The University of Texas at Austin
Operations Research and Industrial Engineering
Cockrell School of Engineering

Decarbonizing the U.S. Energy Economy: Importance of the Demand Side

UT Energy Week
Austin, TX
February 19, 2020

Dr. Benjamin D. Leibowicz
Assistant Professor
The University of Texas at Austin

Kaya Identity

Carbon intensity of energy
(Supply Side)

Changes due to …

- Shifts in the energy resource mix (coal, gas, solar, etc.)
- Carbon intensity of energy production

$$GHG\ Emissions = Population * \frac{GDP}{Population} * \underbrace{\frac{Energy}{GDP}} * \overbrace{\frac{GHG\ Emissions}{Energy}}$$

Energy intensity of the economy
(Demand Side)

Changes due to …

- Efficiency improvements for end-use technologies
- Structural shifts in the composition of the economy
- Changes in lifestyles and consumption patterns

- The Demand Side has been the dominant driver of historical decarbonization in the U.S., and it is not even close.
- Its continued importance tends to be overlooked by researchers, policymakers, and stakeholders.

Historical Reductions in CO_2 per $ GDP

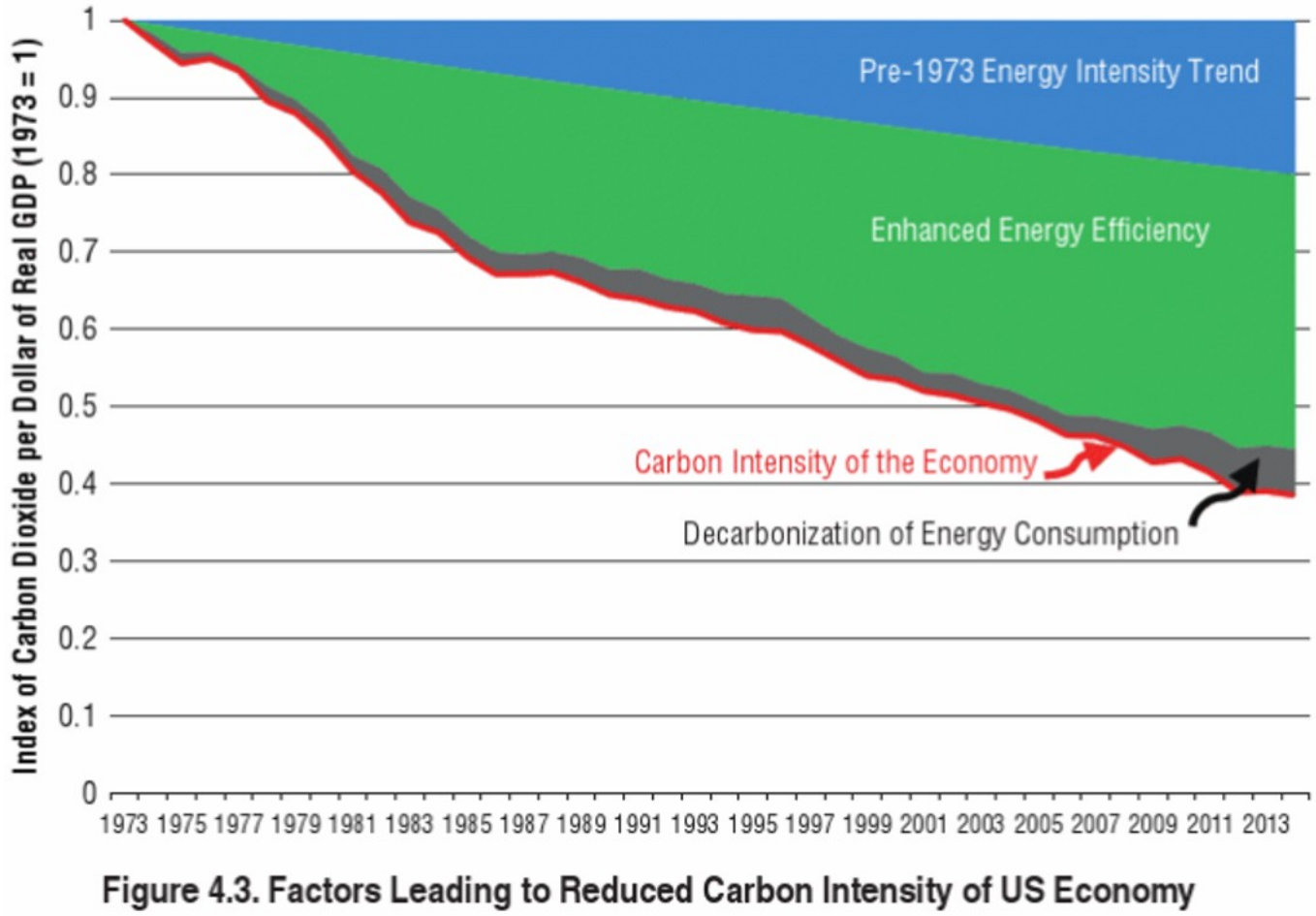


Figure 4.3. Factors Leading to Reduced Carbon Intensity of US Economy

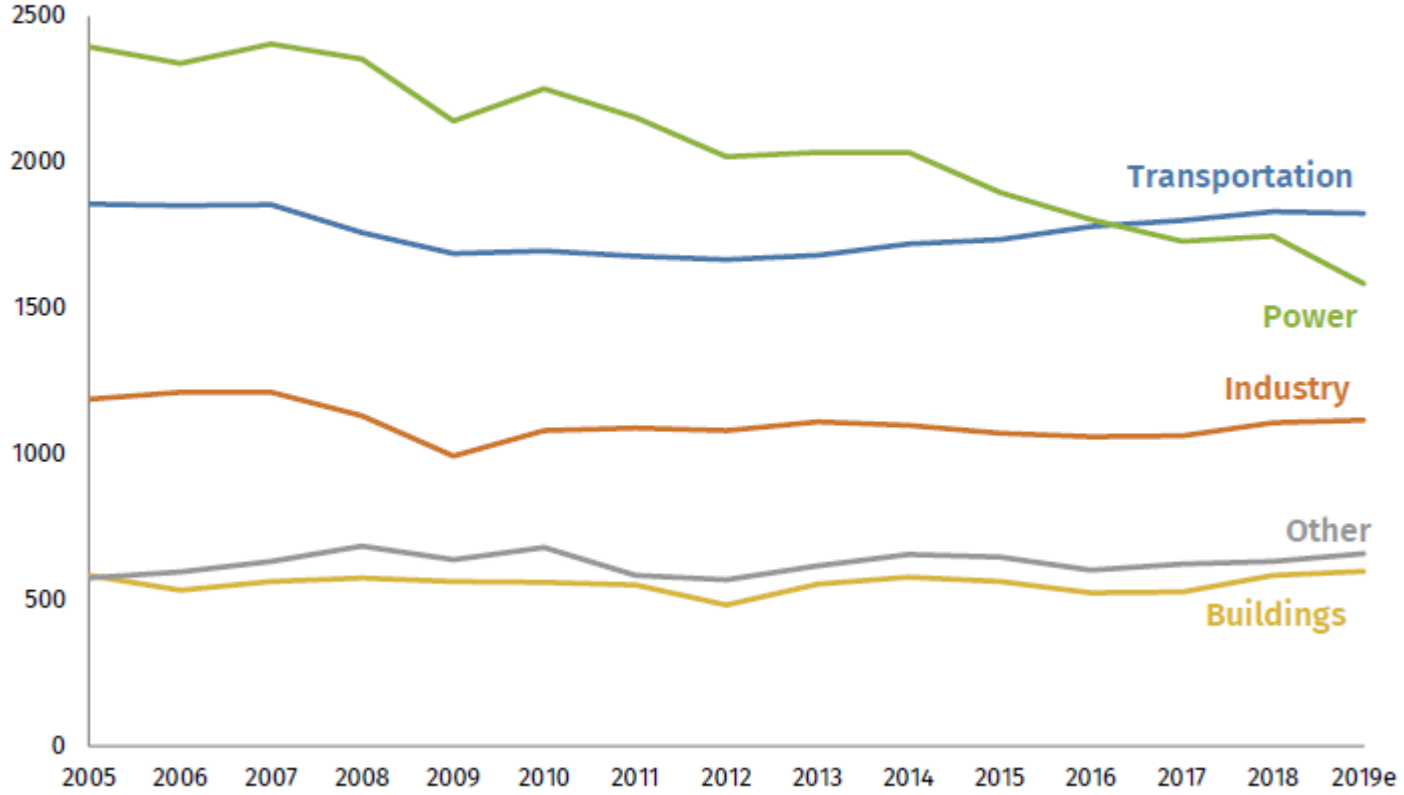
Demand Side contributions

Supply Side contributions

Source: James Sweeney, 2016. *Energy Efficiency: Building a Clean, Secure Economy* (Hoover Institution Press).

