

GUIDANCE

Guidance for companies setting-up a Take Back Chemicals project

Section 2 of the final report of the Take Back Chemicals
project for RVO



2 Guidance

This guidance contains the most important findings for companies from studied cases in the project 'Take Back Chemicals'. These findings, forming concrete handholds for companies in applying a *Take Back Chemicals* business model in the Dutch context, are divided into the topics of 'drivers', 'success factors' and 'points of attention' and finally 'applicability'.

This paper starts by explaining the concept of *Take Back Chemicals*. Secondly, inspiring examples of the case studies used in this study are given. The central piece of this paper presents the findings or learnings for companies, from both an environmental and business perspective (drivers, success factors, points of attention and applicability). The paper concludes with a step by step guide for starting a *Take Back Chemicals* project.

Content of this Guidance

- Concept of Take Back Chemicals;
- Cases;
- Environmental drivers;
- Business drivers;
- Success factors;
- Points of attention;
- Step by Step guide for the start-up of a Take Back Chemicals project.

2.1 Concept of Take Back Chemicals

Take Back Chemicals is a business model aimed to increase the effect of the chemicals used. Traditional business models are based on sales per volume. Opposite to this, applying *Take Back Chemicals*, a supplier introduces a service supporting the *effect* of the materials rather than selling the material itself. Hence, the supplier is paid for the service delivered rather than the amount of substance used, and the type of payment changes from volume-driven (€/ton chemical supplied) to a result-driven, measurable metric (e.g. €/ton treated product). Moreover, the supplier retains ownership of the material it supplies, and takes it back after use: the material is 'leased' to the customer (see Figure 2-1).

At least two actors are present in a Take Back Chemical set-up: a supplier and a customer of the chemicals. For the sake of clarity, this paper discusses mainly the 'classic' manufacturer-user relation, but other variants may exist including for example distributors, blenders or technology providers.

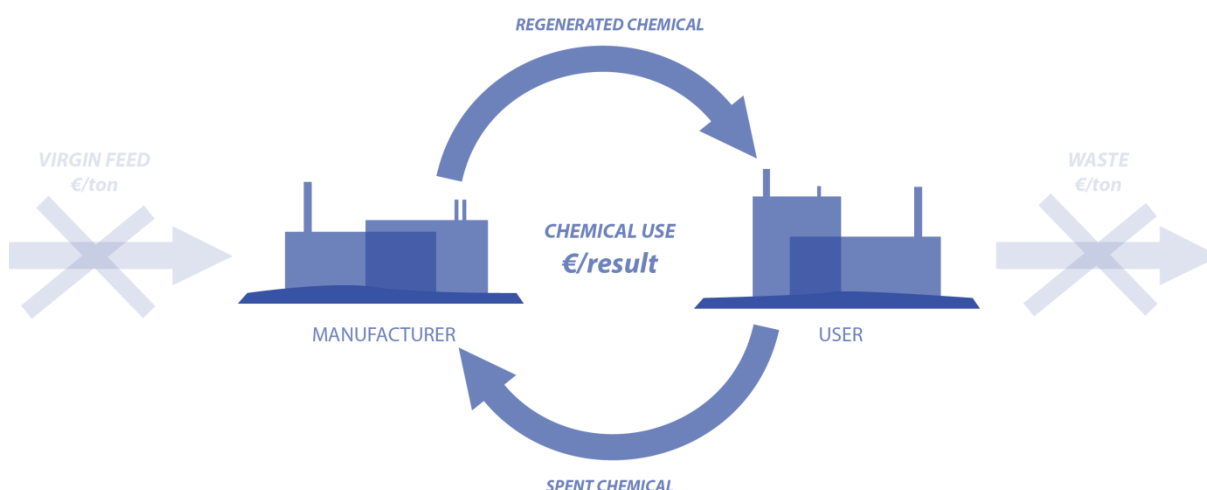


Figure 2-1. Example of a Take Back Chemicals model in a classic manufacturer-user variant. It is the take back of the spent chemical and the result-driven pricing that eliminates the traditional linear model based on €/volume. Other variants of a Take Back Chemicals model may include for example distributors, blenders and technology providers.

Being paid for and being co-responsible for the effect of the substance rather than the delivery of a certain volume, the supplier is stimulated to assist in optimizing the effect of the substance and to use it most economically. See Figure 2-2: opposite to traditional manufacturer-user relationships, the incentives related to the use of material in a Take Back Chemicals situation are aligned. Whereas the user in each case is seeking for most efficient use of its chemicals, the manufacturer is traditionally driven to sell per volume, not necessarily minding the efficiency of use. In a Take Back Chemicals relationship, the manufacturer is included in the use stage, and the efficiency of use impacts the profits of the manufacturer. The traditional principle "the more you sell, the more you earn" is no longer valid. The result is that the interests of the manufacturer and the user are aligned: both aim to continuously increase the efficiency of use of the chemical. This is a major change compared to the traditional economic relationship between a chemical supplier and his customer.

This alignment opens doors to extensive cooperation between the supplier and customer in the development and operation of production processes. In terms of business models, it is the cooperative character and the typical price setting (€/result rather than €/volume) that differentiates *Take Back Chemicals* from simple business integration (the inclusion of upstream or downstream business processes) or outsourcing (the handing of over full responsibility of business processes).

Take Back Chemicals can be seen as a variant of *Chemical Leasing*. For further reading on the generic concept *Take Back Chemicals* or *Chemical Leasing* we refer to earlier reports [3,4,5,6].

