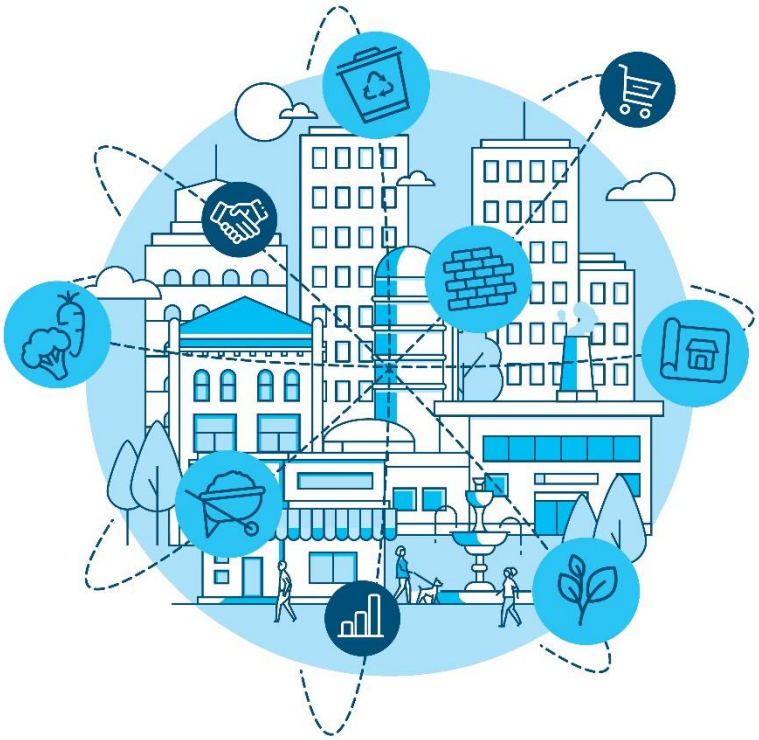
# Business Cases for Circular Construction & Demolition Projects

Danish Association of Construction Clients



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| Abstract | To support the economic viability of the circular economy demonstration actions in CityLoops project, this generic description of a business case model and generic description of execution with a marketing plan has been developed. Based on this model project-specific business cases will be developed to promote reuse, recycling, and revalorisation of CDW. The business cases will take into consideration the 'product' (secondary construction material quality, quantity, technical and environmental properties), an analysis of market possibilities (risk management, stakeholder involvement, cost-benefit analysis), incentives to support demand (procurement procedures), and an economic assessment (using lifecycle cost or total cost of ownership). |
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| License |  <br> |

# Contents

# Introduction

The purpose of CityLoops is to demonstrate and improve circular economy as a new concept in the construction sector by sending construction demolition waste and excavated soil into loops as reused products and materials or as high-valued recycled aggregates. Seven European cities are developing tools and implementing circular economy by using these tools in demonstration projects related to public buildings and infrastructure. As the concept implies, economy is an essential component in a new circular market. It includes three issues: (1) market understanding – which components and mechanisms influence the interactions in the market from material or product to consumer or procurer, (2) business cases – what are the possibilities for building commercial business with more than one profitable bottom line (economy), and finally (3) marketing/ sale – how are the materials and products introduced and implemented as components in new facilities as substitutes for conventionally manufactured materials and products based on virgin resources.

This document includes an introduction to all three elements and is addressed to local authorities that might have new roles in market transformation regarding waste management, professional clients (public as well as private) and their procurers, consultants which support decision makers, demolition companies – as potential new suppliers on the circular market, wholesalers and contractors who may buy and sell these building materials and manage market barriers and risk in the value chain – and finally end users, which are to accept reused or recycled products and materials in the spaces they occupy. Furthermore, the content of this document also is addressed to political decision makers who might be responsible for interventions in the market transformation in return for achieving economic, environmental, and social benefits for society.

# Public & private market relations

As sustainability is key here, the business cases in CityLoops include all these stakeholders and actors in a combination of private supply and public or private demand and acceptance. To address this, a *society-market-business-case-model* has been developed (fig. 8, p. 17). The model includes the main elements of sustainable business cases to satisfy the combination of commercial market interests, common social interest and the customers/ clients/ end user needs and interests.

The model – and the accompanying templates – can be used for two purposes: either to compose and structure a new business case from the bottom (including tendering or procurement criteria), or to evaluate a business case which has been created by unstructured circumstances – both situations are represented within CityLoops demonstration projects (Annex 1). The business case model and templates (Annex 2 and 3) are tools for the demonstration / project managers who are to gather the threads and ensure that all important aspects are handled through

the planning, tendering and execution phase of the projects, and that the results meet the expectations of the involved parties economically, environmentally, and socially.

# Business case analysis

Two templates are annexed to this document: One for analysing the economic business case for the supplier and one for analysing the triple, capitalized business case for the customer, procurer, or client. In some of CityLoops demonstration projects, the clients are public (e.g. municipal government) or semi-public (e.g. publicly-owned waste management company with both commercial and societal interests). In these cases, both templates can be useful for the demonstration managers to illustrate the benefits and/ or costs of using specific materials or products based on secondary versus new resources – for decision makers, use of these templates is recommended both for pre-analysis and later evaluation of the business cases.

By understanding the market mechanism and possibilities to influence it, and by using the methodology in the business case model and the templates for analysis, this report will support project managers to adjust the ongoing CityLoops demonstration projects, and to better plan the replication and upscaling of similar projects in the future.

# Business case model in a circular market

The transition from a linear to a circular economy is challenged in that the structures of the market and its actors must adapt to a new reality. The challenges lie in defining new market roles, identifying and eliminating uncertainties and risks, calculating and determining new price structures, and redefining material flows and distribution channels. This does not occur by itself but requires the dissemination of knowledge and the introduction of various regulations.

The conventional linear market is based on the philosophy of supply and demand and a notion of economic growth, based on an unlimited amount of and access to resources. The easier access to virgin raw materials and the lower the extraction and production costs, the more competitive prices can be. Due to a fine-mesh system, the distribution costs are relatively low and will typically play a limited role in pricing. Simplified, the value of a material will correspond to the market's perception of a competitive price - and to a lesser extent, depending on quality and initial costs. If a material can be extracted, manufactured, and disposed of without regulation - e.g. in the form of environmental and waste taxes which reflect the negative effects on the environment during the process - the value of the material and thus price will simultaneously hide the real social and environmental costs.

The circular economy is similarly based on supply and demand and access to resources, but in this model the growth will to a greater extent be based on the notion that many of the natural resources are limited (or must be limited due to imbalance between population growth and resource consumption), and that the market economy is therefore replaced by a “closing-the-loop model”, in which the life cycle of materials and products is extended, primarily through a more environmentally friendly design that makes it easier to repair, reuse, recycle and manufacture old products, durability is improved, better waste management preserves the materials in one or more loops, and new business models emerge based on leasing, sharing, repair and reuse. An important part of the transition from linear economy to circular economy is thus to ensure that there is a decoupling between economic growth and the production of waste.

## Economic and benefit factors

To begin, the basic factors affecting price formation in a circular market are considered.

| ECONOMIC FACTORS | |
|---|---|
| CAPACITY | CDW PROCESSED ANNUALLY (IN TONS) |
| REVENUES | ENTRY PRICE (PER TON) |
| | EXIT PRICE OF HIGH-VALUE RECYCLED AGGREGATES (PER TON) |
| COSTS | OPERATING AND MAINTENANCE COST (PER YEAR) |
| | LABOR COST (PER YEAR) |
| | CERTIFICATION COST (PER YEAR) |
| INVESTMENT | INITIAL INVESTMENT IN EQUIPMENT, BUILDINGS AND LAND |
| | |
| RETURN ON INVESTMENT (PER YEAR) | |

*Fig. 1: How to measure the value of a CDW recycling business*

The capacity of - and the access to - CDW is a crucial starting factor (fig. 1), but at the same time a challenge in a limited supply if the materials in question can be replaced by competitive (and hitherto unlimited) offer of virgin materials. The final price per ton of CDW will thus have to be compared with the price of the virgin material(s) to be replaced by the CDW and the transformation costs (which may in some cases be affected by smaller scale industrial processes), while the fluctuations in investment costs in equipment, buildings and areas probably will be lower between CDW and new materials. The final price factor (market price) is then determined by costs plus expected return on the investment made, and thus the business case.

