Energy and food

1. Introduction

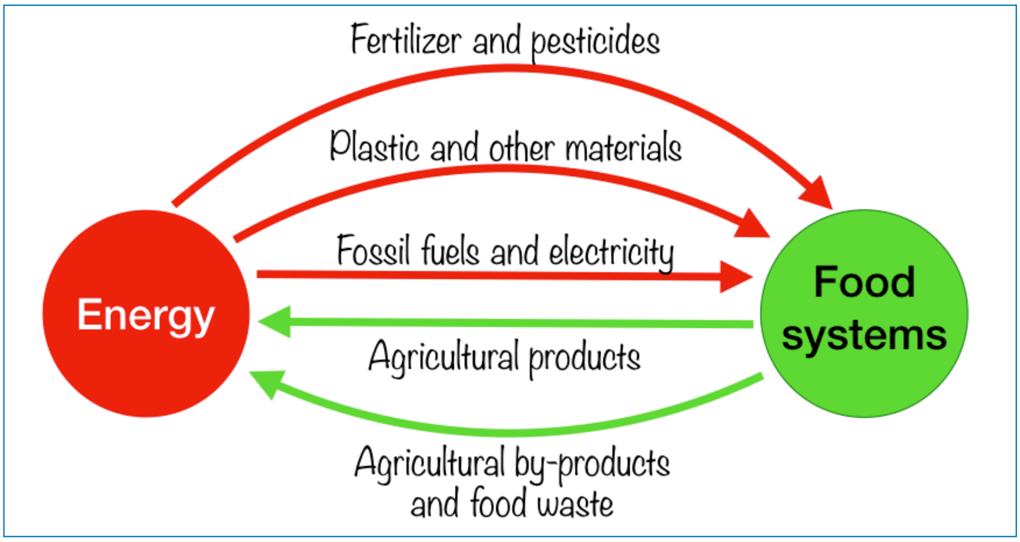
While COP28 on climate change takes place in Dubai, it seems useful to come back on the close inter-linkage existing between **food** and **energy.**

This is all the more important as food systems account for **more than a third of total greenhouse gas (GHG) emissions originating from human activities**. The emissions from food systems can be divided into three categories:

- Those originating from agricultural production proper (39% of the total).
- Those resulting from land use and land-use changes (including deforestation) (31% of the total).
- Those incurred during post-harvest activities (transport, processing, packaging, retail, consumption and end-of-life disposal) (30% of the total) [read pp. 4-7].

Both these key economic sectors are simultaneously providers and suppliers of goods to each other. As illustrated in Figure 1.

Figure 1 - Physical flows between the energy sector and food systems



On the one hand, the **energy sector** (and related chemical industries) supplies the food system with

- Fossil fuels and electricity required for operating farm machinery, for producing in a controlled environment (e.g. greenhouses, industrial poultry houses, food labs and other similar facilities), for transporting, storing, processing and distributing food;
- Agrochemicals (fertilizers, pesticides, veterinary medicines, etc.)
- Plastic, rubber, fibre and other energy-intensive materials that have become virtually indispensable in post-harvest activities.

On the other hand, **food systems** supply to the energy and industrial system with

- agricultural commodities for producing agro-fuels such as ethanol and biodiesel;
- agricultural by-products and food waste used for producing biogas and biofuels.

2. From energy to food systems: food is increasingly energy-intensive

Recent estimates suggest that food systems currently account for at least 15% of global fossil fuels use annually, driving as many emissions as all EU countries and Russia combined [read p. 2].

Industrial food systems are energy intensive and dependent on fossil fuels with the majority of fossil fuel consumption taking place in the processing and packaging stage (42%), and in retail consumption and waste (38%) [read p. 2].

Fossil fuels are also consumed during agricultural production, both directly (e.g. for operating machinery) or indirectly through the use of agricultural inputs such as synthetic agrochemicals (e.g. fertilizer and pesticides). The production of nitrogen fertilizer is particularly energy intensive because it relies on the Haber-Bosch process to fix the nitrogen present in the atmosphere [read pp. 3-5]. Agriculture also uses electricity for running specialized production infrastructure like glasshouses, controlled environment production facilities and industrial poultry and piggery housing. Figure 2 shows the importance of fertilizer and plastic in the chemical industry, the latter being central in food systems at the stage of distribution.

