Global carbon inequality in the long run

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Introduction

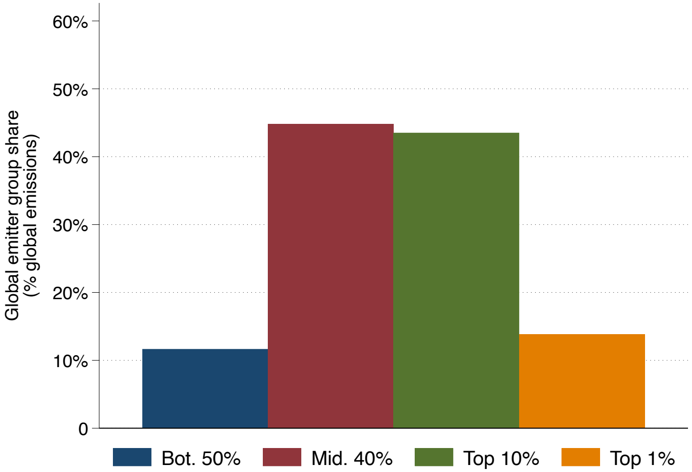
Energy and carbon transitions in the long run

- Deep transformation / decarbonization of modern energy systems necessary to tackle climate change
- Lack of standardized metrics to compare and contrast long run carbon and energy trajectories $\Rightarrow$ few systematic studies on the diversity of trajectories that shaped current energy systems
- This project: revisit the past and current political economy of carbon and energy transition through more systematic macro and distributional environmental accounts [Ongoing]

Methodology: reconstruct long run macro and distributional environmental accounts

- Construct, assemble, systematize historical energy balances and carbon accounts of countries to produce more systematic long run carbon and energy series
- Distribute emissions and energy following Distributional National Accounts principles (Alvaredo et al., 2020) in the recent period and since the mid-19c.

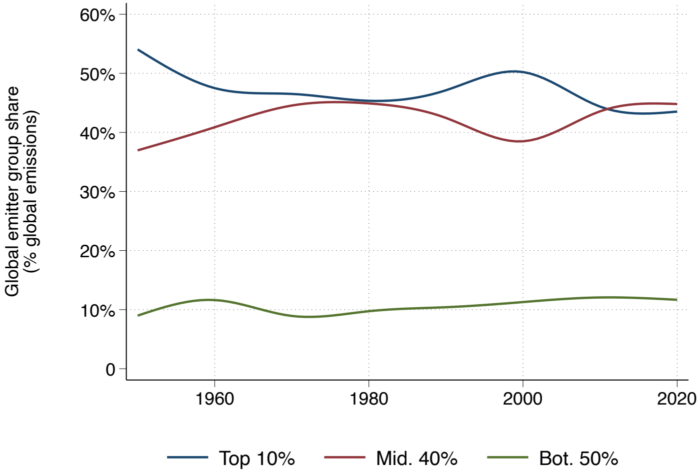
Main result (1) - Top 10% and mid. 40% = 45% emissions, bottom 10% = 10%



Global GHG emissions inequality between individuals, 2020

Source: Author's estimates based on PRIMAP, EORA, WID.world and own estimations. Elasticity 0.8.

Main results (2) - Little change in bottom 50%'s share over half a century



Global GHG emissions inequality, 1950-2020

Source: Author's estimates based on PRIMAP, EORA, WID.world and own estimations

Main results (3) - Rising importance of non-consumption emissions among top 1%

Share of global top 1% emissions from investments, 1980-2020

Source: Author's estimates based on PRIMAP, EORA, WID.world and own estimations

This presentation

- **I - Methodology and data**
  - Combine aggregate and distributional historical data on carbon, energy, income, wealth and consumption
- **II - Global carbon inequality**
  - Strong concentration of carbon emissions since 1850
- **III - Focus on the composition of top 1% emissions**
  - Rising role of investment (vs. consumption) at the top

I - Methdology and data

Build historical energy and GHG balance sheets to study political economy of transitions

- **No historical, int'l, systematic energy balance sheets to date**
  - We construct balance sheets based on (IEA, 2020) BP(2020) for post 1970 data and mobilize a variety of historical sources before
- **Historical fossil-fuels**
  - Mitchell, B. (1995) and Etemad et al. (1991): Fossil fuels imports and exports by nation over past centuries
- **Historical non-fossil energy (wind, water, wood, animal traction): need to produce estimates**
  - Dewhurst (1955), Smil (2008), Kander et al. (2013), OConnor (2014), Kraussman et al. (2018) + own estimates based on FAO, UN, World Bank. Benchmark estimates reported in primary energy.

→[Methodology]

Who is responsible for carbon emissions?

- **Official environmental accounts are based on territorial totals**
  - Since 1990s, IPCC, UN, Nat. Stats. Inst. produce territorial emissions totals (a country is responsible for emissions within its frontiers)
  - Trade and globalization in asset ownership challenge this view
- **Lack of distributional environmental accounts**
  - No standardized measure of individual (or group) level emissions growth.
  - Particularly problematic in the context of policy debates around distributional impacts of climate policies

- **We use the Input-Output Environment framework**
  - Leontief (1966; RES 1970): I-O analysis applied to the Environment as a handy conceptual framework be to reallocate emissions to were they are actually used
  - Intermediate inputs are allocated to final demand (of households or government) or private investments (of households or government)
  - Davis and Caldera (2010 PNAS), Peters et al. (2011 PNAS), Chen et al. (2018 Nature): Multi-Regional extension

- **Before 1970: no input-output tables, we assume footprints correspond to territorial totals from PRIMAP**
  - Available I-O table support this assumption. For earlier periods, west test alternative assumptions to factor in colonization, but little emissions involved.

Inter-industry transactions ("Z") / **Final demand ("Y")** / **Gross output**

		Country 1 Sector 1	Country 1 Sector 2	Country 2 Sector 1	Country 2 Sector 2	Country 1 HHs	Country 1 Govt	Country 2 HHs	Country 2 Govt	Gross output
Country 1	Sector 1	340	150	100	154	150	150	300	160	1504
	Sector 2	354	200	200	600	200	400	300	200	2454
Country 2	Sector 1	300	200	300	60	100	200	290	500	1950
	Sector 2	50	250	427	200	35	400	300	200	1862

Country 1 sector 1 imported 354 from Country 1 Sector 2

Value Added = Sum of Final demands

Country 1	Value Added	460	1654		
Country 2	Value Added			923	848

Total input (x)

Input by country-sector	1504	2454	1950	1862

Carbon emissions ("Q")

Direct Emissions (CO2)	**200**	**300**	**200**	**400**

Source: Author

Stylized Input Output table

[Back]

Leontief Input-Output in an International/Environmental framework

Z: inter-industry transaction matrix,
Y: final demand matrix,
Q: carbon emissions matrix,
x: vector of total input by country-sector

Leontief inverse (impact of final demand on sectors' output):

$$L = (I - A)^{-1} \tag{1}$$

With:

$$A = Zx^{-1} \tag{2}$$

Net carbon intensity of production:

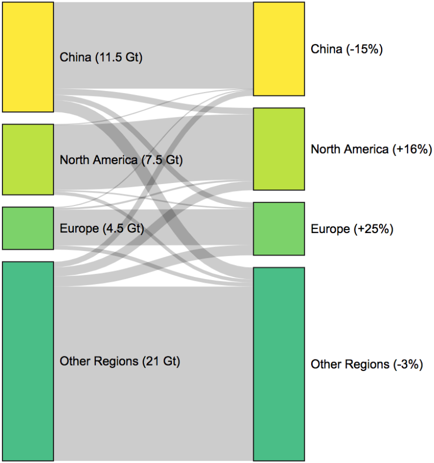
$$C = (Qx^{-1})L \tag{3}$$

Carbon footprint of final demand:

$$N = CY \tag{4}$$

(Carbon intensity of each sector multiplied by final demand requirements of each sector)

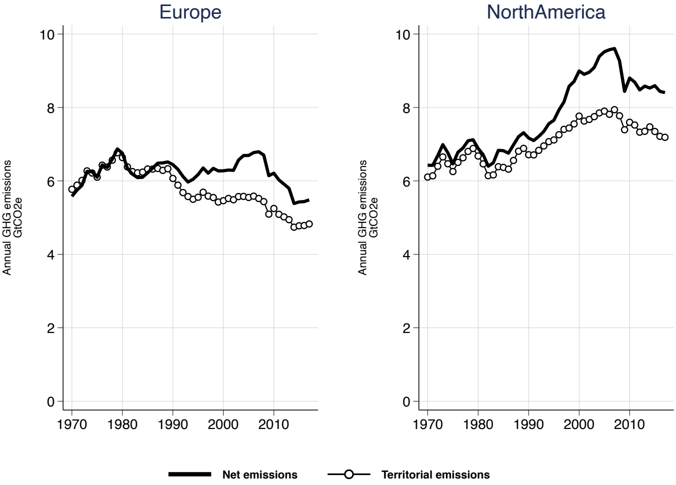
I-O insights: US-Europe net importers (+16-25% territorial em)



Global trade in GHG emissions, 2019

Source: Author's estimates using EORA(2020), IEA(2020) and WID.world(2020). Note: Carbon emissions trade in final demand by household, government and NPSIH sectors (i.e. values are net of carbon included in intermediate consumption trade).