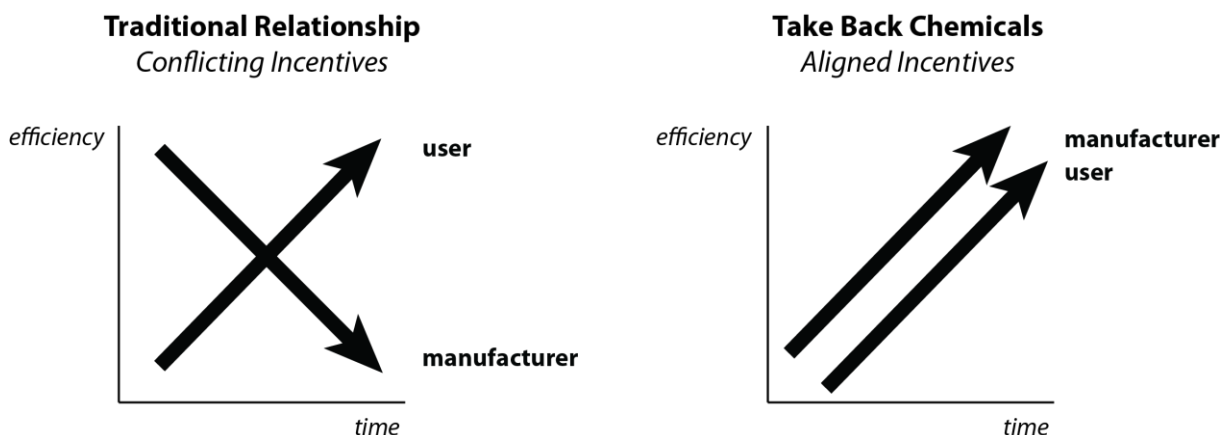


Figure 2-2. *Take Back Chemicals* shows aligned incentives of the manufacturer/supplier and the user. The figure on the left shows a traditional relationship: the user is seeking constant optimization of its chemical use, while the manufacturer – paid per volume – is primarily interested to sell more volumes over time, not necessarily minding about process efficiency. The figure on the right shows the situation where the manufacturer is paid per result – now being triggered to think along with the user to increase the process of use of the chemical over time: the incentives are aligned.

Take Back Chemicals is depicted as a generic concept, enforcing different business goals for different businesses. One size fits all.

Yet, this concept is not brought forward as a wonder method, miraculously improving each and every process. Rather, it is another way to continue the ongoing search for process optimization, client focus and societal well doing. And though the concept itself may be regarded as a 'one size fits all', the implementation and operation requires tailoring to exactly fit the needs of the involved companies. Furthermore, the concept implies a certain openness to change for any organization wanting to benefit from it. It requires the ability to step away from the paved way of thinking and doing. And as business returns may not be huge in direct financial terms, indirect benefits must be valued by the organizations involved. For many, these indirect benefits may bring just that extra needed to consolidate its position and outcompete inland and overseas production. *Take Back Chemicals* has shown to bring new answers to those who manage to apply it right.

2.2 Reviewed Cases in this study

This report is based on the study of 5 cases in the Netherlands, exploring the feasibility of each case in economic, ecological and legal sense. A brief summary of the cases is given below. Lessons learnt from these cases are used for drafting following paragraphs, without direct referral to a specific case for reasons of confidentiality.

Cargill

Food-grade phosphoric acid is commonly used in food production. In an edible oil refinery, this results in high concentrations of phosphates in the effluent. The *Take Back Chemicals* project brings together the user (Cargill) and the manufacturer of the phosphoric acid in order to repurpose the phosphor. This creates a driver to valorize the spent acid and firmly reduce concentrations of phosphates in the effluent, strengthening the factories' license to operate.

DOW

Salt (NaCl) is a common feed in the chlorinated hydrocarbon commodity industry. It may also result as side stream of a process in the same industry. Having such 'waste stream', DOW reduced operational expenses and emissions in effluent by separating, purifying and valorizing the salt. The salt is either valorized in a *Take Back Chemicals* model by having it taken back by the 'supplier' - the manufacturer of a chlorinated hydrocarbon intermediate - or by reselling the salt locally to other chlorinated hydrocarbon industries.

SUEZ Environment

SUEZ Environment (SUEZ) has the ambition to take a central role in enabling the circular economy by turning waste into value. An example is found in the automotive sector. Applying the *Take Back Chemicals* model on the organic solvents used in cleaning of spray paint nozzles by a car manufacturer, the spent solvent is returned to SUEZ, purified and brought back to specifications, so being able to keep the material in a closed loop.

Vlisco

Vlisco, a textile producer, is faced with a European ban on one of its additives (TCE) used in the dyeing of textiles. Alternatives provided by the TCE industry do not entail a successful substitute. By applying *Take Back Chemicals* the innovation pressure was transferred to the supplier of other chemical products. By doing so, the textile producer has been able to more than double its innovation capacity for finding an alternative, TCE-free production process resulting in new routes for investigation.

Hexion

The take or sell back of high-value catalysts is rather common business. Low-value catalysts however often end up as waste (being incinerated). To improve the overall footprint of the plant – directly related to the optimization of the catalysis process - the applicability of the concept of *Take Back Chemicals* was tested to a low-value, organic catalyst used in the production of an intermediate for polymers by setting up a partnership between the user – Hexion – and the manufacturer of the catalyst.

