

FACADES-AS-A-SERVICE

Unlocking financial resources to accelerate the
regenerative and performance-based redevelopment of
circular building envelopes.



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The Circular Buildings Coalition (CBC) is a collaboration that convenes industry leaders who aim to accelerate the deployment of circular solutions as a way of securing a global built environment operating within planetary boundaries while ensuring a just transition. The CBC is an initiative of Metabolic, WorldGBC, WBCSD, EMF, Circle Economy and Arup. The CBC is funded by Laudes Foundation.

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About.

THE FAAS BLUEPRINT PROJECT AND THE ROLE OF GEARCRAFT REAL ESTATE

Façade-as-a-service (FaaS) has evolved over a decade of practice-oriented research and full-scale piloting, inspired by PaaS-based initiatives. The work and results presented in this paper are the outcome of the authors' academic work at Delft University of Technology (TU Delft), as well as professional project development and piloting as part of Gearcraft Real Estate's work. Gearcraft Real Estate is a property development and management firm specialising in the energy improvement and operation of heritage buildings in the Randstad region of the Netherlands. Its focus is on the implementation and operation of energy-efficient building technologies, where possible through the use of circularity-enabling performance-based contracts.

Executive Summary.

We face a polycrisis spanning the socioeconomic and environmental sustainability of both new and existing buildings, from a whole-life-cycle perspective: from the extraction point of raw materials to beyond end-of-(first-)life. The 'linear economy' model is currently understood to be largely responsible for these crises. The concept of a circular economy, on the other hand, offers a vision for a regenerative use of resources.

Product-as-a-service (PaaS) business models aim to change the negative incentive structure of a linear economy with the regenerative practices of a circular economy, by combining products and services in a single offering. Applied to the built environment, PaaS systems thus answer the biodiversity and environmental challenge through reduced waste and reduced need for raw material extraction. In addition, they answer the socio-economic crisis by potentially reducing the whole-life-cycle costs of sustainable buildings, supporting their widespread adoption and potentially increasing their overall market supply by promoting the reuse of existing buildings through affordable deep retrofit interventions. A built-environment-focused PaaS model is façades-as-a-service (FaaS), which foresees a customisable, dismantlable façade that provides a building with any desirable improvement in terms of energy efficiency, controlled ventilation and thermal management, sunlight regulation and energy generation, all adjustable remotely and handled by an expert service provider.

FaaS was piloted in two projects on the TU Delft Campus from 2014 to 2020. Despite successes in engaging and mobilising an integral mix of stakeholders, full FaaS implementation is still hindered by challenges in the business case, contractual structure and bankability. Fiscal reporting and financial real-estate valuation rules, especially

balance sheet extension and monetisation of sustainability and circularity benefits, also continue to pose a significant barrier. With support from the Circular Building Coalition, the FaaS Blueprint project addresses these issues in a third-stage pilot at TU Delft Campus.

Despite initial successes in the development of legal contracts and technological readiness, Phase 1 of the FaaS Blueprint project showed that the main current barrier is the lack of a common assessment methodology to calculate the financial feasibility and business attractiveness of the FaaS model for the stakeholders involved. This in turn is a major barrier to the development of a scalable FaaS provider business model and corporate structure. Informed by efforts so far, this document presents a feasibility analysis in which we outline a comprehensive presentation of learnings and proposed solutions regarding FaaS in the built environment.

Finally, we articulate a potential Phase 2 to develop a common assessment methodology and a FaaS corporate structure. This again requires the engagement of all key actors. We propose the use of a real-life pilot project selected with consideration to dissemination and replication, scalability and upscaling of efforts to take advantage of 'learning by doing'. In addition, Phase 2 should aim at developing an upscaling investment fund to explore the feasibility of FaaS at portfolio rather than individual building level.

FaaS represents a radical shift in the way we plan, design, deliver and manage our built environment. Incremental innovation won't take us there. In order to deal with the complexity of this shift, FaaS pilot projects should work under the guiding concept and methodologies of systemic change.

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1. Introduction.

1.a. THE CONTEXT

The European built environment is currently responsible for 40% of our energy consumption and 36% of greenhouse gas emissions (European Commission, 2020 February 17). The Natural Resources Defense Council reports that building operations are responsible for 28% of global emissions, while building materials and construction processes (typically referred to as embodied carbon) are responsible for 11% (Natural Resources Defense Council, 2023). As the energy supply decarbonises, the share of embodied carbon is expected to rise to half of all new buildings' emissions between now and 2050 (Healthy, Clean Cities EU CINCO, 2022). In addition, European buildings are responsible for around 50% of all raw materials demand, and generate over 35% of total waste in the EU (European Commission, 2024).

While the world still needs large volumes of new construction and affordable housing, most of the buildings that will exist in 2030, and even in 2050, have already been built, and are fast becoming technically obsolete, inefficient and unserviceable (BPIE, 2011). Because of this, a large share of existing buildings is already not in use. Finally, sustainable buildings tend to require a higher initial investment than less sustainable ones, potentially leading to the climate-justice issue of 'green gentrification'.

We, therefore, face a polycrisis spanning the socioeconomic and environmental sustainability of both new and existing buildings, from a whole-life-cycle perspective: from the extraction point of raw materials to beyond end-of-(first-)life.

The concept of the 'linear economy' is currently understood to be largely responsible for these crises. In this traditional system, producers or manufacturers focus on selling their products in one-off transactions, while customers become the owners of the product and take responsibility for their management, maintenance and eventual decommissioning (usually through low-level recycling or landfilling). Producers hand over all responsibility for the management of the product and lose all economic incentives and most legal obligations (except for limited warranties) to design, engineer, and manufacture products that can be potentially (re)used over multiple life-cycles (Baines & Lightfoot, 2013).

