



University of Natural Resources  
and Life Sciences, Vienna  
Department of Economics and Social Sciences

# Socio-metabolic analysis of economy-wide material flows, stock accumulation and service provision in the United Kingdom

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**ÖFG** // ÖSTERREICHISCHE  
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European Research Council  
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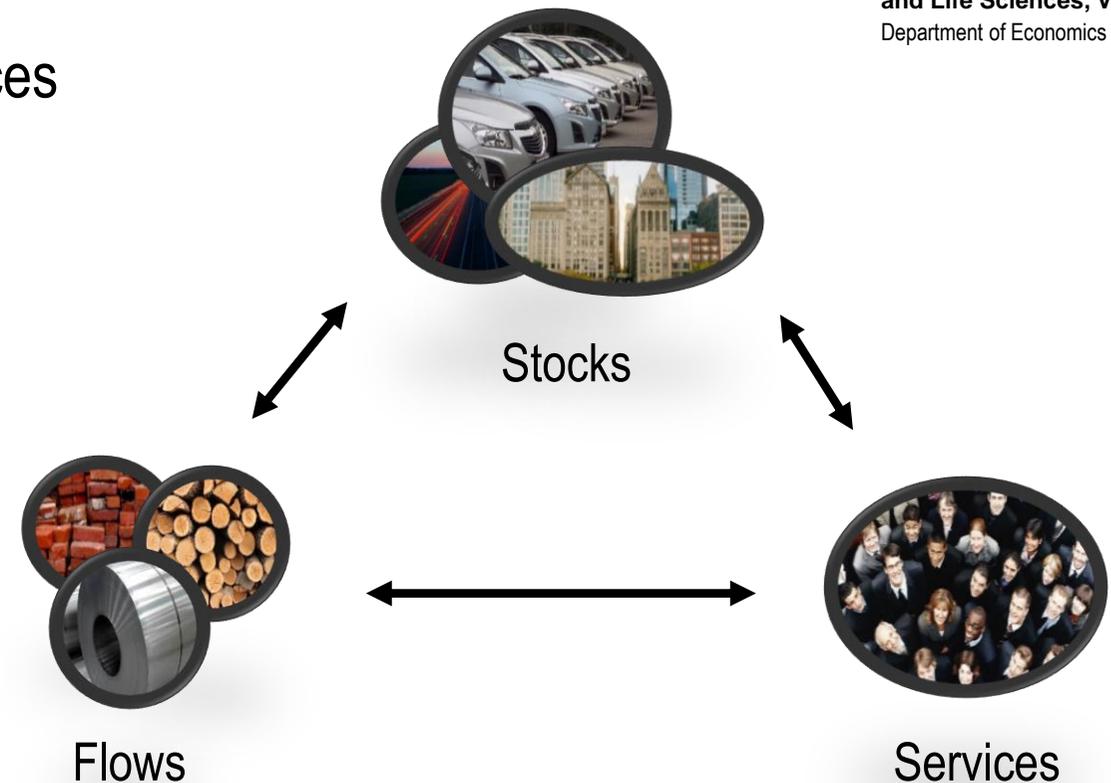
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# Combining economy-wide metabolism with services



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- Stock-Flow-Service Nexus<sup>1</sup>
  - Interplay stocks & flows to provide services
  - Efficiency measures beyond GDP
- In-use stocks take crucial role<sup>2</sup>
  - “Consumption Couplers”
  - “Dynamics Determiners”
  - “Capital- & Power Containers”



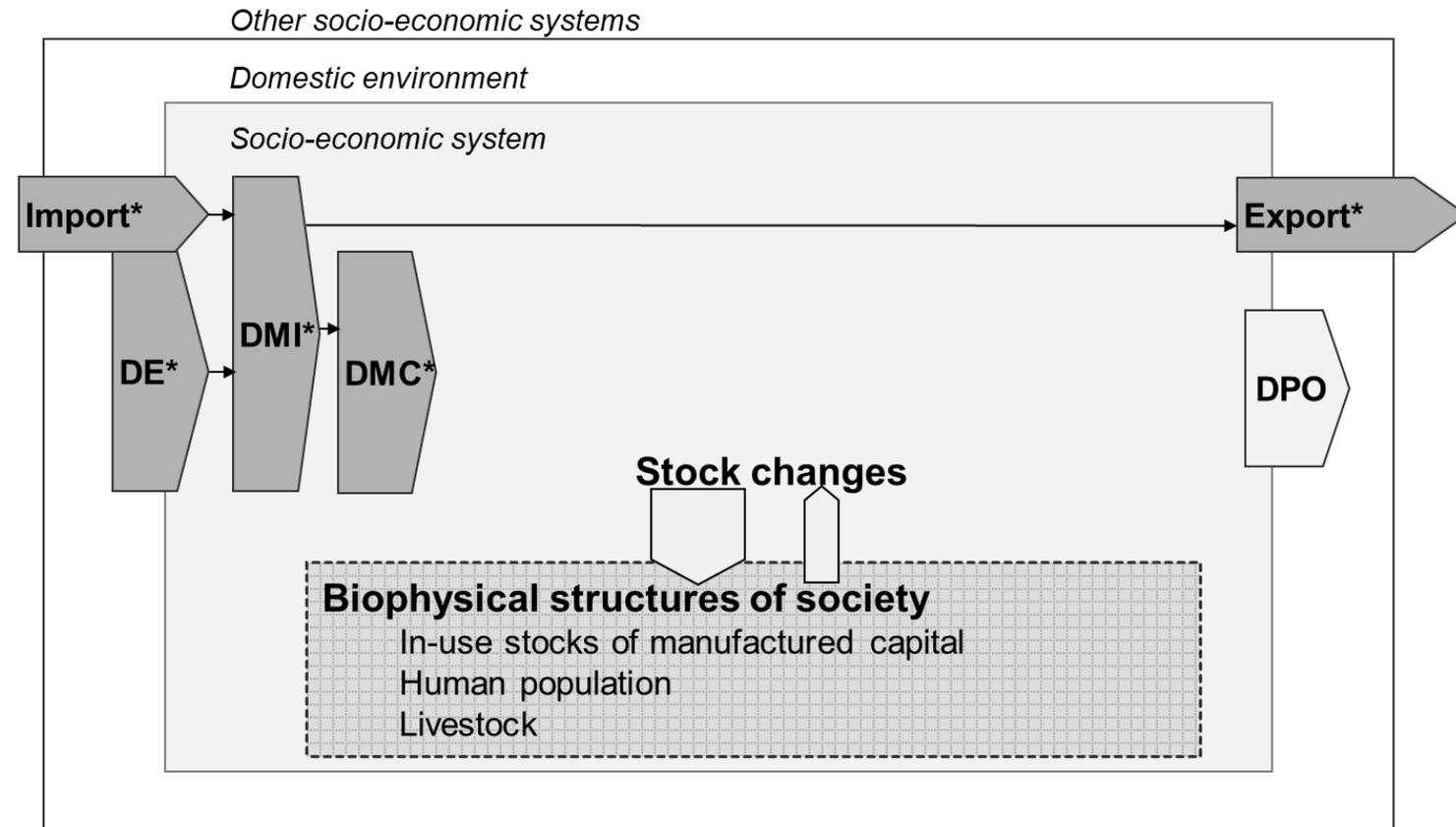
Picture sources: Appendix

<sup>1</sup>Haberl et al. (2017)

<sup>2</sup>Adapted from Pauliuk & Müller (2014)

# Economy-wide MFA well developed – stocks to be included

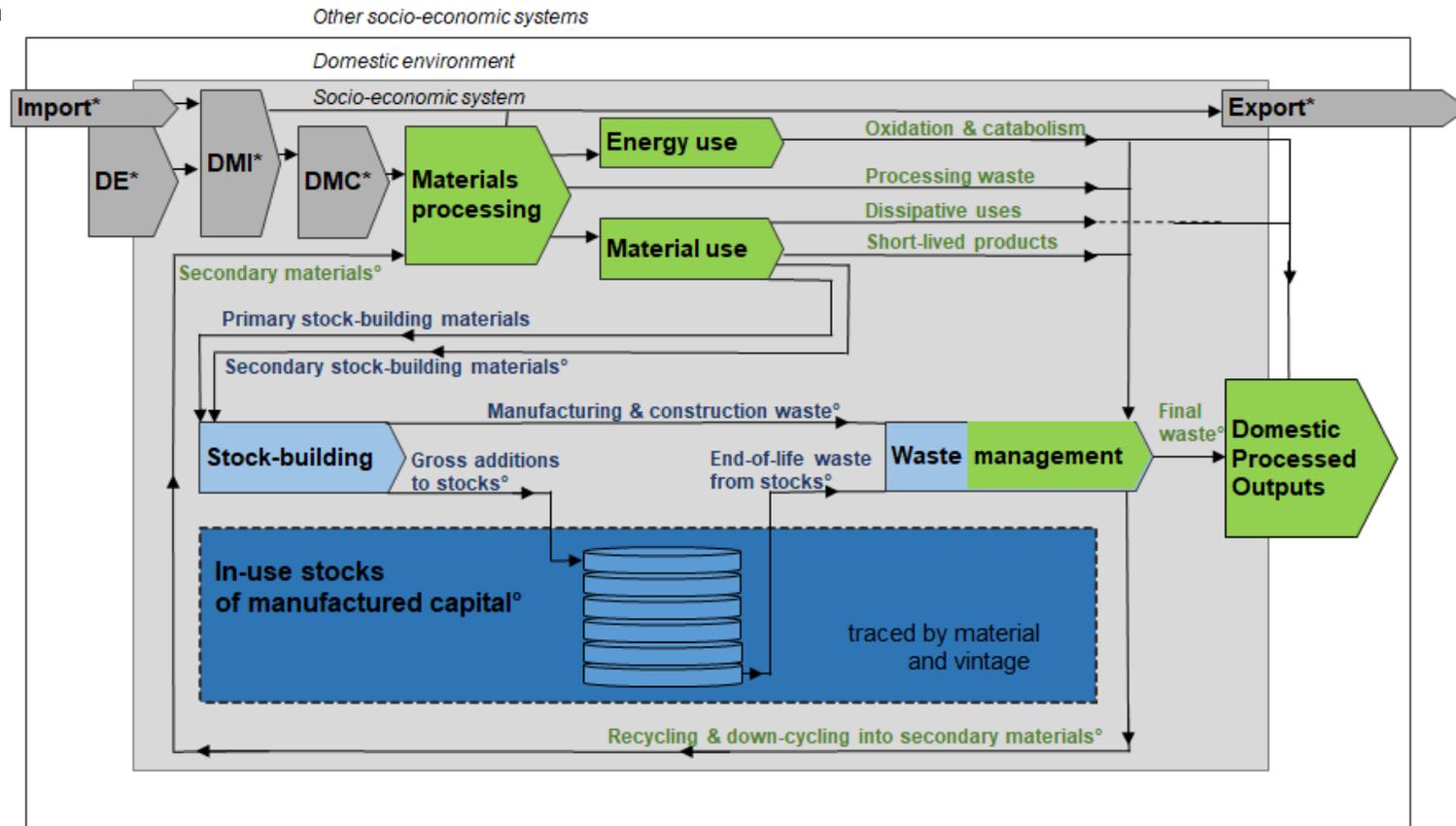
- Dynamic Material Inputs, Stocks and Outputs (MISO-model)<sup>1</sup>
  - Consistent extension of economy-wide MFA
  - Inflow-driven dynamic MFA