The energy intensity of food systems has been increasing for several reasons:

- more mechanization.
- application of larger amounts of fertilizer, pesticides and other fossil fuel-based inputs,
- transport of food on longer distances because of continuous growth of global trade and globalized supply chains,
- because of the development of novel foods like lab-grown proteins resulting from fermentation [read p. 2] that are produced in a controlled environment[1], and,
- consumption of greater quantities of more highly processed food.

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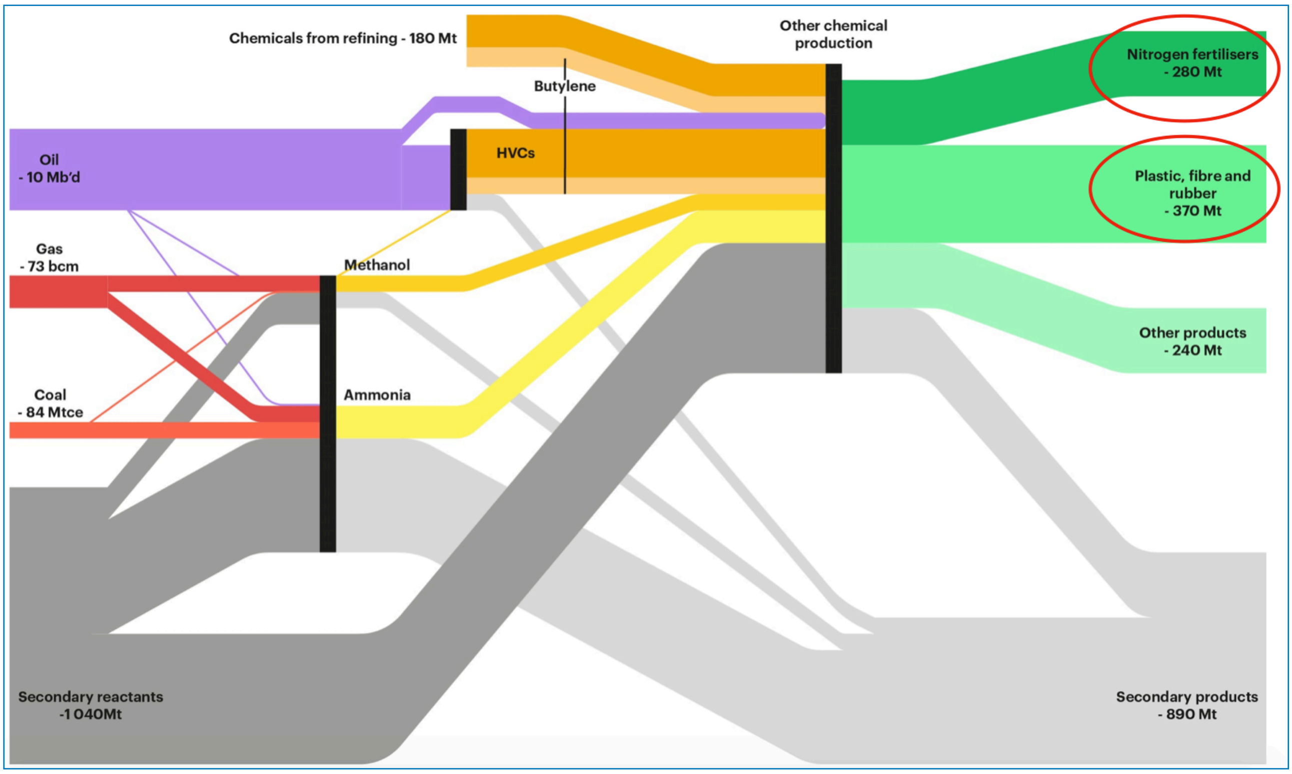
[1] Some studies have shown that lab-grown meat requires up to six times more energy compared to alternatives [read].

