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## Early U.S. meat industry knowledge and response to global warming

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Since at least 1989, the United States (U.S.) livestock industry knew of its role in global warming (Gibbs et al. 1989), and a newly uncovered industry document makes clear that the industry planned to obstruct efforts to shift U.S. diets to reduce emissions (NCA 1989). These internal industry plans add to publicly available evidence that shows that the U.S. livestock industry has, from 1989 to the present, worked to obstruct efforts to encourage meat reduction for the sake of climate change, including recent, modest efforts such as Meatless Monday, as well as a more ambitious campaign in the 1990s to cut U.S. beef consumption in half (Loy and Jacquet 2025). We recognize that a reduction of per capita beef consumption by 50% would have likely faced obstacles beyond those directly imposed by industry, but also see value in exploring what halving U.S. consumption of beef, the most greenhouse gas (GHG) intensive food (Poore and Nemecek 2018; Pierrehumbert and Eshel 2015), might have meant for U.S. GHG emissions reductions. Using a model that reduced annual per capita beef and veal consumption by 50% over 32 years spanning 1992-2023 (and substituted in other foods, including non-beef animal-based products), estimated cumulative averted emissions could have been somewhere between 4 and 13 gigatonnes (Gt) CO<sub>2</sub>eq (estimated U.S. emissions in 2022 were 6.2 Gt CO<sub>2</sub>). The low-tech and immediately available option of halving U.S. beef and veal consumption, resulting in a savings of 125-410 megatonnes (Mt) CO<sub>2</sub>eq per year over the 32-year period, could have been 24-80 times more effective in reducing GHG emissions in a single year than what was achieved cumulatively by reducing methane emissions (mainly in the oil and gas industries) over a similar timespan (1990-2022).

In 1988, climate change was already a public concern. That year, anthropogenic climate change was observed in global temperature (rather than merely predicted by climate models), the countries of the world created the Intergovernmental Panel on Climate Change, and NASA scientist James Hansen testified about climate change in the U.S. Congress, which introduced the National Energy Policy Act of 1988 (Frumhoff et al. 2015). In February 1989, following research about the importance of methane as a potent GHG and the role of livestock as a major source of methane pollution (e.g., Crutzen et al. 1986), the U.S. Environmental Protection Agency (EPA) held a workshop and then published a report in August 1989 titled, "Reducing Methane Emissions from Livestock" (Gibbs et al. 1989). The findings laid out that livestock "are one of the larger anthropogenic sources" of global methane emissions and emphasized that "the current imbalance in the sources and sinks of CH<sub>4</sub> must be corrected" (Gibbs et al. 1989). Under various scenarios, the agency found that globally "a 25 to 75 percent reduction in CH<sub>4</sub> emissions associated with livestock would produce a significant reduction in anticipated future global climate change from the greenhouse effect." The EPA estimated that a 50% reduction of global livestock-related emissions would provide half to three-quarters of the reductions needed to stabilize atmospheric methane concentrations – calculations they considered uncertain yet conservative (Gibbs et al. 1989). In an Appendix, the EPA ran scenarios for reducing methane and concluded "...understanding options for reducing methane emissions from ruminants should be pursued as part of an overall investigation into alternatives for reducing future global warming and its impacts." (Gibbs et al. 1989, p. B-7). The 1989

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3 EPA calculations (Gibbs et al. 1989) did not include methane associated with manure management,  
4 which in 2022 the EPA (2024) estimated was responsible for 9% of total U.S. human-caused methane  
5 emissions.  
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8 *The New York Times* (NYT) headline for its coverage of the 1989 EPA report read: “Methane from Guts of  
9 Livestock is New Focus in Global Warming” and the article highlighted that “of all the major greenhouse  
10 gas emissions...methane...might be the easiest to control” (Stevens 1989). The EPA report noted that  
11 “demand for milk and meat products are the primary factors driving the sizes of animal populations in  
12 developed countries” and laid out ten options for reducing methane emissions, all on the production  
13 side, such as improving productivity, using feed additives, and changing manure management (Gibbs et  
14 al. 1989). No explicit calls for reducing production were made. Policies aimed at changing demand, such  
15 as reducing beef consumption, were not mentioned by the EPA report (Gibbs et al. 1989) or in the NYT  
16 coverage (Stevens 1989).  