<sup>1</sup>Wiedenhofer, D., Fishman, T., Haas, W., Krausmann, F., (2019). Integrating material stock dynamics into economy-wide material flow accounting: concepts, modelling, and global application for 1900-2050.

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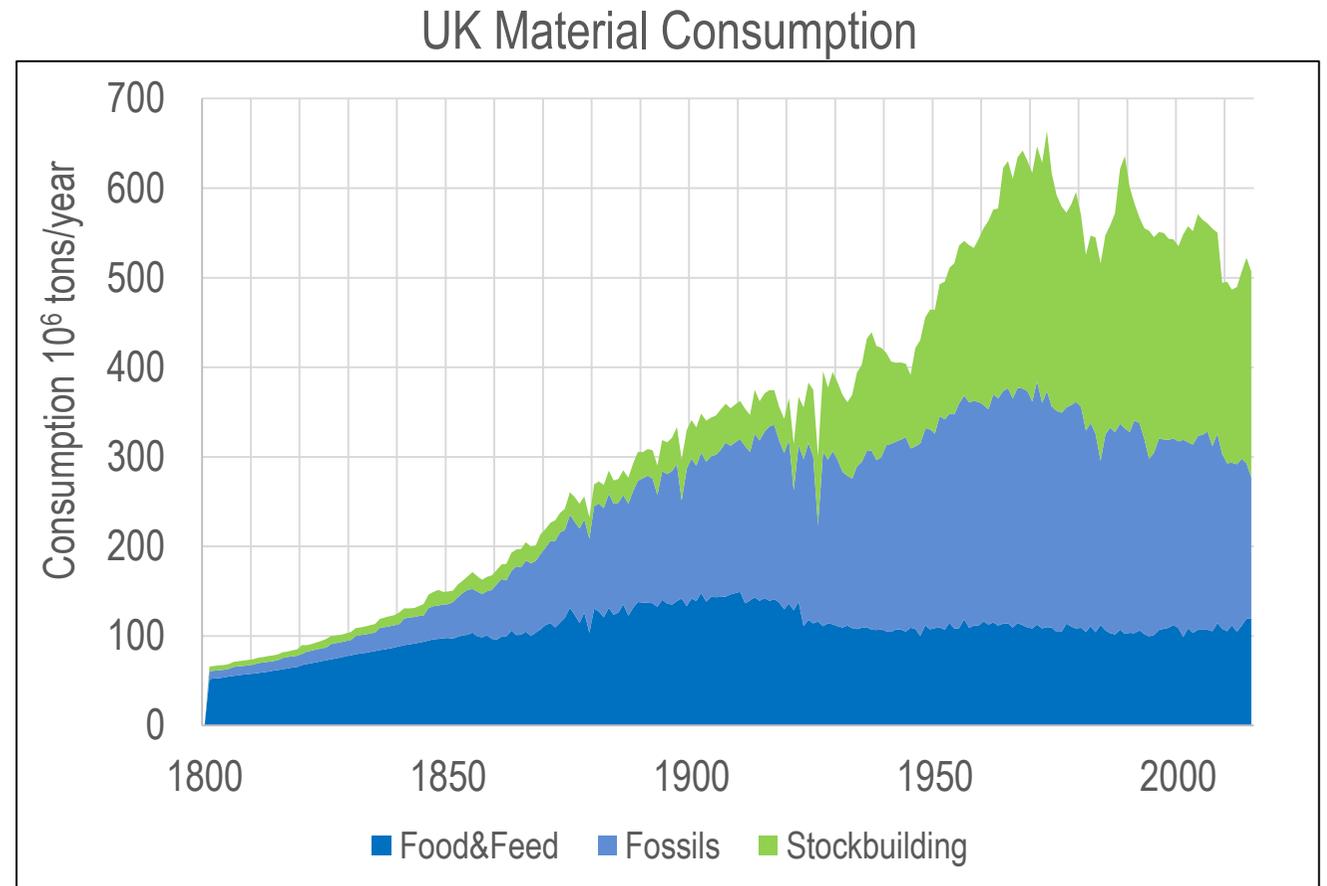


<sup>1</sup>Wiedenhofer, D., Fishman, T., Haas, W., Krausmann, F., (2019). Integrating material stock dynamics into economy-wide material flow accounting: concepts, modelling, and global application for 1900-2050.

# The United Kingdom – a double frontrunner ?



- Frontrunner industrialisation ~1760-1850
- De-industrialisation starts 1980s



<sup>1</sup>Schandl & Schulz (2002)

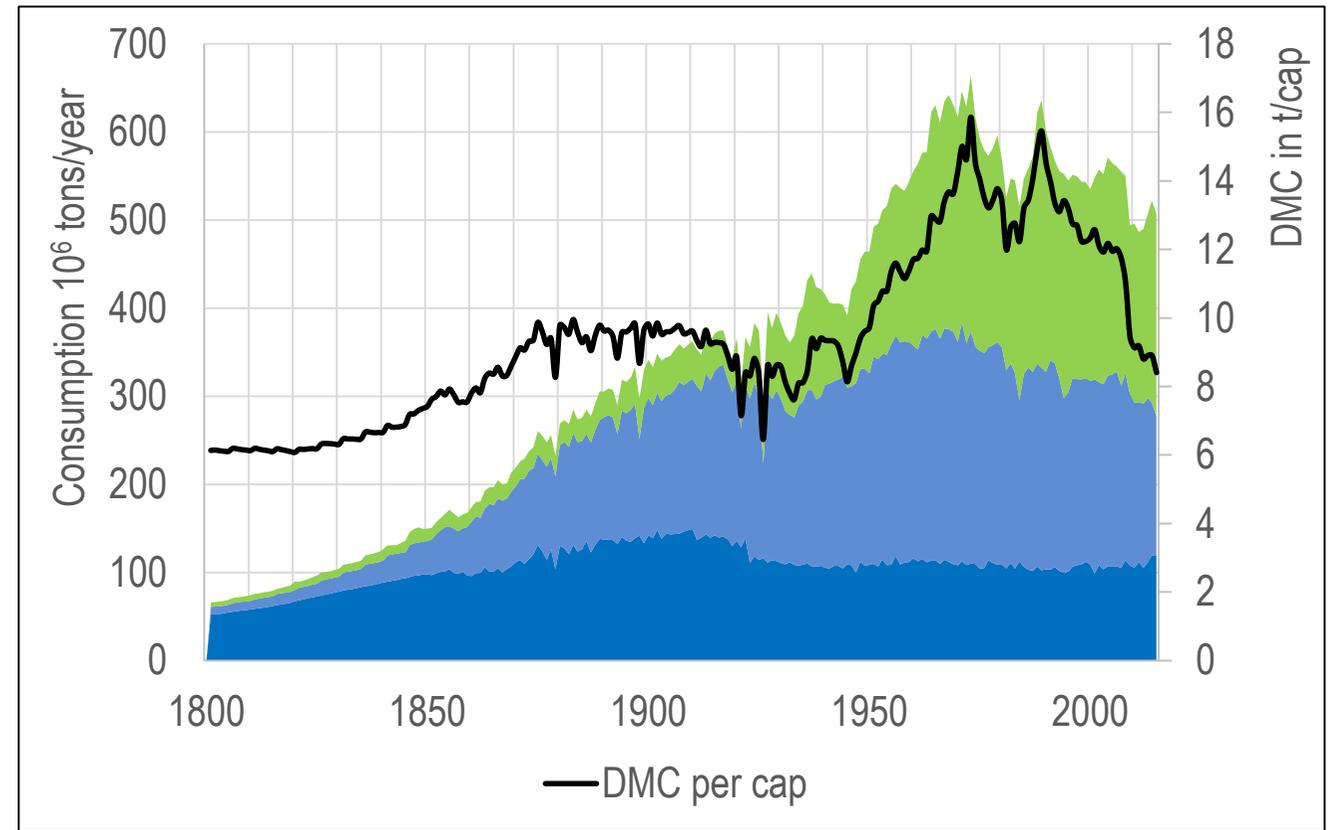
<sup>2</sup>Gingrich (2011)

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UK Material Consumption



<sup>1</sup>Schandl & Schulz (2002)

<sup>2</sup>Gingrich (2011)

