Cities & industrial emissions
MIT 11.165/477, 11.286J

David Hsu
Associate Professor
Urban Studies & Planning
MIT

October 18, 2022

Materials for today

- Mackay chapters 15, appendix H
- Bill Gates. Heres a question you should ask about every climate change plan, August 2019. URL.
- Max Ahman, Lars J. Nilsson, and Bengt Johansson. Global climate policy and deep decarbonization of energy-intensive industries. Climate Policy, 17(5):634649, July 2017. URL.
- Jeffrey Rissman, Chris Bataille, Eric Masanet, Nate Aden, William R. Morrow, Nan Zhou, Neal Elliott, Rebecca Dell, Niko Heeren, Brigitta Huckestein, Joe Cresko, Sabbie A. Miller, Joyashree Roy, Paul Fennell, Betty Cremmins, Thomas Koch Blank, David Hone, Ellen D. Williams, Stephane de la Rue du Can, Bill Sisson, Mike Williams, John Katzenberger, Dallas Burtraw, Girish Sethi, He Ping, David Danielson, Hongyou Lu, Tom Lorber, Jens Dinkel, and Jonas Helseth. Technologies and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070. Applied Energy, 266:114848, May 2020. URL.

Cities & industrial emissions

Key themes:

- consumption as a mechanism of GHG emissions

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- consumption as a connection to larger energy systems

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Mackay's stuff (chapter 15)

- raw materials
- production
- use
- disposal/waste

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- packaging
- chips, semiconductors
- paper
- buildings/construction/roads
- automaking
- imports!

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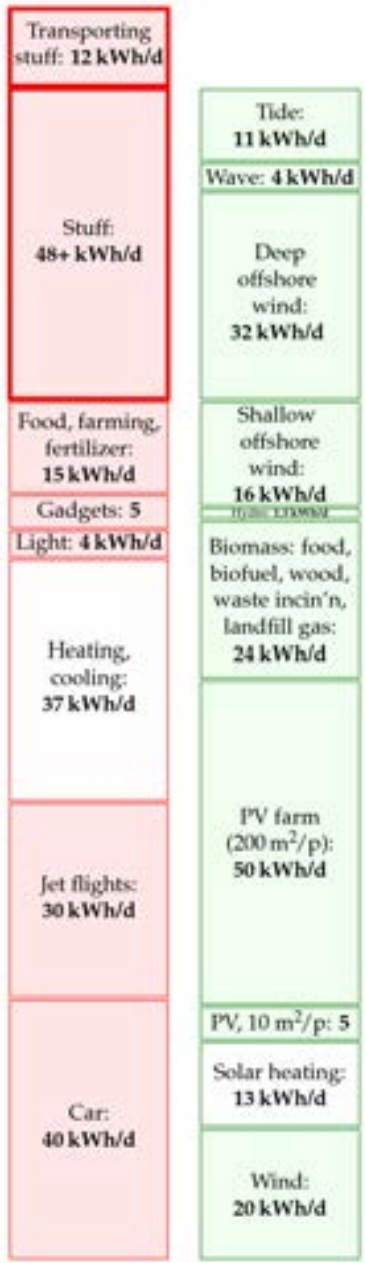

Graphic courtesy of David MacKay.

Mackay's house (appendix H)

Putting everything on the same footing:

Category	Energy	Time period	(equivalent)
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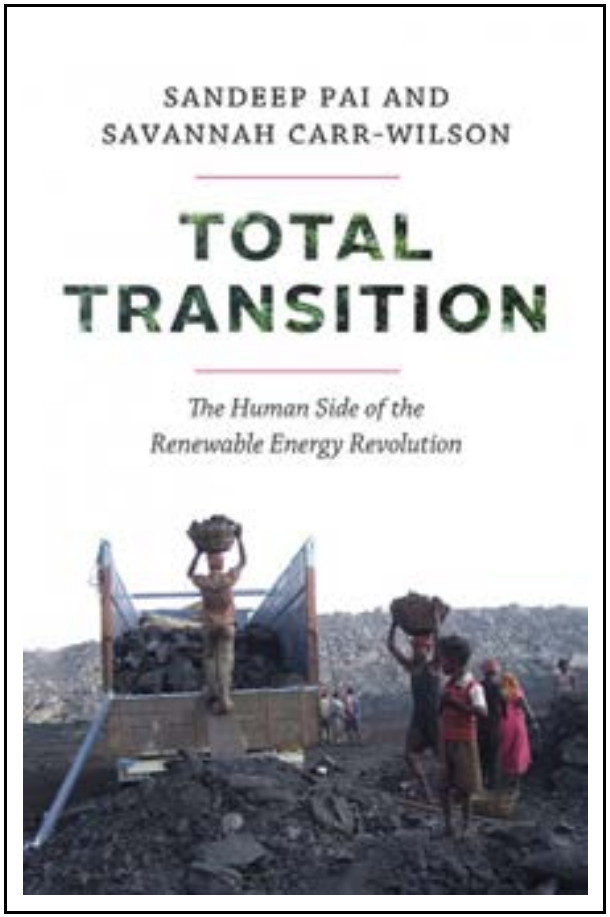
So materials & construction aren't really a problem, right?

Livelihood & climate action

2012 Robert D. Bullard portrait: Dave Brenner, Flickr, CC BY 2.0, Wikimedia.



Rocky Mountain Books, 2018

Livelihood & climate action

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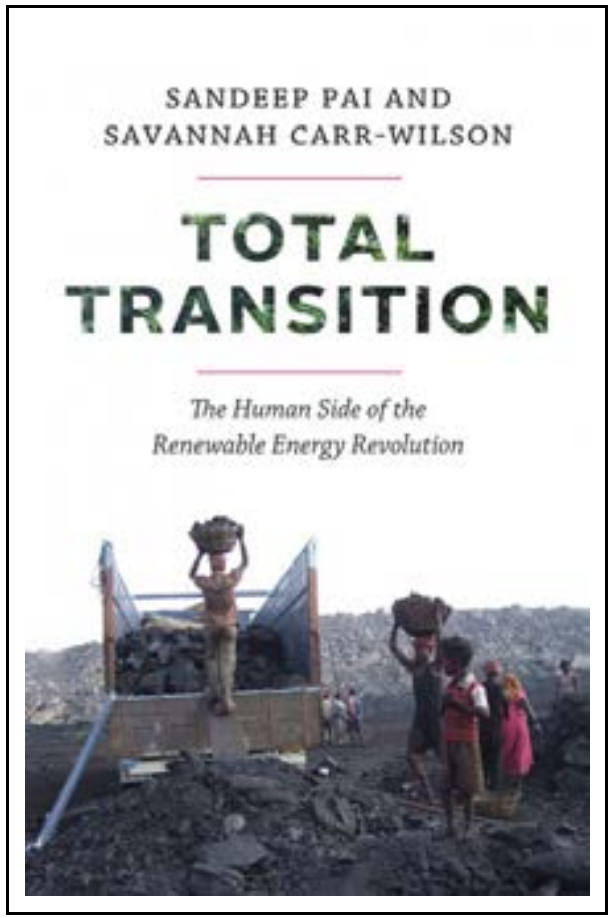

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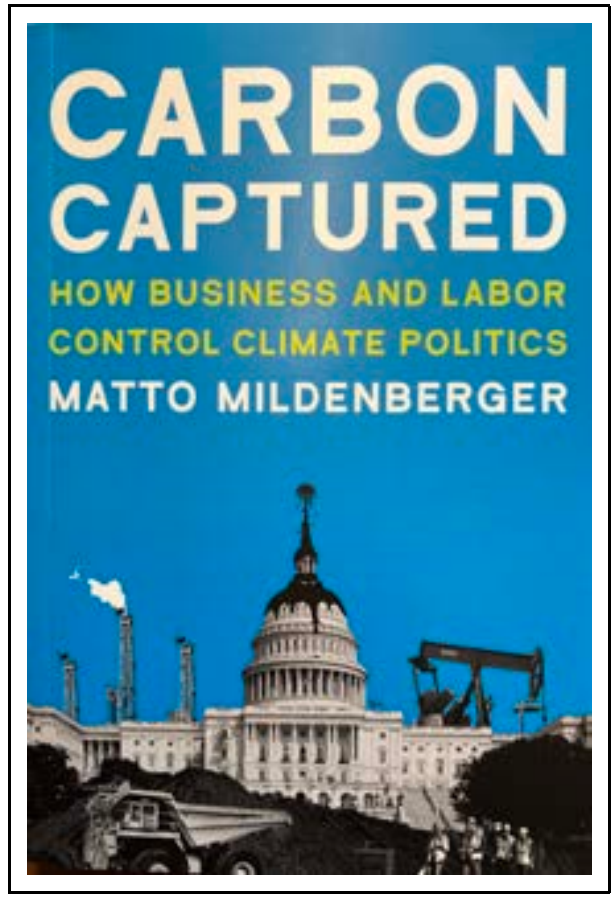
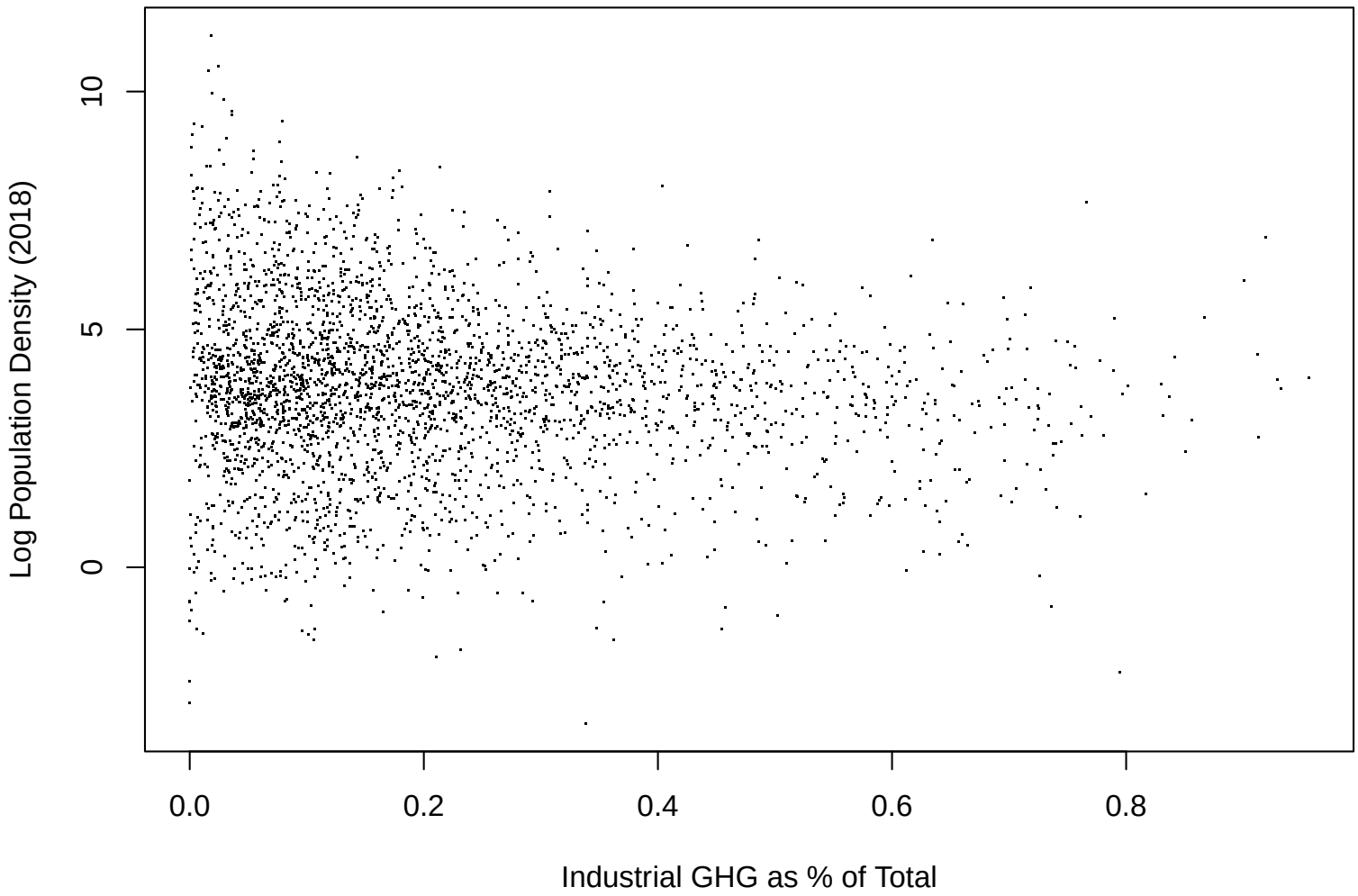