As mentioned above, in a transition from a linear to a circular economy, there will be a need to focus on regulating the market. This can be done by means of various regulators (see fig. 3 and 4) whose intention may be to reflect the real costs (internalization of externalities) or to promote the conversion of the market through “artificial” incentives until the market will regulate itself. This mechanism cannot be implemented by the individual market actor but requires central political action.

On the other hand, in the transition phase, individual market actors can influence interest and non-economic incentives by increasing the number of projects involving the circular economy, by increasing the reuse or recycling of materials, by eliminating or sharing uncertainties and risks and by (collectively) branding the benefits of using and reusing resources. In principle, these efforts will be self-reinforcing and thus lead to increased supply and demand in the market.

At the same time, considering the above-mentioned pricing model, market players - especially suppliers in the value chain - can actively contribute to increasing demand by reducing transformation costs, such as the costs that arise from demolishing (equivalent to extracting) and transforming waste into new resources in different contexts (see fig. 2), so that the market value (final price) can become competitive in relation to virgin materials / products.

At a more general level, there is also a socio-economic effect in reusing / recycling local materials, which can create a greater self-sufficiency and local market resilience, as independence from world market prices and global access to resources, which does not diminish with population growth and consequent increased resource pull.

# Value creation (market drivers)

To understand the mechanisms of the market, one must look at which elements or activities create value and contribute to driving the market in a circular direction, where the main aim is *to save resources (materials) and to reduce waste*.

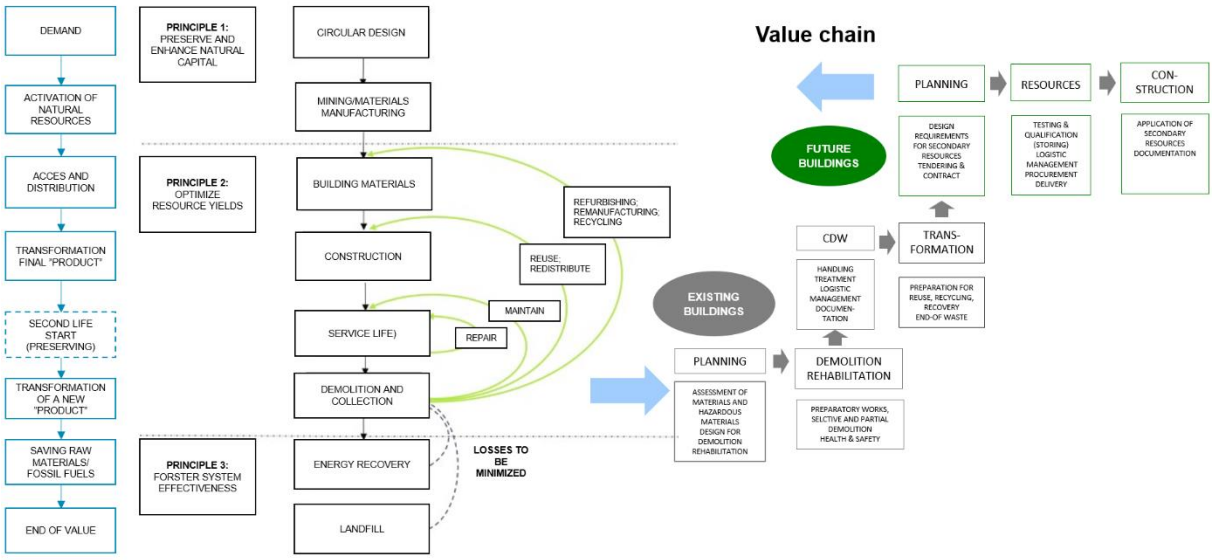



*Fig. 2: From left to right – Value creation capitalized through market driver activities to be realized through value chain activities*

The first column in the figure shows the elements or activities that create value without regard to costs, and as such form the basis for the value creation that accumulates in the value chain shown in the last columns.

The principles and activities shown in the second and fourth columns represent the link between the value creation and the value chain, and become the *market drivers*, which realize the value. If value creation is to remain intact throughout the value chain, there must first be a conscious design strategy that allows for later disassembly (selective demolition) of buildings with the least possible loss of value, and at the same time pay special attention to the *transformation costs* of (new) levels of reuse / recycling - such as where existing materials can be

included in repair work, reused in a new construction (such as brick) or recycled into a building material with secondary content (such as concrete).

# Value chain

In relation to the circular value chain (on the right-hand side of fig. 3), there are three significant changes in relation to the linear value chain:

First, start with resource mapping and demolition planning to get an overview of what materials may be available in the event of renovation or new construction, so that sourcing of materials, design of the building, etc. takes into account available existing materials.

Second, all actors in the circular value chain must interact with each other and develop alternative revenue opportunities (business models) that are specifically linked to the circular economy. Unlike the linear value chain which operates with an expiration date of materials, materials in the circular value chain in principle return to the same link (actor).

Third, construction projects are planned, designed, and constructed based on new parameters for reuse and recycling during and after the life of the buildings.

Compared to the linear system in which demolition typically goes from one cost link, the demolition in the circular value chain will be diffused through multiple links of costs and revenue opportunities. Demolitions will thus be strategically crucial for the start-up of value creation in new sub-value chains, as they release secondary materials to be re-introduced.

# Price markers

Looking at the circular economy in relation to the free market, it is natural to compare the price markers for virgin versus recycled/ recyclable materials/ products, and to look at how regulatory factors could influence market behaviour and thus price formation. Price markers represent the elements – mostly costs – in the price formation that are more or less dictated by the providers themselves, and therefore elements that they can minimize / optimize and adjust in a free market position.

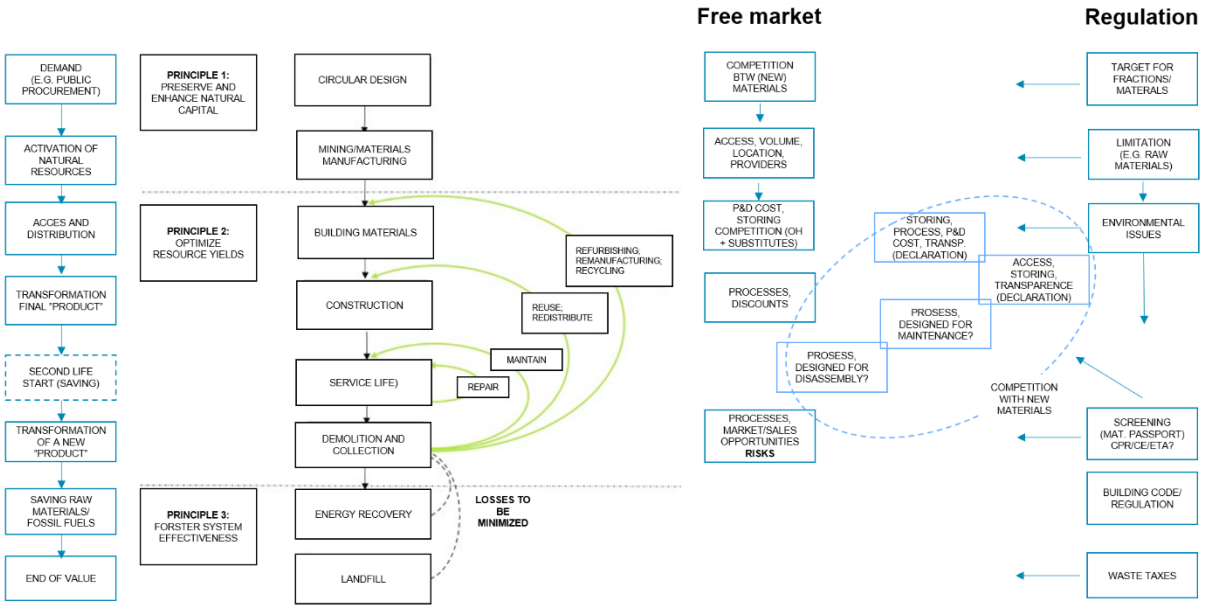



*Fig. 3: Price markers for virgin and reused/ recycled materials /products and potential regulation factors. The markers/ costs related to the blue boxes in the fifth and sixth columns corresponds to the actions represented in third and fourth columns, while the regulation factors in the far right column represent what can affect the free market without influence from the providers.*

Basically, a client (as procurer) will often look at the budget - either based on construction costs or based on life cycle cost (LCC) where operation costs are included - and compare the prices of comparable materials / products on the market. Conventional (known / new) products will often be easier to sell due to experience with lifetimes and risks as well as delivery security, which is why this type of cost (in the free market column) can be lower for virgin than for secondary or reusable/ recyclable materials/ products, and become markers for a lower price.

