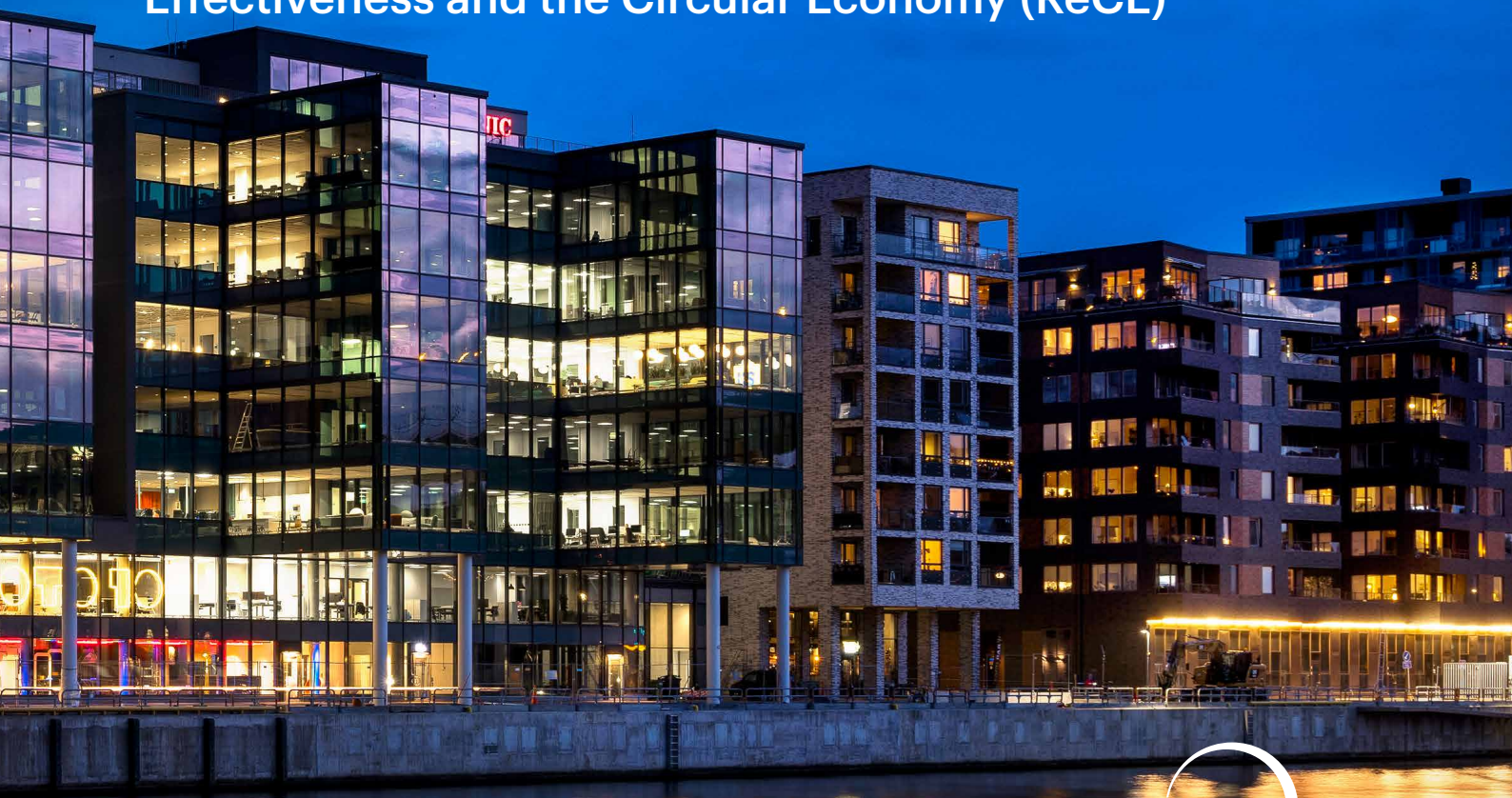
Resource effectiveness through shared space in Sweden – Shared space as the norm

A sector report from the IVA project Resource Effectiveness and the Circular Economy (ReCE)

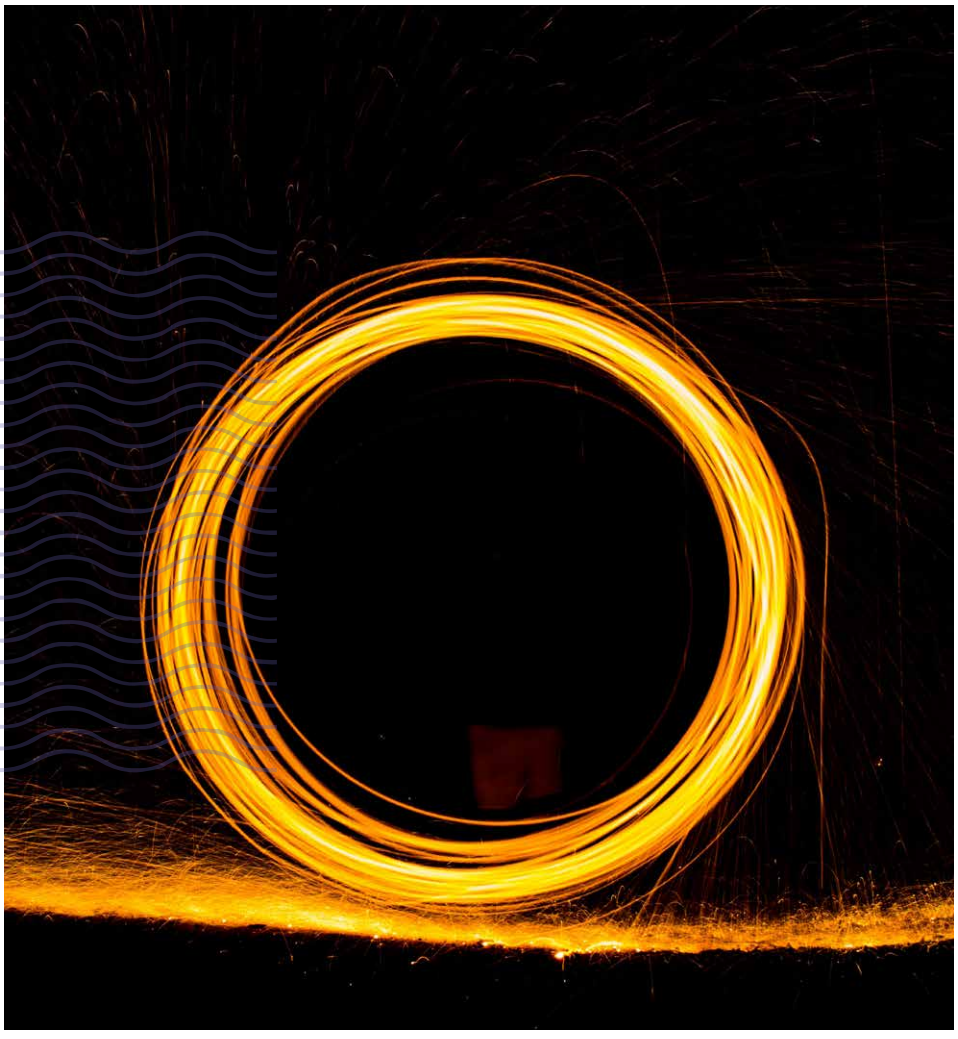


THEME:
CLIMATE-RESOURCES

JANUARY 2020

IVA
Royal Swedish Academy of Engineering Sciences

Contents



Foreword: Resource Effectiveness and the Circular Economy

»The purpose of the project is to strengthen Sweden's competitiveness in a future with finite resources in line with the UN's Sustainable Development Goals.«

The Royal Swedish Academy of Engineering Sciences' project *Resource Effectiveness and the Circular Economy* has assembled more than 50 companies, organisations and public authorities around the **vision** of Sweden being the leading nation as a resource-effective, circular society. The **purpose** is to strengthen Sweden's competitiveness in a future with finite resources in line with the UN's Sustainable Development Goals.

The project's **goals** are: to create a platform for resource effectiveness and circularity; to draw conclusions on Sweden's resource options in public policy, research and industry based on initiatives that are under way, and to create collaboration and forward motion.

Resource Effectiveness and the Circular Economy builds on the IVA project *Resource Efficient Business Models – Greater Competitiveness* from 2014–2016. That project presented the significant potential that exists to make society considerably more resource efficient and to generate new commercial opportunities and business models. It defined five material flows (biomass from wood, steel, concrete, food and textiles) to show where flows are "leaking" and thus where commercial opportunities exist through more effective resource management.

This project continues the work of the previous one, using the same sector breakdown and exploring the commercial opportunities that were identified. It is divided into five subprojects: mobility, facilities, food, textiles and plastics. This report will present analysis and observations from the Mobility subproject. The most important conclusions from all of the subprojects will be compiled and presented as the project's recommendations for a broader societal transformation in a joint synthesis report.

The five subprojects have gathered representatives from the entire value chain to participate in individual work groups. They come from the private and public sectors and from the research community. IVA's work is based on a scientific approach and draws from relevant research, but also involves critical analysis of other issues of relevance. Source references are included where appropriate. The project's results come out of an intense programme of workshops and work group meetings involving a large number of people.

The reason for this initiative from IVA is that resource effectiveness and circularity are both crucial for a future with greater global prosperity. One particularly important aspect is ensuring that we successfully improve efficiency in material management and advance material development. To support this, we also need to design new business models and identify commercial opportunities that will stay relevant many years into the future, meet the UN's Sustainable Development Goals and allow us to remain within the planetary boundaries.

We need sustainable systems that can deliver resources to meet the real needs of society. To achieve this we need a long-term system perspective and an overall understanding of, and system of managing, society's resource flows. We need to take a holistic approach in which all aspects in the production chain are included – from material extraction and raw materials, the design phase, manufacturing, business models and financing, through the user phase to the recycler and back to a new producer. This requires cooperation between all actors, as well as clear rules to create the right incentives and market conditions. We also need to accelerate, and better understand the benefits of, digitalisation, innovation and new business models that focus on resource effectiveness.

A lot is already happening – both internationally and around Sweden – with numerous initiatives and projects examining how resource effectiveness and circularity can be in-

troduced in various sectors. But there is no unifying arena to show the need for a systemic change and where different perspectives can come together. IVA believes that a platform for cooperation between the private sector, the research community, the political sphere and the public sector is essential in order to achieve a resource-effective and circular society. Actors within such a platform are also the project's overall **target group**.

Resource Effectiveness and the Circular Economy was launched at the beginning of 2018 and will continue until mid-2020.

The project's definition of resource effectiveness and the circular economy

Resource effectiveness[1] and circular economy[2] are two distinct concepts under the same umbrella. A measure that supports the circular economy often also supports resource effectiveness. In this project we regard resource use within the planetary boundaries as the overarching goal. In order to manage any conflicting objectives in future development it is important for there to be clarity and an understanding of systems.

The primary focus of this report is more effective management of the value of society's and nature's resources beyond, for example, mere volumes or mass. Unless otherwise stated, this also includes the concept of a circular economy. In cases where conflicting objectives between the concepts are identified, they are described.

Geissdoerfer et al, for example, define circular economy below mainly in terms of the circulation of materials:

> *A regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.*[3]

The project's premise is that resource effectiveness takes priority over the circulation of materials. We believe that it is important to include the user phase in the definition – not just the production phase; to include business models and services – not just physical products:

> *A performance economy goes a step further by selling goods (or molecules) as services through rent, lease and share business models. ... In addition to design and reuse, the performance economy focuses on solutions instead of products, and makes its profits from sufficiency, such as waste prevention.*[4]

The project believes that this perspective is missing in some circular economy definitions, even if it is sometimes considered an implicit aspect. One example is the average car which is parked 95 percent of the time. We do not improve the efficient use of resources by merely recirculating the materials the car is made from – no matter how good we get at it. The effective use of resources ("resource effective-

1 *Europa 2020 – A strategy for smart, sustainable and inclusive growth COM (2010)*, and *A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy COM (2011)*. There is unfortunately no actual definition of resource effectiveness.

2 Kirchherr, J., Reike, D., Hekkert, M., 2017, "Conceptualizing the circular economy: An analysis of 114 de nitions", in *Resources, Conservation and Recycling* 127, pp. 221–232.

3 Geissdoerfer, M., Savaget, P., Bocken, N. and Hultink, E., 2017, "The circular economy – A new sustainability paradigm?" in *Journal of Cleaner Production* 143 (1), p. 759.

4 Stahel, W., "The circular economy", 23 Mars 2016, in Nature 531, pp. 435-438 (https://www.nature.com/news/the-circular-economy-1.19594; accessed 10 December 2019).

ness" = using resources as efficiently as possible while also avoiding negative environmental impact) must be improved.

As Florian Lüdeke-Freund et al. wrote in their article entitled "A review and typology of circular economy business model patterns":

> *The circular economy may not be a final goal, but rather part of an ongoing process to achieve greater resource efficiency and effectiveness.*[5]

This is a theory the project is happy to endorse.

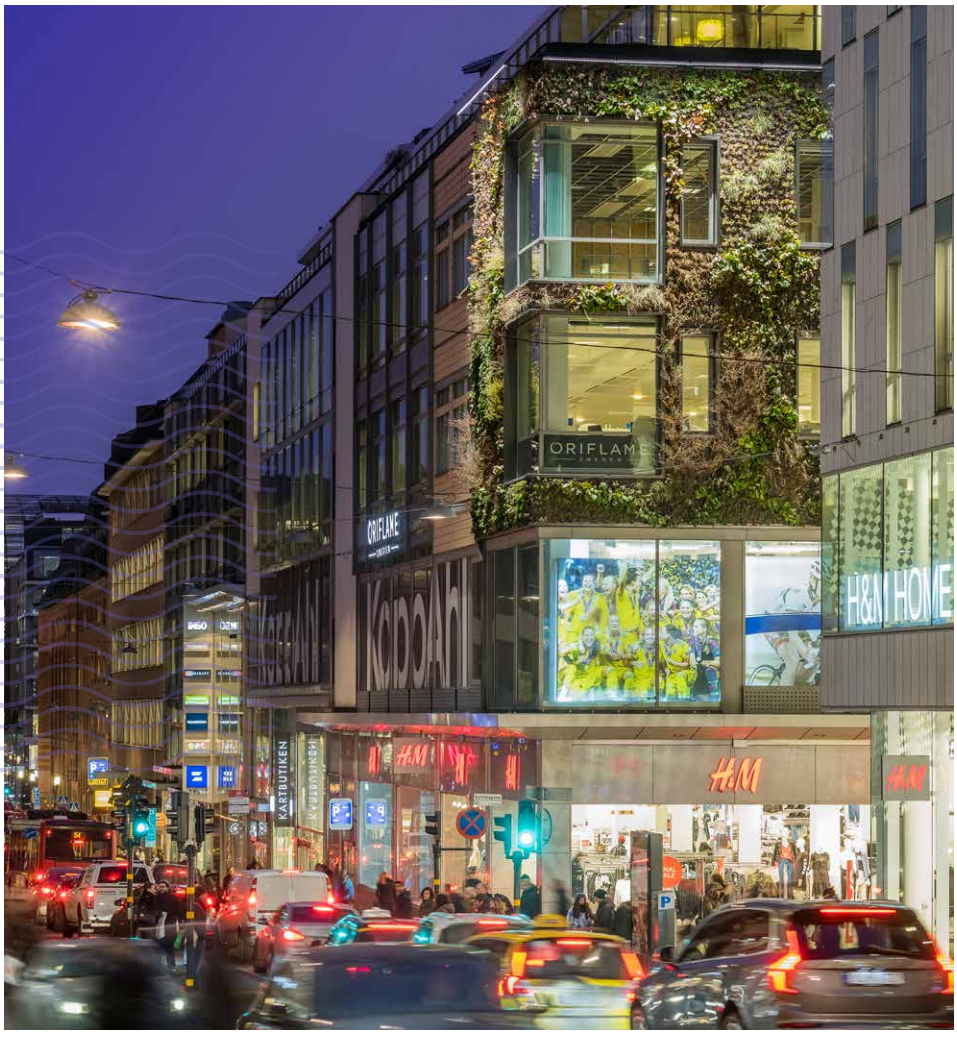
For the project:

Åke Svensson, Chair
Caroline Ankarcrona, Project Manager
Jan Nordling, Project Manager

Work group on shared space

Chair: **Anna Denell**, Vasakronan, Head of Sustainability
Vice Chair: **Mattias Höjer**, KTH, Centre for the Future of Places, Professor
Project Manager: **Liv Fjellander**, IVL Swedish Environmental Research Institute
Ylva Frithiofson, Ramboll Head of Unit
Charlie Gullström, RISE/Viable cities, PhD, Senior Researcher and Design Strategist
Ivana Kildsgaard, Tengbom, Director of Sustainability
Mats Olausson, SEB Merchant Banking, Senior Advisor
Ulf Ranhagen, Sweco/Chalmers, University of Technology/Dalarna University/Smart Cities, professor, Chief Architect
Robin Al-Salehi, IHUS, Director of Sustainability
Monica von Schmalensee, White/National Council Architect/Partner, Senior Advisor for Sustainable Cities
Björn Sigurdson, Uppsala Municipality, Climate Strategist
Camilla Wieslander, Skanska Öresund, CEO

5 Lüdeke Freund, F., Gold, S. and Bocken, N., 2018, "A Review and Typology of Circular Economy Business Model Patterns", in *Journal of Industrial Ecology*, Volume 23, Issue1, February 2019, pp. 36-61.



