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Protein politics: Sustainable protein and the logic of energy

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Abstract

Powerful actors associated with intensive livestock production are repositioning industrially produced meat and farmed fish as "sustainable protein." This repositioning, we show, involves justifying the production of meat through a range of metrics, calculations, and valuations. These metrics and associated indicators underpin claims that sustainable protein is more efficient and less wasteful than conventional meat production. Our analysis questions the relationship between efficiency and sustainability in industrial meat production. We show, first, that the industrial meat sector has always focussed on efficiency and the reduction of waste. What is new is that metrics, calculations, and indicators on efficiency and waste reduction are being repurposed and made public to consumers and investors to underpin claims for sustainable and "climate friendly" meat. While this practice is apparent across the animal agriculture sector, it is especially evident in the production of farmed salmon. Our second argument frames sustainable protein metrics as a political logic. While these metrics have been justifiably criticized as a form of environmental "greenwashing" by environmental non-governmental organizations and others, our own critique builds on Cara Daggett's recent analysis of energy and its political logic. Building on Daggett's work, we aim to provide a more fundamental critique to the efficiency and waste metrics that are used to support claims for sustainable protein, while simultaneously providing the conceptual and political foundation for more progressive futures.

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Résumé

De puissants acteurs associés à l'élevage intensif sont en train de repositionner la viande et le poisson produits industriellement comme des « protéines durables ». Nous montrons que ce repositionnement implique de justifier la production de viande par un ensemble de mesures, de calculs et d'évaluations. Ces mesures et les indicateurs associés sous-tendent des affirmations selon lesquelles les protéines durables sont plus efficientes et génèrent moins de déchets que la production de viande conventionnelle. Notre analyse amène à s'interroger sur la relation entre l'efficience et la durabilité dans la production industrielle de viande. Nous montrons, d'abord, que le secteur de la viande industrielle a toujours misé sur l'efficience et la réduction des déchets. La nouveauté, c'est que les mesures, les calculs et les indicateurs relatifs à l'efficience et à la réduction des déchets sont réutilisés et rendus publics pour les consommateurs et les investisseurs afin d'étayer les allégations de viande durable et « respectueuse du climat ». Si cette pratique est observable dans l'ensemble du secteur de l'agriculture animale, elle est particulièrement évidente dans la production de saumon d'élevage. Notre deuxième argument présente les indicateurs de protéines durables en tant que logique politique. Alors que ces mesures ont été critiquées à juste titre comme une forme d'« écoblanchiment » par des organisations environnementales non gouvernementales et d'autres, notre critique s'appuie sur l'analyse récente de Cara Daggett concernant l'énergie et sa logique politique. En nous appuyant sur le travail de Daggett, nous visons à fournir une critique plus fondamentale des mesures d'efficience et de gaspillage utilisées pour soutenir les allégations de protéines durables, tout en fournissant la base conceptuelle et politique pour des horizons plus progressistes.

Introduction

"A shift in energy cultures and epistemologies, or ways of knowing energy, will entail a thorough transformation of habits of energy production and consumption" (Daggett, 2019, p. 3).

Powerful actors associated with intensive livestock production are repositioning industrially produced meat and farmed fish as "sustainable protein"[1] in response to the long recognized and devastating socio-ecological problems of industrial meat production. These actors include transnational agrifood corporations (TNCs), non-governmental organizations, scholars, and tech start-ups[2] and they are proposing a range of sustainable protein solutions from more efficient and circular (e.g. no waste, net zero) protein produced through animal

[1] Sustainable protein is undefined in this paper. Rather our aim is to interrogate industry and its critics claims and the work that these claims take on.
[2] There are also numerous multi-stakeholder initiatives such as the Forum for the Future "protein challenge" (Forum for the Future, 2016)

agriculture, to new plant-based products and to the speculative promise of lab-produced, cell-cultured meats. There is a growing food studies literature that is critically engaging with how the global meat problem is articulated, as well as the promissory politics and ethical challenges associated with new developments in alternatives to conventionally produced animal proteins (Broad & Biltekoff, 2023; Guthman et al., 2022; Guthman & Biltekoff, 2020; Katz-Rosene & Martin, 2020; Sexton, 2018; Sexton et al., 2019).

Our aim in this paper is to critically assess "sustainable protein," a product promoted by industry as an alternative to meat and fish produced through conventional animal agriculture. To this end, we identify two key matters of concern associated with the emergence of sustainable protein as an alternative to industrial animal agriculture—the concerns of efficiency and waste, and the convergence of both supporters and critics around the metrics of efficiency and waste. First, we show how efficiency and improved resource use, and especially the reduction of waste, underpin the claims for sustainable protein (Finlay, 2003; Guthman, 2022; Landecker, 2019; Weis, 2014). In the farmed salmon sector, for example, the claim of sustainable protein is justified through "eco-efficient" marine based production systems. The global aquafeed company Skretting has described farmed salmon as "the world's most efficient protein generator" (Skretting, 2024 para 3). Geir Molvik, CEO of Cermaq a major salmon farming company declared salmon to be "an essential vector to convert new ocean protein through feed into delicious and healthy food contributing to human and planetary health" (Ocean Panel, 2020, para 31). Woven into industry claims are reductions in greenhouse gas emissions and improvements in feed conversion efficiency. The executive director of Atlantic Canada Fish Farmers claimed that "salmon farming has the lowest carbon footprint of any animal protein farming method and the lowest feed to protein conversion ratio" (Farquharson, 2021, para 10). Farmed salmon is measured *against terrestrial* animal protein, and distinguished by its lower carbon footprint, higher energy efficiency based on its lower feed conversion ratio. Farmed fish, as sustainable protein, is thus justified through an industrial logic, and is supported by a range of efficiency metrics and indicators that assess resource inputs like feed against production outputs like market-ready fish. Yet, as we argue below, equating efficiency with sustainability is problematic, and the use of metrics and indicators for efficiency and waste reduction raises critical questions about how contemporary claims for sustainable protein rely on a longstanding industrial logic in animal agriculture.

