The Digitalisation Consultancy Industry

#DIGITAL4CLIMATE

FOSSIL FREE SWEDEN

The Digitalisation Consultancy Industry

An Innovation Driven Roadmap for Fossil-Free Competitiveness and Global Sustainability

A. Foreword

Sweden will be one of the world's first fossil free welfare nations. This is not just a vision but a firm reality, with several business sectors now presenting their roadmaps for fossil free competitiveness.

This work is crucial in a time when greenhouse gas emissions are decreasing far too slowly to limit global warming to 1.5 degrees Celsius. It is the task of the Fossil Free Sweden initiative to accelerate Sweden's climate mitigation and adaptation efforts, and it has therefore invited business sectors to produce their own roadmaps for fossil free competitiveness to show how they can contribute to a fossil free future, how they improve their own and their customers, business and how it strengthens the competitiveness of Sweden. The response has been overwhelming. In total, thirteen roadmaps have been handed over to the government, and more will be launched.

These roadmaps are unique initiatives. The fact that various corporate networks show how they can contribute to a fossil free future is certainly a good thing, but entire sectors drawing up their own roadmaps for being fossil free by 2045 is an initiative that brings hope for the future. It is not just the actual document that is important, but also the fact that it has entailed a far-reaching process involving many other players through various workshops and seminars. Since there are so many roadmaps, producing them creates a momentum in Sweden, with more and more players taking steps towards being fossil free.

These roadmaps jointly make up a 'Jigsaw Puzzle of Sweden', showing how Sweden can become fossil free while welfare increases. The sectors are, however, owners of their own roadmaps' narratives, and of the policy demands necessary to enable them to realize their ambitions for the roadmaps. Fossil Free Sweden has worked with the sectors in various ways to support them in producing their roadmaps. This has included joint debate articles, participation in workshops, and occasionally giving concrete tips and advice. It should however be emphasised that the roadmaps are products of the sectors' inherent drive and commitment, and that the results and the various political suggestions highlighted are owned by the sectors themselves.

Through these roadmaps a Swedish national team for fossil free development has been created. It has come together to show others that another world is possible. When we demonstrate that a fossil free country is also the way to a better life, there will be a global race to leave the fossil based society.

Svante Axelsson
National Coordinator,
Fossil Free Sweden

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B. Executive summary

WHO ARE WE?

More than 30 leading firms in the digitalisation consultancy industry have joined forces behind this roadmap and we are united in our ambition to help society recognise and tap the potential of digitalisation for a fossil-free future. We believe it is critical that the digitalisation that is providing some of the most powerful tools humankind has ever created is given a framework for contributing to a smart and sustainable future.

WHY ARE WE PREPARING A ROADMAP?

It is going to require total social transformation for Sweden to become climate neutral by 2045 in a way that is sustainable, as well as many technological leaps in rapid succession. The solutions powered by digitalisation, which digitalisation consultants help implement, have enormous potential to enable the reduction of global greenhouse gas emissions (GHG). Studies that limit the focus to only optimisation of current systems show that digital solutions can contribute to an estimated 20 percent reduction of global emissions. But the potential for cutting emissions is considerably larger if we also include the transformative impact of digitalisation, which can help meet society's needs in entirely new ways.

Digitalisation should be considered a catalyst that can hasten development in either a fossil-free and resource-efficient direction or a fossil-intensive and resource-intensive direction. In addition to adopting new technology, we therefore need to work with how technology is used and for what, and to ensure that business models, behaviours, regulations and organisational approaches are adapted for a sustainable and digitalised world.

VISION AND TARGETS

Our vision is that digitalisation consultants will, by 2045, have contributed to reducing energy consumption in Sweden and the rest of the world, giving us a chance to stay below a temperature rise of 1.5 °C. This will be accomplished through focus on the Low Energy Demand (LED) pathway presented in the latest report from the UN Intergovernmental Panel on Climate Change (IPCC).

"We believe it is critical that some of the most powerful tools humankind has ever created are given a framework for contributing to a smart and sustainable future."

This is also the IPCC scenario that delivers the most towards achieving the other global Sustainable Development Goals (SDGs). With a focus on the LED pathway, we will further progress based on increased international collaboration that delivers solutions that are globally sustainable. These global sustainable solutions will enable sharper international competitiveness that leads to high growth in exports of transformative solutions (both products and services). That means solutions that deliver answers to social needs through brand new, resource-efficient and circular innovations.

As digitalisation consultancies, we have set a target for our own businesses to be fossil-free by 2045.

Accelerating the journey towards a fossil-free digital infrastructure is also an obvious focus for us. By taking a proactive role and guiding our clients towards the right infrastructure investments, we can promote the continued reduction of emissions from the underlying infrastructure that digitalisation requires. The target is zero emissions from the digitalisation infrastructure by 2045, with the ambition of getting there fifteen years earlier, in 2030. This will take place alongside the accelerating digitalisation of all sectors of society.

SCIENCE CONFIRMS THE KEY ROLE OF DIGITALISATION

The contents of the roadmap were developed in parallel with and largely based on the strategic long-term vision for a climate-neutral Europe presented by the European Commission on 28 November 2018[1] and the IPCC Special Report on Global Warming of 1.5 °C[2] that describes pathways to achieving the 1.5 °C target by implementing new and smarter solutions (products and services) that lead to steep reductions in energy and resource consumption.

Digital solutions can help reduce emissions in three ways. First, existing systems can be optimised. Second, the uptake of sustainable solutions can be accelerated. Third, transformative changes can be achieved.

A transformative change that results in radical and rapid reductions of GHG emissions occurs when the impacts of digitalisation at various levels work together, i.e., when novel technical solutions, business models, economic incentives, new legislation, social planning, new financing models and methods for assessment and creating transparency, etc., are brought together.

One serious challenge is that the less significant contributions of digitalisation (optimisation of individual products) are relatively easy to explain, measure and support politically, while the greater, transformative and systemic changes are often more difficult to explain, measure and support politically. The transformative and systemic changes demand numerous interacting measures that often require collaboration among government ministries, public agencies and sectors in a way that seldom occurs today. Consequently, focus is apt to end up on the minor contributions of digitalisation, with risk that the major contributions will be ignored.

COMMITMENTS OF THE DIGITALISATION CONSULTANCIES

We, the digitalisation consultancies, must assume greater responsibility for more actively contributing to the global development and implementation of sustainable and fossil-free solutions.

We have prioritised the following strategic commitments.

By 2030:
1. Cut the industry's energy use by half or more by 2030, with the ambition of reaching zero emissions by 2045 (in accordance with the IPCC's LED pathway).

By 2020:
1. Agree a minimum level of knowledge among our employees regarding the impacts of digitalisation from a climate and sustainability perspective.

2. Carry out training initiatives to ensure that our employees meet the minimum level within one year after they are hired.

3. Agree a framework to report positive and negative contributions (Scope 1-4, including avoided emissions).

4. Find resources for building and launching a web platform where the capacity of industry firms as agents of solutions and our contributions to a national knowledge boost are made available to each other, clients, academia and government. We recommend that the platform should include:

   • Presentation of cases including climate impact
   • Training materials, methods and reports
   • Information about joint initiatives
   • Contact details for individuals with particular expertise

5. Adopt new commitments for the period up to 2022 based on conditions in 2020.

CALLS FOR ACTION TO THE SWEDISH PARLIAMENT AND GOVERNMENT

We have identified seven strategic actions within the framework of the roadmap process that could promote the central role of digitalisation in achieving a fossil-free future:

1. APPOINT A DIGITAL TRANSFORMATION COMMITTEE WITH INTERNATIONAL AMBITIONS

Appoint a committee of members from various segments of society and with significant international repre-

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[1] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2050-long-term-strategy
[2] https://www.ipcc.ch/sr15/

sentation, tasked with identifying knowledge gaps, legal barriers, organisational lock-ins and incentives blocking Sweden's routes to accelerating the uptake of digital solutions for a fossil-free future. The committee should also submit proposals for creating incentives for sustainable business models that leverage digitalisation.

International work should be included in the committee's remit. One suggestion is to follow up French President Emmanuel Macron's Tech for Good summit with a more action-oriented Tech for Zero Carbon summit, where the CEOs of the world's leading technology firms and consultancy firms are challenged to collaborate and present action plans for how digitalisation can deliver fossil-free solutions in all critical areas, in line with that identified as necessary in the IPCC Special Report on Global Warming of 1.5 °C.

2. UPDATE APPROPRIATION DIRECTIONS WITH REQUIREMENTS FOR DIGITAL LOW ENERGY DEMAND STRATEGIES

Establish the IPCC's LED pathway as a model for strategic work and task all government agencies, via their appropriation directions, to develop strategies wherein digitalisation enables a globally sustainable fossil-free future through Low Energy Demand scenarios. These strategies should include scenarios capable of delivering a fossil-free future without using technologies red-listed by the IEA, i.e., the technologies that have thus far failed to deliver as previously hoped such as CCS. Allocate resources to the agencies to ensure that expertise on the risks and opportunities of digitalisation is available to those assigned to draft the new strategies.

3. ENCOURAGE REPORTING OF SCOPE 4/ AVOIDED EMISSIONS

Review current incentives for business to report own emissions (Scope 1-3 emissions) and add incentives to also report contributions to reduced emissions in society from the goods and services they provide (Scope 4/avoided emissions). This will shift the focus from problems/risk to innovation/opportunities and unpack the potential of digitalisation to deliver global climate-smart solutions. Initially, incentives for Scope 4 reporting could, for example, be increased by having the Swedish National Pension Funds request the information and for public procurement processes to include Scope 4 reporting when assessing bidders. Scope 4 reporting will also make it

possible for consumers to access data on the climate impact of products. One possibility would be for business sectors to begin developing joint preliminary standards for product categories, which would eventually be based on actual data. Statistics Sweden (SCB) should be allocated additional resources for its work with data related to Agenda 2030 so that relevant data for Scope 4 can also be included. The Swedish Government should also prioritise support for the development of methods for estimating Scope 4 and providing open access to climate data, especially in international contexts, by actively participating in processes like the Task Force on Climate-related Financial Disclosures (TCFD) and the work of the EU Commission with financial data, which is going to affect all multinational business.

4. APPOINT A FAST-TRACK INQUIRY INTO DATA THAT SUPPORTS GLOBAL SUSTAINABILITY

Appoint a fast-track inquiry to determine what data are currently available or can be made available to equip citizens, government agencies and business to develop new and innovative solutions from a global sustainability perspective, i.e., whether it is possible for nine to eleven billion people to use the solution in a socially fair world (in accordance with the World Business Council for Sustainable Development Vision 2050). Data in key areas, including geodata, property data, mobility data, etc., should be included in this study. The issue of how data can be de-identified to assure personal privacy should also be investigated.

It is essential that this data is organised based on social needs, in order to facilitate new solutions and not only improvements of existing systems. Aimed at understanding how data can be used to assess initiatives and the global impacts of initiatives, we recommend that the Swedish Government appoint a Sustainable Data Council, modelled on the National Innovation Council.

5. CLARIFY THE RESPONSIBILITY FOR DIGITALISATION AND SUSTAINABILITY WITHIN ALL GOVERNMENT MINISTRIES

In order to facilitate coordination within the Government Offices of Sweden, we recommend that responsibility in each ministry is clarified as to who will coordinate the impacts of digitalisation from a sustainability perspective. Resources should also be guaranteed in current and

future digitalisation and sustainability initiatives so that the role of digitalisation in achieving fossil-free sustainability is included in both digitalisation and sustainability initiatives.

6. ALLOCATE RESOURCES FOR A NATIONAL KNOWLEDGE BOOST

Implement a national knowledge boost by augmenting current knowledge-enhancing initiatives in the areas of digitalisation and sustainability with focus on how digitalisation contributes to a fossil-free future and sustainability. In order to securely provide for long-term skills needs, all parts of the education system should also integrate the relationship of digitalisation to sustainability as a central aspect. Moreover, Sweden's capacity to attract and retain skills from abroad should be reinforced and regularly evaluated.

We also recommend that relevant government agencies be allocated additional financial resources earmarked for funding a knowledge boost related to the links between digitalisation and a fossil-free future for the groups currently working with digitalisation and sustainability. The knowledge boost should achieve ends including making it possible for interested groups to apply for grants for knowledge-enhancing activities, such as a web platform with the functionality described in the commitments of the digitalisation consultancy industry. We estimate the need for financial support for a shared platform that could contribute to increasing knowledge among those who provide digital solutions and those who use them and for following up the recommendations of the roadmap at SEK four million per year over a three-year period.

7. ESTABLISH TESTBED ZONES FOR SUSTAINABLE DIGITAL TRANSFORMATION

Establish a national initiative in which innovation zones and entire cities interested in acting as testbeds for a fossil-free, ecologically sustainable and socially fair transformation can be brought together. Cities interested in being testbeds in strategic areas where digital solutions for a fossil-free future are developed for various needs in society, such as housing, mobility, nutrition, health and art/science, could be presented as early as in conjunction with the 2019 UN Climate Change Conference COP25 in Chile. The purpose of these testbeds would be to lower the thresholds for testing new methods,

developing new business models, testing technology, arriving at new modes of collaboration and attempting to understand the various impacts and opportunities from a wider systemic perspective. Rapid upscaling would also be facilitated by going from small demonstration facilities to the city level, or the equivalent. Changes in regulations pertaining to building permissions, conveyancing fees, permit issuance, special rules and approaches, fast-track processing, prioritised decision paths, etc., could be tested in these testbeds.

CALLS FOR ACTION TO THE MARKET

So that digitalisation will be able to contribute to a fossil-free future, we present three recommendations within the framework of the roadmap process, to organisations (public and private) that recognise a need to digitalise their operations or reduce their climate impact. These recommendations are:

1. Analyse the catalytic impact of digitalisation on GHG emissions and identify risks of lock-in effects ahead of all strategic initiatives (both climate initiatives and digitalisation initiatives) related to the areas where sustainable solutions are needed to achieve a fossil-free future, such as housing, mobility, nutrition and consumption.

2. In addition to targets for minimising own negative climate impact (Scope 1-3), set positive climate and sustainability targets where the focus is on how your organisation can contribute to reducing climate impact from the global perspective (Scope 4).

3. Require digitalisation consultants to demonstrate that they have integrated climate and sustainability aspects in their core business, that they understand the impact of digitalisation from a climate and sustainability perspective and that they can show that the investment has reduced negative impact and increased innovative, positive climate impact.

C. We stand behind the targets, calls for action and intentions of the roadmap

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Tritech Technology AB
Åke Wernelind, CEO

Usify AB
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1. Starting point

According to the latest research findings presented in the IPCC Special Report on Global Warming of 1.5 °C, global emissions should reach zero before 2050.[3] The Swedish goal of being a fossil-free country by 2045[4] should be considered from this perspective, which has two implications:

1. **A rich country like Sweden should reduce emissions to zero much sooner than 2045**
   For a country like Sweden, where conditions for achieving a zero emissions domestically are so favourable, 2045 is late. The IPCC report aiming for zero emissions by 2050 applies to the entire world, including poor countries and countries where conditions are less favourable and where Sweden's impacts through import and export should be included. The principle of "common but differentiated responsibility" was established in the climate talks at the Rio de Janeiro Earth Summit in 1992.[5] This principle recognises that all countries have a responsibility, but that rich countries that built their prosperity by filling the atmosphere with greenhouse gases have heavier responsibility for reducing emissions and contributing the solutions required. Based on "common but differentiated responsibility", 2045 should be regarded as the absolute deadline for 100% fossil-free solutions in Sweden, but if it is possible, zero emissions should be reached considerably sooner and it is important that the solutions are sustainable from a global perspective. In other words, we should decide how much earlier than 2045 we will achieve zero emissions in a sustainable way, in part by considering the impacts on international competitiveness of being a fossil-free country by 2030.

