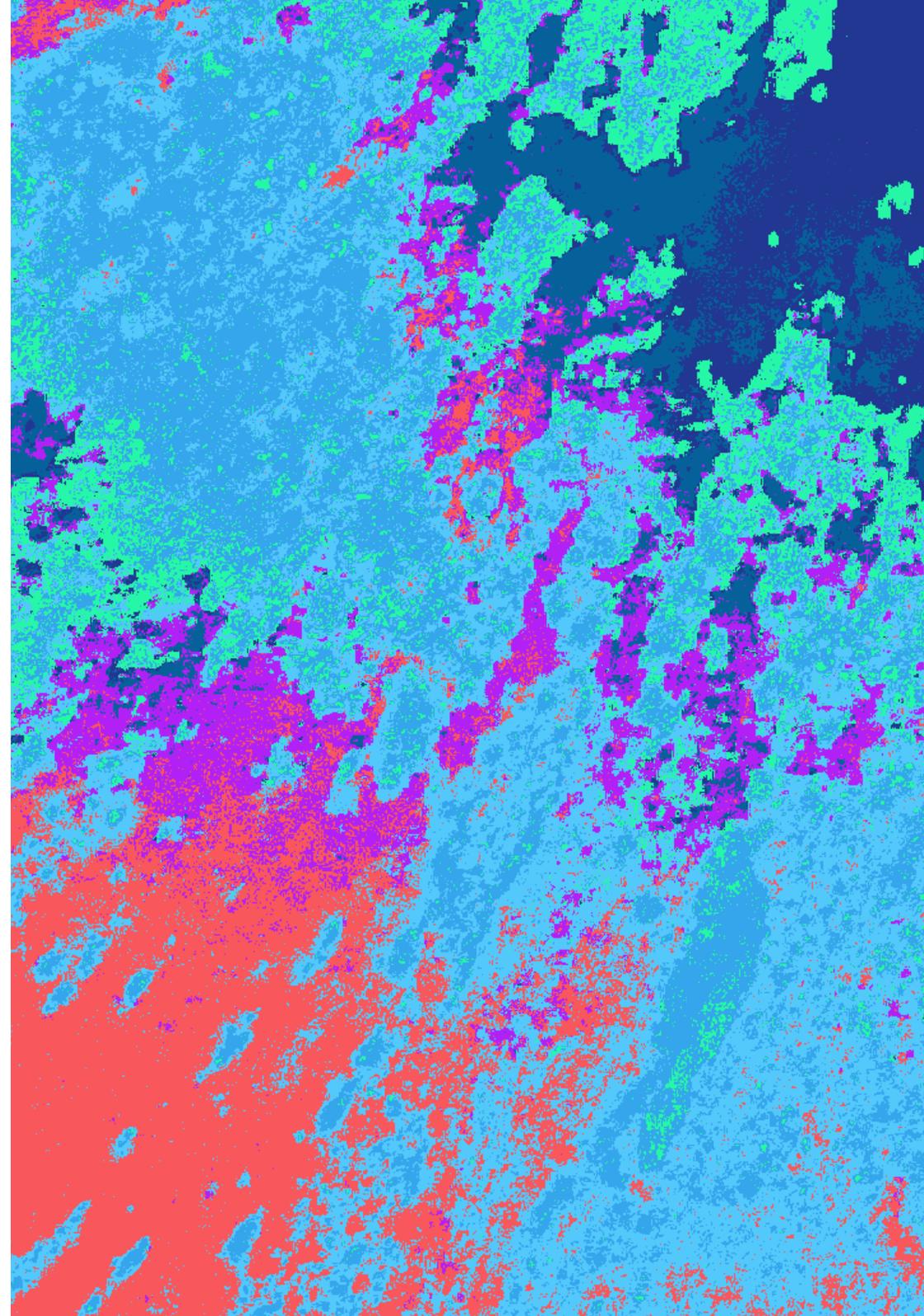


January 2020

# THE FUTURE OF MOBILITY

Imagining how Roland, Nathalie, Mark  
and Maya will get around in 2040



# FOREWORD



**Stefano Brusoni**  
Professor of Technology and  
Innovation Management  
ETH Zurich

## **The effort to predict the future helps us understand the present**

“It is very difficult to make predictions, especially about the future.” This sentiment, often attributed to the physicist Niels Bohr (but most likely originating in an older Danish proverb), perfectly encapsulates the difficulties – and disbelief – faced by those who attempt to make sense of the future.

Both the difficulty and the disbelief originate in the all-too-common misunderstanding about the goal of such efforts. Prediction is not about identifying a specific end-state.

The ultimate societal or economic outcomes to which a new technology will lead, for example, are very difficult to predict, and will always be so. But this is not the point of future, or foresight, studies. Rather, the aim is to build a transparent, inclusive process through which different stakeholders voice their assumptions, ideas and concerns so they can develop plausible evolutionary trends together.

Of course, specific outcomes may be discussed – often in the form of scenarios, which can help articulate assumptions, illuminate specific risks, or highlight potential change triggers and crucial turning points. Yet, the value of such scenarios is not as plausible future outcomes, but rather as devices to focus our attention – and, in so doing, make transparent the assumptions on which we base our decisions in the present day.

In other words, the foresight is less important than the “foresighting”: the structured process of engagement that makes future studies predictive, but not prescriptive. When well implemented, future studies enable us to “check our assumptions” as their consequences unfold. They are about transparency and responsibility, not choice and normativity. It is no accident that the

discussion about future studies is also connected to the even broader discussion about science and technology policies, since this conversation began at a time (the 1960s) when the issue of the responsibilities of the scientific community (which was then promoting contentious technologies such as nuclear energy) came to the fore.

Since then, future studies have been widely used in academic, industry and policy circles alike. Expert interviews, Delphi methods, scenario analyses and many other methods have developed over time in order to support decision makers in their efforts to make sensible choices, as well as to enable interested stakeholders to understand which criteria and assumptions informed such choices.

Future studies cannot take away responsibility, but they can guide, inform and illuminate the key issues at stake. Crucially, they enable people to pause and think of possible unintended outcomes – for other people, organizations or society as a whole. They can offer no guarantee of success, and are not intended to do so. Rather, they offer a structure and a process to continuously update our beliefs about the future, based on whatever evidence emerges along the way.

This last purpose is often neglected. Future studies help us understand the evidence, which is so often incomplete and unclear. By placing current knowledge in the context of our prior expectations, future studies show us when reality began to take a different turn, and might help us understand why and how.

The report you are reading is an excellent example of this approach to future studies. It offers a concise, transparent discussion of the future of mobility, and what that might bring about. It builds on expert interviews, needs analysis, panel discussions and iterative feedback workshops. It concerns itself with the interaction of societal, technological, economic, environmental and political factors that might lead all of us to very different places. It is about predicting, not making predictions. It is about checking assumptions, rather than making them. As such, it provides valuable guidance and advice to all those who are interested in understanding where the domain of mobility is going, whether we look at it as investors, managers, academics or users.



**Patrick Wirth**

Director Investment and Innovation, Group Strategy and Digital Transformation  
Baloise Insurance

### **When entering new territories, you are lost without a map and compass**

The world is changing. The fourth industrial revolution changed our daily life dramatically. Smartphones and the internet are enablers for new, customer-centered business models. Rapid access to scalable cloud services and emerging AI technology are additional drivers for change and innovation across most industries.

Nowadays, 30–50 percent of the premium of a Property & Casualty (P&C) insurer is typically based on classical motor-insurance products. Baloise fits into that category. We are proud to say that our insurance excellence helps us to run the motor insurance business very well. But a range of mega trends are set to have a huge impact on the

motor insurance industry worldwide. Autonomous and connected cars are more than just a vision; we are already seeing them on our roads. Electric mobility is booming, driven also by the sustainability challenges that humankind is facing. A growing sharing economy is emerging out of different economic and social trends. We may be best in class in what we do today, but the world is changing faster and faster. We assume that the need for individual car insurance will decline, and that autonomous cars will make driving safer in the future. We call this scenario for the future of mobility “The Three Zeros”: zero emissions, zero ownership and zero accidents. This will fundamentally change the insurance industry and the solutions it offers to customers and partners.

As Baloise, we have a responsibility towards our customers, employees and stakeholders. In this context, we want to play an active part in the transformation of our industry and adjust our service offerings accordingly. The entire mobility market is undergoing major changes. Big players – strong brands – are struggling with their existing business models. The established automotive OEMs, for example, are under attack from pioneers such as Tesla and the shift away from combustion engines. Uber has changed the taxi business, and newcomer Flixbus is redefining the way we travel. China is at the forefront of the development and usage of new technologies in many areas, such as zero-

emission public transportation. Such trends and offerings might also enter European markets in the foreseeable future.

These changes in the field of mobility will open up new service and risk coverage needs. This situation is a unique opportunity for Baloise as an innovative front-runner. The future of mobility requires new solutions and business models, and we are in a strong position to offer them – across not only traditional risk-coverage solutions, but also new mobility-focused service offerings. For example, we have started to explore new mobility opportunities with our investments in Carhelper and Gowago, but also with our internally incubated spin-off Mobly in Belgium. We also know how to build and scale new companies, as we have shown with Friday, our greenfield digital insurance spin-off in Berlin, Germany. Thanks to our retail and commercial insurance business, we have a broad partner network in the field of mobility. With our startup investments, managed by our Anthemis Baloise Strategic Venture team, we have access to companies that are already offering different types of solutions for the mobility ecosystem.

We are convinced that Baloise has the capabilities to be a relevant future player in the new mobility ecosystems. However, focus and an intelligent use of our resources will be key. To this end, we want to understand the most likely scenarios of how the future might look. Questions to be an-

swered focus on the impact of different trends, the likelihood that they will materialize, and the possible picture of our mobility experience in Europe in 2030 and beyond. Together with Spark Labs and Spark Works, we have developed a map of trends and scenarios that will help us find the best way forward for Baloise in these turbulent times. New opportunities for Baloise in the mobility space are there – we just need to find them.

# INTRODUCTION

The concept of mobility can be interpreted in several ways. The immediate connotations of “being mobile” include the daily commute to work, the school run or a trip to the grocery store. Some go on foot, some catch the metro, some use pedal power, a few even take a boat – and more and more people mix various means of transport. In fact, the dominant means for commuting varies widely depending on the city. In Paris, more than 50% walk, in Vienna almost 75% of citizens commute by public transport and in Copenhagen and Amsterdam most inhabitants cycle to work or school.<sup>1</sup> In general, the level of commuting into a city depends, at least partly, on the population density and patterns of urban development in surrounding areas.<sup>2</sup> Overall, this is mobility out of necessity – a means to a desired end. No one would commute without a job to get to. The journey itself can still be fun, comfortable or pleasant – but the point is the arrival, not the travelling.

When we travel, however, the journey is the destination. We may not even know the exact route in advance, making the discovery exciting in itself. However, we will still need to do far more planning and adjustment to local behaviors, cultures and routines. But more importantly, we have more freedom to explore and feed our curiosity. Within the

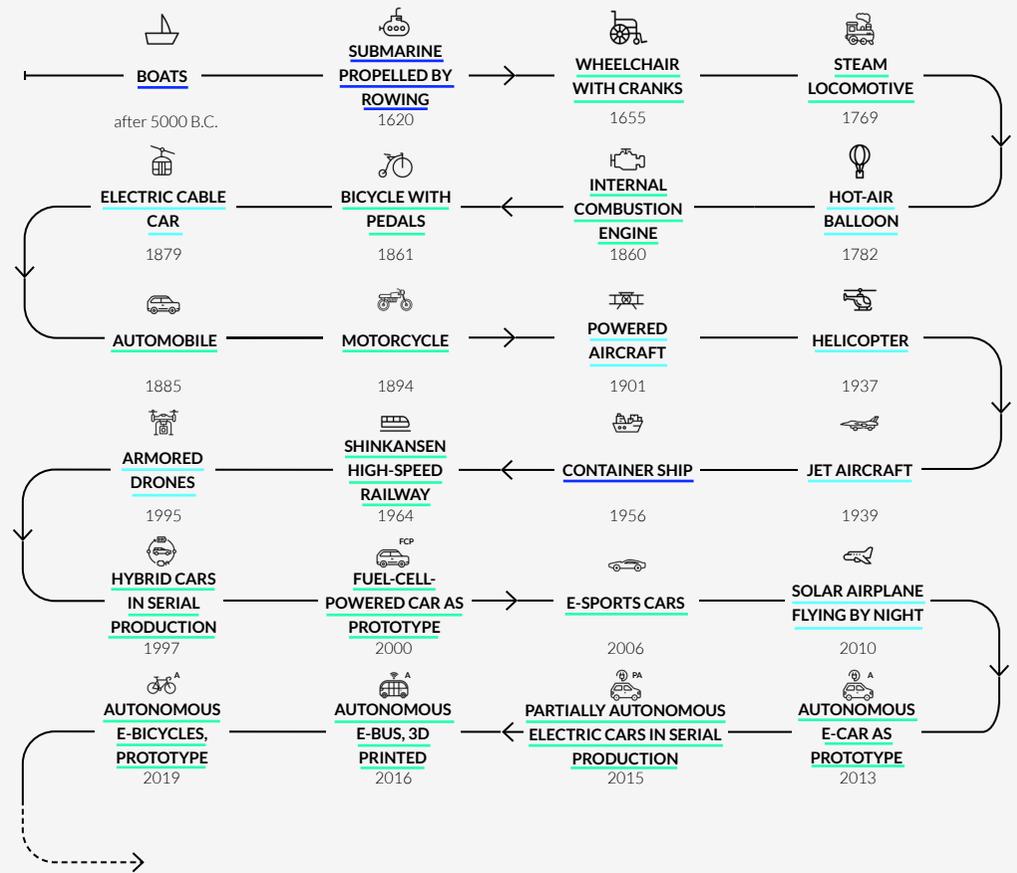
last 10 years, international arrivals at European cities – an indicator for tourist activity – have grown by 45%. While there were 488 million arrivals in 2008, by 2018 the number had surged to 710 million.<sup>3</sup>

Active sports or walking for pleasure are other ways to experience mobility. Forty percent of Europeans exercise or play a sport at least once a week. Mostly this is done outdoors, in locations such as parks, and sometimes even combined with the commute to work (23%). Europeans exercise to improve their wellbeing, to relax or for the pure fun of it.<sup>4</sup>

Sadly, too many people do not get the chance to walk, hike or exercise at all. For them, physical mobility is a desire that can only be achieved through aids and workarounds. Eight out of 100 EU citizens experience a barrier to personal mobility.<sup>5</sup>

These four perspectives underline the vital importance of mobility and its subliminal ubiquity for every European. They sketch the multifarious angles on mobility, especially when considered from a personal level. This is a topic with myriad distinctions and delineations, and they depend heavily on personal experiences, preferences, backgrounds and regions.

## HISTORY OF MOBILITY



■ Land ■ Water ■ Air

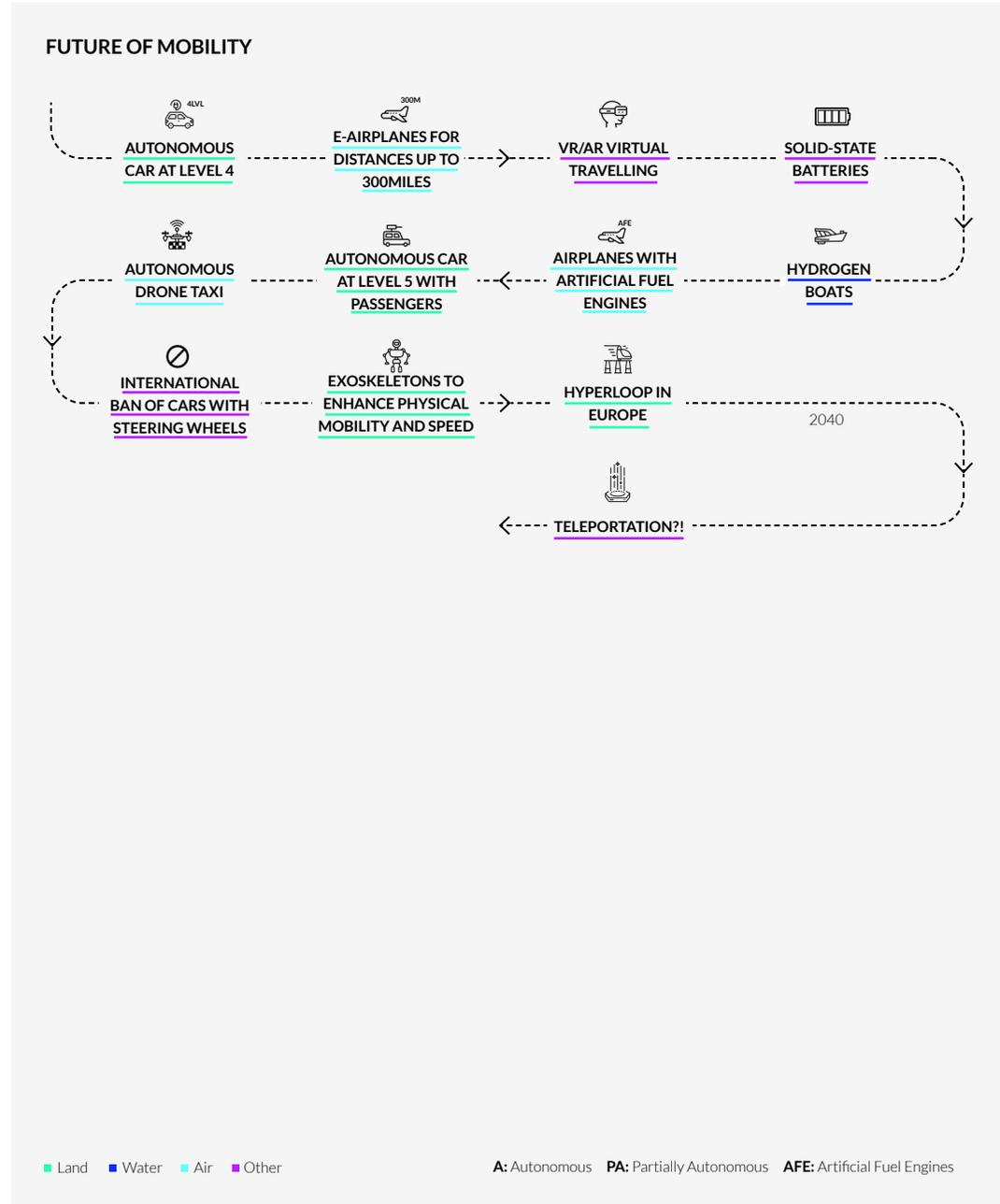
A: Autonomous PA: Partially Autonomous AFE: Artificial Fuel Engines

One universal constant, however, is the fact that mobility – and how we think about it – is always in flux. New means of transport are always being introduced, thanks to continual technological advances. From 1762, steam locomotives took passengers from A to B, while the first rideable bicycles appeared in 1861. Every new invention transforms how we as individuals think about mobility today, and what products, services and jobs are available to us. **But how will this evolve in the future?**

Society is continuously changing in ways that affect needs, desires and preferences when commuting, travelling, exercising or dealing with a disability. All in all, mobility offerings change, and so do their underlying drivers and influencers. One thing is clear: Mobility in 2040 will be different from today, and whatever is coming, the path that takes us there will not be linear.

This study, carried out in collaboration between Spark Labs and Baloise Insurance, aims to provide a glimpse of mobility in 20 years' time. The process of "foresighting," which traces how trends in society, technology, economy, the environment and European politics might evolve over the next 20 years, also offers a way to imagine how mobility will develop within society over the same period. The Trend Radar gives an overview of these trends, their importance for mobility, their likelihood of coming true and their time horizons. Technological Trends are related specifically to the trends

of the other dimensions within the chapter. Additionally, at the end of the research process, all trends were related to the European Commission's megatrends, which can be found at the end of the chapter. The report concludes with four scenarios about how four very different individuals – Roland, Nathalie, Mark and Maya – will get around in the year 2040. Their stories delimit the space in which the actual future will come to pass, and will take you on a journey to experience, at first hand, how it might be to travel in Europe 20 years from today.





# CONTENT

## 07 METHODOLOGY

- 08 Research Design
- 10 Data Collection

## 14 TREND RADAR

### 16 SOCIETAL TRENDS

- 16 Anywhere, Somewhere, X-Where
- 17 Smart Responsive City
- 17 Real and Virtual
- 17 Community Culture
- 18 Social Participation
- 18 Mind-Lifting and Post-Humanism
- 18 New Work
- 19 Simplification
- 19 Slow Culture
- 20 Sustainable Behavior
- 21 Education Revolution
- 21 Digital Reputation
- 22 Technology Fear
- 22 Health as a Status Symbol
- 23 Co-Living for the Single Society
- 23 Hyper-Personalization
- 24 Personal Cloud

### 25 TECHNOLOGICAL TRENDS

- 25 Artificial Intelligence
- 26 Autonomous Transportation
- 26 Processing Power
- 26 New Means of Mass Transportation

- 28 Decentralization
- 28 Autonomous Robotics
- 29 Power Sources and Energy Storage
- 30 Digitally Enhanced Realities
- 30 Digital Replication and Simulation
- 31 Human Enhancement
- 32 Trend Relations

### 34 ECONOMIC TRENDS

- 34 Meaningful Consumption
- 35 Rising Inequality and Extreme Markets
- 35 Localization
- 35 Sustainable Value Propositions
- 36 Convenience and Price over Sustainability
- 36 Public and Private Convergence
- 36 Emergence of Hidden Platforms
- 37 Sharing Economy
- 37 Consumption Equality
- 37 Cities and Rural Areas
- 38 Monetary Substitution
- 38 Safety Culture
- 38 Data Infrastructure and Governance
- 39 Integrated Systems
- 39 Post-Scarcity Economy

### 40 ENVIRONMENTAL TRENDS

- 40 Global Warming
- 41 Rising Sea Levels
- 41 Decarbonization
- 42 Resource Availability
- 43 Land-Use Change
- 43 Environmental Regulations

- 43 Suburbanization
- 44 Pollution
- 45 Recycling
- 45 Extreme Weather Events

### 47 POLITICAL TRENDS

- 47 E-Governance
- 47 Decentralization of Politics
- 48 Big Tech in Politics
- 48 Predictive Governance
- 48 Digital Warfare
- 49 Euro-Pessimism
- 49 Rise of Nationalist Politics
- 50 Green Wave
- 50 Migration
- 50 Emerging Technologies vs. Legislation
- 51 Separatism
- 51 Securitization
- 51 Aging Voters

- 52 Megatrends

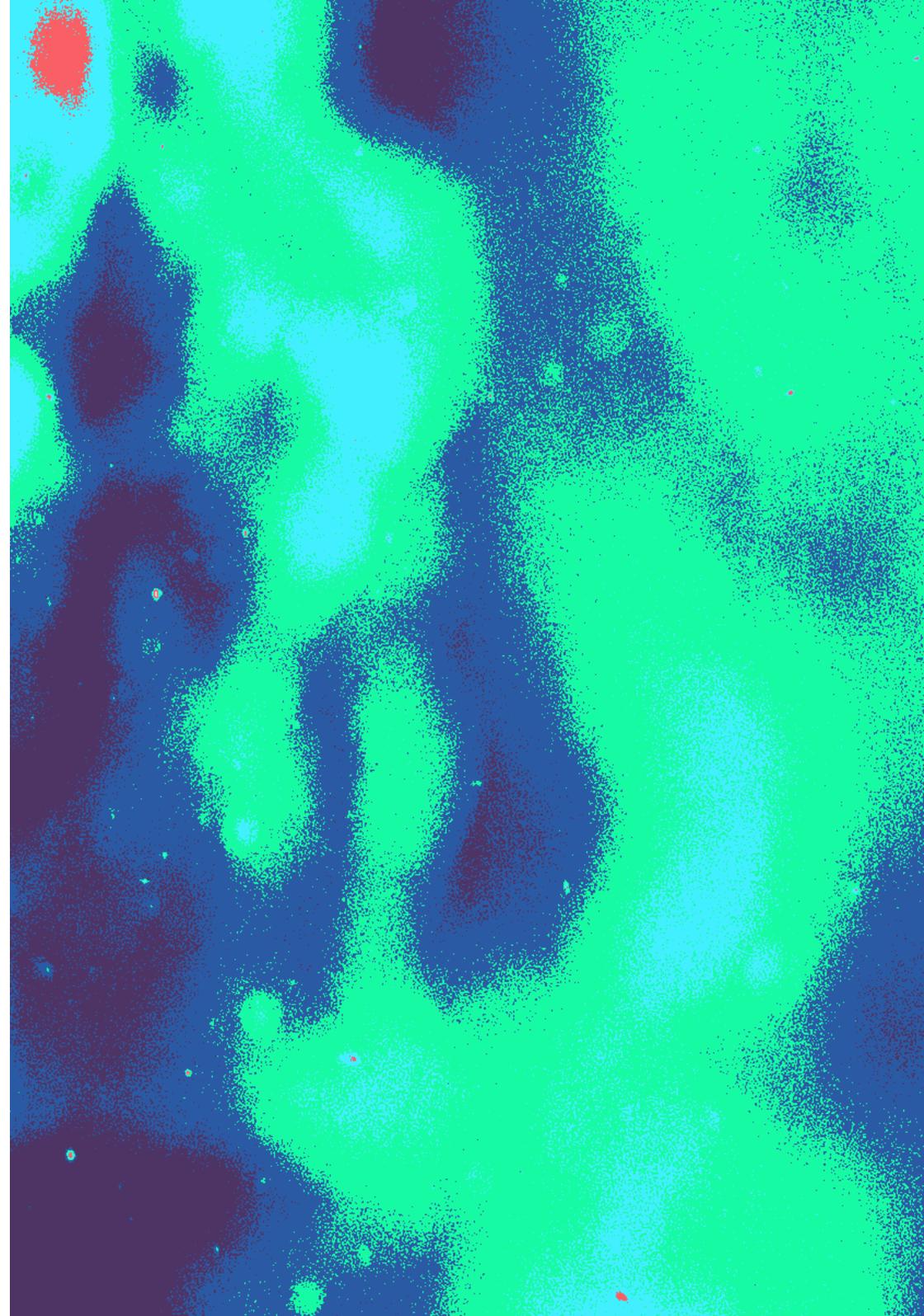
## 53 SCENARIOS

- 54 Human+
- 57 EchoTech Archipelago
- 61 Digital Venice
- 65 Swiss Flow

## 70 REFERENCES

# METHODOLOGY

Sharing methodology makes the research process transparent and explains how the results of this study came about. The approach can be divided into three phases: information collection, scenario building, and testing. Seven researchers were involved in the study, which followed a highly exploratory approach and predominantly relies on primary data obtained through in-depth, semi-structured interviews with experts and extreme users. All references can be found towards the end of this report.