The second issue we examine is the convergence by industrial animal agriculture and their critics on the metrics of efficiency and waste. While industry uses metrics to illustrate environmental improvements through efficiency and the reduction of waste, reports from concerned foundations and environmental NGOs highlight agro-industrial meat production as inefficient and wasteful. The Changing Markets Foundation, for example, highlights how in the production of farmed fish, "using wild-caught fish to feed farmed fish is an inefficient use of protein and a scandalous waste of precious natural resources" (2020, p. 56). Similarly, Greenpeace's report on West African food security in relation to fishing titled "A Waste of Fish" underpinned by the argument that producing fish feed for animals is inefficient compared to using pelagic fish for humans (Greenpeace International, 2019). Our aim is not to argue that industry metrics cannot or should not be challenged. On the contrary, we support the recent International Panel of Experts on Sustainable Food Systems (IPES) report, which has made a crucial contribution to what it aptly calls the "politics of protein," and the uncertain evidence, misleading

statements and overgeneralizations that often underpin recent industry claims (IPES-Food, 2022). We also see significant value in calling out corporations for the uncertainties, generalizations, and exaggerations associated with claims for sustainability when it comes to meat (Christen, 2021; IPES-Food, 2022; Sherrington et al., 2023). At the same time, we are concerned by the convergence around the metrics of efficiency and waste. Salmon farming companies are experts in generating the metrics of efficiency and waste, and we suggest critics entanglement with these metrics has the potential to constrain and limit effective critique.

In response to these two matters of concern, our paper draws inspiration from Cara Daggett's *The Birth of Energy* (2019), and her articulation of the "logic of energy." Daggett's insightful analysis is based on the claim that energy is not a transhistorical object or concept. Instead, energy was "born" in the 1840s when it became tied to the science of thermodynamics and, crucially, to the Protestant ethic of work and waste. The result is a logic of energy that, as Palmer writes, "sutured thermodynamics to Protestantism" and has functioned since then as a political rationality and mode of domination for humans and more-than-human assemblages (2020, p. 2). We draw on Daggett's insights and apply her concepts on the logic of energy to industrial animal production's longstanding concern with efficiency and waste. In turn, we connect the logic of energy, applied through efficiency and waste metrics, to the contemporary context of sustainable protein. Specifically, we argue that the metrics and claims that justify animal protein as sustainable (or not) are, at root, about *energy logics*. By engaging with Daggett's work, we hope to provide a more fundamental challenge to the underlying logic of efficiency and waste metrics that substantiate sustainable protein, while simultaneously providing the conceptual and political foundation for more progressive futures.

Our paper is structured as follows: we begin with a brief overview of the debates within food studies on alternatives to industrially produced meat and we trace the emergence of sustainable protein in farmed fish and in meat produced on land. We then critically examine the underlying logic of the claims for sustainable protein through Daggett's logic of energy. In the third section, we explore the implications of the logic of energy as they apply specifically to sustainable protein and the metrics and indicators that are used to support claims for an alternative to conventional animal agriculture. We conclude by exploring the broader implications of framing sustainable protein and alternatives to industrial animal agriculture through the political rationality of energy.

Mapping the rise of "sustainable protein"

Our analysis aims to contribute to a burgeoning body of scholarship that is critically assessing the social, political, environmental, and welfare claims of emerging alternatives to conventional, industrially produced meat. This rapidly growing body of work has examined the range of alternatives to industrial meat (Katz-Rosene et al., 2022; Katz-Rosene & Martin, 2020; Tourangeau & Scott, 2022; Weis & Ellis, 2022), the role of large corporations in meat alternatives (Sexton et al., 2019), and the significant limitations and

simplifications of proposed alternatives in terms of environmental, welfare, and social indicators (IPES-Food, 2022).

In response to the problem of (un)sustainable livestock production, we see the emergence of two closely connected processes associated with "sustainable protein." The first is the shift within the highly concentrated industrial meat sector from "*meat*" to *"protein,"* combined with new claims for sustainability and resource efficiency. The second process involves the articulation of a range of metrics, calculations and indicators that support claims of sustainability.