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19 However, reducing demand for beef, in particular, for the sake of emissions mitigation was discussed in  
20 other public contexts. In June 1989, two months before the publication of the EPA’s report, the  
21 Greenhouse Crisis Foundation (GCF 1989), a non-governmental group led by Jeremy Rifkin, initiated a  
22 “massive” three-year campaign focused on “101 practical steps each of us can take in our personal lives  
23 to help avert the global warming crisis and develop an ecological lifestyle for the 1990s.” Number four  
24 on the organization’s list was “reduce consumption of meat” (Thomas 1989). Rifkin then published the  
25 book *Beyond Beef: The Rise and Fall of the Cattle Culture* in 1992, planned a book tour to many U.S.  
26 cities, and launched the Beyond Beef campaign that urged individuals in 16 countries, including the U.S.  
27 to reduce beef consumption by 50 percent (Sugarman 1992). The Beyond Beef campaign featured a  
28 series of advertisements, including a full-page ad in the NYT that urged the public to halve their beef  
29 consumption and replace beef “with grains, fruits, and vegetables” (Beyond Beef Coalition 1992).  
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32 Among the attendees of the February 1989 EPA workshop on livestock and methane (Gibbs et al. 1989),  
33 where a draft of the report was presented and discussed, were representatives from the livestock  
34 industry, including an attendee from the California Milk Producers (which became California Dairies Inc.  
35 in 1999) and an attendee from the National Cattlemen’s Association (NCA), the oldest trade association  
36 for U.S. beef producers (which became the National Cattlemen’s Beef Association, NCBA, in 1996). The  
37 EPA report noted that its findings reflected consensus among the attendees (Gibbs et al. 1989).  
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40 Following the EPA workshop, the NCA’s Environmental Planning Group met in Denver in May, June, and  
41 July of 1989 and produced a 17-page “Strategic Plan on the Environment” (NCA 1989). According to this  
42 newly uncovered industry document, the NCA President singled out the environment as one of the trade  
43 association’s three priority issues that year and created an Environmental Planning Group, which  
44 included the same individual who had attended the February 1989 EPA workshop (NCA 1989). The  
45 report indicated that the beef industry saw its role in causing global warming and efforts to reduce beef  
46 consumption for environmental reasons as a public relations issue. The planning group expressed  
47 concern that “recent events like the Alaskan oil spill and potentially global catastrophes like global  
48 warming have broadened and deepened public concern with the whole gambit of environmental issues”  
49 and about President George H.W. Bush’s promotion of “international action on global issues such as  
50 climate change.” The planning group included a list of the 22 environmental issues that impacted the  
51 cattle industry, including “atmospheric emissions” (NCA 1989).  
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54 The NCA (1989) strategic plan noted: “Vegetarian messages are more frequently used by  
55 environmentalist advocacy groups. Elimination or reduction of red meat from the diet is promoted as an  
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3 important way of protecting the environment.” In response, the NCA planned to “establish [a] system  
4 for monitoring the media and environmentalist advocacy group actions” and “enhance the image of the  
5 cattle industry.” The NCA also proposed to “develop crisis management plans for immediate, effective  
6 response to public events and initiatives that impact the industry,” including the efforts of the  
7 Greenhouse Crisis Foundation and the topic of global warming. The strategic plan referred to the GCF’s  
8 messaging about beef’s climate impacts as “misinformed criticism of the cattle industry” and urged the  
9 NCA to “continue to work with influencers in the legislative and regulatory arena to ensure the GCF does  
10 not succeed in promoting the wrong message.” It also encouraged the NCA to “commission position  
11 papers by leading scientific and technical experts on GCF’s specific claims about the environmental  
12 impacts of the cattle industry.” The NCA, for instance, commissioned a Texas A&M University  
13 researcher, F.M. Byers, to address the EPA report (O’Neill 1990). Byers’ report concluded that cattle  
14 were not a significant source of GHGs, including methane, and was covered by the NYT (O’Neill 1990).  
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18 Publicly available evidence suggests that the strategic plan was implemented in various ways. One  
19 industry publication described the Beyond Beef campaign as having “declared war against the beef  
20 industry” (Albertson 1992) and coverage in the *Washington Post* noted “people are screaming at [Rifkin]  
21 on call-in talk shows; Dutton, the book’s publisher, has been receiving letters of protest and phone calls  
22 of discontent, and his [Beyond Beef] book tour was canceled soon after it started... Both [the book’s  
23 publicist] and Rifkin attribute[d] the response in part to disgruntled cattle ranchers” (Sugarman 1992).  