# RESEARCH DESIGN

The research corresponding to this report was carried out between September and December 2019. Its focus is to explore the future of mobility for people in Europe until 2040. The research process was divided into three main temporal phases. First, evidence was collected in a highly exploratory manner from a broad range of sources, and clustered into trends. Second, scenarios were built connecting these trends in order to express uncertainty, pluralism and interactions between the trends, as well as the myriad ways they might combine. Third, trends and especially scenarios were tested and adjusted to improve their validity and quality.

Information and data were collected following the STEEP structure. This means five different perspectives were taken on the topic. How these streams relate to each other is illustrated on the following page. A team of seven researchers was tasked with focusing on Societal, Technological, Economic, Environmental or Political developments over the next 20 years. Within each of these five streams, the focus was on understanding major developments or major drivers of change, to subsequently make sense of how they will impact mobility until 2040. The main sources during data collection were in-depth, semi-structured interviews with

leading experts from universities, public institutions and corporates, as well as interviews with extreme users. Furthermore, interactive formats were used to make sense of the gaps that emerged between the findings from experts and extreme users. More details about the different sources and formats can be found in Data Collection. Interviewees were contacted via e-mail and selected based on upfront desk research, or following a previous interview that generated insightful findings or a recommendation to consider another relevant topic. This illustrates the aforementioned highly exploratory format of this study, where paths were built and redirected along the way, rather than planned from the beginning. Most interviews were carried out by phone, although a few were also conducted face-to-face. Audio recordings and documentation of the interviews, events attended and interactive formats are available upon request.

Each of the researchers worked rather independently to avoid group-thinking. However, weekly meetings allowed for information to be exchanged, and for the research path to be adjusted based on findings from other streams and for engagement in a careful and preliminary synthesis. Overall, this allowed for an open process where infor-

mation from the entire research group could be considered without neglecting continuous exploration, which a study of such scope requires. Throughout the process, the information found was structured into trends, which represent delimited subunits of streams and a graspable entity for discussions. Based on the insights, these trends were then rated by the responsible researcher on the dimension's impact, likelihood and level of maturity. Maturity reflects when the respective trend is expected to have reached full diffusion or manifestation within society. As these ratings were carried out by one researcher, the validity of the quantifications are rather weak. In consequence, the quality could be improved by a follow-up study which involves all interviewees in the rating process.

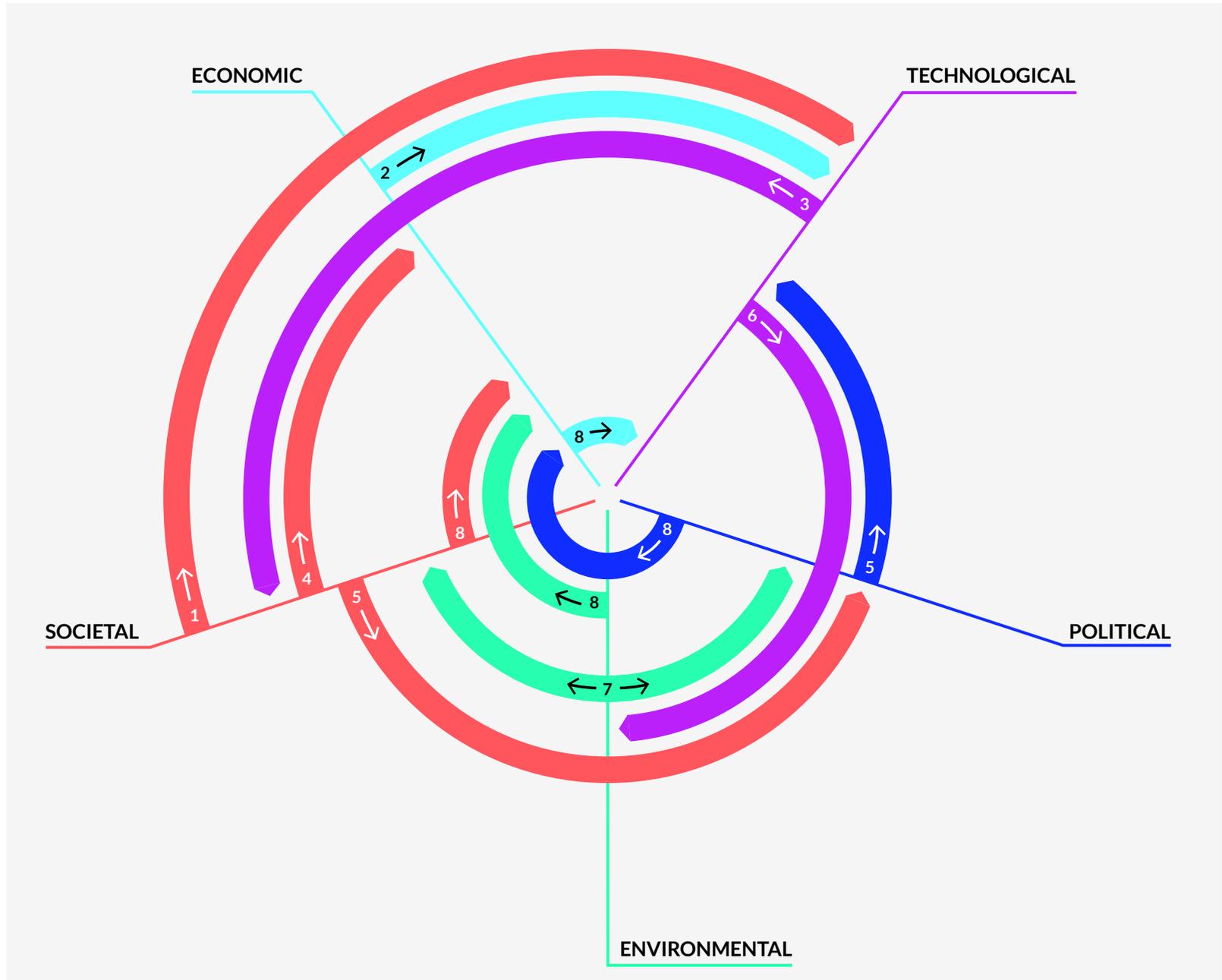
Following this, all researchers participated in a two-day synthesis workshop where all information was brought together to create a holistic understanding in respect of the scope of the research. In detail, the previously mentioned trends were clustered based on their relationships with each other, and their co-dependency was described. Moreover, they were located within an impact and likelihood matrix to get an understanding of which combination of trends will predominantly influence the future of mo-

bility. This matrix then served as a foundation to build scenarios, which aim to outline potential futures through intuitive storylines, and take account of the many ways in which the world could develop. None of these stories will transpire exactly as described. In all likelihood, nothing remotely like them will come to pass. However, in combination, they provide a space to imagine and trace the various trajectories within them. Trends with a high impact and a high likelihood are reflected in most of the scenarios, while those trends with lesser impact and likelihood are present in just one. Together, they draw a picture of the possibilities for mobility in 2040.

To strengthen validity and quality, the scenarios and trends were presented to experts and students, most of whom had not been involved during the first phase of information collection. They provided feedback and critically discussed the research outcome. Several adjustments were made after this process, and some of their reflections are presented alongside the scenarios.

For reasons of transparency and reliability, all references and figure sources can be found at the end of this report.

- 1** Curiosity and human desire for progress drive technological research.
- 2** Early funding fosters technology development.
- 3** New technology arriving as product or service on the market experiences societal selection.
- 4** Further investment appetite and subsequent growth is mediated by societal acceptance.
- 5** Impactful innovations are regulated by politics.
- 6** Adoption of products or services impacts the environment either negatively or positively.
- 7** Environmental effects influence societal and political choices.
- 8** Continuous economic decisions mediate product or service growth based on societal acceptance, political regulations and environmental impact.



# DATA COLLECTION



## EXPERTS

Seventy-six pre-selected experts from universities, public institutions and corporates around the globe have shared their knowledge and provided the foundation for the predictable development of the trends.

- **MiMi Aung**  
Expert in Extraterrestrial Autonomous Robots
- **Kay Axhausen**  
ETH Zurich  
Professor at the Institute for Transport Planning and Systems
- **Gery Balmer**  
Federal Office of Transport  
Vice-Director, Head of Policy Division
- **Carsten Beck**  
Copenhagen Institute for Futures Studies  
Director and Futurist
- **Max Bergmann**  
University of Basel  
Chair of Social Research and Methodology at the Department of Social Sciences
- **René Bohnsack**  
Smart City Innovation Lab Lisbon  
Founder and Assistant Professor
- **Ulrik Brandes**  
ETH Zurich  
Professor at the Department of Humanities, Social and Political Sciences
- **Alice Charles**  
World Economic Forum  
Project Lead, Cities, Infrastructure and Urban Services Platform
- **Chiara Cortinovia**  
Lund University  
Postdoctoral Fellow at the Centre for Environmental and Climate Research
- **Michael Cusumano**  
MIT Sloan School of Management  
Expert in Strategy and Innovation, Especially in Digital Platforms
- **Bas de Geus**  
Brussels Centre for Urban Studies  
Professor of Human Physiology
- **Claus Doll**  
Fraunhofer Institute for Systems and Innovation  
Coordinator of Business Unit Mobility
- **Yves Farge**  
Academie des technologies  
Senior Scientist
- **Markus Farner**  
Federal Office of Civil Aviation Switzerland  
Co-Leader Innovation and Digitalisation
- **Claudio Feser**  
McKinsey & Company  
Senior Advisor
- **Pieter Fourie**  
ETH Zurich  
Urban Mobility Senior Researcher and Expert in Digital Twin Simulation
- **Mickaël Gandecki**  
myfood  
Founder
- **Anja Guelpa**  
Civic Lab  
Chief Executive Officer
- **Lothar Harings**  
Kuehne + Nagel  
Member of the Board
- **Ekaterina Herzig**  
Dufry Group  
Managing Director Switzerland
- **Dmitri Hitrov**  
inlusion Inc.  
Founder
- **Volker Hoffman**  
ETH Zurich  
Professor for Sustainability and Technology
- **Patrick Hofstetter**  
WWF  
Head of Climate and Energy Policy
- **Patrick Hunger**  
CEO Saxo Bank Switzerland until March 2019
- **Stefan Innerhofer**  
VividQ  
Business Development Manager
- **Michael G Jacobides**  
London Business School  
Sir Donald Gordon Professor of Entrepreneurship and Innovation;  
Professor of Strategy and Entrepreneurship
- **Stephan Karpischek**  
Etherisc  
Founder
- **Nikolaos Kastrinos**  
European Commission  
Policy Officer
- **Alexander Klimburg**  
The Hague Centre for Strategic Studies  
Director of the Global Commission on the Stability of Cyberspace Initiative and Secretariat and Director of the Cyber Policy and Resilience Program
- **Finn Köhler**  
Space10  
Resident Learning Designer
- **Benjamin Leiding**  
University of Goettingen  
Research on Blockchain Technologies

- **Jana Lév**  
sharoo  
Head of Strategic Business Development
- **Kevin Liggieri**  
ETH Zurich  
Chair of Science Studies
- **Janina Loh**  
University of Vienna  
Research on Roboethics and Critical Posthumanism
- **Bart Los**  
University of Groningen  
Professor of the Economics of Technological Progress and Structural Change
- **Ernst Lutz**  
ESM Foundation: Research and Development Activities in the Field of Rare and Critical Elements  
Chairman of the Board
- **Cathy Macharis**  
Brussels Centre for Urban Studies  
Professor of Mobility and Logistics
- **William Maloney**  
The World Bank  
Chief Economist, Equitable Growth, Finance and Institutions
- **Anna Kathrin Meier**  
Allianz Global Corporate & Specialty  
Chief Risk Officer
- **Jürg Michel**  
PostBus  
Project Manager “Smart Shuttle”
- **Philippe Monnier**  
WayRay  
Director and Expert for True Augmented Reality
- **Monique Morrow**  
The VETRI Foundation  
Top Digital Shaper Switzerland and Top 50 Women Globally in Tech
- **Caroline Mullen**  
University of Leeds  
Senior Research Fellow at Insititute for Transport, Focus on Mobility Management and Policy
- **Karla Münzel**  
Utrecht University and TNO  
PhD Candidate and Mobility Consultant
- **Christoph Neye**  
MotionLab Berlin  
Founder
- **Alexander Nort**  
Tallinn University of Technology  
Research on Decentralization
- **Petr Novák**  
ETH Zurich  
Professor at the Department of Chemistry and Applied Biosciences and Expert for Battery Technologies
- **Guido Palazzo**  
HEC Lausanne  
Professor of Business Ethics
- **Anthony Patt**  
ETH Zurich  
Professor at the Department of Environmental Systems Science
- **Aurélie Pezous**  
CERN  
Knowledge Transfer Officer
- **Sigrid Pirkelbauer**  
Schweizerische Bundeskanzlei  
Head Mobility- and Innovationmanagement
- **Armin Reller**  
University of Augsburg  
Professor Emeritus at the Department for Materials Resource Management
- **Tobias Reusch**  
Holoeye  
Development Engineer for Microdisplay Technology
- **Marc Roland**  
FarmBot  
Director of Marketing and Sales and Reliability Engineer
- **Rolien Sandelowsky**  
Creative Activist and Philosopher
- **Murod Saymudinov**  
Swissloop  
Project Manager and Expert about Hyper Loop
- **Christian Schaffner**  
ETH Zurich  
Executive Director of the Energy Science Center
- **Michael Schetsche**  
University of Freiburg  
Research on Futurology, Xenology and Exosoziology
- **Ulrich Schimpel**  
IBM  
CTO IBM Switzerland and Expert in Blockchain Technologies
- **Gerhard Schmitt**  
ETH Singapore  
Director of Singapore-ETH Centre, Principal Investigator of Big Data Informed Urban Design and Governance Project
- **Erik Schönenberger**  
Digital Gesellschaft  
General Manager
- **Anja Schulze**  
University of Zurich  
Professor of Technology and Innovation Management
- **Tony Seba**  
RethinkX  
Expert in Technological Disruption, Serial Entrepreneur and Educator
- **Rainer Selvet**  
Wolf 3D  
Chief Technology Officer
- **James Shell**  
Expert in Space Communication
- **Roland Siegwart**  
ETH Zurich  
Professor of Autonomous Systems
- **Slavko Simic**  
DB Systel  
Consultant, Mobility Expert and Team Fermata
- **Bob Sumner**  
ETH Zurich  
Professor at Game Technology Center
- **Gladman Sydney**  
Harvard University  
Expert in Materials Science and Engineering
- **Minoru Tsuru**  
Tesla  
Senior Product Engineer for Superchargers
- **Oliver Väärtnõu**  
Cybernetica  
Chairman

- **Daniel Vogt**  
Harvard University  
Academic Fellow for Research & Technology Transfer
- **Heinz Wanner**  
University of Bern  
Professor Emeritus and Founding Director of the Oeschger Centre for Climate Change Research
- **Tara Welschinger**  
FOIFI ZeroWaste Ladencafé  
Co-Founder
- **Hans Werder**  
Avenir Mobilité  
President
- **Mehmet Fatih Yanik**  
ETH Zurich  
Professor at the Department of Information Technology and Electrical Engineering and Expert in Brain-Computer Interfaces

and countless others who have supported this research, but cannot be named.



### EXTREME USERS

Expert knowledge was complemented by insights from extreme users. They exhibit off-grid positions or behaviors today, and might act as a role model for the masses of the future. Therefore, they account for the “unknown unknowns” and take account of what we cannot see clearly today.

- **Chris**  
Founder of a micro living movement
- **Sandra**  
Sailed to COP 25
- **Alex**  
Bike activist
- **Nadine**  
Police officer in Berlin
- **Lisa**  
Promotes zero waste
- **Simon**  
Owns multiple 3D printing machines in his flat
- **Anton**  
Inventor of winter mobility solution
- **Birgit**  
Lives without a home
- **Erik**  
Lives self-sufficiently in the Emmental
- **Patrick**  
Art and culture geek
- **Joshka**  
Retired at an extremely early age
- **Louise**  
Oldest gas station carrier in Europe
- **Sandro**  
Anti-food waste campaigner
- **Bernhard**  
Hitchhiked all the way to South America
- **Eva**  
Producing all her cosmetics and laundry detergent herself
- **Kathrine**  
Author at online future magazine
- **Alice**  
Bitnation person
- **Luise**  
“Illegal” migrant
- **Fred**  
Super rich and overprotected individual
- **Lukas**  
Digital hacker
- **Jim**  
Leader of a separatist movement
- **Thomas**  
President of a young right-wing party



### EVENTS

Attending mobility-related events gave insights into expert opinions, as well as allowing observations of audience reactions towards the topic. This provided early glimpses into the development of certain trends. Furthermore, product prototypes exhibited at events cultivated hands-on understanding of certain technologies, and helped to contextualize them with related trends in order to predict diffusion.

- **Future of Mobility Summit**  
**September 5, 2019 in Berlin**  
An international meeting for mobility experts and a showroom for disruptive technological applications. Key speakers included Mars Geuze of Hyperloop, Felix Lee of EHang 116 and Sebastian Straubel of Interstellar Ventures.
- **Tour to Empa Research Center**  
**September 9, 2019 in Dübendorf**  
Empa is a Swiss Federal research institute focused on “post-fossil mobility”. The event included a presentation by Christian Bach (Head of the Automotive Power-

train Technology Laboratory) on the challenges and solutions for post-fossil mobility. This was followed by a visit to the demonstration labs to experience these new technologies.

– **Social Democracy in Europe  
September 30, 2019 in Zurich**

The Europa Institut of the University of Zurich invited Peer Steinbrück to speak on the topic of “Social Democracy in Europe”. In front of a packed lecture hall, the former German Federal Minister explored the reasons for the social democratic crisis, and reflected on possible pathways to a successful future. The majority of the audience was male, white, old and of upper-class origin.

– **Brexit: The last chapter?**

**October 8, 2019 in Lucerne**

Mr. Allioth contextualized the emergence and potential consequences of Brexit. Drawing on historical data and analyses, he explained the reasons that lead to the Brexit vote, how the popular petition changed its nature from a soft to a hard Brexit and estimated the consequences. The majority of the audience was male, white, old and of upper-class origin.

– **AWE EU 2019**

**October 17, 2019 in Munich**

This major AR/VR conference featured contributions from many companies engaged in creating and using AR/VR products, for both consumer and

corporate applications. The field research was executed by talking to various types of market actors and by evaluating the customer experience of some available products.

Other events that contributed to the research of this study included the McKinsey Quarterly Insights about Autonomous Driving on September 4, 2019, the ETH Week about Mobility from September 8 to 13, 2019, the Meeting of the Digital Society Initiative UZH “Mobility” on September 12, 2019 and the Future Cities: Actions 2019 FCL Conference on September 24, 2019 in Zurich as well as the Dialoganlass “Multimodalität – Vision und Realität” on October 17, 2019 in Biel.



**INTERACTIVE FORMATS**

Interactive workshops were set up to generate new knowledge from different sources to further broaden the discussion and take into account perspectives from beyond the mainstream. They were also held in order to synthesize information, challenge the findings and find common ground between expert and extreme user positions.

– **Children’s Future Lab**

**October 5, 2019 in Zurich**

In a society where “our children are [...] our future”, this event aimed to explore the acceptance for certain technologies and the mobility offerings of the next generation. The storytelling method was designed to provide a sneak peek into the subconscious of the younger generation and help the creation of scenarios.

This workshop provided space for 22 children from Zurich, aged 8–16, to create a Story of the Future in five mixed-age teams. Their task was to imagine one day in the life of an imaginary character in the future of 2040. Facilitators provided a

structured poster to provide a frame for the taskset. The children used Lego as prototyping material to make the story more tangible. Later on, they were asked to create a timeline of events (2020–2040) that lay behind their character’s life.