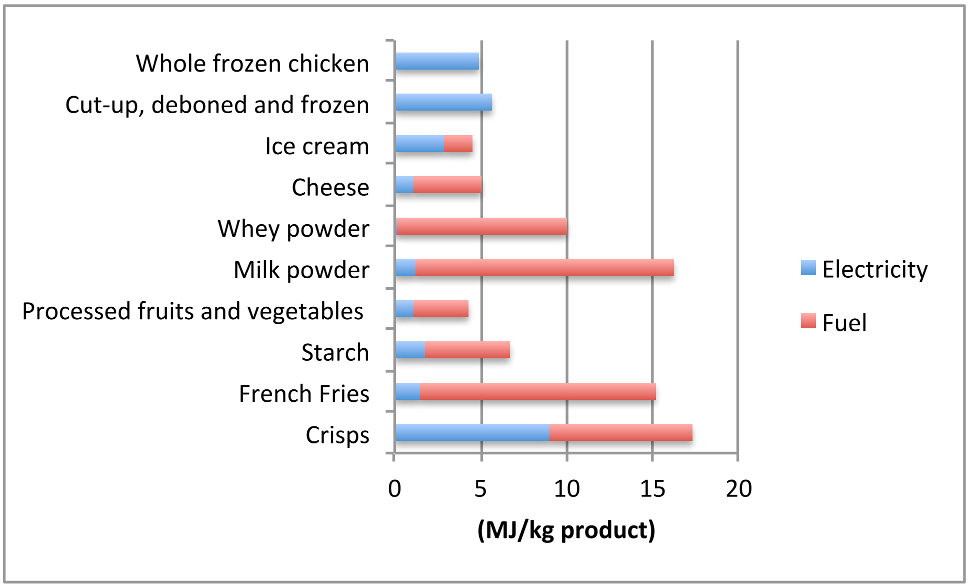
Figure 2 - From energy to chemicals in 2015



Source: Levi and Fernandez Pales, 2018.

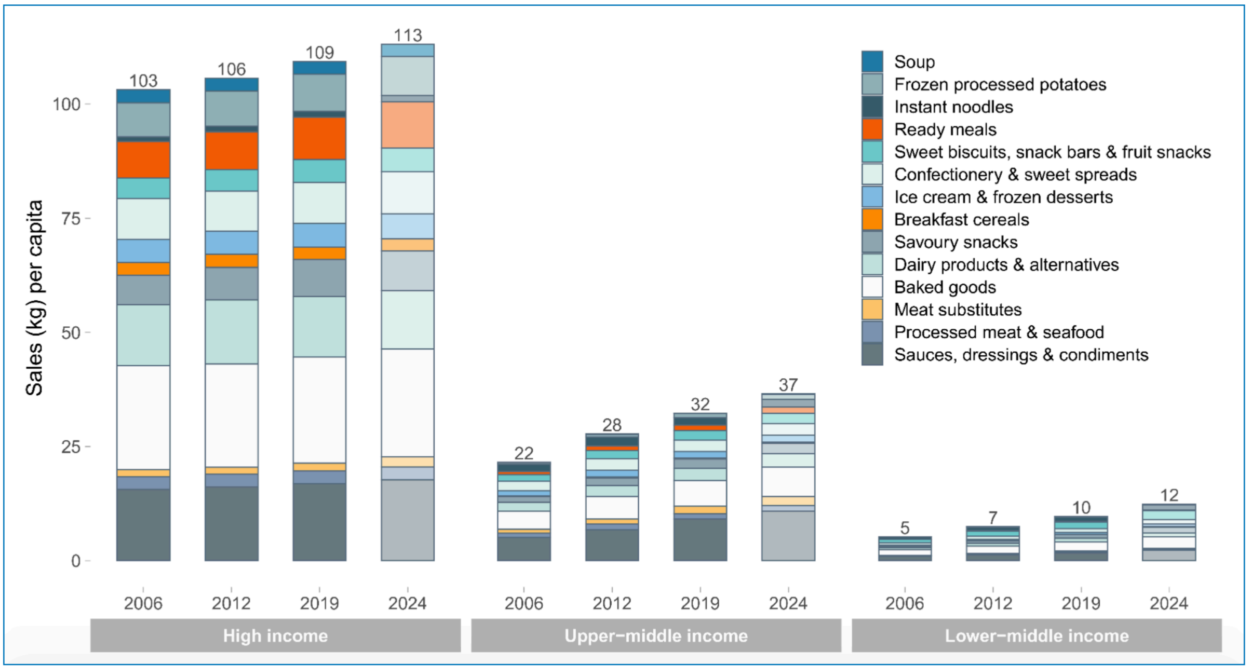
Production of highly processed food is 2 to 10 times more energy intensive than whole foods (Figure 3) and their consumption is dominant in rich countries and rapidly increasing in others (Figure 4).

Figure 3 - Average final electricity and fuel energy consumed to produce selected processed products



Source: Based on Ladha-Sabur et al., 2019.

