Biobased chemistry start-ups: build a factory or outsource production?

Colophon

Project: Biobased chemistry start-ups: build a factory or outsource production?

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Contact:
Guus Dubbink
Business Developer, Invest-NL
guus.dubbink@invest-nl.nl

Roger Blokland
CEO, Relement
roger.blokland@relement.eu

Authors:

Frits de Vries	Invest-NL
Xandra Weinbeck	Invest-NL
Guus Dubbink	Invest-NL
Roger Blokland	Relement
Monique Wekking	Relement
Stefano Iannacone	Relement

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1. Introduction

Virtually all products we touch, use and wear are made by the chemical industry. Whether it is clothing, building materials, consumer goods, vehicles or food packaging, most products are based on chemicals made out of fossil fuel. Chemicals compromise 1/5 of the Netherlands total export value and it is the 4th important industry in the European Union.[1] This industry is predominantly based on fossil feedstocks, with a global demand of 350 million tons of oil per year and expected to rise to over 1 billion tons by 2050. These fossil carbon feedstocks are not sustainable and are critical to replace when moving towards a circular and CO_2-neutral economy. A way to replace the unsustainable carbon feedstock is to obtain and convert carbon from one of the three available renewable sources e.g. recycled material, captured CO_2 from the air or use short-cyclic biomass. In order to achieve this important change towards renewable materials, a great deal of invention and innovation is needed.

However existing chemical companies are often slow to innovate and change as they have locked into capital-intensive assets, conservative value chains, short-term shareholder value and business models not accepting initial higher costs. It is therefore a high to switch from existing, fossil-based offerings and instead move to a competitor offering. Also, the lack of incentives and regulation is not (yet) forcing this much-needed change towards renewables.

Innovative and disruptive chemical start-ups are essential in developing new technologies in this industry towards a circular and CO_2-neutral economy. Often driven by a long-term opportunity and vision, backed by R&D at universities and research institutes, start-ups are often instrumental to accelerate a transition and create renewable solutions.

The chemical industry follows a standard scaling-up procedure starting from a proof-of-principle in the lab, building its own pilot facilities to perform the proof-of-concept, followed by a 10 times larger demonstration facility to end up with a first commercial production plant.

To bring a new chemical/material to the market, both the process as well as the product needs to be proven at scale. However, start-up companies often encounter financial hurdles to scale up their production process. Typically, a pilot or demo manufacturing facility is foreseen which requires large amounts of capital and other resources to build. After building, the story does not end as it takes an organization of skilled employees to operate and improve such a facility. At this point in time, often the market for their chemical innovation is not yet validated.

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[1] VNCI – Over de Chemie. Link: https://www.vnci.nl/over-de-chemie. (Last seen: November 2022)

Therefore, the overall risk is high and providers of capital are hesitant to fund such an endeavour. This raises the question: Is there another methodology that is better suited for start-up companies to proof the process/products in the early phase?

2. Alternative scaling strategy

Instead of following the default chemical scale-up route (namely: creating and developing their own pilot or demonstration facility), start-ups can consider using existing chemical plants and innovation centres for their first production. Outsourced production is well-known in the pharmaceutical industry which typically involves highly functional molecules in low volumes produced via batch processes. However, in the chemical industry, it is no common practice. Nevertheless, outsourcing process development and production of (speciality) chemicals may bring many benefits:

1) Reduce required funding

One of the major hurdles concerning producing chemicals in-house is that the acquisition, building and maintenance of chemical infrastructure and subsequent training in the use of such equipment is incredibly costly. Not only that but for many businesses, providing the space for such equipment will also be an added cost to get the land buildings and permits necessary. Instead, by outsourcing, equipment is rented and the intellectual capital of employees is in an already established chemical manufacturing reality. In some cases small adjustment to existing equipment is necessary, but those expenses are relatively small considering by building completely new plants.