– **Expert Dinner**

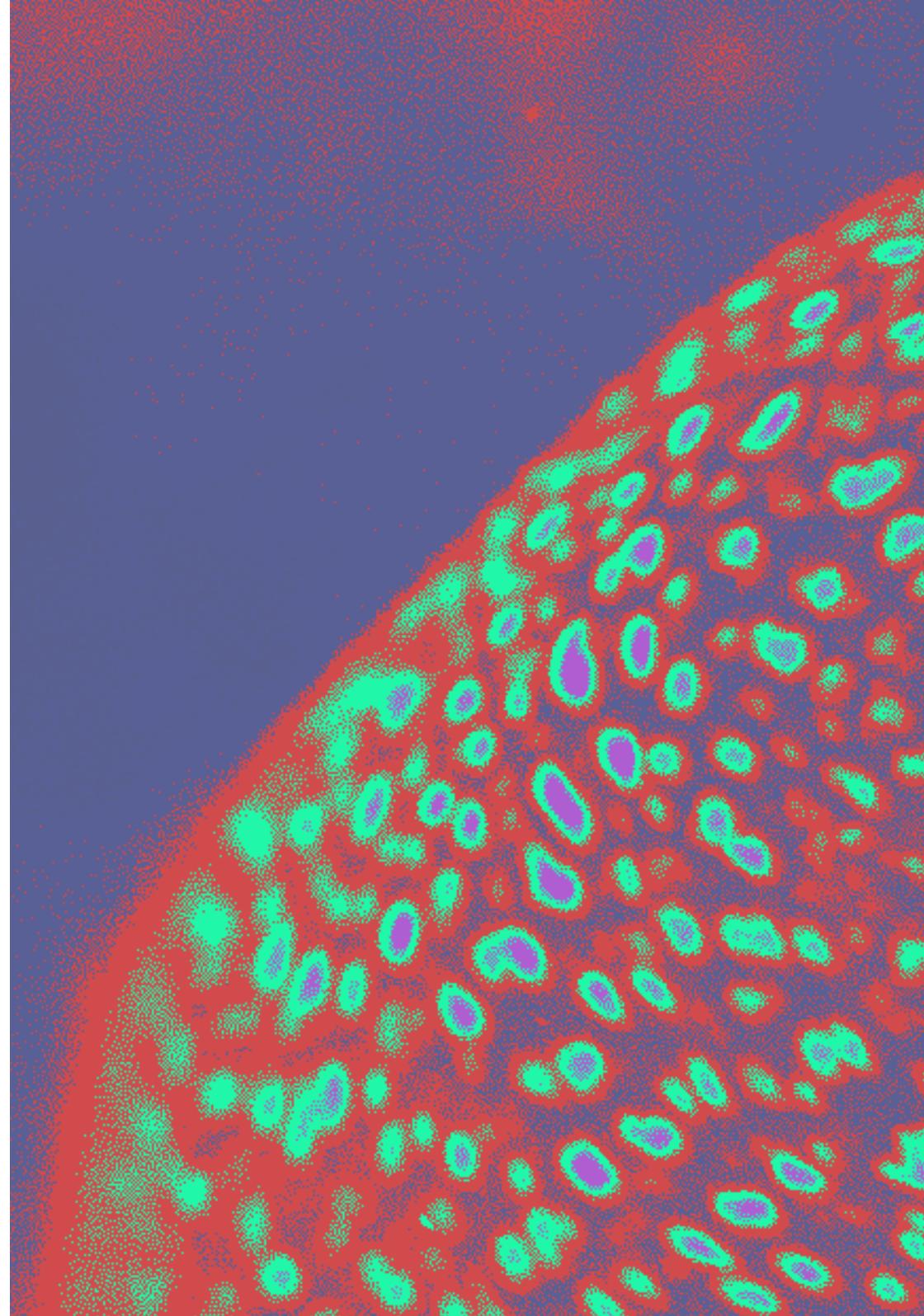
**November 4, 2019 in Zurich**

To refine and improve the quality of the final outcome, the findings from the research process and the scenarios were discussed, questioned and challenged during an expert dinner. Twelve experts from various disciplines met to discuss the preliminary findings on trends and offer their opinion on the Scenarios. First, they were divided into three sub-groups for in-depth discussions, and then gathered in a plenum to reflect on the interconnectedness of the work. The overall criteria for the evaluations were feasibility and probability.

Furthermore, a Generation Y Workshop in Zurich, a Design Thinking Workshop on October 14, 2019 at the MotionLab Berlin, and an online Art Competition were hosted to collect findings from diverse groups.

# TREND RADAR

The Trend Radar presents all 65 trends relevant for mobility, along with in-depth descriptions of each. It should help you to get a quick overview of the different drivers of change that impact the future of mobility, to guide you through the landscape of the future. The Technological Trends are followed by 10 illustrations that clarify their links to Societal, Economic, Environmental and Political Trends.





# SOCIETAL TRENDS

By 2040, there will be 525 million people living within the European Union region (including UK), with a median age of 45. The proportion of people aged 65 and older will be around 27 percent; the number of over-65s is projected to rise from 84.6 million in 2008 to 130 million in 2040.<sup>6</sup> As a result, the old-age-dependency ratio – meaning the relation between economic contributors and economic beneficiaries – is changing rapidly. The challenges arising from demographic shifts, climate change and the rise of new technologies are sure to influence everyday life of the European citizen. Societal values will evolve under the influence of technological advances – although whether these changes will enhance progressive, liberal thinking or lead to further polarization is unclear. Optimists speak of human-centered, responsive design, integrating nature-based digital systems as solutions for livable environments.<sup>7</sup> Pessimists, meanwhile, point to numerous ecological disasters, potential nuclear war and man-made virus epidemics – or argue that artificial super-intelligence has already started taking control.<sup>8</sup> Overall, the key decision-makers of the future are science and technology, politics, religion and business.<sup>9</sup>

## ANYWHERE, SOMEWHERE, X-WHERE

For some parts of society, the “home base” of the future will be everywhere. It will encompass everything that happens at the traditional dwelling and the workplace, as well as third spaces in between, such as railway stations, airports, waiting areas and retail environments. As such places become increasingly important, they will be confronted with new demands from their users. This could mean a higher level of comfort than they can offer today, or adjusted infrastructure depending on the purpose they will serve in the future. And of course, vehicles are another sort of “X-Space,” because being “on the way” to somewhere is becoming a space in its own right. This development will potentially make the mobility journey an experience in itself once more, and less of a transitional necessity when going from A to B. Thus, a vehicle could become a connected education space, a café, a bank, an insurance branch, a shopping mall or a meeting room, reducing the relevancy of any start and end point. “Gas guzzlers” will no longer be judged on their horsepower, but instead by connectivity or ecosystem power, increasing their current mobility supremacy still further.<sup>10</sup>

“At the moment, access to such a decentralized and mobile lifestyle mainly depends on profession and societal status.

It means access to information, influencers and power, and therefore determines the biographies and geographies of life for many.”<sup>11</sup> As a result, the main fault line in contemporary society is not between right and left, nor between capitalists and socialists. Rather, as David Goodhart argues in *The Road to Somewhere: The New Tribes Shaping British Politics* (which probably applies to most other European countries too), the true division is “between the people who see the world from Anywhere and the people who see it from Somewhere.”<sup>12</sup>

In Goodhart’s analysis, “Anywheres,” who represent about 25 percent of the UK’s population today, dominate British culture and society. They pass exams, do well at school, go on to a residential university, work in a major city at some stage, marry late and comprise almost all of the political, journalistic, corporate and artistic elites. They have identities that are “portable” and “achieved,” and pride themselves on being tolerant, meritocratic, egalitarian, autonomous, open to change, internationalist and individualist.<sup>12</sup>

“Somewheres,” meanwhile, who constitute about 50 percent of the UK population, “are more rooted and usually have ‘ascribed’ identities – Scottish farmer, working-class Geordie, Cornish housewife – based on

group belonging and particular places.”

It is this, rather than educational level or social class, that binds them together: they earn, live, work, and vote in widely differing ways, but they are typically more local in outlook. They are communitarian, stable, patriotic, traditional, mindful of security and tied to specific places.<sup>12</sup>

Zooming out, the future belongs to the growing group of “Glocalists,” as mobility is becoming increasingly affordable (see Consumption Equality), which blurs these current distinctions. Glocalists unite both elements at a new level of integration, combining home with an open horizon on the prosperity that has arisen in the big cities through digitalization. For example, numerous socially cohesive villages are growing within cities, in the form of co-living projects.<sup>13</sup> These are cooperative forms of housing in which the residential communities of the 70s are enjoying a renaissance.<sup>14</sup> This effect is related to the trend Real and Virtual.

In terms of mobility, this shift of power will most likely result in a new class of working nomad. These people will work in a very different place, and will have very little real attachment to their home base – if any. While this lifestyle was previously considered highly exclusive and lucrative, the Glocalists are now the new

elite, since they combine the privilege of high mobility and deep relatedness to their local community.

### SMART RESPONSIVE CITIES

In 2040, living will be smart,<sup>15</sup> so cities will need to continuously adjust to changes in their environment through sensor data and connected information systems. However, such a “technology-based Smart City is often disconnected from the citizens.”<sup>7</sup> To mitigate these effects, an urban management system shared between humans and machines, with citizens ultimately in control, will continually create touchpoints to allow discussions around these technological changes. A responsive city with “smart tools can be used to improve convenience and to support participation in the interest of society.”<sup>7</sup> In this case, “everyone will be better informed about what is happening in the city, not through a surveillance system, but through an informative system.”<sup>7</sup>

Furthermore, cities will have unique local elements – integrated, digital systems that are based in nature and rooted in the concept of Citizen Design Science (illustrated in Figure 1). “Citizen Design Science is a participatory design approach that engages citizens through online design tools in the planning process. It can be considered as a symbiosis of traditional participation in urban planning (citizen design) with modern participation methods that build a form of citizen science.”<sup>7</sup>

For mobility, a major question will be whether to “invest in new technologies

or increasing the efficiency of existing infrastructure.”<sup>7</sup> Therefore, Citizen Design Science has huge potential to fulfill the unused potential in our current system. enviroCar<sup>16</sup> is one example, using citizens, traffic planners, scientists and companies to collect and analyze vehicle information in various traffic situations, and gain insights that can support the development of sustainable traffic concepts. Other initiatives are bikeable,<sup>17</sup> bike citizen<sup>18</sup> and CitieS-Health.<sup>19</sup>



Figure 1: Citizens will engage directly and digitally in the urban planning process.

### REAL AND VIRTUAL

The online and offline worlds are slowly merging, and interconnectivity is increasing too. Using virtual reality technology or augmented reality software, the view through a mobile phone camera can be super-

imposed in real time with additional information that appears to be part of the real object.<sup>20</sup> Projects such as Google Glass give a sense of the next step: augmented reality becomes detached from the smartphone hardware.<sup>21</sup> This represents a real advance over current solutions, and will most likely lead to higher diffusion and acceptance. At the same time, companies such as Samsung, Sony, Novartis and Sensimed, as well as research centers across the globe, are working on “smart contact lenses.” Applications for these beyond the medical realm include thermal imaging, “long-distance” vision, augmented reality or controlling devices just by blinking.<sup>22</sup>

These technological advancements could lead to completely new ways of interacting with computer systems. Instead of entering inputs via buttons or keyboards, voice could become the preferred way to interact with your car or smartphone. Additionally, the use of technology that enhances the visual field will create new ways of navigating and open up new business opportunities – especially for entertainment and location-based marketing.

By 2040, “most needs will still be met physically and locally, while specific interests will be realized virtually. The importance of individual transport will therefore decline in the long term.”<sup>8</sup>

### COMMUNITY CULTURE

Lately “we’ve gone a little overboard with individualism,”<sup>23</sup> as the trends Co-Living for the Single Society and Hyper-Persona-

lization illustrate. In response, a new type of collectivism has emerged. It is characterized by situational orientation towards groups and engagement with the community, while retaining a focus on the self.<sup>24</sup> Technology has enabled new forms of situational communities, collaborations and cooperation. Therefore, “local co-working and co-learning communities”<sup>25</sup> are booming, as is the hunt for meetup events. Specialized communities such as Transition Town Totnes are focusing on strengthening the local economy, reducing environmental impact and building resilience for a short-term future in which more expensive energy and a changing climate might begin to manifest themselves.<sup>26</sup>

On the one hand, community culture is growing as an essential way to organize oneself in a new and meaningful way in a highly complex world.<sup>27</sup> On the other, in a world full of autonomous individuals, self-chosen group membership is becoming more significant for one’s own identity and way of life. Part of this collaborative lifestyle is participating in the Sharing Economy.<sup>28</sup> Since this youthful lifestyle is seen as hip and desirable,<sup>A</sup> it is likely to be picked up by older generations too. However, it does have its limits: “Sharing platforms such as Sharoo, Berlkönig or Clevershuttle will not reach the masses, since people prefer to choose how they use their personal car, or who they share a car with.”<sup>29</sup>

<sup>A</sup>A hipster is a person who follows the latest trends and fashions, especially those regarded as being outside the cultural mainstream.

On this theme, in terms of mobility, we can expect that as ownership declines, private-vehicle sharing will require complementary services that regulate access based on the owner's preferences. This could increase the importance of monetary substitution through the use of virtual currencies (e.g. a points system) and make customer ratings even more crucial for the service provider (see Digital Reputation). Furthermore, since these trends will lead to much higher car-usage rates, companies providing services such as vehicle cleaning, maintenance and refueling will grow in importance.

## SOCIAL PARTICIPATION

Social media has risen in just a few years from a marginal phenomenon to a central part of everyday life.<sup>30</sup> In the same way, focused internet communities are increasingly used in the private and public sphere to exchange information in a semistructured manner. In the future, new open and regulated networks will be established that focus primarily on tools for providing direct feedback. They will be used for purposes such as running Smart Responsive Cities, e-voting, etc. Some concrete examples of citizen science projects include birdwatch,<sup>31</sup> PatientsLikeMe<sup>32</sup> and Galaxy Zoo.<sup>33</sup> Figure 2 illustrates the rise in citizen involvement.

As outlined in the trend Anywhere, Somewhere, X-Where, "Digital technology enables citizens to contribute to and to participate in science, but also in design: design of objects, design of buildings,

design of processes. It is the first time in history that so many people are living so close together in urban systems. And as a consequence, governance systems, which were originally set up for far fewer people and far lower population density, need to evolve."<sup>7</sup>

However, "the rise of social media is accompanied by a strong tendency towards the formation of monopolies."<sup>30</sup> And "participation, especially in the online world, is often associated with an informal pressure to conform – the fear of 'dislikes.' People decide in favor of their image."<sup>34</sup> At the same time, however, the scrutiny put into evaluating opinions is declining. "The result could be that people will rashly share their

### RISE OF CITIZEN-SCIENCE PROJECTS

The SciStarter repository has been documenting the rise of citizen-science projects and events. The field is largely decentralized, and dates on this chart reflect the year in which the initiatives were added to SciStarter's records.



Figure 2: Citizens increasingly play a part in shaping their own environment.

political opinion or even vote at the bus stop, influenced by the arbitrary information and impressions impinging on them right at that moment."<sup>30</sup>

## MIND-LIFTING AND POST-HUMANISM

"Futurologists like Nick Bostrom predict that AI will soon be able to keep pace with human intelligence, a super-intelligence will eventually emerge and it could take control of Earth – resulting in the enslavement of humanity."<sup>8</sup>

To keep up in the "race" with AI, the digital offerings of the future will aim at enhancing humans' mental and emotional performance. Tech innovators want to link the brain directly to a computer so that humans merge with AI.<sup>35,36</sup> However, humanists see this as folly. "It is very naïve, how we glorify the ratio,"<sup>23</sup> and "the entire corporeality of man is not taken into account."<sup>37</sup> However, the real danger in this race is "that we lose sight of the human being."<sup>25</sup>

In 2040, the first regulatory discussions will emerge on how and where to limit cybernetic augmentation of the human body. Otherwise, if left unchecked, the trend will open up an unbridgeable divide between those who can afford to become cyborgs and those who cannot.<sup>38</sup> In terms of mobility advances, prostheses, powered wheelchairs and exoskeletons will maintain, reactivate or even improve human capabilities of movement and walking. Some disabilities might become a thing of the past. These advances in individual human mobility will lead to a more inclusive society. Furthermore, human

enhancements could potentially replace some of the currently used modes of transportation in micro-mobility. Depending on the improvement delivered in terms of speed and physical strength, it's even possible that many places will ban the use of such technologies, since they could be regarded as weapons and make people feel threatened.

## NEW WORK

Start-ups are increasingly putting established companies and industries under pressure to innovate.<sup>39</sup> The contingent workforces at such start-ups reject both the well-paid existence of an employee and the comfort zone of the welfare state, preferring to stay independent. Hence, they are becoming an increasingly important economic factor.<sup>40</sup> With their interdisciplinarity, business ideas, working style and approach to problems, contingent workers create an economic ecosystem in which an enormous amount of resources and knowledge are exchanged, because they operate in such a highly networked way.<sup>39</sup> "At least 90 percent of millennials say they would rather work at a startup than a corporate giant"<sup>41</sup> – even though many corporates adjust and slowly allow a similar work-style.

Mobility-wise, these preferences indicate a shift towards more flexible life-styles, including frequent changes of location and working from everywhere, plus high demands for accessibility, seamlessness, simplicity and speed of mobility. The underlying requirements for such behavior are described in the trend Anywhere, Somewhere, X-Where.

“Robots were originally built to make certain tasks easier for people.”<sup>42</sup> Progressive automation begs the question: Who will still have work in the future? “Why work at all? Can’t we imagine a society where people have time, based on an unconditional basic income, for instance, to do whatever they like?”<sup>42</sup> The likelihood of full automation by 2040 is small, because most of the tasks we do are still too complicated for machines. However, there is a good chance that we will have more free time to spend on leisure activities – creating a need for better options in terms of leisure mobility.<sup>43</sup> Figure 3 shows the likelihood of automation for a range of types of work.

Another important value of the future of work is collaboration. Technology is mediating new possibilities to work together in teams, faster and more intensively, on a global basis, without the need to be gathered in the same physical space.<sup>7</sup> Additionally, the uniform nine-to-five life rhythm of the industrial era, with its fixed business hours and rigid separation of work and leisure time, is giving way to a more flexible and mobile lifestyle. Accordingly, expectations of round-the-clock availability of services are rising – from shopping opportunities, whether through e-commerce or stationary retail, and mobility to permanent access to resources in the business world.<sup>44</sup>

Furthermore, work processes are increasingly being reorganized to meet changing preferences and adapt to ongoing Societal Trends. This change in the nature of work, combined with the increase of livable and affordable housing-workplaces in neighborhoods, will drastically reduce daily commuting time.<sup>7</sup> For mobility, “this structural change would ease the current rush hour problem.”<sup>45</sup> Simplified, less crowded commutes will increase people’s acceptance of flexible work hours, and even a shift toward 24-hour work.<sup>41, 46</sup>

### SIMPLIFICATION

People increasingly prefer simplicity over any other criterion. Therefore, they tend to rely on digital assistants to optimize decisions such as choosing the best flight, food or insurance.<sup>10</sup> As assistants’ algorithms improve and their use becomes more mainstream, this reliance is likely to increase. This, in turn, will improve the market position of data aggregators such as Google, and other technological and data-driven companies too.<sup>10</sup> The trend is crucial for mobility, especially considering the rise of “mobility as a service” and the use of platforms.<sup>47</sup> The user base of any data-aggregation company provides an excellent foundation for offering mobility services and providing options such as entertainment services. Because of this reliance on data, privacy regulations in Europe will determine the structure of the mobility market in the year 2040 (see Emerging Technologies vs. Legislation).

### SLOW CULTURE

Today, professional, leisure and family life are all under considerable time pressure – and mobility is contributing to this development. “Until 5000 years ago we were nomadic hunters and gatherers; only then did we settle down. Now, since the 20th century, we have had a new incentive for mobility in the form of the car, which stimulated a completely new behavior: Suddenly it seemed desirable to move continuously from A to B.”<sup>8</sup>

Beyond a certain point, great flexibility and speed are no longer perceived as a benefit, but rather as a burden.<sup>23</sup> In response, people turn towards a more mindful life. Mindfulness is the countertrend to permanent stimulus overload, media-driven excitement and mounting demands on our cognitive resources. “More and more often we question the way we deal with ourselves and the world. Mindfulness arises when you let go and take a few steps back to observe yourself and the world.”<sup>23</sup> This is why more and more people in our hyper-mobile society are looking for ways to slow down, not speed up. “Standstill is becoming a luxury.”<sup>23</sup> On the flip side, however, reducing time spent travelling to work is paramount – especially for commuters. “In 2040 the reason for travelling will change, and we will not commute to work, but instead travel for pleasure. We are wasting too much time on lonely journeys for work purposes.”<sup>45</sup>

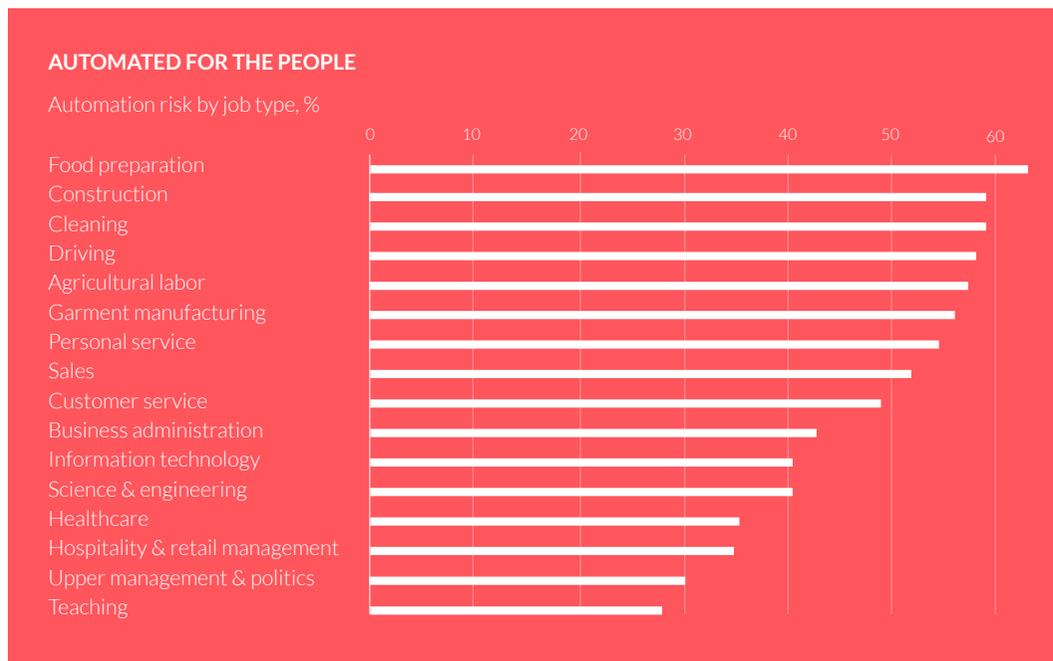


Figure 3: Jobs in food preparation, construction and cleaning are most vulnerable to automation.

## SUSTAINABLE BEHAVIOR

Sustainability has moved center-stage in today's society. It cuts across multiple areas, from renewable energy, organic food consumption and waste reduction to alternative modes of travel and environmentally friendly mobility. More and more consumers, including "young and old, women as well as men, singles, couples and families"<sup>48</sup> are opting for "good" brands – that is, those that are ethical, environmentally conscious and "purposeful." People consciously choose companies that offer not just a product, but a promise to contribute to the lives of customers, employees and society as a whole. However, whether this will result in long-lasting effects is questionable. "Fridays for Future," and similar movements that promote a more sustainable society, have only a limited influence on personal and political decisions.

In terms of energy, the sustainable society's position is very straightforward. In addition to simply saving energy, the focus is on switching to renewable energy sources, intelligent energy storage and higher energy efficiency.

However, when it comes to the consumption of sustainable products and waste reduction, the sustainability trend is less obvious. Organic food, clothing and cosmetics, and the use of recycled materials to produce furniture, continue to increase. Occasionally, this even leads to polarization, as eating habits become the expression of a lifestyle – for better or worse. What is eaten, or not eaten, is a new status symbol

for many, and organic consumption is connected with higher status.

This trend is accelerated by more and more people adopting "extreme" lifestyles, and setting examples that others may follow. "Another important driver for my veganism was actually the influence of a former work colleague who was vegan before me. My extreme behavior was also shaped through new interactions with people sharing the same mindset but practicing it more seriously [...]"<sup>49</sup>

At the same time, these actions sit alongside contrasting behavior on a societal level. Take-away and home-delivery catering are booming, while "recycling and zero waste initiatives increase."<sup>50</sup> "The consumer group agrees that society has to change towards waste reduction in everyday life, using organic food of which one knows the origin, as well as the desire to shop in the neighborhood and shop at a slower pace."<sup>51</sup> Figure 4 shows how the demands for transparency in food produce, and production methods, are growing.

