

Inventory Approach

- Standard US EPA and UN methodologies, guidelines, and tools
- Emphasis on transparency, consistency, and significance
- Preference for Michigan or regional data, where available
- Consumption and production-basis emissions from electricity generation
 - Very simplified approach used for initial analysis

Projection Approach

- Reference case assumes no major changes from business-as-usual (BAU)
 - Includes approved policies and actions to the extent possible (e.g., Energy Efficiency, Renewable Energy)
- Growth assumptions from existing sources
 - State population and employment forecasts
 - US Census and Bureau of Labor Statistics
 - US Energy Information Administration

Coverage

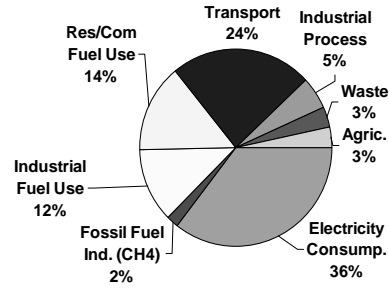
- Six gases per USEPA and UNFCCC guidelines
 - Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulfur Hexafluoride (SF₆)
- All major emitting sectors
 - Electricity Supply & Demand (Consumption Based)
 - Residential, Commercial, Industrial (RCI) Fuel Use and Non-fuel Use Processes
 - Transportation (onroad and nonroad)
 - Natural gas pipeline transmission & distribution
 - Agriculture, Forestry, and Waste
- Emissions expressed as CO₂ equivalent
 - 100-year global warming potentials
 - CO₂ = 1; CH₄ = 21; N₂O = 310; HFC-23 = 11,700; SF₆ = 23,900

Key Points

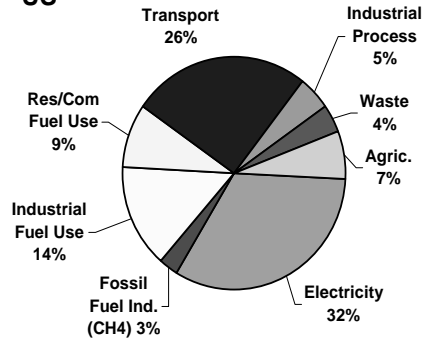
- Preliminary draft for MCAC and TWG review and revision, as needed
- Helpful for diagnosis of GHG emissions, but not a baseline for modeling or compliance for individual options
- Consumption and Production methods
- Gross and Net methods

Michigan & US Emissions By Sector, Year 2000

Michigan



US

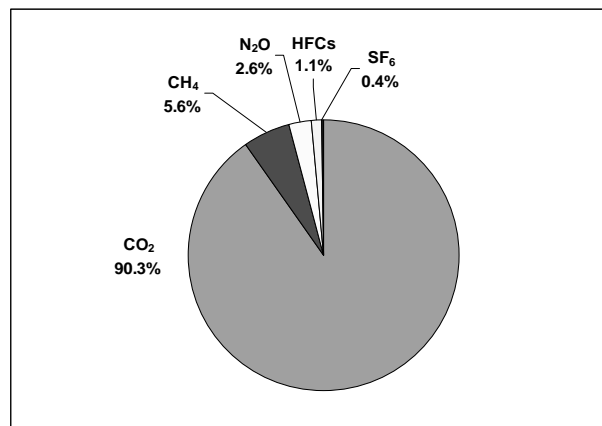


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Michigan Emissions By GHG, Year 2000 (MMtCO₂e Based)

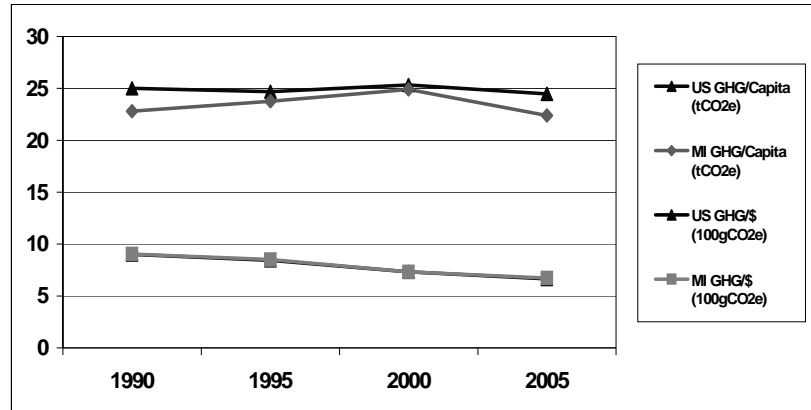


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Per Capita and GSP/GDP GHG Emissions, 1990-2005