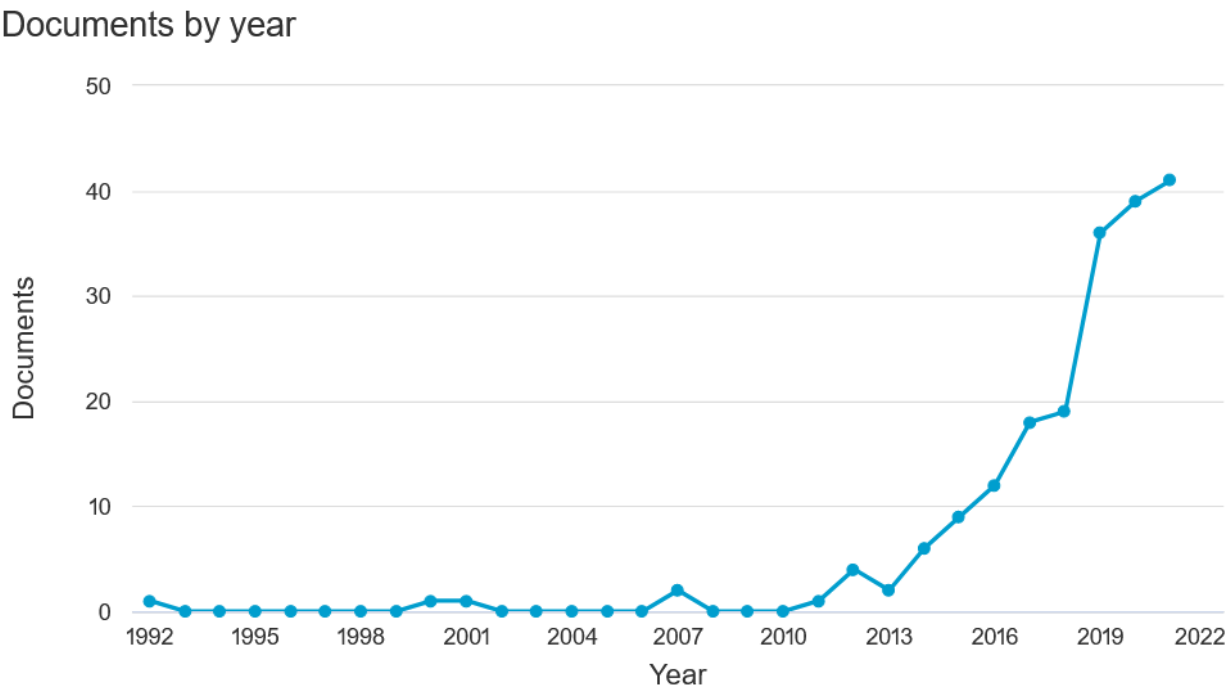
In the last six years, there has been a significant shift within the large and highly concentrated industrial animal agriculture sector from meat to protein. Tyson Foods, one of the world's largest meat companies, re-branded itself as "a protein-focused food company" in 2018 (Little, 2018, para 1).[3] Perdue Farms followed shortly thereafter, committing itself to being the "most trusted name in protein" (Shankar & Mulvany, 2018, para 2). Canada's Maple Leaf Foods has perhaps gone furthest in this shift, declaring as its vision to "be the most sustainable protein company on earth" (McCain & Maple Leaf Foods, 2018). JBS calls itself a diversified protein company, while Cargill, the largest privately owned agrifood TNC in the U.S., is remaking itself as an "ingredients business" that includes protein (Parker & Blas, 2018). In addition, all the large formally meat companies have now invested in alternative and analogue proteins (Guthman et al., 2022; IPES-Food, 2022).[4]

As others have argued (Guthman et al., 2022), the focus on *protein* has the discursive effect of obscuring the problems with meat while upholding the nutritional advantages of protein. The significance of focussing on protein, however, goes beyond obscuring the problems with meat.

"Big protein" is attracting large institutional investors (IPES-Food, 2022). Notable in this context is the Farm Animal Investment Risk and Return (FAIRR) Producer Protein Index, which assesses the world's largest listed protein companies against environmental, social, and governance criteria (FAIRR, 2019). The head of FAIRR has warned institutional investors to avoid conventional meat production and the risk of "stranded assets" associated with conventional meat production (FAIRR, 2018a), instead the aim of the index is to inform investors where best to put their money. Salmon farming corporations are consistently at the top of the Coller FAIRR Protein Producer Index (FAIRR, 2018b, 2023). The harnessing of investment interest, especially institutional investors is an indication of the financialization of the food industry according to Howard and the IPES report (Howard, 2019, 2022). This move to sustainable protein is also now reflected in academic scholarship, which has seen a rapid growth in the debates on this new way of describing the production of meat in industrial animal production systems (Figure 1).

[3] Tyson seems to be pulling back from the protein focus with a series of CEO changes, especially since 2021.
[4] There are indications that the alt-protein (Hui, 2022; Terazono & Evans, 2022) market is softening, and with it, the major meat corporation's focus.

Figure 1: Scopus and Google Scholar results of documents containing the term "sustainable protein" in the title, abstract, or keywords (our analysis).



Our discussion here focusses mainly on farmed salmon, which is of particular interest because the industry presents itself as producing a more sustainable protein than land-based equivalents, and this is supported by the FAIRR reports. However, the move to step away from meat's myriad of problems and toward sustainable protein is widespread. We also draw on recent efforts by the industrial animal agriculture sector to "change the narrative" on meat's environmental impact in the lead up to the most recent global climate change conference in Dubai in 2023 (Sherrington et al., 2023). The particulars of the farmed salmon case are best situated within the wider trends throughout industrial animal agriculture towards sustainable protein.