# The United Kingdom – a double frontrunner ?



**The Guardian**

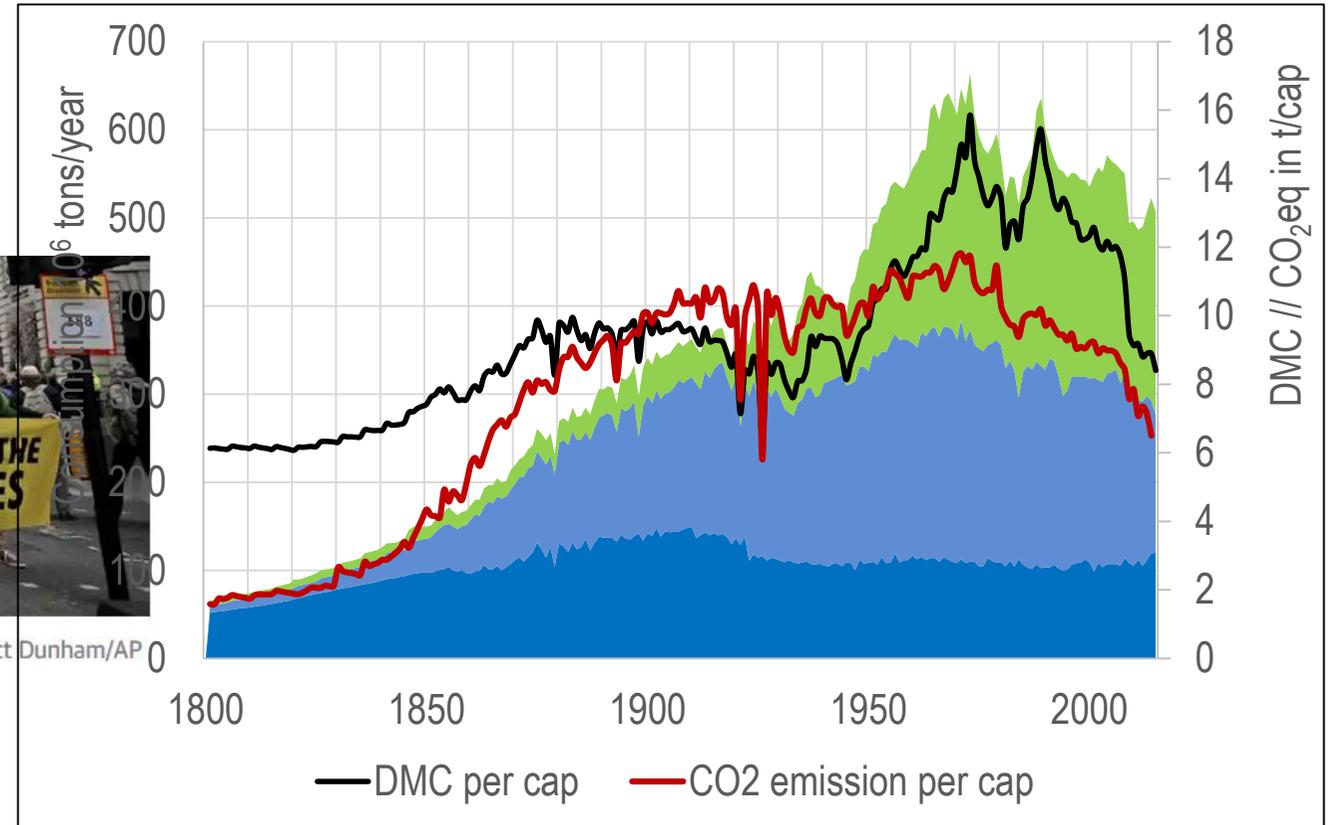
**MPs endorse Corbyn's call to declare climate emergency** Wed 1 May 2019 19:51 BST

[theguardian.com/environment/2019/may/01/declare-formal-climate-emergency-before-its-too-late-corbyn-warns](https://www.theguardian.com/environment/2019/may/01/declare-formal-climate-emergency-before-its-too-late-corbyn-warns)



▲ Extinction Rebellion climate change protesters block a road in the City of London. Photograph: Matt Dunham/AP

UK Material Consumption & CO<sub>2</sub> emissions

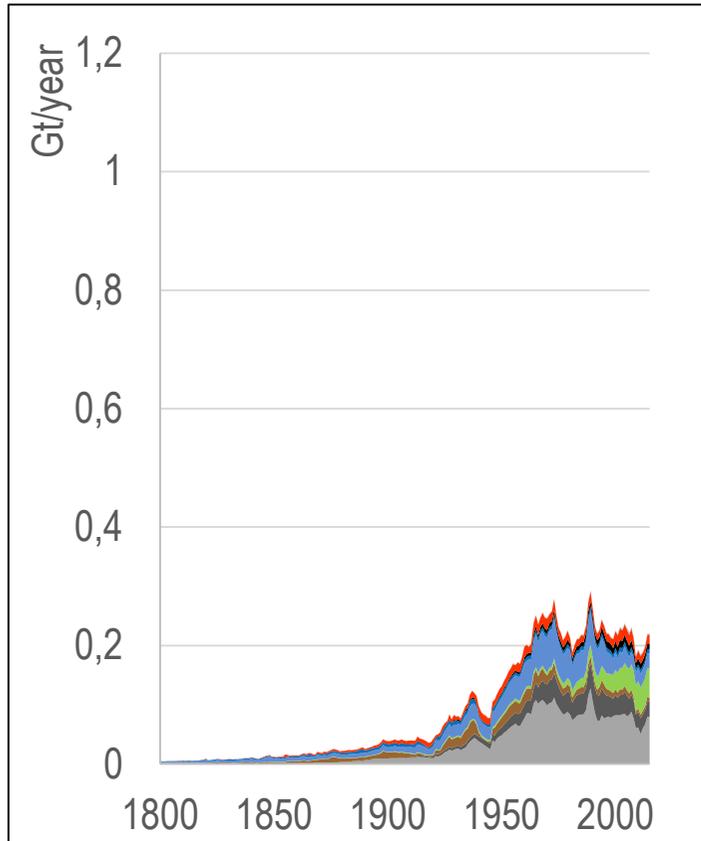


<sup>1</sup>Schandl & Schulz (2002)

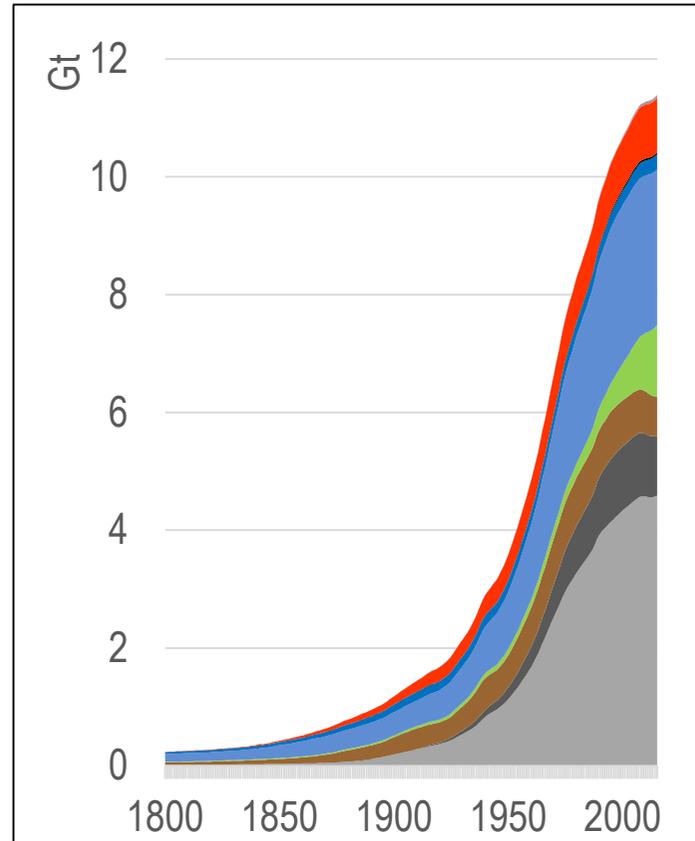
<sup>2</sup>Gingrich (2011)

# UK stocks decreasing too?

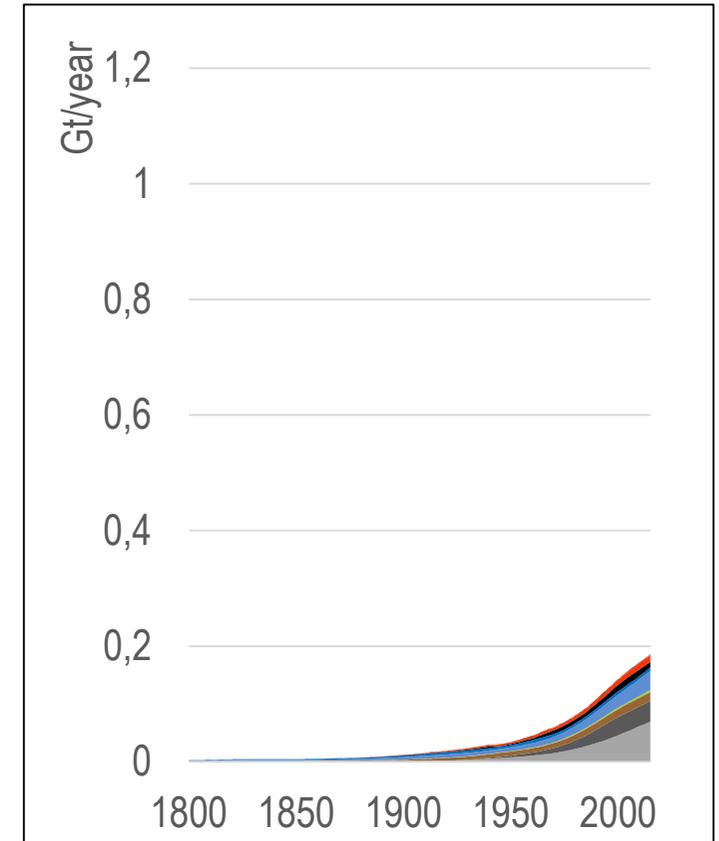
Inputs to Stocks, stacked



In-Use Stocks, stacked



End of Life Outflows, stacked

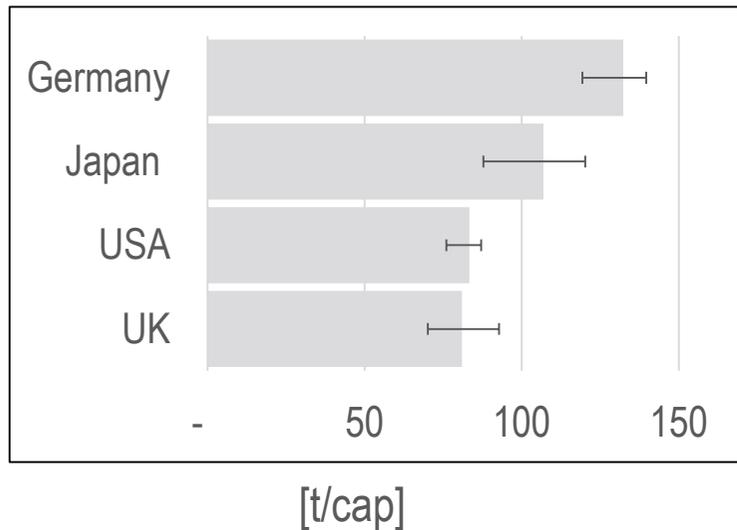


■ Lead 
 ■ Copper 
 ■ Aluminum 
 ■ Iron, steel 
 ■ Paper 
 ■ Solidwood products 
 ■ Virgin\_SandGravel 
 ■ Downcycled\_ConstrMinerals 
 ■ Bricks 
 ■ Asphalt 
 ■ Concrete