2. **A country like Sweden should develop globally sustainable solutions that can be exported**
   It is important that the solutions developed can

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make the greatest possible contribution to reducing global emissions. Sweden is a small country and can have the most impact by developing, implementing and exporting/spreading globally sustainable and competitive solutions.[6] It is therefore important that the solutions developed by Sweden are internationally competitive. It is also essential that the solutions developed are based on sustainable use of natural resources from an international perspective and contribute to other sustainability goals or, at the very least, do not undermine them. Strategies and initiatives in Sweden should therefore always be assessed based on their global sustainability, i.e., whether is it possible for nine to eleven billion people to use the resources in an ecologically sustainable way in a socially fair world.

1.1 WHO ARE WE AND WHY ARE WE PREPARING A ROADMAP?
Numerous firms in the digitalisation consultancy indu-

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[3] http://www.ipcc.ch/report/sr15/
[4] https://www.regeringen.se/artiklar/2018/04/sverige-ska-bli-ett-fossilfritt-valfardsland/
[5] https://en.wikipedia.org/wiki/Common_But_Differentiated_Responsibilities
[6] https://www.wwf.se/source.php/1120404/Powerswitch_singel_komp-3439.pdf

stry have joined forces behind this roadmap and are united in their ambition to help society recognise and tap the potential of digitalisation. We believe it is critical that some of the most powerful tools humankind has ever created are given a framework for contributing to a smart and sustainable future.

It is going to require total social transformation for Sweden to become climate neutral by 2045, as well as many technological leaps in rapid succession. The solutions that digitalisation consultants help implement have enormous potential to make reductions of global GHG emissions possible. Studies that focus on optimisation of current systems show that digital solutions have the potential to contribute an estimated 20 percent reduction of global emissions. But the potential for cutting emissions is considerably larger if we also include the transformative impact of digitalisation, which can help meet social needs in brand new ways.

Digitalisation should be considered a catalyst that can accelerate development in either a fossil-free and re-source-efficient direction or a fossil-intensive and re-source-intensive direction. In addition to adopting new technology, we therefore need to work with how tech-nology is used and for what, and to ensure that business models, behaviours, regulations and organisational approaches are adapted for a sustainable and digitalised world. Digitalisation has already created several new challenges, in that unsustainable businesses are beco-ming more efficient and acquiring new tools to drive unsustainable consumption. At present, digitalisation of-ten contributes to lock-ins to marginally better systems that are unsustainable, rather than long-term sustainable development.

Our aim with the above is to encourage a situation in which Sweden has by 2045 achieved the global SDGs, is a world leader in imports and exports of globally sus-tainable solutions, and that everyone is living well and within the limits of the planet.[7] The Swedish effort to become a fossil-free country has also contributed to, for example, delivering the global SDGs[8], WBCSD Vision 2050[9] and the Half-Earth Project.[10]

1.2 LOOKING AHEAD IN RETROSPECT: WHAT DID PEOPLE IN 1991 BELIEVE THE WORLD WOULD BE LIKE IN 2018?

This roadmap does not include a traditional action ti-meline. The reason is that we are living in an era of rapid change and simple projections have steered us very wrong in the past and/or locked society into outmoded ways of thinking and delivering solutions.

There has been no lack of scenarios over the years, but studies indicate that these scenarios are often more politically motivated than based on what is actually happening, and are rarely linked to concrete actions.[11] Roadmaps and scenarios thus tend to say more about the situation as it is when they are written than about the future they purport to describe. To counteract the tendency to merely extrapolate current trends and to base work on existing influential groups, it is important to think about the similarities as well as the differences we are facing today compared with our past.

There is a space of 27 years between 2018 and 2045 (when Sweden intends to be climate neutral). Some in-dustries have factories that are much older than that and some of those have been operating relatively unchanged for more than a century. If we look back 27 years to 1991,

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[7] The fairness aspect of the transition is important and as regards the vision of living well and "within the limits of the planet," this should not be consi-dered a target that keeps us just this side of total collapse, but rather as a limit within which we are living in harmony with nature. Leaving half the global surface alone is a principle that has gained increasing support in recent years. http://www.half-earthproject.org/

[8] https://sustainabledevelopment.un.org/?menu=1300

[9] From the WBCSD Vision 2050: "...living well and within the limits of the planet. By "living well", we are describing a standard of living where people have access to and the ability to afford education, healthcare, mobility, the basics of food, water, energy and shelter, and consumer goods. By "living within the limits of the planet", we mean living in such a way that this standard of living can be sustained with the available natural resources and without further harm to biodiversity, climate and other ecosystems." https://www.wbcsd.org/Overview/About-us/Vision2050

[10] From the Half Earth Project https://www.half-earthproject.org/discover-half-earth/#why-half
"The crucial factor in the life and death of species is the amount of suitable habitat left to them. As defined by the theory of island biogeography, a change in area of a habitat results in a change in the sustainable number of species by approximately the fourth root. As reserves grow in size, the diver-sity of life surviving within them also grows. As reserves are reduced in area, the diversity within them declines to a mathematically predictable degree swiftly – often immediately and, for a large fraction, forever. If we protect half the global surface, the fraction of species protected will be 85%, or more. At one-half and above, life on Earth enters the safe zone."

[11] http://www.energycrisis.org/bezdek/jfe%20paper.pdf

these industries were almost identical to how they are now. It is understandable that models and studies in these areas/sectors tend to be based on assumptions that the future will be only marginally different from how it is today.

But for the digitalisation industry, very little is as it once was. 1991 was three years after Tim Berners-Lee invented the World Wide Web in 1989 and two years after he designed and built the first web browser. In practice, what we now call the internet, the web and cyberspace did not exist 27 years ago.

Also in 1991, Kodak was a leading company, famous for its innovation. Few would have guessed in 1991 that the company would file for bankruptcy only 20 years later.12 What is particularly interesting about Kodak is that they invented the digital camera and had huge capacity in terms of knowledge about digital solutions. But, because the company was trying to preserve old revenue streams, related in part to traditional film and film developing, Kodak failed to adjust its business model and stay relevant when times changed.[13]

When it comes to which companies and individuals we should study to understand what solutions we should focus on, it might be worth keeping in mind that Jeff Bezos did not create Amazon, the second company (after Apple) to be valued at over one billion dollars, until 1994, three years after 1991.[14] The implication is that a new future company that revolutionises the world as much as Amazon.com would not be created until 2021 in relation to a roadmap to 2045. It would also take five years before Steve Jobs returned to till Apple in 1995, after having been sacked.[15] It took another 16 years before Apple launched its most successful product, the now iconic iPhone, in 2007. Lest we forget, the iPhone was also panned by many experts when it was launched.[16] With good

reason, we can presume that many of the most innovative people and companies who will be shaping the world in 2045 have yet to be born, and solutions that will disrupt society are being ignored by mainstream experts.

As regards new business models and ways to deliver solutions, it might be worth remembering that Encyclopaedias were popular in 1991. In Sweden, the National Encyclopaedia was a political priority and had just published its first volume. Ten years later in 2001, Wikipedia was launched to the almost universal derision of the experts. By 2018, it was the most frequently visited website and has redefined how knowledge can be collected and distributed.[17]

Twenty-two year-old Linus Torvalds released the first version of the Linux operating system in 1991.[18] Few believed open collaboration to develop something as complex as an operating system was possible and, at the time, few were even aware of the existence of something called an operating system.

Twelve years went by after 1991 before the founding of Skype, a company that has helped redefine meetings – and contributed to a situation where many companies now have "meeting policies" instead of "travel policies."[19]

In 1991, it would take five years before Napster, a file-sharing service, was launched. At the time, it was virtually unknown that people could share files. But after a turbulent period in which traditional enterprises spent most of their time trying to stop new technologies to distribute music, new players took the stage. Few predicted the genesis of Spotify in 2008 back in 1991.[20] Daniel Ek, one of the founders, was nine years old in 1991.[21]

Back in 1991, there were not a lot of people planning for that the world's largest hotel chain (Airbnb) would have

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[12] https://www.forbes.com/sites/chunkamui/2012/01/18/how-kodak-failed/#486088566f27

[13] https://hbr.org/2016/07/kodaks-downfall-wasnt-about-technology The right lessons from Kodak are subtle. Companies often see the disruptive forces affecting their industry. They frequently divert sufficient resources to participate in emerging markets. Their failure is usually an inability to truly embrace the new business models the disruptive change opens up. Kodak created a digital camera, invested in the technology, and even understood that photos would be shared online. Where they failed was in realizing that online photo sharing was the new business, not just a way to expand the printing business.

[14] https://money.cnn.com/2018/09/04/technology/amazon-1-trillion/index.html

[15] https://allaboutstevejobs.com/pics/pics_steve/1986_1996

[16] https://bgr.com/2016/07/01/iphone-reviews-original-negative-ballmer-dvorak/

[17] Citing Wikipedia was considered unacceptable for a long time https://en.wikipedia.org/wiki/History_of_Wikipedia

[18] https://en.wikipedia.org/wiki/Linux

[19] https://www.jisc.ac.uk/guides/using-videoconferencing-and-collaboration-technology-to-reduce-travel-and-carbon-emissions

[20] https://www.ema.europa.eu/documents/other/meetings-virtual-meetings-alternative-ways-communicating_en.pdf

[21] https://www.ft.com/content/cd99b95e-d8ba-11e6-944b-e7eb37a6aa8e

no buildings of its own or that the world's largest ride hailing business (Uber) would not own any cars.

In 1991, Ford was focused on making fossil fuel-powered engines more efficient. Anyone who said that one of Ford's (and many other carmakers') biggest competitors would be a company whose business was based on letting car owners act as taxi drivers with the help of their mobile phones would have had a hard time getting people to listen. This should come as no surprise, since one of the companies that dominates this development, Uber, was started almost 20 years later, in 2009.

No leading organisation in 1991 came anywhere near guessing that the price of PV, batteries and LED lightbulbs would drop 60-90 percent in the eight years between 2008 and 2015.[22] It is especially important that we do not forget that the dramatic price cut could have happened considerably earlier if powerful special interests had not focused on improving old technologies and blocking initiatives for new, sustainable solutions.[23]

And yet, there is much that is still the same compared to 1991 and the dramatic changes have up to this point occurred mainly in smaller segments of the economy. But virtually all experts believe that the next 20 to 30 years are going to bring much bigger and much faster changes than we have seen in the last 20 or 30 years.

1.3 LOOKING AHEAD TODAY: WHAT DO WE THINK THE WORLD WILL BE LIKE IN 2045?

Looking ahead, there are several factors that suggest things are going to move even faster than they have in recent decades. Areas like AI, Big Data and the Internet of Things (IoT) have already begun to impact society, but we are only in the infancy of a society in which digitalisation is being combined with biotechnology, materials science & engineering, neuroscience, etc., on a serious level. It is important that digitalisation is not regarded as solely a technical issue. The big changes come when new technology is combined with new business models and new ways of organising society. What we have seen in areas like music in terms of dematerialisation and like transport in terms of sharing is only a beginning, where novel solutions are creating entirely new opportunities, but also challenges.

In the matter of jobs and attempts to create more work in current structures, it might be useful to reflect over the fact that several studies indicate that huge changes are coming. One study, "Emerging Technologies' Impact on Society and Work in 2030", estimates for example that 85 percent of the jobs that will exist in 2030 haven't been invented yet. The study, which was published by the Institute for the Future (IFTF) in 2017, was based on a panel of 20 technology, business and academic experts from various parts of the world.[24] If jobs are going to be created, they will probably be in education, healthcare and creative occupations.[25] In energy, construction, transport, etc. it is highly likely we are going to see a development corresponding to that seen in agriculture during the last industrial revolution.

Opinions vary as to what the future labour market will be like. Some people think the number of jobs is going to increase, at least in the short term.[26] However, the scenario in which large groups of people are not employed should also be included in robust strategies, which few governments have today.[27]

According to World Economic Forum study "Our Shared Digital Future", 60 percent of global GDP is going to be digitalised, while only 45 percent of people trust that technological progress will improve their lives.[28] The authors of the study also write that all sectors are beginning to face deep questions about what the implications of present-day technological advances will be. Showing that technological advances can be socially fair and environmentally sustainable and how this can happen is essential in this situation.

[22] https://en.wikipedia.org/wiki/Daniel_Ek

[23] https://www.energy.gov/eere/downloads/revolutionnow-2016-update

[24] https://en.wikipedia.org/wiki/Global_Climate_Coalition

[25] https://www.rollingstone.com/politics/politics-news/the-koch-brothers-dirty-war-on-solar-power-193325/

[24] https://www.delltechnologies.com/content/dam/delltechnologies/assets/perspectives/2030/pdf/SR1940_IFTFforDellTechnologies_Human-Machine_070517_readerhigh-res.pdf

[25] https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

[26] https://www.weforum.org/agenda/2018/10/future-of-jobs-humans-skills-leena-nair/

[27] https://www.economist.com/leaders/2014/01/18/coming-to-an-office-near-you

[28] http://www3.weforum.org/docs/WEF_Responsible_Digital_Transformation.pdf

There is also a relatively large group who are predicting magnitudes larger changes in the next 20 to 30 years than in the past 20 to 30 years. It might be worth also including scenarios with fundamental changes, such as the possibility extend the human lifespan to 120 or 150 years, whether technology might make work obsolete and how we should educate people in an era of exponential growth. These are examples of issues discussed in a webinar by Ray Kurzweil and Peter Diamandis, two of the world's leading thinkers and futurists – and these kind of disruptions should also be included in strategies for a fossil-free future, and government innovation agencies should include these possibilities in their strategies:[29]

1.4 AGILE APPROACH TO DIGITAL STRATEGIES FOR A FOSSIL-FREE FUTURE

We can say is that it is very probable that if strategies based on what we have now are retained, we are highly likely to lock ourselves into old systems. Most people know this, of course, but since it is easier to build models based on gradual change of what we have than it is to think innovatively, our focus is often incremental. Active inclusion of strategies that also embrace transformative change, where digitalisation is often central, will thus be critical in order to avoid lock-ins. Instead of including only the most probable trends, based on yesterday's models and theories, trends that are less probable but would have major impact also need to be included.

Discussions about what kind of strategies that should be in place for the 2000s have been held in the context of the fossil-free roadmap for digitalisation consultants. The conclusion was that it should be possible to update these strategies quickly and that they should contain multiple scenarios. One way to design a dynamic strategy capable of responding to disruptions and network effects might be to establish a web portal in which various trends are included and where new ones can be added. An interesting example that might serve as inspiration is the "SDG TrendScanner", developed by UNDP and RISE, and the "periodical table" developed by Richard Watson and Anna Cupani at Imperial Tech Foresight.[30] This divides trends into four categories:

Horizon 1: Happening now (Execute).
Horizon 2: Near future 10-20 years hence (Experiment).
Horizon 3: Distant future 20 years + (Explore).
Ghost Technologies: Fringe science & technology. Defined as highly improbable, but not actually impossible. Worth watching.

A strategy of this type could be updated with the speed required to continuously include disruptive trends as part of the solution.

[29] https://www.a360.digital/p/ray-webinar-sign-up-2018-su?mkt_tok=eyJpIjoiWWpFM05HTTNPVGxpWXpCaiIsInQiOiJFU3Z6c1B3MHhtSVl2OVN6QXR-FeWZ0K0lDTUtVK2l5UzY2aUw0MWFjYitCekE5SHBxb1BxNjJ0MEFMT2tKWlVmK0tZRHRlZmdyVEwyK2F3azNzMTVpZFNVaDZmRG8wZDc1TXpFYm-FWMEJUVDB6QXBNY1ZqcDRrVWpEWDNQN1RqNUpRNzRaQmVwOTVQeXI5MUZGRWxxVQmc9PSJ9
[30] https://www.imperial.ac.uk/media/imperial-college/administration-and-support-services/enterprise-office/public/Table-of-Disruptive-Technologies.pdf

2. Optimising, accelerating and transformative solutions through digitalisation

2.1 STRATEGIES FOR DIGITALISATION THAT REDUCE EMISSIONS

The most important contributions of the digitalisation consultancies to reduced emissions can divided into three categories depending on how the reduction is delivered.

1. Optimisation of existing systems
2. Accelerated uptake of best available solutions
3. Transformative changes by delivering on social needs in entirely new ways. This requires changes on multiple levels in parallel as regards e.g. technology, business models and infrastructure.