Introduction: Shared space

»The greatest resource efficiency improvement that could be made in the construction and real estate industries is using existing facilities and their surroundings better and more efficiently.«

In this study sharing of space is defined as giving multiple users access to previously underutilised existing spaces and functions, on a non-profit, public or commercial basis.

There is great interest in sharing spaces and functions and in the business models it open doors to. We are seeing a trend towards more flexible and shorter rental contracts or functions as a service. At the same time, management and employees are in many cases not used to sharing with other businesses or organisations. The way in which contracts, insurance policies, laws and rules are formulated today is presenting tangible obstacles.

Many private, public, non-profit and academic actors are engaged in innovation to sharing solutions; particularly ones that involve sharing between these actors. In order for sharing solutions to be sustainable, actors involved in it need to consider the environmental as well as the social and economic gains that can be made.

Buildings stand for many decades, sometimes centuries. The construction sector accounts for 40 percent of the annual resource use globally and a large share of the resource use and environmental impact of buildings is during new construction.[6] The greatest resource effectivity improvement could be made by the construction and real estate industries using existing facilities and their surroundings better and more efficiently to limit the amount of new construction needed. While this project is focusing on sharing in existing buildings and spaces, there are several other factors that also affect how resource-effective sharing can actually be, such as the fact that building materials and fixtures and fittings are largely reused when remodelling is done to enable sharing, and facilities that are shared achieve a basic sustainability level in terms of work environment and energy use. The IVA project *Attractive Living Environments in Good Cities of the Future* proposed steps to take towards a circular economy. They are also relevant for resource-effective sharing of space.[7]

Many actors are focusing on the social drivers because space sharing can create new work processes, networks,

6 The climate impact of a building during its construction, including material manufacturing and groundwork, is about the same as the building's impact for an estimated 50 years of operation. Erlandsson, M. and Peterson, D., 2015, "Klimatpåverkan för byggnader med olika energiprestanda". Background report for kontrollstation 2015. For the Swedish Energy Agency and the National Board of Housing, Building and Planning. IVL Swedish Environmental Research Institut, report no. U5176".

7 The Royal Swedish Academy of Engineering Sciences (IVA), 2017, "Attractive Living Environments and Flows – Eight themes in planning good cities of the future" (https://www.iva.se/publicerat/attraktiva-livsmiljoer--och-floden--atta--teman-for-planering-av--framtidens-goda-stad/; accessed 17 October 2019).

inspiration and knowledge. Sustainable sharing of space and functions should increase people's wellbeing and promote efficient meeting, education and work spaces, and not take place at the expense of these.

The economic drivers are significant when sharing because savings can be made and new commercial opportunities can arise. Most importantly, there is significant economic potential in using existing buildings more efficiently.

We have focused on sharing of existing facilities, but we are also considering them in the context of surrounding spaces and activities. We have therefore studied the potential for resource effectiveness and circularity in spatial symbiosis – for example, how sharing of spaces, functions and mobility should take place in a type of urban symbiosis,[8] although we have not limited ourselves to urban contexts. The project group has focused in particular on new sustainable business models arising from and involving digitalisation, mobility services and the ongoing climate transformation in society, where the real estate industry has become more integrated with other activities.

The project believes that sharing of space can contribute substantially to reducing resource use and to a circular society if we do the following:

- Employ systems thinking to a greater extent. The use of space needs to be viewed in its broader context and in interaction with other activities in society and other resource flows.
- Economise with natural resources. Sharing facilities is a way to reduce resource use if it reduces new construction, but adaptation and remodelling also need to be done in a resource-efficient way
- Better information on which to base decisions. Indicators are needed to measure and monitor space utilisation. We also need to measure sustainability gains and create models to calculate the financial gains and risks associated with sharing.

The project has taken a four-step approach to the use of space, similar to the Swedish Transport Administration's four-step approach to creating a sound and resource-effective traffic system. The four-step approach is a strategy to ensure good resource economy. These steps can similarly promote the resource-effective use of facilities.[9] The project has chosen to focus on step two – intensifying the use of space, which is based on first looking at how to reduce the amount of space needed. This can also provide inspiration for how remodelling and new construction can facilitate future sharing.

Four-step approach to use of space

1. **Reduce the need for space**, an example being how banks have replaced physical branches with digital services in recent decades.
2. **Intensify the use of space by**, for example, using space and functions simultaneously or on different occasions.
3. **Adapt, supplement or rebuild facilities** or the spaces and functions around them to facilitate sharing.
4. **Build new facilities in a more sustainable way** to facilitate high utilisation simultaneously or on different occasions.

8 Mulder, K., 2016, "Urban symbiosis: A new paradigm in the shift towards post-carbon cities", in *NewDist*, (July), pp. 16-24.

9 Höjer, M. and Mjörnell, K., 2018, "Measures and Steps for More Efficient Use of Buildings" in *Sustainability 10(6)*, 1949 (https://www.mdpi.com/2071-1050/10/6/1949; accessed 17 October 2019).

The project has chosen to look at how to develop a market for sharing between organisations, rather than between private individuals or space effectiveness within an individual business/organisation. We have looked for fruitful ways to match the types of organisations that can benefit from sharing space, rather than focusing on creating spaces that are suitable for all. We have also studied solutions for both simultaneous use of functions and for sharing at different times of the day, week or year. We have focused on spaces that are relatively easy to share and do not contain inventory that is too valuable or that are specially equipped for a particular purpose. Examples could be a building owner renting to tenants who in turn share with others; tenants sharing functions with each other; or an intermediary managing the sharing solution and adding services. We have studied what sharing facilities means in terms of aspects such as symbiosis, design, innovative environments, business models and the role of the financial sector. The project has looked for transformative solutions, but has also studied possible short-term steps.

The work group met 10 times in 2018–2019 and on six occasions held full-day workshops that were attended by around 40 stakeholders to discuss the various themes in the report.

Vision

To achieve a level of utilisation of space that significantly reduces resource use and makes a positive contribution to environmental, social and economic gains.

Goal

The project goal is to facilitate the development of a market for shared space in Sweden involving sharing of functions, equipment and transportation to increase utilisation and thereby reduce resource use.

The subproject’s conclusions

»Cooperation between multiple actors across boundaries is necessary in order to establish a market for shared facilities. There is a great need for facilitators at all levels.«

The project has identified steps that need to be taken to increase sharing of facilities and has defined milestones that could facilitate this increase.

Seven steps to increase sharing of space

1. Take stock on an ongoing basis of how much existing space is being used.

2. Study the space and function needs on an ongoing basis. Can spaces be used differently? Could organisations be organised differently? Would less space be needed if activities were structured differently? Which functions are missing in buildings and/or districts that could supplement existing functions?

3. Is it possible to share space within the framework of existing work processes in the organisation?

4. Identify and communicate which spaces are empty and at which times, and how sharing with certain other organisations is possible simultaneously or at different times.

5. Look at how solutions for sharing space and functions with other organisations could be developed if the conditions were changed through, for example, remodelling, new work processes or different rules.

6. Build for multifunctionality and flexibility in reconstruction or new construction so that facilities/spaces can be used by more organisations and activities now, but also transformed over time to meet new needs.

7. Visualise the effects of sharing facilities:

   a) The environmental, social and financial gains and any losses or rebound effects and drawbacks of sharing.

   b) Include goals and follow-up processes for space utilisation in sustainability reports.

Six actors that could establish space sharing as the norm

Cooperation between multiple actors across boundaries is necessary in order to establish a market for shared space. There is a great need for facilitators at all levels. In its observations, the subproject on shared space has determined what needs to happen (based on which actors should be responsible for which actions) to establish a market to optimally improve resource effectiveness:

All actors

- Produce action plans for how to increase sharing of your facilities – preferably with support from the seven steps for increased sharing of space presented above.

- Enter into partnerships and start pilot projects to develop ways of sharing resources.

- Develop a Nordic system that facilitates industrial and spatial symbiosis to use underutilised resources in line with the UK's National Industrial Symbiosis Programme NISP,[10] and Finnish Industrial Symbiosis System (FISS),[11] where facilities are included as a resource to share in both urban and rural contexts.

10 International Synergies (https://www.international-synergies.com/projects/national-industrial-symbiosis-programme/; accessed 17 October 2019.

11 Sitra, "Information platform to enhance the use of waste and side streams" (https://www.sitra.fi/en/cases/information-platform-enhance-use-waste-side-streams/; accessed 17 October 2019).

The Government

- Create control mechanisms for increased resource effectiveness with an emphasis on the built environment.
- Overhaul the tax code, e.g. VAT rules to enable sharing between organisations.
- Overhaul the rental laws (in Section 12 of the Code of Land Laws) to encourage sharing solutions, such as tenancy protection, termination rules and definitions of homes and commercial premises.
- Overhaul the Planning and Building Act so that zoning plan rules encourage flexibility to enable existing buildings to be used in more ways.
- Produce data on the use of space and functions nationally and internationally, including data on square metres per type of activity and data on the number of users and when spaces are used.

Municipalities

- Offer open digital infrastructure with municipal platforms to show where underutilized space and functions are, to match needs and to support replicability and traceability.
- Require a sharing component to be included in procurement and land allocation processes.
- Create zoning plans that encourage flexibility so that buildings can be used in multiple ways, preparatory land use plans that explain the benefits of sharing, and development contracts that guide actors towards circularity.
- Take a proactive role in creating networks of actors for increased sharing in the municipality through, for example, cooperatives or development companies.
- Create mobility hubs to enable sharing by multiple smaller mobility actors, e.g. through the conversion of multi-storey car parks. The hubs could be expanded to include local sharing solutions.

The private sector

- Develop scalable services that can facilitate sharing and support behavioural patterns around matchmaking, contracts, insurance, safety, service and access. Design for the unique opportunities that sharing offers.
- Develop business models and types of contracts based on the differing incentives for commercial, public-sector and non-profit organisations.
- Produce commercial solutions for space sharing and develop systems for sharing profits and risks between, e.g. building contractors, real estate companies and tenants.
- Design for sharing in connection with remodelling or new construction by paying particular attention to aspects such as security, storage, flexibility, access and health and wellbeing.
- Support the inclusion of standards to measure utilisation in certification processes (e.g. LEED, BREEAM, Sweden Green Building Council, Citylab Action), standardisation and consequence assessments.

The financial sector

- Invest in new business models that focus on sharing.
- Include resource effectiveness and sharing of space as a requirement when providing green financing (e.g. green bonds, green commercial papers, green loans and impact bonds) for buildings.
- Accept and promote the inclusion of sharing as a provision in rental contracts.

- Design insurance policies for different types of space sharing. Participate in preparing proposals for contracts for sharing space – sharing at different levels, at different times and with multiple users.

- Include sustainability gains as well as potential risks associated with shared space in connection with valuation and financial assessments, (for example using indicators for resource use, social gains in the surrounding community, economic gains and peripheral services, calculation of alternative costs, transformation potential or how sharing of facilities contributes to the Global Goals).

Civil society

- Gather organisations that need or can offer facilities and identify common needs and wishes for matchmaking.

- Help to define and explain offerings to, for example, make it easier for actors to rent out space by introducing a guarantee of the condition of the space after renting and that activity in the space is conducted in a way that is ethically acceptable to the party renting it out.

- Spread awareness of the possibility of sharing space and present the positive effects, such as how sharing can increase integration by making other spaces available in the city.

- Highlight the value that sharing with civil society adds, e.g. with the addition of club rooms and assembly rooms, and engagement in an area.

Academia

- Develop utilisation indicators as well as supplementary indicators. Study utilisation rates and define a reasonable utilisation rate in various sectors.

- Produce models and sustainability assessments for space sharing solutions, and study potential rebound effects when sharing space/functions.

- Identify success factors for space sharing related to things like incentives, control mechanisms and the importance of social and cultural factors.

- Produce quality guidelines for the existing building stock to facilitate sharing in the long term, and present models for gradual change from owned to shared space.

- Follow up, evaluate and report regularly on different space sharing initiatives and projects, and spread knowledge and share experiences for use in relevant education programmes.

Analysis

»The Facilities subproject has identified five significant ongoing changes that are impacting the conditions for space sharing: climate and environmental crisis; demographic changes; urbanisation; increased gaps and social engagement; and digitalisation.«

External situation analysis

The Facilities subproject has identified five significant ongoing shifts that are impacting the conditions for space sharing.

Ongoing shifts

1. **Climate and environmental crisis** – The ongoing climate crisis and, in particular, demands for phasing out fossil resources will affect and set limits on how much more we can build. It will also affect which environments it will be possible to function in. The concept of peak resources (peak water, peak oil etc.). means that we cannot continue to use materials in the ways we are used to using them. We need to extract and reuse them in a circular way and reduce the volume we use. We are reaching a point where most of our ecosystems will not be able to endure or may collapse, and we need be able to cope with changes through greater flexibility, resilience, diversity and self-organisation.

2. **Demographics** – We have an ageing population where fewer of us need to support more of us. We are also witnessing growing migration, the pace of which will continue to increase due to the climate crisis. This will affect the types of facilities that will be needed and how fast we can convert them. Space sharing may affect how new, flexible and mobile work processes are developed.

3. **Urbanisation** – As the concentration of people and activities increases, the role of urban areas in creating the necessary conditions for resource-effective use of space and materials, and of energy, food, water and transport flows, will continue to grow in significance. In many cases, it is cities, regions and industries that step up as leaders in meeting sustainability challenges when global decision-making processes move too slowly.

4. **Increased gaps and social engagement** – Inequality is increasing in many areas. Depending on how sharing initiatives are designed, they may cause gaps to widen if they are expensive or they may have an equalising effect if they give more people access to other parts of society. Meanwhile there is a growing desire among citizens and civil society for sharing and co-creating processes to develop society.

5. **Digitalisation** – The great technology shifts taking place now are facilitating more flexible workplaces, reducing the need for physical retail space and offering technical solutions for sharing space and functions. More and more products are becoming services. Using digitalisation in planning processes enables us to measure the effects and facilitate sharing and future adaptations. The rapid development of technology will require adaptive regulation, bringing institutional and technical development together in new ways.