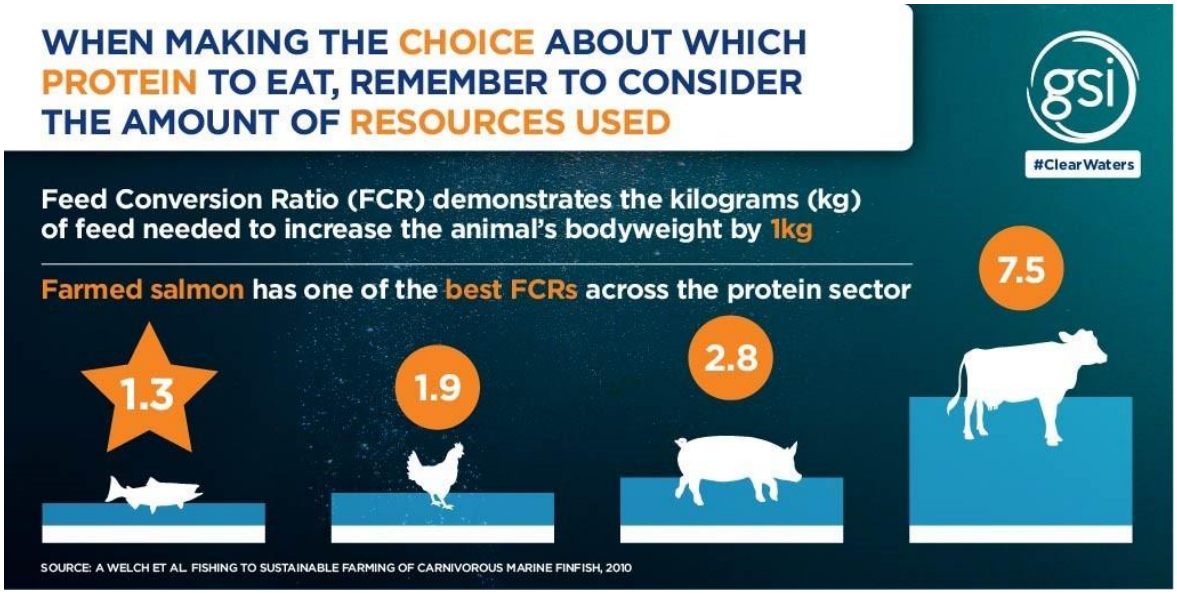
In only a few decades, the farmed salmon industry grew into a big global business. Compared to other CAFO systems it is young although it is founded on traditional industrial animal agriculture principles (Lien, 2015). The industry's sustainability claims, and underpinning metrics primarily rely on the role of fish feed, and the feed conversion ratio (FCR). The FCR is the key measure of efficiency for industrial animal agriculture. At its simplest FCR is a measure of the weight of feed consumed to the weight of animal produced. The faster and greater the accumulation of animal mass, measured by feed weight in and animal weight out, the greater the FCR efficiency. Lien (2015) shows the large effort the industry applies to managing, calculating, and improving its feed systems with the primary aim to improve feed efficiency and reduce waste. And for good reason: feed is by far the largest single cost for the industry and has long been a primary concern for the global salmon sector.

In the last several years, key players in the global salmon sector—including feed companies and salmon grow-out companies—have focussed on promoting

farmed salmon as a sustainable protein.[5] While this messaging is promoted by individual companies, the claims are articulated most clearly through the Global Salmon Initiative (GSI), an organization that describes itself as a "pre-competitive" platform representing many, but not all, of the farmed salmon producers in Europe, North America, Chile, and Tasmania (GSI, 2024, para 5). The GSI's mandate is to represent the industry and to "drive real and measurable improvements in the sustainability profile of the farmed salmon industry" (GSI, 2023, para 2) . While the GSI does not represent MOWI, the world's largest salmon farming company, GSI's messaging is largely consistent with this company's overall strategy. Indeed, many of the metrics currently produced by the GSI originate in MOWI's own set of reports produced from the early 2010s.

The GSI's effort to promote farmed salmon as a "climate friendly," efficiently produced protein is supported by metrics and attractive visualizations that emphasize the difference between livestock production on land and in the ocean (Figure 1). The comparisons require standardizing a portion of protein from farmed salmon, chicken, beef, and lamb and then applying a range of indicators including carbon footprint, land use, protein retention, calorie retention, and edible yield, which are then further compared across land and sea protein production systems. The results across these indicators, according to GSI, are remarkably consistent: producing animal protein in the ocean generates fewer greenhouse gases, it is more efficient, and it is less energy intensive. The data and simplified graphics that are used across the sector play a critical role in the GSI's claim that farmed salmon is a "climate friendly" protein, and substantially more climate friendly than comparable systems producing protein on land and this is highlighted through FCRs (Figure 2).

Figure 2: Feed Conversion Ratio (FCR) (GSI, 2023)



[5] We have argued elsewhere that the farmed salmon industry has a myriad of environmental problems (Martin et al., 2021; Martin & Mather, 2023).

The global farmed salmon sector is notable for the work and resources they have dedicated to supporting claims that this fish is an "eco-efficient" protein. The images that compare the environmental impact of proteins across land and sea are regularly used by the salmon industry to promote farmed fish as a sustainable alternative to meat produced on land.