MIT Press, 2020

Cities & industrial emissions

Highest pop. density & pop. counties in each state:



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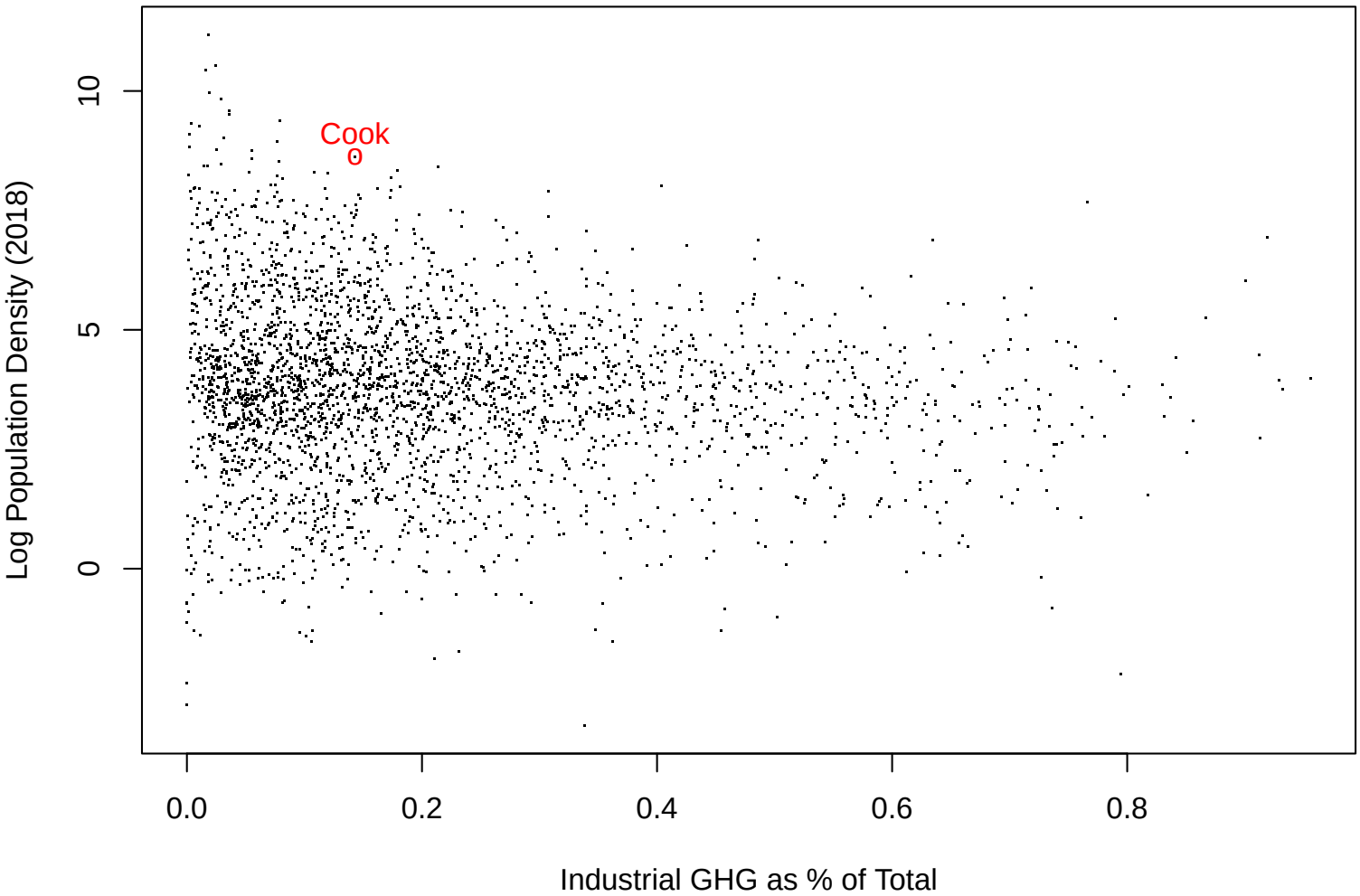

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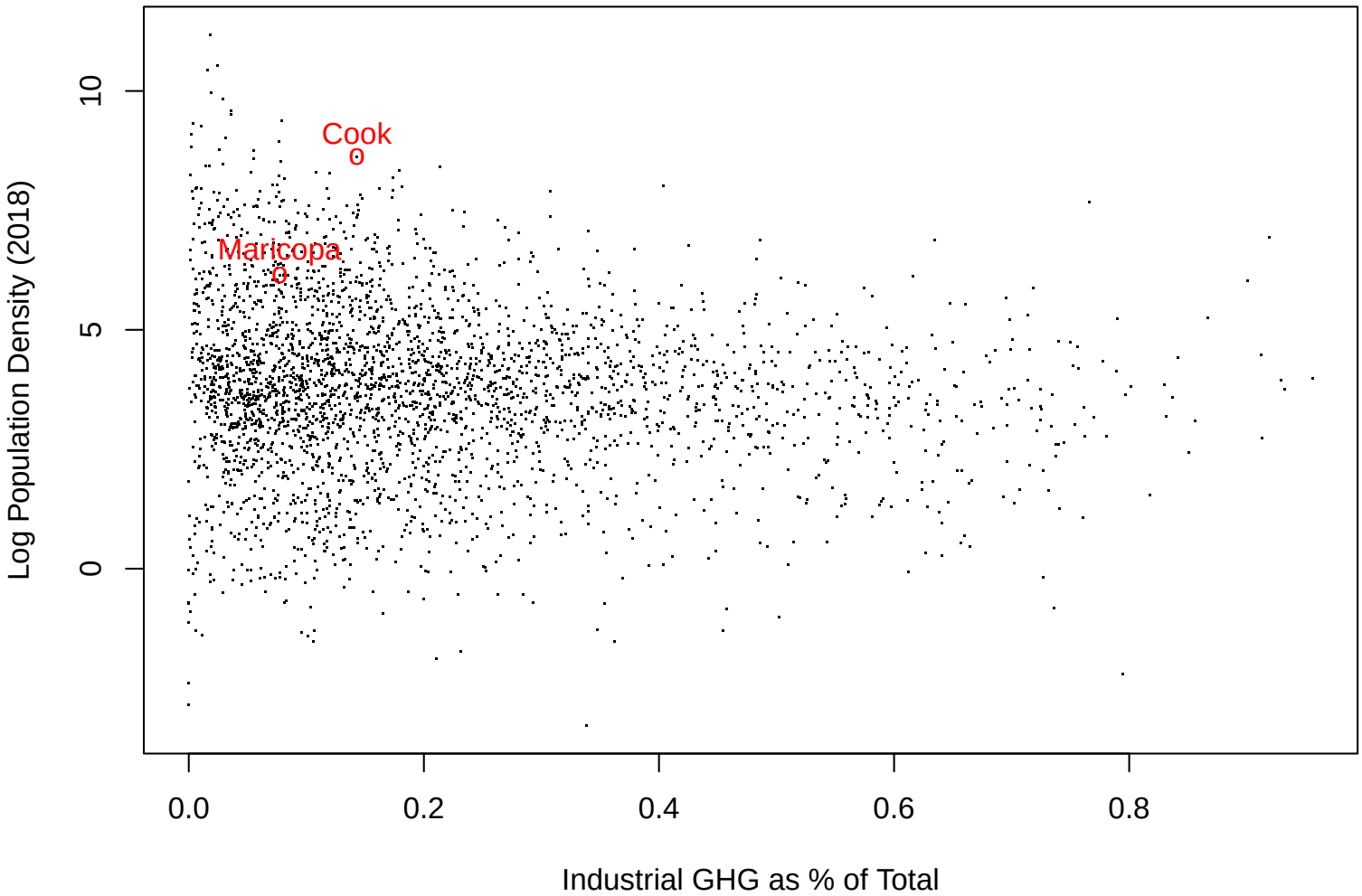

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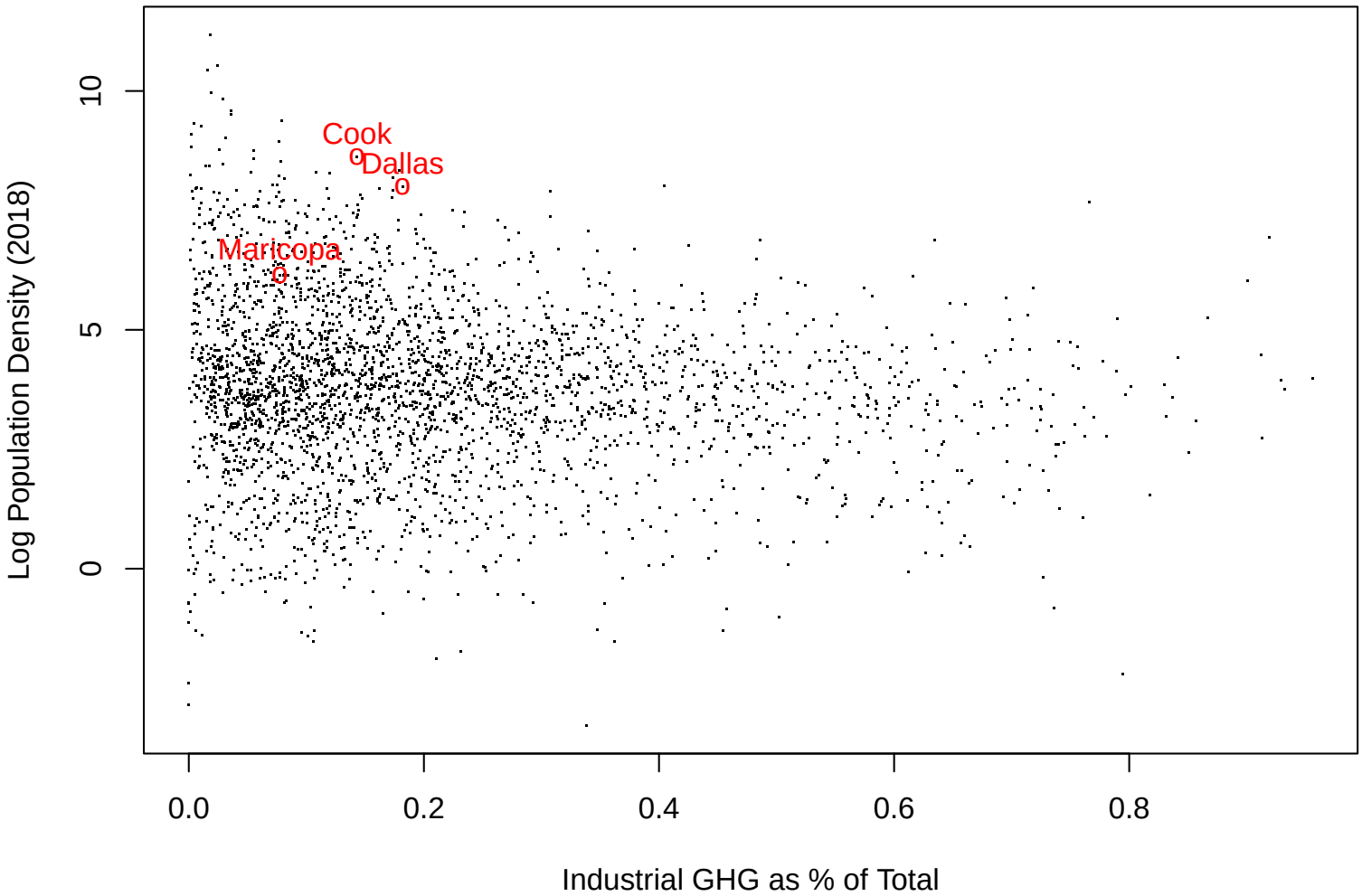