Status today

Political goals and processes

There are several goals and processes – both in Sweden internationally – that address resource effectiveness and shared spaces. Space sharing that reduces the need for new construction has the potential to significantly reduce greenhouse gas emissions and help us meet the goals in the Paris Agreement. Reduced resource use and circularity can help is achieve several of the UN's Global Goals as

well, including climate action and sustainable production and consumption. This is also in line with the EU's Mission for Climate-Neutral Smart Cities and Mission for Climate Change, two of the initiatives defined for the EU's upcoming Research and Innovation programme within Horizon Europe (2021–2027). The EU's Circular Economy Action Plan has, among other things, focused on construction and demolition waste and emphasised the importance of innovation and investment, as well as the need for a monitoring framework. The EU also has a sharing – or collaborative – economy agenda that has identified market access, user protection, liability, taxation and labour laws as key aspects.[12]

At the national level, Sweden's Generational Goal expresses an ambition to have resource-effective cycles without harmful substances. Reducing resource use in the construction sector could make a significant contribution to the environmental goal of "reduced climate impact". Within the goal of achieving "a good built environment", none of the indicators addresses sharing; the resource saving measures mentioned focus on construction and demolition waste and energy consumption. There is no resource effectiveness goal that is relevant to sharing because the focus is on redistribution and efficient use of resources and not extracting new resources. The All Party Committee on Environmental Objectives has determined that resource effectiveness should be an overarching goal to support climate policy. In February 2017 the Government presented a legislative proposal for a climate policy framework linking climate policy more closely to economic policy. The Government's circular economy commission[13] pointed out that Sweden has no national strategy or action plan for a circular economy and called for a delegation, which is now in place and has started its work.

The Government has also adopted a strategy for sustainable consumption that focuses on how actors could facilitate sustainable consumption. The social gains of sharing could make positive contributions to the national public health policy goal of creating the social conditions for good and equitable health for the entire population and close avoidable health gaps within one generation. There is, however, a risk of instead making things worse depending on how sharing solutions are designed. Several of the national processes could impact and be impacted by sharing of space, including the work of the National Council for Sustainable Cities and several of the Government's strategic innovation programmes: Viable Cities (which includes Sharing Cities), RE:Source, Smart Built Environment, Internet of Things Sweden and the previous Smart Cities joint programme.

Fossil-free Sweden is a platform launched by the Government for dialogue and cooperation to accelerate the climate transition. Many municipalities have themselves adopted fossil-free goals for 2030, 2045 or 2050. Several industries have adopted climate roadmaps based on this, including the construction sector, with many real estate companies now on board. Space sharing could become an important factor in reaching the roadmap goals.

Real estate industry

Many significant changes have impacted the demand for space/facilities. The introduction of the "just in time" concept, which emerged in the 1990s, put warehouse inventory on wheels. Ecommerce is reducing the need for physical retail space, but is using large logistics facilities and more transportation. Our industrial estates mainly contain wholesale actors and the volume and retail trade rather than traditional manufacturing. Moving before and after school programmes from their own facilities into schools started in the 1990s. Carpools are reducing the need for parking space. Activity-based offices – and, increasingly, virtual workplaces – have reduced the need for office space.

12 European Commission, 2016, "COM(2016) 356 — A European Agenda for the Collaborative Economy" (http://ec.europa.eu/DocsRoom/documents/16881/attachments/2/translations; accessed 17 October 2019).

13 SOU 2017:22, "Från värdekedja till värdecykel — så får Sverige en mer cirkulär ekonomi".

Commercial space has been a long-term investment in mortgaged buildings for many years, with well-regulated, long-term leases and where each organisation considers it natural to have their own space. For a while now there has been a trend towards greater mobility and shorter contracts. The utilisation rate of office space is low in general, but we have found no studies focusing on the differences between types of facilities or types of activity. Further studies are needed of where the potential is and what the risks are from a work environment, health and wellbeing perspective. Many organisations have reduced their office space in recent years and more and more of them are transitioning to activity-based offices with no fixed locations as part of this trend. The freelance market is increasing and replacing large employers in multiple industries. This is affecting the types of contracts that people want. Renting a space in a co-working model is a small but growing portion of the market. For smaller companies this can be an important solution, while for larger ones, adding co-working space during temporary peaks in business can be a flexible complement. Digitalisation of the workplace and the increasing number of global organisations are also leading to more co-working solutions.

Municipalities

Municipalities have an important role to play in between the citizen-driven and profit-driven sharing initiatives, including providing access to space but also providing digital and physical infrastructure to enable sharing and take advantage of the ecological, social and economic gains to be made from sharing space. Around the country municipal authorities are sharing space with their citizens and non-profit organisations, including facilities that have been shared for many years such as assembly rooms, sports facilities and cultural centres, but also other types of spaces such as kitchens, space for cultivation, space for mobility solutions, and more ways to use public spaces. The task of municipal authorities is fundamentally to safeguard common resources. They are in a good position to support space sharing – both within their own operations (through, for example, sharing space and interiors) and by sharing space with other organisations. There is considerable interest among many municipal authorities but there is also uncertainty about what is permitted. Control mechanisms and support systems need to be defined or reformed in order for initiatives to be successful and to last.[14] Guidelines for Swedish municipalities on the sharing economy from Avfall Sverige and IVL Swedish Environmental Research Institute focus on what role municipal authorities can play in leading, facilitating or providing an arena for sharing initiatives. Analysis shows that there are many smaller shared space initiatives under way but that there is no shared responsibility or strategy on the part of the municipal authorities.[15]

Example of types of sharing

There are many types of ongoing space sharing initiatives within municipalities, industry and civil society, for example:

1. **Shared office space** – *WeWork* and *Workaround* are intermediaries that lease facilities and rent them out as co-working spaces. Many actors are offering peripheral services and support, such as the *Norrsken* hub in old tram depots in Stockholm that offers space, functions and support for start-ups. Some property owners are offering their own co-working concepts. Some actors are offering space to promote inspiring exchange. These include *Vasakronan* and *Chalmers Arkitektur*. Coffice is a

14 Bernstad Saraiva, A. and Andersson, T., 2017, "Rapport 2017:8. Inventering av kommuners arbete för hållbar konsumtion", Swedish Consumer Agency.

15 Andersson, T., Matschke Ekholm, H., Fjellander, L., Harris, S., Ljungkvist, H. and Zhang, Y., 2018, "Rapport B2311. Dela prylar, yta, bil och tid. En vägledning till delningsekonomi i kommunerna", IVL Swedish Environmental Research Institute and Waste Sweden.

combined café and office space where people can work. *Hoffice* is a movement where people share work space in each other's homes. *Deskdoubler* and *Meetrd* are examples of marketplaces for shared empty office space. *Seats2meet* combines matching workplaces with sharing knowledge.

2. **Retail space** – Within retail there is already considerable space sharing happening, e.g. in the form of brands that rent space on a retail chain's sales floor, or commercial tenants with extra space allowing a café to use it.

3. **Municipal offices** – *Nomad Inn* was a past solution in Gothenburg to make spare municipal space available. *Boffice* is a similar initiative in Solna that offers temporary space in various buildings. In most municipalities like Gothenburg, Stockholm and Malmö, schools have opened up space for clubs and people to use outside of school hours. In Järfälla Municipality clubs are free to use space in libraries. In Upplands Väsby a school has multiple functions as a school, before and after school programme, space for local government and a waiting room.

4. **Shared functions** – *Attendo* and *Ullna* provide shared cafeterias for schools and care homes for the elderly, designed based on needs.

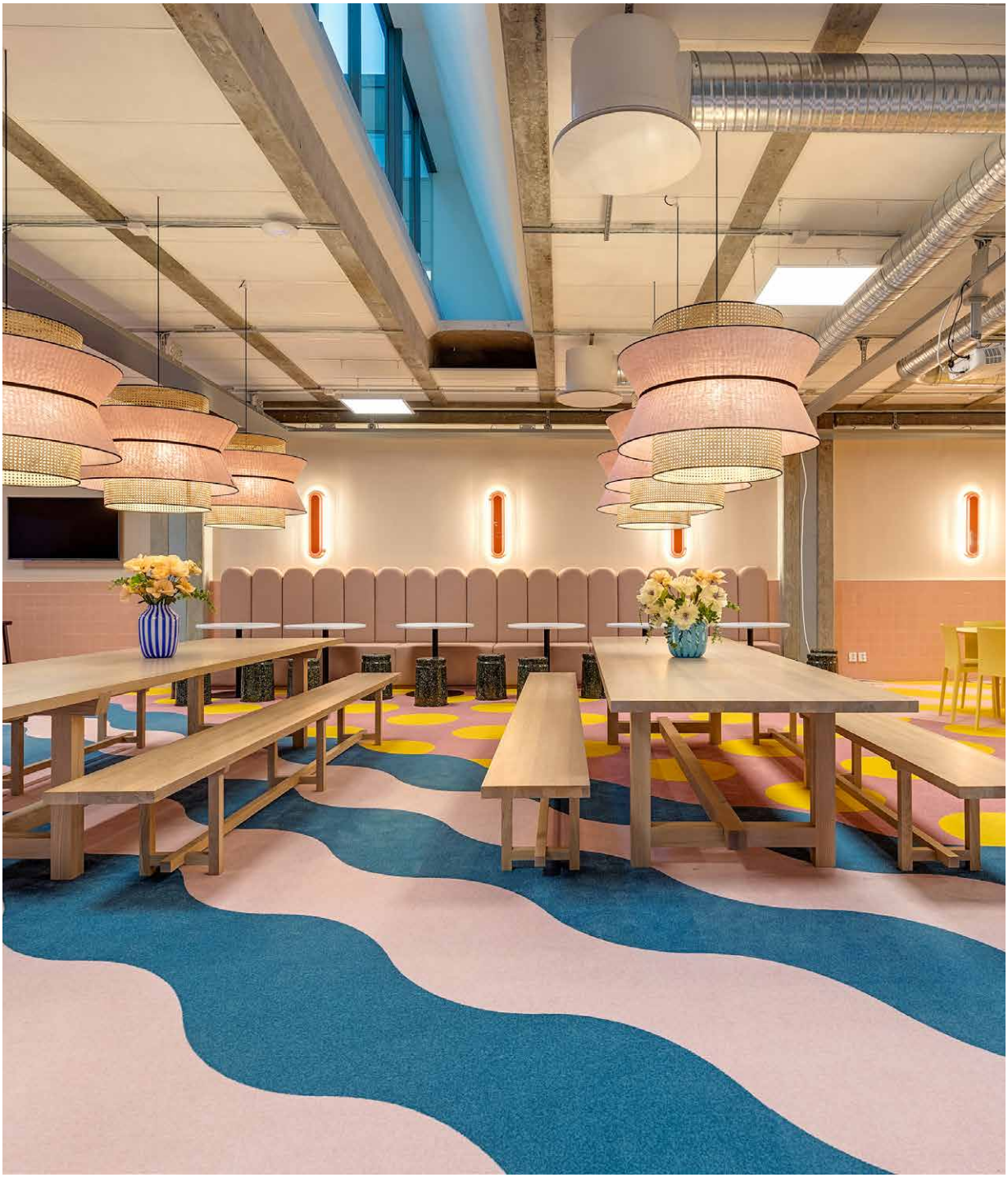
5. **Citizen-driven sharing** – At *Pixlapiren* in Helsingborg people can borrow and develop part of the pier for a period of time. Among other things, volleyball courts, cultivation boxes and workshop spaces have been set up temporarily on the pier. There are also tools and building materials available that can be used to construct a space. In a village outside Umeå an inventory was made of different buildings for sharing to create a vibrant community and slow the sale of public spaces. This has been developed into an association that runs various activities. In *Lindefallet* in Hudiksvall Municipality in Hälsingland 30 or so non-profit associations share a remodelled village school.

6. **Open digital systems** – Helsinki and five other Finnish cities have an open booking system called *Varaamo* which was set up to enable private actors to borrow/rent space. The public library in Helsinki rents out rooms and various items. In Finland in general the municipalities are required to ensure that spaced is shared. District hosts are assigned the task of facilitating the matching of actors in new urban districts. Amsterdam municipality makes all of its offices and spaces available for employees of various administrations, which also reduces commuting. The Netherlands has a long tradition of user contracts in which citizens can take care of and maintain outdoor spaces, such as parks and urban farms.

7. **Built for sharing** – In *Swecohuset* around ten different companies share a meeting space and services. Examples of public spaces built to encourage multiple types of co-use are cultural centres such as *Mångkulturellt centrum* in Botkyrka or *Bergsjöns kulturhus*.

8. **Shared mobility that facilitates shared space** – Uppsala is building mobility buildings instead of underground garages, the idea being to rebuild/tear down structures as needed, but also to bring in other shared mobility solutions. In Finland and Sweden mobility solutions that integrate more options to get from A to B, public transit or by scooter, taxi or rental car such as *Ubigo* and *Whim*.

9. **Mix of functions –> function sharing** – *Ärvingefältet* in Kista, *Stora Ursvik* in Sundbyberg and *Herrgårdshagen* in Gävle offer facilities directly adjacent to residences, which offers better future potential for sharing compared with facilities located at a distance from homes..



Spatial symbiosis

»The most sustainable building is the one that doesn't need to be built.«

Jerker Nyblom, Senior Advisor, Akademiska Hus

Symbiosis in shared space involves actors sharing space and functions, as well as symbiosis with other systems and surrounding spaces. In terms of sharing among actors, the project sees great potential for shared space in offices, schools, public facilities and spaces that are temporarily empty. There are spaces and functions that could be used by several actors at the same time and spaces and functions that could be used by multiple actors at different times of the day, week or year. A relevant approach is to look at the physical space ("If this wasn't a restaurant, what would it be?") and functions (If this restaurant didn't have its own physical space, how would it function?"). Functions that can be shared are equipment and technology, services (such as reception, janitorial or logistics), outdoor environments and roofs, purpose-built facilities (such as kitchens, gyms and workshops) and energy, water and heating flows. Some of the most intensely utilised spaces today in terms of number of users and amount of time occupied are assembly rooms and public transport hubs, as well as care and service facilities. There are also enterprises/organisations where the resource used is water, energy or material flows, and where space can be used intensely by a few users.

Several success factors identified for industrial symbiosis[16] are also relevant for interoperability of shared spaces to work: the existence of a process owner; each actor understanding what symbiosis involves and what they can gain from it; identifying matching actors; the *springboard effect* – to present cooperation that is already happening today, short geographical distances, short mental distances, and a good collaborative climate, a focus on large continual flows and joint problems.

To achieve sustainability gains from sharing space it is more important to look at interaction between many actors in society than at individual matches. Here, municipalities have a key role to play as an arena for cooperation. Today the public sector is more open to sharing than the private sector but, due to the Public Procurement Act, it is more difficult for the public sector to go into the private sector than vice versa. The following actors that could benefit from sharing facilities with each other:

- Organisations within the same industry/sector or that offer supplementary services
- Organisations that inspire each other
- Operations that can be combined, such as care and pharmacies
- Organisations that need similar functions within an area
- Temporary work spaces or pop-ups and organisations with underutilised space
- Professionals and education programmes that can share facilities and equipment.

Drivers

It is crucial to build on the drivers that exist to generate cooperation for a shared space market. Environmental gains are often cited as being the driver for municipal authorities but only a few of them have calculated the environmental effects of the sharing they are engaged in.[17] Measuring and demonstrating the environmental gains of reduced resource use and reduced greenhouse gas emissions could strengthen the economic drivers. A study that looked at 110 global sharing companies found that 94 percent of the organisations claimed they were creating social and environmental gains but only 25 percent of them attempted to measure the gains in a systematic and quantifiable way.[18]

16 Dalväg, E, presentation at IVA, 10 September 2018.

17 Fjellander. L. et al, 2019, "Rapport C3711. Delningens potential", IVL Swedish Environmental Research Institute.

18 Wagner, T., Kuhndt, M., Lagomarsino, J., and Mattar, H., 2015, "Listening to Sharing Economy Initiatives", Report on a Global Survey: 38.