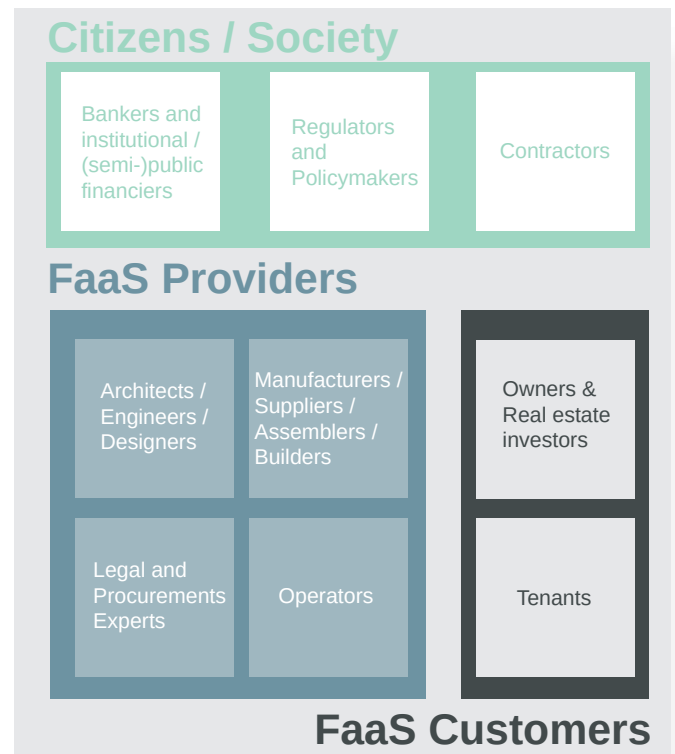


Figure 1. Direct and indirect FaaS stakeholders.

The concept of the circular economy, on the other hand, offers a vision for a regenerative use of resources. As the Communication of the Commission of 11 March 2020, 'A new Circular Economy Action Plan for a cleaner and more competitive Europe', states, the circular economy provides high-quality, functional and safe products, which are efficient and affordable, last longer and are designed for reuse, repair and high-quality recycling (European Commission, 2020).

The EC's Delegated Regulation sets out provisions for technical criteria for a whole new range of sustainable services, product-as-a-service business models and digital solutions that bring about a better quality of life, innovative jobs and upgraded knowledge and skills. The technical screening criteria should follow the principles of circular design and production of the built asset, as well as a circular use of materials used to produce that asset. They should also determine the conditions under which innovative sustainable services qualify as contributing substantially to the transition to a circular

THE BUILT ENVIRONMENT IS RESPONSIBLE FOR:

**40% OF ANNUAL
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EMISSIONS**

**40% OF
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**35% OF
TOTAL
WASTE
IN THE EU**

economy. Considerations regarding the circularity of the materials and the built asset will therefore need to be taken into account from the design phase through to the dismantling phase (European Commission, 2020b).

In line with Europe's vision, the product-as-a-service (PaaS) business model aims to change the negative incentive structure of a linear economy with the regenerative practices of a circular economy, by combining products and services in a single offering. In PaaS models, the tangible product is complemented by other tangible and intangible functionalities and services such as monitoring, repair, replacement and upgrades. With PaaS, products are offered in subscription systems with associated services. Customers therefore do not own the product but subscribe to it and pay a recurring fee. Since ownership is not transferred to the customer, there is great potential for the circular economy, as the manufacturing/providing company is responsible for producing a better product, and has a vested interest in keeping such products – and the material resources they are made of – in efficient and effective operation for as long as possible, and with the highest eventual recovery of secondary material value for future product generations.

Such models have been discussed in academic and industrial theory since the material resource challenge was first identified in the 1960s, but their implementation has been slow and largely limited to business-to-business (B2B) transactions in the automotive sector, industrial machinery, and other non-built-environment sectors.

The 2008 global financial crisis, followed by the COVID-19 pandemic and the Russo-Ukrainian conflict, have highlighted for companies the need to diversify their business models and look for different sustainable alternatives to retain customer loyalty, add new revenue flows and remain competitive. This has given a strong push to 'product-as-a-service' (PaaS) models, which don't sell a physical product through a one-off transaction, but instead charge for its use or functionality while delivering ongoing customer value over time.

Applied to the built environment, PaaS systems can answer the biodiversity and environmental challenge through reduced waste and reduced need for raw material extraction (Vezzoli, Kohtala, Srinivasan, Xin, Fusakul,

Sateesh & Diehl, 2017). In addition, they answer the socio-economic crisis by potentially reducing the whole-life-cycle costs of sustainable buildings, supporting their widespread adoption and potentially increasing their overall market supply, by promoting the reuse of existing buildings through affordable deep retrofit intervention. Built-environment focused PaaS models have evolved by building on the experience of a field of synergetic initiatives:

- Learnings from the PaaS-models of SMEs and global platforms like Airbnb, Lyft and Uber;
- Market developments, such as the Urban Mining Collective and EMA platform, which promote circular practices in the built environment;
- Initiatives like Madaster, BAMP and Concular, utilising BIM and material passports, which enhance transparency, matching (secondary) construction material demand with suppliers' circular offerings through digital platforms.

While many projects and businesses globally have explored the drivers and barriers to PaaS in construction, few examples exist of their practical application in the sector, and those which do exist have only started to upscale in recent years. One reason for the slow adoption of PaaS in the built environment is that financing such models departs markedly from the traditional mortgage-based financing model common to the real-estate sector and is instead more similar to a leasing model used for shorter-lived vehicles and machinery. The complexity of the shift from mortgage to leasing in the case of buildings lies in the disaggregated value chain and multitude of stakeholders involved in the building as an individual unit, as opposed to, for example, a car or an appliance. It also fundamentally questions the traditional perceived solidity of the real-estate asset, which must be increasingly assessed as a temporary collection of short-term technical components. In fact, most existing building-related PaaS models apply to interiors, partitions and fixtures with a relatively short service life. This work focuses instead on façade-as-a-service (FaaS), a type of PaaS applied to the construction sector, which focuses on the façade elements of a building and the expanding range of sustainable technical functionalities that the building envelope is capable of delivering (Azcárate-Aguerre, 2023, Coalition Circular Accounting, 2020).

1.b. Impact on stakeholders.

Having established the societal motivation for FaaS, we will look into the present benefits/drivers by target beneficiaries as per the map of the stakeholder system below.

Owners & Real estate investors



FaaS introduces sustainable investment options, enabling third-party investment in building improvements without legal ownership. Its performance-based structure allows even non-sustainability-focused investors to achieve ambitious environmental goals. FaaS excels in energy efficiency, aligning with regulations for near-zero-consumption buildings, while enhancing overall building quality, occupant satisfaction and long-term durability. The model reduces unforeseen costs during construction and operation, minimising delays and budget overruns. FaaS contributes to the creation of secondary component and material markets, enhancing project flexibility and reducing the need for full repayment before new investments. This approach not only benefits building owners, but also attracts investors and promotes environmental responsibility in building management.

Bankers and institutional / (semi)public financiers



Economic feasibility, in terms of both financial bankability and business attractiveness, is both a key driving force and an implementation barrier to building-energy retrofitting (Bankers without Boundaries, 2023). Business attractiveness of FaaS models, to both the supply and the demand side of the construction and real-estate sectors, can provide an organic motivation to economic actors without the need for regulatory 'carrots and sticks'. A proven financial and business model that results in better risk distribution and sustainability performance while improving the comfort and safety of the target buildings' end-users is likely to be attractive without the need for additional external motivation or imposition.