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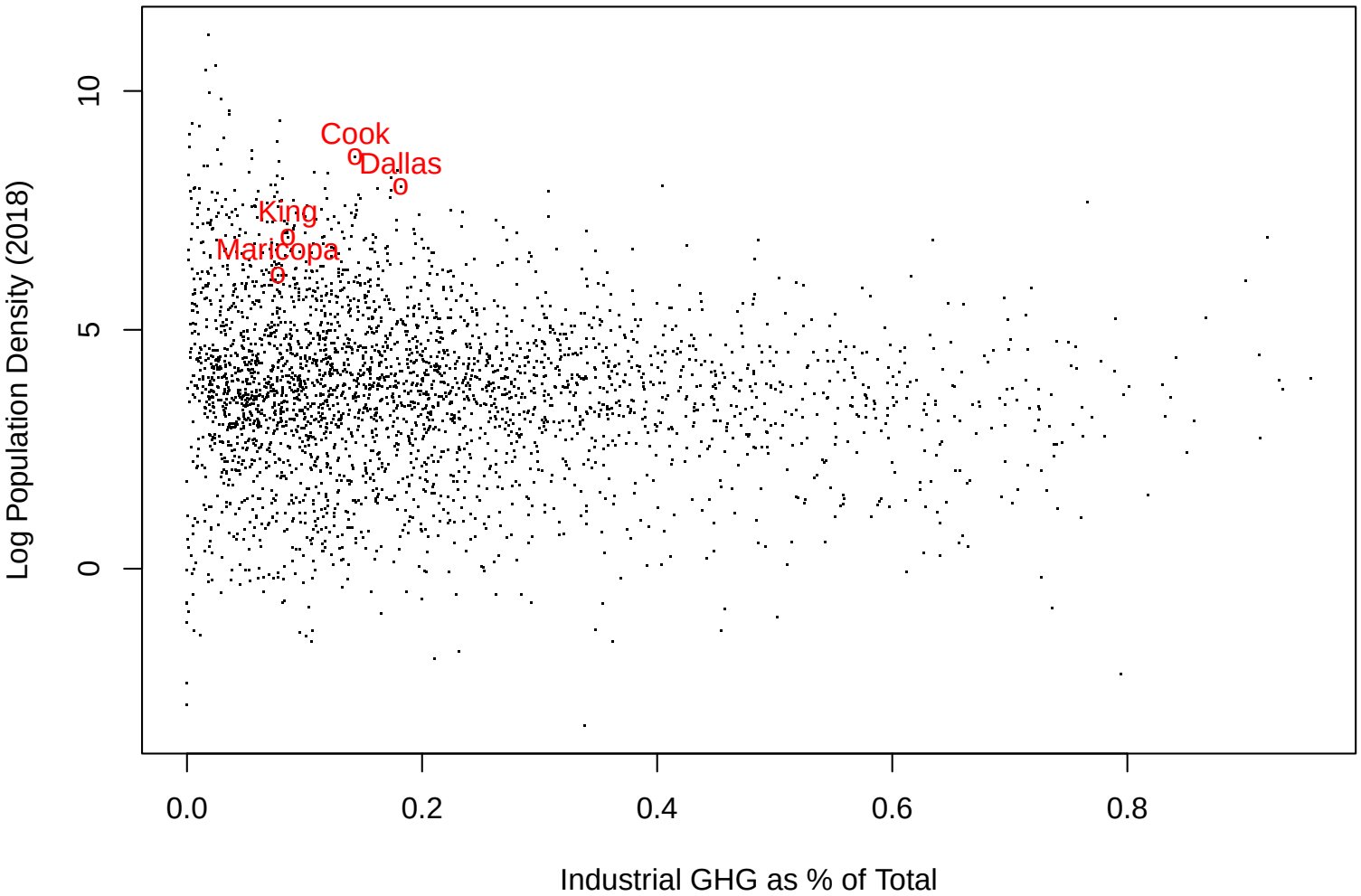

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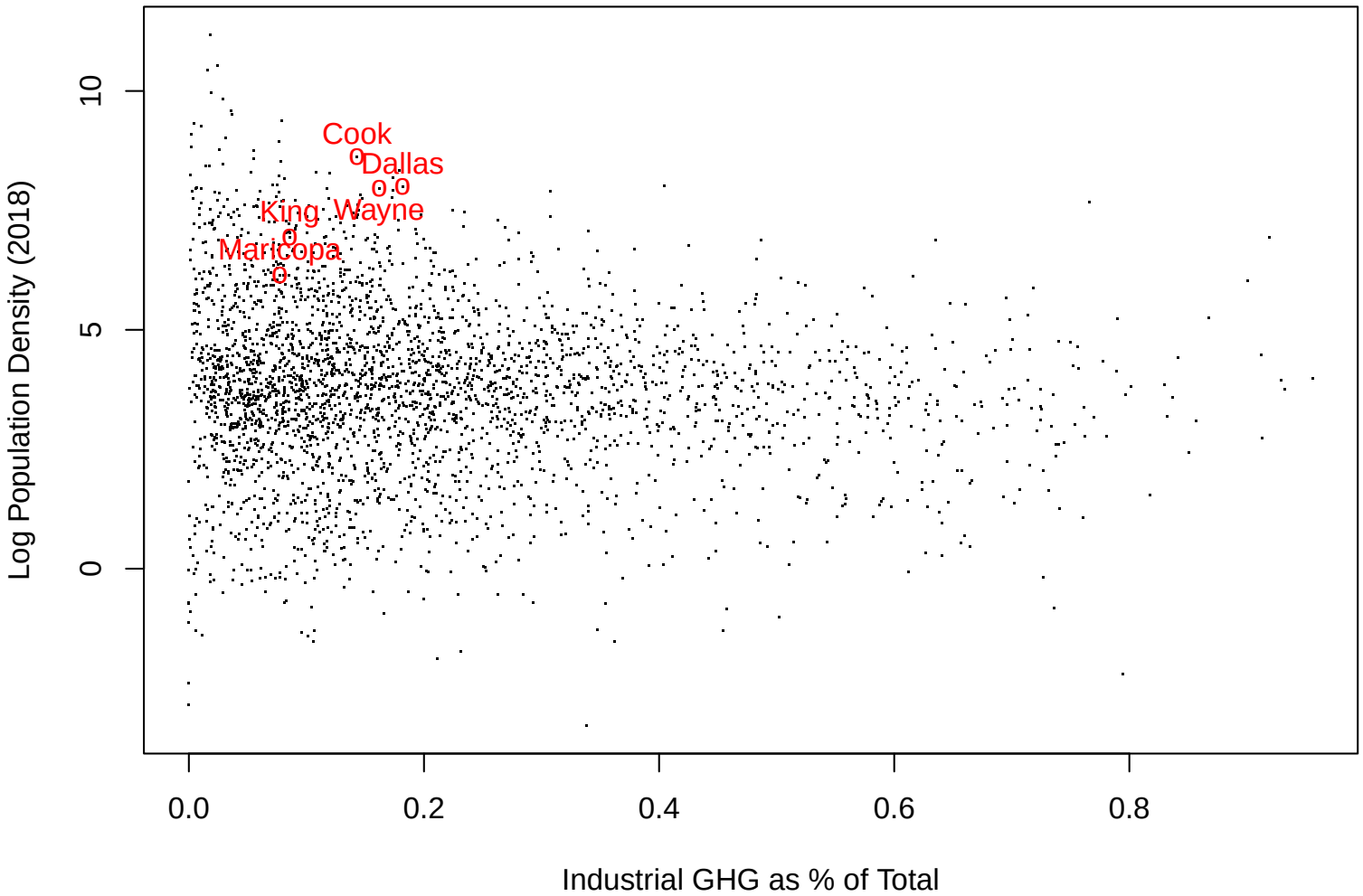

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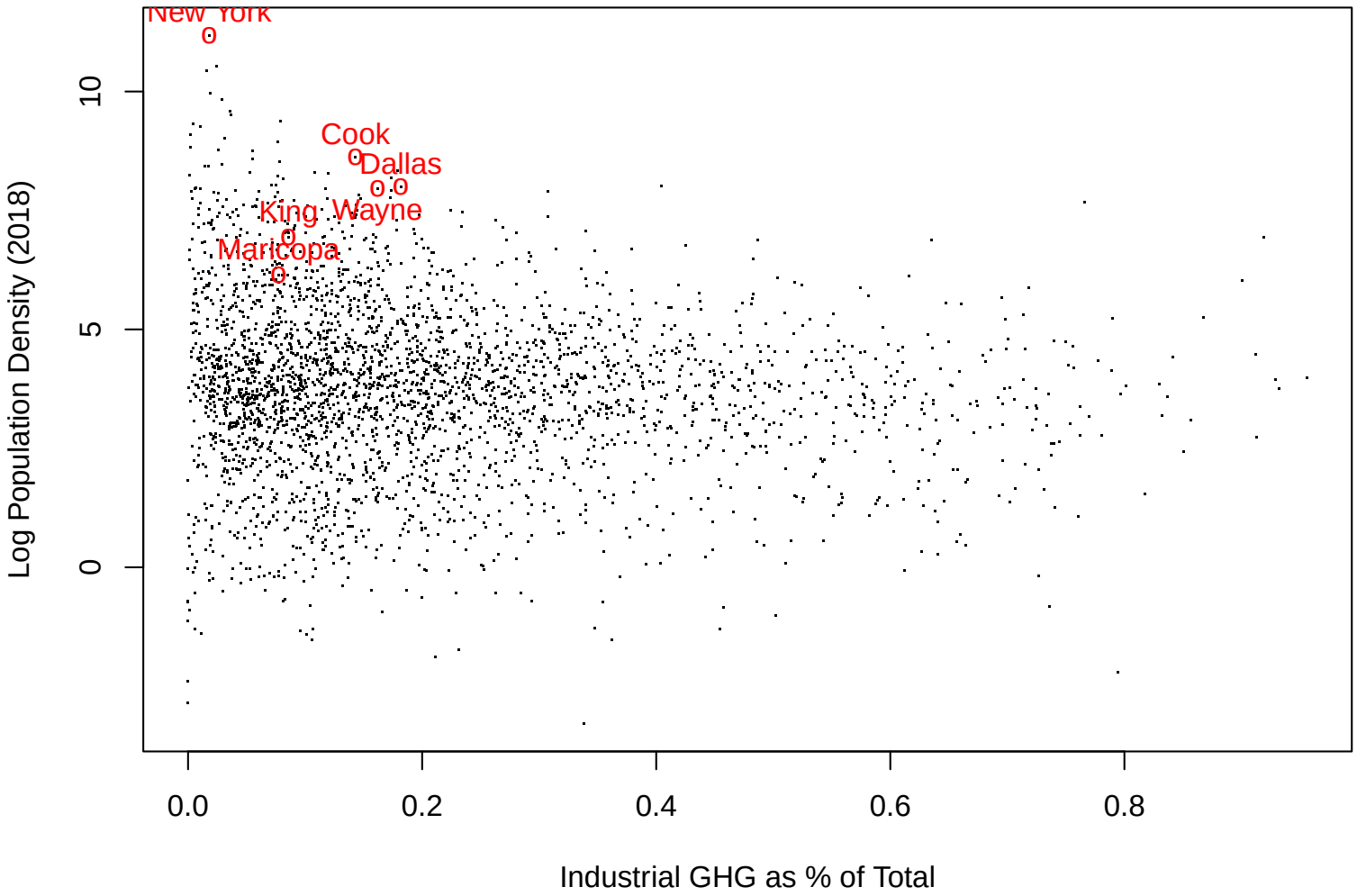