2.3 Environmental drivers

2.3.1 Reduced risk and impact on man and environment

Companies are continually seeking ways to achieve their goals in reducing risk and impact of their activities on man and the environment. The Take Back Chemicals concept shows to be a great medium in achieving next step innovation in this regard. Backed with Life Cycle Assessment studies (LCA), the concept shows overall wins of 20% for resource depletion, energy consumption and water consumption. And by its nature - a highly controlled closed loop - the risk for man and the environment is strongly reduced.

2.3.2 Reduced waste

Take Back Chemicals allows for *avoiding waste*: in best practice it is found that products or substances that are taken back for regeneration/recovery are *not always* considered a waste. Every EU member state is to provide its own legal interpretation of the EU Waste Framework Directive, pointing out when substances are considered a waste. This legal denomination can have significant impact on the ways in which spent substances may be treated. Moreover, it may result in a significant reduction of the total amount of waste produced. Whether the status of waste applies is found to differ per case.

2.4 Business drivers

Four main business goals realized with Take Back Chemicals in the examined cases are identified. These business goals formed the core drivers from an economic view to apply the concept.

When considering these goals one should keep in mind that there are two main perspectives: the supplier/manufacturer and the customer/user of the chemical. Each perspective sheds its own light on the outlined business goals. For the sake of clarity and focus, auxiliary services and related business goals by third parties are not considered in this report.

The four business goals are *Operational excellence*, *Service expansion & market consolidation*, *Lean innovation*, and *Debottlenecking*. Operational excellence and Lean innovation appeal to both the perspective of the manufacturer and the user, as both can take benefit from a faster and less costly innovation process. Market expansion & consolidation appeals more to the perspective of the manufacturer: it relates to the services it can deliver to its clients. Debottlenecking finally appeals more to the perspective of the user: reducing the environmental/administrative/financial burden and increasing process quality may increase its production.

2.4.1 Operational excellence: cost reduction, risk reduction, quality improvement

Operational excellence is a first and most obvious economic incentive for all partners involved in a Take Back Chemicals project. Operational excellence here is described by three main pillars: cost reduction, risk reduction and quality improvement.

Cost reduction is created by the savings inherent to the introduction of Take Back Chemicals. Cases show significant operational cost reductions with positive environmental impact, including savings of energy, water, and material consumption of up to 90%² and the elimination of (hazardous) waste and the use of hazardous materials (e.g. Substances of Very High Concern as defined in annex XIV REACH EC 1907/2006). Depending on the scale of change (highly radical to incremental), investments differ from significant to only requiring rather minor adjustments to existing infrastructure. Payback periods of down to one or two years or even several months were reported [5]. This shows that seeking for cost reductions through the opportunities brought forward by circular thinking, one reaches both economic and environmental goals simultaneously.

Risk reduction relates to the security of supply and the mitigation of cost fluctuations. As in a Take Back Chemicals situation all material is kept within a closed loop rather than being processed in a linear model, risks related to the supply of feedstock are minimized if not eliminated. This is highly relevant for chemicals produced from increasingly scarce resources, from sources in geopolitically sensitive areas or from resources that are subject to high price fluctuations (due to e.g. rapid changes in demand, production or market conditions).

Quality improvement is primarily reached by increased knowledge of use of the chemical and the decoupling of material consumption in the pricing model (€/result rather than €/volume). For example, in one of the cases, a collaboration between user (a producer of automotive parts) and manufacturer/recycler of a solvent was set-up to optimize the process of cleaning of equipment. This cleaning used to be done up to or sometimes above saturation levels of the solvent, resulting in suboptimal regeneration possibilities. Introducing a result-driven rather than a volume-driven pricing model (i.e. €/ton cleaned product) allows for solvent renewal (far) below saturation levels, improving not only the quality of cleaning but also that of reuse of the spent solvent.

2.4.2 Service expansion & market consolidation

Manufacturing – be it of automobiles, food or textile – requires many supporting processes, such as cleaning, purifying or drying. Many of these are crucial for the quality of the final product, yet are not considered core business. And as they are non-core, the chemicals and waste management related to these processes is often found to be suboptimal.

² Based on comparative life cycle assessment (delta-LCA) of the subjected production process

Applying Take Back Chemicals, a manufacturer expands its servicing towards users by supporting the chemicals and waste management, ideally taking back the spent chemicals. Such extended operations generally fit the manufacturer well, as the manufactured chemical often is the core business of the manufacturer, implying extensive product knowledge and likely existing infrastructure for take back and possible regeneration/recovery.

This servicing can be a differentiating factor especially for local suppliers, and allows users to keep its focus on its core activities. For example, in one of the cases the manufacturer of a resin was involved in the substitution process of a toxic solvent used by one of its clients to dissolve the resin. By introducing expertise of the resin and its dissolving and recovery options, the combined effort of user and manufacturer has led to new possibilities for exploration in the substitution process - adding to the chances of remaining existence of the specific use by the client, and sales of the resin. This way the manufacturer could consolidate its relation with its client and its position in the market.

For this to happen, the supplier/manufacturer is required to have extensive knowledge of the production, use and regeneration/recovery of its chemical. A second condition is that the customer/user is open for other/long-term commitments, including shifting responsibilities.