Social gains from sharing are often more immediately visible but can be hard to quantify. Still, many municipal authorities say that their main motivation for sharing is the social gains. More studies have been done of what drives individuals to share than organisations, but as new habits and work processes ultimately depend on the choices made by individuals, his aspect is highly relevant. The main drivers for users are often accessibility, convenience and low risk, while social drivers can motivate people to actually choose to share.[19] The Royal Institute of Technology (KTH) in a project called "Urban Sharing" found that many sharing initiatives are based on proximity between those who will be sharing the resources. Many projects are started by people locally with the help of sharing platforms. KTH has studied citizen-initiated resource pools and systems to share tools, vehicles, gardens, spaces and clothing in Barcelona, Malmö and London.[20] Sharing Cities Stockholm has an ongoing partnership with a citizen initiative in the district of Hammarby Sjöstad. The project is studying processes that promote trust and confidence among neighbours in various residential areas as factors for increased sharing and use of common spaces that have more resources.[21] The MOBO project in Viable Cities and the new residential project BRF Viva built by Riksbyggen in Gothenburg are examples of projects that have looked at incorporating mobility solutions and sharing with *"P-tal O"*, i.e. where buildings have no car parking facilities/spaces, but where innovative planning can lead to new solutions.[22]

Financially there are clear coordination gains and savings to be made, as well as the potential for new business models. The structures of these concepts are new, however, and trailblazers are needed who invest and design sustainable business models. Brand positioning and economies of scale are important factors for established sharing enterprises, while market access and access to growth capital are more important to new sharing ventures.[23] A study from the Economic Policy Forum describes how the sharing economy is changing the economic drivers, with fast and cheap development leading to a supply shock with low entry barriers and the ability to scale up activities without much capital, where time and accessibility are the assets. The study cites the potential for new job opportunities, some of which have been lost due to digitalisation but can be replaced by self-employment and freelancing in a sharing economy. The study also describes obstacles such as labour laws and uncertainty about who has responsibility, who shoulders risk, and tax issues.[24]

Incentives

Property owners

Property owners today have no significant incentives for sharing space that is already fully rented out because they are being paid for 24/7 through the rent they collect. It is possible to develop financial incentives to increase the amount of money they can generate through new types of contracts and to allow for parallel renting or subletting. Brands benefit from there being a good mix of activities in an area and this can also be incorporated into urban planning. There is value in facilities being used; when there is movement in an area it promotes safety and demand for services. It may also benefit the community, reduce future social costs or meet an organisation's sustainability objectives. Space is cheap today compared to if the social costs of construction were

19 Fjellander. L. et al, 2019, "Rapport C3711. Delningens potential", IVL Swedish Environmental Research Institute.

20 Bradley, K., "Urban Sharing – The rise of collaborative consumption and co-use of spaces" (project). Bradley, K., Ekelund, L., 2015, "Dela är det nya äga "(film), LottaFilm (www.delafilmen.info; accessed 26 September 2019).

21 Sharing Cities Sweden (https://www.sharingcities.se/; accessed 26 September 2019).

22 Mo-Bo – Arkitektur för hållbar mobilitet (https://viablecities.com/foi-projekt/mo-bo/; accessed 17 October 2019).

23 Fjellander. L. et al, 2019, "Rapport C3711. Delningens potential", IVL Swedish Environmental Research Institute.

24 Felländer, A., Ingram, C., and Teigland, R., 2015, "Sharing Economy: Embracing Change with Caution", Economic Policy Forum.

included, e.g. through a raw material tax (which is likely in the future). There will probably also be requirements added to public procurement processes, or required levels of utilisation of land.

Tenants

For tenants there are financial gains to be made by sharing costs and commercial opportunities. It offers flexibility and access to networks that can provide both inspiration and skills. Other drivers could be creative and attractive work environments and strengthening employee loyalty and brands. Here too there may be benefits for society and a reduction of the future social costs to meet an organisation's sustainability objectives.

Secondary users

The incentives for secondary users are similar to those of tenants. Networks and flexibility often increase, and sharing also provides easier access to space and functions. The last actor is usually the one with the incentives for sharing but this should be moved up the value chain.

Service developers, service providers and administrators

Sharing facilities will involve a multitude of new services, and the potential for new business models is significant – ranging from system development to packaging, services and intermediaries. To improve the incentives for service developers to share, the practical and regulatory obstacles need to be adapted. Support is also needed for trailblazers who can demonstrate models that work. There are service developers and property managers in public, commercial and non-profit contexts but their incentives may differ depending on what their mission is and how they operate. For adaptation and remodelling for sharing to be optimally resource-effective, we also need to look what incentivises entrepreneurs to make sure they are not making a profit from high resource consumption and so that guarantees can be provided regarding reused materials.

It would be useful to look at resource effectiveness and sharing of facilities on different scales: in a building, a district or a city. When we consider groups of buildings in an area rather than focusing on individual property owners, we see interactions taking place in the area and the impact on different spaces and systems, such as infrastructure, communications and green spaces.

Potential

The impact of sharing solutions on the environment, social factors and the economy depend on how the solutions are designed. There is significant potential for savings, new services and business models, access to more resources, strong brands and employee loyalty, new networks, inspiration and new knowledge, as well as more efficient and flexible operation. There are also potential socioeconomic gains from having new meetingplaces, attractive environments, participation and integration.

In its Circular Economy Playbook, Finnish company Sitra presents shared resources as one of five business models for a circular economy[25] and suggests that recognising the inefficiency of linear business models is a useful starting point to identify the most promising circular business models. Consulting firm PwC estimates that the sharing economy will have a turnover of USD 335 billion dollars globally by

25 Sitra, 2018, "Circular Economy Playbook" (http://www.kasvuakiertotaloudesta.fi/; accessed 17 October 2019).

2025.[26] China has expressed a goal of its sharing economy accounting for 10 percent of the country's GDP by 2020 and 20 percent by 2025.[27] A report from the Ellen MacArthur Foundation, *Potential for Denmark as a circular economy. A case study from: delivering the circular economy – a toolkit for policy makers*,[28] explores how a number of industries could boost the circular economy and what would be a good method for developing policies in a circular economy. Among other things, the study looks at the construction and real estate industries where one of the ideas presented is how sharing, multifunctionality and adaptation of facilities can reduce the need for new construction. The annual value of this in Denmark is estimated to be around EUR 300–400 million up to 2035. This is mainly based on utilisation rates increasing by an estimated 60 percent and a reduction in demand for new facilities of 10 percent, which would mean cost savings. According to the same study the 35–40 percent of office space is being utilised during office hours in Europe. Vasakronan estimates that utilisation is as low as 10 percent if all the hours in a year are included in the calculation.

There is also a risk of negative environmental, social or organisational impacts, which will mean additional costs from increased wear and tear of equipment and environments, increased cleaning and service needs, the need

26 PwC, 2015, "Sharing or paring? Growth of the sharing economy" (https://www.pwc.com/hu/en/kiadvanyok/assets/pdf/sharing-economy-en.pdf; accessed 22 November 2019).

27 State Information Center, (http://finance.sina.com.cn/roll/2017-04-18/doc-ifyeimzx6886194.shtml; accessed 22 November 2019).

28 Ellen MacArthur Foundation, 2015, "Potential for Denmark as a Circular Economy. A Case Study from: Delivering the Circular Economy – A Toolkit for Policy Makers" (https://www.ellenmacarthurfoundation.org/assets/downloads/20151113_DenmarkCaseStudy_FINALv02.pdf; accessed 17 October 2019).

for better ventilation, and regulation of how liability is distributed among actors who are sharing, in particular when private companies reduce their space and instead using municipal space. There could also be negative effects on health and wellbeing if space utilisation is too intense. It is particularly important to preserve the sense of community and security because sharing space and functions can change dynamics.

Challenges

Critical environmental factors and potential rebound effects

For sharing of space to have a positive environmental impact in general and be resource-effective in particular, a few factors are especially critical. (The list is taken from the RE:Sources project focusing on the potential of sharing[29] but has been adjusted based on the information gathered in this study and what is most relevant for facilities.)

1. **High utilisation rate.** In order for shared space to improve resource effectiveness, the sharing solutions need to be widely used. This requires simplicity, building a sufficient critical mass of facilities to share and organisations that want to share, and access to the physical and digital spaces – geographically, in time and on equal terms. The risk is otherwise that consumption and resource use will increase due to adaptation, remodelling, additional services and systems being put in place and then not used.

2. **Resource-effective facilities.** In order for shared space to significantly improve resource effectiveness, the sharing model needs to be established as the norm in all buildings, and not just created for resource-intensive facilities while waiting for renovation, reconstruction or demolition to take place. The functions and the equipment that are obtained for sharing need to be products that are the most efficient throughout their life cycle. There is otherwise a risk of being locked into using inefficient products.

3. **Sustainable use.** The sustainability gains made in shared space should not be used to increase resource consumption in another area.

4. **Modes of transport and distance travelled.** It is important to take into consideration and work together to address the changes sharing space will involve for mobility, in terms of the modes of transport and distance travelled for those using the space. There is often a possibility of reducing emissions through sharing, but there is also a risk of increased emissions if employees have a longer commute to work and if there are no available bike paths or public transport options. Mixing functions as described above is a way to promote sharing with minimised transport by shortening the distances between homes and workplaces.

5. **Extend the life of shared facilities.** Ensure that shared spaces, functions and equipment are of sufficiently high quality so they can be shared and that the sharing solution promotes a sense of responsibility among users for safeguarding what they are sharing. This should be done in a way that does not shorten the lifecycle of spaces, equipment and functions. There is a risk of unnecessary remodelling work and interior's being more quickly replaced if users want to promote their brand. In necessary adaptation and remodelling processes, rather than buying new products, existing ones should be reused, repaired and upgraded to the greatest extent possible.

6. **Effective political support.** When sharing is the most resource-effective solution, both increased

29 Fjellander. L. et al, 2019, "Rapport C3711. Delningens potential", IVL Swedish Environmental Research Institute.

awareness of the potential sustainability gains of sharing and targeted investments in the shared space are needed. If support is misdirected the result could be undesirable effects on markets, society and the environment.

Success factors for upscaling sharing solutions

The following aspects are crucial to ensure that investments are made and shared solutions can be scaled up. (The list is taken from the RE:Sources project focusing on the potential of sharing[30] but has been adjusted based on the information gathered in this study and what is most relevant for facilities.)

1. **Trust.** Trust is the key to the success of a sharing initiative. It is important to trust those we will be sharing with, trust the solution and any intermediaries involved, and trust the facilitating system such as the technical platform. Regulation is needed to provide sufficient protections for both sharing providers and users.

2. **Accessibility.** Geographically and in time – to the resource booking system and the space – relating to how easy it is to get access and who can have access. Sharing can promote accessibility and community and increase integration by, for example, giving organisations and associations access to facilities in new parts of a city during the evening when many offices are empty.

3. **Managed risk.** Sharing is associated with risk which is managed through rules that assign responsibility or through commercial insurance policies. A good user experience is key in ensuring that users will want to share again and in how they communicate their experience to others. It is important to including rating and evaluation tools to help improve sharing solutions and create a basis for trust in other users.

4. **Quality.** Achieving good quality and a good working environment despite increased use requires adjustments to be made to things like ventilation and technical systems. If existing facilities are to be shared sustainably they need to maintain sufficiently high standards of health and safety and avoid excessive energy and resource use or an inefficient layout. They also need to be designed for sharing based on user needs.

5. **Simple solutions.** Simple solutions are needed for matching, booking, identification and access. Convenience is a strong driver for sharing, and solutions that provide access but do not require ownership, management and responsibility are the ones that are attractive.

6. **Visibility and critical mass.** Poor awareness of sharing and actors not being used to sharing result in an insufficient critical mass of users and facilities for sharing. Sharing solutions need to be made visible and easy to find. Similarly, evidence of the positive sustainability effects of sharing needs to be made visible and communicated to users in order to increase sharing.

7. **Affiliation.** People need to feel an affiliation to the space they spend time in, and many want to have their own time, space and personal sphere. In order to successfully scale up sharing, these needs must be incorporated into the design, business models and policies.

8. **Managing negative effects.** The ability to limit and manage the negative effects on conventional business of a sharing economy is an important factor in successfully scaling up sharing solutions. Groundbreaking changes normally meet with significant resistance from existing enterprises who put pressure on decision-makers and hamper the development of new solutions.

30 Fjellander. L. et al, 2019, "Rapport C3711. Delningens potential", IVL Swedish Environmental Research Institute..

9. **Access to capital** is often critical for growth and to achieve critical mass and long-term financial sustainability. This is true for both commercial solutions and non-profit initiatives.

10. **New rules.** Adapting rules and tailoring control mechanisms is important in order for new sharing models to take shape.

Sharing space impacts resource effectiveness in other systems

Sharing space and functions affects resource effectiveness in more ways than merely intensifying the use of square metres. It also affects, for example, the extent to which building materials, fixtures and fittings are reused, upgraded, remodelled or sent out for reconstruction/new construction for sharing. Co-use of space could also generate other resource effectiveness gains, such as shared mobility, shared equipment or shared services.

The investments in reconstruction, interiors, access solutions that will be required to facilitate sharing need to include financial solutions that have mechanisms and assessment methods to minimise the risk of unnecessary resource use. There is a risk of financial gains negatively impacting resource effectiveness, with more space than is needed or excessive remodelling work being done.

A study by KTH,[31] [32] produced scenarios for how the climate impact of Swedish buildings could be reduced by more than 90 percent by 2050. The study concluded that we need to increase the energy efficiency of buildings, remove fossil fuels from the energy mix, optimise and reduce the use of space and reduce emissions from construction and renovation. The two first strategies have been discussed over a long period in the construction and energy sectors and much is already known about how to do go about it. In Sweden and the rest of the Nordic region, we build well-insulated buildings that have low energy use throughout their lifetime. The Swedish energy mix also has a low environmental impact – around 15 grams CO_2/kWh.[33] The two other strategies have been discussed to a significantly lesser extent. Often there are requirements regarding energy use per square metre, but not for how many square metres are being used. More efficient use of space could also reduce the need for new production and thereby also emissions from construction. The effect of new construction on the climate and environment varies among different types of construction and standards. The impact of construction projects can be calculated and compared using life cycle assessment-based tools such as the Construction Sector's Environmental Calculation Tool (BM).[34]

Reduced space means less energy use – during production and in the user phase. If we also take into account infrastructure construction that will not be needed (roads and transport systems, energy and water systems and pipes/cables, parking etc.), the effects of increased space sharing are even greater. A RE:Source project focusing on the potential of sharing ("Delningens potential")[35] produced a

31 Francart, N., Malmqvist, T. and Hagbert, P., 2018, "Climate target fulfilment in scenarios for a sustainable Swedish built environment beyond growth", in *Futures* Vol 98, pp. 1-18.

32 Gaffney, O., Rockström, J., Falk, J., Bhowmik, A.K., Bergmark, P., Henningson, S., Höjer, M., Jackson, R.B., Klingenfeld, D., Loken, B., Nakicenovic, N., Srivastava, L. and Wilson, C., 2019, "Meeting the 1.5°C Climate Ambition moving from Incremental to Exponential Action. Report to the UN Climate Action Summit 2019", Exponential Roadmap 2030.

33 Mata, É. and Johnsson, F., 2017, "Cost-effective retrofitting of Swedish buildings", Chapter 12 (pp. 341-361) in ed. Pacheco-Torgal, F. et al, 2017, *Cost-Effective Energy-Efficient Building Retrofitting*.

34 IVL Swedish Environmental Research Institute, 2017, "Nytt verktyg hjälper dig räkna fram byggnaders klimatpåverkan", (https://www.ivl.se/toppmeny/pressrum/pressmeddelanden/pressmeddelande---arkiv/2017-05-31-nytt-verktyg-hjalper-dig-rakna-fram-byggnaders-klimatpaverkan.html; accessed 26 September 2019).

