# EVERYTHING-AS-A-SERVICE

# XAAS

## HOW BUSINESSES CAN THRIVE IN THE AGE OF CLIMATE CHANGE AND DIGITALIZATION

EXECUTIVE SUMMARY

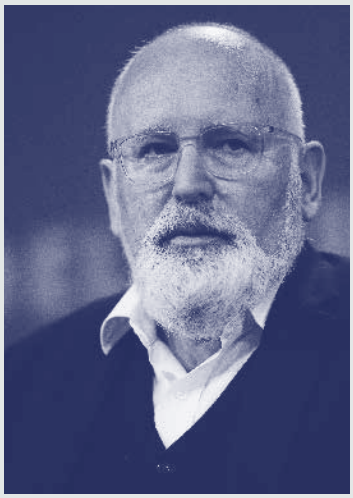

Conducted by

SYSTEMIQ

On behalf of

SUN Institute
Environment & Sustainability
Initiated by Deutsche Post Foundation

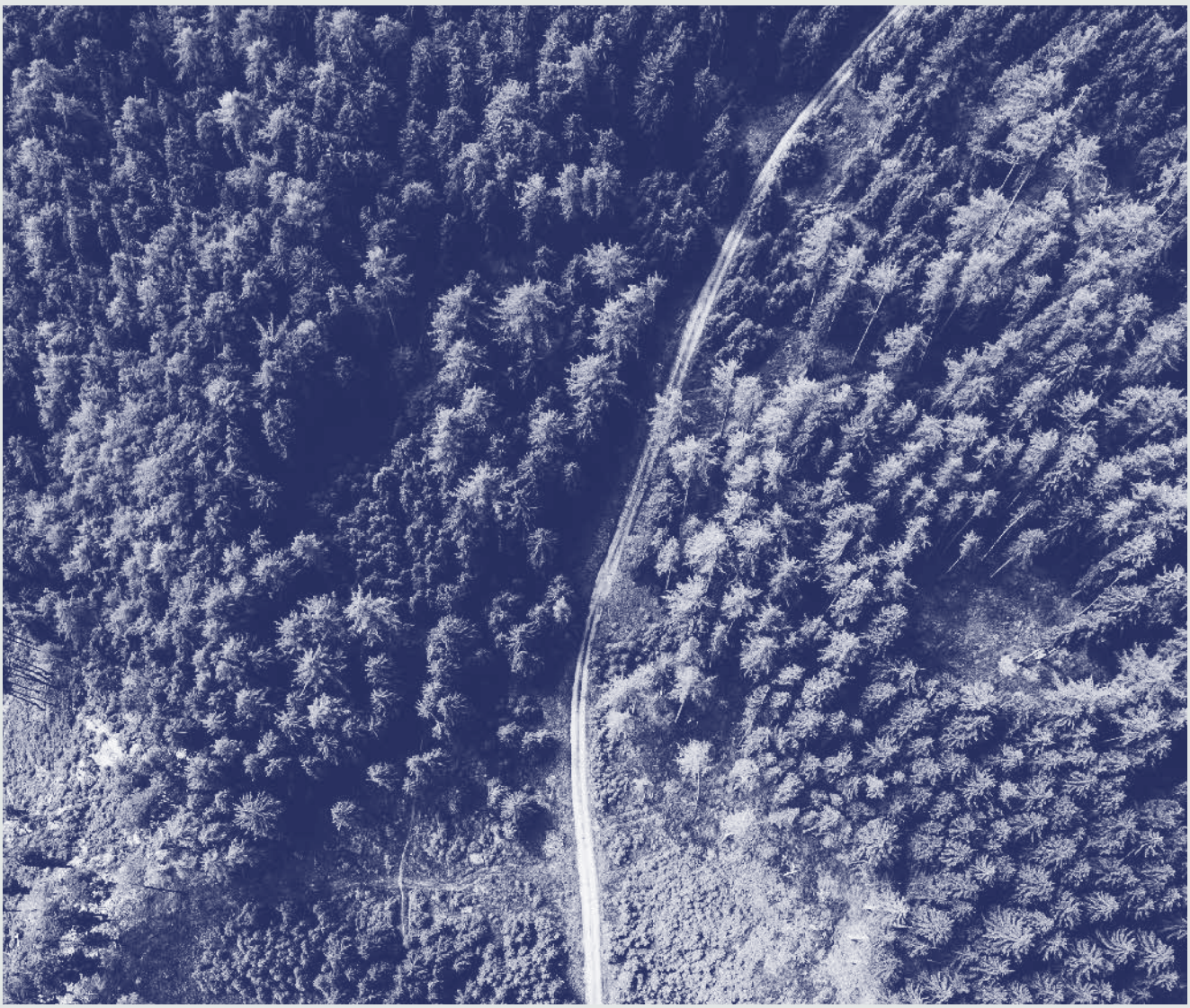
# ENDORSEMENTS



"To reverse the climate and biodiversity crises and build a climate neutral economy by 2050, we must accelerate the decoupling of our economic growth from emissions and resource use. A simple replacement of fossil-based with bio-based will not be enough. We need innovative circular business models that are increasingly service-oriented and drastically reduce our dependency on primary resource extraction.

The Everything-as-a-Service report provides powerful and much-needed evidence on how such models work, and offers clear guidance to have them succeed on the ground. This report is therefore an important contribution to one of the key priorities of the European Green Deal and its Circular Economy Action Plan."

**Frans Timmermans,**
Executive Vice-President of the European Commission



Frans Timmermans photo: Copyright European Union, 2021

"Waste and disposability are woven into today's economy, fueling climate change and limiting opportunities for long-term economic prosperity. Everything-as-a-Service (XaaS) shows how – as part of a circular economy – we can change that, and harness the power of design and innovation to deliver better outcomes for businesses, their customers, and the environment."

**Dame Ellen MacArthur,**
Founder & Chair of Trustees, Ellen MacArthur Foundation

"Germany has set ambitious climate targets. To achieve climate neutrality by 2045, increasing the use of renewable energies is not enough. We need to manage our natural resources differently. For industrial nations, the transition towards a circular economy is an attractive opportunity to drive prosperity within ecological boundaries. As this report shows, demand-side innovations are both a critical and an attractive way to drive the transition: Germany can sell services, outcomes or results in the same successful way in which we have sold products in the past. The report describes a vision in which XaaS can grow into an essential driver of Germany's innovation, competitiveness and employment in Europe and beyond."

**Elisabeth Winkelmeier-Becker,**
Parliamentary State Secretary, Federal Ministry for Economic Affairs and Energy, Germany

"Sustainability is an integrative part of our corporate strategy. Implementing measures inspired by the circular economy makes an important contribution – ranging from product design for sustainability to circular and service-based business models. We all need to seize the opportunity to accelerate the transition towards more resource-productive and sustainable industrial systems."