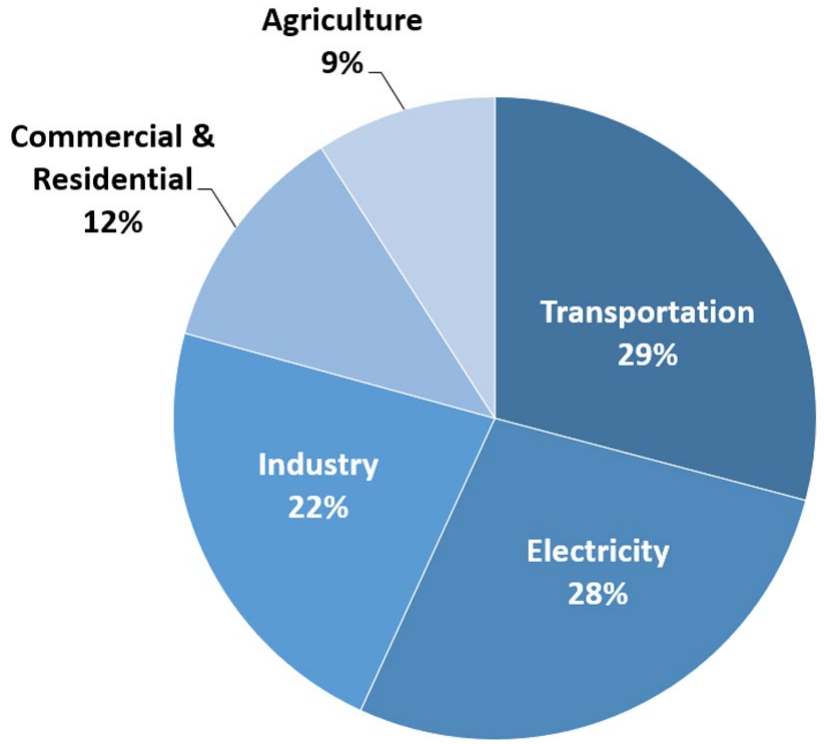
GHG Emissions by Sector

FIGURE 2
Net US GHG emissions by sector
Million metric tons CO2e, IPCC definitions, excludes international bunkers



Source: Rhodium Climate Service

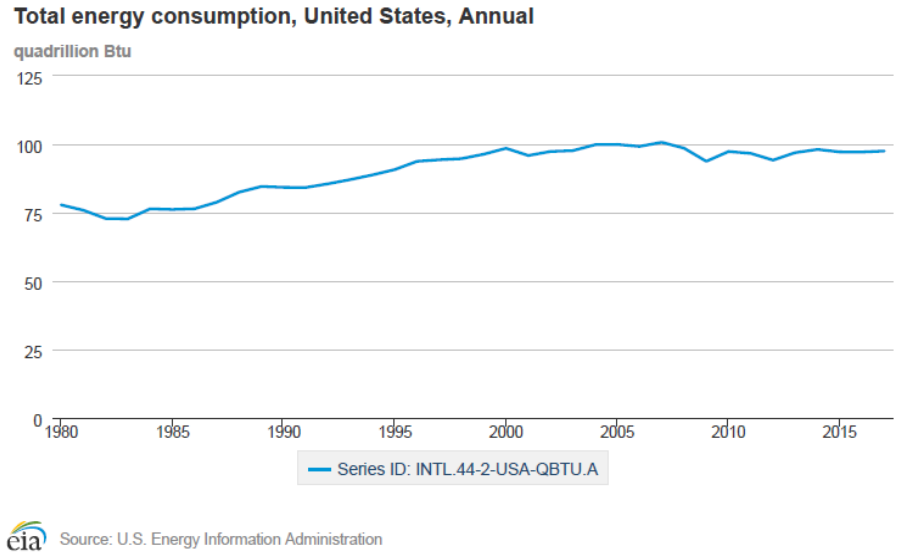
Total U.S. Greenhouse Gas Emissions by Economic Sector in 2017

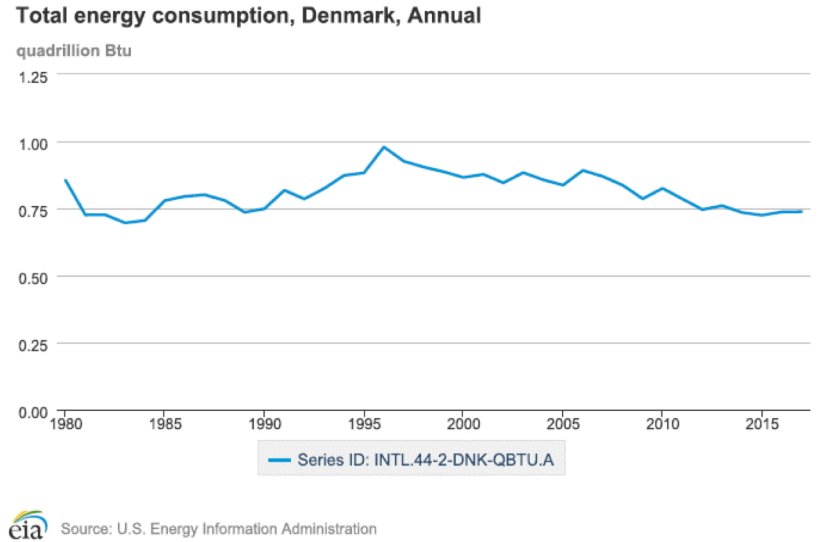


U.S. Environmental Protection Agency (2019). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017