24 The industry initiated the “Don’t blame it on Bossie” slogan and hired the public relations firms Edelman  
25 and Burson-Marsteller (which became Burson Cohn & Wolfe in 2018) to distribute “pro-beef material”  
26 (Kay 1992). The NCA was part of an alliance of 13 industry groups that formed the Food Facts Coalition  
27 (FFC), which urged the public not to “blame the cows” and claimed that the Beyond Beef campaign used  
28 scare tactics and showed “a total disregard for science” (Goerne 1992). The NCA’s Director of Economics  
29 referred to the Beyond Beef campaign in a FFC document as “a radical social agenda” (Lambert 1992).  
30 Outside an April 1992 press conference where Rifkin sliced a Big Mac down the middle with a meat  
31 cleaver to urge consumers to reduce their beef consumption by at least 50%, cattle, dairy and  
32 meatpacking industry groups called the campaign “Beyond Belief” and passed out hamburger patties cut  
33 in half to represent the “other half of the story” (AP 1992; Chicago Tribune 1992). In May 1992, the Beef  
34 Industry Council launched the marketing campaign “Beef. It’s What’s for Dinner” to promote beef  
35 consumption with an advertising budget of \$42 million over the 17 months between then and  
36 September 1993 (Lazarus 1992).  
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41 The industry has systematically pushed back against efforts to encourage meat reduction to address  
42 climate change, as well as shaped public understanding and policy around meat consumption and  
43 climate change (Loy and Jacquet 2025), which is particularly important to recognize as the climate  
44 science community emphasizes the potential of ‘demand-side’ mitigation, including dietary shifts (e.g.,  
45 Poore and Nemecek 2018). As a more recent example, the NCBA funded a UC Davis researcher, Frank  
46 Mitloehner, to address a major United Nations Food and Agriculture Organization (FAO) report on  
47 livestock’s environmental impacts (Wright 2009; Morris and Jacquet 2024). The FAO report (i.e.,  
48 Steinfeld et al. 2006) did not include dietary change as a way of mitigating climate change, nor did the  
49 UC Davis study that challenged the FAO report address dietary shifts (Pietsky et al. 2009). However, in  
50 press coverage related to his rebuke of the FAO report UC Davis Mitloehner was quoted as saying, “we  
51 certainly can reduce our greenhouse-gas production, but not by consuming less meat and milk” (Wright  
52 2009). Mitloehner also spoke about the FAO report at the American Chemical Society and specifically  
53 criticized campaigns aimed to get consumers to eat less meat, including Meatless Monday and Less  
54 Meat=Less Heat in Europe. The press release about his talk was titled “Eating less meat and dairy  
55 products won’t have a major impact on global warming” (ACS 2010).  
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4 Here we estimate what emissions might have been averted had the U.S. cut beef and veal consumption  
5 in half starting in 1992. While there were early campaigns calling for meat reduction to address climate  
6 change (e.g., GCF 1989), they did not specify an amount. The Beyond Beef campaign advocated for the  
7 reduction of beef consumption of at least 50% (in some places with no time horizon, e.g., Rifkin 1992a,  
8 1992b, and in others by 2002, e.g., Beyond Beef Coalition 1992). Beyond Beef also encouraged the  
9 replacement of beef with “grains, fruits, and vegetables”.

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12 We acknowledge that, in addition to the industry opposition identified here, civil society’s call for a 50%  
13 reduction in beef consumption starting in 1992 would have likely faced social and political obstacles to  
14 implementation. In that sense, our estimate represents something close to a ‘best-case’ scenario for  
15 what the Beyond Beef campaign might have achieved. However, in the interest of encouraging “moral  
16 imagination” and “conceiv[ing] of responsibility in terms that extend beyond the presentist and  
17 individualistic orientation of classical liberalism” (Kysar 2011), it is worth considering an alternative  
18 history in which the Beyond Beef campaign was embraced by a public and political system eager to act  
19 on climate change rather than met by industry opposition and marketing to encourage beef  
20 consumption. It’s not impossible to imagine. In 1988, then Vice President George H.W. Bush had said in  
21 a campaign speech, “Those who think we are powerless to do anything about the greenhouse effect  
22 forget about the 'White House effect'; as President, I intend to do something about it” (NYT 1989). A  
23 shift away from beef required no technological innovation and was an immediately available option. We  
24 also note that the notion of a 50% reduction in beef consumption from a 1992 baseline is not  
25 particularly radical. Per capita beef consumption in the U.S. has risen and fallen over time in response to  
26 a multitude of factors and is 35% lower today (58.1 lbs/person  $y^{-1}$  in 2023) than at its peak in 1976 (94.1  
27 lbs/person  $y^{-1}$ ).