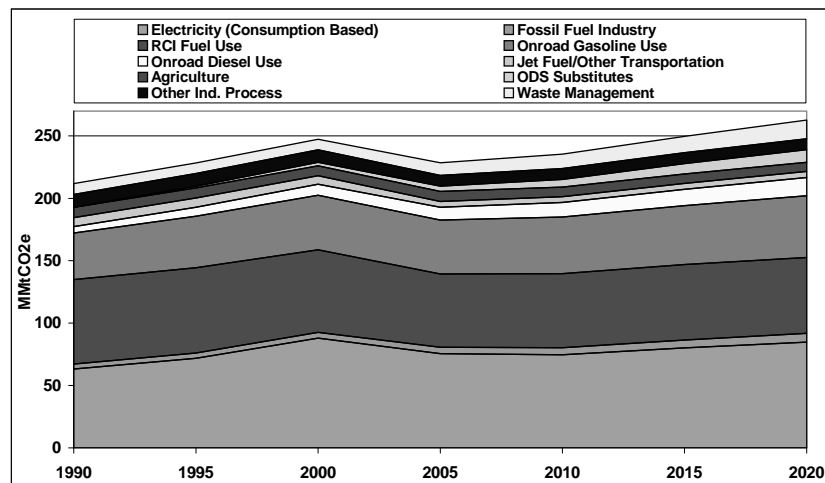


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Gross Michigan GHG Emissions By Sector, 1990-2020

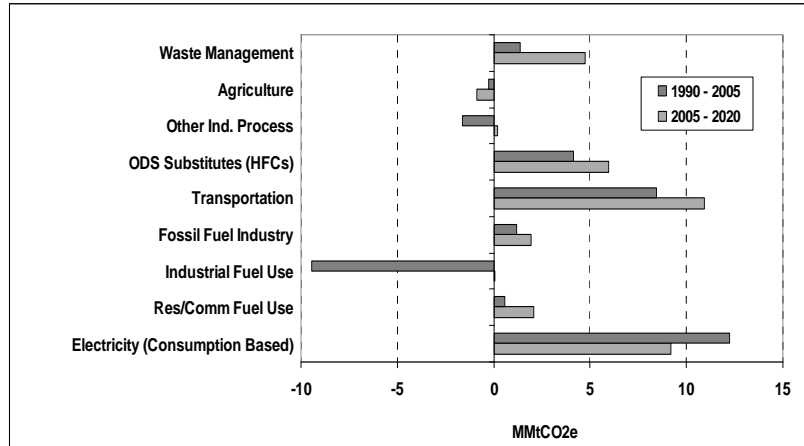


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Michigan Emissions Growth (MMtCO₂e Basis)

