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Custom Development & Manufacturing Organization (CDMO)

Towards net-zero production using a backward integrated chemical network

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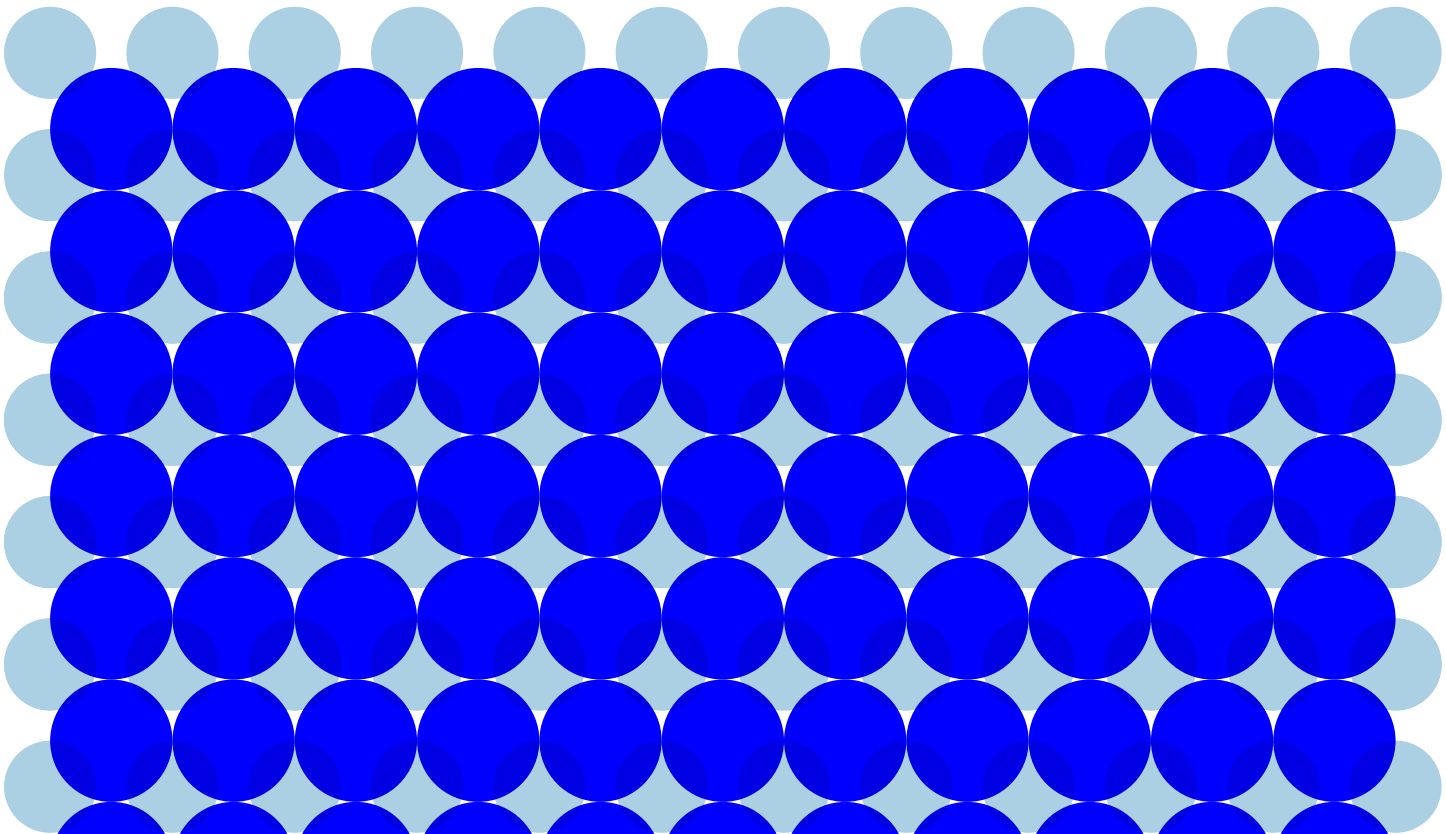
Has your company committed to a net-zero goal? Have you scoped tangible strategies to lower your carbon emissions? Many companies have publicly pledged to meaningfully decrease their greenhouse gas (GHG) emissions by 2050 or earlier, in accordance with the guidelines set out by the Science-Based Targets Initiative. In the chemicals industry, these targets are achievable by implementing a solid plan particularly focusing on reducing emissions associated with raw material purchasing. Arxada can be an invaluable partner on this journey to meet your GHG emission goals by providing low carbon-footprint ingredients.



