissions factor for 7% diesel and 93% gasoline vehicles - tonnes/gal | N | EPA Emission factors |
| 492 | Annual GHG emissions reduction in tonnes | O | L*M |
| | | | |

TR3: Encourage local purchasing of goods and services.

| Value | Parameter Text | Symbol | Formula or Reference |
|-----------------|----------------|--------|----------------------|
| Included in TR1 | | | |
| | | | |

TR4: Increase bicycle lanes/trails connecting commercial and mobility hubs in concert with the City of Edmonds Transportation Plan.

| Value | Parameter Text | Symbol | Formula or Reference |
|-----------------|----------------|--------|----------------------|
| Included in TR1 | | | |
| | | | |

TR5: Continue to implement sidewalk and street improvements throughout the City and especially for Safe Routes for School Program.

| Value | Parameter Text | Symbol | Formula or Reference |
|-----------------|----------------|--------|----------------------|
| Included in TR1 | | | |
| | | | |

TR6: Promote the addition of a shuttle service connection the commercial and mobility hubs.

| Value | Parameter Text | Symbol | Formula or Reference |
|-----------------|----------------|--------|----------------------|
| Included in TR1 | | | |
| | | | |

Edmonds Climate Change Action Plan

TR7: Coordinate with Community Transit to pursue funding opportunities to increase transit service and improve convenience to encourage greater ridership. Encourage the schools to increase funding for busing programs.

| Value | Parameter Text | Symbol | Formula or Reference |
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TR8: Work with local vehicle dealers to further promote hybrid/electric vehicle sales within the community.

| Value | Parameter Text | Symbol | Formula or Reference |
|-----------|---|--------|---------------------------------|
| 8.84 | Vehicle Miles Travelled (VMT) per day per person in 2050 | A | 20% reduction of A in TR1 |
| 42,650 | Estimated population in 2050 (total growth of 7.0%) | B | SWAG |
| 338.75 | No. of annual travel days used to account for weekdays and weekends | C | Edmonds Inventory Report |
| 127.7 | Total annual million miles traveled | D | $A * B * C / 1,000,000$ |
| 14.90 | Average vehicle mileage in mpg | E | Calc. from Inventory Report |
| 35.0 | Anticipated vehicle average in 2050 | F | SWAG |
| 6,355,214 | Gasoline savings in gallons | G | $D * 1,000,000 / (F - E)$ |
| 0.008891 | Emissions factor for 7% diesel and 93% gasoline vehicles - tonnes/gal | H | EPA emission factors & Inv. Rpt |
| 56,505 | GHG emission reduction due to higher fuel mileage vehicles | I | $G * H$ |
| | | | |

TR9: Provide and facilitate where necessary, shared vehicle use such as school carpooling and vehicle on demand parking spaces.

| Value | Parameter Text | Symbol | Formula or Reference |
|-------|----------------|--------|----------------------|
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Edmonds Climate Change Action Plan

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Edmonds Climate Change Action Plan

Our Lifestyle

LF1: Create a campaign to offer recycling facilities to local business and simultaneously provide consumer marketing to inform customers about using these facilities.

| Value | Parameter Text | Symbol | Formula or Reference |
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LF2: Adopt a Zero Waste Goal and develop a Zero Waste Strategic Plan for Edmonds.

| Value | Parameter Text | Symbol | Formula or Reference |
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LF3: Encourage programs to educate and assist homeowners in composting and the creation of facilities to convert organic waste to energy to significantly reduce or eliminate landfill disposal.

| Value | Parameter Text | Symbol | Formula or Reference |
|-------|----------------|--------|----------------------|
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Edmonds Climate Change Action Plan

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LF4: Encourage the creation of home and community gardens including possible use of surplus City properties for the community gardens.

| Value | Parameter Text | Symbol | Formula or Reference |
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LF5: Continue to promote local farmers markets.

| Value | Parameter Text | Symbol | Formula or Reference |
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Our Buildings