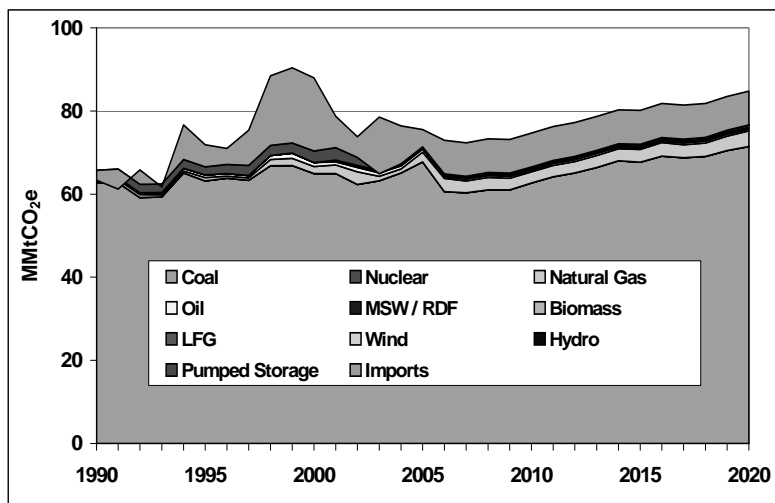


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Electricity - Emissions

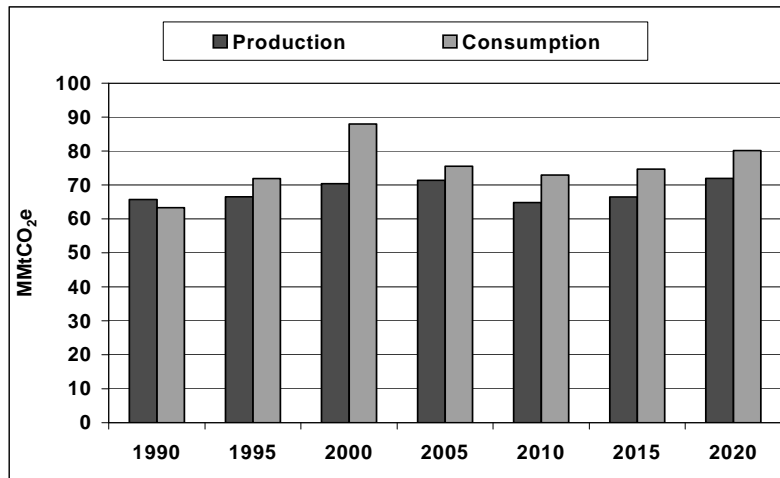


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Electricity - Emissions

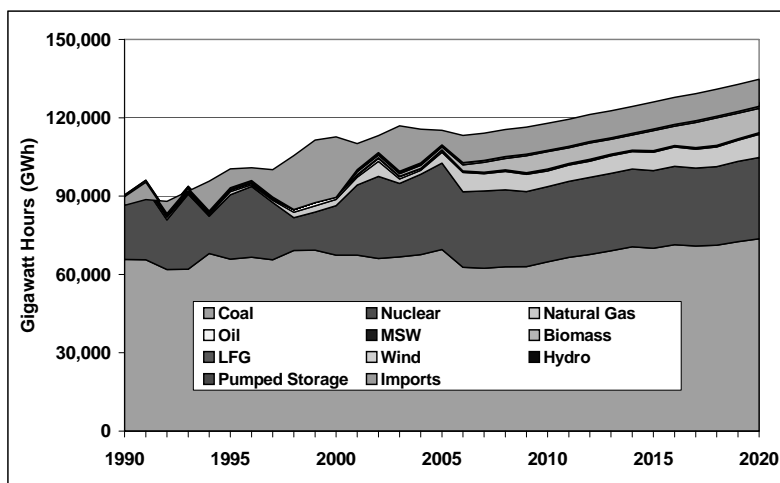


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Electricity – Gross Generation



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Electricity

- Data Sources

- Historical –

- Generation and fuel consumption for 1990-2005
 - 906/920 Monthly Time Series data (*EIA*)
 - Monthly Cost and Quality of Fuels for Electric Plants (*EIA*) – coal-type data

- Forecast –

- MI 21st Century Electric Energy Plan
 - Projected electricity sales
 - EIA/Annual Energy Outlook 2007 for East Central Area Reliability Coordination Agreement (ECAR) region and Mid-America Interconnected Network (MAIN) region
 - Projected trends in combustion efficiency improvement and transmission & distribution losses for 2004-2020

Electricity

- Methodology

- Key Inputs:

- Coal quality used in MI power stations
 - Gross annual primary energy consumption by MI power stations by fuel type
 - Gross annual generation to meet MI demand

- Multiply gross annual primary energy consumption by MI power stations by CO₂e emission factors

- Assign the portion of CO₂e emissions not associated with MI demand to imports/exports

