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INSPIRE

Towards growth for business by flexible processing in customer-driven value chain

EC GA 723748

Deliverable D1.1

Selected case studies

V 1.0

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D 1.1 – Selected Case Studies

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Executive Summary

A range of market trends are creating the urgent need for manufacturing industries to adapt the way they are organised and interlinked within the supply chains. This offers both threats and opportunities for the European manufacturing sectors, and leads to new and reconfigured supply chain configurations, collaborations and business models that shift from cost competitiveness to striving for the highest value. The INSPIRE project is targeted at analysing these trends, the way they may impact supply chain configurations, how flexibility can be designed into these new supply chains and industrial locations based on state of the art enabling technologies, as well as how benefits for resource efficiency and hence environmental footprint can be optimised.

The aim of this first deliverable is providing Business Cases which will serve to analyse the current European networks (as a collection of interrelated value chain partners such as raw material providers, manufacturers, logistics providers, clients, etc.), identify current practices of delocalization, opportunities for and barriers against flexibility as well as current practices for joint resource management and industrial symbiosis. The purpose of studying the selected cases is also to INSPIRE the community, i.e. Illustrate how flexibility can be achieved and how that provides value to aforementioned trends.

The Business Cases have been selected through desk research and consultation with high-level stakeholders. This first analysis is performed making use of the different project partners' networks, previous EU projects (e.g. R4R, F^{3}Factory, BIOCHEM, etc.) as well as other market clusters (e.g. the ECO-INNOVERA network of eco-industrial parks, the Smart Delta Resources regional cluster etc.).

The selection process has been performed in an iterative approach through 4 successive stages. After the **provision of about 100** Business Cases an evaluation table was made with relevant **criteria** to select 24 preliminary suitable Business Cases. In order to get an overview a **stratification** has been made on intuition by the consortium with respect to types of manufacturing (process/discrete) and flexibility, sector and archetype. A final discussion giving the partners the opportunity to amend the obtained list resulted in a **validated selection** that will be used to describe the current European landscape and link it with intensified processing and flexibility environments and development of innovative business models for different sectors in general.

This report has to be considered as a living work document with the results of the validation of a first assessment to understand the current landscape of the European manufacturing/distribution of high value-added goods in horizontal and vertical strategies; 24 selected cases are categorized in:

- 10 "horizontal case studies" focusing on resource optimisation (especially local sourcing and industrial symbiosis),

- 14 "vertical case studies", looking at the interconnection between discrete manufacturing and processing industries (especially in consumer targeted domains like the automotive sector).

In particular next Business Cases have been pre-selected:

Horizontal	Vertical
4 Al recycling via collaborative supply chain	19 PRINTCR3DIT
5 Steel2Chemicals	25 Leather fabric functionalization
18 MOBILE FLIP	26 Steel2Machine
20 REE4EU	27 Flexible manufacturing customized shoes
21 RESYNTEX	29 Implantable Drug Delivery Device
40 Smart Delta Resource (SDR) platform	30 Rapid/ Additive Manufacturing
41 CoPro	38 F^3 Factory
56 Waste2 Aromatics	39 LOGICON
86 Safechem	41 CoPro
90 Veolia	52 Polymer Building-Blocks
108 Chemical leasing for metal	53 Functional Molecular Production
	54 Remote Chemical Production
	94 Nestlé flexible modular factory
	95 Pfizer transportable plant

These 24 preselected Business Cases will provide input to the next phase in which an in-depth analysis will be performed of a set-of complementary Business Cases, representing the different stratifications that have been defined by the partners. Based on a more detailed study including interviews we aim to get useful insights in what is interesting in view of the INSPIRE objectives.

The list of presented Business Cases has to be considered as a 'living work document'. The list always can be subject of modifications and can be adapted based on progressing insight in Business model and Supply Chain reconfigurations in the Process and Manufacturing Industry. It **allows us to adapt the list of cases based on findings along the in-depth analysis making a final selection for the Business Cases at a later stage in WP 1**. This approach guarantees to select the appropriate cases, related with enabling technologies as required in WP 2 and in line with the goals of INSPIRE.

The selection process results in following classified Business Cases:

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Mass customisation of consumer goods	Process industry to customised small scale batches	CRM recycling	Bio-based materials	Re-use and Local sourcing / pre-treatment of waste	Chemical leasing	Remote process control of decentralised production = ICT driven	Local modular / containerised prod.	Decentralised production - industrial symbiosis
• 24 Leather fabric functionalization • 27 Flexible manufacturing customized shoes	• 26 Steel2Machine • 29 Implantable Drug Delivery Device	• 20 REE4EU • 4 Al recycling via collaborative supply chain (AGFA)	• 52 Polymer Building-Blocks • 18 MOBILE FLIP • 90 Veolia • 56 Waste2 Aromatics	• 21 RESYNTEX • 58 Steel2 Chemicals • 40 Smart Delta Resource (SDR) platform	• 86 Safechem • 108 Chemical leasing for metal	• 54 Remote Chemical Production • 41 CoPro	• 95 Pfizer transportable plant • 94 Nestlé flexible modular factory • 38 F3 Factory • 53 Functional Molecular Production	• 39 LOGICON

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1. Introduction

The INSPIRE project is targeted analysing trends, the way they may impact supply chain configurations, how flexibility can be designed into new supply chains and industrial locations based on state of the art enabling technologies, as well as how benefits for resource efficiency and hence environmental footprint can be optimised. The main focus of the project is the analysis of innovative business models that create flexible networks based on intensified processing and therefore benefit more local production. The analysis should contribute to INSPIRE the community, i.e. illustrate how flexibility can be achieved and how that provides value to aforementioned trends.

Based on the description of the current European landscape and the link between intensified processing and flexibility, the expected outcome of the INSPIRE project would be the development of innovative business models for a selection of complementary sectors where new more flexible and demand driven business solutions and supply chain configurations are emerging. The project takes an approach by bringing together the (downstream) manufacturing ("Factory of the Future") community with the (upstream) process industry (SPIRE) community, as well as regional industrial clusters (parks) to study required changes of business models in Europe, due to a.o. 1) further integration of these industries in the value chain leading to more flexible and demand driven business operation and 2) increased trends towards resource sharing and optimization across multiple process industries (e.g. through industrial symbiosis within regional contexts such as industrial parks). This will be realised through an analysis of selected case studies.

This first report covers the approach of exploring new and innovative Business Cases. This results in a list of 24 preliminary appropriate cases that will be used to understand the current landscape of the European manufacturing /distribution of high value-added goods and analyse vertical supply and distribution fluxes and horizontal and local resource optimization strategies.

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2. Background

The Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) Public-Private Partnership (PPP), launched in the framework of Horizon 2020 Programme, aims to develop enabling technologies and solutions along the value chain that are essential to the long-term sustainability of the European process industries, decoupling economic growth from use of resources. In this regard, INSPIRE will design integrated business models creating more competitive clusters through flexible production, resource sharing and process optimization. Specifically, by 2030 SPIRE aims to reduce fossil energy intensity in the process industries by up to 30% from the current levels and reduce non-renewable primary raw material intensity by up to 20% from the current levels. Together these two ambitious objectives will contribute considerably to efficiency improvement in CO2-equivalent footprints of up to 40% from current levels in the European process industries (*source: Cefic.org*).

INSPIRE will propose business models that will eventually lead to a process industry with less stock, less waste, and less transportation, therefore reducing the carbon footprint. INSPIRE is rooted in the concept of increased flexibility through networked manufacturing value chains from resource optimisation towards more flexible demand driven supply chains. The networked based business solutions that the project will investigate, contribute to optimise the environment in Europe from two major angles:

- Flexibility within customer driven supply chains ("vertical"), looking at optimising interdependencies between supply chain partners in a network (whether co-located or distributed, or a combination of both) and optimising their yearly fluxes, based on process intensification and looking at the interconnection between discrete manufacturing and process industries.
- Flexibility in feedstock enabling resource optimisation at the individual supply chain partners, but taking into account the possibility for local sourcing as well as local industrial symbiosis and resource management and optimisation in a multi-stakeholder context ("horizontal").

3. Business Cases

Understanding the current landscape and insight in the meaning of Business Cases and (related) enabling technologies requires a first assessment of a bunch of propositions of cases. The objective of this is to have an in-depth discussion in order to define selection criteria for these and future case studies to be used in the next stages of the INSPIRE project. The Business Cases will serve to analyse the current European networks (a collection of interrelated value chain partners such as raw material providers, manufacturers, logistics providers, clients, etc.) and identify current practices of delocalization, opportunities for and barriers against flexibility/delocalization as well as current practices for joint resource management and industrial symbiosis.

A list of 100 Business Cases has been selected through desk research and consultation with high-level stakeholders. The first analysis of the European networks is performed making use of the different project partners' networks, previous EU projects (e.g. R4R, F³Factory, BIOCHEM, EPOS etc. – *source: spire2030.eu*) as well as other market clusters (e.g. the ECO-INNOVERA network of eco-industrial parks, the Smart Delta Resources regional cluster etc.). The selection further has been made based on relevant market cases for example within the value chains of process industry and existing EU projects that develop (1) flexibility enabling solutions like the FP7 project F³ Factory (process intensification in a modular concept), the SPIRE 5 project PRINTCR3DIT (process intensification through Adaptable Catalytic Reactors made by 3D Printing) or similar projects and (2) regional networks targeted at multi-stakeholder involvement towards joint resource optimisation and sharing.

The 100 different Business Cases are exemplary for different business models with flexible manufacturing that have been selected. They are considered as possibly interesting by the partners and useful in view of analyses of the current European networks. The cases combine one or more of flexibility enabling technology solutions with either vertical or horizontal supply chain reconfigurations.

The list of all proposed Business Cases can be found in Annex 1.

4. Selection process

The examination of the present landscape of suitable Business Cases is expected to result in understanding major drivers and requirements for more flexible and demand-driven sustainable manufacturing and processing by a limited but complementary and representative selection of manufacturing and process industries with potential for implementing a customer-driven model. The aim of the selection process is to address 24 complementary and meaningful Business Cases that will be used to understand the major drivers and requirements for more flexible and demand-driven sustainable manufacturing and processing.

The identification of suitable Business Cases was done in an iterative process between the INSPIRE partners in **4 different and successive stages**. This identification is reflected into insight knowledge of each Business Case with respect to decentralized and flexible production especially for high value products. This approach helps to understand and to get a common view on the network of interrelated value chain partners such as raw material providers, manufacturers, logistics providers, clients, etc. by identifying current practices of delocalization, opportunities for and barriers against flexibility/delocalization as well as current practices for joint resource management and industrial symbiosis. Next selection stages have been passed:

1. **Develop selection criteria**: After assembling different Business Case proposals a first workshop was organised in order to create a common understanding and appreciation of the INSPIRE scope and its approach. A **preliminary questionnaire** was used in order to understand jointly the impact of new business models on requirements for industrial locations (e.g. required resource sharing infrastructures or support services at industrial parks) and the effect on local collaboration models, contracts and cost sharing, including impact on location selection decisions of industries.
2. **Identifying, scoring and ranking of Business Case candidates**: Next, in several workshops with the consortium partners a (pre)selection of relevant Business Cases has been made as a result of a **criteria assessment**. The result is a preliminary list of 24 Business Cases out of 100 proposals from the list.
3. **Develop a stratification methodology for selecting complementary and meaningful Business Cases:** Following a so called "**stratification**" approach the aim was to create structure among the 24 selected cases, to identify crowded and white spots and to perform a first exercise to identify business model archetypes hence **case typologies**.
4. **Fine-tuning, validation and preliminary selection of Business Cases**: Finally a work session was organised in order to amend and validate the obtained results.

This selection process made it possible to select 24 vertical and horizontal categorised appropriate cases.

4.1. Preliminary questions

4.1.1. Key Business Case questions

Preliminary questions have been written down in order to gather preliminary information about a Business Case. The questions assess the changing supply chain configurations and business model types; based on a combination of relevant selection of flexibility enabling technologies, modularity, process intensification and continuous processing, separation, purification and recycling equipment manufacturing technologies, ICT and smart industry and Business Cases looking at the interconnection between discrete manufacturing industries. These questions have been made to asses 100 Business Cases in order to get insight in key concepts of value chains, collaboration mechanisms and thus defining flexibility parameters (spatial, resource) to optimize flows in the value chain. The questions help to define key concepts in collaboration and business and help to evaluate in 3 stages the relationship between the business and horizontal or vertical approach.

- Key Business Case questions
- Link with INSPIRE
- What key activities are involved to deliver a value proposition? Key business model questions

These questions have been translated into next Business Case Templates:

Stage 1: Key business case questions

Write a brief vision of the following topics.

Added partners in the value chains in the Steel industry

No.	Activity	Description	Remark
1.	Where does the business case responds to?		
2.	Describe the Business Vision, Strategy or Objectives		
3.	Which manufacturing processes or technologies are involved?		
4.	What are the possible new technology trends involved (or opportunities resulting from new technologies introduced)?		
5.	What are commercial or operational trends which are driving changes in the business?		

Stage 2: Link with the INSPIRE - Clarify the assumptions

List the assumptions about the business model

No.	Question	Fact (with evidence)	Assumption
1.	How are "vertical" supply and distribution fluxes and requirements influenced by the business case?		
2.	How do "horizontal" stategies interact with the business case?		

Stage 3: Key business model questions

Take reflection on the business proposition (make a checklist of the items below):

No.	Activity	Description	Remark
1.	What key activities are engaged in to deliver a value proposition?		
2.	Who are the value chain partners and Who are the key partners?		
3.	What is the technology readiness of the business case?		
4.	Insert the names of Value Chain partners you have access		
5.	How do you expect the business model will change with respect to the current situation (legal, …)		

4.1.2. Canvas business model

Different workshop provided the partners key concepts of the different Business Cases making use of the preliminary questions for the value chains, collaboration mechanisms etc. In addition and in order to get more insight in the proposed Business Cases, the evaluation of possible changing supply chain configurations has been performed making use of the CANVAS model. This approach takes into consideration all relevant Business Case elements inspired by the business model canvas model developed by *Alex Osterwalder*, considering changes in key supply chain partners and their interrelationship, key activities and the value proposition of the individual supply chain partners, the impact on customer relations, resource management and alignment (e.g. for industrial symbiosis) as well as the changes in company cost structure and key revenue streams.