2) Increases speed

Start-ups are under constant pressure to decrease time to market with a minimum viable product (MVP). Introducing chemical innovations requires start-ups to work throughout the entire supply chain. Not only do they have to work with direct customers but often customers of the customer need to assess performance and adopt an innovation into their offering to the final consumer. This process takes time and therefore this process must be started as early as possible. Using existing infrastructure can speed up the development of an MVP with several years since it will deliver sample material quickly to allow customers to validate this MVP in their product/process.
Furthermore, building a highly qualified team that can meet the requirements needed to scale-up chemical processes is a challenge and takes time. Especially in today's market, where all companies have many open jobs and it is difficult to attract the right candidates.

3) Increases Quality

In organizations where chemical process development is the sole focus, often high-quality research is produced by an experienced team on time. Taking advantage of a custom R&D approach, start-ups get the development needed in better quality than anything that could be produced in-house.

4) Eliminates Risk

Cutting back the number of risks and liabilities within a start-up business is another reason why it may be smart to outsource chemical process development and eventually manufacturing. Chemical manufacturing can be incredibly dangerous should one not be adequately prepared. There is no need to risk costly clean-ups, repairs, or severe wounds when every precaution necessary is meticulously taken to ensure the chemical manufacturing is as safe as possible.

3. Case study Relement B.V.

Relement B.V. is an innovative green chemicals start-up that offers renewable chemical ingredients, called bio-aromatics. Aromatics are key ingredients in many products such as coatings, paints, building materials, adhesives and many more. Aromatics typically offer performance benefits such as hardness, gloss, endurance and scratch resistance. Bio-aromatics can make such difficult-to-recycle products more sustainable. Relement is offering a unique renewable product to the market, called bio MPA that is slightly different from existing aromatic ingredients offering improved product performance compared to fossil-based alternatives, a unique value proposition.

Relement was founded in 2020 and is based in Bergen op Zoom, the Netherlands. The founders are Roger Blokland (CEO), Monique Wekking (CCO) and Stefano Iannacone (CTO). The foundation of the company is bio-aromatics technology developed by Dutch applied R&D organization TNO out of a long-term R&D program called Biorizon.

Relement's bio-aromatics need to be evaluated and tested in various applications. Before such evaluation, customers need to understand the path forward. What if the product is highly effective and a fast commercialization track is needed, what is the plan to scale up? Does Relement intend to build a first manufacturing facility? When? How? Where?

In its development, Relement was faced with a familiar problem: scale-up through its own dedicated pilot plant would take a lot of time and resources to develop. All these things are not easily available for early-stage companies. At the same time, customers need more sample material to validate performance and in turn to test the appetite of their customers. A conceptual design was made by an engineering company revealing 30-35 MEUR investment was needed to build and operate its own demo facility to produce bio-aromatics at a kiloton scale.

Relement decided to change the traditional way of thinking and started scouting the existing chemical production landscape. Knowing that the kilogram samples of bio MPA were prepared in relatively standard equipment, it concluded that manufacturing in larger equipment must be possible.

Relement found that several large chemical companies have extensive scale-up know-how and R&D assets that are open for third-party collaboration. The reason these companies are open for third-party collaboration is that often existing pilot plants are underutilized. Relement also identified several contract R&D centres throughout Europe dedicated to helping start-ups with process development. A short list of possible candidates was created, see appendix 1. During the discussions, it became clear that after this first process development exercise, Relement would be able to approach chemical production companies using the resulting process development information package. This is a so-called process book, a document that entails all process details needed to allow a safe and straightforward production at a ton scale.

Relement decided to pursue contracting and outsourcing first scale-up. A budget was then built around this plan. This would achieve two objectives:

- production of a first quantity (100 kg) of a Minimum Viable Product to allow its first customers to validate product performance based on Relement' renewable ingredient;
- create a process book to allow production at a larger scale.

To find a toll manufacturing partner, Relement initiated face-to-face discussions with potential candidates and visited their facilities. Important criteria for Relement where the strategic fit, experience fit and cultural fit. In other words, what is the teams' know-how and expertise, is it a 'one-stop-shop', and last but not least do we believe in the people to make our scale-up happen?

In the subsequent chapters, the learnings of this process are elaborated upon.

4. Roadmap to low-capital scaling

Toll manufacturing allows to produce first product with relatively low initial funding. This first product allows its launching customers to validate product performance-based. Once customer commercial off-take agreements are in place the business case for building a dedicated production facility is much stronger because the start-up can prove cash flow will be generated towards investors.