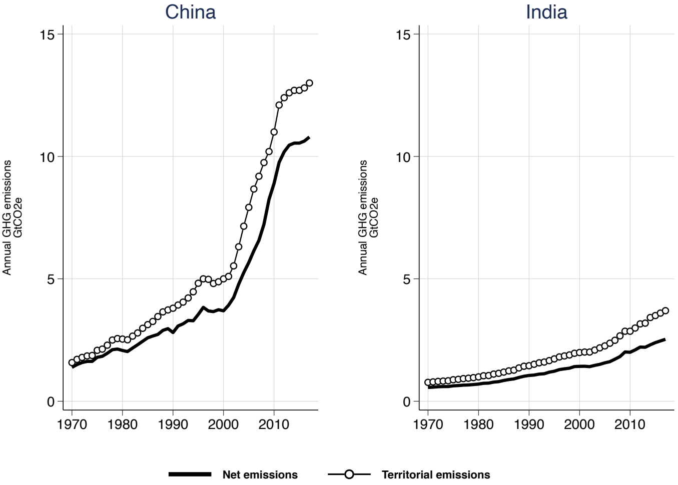
Rise in net carbon imports since 1970 in rich countries



Annual per capita GHG emissions, 1970-2020

Source: Author's estimates based on WID.world(2020) EORA(2020)

Counterpart: rise in net carbon exports since 1970 in emerging countries



Annual per capita GHG emissions, 1970-2020

Source: Author's estimates based on WID.world(2020) EORA(2020)

Distributing emission totals to individuals

- **Question: how to allocate net emissions to individuals?**
  - **Approach 1**: distribute emissions to consumers only (Hubacek et al., 2017 Nature; Chakravarty et al. 2009 PNAS).
    - Issue: what about investment choices?
  - **Approach 2**: all emissions attributed to a few investors in the oil, coal and gas industry (Griffin, 2017)
    - More than 50% of all CO2 emissions since 1850 (and >70% of all *energy* emissions) can be traced back to 100 companies.
    - Issue: what about consumer responsibility?
- **We develop an alternative approach, which factors in both imported consumption (public and private) and investments**
  - We build on, and depart from, Chancel and Piketty (2015)

Who is responsible for carbon emissions?

Standard oil share, 1878

Source: Wikimedia commons

Carbon content of assets: what do we know about it? Not much

La Banque Postale <contact@info1.labanquepostale.fr> Se désabonner

À moi

10:33 (il y a 4 minutes)

Contribuez avec nous à façonner un monde meilleur en investissant de façon durable
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FAITES VIVRE VOS PROJETS,
VALORISEZ VOTRE CAPITAL EN PRÉSERVANT NOTRE PLANÈTE

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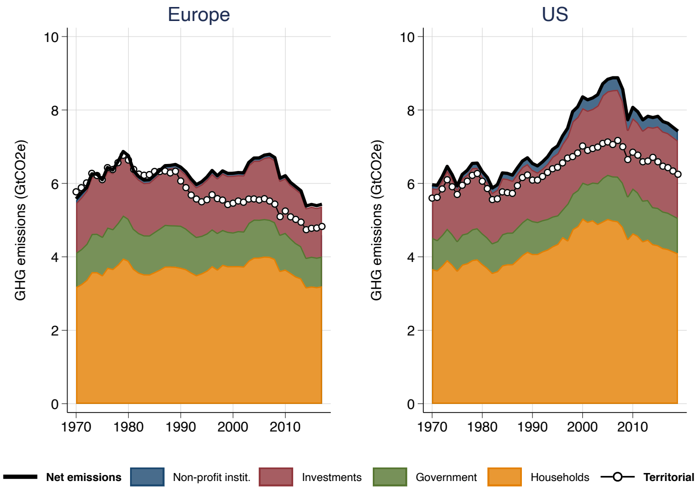
Cher M. Chancel,

En 2020, les encours d'épargne de précaution des Français (Ex. Livret A, Livret de Développement Durable et Solidaire ...) ont battu des records. Pourtant, cette option se traduit généralement par une absence de rémunération (comme les comptes courants bancaires) ou des taux de rémunération qui n'ont jamais été aussi bas après la

We use national accounts framework to distribute carbon to consumers and investors



Annual GHG emissions, 1970-2020

Source: Author's estimates based on WID.world(2020) EORA(2020)

Distributing all emissions to individuals

- We combine Input-Output models with satellite environmental accounts (EORA) and the World Inequality Database database
- per capita GHG footprints (E_i) = Consumption emissions (C_i) + Government emissions (G_i) + Investment emissions (I_i)

$$E_i = C_i + G_i + I_i \tag{1}$$

$$C_i = \begin{cases} k_C \hat{Y}_i^{\alpha}, & \text{if } \mathrm{C}_i > C_{min} \\ C_{min}, & \text{otherwise} \end{cases} \tag{2}$$

$$G_i = k_G \hat{Y}_{i_G}^{\beta} \tag{3}$$

$$I_i = k_I \hat{Y}_i^{\gamma} \tag{4}$$

- Where $\hat{Y}_i$ is normalized income ($= Y_i / Y_{avg}$)

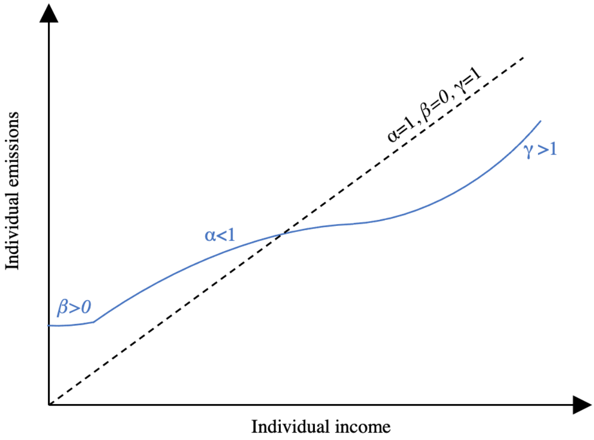
Elasticity values from household surveys

Country	Reference	Year	Relationship	Elasticity
Australia	1	1993-1994	Expenditure-Energy	0.78
Brazil	1	1995-1996	Expenditure-Energy	1
Denmark	2	1995	Expenditure-Energy	0.9
Denmark	2	1995	Expenditure-Carbon	0.9
Denmark	1	1995	Expenditure-Energy	0.86
India	1	1997-1998	Expenditure-Energy	0.86
Japan	1	1999	Expenditure-Energy	0.64
United Kingdom	3	2006-2009	Income-Carbon	0.43-0.6
the Netherlands	4	1983	Expenditure-Energy	0.83
Norway	5	1999-2001	Expenditure-Carbon	0.88
Spain	6	2000	Expenditure-Carbon	0.91-0.99
USA	7	2004	Expenditure-Carbon	0.6-0.8

Elasticity values from household surveys

Source: Author

Multi-elasticity GHG income model



Schematic representation of income-carbon relationship

Source: Author

- Benchmark estimates: α=0.7, β=0 (lump sum govt. emissions), γ=1.3 (distribution of capital incomes); $C_{min} = 0.2xC_{avg}$
- Range tested (1980-2020): α=0.5, 0.6, 0.7, 0.8, 0.9, 1 ; C_{min} =0, 0.1, 0.2, 0.3

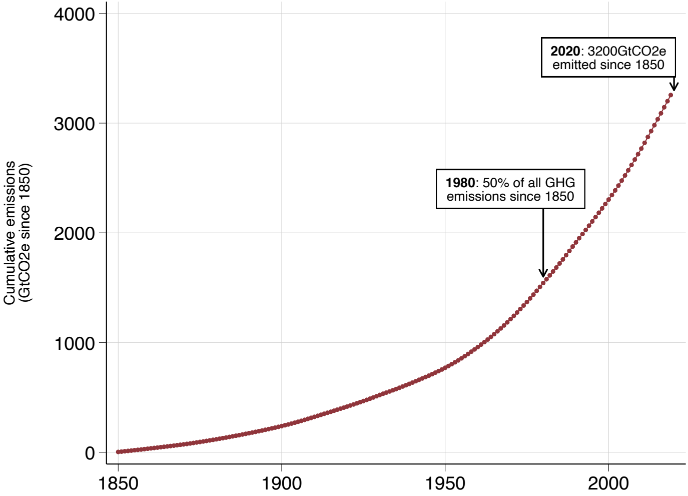
Use income inequality data from WID.world

- We use income inequality estimates from the World Inequality Database (WID.world)
  - Estimates available for all countries 1980-2019 (for all g-percentiles of the distribution)
- Before 1980, we use WID.world and Chancel and Piketty 2021 Long-run historical inequality estimates (beta).

  This database provides estimates for large key countries and all world regions from 1820 onwards.

Global carbon inequality

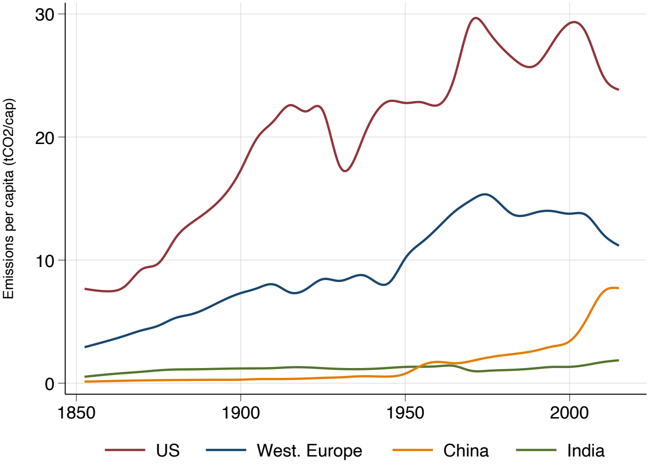
50% of all historical emissions released since 1980



Global cumulative GHG emissions since 1850

Source: Author based on PRIMAP (2016), PRIMAP (2019) and own estimates

Strong variations in historical per capita emissions (cf. PSE Association Seminar)



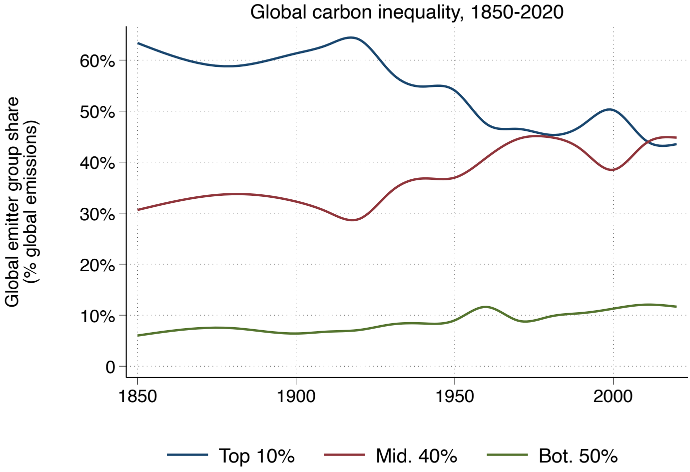
GHG emissions per capita

Source: Author's estimates based on WID.world, PRIMAP and EORA. GHG footprints (i.e. net of imports and exports) excl. LULUCF. See methodological appendix for details. [Methodology]

Strong variations in historical per capita emissions (cf. PSE Association Seminar)

- Strong US-Europe gap due to massive deforestation in the US (Americans deforest in 100 years what Europeans deforested in 1000 years)
- Relatively low efficiency of US production system, due to relatively high natural resource endowment and relatively low labor endowment (contrary to Europe, with relatively high labor vs. low natural capital).