To bring used materials back into the loop as 'new' resources, costs of transformation and preparation of these materials must be added and can affect the market price, making them less competitive. Thus, the transformation cost becomes an important price marker which must be handled by the supply chain.

If a building is designed with potential for disassembly and reuse/ recycling of materials/ components, the initial start-up costs and presumably the other transformation costs will be lower when these go into a new circuit, which will be an increased advantage in the competition with virgin materials/ products.

## Regulators

Instruments such as taxes and fees are well-known types of costs that are used to regulate (curb or promote) the free market, where the market does not by itself meet the political or societal goals. These could be, for example, regulation of over-consumption of non-renewable

resources and limitation of environmentally harmful effects and waste generation. Such regulators can also be a means to internalise externalities, and can be included in the pricing and thus ultimately influence competition in the direction most beneficial for society.

This means that if climate- and environment-damaging effects of extraction of certain virgin raw materials are not capitalized through taxes and thus not included as a cost, then the price will not reflect the real costs of providing the material / product. Conversely, if the recycling of secondary raw materials does not reflect (capitalized) positive effects when used as a substitution for virgin raw materials, then a market error arises in the competition between the two products from a sustainability point of view.

The market price can thus include business competition considerations, where streamlining of production or manufacturing process can be transformed into lower costs and a more competitive market price, but in a sustainable and circular market the requirement must be that all externalities are internalized and effects - positive as well as negative - are included, through regulation.

## Transparency

In addition to taxes and fees, transparency about materials/ products can be a price marker, so that the client has other parameters than the market price to trade on. The conscious procurer will request building product declarations, certificates, building and material passports and resource surveys (of existing buildings), so that they can compare materials/ products on an informed basis and make conscious choices in accordance with the organisation's values and strategies.

# Price influencers

In contrast to price markers, which are generally set by suppliers and/ or centrally by authorities through regulation, there are a number of *price influencers* (or incentives) which are also important for determining the market price of a material/ product. The most significant influencers are supply and demand as well as competition. In addition, there are a few other economic as well as non-economic influencers. Price influencers rely on the behaviour of purchasers and consumers and are thus commonly more variable and influential than price markers. The CityLoops cases are expected to focus on the user (demand) perspective, including the branding effect, the perceived residual value of materials and products before they enter the new loop, the influence from the perceived and managed risks, and savings that can influence the price in a free market. Fig. 4 includes the regulators as VAT and environmental charges that can also be expected to influence the market price - with lesser influence from the end user.

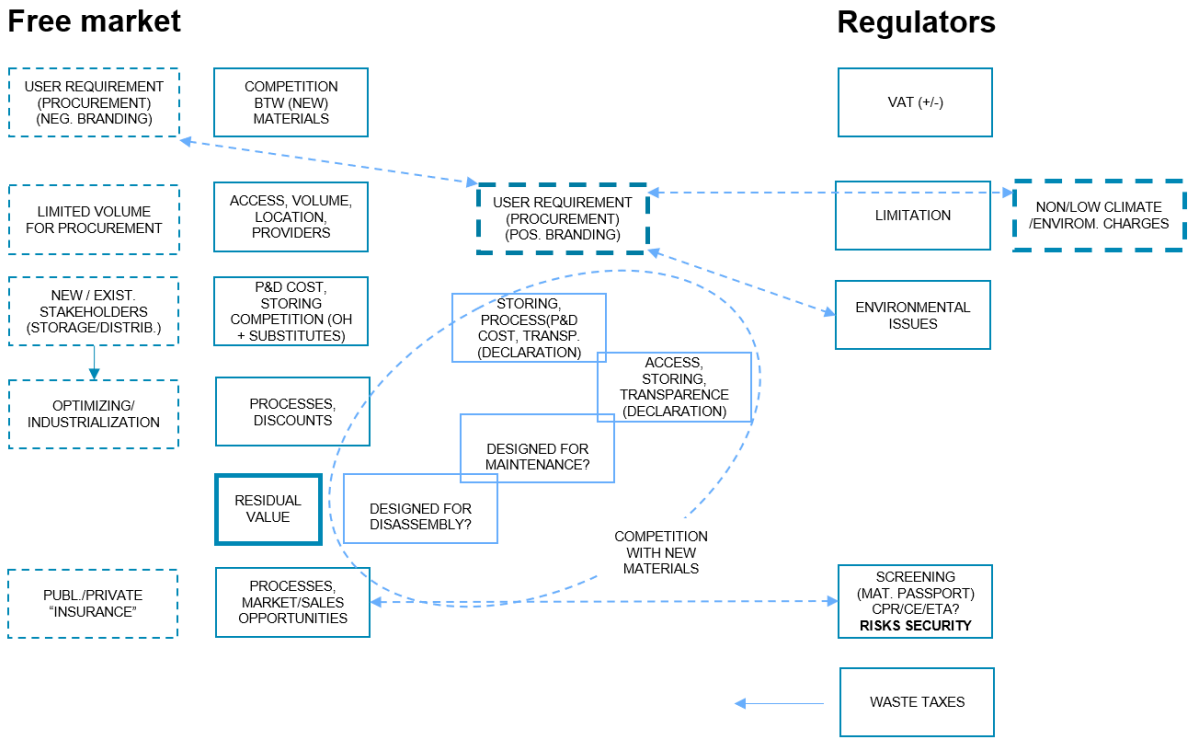



*Fig. 4: Price influencers for virgin and reused/ recycled materials/ products and potential regulation factors*

# Economic parameters

An example of an economic price influence (affected by the end purchasers and customer behaviour) is *risk*, which can typically be capitalized based on an assessment of the worst-case scenario, i.e. what will be the ultimate cost if a material/ product fails and must be wholly or partially replaced. A procurer or consumer can determine and decide on their own risk profile based on (transparent) risk parameters such as durability, disassembly, and repair possibilities and use this in the comparison between different options.

Another example could be *saved waste taxes*, external transportation, and handling costs, etc., if a client chooses to reuse or recycle CDW from a demolished building to a new building in their own portfolio. In addition, greater security is achieved in the risk profile and thus a potential financial benefit.

A third example could be a municipality that must provide services to citizens, and which consciously has a strategy of *saving taxpayer money* by preserving and developing its building portfolio, reusing/ recycling materials, etc. rather than demolishing, disposing of and building new buildings, and where it may affect the property value of the portfolio.

# Non-economic benefits

An example of a non-economic influencer is *branding*, whose value can be difficult to capitalize in conventional economic terms. If a company establishes itself in a building that has been built

or rebuilt with a high sustainability profile, and this is exposed, this may have a positive effect on opportunities for recruiting quality-conscious staff, positive publicity and thus marketing value - and in the long run greater marketability when selling of the premises, as the sustainability of society generally increases.