Electricity

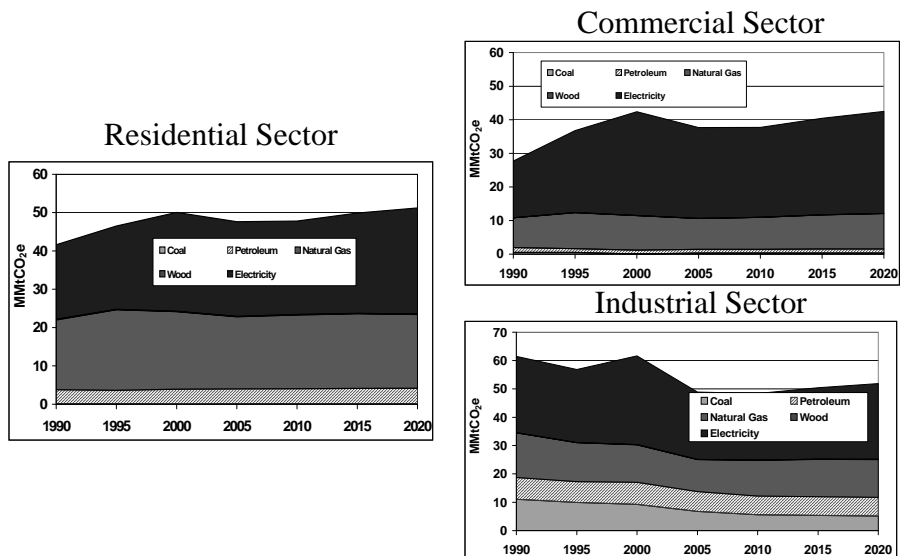
- Key Uncertainties
 - Top-down approach
 - Assumes MI electric systems evolve consistently with the surrounding ECAR and MAIN regions
 - Does not capture all state-specific system characteristics
 - Source of electricity imports and exports
 - Coal quality over time
 - Coal quality for 2005 assumed for forecast period

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RCI



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RCI

- **Data Sources**
 - Historical
 - EIA State Energy Data (SED)
 - EIA Natural Gas Annual
 - Forecast
 - Residential - MI population annual growth rate (2005 – 2020)
 - Comm/industrial - EIA Annual Energy Outlook 2007 (AEO2007)
 - Projected consumption by fuel type for EIA East North Central region
- **Methods**
 - Historic
 - US EPA State Greenhouse Gas Inventory Tool (SIT)
 - Energy consumption multiplied by emission factors
 - Forecast
 - Fossil fuels – annual growth rate applied to latest year of emissions
 - Electricity emissions attribution – MI Electric Plan Forecast

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RCI

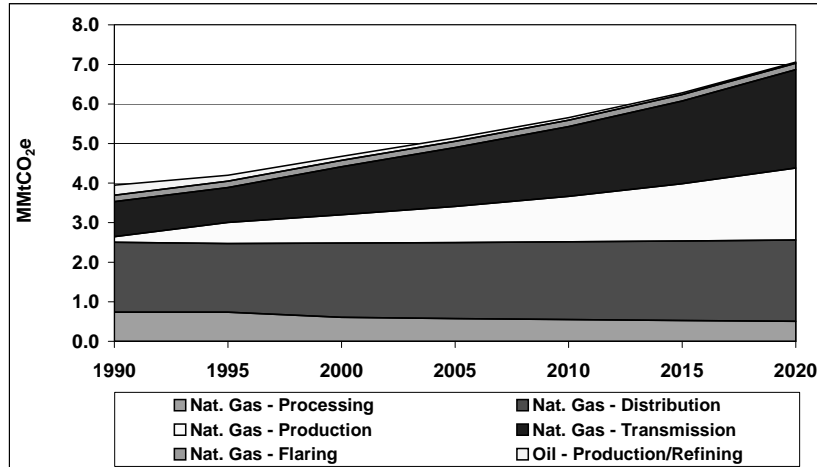
- **Key Assumptions**
 - Residential sector
 - Projections based on normalized regional AEO2007 growth projections of fuel use scaled for MI population
 - Commercial/Industrial
 - Projections based on regional AEO2007 growth projections of fuel use
- **Key Uncertainties**
 - Regional projections
 - Industrial sector growth and mix

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Natural Gas and Oil Industry