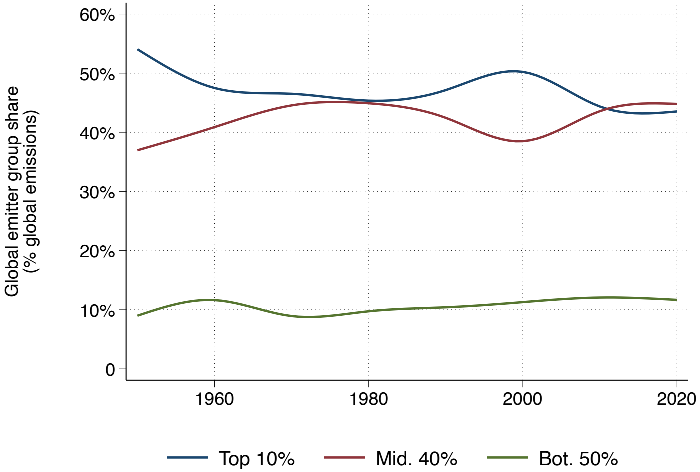
1920-1960: decline in top 10% share (WWs + decolonization)



Global GHG emissions inequality, 1850-2020

Source: Author's estimates based on PRIMAP, EORA, WID.world and own estimations

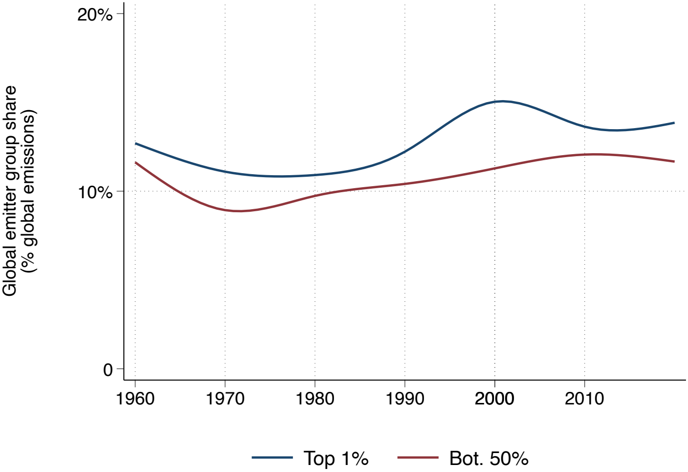
1960-2020: stable shares despite rise of emerging world, no catch-up



Global GHG emissions inequality, 1950-2020

Source: Author's estimates based on PRIMAP, EORA, WID.world and own estimations

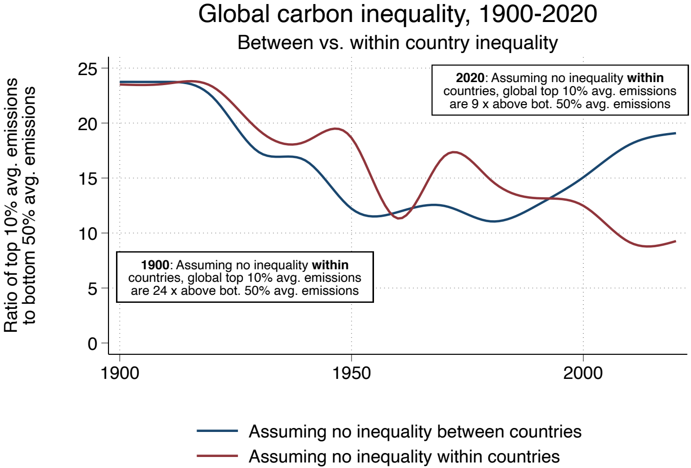
Since 1960, no significant change in gap between bottom 50% and top 1% share



Global GHG emissions inequality, 1850-2020

Source: Author's estimates based on PRIMAP, EORA, WID.world and own estimations

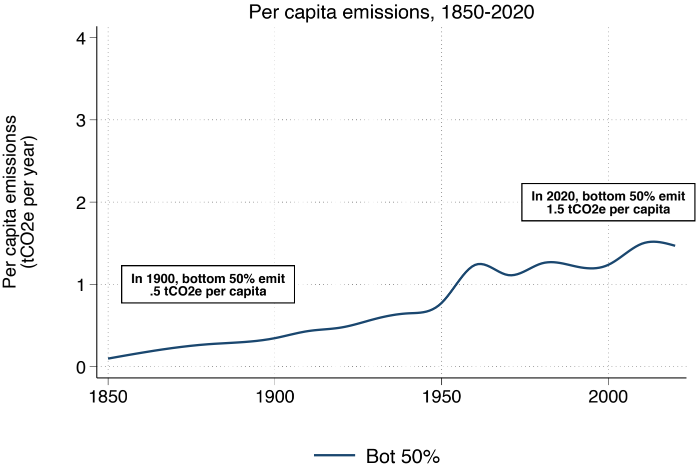
Recent period: decline in between-country emissions counterbalanced by rise in within-country emissions



Author's estimates based on PRIMAP, EORA, WID.world and own estimations

Source:

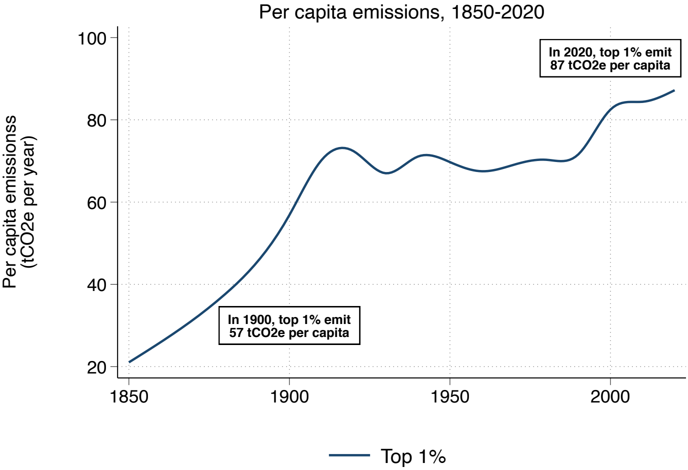
Bot. 50% emissions per capita



Global GHG emissions inequality, 1850-2020

Source: Author's estimates based on PRIMAP, EORA, WID.world and own estimations

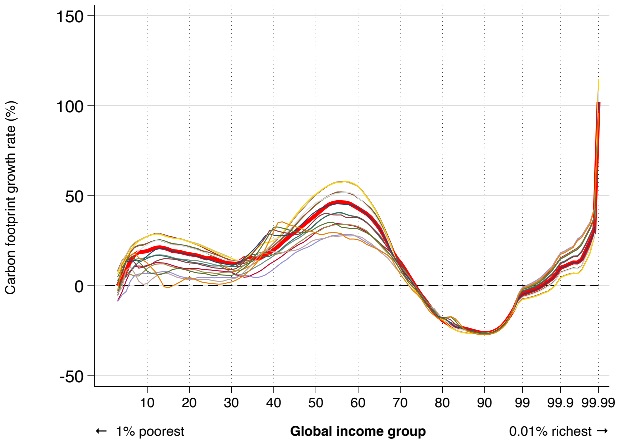
Top 1% emissions per capita



Global GHG emissions inequality, 1850-2020

Source: Author's estimates based on PRIMAP, EORA, WID.world and own estimations

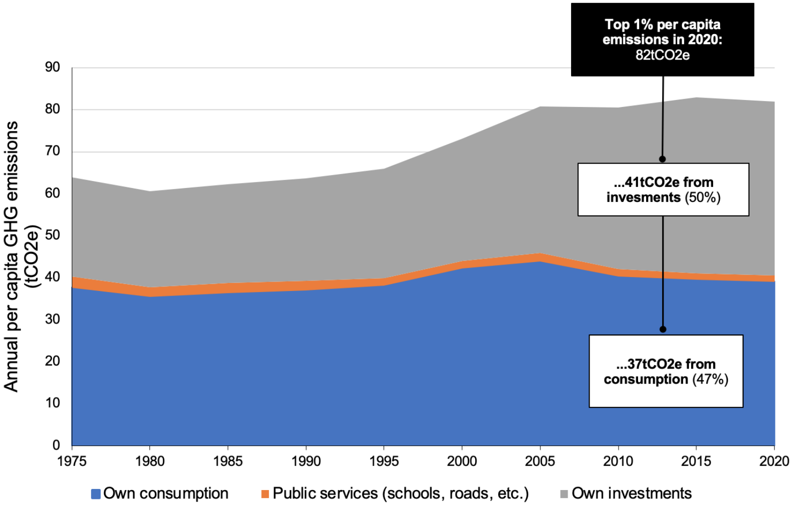
Since 1980, strong growth at the lower-middle, even more at the top, degrowth at the upper-middle



Carbon emissions and inequality, 1980-2020

Source: Author's estimates based on WID.world(2020) and EORA(2019). Note: linear interpolation over 5yr-spans. tCO2e: tonnes of CO2 equivalent, including all Green House Gases. See Appendix for methodological details.