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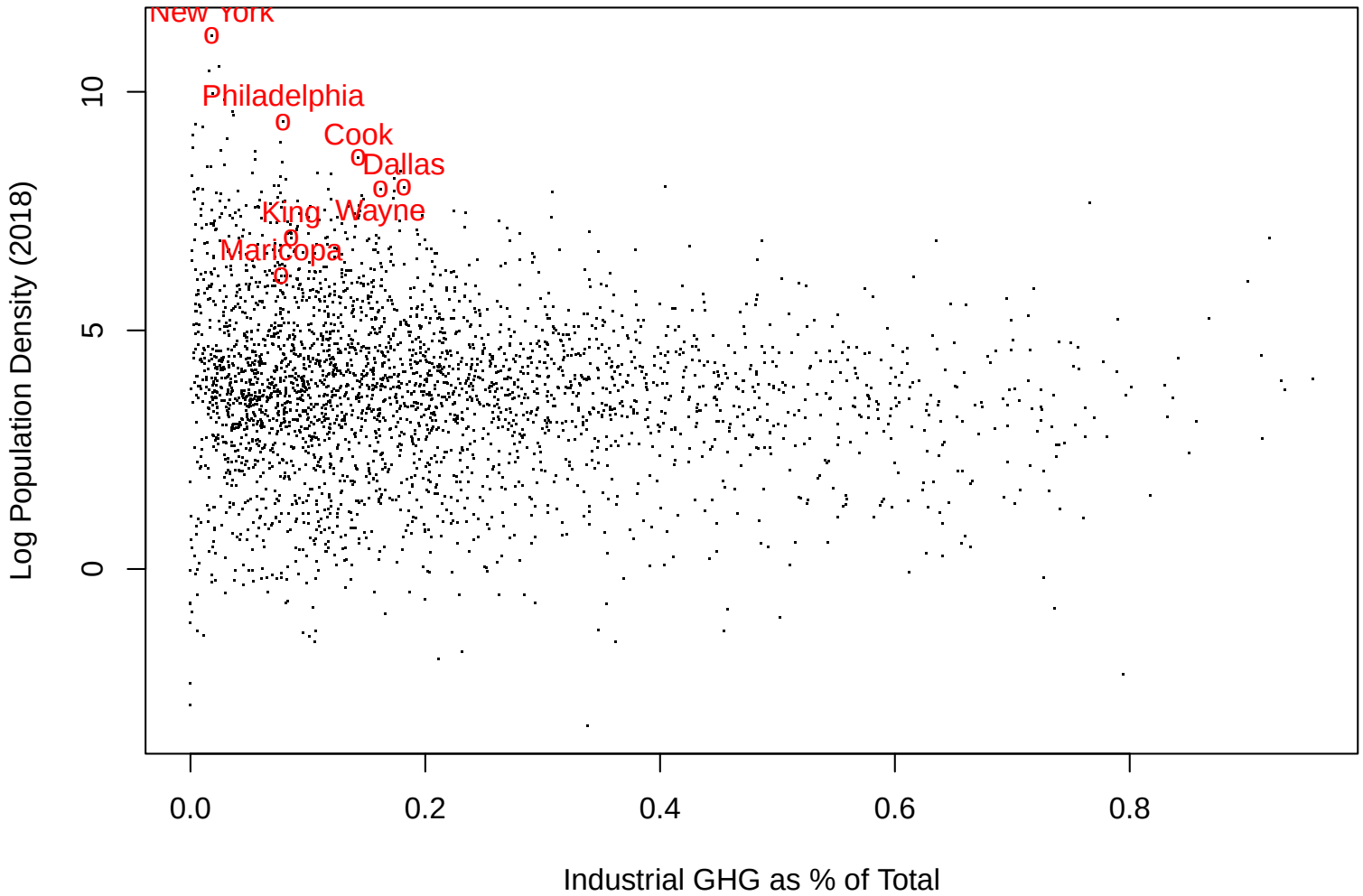

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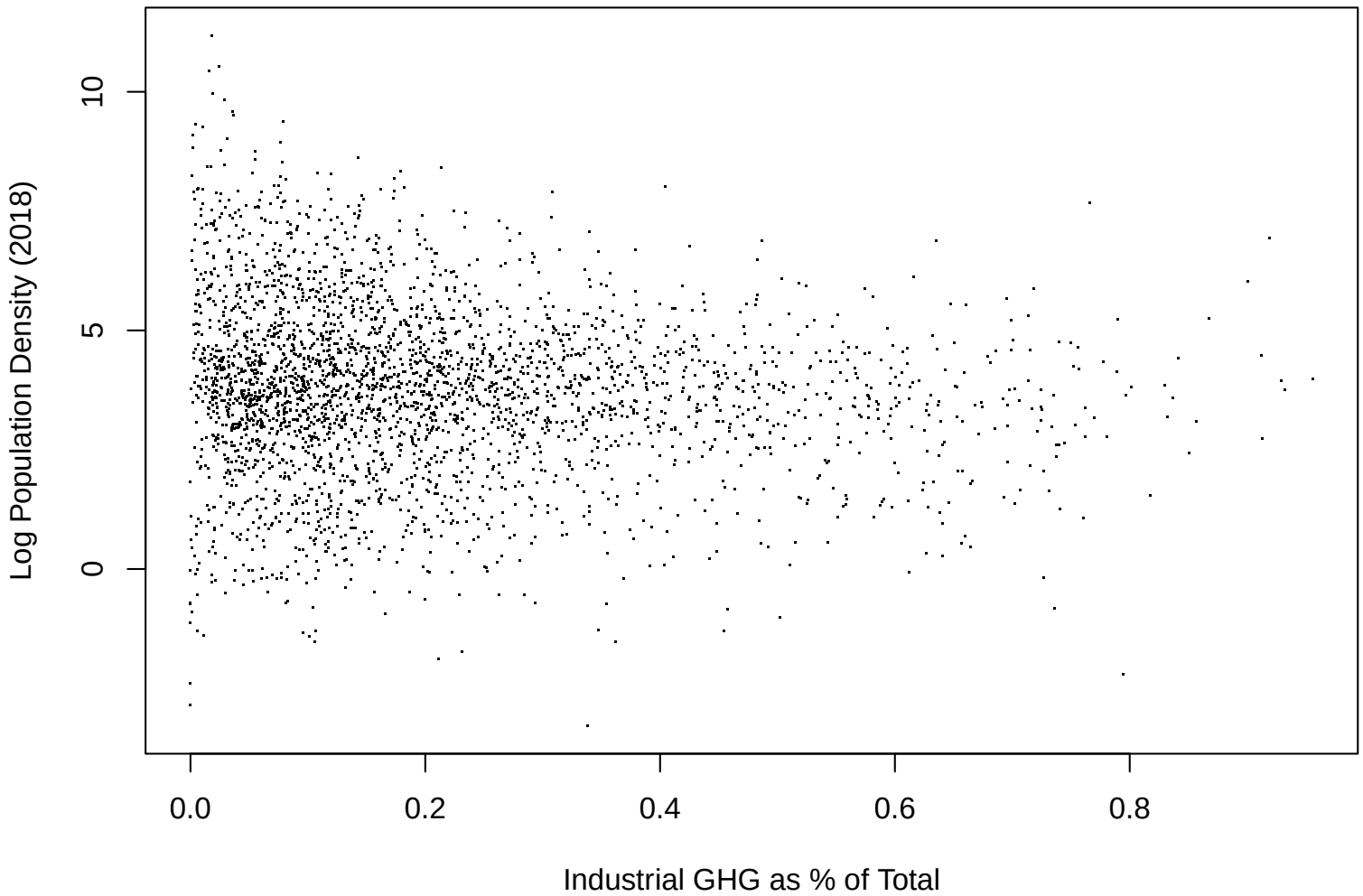

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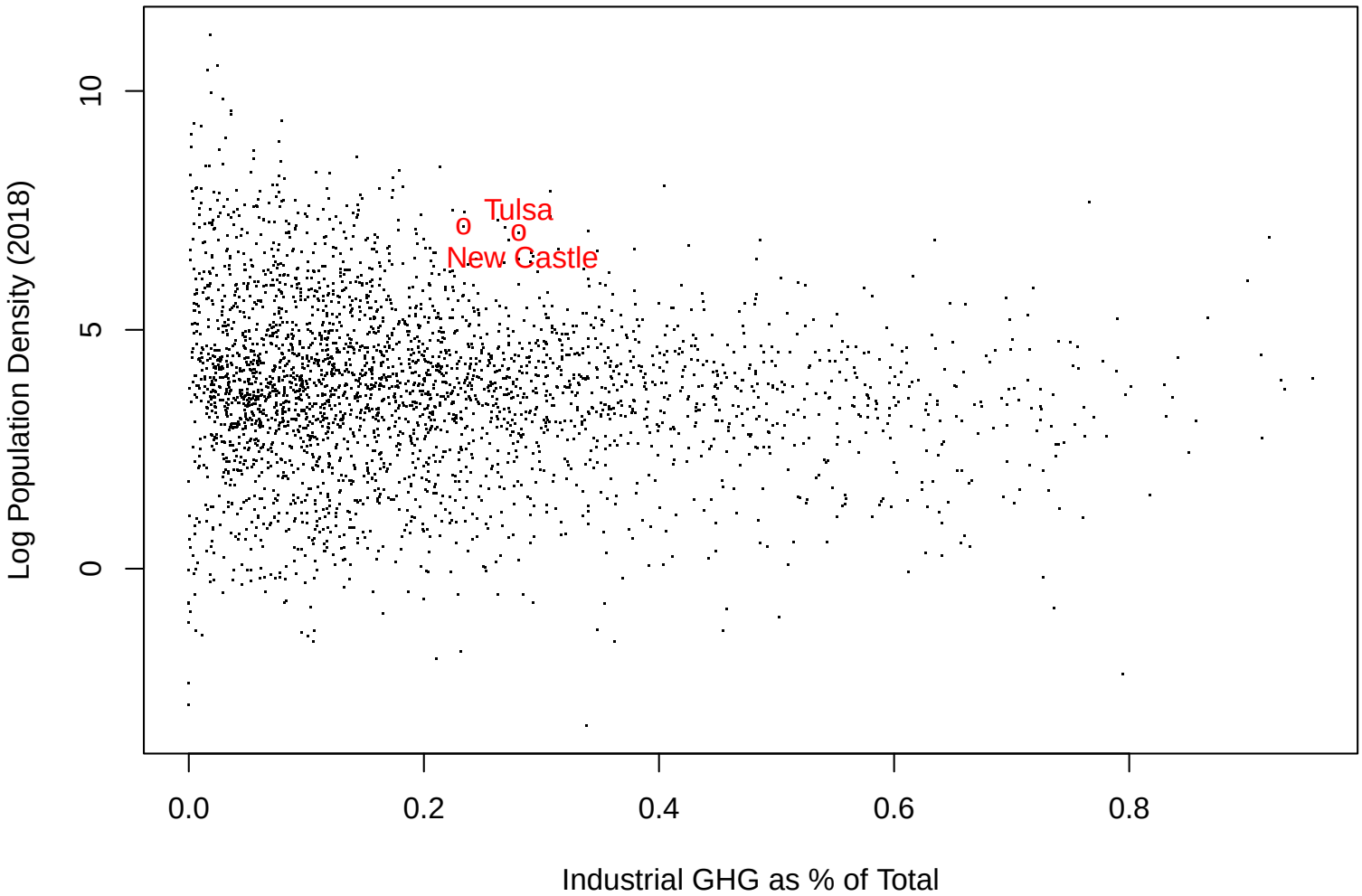