While the land-based livestock sector does not appear as coordinated in developing a single message about meat produced on land, the situation is changing quickly as the sector becomes a key area for debate within climate change forums (GRAIN & IATP, 2018). Indeed, there have been important developments in the last five years or so as animal meat production is identified as a key obstacle in meeting national and global climate change targets. Industry and various industry organizations in North America and Europe have, in response to these challenges, embarked on an aggressive effort to develop metrics and indicators to "change the narrative" about meat. Changing the narrative from the industrial livestock sector's perspective involves promoting meat as a "sustainable nutrition" that can be produced more efficiently and with lower environmental impacts while at the same time providing the world with a nutrient that is critical to human health (Christen, 2021). Several of these efforts have been well publicized including the development of a new metric for greenhouse gas emissions, widely condemned as an attempt to greenwash the environmental impact of meat production (IPES-Food, 2022; Rogelj & Schleussner, 2019).

Industry efforts to "change the narrative" have intensified in the context of recent food and climate change forums including the Congress of the Parties (COP) climate change meetings in Paris (2022) and Dubai (2023). In the lead up to the 2023 COP meeting in Dubai, journalists gained access to leaked documents produced by the Global Meat Alliance (GMA), an organization representing some of the biggest livestock and animal feed producers, outlining an aggressive plan to provide "scientific evidence" that animal agriculture's contribution to climate change is overstated and that industry has the potential to provide the world with sustainable protein (Sherrington, 2023). The documents reveal a coordinated plan to release this science to refute what the industry describes as "ideologically driven" arguments against meat production and consumption with a view to showing how "producers can 'play a key role in environmentally sustainable food systems' and that the sector is 'continuously driving towards carbon-friendly farming'" (Sherrington 2023, p. 2). While the land-based livestock sector may be several years behind the farmed salmon sector, it is quickly adopting a similar strategy of developing metrics, indicators and using "scientific evidence" to convince the public and regulators on the sustainability of industrially produced meat.

The rise of sustainable protein—or "sustainable nutrition" in recent industry reports (Sherrington, 2023)—is coordinated around two key pillars. First is the shift from meat to protein, a shift that we argue detracts from the environmental problems associated with meat in favour of a charismatic nutrient, protein (Guthman et al., 2022; Kimura, 2013). Second, and relatedly, it depends on a range of metrics, indicators, and data that aim to demonstrate that the protein produced in these industrial systems is more efficient and sustainable (Martin & Mather, 2023). While metrics and indicators are perhaps more developed within salmon aquaculture, the evidence suggests that the global land-based livestock sector is also attempting to coordinate around messaging that challenges the existing consensus on the environmental and climate change impacts of industrial livestock production.

In the next section, we attempt to make sense of these claims and the efficiency indicators and metrics by drawing on Daggett's genealogy of energy. We aim to show that these metrics and calculations, that aim to justify meat as sustainable protein, do so through a logic of energy.

Energy as "geo-theology"

Developing metrics and indicators to assess the environmental impact of animal agriculture on land and in the ocean is central to what the IPES has called the "politics of protein" (IPES-Food, 2022). Industry and industry supported organisations are developing and using metrics and indicators to contest rigorous analysis on animal agriculture's significant contribution to climate inducing greenhouse gases and pollution. While industry generated metrics aim to demonstrate sustainability, they do so by relying almost exclusively on claims that these new systems and technologies conserve and use energy more efficiently. Consider, for example, how the salmon aquaculture sector explains why farmed fish achieve a lower feed conversion ratio than animals raised for meat on land. As we noted earlier, the lower FCR for farmed salmon is fundamental to the industry's claims for "eco-efficiency." A key factor that accounts for the differences between land and sea production systems—according to industry experts—has to do with the "bio-energetics" of fish and fish farming (Smil, 2013). Because fish are cold blooded, they require less energy in the form of feed to sustain and grow their bodies. Unlike warm blooded livestock like chickens, cows, and pigs, fish do not need to maintain a steady temperature, which requires additional energy, and by implication greater use of feed (Marine Harvest & Mowi, 2018). There are other additional "energy savings" that come from farming fish for protein, according to industry and aquaculture experts. Farmed fish do not face the same energy demands associated with gravity that affects farmed animals on land. In industry reports, this supports the argument that farmed fish have a "natural advantage in terms of energy efficiency...compared with terrestrial protein equivalencies" (Mowi, 2019, para 4). Energy is used more efficiently because "fish are neutrally buoyant in their watery world and thus do not devote as much food energy to maintain bones/posture against gravity as do land animals" (Costa-Pierce, 2010, p. 96). In other words, the argument goes, fish require less energy to grow in the form of feed than animals on land, and are therefore more efficient protein generators.[6]

The farmed salmon industry centres the role of energy in sustainable protein, which has led us to Cara Daggett's (2019) work on energy and its political logic. Central to her analysis is the claim that energy is not a transhistorical concept, but instead needs be understood in its historical and geographical context. Using this approach, she shows how a new understanding of energy was "discovered" in the mid-1800s, primarily through the efforts of northern British engineers and scientists. Daggett examines the encounter between engineers and steam engines as they puzzled over how coal was converted into movement. Out of this encounter came the "laws" of

[6] It goes without saying that the emphasis on the bioenergetics of fish places less emphasis on genetics, breeding, and the quality of feed, all of which are crucial to sustaining low feed conversion ratios in farmed salmon and other intensive livestock production systems.

thermodynamics (or heat and movement), and with them a new "logic," likened to a kind of mystery of "life." The puzzle of the steam engine produced broad and universal ideas about the essence of energy for machines, and the laws were and applied to other life spheres.