Previous research provided a starting point for our analyses by plotting the key changes of business models on the Canvas as indicated in the following template:

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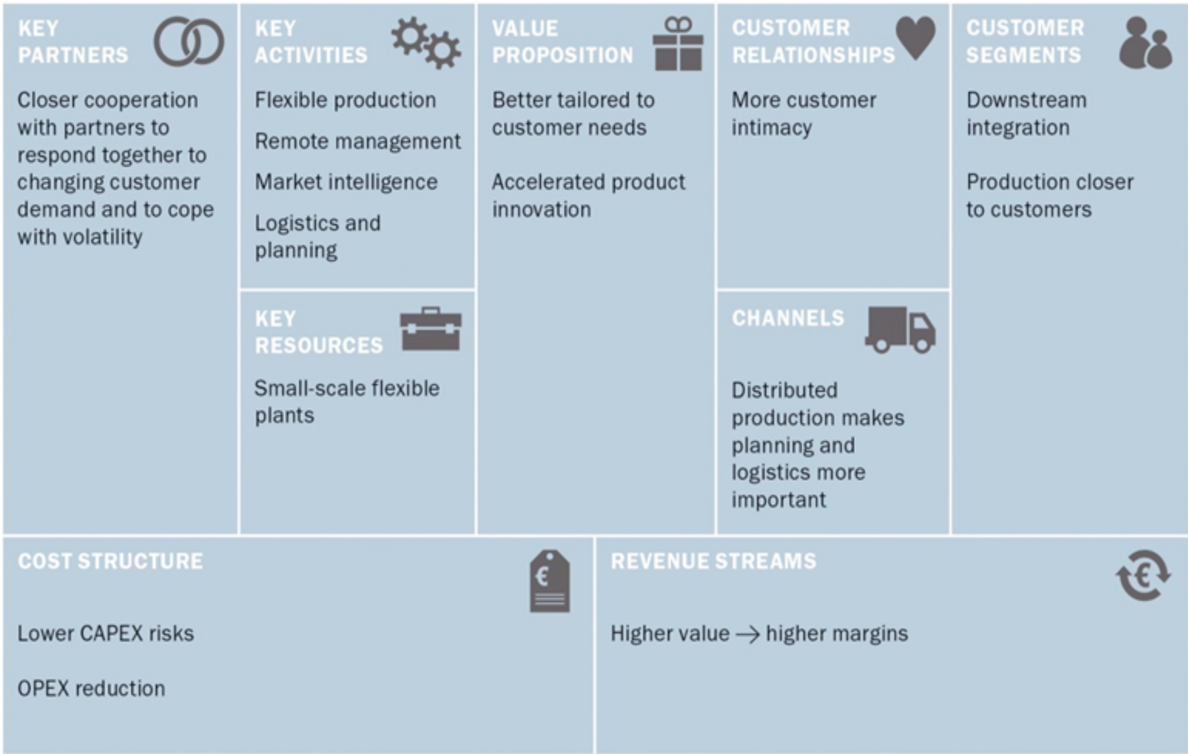

Small scale flexible plants – towards a more agile and competitive EU chemical industry; TNO whitepaper, 2015

The Canvas model has been used to get the Business Case selection to the next level and provide a first evaluation of specific cases in the selection of evolving supply chains. The Canvas assessment enhanced the discussion on how to understand and translate the proposed cases into novel supply chains configuration maps. Moreover, the Canvas model provided information of the business model for each individual supply chain configuration leading to conclusions on how it impacts location design as well as how it impacts resource efficiency (and what is required to accelerate the deployment of these new supply chain configurations).

This first case approach with the preliminary stage questionnaire and Canvas model in addition provided added value to elaborate criteria for a more standardized evaluation in next stage of the selection process.

4.2. Criteria assessment

Following the collection of 100 Business Cases and the approach based on the preliminary questionnaire and the Canvas model, a (pre)selection of case studies was made by the partners taking into account criteria that have been used to assess in a structured and on a common base the 100 selected Business Cases. The list of the different criteria has been developed in parallel with the search of appropriate cases. The rating of each criterion was made by the different partners according each individual finding and then discussed in joint workshops. The criteria used for the assessment are:

BM archetype	Resource as a service / ….		
Business Case	(Brief description of the case)		
Criterion	*Relevance score*		
Technology driven - Relevant technologies for the future	1-5	Is the technology a key DRIVER of impact and an important element in changing the business model? It need not be TRL9 as of yet and it need not be a technological challenge per se	1 = no (new) technology, e.g. financial leasing 2 = small adaptation of existing technology, impact on business model small 3 = technology has some impact on business model 4 = technology has serious impact on business model 5 = technology is a key driver in business model changes
Impact on Supply Chain	1-5	Are supply chain partners (up- or downstream) affected by the case? New roles introduced? Does it require coordination (e.g. by data flows)? Is it changing performance or structure? Will there be (new) middle-men?	1 = no impact on supply chain 2= impact on supply chain is limited 3= structure is more or less the same, but overall performance is increased 4 = new roles will be needed, e.g. information broker 5 = many structure impacts
Impact on Business model	1-5	Is the business model of one or more actors in the supply chain dramatically impacted? Or will it be, if the change is to take place?	Business model of what (of whom)? We focus on the "Value Chain Business model" (How the value chain creates (and captures) value). 1 = no impact on any actor's business model 2 = There is one party whose business model is affected, but changes are small, e.g. move from product to performance based 3 = There are multiple parties whose business model are affected, but changes are small, e.g.

			move from product to performance based 4 = Major business model change required by 1 party 5 = Major business model change required by multiple parties (probably strongly correlated with impact on supply chain) It need NOT be a true business model innovation, as in a "new to the world" type of business model. *Moreover, in some cases the innovation of the business model may the challenge at hand.*
Delocation relevance	1-5	Does the case promote either local sourcing, use, industrialisation (i.e. avoid transport and central production) (- as compared to the reference)	What is the reference? 1 = no delocation relevance 3 = Production is close to Sourcing OR Use 5 = Sourcing, production and use are all local
Discrete manufacturing linked with Process industry	1-5	To what extent does the case require coordination, linking of DM and PI?	1 = No, and no possibility 3 = Potentially, if the case is altered and there is a concrete proposal (e.g. linking precision farming to bio based feedstock forecasting) 5 = very obvious
Customisation	1-5	Does the case specifically support taking into account varying requirements (demands) from customers?	1 = No 2 = Customers can specify only one option, which has limited effect on the customer value 3 = Customers can specify a limited set of options, which have limited effect on customer value 4 = Customers can specify a limited set of options (e.g. cars, shoes?), but with serious impact on customer value 5 = Supplies can be tailored to specific and dynamic measured needs (e.g. IoT, precision farming, …)
Flexibility	1-5	Does the case require or reflect one or more of the flexibility types: capacity, product, innovation, location, feedstock, energy	1 = NONE 2 = One type, but with limited impact 3= One type, having serious impact, or multiple having limited impact 4 = multiple, with 1 type having serious impact, being… because… 5 = multiple, with more than 1 type having serious impact, being… because…
Sustainability relevance	1-5	Does the case improve ecological sustainability? (E.g. would it reflect a 'positive' LCA?). Include	What is the reference? Do we know of any debate on this? 1 = no sustainability contribution

		both footprint (direct/local sustainability effects for the party concerned) and footprint (effects throughout the value chain, LCA).	2 = small sustainability contribution 3 = significant sustainability contribution 4 = large sustainability contribution 5 = very large

Potential to upscale, replicability (Potential to achieve high product value and substantial impact)	1-5	What does it take to replicate or upscale the case to other chains or companies, specifically SMEs? Does the innovation establish higher product value?
		In other words: how much effort does it take to achieve substantial impact on European scale? In terms of sales effort (company by company), installation, configuration? Can the same innovation be used in other chains or outlets?
			The Business Case should have the potential of impact. The purpose of this project is to identify and clarify Business Cases that can achieve impact (for European industry), presumably by "instantiating" the business model more often. Thus the market in terms of # similar cases and the effort to configure locally are to be taken into account.
			1 = No, we don't see it
			2 = Substantial impact, but with few specific large companies
			3 = 1 by 1, e.g. selling equipment company by company with substantial installation efforts.
			4 = Technology is relatively plug and play, standardized
			5 = Technology is scalable, customers do not have to change a lot (technologically or culturally), e.g. Uber

SPIRE relevance	1-5	How relevant is the case for SPIRE scope? Is the technology on the SPIRE roadmap or can it contribute to its objectives?	Does it address Resource Efficiency and the flexibility of the Processing Industry? 1 = not relevant 2= limited relevance 3 = serious relevance 4 = very relevant 5 = extremely relevant
TOTAL SCORE		Scores are simply added up (and therefore criteria weigh equally)	We do not choose the cases mechanistically, but use the scoring for debate and selection.
HORIZONTAL		Inputs AND/OR outputs of the -=focal actor=- of the Business Cases is from different parties, in (potentially) different value chains (e.g. a waste-water treatment facility may take on water from a chemical plant and a food-processor) (?) OR taking bio based feedstock next to conventional feedstock.	Typically associated with Resource Efficiency

VERTICAL		The Business Case takes place within one value chain. Inputs AND/OR outputs changes of the -=focal actor=- of the Business Cases are within the same (existing) value chain. E.g. competitors collaborating ("Captain" in retail) (within the same value chain 'link' type) or a platform like Uber, Airbnb	Typically associated with Optimization (Cost), performance and innovation. Taking on a biobased feedstock is both a Vertical and Horizontal, depending on the specific impacts: A product marketed as green (as a result) is vertical

The first (pre)selection of 24 case studies was made taking into account the overall total score from the criteria table. A number of physical and virtual workshops have been held to jointly score a series of different Business Cases in order to develop a joint understanding on how to score the Business Cases using the selection criteria. Following that all cases have been evaluated by the different partners and scored on a scale of 5. The Business Cases have been ranked according the highest overall score as a result of the sum of the different criteria. As a result **initially** following 24 Business Cases have been pre-selected.

Nr. BC	**Name**	**Score (max 50)**	**Hor / Vert**	**Description**
86	SafeChem	46	H	SafeChem Europe GmbH has a portfolio to manage the product-specific risks of chlorinated solvents. The basis is a closed-loop concept using a container system for the handling of fresh solvents and the take-back of used solvents for recycling. SafeChem is developing innovative concepts such as chemical leasing, where customers can lease the complete cleaning process for a fixed monthly leasing fee.
61	3D Pastaprinting	45	V	3D pasta printing allows companies like Barilla to create pasta of different forms and compositions, but also using local ingredients and local use.
29	Implantable Drug Delivery Device	44	V	Intersection of digital technology and medicine. Currently being developed and tested;
53	Functional Molecule Production	44	V	Specific urethane products with limited shelf life are to be produced at or near customer's site or post-treated. Both different strategies have to be considered.

26	Steel2Machine	43	H	Introduction of technologies - The idea of the case is to investigate new business models and supply chains, enabled by the new "Industry 4.0" technologies, for a higher integration of steel producers (process industry) and customer companies using steel to manufacture final products (discrete manufacturing)
19	PRINTCR3DIT	42	V	The concept of PRINTCR3DIT is to employ 3D printing to boost process intensification in the chemical industries by adapting reactors and structured catalysts to the requirements of the reaction. This manufacturing technique is particularly useful in reactions where diffusion, mixing and/or heat transfer are limitations against reaching higher performance.
32	Electric Motors in automotive industry	42	V	The increasingly important role of electric cars needs to develop new supply chain concepts in automotive industry. This not only involves inbound and outbound processes with external suppliers and dealers but also in-house operations.
2	Neodymium recovery	41	H	Recycling rare earth elements (REEs) used in advanced materials such as Nd magnets is important for the efficient use of REE resources when the supply of several REEs is limited;
20	REE4EU	41	H	The REE4EU project will realize a breakthrough in securing the availability of rare earth elements in Europe, providing for the first time, a cost effective and efficient method of extraction and direct Rare Earth Alloys production from abundantly available in-process and end-of-life rare earth containing waste streams. REE4EU will also develop urgently required market data on end-of-life rare earth availability and a triple value-chain Business Case for a new European secondary rare earth alloys production sector.

24	Leather fabric functionalization	24	V	The case deals with chemical companies providing new services to footwear/clothing sector. Nowadays, customization can start from the provision of customized raw materials and personalized components. The functionalization of raw materials and components implies revision of the production process and of the production network.
52	Polymer Building-Blocks	41	V	Production of building blocks for polymers either by i) recycling / de-polymerisation of plastics and/or by ii) biomass conversion (e.g. thermo-chemical, biochemical,…). Alternative (co)feedstocks to petrochemical feedstock (cracker, BTX plant). This will contribute to secure supply of feedstock, dampen price fluctuations (e.g. oil price) and may reduce effect of unpredictable CO2 taxing.
54	Remote Chemical Production	41	V	Decentral on-site production of process chemicals using (renewable) electricity, e.g. hydrogen peroxide, ammonia, chlorine. Distributed and local conversion of biomass to intermediate products that can be transported stored and traded, in self-contained modules. Several routes exist towards different intermediates: e.g. torrefaction to char, pyrolysis to oil, gasification to syngas.
58	Personalized FMCG	41	V	For cosmetics, shampoos and detergents companies like P&G and Henkel are continuously looking to find new flavours and additives for personalized production, potentially via an "Amazon for detergents"
59	Customized Paint	41	V	Companies like AKZO are looking to create customized paints with specific characteristics.
30	Rapid/Additive Manufacturing Impact of 3D Printing	40	V	New players (e.g., suppliers of these 3D machines/software developers that may sell the codes/manufacture of topologically optimized components) and new product development

	technologies			might require input of these companies;
56	Waste2Aromatics	40	H	Thermochemical and biochemical conversion of sugar and lignin containing residual streams to products like furans, acids, diols, phenols and aromates. Feedstock supply variable in quantity, composition, location, and season.
108	Chemical leasing for metal cleaning	40	H	In an effort to make their metal cleaning processes more efficient and safer, the company searched new ways to optimize its consumption of PERC. The company joined hands with the German chemical supplier SAFECHEM Europe GmbH, a DOW subsidiary, and a German manufacturer of high quality metal cleaning machines, PERO AG, to mutually assess the potential for implementing a Chemical Leasing business model for the cleaning operation.
4	Al recycling collaborative supply	39	H	The Business Case covers aluminium printing plates which are vital consumables to the offset printing industry in a closed loop supply chain. To support the circular economy business model, the setup of a collaborative supply chain with his partners was crucial.
31	Metals and Minerals Industry for Sustainability	39	H	MIT and metals/minerals industry are bringing together ideas and developments of solvents from other industries that could be relevant for metals extraction or minerals separation. Generating new extraction ways reducing the impact in the environment. Metals & Minerals for the Environment (MME) program from MIT

106	Advanced process control (apc) for continuous processing	39	H	APC software to enable real-time control using multiple in-line analytics (PAT) utilising both feed-forward and feed-back control, coupled to new continuous process technologies being brought to market, offer the chance for producers to develop a new 'manufacture at the point of need' model for high value low volume products and reduce the delivered costs of products to the customer by up to 50% through savings in the supply chain, increased stock turns and reductions in non-value adding activities.
90	Veolia	38	H	Veolia has pioneered the production of bio-plastics from sludge. Wastewater treatment systems today often use bacteria that eat sludge and neutralise it into carbon. Using proprietary technology, Veolia achieved a breakthrough in converting this 'wastewater carbon' into biomass rich in PHA. The PHA adds value to the biomass as it has mechanical properties equivalent to polypropylene and is, thus, valuable in making consumer plastics and chemicals.
95	Pfizer transportable plant	38	V	Pfizer, together with partners, developed a concept for Portable Continuous Miniature and Modular Manufacturing. In the concept, formulation is done in a moveable cleanroom that can be transported to customer sites. Active ingredients will still be produced in the US, to minimize technology transfer.
27	Flex manufacture customized shoes	27	V	Mass customisation and personalisation force companies to increase flexibility of the whole supply chain. In a traditional and mature sector as the footwear industry, the implementation of new IT technologies and paradigms together with the introduction of robots in the manufacturing line, advanced sustainable printing and cutting technologies and additive manufacturing can modify the existing design, production and

				delivery processes.
94	Nestlé flexible modular factory	37	V	Nestlé has created a blueprint for a flexible modular factory, that can be built in half the time (<12 months) of a traditional factory, and at 50-60% of the cost. It enables Nestlé to rapidly create a foothold in countries in Africa and Asia, getting closer to their customers and raw material sources. The factory is made of ready-to-use elements that can be assembled on site.

4.3. Stratification approach

In order to obtain a certain stratification in line with the INSPIRE objectives a second assessment of the 24 (pre)selected cases has been made. The goals were to create more overview and structure, to identify crowded and white spots and to make a first exercise to identify complementary business model archetypes. Following 4 stratification categories are used:

- Process industry/discrete manufacturing
- Flexible production and typology
- Sector
- Business model archetype

The stratification according different archetypes has been done based on intuition by the consortium and then validated. The classification in consequence is not based on formal definitions but originally was identified for single companies.

4.3.1. Process industry and discrete manufacturing

Analysing the first set of pre-selected Business Cases, it became clear a difference can be seen between 1) cases predominantly focused on Business model changes in the process industries, 2) cases predominantly focused on Business model Changes in the discrete manufacturingiIndustry and 3) cases where business model changes have been determined by emerging or enabling technologies.