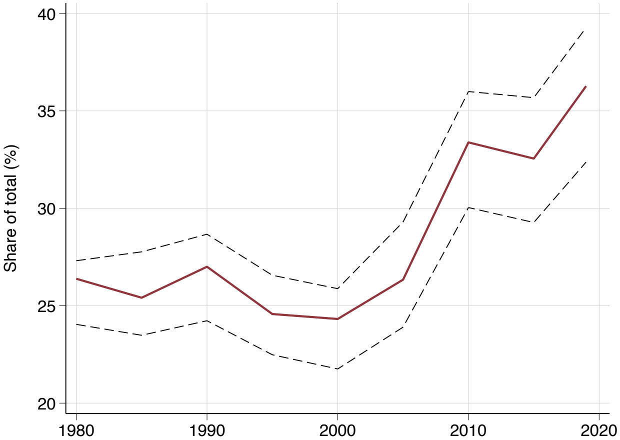
Results: top 1% emissions over 140t CO2, half is investments



Carbon emissions of the global top 1%, 1975-2020

Source: Author's estimates based on WID.world(2020) and EORA(2019). tCO2e: tonnes of CO2 equivalent, including all Green House Gases. See Appendix for methodological details.

Top 1%: Rising share of GHG emissions from investments and capital income



Share of emissions from investments, 1980-2020

Source: Author's estimates based on WID.world(2020) and EORA(2019). tCO2e: tonnes of CO2 equivalent, including all Green House Gases. See Appendix for methodological details.

Summarizing: strong inequality in GHG footprints, key role of investments

- **Current and past emissions largely concentrated**
  - Top 10% responsible for 45% of current global emissions, bottom 50%, 10%. Little change over 60 years.
- **At the top investments play large role in total emissions**
  - More than a third of of top 1% emissions typically missed in consumption-only analyses
  - Investments shape emissions budgets of all groups
  - Policy relevance focus to focus more on investors (standards, asset taxes, etc.)

Concluding remarks

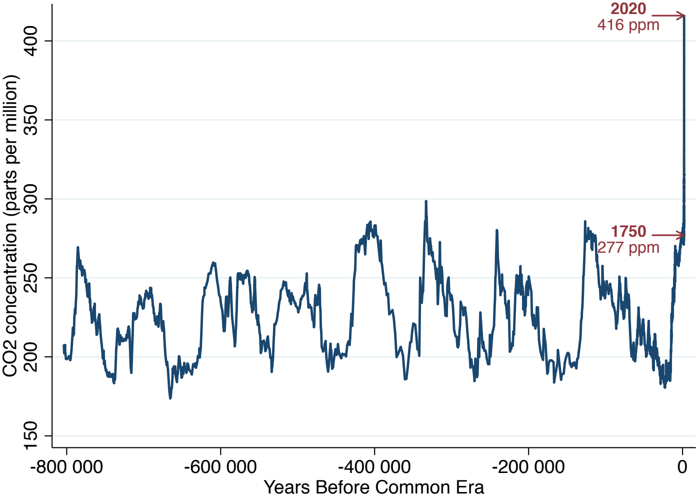
- Importance of internationally comparable metrics to relate and contrast past and present carbon and energy transitions
- Variety of energy/carbon trajectories and current systems in rich and emerging countries
- We still lack basic statistics about global carbon inequality

Additional slides

Current CO_2 concentrations highest in 14m years

- Concentrations and temperatures measured from ice samples
- Current CO_2 concentrations (416ppm) are highest in 14 million years
- 4000 ppm concentrations during the Cambrian period (500 million years BCE, +10 degree surface temperature)
- *Homo sapiens* (300 000 BCE) lived through some variations (+/-100ppm) but never of outside of 180-280ppm range until now.

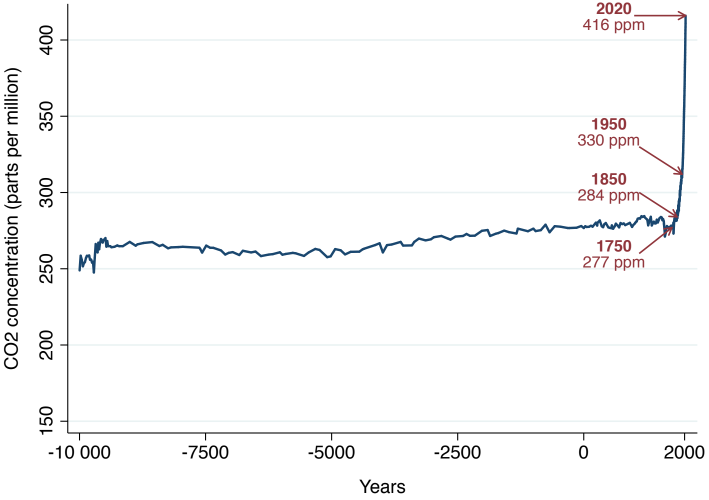
Global GHG concentrations since 800 000 BCE



Global atmospheric CO2 concentration, since 800 000 BCE

Source: Data provided by US National Oceanic and Atmospheric Administration, Earth Systems Research Laboratory (2020). Notes: Average concentration of carbon dioxide (CO2) in the atmosphere.

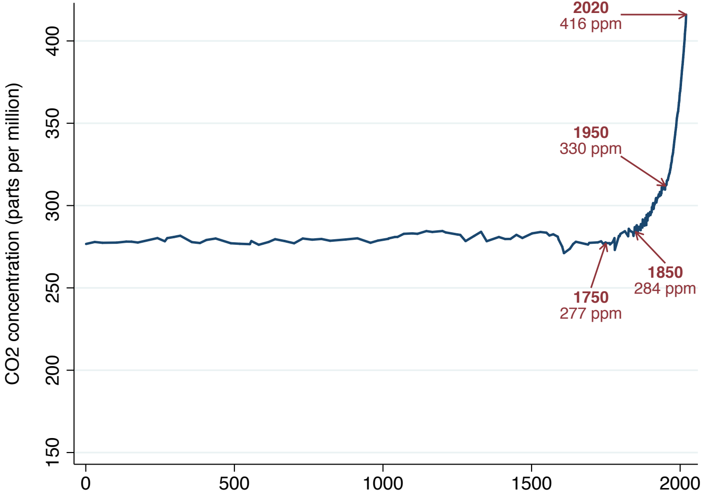
Global GHG concentrations since neolithic revolution



Global atmospheric CO2 concentration since 10 000 BCE

Source: Author based on data provided by US National Oceanic and Atmospheric Administration, Earth Systems Research Laboratory (2020). Notes: Average concentration of carbon dioxide (CO2) in the atmosphere.

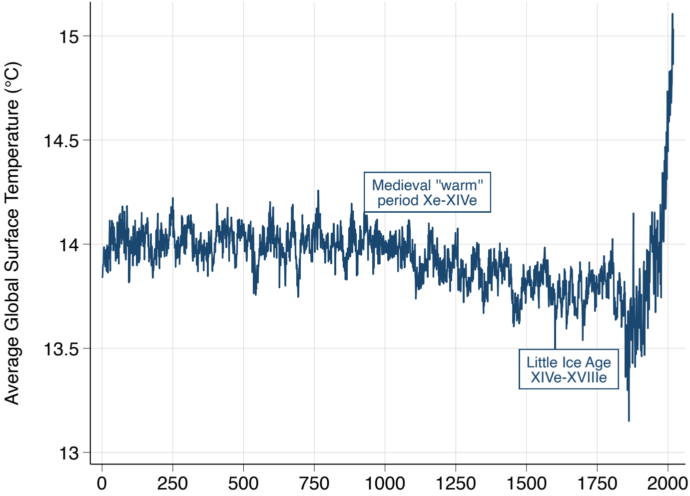
Global GHG concentrations over 2000 years: stable before 1750



Global atmospheric CO2 concentration since 1 CE

Source: Data provided by US National Oceanic and Atmospheric Administration, Earth Systems Research Laboratory (2020). Notes: Average concentration of carbon dioxide (CO) in the atmosphere.

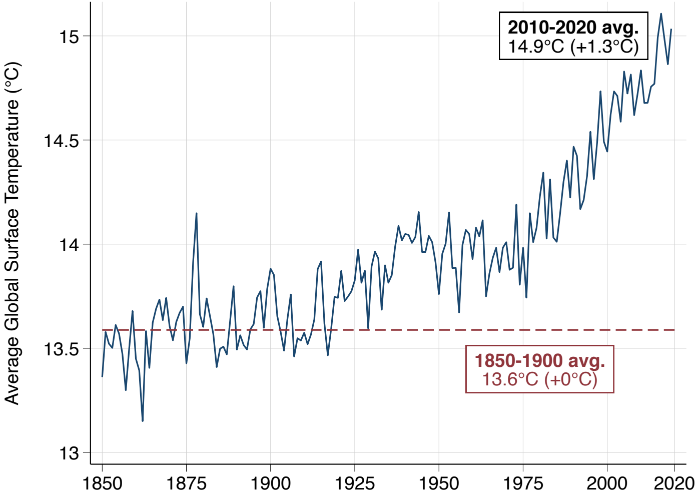
Global temperature anomaly over 2000 years



Global average surface temperature since 1 CE

Source: Data from Pages2K Consortium (2019) for pre 1850 data, HadCRUT4 (2020) and Berkeley Earth (2020) for post 1850 data (annual arithmetic mean between two datasets).

Global temperature increase: +1.3C since 1850-1900



Global average surface temperature, 1850-2020

Source: Data from HadCRUT4 (2020) and Berkeley Earth (2020). *Notes*: Annual arithmetic mean between two datasets.