FaaS providers (teams of manufacturers/assemblers, builders, contractors, operators)



Architects, engineers, designers, façade manufacturers, contractors and builders collaborate under a 'FaaS provider' umbrella, supported by legal and procurement experts. This centralised entity facilitates holistic commissioning, ensuring facilities, systems and assemblies meet defined criteria. FaaS involves detailed planning and preparation, promoting systematic and organised construction, minimising waste, optimising material use and fostering efficient construction processes. The approach encourages façade suppliers to engage in performance-based contracting, providing a balance between commissioned construction and ongoing service contracts. FaaS's circular nature enhances resource management, turning buildings into material banks for reusability and recyclability. It promotes technological innovation, integrating advanced technologies for precision, consistency and efficiency in building components. Overall, FaaS streamlines collaboration, reduces waste and advances sustainability in construction practices.

Regulators and policymakers, tenants, citizens, and society



FaaS modules, being recyclable or reusable, will promote resource efficiency and sustainability. By optimising material use, reducing waste and minimising energy and water consumption during the manufacturing process, FaaS contributes to a reduced environmental footprint. Additionally, the ability to disassemble and reuse prefabricated elements in other projects promotes a circular economy and minimises construction-related waste, aligning with existing and upcoming normative and product regulations. FaaS can accelerate building portfolios' compliance with environmental and health-and- safety regulations and standards of comfort. A better maintained façade will increase the attractiveness, comfort and healthiness of the space in and around the building. It also increases an ageing building's environmental performance and user comfort, thus yielding both direct benefits and co-benefits to society (such as cleaner air and lower noise pollution).

2.a. FaaS and systemic change.

Buildings are complex systems that have a direct and indirect impact on almost all societal actors. FaaS models, addressing the external envelope of a building, are similarly complex. In order to deal with this complexity, FaaS pilot projects work under the guiding concept of systems change. Different definitions of this term have been offered; one of them, by Forum for the Future, applies it in terms of changing systems' patterns or structures: 'System change is the emergence of a new pattern of organisation or system structure. That pattern being the physical structure, the flows, and relationships or the mindsets or paradigms of a system, it is also a pattern that results in new

goals of the system.' John Kania, who developed the systems change practices at New Profit, says: 'We need to work on shifting the conditions that hold the problem in place.' (Si London Hub, 2022.)

Applying the concept of systems change to our work, we develop a theory of change (ToC) as a comprehensive description and illustration of how and why a desired change is expected to happen in a particular context. The FaaS ToC is thus a crucial tool to guide our multi-lever co-creation process, ensuring multi-stakeholder alignment and supporting needs and gap analysis.

Table 1. FaaS Theory of Change

Problem	Barrier	Results	Impact
No incentives to renovate/ retrofit buildings, which makes them unhealthy and polluting (high energy use), or they are abandoned.	Lack of strict or clear regulation (incentives or penalties).	More retrofitted buildings (in use and back in use i.e. previously unused or abandoned) lower new construction needs increased stakeholder	Lower environmental impact of construction sector in operation (lower energy use) and related to raw material resources (reduced waste generation and raw/virgin material extraction)
	High initial investment.		
	Energy savings are not financially attractive (long ROI).		
	Split incentives.		
	Complex decision-making.		
Raw material extraction and processing for the construction of (needed and energy-efficient) new buildings has large negative.	Regulation is not present / not strict enough / does not provide right incentives.		Increased health and comfort across the built environment portfolio
	No economic incentive (uncertainty over price of future material).		More affordable buildings (because of lower initial investment there is less need to increase rents, in addition, more rental space - possibly in excellent locations)
	Regulatory barriers towards reusing materials.		
	Lack of technical expertise with second-hand materials.		

2.b. The FaaS Blueprint project

and the role of Gearcraft Real Estate in FaaS so far

FaaS has been piloted in two projects at the TU Delft Campus from 2014 to 2020. Despite successes in engaging and mobilising an integral mix of stakeholders, full FaaS implementation was still hindered by challenges in the business case, contractual structure and bankability. Fiscal reporting and financial real-estate valuation rules, especially balance sheet extension and monetisation of sustainability and circularity benefits, also continue to pose a significant barrier.

With support from the Circular Building Coalition, the FaaS Blueprint project addresses these issues in a third-stage pilot at the TU Delft Campus. Gearcraft, as a neutral intermediary, facilitates cross-disciplinary discussions among real-estate stakeholders, FaaS providers and finance experts. The Circular Building Coalition supported Phase 1 of the FaaS Blueprint project, which took place over six months in 2023; its activities are detailed below.

Phase 1 focused on the multi-stakeholder co-creation process with the aim of leveraging collective expertise for:

1.

NEGOTIATING BANKABILITY TERMS

by aligning financial stakeholders: In this phase, stakeholders collaborated to align financial terms that enhanced a FaaS project's bankability compared to a 'traditional' project. Financial institutions, investors and project developers engaged in extensive negotiations to establish terms that could ensure project feasibility, risk mitigation and attractive returns. This involved discussions on funding structures, interest rates, repayment schedules, residual value and other key financial parameters. The goal was to create a financial framework that incentivised investment and aligned the interests of all parties involved, fostering a foundation for successful project financing.

2.

DEVELOPING STANDARDISED CONTRACTS

for streamlined transactions: During this phase, standardised contracts were crafted to streamline transactions and create a consistent legal framework. Legal experts collaborated with project developers, contractors and the FaaS team to draft contracts that clearly define roles, responsibilities and terms of engagement. Standardisation helps reduce ambiguity, accelerates the negotiation process and provides a foundation for financial tradability and scalability, facilitating smoother transactions and minimising legal uncertainties.

3.

TESTING AND TRIALLING FAAS PROVIDER CORPORATE STRUCTURE

to ensure clarity and efficiency: A corporate structure was developed to enhance bankability and to adequately distribute and encapsulate financial and technical risks. The scalability of the FaaS model relies on the correct definition of a corporate structure capable of expanding from a single-project scale to a multi-project portfolio-investment-fund scale, which allows for revenue and risk mitigation, more favourable financing terms and even technical trading and cascading of components between buildings in the portfolio.

4.