The roadmap of low-capital scaling done by Relement is shown in Figure 1. In the phases of Minimal Viable Product to Minimum Viable Scaling, the product will be produced by toll manufacturing companies. Only at large-scale expansion (> 50 kiloton/year), the construction of an own facility is re-considered.

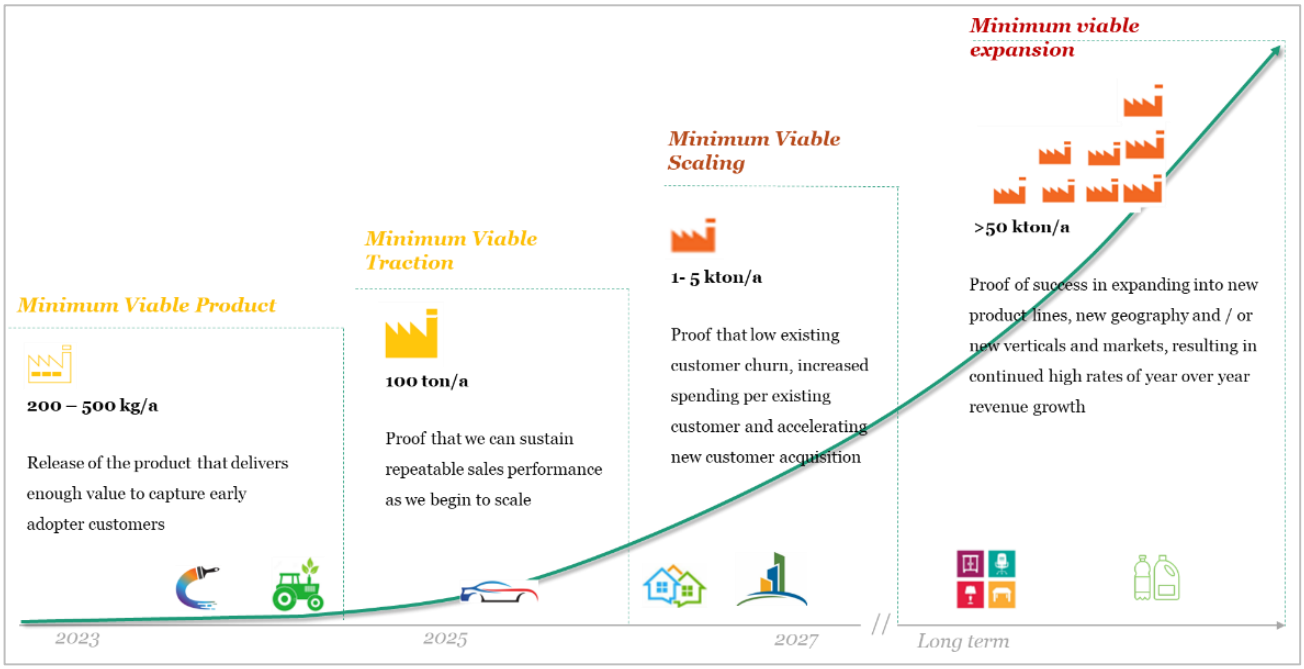


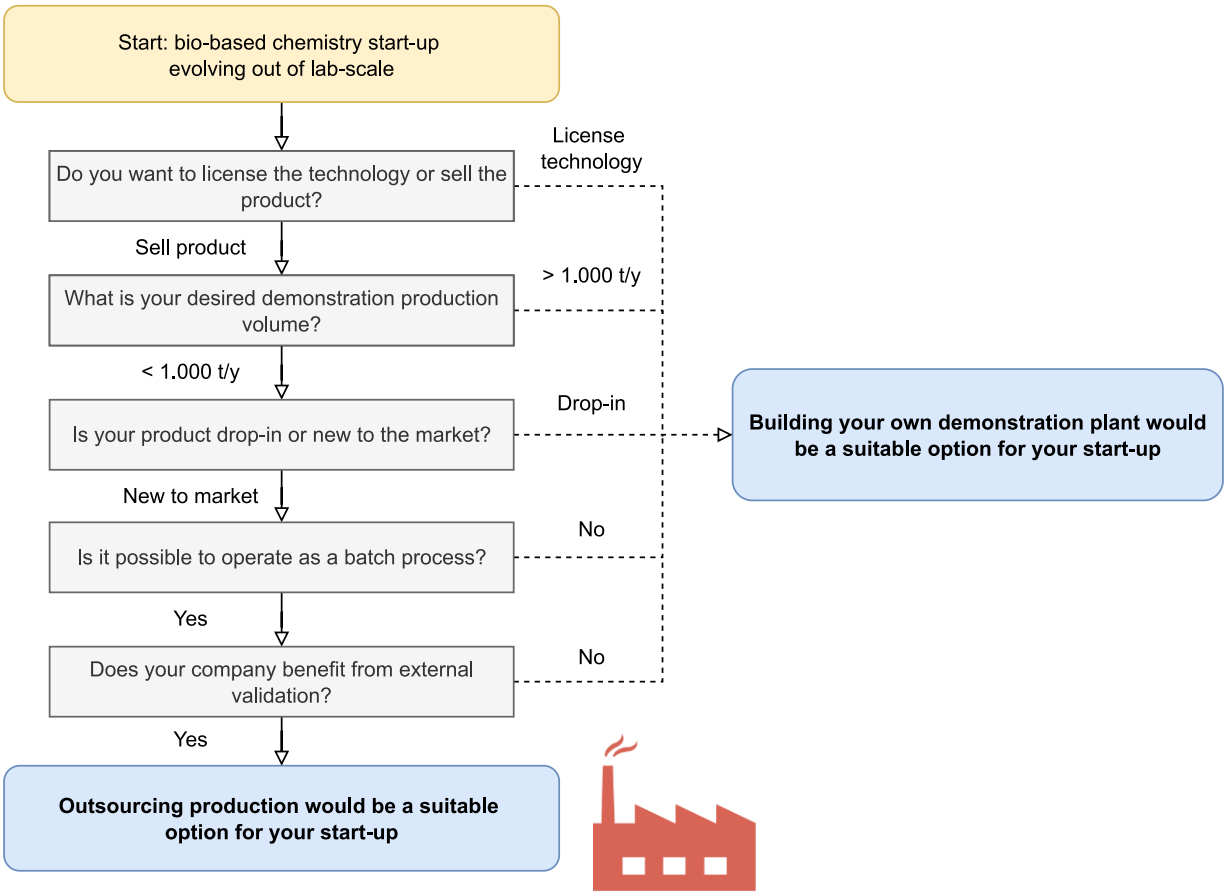
Figure 1 - Roadmap of MPA market launch based on Relement asset light strategy

5. Processes suitable for outsourcing strategy

There is no general rule about the type of processes suitable or unsuitable for outsourcing. However, in case the product can be manufactured in multi-purpose assets (a production system that can manufacture a range of different chemicals) and does not require manufacturing equipment that is specifically designed, it would be worth exploring the possibility of outsourcing production. Even if minimal adaption is needed, outsourcing can still be the right strategy. Often, scale-up labs and pilot plant organizations can rent additional or specialized equipment.

The most efficient way to discover if a specific process is suitable for outsourcing is to start talking to toll manufacturing parties. Prepare a basic information package that allows a third party to quickly assess (preferably without NDA) such as: types of reactors needed, raw materials, general process conditions and anything that can help to assess quickly if the contractor can fulfil demands.

The following quick scan can be used to evaluate outsourced production.



The explanation for this flow diagram is listed in the bullets below:

- Only selling the product is suitable for outsourcing production, because to license a technology it is best to own facilities and have it as a showcase to subsequently be able to license it.
- Only a production capacity below 1.000 tons/year is suitable for outsourcing production because this production volume is the sweet spot tolling producers look at.
- Only products that are new to the market are suitable for outsourcing production because the business case for drop-in molecules is price driven. Outsourced production will be more expensive than having its own production.
- Only processes that can be operated as batch processes are suitable for outsourcing production because usually tolling producers have batch facilities.
- Only companies that benefit from external validation are suitable for outsourcing production because it can add credibility to the technology if it is validated by a reputable and experienced company (please note this is more an advantage than a requirement for toll manufacturing).