Energy vs growth in environm. econonomics: lot of optimism/pessimism, little data

- **Standard growth models: optimism**
  - Solow (1956) growth possible without energy: $Y = F(K, L)$
  - Solow/Stiglitz (RES 1974) introduce energy (E) and tech (e), but E can be substituted by K: $Y = e^{\lambda t} K^{\alpha} L^{\beta} E^{\gamma}$, $\alpha + \beta + \gamma = 1$ (1)
  - In fact, Solow prefers a model where $Y > 0$ possible with $E = 0$: $Y = [\alpha K^{\frac{\sigma-1}{\sigma}} + \beta L^{\frac{\sigma-1}{\sigma}} + \gamma E^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}}$, $\sigma > 1$) (2)
  - Decoupling growth and energy (or resources) isn't an issue (cf. Nordhaus DICE model: only -10% global GDP if temp +6C in 2100) →[More]

- **Ecological economists' critique: pessimism**
  - Georgescu-Roegen (1979): *"No agent can create the material on which it works. Nor can capital create the stuff out of which it is made"*
  - Problem: with Solow/Stiglitz, E can be depleted largely or even entirely
  - Impossibility of growth-energy decoupling

⇒ Quantitative environmental history can help

Solow growth model

Y represents output, K capital and L labor. E represents the flow of energy (or resources) in the production function:

$$Y = F(K, E, L, t) \tag{5}$$

Energy is exhaustible, i.e. taken from a finite stock S_0:

$$\int_0^{\infty} E(t)\mathrm{d}t \leq S_0 \tag{6}$$

Y distributed between Consumption (C) and net invest ($\dot{K}$):

$$C + \dot{K} = Y \tag{7}$$

Population grows at constant rate:

$$L = L_0 e^{nt} \tag{8}$$

[Back]

Solow growth model (contd.)

Cobb Douglas form justified since (i) E seen as essential to production and (ii) output not limited by flow of the resource ("unbounded resources productivity"):

$$Y = e^{\lambda t} K^{\alpha} L^{\beta} E^{\gamma}, \alpha + \beta + \gamma = 1 \tag{9}$$

Constant consumption constraint:

$$C = c_0 L \tag{10}$$

Problem: determine what K,L,E needed to maintain constant consumption , under energy constraints. Must minimize $\int_0^{\infty} E(t)\mathrm{d}t$ under equations (2)-(6).

Solow growth model (contd.)

Solow derives from the above:

$$\dot{K}(t) = e^{\lambda+\gamma n)t} K(t)^{\alpha} E(t)^{\beta} - c_0^{nt}, \alpha + \beta + \gamma = 1 \tag{11}$$

The minimization of $\int_0^{\infty} E(t)\mathrm{d}t$ gives:

$$\frac{\dot{F}_R}{F_R} = F_K \tag{12}$$

Where F_R and F_K are the marginal productivity of resources and capital.

Solow treats the case where Labor and technologies are fixed:

$$E = K^{\alpha} E^{\beta} L_0^{\gamma} \tag{13}$$

Solow growth model (contd.)

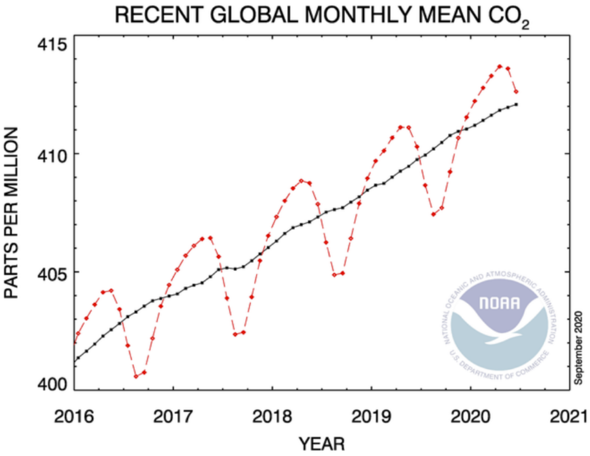
Consumption is possible if and only if:

$$\alpha > \beta \tag{14}$$

Solow's conclusion 1: growth rate of the price of the resource should be equal to interest rate (eq. 8)
Solow's conclusion 2: marginal product of capital must be greater than that of energy (eq. 10)

See Couix (2018) for more a in-depth discussion.

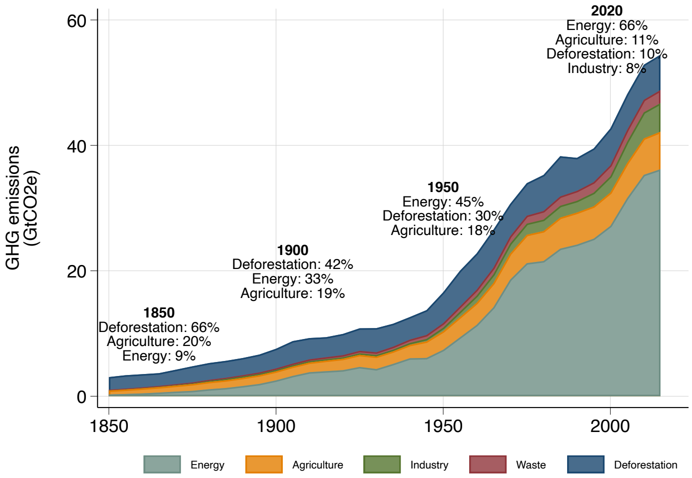
What about Covid and CO2 concentration? Despite lock-down, Business as usual



Global GHG concentration, 2016-2020

Source: Mauna Loa Observatory, US NOAA.

Global emissions in 2020: 2/3 from energy



Total GHG emissions, 1850-2020

Source: Author based on PRIMAP(2016), PRIMAP(2019) and own estimates after 2017. *Notes*: Emissions include all GHGs from all sectors, including land use.

Constructing historical energy budgets

- **Primary energy = total amount of fuels consumed for human and economic processes**

$$E_t = \sum_{i=1}^{n} e_{it} \tag{15}$$

With e_i total amount of fuel i (coal, wood, wind, etc. expressed in Joules thereafter), on year t

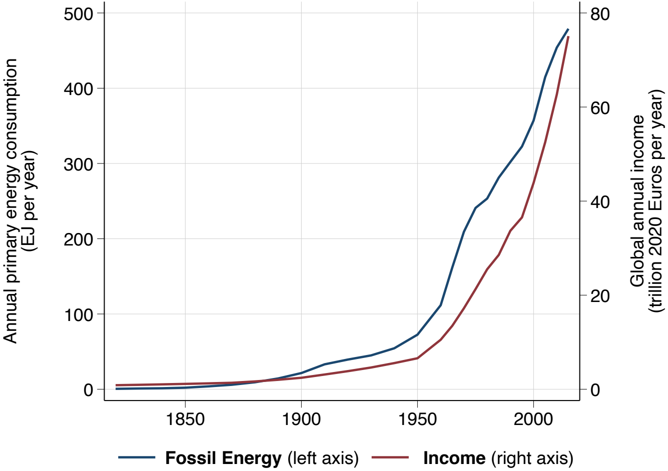
- **Useful energy = amount of fuel after conversion into useful energy by technology**

$$U_t = \sum_{i=1}^{n} e_{it} \times \eta_{it} \tag{16}$$

With η_i the time-varying efficiency of fuel conversion (current coal plant efficiency 40%. Early 18c steam engines efficiency $< 1\%$)

$\rightarrow$[Methodology]

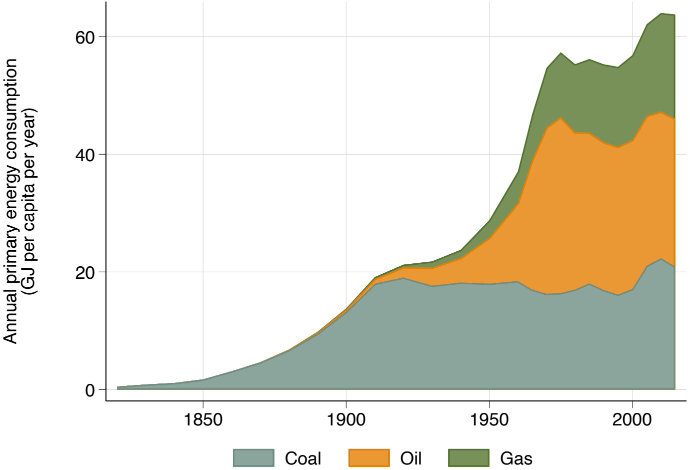
No growth without energy. But how much and which energy needed for growth?



Global fossil fuel use vs. income, 1820-2020

Source: Author, based on combination of sources: BP Statistics(2020), IEA(2020). See methodological appendix for details.

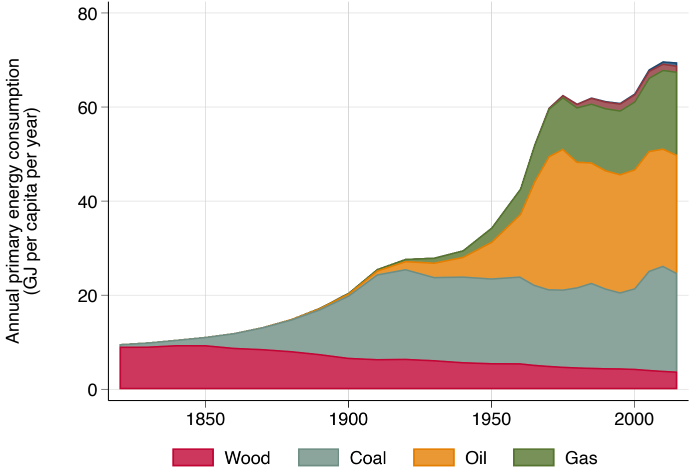
World: no shift out of coal, oil, gas. All graphs below per capita.



Global modern energy consumption per capita, 1820-2020

Source: Author, based on combination of sources: BP Statistics(2020), IEA(2020). See methodological appendix for details.