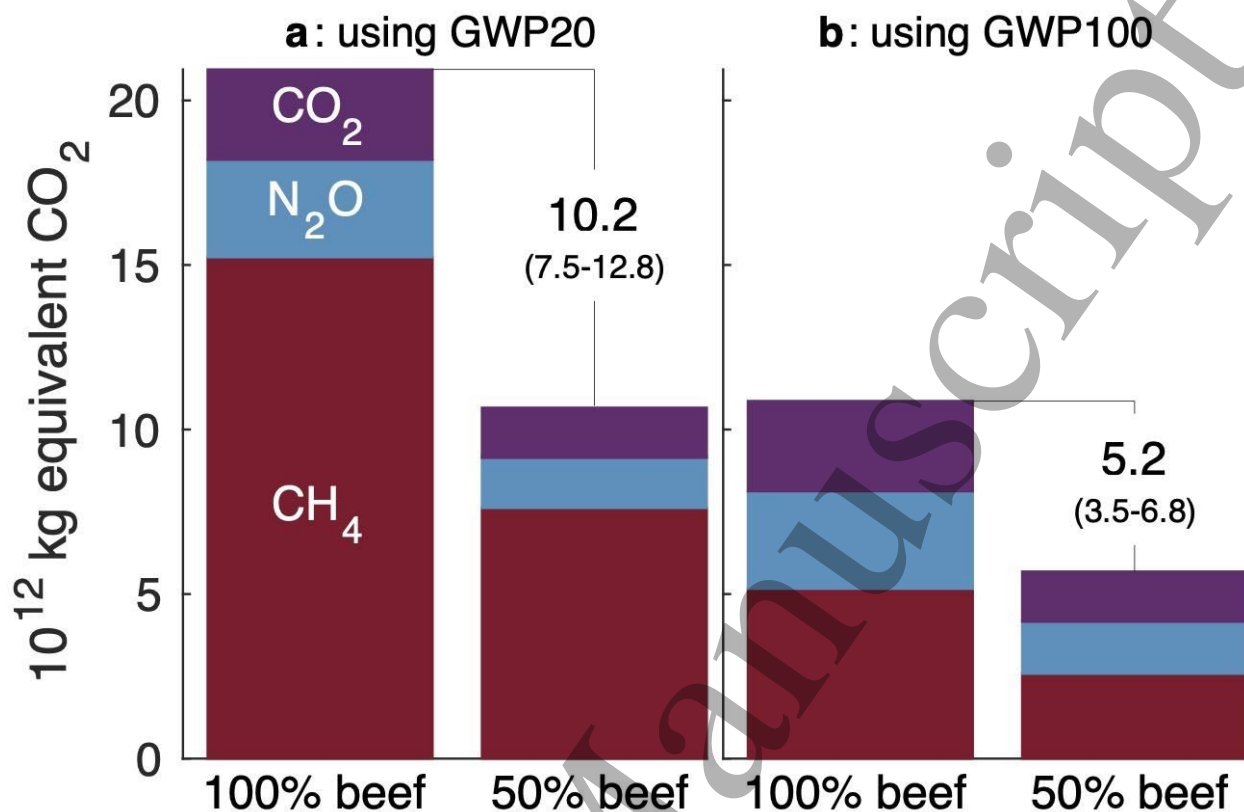
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31 To simulate this potential alternative history, we used modeling to estimate the emission savings that  
32 would have resulted from exact halving of actual recorded annual beef consumption over 1992-2023  
33 (available from the U.S. Department of Agriculture). We envisioned exact replacement by non-beef  
34 alternative food items for the foregone protein using a Monte Carlo formalism, for which each  
35 realization we randomly selected six non-beef food items from a list of 58 plant-based items and four  
36 animal products (dairy, eggs, poultry, pork) and selected their masses so as to make their combined  
37 protein delivery at each of the simulated years exactly equal to half the protein mass beef actually  
38 delivered that year. We then expressed the hypothetical emissions saved by these beef replacements  
39 using both GWP20 and GWP100. Because the possible replacements also included non-beef animal  
40 products, our calculations are slightly more conservative than a hypothetical alternative that replaced  
41 half of the consumed beef and veal with “grains, fruits, and vegetables”, as the Beyond Beef campaign  
42 encouraged.