These are not only three different categories of solutions, they also require identification and support of different methods and tools. Many current models and theories obscure solutions other than those that optimise existing systems. Many of the actions tend to be stock answers to how the climate issue should be managed. Things like

> *"Three categories of changes to which digitalisation can contribute and upon which this roadmap is based."*

traditional eco-labelling, carbon taxes, cap and trade, minimum standards, etc., are all tools that tend to be implemented in isolation and thus mainly favour and focus on optimisation of current systems by punishing the worst products or rewarding the best within a particular product category. To give two examples, these types of models and actions result in better cars, but rarely in smarter

CATEGORIES OF DIGITALISATION SOLUTIONS

Illustration 1: **Categories of digitalisation solutions**
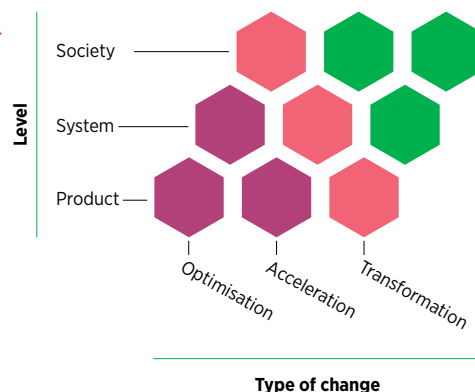
systems for mobility, or give us incentives to produce newsprint in a better way, but not for new and smarter ways to read the news, etc. These tools and how they are implemented contribute, in other words, primarily to optimising current systems, but rarely contribute to accelerated uptake of best available solutions and definitely not to transformative systemic solutions.

Accelerators, classic innovation procurement and competitions like XPRIZE[31] are examples of actions that often support accelerated uptake of best available solutions, which have in many cases been recently introduced and are currently found in the periphery of the market. These actions often focus on getting these solutions to the market and out of what is often called the "valley of death".[32] What often happens is that they are incorporated into existing systems and thus contribute to significant improvements, but still within existing systems.

When it comes to transformative solutions, we need a combination of appropriate tools and a strategy that prioritises more than gradual improvements to existing systems. This is still unusual. Instead of proceeding from how solutions are currently delivered, these strategies are based on the needs of society.

2.1.1 OPTIMISATION

Optimisation of current systems is the most common perspective. Historically speaking, this has been applied in the methods used by most countries and the IPCC. Countries have often used rudimentary cost-benefit analyses and proceeded from a neoclassical economic model that is good at handling marginal changes in current systems related to things amenable to pricing.[33]

Special "process-based integrated assessment models" (IAMs) have been used by the IPCC.[34] More ambitious IAMs have been used recently, but they are still biased towards improving existing systems and towards the supply side (not the demand side).

The potential is very large even if we focus only on how digitalisation can optimise existing systems. Using

relatively conservative estimations, studies in the "SMARTer2030" series from the Global e-Sustainability Initiative (GeSI) have shown that digital solutions can contribute to very large emissions reductions, often 10-30 percent of global emissions. The following findings are listed in the GeSI report "SMARTer2030":[35]

- Digital solutions can enable a 20% reduction of global CO2e emissions by 2030, holding emissions at 2015 levels. This means we can potentially avoid the trade-off between economic prosperity and ecologically sustainable development.

- Emissions from the digital infrastructure as a percentage of global emissions will decrease over time. Research shows that the emissions "footprint" of the digital infrastructure is expected to decrease to 1.97 percent of global emissions by 2030, compared to 2.3 percent in 2020, as predicted in GeSI's previous report. Furthermore, the emissions avoided through the use of digital solutions are nearly ten times greater than the emissions generated by deploying it.

- Digital solutions offer significant environmental benefits in addition to reducing carbon emissions. The most substantial benefits identified by this study include increasing agricultural crop yields by 30 percent, saving over 300 trillion litres of water and saving 25 billion barrels of oil per year.[36]

- One estimation of eight economic sectors - mobility and logistics, manufacturing, food, construction, energy, labour and business, health and learning - shows that digital solutions could generate more than USD 11 billion in economic benefits per year by 2030, equal to China's expected annual GDP in 2015.[37]

- The digital infrastructure is going to connect 2.5 billion extra people to the "knowledge economy" by 2030, giving 1.6 billion more people access to healthcare and half a billion more people access to E-learning tools.

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[31] https://www.xprize.org/
[32] https://www.forbes.com/sites/martinzwilling/2013/02/18/10-ways-for-startups-to-survive-the-valley-of-death/#1e1c607f69ef
[33] https://ec.europa.eu/jrc/en/research-topic/costs-and-benefits-climate-policies
[34] https://www.carbonbrief.org/qa-how-integrated-assessment-models-are-used-to-study-climate-change
[35] http://smarter2030.gesi.org/downloads/Full_report.pdf
[36] Page 42: http://smarter2030.gesi.org/downloads/Full_report.pdf
[37] The actual outcome was 11.2 https://tradingeconomics.com/china/gdp

- Worldwide global growth of the digital economy continues to accelerate, providing the scale necessary to drive greater connectivity and new, disruptive business models. And, as opposed to the old production-line economy, individuals are firmly at the centre of this process.

The first studies from GeSI take a more distinct optimisation perspective, while the method used in the more recent studies is a mix of optimisation within current systems and the type of acceleration of existing solutions described in the following section.

2.1.2 ACCELERATION

Another way that digitalisation could promote emissions reductions would be to identify the best current solutions available and implement them on a large scale as an accelerating contribution. In other words, studies and models that focus on the accelerating contributions identify existing best practices and then encourage them to quickly become mainstream solutions.

The most important current study is arguably "A low energy demand scenario for meeting the 1.5 °C target and sustainable development goals without negative emission technologies", an article by Arnulf Grubler, Charlie Wilson, et al published in Nature in June 2018.[38] This study is included in the IPCC Special Report on Global Warming of 1.5 °C and is the basis of the model pathway P1. This is the first demand-based study included in an IPCC report and it is based on the idea that smart solutions in society can lower the energy demand instead of the supply-based scenario (i.e., the pathway that focuses mainly on the shift from fossil to renewable energy sources and negative emissions).

These accelerating scenarios differ from optimisation in several ways. The drawbacks of the optimising strategies include:[39]

- They do not deliver sufficiently large emissions reductions and are thus predicated on negative emissions technologies. Technologies that do not work yet, are risky and often create other problems.

- They are based on supply-side scenarios and analyses and assume that society will otherwise remain largely the same.

- They tend to obscure the fact that these scenarios also frequently require major socio-economic changes.

- They give short shrift to new possibilities.

There are also other studies that have used similar methods to study scenarios where the uptake of existing technologies is accelerated, e.g. "The Exponential Climate Action Roadmap", which is similarly based on current best practices and their acceleration.[40] This report is based to a great extent on Project Drawdown.[41] Project Drawdown is based on existing solutions and how they can be scaled over the next 30 years. They write that their focus is on solutions that "already are being implemented by humanity around the globe and the potential of these solutions if they are scaled over the next thirty years.[42]

A few of the key conclusions of the Exponential Climate Action Roadmap:[43]

1. Digitalisation can accelerate solutions through optimisation and acceleration (building energy systems), but certain solutions are transformative (car sharing, space sharing and circular solutions). Digitalisation can also accelerate climate leadership.

2. We need to reverse the emissions curve by 2020 and halve emissions every decade at least on the global level (Global Carbon Law), which is supported by SR 1.5.

3. Solutions for halving emissions by 2030 exist in virtually all industries, but need to be scaled exponentially and this is not going to happen by itself.

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[38] https://www.nature.com/articles/s41560-018-0172-6
[39] Presented by Charlie Wilson at a workshop on the potential contributions of digitalisation consultants to a fossil-free future and the contents of the IPCC Special Report on Global Warming of 1.5 °C.
[40] Other studies/calculations are also included, such as Climate Solver and http://exponentialroadmap.futureearth.org/wp-content/uploads/2018/09/Exponential-Climate-Action-Roadmap-September-2018.pdf
[41] https://www.drawdown.org/
[42] https://www.drawdown.org/frequently-asked-questions
[43] Thanks to Johan Falk at Future Earth for this summary.

4. This requires climate leadership to drive demand exponentially (a critical mass of companies, cities, countries and people who start the halving journey), i.e., strong policies and funding.

5. The Exponential Climate Action Roadmap notes that climate leadership, policy and exponential technology can make a halving trajectory possible for all segments.

2.1.3 TRANSFORMATION

Transformative contributions are another way that digitalisation can promote emissions reductions. These contributions are based on widening the perspective from individual solutions to systems. When individual solutions are analysed, changes in technology, business models and infrastructure are included simultaneously. Instead of individual changes in parts of systems, the focus is on transformative systemic changes. The fossil-free agenda in Sweden should focus on and support transformative contributions through digitalisation if Sweden is to become a leading nation of innovation for sustainability.

A key difference between transformative and optimising/accelerating solutions is that the transformative solutions more frequently include rebound effects as an integrated component of the strategy: the changes within the system that implementation of a solution will bring about. Focus has traditionally been on negative rebound effects due to various solutions, i.e., effects that work against a reduction in GHG emissions. If a person starts working at home and dramatically reduces their emissions from commuting by car, the focus is usually on the risk that this person will increase their total emissions by using the money they have saved to pay for a long-haul flight. However, there is nothing to say that this necessarily will be the case: the person could also use their savings to invest in solar panels, which would cut emissions further and save more money, or invest the money in a guide to hiking in the mountains and preparing more sustainable meals after taking a trip by train instead of flying off on holiday and eating more red meat.

Three types of perspectives are found in this category:

1. Feedback perspective: Where focus is on initial changes that lay the foundation for further changes.

2. Convergence perspective: Where focus is on a number of trends, often technical, that converge.

3. Singularity perspective: Where focus on a tipping point.

FEEDBACK PERSPECTIVE

One example of how the feedback perspective can be used is the WWF's work with digitalisation, which is described in the "Outline for the First Global IT Strategy for CO2 Reductions: A billion tonnes of CO2 reductions and beyond through transformative change."[44] The outline focuses on how digital solutions can deliver the first billion tonnes of reductions in GHG emissions and lay the foundation for further systemic changes. The work has identified ten strategic solutions and identifies what is required for the technical, business and institutional changes to be made in a way that enables further reductions through low-carbon feedback, but also analyses what must not be allowed to happen if high-carbon feedback is to be avoided.

Another report, "How did we do that? The possibility of rapid transition"[45] provides examples of various historical situations in which society has undergone rapid transition. These range from how we adapted when the Eyjafjallajökull volcano erupted in April 2010[46] to how the United States changed its economy in response to the threat from Nazi Germany.[47]

Several conclusions can be used as a jumping-off point for change processes:
- We are actually good at adapting when the need arises
- Fairness matters in periods of change and working together works
- Public leadership is needed but often relies on agitation from elsewhere to come about
- There's no one path (there are many different

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[44] https://www.wwf.se/source.php/1183709/global_strategy_for_the_1st__billion_tonnes_with_ict_LR.pdf

[45] https://www.rapidtransition.org/resources/how-did-we-do-that-the-possibility-of-rapid-transition/

[46] https://en.wikipedia.org/wiki/2010_eruptions_of_Eyjafjallaj%C3%B6kull

[47] https://www.cambridge.org/core/books/cambridge-history-of-the-second-world-war/economics-of-the-war-with-nazi-germany/E2F3FE2B9549A-00F2E992673C5C8B28D/core-reader

ways to deliver solutions in all situations and the idea that there is a "right way" is harmful)

- Boldness is effective, but you need to connect actions with reasons
- Inaction costs and seemingly hard courses can produce pleasant surprises
- Accepting boundaries on things like consumption of resources can trigger innovation and bring other expected benefits

Efforts that include analysis of feedback systems usually produce interesting results. The IEA provides one example in its study of digitalisation, which studied automation in the automotive sector, and in this area of technology alone, the consequences vary dramatically depending on how different feedback systems act. In an optimistic scenario, energy use is reduced by about 50 percent - but increases by about 100 percent in a pessimistic scenario.[48] Making choices when a technology can contribute either to a halving or a doubling implies tremendous responsibility for everyone involved.

CONVERGENCE PERSPECTIVE
Convergence perspectives focus on a group of trends, often technical trends, and the transformative changes that can ensue when certain specific trends converge. Two of the most well-known are "Converging Technologies for Improving Human Performance" by M. C. Roco and W.S. Bainbridge, published in 2003[49] and its sequel, "Convergence of Knowledge, Technology and Society" from 2013.[50]

Studies that show the sustainability aspects of converging technological trends are less common, but there are examples, such as "Nanotechnology, Biotechnology, and Information Technology" published by the EPA Science Advisory Board in 2014.[51]

A report that has been widely accepted and has impacted efforts in large parts of the automotive industry and related industries was produced by RethinkX.[52] "Rethinking Transportation 2020-2030" describes one possible result of a convergence of:

1. Electric vehicles
2. Ride-hailing
3. Autonomous vehicles

Digitalisation is the basis of the second two and an important aspect of the first. Together, they would result in sales of Mobility-as-a-Service (MaaS).[53] The result of such an evolution would be a TaaS (Transport-as-a-Service) system, which would reduce the energy requirement by 80 percent and vehicle emissions by 90 percent. If the electricity is produced from renewable sources, an almost entirely fossil-free transport system could be achieved by 2030, driven by digitalisation.[54]

SINGULARITY PERSPECTIVE
Singularities often focus on single technologies and rarely include any alternative scenarios. As a result, they seem less analytical and more prophetic. The most famous in the tech world is the technical singularity outlined by Vernor Vinge[55], for which Ray Kurzweil is the self-appointed spokesperson.[56]

In other words, singularity is a point beyond which current methods are no longer relevant because the situation is fundamentally different to that of today. The AI-caused singularity popularized by Kurzweil is extreme in terms of its consequences as well its specifically predicted date.[57]

Naturally, many people are critical of the type of singularity that Kurzweil represents, including Microsoft co-foun-

[48] https://www.iea.org/digital/

[49] https://en.wikipedia.org/wiki/Converging_Technologies_for_Improving_Human_Performance

[50] http://www.wtec.org/NBIC2/Docs/FinalReport/Pdf-secured/NBIC2-PCA-Final-23July2013.pdf

[51] https://yosemite.epa.gov/sab/SABPRODUCT.NSF/52F6B7D2175F3C61852570E000765A7E/$File/Summary+of+SAB+2004+Workshop.pdf

[52] https://www.rethinkx.com/

[53] https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/59f279b3652deaab9520fba6/1509063126843/RethinkX+Report_102517.pdf

[54] Page 9 in the report above

[55] https://en.wikipedia.org/wiki/Vernor_Vinge

[56] https://en.wikipedia.org/wiki/Technological_singularity

[57] http://www.kurzweilai.net/futurism-ray-kurzweil-claims-singularity-will-happen-by-2045 »I have also set the date 2045 for singularity — which is when humans will multiply our effective intelligence a billion fold, by merging with the intelligence we have created.«

[58] https://www.technologyreview.com/s/425733/paul-allen-the-singularity-isnt-near/

Illustration 2: Climate-KIC strategy for transformative climate solutions

EIT CLIMATE-KIC'S CURRENT PATTERN OF ACTIVITY

1. Incremental
2. Opportunistic
3. Single-point experiments, individually assessed
4. Predominance of technology innovation
5. Europe-focused
6. Supply-led pipeline of ideas, research and business models

EIT CLIMATE-KIC'S 2019-2022 VISION

1. Transformative
2. Deliberate
3. Portfolios of related, connected experiments
4. Innovation across multiple levers
5. Leveraging European leadership
6. Deep demand-driven demonstrations

der Paul Allen, who identified several problems with the assumptions upon which this singularity is based.[58]

Other possibilities are discussed with regard to technical singularity, from molecular nanotechnology[59], via preferences for living in a virtual world[60], to the potential for radical transparency.[61] What unites these perspectives is that they describe a world in which we are entering a new phase, where current frames of reference are no longer relevant due to singular technologies.