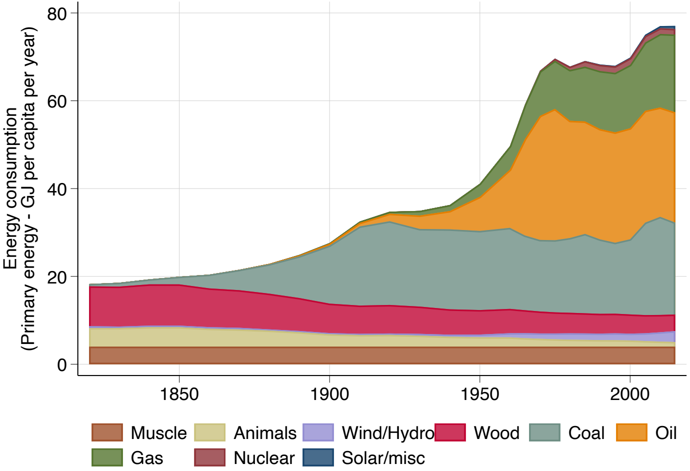
To study long run transition, necessary to include firewood...



Global energy consumption per capita, 1820-2020

Source: Author, based on combination of sources: Smil (2017), BP Statistics(2020), Kander, Malanima, Warde (2014) and WID.world(2020). See methodological appendix for details.

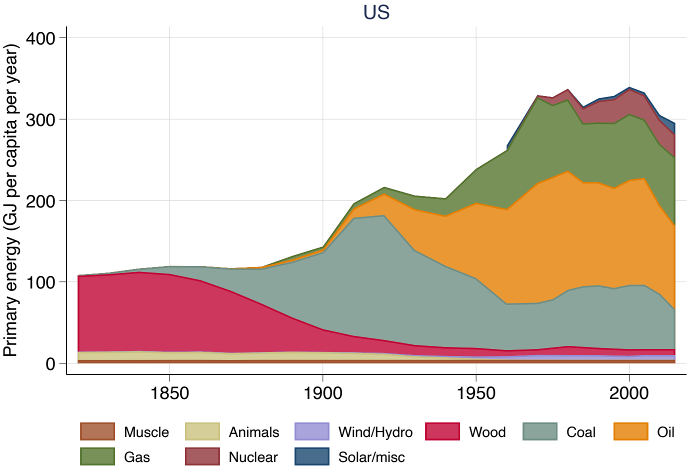
… as well as other old and new renewables



Global energy consumption per capita, 1820-2020

Source: Author, based on combination of sources: Smil (2017), BP Statistics(2020), Kander, Malanima, Warde (2014) and WID.world(2020). See methodological appendix for details.

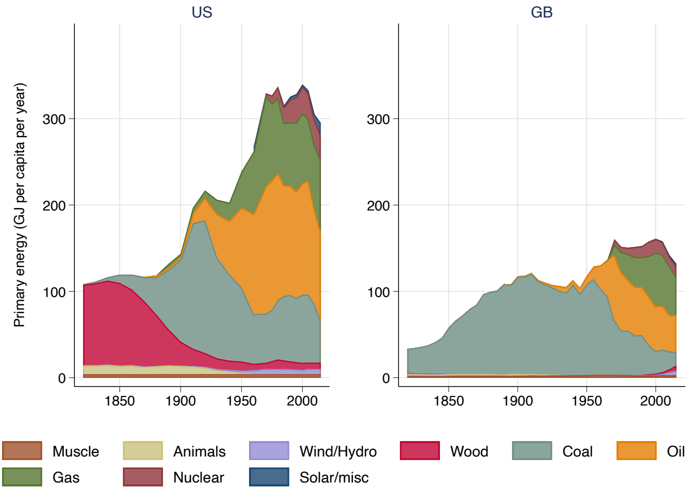
US 2020: energy 4x above world avg. High levels since early 19c.



US primary energy consumption, 1820-2020

Source: Author, based on combination of sources: O'Connor(2014), IEA(2020), WID.world(2020) and own estimates.

Huge difference in energy between US and Europe in early 19c-20c: why?



Primary energy consumption per capita, US vs. UK, 1820-2020

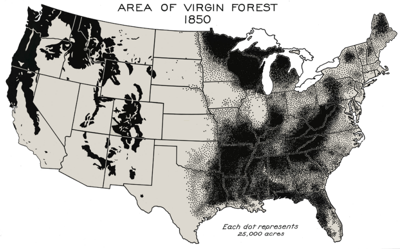
Source: Author, based on combination of sources: O'Connor(2014), Kander, Malanima, Warde (2014), IEA(2020), WID.world(2020) and own estimates. See methodological appendix for details.

Drivers of early US energy-inefficient capitalism

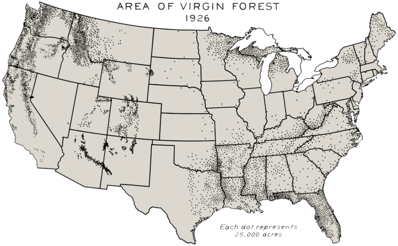
- Natural resources endowment
- Labor endowment
- Politics

Massive US deforestation had lasting impacts

1850



1920

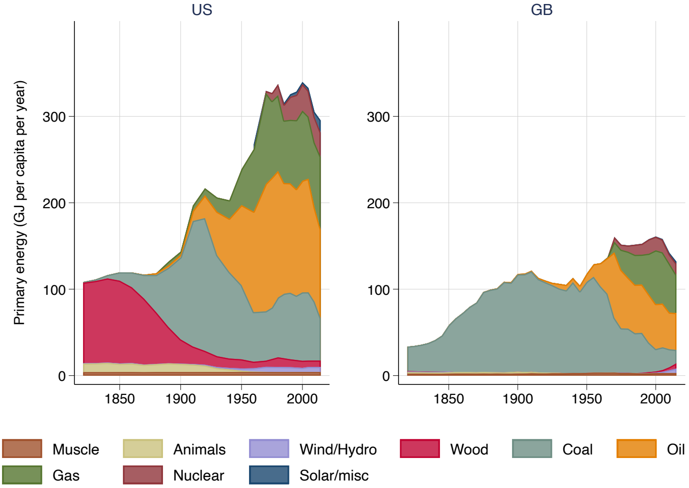


Source: William B. Greeley, US Forest Service.

European capitalism didn't end its forest, depletion happened before

- **Unprecedented speed and scale of deforestation in US 19c.**
  - Between 1820 and 1920, US deforested 1.2m k2 (=FR+DE+UK) or 15% of US area
  - ie. Ile de France deforested every year, for 100 years. Above current Amazonian deforestation rate.
- **European deforestation was much less intensive**
  - European deforestation 1100-1800: 1m km2 loss (data from archeological pollen, Roberts et al. 2017)
  - N. Americans (who were less populated) deforested in 100 yrs as much as Europeans in 700-800 yrs → [Methodology]
- **Consequence: US system less efficient**
  - "All you can take" modes of extraction and production in the US, less so in Europe: wood burner efficiency, steel production (more below)

Per capita energy US 1900: twice as large as the UK (similar per capita incomes)



Primary energy consumption per capita, US vs. UK, 1820-2020

Source: Author's estimates. See methodological appendix for details.

Abundance of labor in Europe made capitalism more energy efficient

- **US production system is energy inefficient**
  - 1890-1920 US: productivity rises less than installed power.
  - Is inefficiency just about endowment? No : In early 20c Europe has large resources left (esp. coal in German).
- **US less labor intensive than EU**
  - Use of capital and energy in the US to compensate for labor shortage
  - Large labor supply in Europe, little energy substitution options: more political power for miners
- **Miners' political power lead to more resource constraints**
  - More regulations in Europe (series of regulations late 19c early 20c
  - Main result: deaths per miner 2x higher US than UK in 1900-1950
  - Extraction and production process must adapt to socio-political context
  - Jevons' "Coal question" (1865), as much social as geological (need to reinvest growth in miners' education)

Abundance of labor in Europe in the shaping of energy efficiency of production

VOL. XXXIX....NO. 12,027.

LABOR'S CAUSE IN EUROPE

THE KAISER'S CONFERENCE AND THE ENGLISH STRIKE.

VAST INTERESTS THE STRIKE INVOLVES —FRENCH, NOT GERMAN, SPOKEN FROM NECESSITY—TIRARD'S FALL.

BY THE COMMERCIAL CABLE FROM OUR OWN CORRESPONDENT.

Copyright, 1890, by the New-York Times.

LONDON, March 15.—If the human race does not from to-day turn over a new leaf and proceed to be prosperous, good, and happy, it will be a cause of much surprise

NYT front page on European coal strikes, 1890

Importance of regulations: automobile politics

- **Much faster pre-war auto growth in the US than Europe**
  - Auto market grows 3x faster US than Europe in 1910s.
  - By mid-1920s, 10x more cars per person in the US than FR/UK/DE

- **Europe imposes more stringent regulations**
  - **DE**: In 1927, SPD heavily taxes automobiles in Berlin to invest in Deutsche Bahn (Bonneuil and Fressoz, 2013)
  - **FR**: early regulations (Conseil Constit., 1902) to limit speed and pollution
  - **UK**: public opinion resistance to auto pollution noise and danger

- **Automobilization of Europe occurs post-war**
  - Significant role played by Marshall Plan (suburban life + oil to break socialist movement & miner power, see Mitchell, 2017)
  - 1900-1950 Europe continued expansion of public transportation, opposite in US (more later)

Resistance to automobile pollution, noise and danger in Europe

THE TRIUMPH OF THE HORSE.