With respect to the typology the 24 (pre)selected Business Cases can be classified according:

Process industry	Discrete Manufacturing	Enabling technologies
• 86 Safechem • 53 Functional Molecule production • 26 Steel2Machine • 2 Nemodymium recovery • 20 REEFEU • 52 Polymer Building-Blocks • 54 Remote Chemical Production • 59 Customized Paint • 56 Waste2Aromatics • 31 Metals and Minerals Industry for Sustainability • 90 Veolia • 95 Pfizer transportable plant	• 61 3D Pastaprinting • 29 Implantable Drug Delivery Device • 32 Electric Motors in automotive industry • 24 Leather fabric functionalization • 58 Personalized FMCG • 108 Chemical leasing for metal cleaning • 4 Al recycling collaborative supply • 27 Flex manufacture customized shoes • 94 Nestlé flexible modular factory	• 19 PRINTCR3DIT • 30 Rapid/Additive Manufacturing Impact of 3D Printing technologies • 106 Advanced process control (apc) for continuous processing • 28 LCA for sustainable assessment in Value Chain

4.3.2. Flexible production and typology

Another way of classifying the selected Business Cases is by looking at the relevance of flexibility. A number of trends in the market have led to a growing need for instant reactions on changing market circumstances and an increasing need for flexibility in operations i.e. Increasing volatility in demand, High volatility in prices for feedstock and energy, Shorter product life cycles and Demand growth in emerging economies.

High Flexible production	Less flexible production	Enabling technology for flexible production
• 61 3D Pastaprinting • 53 Functional Molecule production • 24 Leather fabric functionalization • 52 Polymer Building-Blocks • 54 Remote Chemical Production • 58 Personalized FMCG • 59 Customized Paint • 56 Waste2Aromatics • 90 Veolia • 95 Pfizer transportable plant • 27 Flex manufacture customized shoes • 94 Nestlé flexible modular factory	• 86 Safechem • 29 Implantable Drug Delivery Device • 26 Steel2Machine • 32 Electric Motors in automotive industry • 2 Neodymium recovery • 20 REE4EU • 108 Chemical leasing for metal cleaning • 4 Al recycling collaborative supply • 31 Metals and Minerals Industry for Sustainability • 28 LCA for sustainable assessment in Value Chain (*enabling technology*)	• 19 PRINTCR3DIT • 30 Rapid/Additive Manufacturing Impact of 3D Printing technologies • 106 Advanced process control (apc) for continuous processing

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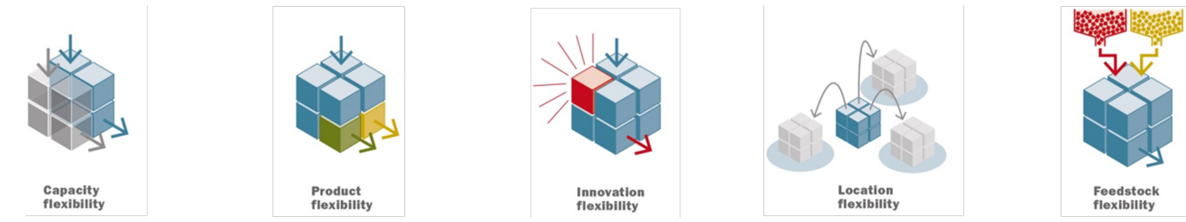
In respond to these trends the industry is increasingly looking for decentralised, flexible production capacity, especially for high value products. Some of the pre-selected cases are more relevant from this point of view than others, as indicated in the categorisation. The flexibility types were originally identified for single companies. At a later stage we might introduce additional types p.e. energy flexibility for feedstock, flexibility in the supply chain due to specific factors etc. In order to enable more flexible and demand driven manufacturing in the supply chain, it is important to look at different types of flexibility to understand the impact on business models, and in consequence on research needs. Currently the concepts of flexible production are mainly applied in R&D and pilot setting, but recently quite some examples of successful commercial implementation were reported mainly in areas where the innovation has the highest value, i.e. pharmaceutics, fine chemicals and specialties. For the purpose of the selection process we can distinguish the following types of flexibility (*typology - source: Small-scale flexible plants - Towards a more agile and competitive EU chemical industry: TNO 2015 R10756*)

- **Capacity flexibility**: a plant should be able to produce small volumes in a cost efficient way. When local demand grows or prices of feedstock or energy drop, it should be possible to scale the plant up or down easily.
- **Product flexibility**: a plant should be easily adaptable to switch to another product.
- **Innovation flexibility**: small-scale plants that are used in R&D and pilot setting should be very easily adaptable to try out innovative products and processes.
- **Location flexibility**: the plant should be moveable from one place to another.
- **Feedstock flexibility**: the plant should be able to handle different kinds of feedstock.

According the type of flexibility the 24 (pre)selected Business Cases with flexibility relevance can be classified as follows:



Capacity flexibility	Product flexibility	Innovation flexibility	Location flexibility	Feedstock flexibility
• 53 Functional Molecule production • 106 Advanced process control (apc) for continuous processing (*enabling*)	• 61 3D Pastaprinting • 24 Leather fabric functionalization • 58 Personalized FMCG • 59 Customized Paint • 27 Flex manufacture customized shoes	• 19 PRINTCR3DIT (*enabling*) • 30 Rapid/Additive Manufacturing Impact of 3D Printing technologies (*enabling*)	• 54 Remote Chemical Production • 56 Waste2Aromatics • 95 Pfizer transportable plant • 94 Nestlé flexible modular factory	• 52 Polymer Building-Blocks • 54 Remote Chemical Production • 56 Waste2Aromatics • 90 Veolia

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4.3.3. Sector approach

The manufacturing sector is probably the most varied activity within the non-financial business economy. Preliminary initial analyses of the pre-selected Business Cases show predominantly features of process industry or discrete manufacturing according different sectors:

Process industry

- **Pharma**
  - 95 Pfizer transportable plant *(location flexibility)*
- **Specialties/fine chemicals**
  - 86 Safechem *(no flexible production)*
  - 59 Customized Paint *(product flexiblity)*
- **Commodities/bulk specialties**
  - 53 Functional Molecule production *(capacity flexibility)*
  - 56 Waste2Aromatics *(location and feedstock flexiblity)*
  - 90 Veolia *(feedstock flexibility)*
- **Commodities**
  - 52 Polymer Building-Blocks *(feedstock flexibility)*
  - 54 Remote Chemical Production *(location and feedstock flexiblity)*
- **Steel**
  - 26 Steel2Machine *(no flexible production)*
- **Metals and minerals**
  - 2 Nemodymium recovery *(no flexible production?)*
  - 20 REEFEU *(no flexible production?)*
  - 31 Metals and Minerals Industry for Sustainability *(no flexible production?)*

Discrete Manufacturing

- **Food**
  - 61 3D Pastaprinting *(product flexiblity)*
  - 94 Nestlé flexible modular factory *(location flexiblity)*
- **Electronics**
  - 29 Implantable Drug Delivery Device *(no flexible production)*
  - 4 AI recycling collaborative supply (*no flexible production*)
- **Automotive**
  - 32 Electric Motors in automotive industry *(no flexible production)*
  - 108 Chemical leasing for metal cleaning (*no flexible production*)
- **Clothing/footwear**
  - 24 Leather fabric functionalization *(product flexiblity)*
  - 27 Flex manufacture customized shoes *(product flexiblity)*
- **Personal care**
  - 58 Personalized FMCG *(product flexiblity)*

4.3.4. Business models archetypes

The initial assessment of the pre-selected Business Cases leads to a first high-level identification and description of different types of complementary business models. These "archetypes" can refer to a full business model, or a simplified basic model or a specific aspect or element of a business model. It is not intended as being comprehensive with respect to the full range of archetypes or classifications but provides the possibility to aim for complementarity and in particular covers business research. The in-depth descriptions of business model archetypes is subject of further analyse. Ordered around 5 'archetypes' of business models, 19 of the 24 (pre)selected Business Cases preliminary could have been classified.

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Customisation	Reuse	Chemical leasing	Decentralised or moveable production	Supply chain optimisation
• 61 3D Pastaprinting • 24 Leather fabric functionalization • 58 Personalized FMCG • 59 Customized Paint • 27 Flex manufacture customized shoes	• 2 Nemodymium recovery • 20 REEFEU • 52 Polymer Building-Blocks • 4 Al recycling collaborative supply • 90 Veolia	• 86 Safechem • 108 Chemical leasing for metal cleaning	• 53 Functional Molecule production • 54 Remote Chemical Production • 56 Waste2Aromatics • 95 Pfizer transportable plant • 94 Nestlé flexible modular factory	• 26 Steel2Machine • 32 Electric Motors in automotive industry

4.4. Final selection and obvious Business Cases

Different cases categorised in the stratification stage are less appropriate hence do not fit in the scope of SPIRE in particular to the core criteria "Discrete manufacturing linked with Process industry" or "Flexibility relevance". Notwithstanding the overall high score > 35/50 according the criteria table a minimum score of '4' for these two criteria has been used to filter cases.

- 4 Cases have been considered as less suitable. One case can be considered as 'no relevant case' (LCA for sustainable assessment in the Value Chain) while three cases (3D Pastaprinting, Personalized FMCG, Customized Paint) have been appreciated having limited connection to discrete manufacturing (vertical cases) nor are they highly representative as resource efficiency cases (horizontal cases).

- In order to obtain a complementary set of relevant Business Cases and based on the progressing insights during the classification process, it has been decided to add additional types of relevant Business Case types which were deemed underrepresented in the pre-selection 1) a Business Case Type focusing on **ICT driven Business model Changes**, 2) a Business Case looking into "**design constraints for new decentralised locations**, which would position them, if applied, in the industrial symbiosis category" (as indicated by the SPIRE-06-2016 call topic) and 3) a forward looking Business Case enabling analyses of modular, **containerised and movable process industries**

4 'new' cases have been added: 'F^3', 'LOGICON', 'CoPro' and 'Smart Delta Resource' (SDR) platform. This results in 24 cases to classify in obvious Business Cases.

Based on and in view of the analyses to be performed in the second phase of WP 1 (analyses of Business Cases) and in WP2 (selection and assessment of 10 enabling technologies for more flexible supply chains), the 24 (pre)selected case studies have been discussed in a final workshop among the partners. In order to obtain a selection in line with the INSPIRE objectives a final selection was made and classified in different sub-archetypes according next horizontal and vertical case approach.

Horizontal
1. CRM recycling
2. Chemical park industrial symbiosis
3. Local sourcing and pre-treatment of waste

Vertical
4. 3DPrinting
5. Bio-based materials
6. Local modular/containerised production
7. Servitisation of the process industry
8. Remote process control of decentralised production = ICT driven
9. Mass customisation of consumer goods
10. Process industry to customised small scale batches

The 3 horizontal and 7 vertical types can be seen as sub architypes of the described stratification. This translates the obtained Business Cases classified according:

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Initial Selection	Customisation			Reuse			Servitisation of the process industry	Decentralised or moveable production		Supply chain optimisation
	• 24 Leather fabric functionalization • 58 Personalized FMCG • 19 PRINTCR3DIT • 27 Flexible manufacture customized shoes • 30 Rapid/ Additive Manufacturing -- Impact of 3D Printing Technologies on Flexibility and Environment			• 4 Al recycling via collaborative supply chain (AGFA) • 18 MOBILE FLIP • 20 REEFEU • 21 RESYNTEX • 40 Smart Delta Resource (SDR) platform • 52 Polymer Building-Blocks • 58 Steel2Chemicals • 90 Veolia • 94 Nestlé flexible modular factory			• 86 Safechem • 108 Chemical leasing for metal cleaning	• 53 Functional Molecule Production • 38 F3 Factory • 41 CoPro • 54 Remote Chemical Production • 95 Pfizer transportable plant • 94 Nestlé flexible modular factory		• 26 Steel2Machine • 32 Electric Motors in automotive industry
Initial Selection	3D Printing	Mass customisation of consumer goods	Process industry to customised small scale batches	CRM recycling	Bio-based materials	Re-use and Local sourcing / pre-treatment of waste	Chemical leasing	Remote process control of descentralised production = ICT driven	Local modular / containerised prod.	Decentralised production - industrial symbiosis
	• 19 PRINTCR3DIT • 30 Rapid/ Additive Manufacturing	• 24 Leather fabric functionalization • 27 Flexible manufacturing customized shoes	• 26 Steel2Machine • 29 Implantable Drug Delivery Device	• 20 REE4EU • 4 Al recycling via collaborative supply chain (AGFA)	• 52 Polymer Building-Blocks • 18 MOBILE FLIP • 90 Veolia • 56 Waste2 Aromatics	• 21 RESYNTEX • 58 Steel2 Chemicals • 40 Smart Delta Resource (SDR) platform	• 86 Safechem • 108 Chemical leasing for metal	• 54 Remote Chemical Production • 41 CoPro	• 95 Pfizer transportable plant • 94 Nestlé flexible modular factory • 38 F3 Factory • 53 Functional Molecular Production	• 39 LOGICON

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5. Results and next steps

5.1. Consolidated list

As a result of the iterative selection process including (1) the (pre)selection of case studies from a list of 100 cases, (2) the ranking according the overall criteria assessment, (3) the stratification and (4) the evaluation made during the final workshop the following case studies have been selected to carry out interviews: 14 "vertical case studies", looking at the interconnection between discrete manufacturing industries (especially in consumer targeted domains like the automotive sector) and 10 "horizontal case studies" focusing on resource optimisation (especially local sourcing and industrial symbiosis).

Horizontal	Vertical
4 Al recycling via collaborative supply chain	19 PRINTCR3DIT
5 Steel2Chemicals	24 Leather fabric functionalization
18 MOBILE FLIP	27 Flexible manufacturing customized shoes
20 REE4EU	29 Implantable Drug Delivery Device
21 RESYNTEX	26 Steel2Machine
40 Smart Delta Resource (SDR) platform	30 Rapid/ Additive Manufacturing
56 Waste2 Aromatics	38 F^3 Factory
86 Safechem	39 LOGICON
90 Veolia	41 CoPro
108 Chemical leasing for metal	52 Polymer Building-Blocks
	53 Functional Molecular Production
	54 Remote Chemical Production
	94 Nestlé flexible modular factory
	95 Pfizer transportable plant

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Classified according the proposed architype this can be presented as:

Customisation			Reuse			Chemical leasing	Decentralised or moveable production		Supply chain optimisation
3D Printing	Mass customisation of consumer goods	Process industry to customised small scale batches	CRM recycling	Bio-based materials	Re-use and Local sourcing / pre-treatment of waste	Servitisation of the process industry	Remote process control of descentralised production = ICT driven	Local modular / containerised prod.	Decentralised production - industrial symbiosis
• 19 PRINTCR3DIT • 30 Rapid/ Additive Manufacturing -- Impact of 3D Printing Technologies on Flexibility and Environment	• 24 Leather fabric functionalization • 27 Flexible manufacturing customized shoes	• 26 Steel2Machine • 29 Implantable Drug Delivery Device	• 20 REE4EU • 4 Al recycling via collaborative supply chain (AGFA)	• 52 Polymer Building-Blocks • 18 MOBILE FLIP • 90 Veolia • 56 Waste2 Aromatics	• 21 RESYNTEX • 58 Steel2 Chemicals • 40 Smart Delta Resource (SDR) platform	• 86 Safechem • 108 Chemical leasing for metal	• 54 Remote Chemical Production • 41 CoPro	• 95 Pfizer transportable plant • 94 Nestlé flexible modular factory • 38 F3 Factory • 53 Functional Molecular Production	• 39 LOGICON

This table represents a total of 24 complementary case studies that combine one or more of flexibility enabling technology solutions with either vertical or horizontal supply chain reconfigurations. They will be analysed in order to determine at a meta-level the trends in "vertical" supply and distribution fluxes and requirements, including geographical distances and constraints (spatial flexibility) in the supply chain of specific interrelated industrial sectors (e.g. automotive, steel and chemicals), and their impact on location selection decisions of industries.

