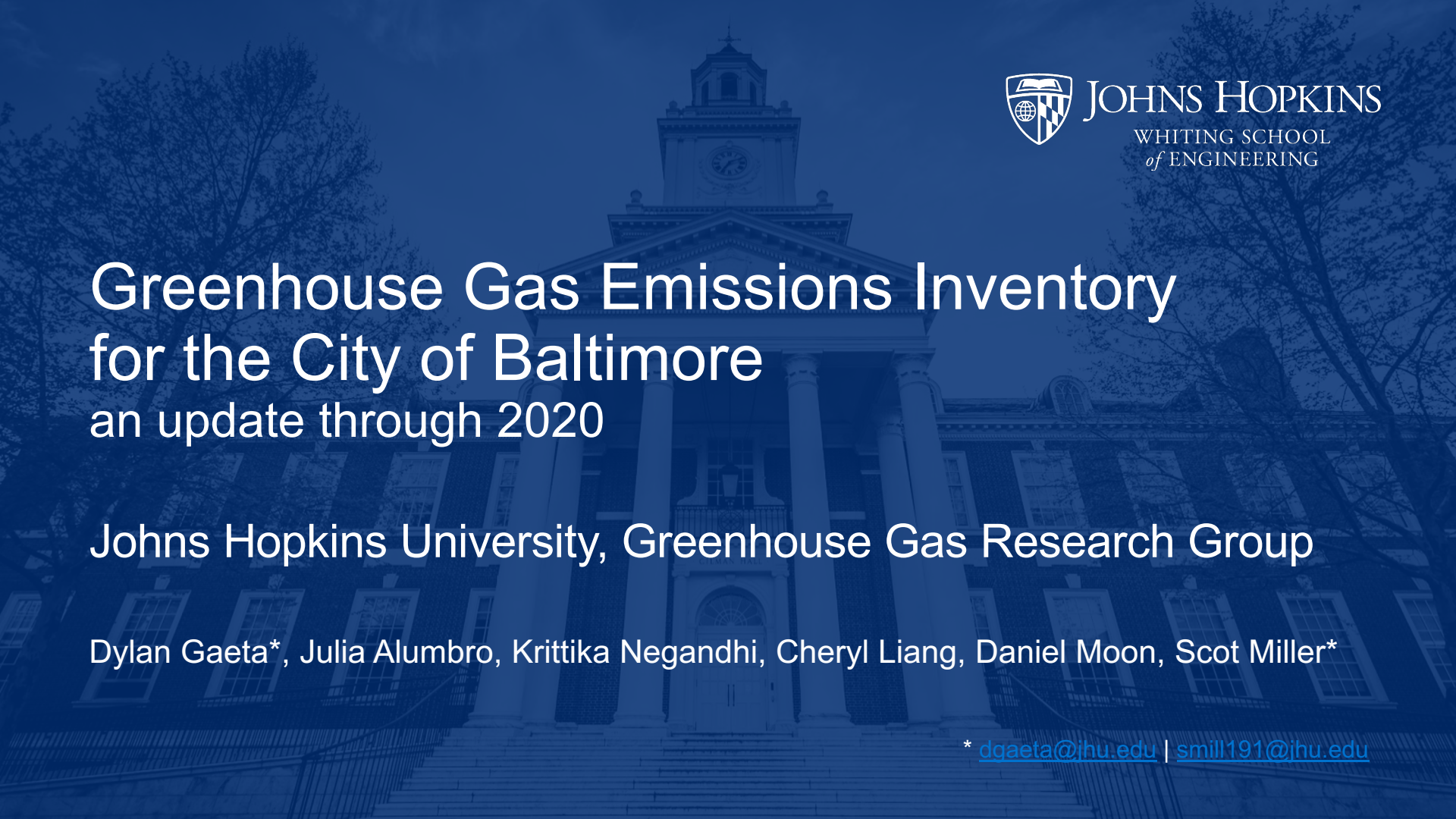

Greenhouse Gas Emissions Inventory for the City of Baltimore

an update through 2020

Johns Hopkins University, Greenhouse Gas Research Group

Dylan Gaeta*, Julia Alumbro, Krittika Negandhi, Cheryl Liang, Daniel Moon, Scot Miller*

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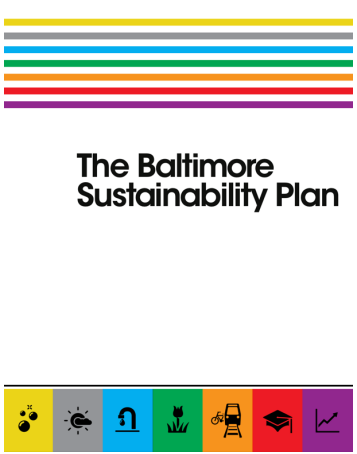
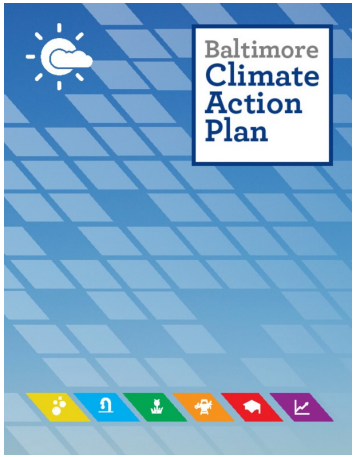
Context for the Greenhouse Gas Emissions Inventory

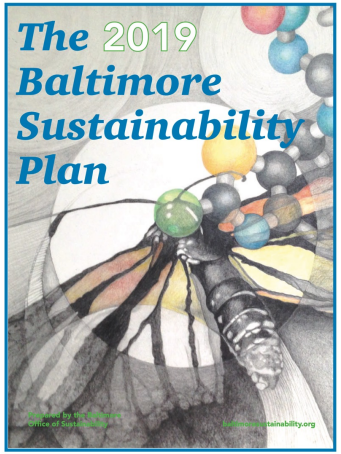
- The City of Baltimore first committed to reducing citywide GHG emissions with the release of the 2009 Baltimore Sustainability Plan
  - Emissions reductions goals were updated in the *2012 Climate Action Plan* and the *2019 Baltimore Sustainability Plan*
    - Updated citywide GHG emissions reduction target to **25% below 2007 baseline by 2020**, and **30% by 2025**



2009



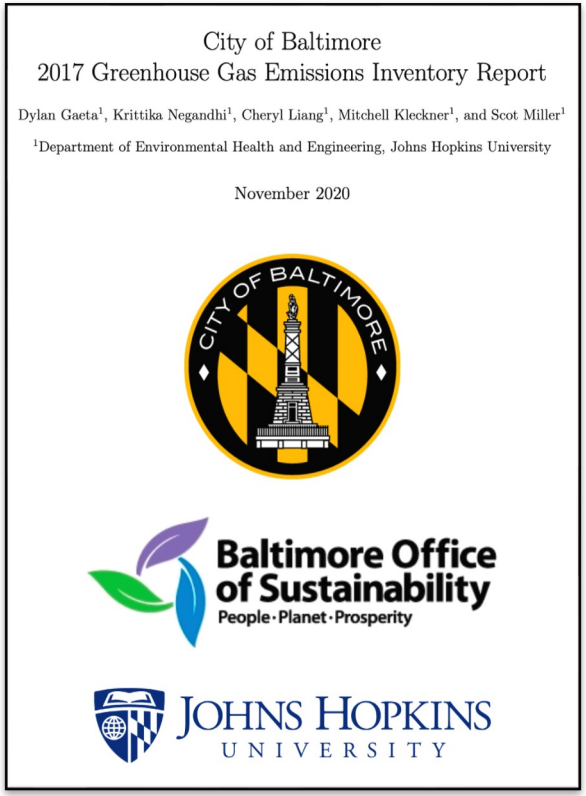
2012



2019

2017 GHG Inventory indicated a need to accelerate emissions reductions

- In 2020, the Baltimore Office of Sustainability teamed up with the JHU Greenhouse Gas Lab to assess the city's GHG emissions reductions through 2017
  - We found that the city had decreased annual GHG emissions by ~13% from 2007 to 2017
    - Falls short of the goal of a 25% reduction by 2020
    - Indicated a need for the city to accelerate future GHG emissions reductions