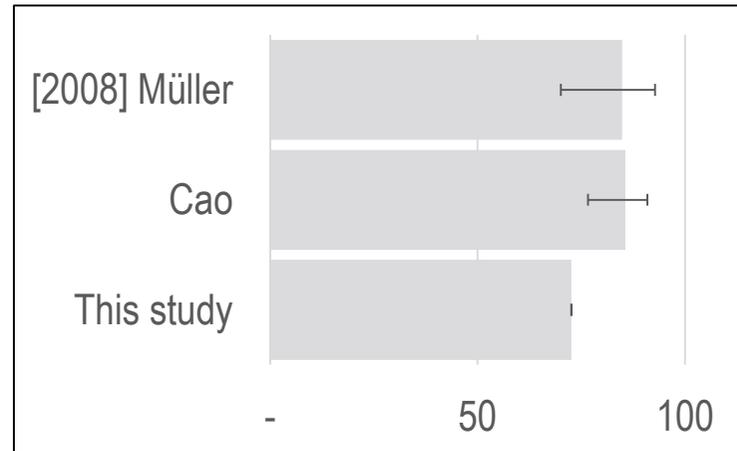
# UK per cap stocks appear lower than elsewhere

- UK 2010: 180 t/cap
- Ø Industrial country 2010: 340 t/cap<sup>1</sup>
- High pop-density, de-industrialisation
- Sand & gravel much lower
- → closer look at road infrastructure
- Most per cap. values +/- other studies

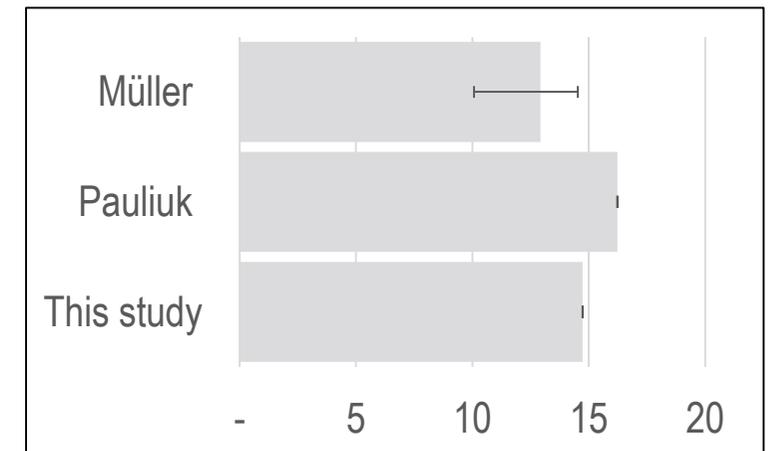
Concrete p cap 2010<sup>2-4</sup>



UK Concrete p cap 2010 / 08<sup>2,4</sup>



UK Iron/Steel p cap 2008<sup>3,4</sup>



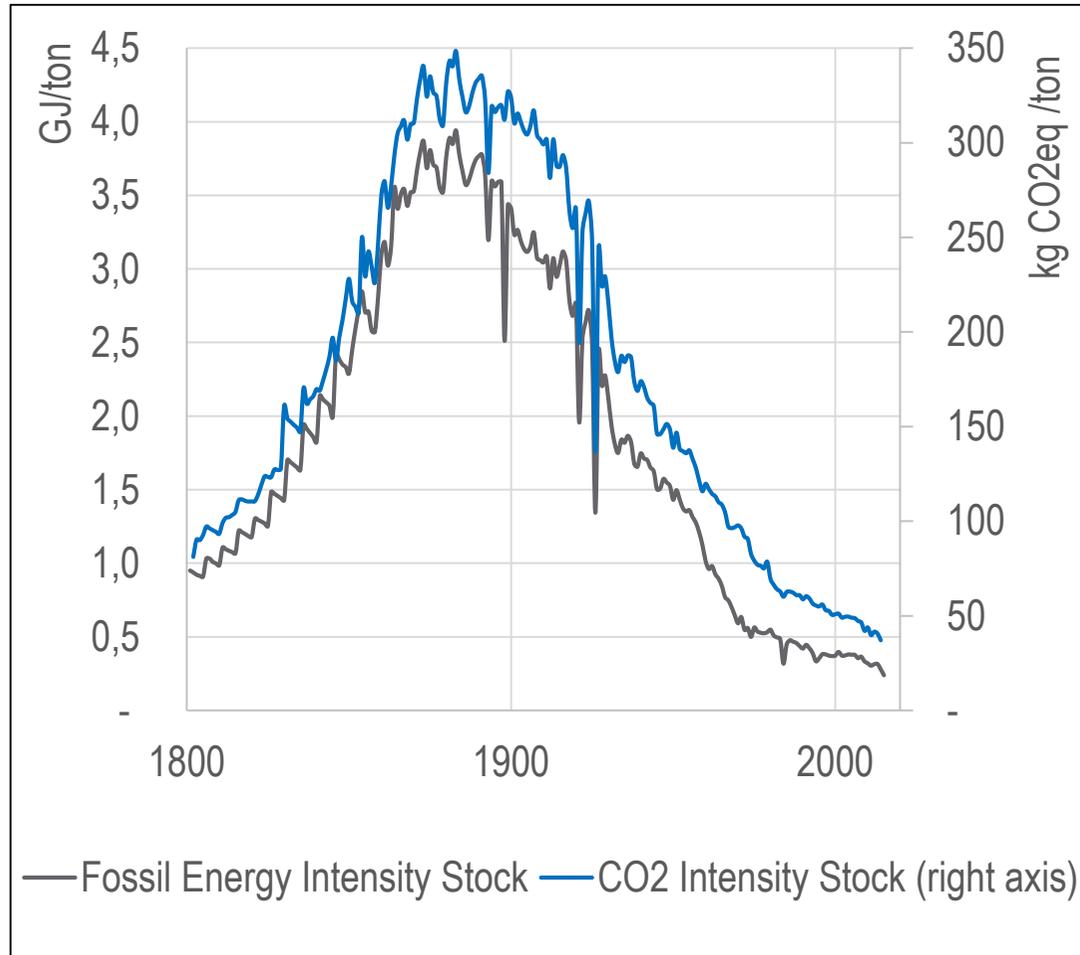
<sup>1</sup>Krausmann et al. (2017) <sup>4</sup>Müller et al. (2013)

<sup>2</sup>Cao et al. (2017)

<sup>3</sup>Pauliuk et al. (2013)