5.2. Next steps

The criteria list has been developed in parallel with the cases and the stratification and archetypes are not based on formal definitions, but rather on intuition - later validated by the consortium. Also the flexibility types were originally identified for single companies. The list of presented Business Cases therefore has to be considered as a 'living work document'. It allows us to adapt the list of cases based on findings along the in-depth analysis making a final selection for the Business Cases at a later stage in WP 1. This approach guarantees to select the appropriate cases, related with enabling technologies as required in WP 2 and in line with the goals of INSPIRE.

Progressing insight will be achieved through empirical evidence and interviews with stakeholders that indicate the technologies (WP2), thus serving as archetypes for the business models to be proposed (WP3). The input from representatives from both discrete manufacturing and process industry will be embedded in the development process of the business model solutions. Specifically, technologies and strategies in use in discrete manufacturing will be considered as potential candidate solutions for mass customization in the process industry through process intensification.

The proposed stratification and categorisations is relevant for future fine-tuning of the Business Case selection once the first wave of Business Case analyses in WP1 will have been done. It is possible one additional flexibility types will have to be taken into consideration for the supply chain or other subcategories need to be introduced e.g. energy flexibility as a subcategory for feedstock.

Based on a final selection of predominant horizontal and vertical Business Cases next steps are the assessment on determining critical success factors that ensure or hinder successful deployment of such forms, defining flexibility parameters (spatial, resource) to optimize flows in the value chain and the identification of major supply chain issues (product/market/consumer/industry characteristics that favour delocalization and flexibility) making globalization and international sourcing more attractive. This results in a short list with critical issues and global/local supply chain configurations as an important source of business model design requirements to be further analysed in the following work packages.

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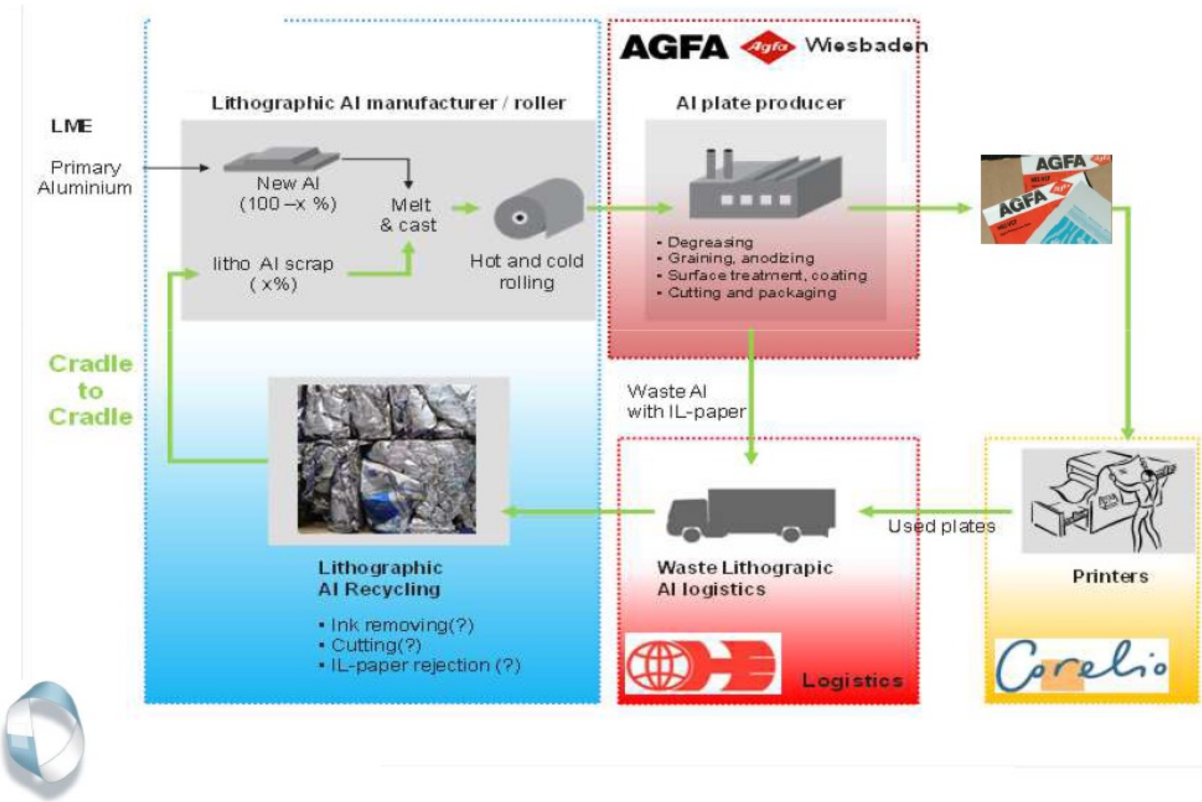
6. Selected case studies

6.1. Horizontal Business Cases

6.1.1. BC 4 Al recycling via collaborative supply chain

The Business Case covers the supply of aluminium printing plates, which are vital consumables to the offset printing industry. Agfa Graphics is a world-leading supplier of such plates, which represent more than 60% of its turnover. Agfa Graphics, as plate supplier, involved aluminium suppliers, logistics partners for scrap collection and print companies to roll-out a circular economy business model, called Net-of-Aluminium (NoA): Agfa Graphics remains the owner of the aluminium at all stages of the life cycle. Consequently, they introduced an Internal Change Program involving Purchasing, Total Quality management, Supply Chain Management, Accounting and Marketing and Sales. To support the circular economy business model, the setup of a collaborative supply chain with his partners was crucial.



In this collaborative Supply Chain, new processes and ICS developments were initiated to manage the inventory of aluminium: as Agfa Graphics now keeps the ownership of aluminium travelling the world, inventory management was extended beyond its own premises, including the inventory at the customers' sites and at recycling plants. The project is selected to bring supply chain projects under the attention. With the project, Agfa Graphics and a number of partners in the supply chain of printing plates presented a sustainable closed-loop solution to their high-volume customers in which high-grade aluminium can be reused without value loss. An evaluation of the carbon footprint for printing plates showed first evidence that the impact of the life cycle of plates on the environment is highly influenced by the production of the aluminium itself. The study demonstrated that current recycling technologies allow for the use of recycled printing plates in the plate production process. This reduces the total carbon footprint with 70% given the aluminium is carefully sent back to the manufacturer after being used on the printing presses. Consequently, the setup of a collaborative supply chain is crucial.

The Business Case involves the supply of aluminium printing plates, which are vital consumables to the offset printing industry. Agfa Graphics is a world-leading supplier of such plates, which represent more than 60% of its turnover. Agfa Graphics, as plate supplier, involved aluminium suppliers, logistics partners for scrap collection and print companies to roll-out a circular economy business model, called Net-of-Aluminium (NoA): Agfa Graphics remains the owner of the aluminium at all stages of the life cycle. Consequently, Agfa Graphics introduced an Internal Change Program involving Purchasing, Total Quality management, Supply Chain Management, Accounting and Marketing and Sales.

6.1.2. BC 5 Steel2Chemicals

Steel2Chemicals builds on a recently developed, lab-scale proven, heterogeneous catalyst (DOW) that enables Fischer Tropsch (FT) technology to use industrial waste-gases to produce chemicals. Such a syngas based route towards high-added value materials and chemicals would, for the first time, enable the use of new feedstocks like waste gases from steel, waste or biomass industry to be used across several carbon consuming industries. The combination of industrial waste-gases, containing CO and H2 into a single stream with high valorisation potential will enable for unprecedented savings in term of costs and environmental emissions (>20 Mton/year CO2-eq) in two of the most energy and resource intensive industries in Europe, i.e. the Steel and Chemical industry.

The project demonstrates that the novel FT technology works with industrial waste gas supplied by a steel mill, while investigating the possibility of a fully circular value chain from steel industry waste-gas to the re-use of waste plastics as carbon source for the steel-mill. Furthermore CO2 utilization will be demonstrated via Accelerated Carbonation Technology as a solution to capture substantial amounts of CO2 in the form of aggregates that are suitable for building & construction applications.

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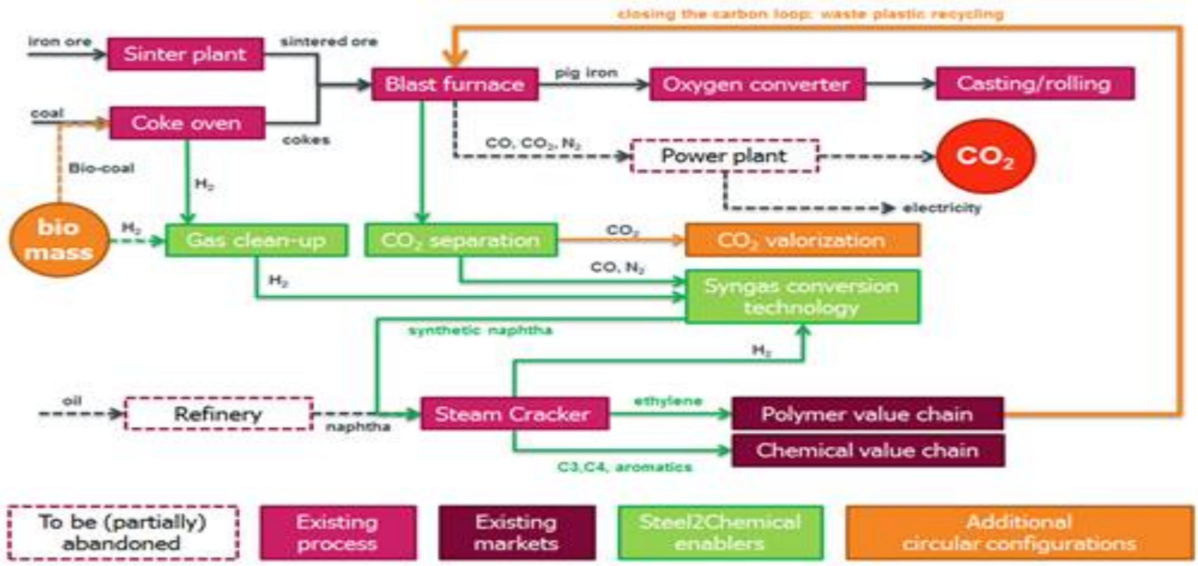
From a "chemical perspective", the project will reduce CO2 emissions and reduce use of fossil resources by:

- Waste CO conversion into products(avoidance of CO2 formation);
- Waste CO2 capture and conversion into building & construction materials (reduction of CO2 emissions);
- Waste-gas used for production of synthetic naphtha (reduction of fossil naphtha use);
- Waste-plastics recycling as feed for Blast furnaces (reduction of coal use).



Successful technical demonstration of the Steel2Chemicals conversion process will enable new partnerships between the steel and chemical industry, as well as partners down the value chain (e.g. Fast Moving Consumer Goods) and side steams (e.g. Building & Construction materials), as a showcase for cross-sectorial industrial symbiosis (IS). The support letters to this project show the interest of these industries.

6.1.3. BC 18 MOBILE FLIP

MOBILE FLIP (Mobile and Flexible Industrial Processing of Biomass) relates to the topics addressed by the call for SPIRE - SUSTAINABLE PROCESS INDUSTRIES, Topic: SPIRE-02-2014 Adaptable industrial processes allowing the use of renewables as flexible feedstock for chemical and energy applications.

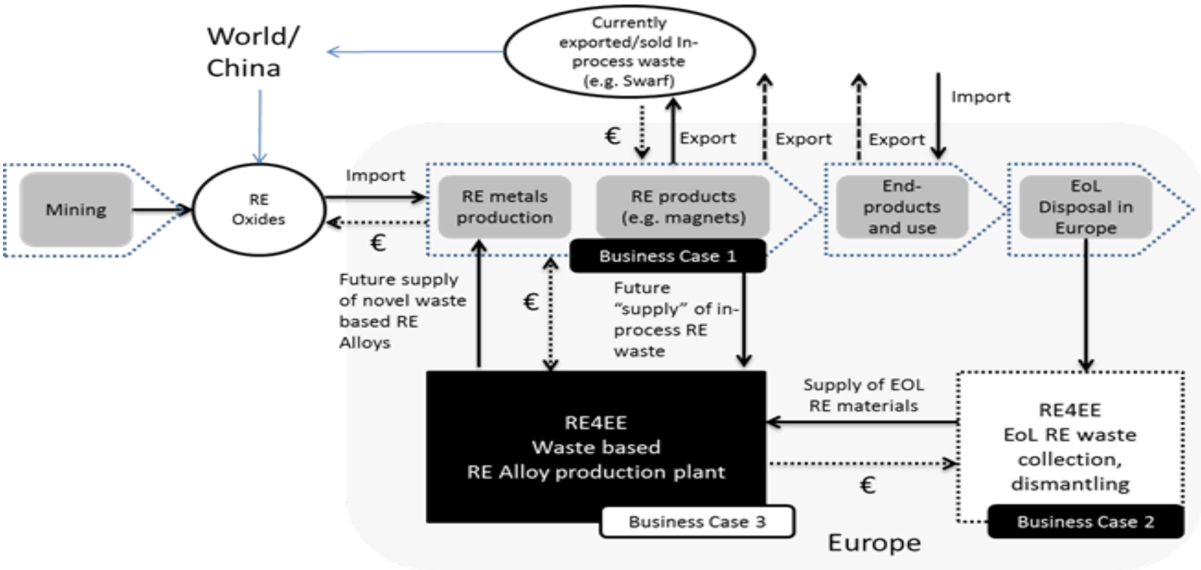
MOBILE FLIP aims at developing and demonstrating mobile processes for the treatment of underexploited agro- and forest based biomass resources into products and intermediates. The processes will be evaluated in terms of raw material flexibility, as the biomass resources are typically scattered and seasonal. Process concepts have been designed around the key technologies pelletizing, torrefaction, slow pyrolysis, hydrothermal pre-treatment and carbonisation. The products vary depending on the process concept, being typically fuels as such or for co-combustion (pellets, torrefied pellets, biocoals), biochars for soil remediation, biodegradable pesticides for agricultural or forestry use or chemicals for wood panel industry and sugars and hydrolysable cellulose as intermediate for the sugar platform.

Some of the products are marketable as such, while some others are intermediates to be further valorised by integrated large industries. In the latter case, the mobile unit pre-extracts the valuable components or densifies the biomass to reduce transportation costs. Over-the-fence integration to large industries will be one means to ensure the availability of utilities, such as steam and electricity, whereas in some mobile process concepts the utilities can be produced at site for internal or external uses. The concept evaluations are supported both by research and industrial (SME and large industries) partners in the whole value chains. Preliminary business plan is presented in the proposal and will be updated during the project. Dissemination, communication and exploitation activities will be an integral part of the project. A milestone is defined in the midterm of the project to identify the most feasible process lines for demonstration. Life-cycle analysis and a wide sustainability evaluation (economic, environmental and social assessment) will be carried out for the process concepts in order to clarify their potential for flexible raw material valorisation.

6.1.4. BC 20 REE4EU

Rare earth elements (REEs) are the seventeen chemical elements lanthanides, Scandium and Yttrium. Because of their geochemical properties, REEs are typically dispersed and not often found concentrated as RE minerals in economically exploitable deposits. REEs are considered “key-enablers” of green technologies, as they are used in hybrid electric vehicles, wind mills, and highly efficient electric motors. The dependence on Chinese exports makes Europe, and western countries in general, extremely dependent and vulnerable to Chinese market control. Therefore REE are considered to be materials with the highest supply-risk.

Regaining REE from RE-containing waste streams may constitute an important RE secondary source in Europe. A recent study, based on detailed trade data, estimates the global trade in RE-containing products in 2010 at around €1.5 trillion, or 13% of the global trade. However, only 1% of RE waste is being recovered as no adequate process is currently available. REE4EU will open-up a fully new route bringing recovery of in-process wastes from PM manufacturing within reach.