INITIATE THE PROCESS OF VERIFYING TECHNOLOGICAL READINESS

through collaborative assessment, fostering a comprehensive and consensus-driven approach to enhance success in the FaaS model: While technical readiness is not considered to be a significant present barrier, the project has dealt mainly with the valorisation and monetisation of functional building and end-user requirements facilitated by installed FaaS technologies. In addition, from a service delivery cost estimation perspective, it is crucial to understand the impact of new technologies and their remote monitoring, as well as future trends which might require these technologies to be updated or upgraded.

Despite initial successes in addressing the topics presented above, Phase 1 of the FaaS Blueprint project showed that the main current barrier is the lack of a common assessment methodology to calculate the financial feasibility and business attractiveness of the FaaS model for the different stakeholders involved. This in turn is a major barrier to the development of a scalable FaaS provider business model and corporate structure. Further engagement with stakeholders to develop this assessment methodology, which is the focus of the proposed FaaS Blueprint Phase 2, is required to overcome inertia and increase confidence to unlock a large portfolio of other interested but still sceptical stakeholders.

Informed by efforts so far, this document presents a feasibility analysis in which we outline a comprehensive presentation of learnings and proposed solutions regarding FaaS in the built environment.



3. Feasibility Analysis.

In general terms, the target stakeholders will need to upskill workers and cooperate much more closely and transparently with other actors in the built environment value chain. Cross-sectoral communication and (long-term) partnerships will need to be developed. This is a common pattern across many circular-economy solutions.

From previous FaaS pilots, we have learnt that the business model faces specific systemic barriers to mainstream adoption, detailed below. These are the barriers we will work on in the FaaS Blueprint. A specific feasibility analysis to overcome these barriers per stakeholder is detailed below.

Compared to conventional construction, FaaS includes challenges related to:

- Project complexity
- Bent, fiscal aspects, regulatory approval or encouragement
- Workforce transition, job displacement
- Technology readiness and integration, customisation limitations, quality control issues, complex logistics, site restrictions, storage requirements, design constraints
- Cultural acceptance, architectural aesthetics

Understanding these drawbacks is essential for a comprehensive assessment of FaaS's applicability in various contexts.



3.a. Owners & Real estate investors:



Circular, performance-based investment valuation in a (mostly) linear system.

Issue

The building envelope is one of the costliest parts of a building.

Façade + services represent some 30% to 40% of a newly built project's cost, and up to 90% of a deep energy renovation project's cost. Therefore it might be tempting for the investor to explore a deferred payment model as opposed to an upfront investment. The investment feasibility decreases, however, when a fair evaluation of costs and benefits is attempted, as the tangible cost of more expensive financing and more proactive maintenance are not offset by the less tangible value of user comfort, externalised management operations, or the potential branding value of a more sustainable building (Azcarate-Aguerre, Conci, Zils, Hopkinson & Klein, 2022).

Feasibility of potential solution

Monetisation of co-benefits

Standard valuation processes to account for these less tangible sources of customer value are a crucial ongoing development that will largely benefit the transition to circular contracting and construction. The figure below shows a range of costs and values that result from a real-estate investment project. Under current valuation standards, most of the softer factors are ignored, since they can't be reliably or consistently calculated. Energy performance labels suffered from the same lack of clearly monetisable value for decades, and are only recently starting to be regularly included in property-value and rental-value assessments. To enable FaaS and other sustainable or circular models, it is crucial to ensure full-spectrum monetisability and highlight hidden costs among traditional contracting alternatives. Such assessment methodologies are the target of practical and academic research by TU Delft and Gearcraft, as well as other organisations from the supply, demand and investment sectors (Rooplal Utmani, 2021).

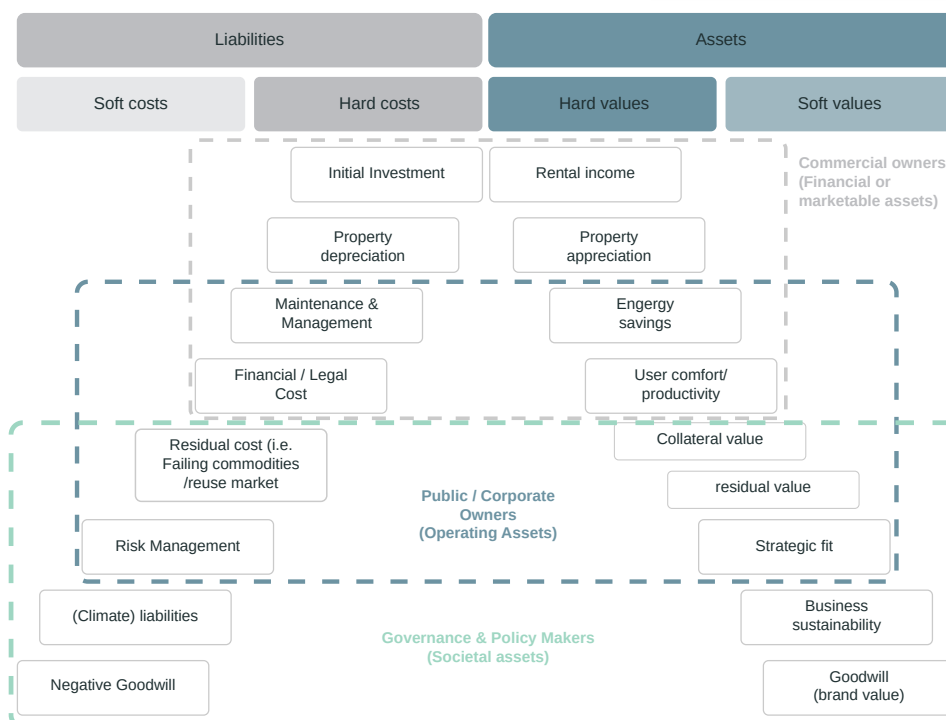


Figure 2. Non-exhaustive list of monetisable parameters in real estate and FaaS investment decisions. From Azcarate-Aguerre et al. (2022).

Issue

The FaaS innovation faces the paradox of having to set up an upscaling infrastructure before realizing its first fully “as-a-Service” pilot case.

The economic feasibility of FaaS can be divided into two scales of operation: the individual FaaS project and the FaaS project portfolio. The investment analysis of an individual FaaS project must provide added value to all three actors in the FaaS equation: FaaS providers (façade builders), FaaS customers (building owners/operators), and FaaS financiers (banks and investors). The complexity of the investment analysis lies in the interaction between the short and long-term interests of these parties, while also spanning a range of factors from the tangible and reliably monetisable to the abstract and unpredictable. The limitations and difficulties to be found at the individual project level can in many cases be expected to find solutions when upscaled to a broader project portfolio. Upscaling, however, requires at least one or preferably several individual pilot projects and is therefore a hurdle that presently requires a lot of time, resources and leadership if it is to be overcome.