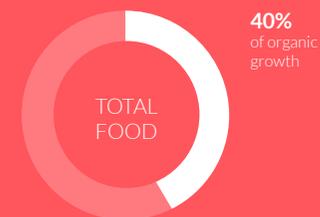
Furthermore, sufficiency is on the increase. This behavioral trend is described by Manfred Linz as "a way of life and economy that puts an end to the excessive consumption of goods and thus materials and energy [...]"<sup>52</sup> This also includes efforts to reduce raw material use and energy consumption. However, such actions depend on deep knowledge of supply chains and material origins, which may be lacking. For example, "Switzerland's awareness of the material cycle is barely existent. Even

Switzerland's industry lacks awareness of the actual resources/rare metals processed, as they mostly assemble imported semi-finished products."<sup>53</sup>

### DEMAND FOR FOOD TRANSPARENCY

In 2018, we saw sustained consumer demand for an understanding of what's in their food and how it's produced

Fresh department organics grew dollar sales 9% in 2018, accounting for



In 2018, sustainable products accounted for



Dollar sales of gluten-free bakery products increased



Contradictory trends have also been identified in relation to travel. Visiting destinations far from Europe is trending. In response, "flight shaming" is gaining traction,<sup>54</sup> while others argue for the "right to fly."<sup>23</sup> Environmentally friendly societal behavior and attitudes, also described as "neo-ecologism,"<sup>55</sup> increasingly encompass much more than nature conservation or opposition to large-scale industry. This can lead to substantial changes in values and behavior, e.g. in regard to modes and manner of travel. "For me, travelling is not about the destination, it's all about the journey. Therefore, I prefer slower means of transportation, as you perceive the journey differently and it feels enriching."<sup>26</sup>

In the context of mobility, people want to project an image of green living, and therefore report that they mainly travel by bicycle. Objective measures, however, suggest that the car is used much more often.<sup>78</sup> It seems that the social and personal effort required to make such a profound lifestyle change is just too high.<sup>56</sup> "I therefore think that the actors will sooner or later end up either in resignation or radicalization."<sup>78</sup>

People have a willingness and desire to live more sustainably at low personal cost. Indeed, as Figure 5 shows, more and more people are willing to incur some extra cost for a socially responsible option. If society picks up on this need, and caters to it with alternative mobility solutions, political and financial incentives and equal rights and responsibilities among all road users, this could enable the change to a post-fossil-fuel,

Figure 4: Consumers want transparency about their groceries' origins.

post-carbon society.<sup>29</sup> Accordingly, in looking forward to 2040, society should aim for “a city toll, no free parking, parking requirements for bikes, no combustion motors in the city, dedicated lanes for alternative mobility (anything but cars), and more and better public transport. Owning a car will, at least in the bigger cities, be irrelevant. It would no longer be attractive, due to all the additional costs that would

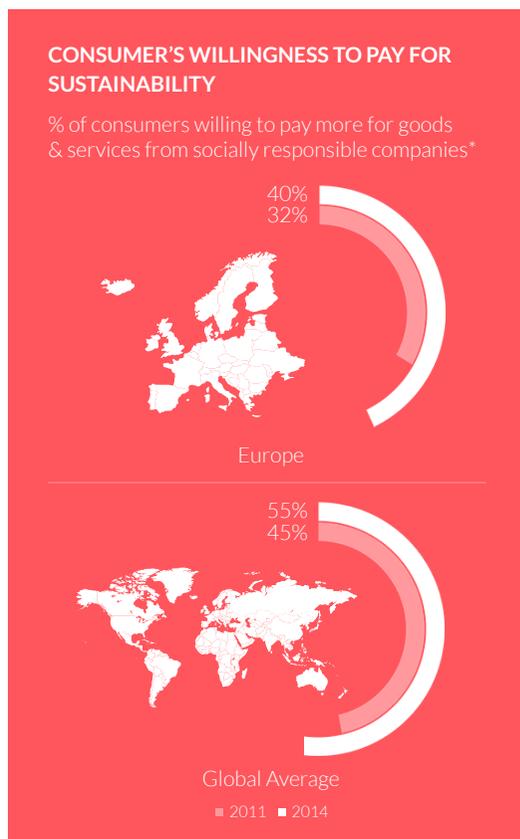


Figure 5: Europeans are increasingly willing to pay for sustainability.

emerge. Further, there would be too many alternatives that serve their needs much better.”<sup>29</sup>

In terms of products and services, the importance of mobility will lead to more durable products, with the option to upgrade parts of the vehicle – including its software – over a lifetime of many years.

Another driver currently influencing consumer behavior is the Greta Thunberg movement. This is making more and more people concerned about the climate, pushing their behavior and consumption patterns more towards sustainability. During the global strikes of 20–27 September 2019, a record 7.6 million people took to the streets to strike for climate action – the biggest climate mobilization in history.<sup>57</sup> However, it is debatable whether this is a truly long-lasting change (since there have been similar “waves” before), and whether people are really willing to fundamentally change their own behavior. “The current sustainability trend will slow down at some point, but waves such as the ‘Greta effect’ are still highly valuable for the environmental politics, especially in relation to new legislation that then reflects positively on the environment at a later stage. Furthermore, behavioral changes are extremely hard to predict. In general humans are rather lethargic and status-quo orientated. However, technological innovations such as the smartphone can highly influence behaviors.”<sup>58</sup>

Rethinking and changing public behavior is more difficult than just adapting new technologies. This is aptly illustrated by the

rebound effect<sup>59</sup>, which shows that the anticipated savings potential of efficiency increases is not always realized. For example, a car that is less of a gas guzzler leads to lower per-mile fuel costs, and this usually influences driving behavior: People tend to use their car more often, drive further and use public transport or bicycles less than they would otherwise. Hence technically feasible efficiency optimization is offset by more frequent or more intensive use, effectively canceling out any efficiency gains.<sup>59</sup>

## EDUCATION REVOLUTION

“We are currently growing up in an education system tailored to the Industrial Revolution. This means that we are learning repetitive tasks that will soon be automated. Thus, we must strengthen humanistic skills, such as communication and interpersonal work.”<sup>25</sup> While this point is increasingly recognized and implemented by schools in Europe, new concepts focus on access to education and self-education. What is more, “People at school will not necessarily have to be prepared for a career, but for a meaningful life”<sup>42</sup> – especially since purely factual knowledge is easily accessible nowadays. YouTube tutorials can be seen as a driver of a silent educational revolution that is taking place on screens in living rooms and offices alike.<sup>60</sup> Massive Open Online Courses (MOOC) with several thousand participants offer a virtual learning environment with curated content, reinforced by self-study and collaborative co-creation of projects. Video clips are a central element

of knowledge transfer, but more complex workshop-like formats (blogs, wikis, webinars) are also used. However, “these MOOCs are very ineffective; so far only two percent of the participants complete such a course at all. But this is also due to the current format, and we think that there is still a lot of potential here, for example with the support of VR.”<sup>25</sup> Consequently, in the future, “information will travel to us, and not we to the information.”<sup>45</sup>

Improvements in AR, VR or other digital education offerings might ultimately even result in a decrease in school commuting. At the same time, we can expect more mobility, because children will have more flexibility to learn basic content independent of a fixed schedule and focus on their individual development at the same time. They might join a range of different communities throughout the day, each requiring a change of location. Parents will most likely prefer that they use supervised modes of transportation, and the demand for mobility will increase and become less focused on rush hours.

## DIGITAL REPUTATION

Reputation has always been a form of currency. Today, how much of that currency people, companies and products can own is increasingly determined by their social networks and digital reputation. Personal digital images and “staged fictitious authenticity”<sup>30</sup> are represented by “uploading tons of photos to the Internet – a huge market, that nobody would have anticipated 20 years



Figure 6: 60 percent of adults across all age groups always trust online reviews as much as personal recommendations.

ago. The technology and infrastructure ensured that this market could develop in this way.”<sup>11</sup> This is even more applicable to the evaluation of companies and brands;<sup>61</sup> as Figure 6 shows, six out of 10 adults trust reviews posted online by strangers just as much as recommendations from people they know.

In the evolving sharing culture of mobility, personal and brand reputation is the currency – and the magic ingredient is trust. Successful platform companies use technology to build trust between strangers. And once trust and reputation are established,

consumers are willing to pay for the experience that offers them.<sup>62</sup>

For the past three years, one ETH Zurich lecturer has been asking their students each semester whether or not they use AirBnB, whether as a guest or a host. Most, if not all, reply that they do. When asked whether they trust their hosts/guests, the reply is also positive, and based on the profile and reviews available on the platform. However, when students are asked if they know or trust their neighbors – next door, or two doors down – the reply is generally muted or negative. Students are then con-

fronted with the fact that they place more trust in a person from the other side of the world based on a set of online data points and comments, than they do in someone they could engage with daily, and have no doubts over who they are. Nevertheless, for whatever reason, their response remains the same.

### TECHNOLOGY FEAR

“Society is in a constant state of alarm. It’s just one crisis after another: the EU refugee crisis, terror attacks like at Breitscheidplatz in Berlin, increasingly severe small conflicts and much more. However, while our perception plunges us into insecurity, we actually live in the safest of times. Nonetheless however, we have never striven so hard for security as we do today.”<sup>63</sup> In the digital world, developments such as trust technology, privacy by design, and data-protection-friendly technology concepts all tend to magnify this trend.

If this trend continues, by 2040, autonomous vehicles might not yet have entered cities because the risk of them being outsmarted and sabotaged is still too high. The realization of other technologies such as hyperloops could be held back in Europe due to high security requirements (given the network effects across a physically connected system). Hyperloops would also be vulnerable to terror attacks, as the hyperloop would be a high-value target with the potential for large-scale destruction, not least the generation of shockwaves if the walls of the loop should burst, as well as

the lack of plans for emergency exits. On top of all that, hyperloops would also be at risk of damage from environmental disasters such as earthquakes.<sup>64</sup>

The rising importance of security aspects will accelerate the convergence of security and technology standards worldwide (see Securitization). Furthermore, based on the evidence collected, the highest security standards will become the default in many applications, as is the case in the airline industry, and will no longer function as a strong marketing proposition (e.g. “Safest car of the year”).

### HEALTH AS A STATUS SYMBOL

Health is becoming a key future topic. In the consumer world, the megatrend has long spread not only to the food sector, but to most other everyday products. Health is becoming a new status symbol, and hence potentially lucrative for many industries. Epidemics such as mental health problems and obesity are placing an extreme burden on society and the healthcare system, and have become the leading causes of death. “Everybody is talking about the carbon problem. But nobody is talking about major issues including the mental health and obesity epidemic, cardiovascular diseases and diabetes – all related to inactivity. Trends in mobility tend towards offering greater convenience, and digital solutions increasingly dominate our lives. As a result, the strains on our bodies are driving an epidemic of depression and anxiety in society.”<sup>65</sup>

However, current developments indicate that, by 2040, cycling will be the transportation mode of choice in the decarbonized cities of the developed world – especially for parts of the society that adhere to Slow Culture and Sustainable Behavior. At the same time, the use of “healthy” modes of transportation will depend on the changing nature of work (see New Work), and whether this will lead to a decrease in mid- and long-distance commuting.

### CO-LIVING FOR THE SINGLE SOCIETY

“More and more people are consciously choosing to be single, independent and free.”<sup>66</sup> Many of them do not strive for the family ideal; even couples frequently choose to live apart. Out of 220 million homes in the European Union, 33 percent



Figure 7: Single-person households are expected to grow most strongly in Europe.

are single-person households. In Sweden, that number is over half of households (52 percent), followed by Lithuania, Denmark and Finland (see Figure 7).<sup>67</sup> However, living in single-person households comes with negative side effects: financial costs on one side, and on the other lower levels of happiness and higher levels of anxiety than those living with a partner and no children.<sup>68</sup>

“Closeness and communication have always been basic needs,”<sup>7</sup> and even single-person householders still want to experience social connectedness. Co-living, which represents one form of Community Culture, arose to meet this need. The idea came principally from young professionals and expats in cities, who may be more digitally connected yet feel lonelier than ever. What’s more, “space is becoming increasingly limited in the big cities. Further, architecture becomes flexible and mobile, and neighborhood can mean something completely new.”<sup>66</sup> From New York and London to New Delhi and Shanghai, millennials are increasingly blurring the lines between home, work and play (see Anywhere, Somewhere, X-Where). They are sharing spaces to save money and time, as well as make new friends.

Increased flexibility in terms of physical workplaces, combined with independent project work and the trend of self-employment, will result in more specialized hubs that will pool likeminded people in an ecosystem-like environment. Subsequently, this will decrease the need for mobility in terms of commuting and business trips.

### HYPER-PERSONALIZATION

Personalization is everywhere: the Starbucks cup or Coca-Cola bottle with our name on it, the personalized Spotify weekly selection, and of course targeted online advertisements. The needs, dreams, desires and thoughts of the individual customer are the new capital.<sup>69</sup> Advances in technology, data and analytics, based on the Personal Cloud, will soon allow marketers to create much more personal and “human” experiences across moments, channels and

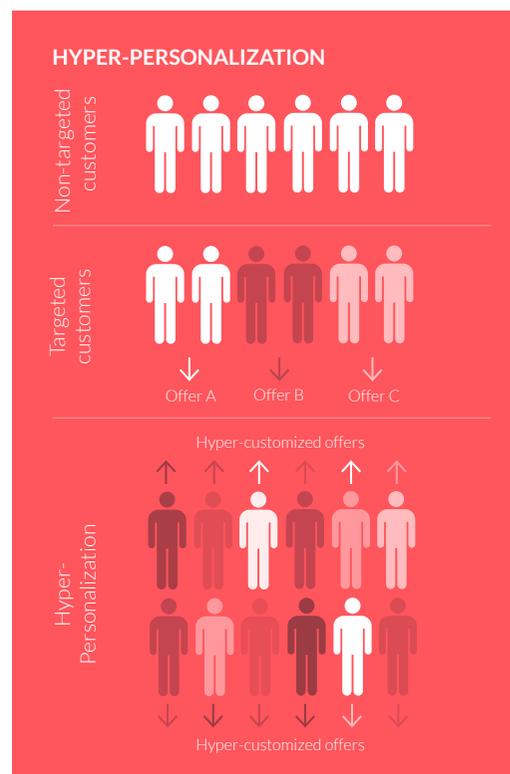


Figure 8: Hyper-personalized offerings treat every customer differently based on data from the Personal Cloud.

buying stages (see Figure 8).<sup>70</sup> Going further, we will increasingly become creative co-designers of the goods we buy – or even co-manufacturers, by purchasing software and making our own products on 3D printers.<sup>71</sup> In the food sector particularly, 3D printing unlocks new possibilities for feeding our personal needs.

Furthermore, the frontline employees of 2040 could rely on insights from advanced analytics to provide a personalized offering. Personal shoppers could use AI-enabled tools to improve service, and facial recognition, location recognition and biometric sensors might become more widely used.<sup>70</sup> Mobility will become highly personalized too:<sup>72</sup> “We have to completely rethink the car. Furthermore, vehicles such as the bus will be completely redesigned. This means that the autonomous bus could become the center of your tax consultation in the future. And all this networking could take place via it.”<sup>25</sup>

For mobility, individualization is currently limited to data, entertainment and visible customizations such as color and interior designs. But we may soon see the introduction individually designed vehicles or modular cars – especially if they allow for the sharing of unused parts, which would drastically reduce the costs of customization. Furthermore, the use of 3D printers in combination with manufacturing software would allow for individual designs that could become very effective tools for company branding, or as a lifestyle communication platform.

## PERSONAL CLOUD

People quantify themselves more than ever before – digitally recording, storing and replaying multiple aspects of their lives. For example, in 2007 a movement called Quantifiable Self was founded in San Francisco, advocating the meticulous tracking of data points such as heart rate, respiration, hours slept or even the number of sneezes and coughs during a day. The goal of the movement is for individuals to find personal meaning in their personal data. This community of curious self-trackers has grown from its origins as a Meetup Group to hundreds of groups worldwide.<sup>73</sup>

By 2040, Personal Cloud will be a natural part of the real digital personality. Figure 9 shows how data might be collected from different points around the body.

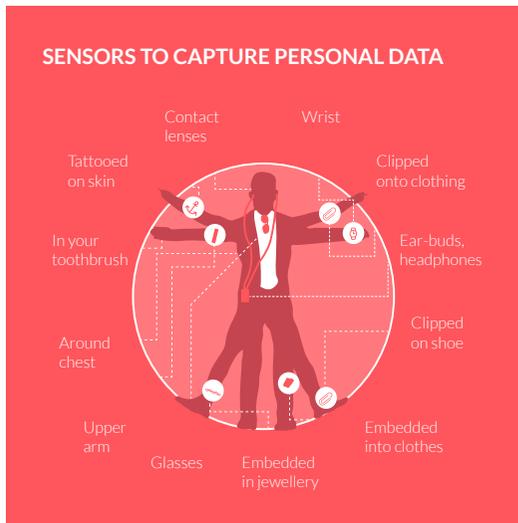


Figure 9: Wearables at different positions at the body provide data for the Personal Cloud.

It will link to the increasing convergence of Real and Virtual and influence a person's Digital Reputation.

This trend is closely linked to discussions of data sovereignty and security. One solution will be that citizens become "owners of their data."<sup>7</sup> But even when customers have ownership over their data, there remains the question of whether they know how and when to make use of it. Data literacy – that is, attaining a better understanding about the implications of personal data – will be a key priority, so that citizens can make more effective use of their data rights.<sup>10</sup> For mobility, "data is key, and sharing data between different mobility sectors is essential in the future. Predictive data, predictive maintenance and the smart combination of data help to improve services continuously."<sup>45</sup>

Who can access data, and how, will be a crucial issue for the mobility sector. It remains to be seen who will be in the best position to capture relevant data from the customer, but with the rising importance of data security and privacy protection in Europe, hardware could become much more important than software. This would improve the position of manufacturers and every company that owns a vehicle that is used in a commercial way.

# TECHNOLOGICAL TRENDS

Processing power will continue to advance through novel data architectures and progress in electronic conductivity. Quantum computing might emerge, accelerating the field of AI and expanding its capabilities immensely. Either technology type can be employed to process big data. Whatever happens, the utmost optimization of all processes and systems through digital replication, simulation and optimization will lead to enormous qualitative and quantitative efficiency improvements.

Mobility will be affected through increasingly interconnected, platform-based ecosystems. These will allow the seamless application of highly differentiated shared means of transportation based on users' requirements and preferences. Human movement will be supported by soft exosuits, enabling the elderly and disabled to regain their physical freedom. Other human-machine interfaces will support teleoperations in a wide range of applications. Advanced autonomous robots will be able to process and react to mechanical as well as tactical inputs, and will take over more and more human tasks.

Decentralization technologies will drive the disintermediation of value chains, thus creating more transparency for consumers.

AR and VR products will be available to everyone, obviating the need for computers and limiting the requirement for mobility. City dwellers will have access to a wide variety of small electric vehicles, integrated with an electric hydrogen-powered public transport system. Some cities will host a mix of individually owned older electric/fuel cars and autonomous battery-powered electric cars, while more pioneering cities will restrict access to fleets of autonomous electric cars. Due to their higher cost, autonomous air taxis will be used only on specific occasions. In the countryside, autonomous electric cars will be individually owned. While tomorrow's trains and planes will be similar to today's, by 2040 the first market use of synthetic fuel will promise to transform this industry.

## ARTIFICIAL INTELLIGENCE

It is certain that AI capabilities will advance by 2040, but whether they will improve at a linear, potential, or exponential rate is unclear. Undetermined improvements in processing power such as quantum computing might drastically accelerate capability growth.<sup>74,75</sup> However, whether and when human-level AI might arrive is highly speculative<sup>1</sup> (see Figure 10) and contested by experts.<sup>74,76-78</sup> Some argue that "it is certain that we will develop an AI that is smarter than humans"<sup>74</sup> by 2040. Others counter that "in the next 10 to 20 years [AI] will not primarily be used to replace human intelligence, but rather to enrich it."<sup>74,78</sup> Furthermore, Roland Siegart doubts that AI will

ever take on human capabilities: "As complex as these systems are, they can't find creative and intuitive good solutions."<sup>78</sup> However, a controlled form of AI might support or replace human activity in specific areas.<sup>77</sup>

Advances in AI will definitely enable humans to process big data more efficiently, profoundly deepening our understanding of complex systems.<sup>77</sup> Examples can already be seen today at CERN, where AI is used to "sort, treat and understand data."<sup>75</sup> Processes and operations will be utterly optimized, allowing enormous efficiency improvements.<sup>77</sup> Based on its rapid data processing ability, AI can be applied in human interactions as a trustable entity that can "act as a moderator, checking statements and identifying blind spots."<sup>77</sup> At the same time, the adoption of AI is heavily dependent on societal and political processes. These mainly concern ethical implications, and are reflected in the trends Technology Fear and Securitization.

AI will foster the development and optimization of any and all forms of autonomous transportation. "Everything that will be automated in the future will be strongly linked to artificial intelligence."<sup>80</sup> AI will optimize the utilization of traffic infrastructure, as well as the coordination of all transportation processes.<sup>77</sup>

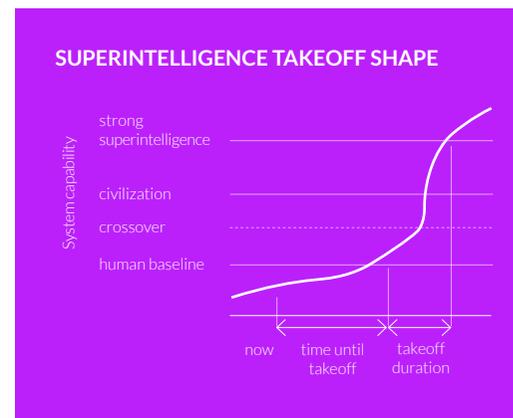


Figure 10: AI will significantly advance, but it is unclear whether it will surpass human intelligence.<sup>79</sup>

## AUTONOMOUS TRANSPORTATION

By 2040, autonomous driving will have reached higher levels, allowing for both people and goods to be transported more independently. Most individual mobility will probably be shared, and made available through platforms as on-demand services, and the first vehicles without a supervisor will go into operation.<sup>74,81,82</sup> Several experts agree that the market maturity of autonomous driving at level 4 will be accomplished within the next three to 10 years.<sup>74,80,81,83</sup> This means the driver could go to sleep and the vehicle can safely navigate by itself. However, it is still equipped with a steering wheel. At first, autonomous vehicles will be restricted to constrained environmental conditions, such as highways and company premises.<sup>76,81,84</sup> Countries will differ in terms of their level and rate of acceptance, as illustrated in Figure 11.

### LEADING COUNTRIES FOR AUTONOMOUS CAR ACCEPTANCE

1	The Netherlands
2	Norway
3	Sweden
4	Finland
5	United Kingdom
6	Germany
7	Austria
8	France
9	Spain
10	Hungary

Figure 11: Among European countries, The Netherlands is the most accepting of autonomous car.

While network effects might enable rapid market penetration of the first suppliers of autonomous driving, replacing the existing vehicle fleet will still take 10 to 20 years.<sup>74,85</sup> The development of higher-level autonomous driving is unlikely to be fostered by established car manufacturers, but rather by new market entrants backed by capital as well as the advanced computing facilities required for simulations.<sup>86</sup>

Autonomy at level 5 is possible as of today, in a controlled and previously mapped area without weather fluctuations. However, all the experts agree that market maturity at this level will take much longer than level 4.<sup>80,81</sup> Introducing higher levels of autonomy depends on the expansion of computing power, 5G networks, the improvement of the sensory perception of the environment, advancements in battery technology as well as overcoming regulatory problems.<sup>80,81,85</sup> Issues yet to be resolved include issues of retrieving sensory information in hazardous weather conditions, as well as the exposure of electric propulsion to cosmic rays.<sup>75,80</sup>

With the emergence of autonomous driving, the current two-sided platforms that provide mobility as a service will be complemented by and experience new competition from self-driving cars. Simultaneously, existing business models will be transformed, becoming either service providers or new forms of multi-sided platforms.<sup>74,77,87</sup>

One potential starting point for autonomous vehicles could be the relocation

of short-term rental cars to areas of highest demand.<sup>47</sup> Instead of transporting a passenger, they will drive themselves to wherever they are needed, increasing the utility rate of the vehicle.<sup>47</sup>

Furthermore, a variety of new business models will emerge, specifically in the area of mobility-based services.<sup>74,80</sup> It is assumed that the cost of transportation will fall sharply as automation, economies of scale and network effects increase.<sup>74</sup>

It is commonly agreed that autonomous driving will enable formerly excluded groups – such as the elderly, people with disabilities and children – to be more mobile, thus increasing the demand for mobility.<sup>74,80,85</sup> In the case where corresponding vehicles are not shared, or the appropriate regulations are not in place, vehicle density will increase, with the potential to overload the existing infrastructure.<sup>80</sup> However, such a higher density could be compensated by higher efficiency. In addition, autonomous driving can create incentives to abolish expensive housing in city centers, further adding to infrastructural congestion while increasing energy consumption.<sup>80</sup>

Finally, autonomous driving has the potential to transform the way vehicle interiors are used. Conventional seating could be replaced, turning cars into meeting rooms, hotels, restaurants, or shops. This has the potential to impact many other businesses and markets.

