

Greenhouse Gas Emissions Inventory and Reduction in Fort Collins

Laura Witte

Climate Policy in Fort Collins



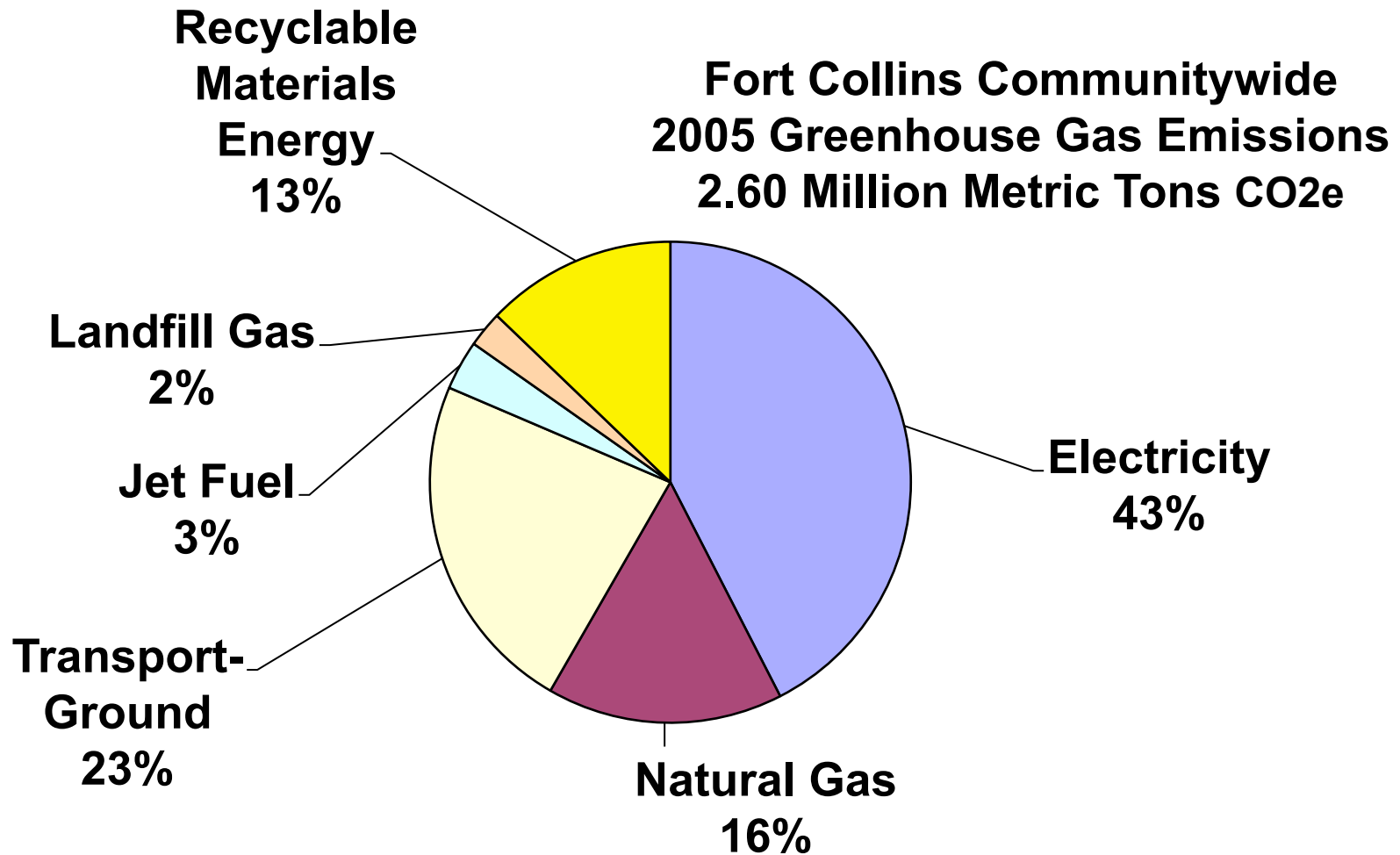
- Biennial greenhouse gas emissions inventory since 1990
- 2005 baseline of 2.6 million metric tons CO₂e
- 2010: emissions 30% below predicted 2010 levels
- 2050: emissions 80% below the 2005 level by 2050