# Per stock efficiency gains partially translate in absolute wins

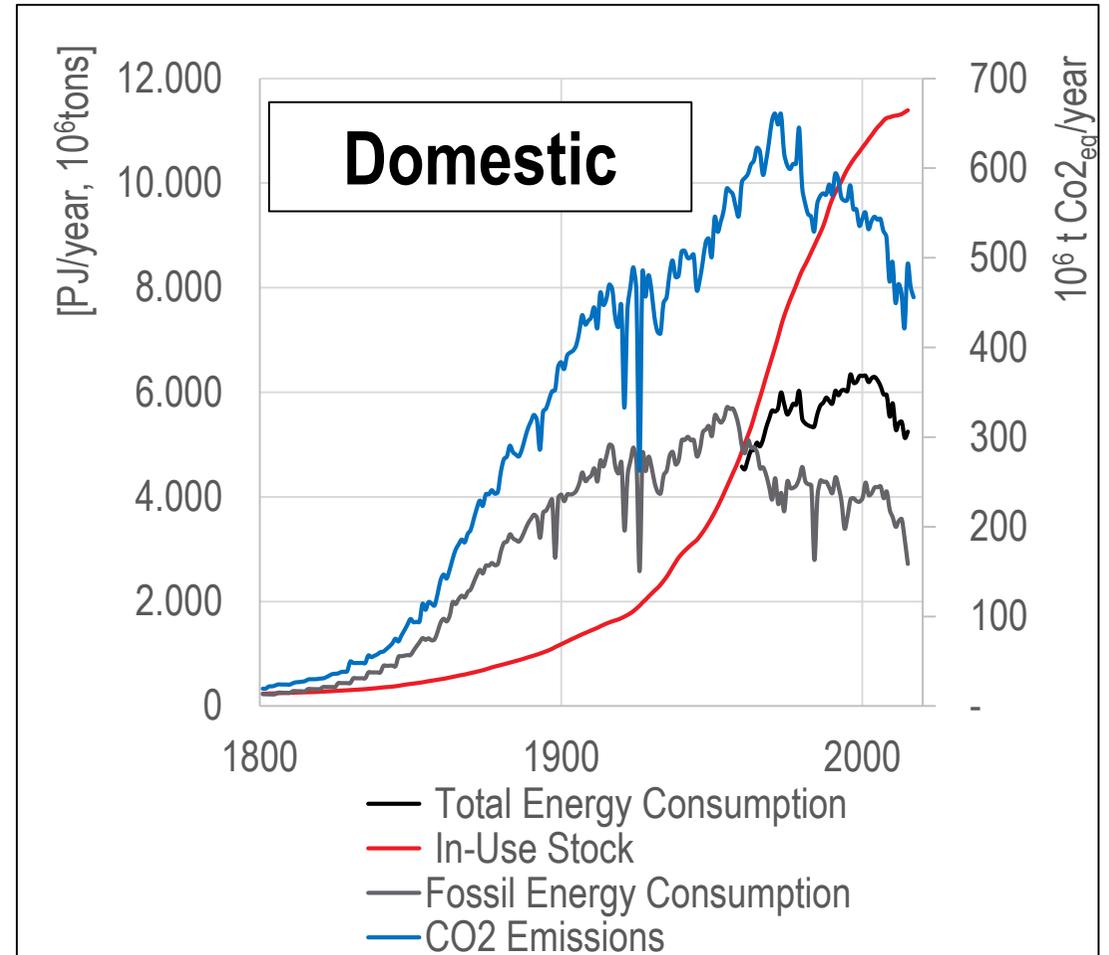
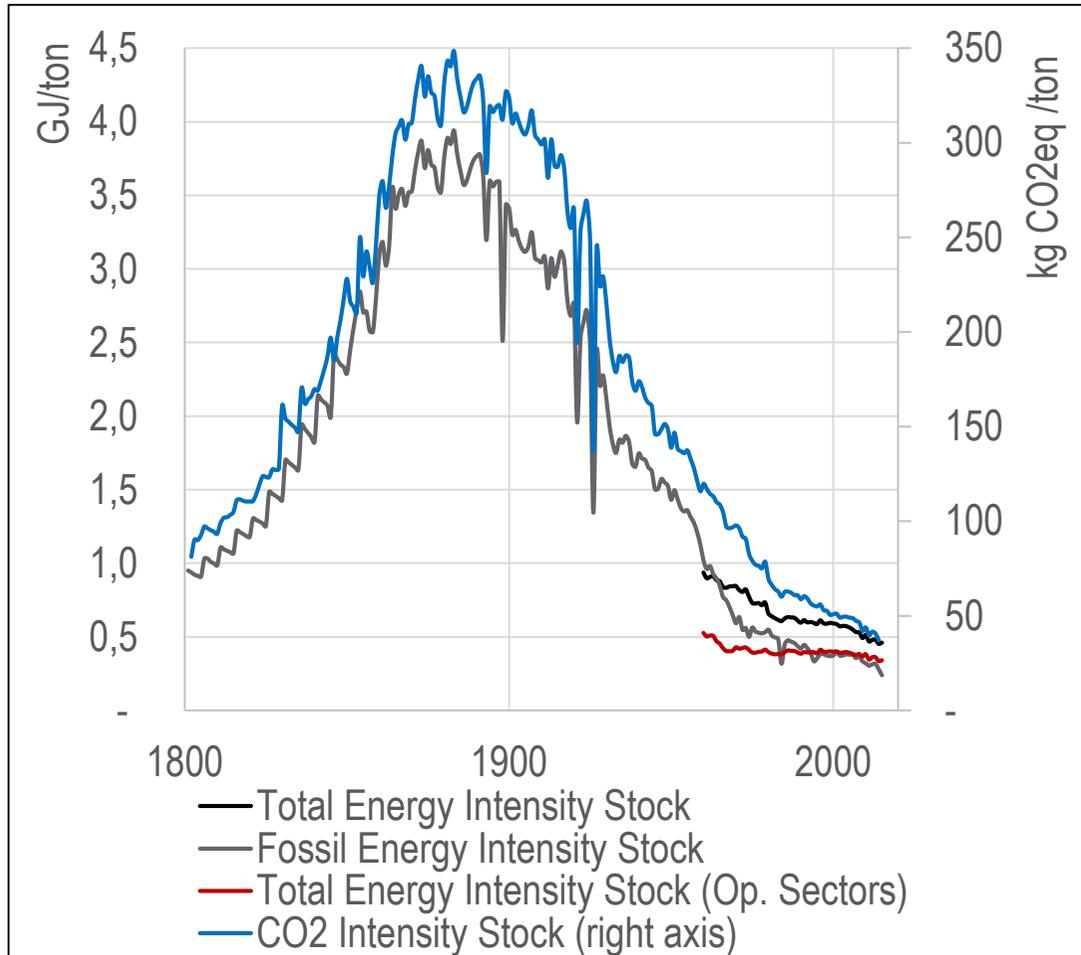
Primary Energy Consumption / CO<sub>2</sub> Emissions per Unit of In-Use Stock



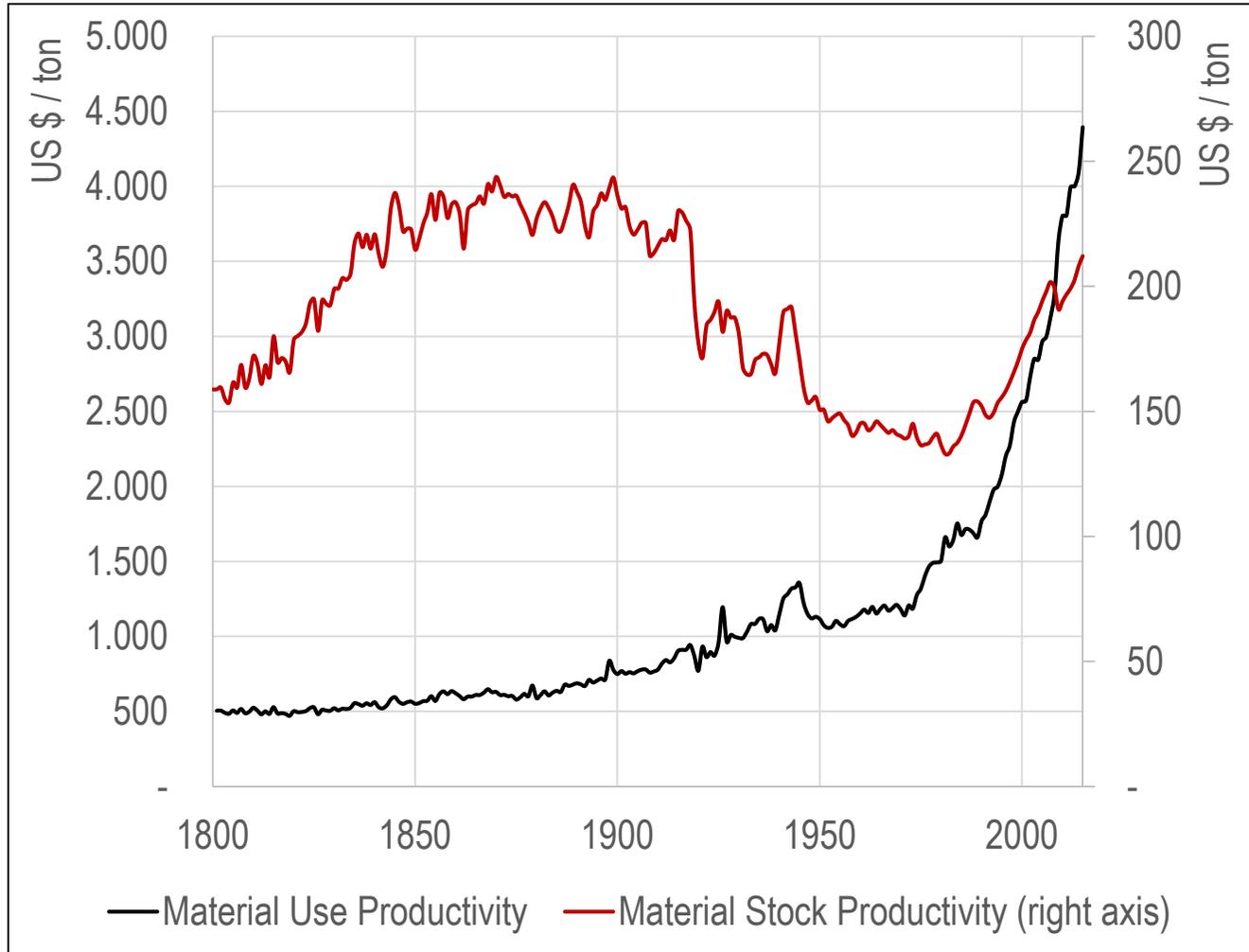
# Per stock efficiency gains partially translate in absolute wins

Primary Energy Consumption / CO<sub>2</sub> Emissions per Unit of In-Use Stock

Stock, Primary Energy Consumption, CO<sub>2</sub> emissions (total)