City of Baltimore
2017 Greenhouse Gas Emissions Inventory Report

Dylan Gaeta[1], Krittika Negandhi[1], Cheryl Liang[1], Mitchell Kleckner[1], and Scot Miller[1]

[1]Department of Environmental Health and Engineering, Johns Hopkins University

November 2020

CITY OF BALTIMORE

Baltimore Office of Sustainability
People · Planet · Prosperity

JOHNS HOPKINS UNIVERSITY

Baltimore is committing to carbon neutrality by 2045

Mayor and Sustainability Office Release Carbon-Neutral Goals for Baltimore City

Tuesday Jan 18th, 2022

Share

Brandon M. Scott
Mayor,
Baltimore City
250 City Hall - Baltimore Maryland 21202
(410) 396-3835 - Fax: (410) 576-9425

FOR IMMEDIATE RELEASE

CONTACT
Jack French
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Baltimore City to Go Carbon Neutral by 2045

BALTIMORE, MD. (Tuesday, January 18, 2022) — Today, Mayor Brandon M. Scott and Director of the Office of Sustainability, Lisa McNeilly, announced an updated set of goals for Baltimore City's Climate Action Plan.

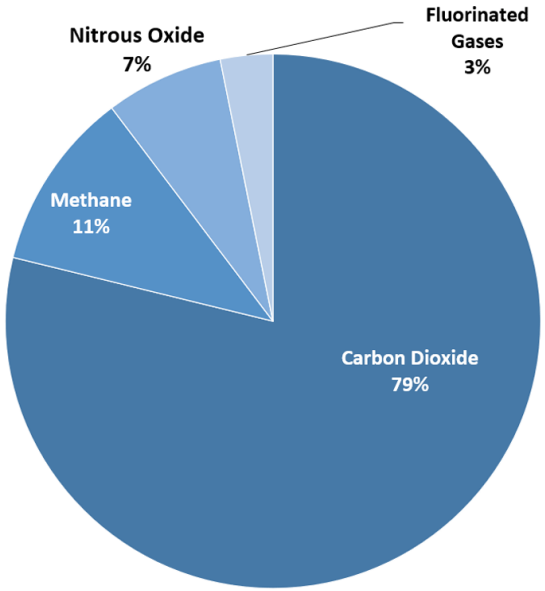
At the direction of Mayor Scott, the City has set a series of targets to achieve 100% carbon neutrality by 2045. The Scott administration is aiming for a 30% reduction in carbon emissions by 2025, a 60% reduction in emissions by 2030, and full carbon neutrality – or 100% reduction in net emissions – by 2045.

- New goals for upcoming Climate Action Plan:
  - 30% reduction by 2025
  - 60% reduction by 2030
  - 100% reduction by 2045 (net zero)

(each relative to 2007 baseline)

Overview of GHG Emissions Accounting

Overview of U.S. Greenhouse Gas Emissions in 2020



U.S. Environmental Protection Agency (2022). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020

- Greenhouse Gas (GHG) Emissions Inventory includes the 3 GHGs that contribute most to climate change:
  - Carbon Dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous Oxide (N_2O)

- Inventory does not include:
  - Fluorinated gases
  - Criteria Air Pollutants (CAPs)
    - Particulate matter (PM2.5 & PM10), Ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_x), lead (Pb)
  - Hazardous Air Pollutants (HAPs) (118 compounds)
    - Toxic metals
    - Volatile organic compounds (VOCs)

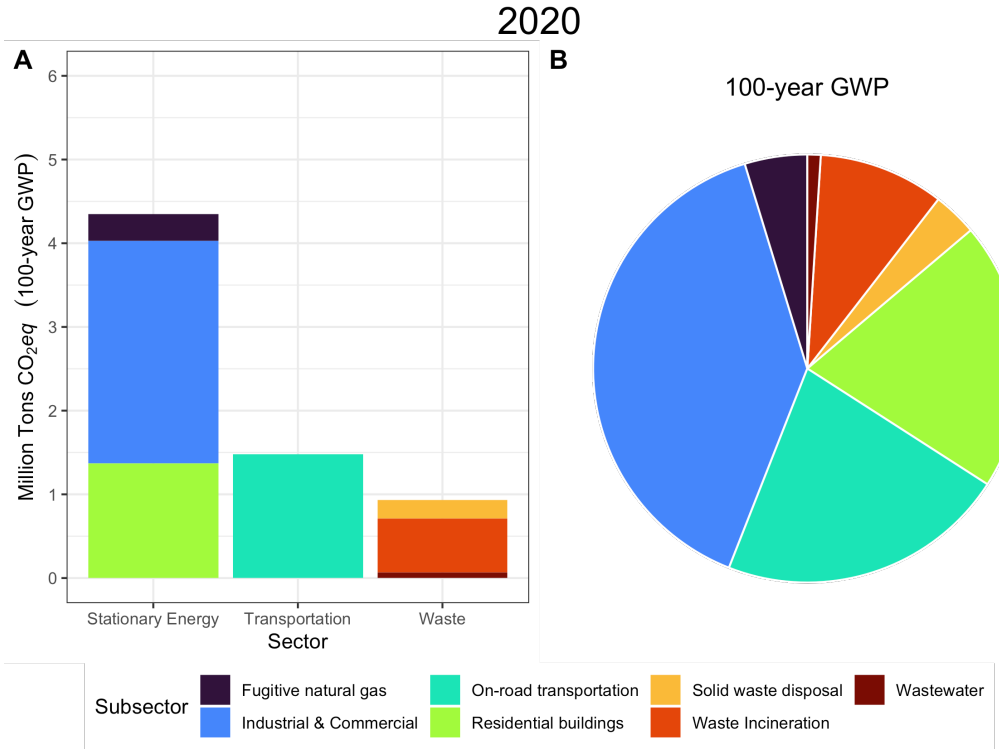
Greenhouse Gas Emissions Reporting Protocol

- We follow the Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC)
  - Developed by the World Resources Institute, C40 Cities Climate Leadership Group, and ICLEI Local Governments for Sustainability
  - The GPC is designed to align with *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*