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Natural Gas and Oil Industry

- Data sources
 - Historic (1990-2005)
 - Miles of transmission and distribution pipeline
 - Pipeline and Hazardous Materials Safety Administration / Office of Pipeline Safety
 - Compressor stations – EIIP default number of stations per mile
 - Forecast
 - Growth rates based on state level historical activity/emissions trends
- Methods
 - Based on EPA State Greenhouse Gas Inventory Tool (SIT)
 - Activity x emission factors

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Natural Gas and Oil Industry

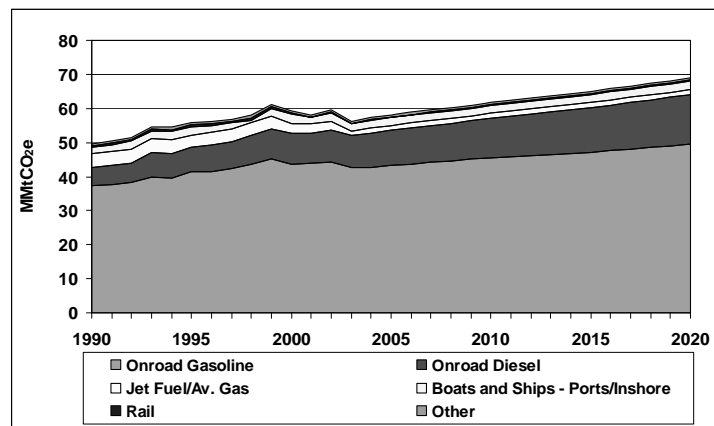
- Key Assumptions
 - Growth rates are process-specific, vary by activity:
 - Natural gas--drilling and field production, processing, transmission, distribution
 - Oil—production, refining, transport
 - EPA EIIP defaults for number of compressor stations per mile of pipeline
 - Growth rate for natural gas production (based on EIA number of wells)
- Key Uncertainties
 - Growth rates by process

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Transportation



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Transportation

- Data Sources: Onroad Vehicles
 - US DOE EIA State Energy Data fuel consumption for 1990-2004
 - State-level vehicle miles traveled (VMT) from MDOT for 1994-2006
 - FHWA VMT for 1990-1993
 - Road-type VMT allocated to vehicle type using FHWA data on vehicle mix by road-type
 - VMT projections from MDOT

Transportation

- Data Sources: Other Transport Sectors
 - Aircraft – EIA SED fuel consumption
 - Aircraft Projection – FAA aircraft operations forecasts
 - Rail and Marine Gasoline– FHWA's *Highway Statistics* and EIA's *Petroleum Navigator*
 - Commercial Marine – EIA national fuel consumption and freight tonnage from Waterborne Commerce Statistics Center
 - Rail/Marine Projection – based on historical growth

Transportation

- **Methods**
 - **Inventory (1990-2005)**
 - **CO2**
 - State Greenhouse Gas Inventory Tool (SIT) and Fuel Consumption
 - **Onroad CH4 and N2O**
 - SIT and VMT
 - **Nonroad CH4 and N2O**
 - SIT and Fuel Consumption

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Transportation

- **Methods for Projections (2005-2020)**
 - **Onroad Gasoline and Diesel CO2**
 - VMT forecasts from MDOT
 - VMT forecasts adjusted to account for projected fuel efficiency improvements and differences in fuel growth rates based on data from 2007 EIA Annual Energy Outlook
 - **Onroad CH4 and N2O**
 - VMT projections, as above
 - VMT allocated to vehicle type using 2007 EIA Annual Energy Outlook data
 - **Aviation**
 - FAA aircraft operations projections
 - Commercial operations applied to jet fuel, general aviation applied to aviation gasoline
 - Jet fuel projections adjusted to account for projected fuel efficiency improvements using 2007 EIA Annual Energy Outlook data
 - **Marine/rail**
 - Historical growth rates used for marine vessels
 - No growth assumed for rail