6. Characteristics of potentially suitable toll manufacturers

Large chemical companies are increasingly looking to help start-up companies scale up their products. This gives them exposure to new initiatives to eventually fill their pipelines. Although chemical companies typically spend a relatively low percentage of their turnover on R&D, there is significant infrastructure and R&D capacity available that is not always fully utilized.

Another category of potential scale-up partners are contract R&D centres that exist throughout Europe. Often created with government support, these contract R&D centres offer equipment, people and resources to assist with scaling up.

As mentioned in chapter 3, important criteria for Relement were strategic fit, experience fit and cultural fit.

- Strategic fit: does the plant produce the same kind of products? What is the achievable volume in the pilot plant?
- Experience fit: what is the available equipment including analytics, chemical production experience, team know-how and expertise?
- Cultural fit: do we believe in the people to make our scale-up happen?

7. Points of attention in toll manufacturer interaction

After the first exploratory conversations with toll manufacturing organizations as described in section 5, the next step would be to sign a Non-Disclosure Agreement (NDA) to allow a more in-depth discussion. This discussion includes all detailed process conditions to confirm the technical, experience and cultural fit between the start-up and the toll manufacturing company. When successful, these discussions will lead to a pricing indication for the scale-up.

Once a suitable facility is found for the scale-up the most important part is to define the contract. These organizations are familiar setting up contracts with third parties and have their own standardized documentation. However, always pay special attention to:

1. Definition of ownership of Intellectual Property and knowhow. Make sure the contract manufacturer does not get rights, all ownership should be with the start-up company.
2. Request visiting the contract manufacturer at any time and as often as you want.
3. Define a feedback scheme. How often would you like to be in contact with the contract manufacturer and discuss the progress, receive reports?
4. The invoice scheme. Make sure it matches with your start-up cash flow.
5. Check environmental permits and safe working conditions.

8. Considerations and drawbacks in the outsource strategy

There are many advantages to choose for outsourced production development. However, one of the most important drawbacks in an early stage of development is the fact one cannot always be part of technical discussions especially when the ideal contract manufacturer is located abroad. Even when you discuss progress on a weekly basis, and visit such company regularly, one will still miss daily discussion from technicians and scientists at the coffee machine. As a consequence, the learning curve of the CTO is reduced.

Furthermore, if the process development is not going according to plan (scaling-up chemical processes can always encounter challenges), the start-up will need to increase the budget for this purpose. If the company would have their own equipment it would be more easy to run a few additional experiments and gather more data.

9. Conclusion

Innovative and disruptive chemical start-ups are essential in developing new technologies in this industry towards a circular and CO_2-neutral economy. To bring a new chemical/material to the market, both the process as well as the product needs to be proven at scale. However, start-up companies often encounter financial hurdles to scale up their production process. Instead of following the default chemical scale-up route (namely: creating and developing their own pilot or demonstration facility), start-ups can consider using existing chemical plants and innovation centres for their first production.

Outsourcing process development and production of (biobased) chemical processes may bring benefits like reducing required funding, increasing speed, increasing quality, and reducing (safety) risks.

There is no general rule about the type of processes suitable or unsuitable for outsourcing. However, in case the product can be manufactured in multi-purpose assets (a production system that can manufacture a range of different chemicals) and does not require manufacturing equipment that is specifically designed, it would be worth exploring the possibility of outsourcing production.

Want to get in touch? Please reach out. Contact information can be found in the colophon.

10. Appendix 1 – List of possible toll manufacturing partners

Name	Location	Website
Innosyn	Geleen, the Netherlands	innosyn.com
Weylchem	Frankfurt Am Main, Germany	weylchem.com
Solvay R&I	Lyon, France	solvay.com
SAS Pivert	Venette, France	sas-pivert.com
Umicore	Bruges, Belgium	umicore.com
Thomas Swan	Consett, United Kingdom	thomas-swan.co.uk

A useful searchable website is presented by the Society of Chemical Manufacturers & Affiliates: https://www.socma.org/commercial/manufacturing-solutions-platform/