THERE is probably nothing more remarkable in the history of locomotion, and we may add in the history of commerce—for it is upon the rapidity and cheapness of transit that commerce mainly depends—than the persistence of the horse. Its original taming and adaptation to the use of man are lost in the mists of antiquity, or enshrined in the legendary annals of primitive poetry and mythology. Classical scholars,

The Economist, 7 Sept. 1907

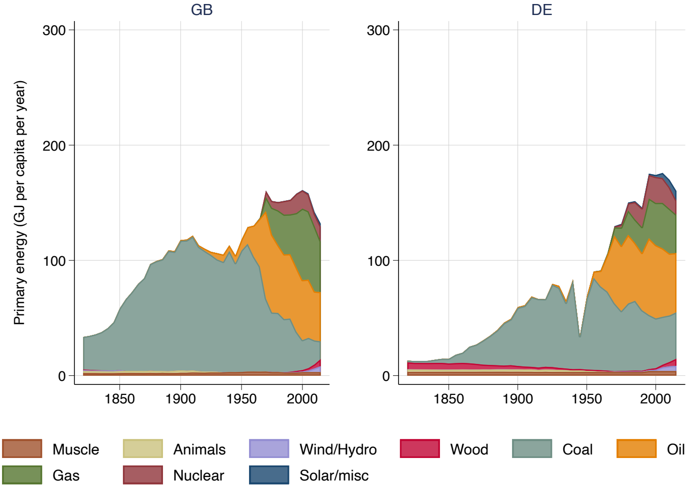
THE INCREASE IN MOTOR ACCIDENTS.

THE increasing insecurity of our streets and highways which has accompanied the general adoption of the motor vehicle and the constant speeding up of traffic is anything but a new source of complaint. In towns and in country districts the same tale of fatal accident, of injury, of noise, dust, smell, and damage to property has for years been told, yet no serious attempt has been made to find a remedy. Our roads are not only less secure, but their condition is worse, and their cost of upkeep has doubled. The Highways Protection

The Economist, 7 Oct. 1911

Source: The Economist Historical Archive

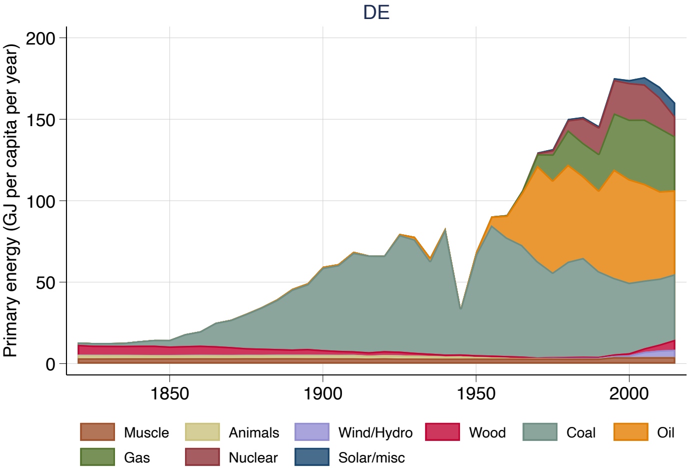
Diverging trajectories within Europe as well



Primary energy consumption in Germany, 1850-2020

Source: Author, based on combination of sources: Kander, Malanima, Warde (2014), IEA(2020) and WID.world(2020). See methodological appendix for details.

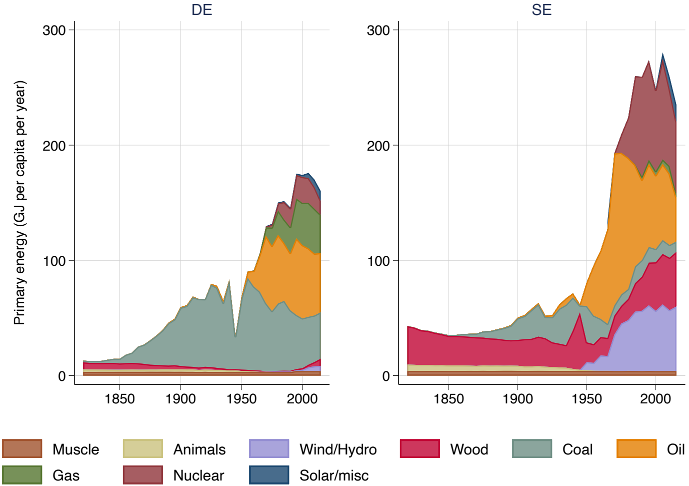
Germany: importance and persistence of coal



Primary energy consumption in Germany, 1850-2020

Source: Author, based on combination of sources: Kander, Malanima, Warde (2014), IEA(2020) and WID.world(2020). See methodological appendix for details.

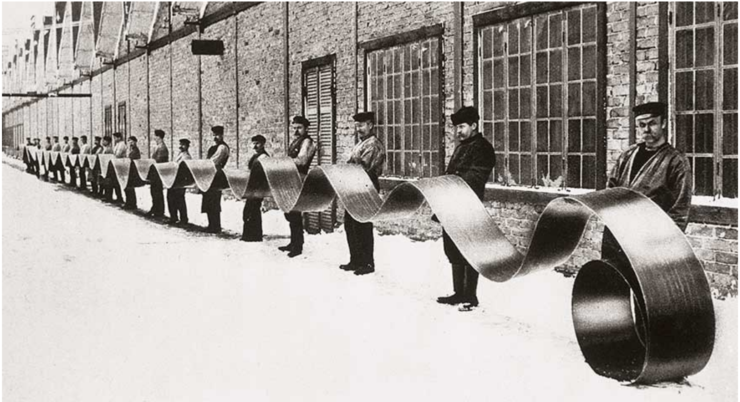
Sweden: larger energy requirements than Germany, very different mixes



Primary energy consumption in Germany and Sweden, 1820-2020

Source: Author, based on combination of sources: Kander, Malanima, Warde (2014), IEA(2020) and WID.world(2020). See methodological appendix for details.

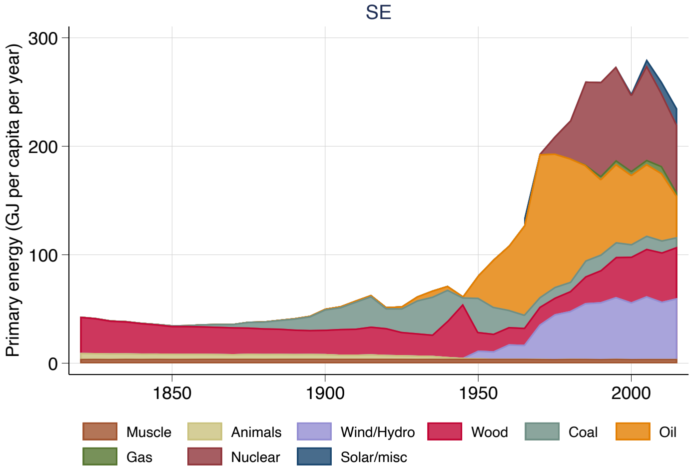
Sweden: long tradition of iron and steel + pulp production with firewood



Sandvik steel Factor, Sweden, early 19c

Source: Sandvik Company online archives.

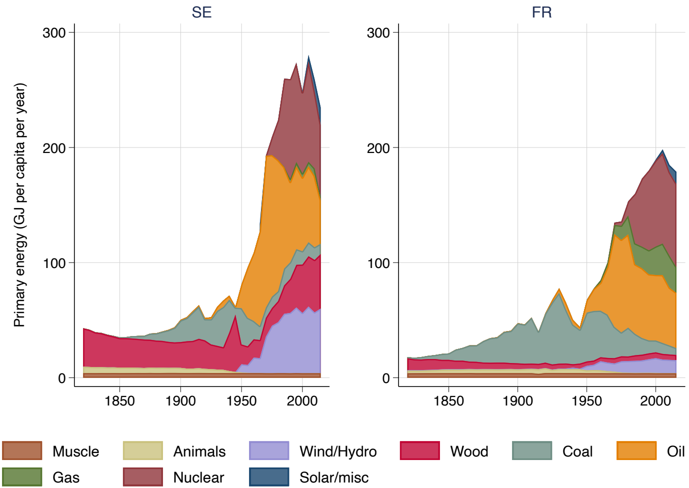
Sweden: importance of renewables + nuclear since 1960s



Primary energy consumption in Sweden, 1820-2020

Source: Author, based on combination of sources: Kander, Malanima, Warde (2014), IEA(2020) and WID.world(2020). See methodological appendix for details.

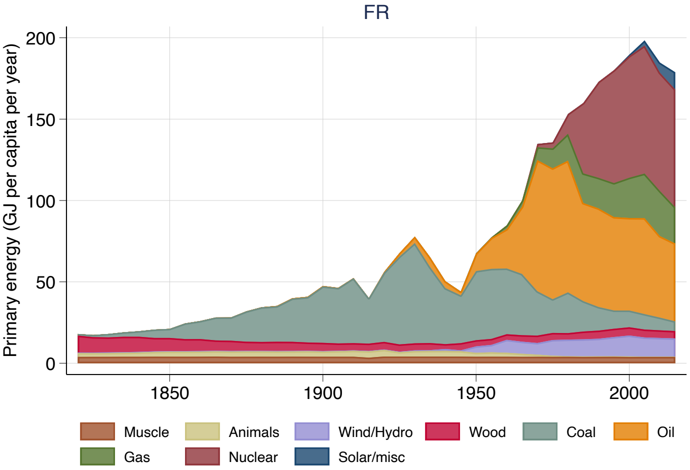
France opted for coal, oil, nuke. Forests 5x less harvested than in Sweden.



Primary energy consumption in Sweden vs. France, 1820-2020

Source: Author, based on combination of sources: Kander, Malanima, Warde (2014), IEA(2020) and WID.world(2020). See methodological appendix for details.