## PROCESSING POWER

New data architectures and lower operating temperatures can drive ongoing improvements in processing power to some extent,<sup>74</sup> but at a certain point, the continuous increase in processing power described by Moore's Law will come up against the constraint of physical limitations. It remains unclear whether quantum computing will allow this natural limit to be transcended. However, while "conventional transistors in our mobiles will not be replaced by quantum computers,"<sup>74</sup> "commercial viability of quantum computing is expected in at least a few areas [...] by the late 2020s."<sup>74</sup>

If quantum computing does resolve the current limitations of computing power, data treatment and timely management will both be improved.<sup>75,80</sup> Furthermore, smaller devices for the processing of information can be expected, enabling more wearable applications in the field of Human Enhancement<sup>88</sup> and significantly accelerating Artificial Intelligence advances.<sup>74,80</sup> In the mobility field, improvements in processing power will accelerate the market maturity of autonomous transportation to level 4.<sup>80</sup>

## NEW MEANS OF MASS TRANSPORTATION

By 2040, mobility might look very different. It might have become an interconnected ecosystem in which a customer no longer travels with a single privately owned vehicle from point A to point B, but via an on-demand service employing differentiated and shared means of transportation offered by differentiated providers on a digital platform.<sup>78,80,81,89</sup>

The development will be facilitated by Autonomous Transportation: by 2030, 95 percent of individual transportation miles will be autonomous, electric and on-demand.<sup>74</sup> Figure 12 shows how such autonomous shared transport might look.



Figure 12: These autonomous pods could be a new means of mass transportation.

There are differing views of the effect on vehicle ownership. Some believe that by 2030 “vehicles will mostly be part of a fleet and not owned individually,” and that the differentiation of mobility offers will allow vehicle ownership to be abolished.<sup>74,78</sup> At the same time, however, “there will always be groups of people who have to, or like to own their personal means of transportation.”<sup>89</sup> More radically, Axhausen points out that studies indicate no significant change in vehicle ownership caused by shared autonomous vehicles.<sup>85</sup>

The key success factor of a mobility platform is adequate demand.<sup>2</sup> Therefore, their implementation in rural areas is not seen as

profitable, and would have to be subsidized.<sup>87</sup> Current ride-sharing models employing a driver impose additional costs, creating a precarious market niche “between scheduled buses for high demand and ordinary taxis for low demand.”<sup>85</sup> Conversely, keeping shared and potentially autonomous vehicles in nearly constant employment – and, therefore, making more efficient use of them – is seen as the key to dramatically reducing ride costs, simultaneously increasing demand. New business models for autonomous vehicles such as sponsorship, mobility services and advertising could also help.<sup>74</sup>

Infrastructure utilization is expected to increase as shared and autonomous services replace journeys by public transport.<sup>3,4</sup> While ride sharing is currently offered, it is rarely used.<sup>4</sup> Additionally, new mobility services will enable formerly excluded groups to be more mobile, increasing the number of infrastructure users.<sup>4</sup> However, rail travel will not disappear. The rail system is expected to remain in place for covering larger distances, supported by on-demand mobility services.<sup>3</sup> Figure 13 shows how rail will retain its overall share of activity, even as other means of transport such as light duty vehicles (LDVs) grow in popularity.

Moreover, the widespread introduction of flying vehicles or vacuum tubes (hyperloops) to the transportation system is not expected until 2040. This is because it generally takes at least two decades for a new concept to leave the research lab and become market-ready.<sup>78,83</sup> Moreover, although flying is far more time-efficient

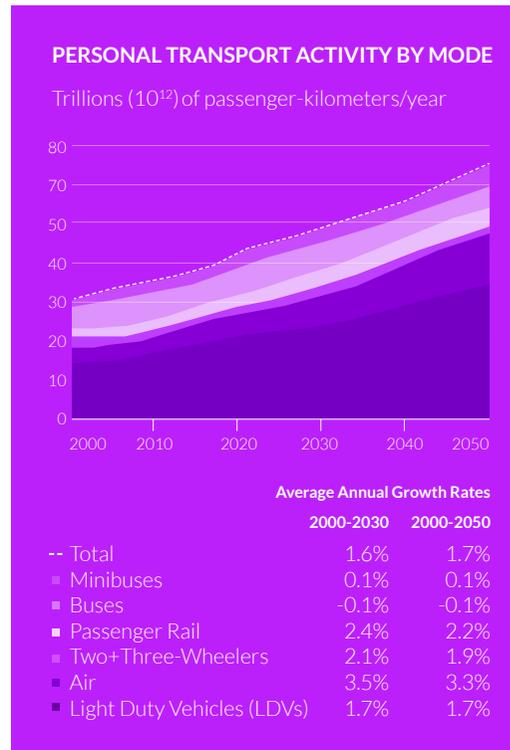


Figure 13: Passenger rail travel is expected to grow steadily, even though new modes of travel will arrive on the market.

than ground-based travel (see Figure 14), it also requires new infrastructure and imposes high energy demands, and the societal impact will be significant.<sup>78</sup> As a result, political wrangling and legislation processes will slow down the implementation of both systems.

Locomotion with rotor blades, as used by helicopters or drones, is considered highly ineffective; gliding with wings as applied in planes is more efficient.<sup>78</sup> Current battery technology, with its low capacity-to-weight ratios and high costs, also call the future ap-

plication of the technology for human transportation into question.<sup>80</sup> However, when we look case by case, flying can still be more efficient than ground-based driving – for example, in mountainous areas, where the same distance can be covered for less energy.<sup>78</sup> Also, future advances in battery technology, as outlined in Power Sources and Energy Storage, might challenge these assumptions.

Society will need regulations to integrate individual flight modes into existing aviation and safety systems.<sup>80,81,84</sup> In particular, passengers and operators will need to be identifiable, and corridors for flying will need to be defined.<sup>81,89</sup>

In general, flying vehicles are not expected to compete with land-based transportation, but rather to sit alongside existing options.<sup>80,89</sup> In consequence, currently inaccessible areas would become accessible, and the places where humans live could shift slightly.<sup>89</sup>

Implementing the hyperloop concept depends not only on regulatory changes, but also on addressing economic viability and safety concerns – as outlined earlier in Technology Fear.<sup>80,90</sup> In addition, the spatial limitations of hyperloop vessels hinder its future adaptation as a mean of mass transportation.<sup>80</sup> It will be most economically viable for current short and middle-distance flights.

While hyperloops need long distances to accelerate to travel velocity and return to rest, their maximum viable distances depend on the economic and ecological cost of a flight covering the same length.<sup>6</sup> For hyper-

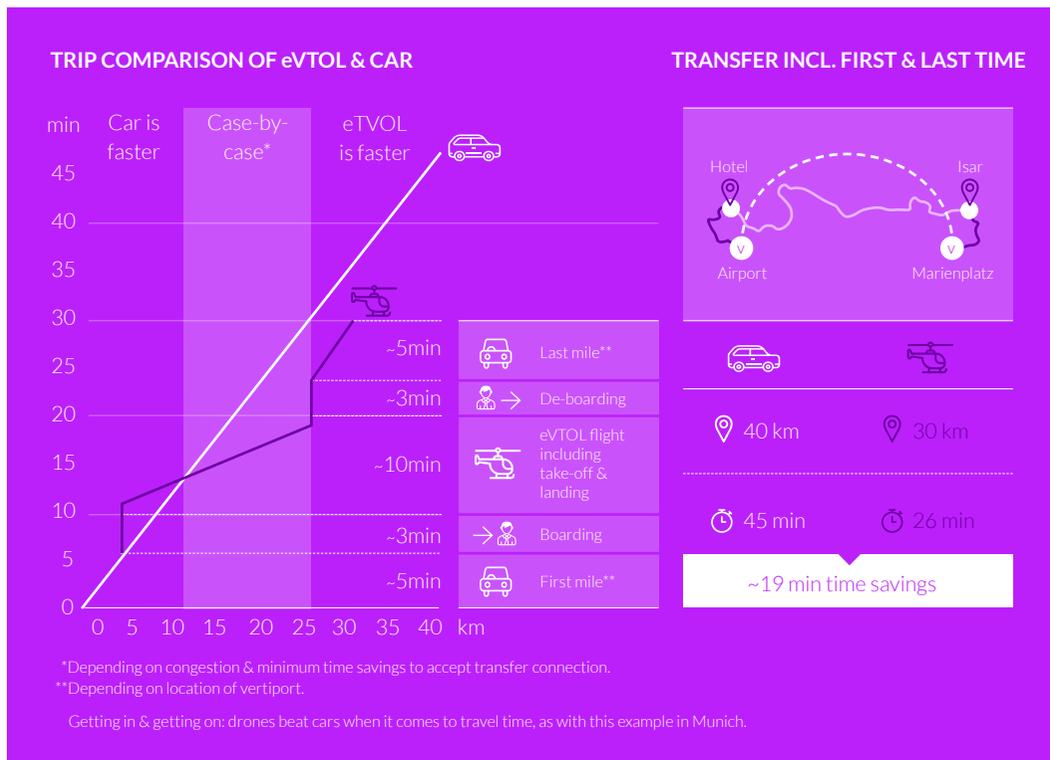


Figure 14: Comparison of flying vehicles with current car-based transport solutions.

loops, these costs consist of the energy used to build and maintain infrastructure and maintain the vacuum.<sup>90</sup>

Furthermore, the infrastructural requirements of hyperloops are immense, making them less suitable for small countries, mountainous areas (requiring the cost-intensive excavation of tunnels) or regions that already have a well-functioning railroad system.<sup>90</sup> However, large, flat territories such as the Arabian peninsula are considered feasible.<sup>83,90</sup>

Finally, the safety of hyperloop passengers in case of an emergency on board is

yet to be resolved. While acceleration and deceleration of the passenger capsule can be achieved with multiple-G forces, the human body cannot survive such force. Once the capsule had come to rest, air would have to be pumped into the corresponding tube segment, which would take a long time. Therefore, the first hyperloop applications are currently envisaged in the realm of cargo transport.<sup>90</sup>

## DECENTRALIZATION

The process of decentralization is strongly linked to Localization. This is mainly enabled by digital technologies and resulting concepts such as platforms, and is being accelerated through the growing use of new technologies such as blockchain and 3D printing. In the future, blockchain will continue to make transactions easier, efficiently mapping the diverse applications occurring in the lifecycles of ecosystems.<sup>77,80</sup> Thereby, it will allow actors within the value chain to be disintermediated, while efficiently taking care of the resulting complexity. Additionally, blockchain will support new interaction models, allowing people or entities to create new businesses in an instant.<sup>77,89</sup>

Blockchain has the huge potential to create a more equal society, where mobility could be seen as a human right.<sup>47</sup> When deployed in relation to infrastructure, blockchain would ensure that no centralized actor, whether public or private, could prevent anyone from accessing a mobility service.<sup>47</sup>

Blockchain also has enormous potential to regulate and enable smart traffic systems. It allows new incentive schemes to be tested, and could also support dynamic systems.<sup>47</sup> Prices could be optimized so that the collective has the highest utility and the lowest price, since no-one would be able to abuse the system's parameters for individual utility maximization.

Blockchain technology will improve both the privacy and security of shared autonomous vehicles, where users must identify themselves before they can use them.<sup>89</sup>

Moreover, blockchain also enables radically new insurance concepts, especially in terms of risk pooling and the nature of the insured entity. For example, instead of insuring individual drivers or cars, the route itself could be insured.<sup>47</sup> This would enable communities to insure very dangerous streets, for example, without relying on costly individual processing of cases, while drivers could feel more secure.

The 3D printing of goods will affect both industrial production and consumers, allowing customized repairs while reducing the need to buy replacements for broken products.<sup>91</sup>

Furthermore, higher market penetration can be expected, as costs for 3D printing devices are declining steadily.<sup>6</sup> We are more likely to see the decentralization of food production in suburbs or rural areas than in city centers, as urban space is limited and economic viability is yet to be proven.<sup>92</sup>

## AUTONOMOUS ROBOTICS

Autonomous systems can already precisely identify their own location, or that of other entities, by using human-like visual perception.<sup>78,93</sup> Handling the added complexity of tactile and mechanical input is severely constrained by the Processing Power so far available – but this barrier might be broken down by further developments in that field.<sup>78</sup> Meanwhile, soft sensors and soft artificial muscles are currently being developed to advance machines' "sense of touch."<sup>94</sup> Figure 15 illustrates the level of tactile interaction reached to date.



Figure 15: An autonomous robot picking up a can from a table.

Progress in robotics is unlikely to result from quantum computing: “Conventional transistors in our mobiles will not be replaced by quantum computers.”<sup>75</sup> Instead, advances in tactile interaction are the key technology of the future.<sup>78</sup> However, even technical experts hold a conservative view on the real-world employment of new robotic approaches: “The technical implementation of a new concept in the field of robotics takes about 30 years.”<sup>78</sup> Taking a different view, Vogt envisages faster employment of new technologies outside the lab: “It can vary between two and five or more years.”<sup>78</sup>

Autonomous robots are expected to operate in isolated environments within the next five to 10 years, followed by a lengthy transition phase in which autonomous systems incrementally carry out more types of human work with greater independence, while humans themselves increasingly focus on supervision.<sup>78</sup>

Despite these advances, robots will still not replace humans for many tasks. “I am therefore very skeptical that in 20 or 30 years, for example, we will have robots that can cook or iron like a human being.”<sup>78</sup>

### POWER SOURCES AND ENERGY STORAGE

When it comes to energy production, the main objective is decarbonization through the use of renewables. Currently, photovoltaic technology seems to be on course to become the main source of renewable energy in Europe.<sup>95</sup> While there is enough sun to meet society’s need for energy,<sup>95,96</sup> it is not clear how quickly countries will make the transition to renewables. Moreover, this change to renewable energy creates a new need for a smart grid to connect different regions<sup>95</sup> and raises the unsolved challenge of seasonal energy storage.<sup>95</sup> “The next breakthrough will be the advancement in the storage of energy, allowing us to store solar power.”<sup>97</sup>

The countries of Europe can be defined as machine-enabled economies that currently thrive on limited energy resources. In the 1970s, a group of researchers forecast a potential energy crisis in the period 2020–40.<sup>98</sup> Placing this in current context, Figure 16 shows projected demand for the main types of energy. A recent review of this prediction suggests that it was largely accurate for the last 50 years.<sup>99</sup> Other experts warn that systemic collapse is a certainty for the OECD.<sup>100</sup> On the opposite side, others suggest that the electrification of transport will transform the energy

sector<sup>74</sup> before resource scarcity hits.<sup>101</sup> We can assume that if the transition to renewable energy production is too slow, developed countries might face some form of systemic collapse in their fragile international supply chains between 2030 and 2035.<sup>102</sup> If any systemic issue arises, its cause would lie in the absence of relevant regulation supporting the energy transition to renewables.

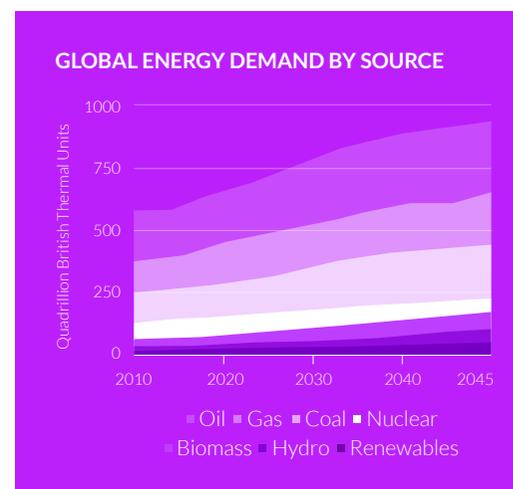


Figure 16: Global demand for renewables is expected to rise slowly.

Fusion, with its promise of unlimited power generation, could meet society’s growing need for energy. However, it remains a very improbable scenario, as it has been “20 years away for the last 60 years.”<sup>76</sup> The European Space Agency’s plan to mine helium-3 on the moon by 2025 is met with similar skepticism.<sup>97</sup>

The trend towards decarbonization also requires changes in energy-storage solutions. This is why “hydrogen and synthetic

fuel, as well as the further development of batteries and charging infrastructure, are essential points for the future of mobility.”<sup>85</sup>

Air travel could run on synthetic fuels produced from renewable energy sources, but these will not be available before 2040.<sup>95,103</sup> Sea travel is already beginning to see its first ferries powered by liquefied natural gas, and this could expand in the future.<sup>76</sup> There is consensus<sup>76,83,95,103</sup> that hydrogen will most probably only be used in long-distance trucks, public buses and heavy machinery, rather than for consumer-owned cars – mainly because of the cost of infrastructure and low efficiency.<sup>76,83,103</sup> Hydrogen infrastructure will be constructed much more quickly if it attracts subsidies, as announced recently by Japan.<sup>104</sup>

Lithium-ion battery technology will remain the main energy-storage solution for the next 20 years,<sup>105</sup> and will be used in consumer cars, air taxis and other short-range transport solutions. The increase in battery production will make electric cars cheaper than fuel cars by 2025.<sup>83</sup> The sustainability challenge of lithium batteries is already well known, and major market players such as Tesla are trying to improve the situation by limiting the presence of some rare earth elements such as cobalt.<sup>80</sup> The technology itself is not expected to change drastically. It is speculated that its energy density could eventually improve twofold, rising to (500 Wh/kg), and that charging speeds could be “achieving 80 percent of full charge in around five minutes” by 2040.<sup>105</sup>

Overall, it is safe to assume that “the comparatively slow progress in battery technology is probably the main constraint for technological development, and even more for the large-scale introduction of autonomous vehicles.”<sup>82</sup>

### DIGITALLY ENHANCED REALITIES

In the future, reality will be increasingly enhanced or replicated via digital devices and technologies such as VR, AR and holograms.<sup>77,90</sup> Future applications might include virtual working models, tele-medicine, tele-education and virtual social interaction. All will reduce the need for mobility, disrupting the way we work, socialize and learn.<sup>77,78,106</sup> However, although the need for mobility will fall, demand will still be mediated by societal adoption, which depends on multiple contingencies.

Although AR is already being applied today in specific contexts, such as scanning luggage at airports, it will come to enhance not only the working environment, but also navigation while driving, in-car entertainment, tourism, gaming, shows and events. Mainstream adoption is expected to take place over the next 10 years, and will mean particularly major changes the entertainment and infotainment concepts offered in future autonomous vehicles, in the context of a customer’s Personal Cloud.<sup>83,88,107</sup>

VR technology is advancing towards the perfect replication of reality in all five senses.<sup>83</sup> As of today, for example, a digital avatar of a physical person can be created based on selfies, enabling virtual social inter-

action. The main future application of VR within corporate environments is simulating work situations for training and improving employees’ performance, advancing operational excellence while lowering costs.<sup>83</sup> Potential applications in mobility include various entertainment and information options within autonomous vehicles.<sup>88</sup> However, expectations for VR are more modest than those for AR, since it has already been on the market for several years, in one form or another.<sup>107</sup>

Generally, simplicity of use will be the key factor for the widespread use of digitally enhanced realities.<sup>83</sup> Existing mobility solutions cannot cover everyone’s mobility needs in every respect, and future digital realities will aim to meet these needs without the need for physical travel.<sup>77,80,88,90</sup> Therefore, physical mobility could play a smaller role in the future than it does today.<sup>77,90</sup> However, since humans are social, receptive beings, virtual applications will not be able to replace physical interaction or the experience of travelling.<sup>80</sup> As a result, what we call “mobility” might change its emphasis from the need to get from A to B to a wish for physical interaction with others and the environment. Some evidence suggests that interaction via social media increases not only the number of social interactions, but also the need to meet friends in person.<sup>83</sup>

### DIGITAL REPLICATION AND SIMULATION

The real-time replication of reality with “digital twins” incorporating dynamic information and simulated agents will allow

many applications from the physical world to be optimized (see Figure 17 and Figure 18). Replication will replace current static models, which provide single and often incorrect solutions, with dynamic models that imitate the real world accurately and produce probability distributions of multiple outcomes.<sup>89</sup> “Dynamic models will be employed in the future. They [will] enable us to design cities proactively and see physical effects beforehand.”<sup>89</sup> This is especially interesting in light of the trends Smart Responsive Cities and Social Participation. Validating developed models still requires the accumulation of field data, which can be acquired by anonymized information extracted from smartphones and other sources.<sup>89,108</sup> Such an approach will rely on Data Infrastructure and Governance and could stem from the Personal Cloud.

By digitally replicating, simulating and optimizing transport systems and infrastructures, we will be able to create novel models of mobility and create tools for



Figure 17: Digital replications of the real world allow easy prototyping and testing, as well as simulations.

Social Participation, but also simulate and validate new modes of transportation.<sup>108</sup> These advances would pave the way for the optimization of mobility demand and supply in real time, and allow the further integration of different complex systems within cities, and even beyond national borders.

Opinions differ on how digital will influence the future design of cities. One view proposes a new concept of urban design where replication, simulation and optimization will be combined with autonomous transportation. A novel concept of urban planning has been digitally tested that could result in the removal of 25 percent of existing streets. “There is the concept of blocks, within which only very slow traffic would be allowed. High-speed traffic would be allowed outside of those building blocks. With this concept you would only require 75 percent of the current road space.”<sup>89</sup> Contrarily, others believe that urban design will not change with autonomous transportation: “As long as demand remains the same, the same road space will be needed for a smaller number of vehicles that will cover at least the same total number of kilometers as conventional vehicles.”<sup>85</sup>

Overall, however, the digitalization of the environment is expected to advance and improve any and all forms of transportation.<sup>80</sup> Through a simulated reality, optimal fleet sizes of shared and potentially autonomous means of transportation can be determined, virtual stations can be dimensioned and perfectly allocated, and parking areas and electric charging points ideally distributed.<sup>3</sup>

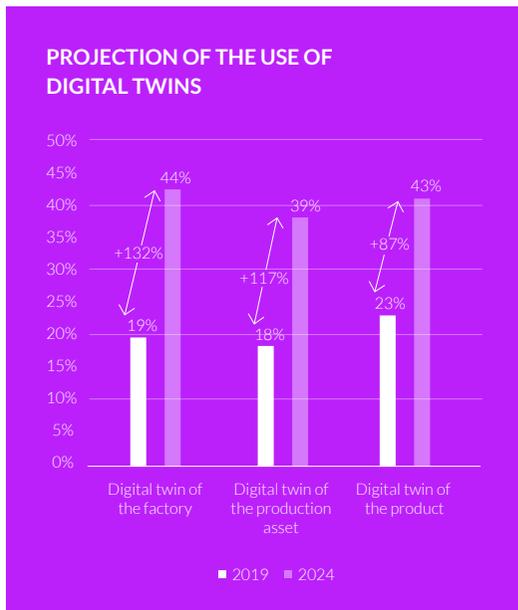


Figure 18: The “digital twin” will gain importance across a range of business fields.<sup>109</sup>

“Preliminary results from a current study show that for Singapore, 6000 to 7000 shared autonomous vehicles would be enough to cover the mobility needs of the entire population,”<sup>89</sup> says Fourie, who is already applying these technologies.

## HUMAN ENHANCEMENT

Exoskeletons augmenting human motion will become wearable robots with soft sensors and muscles. Such soft exoskeletons are far more convenient than those composed of conventional parts: “The key to making wearable technologies attractive is comfort.”<sup>94</sup> Wearable soft devices are likely to be more aesthetically pleasing too, since they “can conform well to the complexity of the human

body.”<sup>94</sup> However, handling the added complexity of tactile and mechanical input in a timely way is constrained by the available processing power, which will be improved by undetermined developments in that field (see Processing Power).<sup>78</sup> While soft robotic technologies are currently being brought from the research environment to the market,<sup>94</sup> the technical implementation of new concepts in the field of robotics is expected to take around 30 years.<sup>78</sup>

Glasses enhancing human vision with additional information in 3D are not yet ready for the mass market. They currently require large devices incorporating processing units, sensors and batteries, as well as projection technology that is presently only deployable on large transparent surfaces.<sup>88</sup> In due course, however, we can be confident that advances in processing power, energy storage and the technical principles of digitally enhanced realities will allow wearable devices for the augmentation of human visual perception. The perception of virtual reality incorporating all senses would require a direct interface between brain and computer, surpassing sensory output devices.<sup>74</sup> Foundational research is being done in this field, but nothing tangible is yet ready for use outside the lab.