Creative Climate Solutions

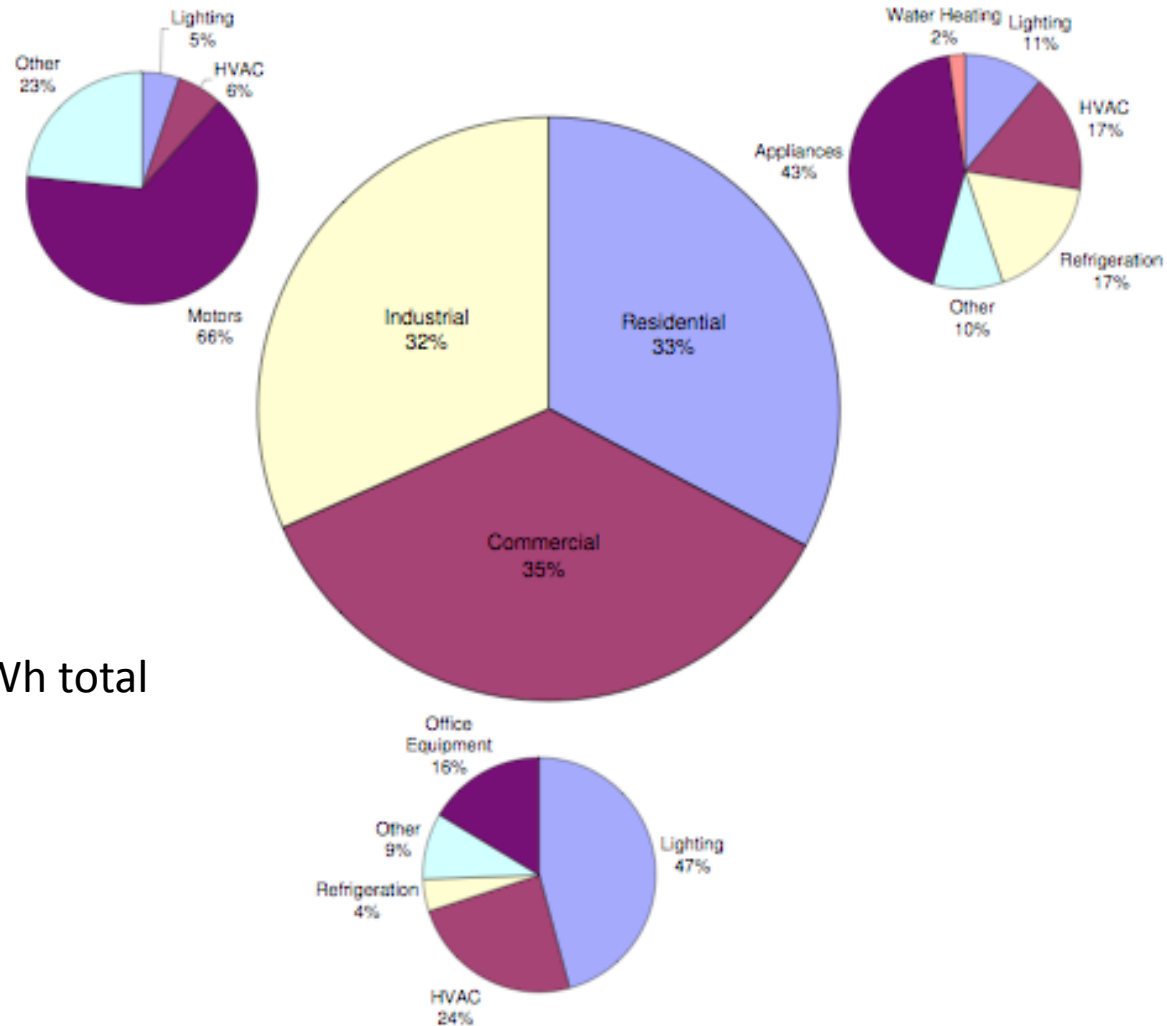
- Fort Collins Sustainability Group
- June '09: 30 highest priority measures determined
- Objective: accelerate 2050 goal to 2030



Narrowing the Scope



Fort Collins Electricity Use by Sector and End-use



1,433,063 MWh total

Carbon Dioxide Equivalent (CO2e)