BU 1: Promote the efforts of utilities and energy companies to increase the proportion of renewable resources in the supply of energy to buildings and facilities.

| Value | Parameter Text | Symbol | Formula or Reference |
|----------|---|--------|------------------------------|
| 124,952 | GHG inventory electrical generation for 2005 | A | Edmonds GHG Inventory, p. 29 |
| 0.000418 | GHG emission factor for electrical generation (tonnes/kwh) | B | eGrid emission factor |
| 37.5% | Reduction needed in GHG emission factor to meet goal | C | (See background) |
| 0.000261 | GHG emission factor needed in 2050 (tonnes/kwh) | D | $B \times (100 - C)$ |
| 46,857 | Annual GHG emissions reduction in the supply of electricity | E | $A \times C$ (tonnes) |
| | | | |

BU 2: Promote the installation of renewable energy projects within the City through zoning allowances, financial assistance and legislation support.

| Value | Parameter Text | Symbol | Formula or Reference |
|-----------|---|--------|-----------------------|
| 17,191 | Number of residents in Edmonds (estimate for 2006) | A | Quick Facts |
| 2.5% | Percent of residents expected to install alternate energy sources | B | PUD ??? |
| 430 | Number of residents installing alternate renewable energy sources | C | $A \times B$ |
| 11,000 | Average kwh per Edmonds residence | D | PUD database |
| 95.0% | Percent energy savings using alternate energy sources | E | Assumption |
| 10,450 | kwh saved per residence | F | $D \times E$ |
| 4,491,149 | Total kwh saved | G | $F \times C$ |
| 0.000418 | Tonnes CO2e per kwh | H | PUD ??? |
| 1876 | Annual GHG emissions reduction for installing renewable energy Projs. | I | $G \times H$ (tonnes) |
| | | | |

BU 3a: In the short term the City will promote energy efficiency via managing the Energy Efficiency and Conservation Block Grant.

| Value | Parameter Text | Symbol | Formula or Reference |
|----------|--|--------|------------------------|
| 30,660 | illuminating fixture annual energy consumption at Public Works - kwh | A | City of Edmonds (SWAG) |
| 25.0% | Percent expected energy savings | B | City of Edmonds |
| 7,665 | total kwh reduction for replacing fixtures | C | $A \times B$ |
| 0.000418 | GHG emission factor | D | PUD |
| 3.2 | GHG emissions reduction | E | $C \times D$ (tonnes) |
| | | | |

BU 3b: In the short term the City will be promote energy efficiency via encouraging residents and businesses to take advantage of the federal tax credit program for 2009 and 2010.

| Value | Parameter Text | Symbol | Formula or Reference |
|----------|---|--------|--------------------------|
| 17,191 | Number of residents in Edmonds (estimate for 2006) | A | Quickfacts |
| 5.0% | Percent of residents expected to utilize tax credit | B | Estimate |
| 860 | No. of residences that install some degree of energy efficiency | C | A x B |
| 344 | No. of residences with electric heat (40%) | D | PUD/PSE database |
| 516 | No. of residences with natural gas heat (60%) | E | PUD/PSE database |
| 10.0% | Anticipated energy savings from energy efficient additions | F | Estimate |
| 11,000 | Average kwh per residence | G | PUD database |
| 300 | Average therms per residence | H | PSE database |
| 378,202 | Total kwhs saved | I | D x G x F |
| 15,472 | Total therms saved | J | E x H x F |
| 0.000418 | Emission factor for electcal generation | K | PUD database |
| 0.0054 | Emission factor for burning natural gas | L | PSE database |
| 242 | Annual GHG emissions reduction for federal tax credit | M | (I x K) + (J x L) tonnes |
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BU 3c: In the short term the City will promote energy efficiency via promoting the PUD's 10% Challenge Program through 2011.