Although these purely technological singularities may seem extreme and few studies include them in their 1.5/2°C scenarios, these futures should not be dismissed out of hand.

EIT Climate-KIC, the largest innovation community in the climate area, is an organisation that focuses on transformative systemic solutions.[62] Transformative change is the crux of the new strategy for 2019-2022 and they list six parallel shifts that will bring about successful delivery of transformative change (see illustration above).[63]

Digitalisation will play a catalytic role for all categories above. As an optimising force, it can optimise already unsustainable systems and make them more competitive and cost-effective. The accelerating component can encourage increased uptake of new unsustainable solutions. The transformative solutions can contribute to dramatic increases in public resources and thus encourage increasing numbers of people to travel, live and consume unsustainably.

2.2. EMISSIONS FROM THE DIGITAL INFRASTRUCTURE

The digitalisation consultancies also have an opportunity to contribute to ensuring that the digital infrastructure required for so much of digitalisation is also fossil-free. However, the boundaries between digital infrastructure and equipment and other infrastructure and equipment are blurring. New technologies like 3D printing are difficult to classify, and with the internet of things, it gets hard to say whether a connected brick is part of the old infrastructure or the digital infrastructure.

However, that traditionally counted as digital infrastructure and which has enabled much of the exponential growth we have seen in society, from the number of

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[59] https://en.wikipedia.org/wiki/Molecular_nanotechnology

[60] http://alonetogetherbook.com/

[61] https://www.diamandis.com/blog/abundance-of-knowledge

[62] https://www.climate-kic.org/

[63] https://www.climate-kic.org/wp-content/uploads/2018/05/Annex1_EIT_CKIC_Strategic-Agenda-2016-2022.pdf

[64] https://www.mdpi.com/2071-1050/10/9/3027

mobile phones to stored data, has according to leading studies reduced its global GHG emissions.[64] This is the way it is, even though many articles in the mass media indicate the opposite.[65] Most of the articles that talk about rapid increases in ICT emissions are based on a simple extrapolation of current trends, assuming that the digital infrastructure would behave like the traditional infrastructure, or else they look at the worst possible cases in order to come up with dramatic headlines.

The fact is that the ICT sector has stopped increasing its energy and carbon footprint and the 2015 footprint looks much like the one in 2010 (with a possible peak in 2012/2013). Networks are still growing, but footprints from user devices are shrinking. This is a major trend shift, even though ICT subscriptions increased from 6.7 billion to 9 billion, TV subscriptions grew by 8 percent to almost 1.6 billion and data traffic in global networks increased by a factor of four during the same period (2010-2015).[66] The authors of the latest study on global digital infrastructure emissions cites several reasons that emissions are decreasing, including more rapid dematerialisation:[67]

Although the digital infrastructure has successfully bucked the trend compared to most other industries on a global level, there is of course no guarantee that this will continue, and robust actions are required to achieve a global fossil-free future. There is also a need for resource efficiency and responsible production.

[65] https://www.theguardian.com/environment/2017/dec/11/tsunami-of-data-could-consume-fifth-global-electricity-by-2025
https://www.greencarcongress.com/2018/03/20180306-mcmaster.html
[66] https://www.mdpi.com/2071-1050/10/9/3027
[67] https://www.mdpi.com/2071-1050/10/9/3027 "An important development that has been identified in earlier papers by the authors, is the introduction of the smartphone and similar terminal platforms, which replaces older, energy inefficient hardware and solutions, and makes all the previous as well as additional new services available via one single platform, just by downloading software applications, i.e., "apps". Thereby, a number of functionalities (such as alarm clocks, calculators, navigators, etc), which previously required separate products and hardware, have been replaced by one single device which, in addition, can be updated with additional functionalities over time. This has for sure been a transformative change for the industry as well as for the users."

3. Industry commitments

The digitalisation consultancy industry recognises that greater responsibility for more actively contributing to the development and implementation of globally sustainable and fossil fuel-free solutions is required. Appendix 7 presents additional proposed commitments discussed in the framework of the roadmap process.

The digitalisation consultancies play a key role as accelerators of the utilisation of digitalisation pathways in all parts of society through knowledge transfer to various parts of society by means including the spread of good examples and support for innovative collaboration across traditional sector lines.

The digitalisation consultancies already have a leading role in the effort to help give companies the conditions and capacity to develop business models based on providing services (not products) and, in the process, to become progressively less dependent upon how the goods used to be produced.

Starting a shift of the business model towards focusing

on what is actually delivered (such as mobility) instead of the product that the company has traditionally used to deliver the service (such as a car) can make companies less dependent on the success of individual technologies. Political governance that makes it more profitable to transition from product to service is necessary to facilitate shifts like these. As one example, procurement/sourcing should focus on the Total Cost of Ownership (TCO) instead of the sticker price. Imposing higher standards of product liability on producers also increases the incentives. In many cases, however, it is primarily support to business capacity to migrate from a business model based on selling the maximum quantity of products (and providing repairs/service) to a business model where the company is paid for the function provided.

Over the decades, digitalisation consultancies have worked in a field where exponential growth is the rule rather than the exception - consider Moore's law for instance - which has informed the business and made the sector accustomed to rapid change.[68] Experience of working in situations where conditions change rapidly is valuable, now that society is poised to undergo swift and serious changes and exponential uptake of sustainable solutions is required.

Through strategic actions from politicians and the market and processes that integrate the digital evolution with sustainability requirements, digitalisation consultancies could play a considerably more active and vital role in the work to achieve a fossil-free future. This could also open up the next generation of opportunities.

We have prioritised the following strategic commitments.

3.1 COMMITMENTS TO 2030
Cut the industry's energy use by at least half by 2030, with the ambition of reaching zero emissions by 2045 (in accordance with the IPCC LED pathway).

3.2 COMMITMENTS THROUGH 2020
1. Agree a minimum level of knowledge among our employees regarding the impacts of digitalisation from a climate and sustainability perspective.

2. Carry out training initiatives to ensure that all employees meet the minimum level within one year after they are hired.

3. Agree a framework to report positive and negative contributions (Scope 1-4, including avoided emissions).

4. Find resources for building and launching a web platform where the capacity of industry firms as agents of solutions are made available to each other, clients, academia and government. We recommend that the platform should include:

   • Presentation of cases including climate impact
   • Training materials, methods and reports
   • Information about joint initiatives
   • Contact details for individuals with particular expertise

5. Adopt new commitments for the period up to 2022 based on conditions in 2020.

The digitalisation industry should develop educational materials for the industry itself and other social sectors and should be encouraged to provide continuing education to all employees regarding the role of digitalisation in achieving sustainability. This includes developing a framework to report positive and negative contributions. The industry will also lead the way and exploit new opportunities to accelerate the fossil-free evolution, such as developing AI solutions to give clients guidance and suggest actions to promote fossil-free progress.

A "code of the year" award should be launched as soon as possible. At present, there are no established awards in Sweden or abroad for the people who are creating the sustainable digital solutions of tomorrow. If their contributions are not recognised, a new generation of people working with digital solutions are at risk of being ignored. An award could increase understanding of the key role of digitalisation and bring more attention to the people, often young people, who are leading the digital revolution.

Accelerating the journey towards a fossil-free digital infrastructure is an obvious focus of the industry. By taking a proactive role and guiding our clients towards the right infrastructure investments, we can promote the continued reduction of emissions regardless of the increasingly rapid digitalisation of all sectors of society.

[68] https://en.wikipedia.org/wiki/Moore%27s_law

4. Calls for action to the Swedish Parliament and Government

We have identified seven strategic actions within the framework of the roadmap process that can promote the central role of digitalisation in achieving a fossil-free future.

The calls for action in this roadmap were developed in parallel with and largely based on the long-term vision for a climate-neutral Europe presented by the Commission on 28 November 2018[69] and the IPCC Special Report on Global Warming of 1.5 °C.[70]

As regards the work of the EU, the Commission report, "A Clean Planet for All: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy" in particular provides a good overview of the role of digitalisation upon which the calls for action presented in this roadmap are based.[71]

The calls for action presented in this report are also based on the IPCC Special Report, and particularly on the pathway described under P1, Low Energy Demand (LED), which has the greatest synergies with other global SDGs and which includes new business models.[72]

An overview of The European Political Strategy Centre is presented in the Commission's new vision. It shows how different parts must cooperate to deliver the type of systemic changes needed to sufficiently reduce emissions. The report mentioned above also highlights the need for a framework to facilitate the emergence of new solutions related to energy, buildings and mobility, as well as the potential of digitalisation to contribute to integrated solutions and new business models.[73] The Commission also emphasises the need for a wider approach to empower citizens with skills for new business models.

Digitalisation is now part and parcel of society, which the Commission's new vision clearly establishes, thus giving the digitalisation sector a unique role. It is therefore gratifying that the Commission has taken a systemic perspective on the potential of digitalisation.

Appendix 71 presents several recommendations and barrier removals also discussed within the framework of the roadmap process. These recommendations and barrier removals should not, however, be implemented in isolation. They should be part of a coherent strategy to optimise the synergies and avoid significant negative rebound effects. This kind of systemic perspective is necessary for actions aimed at achieving more than changes to existing systems.

4.1. APPOINT A DIGITAL TRANSFORMATION COMMITTEE:

A widely supported and comprehensive digitalisation strategy is needed

The Swedish Government should therefore appoint a committee including members from various segments of society and with significant international representation, tasked with identifying knowledge gaps, legal barriers, organisational lock-ins and incentives blocking Sweden's pathways to accelerate the uptake of digital solutions for a fossil-free future. The committee should also submit proposals for creating incentives for sustainable business models that utilise digitalisation.

International work should be included in the committee's remit. One suggestion might be to follow up French President Emmanuel Macron's Tech for Good summit with

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[69] https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2050-long-term-strategy
[70] https://www.ipcc.ch/sr15/
[71] https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_en.pdf
[72] https://www.ipcc.ch/site/assets/uploads/sites/2/2019/02/SR15_Chapter2_Low_Res.pdf
[73] Page 16: https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_en.pdf

a more action-oriented Tech for Zero Carbon summit, where the CEOs of the world's leading technology firms and consultancy firms are challenged to collaborate and present action plans for how digitalisation can deliver fossil-free solutions in all critical areas, in line with that identified as necessary in the IPCC Special Report on Global Warming of 1.5 °C.

We are in the midst of an industrial revolution and there is much to suggest that the rate of change is going to speed up in the next few years.[74] We are past the installation phase for the digital infrastructure and are now entering the phase when digitalisation contributes new solutions and does not only make traditional systems more efficient.[75]

This roadmap therefore argues that a committee is needed to identify and recommend implementable strategic proposals. The work with digitalisation should be continuously revised, so as not to lock society into old structures and thinking based on past reality. Established frameworks like the Paris Agreement and Agenda 2030 are revised every three to five years, but there is a challenge in that the same people and the same companies/organisations often remain over time and have difficulty implementing major changes.[76]

4.2. UPDATE APPROPRIATION DIRECTIONS WITH REQUIREMENTS FOR DIGITAL LOW ENERGY DEMAND STRATEGIES:

Government agencies have the potential to make important contributions
Establish the IPCC low energy demand (LED) pathways as a model for strategic work and task all government agencies, via their appropriation directions, to develop strategies wherein digitalisation enables a globally sus-

tainable fossil-free future through energy-smart scenarios. These strategies should include scenarios capable of delivering a fossil-free future without using technologies redlined by the IEA, i.e., the technologies that have thus far failed to deliver as previously hoped. Allocate resources to the agencies to ensure that expertise on the risks and opportunities of digitalisation is available to those assigned to develop the new strategies.

The scenario in which digitalisation fundamentally alters how society works should be the point of departure for the work carried out by all government agencies. If they instead proceed from existing large companies and known technologies and extrapolate them, this will most likely to obstruct innovation and undermine new solutions.[77] This could easily create a situation that supports established enterprises that lack the ability and/or interest to accept and utilise next-generation sustainable solutions.[78]

The future efforts of government agencies towards a fossil-free future should thus support initiatives based on the assumption that the world is going to change fast. Small and medium-sized enterprises are often the quickest to find new solutions.[79] This means that different strategies for a fossil-free future should be continuously revised and that small businesses and incubators that support new, sustainable enterprises should be given a key role in drafting strategies for sustainability and a fossil-free future.

If we do not believe that society is going to change all that much, or do not want it to, there are four groups of technological solutions that can be used to manage the high level of emissions from the inefficient and unsustainable systems we have today:
1. Geoengineering[80]
2. Negative emissions[81]

[74] https://en.wikipedia.org/wiki/Accelerating_change

[75] "The speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance." https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

[76] http://www.rescuethatfrog.com/wp-content/uploads/2017/03/Rockstrom-et-al-2017.pdf
"The very nature of disruptive progress requires revising the narrative of a detailed roadmap every 2 years, correcting near-term targets to reach the ultimate goal by evolutionary management."

[77] https://ec.europa.eu/research/innovation-union/pdf/innovrefit_staff_working_document.pdf

[78] https://hbr.org/2013/10/11-ways-big-companies-undermine-innovation

[79] https://www.oecd.org/cfe/smes/2090740.pdf
https://www2.deloitte.com/content/dam/Deloitte/de/Documents/Innovation/SME_komplett.pdf
https://www.weforum.org/agenda/2015/10/how-small-companies-can-change-the-world/

[80] https://sv.wikipedia.org/wiki/Geoengineering

[81] https://www.science.su.se/om-oss/nyheter/kevin-anderson-problemet-med-negativa-utsl%C3%A4pp-1.349157

3. Geological storage of carbon dioxide (carbon capture and storage, CCS)[82]

4. Radically increased fossil-free energy production

In addition, there is the group of technologies that make it possible to explore new business models, behaviours and organisational approaches that meet the needs of society in new, fossil-free ways. In the IPCC Special Report on Global Warming of 1.5 °C, this is designated Pathway 1, i.e., the Low Energy Demand (LED) scenario: [83]

5. Smart, circular and resource efficient solutions

These LED solutions, which focus on things including making buildings resource efficient and net producers of renewable energy, transport systems based on virtual meetings and telework, nutritional solutions based on people's willingness to eat healthily and sustainably, will provide what is necessary for a society that is circular, resource efficient and uses little energy. As regards the mobility challenge, for example, this may involve everything from self-driving, shared electric vehicles and virtual meetings where 3D printouts are possible to smart urban planning and more green spaces that make walking in the city more appealing. These technologies and solutions are shaping the new society now emerging. Many of these solutions are smarter, more fun, more delicious, cheaper, more convenient etc., and are not implemented as a result of deliberate/coerced climate protection, which often results in actions people perceive as sacrifices. We often accept LED solutions because they are better, but habits, rules and structures often make it difficult for these solutions to make major breakthroughs.

To be on the safe side, government agencies should have strategies where end-of-pipe/business-as-usual technologies fail to deliver significant contributions. This means that we should always have LED scenarios whose point of departure is to reduce emissions as much as possible and as fast as possible. In other words, Sweden should have multiple strategies for how a fossil-free and resource efficient society can be created by delivering new, smart solutions. In so doing, we will avoid putting all our eggs in the same technological basket.

4.3. ENCOURAGE REPORTING OF SCOPE 4/AVOIDED EMISSIONS THAT UNPACK THE POTENTIAL OF DIGITALISATION:

Web-based and interactive tools for a fossil-free future are needed

Augment current incentives for business regarding reporting of their own emissions (Scope 1-3 emissions) with incentives to also report contributions to reduced emissions in society from the goods and services provided (Scope 4/avoided emissions). This will unpack the potential of digitalisation to deliver global climate-smart solutions. Initially, incentives for Scope 4 reporting could, for example, be increased by having the Swedish National Pension Funds request the information and for public procurement processes to include Scope 4 reporting in the assessment of bidders.