The physical sciences were critical to understanding the transformation of energy in things like the steam engine, but the logic of energy is also indelibly marked by the Protestant ethic. The British engineers and scientists' strong religious beliefs played a central role in shaping the discovery of energy and the formulation of its political logic. In this way, the logic of energy is best understood as a "geo-theology," where the science of thermodynamics joins up with the Protestant priorities of hard work and the reduction of waste (Daggett, 2019). In this marriage of science and religion, energy that is used efficiently is valued while wasted energy is abhorred. The discovery of energy in the mid-1880s thus had a political and religious rationality which continues to shape how we understand energy and its use (or misuse) today.

While Daggett's genealogy of energy relies heavily on scientists and engineers working on the steam engine, the logic of energy as political rationality quickly extended beyond this device. As she writes, the logic of energy began with the steam engine, but it quickly extended to other machines and living systems: "From an initial desire to improve steam engines, scientists and administrators could now apply energetic metaphors to such problems as the design of factories, the nutrition of laborers, the laying of underwater telegraph cables, the freshwater needs of imperial trade and military ships, the availability of healthy and vigorous workers for steam engines, or disease outbreaks in burgeoning, polluted, and filthy industrial cities. Energy was a unit through which all these problems could be connected, measured, charted, and managed" (Daggett 2019, p. 78).

The significance of applying "energetic metaphors" to energy exchanges beyond the steam engine is that it connects energy and work in a very particular way, and in a way that continues to shape contemporary industrial life. According to the logic of energy, work—both human and nonhuman—demands the efficient use of energy and with little waste. At the same time, energy that is not utilized is also considered wasteful because it remains "unworked" and "idle" and represents a human failure to use "freely provided gifts from God" (Daggett, 2019, p. 75). While efficiency and the reduction of waste have become common-sense approaches to work in Western society, Daggett's historical analysis exposes it as a very particular way of governing work, and its entanglement with the logic of energy (2019). In turn, energy was a measure that helped explain, manage, and connect work, industry, and lifeways.

Measurement and calculation underpin the logic of energy. If energy's logic demands the increasingly efficient transformation of energy and the minimization of waste, then measuring, calculating and monitoring these energy exchanges becomes critical. Daggett traces the rise of these measurement systems and their increasing standardization over time, which allowed for comparisons of different energy transformations ranging from the scale of individual bodies and machines to much larger systems of energy exchange (2019). Daggett's intervention on energy and its underlying political logic helps to explain the unquestioned value that is placed on the metrics of efficiency and waste in industrial systems (2019). We now turn to extend and develop her analysis in the context of sustainable protein.

Industrial meat production, sustainable protein, and the logic of energy

Daggett's analysis of energy and its political logic draws primarily from industrial production and initially, the steam engine. However, as we noted earlier, her argument has far broader purchase; it offers, for example, important tools to explain how animals, including horses and humans, came to be understood as "energy transformers" and in turn, their "power (or rate of work) and efficiency (minimization of energy wasted) could be compared" (Daggett, 2019, p. 87). Of course, the idea that animals are energy transformers also applies to industrial animal agriculture where feed provides the energy for animal life, work, and growth.

The metrics and indicators used by the animal agriculture industry to justify sustainable protein are based on a vision of systems that are more efficient and less wasteful at transforming energy in the form of feed into a protein product. These claims are most obvious in industrial aquaculture where, as we have shown, farmed salmon is argued to be an efficient generator of protein through low feed conversion ratios. But these claims about energy efficiency and waste minimization are also evident in land-based production systems that involve chickens, pigs, and cattle. Energy logics are, therefore, central to how the production of animal protein is justified as sustainable.

If energy logics, as conceptualised by Daggett, is central to how sustainable protein is justified, why is this a problem? *First*, and most obviously, improvements in efficiency in animal aqua-agriculture are not necessarily consistent with sustainability. Reisman's (2019) analysis of water use in California's almond sector reveals how claims to efficiency have led to the significant expansion of production in this water-stressed state and to the spread of production into more arid regions thereby undermining any gains through more efficient use of water. Similarly, claims to improved efficiency through sustainable protein by big meat corporations like JBS need to be critically assessed against their public commitments to shareholders to significantly increase the scale of meat production to meet global demands (GRAIN & IATP, 2018). These two examples, as Guthman notes, reveal a common problem where more efficient use of resources is "often conflated with environmental benefits in a whole host of current prognostications of optimal food futures" (2022, p. 73).