Residential Buildings

| Value | Parameter Text | Symbol | Formula or Reference |
|----------|--|--------|----------------------|
| 17,191 | Number of residents in Edmonds (estimate for 2006) | A | Quick Facts* |
| 5.0% | Percent of residents expected to ultimately take the challenge | B | PUD estimate |
| 860 | Number of residents in challenge program | C | A x B |
| 11,000 | Average kwh per Edmonds residence | D | PUD database |
| 1,100 | kwh saved per residence | E | D x 10% |
| 945,505 | Total kwh saved | F | E x C |
| 0.000418 | Tonnes CO2e per kwh | G | PUD ??? |
| 395 | Annual GHG emissions reduction for PUD's 10% Challenge - Residential | H | F x G (tonnes) |
| | | | |

Edmonds Climate Change Action Plan

BU 3c (continued)

Commercial and Industrial Building

| Value | Parameter Text | Symbol | Formula or Reference |
|----------|--|--------|----------------------|
| 4,186 | Number of businesses in Edmonds | I | Quick Facts |
| 5.0% | Percent of businesses expected to ultimately take the challenge | J | PUD estimate |
| 209 | Number of businesses taking the challenge | K | I x J |
| 21,000 | Average kwh per Edmonds business | L | PUD database ? |
| 2,100 | kwh saved per business | M | L x 10% |
| 439,530 | Total kwh saved | N | K x M |
| 0.000418 | Tonnes CO2e per kwh | O | PUD ??? |
| 184 | Annual GHG emissions reduction for PUD's 10% challenge - Busines | P | N x O |
| 579 | Total GHG emissions reduction for PUD's 10% Challenge | Q | H + P |

BU 3d: In the short term the City will promote energy efficiency via promoting any other program that addresses energy efficiency for buildings.

| Value | Parameter Text | Symbol | Formula or Reference |
|-------|----------------|--------|----------------------|
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BU 4: Promote a building retrofit program for improving energy efficiency to reach a long term goal of 45% reduction in energy consumption.

Residential Buildings

| Value | Parameter Text | Symbol | Formula or Reference |
|----------|--|--------|-----------------------|
| 17,191 | Number of residents in Edmonds (estimate for 2006) | A | Quickfacts |
| 40.0% | Percent of households that use electrical heat | B | PUD fact sheet |
| 60.0% | Percent of households that use natural gas heat | C | PSE fact sheet |
| 11,000 | Average kwh per household | D | PUD fact sheet |
| 300 | Average therms per household | E | PSE fact sheet |
| 0.000418 | Tonnes CO2e per kwh | F | PUD fact sheet |
| 0.0054 | Tonnes CO2e per therm | G | PSE fact sheet |
| 5.0% | Percent of households taking advantage of 2009/10 tax credit | H | Estimate |
| 10.0% | Percent in energy savings from federal tax credit program | I | Estimate |
| 158.0 | GHG emissions reduction from electrical energy savings | J | A x B x H x I x D x F |
| 83.5 | Natural gas energy reduction in therms | K | A x C x H x I x E x G |

Edmonds Climate Change Action Plan

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|--------|--|---|-----------------------|
| 241.5 | Short term annual GHG emissions reduction from retrofit program | L | J + K |
| 55.0% | Percent in energy savings from long term effort | M | Goal - see background |
| 17,379 | GHG emissions reduction from electrical energy savings | N | A x B x D x F x M |
| 9,190 | Natural gas energy reduction in therms | O | A x C x E x G x M |
| 26,569 | Annual GHG emissions reduction from retrofit program - Residential | P | N + O (tonnes) |
| | | | |

BU 4 (continued):