**Carla Kriwet,**
Chief Executive Officer, BSH Home Appliances Group

"Business success tomorrow means creating value for environment, society, and business. This requires pioneering research and development, but also new business models that can essentially decouple $CO_2$ emissions from business growth. Scaling XaaS systems that embrace circular economy principles will be important for generating sustainable growth – and calls for a collaborative and focussed effort across industries."

**Saori Dubourg,**
Member of the Executive Board, BASF

"Moving to a circular economy will require fundamental change, such as a shift to producer ownership, where producers take ownership and responsibility for their product over the full lifecycle. This could generate incentives for new XaaS business models to gain a competitive edge through the design of products for durability, dematerialisation, re-use and high-value recycling."

**Paul Ekins,**
Professor of Resources and Environmental Policy, UCL Institute for Sustainable Resources

"As markets tumbled in early 2020, many of us expected that the pandemic would slow global action on climate change, but the opposite happened. The pandemic forced society as a whole to remember the fragility of our planet. The 2021 XaaS Everything-as-a-Service report splendidly raises the importance of climate risks and outlines holistic strategies as we face issues relating to climate change. For us as an investment firm, climate risks are investment risks and we therefore see sustainable circular economy strategies, that aim to reduce carbon emissions, as becoming increasingly important."

**Mirjam Staub-Bisang,**
Country Manager Switzerland and member of the ExCo EMEA, BlackRock,
Senior Advisor BlackRock Sustainable Investing

"Services that unlock value by helping us to better utilise, circulate and improve products and materials are critically enabling first layers of the circular economy. They represent exciting ways in which innovators and designers can begin their journey and apply society's well developed skills in service design."

**Tim Brown,**
Executive Chair, IDEO, and Vice Chair, kyu Collective

"Equipment-as-a-Service offers industrial companies entirely new and disruptive business and production opportunities. By essentially focusing on performance, flexibility and convenience, this allows customers to focus and grow. Beyond that, EaaS is the path to a business model based on circular economy principles. As this report outlines, implementing such models at scale will require collective action within and across industries."

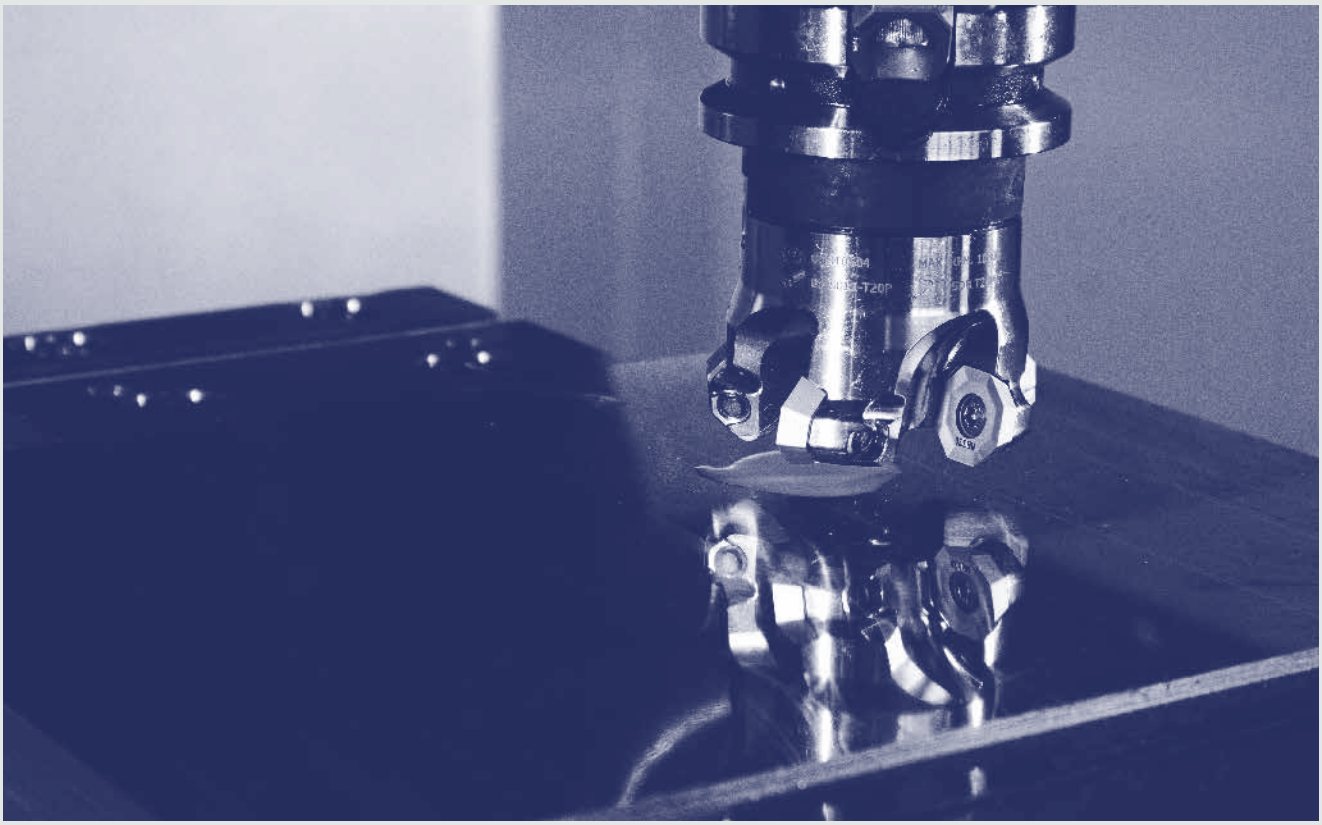
**Peter Leibinger,**
Chief Technology Officer and Vice Chairman of the Group Management Board, TRUMPF

"*Objects as a service* have existed for a long time, offered by hotel owners, ferrymen, taxi drivers. They were classified as 'services' integrated in the tertiary sector, which hundred years ago became dominant in the US economy but which continued to focus its attention on production and productive jobs.

In the 20th century, pioneering manufacturers emerged such as Eastman Kodak selling camera use as a system, MEWA cleaning towels as a service and equipment manufacturer Xerox customer satisfaction instead of photocopiers. In the 1980s, the concept of XaaS emerged in research papers, and in January 1994, The Harvard Business Review published its first case study on XaaS under the title *Xerox: Design for the Environment*.

The full potential of XaaS was first structured and described in my 2006 book The Performance Economy (English 2006, Simplified Mandarin 2008). The concept has since been accepted by an increasing number of companies, and presented in a growing number of publications, the latest being XaaS in your hands."