Feasibility of potential solution

Coordination of FaaS Customers into joint investment funds:

The implementation of FaaS and other PSS models is meeting an implementation block or ‘Catch 22’ situation (see also Coalition Circular Accounting, 2020); despite progress in understanding the business model, no early adopter is willing to take the first step. Counterintuitively, the answer to a lack of individual project early adoption might lie in the setting-up of an upscaling infrastructure beyond the first pilot case(s). The difficulties of financing a single FaaS project can be gradually overcome with the establishment of a FaaS investment fund at a regional scale, to be replicated in different geographic regions or by different service providers and their customer and investor consortia. This will enable the distribution of risks among more and more diverse projects and with the involvement of more stakeholders. Such investment funds are currently being discussed by parties interested in initiating individual pilot projects, as they allow the pooling of resources, the sharing of risks and benefits, and access to better loan and service conditions based on a larger portfolio scale (i.e. as a purchasing group that can eventually access preferential green and circular funds from banks and governments, and better prices from FaaS providers and their sub-suppliers).

3.b. Bankers and institutional/(semi-)public financiers:



Financing a new class of shared-benefit asset.

Issue:

The collateral value provided by a fully functional real-estate property cannot be relied upon so easily in the case of financing only a specific building layer.

This is hard to disassemble and relocate in the case of foreclosure. This means the financing of a FaaS contract is more closely related to a business investment based on the cash flow and business model solidity of the FaaS customer and the FaaS provider, rather than on the underlying value of the physical façade asset as would be the case for a traditional mortgage.

Feasibility of potential solution

Financing FaaS partnerships:

Key challenges are currently being worked out by pilot organisations. The early adoption of FaaS requires trust and transparency among the involved stakeholders. Currently, ongoing pilot projects use open-book methods for potential FaaS customers to understand exactly what assumptions, values, and financial and technical costs are being taken into account in the pricing of the FaaS monthly fees. Early investors must rely on the solidity of the FaaS customer's cash flow, which means that the model is more likely to be implemented first by public or semi-public procurement entities with premium credit ratings. Examples from technically simpler and less costly building components, such as kitchens-as-a-service in the Netherlands, show that early adopters are usually publicly (co-)funded organisations such as housing associations. Such entities can benefit from low interest rates due to the investor's confidence that the monthly service fees will be covered. After several public procurement projects and a solid project portfolio basis, investors become increasingly confident in investing in PSS contracts for more commercial customers.

Issue:

The residual or resale value that lies at the heart of a car leasing model, or any other similar financial constructions, is lacking in statistical data or historical practice in the case of façades.

The residual value of cars in a second-hand market can be predicted with a safe degree of accuracy, based on historical data and market trends. The residual value of façades and their individual components lacks a current second-hand market, despite clear market interest and long-coming regulatory frameworks, which will very likely create and then boost such secondary markets.

Feasibility of potential solution

Combining real estate and material market investments:

Fluctuations in primary and secondary material markets are a source of uncertainty for investors trying to estimate the residual value of PSS offerings. Central banks with a social and economic interest in safeguarding the future value of materials should step in and provide guarantees on these values on behalf of present and future society. This could reflect lower interest rates for projects with a clear plan to recover and redeploy components and materials at the highest possible value and with the lowest loss of embodied energy and carbon.

Issue:

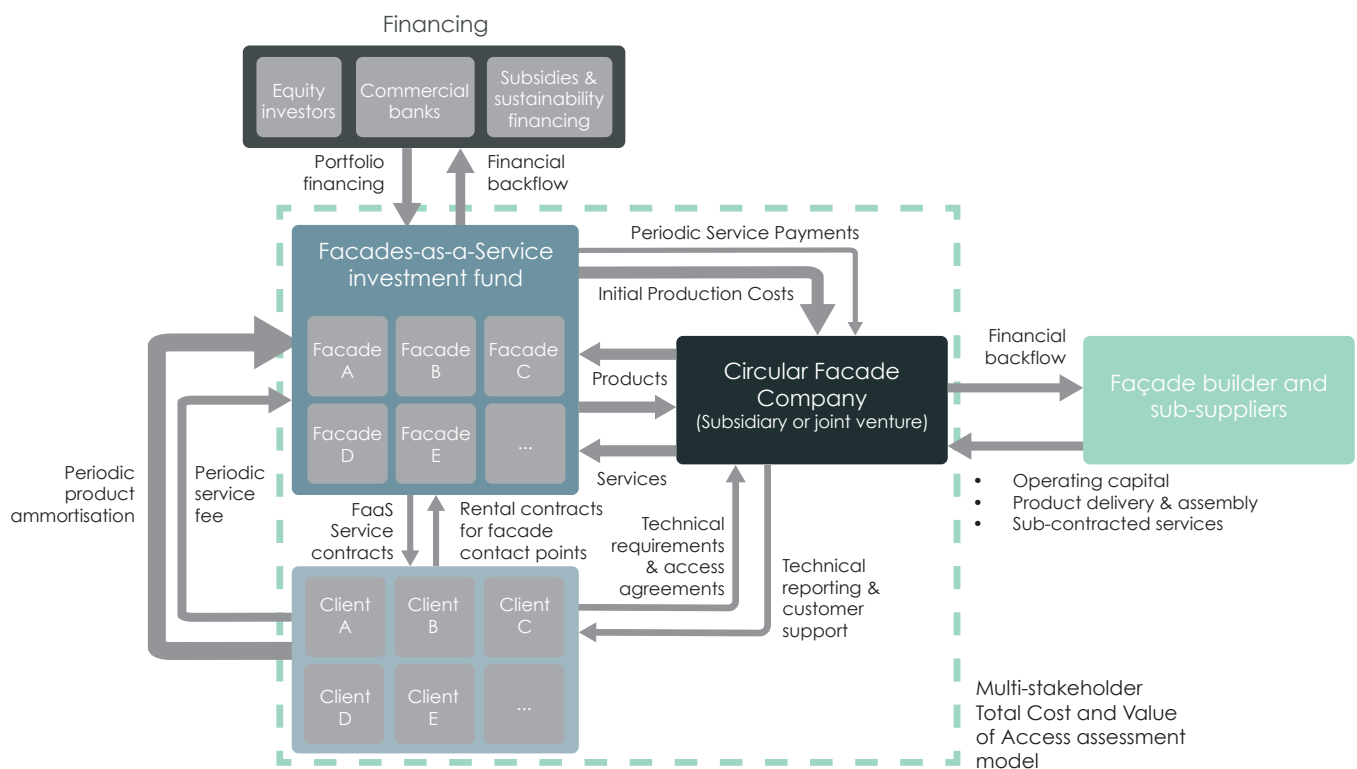
The set-up costs and risks associated with financing individual FaaS projects are considered too high to bear by many potential investors and financiers.