35 Fjellander. L. et al, 2019, "Rapport C3711. Delningens potential", IVL Swedish Environmental Research Institute.

model of shared office space which shows that the total reduction of greenhouse gas emissions could be in the range of between 125 $ktCO_2$/year and 230 $ktCO_2$/year depending on the sharing solution and the assumed potential for reduced floor space, if all office space is converted. If the percentage of shared office space in Sweden were to reach the 10 percent level expected in London, a cautious estimate of a 50 percent reduction in office space needed within that 10 percent would result in 1.4 million m² of space being freed up. In Sweden around 418,000 m² of new office space is built annually. This would in theory be superfluous. Not building the new office space would be equivalent to savings of around 104,500 tonnes of CO_2 equivalents per year (assuming 250 kg CO_2/m²).[36] The study does not quantify resource consumption, but a certain percentage of shared space could mean an equivalent percentage of resources not being consumed in new construction. The amount of furniture and equipment needed is also reduced through sharing, which brings additional environmental savings in terms of resources and emissions.

Sharing of facilities at different times could also provide a better distribution of the flows of energy, water, waste and traffic over a day and week, and thus avoid the peaks and troughs that occur today.

Shared space in industrial and spatial symbiosis

Shared space and functions can be an aspect of industrial symbiosis through common storage solutions and temporary logistics solutions, or other shared flows associated with facilities such as water management, cleaning, cooling or heat. Sharing functions and spaces (such as restaurants, conference rooms and libraries) can be the first step towards a discussion and cooperation for more industrial symbiosis. Sharing space to reuse items and materials and recycle and manage waste could result in more resource-effective systems, control and transport, but could also lead to more industrial symbiosis. When production, processing, repair and upgrading in the manufacturing and remanufacturing industries become more local and based on on-demand 3D printing locally, more nearby, joint and temporary spaces will be needed for this. In Sotenäs the municipal authority is leasing an old industrial plant where enterprises involved in land-based aquaculture can rent space at cost for short periods to identify opportunities for industrial symbiosis. There is also a marine recycling station with a test bed to test new technology and materials. Opening up these types of facilities lowers the threshold for organisations to come in and test innovation and symbiotic opportunities.

One option is to develop a Nordic system to facilitate industrial and spatial symbiosis, as has been done in the UK with the National Industrial Symbiosis Programme (NISP)[37] and in Finland with the Finnish Industrial Symbiosis System (FISS).[38] This could be a system to facilitate symbiosis where recycling and reuse impact design and use of underutilised resources, and where sharing of space and functions can be an important component in a symbiosis system for material flows. A marketplace like this provides opportunities for cooperation and to identify more circular value chains.

36 Fjellander. L. et al, 2019, "Rapport C3711. Delningens potential", IVL Swedish Environmental Research Institute.

37 International Synergies (https://www.international-synergies.com/projects/national-industrial-symbiosis-programme/; accessed 17 October 2019).

38 Sitra, "Information platform to enhance the use of waste and side streams" (https://www.sitra.fi/en/cases/information-platform-enhance-use-waste-side-streams/; accessed 17 October 2019).

Innovation and design

»In future circular construction, existing building will be our greatest resource – both to be fully utilised and to reuse in different ways. From a climate perspective it is more relevant to measure a building's whole life cycle, including construction and design enabling high utilisation and change over time than to measure energy use.« **Sanna Hederus, co-owner and founder, KOD Arkitekter**

The project has identified a need for innovation and design in multiple areas to facilitate sharing of space among organisations. Everything from types of organisational structures and work processes, technical platforms, spatial adaptation and remodelling, to new services, business models and policy adjustments will be needed to facility sharing. The conditions vary for commercial, public-sector and non-profit actors in terms of incentives, VAT and procurement. The rules need to be adjusted in line with new forms of cooperation. Existing cooperation, insurance policies and tax rules are based on an owner renting out to a user who uses the space. The need for adjustment and development is therefore significant to support a structure that includes multiple owners and users.

In organisational structures

Many organisations today are more flexible and not as tied to one location or each employee having an individual space. The existing drivers and needs of an organisation could be the starting point here. Space sharing is often a cultural innovation and it is important to identify ways to lead innovation in this area. A mandate to act is needed within the organisation, as well as support early on in the process. Work processes, routines, organisational structures and social interactions can all be affected. When implementing a solution it is necessary to take into consideration attitudes towards, experience of and the values around sharing. People may also be fearful of and resistant to sharing space. If so, it is important to work on getting people on board and involved, present inspiring examples, address what will be separate, shared and public, and present the social, environmental and commercial gains. Sharing solutions are new for many people and bold goals and ambitions are therefore needed. It is important to review the policies and rules that apply within an organisation so that they promote sharing rather than prevent it. A structure should be created for allocating risk and gains so that one part of an organisation is not carrying the entire cost or risk while another reaps the rewards.

Collaboration and cooperation are needed among actors to produce innovative solutions and create a market for shared space. Partnerships and sharing solutions should be tested in pilot programmes.

In technology

Technological development is resulting in digital spaces that have varying degrees of openness and where separate, individual physical spaces are no longer required. Although there are numerous booking systems and technical platforms supporting sharing services today, integration is needed among different industries and solutions need to be packaged to enable sharing on a larger scale. Support systems are needed to match organisations and identify underutilised local resources. Digitalised support is needed for actors sharing space, in areas such as access, identification, security and booking. Booking systems should be developed for co-use of space with functions categorised by area rather than by facility. Information on available space should be available in realtime based on the various

needs addressed. Several exponential technologies have the potential to facilitate sharing. Blockchain technology can facilitate built-in sharing agreements, artificial intelligence can facilitate matching of actors and the Internet of Things can show what is available in realtime. A digital method is required in order to use and share these systems for equipment, video conferencing etc.

In spatial aspects

Spatial innovation and design for remodelling and extension of existing facilities should focus on: flexible solutions, high quality, access, business security, storage, wellbeing, and creative and efficient environments. Numerous factors need to be combined. It is important to create a flexible structure with sharing options for a broad spectrum of organisations/activities of different sizes. The furniture, floor plan and use of functions can vary from more separate to open. High quality is important so that facilities can withstand greater wear and tear. This means making good material choices and incorporating components that can be replaced and systems for lighting, sound and ventilation that can be adapted for sharing. Health and safety aspects, such as ventilation and fire safety, are affected by having more users. It is important to facilitate access to different parts of a building using technology, locking systems and having more entrances, and also to guarantee the security of the sharing actors. Sharing requires storage and logistics solutions which can be separate or combined as needed. The spatial design needs to provide the right conditions for good services; for example, the facilities should be easy to clean and take care of, and easy to repair and upgrade. For larger scale sharing of facilities, the design needs to meet a range of requirements rather than just general ones. Common functions need to be identified and planned so that they can easily be accessed and used jointly. The right design can facilitate a sense of community through inviting spaces, bike garages, changing rooms, break areas, gardens and entrances. Design can help to shift norms, making sharing space the norm, supplemented by separate spaces as needed. The design of the shared spaces and functions should be seen in the broader context of the surrounding area.

The potential for space sharing is closely related to the architect's specific ability to plan, facilitate and interpret the various needs and potential of organisations/actors for co-using space. There is no standard architectural solution for sharing, but rather many different ones and these depend largely on the physical conditions at the location. The task of the architect is to observe the needs of organisations and their employees and adopt a circular perspective based on symbiosis. The architect has the potential to play a very important matchmaking role and find innovative solutions, and it is therefore essential to engage this industry.

In new business models

Sharing of commercial premises and functions can lead to the creation of numerous new services and business models. The significant commercial opportunities are mainly to be found in add-on services. Packaged solutions and intermediaries that provide contracts, insurance, security, services and access will be crucial in establishing a market for sharing of space. There are no large-scale services coordinating matching of actors and timing, needs and available space. Smart ways to co-use joint functions rather than whole facilities (kitchens, dining rooms, toilets, quite rooms, conference rooms, gyms etc.) are needed. There is also a need for services addressing damage, practical services and disputes. Insurance solutions will need to be developed for different types of agreements. Other services could be joint activities that increase social value or calculating the environmental gains of shared space, and functions and systems such as energy, water and mobility. Actors need to be made aware of these aspects. Frontrunners will be needed to demonstrate success.

In Urban planning

Buildings and facilities are always interacting with the spaces around them. Adjacent outdoor spaces can be used for meetings across generations; a preschool playground could, for example, be used by older children, teenagers or adults, or to create meetingplaces next to shared space

such as workshops for courses or individuals in the same area. It is important to review the existing facilities and plan for which functions will be required for activities, rather than for public or private sector actors or a specific industry, to enable there to be a diverse range of spaces for organisations/activities that change over time. It is also useful to plan for shared services with local places that attract a lot of people to facilitate sharing between more actors in the area. These could be terraces, roof parks, cafés, mobility notice boards (public transport, rental bikes, vehicle pools), reception areas, IT workshops, repair workshops etc.

Sharing of space, functions and mobility should take place in a symbiotic system. During the course of the project, the mobility situation and the nature of space sharing has changed. For example, platforms are being created that steer people towards combined mobility involving bicycles, electric bikes and scooters that extent what is considered a reasonable distance to work etc.

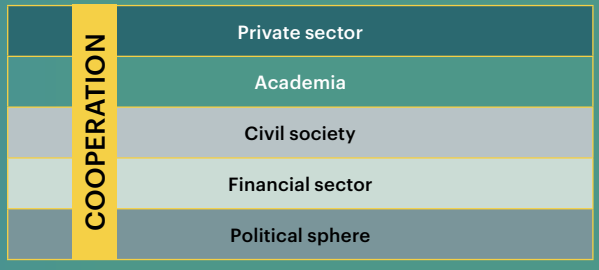
In legal aspects/policies

Contracts that facilitate sharing are needed as well as contract templates that property owners, tenants and users can use. Property owners could produce contracts that encourage sharing of facilities rather than hinder it.

A more systematic review of obstacles in existing law and practice is needed. Current regulations could be reviewed by the Skatterättsnämnden (council for advanced tax rulings). Rental laws need to be reviewed and adjusted for sharing, e.g. with respect to subletting and right of possession. Work environment legislation could be affected if work hours are changed through increased sharing of space during the day/night and week. Rules regarding noise at different times of day could also be affected. From a tax perspective, VAT rules applying to renting space is the main issue to be reviewed. Planning and construction rules, strategic plans (e.g. more detailed general plans) and planning programmes could be redesigned to promote flexibility and sharing of more types of activities in zoning plans. Public authorities and municipalities could require increased utilisation by, for example, only paying contractors rent during working hours to increase subletting, or by limiting the size of facilities supplements in procurement processes. Tax relief could be introduced for high utilisation. Politicians need examples that demonstrate the consequences and gains from sharing.

Case: An actor invites others to share space and functions

WHEN: Simultaneously and constantly.
WHAT: Space and functions are shared in certain facilities.
WHERE: Sharing in the same facility.
HOW: An owner invites other actors to share for a fee.
WHO: Open to those within the organisations that are sharing.



How could space sharing work and what do various actors need to do to make it happen? This is an opportunity to improve resource effectiveness that could be implemented now and involves interesting business models.

A large company has increased its own space effectiveness by having activity-based offices and allowing people to decide which two days of the week to take off. It is now looking into sharing its facilities with other actors and has offered a couple of smaller companies and non-profit organisations access to most but not all of its facilities. It is also looking for services to facilitate this. It also wants to partner with a co-working actor to have flexible access to more locations instead of keeping the margin itself. The property manager is interested in providing some of the services.

From an organisational perspective, the actors need to create work on processes that function when multiple activities are taking place at the same time and also work on organisational culture to take advantage of the benefits of being multiple actors. Technical solutions are needed for identification, security and access to separate areas and for booking common functions. Some spatial adaptation is needed to separate spaces and to create efficient shared spaces. Some adjustments also need to be made to the ventilation system. New types of contracts and insurance policies are needed for shared space and services. This case paves the way for new services and business models involving membership or subscription. To move forward with business development, technology development and financing, the fundamental obstacles need to be addressed, such as VAT on shared facilities – who is obliged to pay VAT and who is not. These solutions could be relevant to all actors who want to share functions at the same time and have a lot of flexibility (e.g. actors that need temporary workspace, or pop-ups); actors who can gain mutual benefits in the same value chain or same network; or actors that are aiming their supplementary offerings at the same target group.

Necessary conditions for innovative environments

»We can't solve problems by using the same kind of thinking we used when we created them.« **Albert Einstein**

By innovation we mean knowledge that is turned into new value; the development of products, services or organisations in both the private and public sectors. In Sweden we are good at creating a climate and an environment for research and innovation, but we are not as good at the scaling up part. If Sweden wants to continue to be at the forefront, we need to ensure that promising innovations have what they need to grow and help our country develop and retain research results and commercial enterprise within our borders.

Having innovative environments within and across different industries is key here. Simply put, these environments could consist of networks where, within a limited geographical area, there is access to 1) universities to provide expertise and academic excellence in specific areas; 2) public funding and risk-sharing for research and innovation projects; and 3) a diverse range of enterprises in the given sector. The latter also involves having access to a functioning market with customers for innovative products and services. This is particularly important to support the growth of small and medium enterprises (SMEs). Innovation will be needed in many areas and in collaboration between multiple actors. The project believes that innovative environments such as academic ones, as well intrapreneurship within enterprises, entrepreneurship and policy development can all play a significant role in increasing space sharing solutions.

In order for sharing solutions to be scaled up and provide sustainability gains, more cooperation will be needed between various actors. New partnership models are needed. One approach is to use pilot projects involving municipal and other authorities, property owners, construction companies, technology companies, the research community and civil society. Trailblazers are needed who, in consultation with organisations and citizens, can identify needs, obstacles, fears and opportunities, develop pilot projects based on these and create a narrative of how sharing can work. Test beds are needed to test exceptions from existing rules or new control mechanisms in relation to separate incentives. This could be done with support from public open digital infrastructure, and involve setting limits to avoid building new offices until existing office space has reached a high utilisation target (e.g. 70 percent instead of 10 percent of offices across all the hours in a year). This could also create new business models for both existing and new facilities and tenants.

An innovation platform is needed to develop business models for sharing. Today many sharing solutions are being tested and developed without benefitting from what other actors have done and studied, and without including the greater context of the needs that exist and the spaces that are available close to each other. A platform is needed to develop common solutions, share experiences and promote large-scale sharing. The platform could match actors, needs and facilities. This could be in the form of a Nordic system for industrial symbiosis including shared space.

Innovation funding is available today, but it will not be sufficient for the considerable transition that is required to ensure the resource-effective use of facilities. New financing solutions, such as capital aggregation, need to be identified. Another solution being discussed is a new credit institution to promote overall resource effectiveness. In the case of shared space, however, the financing needed to pay for necessary remodelling of buildings could come from traditional real estate financing, as this is available and the cost is relatively low.

Business, operational and policy development

»Transformation of our existing buildings and spaces will be increasingly important. But to succeed, we need to find new business models that are based on remake, reuse and, not least, rethink.« **Monica von Schmalensee, White, Architect/Partner, Senior Advisor**

Business and operational development

In order to achieve resource effectiveness and circularity, today's business models need to be transformed. This is true regardless of whether an actor decides to start offering add-on services and products or just wants to adapt its existing core business to new circular conditions. We need to rethink, redirect and redesign many of our processes, structures, habits and behaviours. Including and working in cooperation with all stakeholders is crucial, because no one actor can create the necessary change alone.

Today's business models for owning and renting out facilities are associated with both opportunities and obstacles for space sharing. A forum is needed to discuss and plan for co-use, e.g. for actors along a street or in a district where several businesses and housing associations/property owners join forces to find solutions for sharing facilities. The project believes there are interesting business models at the intersection between how close spaces need to be, how flexible schedules can be and how much time in advance is needed. There are also commercial opportunities between mobility and space, such as common solutions for sharing and having a more flexible view of the concept of "space" in which high mobility can increase utilisation. Added services provide many commercial opportunities and packaged solutions and intermediaries that provide contracts, insurance, security, service and access will be crucial here. Since sharing will often involve different organisations, it is essential to develop services that facilitate cooperation. There are also opportunities to develop services in cooperation with other actors as joint offerings will be in demand.