**Walter R. Stahel,**
Founder-Director of The Product-Life Institute, Geneva
Visiting Professor at the Faculty of Engineering and Physical Sciences, University of Surrey



# SYSTEMIQ TEAM, CONTRIBUTORS AND ACKNOWLEDGMENTS

## THIS REPORT HAS BEEN CONDUCTED BY SYSTEMIQ ON BEHALF OF THE SUN INSTITUTE ENVIRONMENT & SUSTAINABILITY.

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# ABOUT THIS REPORT

In the age of climate change and digitization, we have to rethink prosperity altogether: Our focus must shift from the products we manufacture to the benefit they generate for the user. Everything we produce can be thought and commercialized as a service. This report aims to make a new action-focused contribution to the growing field of practice and analysis around XaaS (Everything-as-a-Service) in two ways:

First, by presenting the positive economic, environmental and social case for this way of doing business, with a focus on the manufacturing sector. XaaS business and operating models can be a critical enabler for the circular economy transition, especially by incentivizing producers to optimize for resource productivity and taking responsibility over the product lifetime. The report quantifies the respective material and $CO_2$ impacts as well as total cost of ownership for three XaaS use cases to demonstrate the economic and ecological potential of such business models.

Second, by providing comprehensive insights on the design configurations and enabling factors that will drive successful strategies for companies innovating and scaling XaaS models. This is important not only to create the enabling environment for XaaS business models to work, but also to avoid potential rebound effects. These can diminish the positive societal impact of business model-driven efforts to decouple natural resource use from economic growth and well-being.

# ABOUT THE SUN INSTITUTE ENVIRONMENT & SUSTAINABILITY

The SUN Institute Environment & Sustainability is a non-profit organisation established in Germany by the Deutsche Post Foundation in 2014. It supports institutions, programs and projects dealing with the environmental challenges and opportunities of globalization and enhanced cross-border activities.

Learn more at www.sun-institute.org

# ABOUT SYSTEMIQ

SYSTEMIQ was founded in 2016 to drive the achievement of the Paris Agreement and the UN Sustainable Development Goals by transforming markets and business models in three key economic systems: regenerative land use, circular materials, and clean energy. A certified B-Corp, SYSTEMIQ combines purpose-driven consultancy with high-impact, solution development and for-purpose investment and partners with business, finance, policymakers and civil society to deliver transformative change. SYSTEMIQ has offices in Brazil, Germany, Indonesia, the Netherlands and the United Kingdom.

Learn more at www.systemiq.earth

# WHAT IS XAAS?

Everything-as-a-Service (XaaS) models combine tangible products and intangible services so that they are jointly capable of satisfying final user needs. In XaaS models, producers typically maintain product ownership and lifecycle responsibility and are consequently incentivized towards adopting circular economy strategies (long-lasting and circular design, use phase intensification, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling). Moving to XaaS models at scale promotes the shift to a performance economy – as outlined by the seminal academic work of Walter Stahel. XaaS examples include access/outcome/performance-focused models, such as turbine power-by-the-hour (Rolls-Royce), Tires-as-a-Service (Michelin), carsharing (ShareNow), Pay-per-Part (TRUMPF), or Lighting-as-a-Service (Signify).[1–4]

# XAAS FAST FACTS

## SCALE OF THE PROBLEM

### CAR-AS-A-SERVICE (CAAS)

**570 MILLION TONNES**

**of total carbon emissions** in Europe from passenger vehicles

**33%**

**increase** of transport-related emissions since 1990

### EQUIPMENT-AS-A-SERVICE (EAAS)

**>90%**

**of machinery and equipment $CO_2$ footprint** from indirect emissions (upstream and downstream Scope 3)

**21.8 MILLION TONNES**

**of ferrous metal scrap** in the EU-27 manufacturing sector in 2018

### WHITE GOODS-AS-A-SERVICE (WGAAS)

**5.5%**

**of total consumer expenditure** for furniture, household appliances and maintenance

**24.2 TWH ELECTRICITY**

**1.5 BILLION LITRES OF WATER**

**annual consumption** from residential laundry

## XAAS IMPACT POTENTIAL (EU)

**70.9 MILLION TONNES**

**$CO_2$ reduction** until 2030 through avoided BEVs and additional BEV-related improvements

**up to 39%**

**TCO reduction** potential from carsharing optimized for circularity

**1-2 MILLION TONNES**

**of ferrous scrap decrease** and related Scope 3 emissions in the manufacturing sector if XaaS resource efficiency can be applied

**37-65%**

**$CO_2$ savings** from EaaS optimized for circularity and resource efficiency

**43-76 EUR**

**potential savings** for a typical household per year by improving lifecycle resource efficiency

**1.3 MILLION TONNES**

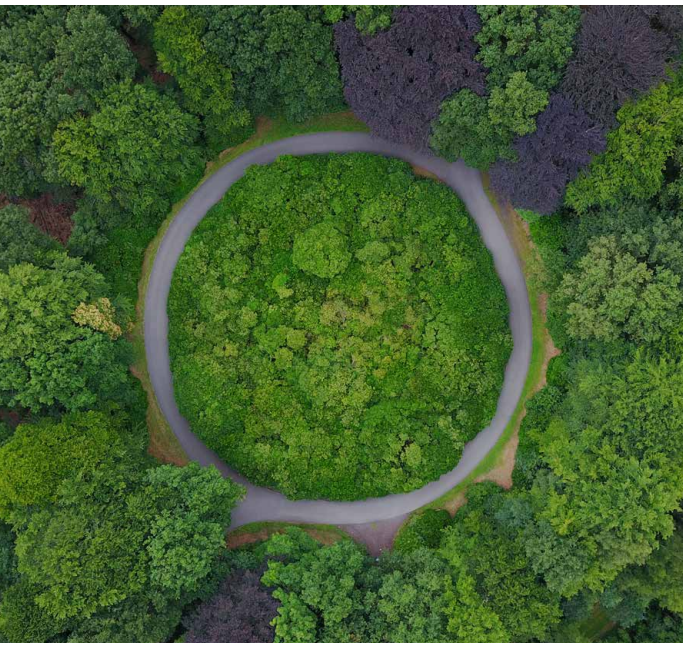
**of $CO_2$ emissions reduction** through adoption of WGaaS until 2030

**Source:** SYSTEMIQ analysis, ICCT (2021), IEA (2021), Meinrenken et al. (2020), Wasserbaur et al. (2020), and Eurostat (2021).

# EXECUTIVE SUMMARY

**Climate change and digitalization are tectonic shifts that will require and reward the transition towards resource-productive industrial systems and dematerialized consumption**. This fundamental transition is not only defining the political debate about green growth and the circular economy, but also reshaping the opportunity space for industrial companies. In this transforming landscape circular business and operating model innovation moves centre stage. XaaS (Everything-as-a-Service) models describe core green, digital economy models and can create significant value – if well designed with a view to the key parameters that lead to more sustainable outcomes. This report aims to make an action-focused contribution to the growing field of practice and analysis around XaaS in two ways: first, by presenting the positive economic, environmental and social case for this way of doing business, with a focus on the manufacturing sector. Second, by providing comprehensive insights on the design configurations and enabling factors that will drive successful strategies for companies innovating and scaling XaaS models.