Scope 4 reporting will also make it possible for consumers to access data on the climate impact of products. One possibility would be for business sectors to begin developing joint preliminary standards for product categories, which would eventually be based on actual data. Statistics Sweden (SCB) should be allocated additional resources for its work with data related to Agenda 2030 so that relevant data for Scope 4 can also be included. The Swedish Government should also prioritise support for the development of methods for estimating Scope 4 and for open access to climate data, especially in international contexts, by actively participating in processes like the Task Force on Climate-related Financial Disclosures (TCFD) and the work of the EU Commission with financial data that is going to affect all multinational business.

Instead of proceeding only from own emissions (Scope 1-3), which is most relevant to companies with large own emissions, focus on Scope 4 facilitates the opportunity to identify and support new innovations.

Thus far, the effort to reduce emissions has focused extensively on reducing emissions from the type of businesses that currently contribute to large-scale emissions.[84] This is important and must continue, but it does not suffice, due to two trends:

[82] https://sv.wikipedia.org/wiki/Geologisk_lagring_av_koldioxid
[83] http://www.ipcc.ch/report/sr15/
[84] https://www.ipcc.ch/working-group/wg3/?idp=5

1. **New solutions are being developed at speed**
   The rapid development and implementation of both new technologies and new business models means that current ways of delivering solutions should not be considered the be-all and end-all. The fourth industrial revolution, with new technology and new business models, has already radically changed many industries and makes it clear that current solution pathways cannot be taken as gospel.[86] It is obvious today that emissions from CD manufacturing are not what should be prioritised, if we are focusing on music for example. We now listen to music mainly through solutions in which CDs are irrelevant. Most companies are currently reviewing opportunities to shift focus from delivering products to providing services. The opportunity to achieve sustainable success in this shift from products to services depends on whether more resource-conservative consumption, aided by circular business models, can be supported or undermined.

2. **New businesses are emerging fast**
   Generally speaking, the rate of social change seems to be increasing. In the next 10 years, half of the companies on the Fortune 500 list may disappear and be replaced by new enterprises.[86] Those that want to stick around and those that want to make the grade must bring the potential of digitalisation together with the need for fossil-free solutions. It is high time for Sweden's climate work to focus on businesses, big and small, that are using the potential of digitalisation to combine new technologies with new business models that are heading for a fossil-free future. It is extremely unlikely that the industrial structure and the type of solutions in use will not change by 2045, so an extrapolation of business as it is today should not be considered the only, or even the most probable, scenario.

4.4. APPOINT A FAST-TRACK INQUIRY INTO DATA THAT SUPPORTS GLOBAL SUSTAINABILITY

Appoint a fast-track inquiry to determine what data are currently available or can be made available to equip citizens, government agencies and business to develop new and innovative solutions from a global sustainability perspective, i.e., whether it is possible for nine to eleven billion people to use the solution in a socially fair world (in accordance with the World Business Council for Sustainable Development Vision 2050). Data in key areas, including geodata, property data, mobility data, etc., should be included in this study. The issue of how data can be de-identified to assure personal privacy should also be examined.

It is essential that this data is organised based on social needs to facilitate new solutions and not only improvements of existing systems. Aimed at understanding how data can be used to assess initiatives and the global impacts of initiatives, we recommend that the Swedish Government appoint a sustainable data council, modelled on the National Innovation Council.

In the fourth industrial revolution that society is currently undergoing, digitalisation is the underlying trend that is fundamentally changing society through brand new conditions in terms of transparency, access to data, opportunities to analyse and visualise information, etc.[87] This is affecting everything from values and legislation to business models and global cooperation.[88] This same digitalisation is also creating pathways to develop new solutions, including resource efficient and fossil-free solutions. These new solutions can often be magnitudes better than earlier solutions because digitalisation is enabling e.g. dematerialisation[89] and new business models.[90]

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[85] Bill Ford's thoughts about where the most exciting ideas in mobility are coming from is a good example. He mentions Uber, Zipcar, Apple and Google, but not other automakers. https://www.wired.com/2015/11/bill-ford-interview-vision-for-world-without-cars/ How music, books and the film industry have changed is widely understood, but similar changes are now occurring in other areas. Initially, this involves optimisation of current systems, such as car sharing and space sharing.
[86] https://www.innosight.com/insight/creative-destruction/
https://www.businessinsider.com/chambers-40-of-companies-are-dying-2015-6?r=US&IR=T&IR=T
[87] https://en.wikipedia.org/wiki/Fourth_Industrial_Revolution
[88] http://www.un.org/en/digital-cooperation-panel/
[89] https://en.wikipedia.org/wiki/Dematerialization_(economics)
[90] http://smarter2030.gesi.org/downloads/Full_report.pdf
http://www.wwf.se/source.php/1183709/global_strategy_for_the_1st__billion_tonnes_with_ict_LR.pdf

4.5. CLARIFY RESPONSIBILITY FOR DIGITALISATION AND SUSTAINABILITY WITHIN ALL GOVERNMENT MINISTRIES

In order to facilitate coordination within the Government Offices of Sweden, we recommend that responsibility in each ministry is clarified as to who will coordinate the impacts of digitalisation from a sustainability perspective. Resources should also be guaranteed in current and future initiatives with regard to digitalisation and sustainability so that the role of digitalisation in achieving fossil-free sustainability is included in both digitalisation and sustainability initiatives.

4.6. ALLOCATE RESOURCES FOR A NATIONAL KNOWLEDGE BOOST

A national knowledge boost should be carried out in which current investments in increasing knowledge in the fields of digitalisation and sustainability are augmented with knowledge about digitalisation for sustainability. In order to securely provide for long-term skills needs, all parts of the education system should also integrate the relationship of digitalisation to sustainability as a central aspect. Moreover, Sweden's capacity to attract and retain skills from abroad should be reinforced and regularly evaluated.

We also recommend that relevant government agencies be allocated additional financial resources earmarked for funding a knowledge boost related to the link between digitalisation and a fossil-free future for the groups currently working with digitalisation and sustainability. The knowledge boost should achieve ends including making it possible for interested groups to apply for grants for knowledge-enhancing activities, such as a web platform with the functionality described in the commitments of the digitalisation consultancies. We estimate the need for financial support for a shared platform at SEK four million per year over a three-year period.

4.7. ESTABLISH TESTBED ZONES FOR SUSTAINABLE DIGITAL TRANSFORMATION

Establish a national initiative in which zones and entire cities interested in acting as testbeds for a fossil-free, ecologically sustainable and socially fair transformation can be brought together. Cities interested in being testbeds in strategic areas where digital solutions for a fossil-free future are developed in various areas, such as housing, mobility, nutrition, health and consumption, could be presented as early as COP25. The purpose of these testbeds would be to lower the thresholds for testing new methods, developing new business models, testing technology, arriving at new modes of collaboration and attempting to understand the various impacts and opportunities from a wider, systemic perspective. Rapid upscaling would also be facilitated by going from small demonstration facilities to the city level, or the equivalent. Changes in regulations pertaining to building permissions, conveyancing fees, permit issuance, special rules and approaches, fast-track processing, prioritised decision paths, etc., could be tested in these testbeds.

5. Calls for action to the market

So that digitalisation will be able to contribute to a fossil-free future, we present three recommendations within the framework of the roadmap process to organisations (public and private) that recognise a need to digitalise their operations or reduce their climate impact. These recommendations are:

5.1. ANALYSE THE CATALYTIC IMPACT OF DIGITALISATION ON GHG EMISSIONS

Analyse the catalytic impact of digitalisation on GHG emissions and identify risks of lock-in effects before all strategic initiatives (both climate initiatives and digitalisation initiatives) related to the areas where sustainable solutions are needed to achieve a fossil-free future, such as housing, mobility, nutrition and consumption.

5.2. ANALYSE AND REPORT SCOPE 4 IMPACT

In addition to targets for minimising own negative climate impact (Scope 1-3), set positive sustainability targets where the focus is on how your organisation can contribute to reducing climate impact from the global perspective (Scope 4).

5.3 IMPOSE CLIMATE REQUIREMENTS ON DIGITALISATION CONSULTANTS

Require digitalisation consultants to demonstrate that they have integrated climate and sustainability aspects in their core business, that they understand the impact of digitalisation from a climate and sustainability perspective and are that they are able to show that the investment has reduced negative impact and increased innovative, positive climate impact.

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Appendix 1: List of possible proposals and barrier removals

The following recommendations for targets and calls for action for globally sustainable digitalisation are based on existing reports and processes focused on how digitalisation can contribute to sustainability.[92] This was supplemented by work in reference groups, working groups and dialogues with other roadmaps and workshops focused mainly on selecting and sorting existing recommendations to select those that fit the present context and are connected to the role of digitalisation consultancies.

Seven calls for action to the Swedish Riksdag and Government and three to the market, based on the recommendations below, are identified as strategic and included in the summary of the roadmap. In addition, the digitalisation consultancy industry has agreed three commitments of its own. The process has, however, identified several recommendations that could provide valuable contributions, which are outlined below.

The recommendations are divided into four categories:

1. **Calls for action to the Riksdag, Government and political decision-makers at the EU, county council and local authority level**
   These are aimed at political decision-makers with the power to change laws and incentive structures, as well as to change their approach so that they move away from traditional industries and towards being challenge-driven and encouraging new clusters.

2. **Market actions**
   These affect all users of digital solutions in society.

3. **Calls for action to the digitalisation consultancy industry**
   These recommendations focus on those that are facilitated by cooperation among individual firms and groups of firms in the digitalisation industry in order to achieve results. The capacities of firms to drive various issues will vary.

CATEGORIES OF DIGITALISATION SOLUTIONS

Illustration 1: Categories of digitalisation solutions
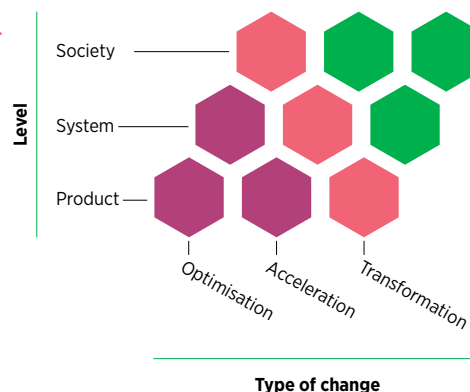
[91] See Appendix 1 for a list of the reports and texts upon which the recommendations were based.

4. Overall goals
These goals provide the opportunity for various actors from different parts of society to cooperate towards common goals.

It is important to remember that the contributions of digitalisation consultancies occur at various levels and help further various types of change (see the illustration page 34).[92] Examples of the categories are provided in Appendix 2. If there is no proactive strategy on the part of digitalisation consultancies, client training and political support, activities are prone to being concentrated to optimisation of products and systems. These actions can make important contributions, but can also exacerbate lock-ins and accelerate unsustainable trends. It is also within optimisation that a large share of the negative contributions is found, such as more efficient unsustainable industries and accelerated unsustainable consumption.

Note that there are no hierarchies for "level" and "type of change," meaning that it is not better to be at a certain point in the matrix above than to be at a different one. The point is whether the contribution will lead to the goals that have been set, including other consequences. It should be clarified, however, that optimisation of products, as well as systems, has thus far often led to lock-in effects and can block innovations aimed at other types of change. Likewise, unilateral focus on the product level can result in the failure to realise opportunities at the systemic and social levels.

1. CALLS FOR ACTION TO THE SWEDISH PARLIAMENT, GOVERNMENT AND POLITICAL DECISION- MAKERS AT THE EU, COUNTY COUNCIL AND MUNICIPAL LEVEL

1. Appoint a "digital transformation committee" tasked with identifying knowledge gaps, legal barriers, organisational lock-ins and incentives blocking Sweden's opportunities to accelerate the uptake of digital solutions for a fossil-free future. The work should also zero in on how companies should be able to shift focus from the products they produce to the services they provide.

2. Greater focus on national initiatives to drive exports of globally relevant fossil-free solutions. Actions to reduce emissions in Sweden are often set against actions abroad. There need not be any conflicts between them. Sweden should become a global testbed for globally sustainable solutions of particular urgency. Sweden already enjoys international leadership in having been appointed to head up the efforts of Mission Innovation to develop a framework for estimating emissions reductions from various solutions.[93] Many companies already have targets for how their solutions are contributing to reducing emissions in society. Sweden could become the first country in the world to set a target for how much Swedish solutions will reduce emissions worldwide. A preliminary target of 150 million metric tons per year by 2030, about three times Sweden's own emissions, could be a good start. The Swedish Energy Agency's analysis of the potential of various small businesses and its initiative "A Challenge from Sweden" is a good beginning, but resources allocated to this type of international initiatives should increase to at least SEK 1 billion.[94]

3. The Swedish Government should establish the world's first "transformation initiative" for sustainability in the fourth industrial revolution. Our prime minister should follow up Macron's Tech for Good summit with a more action-oriented Tech for Zero Carbon summit where the most prominent CEOs in the world are challenged to present action plans for how we can deliver fossil-free solutions in all central areas by 2030. In connection with this, Sweden could also launch six cities for a digital fossil-free future in various areas such as housing, mobility, nutrition, health and consumption.

4. The catalytic impacts of digitalisation should be analysed in all strategic initiatives. The opportunities and challenges of digitalisation should be included in the analyses. Strategic sustainability initiatives should include expertise on the capacity of digitalisation to deliver sustainability goals and strategic digitalisation initiatives should include expertise on the relationship of sustainability topics to digitalisation.

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[92] The various types of changes are discussed in the section.
[93] https://www.misolutionframework.net/
[94] http://challengefrom.se/

5. Strive to reform existing organisations and processes and create new ones, so that they can be continuously improved to take advantage of new opportunities. Major revisions of all central strategies and initiatives should be carried out at least every other year (in line with the revisions of deliverables under the Paris Agreement and the SDG effort). Principles for this work can be found in reports such as "Mission-oriented Research & Innovation in the European Union" by Mariana Mazzucato.[95]

6. All political roadmaps and other climate strategies should include various scenarios for 1.5 °C avoid putting all the eggs in one basket. This applies in particular to technologies whose capacity to deliver is uncertain. Useful references include the IEA's "Tracking Clean Energy Progress".[96] The purpose here is to avoid situations where the future of vital industries is utterly dependent upon technologies that might not make significant contributions before 2050.

7. Existing strategies for sectors and industries should be augmented with strategies based on the needs of society, such as places/housing, transport/mobility and health/nutrition. In order to deliver solutions, Sweden should take the lead in developing strategies and structures designed on the basis of social needs and preferences instead of how society was organised in the past. Moving from organising organisations and models based on how we have traditionally produced solutions to what society needs applies in particular to how government ministries and agencies are structured.

8. Strategies and initiatives in Sweden should be assessed based on their global sustainability, i.e., whether is it possible for other countries to use the solutions and whether it will eventually be possible for nine to eleven billion people to use the solutions in a socially fair world. One of the aims here is to ensure that investments in exports and innovation maintain high international standards. Ambitious targets are used by companies like Google to encourage innovative thinking, but are rarely used in sustainability work.

9. Resources should be allocated to small enterprises and incubators that support new, sustainable businesses, which rarely have the resources to participate in various processes where proposals are designed, so that they can be given a central role in the formulation of strategies for sustainability and a fossil-free future.

10. Digitalisation consultancies should be included in all relevant forums and processes. A person within the Government should be put in charge of a "digital fossil-free future" so that the industry and others interested in the role of digitalisation for a fossil-free future can engage in meaningful dialogue.

11. Eliminate zero as a norm (get rid of the unilateral focus on business as the problem, where the best that can be done is to reach zero) and provide support to companies willing and able to deliver globally sustainable solutions.

12. Review legislation with regard to the potential of digitalisation to ensure opportunities for:

    a. Dematerialisation
    b. Shift from products to services
    c. Global resource efficiency
    d. Disruptive changes and not only incremental changes

13. Use public procurement processes as an engine of the climate transition by accelerating demand for globally sustainable digital solutions. Strengthen the expertise of public procurement officers pertaining to the Swedish Public Procurement Act in relation to digital solutions and ensure that follow-up is as strict as procurement requirements. Set a date before 2045 when all public procurements must be fossil-free and drive innovative solutions in order to encourage leadership in public operations.

14. Evaluate the role of various government agencies in supporting the development and implementation of sustainable digital solutions. Thereafter, expand appropriation directives based on the identified opportunities that digital sustainability can deliver.