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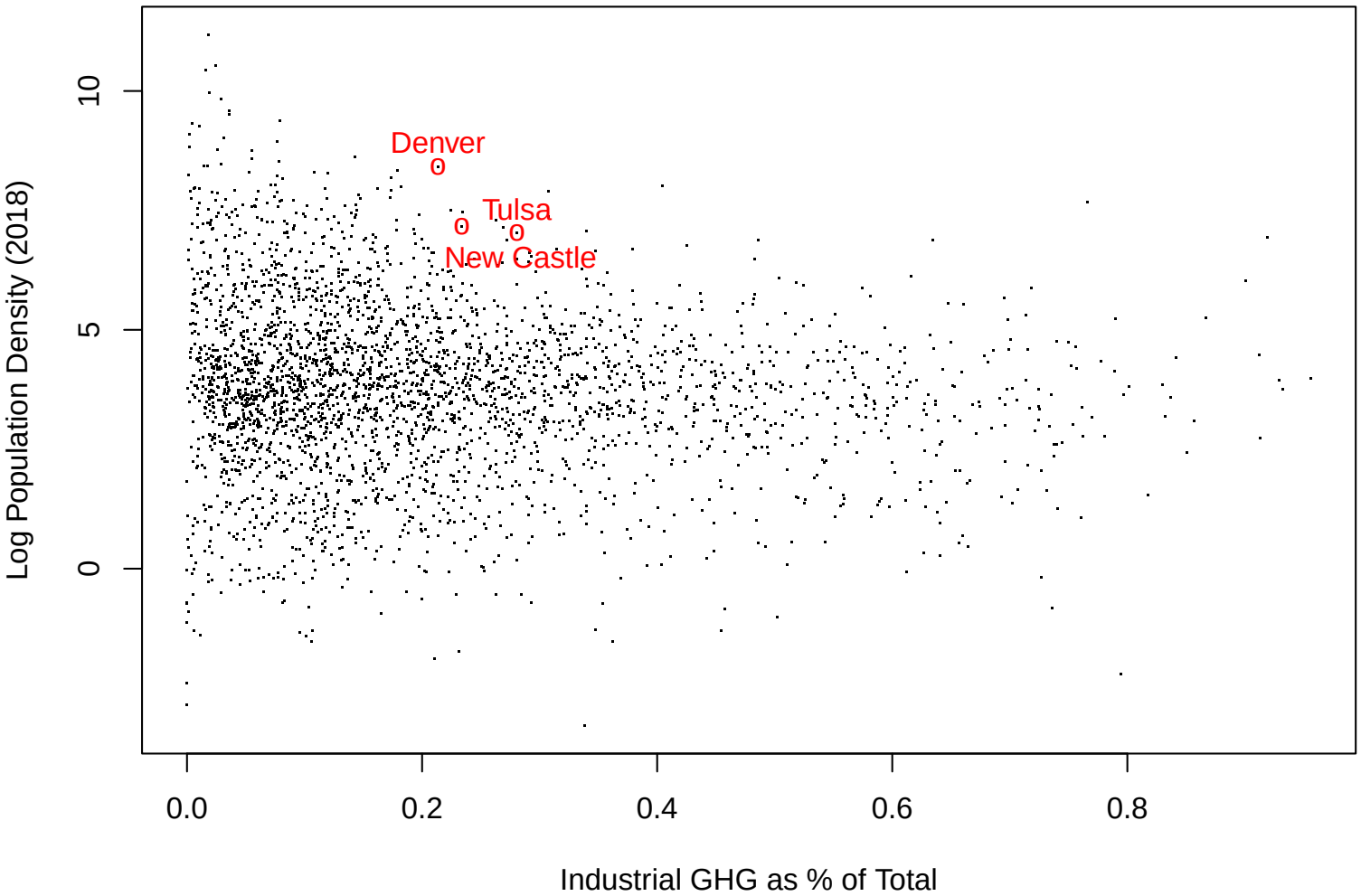

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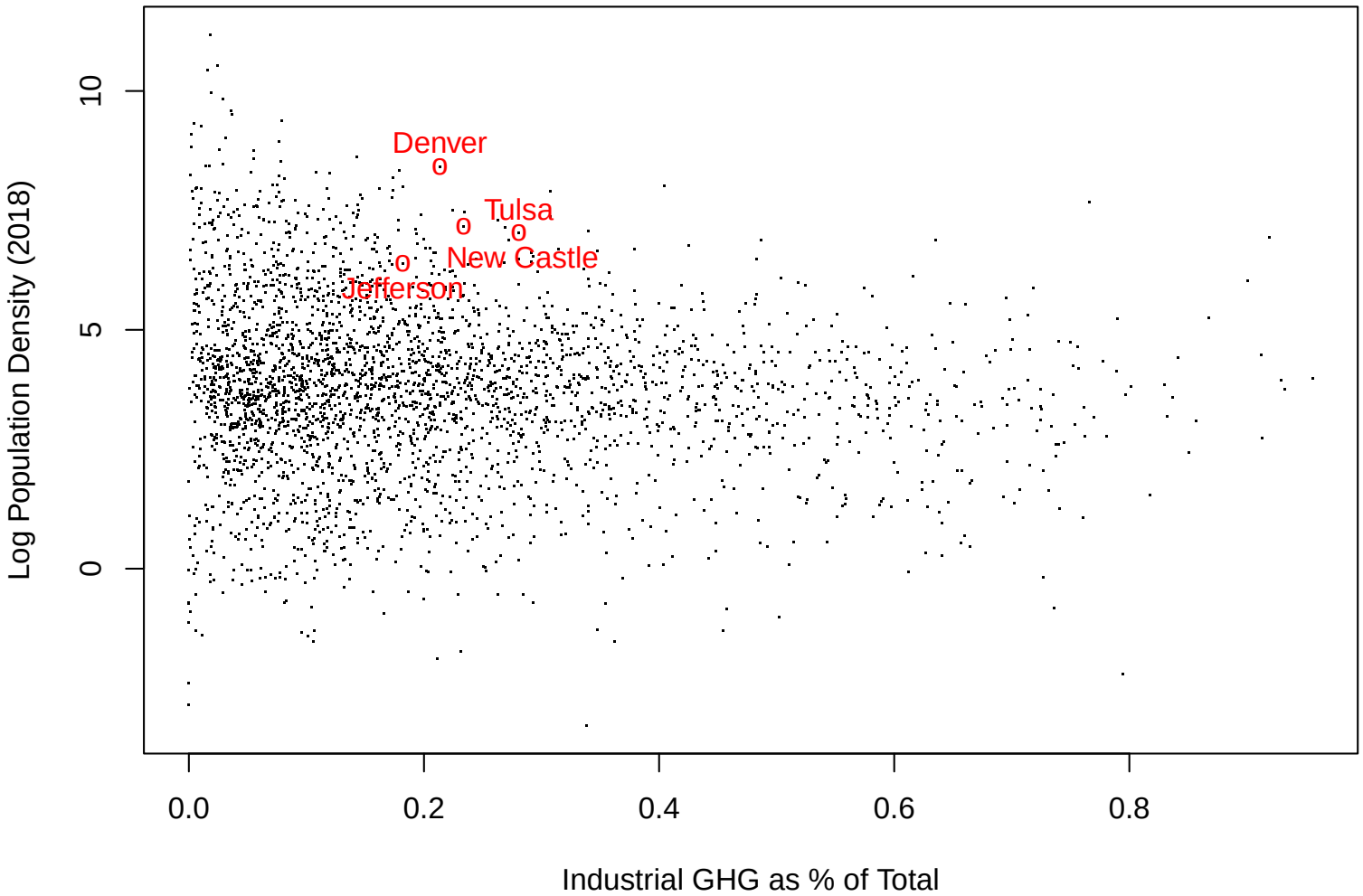

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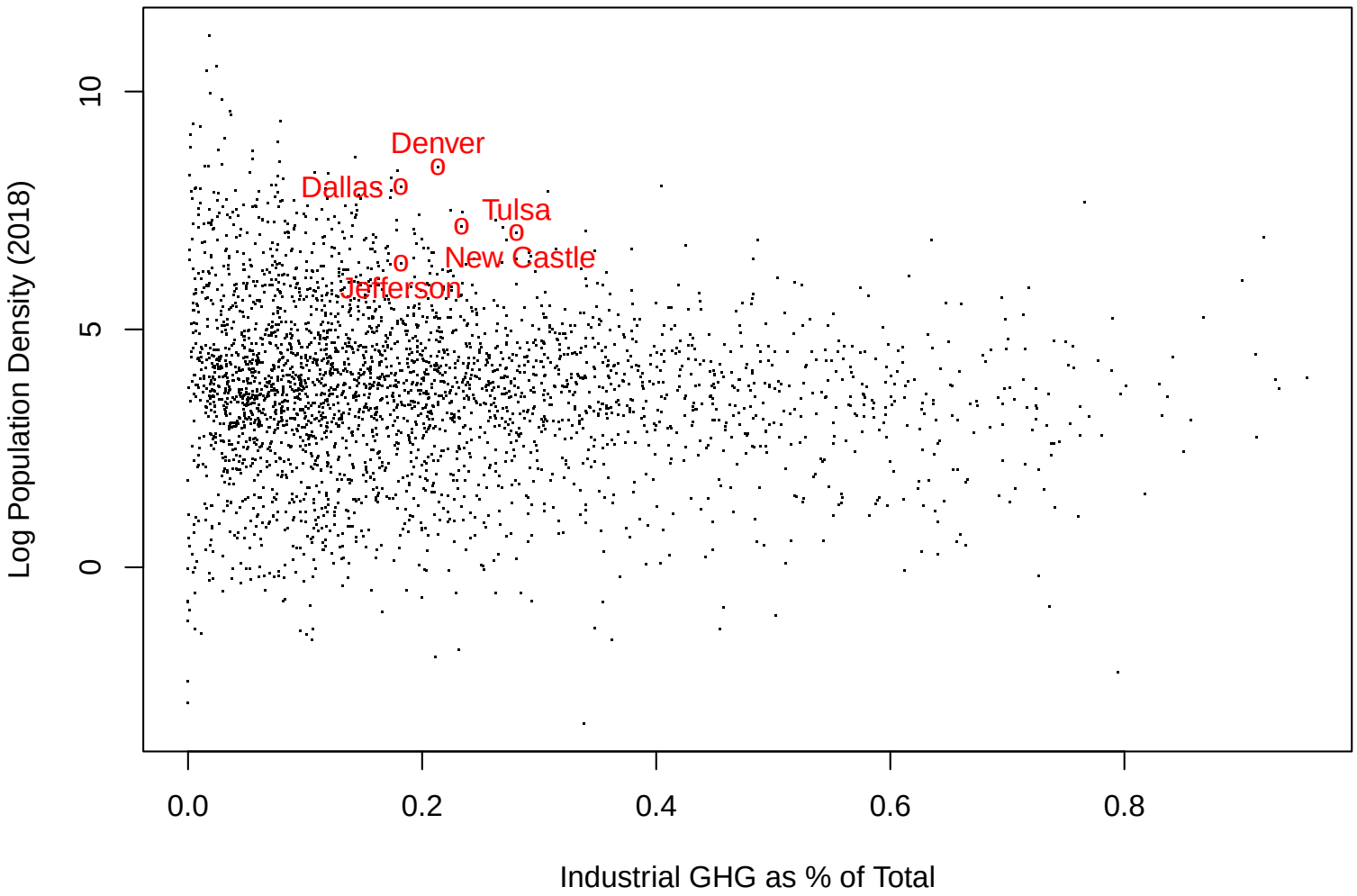

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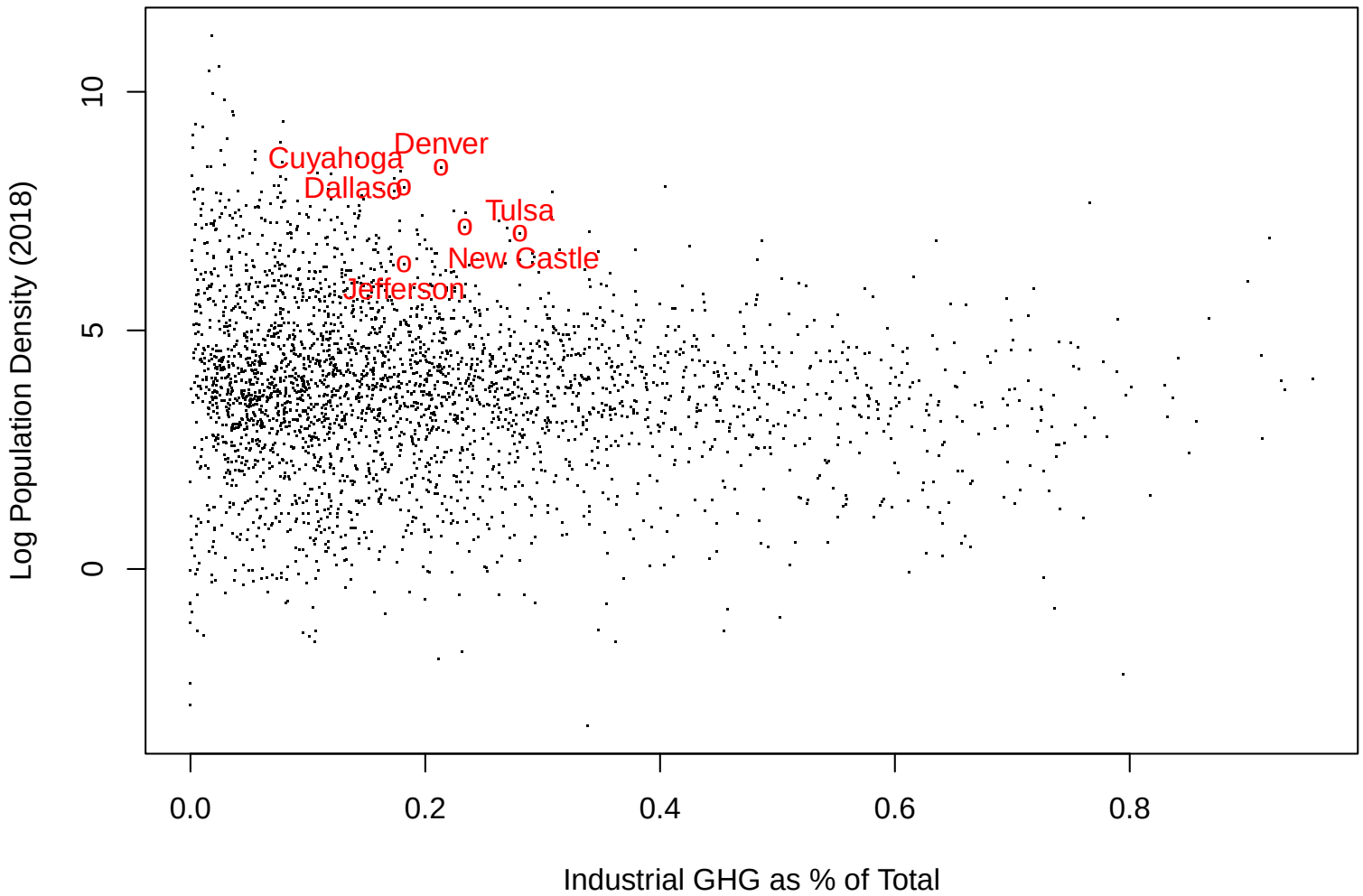