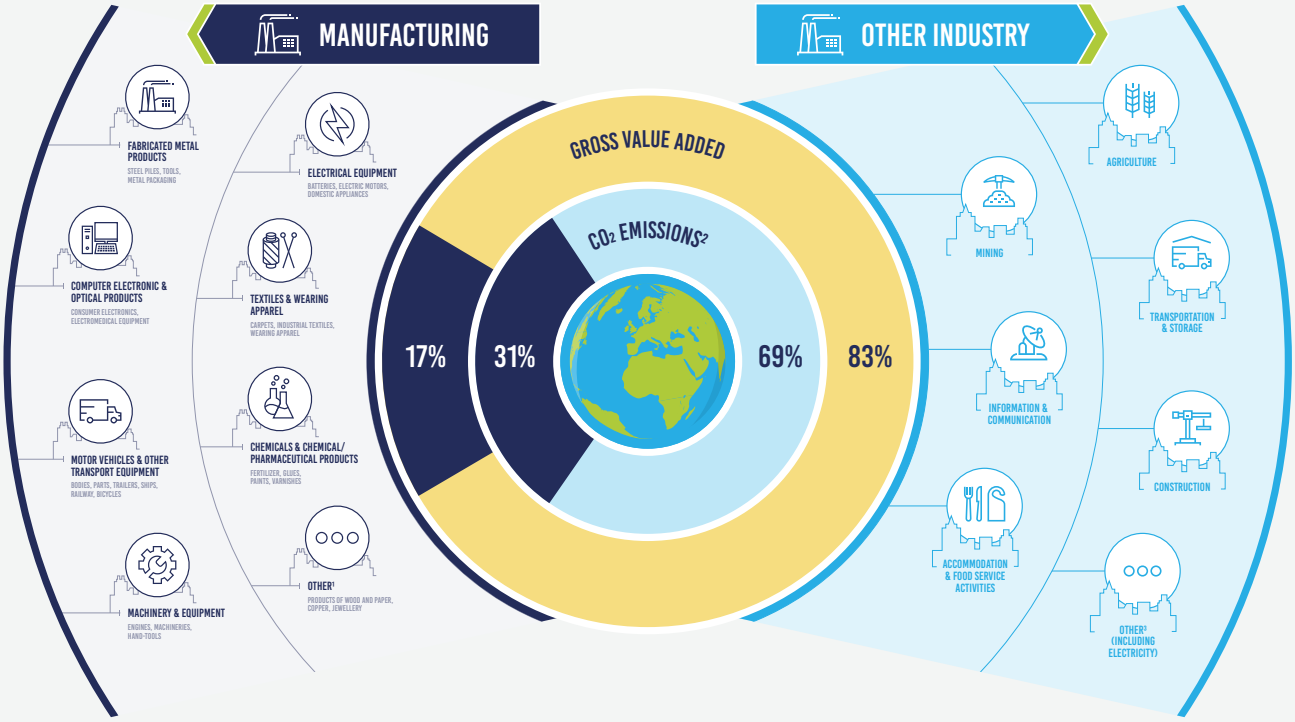
**Climate action has become a strategic priority across industrial sectors and requires carbon reductions that go beyond Scope 1-2 improvements of conventional production systems.** Recognizing that emissions have risen from 53 billion tonnes (Gt) $CO_2$e in 2015 to almost 60 Gt globally,[5] many of Europe's leading economies and companies have developed ambitious decarbonization plans and are actively exploring the opportunity space towards sustainability impact. To achieve net zero in 2050, massive reductions are needed until 2030 which have now been politically endorsed in Europe (minus 55%), the US (minus 50-52%), and many other countries (e.g. Norway, minus 50-55%).[6–8] Since the Paris Agreement, progress on low-carbon solutions and markets has been much faster than many anticipated, yet at the same time, global material extraction is still increasing and, if trends continue, will double by 2060.[9] According to the International Resource Panel, more than 50% of emissions are caused by resource extraction and processing.[10] Required carbon reductions by industry companies are too large to be delivered by Scope 1-2 improvements only. These emissions are already high (see Exhibit 1) but represent a small share of overall industrial emissions. On average, only 1/4 of a product's lifecycle emissions result from a company's direct operation.[11] Progressive companies have to reach beyond the product build phase to measure their footprint. They have to manage their Scope 3 emissions along the full value chain and lifecycle including emissions embedded in materials, components (upstream) and those in the use phase (downstream).[12,13]



**Achieving Paris-compliant impact requires decoupling economic prosperity from resource consumption – it demands a focus on resource productivity and service systems as means to achieve a circular economy**. Circular systems focus not only on designing out waste and managing a material resource base, but also keeping products and materials in use, driving better utilization of resources. This has high potential to reduce product lifecycle $CO_2$ emissions. As stated, in many cases the use phase emissions make up the majority of the product lifecycle footprint (e.g. ~50% for computer equipment, ~60% for capital goods, ~80% for cars).[11] The decarbonization potential achieved by a circular economy is further leveraged by supporting the conservation and restoration of biodiversity and

EXHIBIT 1

## Overview of European manufacturing industry (subsectors), related $CO_2$ emissions and gross value added.




[1] Other Manufacturing categories, e.g. Furniture, Paper, Basic Metals
[2] $CO_2$ emissions accounts by NACE activity in 2019
[3] Other NACE Rev.2 codes, e.g. Financial and Insurance Activities, Education, Real estate activities