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[95] https://publications.europa.eu/en/publication-detail/-/publication/5b2811d1-16be-11e8-9253-01aa75ed71a1/language-en
[96] https://www.iea.org/tcep/

15. Establish import and export targets in which globally sustainable digital solutions are included.

16. Organise the work within the Government Offices of Sweden and government agencies based on social needs, not traditional sectors, to a greater extent.

17. Ensure that the sustainability perspective is included in all relevant digital initiatives and that the digital perspective is included in all relevant sustainability initiatives. People who can bridge the two worlds should be included in all central processes. This includes, for example, digital advisory councils, public inquiries on sustainability, strategic innovation programmes, etc.

18. Ensure that people with expertise in digital sustainability are found in all relevant forums where digital sustainability can contribute.

19. Task an appropriate actor to provide and administer an open access database containing generic climate data that is life cycle-based, quality assured and representative of all sectors and vital areas (including housing, mobility and nutrition) in Sweden.

20. Task an appropriate actor to develop public procurement criteria for and definitions of climate positive solutions in dialogue with the market.

21. Utilise incubators and science parks to bring the offering in Swedish innovative power to the fore, with focus on globally sustainable digital solutions.

22. Create clear incentives for resource and energy efficiency by means of taxes, regulations/laws, targets and inspections.

DESIRABLE MARKET ACTIONS

The following would be desirable in the market, primarily users and procurement officers, for solutions in which digitalisation plays a key role or has the potential to do so. One challenge is that knowledge of the potential and opportunities of digitalisation is necessary to be able to contribute actively as long as frameworks and rules do not make sustainable digital solutions standard. The first desirable market action thus becomes a skills boost and political support that moves the frame of reference/ norm from traditional solutions to sustainable solutions that mine the potential of digitalisation.

1. The catalytic impacts of digitalisation should be analysed in all strategic initiatives related to areas important to a fossil-free future, including housing, mobility, nutrition and consumption. The opportunities and challenges of digitalisation should be included in the analyses. Strategic sustainability initiatives should include expertise on the capacity of digitalisation to deliver sustainability goals and strategic digitalisation initiatives should include expertise on the relationship of sustainability topics to digitalisation.

2. Strive to reform existing organisations and processes and create new ones, so that they can be continuously improved to take advantage of new opportunities. Major revisions of all central strategies and initiatives should be carried out at least every other year (in line with the revisions of deliverables under the Paris Agreement and the SDG effort).

3. Existing strategies for sectors and industries should be augmented with roadmaps for meeting the needs of society, such as places/housing, transport/mobility and health/nutrition. In order to deliver solutions, Sweden should take the lead in developing strategies and structures designed on the basis of social needs and preferences instead of how society was organised in the past to deliver solutions. The inherent potential of digitalisation to deliver solutions in novel ways will require re-examination of everything from organisations and economic models to legal frameworks and knowledge gaps. Proceeding from needs instead of current products is one of the most important ways to power sustainable innovation.

4. Use tools and methods to differentiate between the "greening of IT" (where focus is on reducing the impact of IT) and "greening with IT" (which focuses on how IT can contribute to sustainability) and clarify goals and responsibilities in each area.

5. Analyse how digitalisation can contribute to radi-

cal improvements, including in businesses where digital solutions have not previously been used to any appreciable extent.

6. In addition to internal targets for minimising own negative impact, also set positive sustainability targets where the focus is on what companies and business can contribute.

7. Allocate resources for disruptive digitalisation solutions where investments can be made in numerous small projects where the likelihood of success is small, but where the consequences will be immense if they do succeed.

8. Shift focus from products to services and circular solutions.

9. Integrate digitalisation consultants as a link in the value chain as regards business development and sustainability work.

10. Increased usage of Fossil-free Sweden and other global sustainability goals as drivers of innovation and increased long-term business profits.

11. Demand that digitalisation consultants use methods to ensure sustainability and a fossil-free future through digitalisation in relevant areas. For example, by choosing digitalisation consultants that integrate climate work in their core business and demonstrate reduced negative impact and innovative positive impact.

3. CALLS FOR ACTION TO THE DIGITAL-ISATION CONSULTANCY INDUSTRY

The following are calls for action to the digitalisation consultancy industry so that it will be able to effectively contribute to a fossil-free Sweden that contributes globally sustainable solutions. These commitments are divided into two categories. The first concerns life cycle GHG emissions from ITC equipment, which according to the latest estimations correspond to about 1 percent of global emissions.[97] The second category concerns the contributions that the industry can make by helping society use digitalisation to deliver globally sustainable

and innovative fossil-free solutions, which corresponds to a large part of the 98 to 99 percent that has nothing to do with ICT emissions.

Actions applicable to how digitalisation is used

The digitalisation consultancies' greatest impact is made through helping clients take advantage of the opportunities that digitalisation offers. This is accomplished by optimising current processes, accelerating the use of new solutions and the development of new transformative solutions. Several recommendations follow, which were collected and prioritised during the process so that all firms involved will be able to begin the work to support a fossil-free Sweden.

1. Establish a shared web platform where clients, partners, politicians and others can find firms willing to deliver sustainable digital solutions that support a fossil-free future. Good examples should also be gathered on the platform.

2. Initiate a process, e.g. via a "digital fossil-free future index" where the contributions of various social actors are evaluated to enable assessment of whether the potential of digitalisation has been brought to the fore, whether actions have been taken and ultimately lead to concrete contributions to a fossil-free future. Data could be based on factors including what actions were taken to ensure that digitalisation actions contribute to fossil-free targets and how well digitalisation was included in climate goals. Date could initially come from CDP reporting and could later come from the reporting that would be instituted if the Swedish Government decides that relevant companies must report their Scope 4/climate positive contributions from that which they are selling.

3. Establish a Digitalisation Centre or a demonstration facility or invite existing facilities that exemplify the strengths of digitalisation and its contributions to a fossil-free future (in some cases, this may require funding).

4. Prepare a proposal for how the Swedish Riksdag could be digitalised and lead the way with good examples ahead of future "travel-free" conferences

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[97] http://www.mdpi.com/2071-1050/10/9/3027

or international summits and implement this proposal on behalf of the Swedish Government.

5. Contribute to the development of systems to collect, process and present data that makes it easier for political and business leaders to go beyond unilateral focus on GDP and profits and also include other values that make it easier to steer society in a sustainable direction.

6. In dialogue with relevant actors, clarify the catalytic impacts of digitalisation, i.e., that digital solutions can accelerate both negative and positive trends in relation to clients, suppliers and politicians, and take an active position in favour of solutions that lead towards the goal. Industry wide materials should be developed.

7. Make clients, partners and politicians aware of the risk of lock-in, i.e., when actions are taken to improve the situation but these actions lock in the organisation at an unsustainable level for far too long. Self-reporting of the industry's success in this regard should be encouraged.

8. Support the capacity of clients, partners and politicians to understand the need to work with disruptive ITC strategies that produce brand new opportunities and not only improvements of existing solutions.

9. Contribute to increasing the understanding that sustainable digital solutions usually require a combination of new technological solutions, new business models and new skills - and not merely hardware.

10. Help clients report both traditional reduced negative impact from their businesses (Scope 1-3) and positive/negative impacts from the core business (Scope 4 or avoided emissions).

11. Launch Code for the Planet (a new initiative) to put the spotlight on the role of coders/digitalisation consultancies in creating and delivering globally sustainable solutions, including a fossil-free future.

12. Spread good ideas and plans - next practice - as

well as best practice among different companies, industries and sectors.

13. Support a Swedish, Nordic, European and international accelerator to weld the digital revolution to the need to achieve a fossil-free future before 2045 across the globe.

14. Review opportunities to develop actions that reduce the negative consequences of e-commerce, such as features that reduce impulse shopping.

15. Explore the opportunity to develop a system to make it possible for digitalisation consultancies to refrain from business that leads to higher emissions and/or lock-in of unsustainable systems.

16. Support dematerialisation where it makes the biggest difference, including teleworking, videoconferencing, uploading physical documents to the cloud and encouraging people to favour experiences over physical consumption.

17. Support transport solutions that include and underpin virtual and digital solutions, such as virtual meetings and 3D printing.

18. Train and appoint people responsible for the sustainable business opportunities of digitalisation to boards of directors, senior company management and among other employees.

19. Develop methods and processes that digitalisation consultancies can use to assess the journey towards the goals.

COMMITMENTS RELATED TO ITC EQUIPMENT AND INFRASTRUCTURE

1. Encourage ITC as a service to streamline usage and encourage owner liability over the entire product life cycle.

2. Favour circular solutions and modular technologies to dramatically reduce the resources consumed by ITC equipment.

3. Ensure energy efficient and fossil-free solutions, aiming for net production, for underlying infrastructure such as data centres. The precautionary

principle should be observed as regards using waste heat from data centres and other ITC equipment to prevent lock-ins to unsustainable and inefficient systems.[98] Efficiency is increasing fast in the ITC sector and using ITC equipment as elements can be problematic if the aim is to drive new and efficient technology. This also requires joint planning of new residential/commercial property and ICT infrastructure to prevent the creation of infrastructure that locks us into inefficient systems that reduce incentives to build energy-efficient buildings and energy-efficient ITC equipment.

4. OVERALL GOALS

These goals are aimed at establishing common targets for various firms so that Sweden will be able to deliver fossil-free and globally sustainable digitalisation solutions and where clusters of firms contribute to implementation.

- 2019 Establish a virtual meeting place where people with expertise in digital solutions for a fossil-free future can meet people who are interested in these types of solutions.

- 2020: Firms that work with digitalisation provide opportunities for employee training courses on the role of digitalisation in sustainability, aimed at increasing capacity and coordination as regards the delivery of globally sustainable fossil-free solutions. Leading universities integrate knowledge about the role of digitalisation in sustainability in the courses.

- 2020: A national strategy for the role of digitalisation in achieving a fossil-free future is established in dialogue among the Swedish Government, the Riksdag, business leaders and other relevant social actors. In this strategy, the roadmap is revised continuously and significant reprioritisations are made regularly. These strategies should also be developed at the city and county level. Prominent municipalities and county councils can take the lead in order to inspire an ambitious national strategy.

- 2020: Goals and support for smart digital solutions

are established as essential to a fossil-free Sweden, with greater focus on companies that deliver globally sustainable solutions for a fossil-free society through the products and services they sell.

- 2020-2044: Roadmaps are continuously revised as digital solutions are given an increasingly prominent role over time.

- 2045: Sweden has been a fossil-free country for several years and is an international powerhouse in developing, implementing and trading in globally sustainable solutions for mobility, housing and nutrition/health/sustainable consumption patterns (the greatest challenges to achieving a fossil-free future). During the period of 2025-2045, these solutions have reduced GHG emissions by at least 500 million metric tons (avoided emissions) around the world, through various initiatives.[100]

The following six overall key factors are critical to achieving a globally sustainable society that is fossil-free and where the digitalisation consultancy sector makes significant climate-positive contributions:

1. More extensive collaboration among different groups in society and inclusion of new knowledge by basing actions on social needs (such as mobility, nutrition and housing) and not only on existing sectors. This facilitates new business models where digitalisation consultancies can contribute to more than changes to existing systems.

2. A shift of focus from:

   a. Products and problems to services/function and solutions through a shift of focus from products to services in public procurements, legislation and government agencies.

   b. Sectors and companies to clusters by including different groups, companies, civil servants, NGOs, academics, etc., who focus on delivering a solution.

   c. Optimised improvement via acceleration to also embracing transformative improvements

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[98] https://datacenterfrontier.com/a-look-at-data-center-of-the-future/
[99] Through organisations and initiatives such as Business Sweden, A Challenge from Sweden, Viable Cities, Swedish Incubators & Science Parks and the Mission Innovation Solutions Framework.

by including models and experts who have the tools and experience to go beyond improvements to existing systems.

d. Linear resource consumption and ad hoc actions for circularity to extreme resource efficiency and circularity at the social level by focusing on global sustainability and not only national improvements in isolated areas (because this can lead to lock-ins to unsustainable systems and difficulties exporting these solutions).

3. Flexible rules that can adapt to changed situations and do not lock society into old solutions when new ways to deliver solutions arise.

4. Solutions should be globally sustainable and focus on imports/exports and other ways to spread sustainable solutions are key to achieving the greatest possible benefit.

5. A financial system that supports solutions, including disruptive solutions, and does not only avoid the most polluting companies (i.e., go from only selling assets in polluting companies to supporting the companies that sell the solutions that society needs).

6. Public procurements as engines of transition and innovative thinking by means including allowing opportunities for public procurements to support world-leading innovations.

Work in these six areas can begin immediately. An international group of experts could deliver recommendations on an ongoing basis.

Appendix 2: Starting point for the roadmap and participants

The roadmap for the digitalisation consultancy industry must clarify how the industry, in cooperation with politicians and other decision-makers, can enable a transition to a fossil-free Sweden that drives globally sustainable solutions.

The roadmap was prepared within the framework of the Fossil-free Sweden initiative and Cybercom was the project manager, leading the effort to prepare a roadmap for a fossil-free, climate positive and competitive digitalisation consultancy sector by 2045. By generating consensus in the industry, the roadmap can further and hasten development towards fossil-free and climate positive business opportunities through a number of calls for action and recommendations.

The roadmap will make available the total body of knowledge about the climate impact to which the digitalisation consultancy sector's value chain contributes. It will shed light on the trends, drivers, obstacles, targets and business benefit of climate work for a wide group of roles and stakeholders.

The support of all key links of the value chain will be a success factor for the roadmap. Accordingly, various representatives are invited to get involved in the working process. It is important that we gain the participation of a wide array of stakeholders relevant to the digitalisation consultancy sector, such as clients, suppliers, cities and investors.

The roadmap was presented to the Swedish Government in spring 2019.