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Transportation

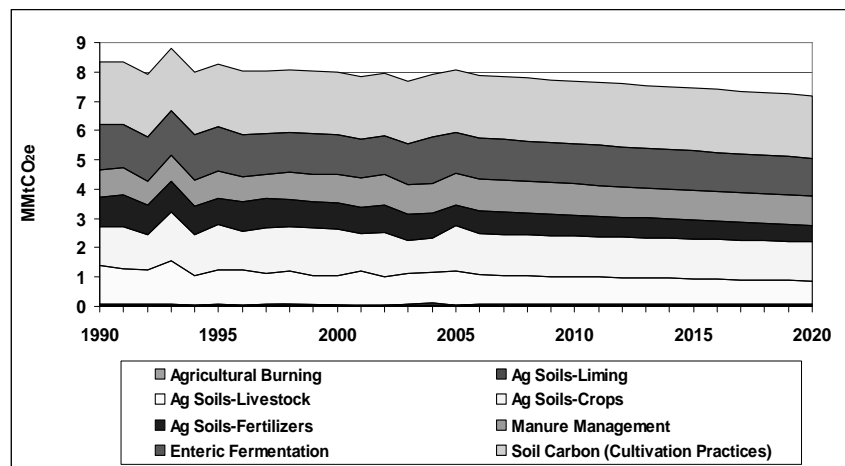
- Key Assumptions
 - Available VMT projections are accurate
- Key Uncertainties
 - Future vehicle mix – based on national estimates
 - Consumption of international bunker fuels in the aircraft sector

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Agriculture



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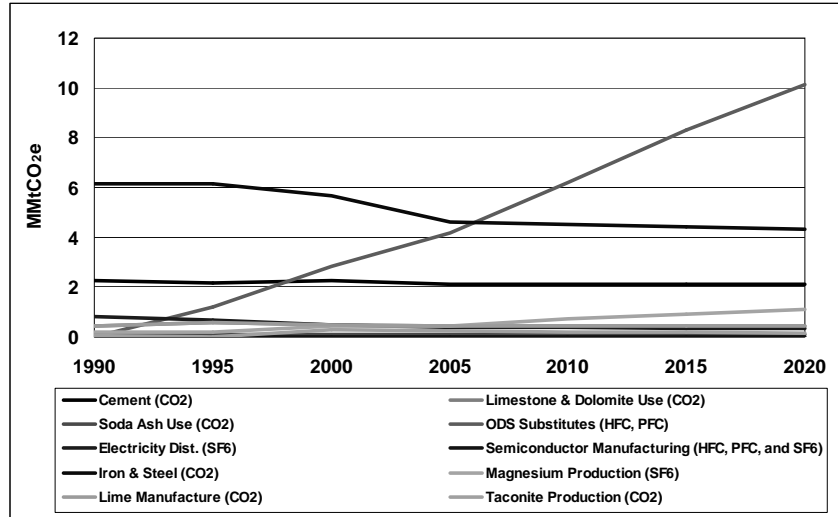
Agriculture

- Data Sources
 - Crop Production: USDA/NASS
 - Livestock: USDA/NASS
 - Fertilizer: Fertilizer Institute
- Methods
 - Crops: SIT emission factors and crop production data
 - Livestock: SIT emission factors and livestock populations
 - Fertilizer: SIT fertilizer consumption
 - Dairy cattle population projections based on FAPRI report.
 - Broiler and turkey population based on 2000-2005 data
 - All other livestock projections estimated based on linear forecasts of 1990-2005 populations
 - Projections for other categories based on historical growth trends

Agriculture

- Key Assumptions
 - Future growth for agricultural soils will follow historical trends
 - Livestock population growth will follow historical trends
- Key Uncertainties
 - Manure management emission factors derived from limited data sets
 - Livestock numbers based on point estimates for each year to represent populations that fluctuate throughout the year
 - Projection assumptions

Industrial Process



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Industrial Process

- Data sources
 - Historic
 - US EPA National GHG Inventory
 - ODS substitutes, electric distribution, semi-conductors
 - MDEQ
 - Taconite production and magnesium casting
 - USGS
 - Cement manufacture (clinker and masonry cement), soda ash consumption, iron and steel production, lime production, and limestone/dolomite use
 - Forecast (annual growth rates from 2004/2005 to 2020)
 - MI employment data – lime manufacture, iron & steel
 - Historic trends –
 - Cement and lime manufacture, limestone/dolomite use, taconite
 - US EPA National Inventory Forecast
 - ODS substitutes, electric distribution, semiconductors, magnesium
 - US Geological Survey (USGS) – soda ash use
- Methods
 - Based on EPA SIT