The project, funded in the frame of Horizon 2020 TOPIC SPIRE-07-2015, will realize a breakthrough innovation in the field of Recovery Technologies for Metals and other Minerals. It will make available Rare Earth elements and Rare Earth alloys for magnet production by developing, for the first time at industrial scale, an efficient and cost effective method of extraction based on integrated high temperature electrolysis (HTE) and Ion Liquid Extraction (ILE). The Business Case includes a direct production contributing to secure an Independent European Rare Earth Elements Supply Chain. The Route for Rare Earth Alloys which will be achieved through in-process and End-of-Life permanent magnets as well as Ni metal hydride battery waste. REE4EU will also develop urgently required market data on end-of-life rare earth availability and a triple value-chain Business Case for a new European secondary rare earth alloys production sector.

6.1.5. BC 21 RESYNTEX

The objective of RESYNTEX is to create a new circular economy concept for the textile and chemical industries. RESYNTEX is a research project funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No 641942. It aims to develop innovative recycling processes and generate new secondary raw materials from textile waste. The project aims to create a new circular economy concept for the textile and chemical industries. Using industrial symbiosis, it aims to produce secondary raw materials from unwearable textile waste. Core Project Aims: (1) Design a complete value chain from textile waste collection through to the generation of new feedstock for chemicals and textiles, (2) Improve collection approaches while increasing public awareness of textile waste and social involvement, (3) Enable traceability of waste using data aggregation. The collected data will evaluate the performance of the new value chains by means of a life cycle assessment (LCA) and life cycle costing (LCC), (4) Develop innovative business models for the chemical and textile industries and (5) Demonstrate a complete reprocessing line for basic textile components, including liquid and solid waste treatment.

Through industrial symbiosis, it aims to produce secondary raw materials from textile waste. The project models a complete value chain from textile waste collection through to new marketable feedstock for the chemical and textile industries. It will focus on the reprocessing of blends and pure components of unwearable textile waste. Moreover, it will improve collection approaches and increase public awareness of and social involvement with the issue of textile waste, enable traceability of waste processing using data aggregation, develop innovative business models for the chemical and textile industries, and demonstrate a complete reprocessing line for basic textile components, including liquid and solid waste treatment.

6.1.6. BC 40 Smart Delta Resource

The Smart Delta Resource (SDR) platform is an initiative of eleven power companies and raw material-based industrial companies in the Delta region joining forces to strengthen the competitive power of the Zeeland industry. These companies launched a platform to explore the possibilities for exchanging energy and raw materials amongst themselves. The chemical, energy, food and steel industry all work together to define industrial connections – symbiosis – and use this as a basis for concrete Business Cases. This will allow them to improve competition on the world market and it will also help to realise ecological and social improvements. The platform makes an important contribution to the transition process towards a cyclical economy, for both existing fossil-based industries and future companies based on renewable energy and raw materials. The aim is to improve competition towards (1) Innovations in energy & resource efficiencies. Cross sectorial: Chemical, Steel, Food and Energy: complementary (2) through collaboration: new opportunities and industrial symbiosis and (3) Growth opportunities for 3rd parties in the region.

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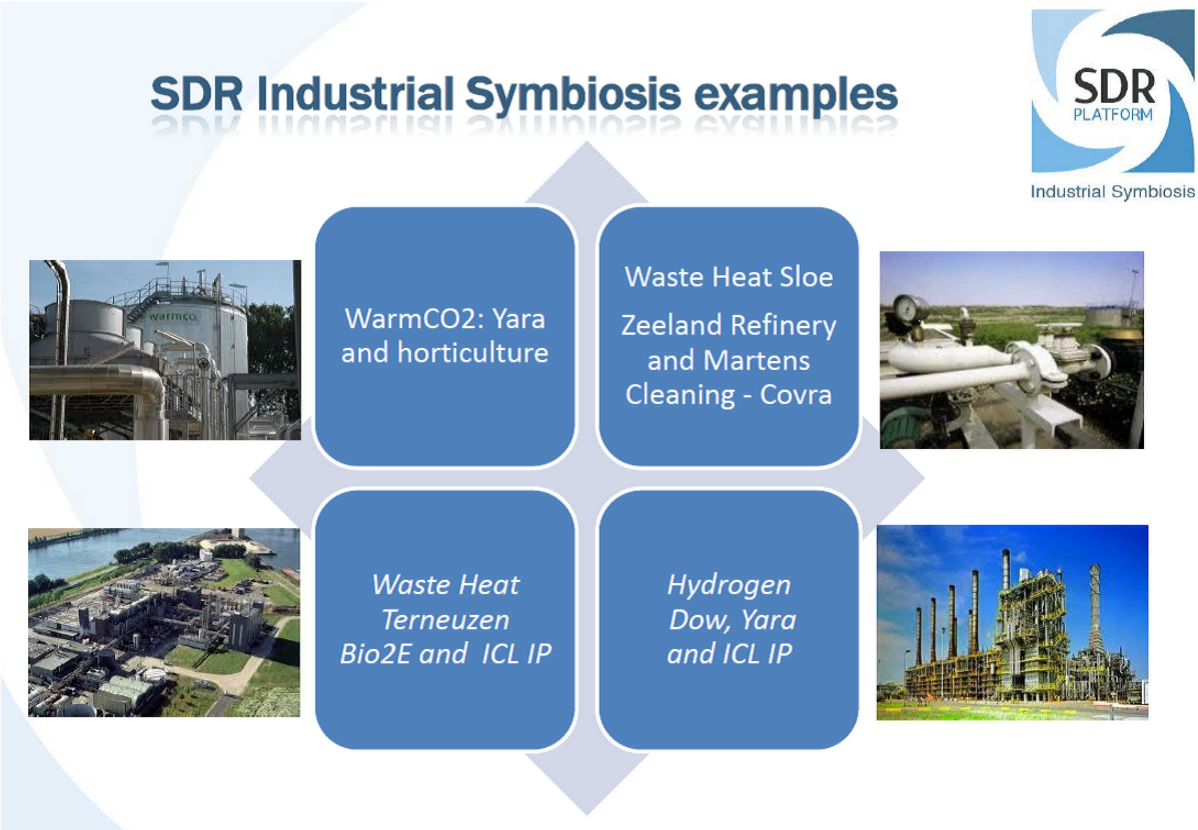


6.1.7. BC 41 CoPro

Improved energy and resource efficiency by better coordination of production in the process industries » (CoPro) addresses the call SPIRE 02-2016 and will make significant contributions towards Efficiently utilising existing plants by integrated plant-wide scheduling and control.

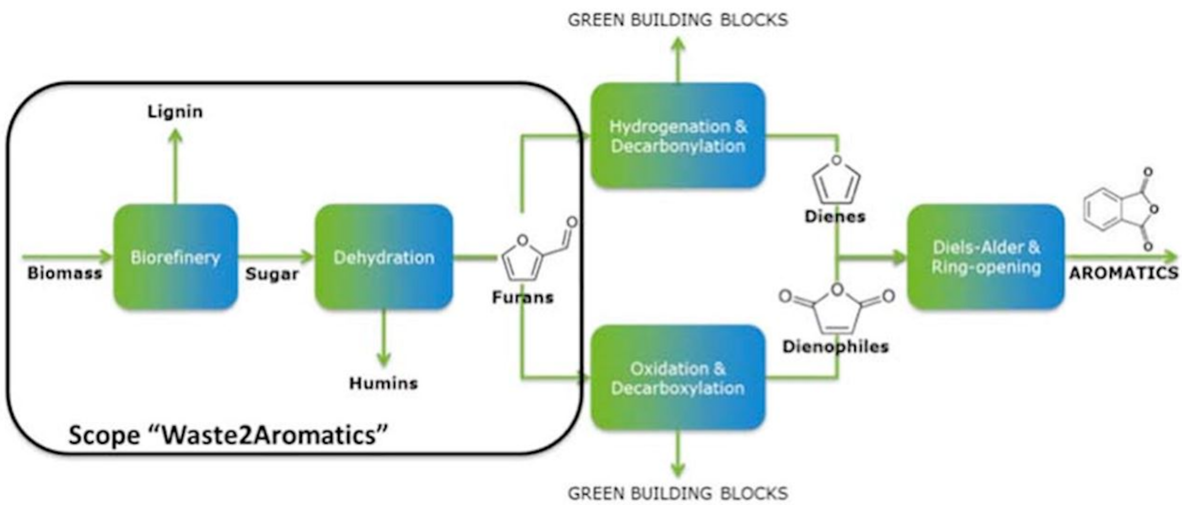
CoPro will provide tools for the plant-wide optimisation of continuous and discrete decisions will develop technology for balancing production and consumption in industrial parks for industrial symbiosis and will address power plant scheduling and demand side response. The aim of the Business Case is to improve coordination of connected units in a site and within a chemical park and buffering the effects of fluctuating renewable energy production and distribution by integrating demand side response with plant-wide scheduling and control. CoPro develops online data analytics and novel forms of information presentation that lead to a symbiosis of operators and computer-based control algorithms. The solutions are enabled by the integration of the IT infrastructure of the plants via a neutral integration platform that connects to different IT systems. CoPro pays special attention to methods for the efficient development of plant models as the basis for advanced control, scheduling, and coordination.

The objectives are motivated by five challenging and characteristic use cases from different sectors of the process industries: (1) (Petro-) chemical production, (2) Coupled large-scale production units in an industrial park, (3) Cellulose fibre production, (4) Production, formulation and packaging of consumer goods and (5) Sterilization and packaging of food.

The technologies that are developed are nonetheless of a generic nature and can be applied to all sectors of the process industries and also to production sites in other sectors. CoPro builds upon results of the MORE and DYMASOS projects and makes a further step forward to apply and extend them to plant-wide coordination and control, and towards market-based coordination mechanisms for Industrial Parks.

6.1.8. BC 56 Waste2Aromatics

Aromatics are one of the main feedstocks of the chemical industry, constituting 40% of the total market. Currently, these are exclusively produced from fossil sources, generating considerable CO2 emissions. The project aims to prove that it is possible to convert waste streams into furans, the raw materials for aromatics, with a highly promising Business Case.



This results in turning biodegradable waste, nappies, compost and sieving material from wastewater into valuable raw materials for the chemical industry bringing the circular economy and the commercial production of cost-competitive bio-aromatics significantly closer.

6.1.9. BC 86 SafeChem

SAFECHEM, a subsidiary of The Dow Chemical Company, is an experienced provider of services and solutions related to the safe and sustainable use of solvents for surface and dry cleaning applications. The Business Case addresses Closed-loop Risk Management Solutions. As the industry

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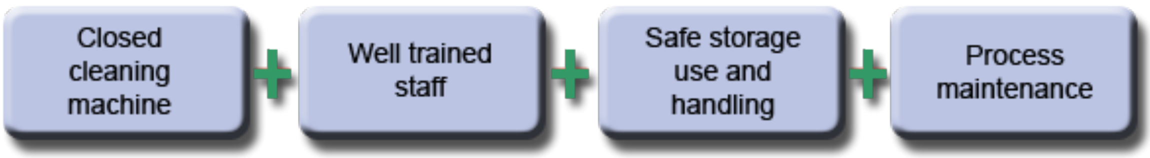
became aware of the risks associated with chlorinated solvents, these products became regulated more stringently, starting in Germany and Switzerland. Founded in 1992, SAFECHEM introduced a closed-loop system enabling customers to use chlorinated solvents safely as a cleaning agent for their top quality products. Together with a full range of services, this solution enables active Risk Management and promotes responsible handling of chlorinated and non-chlorinated solvents starts during the production process, continues during a filling process, the delivery and take-back of the product until the handling by the customer.

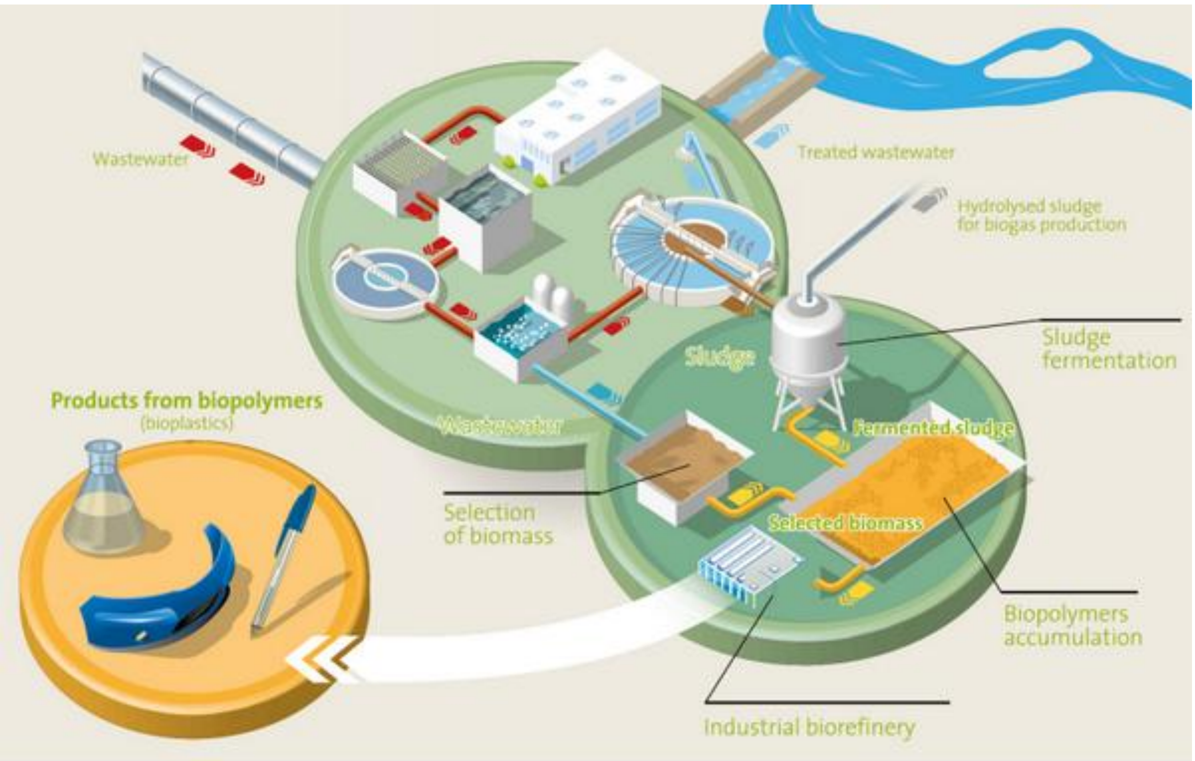


SAFECHEM is committed to the principles of Responsible Care and Product Stewardship and develops additional business models and services for chemicals in various industries and applications. SafeChem Europe GmbH has a portfolio to manage the product-specific risks of chlorinated solvents. The basis is a closed-loop concept using a container system for the handling of fresh solvents and the take-back of used solvents for recycling. SafeChem is developing innovative concepts such as chemical leasing, where customers can lease the complete cleaning process for a fixed monthly leasing fee. A close cooperation with the customer allows efficient monitoring and optimizing of the entire cleaning process at customers' sites. *(source: SafeChem Polfree, D2.4 New business models that support resource efficiency, 2014, TNO and others)*

6.1.10. BC 90 Veolia

Research has shown that many of the bacteria found in activated sludge, which purify wastewater in biological treatment processes by feeding on organic contaminants, can under certain conditions convert these contaminants into biopolymers with similar properties to polymers produced by the chemical industry.