There is a *second* problem with the industry claims of sustainable proteins improved measures of efficiency and waste. These claims are presented as new innovations in animal agriculture, but the reality is that the industrial animal agriculture has always focussed on efficiency and waste. A rich political economy scholarship describes the interactions between capital, agriculture and animals, whether Friedmann's (1992) "grain-livestock complex" built on the seemingly efficiently produced grain surpluses in temperate regions, Specht's (2019) "cattle-beef complex," a set of institutions stretching back to the nineteenth-century that relied on technologies, capital and political struggle to efficiently produce cheap beef for U.S. eaters, or Boyd and Watt's (1997) "southern broiler complex," which adopted just in time chicken production to maximise material and time efficiencies in the latter half of the twentieth-century. Indeed, as the nineteenth-century and twentieth-century history of industrial meat production has revealed, the sector has always worked towards improving efficiency and waste reduction by commodifying waste and enfolding all parts of the animal into market relations (Cronon, 1992; Guthman, 2022; Shukin, 2009; Sinclair, 2016). In Cronon's words, "the packers worshiped at the altar of efficiency, seeking to conserve economic resources by

making a war on waste" (Cronon, 1992, p. 249). The management and focus on efficiency and waste, as the scholarship has shown, is the history of industrial meat production.

Recent scholarly work has demonstrated industrial animal agriculture's laser focus on efficiency and waste and the production of highly standardized animals, but with significant welfare implications (Blanchette, 2020), "efficiencies so great they produce death and deformity" (Guthman, 2022, p. 82). The drive for efficiency in feed and feeding and the constant effort to reduce waste through system efficiencies is illustrated most starkly through Blanchette's (2020) analysis in *Porkopolis* with the thousands of product codes for parts of pigs' bodies that are transformed into a variety of commodities. The commodification of animals in CAFOs leads to detachments (Emel & Neo, 2015) and obliterates any real links to society (Winders & Ransom, 2019). In turn, the disassembly of animals into parts or components is a precondition for the emergence of waste (Shukin, 2009 p. 71-2). The drive for efficiency reaches into all aspects of industrial meat production from seeing animals as machines, or "things" (Weis, 2018) that convert energy into body mass, disassembled into parts, and then transformed into cheap meat. Industry values animals as workers whose purpose is to produce as much meat as possible, as quickly as possible, and with as few inputs as possible (Specht, 2019)—a serious manifestation of efficiency.

Mark Finlay's (2003) analysis of the industrialization of hog production in the U.S. after the Second World War provides key evidence on how the logic of energy operated. Finlay shows how the focus on "controlling labour and energy inputs" resulted in a shift from animal husbandry to industrial management (2003, p. 238). Industrial animal production "compressed the time, space, labour and energy associated with hog production along the lines of an efficient industry" (Finlay, 2003, p. 238), or in Cronon's words the "annihilation of space"(Cronon, 1992, p. 96). Any industrial undertaking relies on intense energy "inputs" to efficiently produce "outputs" with as little waste as possible. Within this logic of energy and work, animals were machines, and could be improved through genetics because one cannot have "poor machinery to put the raw product [or feed] through" (Finlay, 2003, p. 242).

If the emphasis on efficiency and waste minimization is longstanding in industrial meat production, how has it become central to claims for sustainable protein? The example of Maple Leaf Foods in Canada illustrates how agri-food capital has focussed on promoting processed meat as sustainable but based on a more longstanding concern with efficiency. Maple Leaf Foods undertook the creation of an extensive sustainability program that culminated in their "Raise the Good in Food" blueprint (Maple Leaf Foods, 2021, p. 6). Embracing the message "you manage what you measure" (Maple Leaf Foods, 2021, p. 9), sustainability's promise of a value shared equally amongst its stakeholders produced a newly calculable arena for Maple Leaf Foods to manage their efficiency, though it had been a distinct area of concern for the company for decades. For instance, before it was consolidated into Maple Leaf Foods Inc. in 1990, Canada Packers Ltd. developed an accounting framework unique to the company called the "opportunity cost metric", that measured the "true profit performance" of various departments based on a fixed rate of capital invested in each plant, plus its "working capital" (MacLachlan, 2016, p. 191). This allowed calculations of a rate of return measured as a percentage of the capital employed, showing that the greater the slaughter capacity of a plant the higher its return. Profitability became distinctly tied to volume, a "clear demonstration of the economies of scale in meat

packing" (MacLachlan, 2001, p. 190). It was these economies of scale that justified the current highly concentrated meat production industry, and before it aimed to be the "most sustainable," Maple Leaf Foods' goal was to aim for efficiency through competitor buy outs and worker pay cuts (Mahood, 1997). That the hire of a new VP of Sustainability & Shared Value in 2015 was explicitly mandated to oversee efforts to become an even "more efficient" operator (Maple Leaf Foods, 2021, p. 9) hints at the energy logic behind the never-ending work of meat's pursuit of both efficiency, and now, sustainability.

The *third* problem with the logic of energy has to do with the enumerative politics of efficiency and waste. The critical social science scholarship on industrial agriculture has convincingly demonstrated that animal agriculture is enormously inefficient and wasteful. Indeed, critical scholars regularly point out that industrial livestock production is a massively inefficient way to produce protein for human consumption in contrast to plant proteins (Sexton et al., 2022; Weis, 2014; Weis & Ellis, 2022). Weis (2014) highlights the industry's inefficient use of resources such as feed that is a "systemization of waste." The inefficient "ecological hoofprint" extends to its reliance on resource intensive feed monocultures, and its disastrous production of waste and greenhouse gas (GHG) emissions (Weis, 2014). Industry critics, then, use metrics and indicators to reveal agriculture's enormous environmental "hoofprint." Yet industry also uses metrics and indicators—including the environmental footprint of animal agriculture—to make claims for efficiency and waste minimization in the production of sustainable protein. In other words, the critics of industrial animal agriculture and the defenders of "sustainable protein" *both* rely on indicators and metrics of animal agriculture's environmental hoofprint (or "finprint;" Martin & Mather, 2023).