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46 Had the U.S. consumed 50% less beef and veal from 1992-2023, surface temperature radiative forcing  
47 equivalent to an estimated 5-10 Gt CO<sub>2</sub>eq would have been averted (depending on the considered time  
48 horizon, with a full range over both time horizons of 4–13 Gt; we used a 27 methane-to-CO<sub>2</sub>-equivalent  
49 conversion factor for a century time horizon; IPCC 2023), with a plausible range of approximate mean  
50 annual averted emissions of 125-405 Mt CO<sub>2</sub>eq  $y^{-1}$  (see the numerical differences in Figure 1). Given the  
51 most recent available total U.S. gross GHG emissions, 6.3 Gt CO<sub>2</sub>eq  $y^{-1}$ , these annual emission savings  
52 amount to 2-6% of annual gross emissions (see SM for estimates of annual averted emissions using the  
53 GWP100 metric for 1990-2022).

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3 The significance of missed opportunities for reducing consumption can also be weighed against the  
4 effects of various other mitigation strategies. For example, over a 33 year period of 1990-2022, methane  
5 emission reduction efforts, primarily focused on the oil and gas sector, have reduced U.S. annual  
6 methane emissions from 872 to 702 Mt CO<sub>2</sub> equivalent y<sup>-1</sup> – a mean improvement rate of 5.2 Mt CO<sub>2</sub>  
7 equivalent y<sup>-1</sup> (EPA 2024) – or the equivalent of 0.1% of total US gross GHG emissions in 2022 (6.2 Gt  
8 CO<sub>2</sub>eq). The ratio of the possible emissions averted from cutting beef and veal consumption in half, 125  
9 to 405 Mt y<sup>-1</sup>, and the realized effects of the concurrent methane reduction efforts, 5.2 Mt y<sup>-1</sup>, indicate  
10 that a single year of cutting beef and veal consumption in half could have reduced emissions by as much  
11 as 24-80 years of the average U.S. methane emission reduction efforts. Despite the imperative to  
12 address methane production across all sectors, including livestock (Shindell et al. 2024), the emphasis  
13 today remains on energy. For example, the International Energy Agency's (2023) Global Methane  
14 Tracker initiative focused only on oil and gas, and coal.  
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18 Taken together, this work shows that, since at least 1989, organizations representing and funded by the  
19 U.S. livestock industry 1) were aware of the industry's role as a major contributor to global warming; 2)  
20 knew that demand-side mitigation opportunities existed to reduce emissions; and 3) worked to obstruct  
21 non-government campaigns focused on addressing the industry's climate harms and to shape public  
22 understanding, which may have hindered the potential for a dietary shift as an emissions mitigation  
23 strategy. If the U.S. had reduced beef and veal consumption by 50% starting in 1992 and replaced that  
24 consumption with other products (including those from other animals) it is possible that somewhere  
25 between 4 and 13 Gt CO<sub>2</sub>eq could have been avoided between 1992-2023.  
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28 Our views of responsibility for climate change are rapidly changing in a dangerously warming world  
29 (Jamieson 2015; Lazarus et al. 2021). Our understanding of what the fossil fuel industry knew about  
30 global warming and how it responded (e.g., Franta 2018, Supran et al. 2023) has been an important part  
31 of that process. Similarly, these updated perspectives of historical records contextualize contemporary  
32 U.S. meat industry efforts to shape climate understanding in line with the industry's financial interests  
33 and provide an initial attempt to quantify the significance of these actions.  
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**Figure 1.** Comparing cumulative 1992-2023  $\text{CO}_{2\text{eq}}$  emissions (in billion metric tons) for actual U.S. beef and veal consumption and for halving them (left and right bars in each panel respectively) using GWP20 (panel a) and GWP100 (panel b). The right bar of each panel shows modeled emissions from U.S. beef consumption after replacing half of beef and veal consumption with alternative foods containing the same amount of protein from a list of 58 plant-based items and four animal-based products (eggs, dairy, pork and poultry) with items' masses chosen so as to exactly replace the protein lost by halving beef and veal. We only consider the portion of the diet for which beef and veal or their replacements account, not the whole diet. Numbers in parentheses are the 5th and 95th percentile of the inferred distributions. The mean emission difference due to the halving beef and veal is given numerically (e.g., 10.2 Gt in GWP20) with the full plausible range in smaller font parenthetically below). The 20-y time horizon values are calculated by multiplying the emitted methane mass, in  $\text{kg CH}_4 \text{ y}^{-1}$ , by  $81.2 \text{ kg CO}_{2\text{eq}} (\text{kg CH}_4)^{-1}$ . The results indicate that, if adhered to continuously since 1992, the proposal to cut U.S. beef consumption in half would have yielded probable national emission reductions equivalent to about 4-13 billion metric tons  $\text{CO}_2$  equivalent nationwide.

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