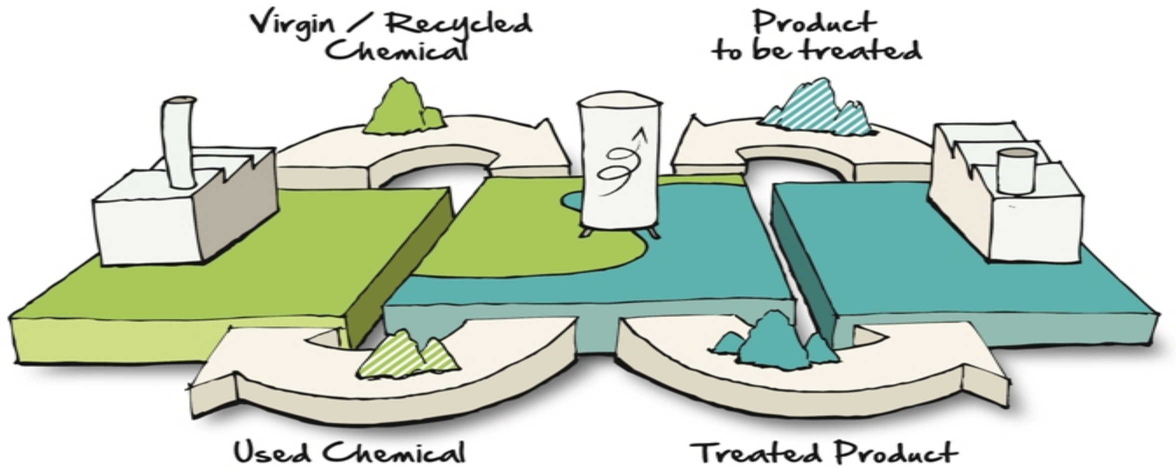
Veolia has pioneered the production of bio-plastics from sludge. Wastewater treatment systems today often use bacteria that eat sludge and neutralize it into carbon. Using proprietary technology, Veolia achieved a breakthrough in converting this 'wastewater carbon' into biomass rich in PHA. The PHA adds value to the biomass as it has mechanical properties equivalent to polypropylene and is, thus, valuable in making consumer plastics and chemicals. Veolia produced the first biopolymers from municipal waste in 2011, and is now refining the process to meet end-customer specifications at full-scale wastewater treatment sites in Belgium and Sweden.



Technologies facilitate biopolymer production within activated-sludge and biofilm biological treatment processes by creating optimized process conditions for increasing the presence of biopolymer-producing bacteria. The produced biopolymers are polyhydroxyalkanoates (PHA), and PHA-rich biomass is harvested and converted into valuable starting materials for the plastic and chemical industries. The biopolymer processes enable the recovery of value-added renewable resources, including biopolymers, lipids, minerals, other platform chemicals and sources of energy as by-products from process and wastewater management services. *(ref Polfree, D2.4 New business models that support resource efficiency, 2014, TNO and others)*

6.1.11. BC 108 Chemical leasing for metal cleaning

Chemical leasing for metal cleaning is a business model in which the chemical company supplies a substance for a specific service, but retains ownership of the chemical. It is intended to shift the focus from increasing sales volume of chemicals towards a value added approach. It may lead to more efficient use of chemicals, and to quality, environmental, and economic benefits. The Business Case is about the local manufacturer FKL producing metal parts such as bearings and cardan shafts for the global car industry. The cleaning of metal parts required the use of big amounts of perchloroethylene (PERC) - a chlorinated solvent-, and every year FKL was consuming 30 tons of solvent and producing 24 tons of hazardous waste. Moreover, the solvent was emitted to the environment and the working environment resulting in potential damages to the workers' health. In an effort to make their metal cleaning processes more efficient and safer, the company searched new ways to optimize its consumption of PERC.

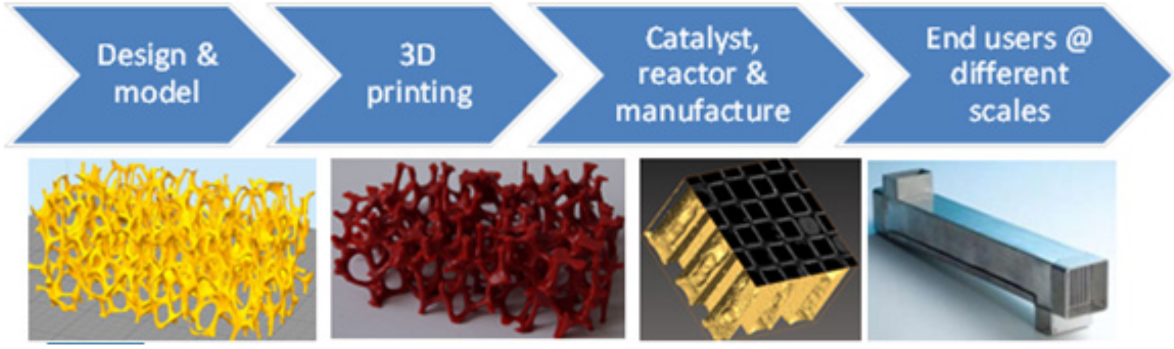


Through the adoption of the chemical leasing model FKL achieved significant economic, environmental and occupational health and safety benefits. Moreover, the company reduced its production of hazardous waste more than 16 times. The service model is an innovative business model in which the concept of chemical leasing is combined with circular (economy) thinking. The model establishes a new mode of cooperation between the chemicals supplier and user/processor. Within the model, the supplier is no longer paid per unit volume, but for the function performed by the chemicals (e.g. payment per square meters cleaned surface). The chemicals used remain the property of the supplier and are hereby also taken back after use with the aim to recycle or process the chemicals so they can reenter the value chain. The model creates a continuous driving force for the optimization of the chemicals used, and the process in which they are applied. This results in both cost and material savings for both parties with economic and environmental benefits. *(Source: https://europa.eu/eyd2015/en/unido/stories/business-model-chemical-industry-circular-economy-works)*

6.2. Vertical Business Cases

6.2.1. BC 19 PRINTCR3DIT

Catalytic reactors account for production of 90% of chemicals we use in everyday life. To achieve the decarbonisation of European economy and comply with the 20-20-20 target, resource utilization and energy efficiency will play a major role in all industrial processes. The project PRINTCR3DIT refers to Process Intensification through Adaptable Catalytic Reactors made by 3D Printing. The concept of PRINTCR3DIT is to employ 3D printing to boost process intensification in the chemical industries by adapting reactors and structured catalysts to the requirements of the reaction. This manufacturing technique is particularly useful in reactions where diffusion, mixing and/or heat transfer are limitations against reaching higher performance. The utilization of the concept of 3D printing will also reduce the resource utilization of reactor and catalyst manufacture, energy consumed (< 15%) and transportation.

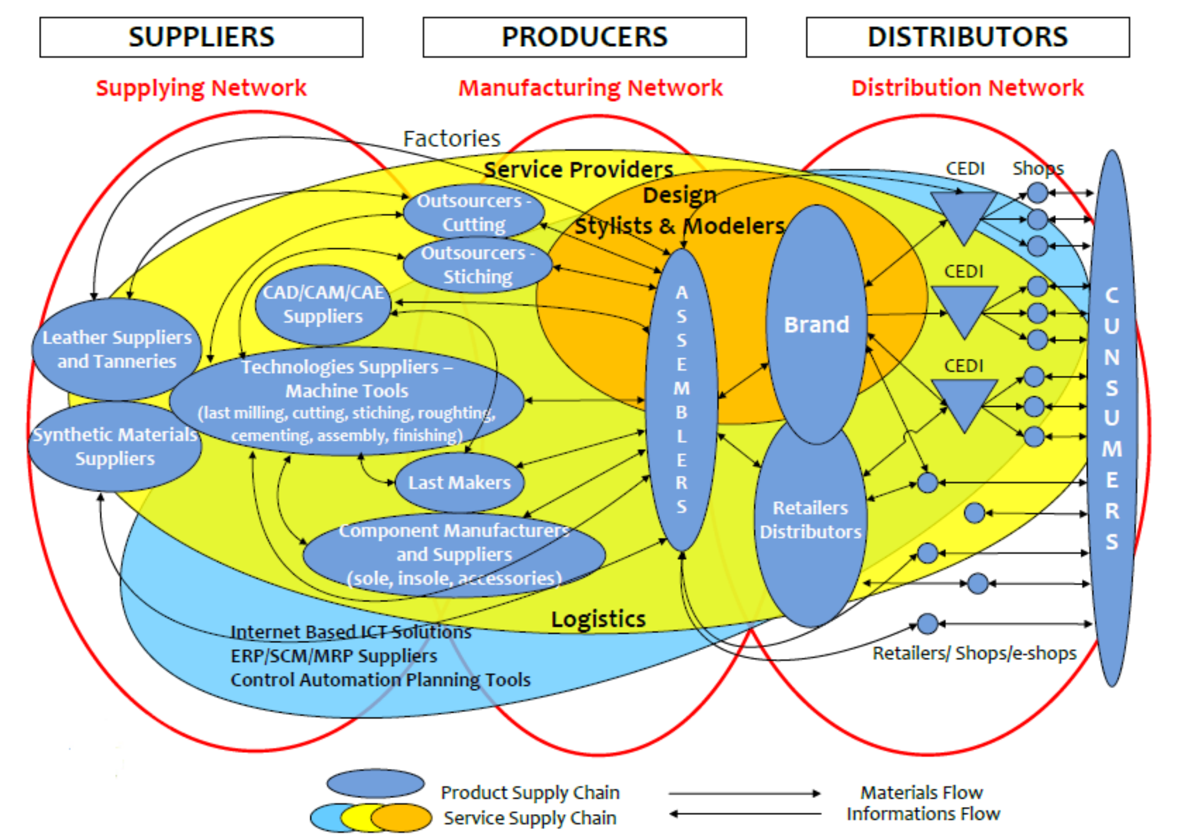


The methodology will be applied to three markets of fine chemicals, specialty chemicals and fertilizers, ranging from few tons to millions of tons of production per year. This demonstrates the enormous versatility of 3D printing for reactor and catalyst designs that cannot be improved with traditional building and design tools. For all these processes, the challenges to be solved are thermal management, innovative reactor design and flow distribution. These examples will provide realistic data in different markets to delineate Business Case scenarios with the options of new integrated plants or retrofitting for large-scale applications. Application of cutting-edge 3D printing to catalytic reactors will foster higher productivity, a more competitive industrial sector and higher value jobs in Europe - keeping leadership in such a challenging arena. PRINTCR3DIT is a joint effort between world-leading industries (4), innovative SMEs (4), R&D institutes (4) and a university that aim to accelerate deployment of a set of products to the market.

The concept of PRINTCR3DIT contains the employment 3D printing to boost process intensification in the chemical industries by adapting reactors and structured catalysts to the requirements of the reaction. This manufacturing technique is particularly useful in reactions where diffusion, mixing and/or heat transfer are limitations against reaching higher performance. The utilization of the concept of 3D printing will also reduce the resource utilization of reactor and catalyst manufacture, energy consumed (< 15%) and transportation. Concept: The methodology will be applied to three markets of fine chemicals, specialty chemicals and fertilizers, ranging from few tons to millions of tons of production per year. This demonstrates the enormous versatility of 3D printing for reactor and catalyst designs that cannot be improved with traditional building and design tools. For all these processes, the challenges to be solved are thermal management

6.2.2. BC 24 Leather / fabric functionalization for product customisation

Mass customisation and personalisation force companies to increase flexibility of the whole supply chain. In a traditional and mature sector as the footwear industry, the implementation of new IT technologies and paradigms together with the introduction of robots in the manufacturing line, advanced sustainable printing and cutting technologies and additive manufacturing can modify the existing design, production and delivery processes.



In the business model, a change in the relationship with the suppliers will be necessary as new market requirements with increased responsiveness and flexibility go in line with a dramatic reduction of products life-cycle. It requires solutions supporting the flexible and sustainable management of globalized networks and the identification and adoption of new emerging technologies to open new business opportunities for innovative solutions. Footwear companies are mostly SMEs concentrated in regional clusters, with peculiar specializations even if suppliers may be geographically dispersed over large areas (within and outside Europe). The realization of customized products in small series will probably push towards a more local based supply chain.

6.2.3. BC 26 Steel2Machine

The idea of the Business Case is to investigate new business models and supply chains, enabled by the new "Industry 4.0" technologies, for a higher integration of steel producers (process industry) and customer companies using steel to manufacture final products (discrete manufacturing). Currently the two sectors and not very integrated. Higher integration allows designing and manufacturing steel highly customized for final applications (for example in the automotive, aeronautics, mechanical, ... sectors) for higher final products' performance, added value for customers, increase recycling potential. "Industry 4.0" technologies, as well as steel technologies for low volumes and high quality, would enable such a business model since they would allow a higher interconnection and coordination among all the extended supply chain companies, bettere resources saturation and lower lead time.

Industry 4.0 technologies entail extended sensorisation of all supply chain companies, big data analytics and advanced modelling to extract value from information, systems for real-time communication in the supply chain, etc.. Also sustainable steel making technologies for flexible production in small lots are relevant technologies for the implementation of the targeted business model. The new business model entails the development of a platform in which steel producers and manufacturing users can meet and exchange information to optimise the cooperation (based on big data, optimisation models and algorithms, etc…). Such a technology-enabled cooperation model would have a significant impact on the supply chain, which is currently fragmented. The case implies major business model change required by multiple parties in the supply chain. Steel producers will have to change the way they design and produce steel. Manufacturing customers will establish deeper relationship with steel producers and will in turn offer highly personalized products. In addition, circular economy will be implemented, leading also to the involvement of new supply chain roles. The delocalisation dimension is not deeply affected by the business model. However, higher information availability and exchange will enable a better recourse to local resources and partnerships. One of the main goals of the business model is to customise steel in order to increase the customisation level of final products. Thus, customisation is one of the major results of this Business Case. The goal of the case is exactly to integrate process and discrete manufacturing for extended supply chains. The Business Case will imply significant impacts on multiple customisation dimensions. Higher and better information exchange will allow to dynamically setup most suited supply chains to reduce lead times, to exploit capacity availability, to enable orders change, to exploit opportunities to reduce energy consumption, etc... The business model is replicable in any sector in which process industry provides inputs to discrete manufacturing industry. Enabling technologies are the same in all cases; they should be instantiated according to specific industrial applications.

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6.2.4. BC 27 Flexible manufacturing of customized shoes

Over the last decade most of tanneries had to face various problems related to the environmental impact of the tanning process since the process is very polluting both during the processing and at the end when releasing to the soil, air, water bad substances. The more and more restrictive regulation forces companies in a continuous improvement of production processes. Moreover consumers pay an increasing attention to the presence of noxious substances in leather and related products which can damage the health. Leather is used in many sectors like footwear, accessories, automotive, furniture, etc. Use of new vegetable tanning system allows avoiding use of highly polluting chemical. This new process is already applied by some companies with a critical trade-off between lower quality of the leather after treatment and higher sustainability. In the business model chemical companies are providing new services to footwear. The functionalization of raw materials and components implies revision of the production process and of the production network. According to the type of process for functionalization it is possible this process takes place at the supplier, at the manufacturer or even at the retail site. From the technological point of view there are two challenges for the future: to find the right chemical composition for treatment requested and to find the right process to assure the treatment is stable i.e. does not release on the body bad substances.

KEY FIGURES FOR THE TEXTILE AND CLOTHING INDUSTRY

The total EU-27 textile and clothing industry, including manmade fibres, did represent in 2013:

- Turnover of 166,500 million Euro of which: textile & manmade fibres represent 55% and clothing 45%
- Companies: 172,662 companies of which: textile & manmade fibres represent 31% and clothing 69%
- Employment: 1,664,000 workers of which: textile & manmade fibres represent 38% and clothing 62%
- Turnover per employee exceeded 100,000 Euro, and 2.5% of turnover was reinvested.

KEY FIGURES FOR THE LEATHER AND FOOTWEAR INDUSTRY

The leather and footwear industry, did represent in 2011:

- Turnover of 31,196 million Euro of which: tanning represents 25%, footwear 45% and leather goods 30%
- Companies: 24,185 companies of which: tanning represents 7%, footwear 49% and leather goods 44%
- Employment: 392,264 workers of which: tanning represents 9%, footwear 70% and leather goods 21%
- Turnover per employee reached nearly 80,000 Euro.