Energy Demand Trends

- Models often assume a backdrop of ever-increasing energy demand, but this typical assumption is …
  1. Already wrong for many advanced economies, and …
  2. Energy demand reductions can be purposefully accelerated through policies, technology strategies, and individual choices





Low Energy Demand Mitigation Pathways

nature energy

ANALYSIS

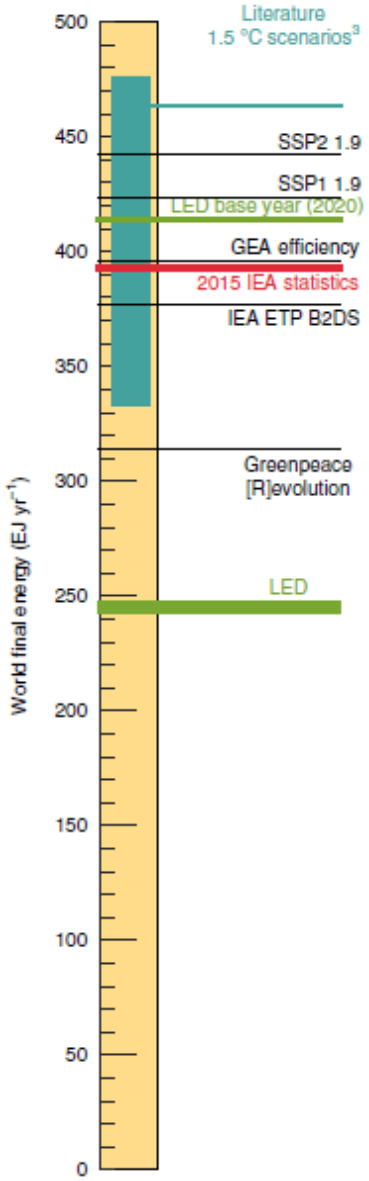
https://doi.org/10.1038/s41560-018-0172-6

A low energy demand scenario for meeting the 1.5 °C target and sustainable development goals without negative emission technologies

Arnulf Grubler[1*], Charlie Wilson[1,2], Nuno Bento[1,3], Benigna Boza-Kiss[1], Volker Krey[1], David L. McCollum[1], Narasimha D. Rao[1], Keywan Riahi[1,4,5], Joeri Rogelj[1,6], Simon De Stercke[1,7], Jonathan Cullen[8], Stefan Frank[1], Oliver Fricko[1], Fei Guo[1], Matt Gidden[1], Petr Havlík[1], Daniel Huppmann[1], Gregor Kiesewetter[1], Peter Rafaj[1], Wolfgang Schoepp[1] and Hugo Valin[1]

Table 2 | Impact of the LED scenario on final energy demand in 2050

		Region	% change in activity levels (2020–2050)	% change in energy demand (2020–2050)	Activity levels in 2050	Energy demand in 2050 (EJ)
End-use services	Thermal comfort	North	6	−74	47×10^9 m²	8
		South	63	−79	218×10^9 m²	8
	Consumer goods	North	79	−25	67×10^9 units	13
		South	175	54	186×10^9 units	28
	Mobility	North	29	−60	25×10^{12} passenger km	16
		South	122	−59	73×10^{12} passenger km	12
	Contingency reserve					
Upstream	Public and commercial buildings	North	49	−64	35×10^9 m²	5
		South	77	−82	68×10^9 m²	3
	Industry	North	−42	−57	1.0×10^9 t	26
		South	−12	−23	5.4×10^9 t	82
	Freight transport	North	109	−28	31×10^{12} tkm	11
		South	75	−12	51×10^{12} tkm	17
	International aviation and shipping (bunker fuels)					
Total		North[a]		−53		82
		South[a]		−32		153



"Down-sizing the global energy system dramatically improves the feasibility of a low-carbon supply-side transformation."

Rapid system transformations are more likely to be led by end-use technologies (small, flexible) than by energy supply systems (large, inflexible).

Demand-side strategies largely avoid the carbon leakage problem.

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