Process owner: Cybercom
Main author and process manager: Dennis Pamlin, Cybercom
Co-author and coordinator of the roadmap process: Ingemar Jansson, Cybercom

STEERING GROUP

- Convener: Dennis Pamlin, Cybercom
- Cecilia Pfannenstill, Quality & Sustainability Director, CGI
- Niclas Ihren, CEO, Founder, Matters Group
- Marcus Liu, Digital Transformation and Business Development, Almi
- Niklas Grybe, Senior Advisor Digitalization, RISE
- Kristina Cato, Director Corporate Communication, Sustainability and Brand, Cybercom
- Maria Mähl, Director and Partner, Arabesque Asset Management
- Matilda Gennvi Gustafsson, IoT Sustainability Director, Ericsson
- Staffan Movin, Managing Director, MTC; Program Director, KTH Executive School
- Tomas Haglund, Nordic Director, Accenture Sustainability Strategy, Accenture

REFERENCE GROUP

Acando, Accenture, Accigo AB, Advania Sverige, Antrop AB, Atea Sverige AB, ayond AB, B3 Consulting Group AB, Berge Consulting AB, Capgemini Sverige AB, Cartina AB, CGI, Combitech, Cybercom Group AB, Eicorn AB, Etteplan AB, Implement Consulting Group, IRM, jayway, Knightec AB, Knowit, Netlight, Prevas AB, Proact IT Sweden AB, R2M, Semcon AB, Sigma IT Consulting, Softronic AB, Sopra Steria Sweden AB, Sweco Position AB, Sylog Sverige AB, Tieto, Tritech Technology AB, Usify AB

AREA HEADS

Responsibility for coordination of three areas is allocated as follows.
Sources for various sections/reports/materials: Eva-Karin Anderman from Usify
Input for recommendations and examples: Carl-Harald Andersson and Jeanette Johansson from Sigma IT Consulting

Input from clients: Sofia Hertz, Elisabet Brodin and Olle Norberg from Cartina AB

DIGITALISATION CONSULTANCIES

The digitalisation consultancy industry is not a homogeneous group with a long history. Many firms in the industry are young, and those that have participated in the work to prepare the digitalisation consultancy industry's roadmap come mainly from one or more of the following areas:

1. Providers of digital hardware
2. Providers of consulting services
3. Business developers focused on the opportunities of digitalisation
4. Sustainability consultants focused on the opportunities of digitalisation

THE ROADMAP PROCESS

The work was organised by establishing a reference group with all interested firms.[100] This was the core of the process. A steering group was attached to the reference group to give an overall strategic direction to the work and to promote support in various parts of the value chain. A small group from within the reference group reported interest in driving various sub-issues in the roadmap process. The four parts were:[101]

- Delivering source materials for various sections with background information in the roadmap
- Providing input on various possible recommendations
- Obtaining input from clients and other parts of the value chain
- Reviewing opportunities to attend/participate in various processes and events

The work was formally begun on 31 May 2018 when the reference group met for the first time.[102] The majority of the work was carried out through virtual meetings and digital collaboration tools to make participation possible for people who could not physically attend meetings. Tools like Skype, menti.com, Typeform, Dropbox and Microsoft Teams were used to enable continuity, interactivity and participation. There were also discussions about opportunities to present the roadmap in a format that would be more interactive than a conventional, static PDF.[103]

When it turned out that the Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5 °C would include a scenario based on smart solutions in society (instead of focusing on improvements to existing systems and increased supply of renewable energy), a workshop was arranged on 28 August 2018 with one of the main authors of the report, Charlie Wilson, to discuss the consequences of Swedish roadmap efforts and how a roadmap for the digitalisation consultancy industry should be designed.[104]

The work to prepare the roadmap was also presented at Fossil-free Sweden's autumn workshop on 15 October.[105] A survey to all participants at the workshop and others interested in digitalisation and sustainability was sent out. The responses from more than 40 people made it clear that there is tremendous interest in the potential of digitalisation, but also that focus still seems to be on making current operations more efficient.[106]

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[100] See Appendix 2

[101] The following individuals were responsible for the various parts:
Source materials for various sections/reports/materials: Eva-Karin Anderman from Usify
Input for recommendations and examples: Carl-Harald Andersson from Sigma
Input from clients: Sofia Hertz, Elisabet Brodin and Olle Norberg from Cartina
Participation/attendance in processes and events: Eva Vati from Ework Group

[102] http://news.cision.com/se/miljo--och-energidepartementet/r/it-konsultbranschen-samlas-for-ett-fossilfritt-sverige,c2537347

[103] The page following the cover of this roadmap provides a modest illustration. A classic quotation most often found in reports is included, as is a direct link to a YouTube video in which the potential of digital technology is discussed and one of the first ".earth" pages where the concentration of CO2 in the atmosphere is reported almost in real time.

[104] https://www.tyndall.ac.uk/people/charlie-wilson See https://www.nature.com/articles/s41560-018-0172-6 for information about co-authors.

[105] http://fossilfritt-sverige.se/pa-gang/fossilfritt-sveriges-hostworkshop/

[106] The survey was coordinated by Cartina and showed great interest among the companies in the link between digitalisation and sustainability. However, the vast majority focused on the opportunities of digitalisation to optimise existing operations.

Appendix 3: Categories of digitalisation solutions

Examples of various actions in the areas of mobility, nutrition and construction are provided below. These are examples only and nothing else. The aim is to illustrate the many different types of contributions that digitalisation consultancies can make.

1. **Product optimisation (risk of lock-in of unsustainable products)**
   - A fossil-fuel powered vehicle in which the engine is controlled more efficiently
   - Meat-based meals served with information about GHG impact
   - Lamps in a building that are controlled more efficiently

2. **Product acceleration**
   - Support for development and deployment of electric vehicles
   - Support for development and implementation of synthetic meat
   - New lighting technology

3. **Product transformation**
   - From vehicle to development of an integrated hydrogen gas/electrical system that utilises surplus energy in buildings.
   - From meat to development of new and smart plant-based proteins, or even protein derived directly from electricity.
   - From lamps to support for designs that reflect natural light or development and implementation of natural biomimicry/fluorescent compounds.

4. **System-level optimisation (risk of lock-ins of unsustainable systems)**
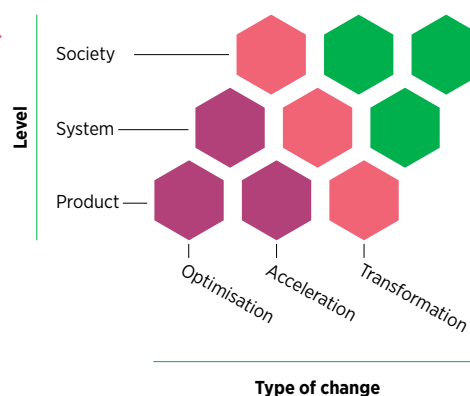   - Support for smarter vehicle control
   - Development of systems to recycle food waste
   - Development of systems for optimised heating of residential neighbourhoods

5. **System-level acceleration**
   - Development of control systems for EV char-

CATEGORIES OF DIGITALISATION SOLUTIONS

Illustration 1: Categories of digitalisation solutions

ging in a city that integrates buildings and mobility

- Support for urban farming and new ways of producing protein from algae and insects
- Support for buildings that are net producers of renewable energy

6. **System-level transformation**
   - Support for urban planning where walking and cycling are the main modes of physical movement of people and the use of drones and tunnel-based solutions for products that need to be moved; this includes virtual meetings and the potential of 3D printers
   - Development of systems that integrate food and health through smart homes where food production and insulation are integrated and where green spaces are developed so that people will be able to grow their own food and to encourage physical activity
   - Support for urban planning that includes virtual places, future tunnels and infrastructure for drones, along with modular building based on sharing

7. **Society-level optimisation (risk of lock-ins of unsustainable communities)**
   - Support for systems that evaluate vehicle emissions per km using GPS solutions and support solutions that are not globally sustainable due to local conditions
   - Support for systems for using food waste to such an extent that countries become net importers of waste
   - Development of systems that monitor guidelines for reducing energy consumption per m2 in buildings without considering global needs and linking of inefficient industries and neighbourhoods without considering technological advances.

8. **Society-level acceleration**
   - Support for a transport and mobility system based on electrification and hydrogen gas, where the majority of transports have been eliminated with the help of digital solutions, either through dematerialisation or local production using 3D printers and other solutions and support for initiatives that reduce the scope for social actors that support fossil fuel-powered vehicles by means of e.g. higher taxes and transparency regarding the consequences of their businesses
   - Support for sustainable nutrition systems where globally sustainable foods are identified and leading social actors such as chefs and restaurants spread these to citizens, and support for initiatives that reduce the scope for social actors that run restaurants with frenetic environments serving processed, unhealthy and unsustainable food by means of e.g. higher taxes and transparency regarding the consequences of their businesses
   - Support for new, modular and sustainable buildings designed for flexible use and adapted to different seasons

9. **Society-level transformation**
   - Development of systems focused on 4D printers and virtual solutions along with planning based on what products can be produced globally and resource efficiently (based on the sunshine that various places get and other factors)
   - Support for systems based on health and that integrate nutrition and wellness for optimal sustainability and include the social advantages of healthy food and slow eating
   - Development of a web platform to plan construction based on how the good life and creative communities are optimally supported with places where individuals and groups of people can be in a globally sustainable way

Appendix 4: Strategic trends supporting the roadmap (graphical overview)

Many of the underlying trends related to digitalisation are exponential. However, the human brain has difficulty understanding the difference between linear and exponential development and much of our education, not least importantly in economics, is based on models where change happens by means of simple mechanisms that gradually alter the system, e.g., a carbon tax that is gradually increased.[107] Presenting results graphically makes it easier to understand the difference. This overview of trends is therefore based on charts. Many of the charts come from Statista, which is an example of how data is becoming increasingly accessible.[108]

While this roadmap was in process, a number of reports were published that discussed the central role of digitalisation in the matter of climate change. A few examples:[109]

1. Beyond comparison, the most important report was the IPCC Special Report on Global Warming of 1.5 °C that was published on 8 December.[110] For the first time, this report included a pathway (P1) that focused on sustainable consumption patterns instead of increased supply of renewable energy as in the past, meaning that the opportunities of digitalisation were assigned a key role.[111] An entire scenario that shows the potential of digitalisation was included for the first time, rather than merely isolated examples. This pathway is also the one that delivers by far the best on the other global sustainable development goals. Much of the digitalisation consultancy industry's roadmap is based on this IPCC report and the research upon which it was based.[112]

2. As regards the direct consequences for Sweden, the Commission's "A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy" is probably the most important.[113]

3. In conjunction with the UN High-Level Political Forum on the Sustainable Development Goals in July 2018, GeSI and Accenture jointly published "#SystemTransformation – How Digital Solutions will Drive Progress Towards the Sustainable Deve-

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[107] Research suggests that children's thinking (and that of certain indigenous peoples) is naturally logarithmic (where the curve is the mirror-image of exponential thinking). This indicates that our linear thinking is something that develops when we are exposed to linear thinking and representations in the society around us. This may be worth considering in terms of education. Discussions of this are found in the chapter "A Head for Numbers" in "Alex's Adventures in Numberland" by Alex Bellow, for example. The difficulty that most people have with exponential change is often mentioned in discussions of new technology, as here: https://www.businessinsider.com/kurzweil-brain-exponential-thinking-problem-2016-3?r=US&IR=T&IR=T

[108] https://www.statista.com/

[109] Numerous articles have also drawn attention to the relationship between digitalisation and sustainability, such as https://sloanreview.mit.edu/article/the-convergence-of-digitalization-and-sustainability/

[110] https://www.ipcc.ch/pdf/session48/pr_181008_P48_spm_en.pdf

[111] The new and unique aspect of the report is Pathway 1: http://www.ipcc.ch/report/sr15/

[112] The PI pathway in the IPCC report is based on the article "A low energy demand scenario for meeting the 1.5 °C target and sustainable development goals without negative emission technologies" by Arnulf Grubler, Charlie Wilson, et al published in Nature in June 2018. https://www.nature.com/articles/s41560-018-0172-6

[113] "The transition also requires further scaling-up of technological innovations in energy, buildings, transport, industry and agriculture sectors. It can be accelerated by breakthroughs in digitalisation, information and communications, artificial intelligence and biotechnology."

lopment Goals", a report that presents the potential of digitalisation.[114] Digitalisation is now being ascribed an increasingly central role when global sustainability topics are discussed, which is giving groups that have not previously understood the key role of digitalisation increasing opportunities to learn about them.

4. The World Economic Forum and KPMG also jointly published "Bold Ideas to Accelerate Sustainable Energy Innovation", a briefing paper based to a great extent on the potential of digitalisation.[115] This work was connected to Mission Innovation,

which was initiated during the Paris climate summit. It is encouraging that new initiatives are focusing on digitalisation.

5. IEA's "Tracking Clean Energy Progress" (TCEP) included digitalisation for the first time.[116] The analysis was based on the report on energy and digitalisation published by IEA in 2017.[117]

6. "The Exponential Climate Action Roadmap", whose conclusions included that: "Digitalisation and climate strategies must become one and the same thing, with extensive mutual reinforcement."[118]

4.1 THE DIGITALISATION INFRASTRUCTURE[119]
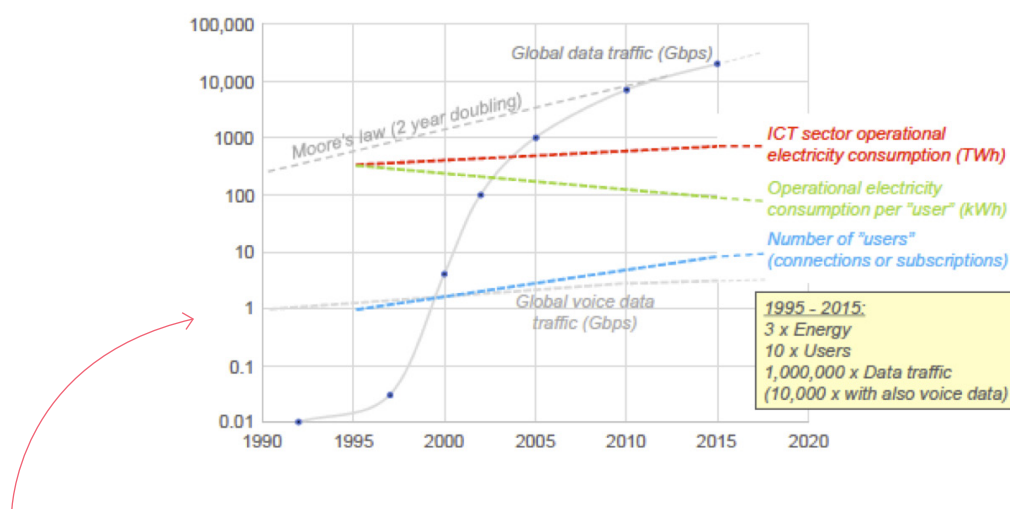
Figure 1: Total data traffic, operational electricity consumption and number of ICT users (connections or subscriptions) in the sector from 1990 to 2020. Note that only human users were included based on available subscription data and IoT connections were excluded.

[114] http://systemtransformation-sdg.gesi.org/160608_GeSI_SystemTransformation.pdf
[115] https://www.weforum.org/agenda/2018/05/six-bold-ideas-accelerate-sustainable-energy-innovation-tatsuo-masuda/
[116] https://www.iea.org/tcep/
[117] https://www.iea.org/digital/
[118] https://exponentialroadmap.org/
[119] https://www.mdpi.com/2071-1050/10/9/3027/htm