GPC includes emissions from 6 main sectors

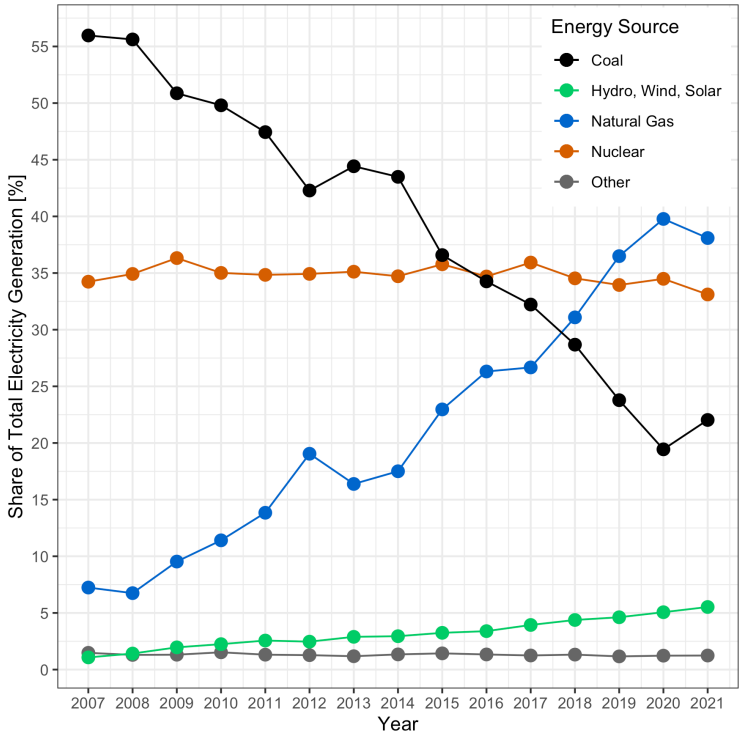
Sector Sub-sector
1. Stationary Energy
1.1 Residential buildings
1.2 Commercial and institutional buildings and facilities
1.3 Manufacturing industries and construction
1.4 Energy industries
1.5 Agriculture, forestry, and fishing activities
1.6 Non-specified sources
1.7 Fugitive emissions from coal
1.8 Fugitive emissions from oil and natural gas
2. Transportation
2.1 On-road
2.2 Railways
2.3 Waterborne navigation
2.4 Aviation
2.5 Off-road
3. Waste
3.1 Solid waste disposal
3.2 Biological treatment of waste
3.3 Incineration and open burning
3.4 Wastewater treatment and discharge
4. Industrial Processes & Product Use (IPPU)
4.1 Industrial processes
4.2 Product use
5. Agriculture, Forestry, & Other Land Use (AFOLU)
5.1 Livestock
5.2 Land
5.3 Aggregate sources and non-CO_2 sources on land
6. Other Scope 3
6.1 All Other

- Baltimore's emissions are primarily from the first 3 sectors

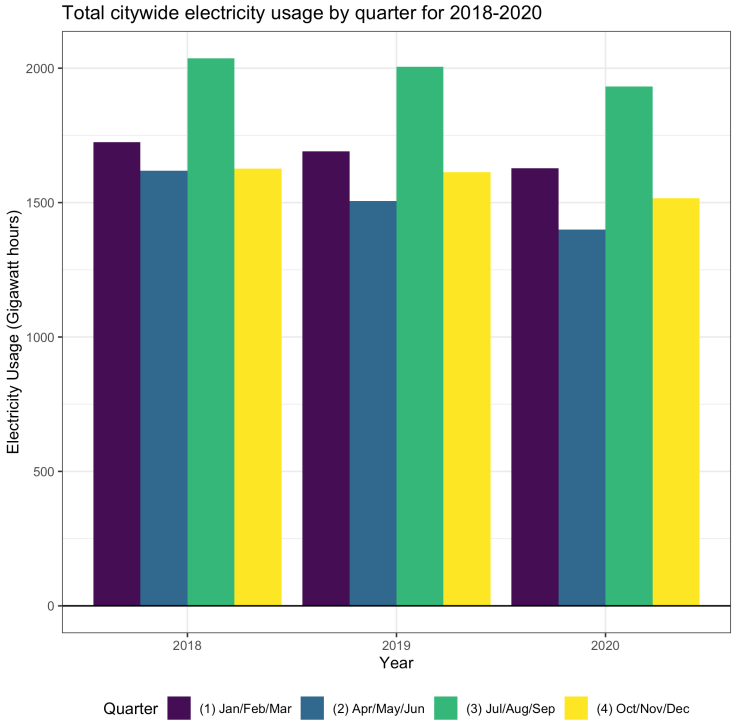


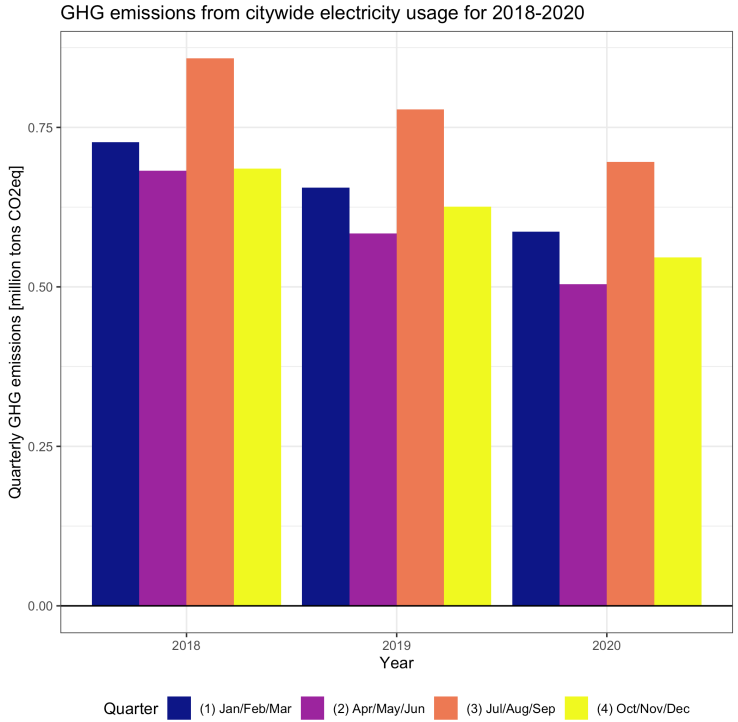
Sector 1: Stationary Energy (electricity)

- BG&E purchases the electricity it delivers to Baltimore City from PJM Interconnection, the regional electricity grid operator
- The fuels used by PJM grid suppliers to generate electricity are the source of large GHG emissions
  - The share (%) of each fuel in the overall PJM fuel mix determines the overall CO_2 emissions factor for BG&E's electricity
- Baltimore's GHG emissions reductions since 2007 were largely driven by the replacement of coal power with natural gas power
- Growth in the fraction of renewable energy sources on the PJM grid has been slow



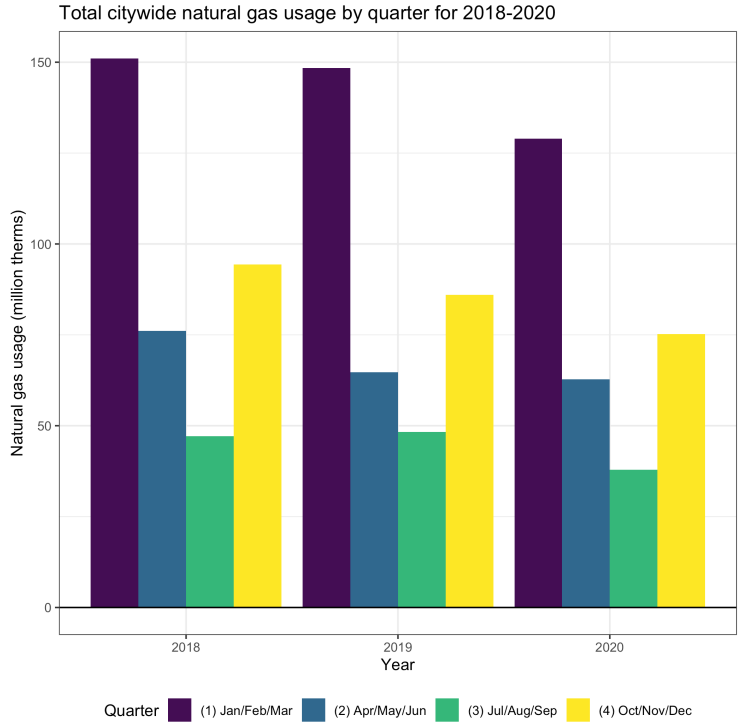
Sector 1: Stationary Energy (electricity)