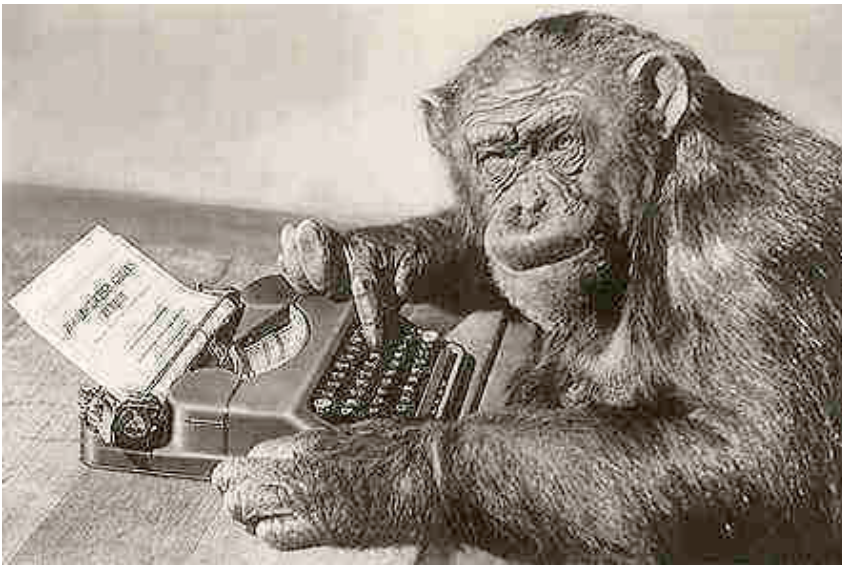
| Greenhouse gas | Major human sources | Avg. Atmospheric residence time, years | Global Warming Potential (GWP) | Estimated contribution to greenhouse warming, % |
|---|--|--|--------------------------------|---|
| *Carbon dioxide (CO ₂) | Combustion, deforestation | 50—200 | 1 | 55 |
| *Methane (CH ₄) | Rice fields, livestock, landfills, petrol production | 10 | 11 | 15 |
| *Nitrous oxide (N ₂ O) | Fertilizer, acid synthesis, deforestation | 150 | 270 | 6 |
| CFC-12 (CCl ₂ F ₂) | Refrigeration compressor fluid | 130 | 7100 | 11 |
| CFC-11 (CCl ₃ F) | Plastic foam blowing solvent | 65 | 3400 | 7 |

Inventory Methodology

- Short ton CO₂e emitted per MWh electricity consumed: 1.698
 - USEPA's eGrid output emission rates CO₂, CH₄, and N₂O specific to fuels burned in Colorado
 - Local power mix 73.5% coal, 19% hydro, 6% purchases, 1% renewables and < 1% natural gas



Estimation



- A. Select end-use proportion relevant to measure
- B. Further divide into components
 - A. Based on EIA regional/national trends
- C. Estimate extent to which measure already implemented
 - A. Based on market shares
- D. Calculate new 2005 energy consumption and CO₂e emission after complete implementation
 - A. Gross, per capita, per household
- E. Apply new 2005 per cap/per hh consumption to 2030 projections
 - A. Housing/pop projections based on compound growth since 2000
- F. Projections for 2030 energy consumption and CO₂e levels

Lighting

- 11% of residential electricity used for lighting: 50,000 MWh
- Conservatively 80% of energy used for incandescent lighting
- CFL 4x more efficient than incandescents
- After 100% replacement in 2005
 - 23,500 tonnes of CO2e conserved
 - New lighting energy 20,000 MWh
- 2030

| | 2005 value, kWh | 2030 total, kWh | 2030 total, MWh | CO2 emission, short tons | CO2 emission, tonnes |
|--------------------------|--------------------|-----------------|-----------------|-----------------------------|-------------------------|
| Per cap E consumption | 151.25 | 27,718,391.10 | 27,718.39 | 23,532.91 | 21,348.70 |
| Per hh E consumption | 347.21 | 38,887,718.28 | 38,887.72 | 33,015.67 | 29,951.31 |