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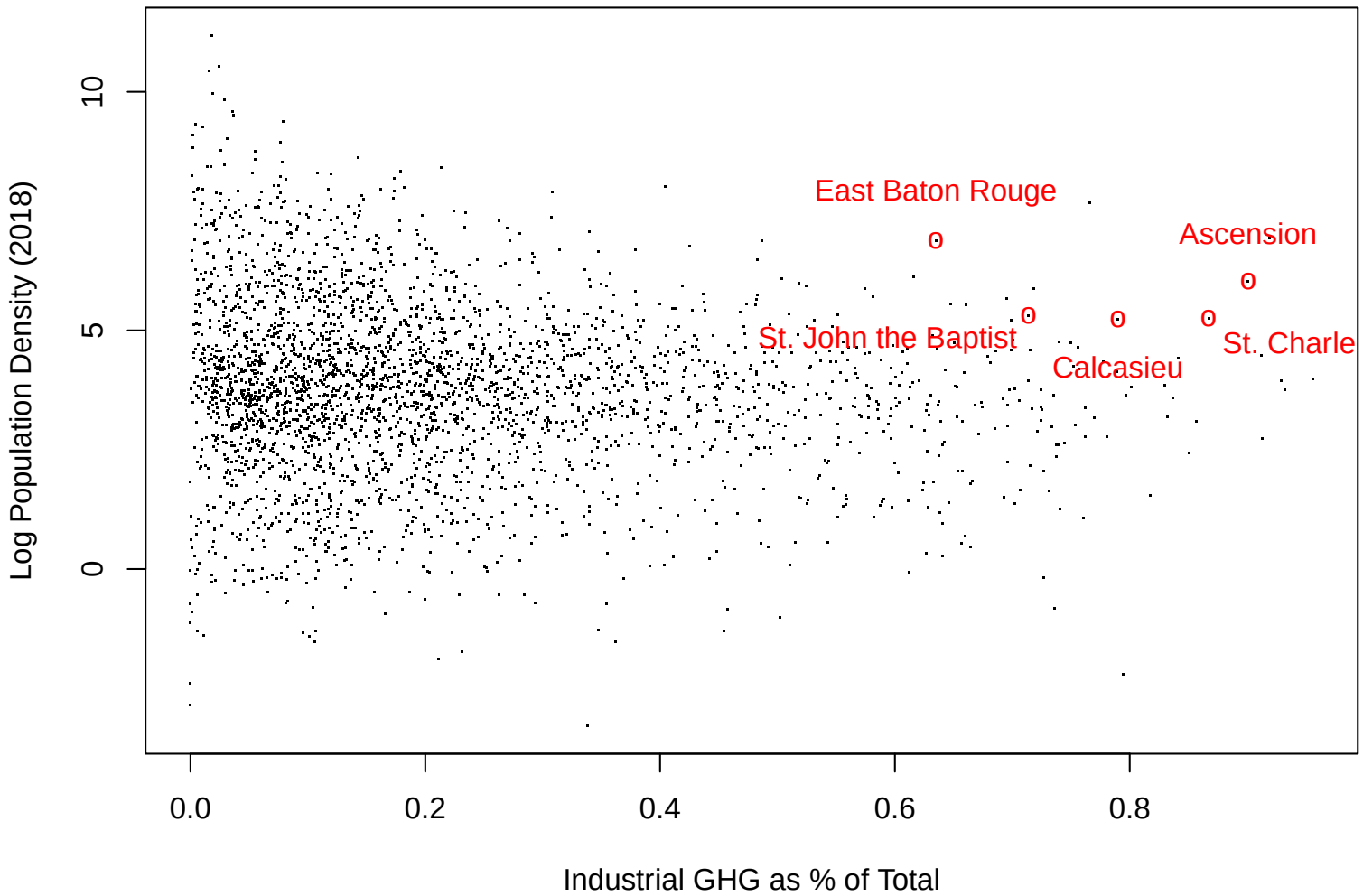
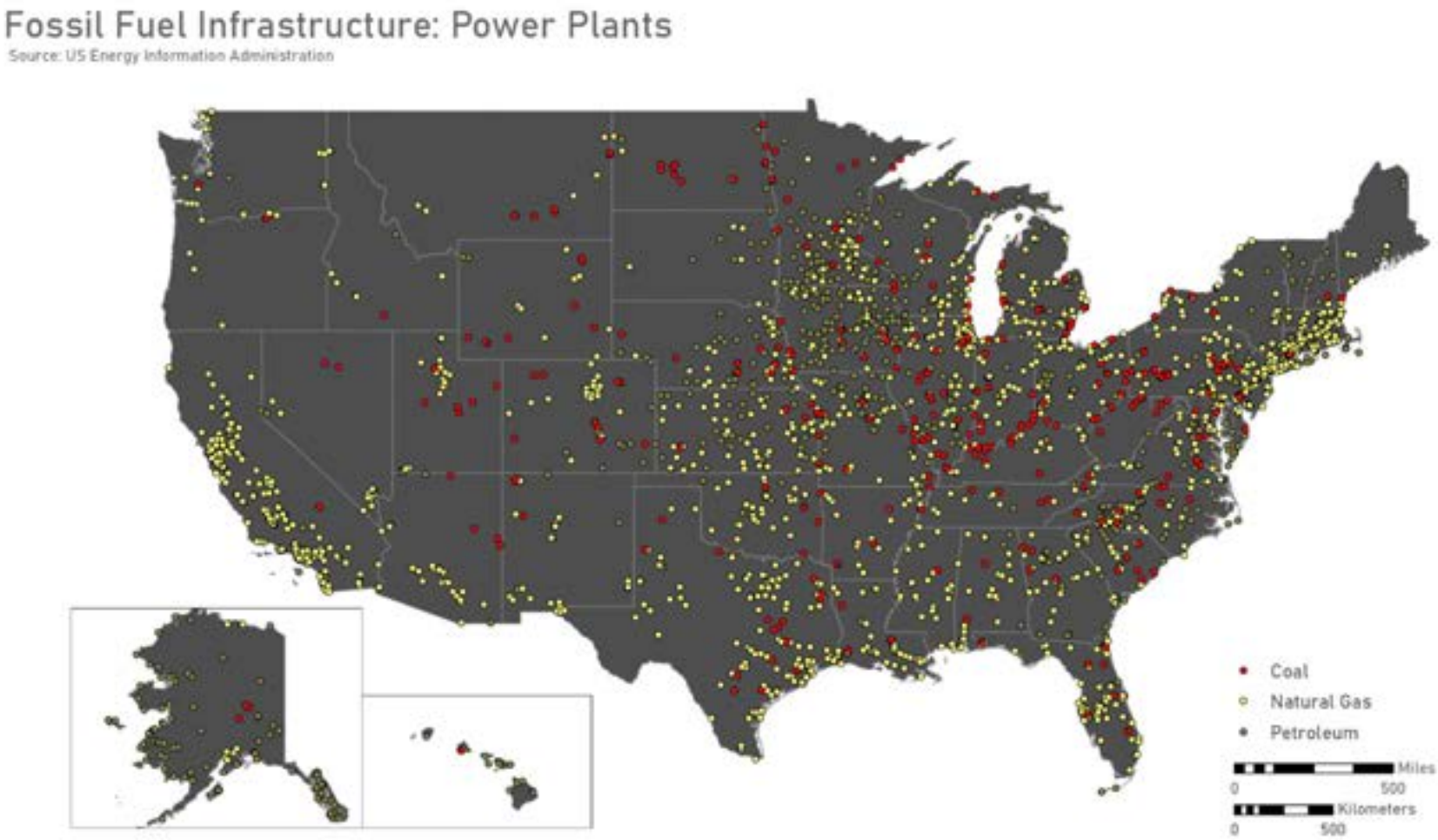


Cities & industrial emissions

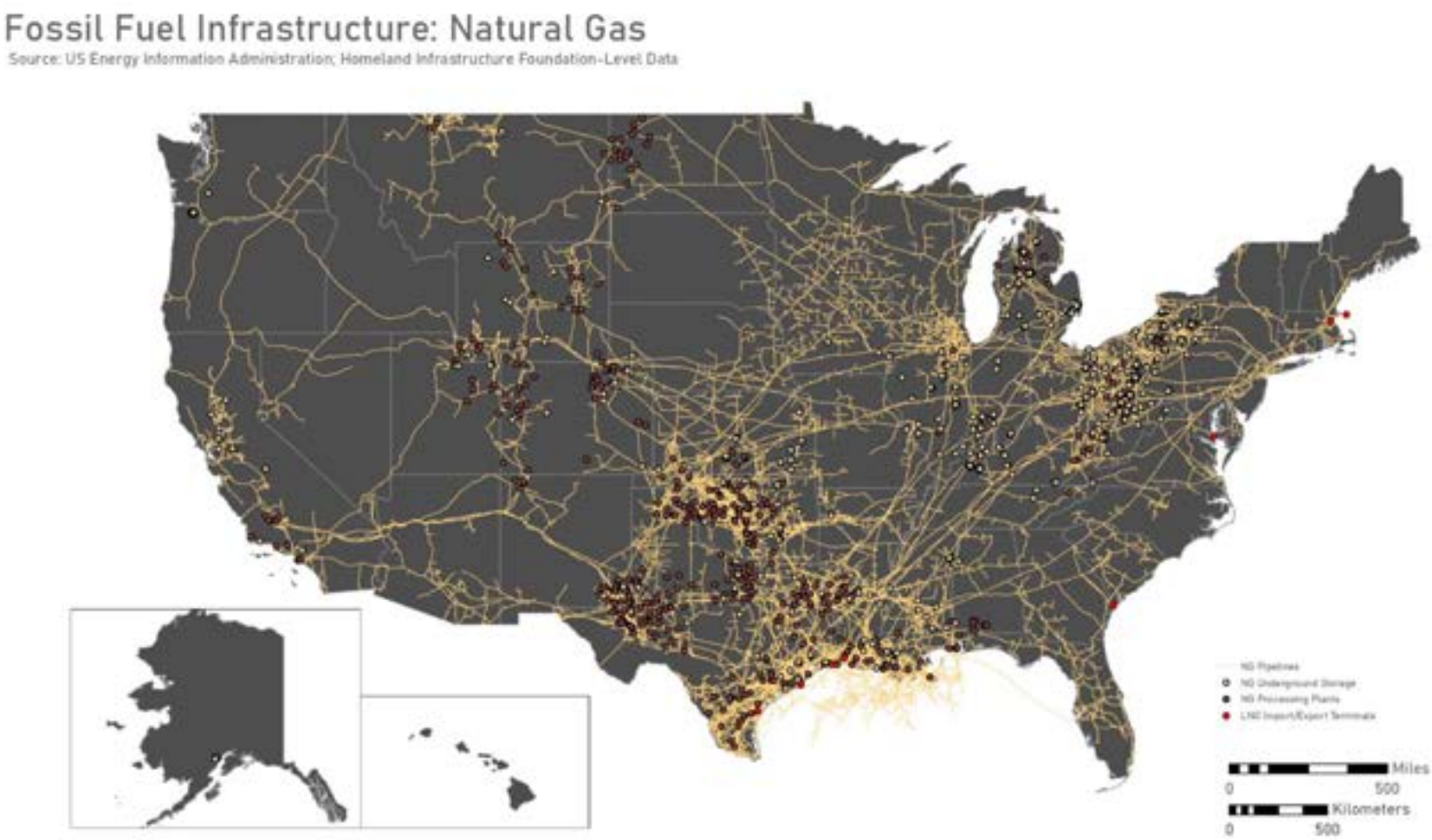
Highest pop. density & industrial emissions are all in LA, TX, and VA:

County	State	%Indus.GHG	2018 pop	Nonwhite %
St. John the Baptist	LA	0.714	43,446	60.4
East Baton Rouge	LA	0.635	444,094	52.7
Hopewell	VA	0.766	22,408	49.0
Jefferson	TX	0.695	255,210	41.7
St. Charles	LA	0.867	52,724	30.2
Calcasieu	LA	0.790	200,182	29.8
Ascension	LA	0.901	121,176	27.1
Brazoria	TX	0.647	353,999	27.0
Gregg	TX	0.616	123,494	25.5
Covington	VA	0.919	5,582	17.4

ProPublica article on "Cancer Alley" in Louisiana



Hsu and Ulama, 2020, from USEIA and DHS data.