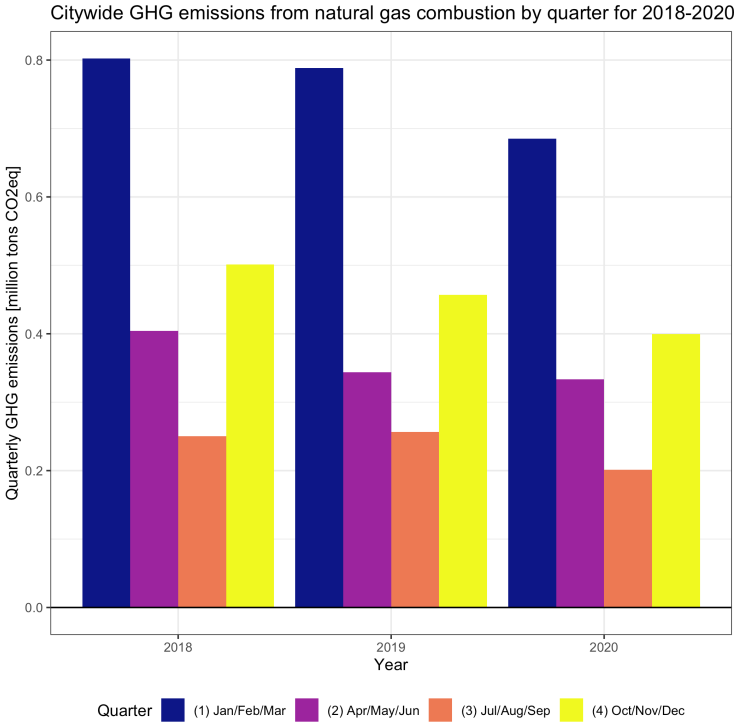




- GHG emissions are a product of citywide electricity consumption and the overall carbon intensity (emissions factor) of the PJM grid

Sector 1: Stationary Energy (natural gas)

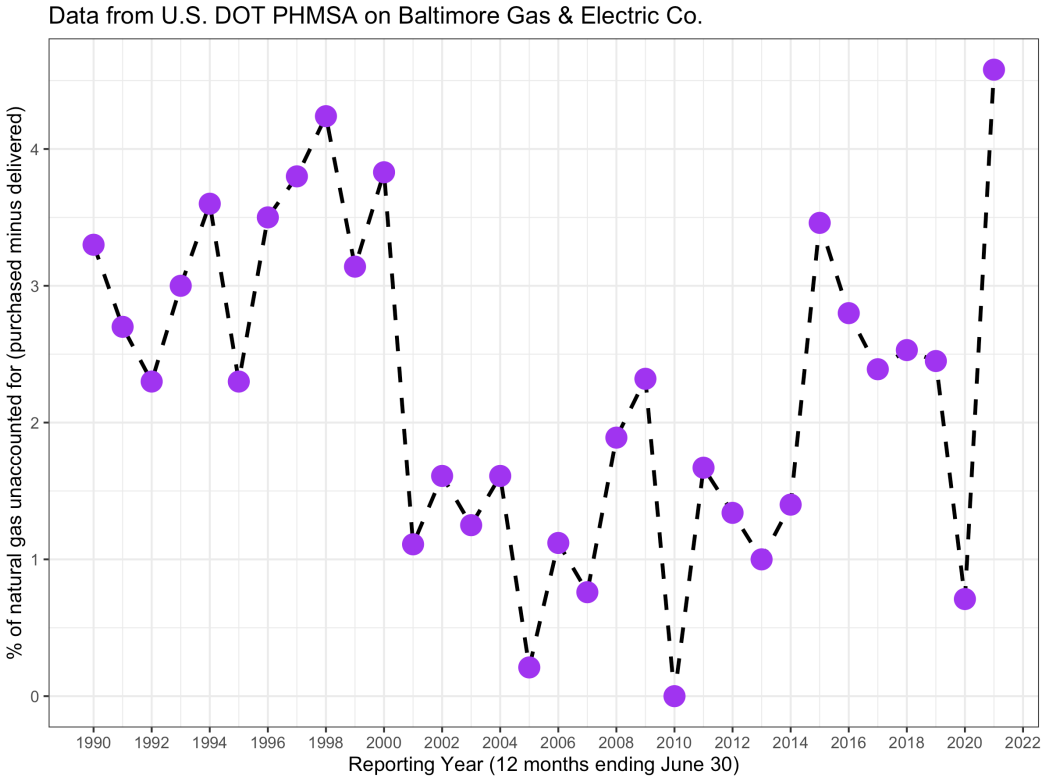




- GHG emissions from natural gas combustion scale with consumption

Sector 1: Stationary Energy (natural gas)

- Combusted natural gas emissions are not the whole story
- Fugitive natural gas emissions are the potential party-crasher
  - Natural gas is predominantly (>90%) methane (CH_4)
  - CH_4 is a much more potent GHG than CO_2
    - 1 ton of CH_4 traps
      - 28x more heat than CO_2 over the next 100 years
      - 84x more heat than CO_2 over the next 20 years



U.S. DOT PHMSA = Pipeline and Hazardous Materials Safety Administration

Sector 2: Transportation

- Traffic emissions modeling done by the Maryland Department of the Environment (MDE)
  - Using the U.S. EPA tool MOVES (Motor Vehicles Emissions Simulator) 3.0

2017

Fuel Type	Tons CO_2eq
Gasoline	1,408,506
Diesel	361,590
CNG	3,399
E85	6,895
Total	**1,780,390**

2020

Fuel Type	Tons CO_2eq
Gasoline	1,140,244
Diesel	329,181.3
CNG	6,654.4
E85	1,925.0
Total	**1,478,005**

