Agricultural Research & Technology
Open Access Journal
ISSN: 2471-6774

Juniper Publishers
key to the Researchers

Opinion
Volume 25 Issue 5 - April 2021
DOI: 10.19080/ARTOAJ.2021.25.556317

Agri Res & Tech: Open Access J

Call to Action - Food Production in Industrial Symbiosis

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Submission: April 09, 2021; **Published:** April 14, 2021

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Opinion

Food production in industrial symbiosis is an R&D opportunity addressing the food-energy-water nexus and therefore sustainable development. The low-hanging fruit of this opportunity are already being developed in ongoing projects. The urgency of climate action as well as other sustainable development goals merits an accelerated effort to develop and deploy far greater variety and capacity for symbiotic, industrial-scale food production.

Three points of departure collectively point to a potential opportunity to create sustainability and resilience with food production in industrial symbiosis:

i. The water-energy-food nexus conceptualizes the "inextricable linkages between these critical domains" and is "central to sustainable development[1]".

ii. Parker & Svantemark (2019) concludes "distributed symbiotic food production can contribute to resilience to the most threatening of the relevant risks identified and that, therefore, more in-depth investigations of how symbiotic systems can contribute to resilience are merited[2]".

iii. Parker & Kiessling (2016): "Arable land, artificial fertilizers, and freshwater resources are the base for our present food systems but are limited. At the same time, energy resources in the form of waste heat are available in ample quantities[3]".

Low-grade waste heat is an abundant resource that will increase over time

There are two main drivers making low-grade waste heat a lasting and abundant resource, the electrification of industry and digitalisation. The electrification of industry is driven by the competitive need to increase efficiency, coupled with the social demand to reduce use of fossil fuels. Processes today driven by combustion, predominantly of fossil fuels, are being pushed towards the corresponding electrical processes. digitalisation is increasingly evident in communications, products, services and businesses, resulting in the proliferation of mass data centres. These data centres require cooling. The resulting heat is generally low-grade.

Cooling temperatures for electronics and information technology will still vary. A case study is the European Spallation Source ESS, a neutron source currently under construction, powered by what will be the world's most powerful linear accelerator. ESS has a goal to recycle all waste heat. As a research facility, ESS publishes its design reports and numerous papers and conference proceedings. The ESS Energy Design Report details three cooling temperatures, a high-temperature level at 70-90°C, a medium range at the conventional cooling system level of 40°C and an also conventional chilled water loop at 5-10°C. The chilled water requires chillers, which conventionally reject heat at around 25°. The ESS envisioned employing heat pumps that deliver more useful reject temperatures, which of course comes at a cost of some additional energy use for the heat pumps[4]. The ESS case illustrates why most waste heat from cooling electrical processes will be low-grade, perhaps 30-40°. Tap water requires heating to 55°, to avoid bacterial build-up. Room heating with floor heating only requires temperatures a few degrees higher than the desired room temperature. However, existing buildings tend to be designed for a heat delivery at conventional temperatures

[1]UN-Water, 'Water, Food and Energy'.

[2]Parker and Svantemark, 'Resilience by Industrial Symbiosis? A Discussion on Risk, Opportunities and Challenges for Food Production in the Perspective of the Food-Energy-Water Nexus'.

[3]Parker and Kiessling, 'Low-Grade Heat Recycling for System Synergies between Waste Heat and Food Production, a Case Study at the European Spallation Source'.

around 80°, thus requiring retrofitting a heating system to allow use of low temperatures. The combined needs of duplicate heating systems and retrofitting make low-grade district heating systems impactable for existing residential areas.

Emerging case studies demonstrate the opportunity

Two ongoing R&D projects are illustrative of the opportunities offered in connecting waste heat with food production. The University of Linköping with the support from The Kamprad Family Foundation for Entrepreneurship is running 'Empowering Regenerative Businesses for Increased Resource Productivity and Sustainable Business Growth'. The project defines 'regenerative business' as "entrepreneurial initiatives that adopt value creation from residual resources as a core business". The CORALIS[5] project seeks to demonstrate industrial symbiosis in Europe.

Three of the involved businesses are particularly relevant here. Econova takes materials from industry that have traditionally been considered waste and converts them into new raw materials, such as fertilizer and soil improvement. Swedish Algae Factory farms algae in symbiosis with salmon farming. WA3RM (this author's employer) creates regenerative business from industrial waste streams.

The Econova example illustrates that there are more connections between industrial waste streams and agriculture than just waste heat. The on-land, closed-loop salmon farms such as the ones that Swedish Algae Factory works with need only 20°-heat for the fish to thrive. WA3RM's current projects include greenhouses supplied with 45°-55°-heat and fish farms for tropical fish requiring 30°.

The projects also demonstrate that symbiotic food production can deliver on many sustainable development goals besides climate change, such as avoiding eutrophication, protecting aquatic environment, job creation and economic growth.

Action is needed from researchers, developers and government

All too often, government is a barrier rather than a support for symbiotic food production, mainly due to the various schemes supporting unsustainable, traditional food production. This needs to be addressed to effectively combat climate change and to develop sustainably. The R&D imperative is to push harder towards commercial development on all promising initiatives in cultivation, digestion, fermentation and so on that can input into the food chain as food or fodder, or as fuel.

DOI:10.19080/ARTOAJ.2021.25.556317

[4]Parker et al., 'ESS Energy Design Report'.

[5]https://www.coralis-h2020.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958337.

How to cite this article: Thomas P. Call to Action - Food Production in Industrial Symbiosis. Agri Res & Tech: Open Access J. 2021; 25 (5): 556317. DOI: 10.19080/ARTOAJ.2021.25.556317