Soft exoskeletons will also become novel human-machine interfaces, overcoming the limitations of conventional input devices. Furthermore, they will enable teleoperations with haptic feedback, capturing the controller’s movements and replicating them at a remote location in real time.<sup>94</sup> How-

ever, current limitations in data transmission, which mean time delays to haptic feedback, might prevent the technology from reaching market maturity in the foreseeable future.<sup>78</sup>

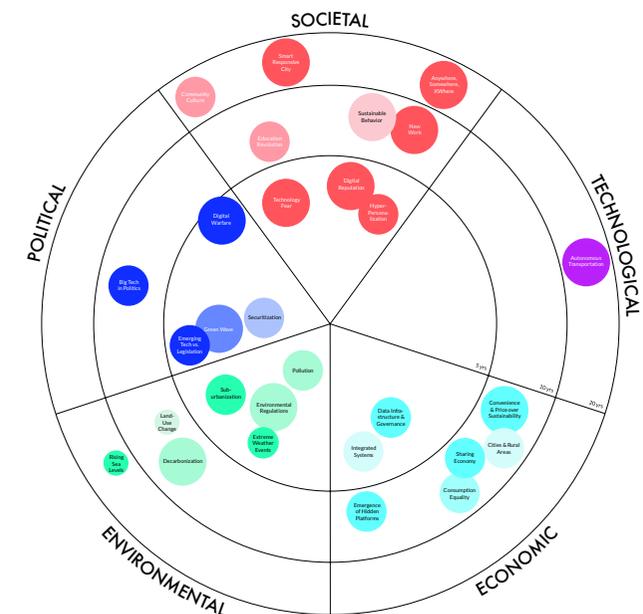
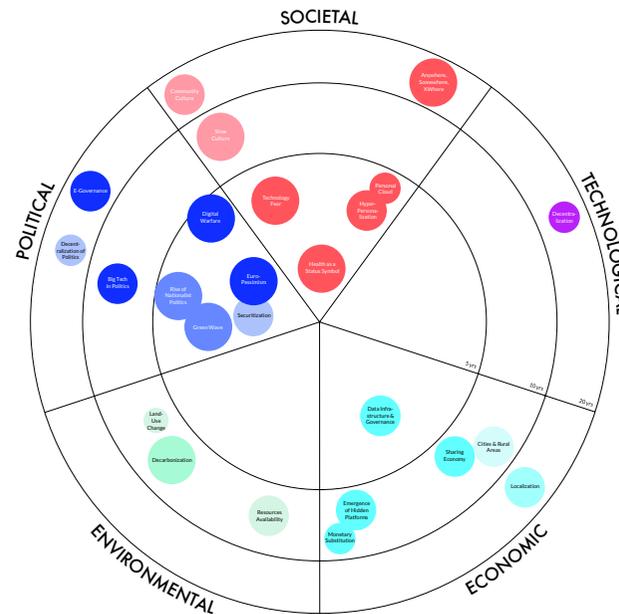
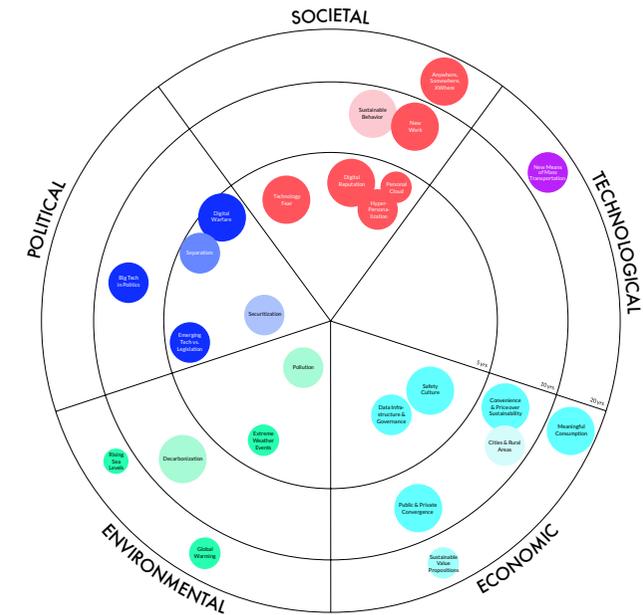
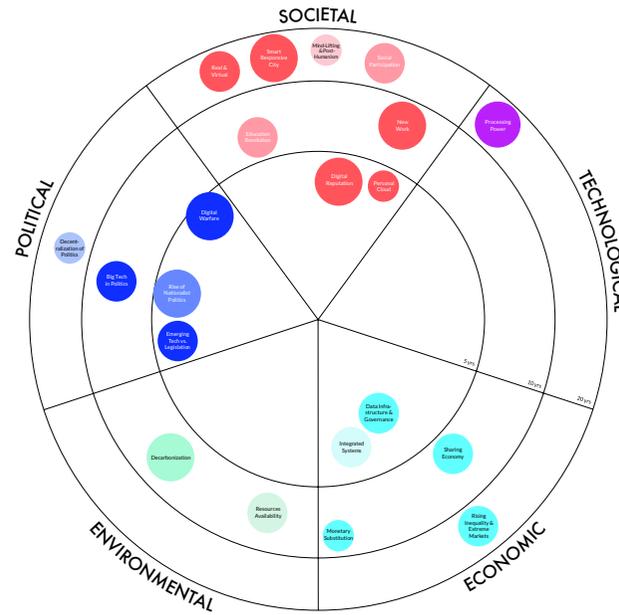
Wearable exoskeletons will enhance human movement and, therefore, active mobility modes. They will enable the physically disabled and elderly to regain mobility, and support physiotherapeutic applications (see Figure 19).<sup>80</sup>

Depending on advances in processing power and data transmission, teleoperation might significantly decrease mobility, as it would allow tasks with different purposes to be executed remotely.<sup>78,94</sup> This includes tele-surgery, or allowing experts to solve distant problems locally. A “perfect replication of all sensory impressions would [...] contribute to reducing the need for physical mobility,”<sup>77</sup> and definitely lead to ethical discussions and tensions between Emerging Technologies vs. Legislation.



Figure 19: Human enhancement will help people with injuries and even disabilities to regain their strength.

# TREND RELATIONS



The following 10 illustrations show how the various technologies are connected to Societal, Economic, Environmental and Political Trends. Each radar focuses on a single technology, or a group of technologies synthesized in a single trend, together with all other drivers of change. In most cases the trends have bidirectional effects and exhibit codependencies. Ultimately, however, they affect technological diffusion. To find out more about the specific trends and make sense of their connections, please read the trend descriptions.



# ECONOMIC TRENDS

The economy in Europe is driven by the big challenges of today: connectivity, climate change, demographics, digitalization, ecosystems, energy, resources, technological changes and the global shifts in economic and regulatory power.

The future is unknown, uncertain and, in most cases, impossible to predict with any accuracy. But we do know that the economy in Europe is changing under the influence of many global developments. Competitiveness, equality and sustainability will determine European decision-making and policy-building. The overarching theme will be ensuring that Europe remains innovative, providing accessible markets and implementing regulations that ensure growth and prosperity for future generations.

The big drivers of today will determine Europe's economic situation in the future. On the macro level, many of the established institutions, such as the nation state and central banks, are being challenged by new actors. The technological progress in digitalization is creating a major shift in the way we work, share resources and create value. The future economy will become more fragmented, and a prosperous Europe will require thoughtful, long-term policy-setting. With the rest of the world catching up

to the developed countries, Europe is well positioned to enter new markets and become a key decision-maker in global policymaking.

## MEANINGFUL CONSUMPTION

Around the world, the speed of living is accelerating. Communication, lifestyles and trends have a shorter lifespan, while the internet allows for even faster diffusion. New products are introduced to the market more quickly, and the ongoing success of services such as Amazon Prime (which delivers purchases the next day for free) reflects consumers' preference for speed.

At the same time, trends such as minimalism and the Green Wave point to a slower, more conscious and more deliberate way of consumption. This is confirmed not only by anecdotal evidence of several growing lifestyle communities<sup>110-113</sup> – such as those centered on permaculture, minimalism or extreme early retirement – but also by studies that have highlighted the negative health effects of increased hyper-connectivity.<sup>114</sup> Figure 20 illustrates smartphone owners' increasing willingness to invest in leisure and recreation.

In terms of the products we consume, there is higher turnover and more variety, but at the same time, more targeted consumption – quality over quantity. These opposing trends are illustrated by the growth of products available through online shopping and mass customization, as well as the increasing market share of organic and fair-trade products.

Based on evidence indicating the emerging trend of conscious consumption,<sup>111,112</sup> it seems likely that the current rapid product turnover will be replaced by longer-lasting products, and profits will shift even further towards service-based business models. Nevertheless, if new value is provided and access is cheap and reliable, consumers are likely to replace products more quickly, and conscious consumption will increase

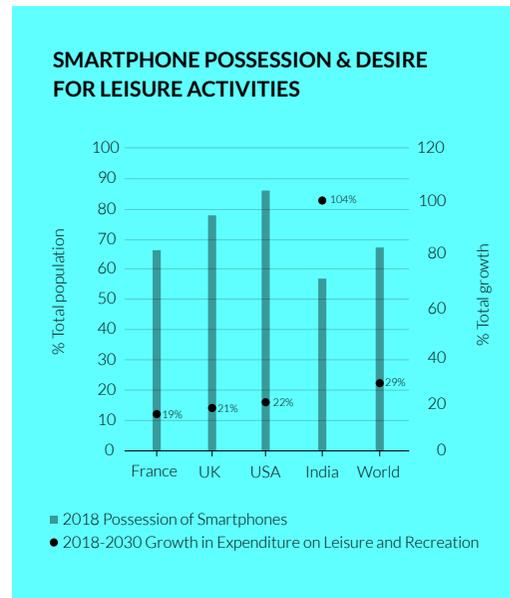


Figure 20: As smartphone possession increases, consumer expenditure on recreational and cultural services is also set to grow strongly, especially in markets where digital stress levels are highest.

only for very specific markets, such as traveling or housing. If the trend of conscious consumption does become more dominant, this will create opportunities for more human-oriented business models. These products and services could focus on personal interaction, local experience and integrity, instead of quality or price.

For mobility, the trend towards more rapid product change could increase the importance of mobility-as-a-service and modes of quasi-ownership, such as leasing. Buying an individual mode of transportation will become a highly customized and deliberate decision. This will make high-quality service and local products more viable.

## RISING INEQUALITY AND EXTREME MARKETS

The richest one percent are driving inequality.<sup>115</sup> New modes of mass transportation, such as low-cost airlines, are increasingly affordable to most of society. The demand for luxury mobility (e.g., first class seats, private jets) is growing much more slowly – at yet, the same time, the “luxurification” of society as a whole is ongoing.<sup>116</sup>

In general, we can expect that new and truly disruptive innovation will most likely emerge for the luxury market first. This was the case with the introduction of the automobile, commercial aircraft and private transportation, all of which are now accessible by most of the European population. A more recent example in mobility would be the case of Tesla, where the first model was clearly in the luxury

segment, and through a trickle-down effect, subsequent models became more affordable to a wider public.<sup>117</sup>

## LOCALIZATION

The megatrend of globalization will continue – and, according to some experts, even accelerate during the next few decades<sup>118</sup>.

At the same time, local economic activities and national value chains are growing in importance.<sup>114</sup> From a societal perspective, a new group – Glocalists – has arisen (see Anywhere, Somewhere, X-Where). This may also reflect society’s changing levels of trust: Europeans have been reported to have more than twice as much faith in regional and city governments than in national ones.<sup>119</sup> “But what’s already clear from multiple mergers around the world, whether we look at Russia, China and now Southeast Asia [where Uber has been sold to local rivals], it’s clear that the local operating model is the one that’s going to win out over the long term.”<sup>120</sup>

The move towards localization is enabled by Societal Trends such as sustainability, health, ethics and nationalism, as well as new technologies such as 3D printing, the mixing of global and local value chains (e.g., which products are truly free of non-local inputs?), resources, raw materials and branding.

In mobility generally, local products and platforms will become more relevant. Multi-national companies will adopt their products and services (see Hyper-Personalization), but they will compete in local mobility markets with publicly funded mobility providers. This

will create new business opportunities for smaller companies to either collaborate with large established players, or to find their niche within the competitive mobility markets.

## SUSTAINABLE VALUE PROPOSITIONS

As mentioned in Sustainable Behavior, the concept of sustainability is also gaining importance from an economic perspective. More recently, this seems to be related to awareness about climate change,<sup>121</sup> but also exploitative (global) value chains, animal rights, health and conscious consumption for ethical, moral or lifestyle reasons. Figure 21 illustrates some of the reasons why consumers are willing to pay a premium for a product, several of which are linked to sustainability.

The installation of more sustainable infrastructure and vehicles is expected to require massive investments – up to €1 trillion – by 2030.<sup>122</sup> including cost, social status and driving habits, although it is agreed that current and expected costs play a major role. We use a partial equilibrium model that minimizes total energy system costs to assess whether EVs can be a cost-effective option for the consumers of each EU27 member state up to 2050, focusing on the impact of different vehicle investment costs and CO<sub>2</sub> mitigation targets. We found that for an EU-wide greenhouse gas emission reduction cap of 40% and 70% by 2050 vis-à-vis 1990 emissions, battery electric vehicles



Figure 21: Sustainability is an increasing driver for paying a premium.

(BEVs it seems likely that governments will need a good strategy to incentivize this shift, since most investments will come from private sources.

In the future, product transparency and sustainability aspects will become more important. For mobility, fuel-based modes of transportation and noisy cars will have a worse public image.

**CONVENIENCE AND PRICE OVER SUSTAINABILITY**

Convenience and price are considered the most important factors in a purchase decision. In the future, depending on affordability, convenience will most likely be the main decisive factor.<sup>123, 124</sup> As Figure 22 shows, people are willing to pay more if it allows them to reclaim some leisure time – particularly if they spend most of their days at work.

At the same time, the importance of sustainability is rising (see Sustainable Value Propositions), and image will remain an important decision factor for many consumers.

The rise of convenience will depend on its affordability, and this will drive future demand for mobility, as illustrated by this statement by Australian transport researchers: “Demand for mobility grows with affordability.”<sup>125</sup>

In general, the evidence collected suggests that consumers will have more options, and hence show less loyalty, in the future. Additionally, evidence from other markets and expert predictions indicates that convenience will play a bigger role than sustainability in consumers’ buying decisions.

Although the societal trend of sustainability is more visible and expected to grow in importance and public favor, the minimum level of convenience within a product or service is expected to rise in the future. For mobility, this will increase the importance of customer-friendly user experiences and responsive support services.

**PUBLIC AND PRIVATE CONVERGENCE**

Several indicators and experts point out that large public mobility providers are diversifying and adapting in such a way that moves them closer to the solution portfolios of private providers. In other words, the differences between public and private mobility providers are decreasing. This public-private convergence is illustrated by the trend towards UN working with non-government organizations (see Figure 23).

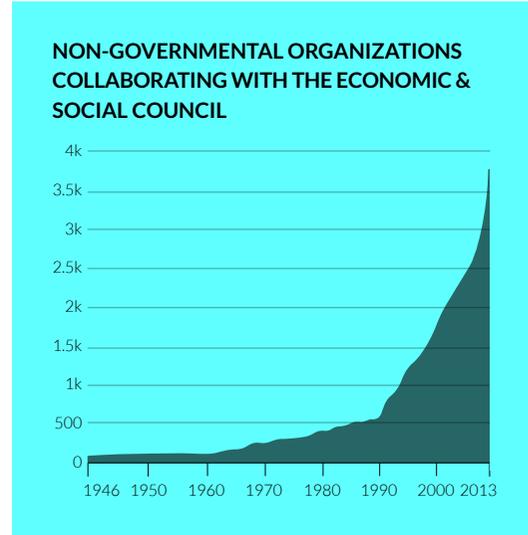


Figure 23: The increasing collaboration of the UN with non-governmental organizations reflects the convergence between the private and public sectors.

“The separation between public and private transport is going to fade away. Because today, what’s the real difference between public and private providers? Because it’s not about owning anyway, and today public transportation companies are increasingly diversifying their product and service portfolio.”<sup>126</sup>

Based on the evidence and indicators collected, it seems likely that large public mobility providers will ally with governments to sustain their market power.

**EMERGENCE OF HIDDEN PLATFORMS**

Complementary products (e.g., charging networks for electric vehicles) rely on network effects. A stable infrastructure provides market power and creates path

dependency. The widespread diffusion of charging infrastructure is a key component for customers when they are considering switching to a non-fuel-based mode of transportation (see Figure 24).

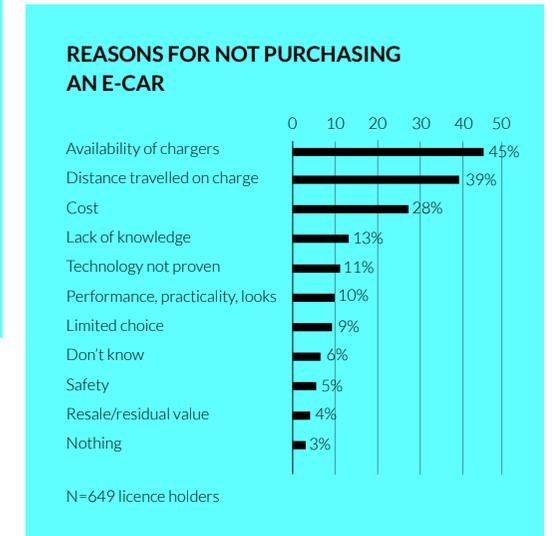


Figure 24: Hidden platforms impact the adoption of new mobility modes.

Charging stations for EVs are often private and small-scale, with different patterns of geographical coverage than gas stations. Finding the best locations and partnerships and establishing a stable network will create standards for charging that will dominate for a long time.

Governmental support for specific types of infrastructure (e.g., charging stations vs. hydrogen) is an important factor – although it’s hard for the government to predict which standard will become dominant in the future.<sup>127</sup>



Figure 22: People of employment age, in particular, are willing to spend money to save time.

## SHARING ECONOMY

The business models of providing access to goods and services in a collaborative way is giving way to a form of centralized access.<sup>126</sup> In the context of mobility, the future of the sharing economy will be increasingly professionalized. Some (e.g., Elon Musk) argue for an increase in the sharing of privately owned vehicles. Factors that make this potentially viable include the scarcity of parking spaces, the high cost of vehicle ownership, the possibility of autonomous driving and access and control/security features that replace trust and reputation.

Nevertheless, convenience and reliability are still paramount for consumers using mobility-as-a-service concepts, which makes it more likely that we will see a rise of professionalized sharing-economy business models, as opposed to consumer-to-consumer sharing of individually owned vehicles, which is mainly confined to those who are highly motivated to save money or help the environment (see Figure 25). Another possibility involves a hybrid form, where specific processes such as cleaning, charging, maintenance or service are outsourced by the private vehicle owner.

An additional impact of the sharing economy and related concepts is the increasing need to match up demand and supply. Recent examples show that car-sharing services are willing to offer significant price reductions when the user is willing to go and pick up a car from an area with low demand.<sup>10,47</sup>

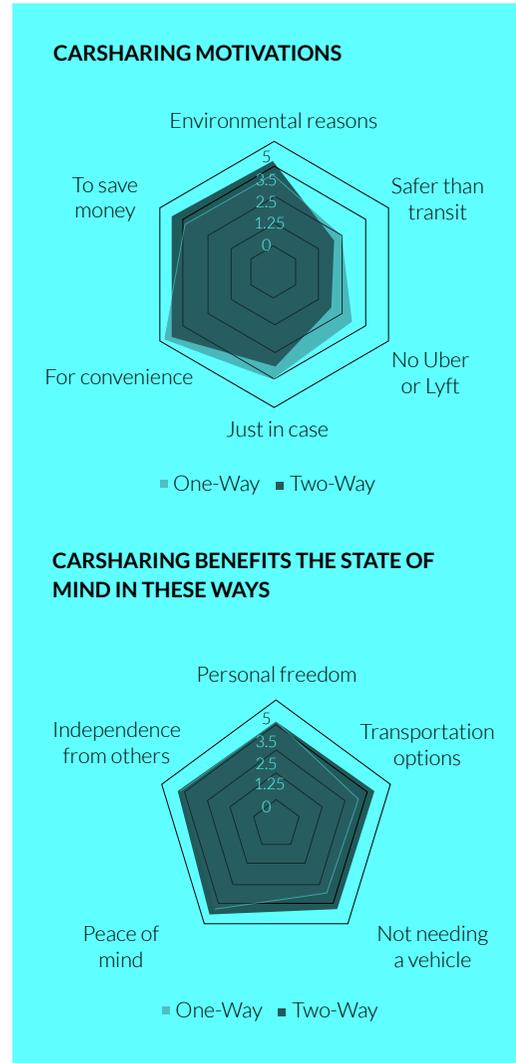


Figure 25: People share their own cars mainly in order to save money, and for environmental reasons.

A true sharing economy will emerge only in a less open social form, such as hubs and local communities.

## CONSUMPTION EQUALITY

Many services, especially entertainment, are becoming cheaper or even free.<sup>128</sup> Meanwhile, the prices of many modes of transportation are either decreasing (as for budget services like EasyJet or FlixBus<sup>129</sup>) or increasing due to regulation<sup>130</sup> (e.g., fuel-based modes).

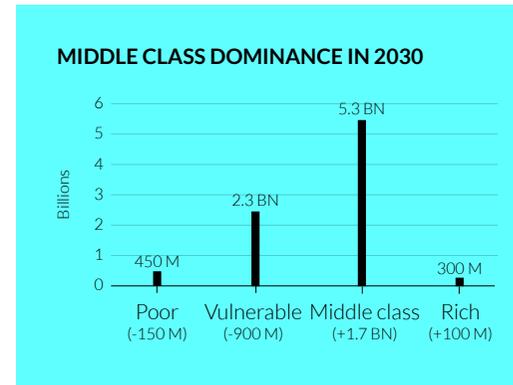


Figure 26: The middle class will dominate by 2030.

With more consumption in general, higher-income classes will demand new types of mobility for exclusivity, and they will be able to afford them – as Figure 26 shows, the middle class will become the dominant group in our society by 2030.

These in-demand services could include integrated mobility solutions like private jet chartering and new modes of transportation such as air taxis<sup>130</sup> (see, e.g., the collaboration between Boeing and Porsche<sup>131</sup>).

## CITIES AND RURAL AREAS

In the European context, the rise of megacities during the next few decades is highly unlikely. In fact, overall, it's expected that

fewer than one in 10 of the world's population will live in megacities by 2030 (see Suburbanization). Only around seven percent of the European population will live in cities of more than five million people, with most living in cities of between 100,000 and one million inhabitants. Across the Atlantic, however, about 25 percent of US citizens will live in megacities by 2030.

Along with the changing nature of work (see New Work), this also means that many people will spend a large share of their lifetime in indoor environments.<sup>114</sup> Indoor mobility will increase in importance, driven by an aging society and the rise of “local hubs.” If people are spending a lot of time in large-scale indoor environments (e.g., airports, shopping centers) there will be demand for navigation and mobility innovation within such environments.<sup>132</sup>

Urban and suburban mobility concepts are often complementary, whereas rural areas require very different concepts.<sup>87,127</sup> At the same time, they also provide opportunities for more radical solutions, since complexity is lower. Moreover, there is less need for regulation, since there are fewer diverse interests to consider and integrate.<sup>126</sup> However, providers and policymakers tend to focus on the urban outdoors in the context of mobility, with less focus on rural areas.

“If transportation is no longer an issue – for example, with autonomous vehicles – people will adapt their mobility behavior. We can expect the countryside to be even more populated if commuting is so conveni-

ent that people can basically start working [when they get into the vehicle], because they are not driving themselves.”<sup>123</sup>

Based on the evidence, rural areas are less competitive, more lightly regulated markets for mobility. With looser regulations – for example, in terms of noise pollution and the location of launch and landing pads – it seems likely that more radical mobility concepts could be integrated more quickly in these markets, stimulating innovation in less populated areas. As a result, they could improve rural areas’ quality of life and increase the demand for land in such areas.