Similarly, a municipality with a conscious sustainability strategy can benefit from branding, for example, to attract conscious taxpayers by making proven purchasing decisions that reduce the $CO_2$ footprint, reduce harmful environmental effects, and thus solve a societal problem.

# Business case

The factors and parameters mentioned above will all influence supply and demand and thus the business case is created. The challenge then lies in transforming and implementing the parameters in the value chain. This requires a clear division of roles and risks, and regulation of market errors that impede fair competition, e.g. by internalizing externalities, to create transparent material flows, deliver security, and minimise or eliminate risks.

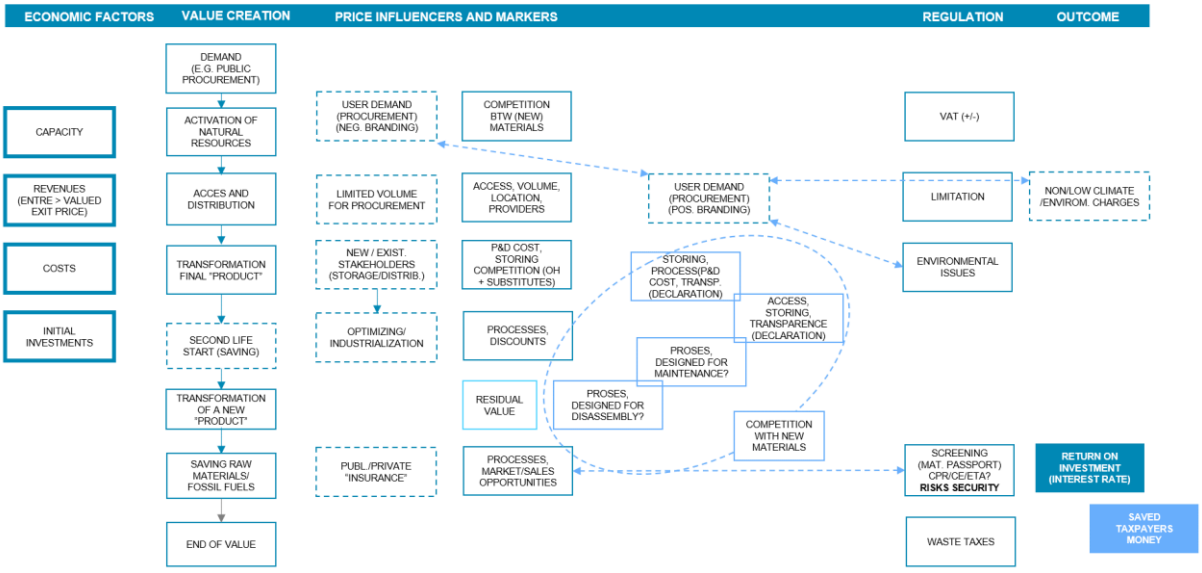



*Fig. 5: The business case occurs in combination of parameters related to new and reused/ recycled materials/ products and potential regulation factors in the business model (market model) – see also fig. 8*

As shown in fig. 1 and fig. 6, the overall economic parameters of the business case are defined by availability and access, the revenues between the purchase and sale of raw materials, less costs and added benefit of the investments.

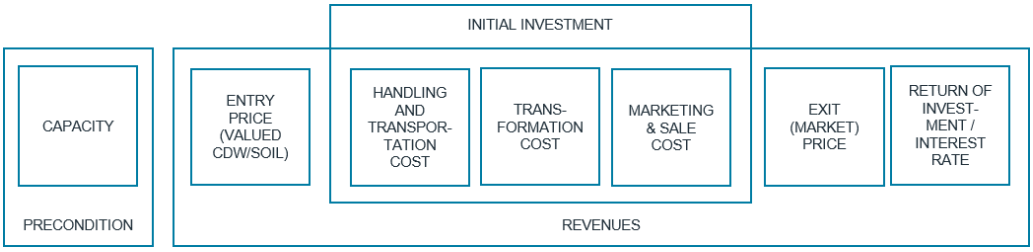



*Fig. 6: The basic market economy model*

As previously described, the starting point in the linear value chain is that the virgin raw material or resource capacity is unlimited, and the extraction (and disposal) will be regulated by market demand. In addition to the overall parameters, the price will also be determined by the market's supply, free competition, and customers' willingness to pay.

The circular economy is based on the premise that the virgin raw material or resource capacity is limited and therefore must be replaced in whole or in part by secondary resources for up to several loops. This presupposes that the secondary resources can compete with the virgin ones in terms of capacity, quality, and price, and that the market is able to supply on demand.

Having covered the market factors, the following sections fill explore factors which are more closely connected to the business cases. These factors will also be included in the analyses of the concrete business cases in the CityLoops demonstration projects (Annex 1).

# Transformation cost

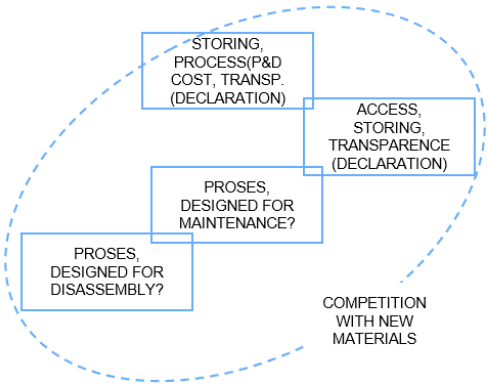



*Fig. 78: Actions for transforming materials into new applications*

The business case in the circular economy is based on the same overall economic parameters as the linear economy, but will be challenged on availability and transformation costs (the costs associated with converting secondary resources to new applications or aggregates – fig. 7). At least in the transition between the two market economies, the price will often be higher for secondary resources due to market conditions such as volume, access, less streamlined manufacturing costs and limited marketability. In addition, as stated in the value chain section, it will require strategic material handling, including delivery security, a well-defined new role and risk distribution, and a different interaction between the parties involved to define and build the circular business case.

**Example:**

A client needs 30,000 bricks of a suitable quality for a facade and demands used stones in the market. A supplier would like to deliver, has the manufacturing setup for receiving stones from demolition, cleaning methods, sorting, stacking, and palletizing ready for delivery. The first challenge is to match the two parties, e.g. through a (digital) marketplace. The next challenge is to define a price which matches both the client's expectations of a competitive price level, and the supplier's expectations of acceptable profit. The client must consider if they are willing to pay more for the used bricks than the market price for new bricks and be willing to take some risk buying a product which may have less reliable certification. For this case, it is assumed that the used bricks seem to be in good quality and declared free of harmful substances by plug samples, and thus are comparable with the new bricks. The supplier has control of their supply chain and business case that requires an end price approximately 15% higher

than comparable products to reach the expected return of investment. *Will these two opposite interests be able to meet in the future market? What are the options for minimising the gap between the two parties?*

## Declaration requirements

The capacity challenge can be partly solved by introducing regulation of allowable resource consumption, but declaration requirements can also encourage conscientious consumers to take this into account and be an incentive for a procurer to explore the market for secondary resources before decisions are made on the use of virgin raw materials. At the same time, this creates an incentive for an increased demand for secondary resources, which can attract a greater supply and thus a greater utilization of the capacity that it is possible to create for the market. The greater the supply of secondary resources, the more competition will be possible.

## Market influences

As previously mentioned, branding is a possible influence on how the price is created in the market. By capitalizing branding - either in economic, environmental, or social terms - a potential opportunity for a higher value consideration and sale at a higher price is achieved. The branding narrative will typically depend on how the provision of a material or product affects the environment or the climate. Similarly, the determination of charges against resource constraints and negative environmental impacts will potentially affect the price and thus competition, provided that the supplier expects an unchanged return on investments.

## Market response to risks

A significant factor for the procurer is whether they assume a (increased) risk by purchasing secondary resources. *Is sufficient information provided on the content and capacity of the material or product? Does the CDW contain harmful substances, and can it be delivered at the building site at the right time before construction starts, and thus within design parameters?* The European market is still relatively immature in dealing with this, and work will continually have to be done to structurally resolve the risk factor.