On-road vehicle emissions decreased by ~17% from 2017 to 2020

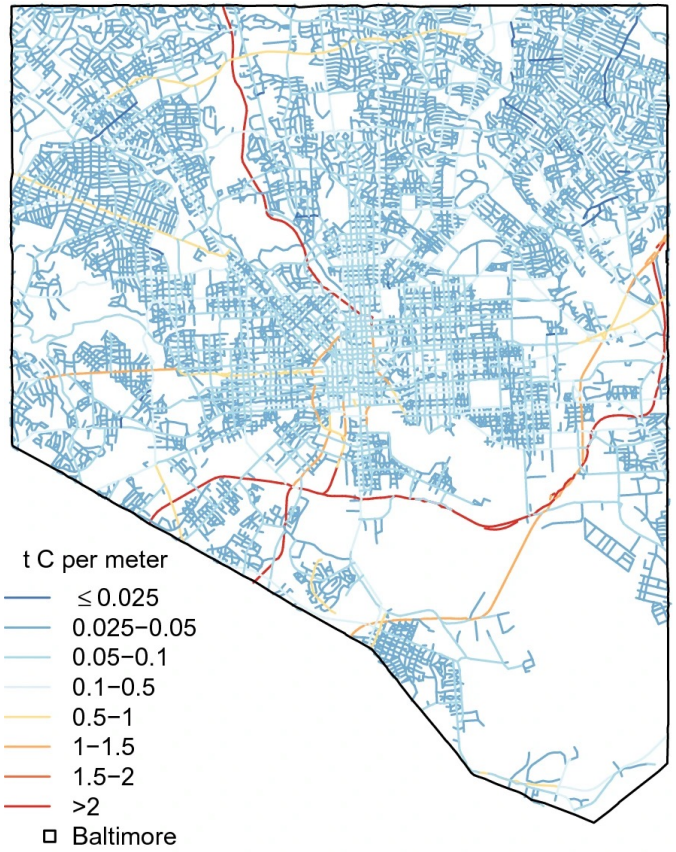
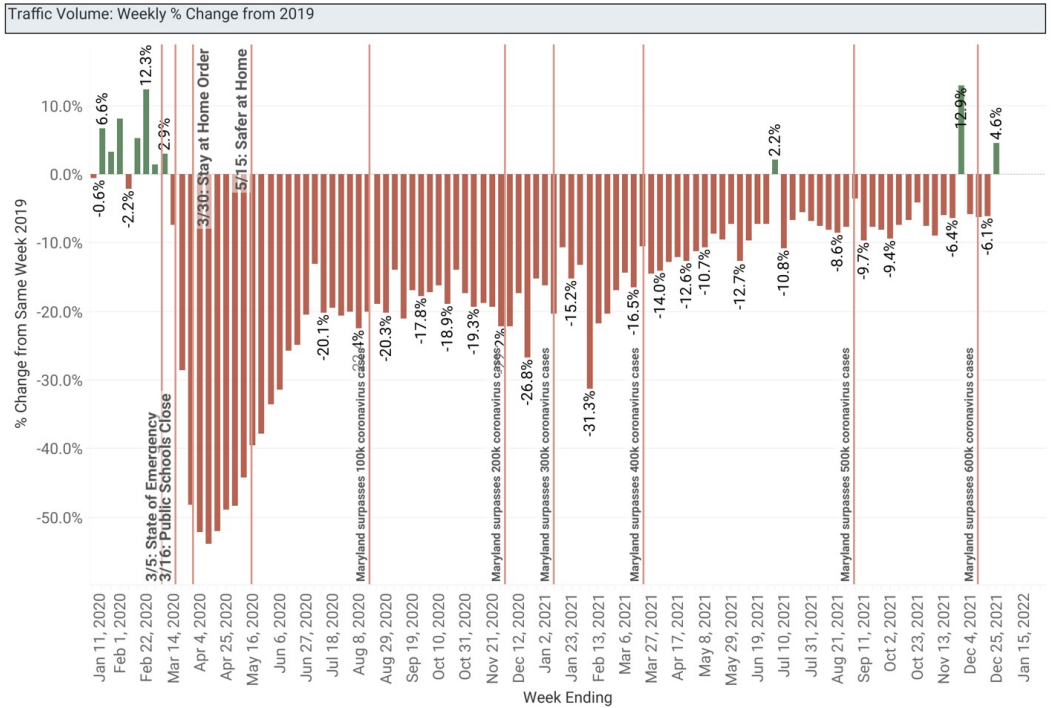


Figure 5, Roest *et al.* (2020) Informing urban climate planning with high resolution data: the Hestia fossil fuel CO_2 emissions for Baltimore, Maryland

Sector 2: Transportation

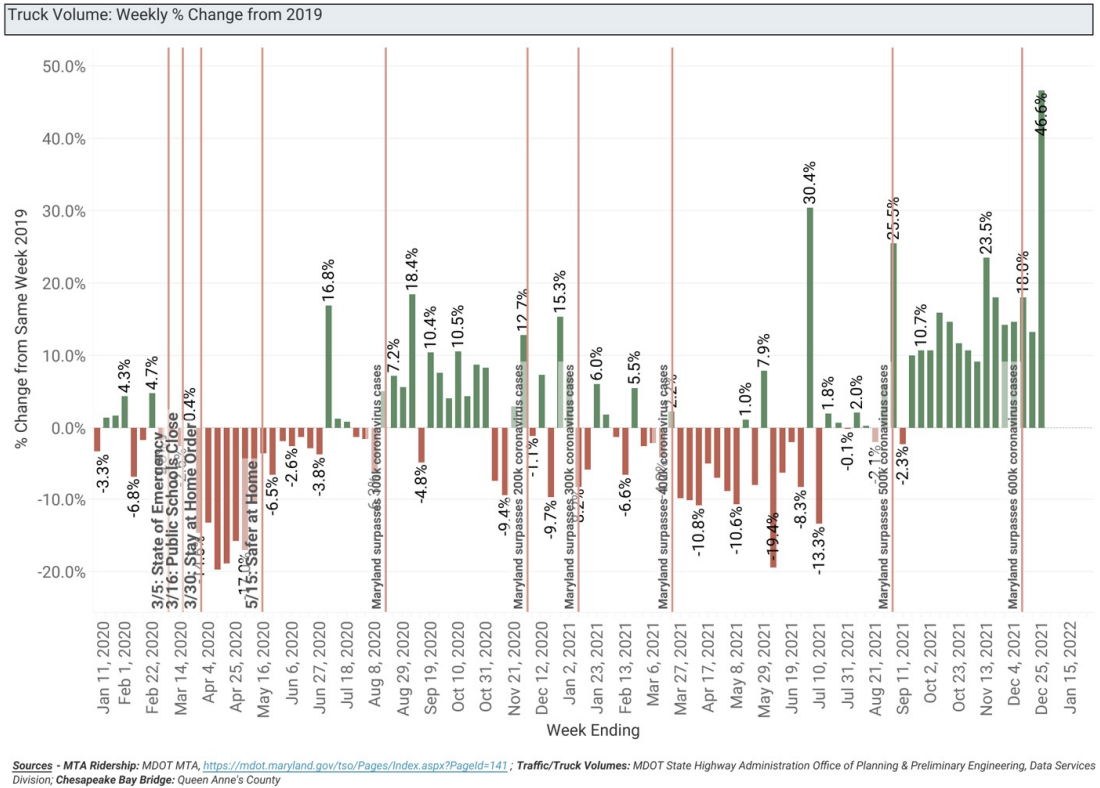
- Why did GHG emissions drop by 17% between 2017 and 2020?
  - Largely driven by an 18% drop in vehicle miles traveled
- Passenger vehicle traffic dropped dramatically after the COVID-19 pandemic started
  - What about large freight/delivery trucks?



***Sources* - MTA Ridership:** MDOT MTA, https://mdot.maryland.gov/tso/Pages/Index.aspx?PageId=141 ; **Traffic/Truck Volumes:** MDOT State Highway Administration Office of Planning & Preliminary Engineering, Data Services Division; **Chesapeake Bay Bridge:** Queen Anne's County

Sector 2: Transportation

- Large diesel truck traffic volume *increased* after the pandemic started
  - Likely caused by increased demand for shipping/delivery
- Truck traffic increase complicates the traffic emissions story
  - Increase in truck emissions could offset marginal increases in passenger vehicle fuel-efficiencies



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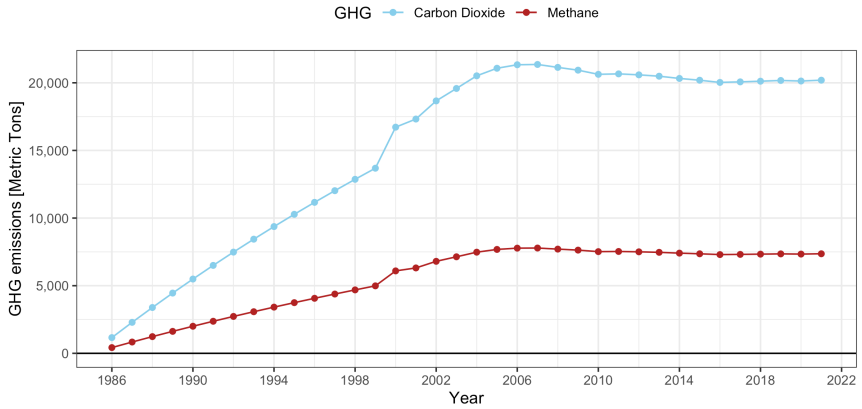
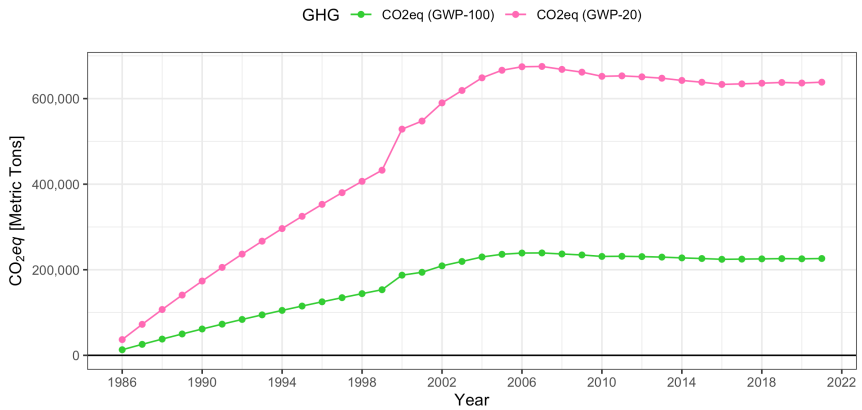
Sector 3: Waste (Quarantine Road Landfill)