### MONETARY SUBSTITUTION

Money is frequently being replaced by the exchange of new types of currency (e.g., likes on social media). New ways of working in this new economy include passive (e.g., providing access to your data) and quasi-passive work (e.g., watching YouTube ads). In the future, we can expect the rise of non-monetary exchange.<sup>10,133</sup> “In the year 2050 I pay via ‘silent’ processes in the background, which also include automated payments between objects, such as cars. Payment is supplemented by ‘splitting’ and ‘swapping,’ creating a new system for ‘valuation.’ Consumers create their own digital ‘currencies.’”<sup>133</sup>

The success of new currencies and the emergence of a diverse landscape of “money” will depend on the creation of business models that benefit companies, ecosystems and customers.<sup>10</sup> While the large-scale use of monetary substitution is not yet estab-

lished, we can already see a shift, and digital currencies are on the rise in many areas and industries.<sup>47</sup> Therefore, we can also expect lower importance for (fiat) money, less power for central banks and greater importance for digital platforms, consumer-to-consumer transactions and shared consumption.

### SAFETY CULTURE

Cars are becoming safer (see Figure 27) and require less maintenance, and consumers have a strong preference for safety – as described in Technology Fear. Safety influences both public image and public perception, especially in relation to new technology (e.g., accidents with Tesla’s autopilot).

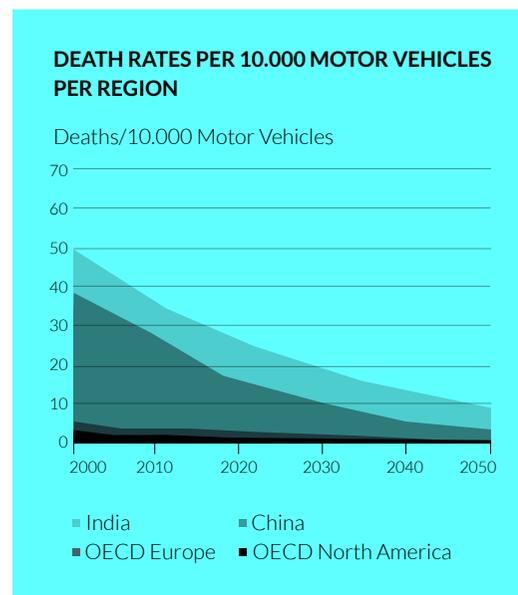


Figure 27: Motor-vehicle death rates are expected to plunge globally.

In the mobility arena, safety will come to depend mainly on IT infrastructure.<sup>134</sup> This will create a dominant position for whoever is in charge of data control and monitoring. In Europe, intelligent transport systems and traffic surveillance will figure more strongly, and governments will divide the balance of power between mobility and data providers. A relevant trend in this context is Securitization.

### DATA INFRASTRUCTURE AND GOVERNANCE

Governments providing digital infrastructure is very beneficial in terms of aggregating mobility solution providers and allocating their services to customers while ensuring safety, privacy and traffic optimization.<sup>134</sup> When we look at the advantages and disadvantages of the market monopolies or dominance of data aggregators (e.g., Google), considering network effects and the pros and cons of public data aggregation in terms of data privacy and security, the private sector does not seem the best option. Striking the right balance between network effects and market power is expected to remain a key challenge for mobility policy makers.

Stricter regulation is expected, especially related to market access and requirements (as in the airline industry), because of increased system complexity and integration. This will open the door for more local mobility providers and business models. Furthermore, the improvement of AI systems (see Artificial Intelligence) relies on access to big data. The importance of

“mobility management and governance” is also reflected in the creation of new positions – as evidenced by the city of Chicago announcing a Chief Mobility Officer.<sup>135</sup>

“The car manufacturer or the leasing companies could provide access to the car, and act as integrator, making a for-profit business model. Another option is that the government has the role of a (data) integrator for safety.”<sup>126</sup>

Based on the evidence, it seems highly likely that the aggregation, integration and sourcing of relevant mobility data will be done under the supervision of the public authority. This will ensure that all relevant data are shared by, and between, private mobility providers. Figure 28 shows some of the data points that might be involved. Additionally, the public sector is best placed to ensure data security for citizens, and this could lead to the more widespread use of concepts such as crowdsourcing by citizens. This, in turn, will improve smart traffic and other related systems.

### INTEGRATED SYSTEMS

Another increasingly important trend is the integration of multiple solutions into a single product or service, and the higher-order integration of these products and services into an ecosystem.<sup>134</sup>

Integrated solutions can take the form of multi-device integration, like Apple’s, or a meta-operating system that enables very different products and platforms to be brought together. Overall, transporting people is not a high-margin business.<sup>87,136</sup>

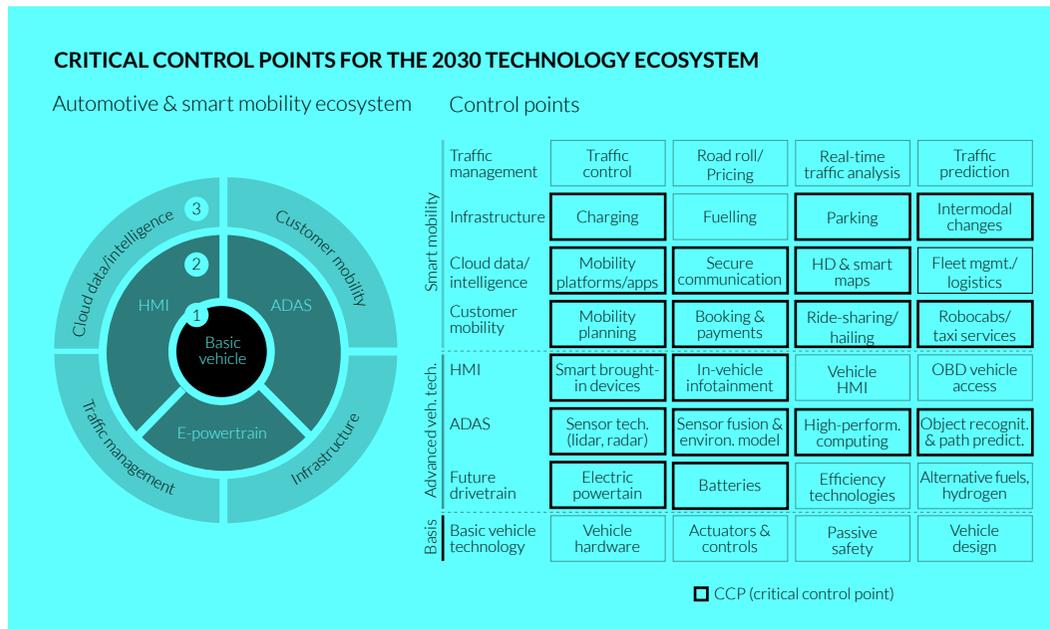


Figure 28: The mobility of the future will rely on a broad set of data points, which might be coordinated by governments.

This, combined with the attempt to deliver such services via a platform strategy, is leading to losses – as the cases of Uber and Lyft indicate.<sup>137</sup> Providing insurance in the context of mobility is scarcely any more profitable. In many markets it merely represents a way to gain access to the customer: a “loss leader” that is heavily subsidized.<sup>47</sup>

Therefore, it seems likely that future mobility providers will tend to focus on niche solutions or integrated products, since they might promise more profit than simply moving people from A to B. Additionally, the trend of large mobility OEMs to have their own captive banks, or recent developments such as Tesla’s effort to partner with an insurance company,<sup>47</sup> show that manufac-

turers increasingly choose insourcing to reduce their costs and exert more control over the ecosystem.<sup>10</sup>

In the next 10 to 20 years, it seems very likely that we will see similar patterns for mobility to those for software and IT, as several experts have pointed out.<sup>87,124,128</sup> This includes the rise of highly integrated products – such as the Apple iPhone, for example – and the growing importance of the ecosystem that is incorporated within the product.

#### POST-SCARCITY ECONOMY

Resource scarcity is not an issue for digital products, and in many cases, not even for digital storage either.<sup>128</sup> Additionally, access-

ing new resources (e.g., extraterrestrial asteroid mining) could lead to very different business models and products, and potentially shift power to the frontrunners in space exploration.<sup>138</sup>

Considering the growing affordability of goods<sup>116</sup> and changing consumer preferences in Europe, it seems likely that non-material elements of consumption such as time, service quality or image will become more important, since access to raw materials is no longer considered either an exclusivity or a major competitive advantage.

In the future, mobility providers will tend to focus more on ecosystem elements and providing solutions that lead customers to pay continuously, by creating a lock-in effect.

# ENVIRONMENTAL TRENDS

Over the last few decades, concerns about sustainability and the wellbeing of the environment have grown in Europe. From protests against nuclear energy and forest dieback in the 80s to the current climate movement across Europe, ecological considerations have been placed firmly on the agenda and will have an ever-greater impact on how decisions are made in the future, on both an individual and a societal level.

The threat of climate change, and the associated risks such as extreme weather events and rising sea levels, demand a massive change in the way we live in the western world. To achieve the political goal set in the Paris Agreement – limiting global warming to below 2°C, or even an increasingly unlikely 1.5°C, to prevent the worst effects of a warming world – every sector must be decarbonized and greenhouse gas emissions (GHG) must be reduced to net-zero as soon as possible. This requires replacing old technologies, e.g. in energy production or mobility, with sustainable alternatives, as well as changing people's behavior in areas like traveling, recycling or food choices.

There seems to be a broad societal and political consensus in Europe about the importance of sustainability, addressing climate change and preserving a healthy environment for future generations. However, we are not yet on a pathway that would allow Europe to stay true to its ecological commitments. In the near future, much will be decided by the political agendas of European countries, even though the economy seems to be moving forward ever more quickly already, and the pressures from consumers and voters are only likely to increase.

## GLOBAL WARMING

Warming of the climate system is unequivocal, and mainly driven by increasing anthropogenic greenhouse gas emissions (GHG) over the last century.<sup>139</sup> Although Earth's climate has always been changing, the speed of recent developments, especially the global average temperature increase, is unprecedented, and poses severe risks for the future, e.g. raising sea levels or increasing extreme weather events.<sup>140</sup>

Global temperatures have already increased by 0.8°C since the beginning of the 20th century, and will rise even further in the future. The exact development of the global temperature for this century is hard to predict, as it depends heavily on future global GHG emissions, and therefore on socio-economic developments and climate policy. Pathway scenarios from the Intergovernmental Panel on Climate Change (IPCC) range from a best case of sub-1.5°C warming to business-as-usual scenarios with a temperature increase of 3–5°C by the end of the century,<sup>141,142</sup> with potentially severe and irreversible consequences for natural ecosystems and the human race.

Since global averages are usually used when discussing temperature increase, it is important to remember that regional differences can be considerable. Depending on the location, beneficial effects could arise as

consequences of higher temperatures in some areas – e.g. lower demand for heating, or better conditions for agriculture.

In 2015, 195 countries signed the Paris Agreement, a global action plan to avoid the most severe consequences of climate change by keeping global warming below 2°C, and even strive for less than 1.5°C warming, setting a vision and a clear target for a climate-neutral future.<sup>143</sup> Although the agreement is supposed to be legally binding, there is no mechanism or entity to enforce commitment, so there is a risk of countries free-riding.<sup>144</sup>

Currently, the world is not on a pathway that would allow temperature increases to be kept below 2°C, and achieving the 1.5°C target gets less likely every year.<sup>145</sup> Optimistic forecasts are highly dependent on the ability to remove CO<sub>2</sub> from the atmosphere,<sup>146</sup> e.g. via forestation or direct extraction.<sup>147</sup> “We will probably be at 1.5° global warming by 2040, and then the question is whether we have the ability and willingness to pay to pull the CO<sub>2</sub> out of the air.”<sup>148</sup> Some scientists even criticize the IPCC for understating the difficulty of reaching these targets, calling them virtually impossible to achieve in the present political and economic environment.<sup>149,150</sup>

The driver for the global temperature increase is anthropogenic GHGs, especially CO<sub>2</sub>. Globally, the primary sources of GHG

emissions are electricity and heat (31 percent), transportation (15 percent), manufacturing (12 percent), agriculture (11 percent) and forestry (six percent). Energy production of all types accounts for 72 percent of all emissions.<sup>151</sup> Figure 29 shows projected potential emission reductions by 2030 across the major contributors to GHGs. In the EU, the contribution of mobility is even higher, at 30 percent.

Since the mobility sector is such a major contributor to the problem of global warming, it is likely that, if the global community wants to achieve the 2°C target, a massive transformation of the sector must take place, significantly reducing emissions from transportation by the middle of this century,<sup>148</sup> either by making current

technologies more efficient or by switching to low-carbon alternatives. Some experts think that the main point to address is a change of primary energy production: “In the perspective of climate, I don’t think we actually have to change much besides of the supply of energy, and that’s basically it for now.”<sup>148</sup>

### RISING SEA LEVELS

One of the major effects of global warming is global sea levels rising, primarily due to accelerated loss of ice from the Greenland and Antarctic ice sheets, and mass loss from other glaciers as well as ocean thermal expansion.<sup>152</sup> Sea level has already risen by 11–16cm in the 20<sup>th</sup> century<sup>153</sup> (being stable in the centuries before), and the trend is

expected to continue in the future. Since 1993, the pace of sea-level increase has doubled compared to the annual increase throughout most of the 20<sup>th</sup> century.<sup>154</sup> Even under the most optimistic assumptions in regard to future GHG emissions, most models show that it is likely that we will see an increase of another 0.5m this century (see Figure 30).<sup>155</sup>

economic loss and other societal problems along low-lying coastal areas across Europe unless additional adaptation measures are implemented.”<sup>156</sup>

So-called “nuisance flooding” – not dangerous or deadly, but still disruptive – has already increased drastically over the last 50 years,<sup>154</sup> putting safe and reliable transport at risk in urban coastal areas, and making investments into adaptation measures such as dikes necessary for the future. Without such measures, annual flooding damage in Europe is expected to increase from €1.25 billion today to €93–961 billion by the end of the century.<sup>157</sup>

For personal mobility, the reliability and safety of infrastructure will become a key value proposition for areas that are threatened by rising sea levels. This will require a combined effort from multiple actors, and has the potential to make society at large more aware of the importance of public investments. This effect of trust in government could spill over to other areas, and confer greater power on governmental institutions and public mobility providers compared to private companies in the mobility markets.

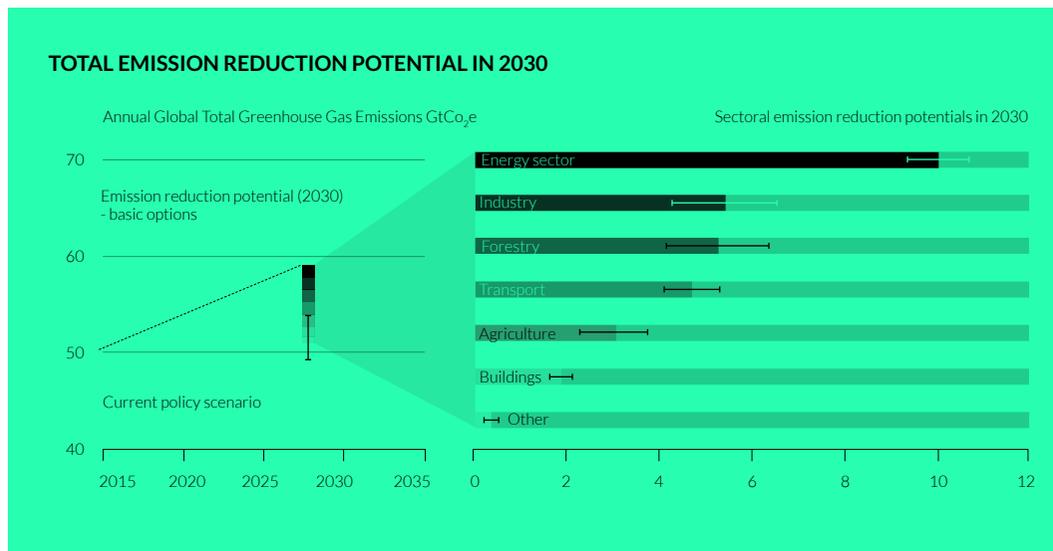


Figure 29: Since electricity and heat are the main sources for GHG emissions, the energy sector also exhibits the greatest potential for reduction by 2030. Transport ranks in fourth place.

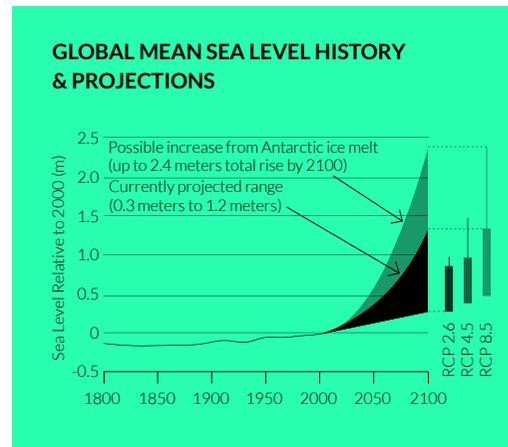


Figure 30: Historic sea-level rise reconstruction and projections to 2100 under different emission scenarios. The worst-case scenario of 2.4m increase within this century would be physically possible with major contributions from melting ice in Antarctica.

Rising sea levels particularly threaten critical urban infrastructure on the coast, from roads and bridges to oil, gas and water supplies, power plants, etc. The European Environment Agency writes that “projected sea level rise, possible changes in the frequency and intensity of storm surges, and the resulting coastal erosion are expected to cause significant ecological damage, eco-

### DECARBONIZATION

Acceptance of the climate problem is growing in science, society and increasingly politics too – following recent European and national elections (see Green Wave).<sup>158</sup> As a result, we are seeing new policies to address the main driver of the problem: anthropogenic GHG emissions.

EU member states, as a group, are one of the three largest emitters of GHG on an absolute basis (after China and the US).<sup>159</sup> By 2050 at the latest, many countries around the world, and the EU itself, are aiming to reach carbon neutrality, as their energy strategies reveal.<sup>158,159</sup> This push towards a low-carbon or carbon-free economy is requiring a decarbonization of all aspects of human life, and all sectors of the economy, from food and energy production to transport.

The extent and speed of the transition away from fossil fuels is hard to predict, since it depends on so many different factors. “I think it is very unlikely that we will reach zero emissions by 2040. However, I view it as feasible by 2050 for developed countries, and by 2060 for developing countries.”<sup>148</sup> Command and control policies and bans frequently seem inevitable if these targets are to be reached. However “it is essential for each individual to realize that the key to a more sustainable world is not about either a complete transformation or none at all. There is a very healthy middle ground, where it is more about conscious decisions rather than sacrificing.”<sup>160</sup>

In the EU, transport is an area of particular concern, as it is responsible for nearly 30 percent of the EU’s total CO<sub>2</sub> emissions, of which 72 percent comes from road transportation. As part of efforts to reduce CO<sub>2</sub> emissions, the EU has set a goal of reducing transport emissions by 60 percent, compared to 1990 levels, by 2050.<sup>161</sup> This push for decarbonization is driving the popularity of e-mobility (i.e. a 35 percent

increase per annum in Switzerland)<sup>161,162</sup> and alternative fuels (i.e. hydro), as well as technology to reduce emissions of combustion engines (i.e. carbon capture and storage)<sup>163</sup> (see Power Sources and Energy Storage). At the same time, demand is growing for Sharing Economy models to reduce the overall number of cars. Some experts, however, point out the potential challenges for this transition towards a low-carbon transportation system: “Energy supply is totally underestimated. Autonomous cars, for example, require high levels of energy due the constant data transfer, the server systems, and the cloud. The energy demand required for an E-Mobility world can only be met with coal-fired power plants, which are not a solution in regard to the elimination goal of CO<sub>2</sub>.”<sup>164</sup>

For a carbon-free or low-carbon transport system, technological advancement needs to go hand-in-hand with new business models and political measures. Hence, the extent and likelihood of this scenario is difficult to forecast. However, current developments do suggest a transport system that generates fewer emissions compared to the status quo.

### RESOURCE AVAILABILITY

In the context of mobility, resource availability will be a central topic for several reasons.

First, many engines today still work by combustion and rely on fossil fuel. The IEA foresees an oil-supply shock by 2025, if no massive investment in new production methods is made (see Figure 31).<sup>165</sup> As ex-

perts disagree on peak oil forecasts, stable oil supply becomes more and more unpredictable. Others suggest that renewable energies have now become as cheap as fossil energy,<sup>148</sup> transforming the energy sector. Hence, the automotive industry is extrinsically motivated to switch to alternative engines, and so are governments globally. Two leading contributors to future oil-demand growth, China and India, have each announced plans to transition their transportation fleets to electric vehicles by investing in infrastructure and supporting electric battery research and development.<sup>166</sup>

On the other hand, more than 20 Critical Raw Materials (CRMs), including Cobalt, Magnesium and Silicon Metal, have high risks associated with their supply. These materials – used, for example,

in environmental technologies, consumer electronics and aviation – are not only critical for key industry sectors and future applications, but also for the sustainable functioning of the European economy.<sup>167</sup>

In regards to future mobility, experts identify various challenges: “The biggest challenge for vehicles running with batteries is obviously the rare earth metals. Lithium and cobalt can be classified as critical, which is already visible today, as shown by the current market volatility.”<sup>164</sup> However, the importance of these challenges is rated differently depending on the source: “In the future, we will encounter a bottleneck of traditional metals rather than one of rare-earth metals. For example, a complete shift to electromobility by 2040 will lead to a copper scarcity. The issue with rare elements is not necessarily the scarcity – it is the nasty extraction, which causes severe negative environmental effects.”<sup>53</sup> Some of the materials used for applications such as generators in wind turbines, motors in electric vehicles, etc. are obtained in countries where basic human rights and the environment are insufficiently protected (i.e. China, Kongo, etc.),<sup>168</sup> and hence supply is tied to severe consequences for society and the environment. In the context of rising awareness of climate issues, this might lead to calls for more responsible production with potential economic consequences (such as rising prices).

If more finite resources such as metals and rare earth metals are used to produce sustainable vehicles, this could result in either

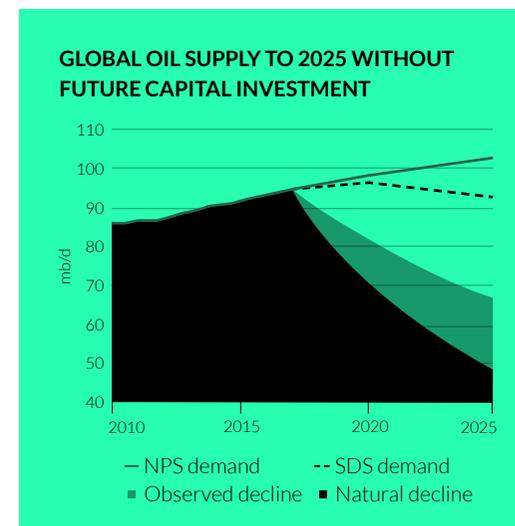


Figure 31: An oil-supply shock is expected for 2025.

increasing prices for these materials, or increasing innovation in terms of extracting methods (i.e. mining), with the potential of falling prices. This could make electric vehicles and other sustainable modes of transportation less attractive, and inhibit their subsequent wider diffusion.

### LAND-USE CHANGE

In addition to GHG emissions, land-use change and deforestation also lead to accelerated global warming. It is estimated that between 10 percent and 20 percent<sup>169,170</sup> of global GHG emissions come from deforestation and land-use change, making it an important topic when considering measures to mitigate global warming. The main driver in this context is the permanent destruction of forest cover to make the land available for economic activities such as crop farming or cattle ranching. According to the WWF, “we’re losing 18.7 million acres of forests annually, equivalent to 27 soccer fields every minute.”<sup>171</sup> Under the current political situation – e.g. in Brazil, which is a major player in regard to deforestation – this trend is expected to continue or even accelerate over the next few years.<sup>172</sup>

In regard to mobility, the topic of biofuels is particularly relevant, and linked to the problem of deforestation. Over the past few decades, the biofuel industry has grown and demand has increased, given that biofuels are seen as a viable low-carbon alternative to conventional fossil fuels. Demand is expected to increase further. One key driver behind increasing demand is the aviation

industry,<sup>173</sup> where biofuels seem to be one of the only options to achieve emission reduction targets.