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Industrial Process

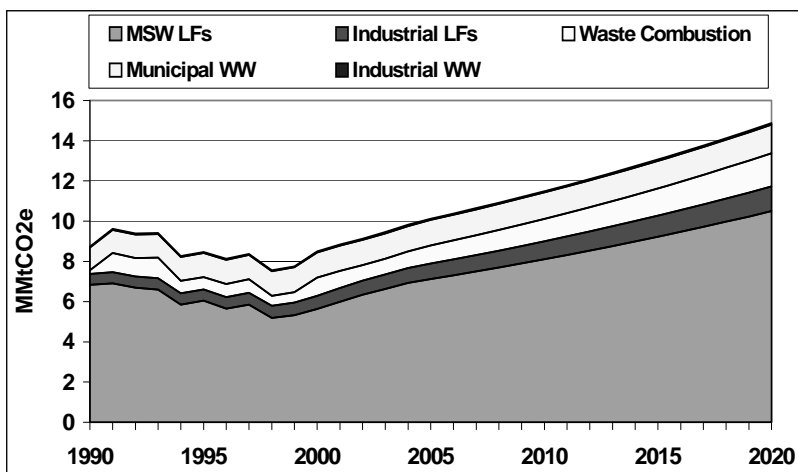
- Key Uncertainties
 - Actual production data for estimating historical emissions
 - Growth rates used to forecast emissions
 - Application of annual industrial growth rate for 2004-2014 to forecast emissions to 2020
 - Based on historic trends
 - Industry activities to reduce GHG emissions

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Waste Management



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Waste Management

- Data sources
 - Annual disposal volumes for 1996-2005 from MDEQ
 - SIT default disposal data used from 1960-1995 (population-based)
 - SIT default data on waste combustion
 - State population and SIT default data for municipal and industrial wastewater treatment
- Methods
 - SIT with data sources above
 - SIT defaults to account for controls
 - Growth based on historical emissions
 - Accounts only for waste generated in Michigan, not imported waste

Waste Management

- Key Assumptions
 - Growth Rates
 - Landfills – based on historic emissions growth (1996-2005)
 - Industrial solid waste – based on SIT default assumption of 7% of MSW waste-in-place
 - Industrial and Municipal wastewater – based on historic emissions growth (1990-2005)
- Key Uncertainties
 - Future controls applied to uncontrolled landfills
 - Controls by individual landfill
 - Industrial landfills – SIT default of 7% of municipal landfills

Forestry and Land Use Emissions (MMtCO₂e)

	1990	1995	2000	2005	2010	2020
Forested Landscape (excluding soil carbon)	-40.64	4.21	4.21	-4.36	-4.36	-4.36
Urban Forestry and Land Use	-10.06	-5.83	-3.69	-3.91	-3.91	-3.91
Forest Wildfires	0.02	0.02	0.02	0.02	0.02	0.02
Total	-50.67	1.60	0.55	-8.25	-8.25	-8.25

Forestry

- **Data Sources**
 - USFS carbon stock data for 1979-2002 based on FORCARB2 model
 - USFS also provides modeled estimates for harvested wood products
- **Methods**
 - Forestry: USFS FORCARB2 carbon stock change model provides carbon pools for each inventory cycle
 - Flux calculated for each pool based on difference in time between inventory cycles
 - Carbon pool data for the 1979-1992 and 1992-2002 time-periods used to quantify fluxes.

Forestry

- Key Assumptions
 - 1979-2002 carbon stock change representative of current and historical conditions
 - No significant change in sequestration from 2006-2020
- Key Uncertainties
 - Effects of future development on forested acreage
 - Effects of near-term climate change on forest sequestration levels
 - Methodological differences in USGS Forestry Inventory Analysis (FIA) surveys
 - MI's 2003 carbon stock data

Break