The chance of the FaaS provider or the FaaS customer failing, or having financial difficulties or negative real-estate market performance, places the financial case at risk of default. Without a secondary component market, the foreclosure value of the façade in such a scenario is likely insufficient to recover the loan principal. As in the case of real-estate owners, such individual project barriers are more likely to be overcome when expanding the model to an investment fund/FaaS portfolio level.

Feasibility of potential solution**Institutional banking of a FaaS investment fund:**

The FaaS investment fund mentioned above also has an impact on potential investors and bankers. The top corporate level of the investment fund holds the equity investment of customers and investors and allocates it to the diverse FaaS projects under its management. Each of these projects is organised as a subsidiary special purpose vehicle, which limits risks and exposure between projects. Banks and other institutional investors can invest in individual projects, or in the fund as a whole, knowing that the fund pools the resources and shares the risk among many different project profiles. The investment fund has access to preferential FaaS providers at high-volume rates, and will eventually also be a supplier of secondary façade components and materials (as the end-of-service of the FaaS projects approach) which can be offered to the market or reassigned among member projects within the investment fund in a cascading fashion according to technical needs and user demands.

Figure 3. Proposal for an upscaled FaaS investment fund structure.



A brief timeline of FaaS.

1980s

Development of product-service systems in academic theory and industrial practice. Gradual alignment with energy efficiency goals resultant from the 1970s energy price crisis, and with material resource availability concerns emerging since the 1960s, and which later lead to circular economy theories.

Development of decentralised façade-integrated technologies capable of controlling indoor climate through active sun-shading, ventilation, heating and cooling capacity, energy generation and multiple other technical functionalities. Such technologies have had a slow market absorption under traditional construction practices, but can technically enable FaaS business models.

2000s

**2012-
2016**

Research, planning and construction of first FaaS technical pilot project at TU Delft's Faculty of Electro-technical Engineering and Computer Sciences. Showcasing existing and upcoming façade-integrated technologies, and how these could address building energy retrofit goals and increasingly pressing circular-economy objectives.



Figure 4. FaaS Technological readiness pilot project at TU Delft, EWI building. Picture: M. Bilow, 2016

Planning and construction of first FaaS management pilot project at TU Delft's Faculty of Civil Engineering and Geo-sciences. The project aimed to uncover and solve as many systemic issues as possible in terms of decision-making, bankability, corporate organisation, legality of service contracts and technical collaboration of supply-chain and reverse-logistics chain.

**2018-
2020**



Figure 5. FaaS Management process pilot project at TU Delft, CiTG building. Picture: J.F. Azcarate-Aguerre, 2019.

2024+

Implementation and upscalability of FaaS model according to realistic commercial parameters. More on this in the 'Next steps' section.

3.c. FaaS Providers



Team of manufacturers / assemblers, builders, contractors and operators

Issue:

FaaS providers will need to work closely across teams towards standardisation and modularity of components and services.

This is necessary to ensure that the business model works seamlessly (for example, early design choices will have to take into account the necessity for parts to be easily adapted or replaced, cashflows aligned, and materials and components recovered). Processes must be set up for the long-term management of façades, which must also be designed, engineered and built in a way that optimises life-cycle management costs and eventual decommissioning and material value recovery or harvesting. Elevating project management competencies is essential for the effective planning, execution and monitoring of circular construction projects. This encompasses skills in scheduling, cost control, risk management and stakeholder coordination.

Feasibility of potential solution

FaaS provider logistics and processes

Façade construction companies are already robust in terms of organisation and logistics, with both back-office and on-site staff trained in assembly, transportation and installation processes, as well as troubleshooting and maintenance after the project delivery. In the case of the Netherlands, façade engineering takes place in-house, or in close collaboration with professional façade engineering consultants and system suppliers, allowing for the re-engineering of dismountable, upgradable and reusable façades. The logistics of disassembly and relocation – while new and complex, and leading to unexpected difficulties and opportunities for damage and loss of value – have been tested in recent pilot projects (e.g. Re:Born Real Estate's Satelliet tower in Amsterdam), even on building systems not originally intended for disassembly. Such processes can be quickly understood and embedded into the builder's scope of action.

Issue:

Construction value chains will need to face the complexity of new decision-making structures between FaaS providers, customers and financiers.

Enhancing client relationship skills and communication abilities is essential for professionals involved in circular construction. Effective communication with clients, understanding their needs, and educating them about the benefits of FaaS contribute to successful project engagements and long-term partnerships.

Feasibility of potential solution

FaaS delivery and customer relations.

A closer, more trusting and long-lasting connection to customers based on total cost of ownership solutions is a high-value priority for façade builders used to competing largely on the basis of initial construction cost. Strategic alliances can be created between façade builders experienced in the initial construction phase and façade management companies experienced in their management. An open discussion between these parties and their customers could provide sufficient statistical data on long-term project costs and processes, and the likelihood of mid-life-cycle changes and upgrades being required as a result of changing end-user or market trends.

Issue:

Setting up (re-) manufacturing facilities and implementing circular construction methods might require a significant initial investment, which can be a barrier for smaller companies or projects.

Feasibility of potential solution**Reverse logistics value chains:**

Progress is being made by companies such as New Horizon in the Netherlands, setting up both the technical mechanisms for the recovery of disassembled building components and the creation of open and collaborative secondary-element marketplaces for the trading of recovered and remanufactured components. The small scale of individual façade building companies, and the resulting investment limitations on large remanufacturing facilities, can be overcome through shared investment at an industry branch organisation level. Despite competition over individual projects, all metal façade fabricators in a national context have a shared interest in preserving raw material within their national (or European) borders and preventing material leakage and global price competition, which threatens the safety and reliability of their raw material supply. Co-investment and data sharing are crucial in the transition to secondary-material-based supply chains.

Issue:

Ensuring consistent quality across all second-life elements can be challenging, leading to additional costs and delays.

Meeting static, fire, thermal and acoustic requirements using secondary raw materials can lead to additional costs. The use of secondary raw materials is a niche but expanding market. It must be enhanced through multi-sectoral collaboration towards policy and regulatory enablers, together with the development of a digital industry (market and data) for the construction sector.