Commercial, Industrial and Civic Buildings

| Value | Parameter Text | Symbol | Formula or Reference |
|----------|---|--------|-----------------------|
| 4,186 | Businesses and civic facilities | A | Quickfacts |
| 85.0% | Percent of facilities that use electrical heat | B | PUD fact sheet |
| 15.0% | Percent of facilities that use natural gas heat | C | PSE fact sheet |
| 21,000 | Average kwh per facility | D | PUD fact sheet |
| 600 | Average therms per facility | E | PSE fact sheet |
| 0.000418 | Tonnes CO2e per kwh | F | PUD fact sheet |
| 0.0054 | Tonnes CO2e per therm | G | PSE fact sheet |
| 15.0% | Percent of facilities taking advantage of 2009/10 tax credit | H | Estimate |
| 10.0% | Percent in energy savings from federal tax credit program | I | Estimate |
| 468 | GHG emissions reduction from electrical energy savings | J | A x B x H x I x D x F |
| 31 | Natural gas energy reduction in therms | K | A x C x H x I x E x G |
| 499 | Short term GHG emissions reduction from retrofit program - Commercial | L | J + K (tonnes) |
| 55.0% | Percent in energy savings from long term effort | M | Goal |
| 17167 | GHG emissions reduction from electrical energy savings | N | A x B x D x F x M |
| 1119 | Natural gas energy reduction in therms | O | A x C x E x G x M |
| 18286 | Long term GHG emissions reduction for retrofit program - Commercial | P | N + O (tonnes) |
| | | | |

BU 5: Develop a program to achieve water conservation in existing buildings and landscaping with a goal of reducing water use by 30% by the year 2020.

| Value | Parameter Text | Symbol | Formula or Reference |
|-----------|--|--------|-------------------------------|
| 4,202,400 | kwh used in 2006 Water/Sewer Treatment Plant | A | City Edmonds Emissions Report |
| 0.000418 | Tonnes CO2e per kwh | B | PUD fact sheet |
| 1756 | Tonnes GHG emissions from electrical energy | C | A * B |
| 13,685 | Therms used in 2006 Water/Sewer Treatment Plant | D | City Edmonds Emissions Report |
| 0.0054 | Tonnes CO2e per therm | E | PSE fact sheet |
| 74 | Tonnes GHG emissions from natural gas energy | F | D * E |
| 1829 | Total tonnes of GHG emissions from Water/Sewer Treatment Plant | G | C + F |

Edmonds Climate Change Action Plan

SUMMARY OF GHG REDUCTION FROM "OUR BUIDINGS"

| Action Code | Short term | Long Term |
|-------------|------------|-----------|
| BU1 | | 46857 |
| BU2 | | 1876 |
| BU3 | 1,218 | 1218 |
| BU4 | 740 | 44856 |
| BU5 | 549 | 549 |
| BU6 | | 1523 |
| BU7 | | |
| Total | 2507 | 96,879 |

* Quick facts shows 16, 904 households in 2000 with a 1.7% population growth from 2000 to 2006

Edmonds Climate Change Action Plan

Our Environment

EN1: Inventory tree and vegetative cover to determine existing resources and carbon sequestration and establish city-wide goals and strategies to increase carbon sequestration.

| Value | Parameter Text | Symbol | Formula or Reference |
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EN2: Adopt ordinances to regulate the removal and replacement of significant trees and preclude sale of invasive non-native plants.

| Value | Parameter Text | Symbol | Formula or Reference |
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EN3: Update zoning regulations for parking lot landscaping to increase shading and reduce thermal gain.

| Value | Parameter Text | Symbol | Formula or Reference |
|-------|----------------|--------|----------------------|
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Edmonds Climate Change Action Plan

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EN6: Promote the implementation of a regulation to require the use of pervious concrete wherever possible.

| Value | Parameter Text | Symbol | Formula or Reference |
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EN7: Participate in a regional vulnerability assessment and prepare a local vulnerability assessment for Edmonds.

| Value | Parameter Text | Symbol | Formula or Reference |
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EN8: Continue to provide emergency planning and community awareness.