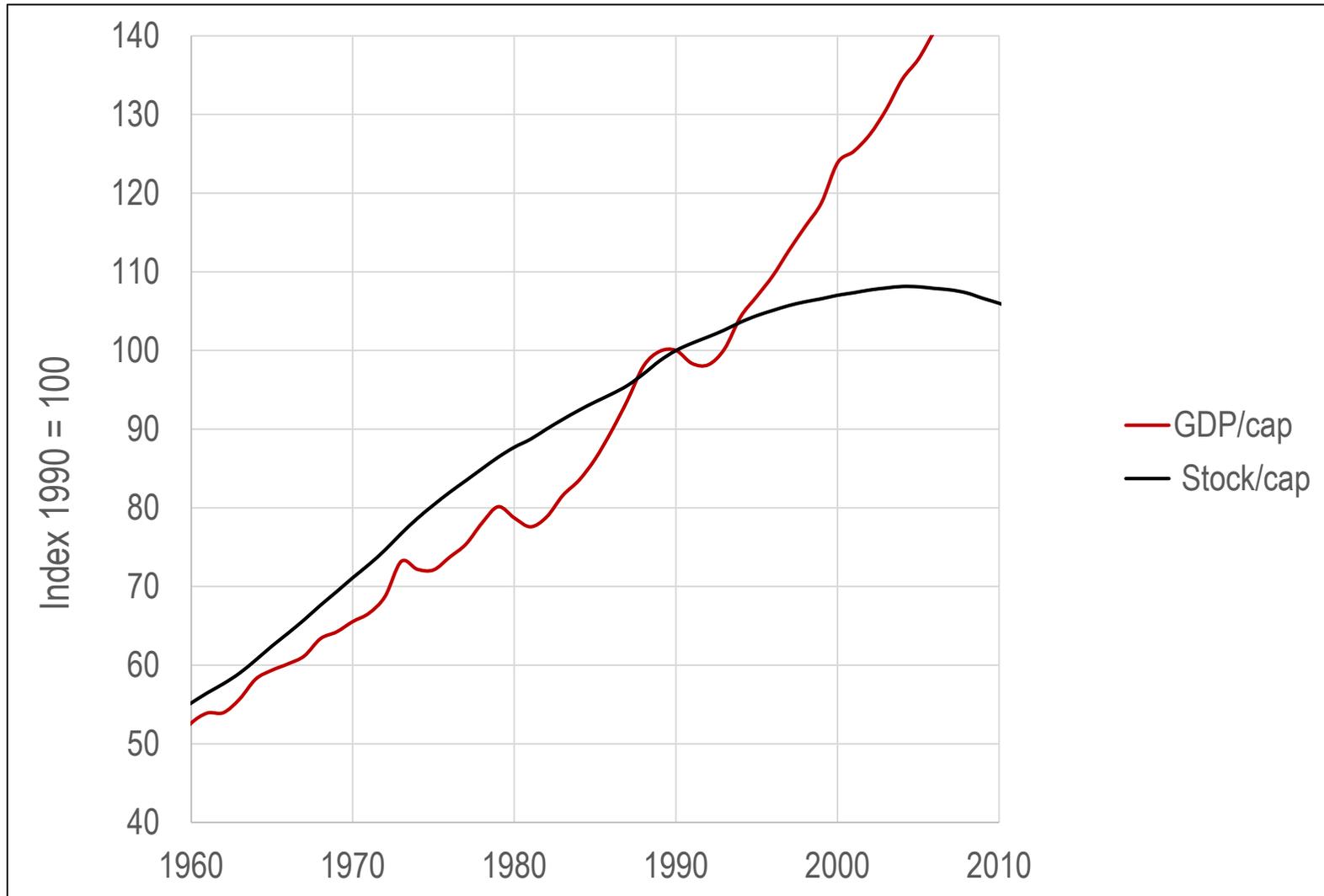


# Decoupling? Productivity of material flows and stocks

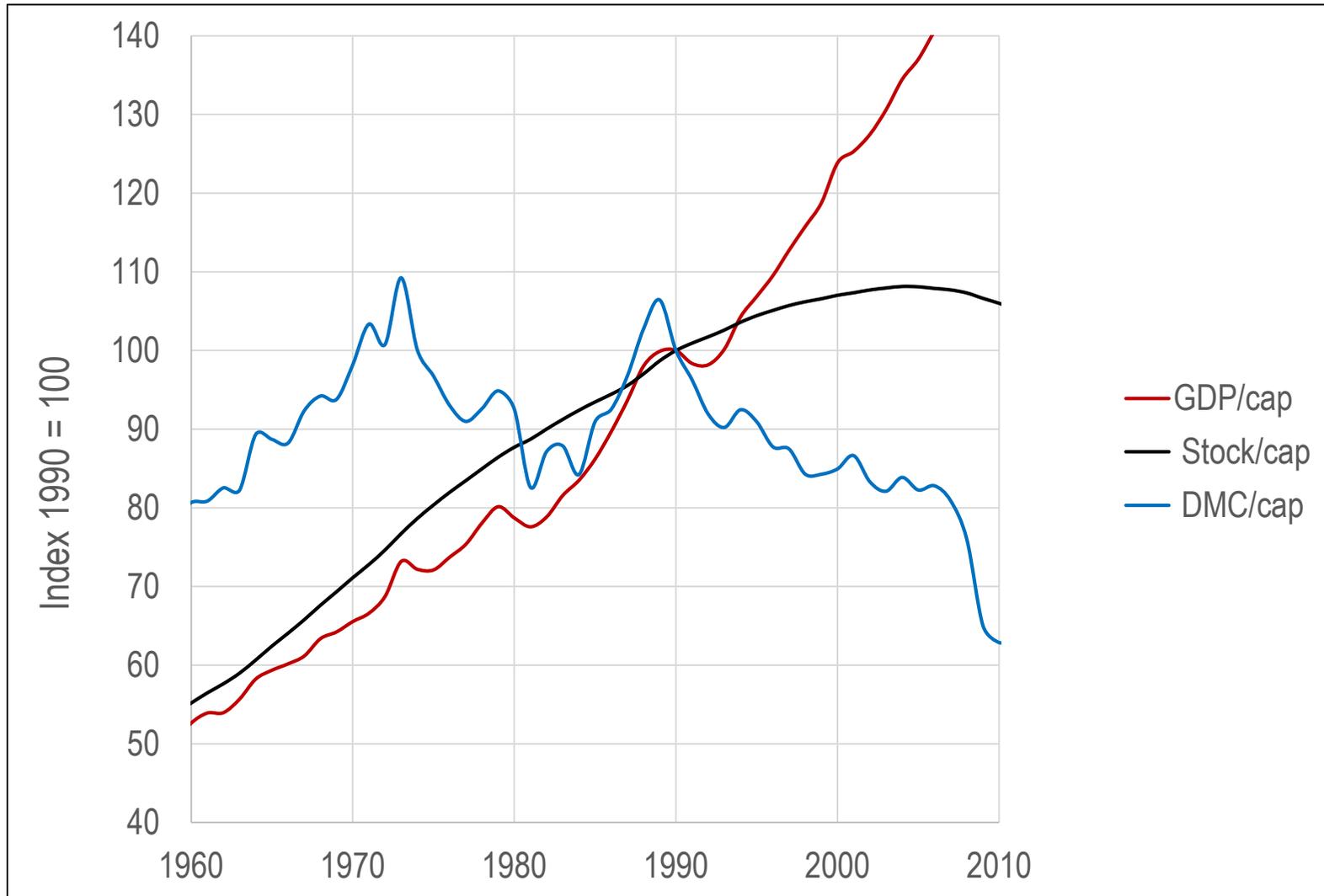


- *Material use productivity 9x*
- *Stock productivity +/-30% of mean*

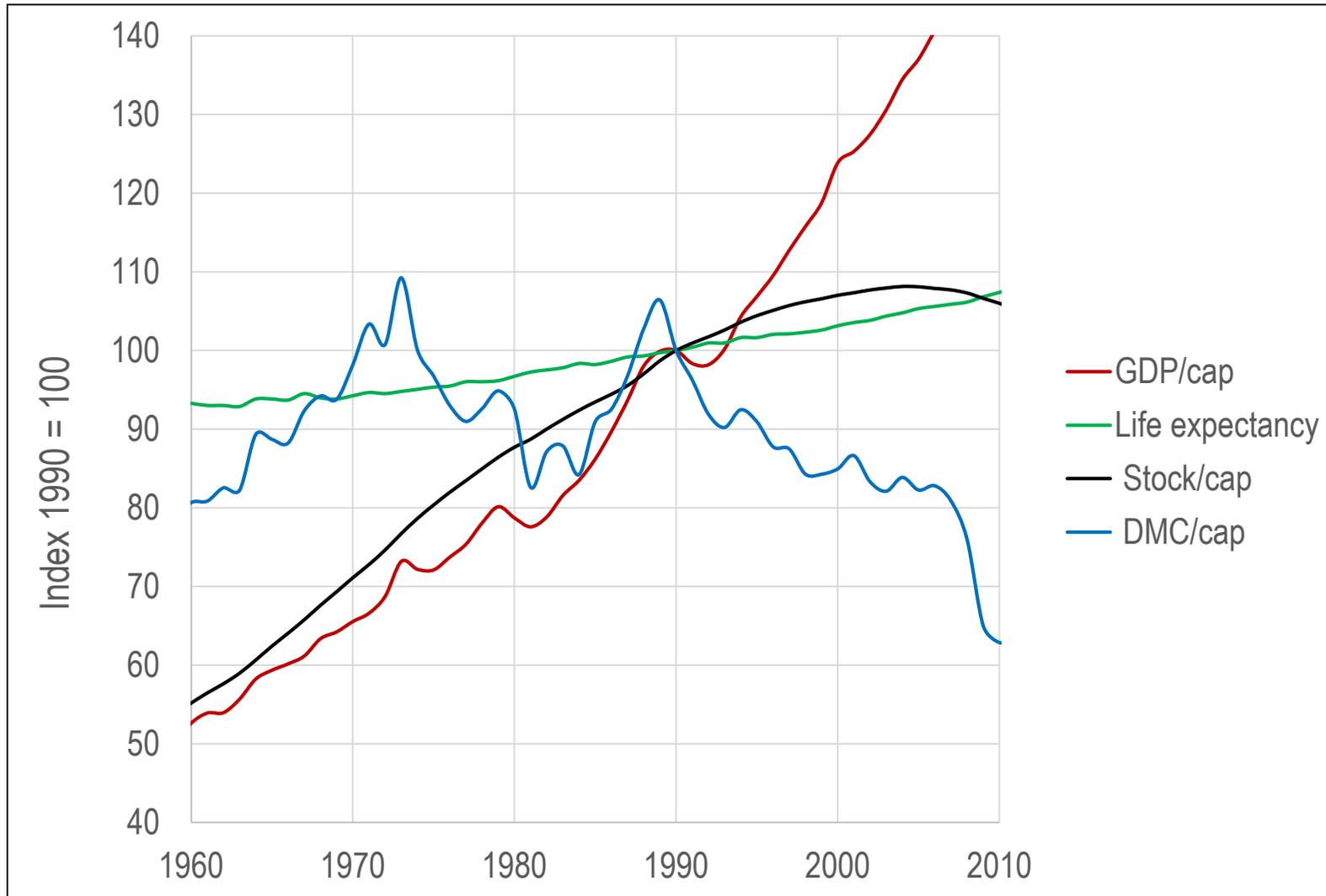
# Aggretate stock-flow-service nexus



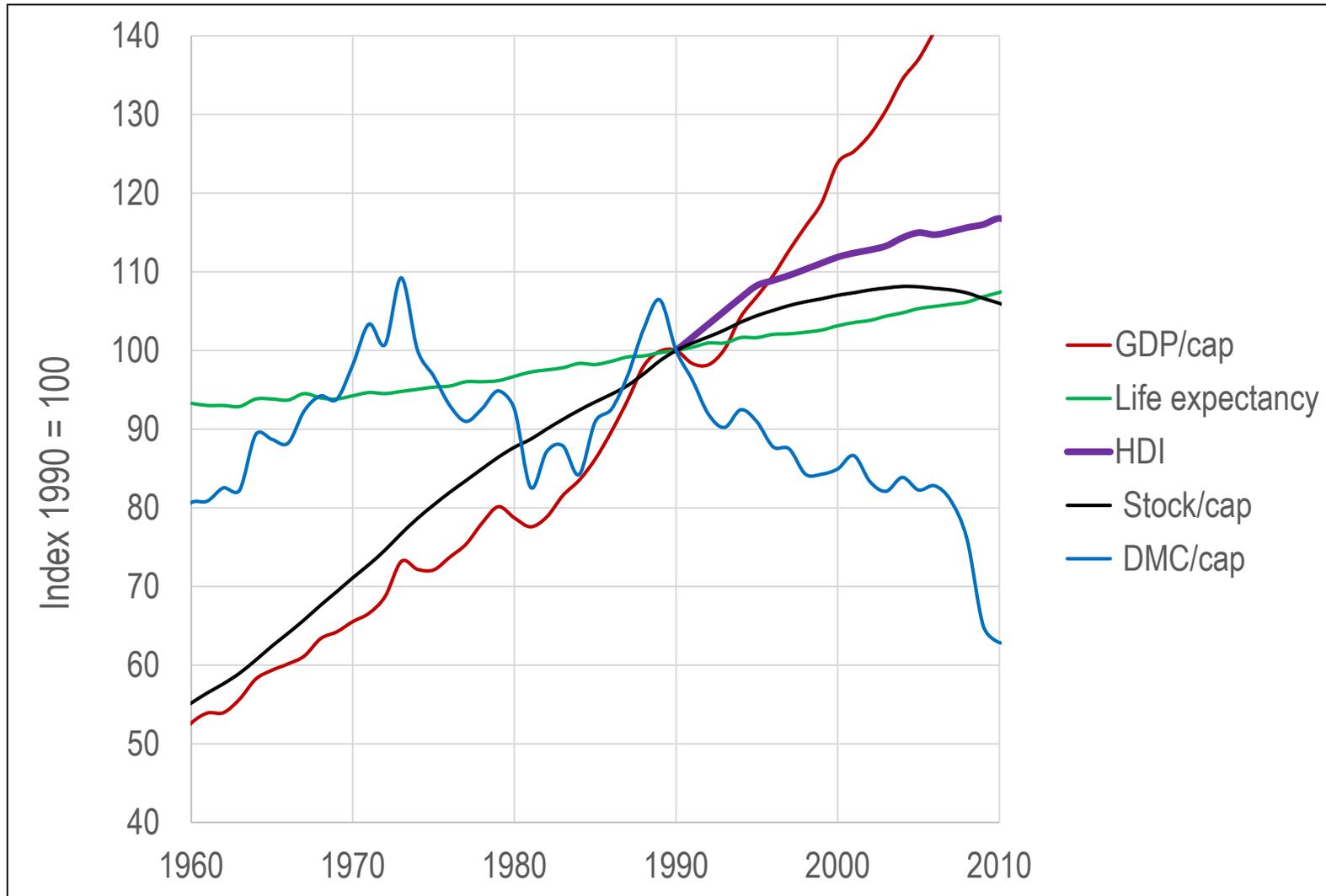
# Aggretate stock-flow-service nexus



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# Aggretate stock-flow-service nexus



# Next Steps & Key Messages



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- Next Steps
  - Connection to more disaggregated service indicators