2.4.3 Lean innovation

Innovation is generally regarded as a business necessity, yet not necessarily as an easy process. It is often costly, time consuming and results are uncertain beforehand – impeding any innovation process. Specific for innovation related to chemical use, one may find that this process is at risk when:

- a) The chemical use is considered non-core. This issue relates mainly to the user of a chemical.
- b) There is a lack of knowledge about the exact behavior and functioning of the used chemical. This issue relates mainly to the user of a chemical.
- c) There is a lack of knowledge about the use and purpose of the used chemical. This issue relates mainly to the manufacturer/supplier of a chemical.
- d) The company tends to have a tunnel vision on its existing processes. This issue relates to both users and manufacturers/suppliers.
- e) There are financial challenges: investments are considered too large, or pay-back times too long. This issue relates to both users and manufacturers/suppliers.

In each of these cases, it may prove to require relatively high amounts of resources to assure a desired outcome when trying to fulfill the innovation process as a stand-alone company.

Applying Take Back Chemicals, *lean innovation* can be reached. Lean innovation refers to innovation with the least amount of resources possible. By sharing and combining knowledge, assets or financial capacity, the innovation process is speeded up, results are improved and actual implementation is made possible. Also, as the focus of both involved parties now is on the result rather than the volumes (due to dematerialization in the business model), each of these parties can feel free to suggest new processing methods or even new chemicals.

For example, in one case the combined knowledge of the user and the manufacturer has led to new insights and fruitful directions in a substitution issue. In another case, the use of another's existing, under-utilized assets, has proven to be a way to cut costs. In a third example, the allocation of investment was shifted to another party for whom the investment is acceptable – obviously accounting for all related production costs, financial costs and profits between the involved partners.

This lean innovation obviously benefits the chemical user in terms of process optimization, but also has its benefits for the manufacturer/supplier, in terms of servicing and enforced client knowledge and relation.

The setting in which this takes place is crucial. Trust is of high importance and a key pre-requisite for any fruitful collaboration: inherent to any Take Back Chemicals project, the user and manufacturer do not invent everything by themselves, but rather do so collaboratively (minding intellectual property throughout

the project is important). This applies directly from the start-up and explorative phase of a Take Back Chemicals project. And while trust and collaboration remain key throughout the entire process, contractual agreements and pricing (i.e. €/result rather than €/volume) can be introduced in a later stage to create a continuous innovation pressure, stimulating the supplier to keep innovating.

The kind of innovation the concept applies to is open. The induced innovation can be either incremental, referring to operational excellence (e.g. reduced consumption or quality improvement), or rather radical (e.g. answering to substitution issues).

2.4.4 Debottlenecking

A plant's environmental impact is limited by its environmental permit and other legislation. Such existing limits can form a bottleneck when planning to increase or change production. Moreover, for every new activity or permit renewal, companies are faced with continuously intensifying legislation while governments are aiming to push companies to pollute less. To retain a position in the EU, companies are driven to create more value within existing limits.

Applying Take Back Chemicals, overall environmental impact is reduced due to process optimization (also see *Operational excellence* and *Lean Innovation*). Cases show significant operational cost reductions with positive environmental impact, including savings of energy (and related CO₂-eq emissions), water, and material and the elimination of (hazardous) waste and the use of hazardous materials (Substances of Very High Concern). These waste reductions are to be seen from both an environmental and a legal perspective, as the legal status of material has significant consequences for handling. Different legal solutions are seen in the reviewed cases, including the use of *by-product* and *end-of-waste* status (article 5 and 6 of the waste framework directive) but also *avoiding waste*. The latter is exemplified by reasoning of the Dutch government adopted in one of the cases that, in a controlled mechanism such as Take Back Chemicals, spent chemicals that are taken back do not necessarily pass through the waste stage. In this case, the material is regarded as downstream use³ of the product throughout use, recovery and reuse (as is to be defined in its REACH dossier).

Such process optimizations can have a large impact on for example emissions to air, discharge to surface water or sewage, and obviously waste production itself. And while impacts are reduced, space within the environmental permit or enhanced *license to operate* is created to intensify or modify activities.

³ Downstream use is the use of chemicals under REACH and CLP. Examples of downstream users include formulators, who produce mixtures which are usually supplied further downstream, and end-users, who use substances or mixtures but do not supply them further downstream.

2.5 Success factors

2.5.1 Reusability

A first precondition for applying a take back system is the reusability of the substance. Reusability, preferably with its original purpose, guarantees the economic value of the material throughout its use and take-back. Cost effective recovery solutions are essential in defining whether a material is reusable or not. Knowledge of the exact volumes, composition of material streams and the range of acceptance for impurities are leading in finding such cost effective recovery solutions.

2.5.2 Profitability

There's no business case if no money is made. Though finding a technical solution for setting up a take back system itself is mostly not the major hurdle, finding one which is cost-effective is a bigger issue. Often, increased savings can be achieved by the use of existing assets and proven technologies. Profitability furthermore is largely depending on the (original) volume and value of the material handled. Reported profitability differs case by case, but cost reductions of 20% are to be expected.

2.5.3 Trust & Commitment

Cases tend to thrive best when partners know each other well. Trusting each other and mutual commitment to the project is highly important for its success. This is supported by an open view from the management team towards innovation, and reasonable interest in a long term relation from both sides. Usual suspects for partners are therefore found is an existing producer – client relationship, but newcomers or third parties like waste companies and technology/equipment providers may also bring crucial value.