Figure 4 - Ultra-processed foods sales (kg) per capita by country income level (2006-19 with projections to 2024)



Source: Baker P. et al., 2020.

As the use of fossil fuels for transport, power, and heating is expected to decline in an effort to reduce the carbon footprint, energy and chemical corporations rely on plastics and agrochemicals (fertilizer and pesticides) to use up most of the petrochemicals in the future, thus securing their huge profits. In the US alone, the industry projected to spend over USD 164 billion from 2016 to 2023 on petrochemical facilities. The same trend can be observed in several other countries [read p. 10].

Needless to say, they will do everything in their power to avoid agriculture and food from graduating out of agrochemicals and plastic, as these two families of products make up a large part of the output of the chemical industry! (Figure 1.)

3. From agriculture to energy: an increasing volume of biomass is being used to produce energy

Food systems and energy are intertwined not just because food systems are energy intensive, but also because agricultural (and food) products can be used for energy production.

Energy production from agricultural commodities has been growing as bioeconomy developed, and it competes with the use of agricultural products for food [read], particularly when oil prices are high or when biofuels[2] are supported by countries.

[2] Biofuels include ethanol (mostly from the processing of sugarcane), biodiesel resulting from trans-esterification of vegetable oils (e.g. soybean, canola/rapeseed, corn, sunflower, palm and alga oils) and animal fats, as well as renewable diesel and other non-food biofuels (e.g. jatropha) and bio-intermediates produced from nearly any biomass feedstock, including gas (biogas). When biofuels are made from agricultural commodities, they are often referred to as agro-fuels.

In Europe, tax credits, subsidies, and loans have been widely used to boost production of biofuels produced from the processing of biomass (including agricultural commodities and by-products) in an effort to reduce reliance on fossil fuels. This can have dramatic impact on deforestation by expansion of cultivation of crops that enter in the production of agro-fuels. This is illustrated by a study conducted by Transport&Environment that estimated that the European Union's palm biodiesel policies caused the loss of a tropical forest area the size of the Netherlands between 2009 and 2019 [read].

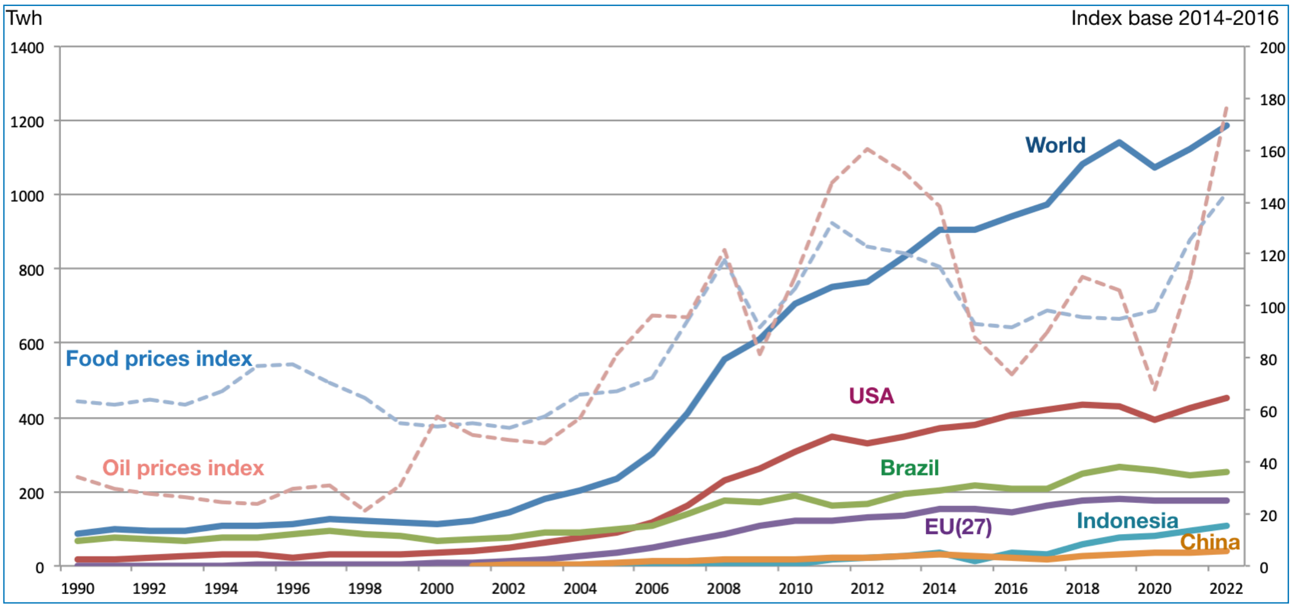
Let's remind here that around 11 million tonnes of vegetable oil are processed in the EU to make agro-fuels, an amount that is equivalent to 45% of the total use of vegetable oil in the Union, and that in the US, 140 million tonnes of maize are consumed for the same purpose (equivalent to 70% of the domestic maize market) [read in French].