Feasibility of potential solution**Secondary products and components regulation and certification**

Regulatory guidelines must be developed for dealing with technical and legal liabilities over reused components. Manufacturing industries in other sectors (e.g. automotive and construction machinery) have already been working with recovered components for decades and developed screening and testing procedures for recovered and remanufactured components. In the case of construction, this process is more complex due to the lack of standardisation between projects, and the huge diversity of suppliers and components spanning decades or centuries of technological development. A solid market for secondary materials and components, based on both organic market pull and artificial regulatory push, would motivate the development of such testing and certification processes and the healthy allocation of liabilities over the performance of secondary elements.

Issue:

Coordinating the timely availability of various second-life components requires intricate logistical planning.

This can be costly, challenging and time-consuming. Storing second-life components until they are needed again might require additional space, leading to temporary land use and potential environmental concerns. Proficiency in logistics and supply chain management is indispensable for orchestrating the transportation, delivery and installation of modular second-life components. This encompasses optimising transport routes and inventory management, and guaranteeing the timely delivery of materials to the construction site.

Feasibility of potential solution**Creating secondary component markets and brokerage services**

The emergence of digital material data repositories such as Madaster and material brokerage experts and services is another crucial step to efficiently link secondary building component owners with new potential reused/remanufactured component customers. Successful examples exist of material brokerage services linking secondary façade elements to new (even if downcycled) projects in which they can be used as internal partitions with lower technical performance requirements. Such examples include the ABN AMRO CIRCL pavilion in Amsterdam, designed by Architecten Cie, and the BlueCity offices in Rotterdam, designed by Superuse Studios. Projects like the previously mentioned Satelliet tower in Amsterdam show that an early link between outgoing and incoming project commissioners can lead to a better disassembly, remanufacturing and reassembly process, saved transportation and storage costs, and same-level reuse of components without downcycling consequences.

Issue:

Modular, circular construction often involves standardised modular components.

This can be perceived as limiting the level of customisation and unique design features that can be incorporated into the building. Elevating expertise in architectural design and engineering is paramount to conceive modular designs that encompass both structural robustness and aesthetic appeal, while also being efficient to fabricate and assemble. In addition, the modular nature of FaaS components can lead to limitations in the size and span of spaces that can be created, which might not align with certain architectural or functional requirements. Finally, while modular offsite construction reduces onsite labour, it requires meticulous site preparation to ensure that the prefabricated elements fit seamlessly during assembly. Any discrepancies in site preparation can lead to challenges during installation. Design alterations or unexpected changes during the construction process might be harder to accommodate in offsite construction due to the replanned and prefabricated nature of components. Integrating advanced technologies or systems into prefabricated, circular elements might require additional planning and coordination, potentially leading to higher costs or delayed implementation until the learning curve is overcome.

Feasibility of potential solution

Creating digital infrastructure and competencies services:

FaaS requires proficiency in modular design principles, parametric modelling and building information modelling (BIM). Competence in utilising these technologies enables better coordination, communication and efficiency in industrialised construction projects.

Issue:

FaaS provider entities will see the need to update their staff's skillsets to take into account flexible and circular use of resources, with a high degree of repairability and an unspecified number of lives beyond the first life cycle.

To align with circular-economy principles, it is essential to provide the workforce with training in selecting environmentally friendly materials, recycling and waste reduction. Additionally, mastering the skills required for the assembly of FaaS elements holds significant importance. This is because the installation and finishing of FaaS structures can often be intricate and specific to the product or project, necessitating prior training or on-site demonstrations with the construction team involved. Transitioning from traditional construction to FaaS methods might lead to temporary displacement or skill gaps in the industry. A critical bottleneck is the lack of skilled labour, specialised in circular construction. The special nature of this work requires a new set of skills that are currently lacking, making it difficult to find qualified people to carry out these projects effectively.

Feasibility of potential solution

Educational and social change and skill development.

Educational programmes which equip students, industry, public servants and investors with skills regarding circular economy in the construction industry are increasingly common. These will greatly support accelerating the learning curve and thus the cost-efficient adoption of the solution in the sector.

3.d. Regulators and policymakers, tenants, citizens, and society



Issue:

There are common goals and policies for circular economy in the construction sector, but the implementation and practices vary.

The lack of comprehensive compliance standards and regulations tailored to circular construction is a challenge for FaaS projects, creating uncertainty. Clear guidelines and regulations are essential to ensure consistency, safety and quality across all projects and their absence can prevent industry-wide adoption.

Feasibility of potential solution

Harmonisation of regulatory standards, incentives and penalties.

A project or portfolio could link it to the relevant EU initiative, such as the EU Taxonomy. As part of updates to the Taxonomy, the EC developed technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to the transition to a circular economy (European Commission, 2023). The need and requirements for these criteria were published in a Delegated Regulation on 27.06. The technical screening criteria are set out in Annex II to Regulation (EU) 2020/852. This provides criteria for both the construction of new buildings (p.236) and the renovation of existing buildings (p.240):

- At least 70 % (by weight) of the non-hazardous construction and demolition waste [...] generated on the construction site is prepared for reuse, recycling and other material recovery [...]
- Operators limit waste generation in processes related to construction and demolition [...] and facilitate reuse and high-quality recycling by selective removal of materials [...]
- Building designs and construction techniques support circularity and in particular demonstrate, [...] the disassemblability or adaptability of buildings, how they are designed to be more resource efficient, adaptable, flexible and dismantlable to enable reuse and recycling.

Criteria for Acquisition and ownership of buildings could also be of interest.

Issue:

Certain regions may have regulations or zoning restrictions that limit the use of FaaS.

Local authorities might need to adapt their guidelines to accommodate this approach, leading to additional administrative efforts and delays. For example, in the case of the Netherlands, with similarities in other EU and foreign countries, the fiscal system does not yet align with, let alone incentivise, the implementation of PSS contracting alternatives. The timeline for the construction and setting up of SPVs or other corporate structures can result in additional transfer tax being due (e.g. when transferring the façade from the façade builder to the façade service company).

Feasibility of potential solution

Fiscal incentives to circularity.

The tax code should instead motivate business models which enable circular material use. It could do so by providing a lower value added tax (VAT) rate to contracting models, which can be established and monitored to enable the high-value recovery of materials and the improvement of the building's energy performance. Alternatively, it could defer VAT or corporate tax on investments that are taking a risk against material value recovery.