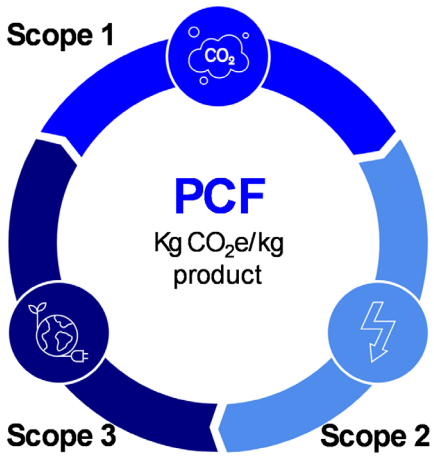
Towards net-zero production using a backward integrated chemical network

The Product Carbon Footprint (PCF) of a chemical quantifies the total greenhouse gas (GHG) emissions throughout its lifecycle. A "cradle-to-gate" assessment captures emissions from the extraction of natural resources, raw material production, transportation, manufacturing processes, waste treatment, and, optionally, packaging. Here, we outline Arxada's capabilities in assisting customers on their journey to net zero. This includes vertical integration of critical raw materials into the existing chemical network, the option to use biogenic feedstocks and green energy sources, and established relationships with reliable suppliers. Additionally, Arxada supports its customers with PCF calculations in compliance with internationally recognized standards.

Typically, the Product Carbon Footprint (PCF) is expressed in kilograms of carbon dioxide equivalents per kilogram of product (kg CO2e/kg). Categorizing emissions helps companies identify their sources and develop targeted strategies to reduce their overall carbon footprint. It is crucial to understand the entire value chain and its distinctions to calculate an accurate PCF. The GHG Protocol[1] categorizes emissions into three groups (Figure 1):

- Scope 1: Direct emissions from sources controlled by the producing company, such as emissions related to production processes,
- Scope 2: Indirect emissions associated with services produced outside of the company such as energy,
- Scope 3: Other indirect emissions in the value chain that are not controlled by the producing company, including emissions from the production of raw materials, transportation, and disposal.

Figure 1. The three scopes of PCF as defined by the GHG protocol.

