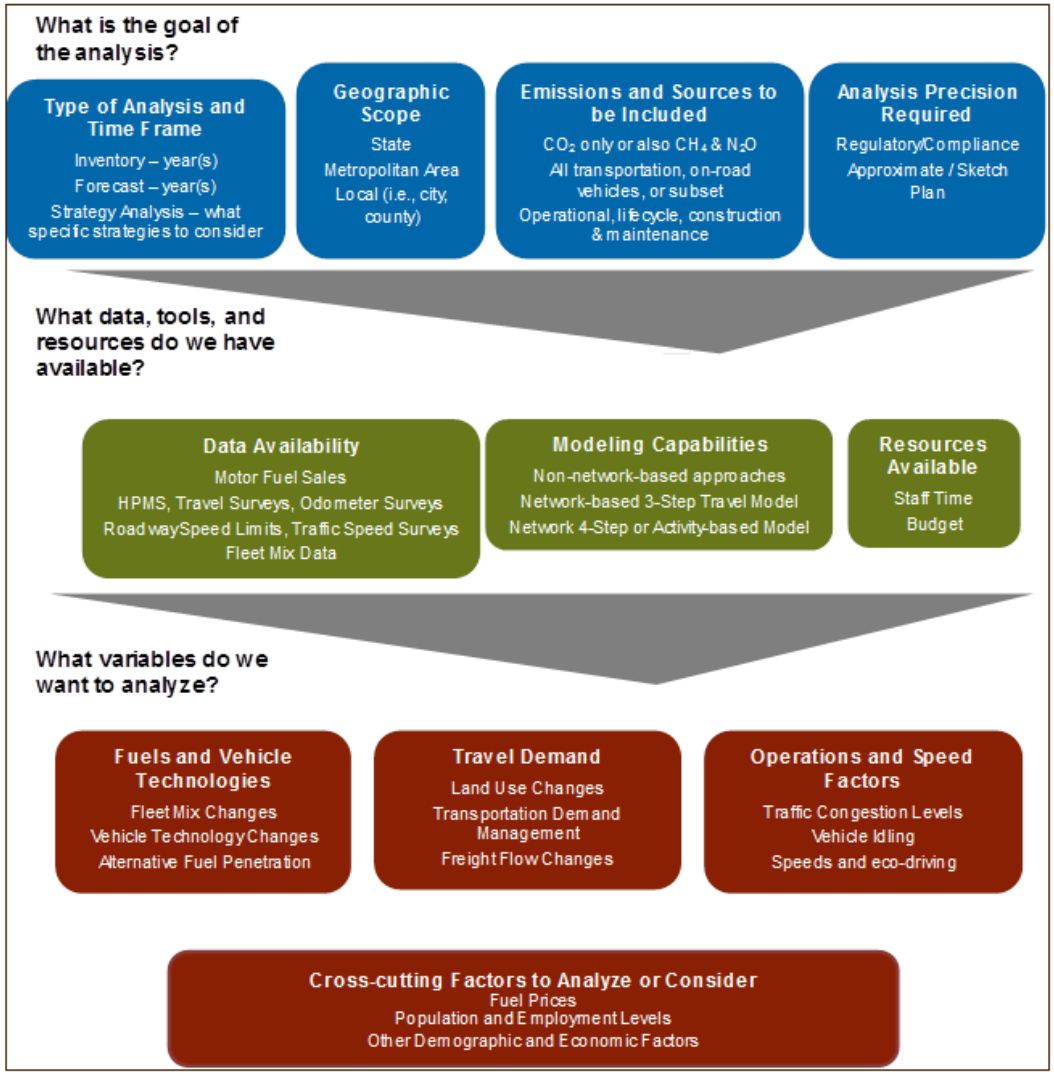
Transportation & Mobile Sources of Greenhouse Gas Emissions

Boundaries, Calculations,
and Ozone v. Climate Change

July 28, 2014

Accounting for GHG Emissions from Transportation & Mobile Sources

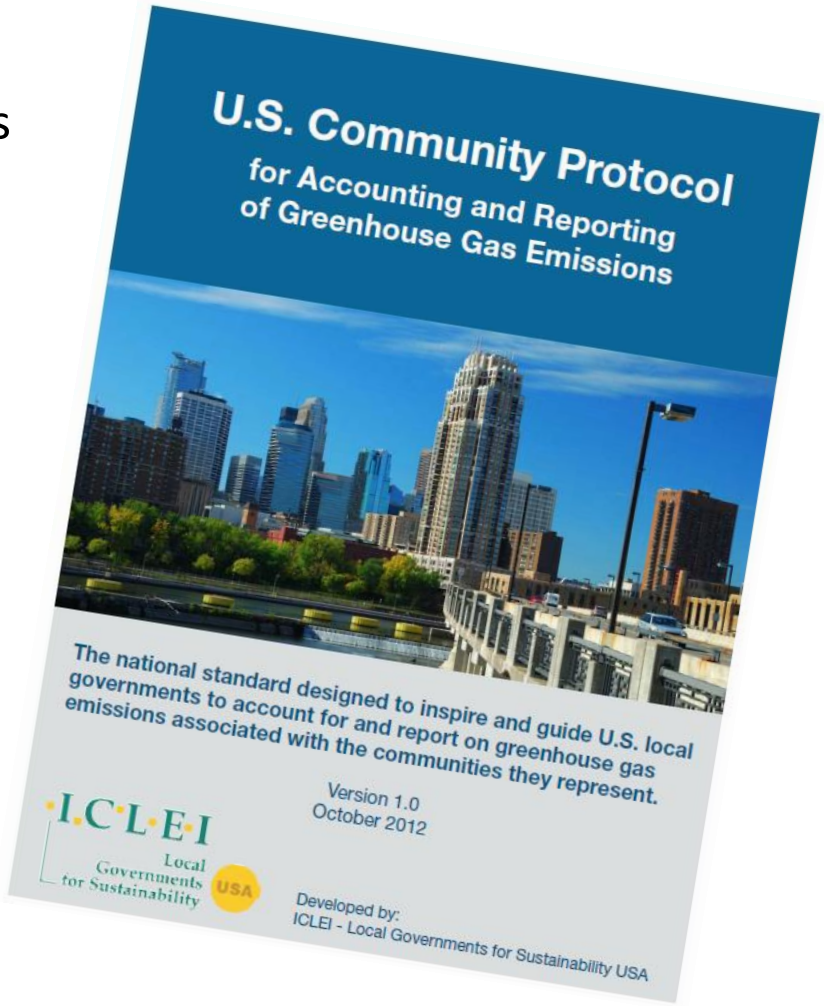


http://www.fhwa.dot.gov/planning/processes/statewide/practices/ghg_emissions/handbook.cfm

Protocol

- Developed by ICLEI (Local Governments for Sustainability)
- ICLEI is the world's leading association of cities and local governments dedicated to sustainable development
- Protocol Released October 2012
- Designed to guide *U.S. local governments* to account for and report on community wide greenhouse gas emissions