  - → differentiate stock types over economy-wide materials
  - Close-up UK road stock
- Key messages
  - UK domestic material consumption & CO<sub>2</sub> emissions recently decreasing
  - including emissions from aviation/shipping shrinks improvements
  - Including trade footprints → any improvements ?
  - In-use stocks seem to stabilize – however dependent on accuracy of lifetimes!



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# Thank you for listening!

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# Backup Slides

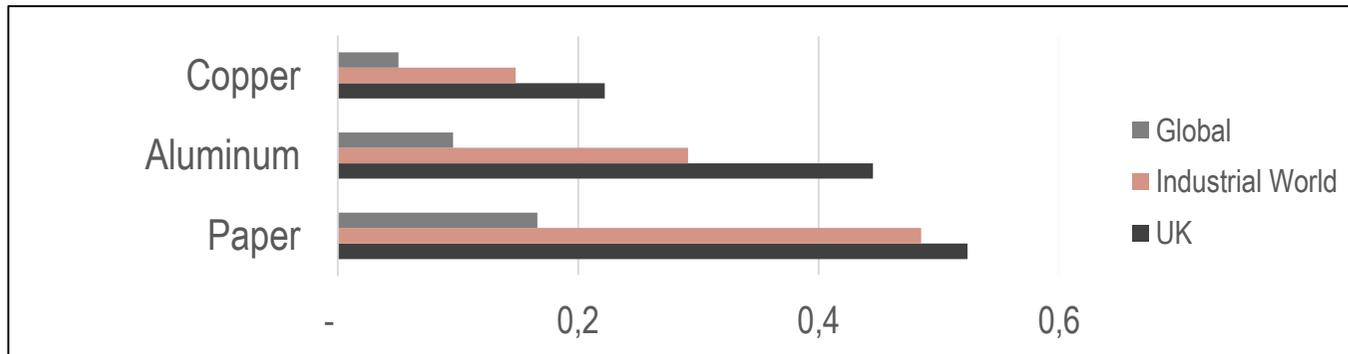
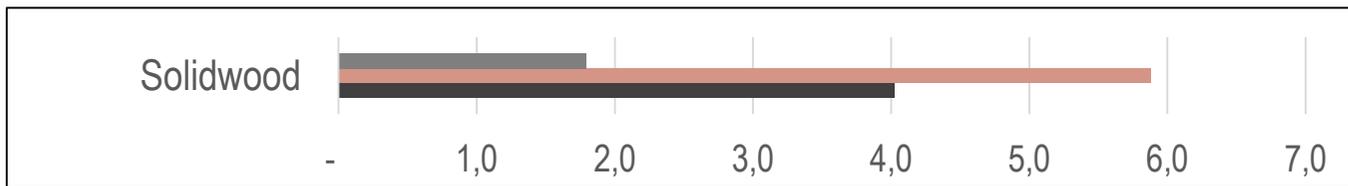
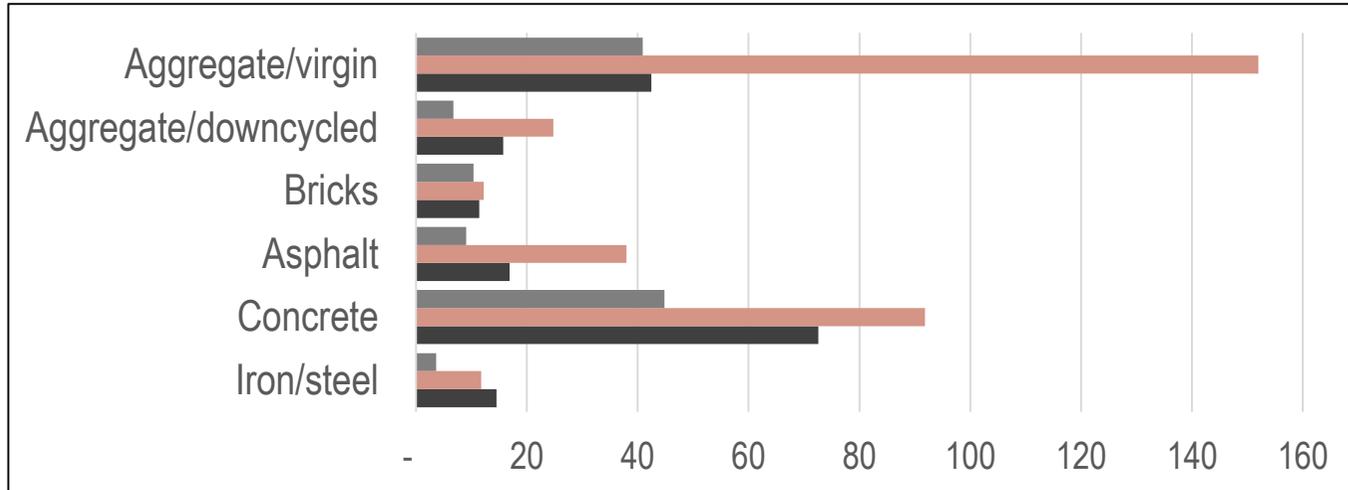