2.6 Points of attention

2.6.1 Ignorance

A first point of attention is ignorance: the concept and applicability or way to implement the model is to a large extent not sufficiently known. As indicated, this can exist on firstly the level of ignorance of the Take Back Chemicals concept, i.e. the possibilities between companies. Secondly, ignorance of how to implement the radical change that the model implies to one's own processes, i.e. not being able to judge whether and how a Take Back Chemicals solution could fit one's company. The first is a hurdle in the general dissemination of the concept, and in exploratory conversations with potential partners. The latter is a hurdle faced in a succeeding stage, when it comes to more in-depth conversations when exploring a concrete case.

2.6.2 Alignment of organization

The alignment of the organizations involved is another point of attention. Such alignment is supported by firstly a mentality change throughout the company, as the impact of the business model switching from volume based to service based is significant for multiple departments. Following from this, such change requires the involvement and managerial change of multiple departments. This is not run by solely the purchasing, sales, sustainability/HSE or operations team. It requires change from people at different operational and management functions in each of these departments.

2.6.3 Scalability

The scale of the project should be wisely picked. The model of Take Back Chemicals is suitable for full scale production sites. For a first project however, too large volumes may be regarded as being too risky. On the other hand, too small volumes may be regarded as not being worth the effort. The level of scale obviously hangs together with the (original) value of the material and regeneration/purification costs. Moreover, the volatility of volume should be clear, so that upper and lower boundaries can be defined and business continuity can be secured. Scalability, or growth of the case or concept within the company, should be a goal for any (pilot) project starting at a smaller scale. Finally, scale may also define whether borders are crossed. Crossing national borders with a Take Back Chemicals case brings more legal uncertainty than staying within a single region (and single authority).

2.6.4 Legal certainty

Legal certainty is a major requirement for companies to make a move. And uncertainty can be high as legally many things change. Intercompany relations change, but also the way material is perceived, and the applicability of law hereon. In a (ideal) Take Back Chemicals situation, no waste is created, and all material is handled under REACH and CLP/GHS. This raises the question for example whether the waste framework directive applies or not. And if not, how to deal with REACH and CLP/GHS? Also, applying a Take Back Chemicals model implies changing from product to service, which raises new questions on liability.

This has consequences firstly relating to criminal law and administrative law. Criminal law in the sense of what 'operations' are determined by law, by which law, and thus what results in a violation of the law. Administrative law in the sense of how are governments and companies to act and react to each other in the new situations that are created (e.g. when to notify, what should be determined in the permit, etc). Secondly, civil law. This mainly relates to liability. In itself, liability is not a new topic – it is a standard subject in contracts, and dependence of one's production process on another company's performance isn't new either – but how liability is defined in the new intercompany relation that is created needs to be put to paper. Apart from standard elements to be included in a contract (such as the subject of the contract, the duration, the representation including the authority level of each party, product specifications, intellectual property, liability rules, procedures for administration, reporting, etc.), special attention should be given to the calculation method for payment of the supplier. Another specific item to be regulated is the

cooperation between and the management of the employees and equipment of each contracting party (such as organizational structure, location of work/performance, required skills and competencies, training, etc.).

Thirdly, competition law. As with all partnerships between economic actors, anti-trust rules should be carefully followed when implementing the Take Back Chemicals model. Different legal regulations contain antitrust rules. The Treaty on the Functioning of the European Union describes the basic (and brief) provisions (Member States are allowed to adopt and apply on their territory stricter national laws than the European rules). The core principle comes down to the following: it is prohibited to hinder fair trade or the functioning of the common market by agreements, decisions and/or concerted practices. On the other hand, agreements or decisions improving the production or distribution of goods or promoting economic or technical progress are tolerated on condition consumers receive a fair share of the resulting benefit. Important practical implications hereof are that all involved parties remain free to set their pricing, that information is only shared on a need to know basis and that the supplier or user of the chemicals remains free to use his expert knowledge for other customers/suppliers. Since Take Back Chemicals can only be successful on the basis of a close cooperation between the different parties involved, a project-specific analysis of the possible anti-trust risks is necessary before the implementation of the model.

2.6.5 Administration

The way a business is administered and its tax profile changes when it shifts from selling products to selling a service. The following discusses the consequences for three different types of taxes.

Corporation tax

A major change is the allocation of the chemicals as assets. In the new Take Back Chemicals situation, the manufacturer will add the products that are part of its new service to its balance sheet, and these will be depreciated as assets. The user – applying an operational lease – will not add the chemicals to its balance sheet.

Furthermore, the following could be taken into account:

- Deduction of income by interest for financing of purchase/manufacturing of chemicals by the owner;
- Diverse national innovation stimulation regulations, such as, for the Netherlands: Innovatiebox, WBSO, Milieu-investeringsaftrek (MIA), Willekeurige afschrijving milieu-investeringen (Vamil) and Energie-investeringsaftrek (EIA).

Value added tax (VAT)

In general, VAT is not a net cost for VAT taxable companies, and generally this does not change when applying the Take Back Chemicals model. What needs to be taken into account though is the allocation of VAT in international transactions: products and services may be taxed differently (e.g. products are often taxed in the country of production whereas services are often taxed in the country of use).

Customs and excise tax

Customs and excise tax are relevant when the model is applied between companies in countries inside and outside the European Union. It is advised to plan the customs/excise taxes or permits in advance to prevent additional costs in such cases.

Further details are shared in annex 5.

2.7 Applicability

The applicability of the Take Back Chemicals concept is defined by the type of chemical, type of process and type of industry. Examples of these are given in Table 1 at the end of this section.