It is expected to increase in the value of the product and to create a new value proposition which need to valorise the new functionalities. Also the relationship with the customer can change because it is necessary to find a way to collect the specific requirement from the customer himself and in some case to explain him how to apply the treatment. In the business model, a change in the relationship with the suppliers will be necessary.

6.2.5. BC 29 Implantable Drug Delivery Device

Implantable devices in the pharma industry are called upon to serve a variety of functions, from vascular stents that preserve blood flow to electrostimulation devices that regulate heart rhythm or block spurious signals in the brain to orthopedic devices that mechanically reinforce the spine or restore range of motion of hips and knees. For over a decade, there has been an increasing convergence between implantable devices and drug therapies, including devices that deliver drugs as a primary action. The materials lend themselves to manufacturing processes based on molding or extrusion. Traditionally, the business approach has focused on molding silicone drug delivery devices using injection and compression molding techniques. Several factors now must be considered in optimizing the material formulation and developing a robust molding or extrusion process. The material system (e.g., liquid silicone vs. high consistency rubber), mixing or compounding technique, temperature, and pressure will all potentially affect the drug release consistency and drug content uniformity of a manufacturing lot. In some cases, co-extrusion or overmolding of a thin, drug-free layer has been used to enable a more uniform release of the drug from the implant.

Implantable drug delivery devices offer several advantages over conventional oral or parenteral dosage forms. First, implantable devices allow site specific drug administration where the drug is needed most. Examples include implants used in the treatment of brain tumours or prostate cancer. This may also allow for significantly lower doses of the drug, which can minimize potential side effects. Second, implantable devices allow for sustained release of a therapeutic agent. The last and perhaps most important advantage is patient compliance, as the treatment regimen associated with an implantable device is generally less burdensome than pills or injections. The flexibility relevance is high, personalization almost with the biosensors releasing drug in response to physiological or metabolic changes in the patient. New players (Microchips) are involved in the value chain producer/Pharma/hospital/patients; new products (potentially cannibalizing the demand of products in the current portfolio); new manufacturing processes for the new product and/or changes in the current manufacturing system; new suppliers providing different/new products/components and the new way to administer the drug.

6.2.6. BC 30 Rapid/Additive Manufacturing

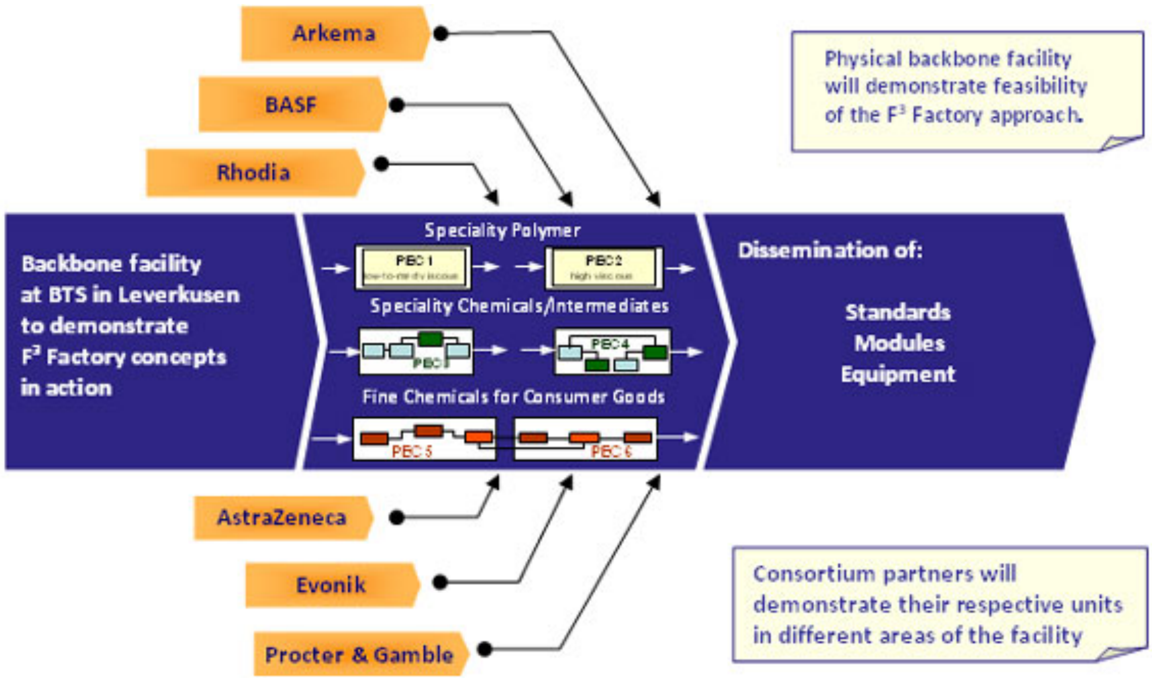
To maintain a competitive advantage against low-cost overseas competition European companies must design/produce increasingly added value by complex & personalized products. The Business Case RM Machine "Capacity" contains purchasing (renting) or investing in in-house RM Capacity in a centralized manner and renting at locations closer to customers. The aim is to enhance the production on demand closer to the customer (move from a centralized production/distribution model to globally distributed supply chains or containerized). The impact of the Business Case includes the reduction of the lead time to produce and even to develop new products. The production in different locations to move production closer to customer is made possible by the introduction of digitalizing in the supply chain enabled by rapid manufacturing. Certain stages of the SC can be eliminated by sending raw materials such as minerals/metals to a manufacturing site and then bringing back the finished good to the destination site.

The impact of 3D Printing Technologies on Flexibility and Environment is already evaluated for simpler products but the future is promising for complex products at a larger scale. The changes in the supply chains/business model depend heavily on the success of the technology in the near future. New players (e.g., suppliers of these 3D machines/software developers that may sell the codes/manufacture of topologically optimized components) and new product development might require input of new companies. Similar machines can be used almost anywhere with the potential to be used for very simple products (mugs) and highly complex products (such as the ones for the aerospace industry for lighter/stronger highly efficient parts; heat exchangers; RM being feasible for automotive/manufacturing/medical supplies).

6.2.7. BC 38 F³ Factory

To remain competitive and strengthen their global technological leadership, the EU chemical process industries need to focus on faster, more flexible production methods. The F³ Factory (flexible, fast, future) project's results offer a new paradigm for the future of chemical production by demonstrating the advantages of operating modular continuous plant processes that are more economical and sustainable than current operations. They are a concrete demonstration of the project's key aims to: (1) Deliver radically new 'plug and play' modular chemical production technology, capable of widespread implementation throughout the chemical industry and (2) Deliver whole process design methodology by applying novel process intensification concepts and innovative decision tools to ensure raw materials and energy are employed more economically.

The project was launched in June 2009 and has run for four years. It had total funding of €30 million including €18 million from the European Commission FP7 research programme and was coordinated by Bayer Technology Services. In May 2013, the project had its final conference where it presented the results of the collaborative research on fast, flexible, modular production technology for the future chemical industry and beyond. F³ Factory attracted 24 partners, including seven leading European chemical companies. They crossed competitive boundaries to collaborate on innovative production concepts and process intensification technologies to combine the advantages of large scale, better optimised plants with those of smaller more flexible facilities. The diversity of the partners enabled processes to be tested across a range of products from polymers to chemical intermediates, pharmaceuticals and consumer products. The success of this approach is proven by the seven industrial case studies spanning a broad range of process industry sectors including pharmaceuticals, chemical intermediates, specialty polymers and consumer products. They were used to prove that the innovative model put forward by the project can change the chemical production sector making it faster and more flexible.



The seven cases are:

- Water Soluble Speciality Polymers
- Continuous Processing for Pharmaceuticals
- Continuous Production of Chemical Intermediates
- High-Volume, Biomass-based Intermediate Chemicals
- Active Pharmaceutical Intermediates
- Intensified Reaction Technology for Surfactants
- Highly Viscous Polymers

6.2.8. BC 39 LOGICON

On European level small forwarders, carriers and other logistic SMEs are in need of affordable, reliable and trusted data-interchange solutions to take part in international trade and commerce flows. LogiCon (Lean Secure and Reliable Logistic Connectivity for SMEs) aims at setting up, testing and facilitating the adoption of low-cost, low-barrier data connectivity solutions. The above activities will be carried out in four national living labs, each one with specific objectives, dealing with three main challenges: 1) enabling connectivity, by selecting, refining, testing and promoting state-of-the-art solutions and platforms, through involvement of a vast audience of SMEs; 2) engaging communities, either cargo communities around port and inland terminals or business networks run by large companies, to favour standards adoption and to support risk assessment and dashboards for key indicators like emissions and load factor; 3) prepare for cooperation in a global freight management ecosystem, foreseen for the future, where capacity will be optimized and flows will be synchronized among the different involved actors. As part of the Logicon strategy, results that are adapted to the context (i.e. Living Labs) where the problems are detected, which implies results are different from each other - even when based on same principles.

The problems and ambitions of the living labs are:

- Polish living lab. Planning of hinterland rail transport from or to the port of Gdynia involves many actors and consumes a lot of time for exchange of information – phone calls, faxes and emails. This problem causes the hinterland planning of the port of Gdynia to be less efficient and less attractive for its customers. The problem addressed in Polish Living Lab includes rail transport and truck last mile transport.
- Dutch living lab. The Twente region has the ambition to become a logistics hotspot, strategically located between the deep-sea port of Rotterdam and the hinterland and very well served by road, rail and waterways. The Dutch LL created a light-weight, low-cost and flexible infrastructure for sharing data including dedicated apps and services. These apps and services enable e.g. lock planning supporting both barge operators and Rijkswaterstaat and a connection to existing systems where real-time information of terminal services becomes available.
- Spanish living lab. The Spanish Living Lab enabled small transport service providers automatic data exchange with large forwarders. LogiCon developed apps for web and smart devices for truck drivers to support service information exchange, e.g. tracking of truck departure and arrival, creating and sending of transport orders and invoices.
- Italian living lab. Interporto Bologna exploits the Bologna Freight village where a lot of SME companies are located (60% of the total tenants). SMEs lack an easy opportunity to engage in new business. Now, this is a time-consuming activity that is even more difficult to perform because of the small number of employees that are available with SME players.

The issue of adoption is an important one, especially as the project's solutions are focused on SMEs and it can be difficult to reach this target group. All Living Labs have already consulted with their larger SME community in a series of stakeholder workshops. In these workshops, all Living Labs presented their drafts of their solutions to the SME community. The feedback of the community has been used as input for further solution iterative re-designs.

6.2.9. BC 52 Polymer building blocks

The business case covers the production of green building blocks by moving from Petrochemical (Cracker, BTX plant) to a combination of i) Recycling/de-polymerisation and ii) Biomass conversion (e.g. hydrothermal, biotechnological,…). Block polymers (BPs) derived from biomass (biobased) are necessary components of a sustainable future that relies minimally on petroleum-based plastics for

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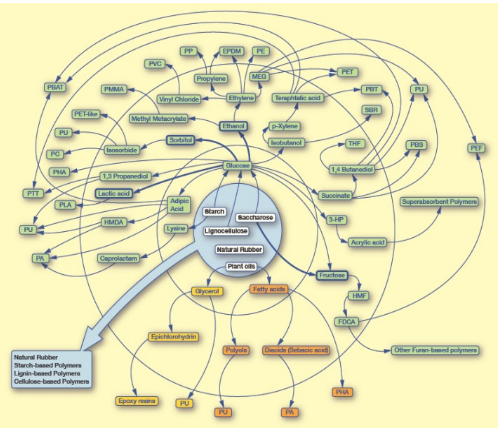
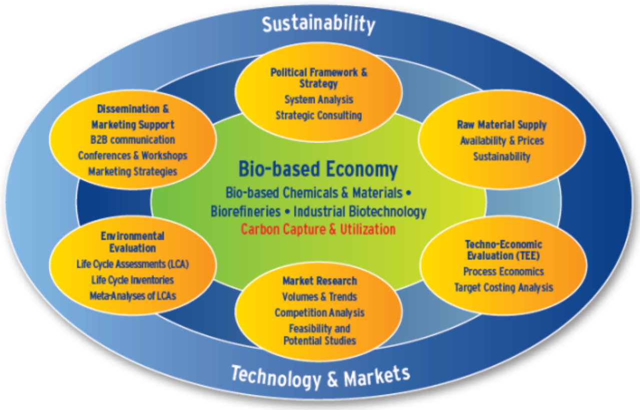
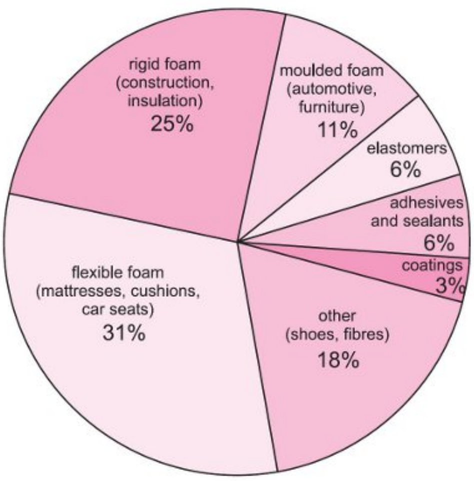
applications ranging from thermoplastic elastomers and pressure-sensitive adhesives to blend compatibilizers. To facilitate their adoption, renewable BPs must be affordable, durable, processable, versatile, and reasonably benign. Their desirability further depends on the relative sustainability of the renewable resources and the methods employed in the monomer and polymer syntheses. Various strategies allow these BPs' characteristics to be tuned and enhanced for commercial applications, and many of these techniques also can be applied to manipulate the wide-ranging mechanical and thermal properties of biobased and self-assembling block polymers. From feedstock to application, this review article highlights promising renewable BPs, plus their material and assembly properties, in support of de novo design strategies that could revolutionize material sustainability.





6.2.10. BC 53 Functional Molecule Production



The polymeric materials known as polyurethanes form a family of polymers which are essentially different from most other plastics in that there is no urethane monomer and the polymer is almost invariably created during the manufacture of a particular object. Specific polyurethane products with limited shelf life are produced at or near customer's site or post-treated. (These different strategies have to be considered.) Several technologies are in consideration usage of polyurethane typically in discrete products.

There is a fundamental difference between the manufacture of most polyurethanes and the manufacture of many other plastics. Polymers such as poly(ethene) and poly(propene) are produced in chemical plants and sold as granules, powders or

films. Products are subsequently made from them by heating the polymer, shaping it under pressure and cooling it. The properties of such end-products are almost completely dependent on those of the original polymer.
Polyurethanes, are usually made directly into the final product. Much of the polyurethanes produced are in the form of large blocks of foam, which are cut up for use in cushions, or for thermal insulation. The chemical reaction can also take place in moulds, leading to, for example, a car bumper, a computer casing or a building panel. It may occur as the liquid reactants are sprayed onto a building surface or coated on a fabric.