## Building and materials passport

One of the ways to reduce the client's risks is by requiring environmental and resource mapping in connection with demolition or excavations and, in continuation of this, determining the content of the secondary resources in building and material passports together with declarations in resource flows and life cycle assessments (LCA). These methods create the necessary transparency and make it possible to compare advantages and disadvantages across virgin and secondary materials, including $CO_2$ footprints.

## The various actors

The development and perception of the business case also depends on whether the involved actors are commercial or non-commercial. Commercial actors will be focused on creating business through the value chain, while non-commercial actors such as public (state, regions, and municipalities) or social housing organisations will be focused on saving taxpayers' money, securing low rents, and possibly creating local jobs. The interests of the commercial players will thus be aimed at ensuring a high, albeit competitive, final price and profits, while the interests of the non-commercial players lie in ensuring as low a purchase price as possible and thus saving costs. These are elementally opposite interests, but at the same time the core of competition in pricing.

## The balanced business cases

Creating the circular market requires balancing these opposing interests. This means that the provider on the one hand must have sufficient (economic) benefits and thus an incentive to "extract" and provide the secondary resources in competition with virgin resources, and that the procurer (customer/client) on the other hand must have the incentive to choose and the willingness to pay for the secondary rather than virgin resources - even if there is a price difference to the detriment of the secondary. Until there is a regulated market for the circular economy, this balance will often have to be established through a negotiation between provider and procurer.

However, in a sustainable future there are other factors to be considered besides economy - often described as the triple bottom line. These considerations are included in the society-market-business-model below - fig. 8, and will be tested in the CityLoops demonstration projects.

## Procurer’s strategy

An effective incentive to demand secondary resources - provided sufficient quantity is available - is to define a procurement strategy. The strategy can set goals and frameworks and establish the principles and criteria for the procurement, considering social and environmental conditions, market stimuli, project budgets, etc., and thus how sustainable the procurement must be in both the short and long term.

The private procurer is free to decide principles and criteria in their strategy, while a public procurer will be connected to restrictions such as fair competition and equal treatment between providers and requirements to choose the economically most advantageous material/ product. While fairness and equality are relatively simple to deal with, the economic issue is often conversely relatively open to interpretation when all factors are considered.

## Provider's required response

Not all procurers/ clients have a clear procurement strategy and will be affected by the choice of material on the market. To meet the buyer's incentives, the provider must often analyse which “problem” the client needs to solve and in which context the problem must be solved to deliver products or materials - new and used - that at least correspond to the client's expectations.

**Example:**
A client requests a waste shed, but after a problem analysis, they instead expects a physical solution that cleans up a specific area and that can organise not just waste, but also act as a temporary storage place, a potential meeting place with an exchange centre, and a piece of architecture that creates visual value and atmosphere on the site. The provider who, through their analysis, can uncover the client's actual needs, and who will be able to provide the comprehensive solution at a competitive price, will often receive the order.

## From pilot demonstration to standard practice

In the transitional phase between linear and circular economy, it will be necessary to carry out a series of demonstration projects to test theories in practice and create a dialogue between market actors (see also CityLoops Task 2. 4 - Co-development of planning and decision-making guidelines). The aim of the demonstrations is to gain experience - good and bad - to define frameworks and conditions and thus conventions for a new circular market. The framework and conditions must include all the mechanisms defined above, as well as a certain agility in relation to regulating any market failures. In addition, the conditions must consider the internalisation of externalities and thus all positive and negative effects of extraction, production, transformation, transport, and disposal at the end of a material/ product’s service life.

# Society-market-business-case-model

The sustainable business case occurs when private economic and societal interests are not conflicting, and it is in the interaction between the parties involved that the circular market establishes itself and becomes viable.

Within academic research, various business case models for circular economy have been developed, including The triple layered business model canvas: A tool to design more sustainable business models (Alexandre Joyce; Raymond L. Paquin, 2016) ©. The ‘triple” refers to the three bottom lines (or dimensions); economic, social, and environmental in the UN report Our Common Future (Brundtland, Gro Harlem; et al, 1987).

In this context, a simpler model for building the business case has been developed. The model combines value creation (costs and revenues), resources, activities, stakeholders/ partners, customers, marketplaces, savings, and risks (fig. 5) with key elements of the economic value

chain (fig. 6), and main environmental, social and economic interests (fig. 8). The simple model does not include regulation factors (fig. 6), which must be changed and managed structurally.

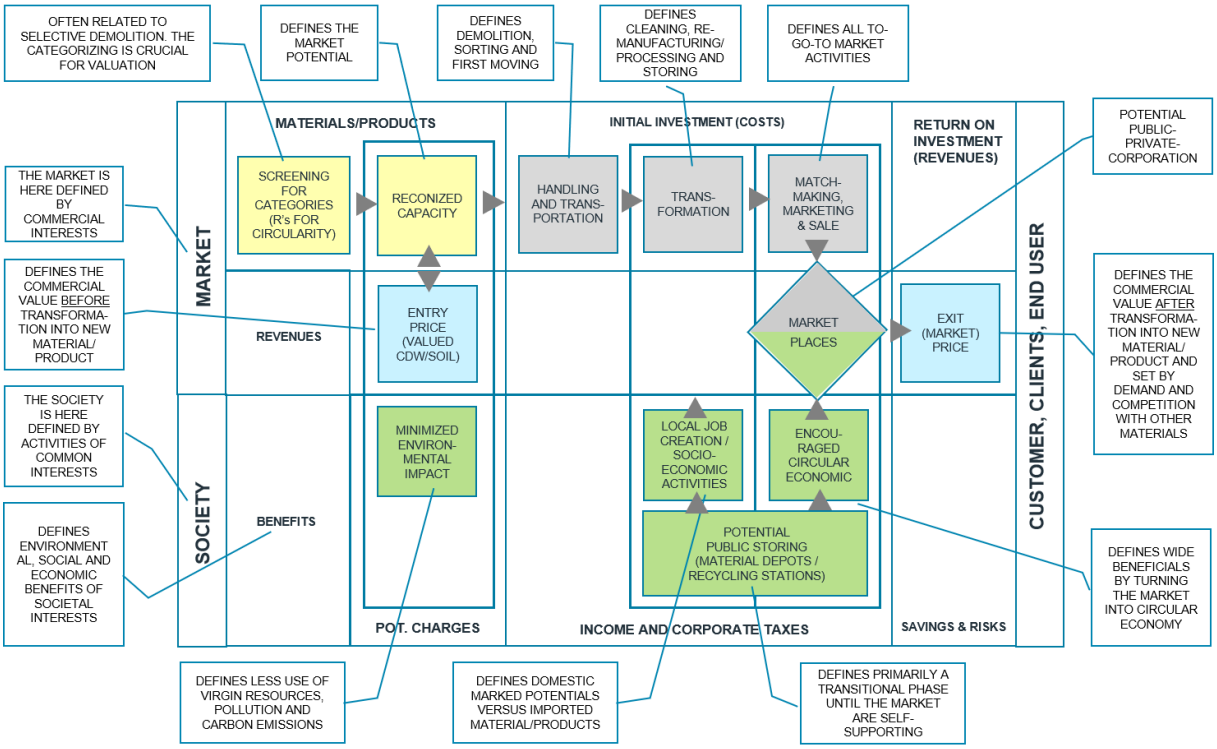



*Fig. 8: Society-market-business-case-model shows basically, which elements a sustainable business case must include to satisfy the combination of commercial market interests, common societal interest and the customers/ clients/end users' needs and interests. The yellow boxes represent the material/product capacity as a precondition for starting the value chain, and the blue boxes represent the start and the end of the value chain.*

# Precondition: Material/ product capacity

To start a business case – regardless of market conditions – there are two crucial preconditions that must be fulfilled; available materials/ products and capacity to meet the market demand. In the circular context, this basically means that there must be CDW or soil available for an open demand or a predefined customer/ client (procurer). The procurer will expect that the materials/ products are well-defined with regard to the waste hierarchy or classified after the R's for circularity; reuse, repair, refurbish, recycle etc. (refer to Circular Economy: Measuring Innovation in Product Chains Potting, J. et al, PBL, NL 2017). The precondition for this will be a *pre-demolition audit,* sampling (CDW and soil) and *selective demolition* (see CityLoops Tool Factsheets). If the materials/ products (secondary resources) only need to be handled and need no transformation, they can be declared market-ready at this early stage, e.g. in a material passport, otherwise this action takes place later after transformation activities.