- One other option – World Resources Institute international accounting tool

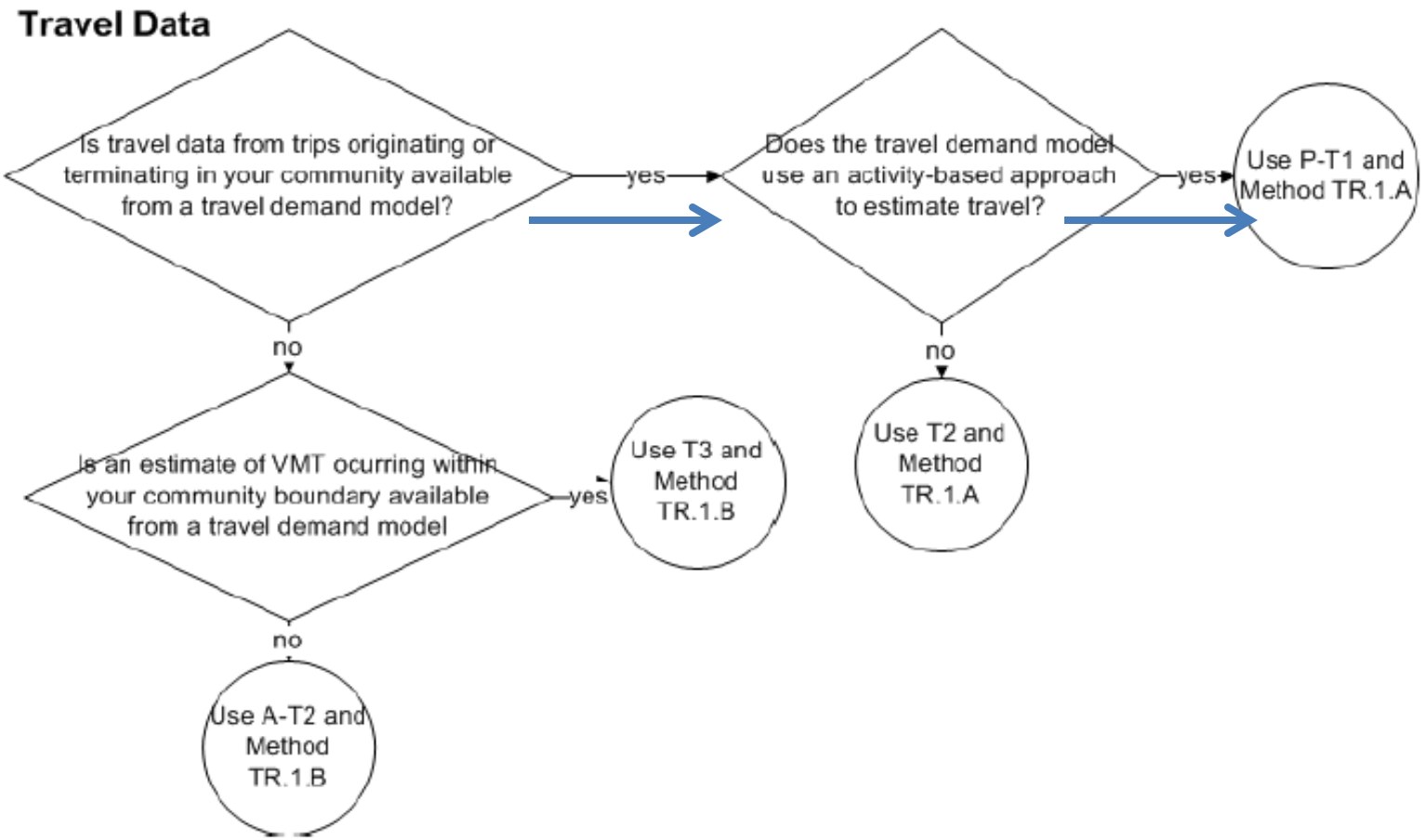


GHG Source	GHG Types	Data Required	Available Methodologies
Passenger vehicle operation	CO_2, CH_4, and N_2O	Output of a regional travel demand model	TR.1.A
		OR	
		-Vehicle distance traveled within the jurisdiction	TR.1.B
Freight and service truck operation	CO_2, CH_4, and N_2O	- State or county level truck VMT data from FHWA HPMS or other source - Jobs in truck-generating industries for municipality, county, and/or state	TR.2.A
		OR	
		- Travel demand model output – heavy duty VMT and speeds by network link (TR.2.B), or truck trip-ends and associated trip lengths (TR.2.C), in municipality - Speed-based CO_2, CH_4, and N_2O emission factors from MOVES or EMFAC model	TR.2.B TR.2.C
Freight rail operation	CO_2, CH_4 and N_2O	- Line-haul freight movement (annual ton-miles moved by rail line, for all rail lines traversing the community) - Switching yard activity (number of locomotives and annual hours of operation per locomotive) - Line-haul and switching locomotive emission factors	TR.3
Transit operation fuel combustion	CO_2	- Actual fuel use ***or*** -Fuel use estimated from vehicle miles traveled and vehicle fuel economy	TR.4.A
Transit operation fuel combustion	CH_4 and N_2O	- Vehicle miles traveled by vehicle type ***or*** - Fuel use by vehicle type	TR.4.B
Transit traction power	CO_2, CH_4 and N_2O	- Electricity use by mode	TR.4.C
Attribution of Transit emissions		- Geographic data source of the transit agency's routes for each mode as well as the transit vehicle schedule (headways). - Number of ferry stops in each jurisdiction	TR.4.D, TR.4.E, TR.4.F

Not Included – Not applicable

GHG Source	GHG Types	Data Required	Available Methodologies	
Operation of inter-city passenger rail	CO_2, CH_4 and N_2O	- Number of trains per day - Length of track within community - Energy intensity of passenger rail	TR.5	Not Included – Data not available
Air travel-aircraft emissions	CO_2	Airport inventory	TR.6.A	
		OR		
		- FAA's AEDT/SAGE emissions model output for airport in a calendar year ***or*** - ACRP Report 11 Airport Inventory Method 1 or 2	TR.6.B	
Air travel-ground support equipment and vehicles	CO_2, CH_4 and N_2O	Airport inventory	TR.6.A	
		OR		
		Fuel consumption of airport fleet vehicles and ground support equipment	TR.6.C	
Attribution of Air travel emissions		Airport passenger surveys that identify the number of passengers that are traveling to/from the community	TR.6.D	Not Included – Data not available
Marine vessels	CO_2, CH_4 and N_2O	• Total number of vessels operating within community's waters by type • Activity hours of vessel within community's waters • Maximum power (kilowatt) rating of each vessel and average load factor • Power used by ships during hoteling	TR.7.A	Not Included – Not Applicable
Other off-road equipment	CO_2	- Number of building permits in county and jurisdiction Number of households in county and jurisdiction	TR.8.A	
Fuel upstream lifecycle emissions		- The same data required for TR.1 through TR.8 broken down by type of fuel - Scaling Factors for Full Fuel-Cycle Emissions in Table TR.9.1	TR.9	Not Included – Data not available