Many sharing solutions and business models are being tested today; property owners are communicating about opportunities for sharing, tenants are sharing and networks of organisations are sharing space and functions with each other, or jointly owning or leasing. The *dimensions* below could serve as support to study the potential for and design business and operating models for sharing of space. When does sharing happen? What is being shared? Where is sharing happening? How is it done and who is sharing?

Dimensions of sharing

WHEN?	• Simultaneously/At different times • All the time/Repeatedly/On one occasion
WHAT?	• Space/Function • Access to everything/Access to several parts/Access to a specific part
WHERE?	• Within the same space/In the same building/In the same area/In the same network
HOW?	• Owners invites other actors to share with them/Different owners agree to share with each other/An actor manages the sharing solution for participating actors/Actors rent or own together • Free of charge/Pay as you go; subscription; participant fee/Sharing of costs and investments
WHO?	• Open to all/Open for those within the organisations that are sharing/Open for certain individuals or groups that have been approved by owners

New actors entering the market are important in innovating for the necessary disruptive and gradual development. We need platforms for matchmaking on a broader scale to match needs and sharing opportunities to facilitate space sharing. There is currently plenty of technology facilitating sharing and new types of contracts are being tested, but most of the contracts are still untested from a tax and legal perspective. Below are some proposals:

- Include a sharing component green contracts
- Establish tenant contracts where responsibility is assigned to a third party, e.g. urban farms or showrooms in reception areas
- Rent out fully equipped facilities in blocks of time/by the hour to different actors over a 24-hour period
- Rent out access to space in different locations in the city depending on where space is available
- Open a "space bank" where people can borrow a space for a short period to test or present a concept
- Develop co-use formats where users pay and agree on actual use of energy, water, Wi-Fi, services and space.

Insurance solutions are also needed so that actors sharing space and equipment can feel secure. Property owners need support in the form of calculation models on which to base sharing decisions, addressing the environmental, social and financial benefits. A price could be put on things other than square metres and services, such as access to culture, green spaces, networks and community. A price on lost value could also be introduced. Research institutions could produce models to measure benefits and value – not just financial value but social and ecological value as well.

Policy development

Current regulations are not adapted for sharing, and adjustments will therefore be needed in the future. Since sharing solutions are new and regulations need to be developed, there is an opportunity right now to identify what constitutes sustainable use from a resource effectiveness, wellbeing and social gains perspective. Existing laws are based on individual ownership/use and not co-use. Laws and regulations that need to be adapted are the Planning and Building Act, rental laws (Chapter 12 in the Land Code), VAT rules for renting facilities, bookkeeping and deduction rules, the Public Procurement Act and various types of control mechanisms.

Land use plans and zoning plans

The land use plans present a long-term vision for municipal spatial development and land use. This could be made more detailed for different parts of municipalities and cities

through more specific land use plans. Although land use plans are not binding, there is a possibility here to address and propose a focus on resource effectiveness, including ways of improving use of land and facilities. Zoning plans, which are based on land use plans and are binding, state what type of use is permitted for a specific district/building. If an organisation that intends to share can be considered the primary organisation, adaptations for sharing would require building permits. Zoning plans have designations that could be combined to provide more flexibility, such as office, commerce, culture and school, but homes could also be included to enable mixed functions. This could be introduced as an objective and guidelines in zoning plan development programmes and in the municipal authorities' actual zoning plans and land use instructions. There are several examples of where this has been done. In Frihamnen in Gothenburg the municipal authority adopted a zoning plan that includes flexibility in building use. Linköping adopted an addition to its land use plan to make schools attractive spaces during the evenings, weekends and school holidays. In Malmö schools, preschools and other actors are co-using facilities for sport, libraries and cafés. In Uppsala co-use is also prioritised in the land use plan, mainly in connection with new school buildings. The office in charge of facilities at the Uppsala urban planning administration has developed a model for four ways to use space:[39]

1. Parallel co-use in which two organisations have different facilities but share peripheral space, e.g. conference rooms.

2. Alternating co-use during different times, for example a sports ground used by both schools and sports clubs.

3. Long-term serial use, where a building that already stands is adapted for flexible use.

4. Multifunctional spaces, where facilities and spaces in urban environments are used by several different organisations and groups for different purposes, for example schools, sports facilities and the public sharing parkland.

Rental laws (Chapter 12 Rent in the Land Code)

Rental laws regulate things like contracts, termination and right of tenancy. It is possible to bypass certain provisions such as protection of tenancy in the rental law under certain conditions. Protection of tenancy exists to protect tenants, which is an important component to preserve when developing a sharing economy. Protection of tenancy as it is today is not an obstacle for contracts that involve use during different times. On the other hand, it makes tenants' dependence on each other greater or increases risk for intermediaries or property owners depending on how it is structured. If tenancy is given for part of a function without sole rights, for example use per hour or part of a 24-hour period for a facility or unspecified part of a facility, it is not considered a rental agreement and is therefore not subject to the right of tenancy rules. If a space is given to another party free of charge (and without any other form of compensation) it is not considered a rental agreement.

VAT rules

The VAT issue needs to be resolved in order for sharing of facilities to be rolled out on a broad front. The main rule is that renting of space is not subject to VAT. Nor can a party renting out VAT-free deduct VAT on costs, which is why since 1979 there has been a system of voluntary tax

39 National Board of Housing, 2017, "Rapport 2017:16. Skolans nya plats i staden. Kommuners anpassning till skolvalet och urbana stadsbyggnadsprinciper" (https://www.boverket.se/globalassets/publikationer/dokument/2017/skolans-nya-plats-i-staden.pdf; accessed 26 September 2019).

on rental facilities when renting commercial premises. It is very important for property owners and tenants involved in sharing for renting to be subject to VAT so that they can deduct VAT on construction, investments, maintenance and operating facilities. The system of voluntary tax has several antiquated criteria that must be met. These include that tenants run operations that are subject to VAT, that a certain defined space is rented and the space is rented on a permanent basis, i.e. full-time and for at least a year. The VAT rules needs to be changed to facilitate space sharing. Proposals have been submitted by Fastighetsägarna (property owners' association) and the Confederation of Swedish Enterprise to the Government and the Riksdag (parliament), but no response has yet been received. Before the law is changed it would be useful for Skatterättsnämnden (council for advanced tax rulings) to test a number of cases in order to answer some questions that remain to be resolved.

Procurement

Authorities and municipalities should require efficient time and space sharing. This could be done, for example, by a contractor such as a care provider being required to specify rental costs and then only receive compensation for space rented during work hours. This would significantly increase the incentive to sublet space. Today there is a limit on the size of the facilities supplement in procurement.

Support for sharing facilities in rural areas

A study on a cohesive policy for Sweden's rural areas shows that the strong national sectorisation policy is a problem for rural politics.[40] The ability of rural areas to develop and grow, based on cooperation between actors at different levels, is lowered in a sector-based system compared with where geography is considered important. In order for rural development to succeed it is therefore essential to have an approach and tools that make it possible to coordinate actions within different policy areas. For sharing of facilities to take place in the public sector in rural areas, a government agency needs to be assigned specific responsibility for coordinating government services in a shared space. Sharing facilities and resources provides an opportunity for large areas of Sweden that currently lack government services. Today, through the EU's rural policies and through the Swedish Agency for Economic and Regional Growth, there is national support for this type of coordination.

Sharing facilities in rural areas in the private sector has taken place for a long time in the form, for example, of agents for pharmacy services, for Systembolaget etc. being in one commercial space. Although rural areas have high social capital and sharing of spaces is coordinated by driven individuals rather than companies, this still has not reached the sustainability required for space sharing as a phenomenon to be permanent and the norm. Today there are examples of coordinating actors working on a non-profit basis or ones that are privately financed. Better conditions are needed for these initiatives to become long-term solutions.

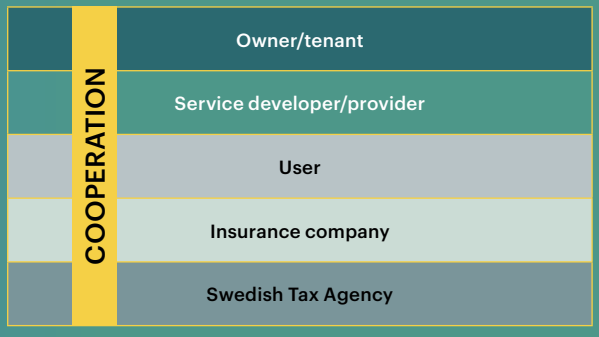
Control mechanisms

National and regional control mechanisms are needed where resource-efficient use is not sufficiently profitable, where the infrastructure to make it sufficiently profitable is new, or where the negative effects are not included in the costs today. The fact that business models do not follow the value chain but instead require incentives for cooperation across industries and new types of activities presents a challenge for sharing.

40 SOU 2017:1, "För Sveriges landsbygder – en sammanhållen politik för arbete, hållbar tillväxt och välfärd".

Case: Professionals and education programmes share facilities and equipment

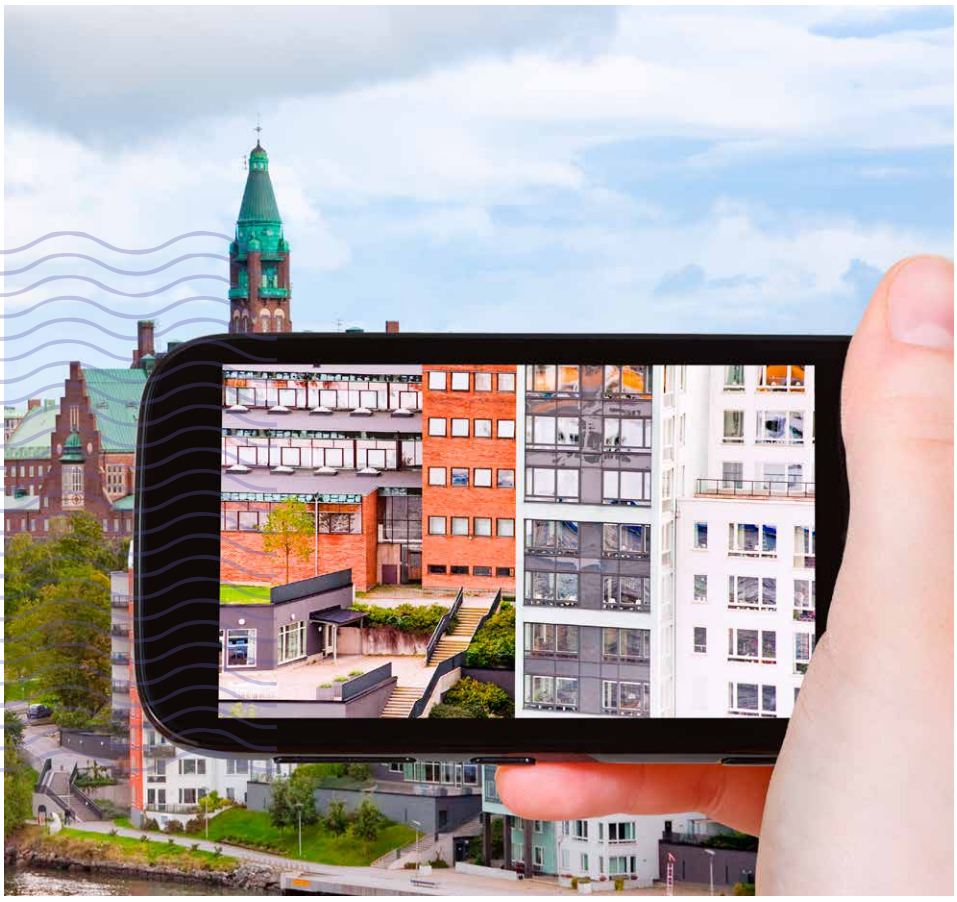
WHEN: Different times on repeated occasions.
WHAT: Space and functions are shared in certain parts of each other's facilities.
WHERE: Sharing in the same network.
HOW: Different owners agree on sharing with each other for a fee or free of charge.
WHO: Open to certain people or groups within the sharing organisation.



How could sharing of facilities work and what do various actors need to do to make it happen? This is an opportunity to improve resource effectiveness that could be implemented now and contains interesting business models.

Education programmes and professionals share specially equipped facilities crafts, art, food preparation, gyms, libraries or labs. Some of the participating organisations have access to some of each other's facilities regularly at pre-determined times. These are packaged as a service and rented out/lent in blocks of time. This is run by one of the actors with support from an intermediary who facilitates the solutions.

The owner of the facility needs to see the benefits and offer opportunities. Effective contracts are needed between the parties to encourage more users to join and address the right of tenancy and solutions for where different VAT rules apply, as well as insurance solutions for multiple users. From an organisational perspective the organisations, employees and students need to identify work processes for being in different facilities and at different times where others are also using the space. Users need to feel confident that the solution will work and is reliable. Trailblazers are needed to test solutions and opportunities. It is likely that very little spatial adaptation will be needed as the actors are in the space at different times using the same functions. Actors need their own storage space, technology for booking and access to separate areas. Sharing-related services for access, identification, security, insurance, dispute resolution, booking, mobility and possibly also logistics need to be developed and offered by an intermediary. These solutions can be used by all organisations that share functions at different times.



The financial sector

»There is enormous potential for using existing buildings better and more intensely. We only need to look at office buildings – on average only around 10 percent of office space is being used. Obviously not all space can be used 100 percent of the time, but there are significant sustainability gains to be made by increasing sharing.« **Anna Denell, Sustainability Director, Vasakronan**

Actors in the financial sector want to see long-term and profitable circular projects in various industries. Financial investors want profitable business cases and well-planned and structured projects with a long-term technology perspective. The financial sector also likes to see long-term and reliable strategies. Today, however, there are no clear goals, indicators or benchmarks for resource effectiveness initiatives to make it easier for financial sector actors to evaluate business models.

A taxonomy for each industry is currently being discussed as part of EU directives. An EU taxonomy is a voluntary system aimed at producing metrics in order to use, for example, green bonds. Investments are needed in actors that are trying to make their operations greener.

Only financing sustainable organisations will in time be business critical for the financial sector. The project's conclusion is that the financial sector has a key role to play in influencing what gets financed and it has the ability to steer a course towards more sustainable solutions by offering a lower price for green financing than for other types of financing. It is imperative for the financial sector to understand the environmental benefits of using existing resources more effectively. The insurance industry can also help by producing new types of insurance solutions for sharing.

Both the financial sector and the construction and real estate industries need to start including costs for the impact their activities have. Economists at the Swedish Transport Administration raised the internal price of carbon emissions in 2019 by close to 700 percent and this changes the way calculations are made for construction projects.[41]

Valuation

Sharing of facilities on a large scale could involve new ways of assessing risk and gains, which could also affect the value of real estate in general. Real estate has traditionally been an asset class of its own from a capital management perspective. The ever-shorter contract terms and the flexibility and mobility demanded by tenants could in time change views of real estate as an asset class with the stable cash flows that come from long, fixed contracts no longer existing to the same extent. More flexible rental contracts could result in more vacancies and risk for property owners – and thereby also for the financial sector. Having more users could also increase operating and maintenance costs, which in turn would lead to lower property values.

But more users also means more vibrant districts and neighbourhoods, which in turn makes real estate more attractive and could increase its value as well. More users and more flexible contracts could also lead to higher revenue. Investors appreciate flexible solutions if there is a good spread of risk through, for example, the tenant structure and variation in the length of contracts. The risk could be the same or lower for an investor with flexible contracts as with few long ones – as long as the mix and location are right.

41 Nilsson, PM, 2019-09-29, "Klimatet har fått nytt pris", in *Dagens Industri* (https://www.di.se/ledare/klimatet-har-fatt-nytt-pris/?fbclid=IwAR081OY4NHoTGCihjslHOOD5ur9pLPeNqtCQ6ZUgmnye_hlnF-d1QePrONU; accessed 17 October 2019).