## Entry price

The valuation of the material/ product starts with an *entry price* that could be defined by the demolition cost and the R-category for circularity or be compared with the entry price of a virgin material substitute. The entry price may be negative (as a cost) or positive (as a revenue). If the owner of the building or the soil which is generating the materials/ products has no expectation of economic benefits to compensate the demolition costs, the entry price can be zero. This will increase the opportunity for a more competitive exit price on the market. This situation can occur if the building owner wants to reuse the material in a new building in their own portfolio. If the materials are valued at zero as the entry price and will be used by a third party, it gives an opportunity for a revenue for the demolition company.

## Environmental impact

An important societal impact of circularisation of materials/ products is the reduced use of virgin resources. If the procurer of secondary materials/ products is a public client, it can be part of a local policy to increase “green procurement”, where the environmental impact is explicitly beneficial to society – perhaps in a combination with fiscal measures (reduced waste taxes to encourage circularity or increased charges to avoid use of virgin resources). With regard to private clients and developers, the local authorities might have a chance to encourage those to take environmental responsibility through district plans.

## Initial investments

To prepare the secondary resources (CDW/soil) for the market, the supply chain has to make an initial investment to carry the cost of *handling, transportation, transformation, declaration, storing, marketing, sale* and perhaps delivery to the end user. Until the circular market is established in full scale and comparable with the conventional market for new materials/products, a new or redefined supply and value chain must be developed – fig. 10. The encouragement of supply chain investors depends on the market capacity, the demands from procurers and end users, and whether it is an open market situation, or one based on predefined orders, meaning no flow-stops in the loop. Indefinite storage includes an economic risk which will affect the costs – and the exit price. To avoid this, matchmaking in an early phase can be an important effort.

The supply (and investor) chain can and will be defined by the circumstances in the market, and expectedly fragmented in the developing phase, for example as in scenario C below, where screening, demolition, first handling and transportation, transformation and sales activities can be divided between several actors. Each actor will be focused on one aspect to the detriment of the full chain and affect the cost level – and again the exit price. By gathering competences and tasks with fewer actors, as seen in scenario B below, will lead to less suboptimisation, easier risk handling and a more profitable business. The most sustainable business case will likely occur in the hands of one supplier (such as system supplier or turnkey contractor

as in scenario A below) which is focused on optimising the whole process and at the same time focused on getting the materials/ products on the market.

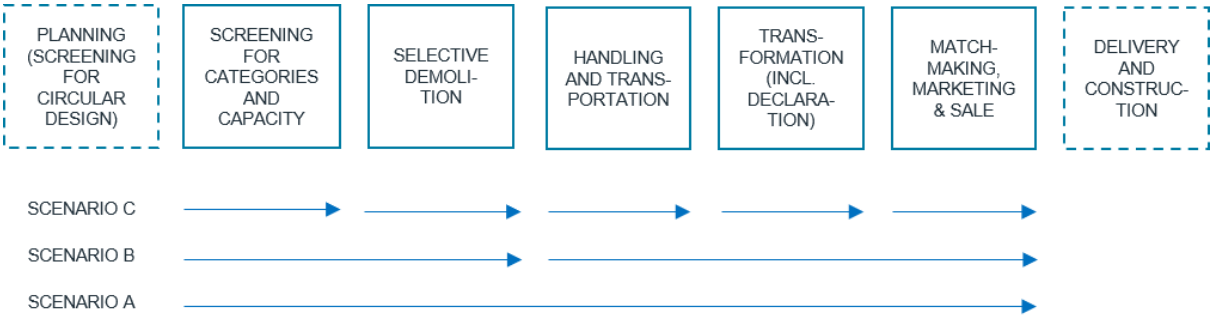



*Fig. 9: Three examples of investor scenarios in the supply chain. Each scenario will affect the valuation, market transparency, risk management, matchmaking, optimizing potentials and opportunities in public (society) and private (market) relations.*

# Societal benefits

A circular market of resources initiates local (domestic) activities especially in countries with few natural resources or production capacities – opposite to the market for virgin materials and products, which are more globally structured. Important issues, such as climate protection, and sustainable use of (virgin) resources as well as training citizens for the job market, are often a regional and community responsibility. To deal with these responsibilities – especially in a market transition phase – it can be beneficial to establish public-private-partnerships, including elements as illustrated in fig. 8.

Both society and private (market) actors have an interest in *creating jobs*, and new jobs mean new opportunities for economic activity, potential profit for businesses and a base for more income and corporate taxes, and can therefor encourage a circular local economy.

In communities where CDW and excavated soil is subject to national and/ or local regulation – and perhaps is somehow only partially liberalised – it can be beneficial for the public actor to support the market transition if it does not distort the market negatively. There are three (non-exclusive) particular ways to do this: by increasing the market through *procurement*, by co-establishing *marketplace(s)* as in fig. 10, and by supporting the establishment and operation of *storage facilities* such as waste stations, recycling centres and temporary storage facilities. These are familiar instruments, especially in P2C (producer to consumer)-relations, where costs often are financed by community taxes and substitute private facilities when they are not profitable, as in South Harbour Recycling Centre (Copenhagen, DK) – fig. 11. By including these mechanisms as the denominator in the equation, it can support the market by lower transition costs and potentially a lower exit price.

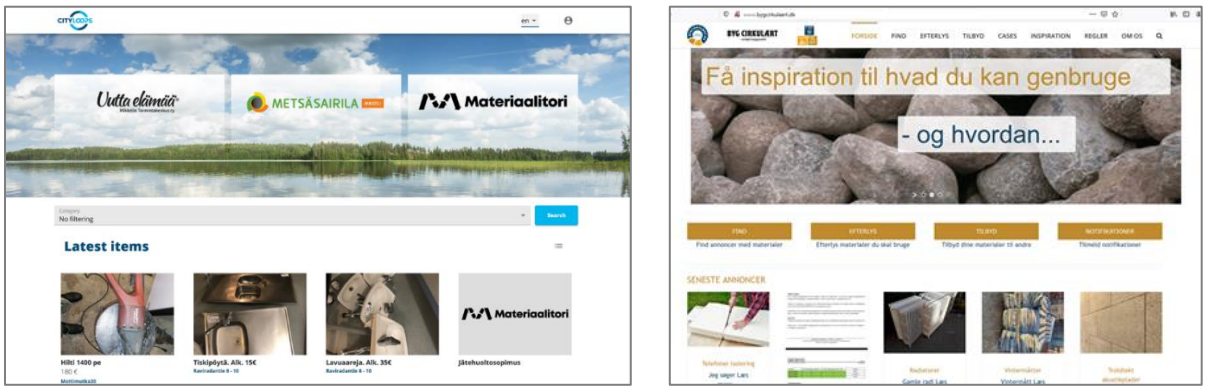



*Fig. 10: Two examples of digital marketplaces for CDW and soil – https://kiertoon.fi (left) developed by City of Mikkeli (FI) for the CityLoops project, and http://www.bygcirkulaert.dk/ (right) developed by a public-partner-corporation by the Municipality and Business Cluster of Gladsaxe (DK).*

*Fig. 11: South Harbour Recycling Centre in Copenhagen with a second-hand shop, test laboratory for teams of entrepreneurs to develop new products and circular business ideas and transform materials that would otherwise become waste into new products, and wholesale of large quantities of recycled materials to companies, individuals and organisations. Source: https://sydhavngenbrugscenter.kk.dk/*

# Savings and risks

The described business case model above merges private commercial interests with public environmental, social, and economic interests by promoting a circular market for CDW and soil, and at the same time saving resources such as virgin raw materials, subsidies for marginalised and vulnerable citizens, ethical use of taxpayer's money, and decreasing potential carbon pollution.