Appliances

| Appliance | Usage proportion | Avg wattage, W | Yearly hours of use per hh | Yearly consumption per hh, kWh | Total, kWh |
|---------------------------------|------------------|----------------|----------------------------|--------------------------------|----------------|
| Dishwasher, reg (load/day) | 0.62 | 1,201.00 | 426.31 | 512.00 | 17,656,965.12 |
| Microwave | 0.86 | 1,400.00 | 149.29 | 209.00 | 10,006,369.76 |
| Oven | 0.45 | 12,200.00 | 57.60 | 702.72 | 17,461,471.59 |
| Range | 0.72 | 4,000.00 | 480.00 | 1,920.00 | 76,893,235.20 |
| Clothes dryer | 0.70 | 5,500.00 | 204.00 | 1,122.00 | 43,686,304.20 |
| Washing machine, reg (load/day) | 0.79 | 1,808.00 | 186.00 | 336.29 | 14,702,053.44 |
| Toaster | 0.34 | 1,198.00 | 41.74 | 50.00 | 938,313.22 |
| Coffee maker | 0.48 | 900.00 | 128.89 | 116.00 | 3,093,470.55 |
| Other | N/A | N/A | N/A | N/A | 10,811,916.92 |
| | | | | Total, kWh | 195,250,100.00 |

Appliances (cont.)

- Energy efficient models use approx. half the energy of traditional models
- After complete replacement of dish and clothes washing machines:
 - 13,000 tonnes CO2e conserved
 - New appliance energy 180,000 MWh

| | 2005 value, kWh | 2030 total, kWh | 2030 total, MWh | CO2 emission, short tons | CO2 emission, tonnes |
|-------------------------|--------------------|-----------------|-----------------|-----------------------------|-------------------------|
| By cap E consumption | 1,400.14 | 256,583,694.52 | 256,583.69 | 215,786.89 | 195,758.57 |
| By hh E consumption | 3,214.10 | 359,975,959.38 | 359,975.96 | 302,739.78 | 274,640.91 |

Refrigeration



| Type | Usage proportion | Yearly consumption per hh, kWh | Total, kWh |
|---------------------|------------------|--------------------------------|---------------|
| Stand-alone freezer | 0.35 | 854.41 | 16,833,618.47 |
| Refrigerator | 1.00 | 1,087.16 | 60,358,281.53 |
| | | Total, kWh | 77,191,900.00 |

Refrigeration (cont.)

- After 100% replacement with energy-efficients in 2005
 - 27,000 tonnes CO2e conserved
 - New refrigeration energy of 42,000 MWh

| | 2005 value, kWh | 2030 total, kWh | 2030 total, MWh | CO2 emission, short tons | CO2 emission, tonnes |
|-------------------------|--------------------|--------------------|--------------------|-----------------------------|----------------------------|
| By cap E consumption | 331.32 | 60,716,100.0 0 | 60,716.10 | 51,062.24 | 46,322.89 |
| By hh E consumption | 760.56 | 85,182,093.8 5 | 85,182.09 | 71,638.14 | 64,989.03 |

Heating, Ventilation, and Air Conditioning

- Local consumption $\frac{1}{2}$ of regional consumption
 - Not reasonable to apply regional trends to FC data

| Type | Usage proportions | Yearly consumption per hh, kWh | Total, kWh |
|---------------------|-------------------|--------------------------------|----------------|
| Central AC | 0.51 | 2,796.00 | 79,807,294.89 |
| Room unit AC | 0.08 | 950.00 | 4,171,725.00 |
| Evaporative cooler | 0.26 | 1,183.00 | 17,108,522.34 |
| Fan, whole house | 0.05 | 781.20 | 2,172,634.38 |
| Fan, ceiling | 0.65 | 138.00 | 4,989,383.10 |
| Furnace fan | 0.71 | 500.00 | 19,831,938.79 |
| Main heating system | 0.21 | 1,846.40 | 21,898,351.44 |
| | | Error, kWh | -72,787,949.94 |
| | | Total, kWh | 77,191,900.00 |

Conclusions and Future Work

- Inventory is time-consuming but a necessary task for keeping communities on track for carbon reduction goals.
- Before the summer is over, I intend to sort out the HVAC estimation and to begin to learn more about transportation.



Acknowledgements

- NSF, CMMAP, and Scott Denning
- Lucinda Smith of the Fort Collins City government
- Xcel Energy and Fort Collins Utilities
- The Energy Information Administration
- The Fort Collins Sustainability Group