6.2.11. BC 54 Remote Chemical Production

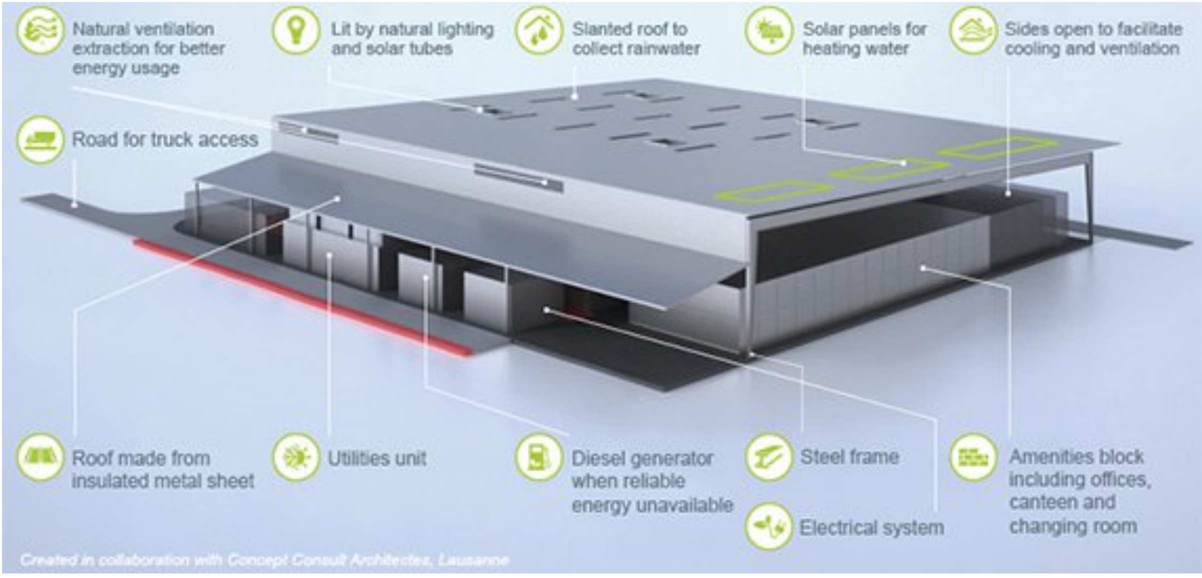
The Business Case concerns the implementation of a decentralised on-site production of process chemicals using (renewable) electricity, e.g. hydrogen peroxide, ammonia, chlorine. Distributed and local conversion of biomass to intermediate products that can be transported stored and traded, in self-contained modules. Several routes exist towards different intermediates: e.g. torrefaction to char, pyrolysis to oil, gasification to syngas and further to chemicals. Remote Chemical Production converts biomass to intermediate products that can be transported, stored and traded in self-contained modules locally in remote areas. It employs higher levels of automation within chemical production plants with in consequence a significantly reduction of the OPEX. Remote-control systems reduce the need for (often highly skilled) personnel at every production location. Especially in the case of distributed small-scale production it can offset the negative effects of economies of scale.

A good example of such a case is that of AkzoNobel11 where small-scale chlorine production units are operated on the end-user's site from a central unit using remote-control systems. By implementing sensors and making production more intelligent, more insight in production and the condition of assets will result in more efficient and robust production. Sensor information can be used for condition based maintenance, which will prevent downtime and reduce maintenance cost, because problems will be reported at an earlier stage. It may also reduce the need for e.g. spare parts. When ICT is implemented across the value chain, supply chain management will enable better and faster reaction on changes in demand. This will reduce the need for high levels of product stock.

6.2.12. BC 94 Nestlé flexible modular factory

Nestlé has created a blueprint for a flexible modular factory, that can be built in half the time (<12 months) of a traditional factory, and at 50-60% of the cost. It enables Nestlé to rapidly create a foothold in countries in Africa and Asia, getting closer to their customers and raw material sources. The factory is made of ready-to-use elements that can be assembled on site. If needed, the factory can be moved or expanded. The factory will fulfil relatively simple processes like mixing dry goods, e.g. Maggi bouillon cubes.

The modular factory will be made of multiple, easy-to assemble component sections designed to offer a highly flexible, simple and cost-effective solution for creating production sites in the developing world. Often, investing in these countries can be high-risk, as they can lack infrastructure, reliable energy sources and building expertise but the modular factory concept will enable Nestlé to rapidly establish a footprint, creating local jobs and being closer to its customers and its raw materials.



The average Nestlé factory takes between 18 and 24 months while the new modular factory could be complete, and up and running, in less than 12 months, at 40% of the costs. The design is a further development of Nestlé's current 'box-in-a-box' concept already used in countries with challenging conditions. In these, an existing structure – such as a warehouse – is used as a shell structure and a simple factory built inside. The modular factory takes this a step further, using a series of purpose-built factory sections which can be brought, ready-to-use, directly to the site and connected to each other according to requirements. These could include, for example, a ready-to-use generator and boiler, a staff canteen and changing rooms for factory employees. The factory can then be expanded, moved or its function transformed without having to start from scratch. The modular factory concept is designed to industrialise simple processes like repacking and mixing dry goods such as Maggi bouillon cubes, rather than creating more complex products. *(source Nestlé flexible modular factory http://www.nestle.com/media/newsandfeatures/modular-factories)*

6.2.13. BC 95 Pfizer transportable plant

The business needs of the pharmaceutical industry are evolving. Over the past five years, breakthrough therapies for oncology and rare and orphan diseases have placed increased pressure on drugmakers to accelerate product development while reducing development costs. Meanwhile, with the rise of precision medicine, pharmaceutical manufacturers are now expected to quickly produce a wide variety of products at significantly lower volumes.

Pfizer, together with partners, developed a concept for Portable Continuous Miniature and Modular Manufacturing. In the concept, formulation is done in a moveable cleanroom that can be transported to customer sites. Active ingredients will still be produced in the US, to minimize technology transfer. The concept should result in a shorter time to market, more responsiveness to customer demand (6-8 months from order), operational flexibility (multiple products and scales) and lower upfront investments and operational costs.

New drivers are pushing many pharmaceutical companies to look beyond traditional batch manufacturing processes and begin experimenting with a variety of continuous and flexible manufacturing techniques. Pfizer is no exception. The pharmaceutical giant first began leveraging continuous manufacturing for select products in the 2008-2012 timeframe. However, recently, the company's focus has been on adding even more speed and flexibility into the continuous manufacturing concept. The result is what Pfizer calls Portable, Continuous, Miniature, and Modular (PCMM) Development and Manufacturing.

With PCMM manufacturing, Pfizer partners produce prefabricated pharmaceutical components of a pharmaceutical continuous manufacturing line (e.g. processing equipment, control systems, cleanrooms) that are produced as separate modules and shipped to a central warehouse facility for quick assembly. For its initial PCMM manufacturing pilot, Pfizer had prefabricated PODs produced in Belgium and Texas respectively. The company then had these units shipped to its Groton, CT, warehouse for assembly and operation. Videos illustrating the general POD concept can be viewed here. At first blush, Pfizer's PCMM initiative may sound a lot like other modular or flexible manufacturing approaches in play throughout the industry. However, there are a few key characteristics that differentiate Pfizer's PCMM approach from other modular manufacturing techniques. *(source Presentation of Michael K. O'Brien, Ph.D. at IS Biotech Flexible Facilities & Systems, Rosslyn, Virginia March 14, 2013)*

7. Conclusion

The aim of this first deliverable is the provision of Business Cases which will serve to analyse the current European networks (a collection of interrelated value chain partners such as raw material providers, manufacturers, logistics providers, clients, etc.), identify current practices of delocalization, opportunities for and barriers against flexibility/delocalization as well as current practices for joint resource management and industrial symbiosis.

The selection process has been performed in an iterative approach resulting in 24 selected cases categorized in horizontal case studies focusing on resource optimisation and vertical case studies looking at the interconnection between processing industries and discrete manufacturing industries. As a result of a more in depth presentation of some of these Business Cases it became clear most cases can be categorized into certain archetypes (resources, derived value chains, …). Also many business cases contain both horizontal and vertical aspects.

The list of presented Business Cases has not to be considered as a final selection but is subject of modifications and can be adapted based on progressing insight in Business model and Supply Chain reconfigurations in the Process and Manufacturing Industry. It allows us to adapt the list of cases based on findings along the in-depth analysis making a final selection for the Business Cases at a later stage in WP 1. This approach guarantees to select appropriate business models that can lead to an industry with less stock, less waste, and less transportation through networked manufacturing value chains from resource optimisation towards more flexible demand driven supply chains.

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Annexe 1: List of Business Cases

			Criteria										
N°	Business Cases used to evaluate	BM archetype	Technology driven	Impact on Supply Chain	Impact on Business Model	Delocation relevance	Discrete manufacturing linked with Process industry	Customisation	Flexibility relevance	Sustainability relevance	Potential to upscale, replicability	Spire relevance	TOT SCORE
1	**TabaChem**	leasing	1	3	4	2	2	2	4	5	5	5	**33**
2	**Neodymium Recovery**	resources	3	5	5	5	3	4	2	5	4	5	**41**
3	**Enhanced Phosphate recovery from wastewater**	resources	4	5	5	5	1	2	1	5	4	3	**35**
4	**Al recycling via collaborative supply chain**	resources	1	5	4	3	5	2	4	5	5	5	**39**
5	**Steel2 Chemic**	waste valorisation	4	4	4	3	1	2	2	5	5	4	**34**
6	**Polymers from renewable resources - NatureWorks**	resources	4	3	2	4	2	2	2	4	3	2	**28**

7	**Cradle to Cradle Paper Industry**	resources	2	3	4	3	2	2	2	4	4	2	**28**
8	**Local textile-clothing production Trigema**	Local production	2	3	3	5	3	2	2	4	4	3	**31**
9	**HTC Mechanical Cleaning Technology**	resources	3	1	1	1	2	2	3	4	4	2	**23**
10	**Plastic waste recycling Van Werven**	resources	3	3	4	3	2	2	2	4	4	2	**29**
11	**Toyota Material Handling - Forklift Rental Solution**	leasing	2	2	3	3	1	3	3	3	3	2	**25**
12	**Packaging reduction through dispensing machines**	resources	2	2	3	2	2	2	2	4	4	1	**24**
13	**Re-use waste materials at Van Gansewinkel**	resources	3	3	3	4	1	1	4	4	3	3	**29**
14	**Data Analytics and New Models for the Agriculture Industry in Europe**	Introduction technology	4	3	?	3	1	5	4	2	5	2	**29**
15	**Urban Mining -**	resources	5	4	4	3	4	2	3	5	4	4	**38**

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	ADIR											
16	**Energy and resource management systems**	process optimization	2	2	5	4	2,5	2,5	4	3	4	4	**33**
17	**Circular economy - FISSAC**	resources	3	4	4	4	3	2	3	4	4	4	**35**
18	**MOBILE FLIP Mobile and Flexible Industrial Processing of Biomass**	resources	3	4	3	4	3	2	4	4	4	4	**35**
19	**PRINTCR3DIT Process Intensification through Adaptable Catalytic Reactors made by 3D Printing**	process optimization	5	4	4	4	3	4	5	4	4	5	**42**
20	**REE4EU Integrated high temperature electrolysis (HTE) and Ion Liquid Extraction (ILE)**	resources	5	5	4	4	4	4	2	4	4	5	**41**
21	**Circular economy**	resources	3	4	4	4	3	2	3	4	4	4	**35**

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	RESYNTEX											
23	**Terra**	resources	3	3	4	4	2	3	2	3	4	4	**32**
24	**leather/ fabric functionalization for product customization**	introduction of technology	4	4	4	4	5	5	4	3	5	3	**41**
25	**vegetable tanning for sustainability**	Introduction of tecnologies	3	4	4	4	3	2	3	4	4	4	**35**
26	**Steel2machine**	customization	4	4	5	2	5	5	5	3	5	5	**43**
27	**Flexible manufacturing 4 customized shoes**	process optimization	4	4	4	4	3	5	4	2	4	3	**37**
28	**LCA for sustainability assessment in value chain**	LCA	4	5	3	3	5	1	4	5	4	4	**38**
29	**Future of Drug Delivery -- Implantable Drug Delivery Device**	technology/process change	5	4	5	4	3	5	5	5	4	4	**44**
30	**Rapid/Additive Manufacturing -- Impact of 3D Printing Technologies on**	process optimization	5	3	4	4	3	5	5	4	4	3	**40**

	Flexibility and Environment												
31	**Metals and Minerals Industry Prospects for Sustainability**	resources/SC redesign	4	4	4	4	3	2	4	5	5	4	**39**
32	**Electric motors in automotive industry as tools for lower emission industries**	technology/SC redesign	5	4	4	4	4	5	4	4	4	4	**42**
33	**Liquid nitrogen in the refrigerated supply chain**	technology/process change	4	5	4	2	4	1	4	4	3	4	**35**
38	**F³**	modular plants	3	5	4	3	4	1	4	4	3	4	**35**
39	**Logicon**	collaboration	4	5	4	2	4	1	4	4	3	4	**35**
40	**Smart Delta Resource SDR**	collaboration	4	5	4	2	4	1	4	4	3	4	**35**
41	**CoPro**	collaboration	4	5	4	2	4	1	4	4	3	4	**35**
51	**Green Hydrogen**	(green) Drop-In	5	5	4	4	5	5	4	4	5	4	**45**
52	**Polymer Building-Blocks**	(green) Drop-In	5	4	4	5	3	2	5	4	4	5	**41**

53	**Functional Molecule Production**	customisation	5	5	5	5	4	4	5	3	3	5	**44**
54	**Remote Chemical Production**	flex production	5	4	5	5	2	3	5	4	3	5	**41**
55	**Local and Hazardous**	safety	5	3	3	5	1	1	4	4	3	5	**34**
56	**Waste2Aromatics**	waste valorisation	5	4	4	4	2	3	4	5	4	5	**40**
57	**Avantium PEF bottles**	waste valorisation	5	4	4	2	3	1	3	4	4	5	**35**
58	**Personalized FMCG**	customisation	3	5	5	5	3	5	5	2	4	4	**41**
59	**Customized Paint**	customisation	3	5	5	5	3	5	5	2	4	4	**41**
60	**Beaulieu recyclable carpets**	resources	5	4	4	1	3	1	1	5	4	5	**33**
61	**3D Pastaprinting**	customisation	5	5	5	5	5	5	5	3	4	3	**45**
62	**Waste to Wax**	waste valorisation	5	4	4	1	1	1	1	4	3	4	**28**
63	**Cyberpack**	waste valorisation	3	5	3	2	5	3	3	5	3	5	**37**
66	**Envac Optibag**	waste valorisation	5	2	5	5	1	1	5	5	4	3	**36**
67	**BMW electric car**	new products	4	4	4	2	5	5	5	5	3	5	**42**
69	**Waste Producer Exchange**	waste valorisation	1	5	5	5	1	1	5	5	5	3	**36**

86	**SafeChem**	Recycling	5	5	5	5	3	3	5	5	5	5	**46**
87	**WornAgain**	waste valorisation	3	4	4	4	5	3	3	4	3	3	**36**
90	**Veolia**	waste valorisation	5	3	4	4	3	3	3	5	3	5	**38**
92	**OCE: from selling printers to printing as a service**	leasing	2	3	4	1	3	1	3	3	4	2	**26**
93	**Akzo chlorine production at customer location**	local production	2	3	3	3	1	2	3	3	3	3	**26**
94	**Nestlé flexible modular factory**	modular production	4	3	3	5	5	1	5	3	4	4	**37**
95	**Pfizer transportable plant**	modular production	4	3	4	3	5	4	5	2	4	4	**38**
96	**Youbar: create your perfect protein bar**	customization	3	2	2	1	1	4	3	1	3	3	**23**
97	**Customized personal care by OnlyYours**	customization	2	2	2	1	3	3	1	1	3	1	**19**
99	**Nike customized shoes**	customization	3	3	2	1	1	4	3	1	3	3	**24**
100	**Jaguar Land Rover flexible production facility**	Flexible production	4	3	3	1	3	1	3	1	3	3	**25**

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101	**High value cake manufacturing**	customization	2	1	1	1	1	1	1	1	3	1	**13**
102	**"Spool to spool" processing tool for printable electronics**	flexible production	5	3	3	1	3	4	5	1	4	4	**33**
103	**Enhanced tool functionality to streamline component manufacturing**	customization	5	3	3	1	1	4	3	2	4	3	**29**
104	**Single use bioreactors**	increased asset utilization	5	5	5	5	3	4	4	3	4	3	**41**
106	**Advanced process control (apc) for continuous processing**	customization	5	4	4	3	3	5	3	4	5	3	**39**
108	**Chemical leasing for metal cleaning**	leasing	4	4	5	4	5	3	2	4	4	5	**40**