4. Next Steps.

As previously stated, a potential Phase 2 should focus on the major barriers for the FaaS business model to be successfully disseminated and upscaled, and should therefore set the following objectives:

1. Development of a common assessment methodology to calculate the financial feasibility and business attractiveness of the FaaS model to the different stakeholders involved
2. Establishment of a FaaS provider corporate structure
3. Ideation of a FaaS upscaling investment fund

This once again requires the engagement of all key actors, since the business plan is based on an interdependent scheme. Throughout the phases of the project, the relevance of each stakeholder will vary; however, all key actors need to be involved throughout the process to guarantee trust and transparency.

To do so, we propose the following activities.

1. ■

DEVELOPMENT OF A COMMON ASSESSMENT METHODOLOGY

This will apply the following criteria:

- A. Outline clear objectives, including environmental impact reduction and financial sustainability;
- B. Showcase the economic, environmental and social benefits of a circular façade-as-a-service;
- C. Specify the chosen building, detailing its current state and proposed circular interventions;
- D. Include a comprehensive feasibility analysis, considering the availability of circular materials, technologies and costs;
- E. Establish the key stakeholders and align goals;
- F. Ensure compliance with local regulations and codes;
- G. Address potential challenges and risks;
- H. Outline a timeline for implementation, allocate resources efficiently and ensure compliance;
- I. Emphasise knowledge-sharing to encourage the scalability of the project.

2.

IDENTIFICATION OF A FIRST PILOT FOR A CIRCULAR FACADE

For the development of a FaaS provider corporate structure, we propose to identify a first pilot, carefully considering factors such as building type, location, financial sustainability and the potential for circular materials, targeting replicability and scalability. This will allow the development of the assessment methodology through a ‘learning-by-doing’ approach.

3.

ESTABLISHMENT OF A FAAS UPSCALING INVESTMENT FUND

Financial experts will collaborate to define the fund’s investment strategy, risk management protocols and fundraising targets. Legal frameworks will be established, and operational procedures will be refined to align with the FaaS fund’s objectives. Partnerships with key actors, including institutional investors, private individual investors and industry players, will be solidified. Comprehensive due diligence will be conducted on potential investment opportunities.

4.

TRANSVERSAL ACTIVITIES

The action plan for the project will also involve transversal activities to:

- A. Coordinate with key actors (presented in next section);
- B. Provide for adaptive management, regular monitoring and feedback loops to ensure the plan evolves in response to changing circumstances once the pilot is running and facilitate agile course-correction;
- C. Develop and implement a communication strategy to engage and inform the community and the FaaS network. This will include the synthesis of insights to craft a comprehensive roadmap for replication, an action-driven summary of findings with brief and punctual recommendations to each stakeholder group, and decision-making flow charts, and will highlight the importance of finding the right consortium partners from the start of the process.



5. Key Actors we will work with.

Below we present the specific actors we identified to engage in the FaaS Blueprint Phase 2 project.

1.

OWNERS & REAL ESTATE INVESTORS

A focus on circularity and sustainability is becoming increasingly important due to growing awareness of environmental and social responsibility. This sector is key for the successful understanding of the market value and added value of the FaaS model. Several important real-estate valuers, appraisal firms and organisations are involved in assessing the sustainability and circularity aspects of properties. Some key players in the valuation field are: RICS (Royal Institution of Chartered Surveyors), IVBN (Dutch Association of Institutional Investors in Real Estate), Dutch Green Building Council (DGBBC), local sustainability consultants, homeowners' associations and real-estate developers and owners.

2.

BANKERS AND INSTITUTIONAL/(SEMI)PUBLIC FINANCIERS

The Netherlands has several important institutions and organisations connected to circularity and sustainability in the banking and public finance sectors that would be relevant to the FaaS model. These institutions play a crucial role in promoting sustainable and circular practices in the country. Not all of them need to be involved, especially in the early stages of the project, but it is fundamental to have at least one of these key financial actors financially supporting the FaaS model. The main key actors are InvestNL, Triodos Bank, Rabobank, Dutch Development Bank (FMO), Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO), Dutch Green Finance Platform, and Circular Economy Investment Fund (CEIF).

3.

FAAS PROVIDERS

They play a crucial role in overcoming the challenges related to the standardisation and modularity of components, recoverability, long-term management of the façade, project management and monitoring. The Dutch market for circular buildings has been growing and companies such as Re:Born Real Estate has been developing a portfolio of projects that address all these challenges aforementioned. Other possible partner companies should be scanned.

Manufacturers that already have the facility to implement circular construction methods are not abundant. The Dutch company New Horizon has been successful in this regard and appears as a natural key actor. Ciskin is a joint venture of two Dutch façade fabricators and a Norwegian aluminium façade system supplier, which has developed a market-ready, circularity-enabled façade system and the business model for service-based delivery. Due to the relatively small scale of the pilot and the possibility of fragmenting the circular production, smaller companies can become responsible for small components of the façade. In this regard, an effort must be made to map and identify possible small manufacturers that could join this collective effort. The main challenge of this network of manufacturers lies in the capacity of strategic coordination.

4.

REGULATORS AND POLICYMAKERS, TENANTS, CITIZENS, AND SOCIETY

Traditional regulations and standards in many cases hinder the implementation of FaaS and other PaaS models. The comprehensive FaaS assessment methodology previously mentioned should be validated by organisations such as the NVM (a Dutch association of real-estate agents and appraisers), Belastingdienst (the Netherlands Tax Administration), and Woonbond (an interest group for Dutch tenants and home-seekers).

5.

ACADEMIC ACTORS.

The FaaS model has been studied at the Departments of Architectural Engineering and Technology and Management in the Built Environment of TU Delft. There it has developed an extensive knowledge network that is key not only for theoretical grounding but also for furthering applied research. Other institutions that deal with urban and regional governance could also be included in this partnership.



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List of Acronyms.

B2B	Business-to-business	PaaS	Product-as-a-Service
BIM	Building Information Modelling	PSS	Product Service Systems
CEIF	Circular Economy Investment Fund	RICS	Royal Institution of Chartered Surveyors
DGBC	Dutch Green Building Council	RVO	Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland)
EC	European Commission	SME	Small and Medium Enterprises
EU	European Union	SPV	Special Purpose Vehicle
FaaS	Façades as a Service	ToC	Theory of Change
FMO	Dutch Entrepreneurial Development Bank (Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden)	VAT	Value Added Tax
IVBN	Dutch Association of Institutional Investors in Real Estate	VvE	Homeowners' Association in the Netherlands (Vereniging van Eigenaars)

Colofon.

AUTHORS

JUAN F. AZCARATE-AGUERRE (PhD),
MIRA CONCI (PhD),
IGOR T. MORENO PESSOA (PhD)

DESIGN & LAYOUT

NICK 'S GRAVEMADE (BSc.)

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