2.7.1 Type of chemical

The use of chemicals can generically be divided into two categories:

- Use with consumption (e.g. feedstock, fuels);
- Use without consumption (e.g. catalyst, detergent, solvent).

As Take Back Chemicals is about retaining ownership and reuse or recovery of chemicals, the concept works best for chemicals which are used without being consumed (or irreversibly modified). This means the spent chemical should be able to be separated on-site, be sent to purification and be reused.

Secondly, the concept works best for chemicals with a relatively high value. As the spent chemical is reused or recovered, requiring certain processing, this value is defined by:

- the value of virgin production;
- the degree of contamination in the spent chemical and
- the cost of purification.

Thirdly, the chemical needs to come in not too small volumes to attain a minimum absolute value. On the other hand, larger volumes tend to be considered part of core business (e.g. feed of the process rather than auxiliary chemicals) and are therefore a less obvious (first) option. Certainly in the case of a first exploration (demonstration phase), the concept works best for chemicals with a, relative to the company, medium volume. Successful cases have reported volumes of 200 to 50,000 ton/a.

2.7.2 Type of process

The processes most suitable for applying the Take Back Chemical concept for chemical users are those in the periphery of the user's core process. The chemical use should be necessary for the proper execution of the core activities, but not entails its focus and added value. Such processes include the cleaning of tanks, purification, dissolving, catalysis, dewatering, etc.

At the same time, the manufacturing of the chemical, including downstream use to a certain extent, generally is considered the core process of the manufacturer. Hence, the manufacturer has great knowledge of its chemical, and potential interest to extend its servicing around its production.

2.7.3 Type of industry

The suitability of the lease-based models to the European (chemical) industry has previously been researched on a wider level [6] and specifically for *Take Back Chemicals* in the Benelux [4,5]. It is applicable to generally all manufacturing subsectors, including the manufacturing of food and beverages, machinery and equipment, textiles, basic pharmaceutical products and pharmaceutical preparations, rubber and plastic products, basic metals, motor vehicles and electronic and optical products.

Companies are required to have a certain minimum size. Earlier studies [4,5] found that companies with less than 20 employees are less suitable for implementing the model due to organizational lay-out of the company (e.g. allocation of time of employees and assets can be an issue for smaller firms).

Finally, companies need to have extensive knowledge about their process and possibly that of their partner, i.e. they should be able to work on specifications. This requires (chemical) expertise, measuring equipment and resources to execute pilots.

Table 1: Examples of industries, processes and chemicals to which Take Back Chemicals may apply, sorted to applicable industrial processes. This table is based on underlying and earlier research [5,6].

Industrial process	Industrial Sectors	Substances	Unit of payment
Purification of chemicals (incl. drying)	petrochemical industry, pharmaceutical industry, cosmetic industry, ...	(a)polar solvents, acids, organic and inorganic compounds, ...	€/kg treated product or monomer, €/unit removed compound
Wastewater treatment	Broad spectrum of industries	Organic and inorganic compounds	€/m ³ treated water €/unit removed compound
Cleaning of working areas and installations	Food industry, cosmetic industry, pharmaceutical industry, electronics industry, ...	Detergents, (a)polar solvents, acids, ...	€/m ² cleaned surface
Surface treatment: Greasing/degreasing, powder coating, wet painting, galvanization, thermal zinc galvanization, electroplating	Automotive industry, metal industry, electronic & optical products, machinery and equipment manufacturer	(a)polar solvents, paints, abrasives, acids, lubricants	€/number of pieces €/m ² , €/kg
Pre- and post-treatment of articles	Textile industry, health care industry, workwear industry, ...	Paints, fire retardant, antibacterial and water resistant products, solvents, ...	€/m ² treated textile, €/unit treated product

2.8 Step by Step Guide

The following Step by Step section guides you through setting up a Take Back Chemicals case, from ideation to business case. It is emphasized that this applies strictly to the set-up; further detailing, piloting, implementation and maintenance for example require different steps and actions.

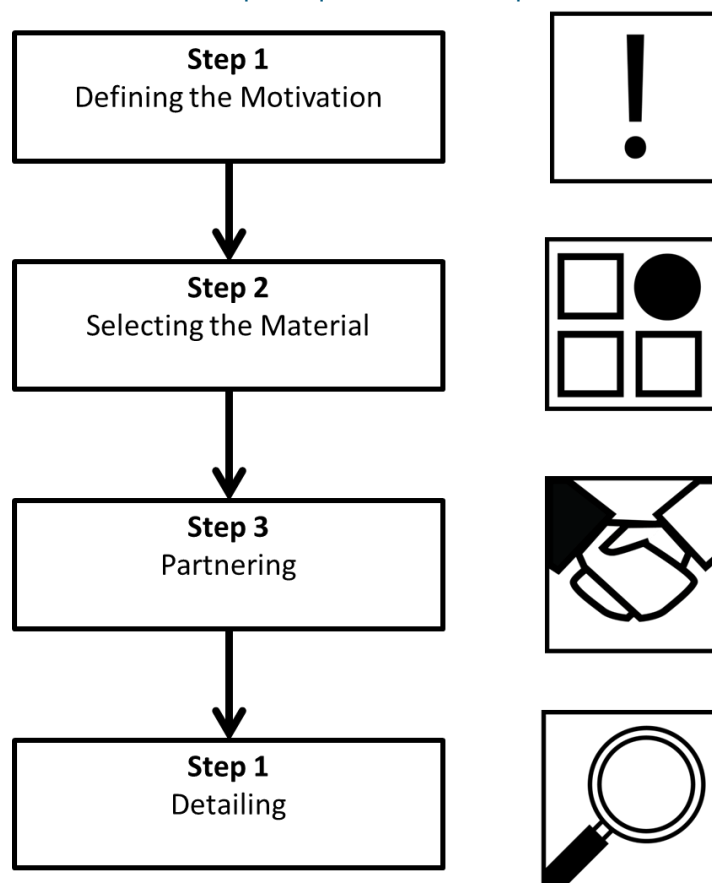


Figure 2-3: Steps to follow in setting up a Take Back Chemicals project.