Emissions from On-Road Travel



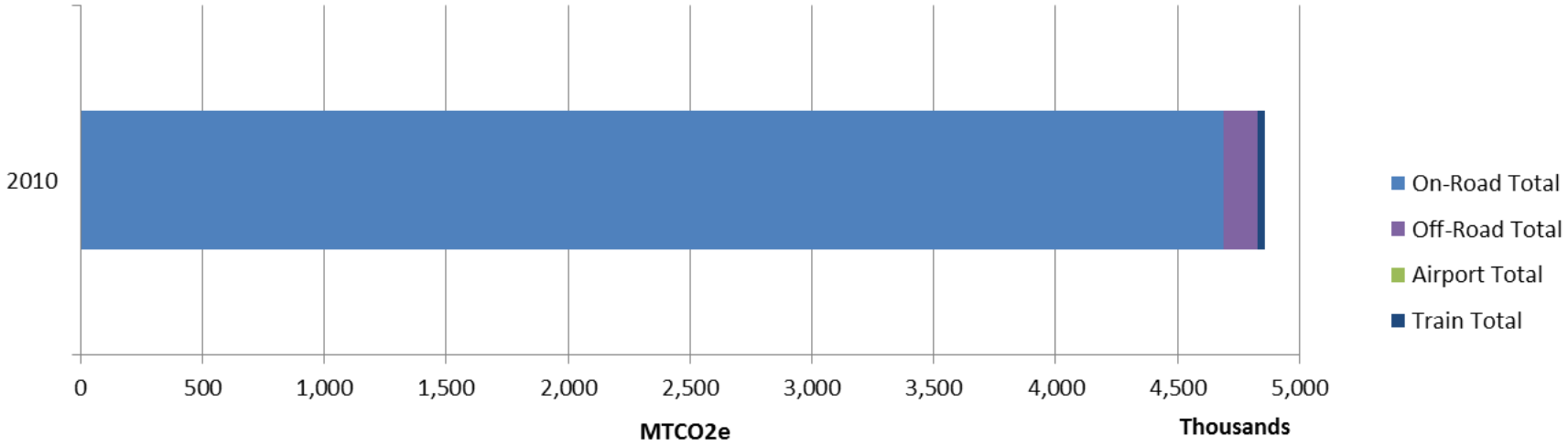
Estimating Emissions from On-road passenger Vehicles

Annual Vehicle Miles Traveled (mi) x (energy/mile) x (CO2e/energy) = Annual CO2e

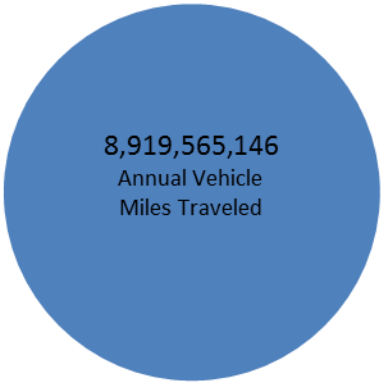
- Annual VMT = Daily VMT x 329 days

- 2010 Data for Travis County *(provided by Texas Transportation Institute)*
  - Daily VMT totals = 27,106,899
  - Daily CO2 = 14,219 tons
  - Daily CH4 = .56 tons
  - Average CO2 / mi = 0.0005
  - Average mpg = 21.88
  - Annual Days = Summer weekday * 329 (adjusted for low travel days)

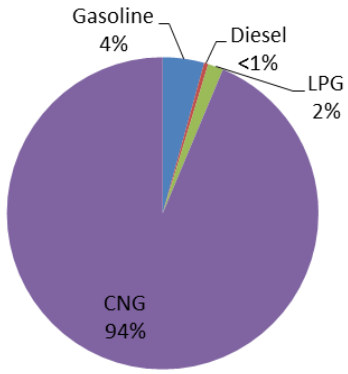
Transportation & Mobile Sources



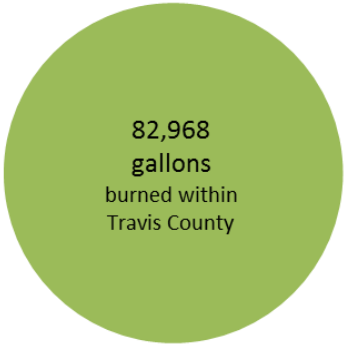
Travis County On-Road Emissions
4.7 Millon MTCO2e