In 2019 the Science Based Targets initiative (SBT) produced a method for investors to set research-based goals in line with the Paris Agreement. Growth Analysis in a report entitled "ESG and transparency – the road to a green transition of the economy?" analysed the financial sector's tools for assessing sustainability risks (so-called ESG valuations), the EU Sustainability Directive and the voluntary Science Based Targets (SBT) initiative and draws the conclusion that none of these instruments in their current form will lead to a green transition of industry overall. At the same time, in a UN initiative, 130 banks and 49 countries have adopted "Principles for Responsible Banking",[42] This includes all of the main banks in Sweden. The principles state that banks are to adapt their business strategies to the Global Goals for sustainable development and the Paris Agreement on the climate, set goals for how they will make a positive contribution to sustainable development and reduce negative impacts, encourage their customers to be more sustainable and be transparent and accountable for progress.

Performance measures will be needed so that the financial sector can assess the risk and opportunities in sharing of facilities. The financial sector needs support to understand and be able to calculate the sustainability gains of increased utilisation in relation to the economic risks that may be associated with lending to a property owner with a "different" contract structure. Factors here include how an investment contributes to the Global Goals, or how high the transformation potential is (i.e. how easy a space can be changed), which in itself could lead to opportunities being valued differently. Environmental certification systems for buildings are another tool used by the financial sector to assess how sustainable a build is. In the future these need to include more details on utilisation to promote increased resource effectiveness.

42 UNEP Finance Initiative, 2019, "What are the Principles for Responsible Banking designed to achieve?" (https://www.unepfi.org/banking/bankingprinciples/; accessed 17 October 2019).

Insurance policies

In this study we have only looked at sharing by legal, not physical, persons, because legal persons always have some form of contract for their activity, and thus sharing solutions between entities are easier to insure than those between individuals. There is still great reluctance among insurance companies where there are business models that involve many unknown users.

One insurance solution could be for each actor to have a separate insurance policy. In this scenario though, mechanisms would be needed to show where a particular insurance policy applies and that signals to the others when a policy goes into effect. In order to develop insurance policies, there needs to be clarity in sharing solutions about who is guaranteeing what. Technology should be able to provide good support as digitalisation and technical solutions such as sensors can easily monitor who is using what and when. Blockchain technology could document the various elements and keep them all together. Another solution is for a property owner to have an insurance policy for everything that happens within the facility, or an intermediary to be insured for all those who book the service. It could be possible to have insurance for the property, supplementary insurance for interiors, equipment, actual activities taking place and the individuals using the facilities.

Insurance companies are engaged in assessing risk so they should be able to lead the way in the financial sector to find solutions. Here, the insurance industry faces the same challenge as banks in assessing risk and commercial opportunities in new business models. The size of the customer base is important when establishing premiums. If insurance premiums go up due to sharing, the extra insurance cost could be included in the customer price. When sharing makes things simpler and convenient, it is often possible to charge a higher price.

Insurance policies are often in line with contracts, so as different types of contracts are developed this will also help solve the insurance issue Alternatively, new services and contracts could be created within the insurance industry in cooperation with sharing actors. Insurance providers need to be able to spread risk and having many users could be an advantage here. Insurance solutions could also be developed in international cooperation through the *Sharing Cities Alliance*.

Financing

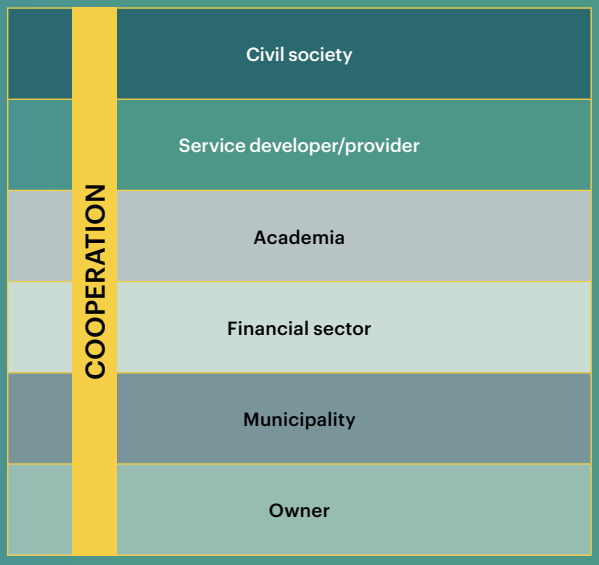
There is quite a substantial amount of innovation funding and risk capital available for pilot programmes; the main component that is lacking is long-term financing. Significant transformation will also be needed in many areas and there is not sufficient innovation funding for the scale that this will involve.

The financial sector could establish a platform for financing resource effectiveness in several phases, with pilot projects first being financed using existing and new innovation funds. Start-ups and implementation of pilot programmes could be financed with venture capital, and transformation and upscaling could be financed by aggregated solutions. This could be in the form of a portfolio with a governing body, large green bonds that include a sharing requirement, or a development company where municipal, private sector and other actors work together. Examples of this exist in London. Today there are more government subsidies for exports than for domestic initiative innovation. However, new innovations are needed to sustain exports. Sharing solutions will be very attractive as urbanisation continues in combination with the peak resources issue and the ongoing climate crisis.

If facilities are shared to a greater extent, the lines between public and commercial spaces will become blurred, which will require joint responsibility for development of public spaces. Property owners around Frölunda square, for example, came together to upgrade the square. New types of financing are needed for sharing where organisations and citizens do not have sufficient buying power to fund remodelling for sharing. Here, actors and citizens could contribute their commitment, time and knowledge to supplement financing, or use crowdfunding to fund development.

Case: Cooperation in urban development

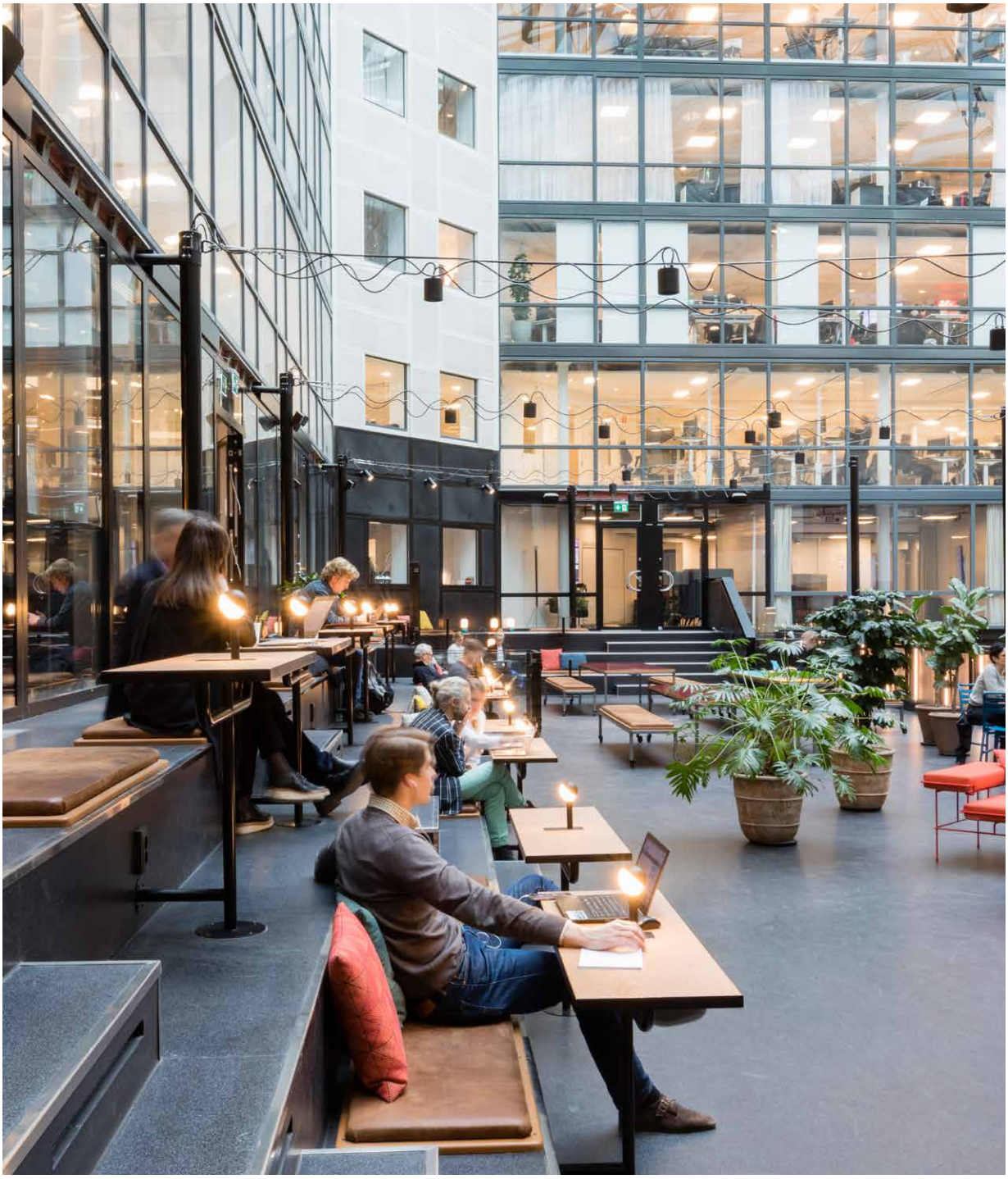
WHEN: Some solutions involve simultaneous sharing and others sharing at different times; some are continuous and others take place on separate occasions.
WHAT: Space and functions are shared. Certain solutions involve access to everything and others to a specific part.
WHERE: Sharing takes place in a defined area.
HOW: In some solutions there are owners who invite other actors to share with them, in others there are different owners who agree to share with each other or an actor who manages the sharing solution for the participating actors. Some solutions are free of charge, others have a pay as you go solution or charge participant/subscription fees for users. Participants in pilot programmes share costs and investments.
WHO: Some solutions are open to all; others are open for the sharing organisations.

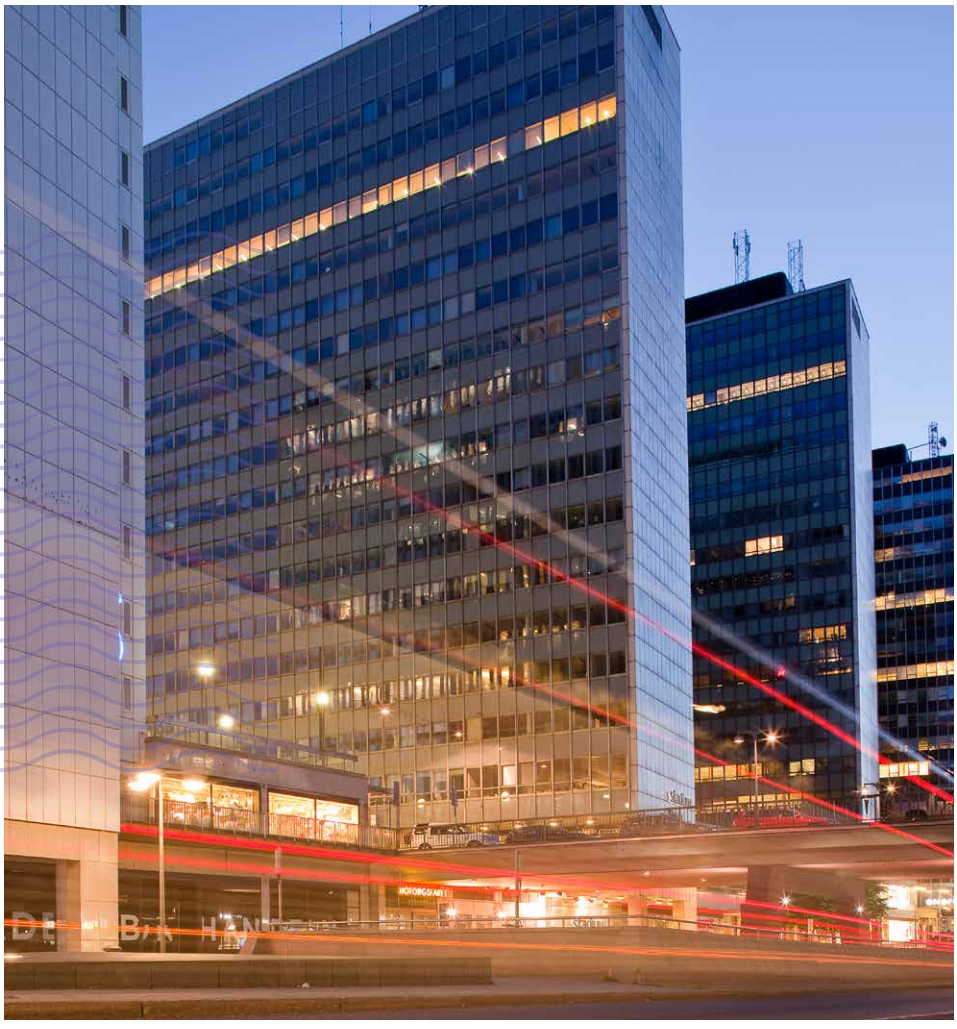


How could sharing of facilities work and what do various actors need to do to make it happen? This is an opportunity to improve resource effectiveness that could be implemented now and contains interesting business models.

The city is looking at developing an area where two municipalities share a border and are planning a pilot project in partnership with several commercial enterprises, a couple of organisations and a housing company to increase utilisation of space. This is being done through remodelling and adaptation of functions that can be shared, but also by producing technical systems to support different actors as they develop services for shared functions. The city is also looking at incentives for different actors to increase utilisation of existing functions.

Many actors are interested in creating partnerships between, for example, municipalities, property owners, technology companies and research actors to use pilot programmes to study models and solutions for how this could work. The pilot programmes could evaluate and monitor the progress of new business models. Packaging of services to profile an area is being tested. Technical solutions are being produced and tested for access, security and booking. Operational models for how to work in shared environments are being designed and their progress is being monitored. Physical rebuilding and design of surrounding areas is being carried out to facilitate sharing. This could involve exceptions and attempts to see how rules and policies can be adapted for sharing. It could also be possible to implement solutions in the form of a district tenant owners' association or a residential and work cooperative in facilities operated by civil society actors, residents and local businesses. There are examples of villages that have started enterprises and road associations financed, for example, by *in kind* work. The municipality is offering long-term tenancy and allocating land, and offering infrastructure that residents themselves complete. Civil society and residents could show what is needed and present informal solutions that may already be in progress in the area but that need platforms for sharing. This could be done by a development company with municipal, commercial and other actors working together. A development company or an economic association with a governing body could enable a sufficient number of initiatives to be combined in a cluster that can attract financing. Municipalities working in cooperation may need regional support so as not to be bound by municipal boundaries, and could design scalable solutions and partnerships for open source code solutions etc. As this involves significant cooperation, there are also multiple types of sharing solutions





Measuring utilisation

»Indicators for utilisation need to be developed in order for organisations to identify potential, set goals and follow up progress, and in the longer term to facilitate utilisation requirements for various spaces.«

To measure how space is used

These are complex issues and it is difficult to generalise because the potential for sharing space depends on the specific conditions of the facilities and the location, which activities will take place there, what sort of collaboration can be arranged, how other shared functions outside the facilities will interact and the ability of the architect to facilitate sharing. Indicators for utilisation need to be developed in order for organisations to identify potential, set goals, and follow up progress, and in the longer term to facilitate utilisation requirements for various spaces. These indicators will be instrumental in the ability to assess and monitor progress, but they will need to be combined with other key ratios to provide a comprehensive picture.