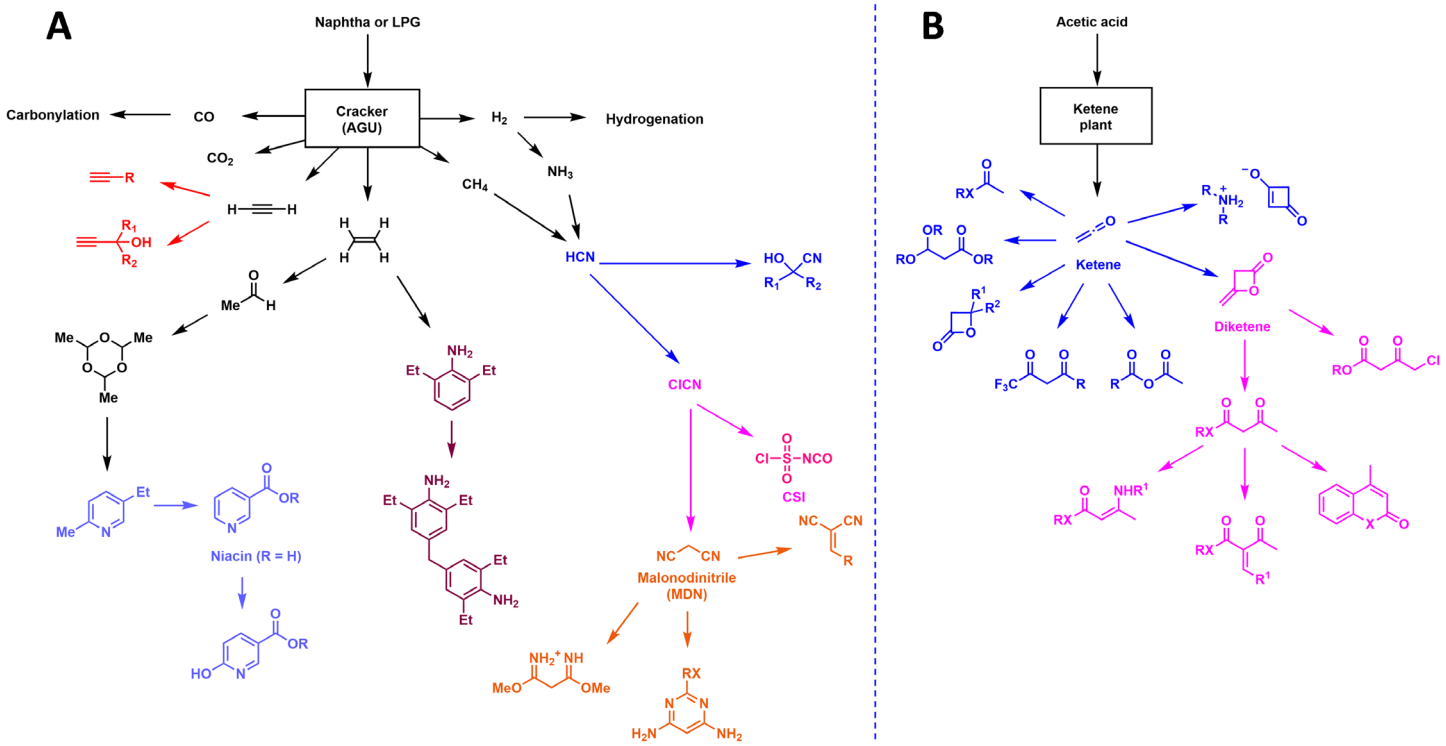


The Chemical Network

Arxada has the unique capability to reduce emissions by providing highly backward-integrated chemical solutions at its Visp manufacturing site. Unlike other Contract Development & Manufacturing Organizations (CDMOs), Arxada is not limited to the supplier network to source low-PCF starting materials but can vertically integrate them into the existing chemical network, thus accounting for the associated emissions as part of Scope 1. For instance, the Visp's cracker (Acetylene Generating Unit, AGU) continually produces several streams of important base chemicals, such as acetylene, ethylene, or methane. These may then be converted into multiple secondary products. For example, methane acts as feed for the cyanide unit, where it is subsequently converted into hydrogen cyanide (HCN). By further conversion of these streams, a multitude of building blocks and reagents can be accessed, such as malonodinitrile (MDN), an extensively used building block for products in the fine chemical, vitamin, agrochemical, pharmaceutical, and semiconductor sectors[2]. The example of niacin (vitamin B3), starting from ethylene, showcases how a marketed product can be fully backward integrated into the chemical network (Figure 2A).

Similarly, acetic acid is fed into the ketene loop reactor. The reactive intermediate ketene is available "on demand" for conversion into other products, such as acetylated intermediates or diketene, which is among others a useful reagent for the introduction of acetoacetyl groups[3] (Figure 2B).

Figure 2. A. Chemical network based on the cracker (AGU) at Visp manufacturing site, B. Chemical network based on the ketene plant.



Leveraging alternative feedstocks

Biogenic carbon sources obtained from biomass growth can be considered low carbon because they are part of the short-term carbon cycle of the planet. Biogenic GHG emissions are thus compensated for by the uptake of CO2 during the growth phase associated with the raw material (e.g. growth of a plant). This carbon balance can be accounted for in two ways: since biogenic carbon is balanced out overall, both uptake and emissions are excluded from the carbon footprint calculation (the so-called 0/0 or carbon neutral approach)1. In the alternative approach prescribed by ISO 14067, biogenic carbon is reported separately, the uptake counting negative and emissions positive (-1/+1 approach)[4]. It is therefore possible to replace fossil raw materials with biogenic input streams to reduce the overall Scope 1 footprint of the products. At Arxada the cracker feed can be replaced with green sources, such as green naphtha, to produce a range of intermediates (see above) with net-zero emissions. In the same way, acetic acid used in the ketene reactor can be taken from biogenic sources, which provides access to lower carbon intermediates. In essence, the option of backward integration allows for control of the GHG emissions associated with these raw materials and ultimately reduce them to net-zero.