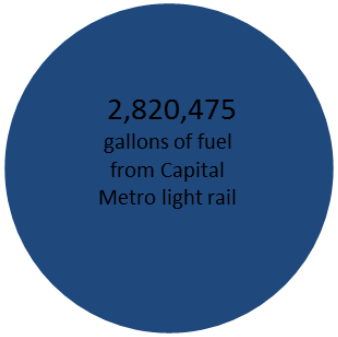
Off-Road Fuel Use
140,000 MTCO2e



Airport Jet Fuel
794 MTCO2e



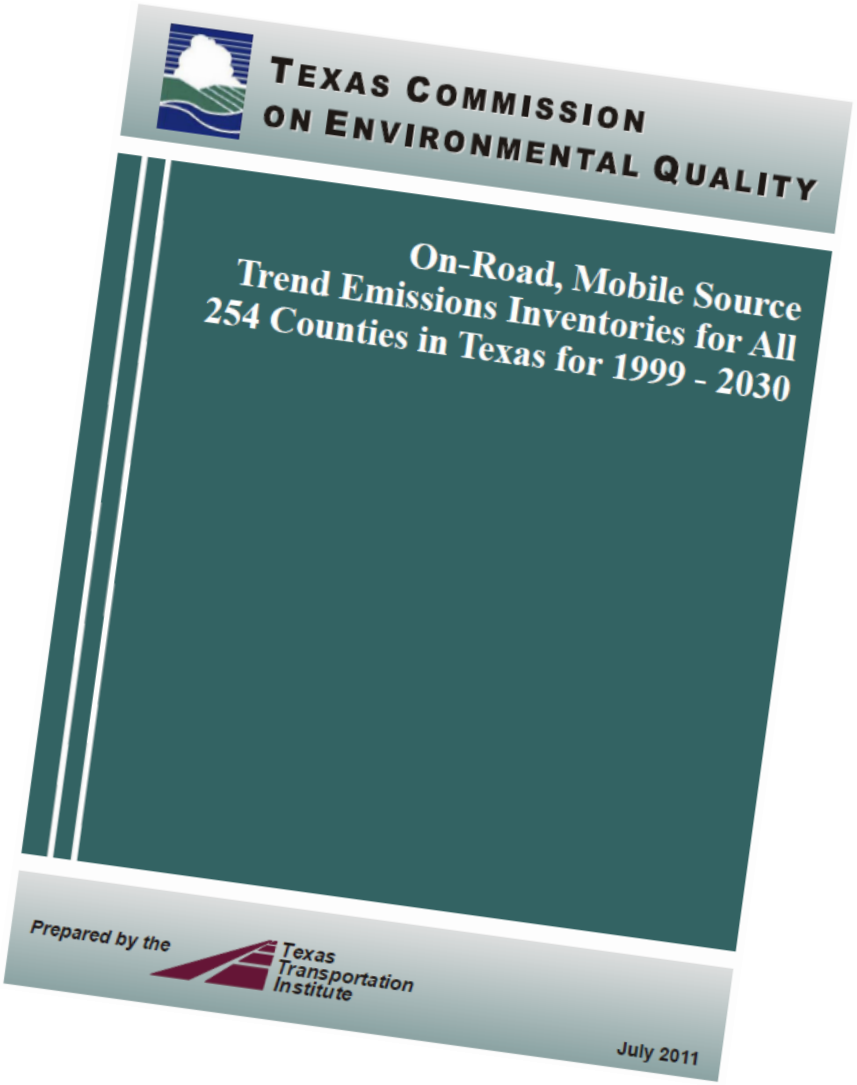
Train - Diesel
28,628 MTCO2e



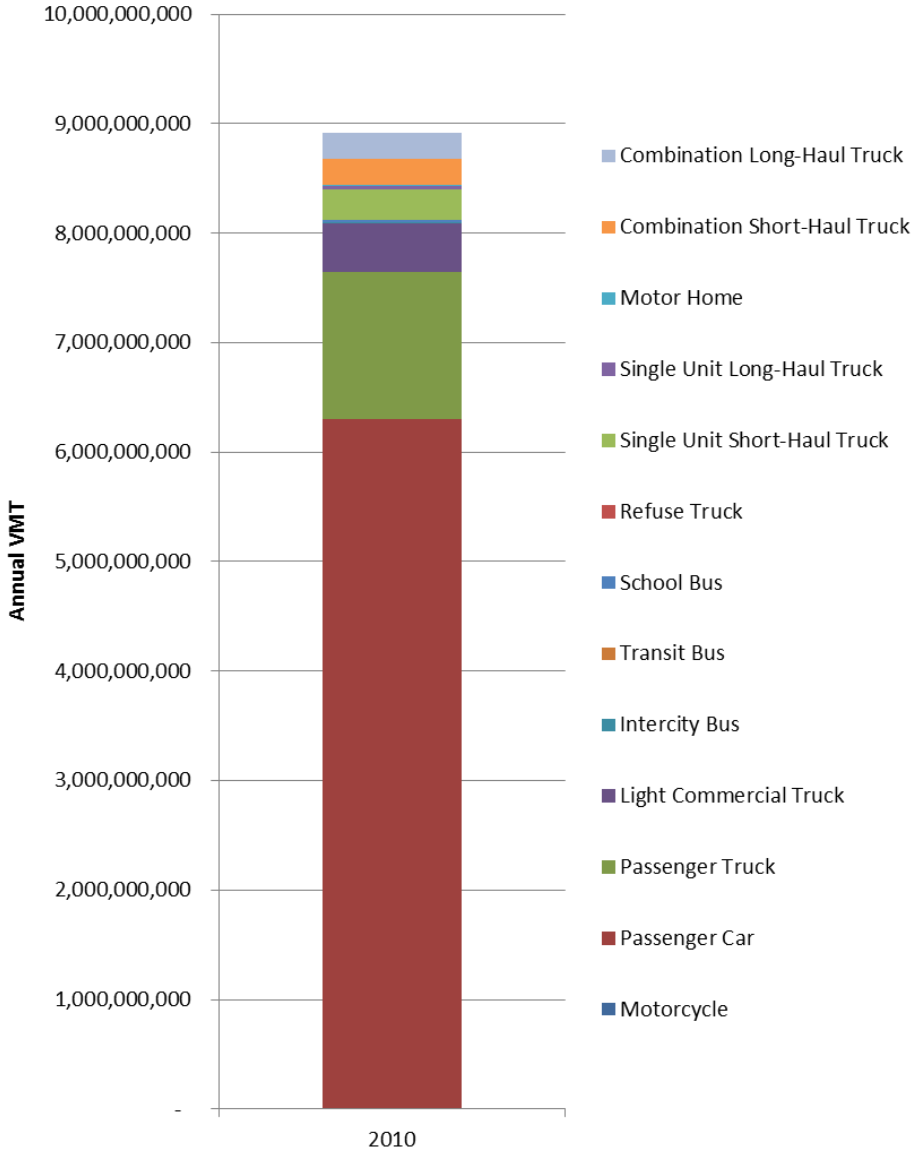
TCEQ On-Road Trend Report

Dennis Perkinson, PhD
Texas A&M, Texas Transportation Institute

- Context – Larger Study
- Overview of Methodology
  - Boundaries
  - Data Sources
  - Assumptions
    - Travis County fleet age
    - Travis County fleet mix