The development of biofuels, started in the 1970s, at the time of the then oil crisis, was given a strong impulse during the food crisis of 2007-2008 [read pp. 3-6]. At that time, a vast land-grabbing movement was initiated in which 25 to 40% of the land acquired was used for growing either crops for producing non-edible oils (e.g. jatropha) or "mixed" crops (e.g. maize, soya, oil palm or sugarcane) that could switch from food use to agro-fuel production depending on which is the most profitable [read p. 9].

With biofuels having become part of the food and agriculture landscape, the linkages between oil and agricultural commodity prices have been analysed by a multitude of research studies (see, for example, here, here, here and here). It seems that the linkage has turned stronger with time, but the complexity of the relationship existing between the two, as energy is at the same time a cost component of increasing importance for agricultural commodities and a competing source of demand for agricultural outputs, has made that there is no clear research consensus.

But there is solid evidence of a considerable increase of production of biofuels from the middle of the first decade of this century when both prices of oil and of agricultural commodities started to rise, the US, Brazil and the EU being the main actors of this event. A graphical representation of the evolution of biofuel production and of variations of food and oil prices shows that the development of biofuels has been taking place in a period of price instability characterized by an upward trend, as the world started to become more conscious of climate change and resource limits (Figure 5).

Figure 5 - Biofuel production, food and oil price indexes



Sources: data from [Our world in data](), [FAO]() and [INSEE]().

With the current acceleration of the climate crisis [read], the perspective of a likely end of the central role played by fossil fuels in energy, there is a fair probability that biofuels will continue to grow, as bioeconomy as a whole develops. This will likely increase the pressure on natural resources (land and water, in particular), with the consequence of modifying land use, thus generating new GHG emissions and annihilating at least in part the emission reduction function that biofuels were expected to have in the mind of those who encouraged their production. Moreover, by using a growing share of the agricultural output, agro-fuels will also contribute to more demand for them and likely push food prices upwards [read here pp. 3-4 and here].

4. Conclusion

Energy and food are almost inextricably intertwined.

Food systems are dominated by a few major multinational corporations [read here and here]. So is the energy sector. It is in the interest if these two groups of large private operators to preserve the existing system and control its evolution. They are able to fund powerful lobbies and even succeed in having influence on the way scientific research is being conducted and on its results [read]. They are also strongly represented and very active in global events such as food summits and climate conferences and they are actively involved in modifying food systems with the view of shaping the future to their own advantage [read].

In this future, bioeconomy will play a greater role and its likely development will most probably increase pressure on natural resources and bring about higher food prices.

In this context, it will be crucial to make agriculture less energy-intensive. This will contribute to the combat against climate change and help to escape from the grip of the giant companies operating in the energy and chemical sector.

This combat will have to be systemic and take into account the complex interrelations existing between food and energy. It will imply to modify production methods in both the energy systems and food systems, as well as transforming our way of consuming energy and of eating.

Materne Maetz
(December 2023)

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To know more:

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- Global Alliance for the Future of Food, Power Shift: Why We Need to Wean Industrial Food Systems Off Fossil Fuels, 2023.
- Global Alliance for the Future of Food, Toward Fossil Fuel–free Food: Why Collaboration Between Food & Energy Systems Players Is Key, 2023.
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- Baker P., P. Machado, T. M. Santos, Show et al., Ultra‐processed foods and the nutrition transition: Global, regional and national trends, food systems transformations and political economy drivers, Obesity Reviews, 2020.
- Ladha-Sabur A., S.Bakalis, P. J. Fryer, E. Lopez-Quiroga, Mapping energy consumption in food manufacturing, Trends in Food Science & Technology, Volume 86, 2019.
- Levi, P. and A. Fernandez Pales, From energy to chemicals, International Energy Agency, 2018.

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