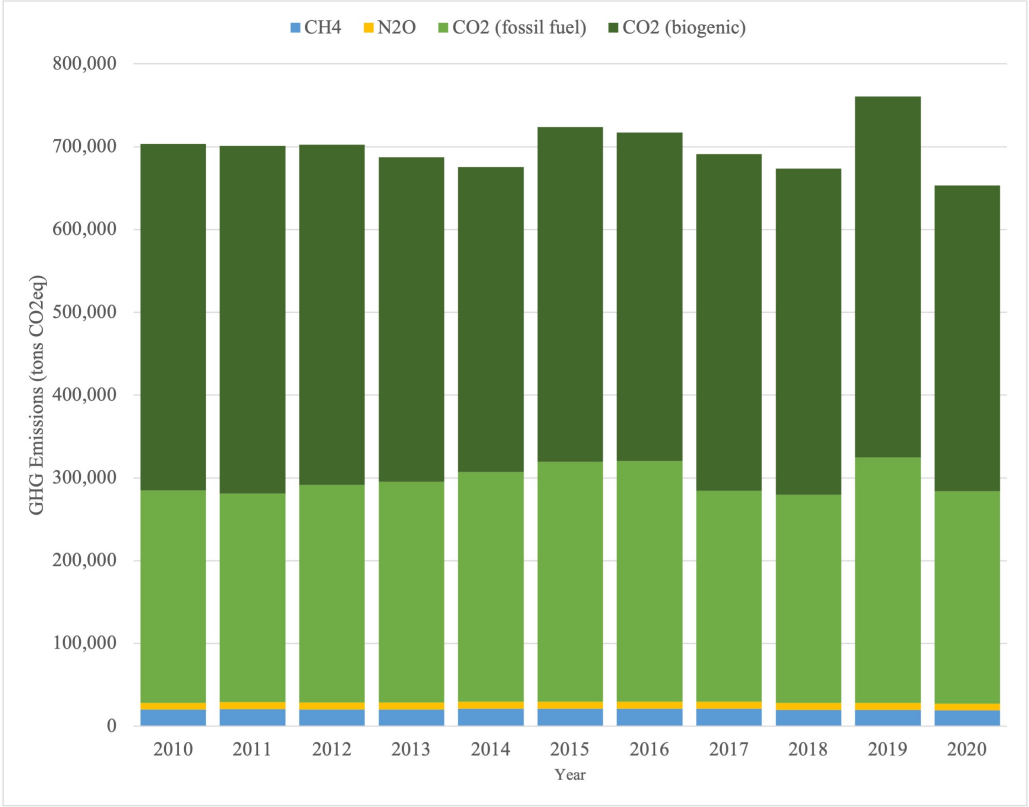
- GHG emissions from the Quarantine Road Landfill occur as the result of decomposing landfill waste
  - Landfills tend to emit large quantities of CH_4 released by the anoxic (oxygen-poor) decomposition of organic waste
- Emissions modeling done by the Maryland Department of the Environment (MDE)
  - using the U.S. EPA tool LandGEM (Landfill Gas Emissions Model) 3.0



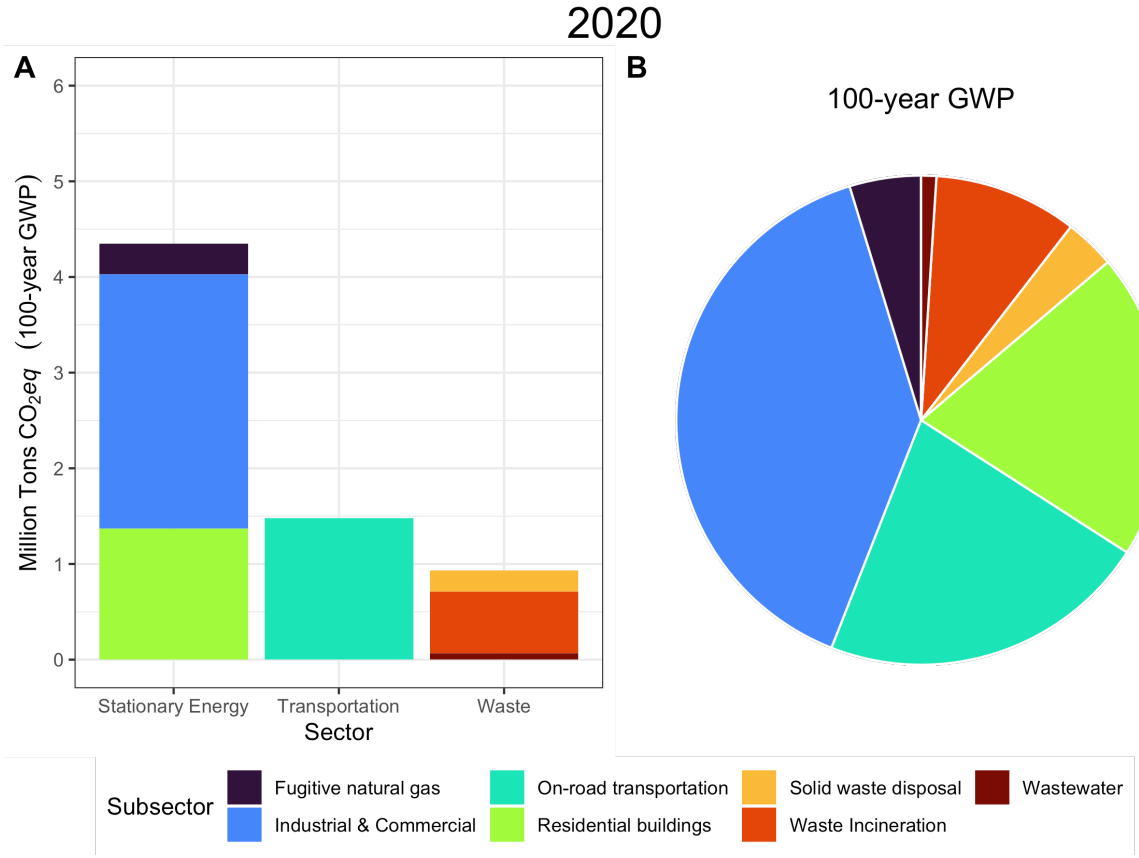


Sector 3: Waste (Wheelabrator Incinerator)