4.2 HUMAN CONNECTION

A couple of examples of how we humans have become more connected follow.
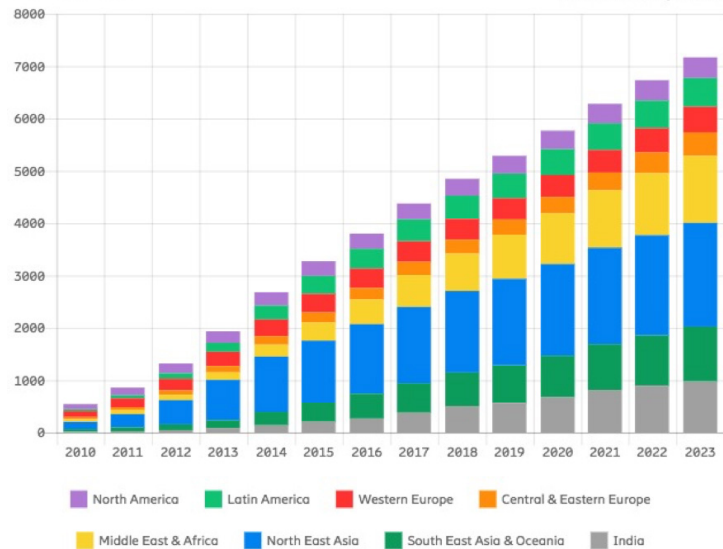
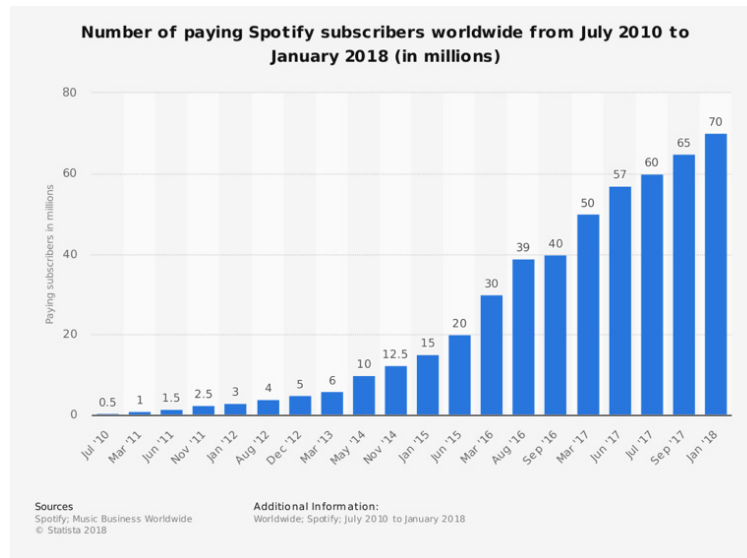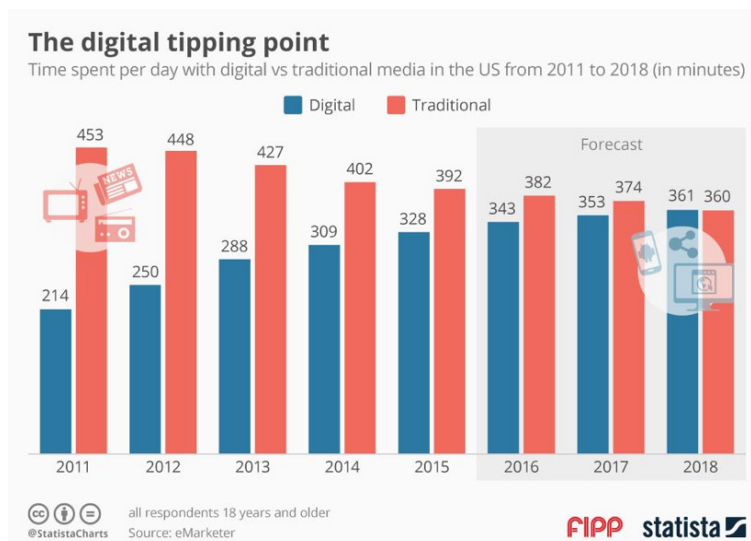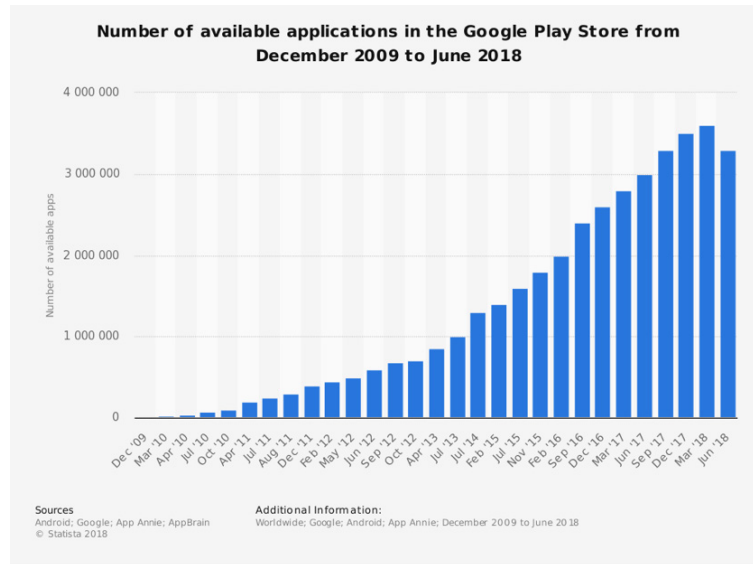**Figure 2:** **Number of mobile phone subscriptions** [120]
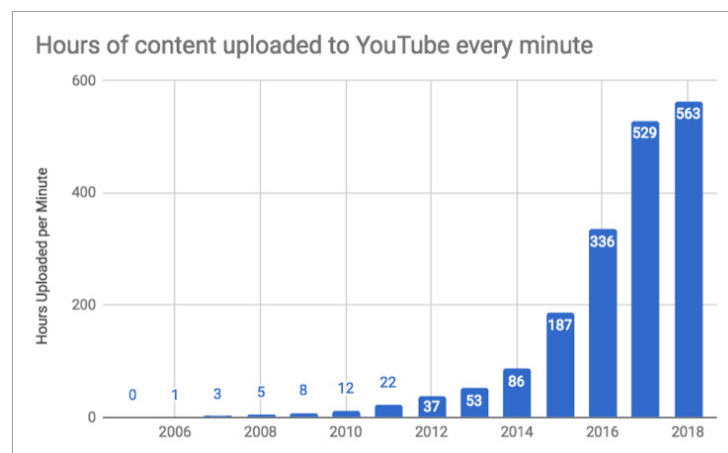
Figure 3: **Hours of content uploaded to YouTube every minute.** [121]

[120] https://www.ericsson.com/en/mobility-report/mobility-visualizer?f=1&ft=1&r=2,3,4,5,6,7,8,9&t=1,2,3,4,5,6,7&s=1,2,3&u=1&y=2010,2023&c=1
[121] http://videonitch.com/2017/12/13/36-mind-blowing-youtube-facts-figures-statistics-2017-re-post/

Figure 4: **Number of paying Spotify subscribers**[122]

Number of paying Spotify subscribers worldwide from July 2010 to January 2018 (in millions)

Figure 5: **The media we consume**[123]

The digital tipping point — Time spent per day with digital vs traditional media in the US from 2011 to 2018 (in minutes)

[122] https://www.statista.com/statistics/244995/number-of-paying-spotify-subscribers/
[123] https://www.fipp.com/news/insightnews/chart-of-the-week-the-digital-tipping-point

Figure 6: **Number of apps in the Google Play Store**[124]

Number of available applications in the Google Play Store from December 2009 to June 2018

Sources
Android; Google; App Annie; AppBrain
© Statista 2018

Additional Information:
Worldwide; Google; Android; App Annie; December 2009 to June 2018

Figure 7: **Number of apps in the Apple App Store**[125]

Number of available applications in the Google Play Store from December 2009 to June 2018

Sources
Android; Google; App Annie; AppBrain
© Statista 2018

Additional Information:
Worldwide; Google; Android; App Annie; December 2009 to June 2018

[124] https://www.statista.com/statistics/266210/number-of-available-applications-in-the-google-play-store/
[125] https://www.statista.com/statistics/276623/number-of-apps-available-in-leading-app-stores/

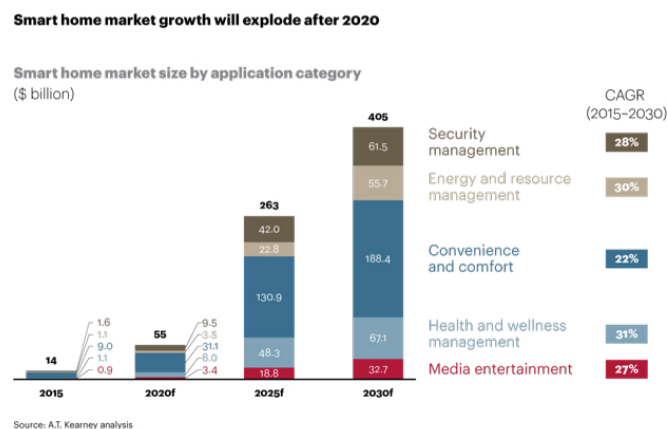STRATEGIC TRENDS SUPPORTING THE ROADMAP (GRAPHICAL OVERVIEW)

4.3 THE CONNECTION OF THINGS

A few examples of how things are becoming increasingly connected are given below.

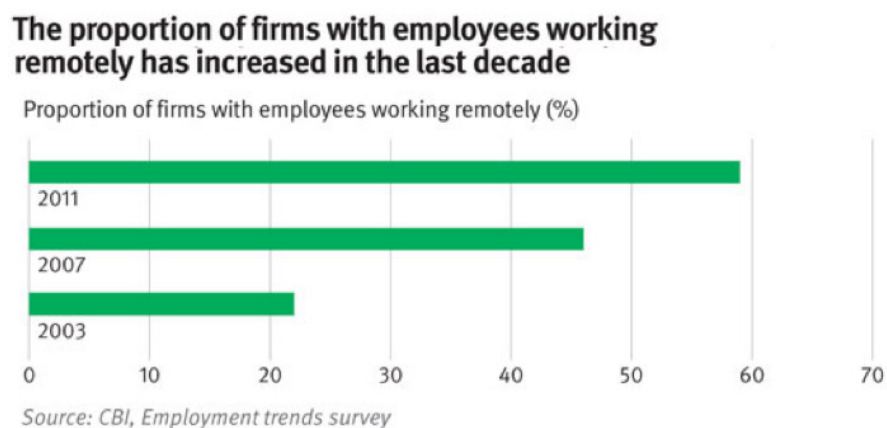**Figure 8:** **Where IoT projects are found in society.**[126]
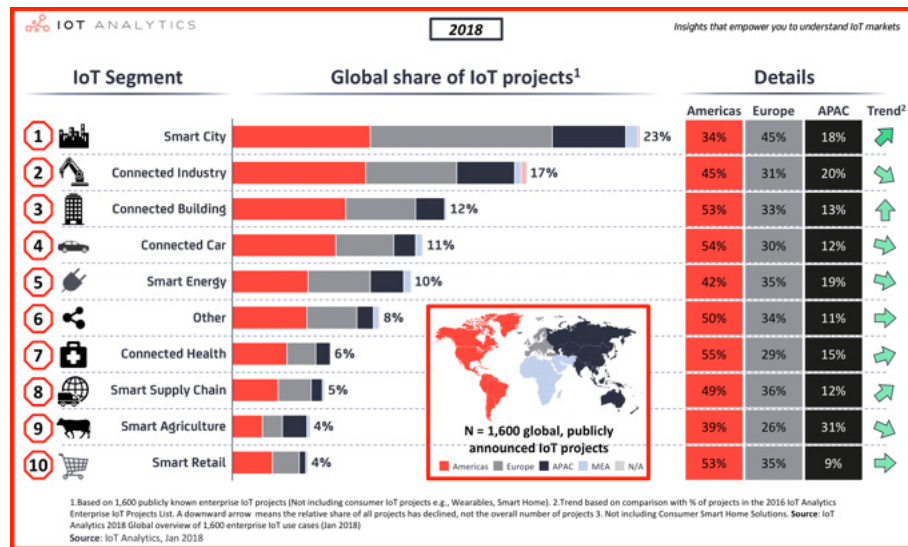
Figure 9: **The smart home market.**[127]

[126] https://iot-analytics.com/top-10-iot-segments-2018-real-iot-projects/
[127] https://www.atkearney.com/communications-media-technology/article?/a/the-battle-for-smart-home-open-to-all

Figure 10: **E-commerce sales v. department store sales in the US.**[128]

E-Commerce Sales v. Department Store Sales

Source: US Commerce Dept. WOLFSTREET.com
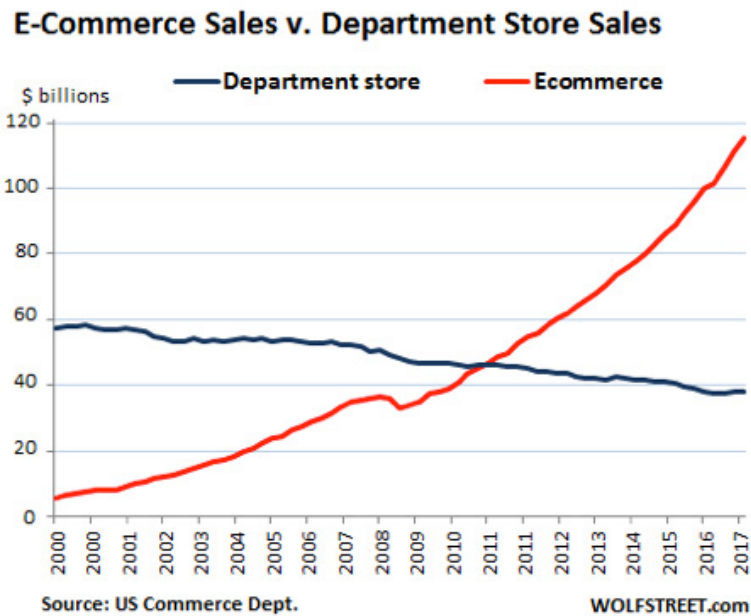
Figure 11: **Proportion of firms with employees working remotely** [129]

The proportion of firms with employees working remotely has increased in the last decade

Proportion of firms with employees working remotely (%)

Source: CBI, Employment trends survey

[128] https://seekingalpha.com/article/4126702-e-commerce-really-crushing-brick-mortar-sales?page=2
[129] https://www.carsonshold.com/talks/keys-to-working-remotely/#/

Figure 12: **Development of electric cars** [131]

Beyond horsepower
Just as motor vehicles displaced horses a century ago, electric cars could replace motor vehicles in the next 10 to 25 years.
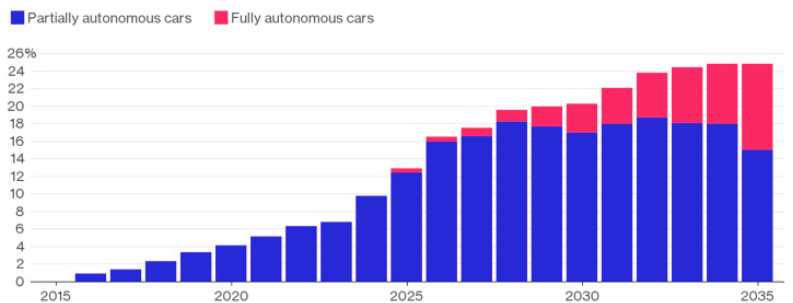(per thousand people, log scale)
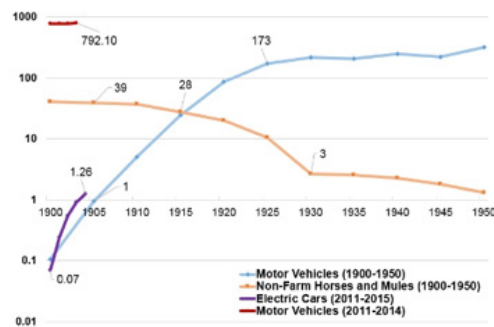
Note: Electric car graph line starts in 2011.
Source: Cherif, Reda, Fuad Hasanov, and Aditya Pande, 2017, "Riding the Energy Transition: Oil Beyond 2040," IMF Working Paper 17/120.

Figure 13: **Proportion of self-driving cars**[132]

Autonomous Car Sales Will Surge By 2035
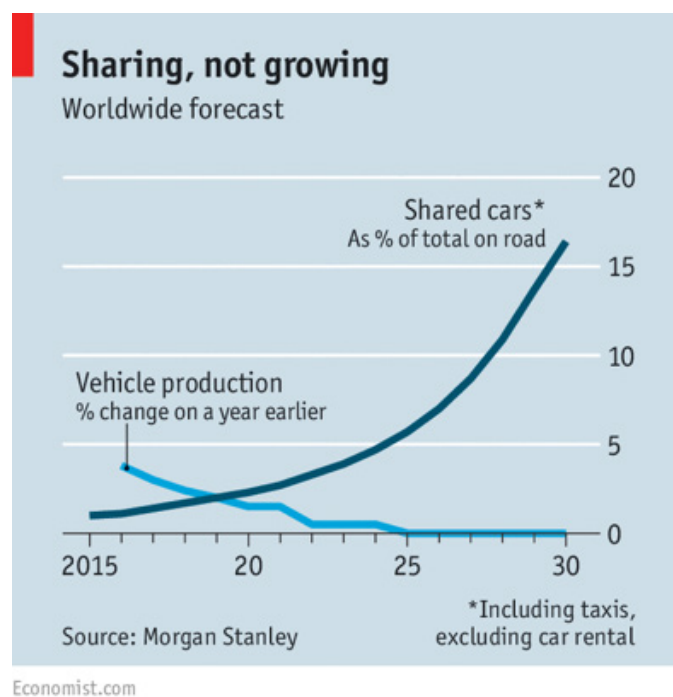The cars will represent 25 percent of the global market

Source: The Boston Consulting Group
Note: 2015 data
Bloomberg

[131] https://blogs.imf.org/2017/07/31/chart-of-the-week-electric-takeover-in-transportation/
[132] https://www.reuters.com/article/autos-bcg-autonomous/12-million-driverless-cars-to-be-on-the-road-by-2035-study-idUSL1N0UN2GQ20150108

Figure 14: **Number of shared cars** [132]

Sharing, not growing
Worldwide forecast

Shared cars*
As % of total on road

Vehicle production
% change on a year earlier

2015   20   25   30

*Including taxis,
excluding car rental

Source: Morgan Stanley

Economist.com

[132] https://www.economist.com/business/2016/01/09/the-driverless-car-sharing-road-ahead

#DIGITAL4CLIMATE

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