**Source:** Eurostat.(2021). Data available at: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_ac_ainah_r2&lang=en

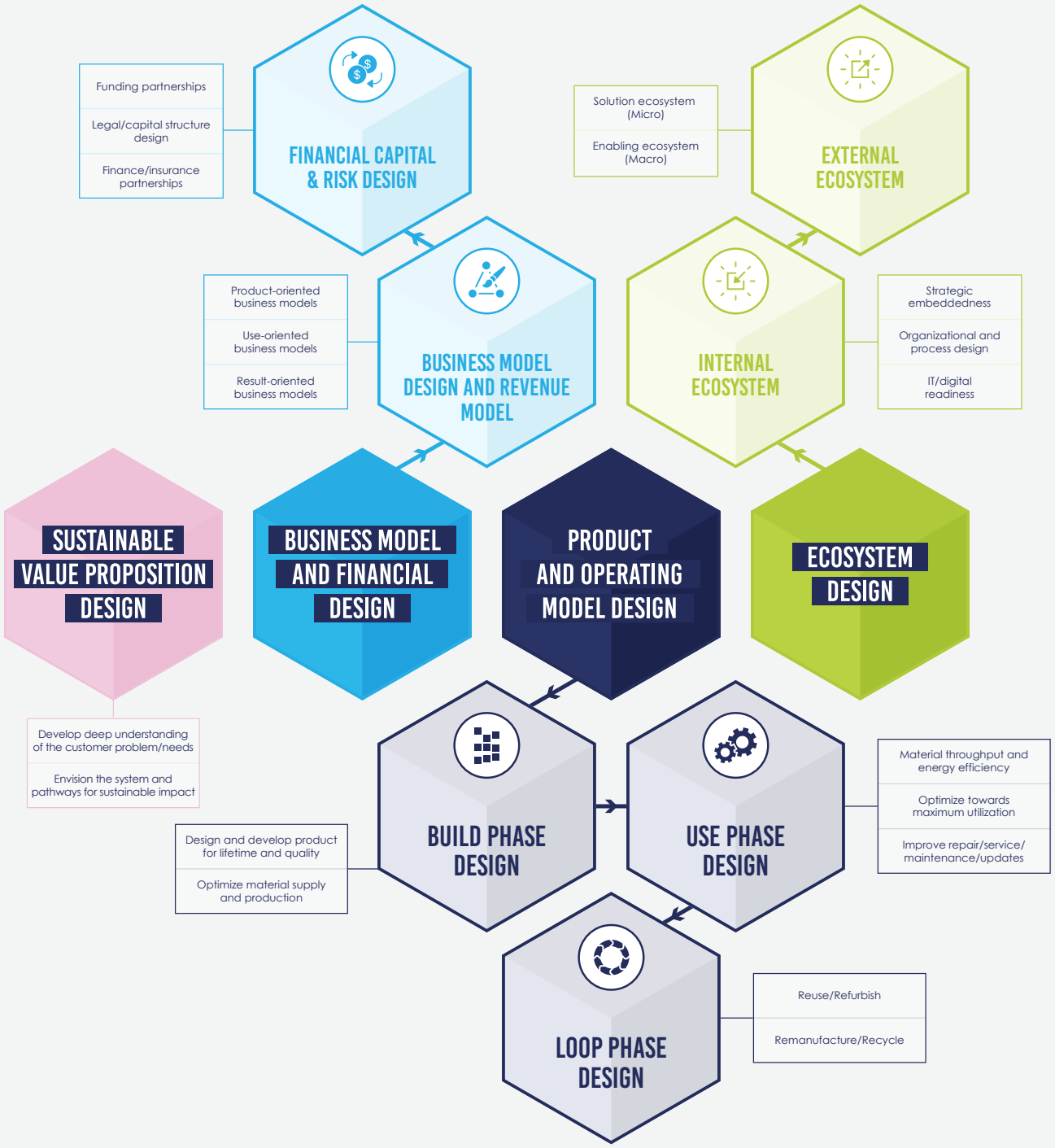
the minimization of pollution. The circular economy lens, a regenerative economic model by design, describes pathways and new business models for economic growth opportunities and value creation from fewer resources. Circular business models play a crucial role to increase customer utility as well as decrease resource consumption and the full scope of $CO_2$ emissions. Digitalization builds a new foundation and offers unprecedented opportunities for such new, dematerialized, circular business models. Leading companies are shaping the cutting edge of innovation – product innovation, service innovation, and system innovation.

**Global market dynamics and increasing competitive pressure reinforce the need for many organizations to design more productive and service-oriented systems.** New sources of growth and differentiation are needed in many sectors. As markets mature and penalties for resource-intensive products increase, companies are looking out for new business opportunities. Supply chains need to strengthen their resilience and transparency. Winning new talent still represents one of the main managerial challenges. In recent years digitalization and Industry 4.0 have transformed operations substantially – especially with respect to data analytics and intelligence, connectivity, and computational power, as well as robotics and human-machine interaction. During the COVID-19 pandemic alone, the adoption of digital technologies in companies has increased significantly by up to seven years.[14] Industry operates in a new normal: faced with a complexity of internal and external challenges, but equipped with a technology stack and momentum that enables sustainable economic value creation.

**XaaS models are a powerful climate-compatible solution that can deliver both environmental benefits and more economic value.** Offering Everything-as-a-Service (XaaS) follows the idea to enable access instead of ownership, selling utility or services instead of products: people don't need cars, but mobility; they don't need washing machines, but clean clothes; they don't need pesticides, but plant protection or yield. Delivering utility/outcomes/performance changes everything. For society, XaaS models can democratize consumption, strengthen regional value creation and decent employment, and can entail positive health impacts. For customers/consumers, XaaS models can provide a better way to achieve their needs. For producers, XaaS models have the potential to strengthen deep customer relationships and to increase (and capture) value pools. By shifting ownership, control and responsibility to producers (producer ownership), XaaS models are naturally incentivized towards maximizing resource productivity and lifetime value. Selling outcomes (e.g. mobility, yield) goes with the incentive to achieve this by using less material, waste and operating cost. At the end of the use cycle, retained ownership enables remanufacturing and recycling of valuable raw materials. In doing so, such business and operating models are a critical enabler of the circular economy. From a systemic perspective, producer ownership is one of the most elegant ways to drive sustainable product design choices.[15] The degree of potential sustainability impact is massive but will depend on the ambition level of the producer when designing an XaaS model.

**To deliver both economic and environmental benefits, XaaS systems must be designed along four critical design parameters.** Currently, strategic shifts to XaaS models can be observed across manufacturing sectors and a vast diversity of products.[16,17] This trend tends to hold across a broad range of company sizes, development stages and geographies. Think of famous product service examples such as Rolls-Royce's power-by-the-hour, Michelin's Tires-as-a-Service or ShareNow's carsharing model and less known examples such as Signify's Lighting-as-a-Service, CWS's Workwear-as-a-Service and TRUMPF's Equipment-as-a-Service (EaaS) model. In the machinery and equipment sector, EaaS models are expected to grow by 35% annually until 2025.[18] The case of mobility illustrates that Car-as-a-Service (CaaS) and shared mobility becomes more and more acceptable and a norm, for instance within companies (e.g. Siemens' new car policy), cities with high population density (e.g. Helsinki), or consumers.[19–21] The market for alternative vehicle ownership models for smart and flexible mobility is projected to grow by a factor of 4 (to 463 billion EUR) until 2035.[22] However, many producers are stalled by the complexity of design choices and neglect the environmental potential of XaaS models – much of the time this is due to lack of awareness of the enormous potential, and in the worst case results in rebound effects. The design and optimization process requires decision-makers to understand the complexity of design choices and their environmental implications – to eventually be able to advance both the economic and environmental potentials at the same time. Configuring a coherent XaaS model on this basis should address four critical design blocks (Exhibit 2). The complexity of configurations as well as the pathway to take design choices depends on individual organizational characteristics:

## Four building blocks to configure XaaS models.




**Source:** SYSTEMIQ.

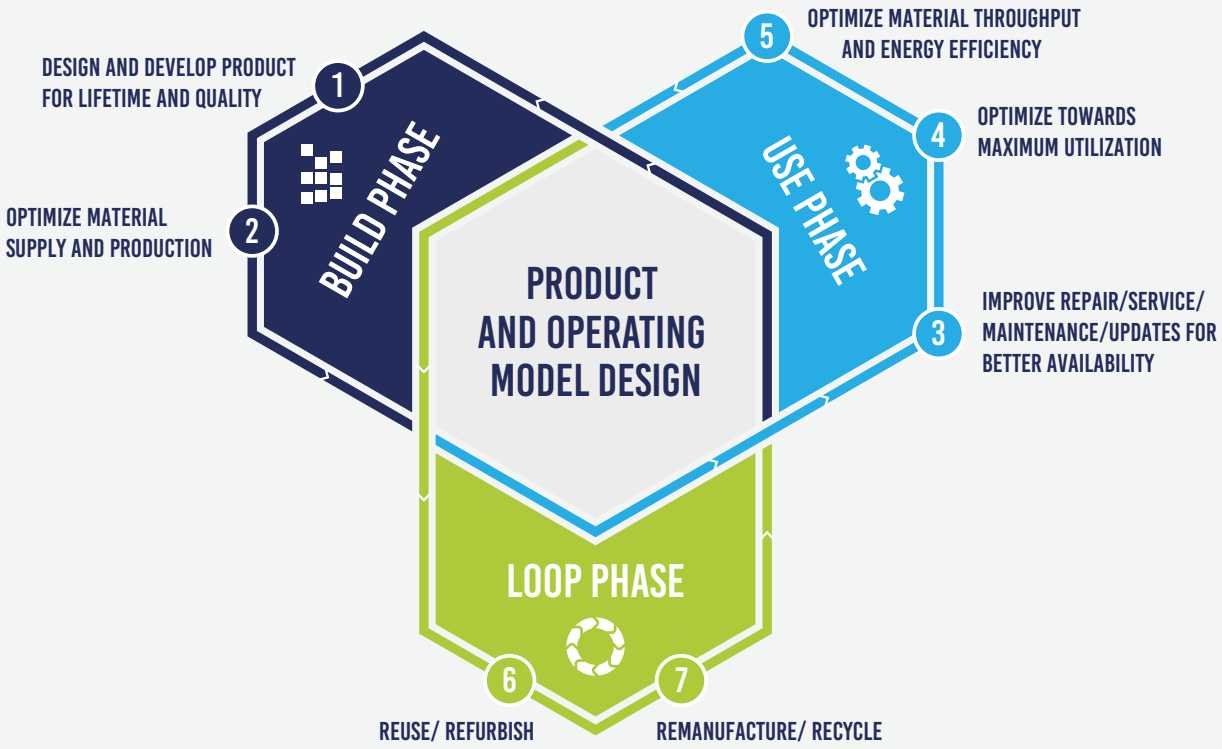
- **Sustainable value proposition design: developing a clear value proposition and impact ambition early on.** Companies should identify and define the basic human or societal needs their offering is trying to meet with the XaaS model. For example, a car manufacturer has to decide how to sell mobility (e.g. car usage, passenger kilometres). In the end, customer utility counts and is the ultimate measure of customer value. Beyond that, understanding the wider system (e.g. for a car maker the mobility system) is key to deriving pathways to maximize sustainability impact (e.g. addressing systemic inefficiencies, anticipating rebound effects). Together, a sustainable impact ambition and a customer-centric value proposition are the foundation for configuring the XaaS model.

- **Business model and financial design: configuring the fundamental business model orientation as well as financial set-up and risk management**. There are four main archetypes available to identify suitable XaaS business models. Those include use-based business models or result-oriented schemes, where ownership is kept at the producer/provider level. Another option are product-oriented models, where product ownership is still transferred to customers but value creation is deeply linked to service/performance contracts. Finally, there are sharing platforms, which go beyond the use-/result-oriented models by single producers/providers and typically offer multiple products. There is no silver bullet answer to business model design and many feasible combinations exist between models, yet the design choice strongly influences the requirements regarding funding and financial design. Thereby companies developing XaaS models need to specifically design mitigation strategies to manage financing risks, operating risks and commodity risks, as well as information risks.

- **Product and operating model design: "simply" switching the business model is not enough – unleashing full economic and environmental benefits requires addressing product and operating model design levers (Exhibit 3)**. To optimize total cost of ownership (TCO) and decarbonization potential, a circular product and operating model needs to be implemented in the XaaS model. Key circular value levers address the full product lifecycle in terms of (a) build phase (e.g. develop product for quality and lifetime, optimize material supply and production), (b) use phase (e.g. improve repair/maintenance for better availability, increase utilization, optimize material throughput and energy efficiency), as well as (c) loop phase (e.g. reuse/refurbishment, remanufacturing/recycling). To effectively reduce the environmental impact of products through XaaS models combining the key levers, it is required to understand where these impacts (e.g. $CO_2$ emissions) occur along the lifecycle.

- **Ecosystem design: optimizing the internal organizational set-up and finding the right partners for implementation to manage resource/service flows, financial flows, and information flows.** On an (a) intra-organizational level, it is critical for companies to consider that XaaS models typically require more interdisciplinarity and an agile/collaborative approach between R&D, Operations, Sales/Customer Service departments. Furthermore, XaaS projects benefit substantially from strategic embeddedness and strong senior management and shareholder support. Decision-makers have to be aware that XaaS models may require building new capabilities (e.g. with respect to data/digital, agile/SCRUM, sustainability/LCA). Proactively addressing change management aspects (mindset, purpose, structures, etc.) is therefore particularly relevant for established organizations. Beyond that, it is essential to

**Seven circularity levers address all three lifecycle phases of the product.**




**Source:** SYSTEMIQ.

assess whether the IT/technology stack is ready to manage XaaS processes (e.g. ERP system, predictive analytics). On the level of the (b) solution ecosystem (micro) an organization may not be able (or may not want) to cover all activities needed to deliver the XaaS solution internally. Choosing and orchestrating the right ecosystem design (partners) along the value chain and across industrial borders from the start is essential to deliver complex XaaS models. Finally, the level of the (c) enabling ecosystem focuses on creating supporting structures and collaboration beyond the boundaries of the solution ecosystem to drive innovation or to represent common interests. This typically requires defining a clear goal (e.g. scaling the XaaS model, regional value creation, industry sector decarbonization) and may include further relevant parties from politics (e.g. communities, municipalities, nations), society (consumer associations and NGOs), business/industry (e.g. associations, standard setting bodies) and research (e.g. universities, research institutions, innovation hubs).