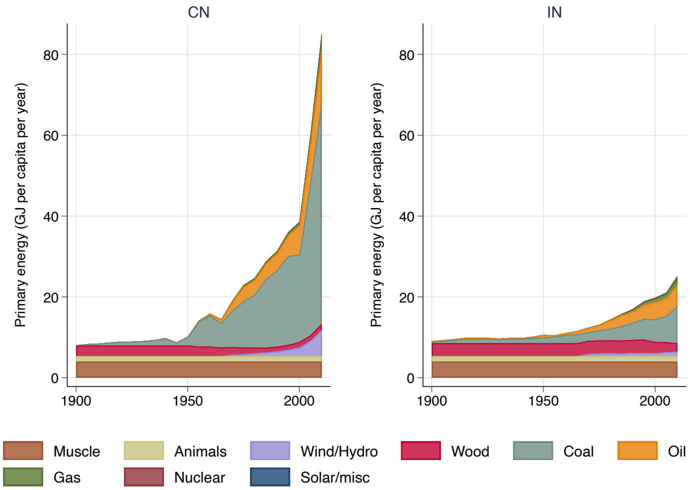
France post-1970s: opted for nuclear, v. limited renewables



Primary energy consumption in France, 1820-2020

Source: Author, based on combination of sources: Smil (2017), IEA(2020), ADEME(2019), Kander, Malanima, Warde (2014) and WID.world(2020). See methodological appendix for details.

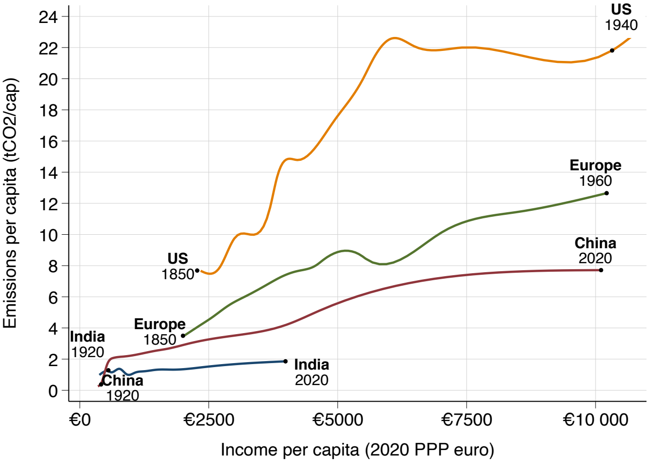
CN to phase out coal by 2050: 3x faster than what Europe achieved



Primary energy consumption in China and India, 1900-2020

Source: Author, based on combination of sources: Mitchell(2003), BP(2020) IEA(2020), ADEME(2019) and WID.world(2020). See methodological appendix for details.

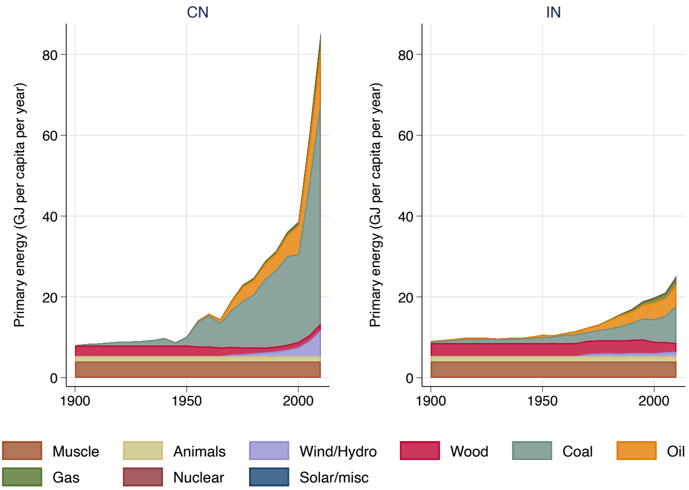
A variety of carbon-growth models: US vs. Europe vs. CN vs. IN



GHG emissions per capita (excluding deforestation)

Source: Author's estimates. Consumption based emissions (i.e. net of imports and exports). See methodological appendix for details.
[Methodology]

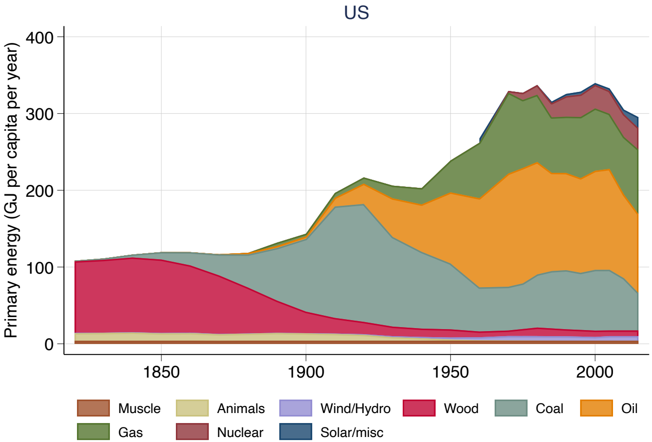
India: development without carbon?



Primary energy consumption in China and India, 1900-2020

Source: Author, based on combination of sources: Mitchell(2003), BP(2020) IEA(2020), ADEME(2019) and WID.world(2020). See methodological appendix for details.

Energy transitions: a history of alternatives (sometimes missed)



Global primary energy consumption, 1820-2020

Source: O'Connor(2014), IEA(2020), WID.world(2020) and own estimates. See methodological appendix for details.

1940s: US worried about running out of energy resources

- Truman's Paley Commission (1952) recommends development of renewables to reduce energy inputs: a more knowledge intensive energy system
- Alternatives are known: solar house developed at MIT 1939-49, electric tramways in US cities ...

MIT's Decentralized solar house 1939-49

1940s: US worried about running out of energy resources

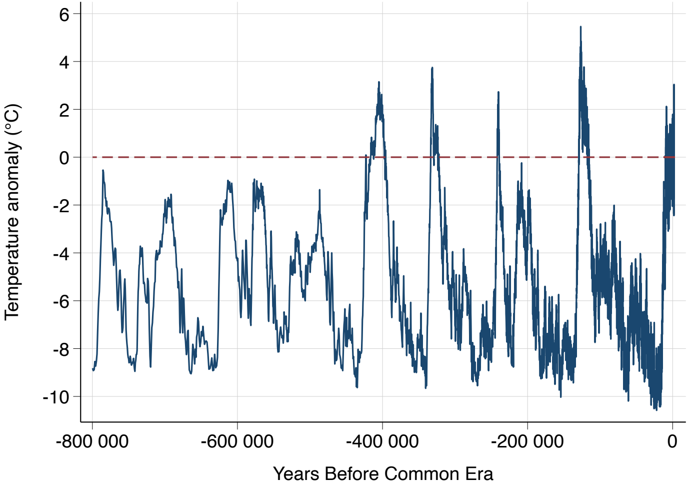
- Strategy by centralized electricity to break decentralized options (Bonneuil and Fressoz, 2013)
- Entente from oil & car industry to break public electric transportation (GM condemned in 1951)

1950s: Destruction of US public electric transport system by oil & car industry

(Terminal Island, Calif.) AWAITING DESTRUCTION--Old Pacific Electric cars are piled up like toys at junkyard, awaiting dismantling to become scrap metal.
Los Angeles Times, March 19, 1956

Source: UCLA Digital Archives Library

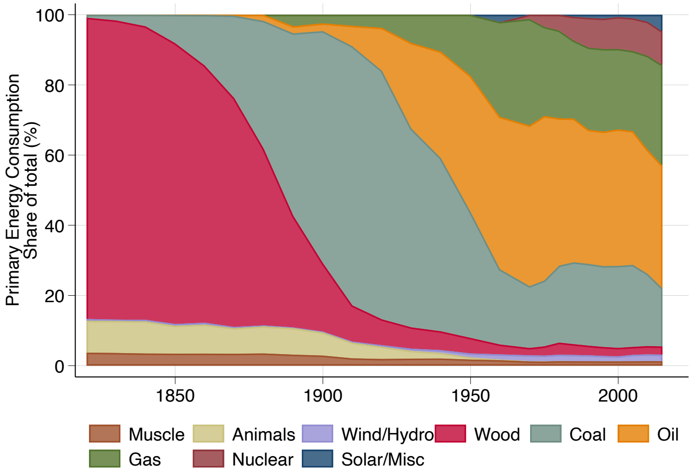
Global temperature anomaly in the very long run



Temperature anomaly in the South Pole since 800 000 BCE

Source: Data from Jouzel et al. (2007). [Back]

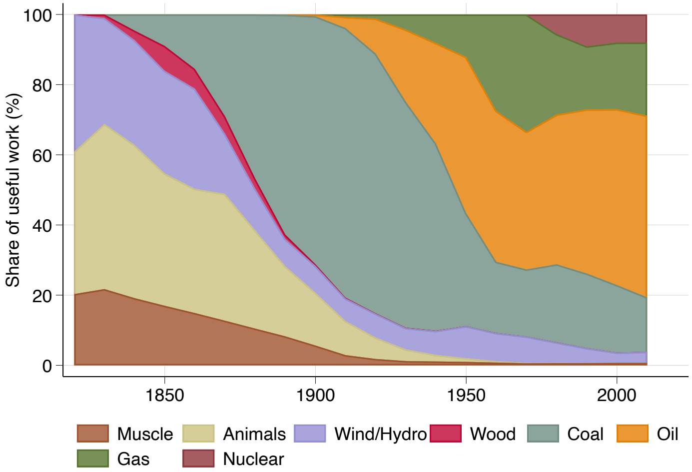
Below: primary energy (matters for the planet). Next slide: useful work (after energy production losses).



Share of primary energy in the US, 1820-2020

Source: Author, based on O'Connor(2014) and IEA(2020) for the recent period.

Focusing on useful work changes the picture, but useful work=1-10% primary energy



Share of useful work in the US, 1820-2020

Source: Author, based on O'Connor(2014) and IEA(2020) for the recent period.

→ [*Back*]

Detailed sources: historical data used

- UNFCCC https://di.unfccc.int/time_series
- PRIMAP (2020) data downloaded from PRIMAP database, based on Gütschow, J.; Jeffery, L.; Gieseke, R.; Günther, A. (2019): The PRIMAP-hist national historical emissions time series v2.1 (1850-2017). GFZ Data Services. https://doi.org/10.5880/pik.2019.018.
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[Back]

Detailed sources: historical data used

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