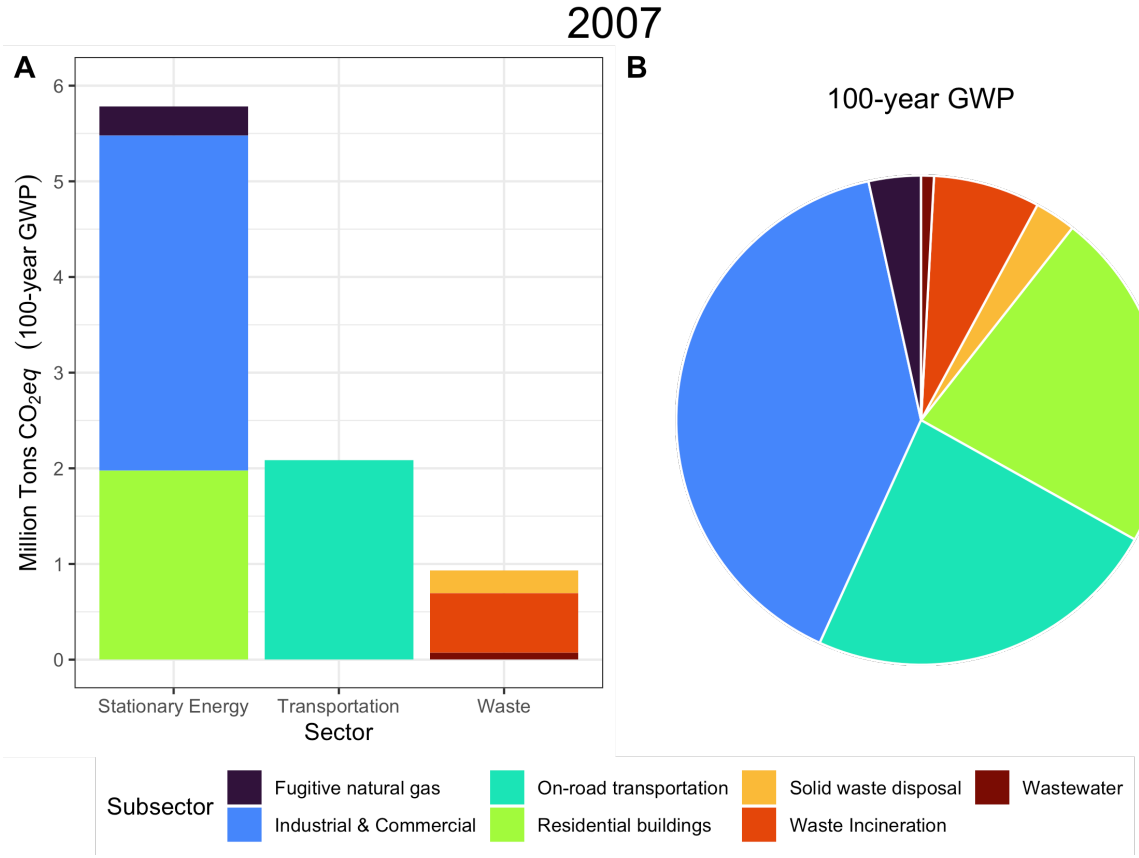
- The Baltimore Wheelabrator solid waste incinerator is the largest point source of GHG emissions in Baltimore
  - ~9.5% of citywide emissions
  - Annual emissions reported to the EPA (FLIGHT)
- Annual GHG emissions have essentially not changed since the 2007 baseline (619,224 tons)
- In terms of GHGs, Baltimore Wheelabrator emits mostly CO_2
  - But also emits other CAPs and HAPs



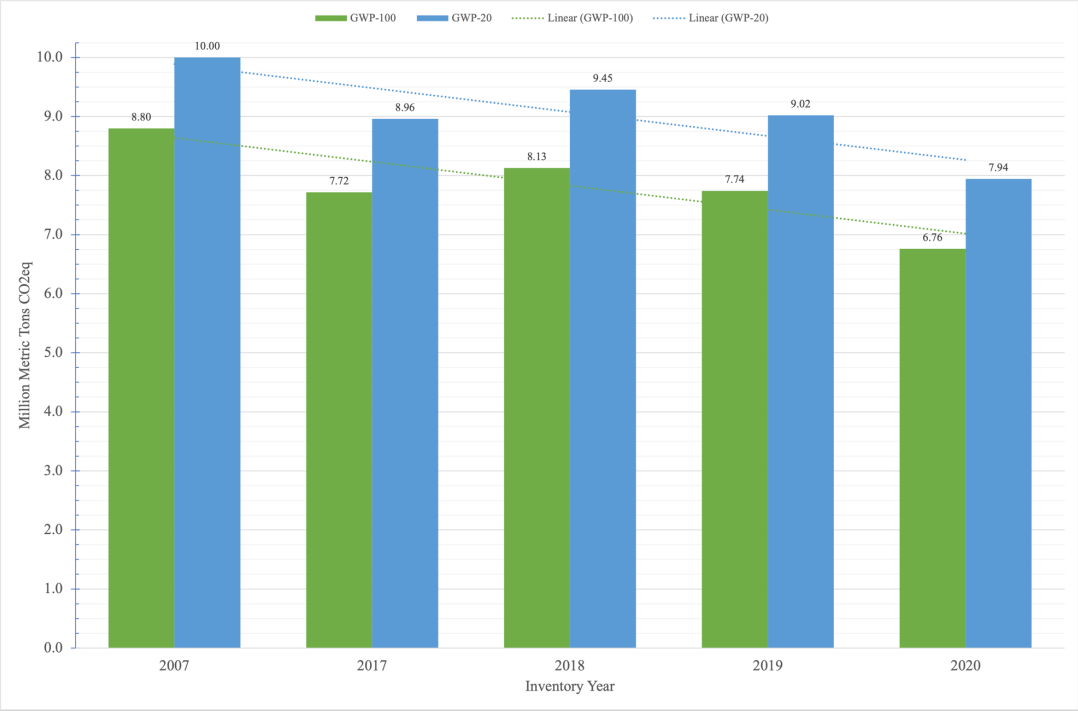
Citywide GHG emissions inventory (2020)



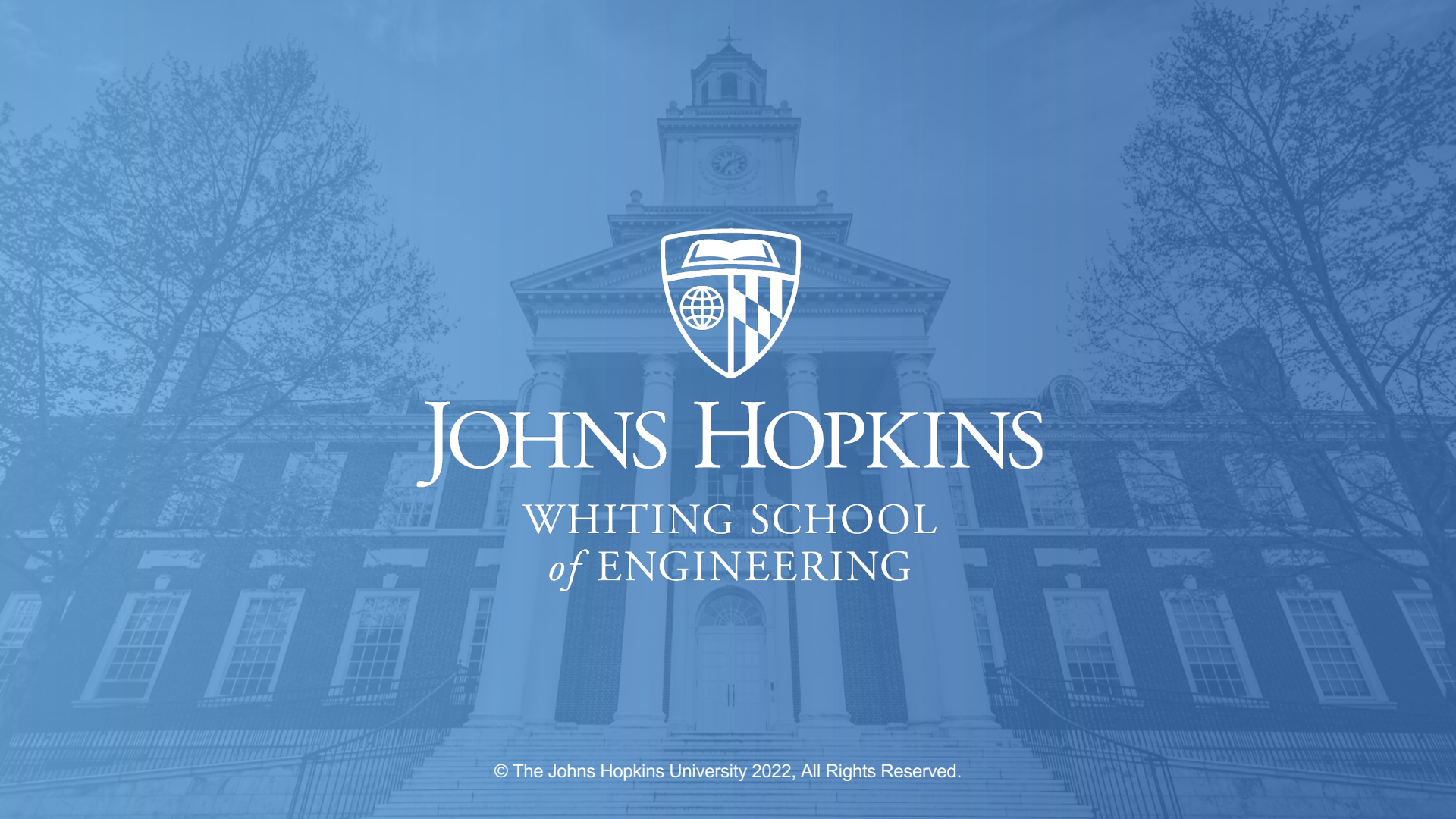
Citywide GHG emissions inventory (2007)