Vehicle Mix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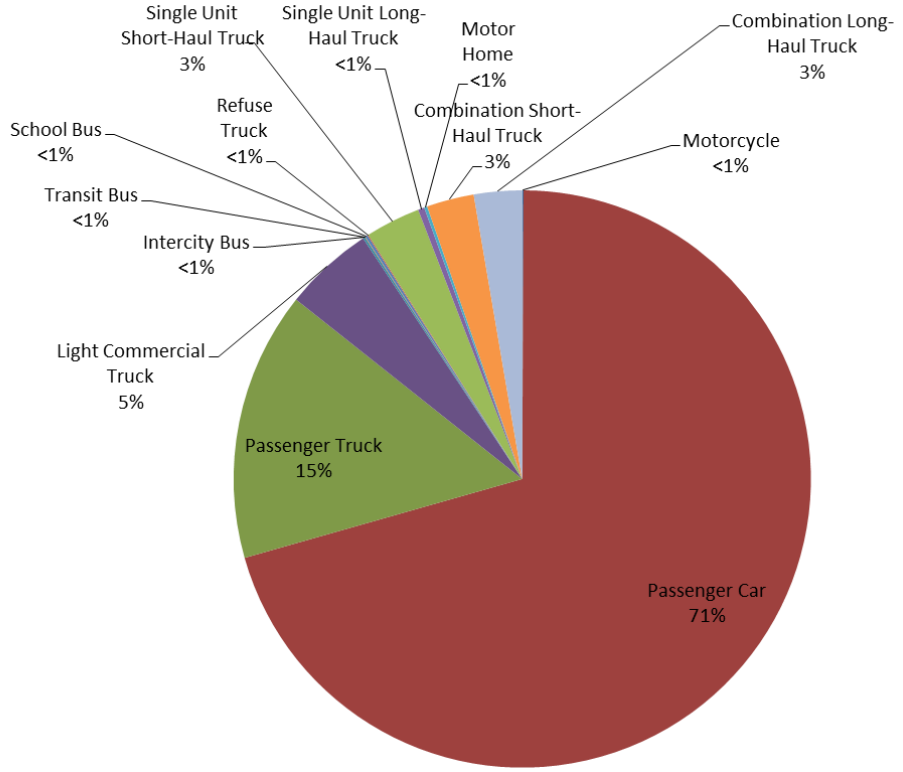
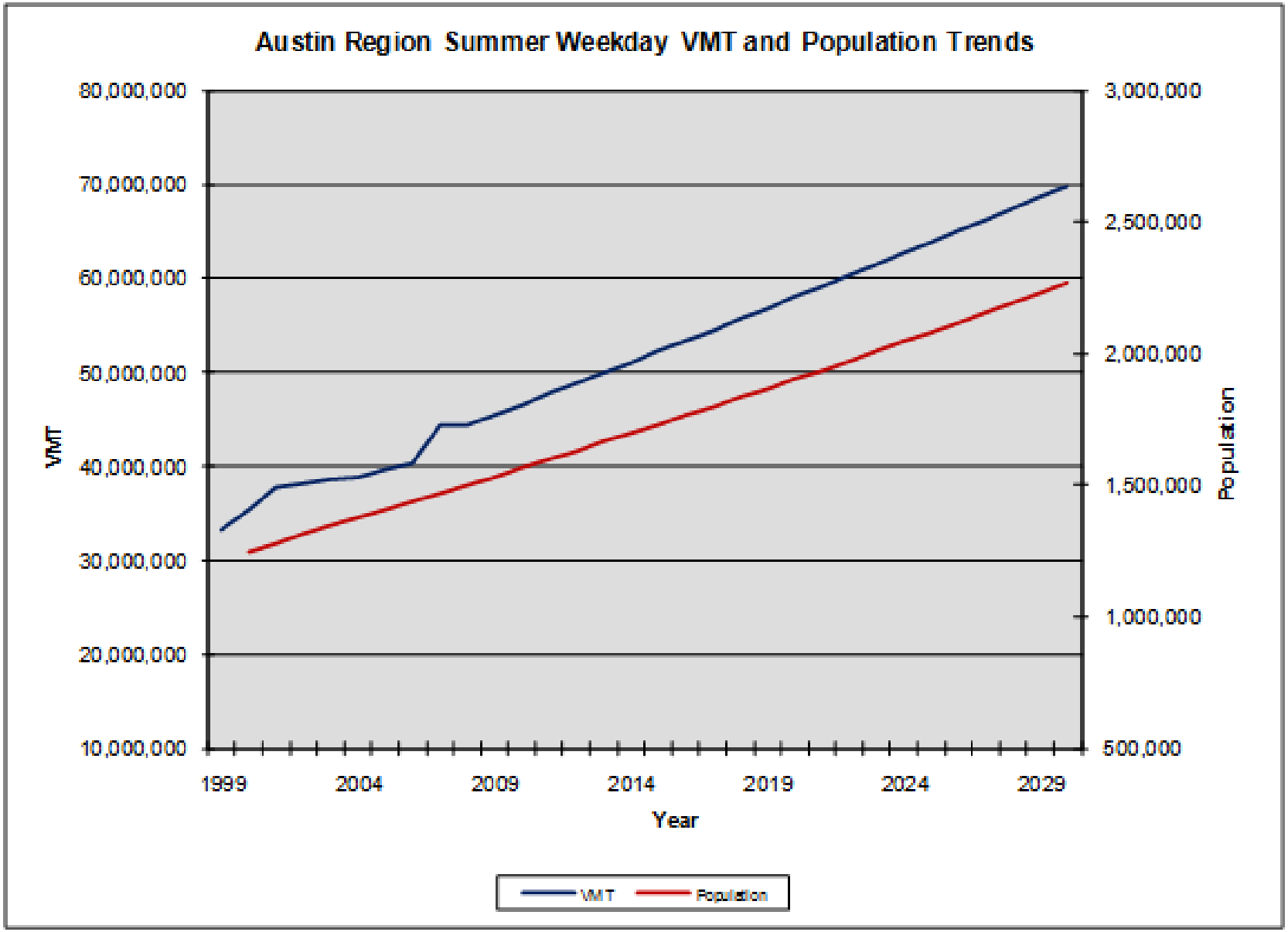
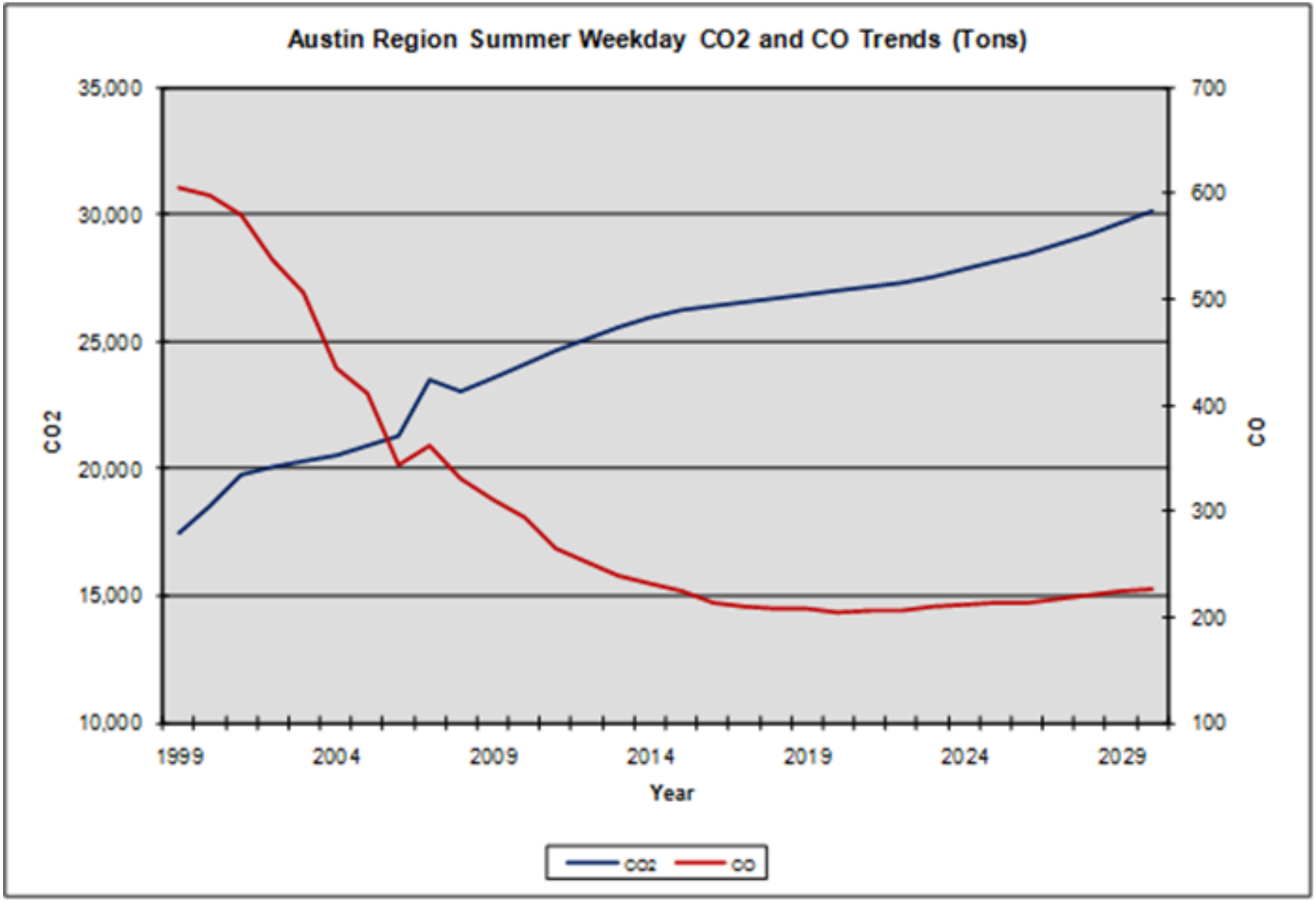
2,000,000,000
1,000,000,000
-
Annual VMT
2010
Combination Long-Haul Truck
Combination Short-Haul Truck
Motor Home
Single Unit Long-Haul Truck
Single Unit Short-Haul Truck
Refuse Truck
School Bus
Transit Bus
Intercity Bus
Light Commercial Truck
Passenger Truck
Passenger Car
Motorcycle