This guide relates to *drivers*, *success factors* and *points of attention* as mentioned in earlier in this section. Step 1 'Defining the motivation' points out the drivers of the partners involved. Step 2 'Selecting the material' and step 3 'partnering' secure the success factors. In step 4, the *detailing* phase, all points of attention are tackled.

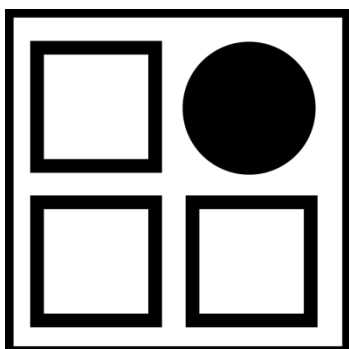
This guide is written from two perspectives: that of the **manufacturer** and that of the **user** of chemicals. Each follows the same steps, but seen from a different angle.

2.8.1 Step 1 - Defining the motivation



The idea to start a Take Back Chemicals project may originate either from a manufacturer or a user of chemicals. The goal that is defined may obviously differ a lot between these parties. It is emphasized that defining this goal is of high importance as a first step. Firstly to check whether the application of a Take Back Chemicals model really delivers the right answers to your organization. Secondly, as applying a Take Back Chemicals model involves a lot of change, the organization of it may prove to be rather difficult if the motivation is not very clear from the start. Different motivations are elaborated on in section 0 and 0.

2.8.2 Step 2 - Selecting the Material



A second step is defining the material to which to apply the new business model. Do note that the material is directly related to a production process. And since the result of this production process is the final goal, one should be open for change of both production process and chemicals used as an outcome of applying Take Back Chemicals.

In this step, the success factors *reusability* and *profitability* [0] are briefly checked and secured.

Manufacturer

The chemical used should be a process chemical, one that does not end up in the end product. This relates to the process of the user; the chemical is the product of the (core) process of the manufacturer. This implies that to select a suitable material, the manufacturer needs to have a proper understanding of the use of the chemicals it sells. If it has no view on the application, and with that the potential for recovery and the costs and benefits involved, it will have a hard time setting up a case. This also includes a first impression of the technical possibilities to separate (at the user) and recover/purify the material (in new or existing assets).

Volumes do not need to be large at first (or are preferred to be relatively small to be able to be used in a pilot), but can reach full production capacity over time. In fact, in many cases a larger volume spread over multiple clients proves a more stable business.

In general a high initial material price (feedstock price) or an energy intensive manufacturing process strengthen the business case for recycling.

User

For the user, the chemical being a process chemical not ending up in the end product implies that the model cannot relate to feedstock chemicals and are mostly applied in relevant yet non-core activities. Because of this, volumes may be relatively small, but not too small not to be of any significant absolute value.

When selecting a suitable material, the user needs to have a proper understanding of the production process and possibilities for recovery, i.e. at least understanding of the exact composition of the material after separation. It requires a good insight of and flexible view on one's current processes to define the best way to separate the material in its most pure (non-contaminated or diluted) form. A first impression of the technical possibilities for further processing for reuse, including at least the specifications for the material to be reused in one's own plant, is mandatory.

2.8.3 Step 3 – Partnering



Finding a partner is the next step in concretising the Take Back Chemicals case. With a partner, assumptions made in the previous step can be checked, and further ideation and development is enhanced by the collaborative approach. The company initiating the idea now for the first time comes out with the idea, while approaching its (potential) client or supplier. Doing so requires certain commitment – at least a project definition and resources, being a team and time. The step is completed when the same is reached at the other side of the table: when your partner shows the same commitment. This mutual commitment fosters the trust needed to let collaboration flourish. In this step, the success factor Trust & Commitment [0] is checked and secured.

Manufacturer

The project team from the manufacturer's side is usually led by the sales department, potentially in line with the sustainability/HSE department. Core team members should furthermore at least cover production and quality assurance.

Finding a partner often goes through the sales team, tapping from either existing or new relations. The best partner is an existing user with whom a pilot can be executed and further roll-out has the best perspective. This is a company with a use representative for the market (i.e. implying that the found solution can be repeated), with an open mind towards innovation (i.e. showing a collaborative attitude), and, if applicable, with the right position in the 'pecking order' (to ease further roll-out after success). Also bare in mind that the partner should either know its process very well, or be open for extensive collaboration and information sharing about it.

User

The project team from the user's side is usually led by production or the sustainability/HSE department. Core team members should furthermore at least cover purchasing/sourcing and quality assurance.

Finding a partner often goes through the purchasing/sourcing team, tapping from either existing or new relations. Same as for the manufacturer, the user should be looking for a partner willing to launch a pilot. In the case of a single supplier the partner is often obvious. But do notice that relations which are not a supplier at the moment, or which are suppliers of auxiliary products (but also used in the process), could very well be an option as well. The best partner is the one that can provide a stable solution for a long term. This is a company with a stable economic position, with an open mind towards innovation (i.e. showing a collaborative attitude), and as close to the plant as possible (to lower transport costs, an important factor as transport can increase).