Low Carbon Footprint Energy Sources

The production of chemicals requires energy input. This comes mainly in the form of electricity and process steam, which both have an associated Scope 2 footprint. Arxada's Visp site is connected to the Swiss electricity grid, which can supply low-emission electricity coming from a mixture of hydroelectric and nuclear power. Steam is typically generated by the combustion of natural gas for heat. There is an option of using biogas (biomethane) instead of brown natural gas, thereby rendering the associated emissions biogenic. Biogas is readily available from the Swiss Natural Gas Network. In this fashion, steam production can become carbon-neutral concomitantly lowering the PCF. Therefore, the production in Visp can be run with a low level of GHG emissions associated with electricity and steam. Furthermore, Arxada is closely monitoring global policies, as the accounting rules for biogenic emissions are evolving rapidly.

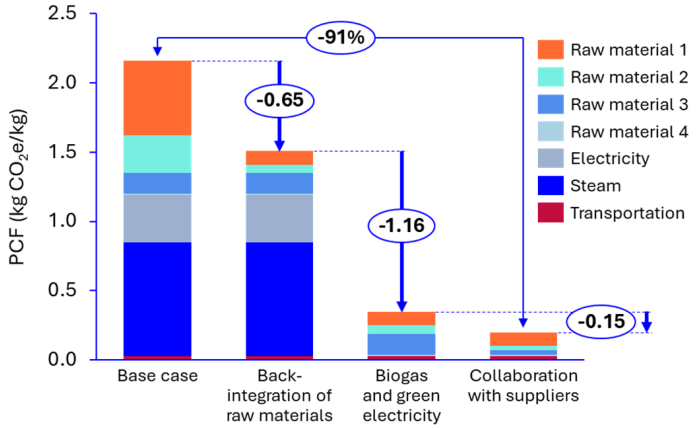
A Network of Trusted Suppliers

Scope 3 emissions are typically dominated by category 3.[1] (purchased goods and services)[5]. This category is highly dependent on the raw materials used for a given process and the suppliers selected for those raw materials. From one chemical process to another, the list of raw materials and requirements may vary considerably. Arxada relies on a network of trusted suppliers with long-term, stable business relationships. For each given project, Arxada thoroughly evaluates the available sources, not only in terms of quality, price, and reliability, but also of their commitment to sustainability[6]. We typically prefer suppliers with low-footprint products (especially when those footprints are certified) and a clear path for future lowering of emissions. In this way, Arxada can offer a supply chain that is both economically as well as environmentally sustainable.

Calculation of the Carbon Footprint

Ultimately, the final Product Carbon Footprint (PCF) associated with the product will be of utmost interest. During the proposal phase, Arxada's team provides an ongoing calculation of the carbon footprint in parallel with cost and timeline estimations, as the technical feasibility and plant fit are scoped. As the project moves through the different phases of collaboration, the team continuously refines the calculation and works on reducing GHG emissions, always in close alignment with the customer's needs. State-of-the-art software and commercially available databases, which comply with current guidelines, such as ISO, GHG Protocol, TfS (Together for Sustainability initiative), or SBTi (The Science Based Targets initiative), are used as basis for the PCF calculations (Figure 3). In case external input is needed, consulting with partner companies, including validation of the PCF reports, can be arranged.

Figure 3. Use case illustrating how Arxada stepwise optimization can result in an overall >90% reduction of the PCF.



Summary

We propose to tackle the problem of PCF reduction in a threefold approach: backward integration of critical raw materials into our chemical network (Scope 1), use of zero-emission energy sources (Scope 2), and extensive collaboration with our suppliers (Scope 3). Arxada is a partner of choice if you want to reduce the PCF of raw materials in your value chain. We can provide solutions tailored to customers' needs for minimizing GHG emissions, thus reducing the environmental impact of their products.

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Our offer

- **Fully integrated CDMO services**
- **Net-zero Scope 1 and 2 production by backward-integration into the chemical network, use of biogenic raw materials, and zero-emission energy sources**
- **Minimal Scope 3 emissions through focus on PCF for building our supply chain**
- **Calculation of PCF and continuous improvement**
- **Silver EcoVadis Medal 2025, advancing from Bronze in 2023, ranking Arxada in top 15% for sustainability**
- ***Focus on what matters to you***

Acknowledgments

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For further information and/or if you would like Arxada to support your project(s), get in touch with:
myproject@arxada.com

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