Single Unit Short-Haul Truck 3%
Single Unit Long-Haul Truck <1%
Motor Home <1%
Combination Long-Haul Truck 3%
School Bus <1%
Refuse Truck <1%
Combination Short-Haul Truck 3%
Motorcycle <1%
Transit Bus <1%
Intercity Bus <1%
Light Commercial Truck 5%
Passenger Truck 15%
Passenger Car 71%

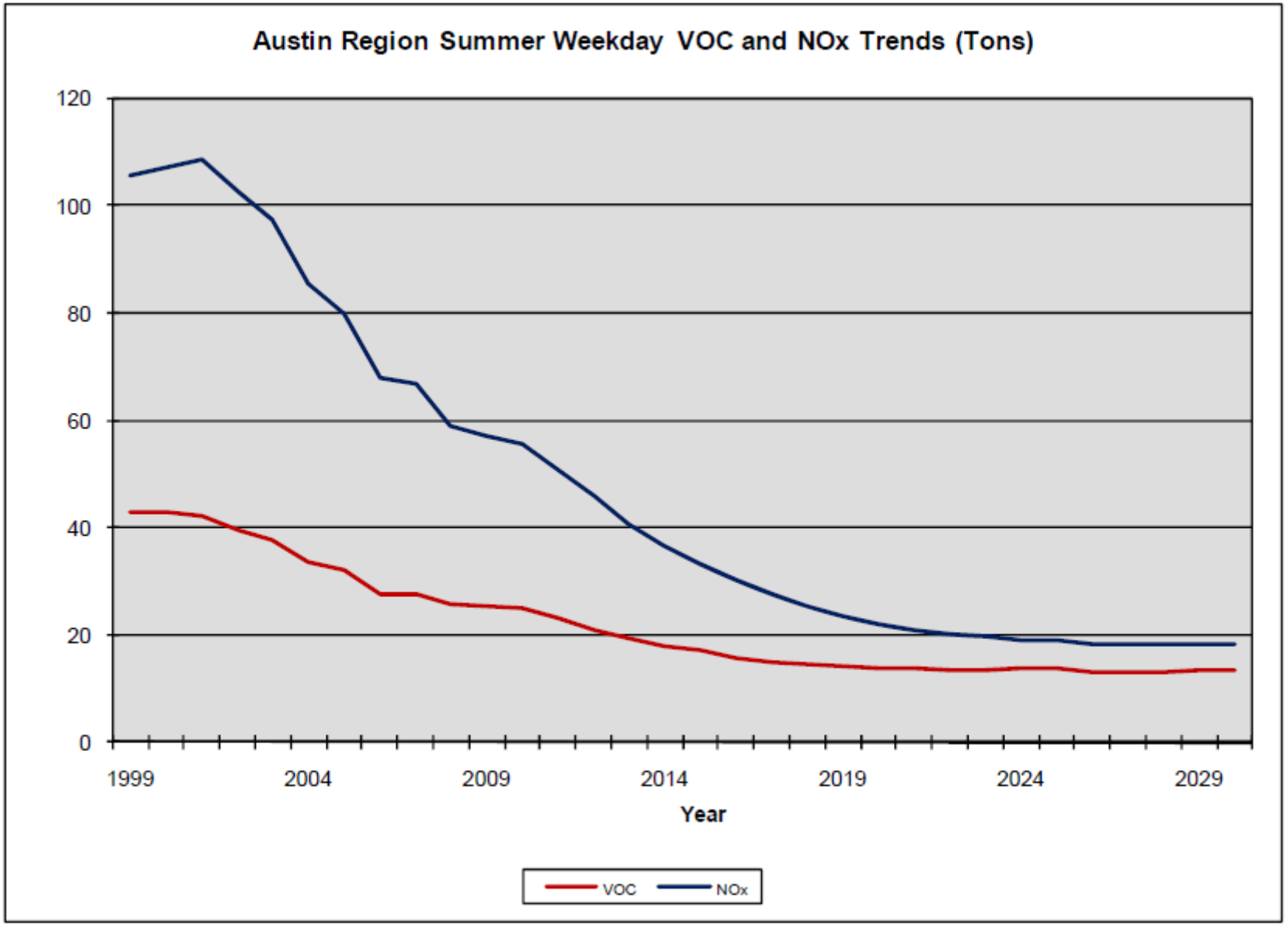
Austin Area Regional Trends



Austin Area Regional Trends



Austin Area Regional Trends

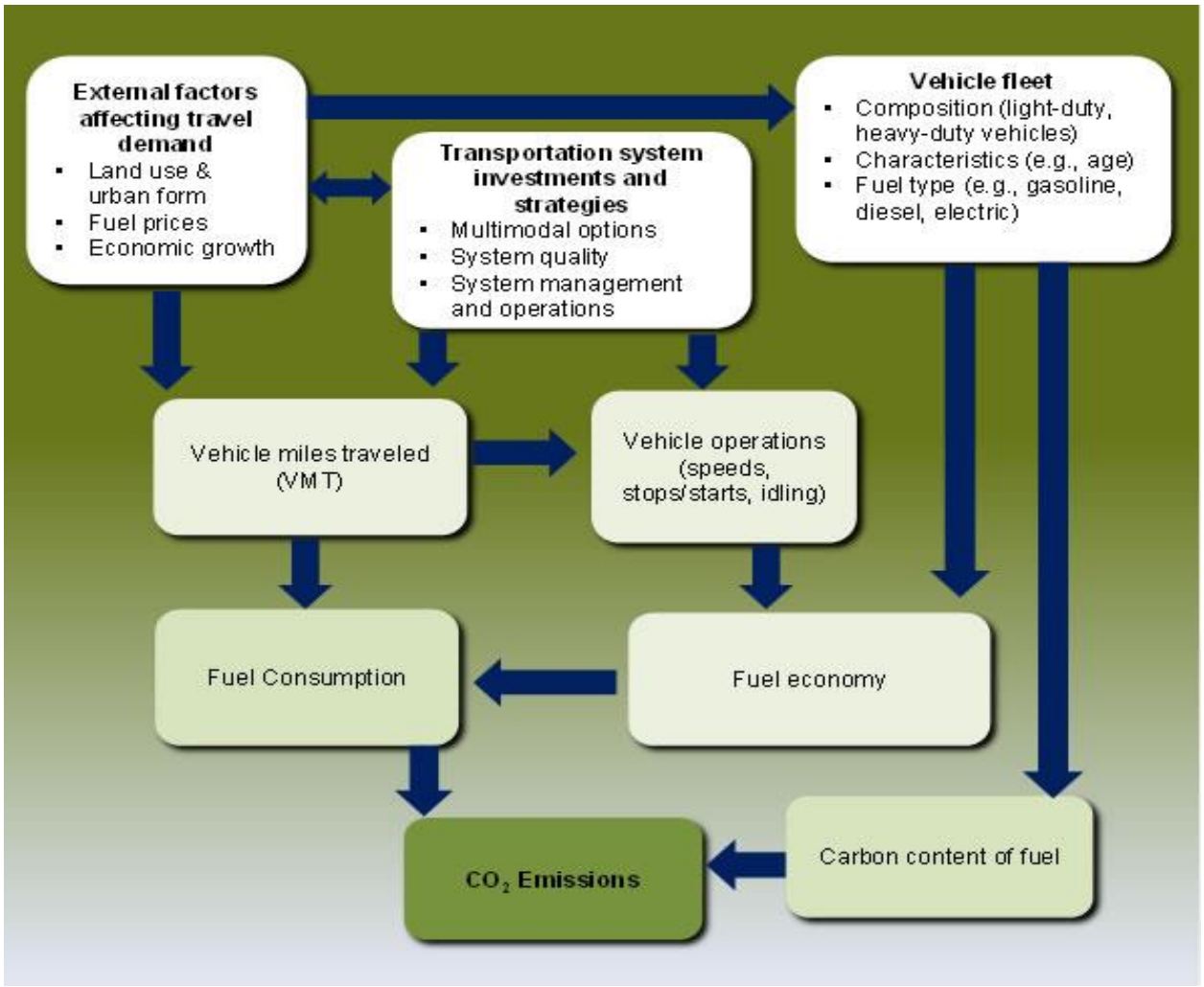


Boundary Discussion