In this stage, first assumptions on technical and economic feasibility are checked. Not in detail (as that is the next step), but on a high level of shown mutual interest in pursuing the project. This stage does not yet include the full calculations for a business case, but it does include the strategic motives (drivers) of all partners involved.

2.8.4 Step 4 – Detailing



Keeping secured the drivers and success factors as identified in the previous steps, now is the time for detailing and checking the main points of attention. The following seven steps come in generally this order, but may involve several iterations.

1. Defining technological solutions;
2. Exploration of economic gains;
3. Defining ecological gains;
4. Defining legal framework;
5. Defining economic model;
6. Exploration administrative consequences;
7. Business case.

This section is no longer divided in a manufacturer and a user section as the project teams of the companies involved should now function as one.

Defining technological solutions

A first step in the detailing phase is to come to a conceptual technical solution. This is of high importance as a first step, because this largely defines the treatment costs and narrows down options for the optimal location of treatment – potentially having consequences for legal framework and economic model.

A Take Back Chemicals case involves innovation on many levels (economic, organizational, legal and technical). To avoid the project from drowning in too many new factors, it is advised to seek technological solutions that are as proven as possible.

One way in doing so is to seek for solutions that are close to the current operations of either the user or the manufacturer. Utilizing their knowledge of current processes, innovation can be eased. Also, this may lead to the utilization of existing assets, lowering the capital costs of the project.

The definition of technical solutions tends to involve quite some testing, mainly on the purity and reusability of the material by the manufacturer and/or the user.

Exploration of economic gains

In a second step a first glance of economic gains is defined. It is intertwined with the previous step though, as economics is often a main criterion in the selection of technical solutions.

Economic gains at this point are defined for the project as a whole, meaning the product of all costs, avoided costs and added value – the definition of company profits follows from the business case at the end of the detailing. The lack of prospected economic gains at this stage usually leads to termination of the project.

Defining ecological gains

The definition of ecological gains can be run simultaneously with the previous step, i.e. right after the definition of the technological solution, but often follows after a go/no-go closing the previous step. The ecological gains are defined from a life cycle perspective (life cycle assessment, LCA), allowing to include all impact over the value chain. This step is important to back specific drivers (e.g. the lowering of environmental impact).

Defining legal framework

Legal certainty is a major requirement for companies to make a move. And uncertainty can be high as legally many things change. Intercompany relations change, but also the way material is perceived, and the applicability of law hereon. In a (ideal) Take Back Chemicals situation, no waste is created, and all material is handled under REACH and CLP/GHS. This raises the question for example whether the waste framework directive applies or not. And if not, how to deal with REACH and CLP/GHS. Also, applying a Take Back Chemicals model implies changing from product to service, which raises new questions on liability. See also section [2.6.4].

In this stage, the legal architecture is defined. Main questions relate to the ownership (who is the owner of the material?) and the shift of ownership and liabilities (is there a shift of ownership of the material?). This forms a basis for not only the applicable legislation, but also for the economic model, the next step.

Defining economic model

After having defined the technological solution, the gross economic potential and having defined the applicable legal framework, it is now time to define the exact roles and actions. If the case involves a shift from product to service – as an ideal Take Back Chemical case does - the result of this service should be carefully defined. And so should the compensation. For example, one could change from €/ton solvent (solvent as product), to €/cleaned item (cleaning of items as service) or €/m² steel surface (cleaning of surface as service). In this economic model, the total costs, investments and wins for each party involved should be made clear, and a 'fair' distribution should be created to redistribute these so that all parties involved have an economic interest high enough to proceed. For example, it may turn out that one partner has to do major investments for a regeneration unit, while the other partner gets the gains of avoiding

waste treatment costs. A 'fair' redistribution shares some of these gains with the other partner to make the investment possible.

At this stage the actors are defined, i.e. manufacturer/supplier and user, but potentially also a waste treatment service provider, an equipment provider, distributors and consultancies. Actions include the new value-based service, but may for example also include a new definition of use; each actor will have its own actions.

Though the contractual phase usually comes after the pilot, it is wise to also already think about the consequences of failure of the other party involved. For example, how quickly can the party be replaced, i.e. can the same construction be set-up with another party? Or can the 'old system' remain as a back-up?

Exploration administrative consequences

Business administration may impact the business case of the project. When the economic model is roughly outlined, impact on administration as outlined in section 2.6.5 can be executed, to serve as input for the next step.

Business Case

With the questions raised in the previous steps answered, the team is ready to define the business case. Note that the project itself has its business case, but each company involved may hold its own business case attached to the project. All these business cases should be sound for the project to be able to continue.

The business case of the project should at least include the following elements:

- Value proposition (the newly defined service and use);
- Actors & Actions;
- Legal definitions;
- Revenues (including avoided costs), costs and investments;
- Financial view (e.g. Cash flow, Net Present Value, pay-back time).

The definition of the used chemical and the (newly found technical solutions for the) production or regeneration/recovery hereof are subject to the parameters mentioned in the above, and in itself should not be leading. In fact, the final contractual agreement could even not mention these, as it is the result of the service which is leading.

The main outcome of this preliminary business case is the go/no-go for further investment, being a pilot.