Daggett addresses this problem of a shared concern around metrics and indicators in the conclusion to her book. She writes that critical scholars and activists are at risk of becoming "mired in a back-and-forth over accounting logics that, in the spirit of neoliberalism, sidelines normative and political claims" (Daggett, 2019, p. 192). In other words, both sides of the political debate on animal agriculture operate within and through energy's political logic. It allows industry to set targets and to claim improvements in efficiency and waste reduction as a way of addressing environmental concerns that are difficult to challenge because they appeal to energy's logic and its commitment to efficiency and the reduction of waste. At present, corporations that manage industrial animal systems continue to value and rely on the logic of energy and its metrics. A recent example from the GSI sustainability report: "the lower the FCR, the more efficient an animal is in retaining the protein and energy from the feed and converting it into food for humans" and 'harnessing…waste to become a resource" (GSI, 2021, para 10). The devastating environmental and social problems associated with these systems seem to be left untroubled as animal agricultural proponents continue to highlight improvements rather than any fundamental change. Instead, as Daggett argues, progressive alternatives require "new ways of thinking about, valuing and inhabiting energy systems" (2019, p. 3).

The *fourth* problem with the logic of energy as it applies to sustainable protein has to do with Daggett's argument about how the logic of energy should be understood as a mode of domination. In the second part of her book, Daggett extends her analysis of energy's logic as emerging out of a specific industrial context to examine how it plays a key role in shaping and guiding European imperialism from the late 1880s to the early twentieth-century. Her aim is to use this

evidence to show how "putting the world to work" through the logic of energy guided and justified Western imperial conquests from the mid-1800s and beyond (Daggett, 2019, p. 1). Through this analysis, she makes the case for energy as a political rationality that served imperial domination, as providing yet another framework, or "Western code," with which to organize a world of different, and usually subjugated, people and things (Daggett, 2019, p. 136). This is an opportunity to think through how we are implicated in putting animals and humans to work in industrial systems, and the modes of domination that subject animals and humans.

The "logic" of sustainable protein, and industrial animal agriculture more generally, can be reframed and illuminated with Daggett's conception of the logic of energy. If energy logics are central to both conventional animal agriculture and more claims for alternative systems for sustainable protein, then we need to see these systems as dependent on the domination of animals who must perform the role of efficient "energy transformers" and supported by the labour of human workers. The making of sustainable protein involves shifts at the corporate level with potential significant implications for flows of investment, combined with the production of new metrics and associated claims for sustainability and circularity in resource use. While existing scholarship has justifiably challenged these metrics and claims, we point to the deeper logics that justify these claims and that are consistent with a deeply held Western epistemology on energy and efficiency.

Conclusion: Beyond the logic of energy

The logic of energy, with its emphasis on efficiency and the effective use of waste, has long shaped industrial livestock production. Our claim is that these same goals of efficiency and the minimization of waste are fundamental to contemporary justifications of sustainable protein. In other words, the same logics that shaped the industrialization of *meat production* with all its environmental, social, and animal welfare problems are being used to justify *sustainable protein production*. We reach this argument through a detailed engagement with Daggett's work on the logic of energy, by building on an existing body of scholarship on the history and contemporary dynamics of industrial livestock production, and through a close analysis of recent claims by the farmed salmon industry that this fish represents the ideal sustainable protein. Sustainable protein is also justified through commitments to reducing waste or to using waste productively either by producing new commodities for exchange or by recirculating waste back into production.

The problem with the logic of energy is that it suspends the political and makes it impossible or difficult to speak about alternatives that do not frame efficiency and waste as a central concern. This framing also entangles proponents of more efficient "alt-proteins" and less wasteful "circular" economies. In the conclusion to his book, *Porkopolis*, Alex Blanchette bemoans the way in which the goal of efficiency dominates both the humans and non-humans in the industrial pork sector in the U.S. (2020). He ends by calling for "a positive politics of inefficiency," and notes how the idea of an unworked animal has become unthinkable (Blanchette, 2020, p. 237). This is the power of the logic of energy, where inefficiency is deeply political, and where leaving something "unworked" is a radical proposal.

Daggett ends her book more hopefully by reminding us that "there are other (scientific, political, spiritual) modes of knowing and experiencing energy that do not elevate productivity as a primary goal for human well-being" (2019, p. 195). She encourages us to disrupt and displace the logic of energy that demands efficiency, and argues that, in so doing, "we open up space to judge technology and automation according to other energy and ecological imaginaries of what constitutes a good life, or a well organism" (2019, p. 195). By disrupting the logic of energy, we can begin to value life over efficiency. When we break away from the logic of energy and acknowledge the many other ways of knowing and experiencing, we can escape what Vandana Shiva has called "monocultures of the mind (1993)." Importantly, to Daggett's conceptions, energy is a mode of domination and to that end reconceptualising our relationship with animals should be a central concern. Otherwise, we will continue to be locked into the logic of energy, and its co-conspirators efficiency and waste. A displacement of the energy logic makes space for the many alternative possibilities of food production that centre life rather than efficiency, abundance rather than waste, and relations rather than domination.

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