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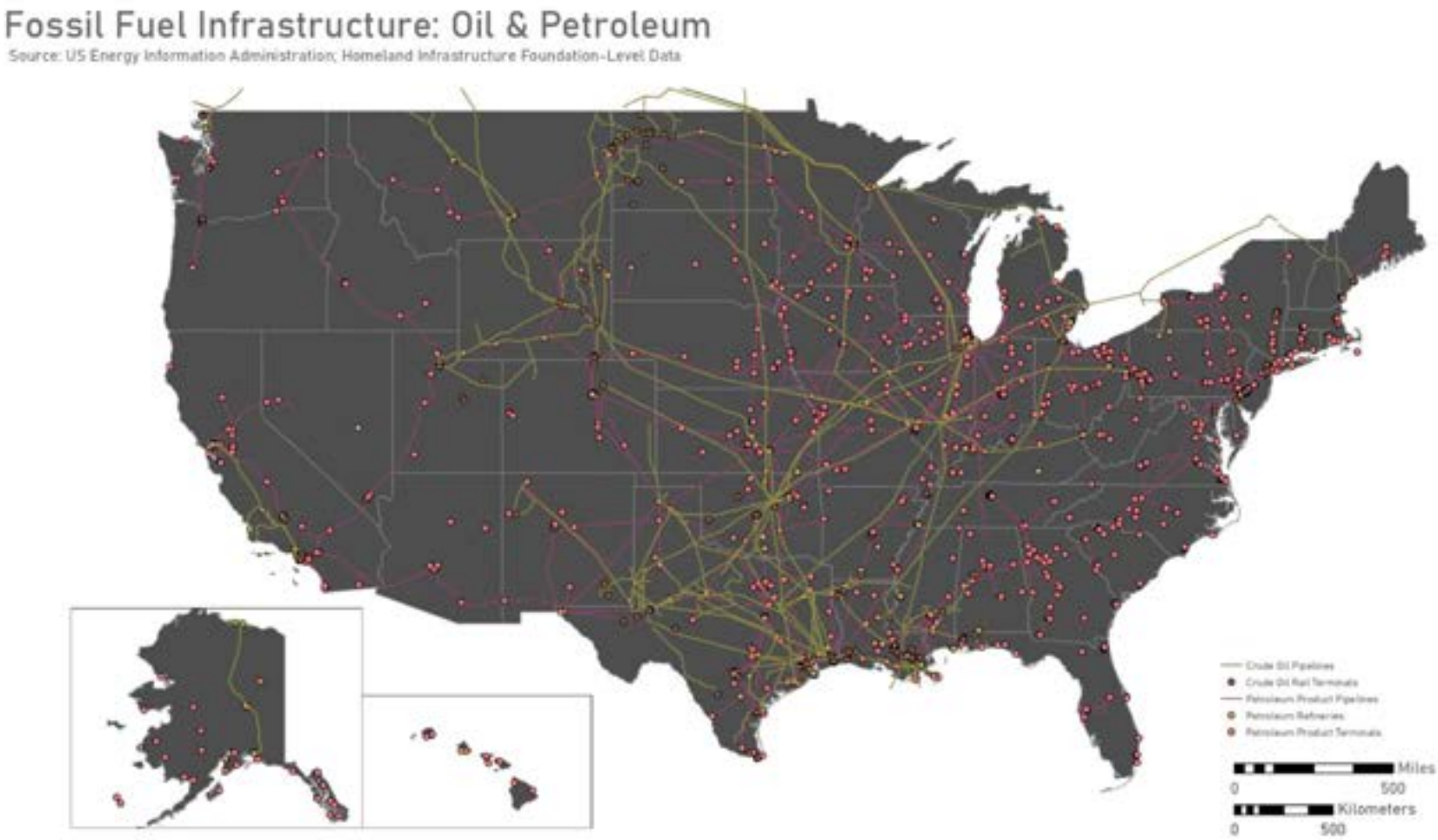

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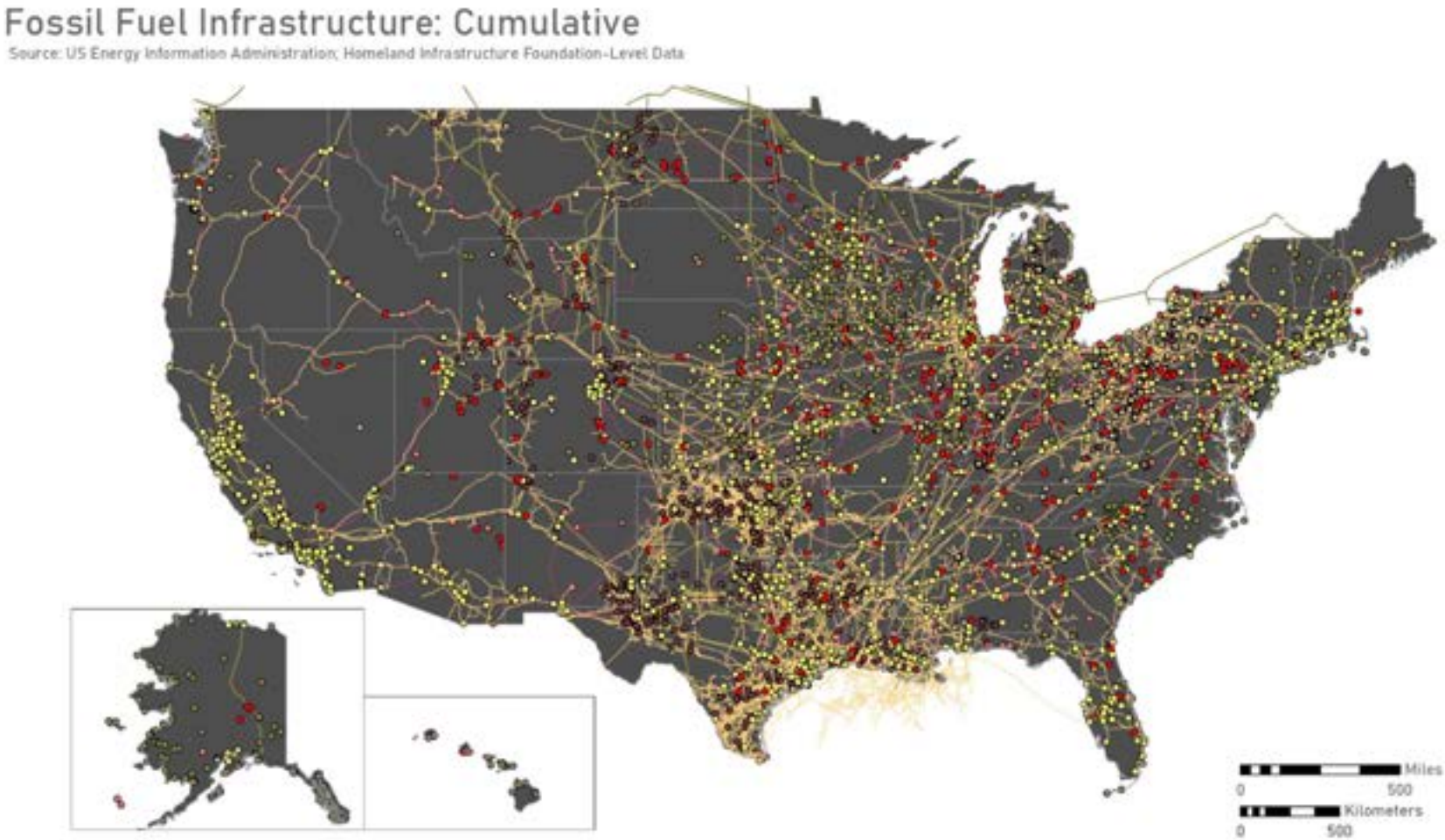

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Ahman, Nilsson & Johansson, "DD for EII", 2017

Acronymic panic!

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6. BCAs: border-carbon-adjustments
7. CCS: carbon-capture-(utilization)-and-storage

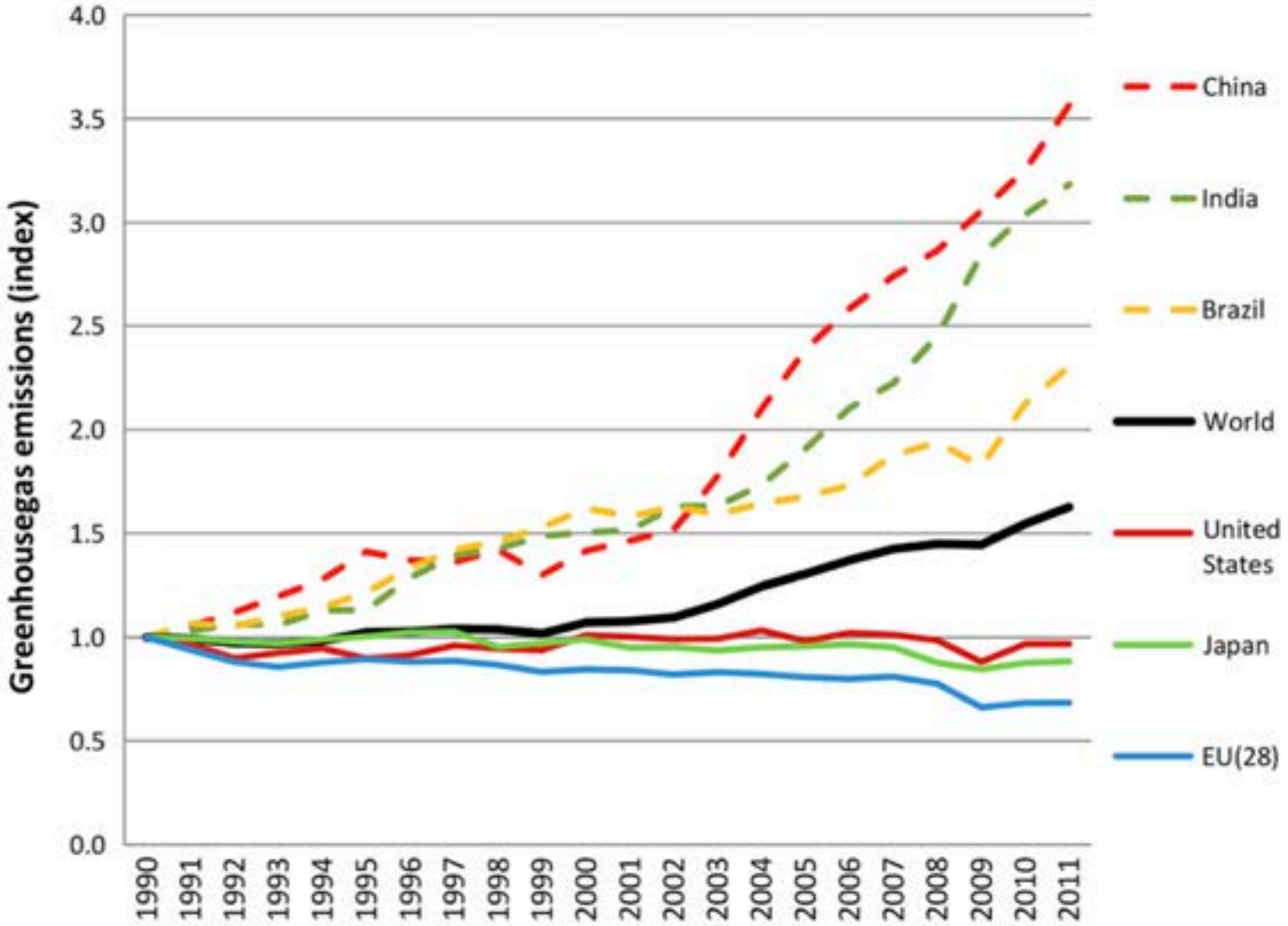

Figure 1. Index of global industrial direct GHG emissions. The data are normalized to 1990, when UNFCCC accounting started. *Source*: Data are from (WRI, 2015).