**Three quantified case examples demonstrate that XaaS models could create impact ranging from minus 24 to 65% in $CO_2$ emissions and 2 to 39% in terms of final TCO reduction.** These cases illustrate the impact of ambitiously designed XaaS models in terms of providing utility, while decreasing resource intensity and increasing profit pools. Each time, we present impacts of less and more optimized XaaS models to show how the level of ambition influences results (Exhibit 4). For all cases modelled and presented in the report, reductions in $CO_2$ and TCO are not a given but depend on (a) designing product and operating model for maximum circularity, (b) pricing, i.e. the potential capturing of TCO effects by the provider, and (c) the enabling ecosystem for the XaaS model and its benefits, including avoidance of rebound effects. Today, there is high risk in failing in some of these dimensions, as many XaaS examples show.

## EXAMPLE 1

Shifting to Cars-as-a-Service (CaaS) – an important element for shaping the future of sustainable mobility. The uptake in electrification of passenger road transport (switch from ICE to BEV) powered by more and more renewable energy will eliminate tailpipe emissions in the long run (minus ~30-65%)[i]. But in the mid-term, irrespective of the powertrain electrification, decarbonizing the build phase will become crucial to reach climate neutrality for the automotive value chain. A circular CaaS product and operating model could complete the transformation towards sustainable passenger transport and decarbonize the $CO_2$ emissions caused by a BEV by ~25% in a car subscription model (Scenario 1) and by ~45% in a free float carsharing model (Scenario 2). An initial analysis indicates that a free float carsharing model could achieve TCO benefits of up to ~39% for consumers.

From an aggregated CaaS perspective, this could lead to a reduced European BEV stock[ii] of 17% (ca. 5.8 million vehicles) providing the required mobility demand, translating into $CO_2$ savings from avoided production of 70.9 million tonnes (Mt) $CO_2$ until 2030 and additional annual BEV-related savings of 8.3 Mt $CO_2$. Beyond that, from a systemic perspective, it is critical to emphasize that CaaS models should be seamlessly integrated with other even more sustainable modes of transportation (e.g. walking and bike riding for short distances, public transportation and railways) to maximize the overall environmental benefits.

## EXAMPLE 2

Machinery and Equipment-as-a-Service (EaaS) – enabling a resource-efficient manufacturing industry. The $CO_2$ footprint of a typical machine in the use phase often exceeds that of its build phase by a factor of 20. Capitalizing on Industry 4.0 investments and capabilities, EaaS models have the potential to decarbonize the full lifecycle emissions, including the production process. The case in this report builds on the reference example of a state-of-the-art metal laser cutting machine. The analysis reveals that $CO_2$ emissions can be reduced by ~37% when the machine is offered in a result-oriented Pay-per-Part model (Scenario 1). Extending Scenario 1 to a demand-pooling marketplace production platform (Scenario 2) decreases emissions by up to ~65%. The decarbonization potential mainly stems from the use phase resource efficiency: optimization for lifecycle efficiency per design, increased production capacity (utilization) combined with improved results with less scrap in terms of metal sheets processed into functional parts. Due to the increased capacity and improved material throughput, TCO can be reduced by ~16–24%, depending on the EaaS scenario (Exhibit 4), while CapEx switches to OpEx for the customer.

An aggregated lens to EaaS shows that this model can play a crucial role in decarbonizing machinery and metal processing overall. To illustrate, if 30% of newly installed laser cutting machines until 2030 were offered in comparable EaaS models (20% EaaS 1.0; 10% EaaS 2.0), then 6.3 Mt $CO_2$ could be saved through improved machine lifecycle

i Minus 30% with European electricity mix 2019 to 65% with entirely renewable energy.

ii Assuming the European BEV fleet in 2030 (according to the IEA Sustainable Development Scenario) would adopt 20% subscription-based models and 20% carsharing.

footprints. From a systemic perspective, a deeper value chain integration and ecosystem cooperation can potentially lead to further optimization of resource flows. Implementing XaaS logics along the supply chain (e.g. Metals-as-a-Service, Components-as-a-Service and Product-as-a-Service) is the logical next step in creating functionally connected, outcome- and utility-focused systems.

## EXAMPLE 3

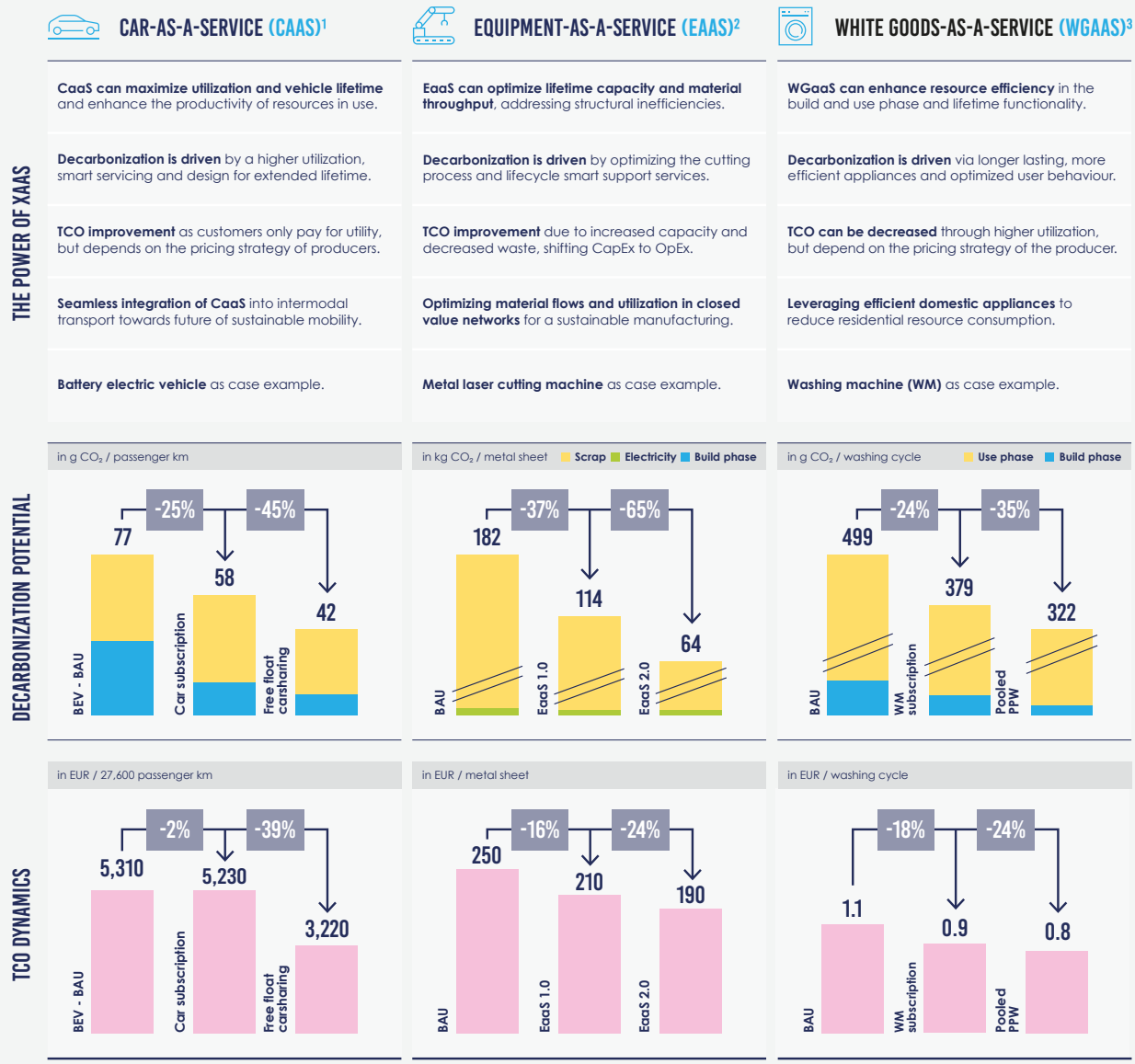
**White Goods-as-a-service (WGaaS) – a driver for resource productivity of domestic household appliances.** This case explores the example of washing machines (WMs), which are the most resource-intensive domestic appliance consuming 1.4 Mt of materials, 24.2 TWh of electricity, and 1.5 billion litres of water in Europe per year. Offering WGaaS can be a critical enabler for optimizing associated environmental build and use phase impacts. Offering WMs in subscription models (Scenario 1) can enable the widespread instalment of top-of-the-line WMs with higher lifetime and resource productivity through maintenance, increased efficiency and material recovery. The $CO_2$ footprint could be decreased by ~24% compared to an average WM. Operating a pooled Pay-per-Wash model (Scenario 2) could decrease emissions from laundry washing by ~35% through additional effects such as higher load utilization. WGaaS shifts upfront costs over the use phase, making high-quality WMs accessible to more customers. The resulting lifecycle resource efficiency entails a TCO reduction potential of between ~18% (Scenario 1) to ~24% (Scenario 2).