Summary of GHG emissions 2018-2020



- Total citywide GHG emissions have continued to decrease through 2020
  - From 2007 baseline, Baltimore's GHG emissions decreased by:
    - 12.3% through 2017
    - 7.6% through 2018
    - 12.0% through 2019
    - 23.2% through 2020
- Baltimore *almost* hit the target of 25% GHG emissions reductions by 2020



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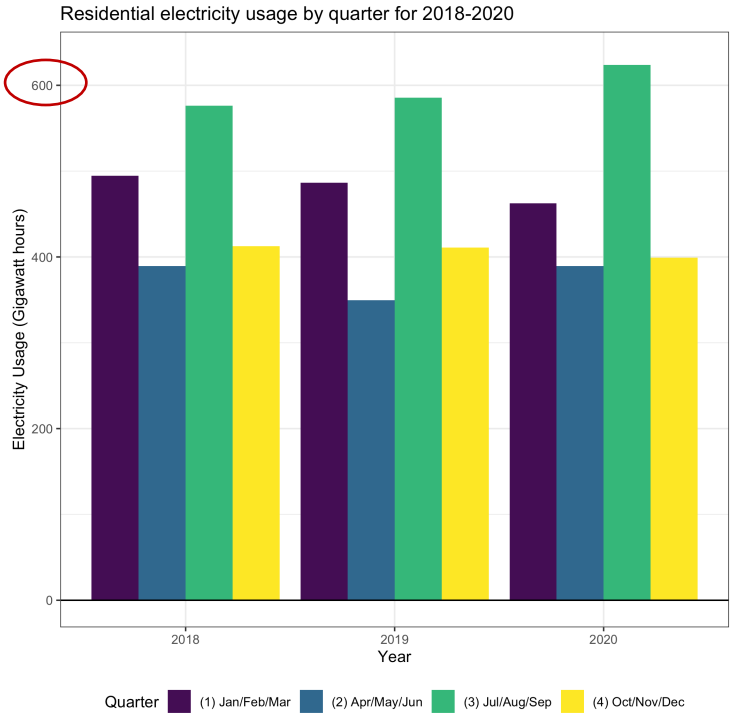
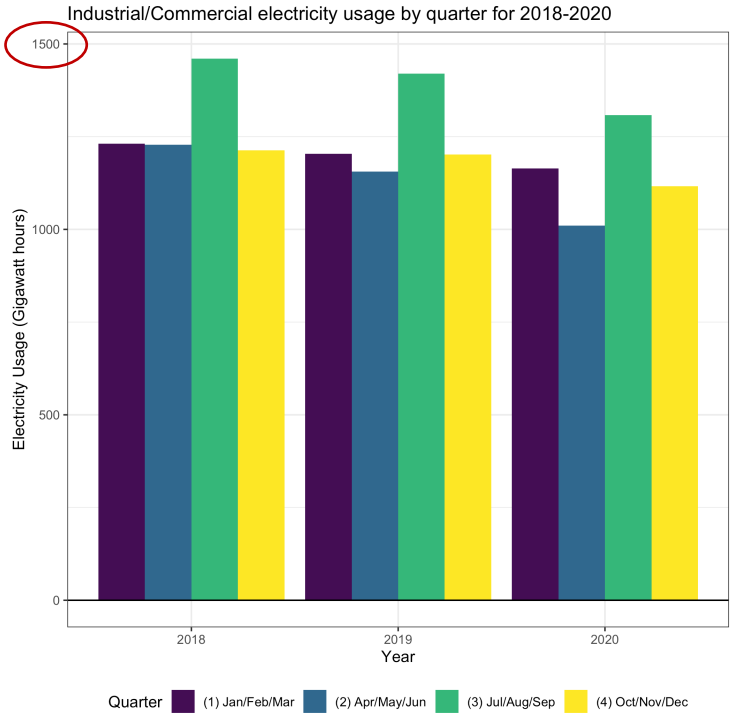
Residential vs. Industrial/Commercial Electricity Emissions

Residential Electricity (~38%)

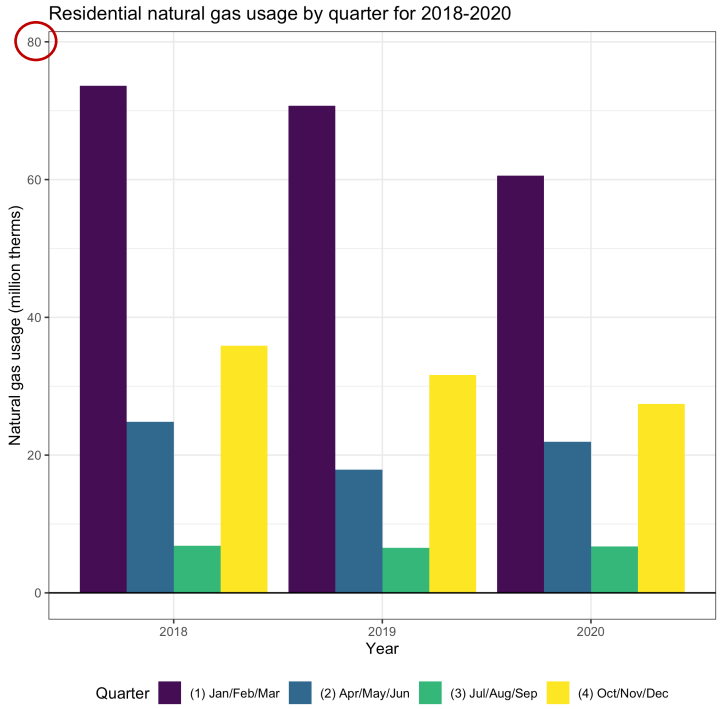


Industrial/Commercial Electricity (~62%)



Residential vs. Industrial/Commercial Natural Gas Emissions

Residential Natural Gas



Industrial/Commercial Natural Gas