Fundamental issues of efficiency, equity, and fairness

Issues to be negotiated within and between countries:

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- carbon leakage: loss of competitiveness and relocation of industry to other countries
- political stability
- transport infrastructure
- labour legislation
- access to markets and feedstock
- industrial policy

Can national policies be scaled down?

Table 1. Reported policy responses for EIIs.

	Mitigation policies and measures with an intended direct effect	Mitigation policies and measures with intended long-term effects
EU	Regulated target for industry together with the power sector via the EU ETS Regulations reducing emissions of industrial gases Energy efficiency directive that forces member states to enforce energy efficiency in industry	Funding for demonstration of CCS and bioenergy project with some relevance for industry (the New Entrants Reserve programme (NER 300))
Japan	Implementation by Voluntary Action Plans by industry (Keidaren) for promoting energy efficiency Subsidies for increasing the adoption of BATs	Published a 'low carbon technology roadmap' relevant to steel. Includes research efforts on CCS and 'electrification of industry' including 'Course 50' for steel
US	Energy Star Program for industry for adopting energy efficient technologies Several programs for non-CO_2 industrial gases Voluntary program for the aluminium industry BAT regulation and tax credits for CCS	The ARPA-E program focusing on energy with relevance to EIIs Several initiatives to boost manufacturing in the US are mentioned, but with no targets for decarbonization

Can national policies be scaled down?

China	Major programs on energy efficiency in industry (1000 enterprises) Mandated phase-out of 'outdated backward' industries Pricing policies favouring energy efficiency including several new carbon trading systems Major host of CDM project for non-CO_2 gases	Discussions on future industrial restructuring and circular economy towards a more service-oriented economy in the tertiary sector Research programmes for CCS in steel production
India	'Mission on Energy Efficiency' including the PAT scheme for industrial efficiency and a charter for efficiency in industry Policy for finding CDM-financing for efficiency	Research mainly on bio economy, e.g. bio-refineries, bio-waste in industry and biofuels
Brazil	Sectoral plan for industry including energy conservation programmes Policies promoting shift to natural gas in industry and to charcoal in the iron & steel industry	Extensive research on bio-economy Policies for increasing charcoal use in steel industry Encouraging use of charcoal from plantations instead of native forests

Based on latest National Communications (6 for Annex 1 and 2 for non-Annex 1) available at www.unfccc.int

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Technologies and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070

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[a] Energy Innovation LLC, 98 Battery St Ste 202, San Francisco, CA 94111, USA
[b] Institut du Développement Durable et des Relations Internationales (IDDRI), 27 rue Saint-Guillaume, 75337 Paris Cedex 07, France

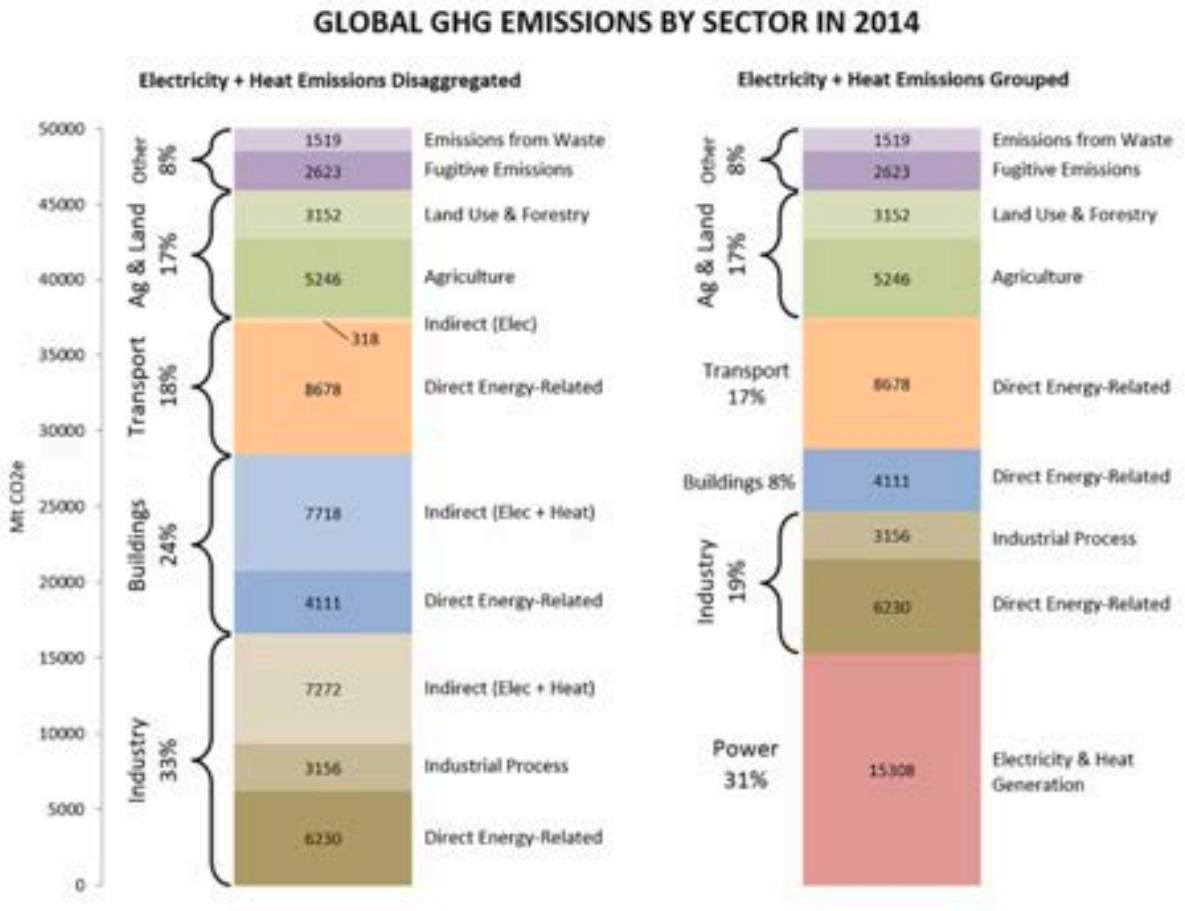

Fig. 1. Emissions by sector in 2014, displayed with indirect emissions (from the generation of purchased electricity and heat) assigned to the sectors that purchased that energy, or grouped into a single "power" sector. For more detail on which industries are included in the "industry" sector, see Fig. 2. Emissions from agriculture, from waste (e.g. landfills, wastewater treatment), and fugitive emissions (e.g. methane leakage from coal mines and natural gas systems) are not considered part of the industry sector in this paper [3,4].

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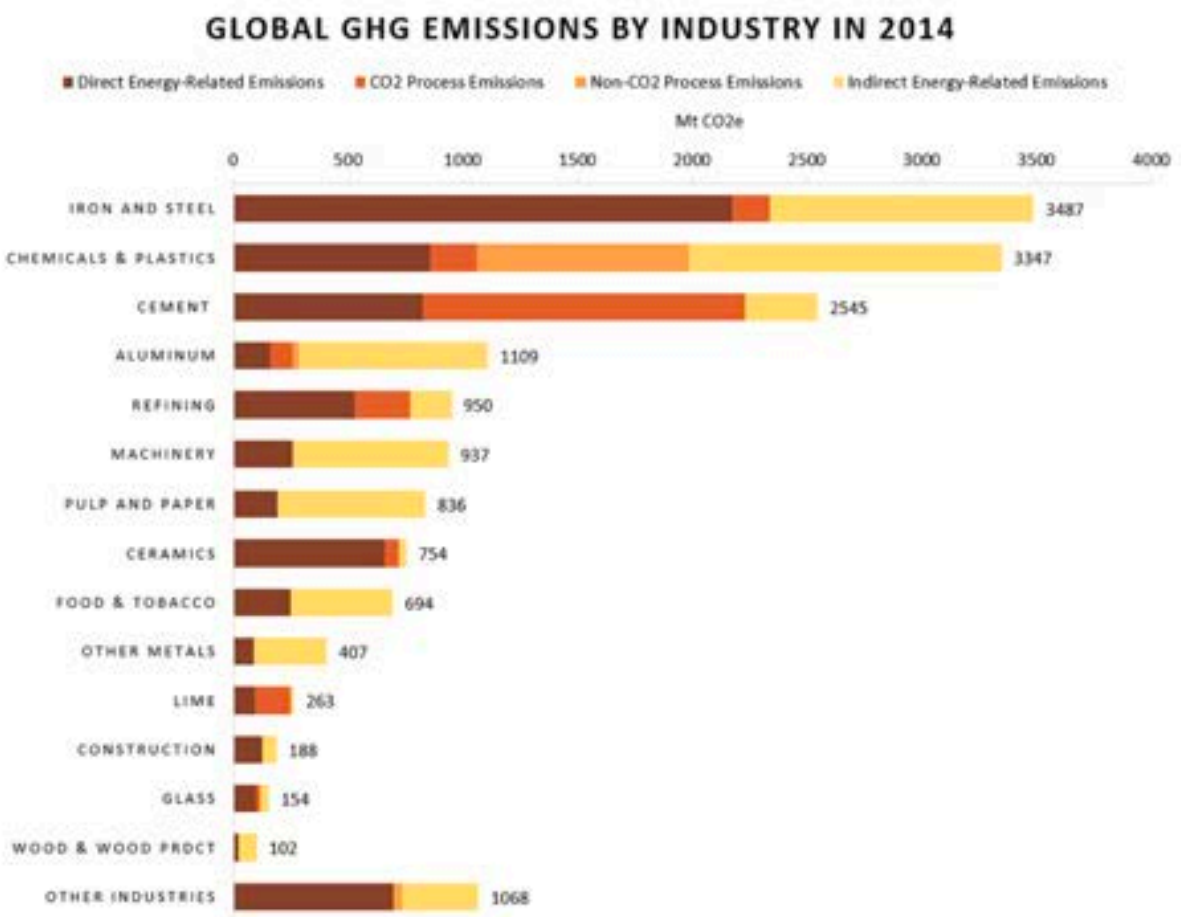

Fig. 2. Industry sector GHG emissions disaggregated by industry and by emissions type. Energy-related emissions are from fuel combustion, while process emissions are from other industrial activities. Direct emissions are from industrial facilities, while indirect emissions are associated with the production of electricity or district heat purchased by industry (not generated on-site). Emissions associated with transporting input materials and output products are considered part of the transportation sector and are not included in this figure. "Chemicals and plastics" includes all fluorinated gas emissions, even though most of those gases (e.g. refrigerants, propellants, electrical insulators) are emitted due to the use or scrappage of products. Chemicals production by refineries is included in the "refining" category, not the "chemicals and plastics" category. "Ceramics" includes brick, tile, stoneware, and porcelain. "Food and tobacco" includes the processing, cooking, and packaging of food, beverage, and tobacco products, not agricultural operations. "Other metals" includes copper, chromium, manganese, nickel, zinc, tin, lead, and silver. "Lime" only includes lime production not accounted for in another listed industry (e.g. cement). Total industry sector emissions do not match those in Fig. 1 due to differences in data sources [4–20].

Rissman et al policies & interventions

Supply-side:

- CCUS
- Low-carbon development for developing countries
- Worker retraining
- Firms influencing government decisions
- Low carbon steel production
- Electrolysis
- Renewable energy
- Electrification
- Hydrogen production & use

Demand-side:

- Material substitution
- Material efficiency
- Reduced material use
- Sharing of public goods
- Efficiency standards
- Circular economy
- Data transparency
- Building codes

Thank you!