- City of Austin v. Full CAMPO region
- Transportation source types included
- Fleet mix and age
- Emissions and CAFÉ standards

- Are we missing anything?
- Is this inventory useful for planning purposes and for tracking progress into the future?

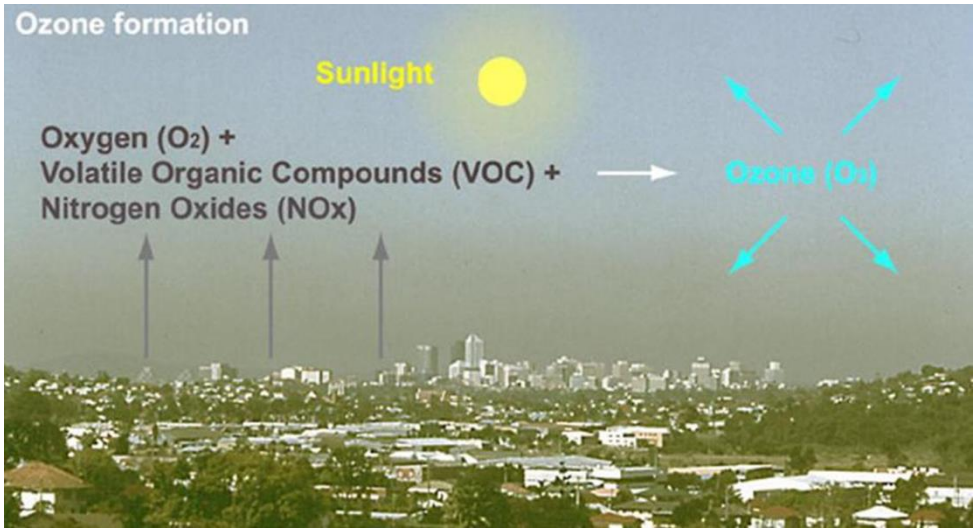
How it all fits together

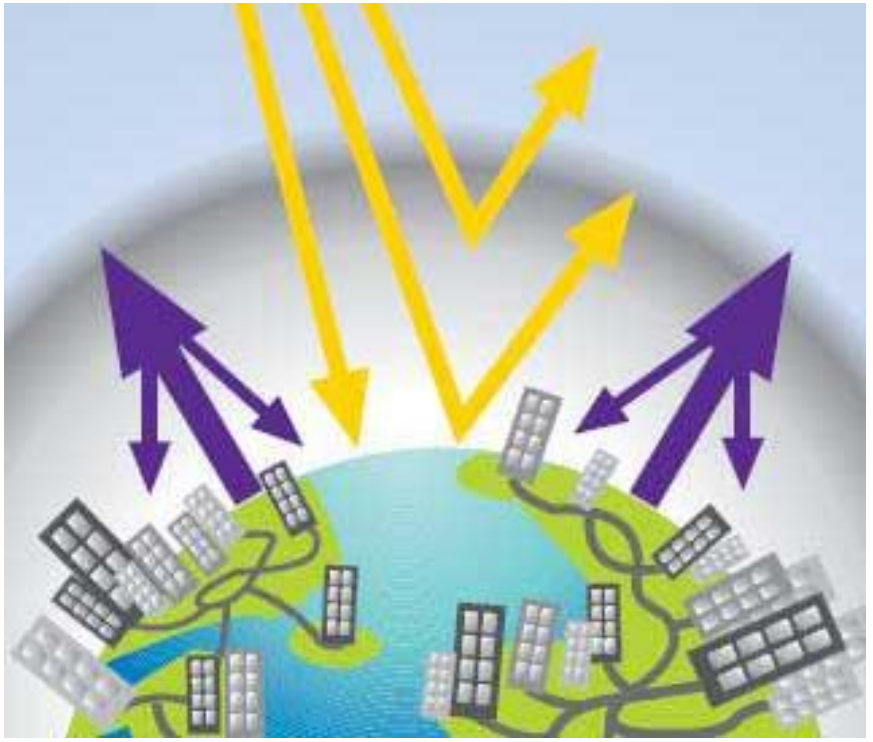


http://www.fhwa.dot.gov/environment/climate_change/mitigation/publications_and_tools/ghg_handbook/chapter02.cfm