Regardless of which business case model is chosen, the circular market will include some risks (and barriers) for all involved actors. The risks can be related to both framework and market conditions, such as:

- Lack of updated regulation - on both EU and national level, including the Building Products Regulation (CDW considered as waste, not material/ product, so there are no CE/ETA labelling or quality standards/ certificates for the use of it), national Building Codes etc.

- Potential political acceptance of current unlimited access to virgin raw materials (and perhaps no economic regulation penalising excessive use of non-renewables)
- Lack of material or product capacity of the right quality at the right time (transparency and timing in the supply chain)
- Mismatch between supply and demand (limited customers, no sufficient incentives among potential procurers, long time storing etc.)
- No functioning marketplace(s)

These or any other risks or barriers should be reflected in tendering and contracting processes and require a clear definition of roles and responsibilities, but can in some cases also be solved in partnerships with shared risks. Until the circular market is fully developed and regulated both legally and politically, the market actors must take some enlightened chances and collaborate to find suitable solutions.

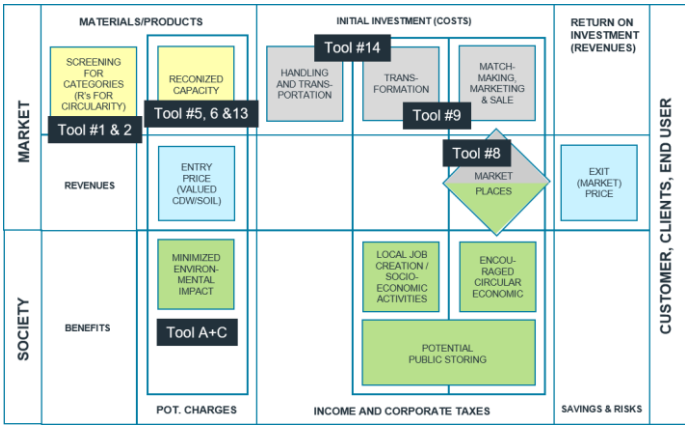
## Exit price

The exit (market) price is an essential driver for the market economy and the business case. It can be presented as simple or complex depending on which factors will be included in the price setting. It can reflect all measurable costs and expected benefits including return of commercial investment, but will also reflect the customers or procurer's willingness to pay. The composition and mechanisms of the price factors described previously are simply repeated here as the tipping point of the value chain, when the price meets the customers, clients, or end users. *Will the exit price be competitive in an unlimited, open material/ product market – or will the buyers in some cases accept a potentially higher price in a broader spectrum of environmental, social, and socio-economic factors in their decision making?* The answer to these questions defines if the business case will be sustainable or not.

# Demonstration projects

Six European cities, Apeldoorn, Bodø, Høje-Taastrup, Mikkeli, Roskilde and Seville, will test different developed tools in a series of circular construction demonstration projects (see Annex 1) including this business case model (fig. 8). Fig. 12 shows the relationships between the society-market-business-case-model and the other developed tools in the CityLoops project.

## Related tools




#1. LCA for concrete, soil and mixed CDW

#2a. Pre-demolition screening procedure (audit)

#2b. Selective demolition procedure

#5. Potential Reuse assessment for soil (prognose)

#6. Methodology for assessment of projects fit for soil reuse

#13. Quality assessment for CDW

#14. CDW flow optimizing

A. Planning & decision-making guidelines

B. Business cases (generic model)

C. Procurement guidelines

*Fig. 12: Tool overview regarding optimizing the business cases in the CityLoops demonstration projects – including Tool B (fig. 9).*

# Marketing strategy and plan

To realize the business cases, a marketing strategy and plan can be a useful tool. Several marketing theories points out 5-10 crucial elements to be included in a marketing plan. In CityLoops, some of these elements connected to the business case model above will be investigated from the commercial partner(s) point of view and in relation to the 11 categories (material types) of CDW and soil.

## Market research

As the European circular construction market is still premature, it must be analysed for the following:

- Needs - Which problems will be solved by the commercial introduction of secondary resources?
- Capacity - Which materials/ products can be made available and in which amount?
- Dynamics - Is there a lock-in-situation, potentials for a niche, or competitive suppliers on the market?
- Supply chain: Who are the actors, are they reliable, and will they cooperate?
- Timing: Will the materials/ products be available in the right amount at the right time?
- Price levels: Are there comparable (new) materials / products on the market?
- Potential customers: Which segments for the specific material or product categories?
- Marketplaces: Are there functioning platforms, and do they include matchmaking?

### Needs

The European building sector is and will for decades to come generally be saturated with new materials and products, and the “burning platform” can be indistinct for some time yet. To create a demand for sustainable solutions with CDW and excavated soil, it may be necessary to

create narratives about which problems can be solved and about the long-term effects of today's decisions about recovering resources through lifetime extension, reuse, recycling, etc.

A long as buildings and infrastructure can be constructed with unlimited materials and products, there must be arguments other than access to resources to create and support the circular economy. These could be environmental and climate protection, but that will often be considered as a societal and not individual problem. Therefore, the narrative must include solving more individualised needs, such as through branding or aesthetic value creation through architectural quality, which are often mentioned as unique selling points.

## Capacity

As previously described, capacity and availability of secondary materials/ products is a crucial element in the circular construction business case, and it is therefore essential for the supplier to be able to convince potential customers through the marketing plan and process that the capacity of the marketed materials or products actually are (or will be) available – before or after demolition or excavation.

## Categories and customers

The materials and products from CityLoops demonstration projects can be mainly categorized as:

| MATERIALS / PRODUCTS* | PRIMARY CUSTOMERS / PROCURERS | MAIN NEW RESOURCE |
|---|---|---|
| Concrete including pavement tiles | B2B: Road and building construction companies, concrete production companies (typically based on demand from clients) | Road fill, building foundations, new pavement tiles |
| Asphalt | B2B: Road construction companies, asphalt production companies | New asphalt |
| Bricks | B2B, (B2C): Construction clients, homeowners | Facades |
| Construction timber | B2B, (B2C): Building construction companies, timber manufacturing companies, homeowners | Construction timer / cladding |
| Soil, uncontaminated | B2B: Road and landscape construction companies (typically based on demand from clients) | Terrain regulation, landscape purposes, noise barriers |

| | | |
|---|---|---|
| Soil, contaminated | B2B: Road and landscape construction companies (typically based on demand from clients) | Same as uncontaminated soil after cleaning |
| Metal scrap | B2B: Scrap dealers | New construction metal |
| Insulation (mineral wool) | B2B, (B2C): Insulation production companies (typical take-back scheme), small occurrences of sales to private customers | New insulation |
| Glass | B2B, (B2C): Glass production companies (typical take-back scheme), small occurrences of sales to private customers | New glass or insulation |
| Bituminous roofing | Asphalt production companies | New asphalt |
| Gypsum boards | B2B, (B2C): Gypsum board production companies (typical take-back scheme), small occurrences of sales to private customers | New gypsum boards or direct reuse if not damaged |
| Fixtures, furniture etc. | B2P, B2B, B2C: Typically sold on digital platforms | 1:1 direct reuse for same purpose |

# Market strategy and plan

To ensure that the market introduction will be effective, profitable, and measurable, a promotion strategy is needed. The strategy must address the following:

- The match between the materials/ products and the customers/ procurers
- How the materials/ products should be represented on the market (on which platform, in which format and using which narrative)
- What price structures will be used (target prices in competition)
- Geographical issues – should the goals be national, regional, or local (e.g. consider rewarding minimised transport)
- Own business branding and positioning, and
- Market goals and monitoring of results.