Work environment directives have requirements for how large a space needs to be based on variants such as the number of users. In the "regulations on workplace design"[43] there are, for example, requirements such as "workplaces are to have sufficient space for the activities taking place in them". The standards are in the form of ratios for how many square metres are needed for a given number of users for different types of facilities, such as schools and care facilities, in order to have a good environment in which people can exist and can work. Statistics Sweden has data on things like energy use based on square metres – not categorised by types of activities but by the years in which the buildings were built. This is currently under review. At the European level there is the Eurostat database[44] which has a data on totals for the number of square metres of built space, but not for what type of activities it is used for. The European Commission's database for energy monitoring in buildings[45] has estimates from 2013 of square metres used per type of activity: school, healthcare, hotel and restaurant, office and wholesale and retail. The breakdown of homes and other premises differs considerably within the EU, but in all member states residential accounts for the majority. This indicates the need to consider utilisation rates in homes as well, but also to discuss sharing between residential and commercial. In the EU the breakdown of commercial facilities in general is offices (both private and public sector) 30 percent, retail 27 percent and education 16 percent. The conclusion is that today there is no current data on square metres per type of activity and data linked to the number of users and when spaces are being used.

User intensity

There are technical systems that measure who is present, for example, through sensor-activated lighting or ventilation, and entry systems that show which individuals are in the facility, as well as apps that show in more detail who is where. Space utilisation is, however, often still measured through observation.

43 Arbetsmiljöverket, "Lokalernas storlek beror på verksamheten" (https://www.av.se/inomhusmiljo/lokaler-och-arbetsutrymme/lokalernas-storlek/; accessed 26 September 2019).

44 Eurostat, "Built-up areas" (https://ec.europa.eu/eurostat/databrowser/view/t2020_rd110/default/table?lang=en%202019-08-30; accessed 26 September 2019).

45 European Commission, "EU Buildings Database" (https://ec.europa.eu/energy/en/eu-buildings-database; accessed 26 September 2019).

How relevant it is to know the number of users in a space depends on whether the space is mainly for people that are performing an activity, or if it is mainly a space that contains items, flows and so on (which may be managed by people, but where there is no correlation between number of people and how well-utilised the space is). For kitchens, warehouses, workshops, energy facilities etc. the number is less relevant, but for offices, education facilities, care facilities, cafeterias and communication infrastructure, the number of users is highly relevant.

When we add users there is a big difference between measuring the number patients, temporary guests, repeat users or employed staff. How an indicator of how the length of time these categories of individuals use the space is interpreted depends on the type of activity. A high turnover of people could mean that people are doing things more efficiently; higher turnover could mean that more users need the space for a shorter rather than a longer period (which could require more space).

Metrics

One option is to use the ratio square metre/hour (m^2*h) as a way to measure how often a space is used. This does not tell us anything about how intensely the space is being used nor if it is being used by one or a hundred employees, but it could be used as a way to identify large spatial and time vacancies in a building and to show untapped potential. In one study[46] a comparison is made of ways to measure the

46 Francart, N., Höjer, M., Mjörnell, K., Orahim, A., von Platten, J., och Malmqvist, T., 2019, "Sharing indoor space: the perspectives of stakeholders and the use of complementary energy metrics", manuskript, KTH.

energy use in buildings. Today this is mainly measured by energy/m². This could be supplemented with a ratio of energy/person or energy/person hours. In the literature there are examples of space efficiency ratios linked to energy use for spaces such as offices (energy/employee), hotels (energy/hotel night), hospitals (energy/bed), schools (energy/pupil or pupil hour). Another way is to measure resource use/person using the facility. This could supplement the climate footprint/person ratio.

A utilisation indicator needs to be related to square metres, hours and users while also taking into account the different conditions and circumstances of various operations or activities. Studies are needed to design indicators and look at the consequences, and to identify how an indicator could include the potential utilisation rate for the organisation/activity and thus make it possible to compare different values. This type of indicator would need to include space necessary for systems such as ventilation etc. *Square metre/hour* could be the general ratio, with the number of users included in a reference ratio, because the relevance and limit on the number of users is the parameter that will differ the most depending on whether it is healthcare, education, offices or manufacturing etc.

A large measure of caution is needed when measuring space efficiency. It is easy to regard very high utilisation of a space as better from a financial and environmental perspectives than low utilisation. But there are social limits and limits relating to the physical building on how intensely a building can be used. The wellbeing of the people using the space could decline if it is too crowded, if there is a high turnover of people, if there are too many people to relate to or if people feel they no longer belong in the environment or context, feel insecure or unsafe, or if the ventilation or sound-absorbing properties in the facility are not able to handing multiple simultaneous users. Particular attention may need to be paid to these aspects in healthcare and care contexts. Measurements should include what is reasonable in relation to the activities taking place and support sharing that leads to improvement, or at least does not make things worse in terms of health, wellbeing, affinity, safety and security, access, work opportunities, equality, social encounters and knowledge exchange, as well as engagement of the local community. An article by Forooraghi et al (2019) presents examples of problems relating to health and wellbeing, where areas such as leadership, occupational health services, architecture and property development risk having entirely different priorities when they should be working towards common objectives.[47] Another article by Jin et al (2016) discussed the differences between the measured and perceived quality of the indoor environment in office buildings.[48]

Our conclusion is that up to now there is a lack of national data or established indicators. Statistics at both the national and EU levels need to be obtained for square metre per type of activity, and data on the number of users when spaces are shared. An important research objective here is to study more closely the consequences of how indicators are designed. Until such time as this research exists, organisations could contribute to development in this area by testing their own utilisation goals and indicators inspired by the observations above, and be transparent about their discoveries and results. In time, indicators could include a reporting requirement for certain types of activities, or voluntary reporting of benefits. A measuring tool would also make it easier to include a sharing component in standardisation models and certification processes.

47 Forooraghi, M. med flera, 2019, "IOP Conference Series: Earth and Environmental Science", Vol 297. 012013.

48 Jin, Q., Wallbaum, H., Leiblein, T. med flera, 2016, "Assessments of indoor environmental quality on occupant satisfaction and physical parameters in office buildings", The 14th International Conference of Indoor Air Quality and Climate.

References

Arbetsmiljöverket, "Lokalernas storlek beror på verksamheten" (https://www.av.se/inomhusmiljo/lokaler-och-arbetsutrymme/lokalernas-storlek/; accessed 26 September 2019).

Andersson, T., Matschke Ekholm, H., Fjellander, L., Harris, S., Ljungkvist, H. and Zhang, Y., 2018, "Rapport B2311. Dela prylar, yta, bil och tid. En vägledning till delningsekonomi i kommunerna", IVL Swedish Environmental Research Institute and Waste Sweden.

Bernstad Saraiva, A. and Andersson, T., 2017, "Rapport 2017:8. Inventering av kommuners arbete för hållbar konsumtion", Konsumentverket.

National Board of Housing, Building and Planning 2017, "Rapport 2017:16. Skolans nya plats i staden. Kommuners anpassning till skolvalet och urbana stadsbyggnadsprinciper" (https://www.boverket.se/globalassets/publikationer/dokument/2017/skolans-nya-plats-i-staden.pdf; accessed 26 September 2019).

Bradley, K.., "Urban Sharing – The rise of collaborative consumption and co-use of spaces" (project).

Bradley, K., Ekelund, L., 2015, "Dela är det nya äga "(film), LottaFilm (www.delafilmen.info; accessed 26 October 2019).

Dalväg, E, IVA presentation, 10 September 2018.

Ellen MacArthur Foundation, 2015, "Potential for Denmark as a Circular Economy. A Case Study from: Delivering the Circular Economy – A Toolkit for Policy Makers" (https://www.ellenmacarthurfoundation.org/assets/downloads/20151113_DenmarkCaseStudy_FINALv02.pdf; accessed 17 October 2019).

Erlandsson, M, and Peterson, D., 2015, "Klimatpåverkan för byggnader med olika energiprestanda. Underlagsrapport till kontrollstation 2015. For the Swedish Energy Agency and the National Board of Housing, Building and Planning. IVL Swedish Environmental Research Institute, report no. U5176".

European Commission, 2011, "Europa 2020 – A strategy for smart, sustainable and inclusive growth COM(2010) 2020 final", (https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF; accessed 1 October 2019).

European Commission, 2011, "A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy COM(2011) 21", (https://www.cbss.org/wp-content/uploads/2012/10/resource_efficient_europe_en.pdf; accessed 29 November 2019).

European Commission, 2016, "COM(2016) 356 – Europeisk agenda för delningsekonomin" (http://ec.europa.eu/DocsRoom/documents/16881/attachments/2/translations; accessed 17 October 2019).

European Commission, "EU Buildings Database" (https://ec.europa.eu/energy/en/eu-buildings-database; accessed 26 September 2019).

Eurostat, "Built-up areas" (https://ec.europa.eu/eurostat/databrowser/view/t2020_rd110/default/table?lang=en%20 2019-08-30; accessed 26 September 2019).

Felländer, A., Ingram, C., and Teigland, R., 2015, "Sharing Economy: Embracing Change with Caution", Economic Policy Forum.

Fjellander. L. et al, 2019, "Rapport C3711. Delningens potential", IVL Swedish Environmental Research Institute.

Forooraghi, M. et al, 2019, "IOP Conference Series: Earth and Environmental Science", Vol. 297: 012013.

Francart, N., Höjer, M., Mjörnell, K., Orahim, A., von Platten, J., and Malmqvist, T., 2019, "Sharing indoor space: the perspectives of stakeholders and the use of complementary energy metrics", manuscript, KTH.

Francart, N., Malmqvist, T. and Hagbert, P., 2018, "Climate target fulfilment in scenarios for a sustainable Swedish built environment beyond growth", in *Futures* Vol 98, pp. 1-18.

Gaffney, O., Rockström, J., Falk, J., Bhowmik, A.K., Bergmark, P., Henningson, S., Höjer, M., Jackson, R.B., Klingenfeld, D., Loken, B., Nakicenovic, N., Srivastava, L. and Wilson, C., 2019, "Meeting the 1.5°C Climate Ambition moving from Incremental to Exponential Action. Report to the UN Climate Action Summit 2019", Exponential Roadmap 2030.

Geissdoerfer, M., P., Savaget, N., Bocken, N. and Hultink, E., 2017, "The circular economy – A new sustainability paradigm?", in *Journal of Cleaner Production* 143 (1), p. 759.

Höjer, M. and Mjörnell, K., 2018, "Measures and Steps for More Efficient Use of Buildings" in *Sustainability* 10(6), 1949 (https://www.mdpi.com/2071-1050/10/6/1949; accessed 17 October 2019).

IVL Swedish Environmental Research Institute, 2017, "Nytt verktyg hjälper dig räkna fram byggnaders klimatpåverkan", (https://www.ivl.se/toppmeny/pressrum/pressmeddelanden/pressmeddelande---arkiv/2017-05-31-nytt-verktyg-hjalper-dig-rakna-fram-byggnaders-klimatpaverkan.html; accessed 26 September 2019).

International Synergies (https://www.international-synergies.com/projects/national-industrial-symbiosis-programme/; accessed 17 October 2019).

Kirchherr, J., Reike, D. and Hekkert, M., 2017, "Conceptualizing the circular economy: An analysis of 114 definitions" in *Resources, Conservation and Recycling* 127, pp. 221-232.

Royal Swedish Academy of Engineering Sciences (IVA), 2017, "Attractive Living Environments and Flows – Eight themes in planning good cities of the future" (https://www.iva.se/publicerat/attraktiva-livsmiljoer--och-floden--atta--teman-for-planering-av--framtidens-goda-stad/; accessed 17 October 2019).

Lüdeke-Freund, F., Gold, S. and Bocken, N., 2018, "A Review and Typology of Circular Economy Business Model Patterns", in *Journal of Industrial Ecology*, Volume 23, Issue 1, February 2019, pp. 36-61.

Mata, É. and Johnsson, F., 2017, "Cost-effective retrofitting of Swedish buildings", chapter 12 (pp. 341-361) in ed. Pacheco-Torgal, F. et al, 2017, Cost-Effective Energy-Efficient Building Retrofitting.

Mo-Bo – Arkitektur för hållbar mobilitet (https://viablecities.com/foi-projekt/mo-bo/; accessed 17 October 2019).

Mulder, K., 2016, "Urban symbiosis: A new paradigm in the shift towards post-carbon cities", in *NewDist*, (July), 16-24.

Nilsson, PM, 29 September 2019, "Klimatet har fått nytt pris", in *Dagens Industri* (https://www.di.se/ledare/klimatet-har-fatt-nytt-pris/?fbclid=IwAR081OY4NHoTGCihjslHOOD5ur9pLPeNqtCQ6ZUgmnye_hlnF-d1QePrONU; accessed 17 October 2019).

PwC, 2015, "Sharing or paring? Growth of the sharing economy", (https://www.pwc.com/hu/en/kiadvanyok/assets/pdf/sharing-economy-en.pdf; accessed 22 November 2019).

Jin, Q., Wallbaum, H., Leiblein, T. et al, 2016, "Assessments of indoor environmental quality on occupant satisfaction and physical parameters in office buildings", The 14th International Conference of Indoor Air Quality and Climate.

Sharing Cities Sweden (https://www.sharingcities.se/; accessed 26 September 2019).

Sitra, 2018, "Circular Economy Playbook" (http://www.kasvuakiertotaloudesta.fi/; accessed 17 October 2019).

Sitra, "Information platform to enhance the use of waste and side streams" (https://www.sitra.fi/en/cases/information-platform-enhance-use-waste-side-streams/; accessed 17 October 2019).

SOU 2017:1, "För Sveriges landsbygder – en sammanhållen politik för arbete, hållbar tillväxt och välfärd".

SOU 2017:22, "Från värdekedja till värdecykel – så får Sverige en mer cirkulär ekonomi".

State Information Center, (http://finance.sina.com.cn/roll/2017-04-18/doc-ifyeimzx6886194.shtml; accessed 22 November 2019).

UNEP Finance Initiative, 2019, "What are the Principles for Responsible Banking designed to achieve?" (https://www.unepfi.org/banking/bankingprinciples/; accessed 17 October 2019).

Wagner, T., Kuhndt, M., Lagomarsino, J., and Mattar, H., 2015, "Listening to Sharing Economy Initiatives", Report on a Global Survey: 38.

The Royal Swedish Academy of Engineering Sciences (IVA) is an independent academy whose mission is to promote the engineering and economic sciences and the advancement of business and industry. In cooperation with the business community and academia, IVA initiates and proposes measures to improve Sweden's industrial expertise and competitiveness. For more information about IVA and the Academy's projects, see the website www.iva.se.

Published by: The Royal Swedish Academy of Engineering Sciences (IVA), 2020
Box 5073, SE-102 42 Stockholm, Sweden
Tel. +46 (0)8 791 29 00

IVA publishes various types of reports within the framework of its activities. All reports are fact-checked by experts and then approved
for publication by IVA's President.

IVA-M 518
ISSN: 1100-5645
ISBN: 978-91-89181-00-7

Project Management: Liv Fjellander
Text: Liv Fjellander
Editor: Joakim Rådström, IVA
Co-ordinator: Gustaf Wahlström, IVA
Illustrations: Moa Sundkvist & Jennifer Bergkvist
Photos: Gustav Kaiser/Vasakronan, Unsplash, buskfyb/flickr, Shutterstock, Gonzalo Irigoyen/Vasakronan, Dino Soldin/Vasakronan, Vasakronan, Rebecca Allen/Sharing Cities Stockholm, Peter Fristedt/flickr, Epicenter Stockholm, United Spaces Studio Malmö
Layout: Pelle Isaksson, IVA

This report is available to download as a pdf file at www.iva.se

IVA

Royal Swedish Academy of Engineering Sciences

in cooperation with

FORMAS

IKEM
Innovations- och kemindustrierna i Sverige

MISTRA
Stiftelsen för miljöstrategisk forskning

SVENSKT NÄRINGSLIV

Teknikföretagen

tillväxtverket

VASAKRONAN

VINNOVA
Sveriges innovationsmyndighet

FORSK