Overall, WGaaS can have an aggregated impact for reducing residential resource consumption and $CO_2$ footprint. Assuming that 20% of WMs sold in the EU until 2030 would be provided via circular subscription models and 10% by pooled Pay-per-Wash solutions, 49 million m³ water and 1.2 TWh electricity can be saved. Together with reducing the impact of materials embedded in WMs, this translates into savings of 1.3 Mt $CO_2$ emissions. At the same time, households could save between 43-76 EUR per year (in total ~2.2 billion EUR until 2030). Taking a long-term outlook, from a systemic perspective beyond the scope of this case, the next evolution of WGaaS could develop into full-service schemes, building on a high degree of automation and value chain integration (e.g. automated ironing) or at-scale (last mile) logistics.



EXHIBIT 4

## Transitioning to XaaS: Measuring the ecological and economic effects of three use cases optimized for circularity.




**Source:** SYSTEMIQ analysis based on multiple sources.
[1] SYSTEMIQ analysis based on OECD and ITF (2020), IRP (2020), Ecoinvent (2020), Volkswagen AG (2021a, 2021b, 2021c), Schwacke (2020), expert interviews.
[2] SYSTEMIQ analysis based on data provided by TRUMPF Group (2021).
[3] SYSTEMIQ analysis based on Sigüenza et al. (2021), Bocken et al. (2018), Homie (2021), BlueMovement (2021), EcoTopTen (2021), expert interviews.

**The shift to XaaS is a pro-market, pro-growth and pro-technology agenda.** Scaling XaaS as a basis for the circular industry transformation at the required pace requires a strong digital infrastructure, new forms of collaboration and a set of (market-oriented) policy interventions. This study explores the role of these enablers to accelerate and bring the XaaS models to their full potential.

- **First, the technology stack of companies and sectors will be critical to manage XaaS data/ information flows – open architectures will be**

**needed to enable circular production systems.** On the one hand, the digitalized Industry 4.0 builds the foundation from which XaaS models emerge, and on the other hand, IT/digital capabilities will play the key role in satisfying additional increasing data needs driven by economic and ecological requirements (e.g. carbon accounting). A company's readiness for XaaS implementation will be dependent on IT/digital (e.g. data capturing and analytical capability), and drive the overall digital transformation.

- **Second, policymakers can apply demand-side instruments to strengthen ownership of producers and to create a level playing field for all actors.** Regulation can be powerful to accelerate and provide stimuli, but also plays a pivotal role to adjust for systemic rebound effects. Overall, policymakers should address three key policy instruments and evaluate cross-sectoral measures to foster the shift towards sustainable XaaS models that fulfil circular economy principles and reward access over ownership. In particular, (a) economic and market instruments should create strong fiscal incentives, such as carbon pricing, to encourage resource efficiency or discourage consumption patterns with negative footprints.[23] Economic instruments should essentially incentivize producers to retain value of products by taking responsibility over the product lifetime and keeping ownership. Funding support or access to capital/grants can be important to enable the uptake of circular XaaS models. In addition, since public authorities are responsible for spending over 14% of the GDP per country in the EU, procurement rules should be evaluated towards applying guidelines for Green Public Procurement including rules for XaaS models as soon as possible.[24] Second, (b) regulatory instruments and standards should connect products to producers to facilitate a lifecycle perspective and producer ownership responsibility, but also evaluate the effectiveness of Ecodesign and waste regulations for XaaS models. In addition, standards are a verifiable way to control socially and environmentally acceptable business practices, unify terminology and facilitate necessary interfaces for the exchange of information. Finally, (c) empowering public and private institutions as well as consumers will be critical. This should include information and awareness campaigns to educate organizational actors (e.g. key decision-makers and institutional investors) as well as consumers about both the economic and environmental impact potential of XaaS models.[25]

- **Third, mobilizing industry action and adoption of XaaS models would benefit from facilitating exchange and collaboration among the emerging ecosystem of pioneers.** Owing to the complexity of the outlined design decisions, networking, exchange and best-practice sharing in the precompetitive space is necessary to enable organizations to continuously optimize their XaaS model configuration. Furthermore, in order to foster specific regional value creation (e.g. specific industrial clusters) or integrated XaaS models (e.g. alignment of XaaS models across value chain steps) stronger collaboration and systemic partnerships will be essential. In this context, entrepreneurial innovation will be vital to address many of the emerging challenges with novel solutions, help incumbents to transform to sustainable XaaS models quickly, and thereby accelerate the wider industry transformation towards sustainability and resource productivity.

**Combining climate neutrality and digitalization into XaaS is an attractive vision for Europe.** XaaS can provide better ways for consumers and society to fulfil their needs. Industrial companies may drive decarbonization and unleash innovation and competitive differentiation. By strengthening the ownership of producers, XaaS presents a first-best solution, addressing the full scope of emissions, creating a level playing field for all actors. Consequently, countries, companies and investors now have a once-in-a-generation opportunity to decouple economic prosperity from natural resource use and environmental impact, creating millions of jobs and more resilient economies.[26]

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# EVERYTHING-AS-A-SERVICE

# XAAS

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