Ozone v. Climate Change

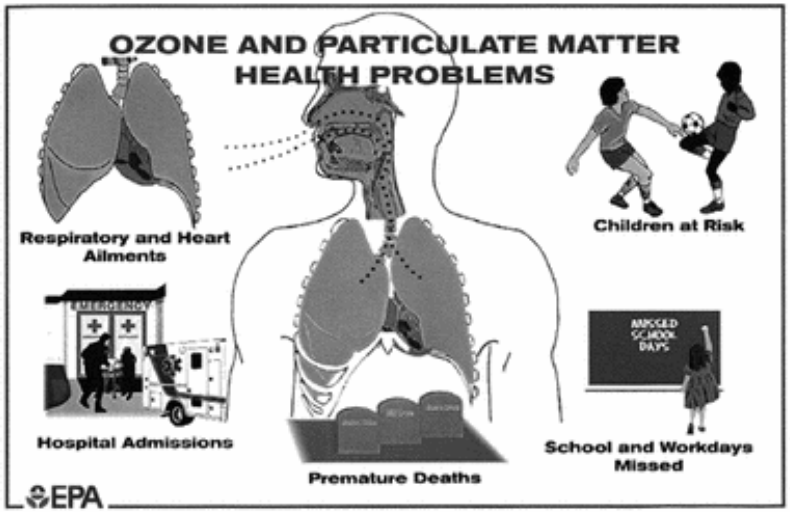
Atmospheric Phenomenon

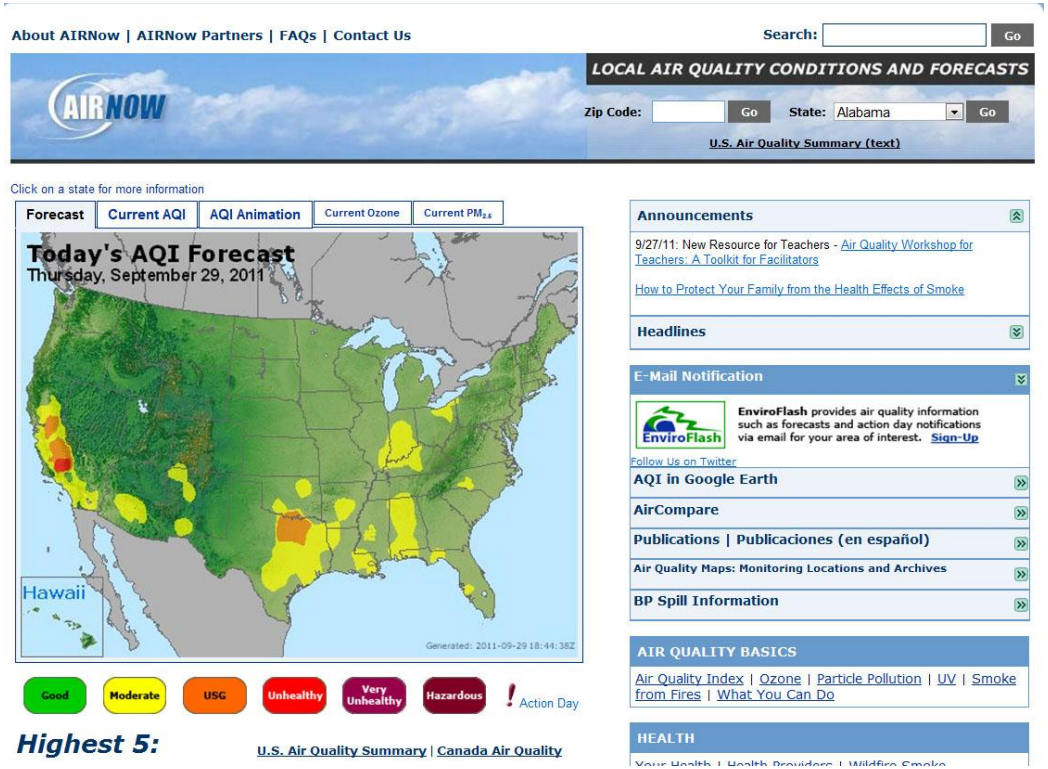




THE GREENHOUSE EFFECT

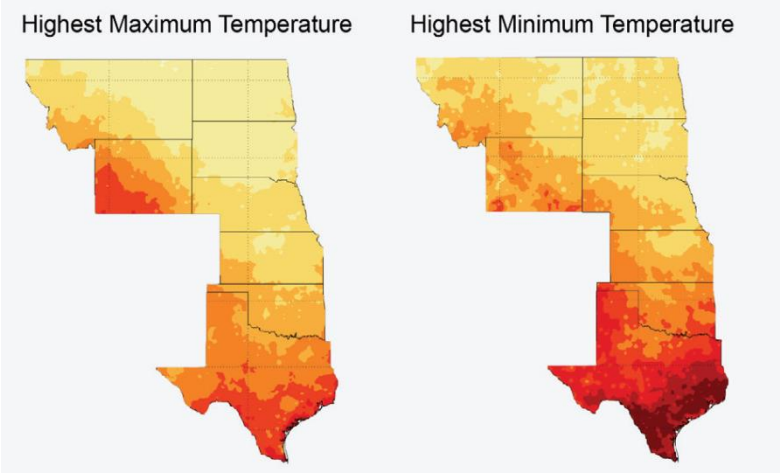
Ozone Effects

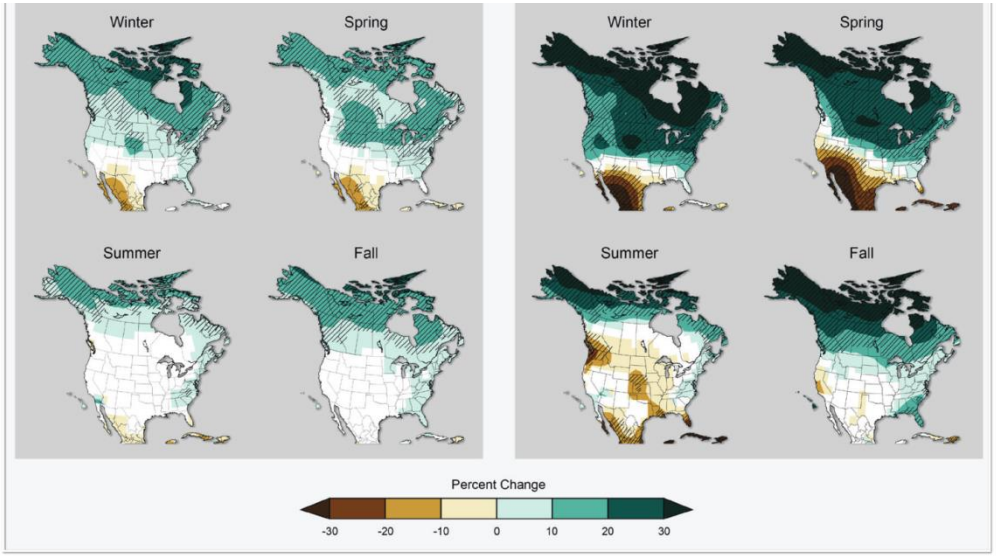




Climate Change = Increased frequency of extremes (2041-2070)

Higher Scenario





Days per year where 2041-2070 temperature will exceed historical hottest week of the year

Source: 2014 U.S. National Climate Assessment

Where do NOx and VOCs come from?

Figure 3: Ozone Season Day Emissions by Source Category for Travis County, 2008 (tons per day)

Source Type	NOX	VOC
On-Road	35.99	15.88
Non-Road	14.10	10.40
Point	9.74	1.18
Area	3.47	44.16
TOTAL	63.30	71.62

- Tons per day is important because of how ozone is formed and how it affects humans
- Annual tons = 23,000 NOx and 26,000 VOC
- The focus for reductions tends to be on transportation (on and off-road)

EPA 2008

Average Emissions and Fuel Consumption for Passenger Cars*

Pollutant/Fuel	Emission & Fuel Consumption Rates (per mile driven)	Calculation	Annual Emission & Fuel Consumption
VOC	1.034 grams (g)	(1.034 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	27.33 lb
THC	1.077 g	(1.077 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	28.47 lb
CO	9.400 g	(9.400 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	248.46 lb
NOx	0.693 g	(0.693 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	18.32 lb
PM_{10}	0.0044 g	(0.0044 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	0.12 lb
$PM_{2.5}$	0.0041 g	(0.0041 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	0.11 lb
CO_2	368.4 g	(368.4 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	9,737.44 lb
Gasoline Consumption	0.04149 gallons (gal)	(12,000 mi/yr) / (24.1 mi/gal)	497.93 gal

CO2 / Climate Change v. NOx / Ozone

- NOx and Ozone
  - Emissions can immediately impact local human health if the conditions are right (sun, heat, humidity, wind direction)
  - The pollutant levels are small comparatively to CO2 and their atmospheric lifetime is very short
  - Regulations and control technology have been very affective at reducing emissions while still using fossil fuel

- CO2 and Climate Change
  - Emissions don't immediately impact local human health
  - Emission amounts are very large and CO2 stays in the atmosphere for over 100 years
  - Fossil fuels are the issue and there is no add-on "control technology"

Discussion

Next Steps?