OUR ECONOMY

EC1: Continue to promote new green business opportunities.

| Value | Parameter Text | Symbol | Formula or Reference |
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EC2: Support and encourage green business program.

| Value | Parameter Text | Symbol | Formula or Reference |
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EC3: Continue to expand the supply of affordable housing, which reduces commute times and congestion.

| Value | Parameter Text | Symbol | Formula or Reference |
|-------|----------------|--------|----------------------|
| | | | |

SUMMARY OF EDMONDS GHG EMISSION REDUCTIONS

| Action Items | GHG Reduction Goals - Tonnes | | | |
|--|------------------------------|--------|--------|--------|
| | 2012 | 2020 | 2035 | 2050 |
| OUR TRANSPORTATION AND LAND USE | | | | |
| TR1 | 1,300 | 4,775 | 11,300 | 17,802 |
| TR2 | 36 | 130 | 310 | 492 |
| TR3 | | | | 0 |
| TR4 | | | | 0 |
| TR5 | | | | 0 |
| TR6 | | | | 0 |
| TR7 | | | | 0 |
| TR8 | 4,130 | 15,160 | 35,800 | 56,505 |
| TR9 | | | | 0 |
| TR10 | | | | 0 |
| Subtotal | 5,466 | 20,065 | 47,410 | 74,799 |
| OUR LIFESTYLE | | | | |
| LF1 | | | | |
| LF2 | | | | |
| LF3 | | | | |
| LF4 | | | | |
| LF5 | | | | |
| Subtotal | 0 | 0 | 0 | 0 |
| OUR BUILDINGS | | | | |
| BU 1 | 200 | 6,000 | 26,400 | 46,857 |
| BU 2 | 5 | 100 | 990 | 1,876 |
| BU 3 | 1,218 | 1,218 | 1,218 | 1,218 |
| BU 4 | 740 | 8,000 | 26,350 | 44,856 |
| BU 5 | 549 | 549 | 549 | 549 |
| BU 6 | 25 | 125 | 825 | 1,523 |
| BU 7 | 0 | 0 | 0 | 0 |
| Subtotal | 2,737 | 15,992 | 56,332 | 96,879 |

| Action Items | GHG Reduction Goals - Tonnes | | | |
|------------------------|------------------------------|---------------|----------------|----------------|
| | 2012 | 2020 | 2035 | 2050 |
| OUR ENVIRONMENT | | | | |
| EN 1 | | | | |
| EN 2 | | | | |
| EN 3 | | | | |
| EN 4 | | | | |
| EN 5 | | | | |
| EN 6 | | | | |
| EN 7 | | | | |
| EN 8 | | | | |
| Subtotal | 0 | 0 | 0 | 0 |
| OUR ECONOMY | | | | |
| EC 1 | | | | |
| EC 2 | | | | |
| EC 3 | | | | |
| EC 4 | | | | |
| Subtotal | 0 | 0 | 0 | 0 |
| TOTALS | 8,203 | 36,057 | 103,742 | 171,679 |

| Edmonds GHG Emissions Inventory | | | | | |
|---------------------------------|------------|---------------|---------------|---------------|---------------|
| Sector | Source | 1990 | 2000 | 2005 | 2009* |
| Resident | Electrical | 41614 | 63575 | 80328 | 83541 |
| | Nat. Gas | 28550 | 44884 | 43926 | 45683 |
| Commer. | Electrical | 22671 | 33650 | 44624 | 46409 |
| | Nat. Gas | 9770 | 12557 | 13559 | 14101 |
| Industrial | Electrical | 10 | 36 | 0 | 0 |
| | Nat. Gas | 21 | 13 | 74 | 77 |
| Transport | Gasoline | 58980 | 77510 | 73614 | 76559 |
| | Diesel | 11029 | 15427 | 15398 | 16014 |
| | Marine Gas | 2484 | 3232 | 2941 | 3059 |
| Waste | | 4428 | -2504 | -3333 | -3466 |
| TOTAL | | 179557 | 248380 | 271131 | 281976 |

* Estimated