The next step is to merge the strategy into a plan based on cumulative action, for example, starting with awareness raising (advertising, website), direct marketing (campaign, sales letters, brochures, flyers), direct (canvas) sale, networking and trade shows, publicity (articles that promotes expertise), and actions for representation, e.g. on a digital platform (own or open format with larger selection) with reliable delivery conditions.

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# Annex 1

## Business cases in the CityLoops demonstration actions

### Apeldoorn

In the demonstration, Apeldoorn aims to develop several business cases for concrete materials transformation for reuse to test in the transformation period. The focus will be on developing and testing new, high value applications for recovered materials, for example as sidewalk tiles and/ or the reuse of concrete aggregate in new concrete roads and cycle paths in the pilot demonstration urban redevelopment project. These could potentially include the cement bricks taken out of the Griffiersveld road. The cement bricks can be crushed, and the crushed material and remaining non-hydrated cement can be used to make new bike paths. In addition, by setting up a digital marketplace for construction materials, citizens can also buy/ sell materials.

### Bodø

In Bodø, the business case of the pilot will particularly focus on managing legal, logistical, and technical (including treatment processes and soil analysis) issues related to on-site handling and reuse of soil. An important business case is assessing the amount and quality of the masses on the old military airport site and evaluating if there is sufficient need to justify investment in building a PFAS cleaning facility locally.

### Høje-Taastrup

At the existing town hall, values of materials and transport will be estimated in order to make a comparison, and Høje-Taastrup municipality will assist the buyer in trying to find a market for the materials that are not to be (re-)used on-site. If possible, a business case showing the economic output of the selective demolition will be prepared. The business case for using recycled materials will be investigated at the new town hall, where recycled concrete from Taastrupgård apartment blocks demolition is being used in the concrete foundations. Regarding soil, the impact of the soil strategy on the total cost of handling excess soil will be evaluated.

### Mikkeli

To explore the potential business case for scaling up circular CDW management practices, Miksei Mikkeli and XAMK are holding innovation workshops (in the form of virtual meetings due to covid-19) with stakeholders including the City of Mikkeli, the local waste management

company and the operational centre responsible for public equipment at least once per month during the preparation and implementation phase of the CityLoops demonstrations.

One focus on business cases is to collect and analyse data in order to calculate a feasible, scalable financial model based on experience in the demonstrations. This involves active efforts from Miksei Mikkeli to encourage users (both supply and demand) of the digital material marketplace and to find buyers for the salvaged building parts and equipment from pilot demolitions.

## Roskilde

Roskilde will focus on a business case of using the soil and concrete mix freed from under Parking House 1 at the Musicon area. They have saved almost 400 000 DKK by using a circular approach, with savings from using the soil and concrete mix freed from under the parking house for unbound subbase, which could replace virgin gravel. Crushing concrete locally and reusing it on-site in construction has kept costs and carbon emissions down. This has proven to be an appropriate solution. The cost savings are compared to a conventional scenario, with waste handling fees for scrapping, loading and disposing of concrete residues, as well as delivery and installation of new gravel filling.

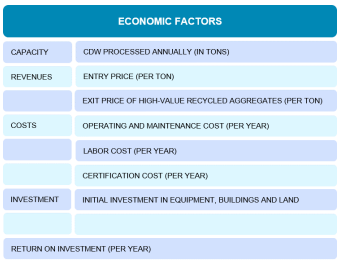
The P-house 1 itself is built for disassembly with a steel skeleton and premade components assembled by bolts and minimal use of concrete. The $CO_2$-savings from choosing this construction have been calculated. The economy of choosing this construction is good, but it is hard to provide a clear business case on the circular construction versus a conventional concrete based construction, as you would need to know the price of the alternative. Roskilde and Capital Region Denmark will see if it is possible to make a sensible business case.

## Seville

FERMOVERT is in charge of the transformation and selling of CDW in Seville. Potential valorisation options to reduce the landfilling of CDW will be evaluated, taking into account the placement of treatment plants. This will also define the characteristics that such CDW must fulfil in order to be used in construction works. A business case will be prepared according to the template prepared in CityLoops, e.g. assessing the possibility of reusing CDW as filling elements in EMASESA's construction works.

# Annex 2

## Supplier business case analysis (template)

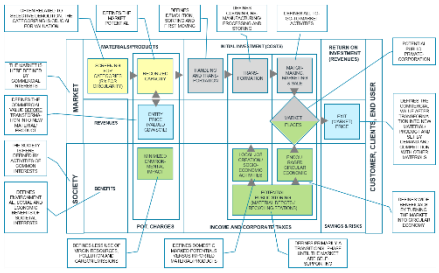



*Reference, fig. 1*

| **Material/product (CDW/soil)** | Crushed concrete as new aggregate materials (Example) | |
|---|---|---|
| **Pricing elements** | **Available capacity (access) Ton / M$^3$** | **Definition** |
| Secondary material / product (CDW/soil) – entry price (€) | | The entry price can be negative or positive. If a building owner do not want to capitalize the value of CDW after demolition, the entry price can be zero or be valued as a revenue for e.g., the demolition company. |
| Handling, transformation, and marketing costs (€) | | Includes e.g., handling on site, transportation, transformation into high-valued recycled aggregates (labour costs), storing and marketing / sale. |
| Certification costs (€) | | Includes e.g., testing and certification regarding to CE/ETA (Building Products Regulation, EPD (Environmental Product Declaration) |
| Investments (€) | | Includes initial investments in equipment, buildings, and land. If CDW/soil are stored by e.g., a client, the investment cost will be lower in the specific (project based) business case. |
| Return on investment (€) | | Typically estimated business income e.g., for re-investment |
| Secondary (CDW/soil) – exit (market) price (€) | | |
| New material / product (€) | | Comparable market prices – it might affect the market price in terms of competition |

# Annex 3

## Client/procurer business case analysis (template)



*Reference, fig. 8*

| **Material/product (CDW/soil)** | Crushed concrete as new aggregate materials (Example) | | |
|---|---|---|---|
| **Costs, revenues, and capitalized benefits** | **Accessible capacity (access) Ton / M³** | **Needed (additional[1]) capacity Ton / M³** | **Definitions** Costs/negative effects are marked by minus (÷) |
| Economic impact (€) | | | Charges, local income taxes from new jobs, local corporate and sales taxes (perhaps capitalized branding) |
| Environmental impact (€ or capitalized non-economic benefits) | | | Includes capitalized benefits as saved virginal resources, saved $CO_2$ emissions (LCA), saved energy, charges (public benefit) etc. |
| Social impact (€ or capitalized non-economic benefits) | | | Includes e.g., saved cost by socio-economic activities |
| Other impacts or benefits (€) | | | E.g., valuated reuse or recycling of own CDW and / or soil, temporary storing |
| Calculated risk cost (€) | | | E.g., legal consultancy, insurance |
| Offered market price (€) | | | Includes all capacity, transformation, marketing costs plus sales taxes |
| Offered market price for new material (€) | | | For comparison |

[1] *When the capacity of CDW/soil is too small for the whole enterprise / project, and it is necessary to add with new (conventional) materials / products, based on virginal resources*

# CITYLOOPS

CityLoops is an EU-funded project focusing on construction and demolition waste (CDW), including soil, and organic waste (OW), where seven European cities are piloting solutions to be more circular.

Høje-Taastrup and Roskilde (Denmark), Mikkeli (Finland), Apeldoorn (the Netherlands), Bodø (Norway), Porto (Portugal) and Seville (Spain) are the seven cities implementing a series of demonstration actions on CDW and OW, and developing and testing over 30 new tools and processes.

Alongside these, a sector-wide circularity assessment and an urban circularity assessment are to be carried out in each of the cities. The former, to optimise the demonstration activities, whereas the latter to enable cities to effectively integrate circularity into planning and decision making. Another two key aspect of CityLoops are stakeholder engagement and circular procurement.

CityLoops runs from October 2019 until September 2023.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 821033.