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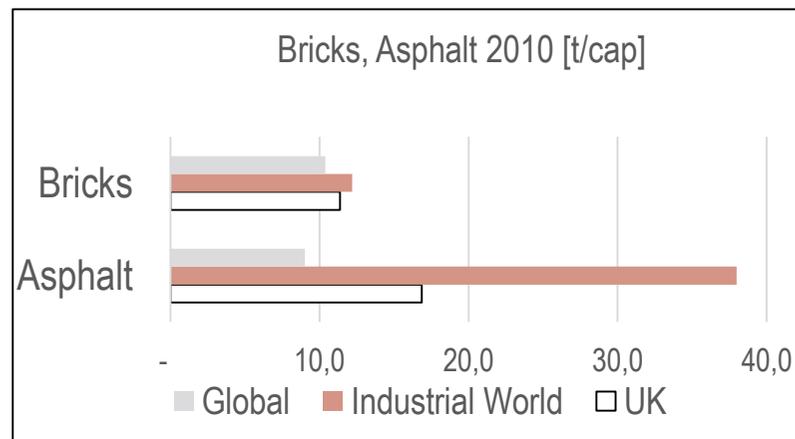
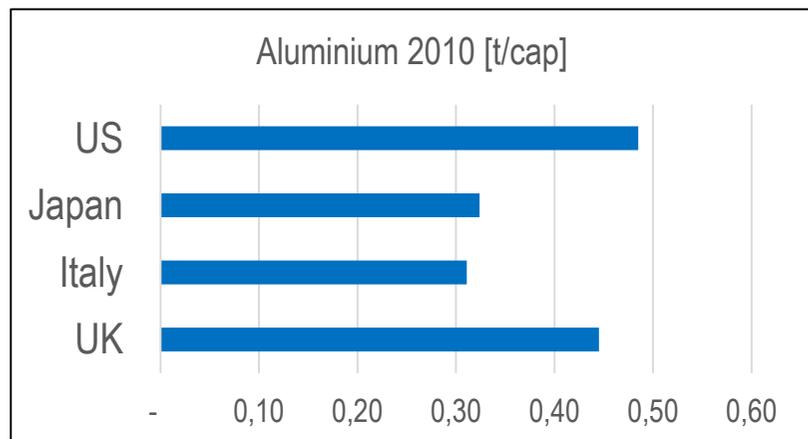
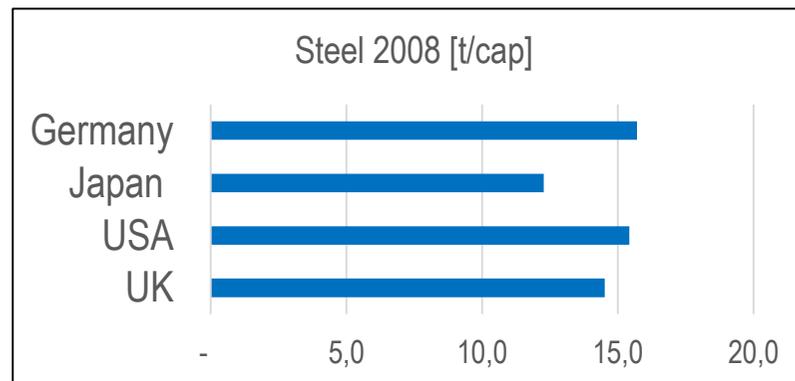
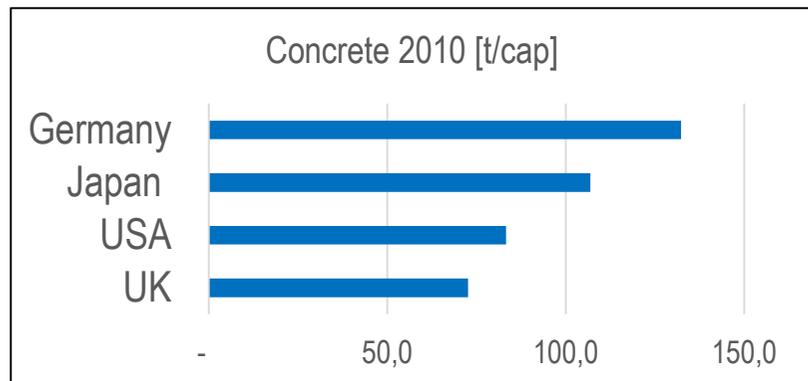
# Per Capita Stock Comparison



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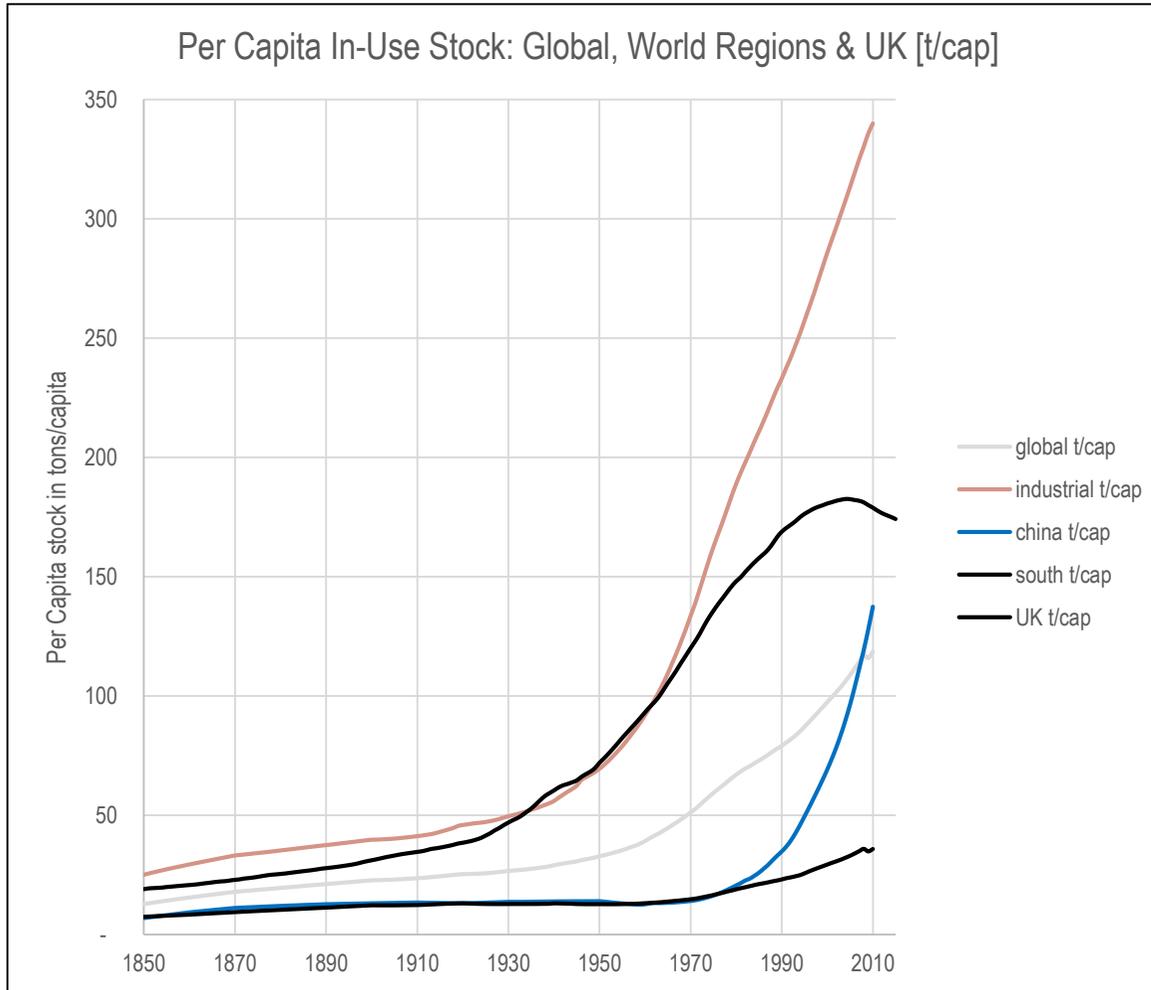


Per capita in-use stock [t/cap]



Per capita in-use stock [t/cap]

# UK vs. Regional Stock Dynamics



- Fishman *et al.*, 2014:
  - *In-Use Stocks 2005*
    - USA: 375 t/cap
    - Japan: 310 t/cap

**Table S3: Country groups**

	<b>Industrial countries</b>	<b>China</b>	<b>Rest of the World (RoW)</b>
<b>Population 2010 [millions]</b>	1,461	1,336	3,938
<b>GDP/cap/yr 2010 [1990 intern. Geary Khamis \$]</b>	18,979	6,714	3,737
<b>Definition of world regions</b>	Europe, Soviet Union/ Former Soviet Union countries (USSR/FSU), USA, Canada, Australia, New Zealand, Japan	China	All other countries: Asia excluding Japan and China, Africa, Latin America and the Caribbean, Oceania excluding Australia and New Zealand
<b>List of considered countries</b>	Austria, Belgium, Luxembourg Denmark, Finland, France, Germany,	China	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Dem Republic of), Congo
			Greece, Iceland, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, Belarus, Kazakhstan, Kyrgyzstan, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, T.F.Yug.Rep. Macedonia, Republic of Moldova, Poland, Romania, Yugoslavia, Slovakia, Slovenia, Ukraine, Canada, United States, Australia, New Zealand, Japan
			(Republic of), Côte d'Ivoire, Djibouti, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Réunion, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania (United Rep of ), Togo, Uganda, Zambia, Zimbabwe, Ethiopia (Territory of), Eritrea, Ethiopia, Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, Fiji Islands, French Polynesia, India, Indonesia, Korea (Dem People's Rep), Korea (Republic of), Laos, Malaysia, Mongolia, Myanmar, Nepal, New Caledonia, Pakistan, Papua New Guinea, Philippines, Samoa, Solomon Islands, Sri Lanka, Thailand, Timor-Leste, Vanuatu, Viet Nam, Argentina, Bahamas, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Suriname, Trinidad and Tobago, Uruguay, Venezuela (Boliv Rep of), Algeria, Bahrain, Egypt, Iran (Islamic Rep of), Iraq, Israel, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates, Yemen

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In: Sustainability 9

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- UK 255 people/km<sup>2</sup> - [2010](#)
  - <https://ec.europa.eu/eurostat/tgm/table.do?tab=table&language=en&pcode=tps00001&tableSelection=1&footnotes=yes&labeling=labels&plugin=1>
- Germany 229 people/km<sup>2</sup> - 2010
  - [http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Presse/pm/2009/11/PD09\\_417\\_12411.psm1](http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Presse/pm/2009/11/PD09_417_12411.psm1)
- United States 33 people/km<sup>2</sup> - 2019  
(<https://www.census.gov/population/www/popclockus.html>)
- Russia 8 people/km<sup>2</sup> - ? ([http://www.gks.ru/free\\_doc/2010/popul10-Pr.xls](http://www.gks.ru/free_doc/2010/popul10-Pr.xls))

- Fotos
  - <https://www.clydeco.com/services/projects-and-construction>
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  - Bricks <https://www.treehugger.com/clean-technology/cigarette-butts-make-better-bricks.html>
  - Wood [http://www.stackyard.com/news/2017/12/environment/06\\_fao\\_wood.html](http://www.stackyard.com/news/2017/12/environment/06_fao_wood.html)
  - Sand&Gravel <http://www.thebluebook.com/iProView/809520/>
  - Buildings <https://www.nrdc.org/issues/energy-efficient-buildings>
  - Cars <https://www.autotrader.com/car-shopping/buying-car-what-does-fleet-use-mean-250047?rinno=1>
  - People <http://www.bbc.co.uk/learningenglish/english/features/the-english-we-speak/ep-151013>