However, an increase of biofuel production might lead to additional deforestation, due to increasing demands for space to grow crops. Considering these side effects, most biofuels are not as green as they seem.<sup>174</sup> There is also a debate about other negative side effects of biofuel production, e.g. a negative impact on food security<sup>175</sup> because food crops are used for fuel instead.

The debate about the “environmental friendliness” of biofuels might influence the pathways of diffusion of alternative technologies such as electric vehicles, providing an argument for the continued use of conventional engines with a more sustainable fuel. This potentially makes it harder to achieve emission reduction targets in a transportation sector still based on conventional engines, and might accelerate the phase-out of these technologies.

### ENVIRONMENTAL REGULATIONS

Over the course of the last few years, a wide range of policy measures to reach the goal of Decarbonization have already been implemented. They range from incentives and command-and-control policies to the implementation of carbon-trading systems and CO<sub>2</sub>-offset schemes, as well as subsidizing renewable energy (i.e. wind, solar, hydro).<sup>176</sup> Experts believe that “policies in relation to technologies have to be separated into two stages. Firstly, they are required to enable the emerging tech-

nologies to function well and support them in the adaption process. Secondly, make them more prominent in order to substitute the traditional ones phasing out the fossil fuels.”

Experts criticize current EU policies on the grounds that they are unlikely to deliver emission reductions quickly enough to limit global warming to less than 2°C (Paris Agreement) and do not address the timely phase-out of fossil fuels either adequately or visibly.<sup>177</sup> The decarbonization of the transport sector depends largely on electrification, and hence the electricity sector must also be decarbonized as quickly as possible. As a result, the European Academics Science Advisory Council is urgently calling for policy to disincentivize fossil fuel, reduce or contain the demand for motorized transport and shift passengers and freight to transport modes that produce fewer emissions (e.g. buses, trains and ships), while improving vehicle design and the efficiency of combustion-based powertrains, mainly through hybridization.<sup>177</sup> Some European cities are already working on such legislative frameworks,<sup>178</sup> and the current political situation might allow for certain changes in this direction (see Green Wave). “The recently submitted legislation for new climate policies is extensive and looks very promising, [...] although almost all the regulatory instruments are not yet mature [...]”<sup>179</sup>

Evidence suggests that the EU is working towards an integrated, modern and sustainable mobility system, which is con-

nected to the energy and digital networks. In this system, citizens and businesses must be offered safe, smart and seamless mobility solutions across Europe, and European infrastructure must be among the most advanced of the major global economies.<sup>180</sup> It is clear that “the political majority of developed countries agrees on the transition away from gasoline and diesel cars for many reasons.”<sup>148</sup> This steps up the pressure on the automotive sector to come up with alternatives to combustion engines to adhere to the EU’s goals and regulations.

### SUBURBANIZATION

The level of urbanization in Europe is set to rise from today’s 74 percent to about 83.7 percent by 2050.<sup>181</sup> Two main paths for the future have been distinguished for European Functional Urban Areas (defined as the cities themselves plus their commuting zone), using population projections from 2010–50. Half of them will suffer from a population decrease, with 12 percent of cities losing over a quarter of their inhabitants.<sup>182</sup> Some cities will see a slight increase in total population, or no change, with a medium densification of city centers and suburbs – a trend that is expected to be prominent in capital cities.<sup>182</sup> “There will be more big cities, very big metropolitan areas, and an increase in small and medium-sized cities.”<sup>183</sup> Other cities, however, will experience a decrease of total population, with a de-densification of the city centers and a slight densification of suburbs.<sup>182</sup>

Despite some experts being optimistic that “urban sprawl is not an option; which in Europe we sort of realized [...],”<sup>183</sup> the European Commission views urban sprawl as an increasing challenge to maintain and update existing infrastructure in order to manage cities’ sustainability and connectivity.<sup>181</sup> Several communities in Europe, however, have already successfully combated the effects of urban sprawl.<sup>184</sup>

“One of the major points in Europe is how we can balance the compactness of cities with the need for green spaces and a more environmentally friendly urban environment that makes sense.”<sup>183</sup> Apart from population density posing questions concerning the capacity to accommodate the concentration of waste and pollution,<sup>185</sup> greater densities can also have a positive effect on lowering energy consumption and curbing GHG emissions, given that the transport system and buildings are suitably adapted.<sup>186</sup> Urban sprawl, on the other hand, increases energy consumption and congestion<sup>185</sup> as well as the reliance on private automobile transportation.<sup>184</sup>

Based on the assumption that one-third of European cities will see their populations grow by more than 10 percent by 2050, an increase in road traffic and greater use of railways and underground transportation is anticipated, threatening to reach capacity limits.<sup>182</sup> One approach is to reduce personal travel by redesigning cities and bringing services to the people, making all necessities available within

walking distance.<sup>182</sup> “In a future scenario we will see a lot more people walking and cycling (‘Your next car is a bike’), which is going to have added benefit in terms of our health and air pollution and overall emissions. Additionally, I think that there will also be a shift towards the electrification of mobility and cars, and actually at a certain point we are going to shift to hydrogen.”<sup>187</sup> Even today, there is already a growing part of the population who use cycling as their main mode of transportation: “I bike everywhere in all weathers, also long distance. It has the beneficial effect of exercising while getting from A to B.”<sup>188</sup>

Based on that development, one possible effect is that “mobility will be less valued in 2040 as urbanization decreases commuting distances and available space, thus alternative modes of transport like improved electro scooters [...] become more prominent. [...]”<sup>179</sup> Other experts, however, don’t foresee mobility being less valued, because “nobody wants to step back or return to their box. Therefore, less mobility is no option for the future. A more likely future scenario is a Europe without combustion engines which provides even a higher level of freedom.”<sup>153</sup>

## POLLUTION

Pollution comes in various forms. Water pollution is primarily caused by runoff from agricultural fields, industrial sites or urban areas, including fertilizers or toxic chemicals, raw sewage and trash pollution. Soil pollution can originate from industrial sources, or

the improper disposal of toxic chemical substances such as asbestos, lead and PCBs, and overuse of pesticides/herbicides.<sup>189</sup> Light and noise pollution can also be important in many contexts. Most relevantly to the theme of mobility, a major source of air pollution results from the burning of fossil fuels in vehicles or factories.

In many areas, vehicle emissions have become the dominant source of air pollutants, including carbon monoxide, carbon dioxide, volatile organic compounds or hydrocarbons, nitrogen oxides and particulate matter.<sup>190</sup> Emissions, particularly from diesel vehicles, contribute to the formation of smog: a dense layer of particulate matter that forms a low-hanging cloud over many major cities and industrial zones. Nitrogen and sulfur oxides in the air contribute to acid rain, which is a form of precipitation with a lower (more acidic) pH than normal. Acid rain harms forests and water-dwelling species, and degrades outdoor statues, monuments and buildings.<sup>189</sup>

From a public health perspective, pollution in highly affected areas causes birth defects in babies, causing children to children lose 30–40 IQ points, and reduces life expectancy to as little as 45 years because of cancers and other diseases.<sup>191</sup> Further, with seasonal changes and global warming, pollution levels rise due to increased solar radiation. Global premature deaths attributable to pollution increased by 89–124 percent over the period 1960–2009, dominated by large increases in China and India.<sup>192</sup> (Figure 32 shows the corresponding



Figure 32: Premature deaths caused by air pollution in Europe, by country.

figures for Europe.) In Europe, the high levels of the dangerous fine particulate matter known as PM2.5, which can lodge deep in the lungs and pass into the bloodstream, appear to have reached a plateau, after more than a decade of gradual reductions.<sup>192</sup>

Overall, the situation is urgent, and action is needed to reduce pollution levels in all sectors. So far, the lack of empirical air pollution data at a hyperlocal level has made it difficult for city leaders to incorporate local air pollution and associated health concerns into city policy discussions. To help gauge air quality, innovative mobile sensing technologies are becoming more widely used to collect air pollution data in cities. The city of Houston is testing a “smart fleet” pilot that is a cost-effective, scalable model for mapping air pollution using municipal vehicles.<sup>193,194</sup> Furthermore, the company Green City Solutions addresses the global problem of air pollution by combining a special moss culture, installed on vertical surfaces such as walls, with Internet-of-Things (IoT) technology. Named City-Tree,<sup>195</sup> the solution combines specific plants that eat particulate matter (PM), nitrogen dioxide and ozone, offsetting 240 tons of CO<sub>2</sub> equivalents per year in total. CityTree has the same effect as up to 275 urban trees – but requires 99 percent less space.<sup>195,196</sup>

Finally, in the context of mobility, about a dozen countries and around 20 cities around the world have proposed banning the future sale of passenger vehicles powered by fossil fuel. In some places, direct measures to reduce air pollution are already in force –

e.g. the recent restriction of inner-city car usage in Delhi.<sup>197</sup> Japan has a comprehensive plan for a “hydrogen economy by 2040.”<sup>198</sup> The automotive industry is reacting accordingly to these developments, and changing its focus towards alternatives to the fossil-fuel based engine.

## RECYCLING

Processing waste materials into new, usable materials and objects is a viable way to reduce the usage of fresh raw materials. It therefore has the potential for multiple beneficial effects, ranging from cost savings to reducing GHG emissions. However, the recovery rate for recycled materials – the percentage of materials tossed into recycling bins that actually ends up being processed into new products – is just 31 percent on average in Europe, varying per country.<sup>199</sup>

Plastic that is not reclaimed often ends up in landfills or as litter, where it can easily enter delicate marine ecosystems and harm many species. A major priority for EU governments is to develop more efficient recycling technologies, mainly to increase sustainability. Major developments are being made in the fields of paper and plastic. When it comes to aluminum, even the foil used in laminate packaging will soon be designed for greater durability, or to be recycled cost-effectively. EU plastic recycling capacity will be significantly extended and modernized by 2040, applying AI and robotically supported waste separation.<sup>200</sup> Finally, waste can be a potential source

of energy, fuels, and value-added products, if appropriately and wisely managed.<sup>201</sup>

The current major pathways of plastic recycling include mechanical recycling, monomer recycling and pyrolysis.<sup>202</sup> Regarding energy generation from solid, liquid and gaseous fuels, pyrolysis is a promising pathway, especially for the mobility industry. Upgraded pyrolysis oil can be used directly as transport fuel for road vehicles, naval vessels and aircraft.<sup>203</sup> These improvements in waste management create increasingly valuable feed-stocks for industries, leading to profit opportunities, new collaborations and increasing demand for recycled plastic. Furthermore, the demand for fossil fuel falls, as do CO<sub>2</sub> emissions. In the long run, the potential annual energy savings that could be achieved from recycling all global plastic waste is equivalent to 3.5 billion barrels of oil per year.<sup>204</sup> However, at this point, there are many technical, operational and socioeconomic challenges, all of which must be overcome in order to achieve the maximum economic and environmental benefits of biorefineries.<sup>201</sup>

Overall, the EU is taking a leading role in a global dynamic, with countries engaging and cooperating to halt the flow of plastics into the oceans and taking remedial action against plastics waste already accumulated. Best practices are being widely disseminated, scientific knowledge is improving, citizens are mobilizing and innovators and scientists are developing solutions that can be applied worldwide.<sup>204,205</sup> The topic of recycling is expected to become even more relevant for

the future, “as basically already today our electro waste contains a higher density of gold than the soil in Africa, where the gold is extracted. This also applies for rare metals.”<sup>53</sup> However, in many cases, “currently, recycling is not worthwhile due to the low cost of the primary extraction of metals.”<sup>164</sup>

For the mobility sector, a transition towards more sustainable modes of transportation brings new challenges when it comes to recycling – for instance, in regard to the batteries that are necessary for the electrification of transportation: “In an electric-vehicle scenario, I am concerned about what we are going to do with the batteries, and I don’t think we have fully thought about it.”<sup>187</sup> These issues have to be addressed before sustainable mobility can be achieved.

## EXTREME WEATHER EVENTS

Another effect of global temperature rises is the growing number of extreme weather events around the world. Depending on the world region, more droughts, more floods, changing precipitation patterns, and heat waves are expected to occur more frequently in the next decades,<sup>140</sup> with negative impacts on ecosystems, infrastructure and human life. Some effects of changing weather patterns can already be observed, e.g. in more frequent droughts and wildfires in California,<sup>206</sup> or the heavy precipitation intensification that has been recorded across many regions of the world.<sup>207</sup>

In Europe, cities are particularly vulnerable to extreme weather events due to their dense accumulations of population, infras-

structure and economic activity.<sup>208</sup> “One challenge is to manage heavy downfalls of storm water in cities, as permeable areas that could absorb water are locked and our sewage system cannot process this immense quantity of water, which will result in flooding.”<sup>183</sup> In recent years, heat waves have already had a significant impact on human health in Europe – for example, the record temperatures of summer 2003, which led to more than 70,000 deaths across the continent.<sup>209</sup>

These trends are expected to continue over the decades to come, increasing the risk of damages through extreme weather events

in the future. These risks vary depending on the area. The effect on human health and the threat to key infrastructure from floods, storms and wildfires will be most people’s closest experience of the consequences of climate change, potentially making their behavior more sustainable (see Sustainable Behavior).

As most economies depend heavily on personal and freight transport, disruption of the transportation systems incurs severe damages – both personal and economic.<sup>210</sup> Coastal infrastructure, in particular, is threatened by floods, storms and rising sea

levels.<sup>156</sup> Other future negative effects for the mobility sector include debris on roads and rail tracks after more frequent storms, as well as thermal expansion of bridges, loss of integrity of pavements and deformation of rail tracks. There is even the risk that construction activities will be constrained by heat waves, making it harder to build and maintain essential infrastructure.<sup>211</sup>

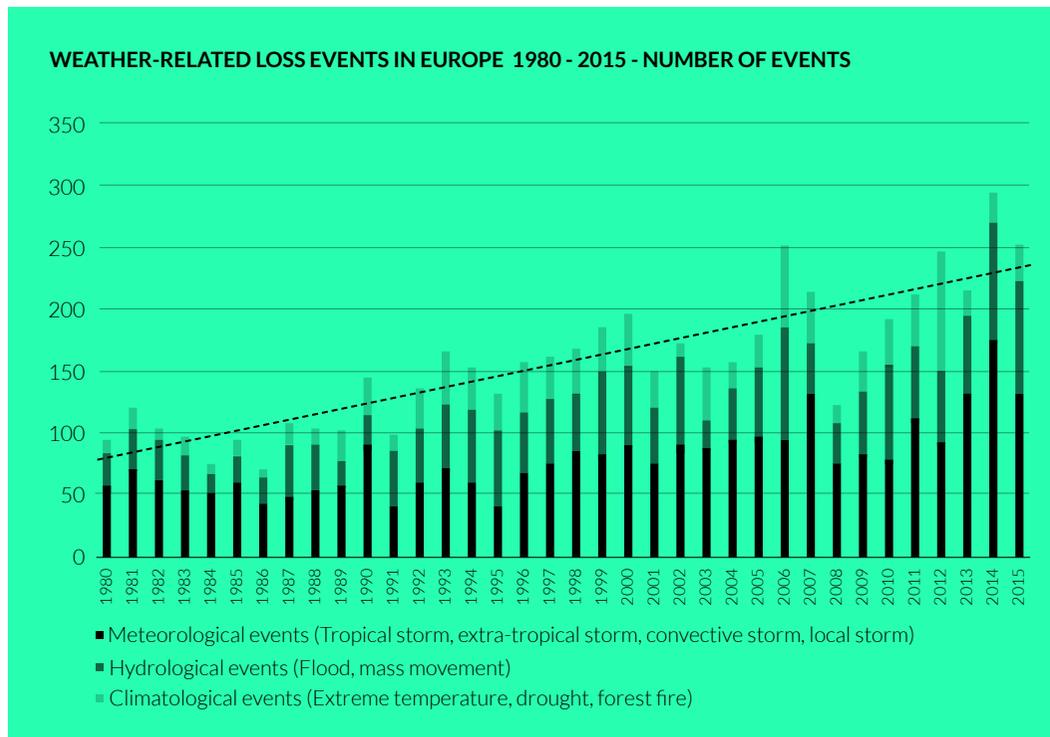


Figure 33: Meteorological, hydrological and climatological events are steadily increasing.

# POLITICAL TRENDS

Politics is strongly reactive to developments within society (the more direct the democracy, the stronger the link). Many societal developments are triggered by technology, and hence extremely difficult to predict, as societal processes don't necessarily follow linear developments. However, there are a few developments, including digitalization (covered throughout the Technological Trends) and the Green Wave, that could help to give at least some sense of where politics might be headed over the next 20 years.

security and protection, potentially caused by (increasingly likely) attacks on individual data infrastructure and digital systems, driving more national and international legislation.

On the other hand, the Green Wave is gaining momentum in the EU, and could potentially have major implications for the future of mobility, leading towards a more sustainable, carbon-reduced (or even carbon-free) future.

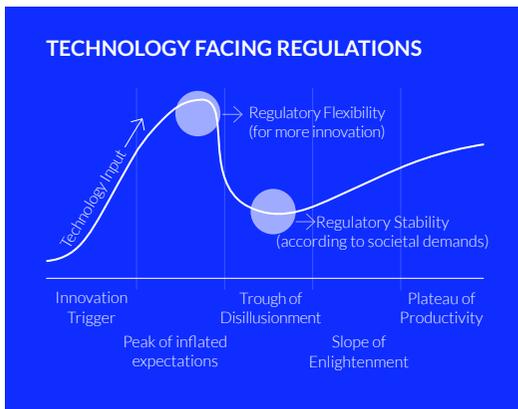


Figure 34: How technologies evolve in the face of regulatory processes.

The public sector will undergo structural change through the digitalization of many governmental services. We will also see greater societal awareness of data

## E-GOVERNANCE

Generally, data security in the context of a digitalized government is a highly critical issue. IT experts call for a slower digitalization process that would give time to build up country-specific and internal resources to guarantee maximum data security – especially for data that could bear economic value, or that relates to personal health or political values. This development, however, runs counter to the logic of globali-

zation and the spread of technology.<sup>212-215</sup> Experts suggest that the digitalization of governmental services will spur public debates about data and cyber security, as it also poses certain threats and challenges (i.e. collapse of the internet, data storage, data privacy vs. transparency, digital warfare, etc.).<sup>215,216</sup> Hence, it is extremely difficult to predict how initiatives and referenda relating e-governance (e.g. the rejection of e-voting in Switzerland<sup>216</sup>) will alter the speed of service digitalization. If done right, e-governance could be one of the central building blocks of Smart Responsive Cities, and hence smart mobility within cities. Figure 35 shows the top e-government performers around the world.

## DECENTRALIZATION OF POLITICS

Today's governments could potentially be profoundly affected by crypto-technology (see Decentralization) due to its core mechanisms of decentralization and automation of transactions. Some envisage entire governments being based solely on smart contracts (i.e. payment of rent, marriage, etc.), and some voices even predict that large nation states as we know them today will collapse by 2050.<sup>217</sup> More likely, though, is that the physical and digital state will coexist.<sup>217</sup>

### TOP E-GOVERNMENT PERFORMERS IN EUROPE

1	United Kingdom
2	Finland
3	Sweden
4	The Netherlands
5	France
6	Estonia
7	Germany
8	Austria
9	Spain
10	Norway
11	Belgium
12	Slovenia
13	Italy
14	Lithuania
15	Luxembourg
16	Ireland
17	Iceland
18	Switzerland

Figure 35: The UK has the most advanced E-Government system.

Nevertheless, with technology enforcing the concept of decentralization, the case of separatist and independence movements, as well as that of federalism, is further strengthened. Separatist movements are in contact not only with each other, mutually reinforcing each other's positions, but also with providers of digital decentralization, i.e. blockchain-based start-ups such as Bitnation. Hence, technology that allows for decentralization could potentially enforce the creation of parallel states.<sup>218,217</sup> Whether and how this might evolve is extremely difficult to predict (as it would involve a collapse of the existing system), and forecasts appear to be linked to authors' own personal beliefs (some see it happening before 2050, others not at all).

Mobility could be affected insofar as more fragmented states would complicate the integration of mobility solutions over larger territories (i.e. stronger border protection) and/or make the population more locally oriented (see Anywhere, Somewhere, X-Where) and hence lessen the need for mobility.

### **BIG TECH IN POLITICS**

Digital communication platforms such as Facebook and Twitter have proven that they can be misused for political propaganda (i.e. covert influencing). “[...] Even the published Russian military strategy says that the military itself is not the most important tool anymore – non-military means will be the most important in the future,” as Alexander Klimburg, Director of the Cyber Policy and Resilience Program at The Hague Centre for

Strategic Studies, says.<sup>215,219</sup> This leads to growing demands for regulation and calls for tech companies to take on more responsibility for the content published on their platforms, and protect the users of their services.

Besides covert influencing, tech companies also collect a great deal of personal data on their users that could potentially be misused for economic gain. With the enactment of the new GDPR (General Data Protection Regulation), the EU has positioned itself as a guardian of its citizens' digital privacy rights and, globally, as a bulwark against data surveillance by states such as China.<sup>215,216</sup> Experts are in favor of this development, as the following statement from Erik Schönenberger shows: “[...] GDPR forces big tech, e.g. Facebook, to respect EU data privacy laws, which is a first step in the right direction.”<sup>216</sup> Depending on how states enforce the new legislation,<sup>216</sup> it can have different implications for all kinds of integrated and smart mobility, as well as automated driving, since these vehicles use and rely on extensive data on the user (see Personal Cloud) and the surrounding area. Potentially, this could lead to cumbersome regulatory processes that slow down the introduction of automated driving. As a result, we might not see this in operation before 2040;<sup>220,221</sup> the same points apply to autonomous flying and hyperloops.

Libra, the cryptocurrency project initiated by Facebook, is another example how tech giants could influence politics.

Potentially, they could even compete against governments by creating their own monetary policies or undermining the importance of the current financial system.<sup>47</sup> (See also Monetary Substitution.)

### **PREDICTIVE GOVERNANCE**

Data and algorithmic decision-making are already widely used, in areas such as law enforcement and criminal justice. AI can help detect patterns in huge datasets, identify people in videos using facial recognition, improve forensics analysis and play a part in predictive policing (see Artificial Intelligence). “The use of predictive analytics to flag potential future behavior [...] has been particularly controversial, as the data used may be biased against particular groups or communities, resulting in discriminatory decisions,” as the United Nations Institute for Disarmament Research notes.<sup>222</sup> One possible safeguard against the potential for power abuse by a centralized entity could be the use of a decentralized technology such as blockchain.<sup>47</sup>

Depending on technological developments (i.e. quantum computing; see Processing Power), algorithmic decision-making could explode in terms of both accuracy and popularity. However, it is unlikely that it will ever be perfect, for the reasons stated above, and hence critical scrutiny will continue. Furthermore, the current behavior of extreme users suggests that there might be resistance against largely data-driven government for data privacy reasons, and hence, regulations might restrict and slow down usage (see E-Governance).<sup>212,213,216</sup>

It remains to be seen whether the attempt at data sovereignty for the customer in its current form is the optimal solution. For example, when users are browsing the Internet and receive a cookie notification, in most cases they don't understand or care about the option to protect or actively and consciously own their data, merely seeing the interruption as an inconvenience.<sup>10</sup>

For mobility, further advanced use of data and algorithmic decision-making could potentially mean more accuracy with regards to the distribution, coverage and reach of potentially automated services. However, greater resistance could also open up a space for a discussion of anonymized personal data wallets, ultimately leaving customers with sovereignty over their own data.

### **DIGITAL WARFARE**

Using digital warfare, countries that were previously weak (due to their size, or the relative strength of their economies) can now challenge and attack powerhouses such as the US or China. This leads to a shift in international power dynamics, and creates an urgent need for international regulation. “I believe we need a controlled approach to regulating cyber conflict. If it's uncontrolled, it will be tit for tat – attacks will be countered with attacks. We need to cooperate on a global level.”<sup>215</sup> As this quote from Alexander Klimburg and other expert interviews shows, there is absolutely no doubt that digital systems will be

subject to attacks, and those that have transpired so far (e.g. Stuxnet, attacks on oil production, etc.) have been merely the beginning.

To prevent large-scale attacks, a global framework needs to be built. Cyber security and cyber defense will become more and more central for all countries to protect themselves from cyber war. Some experts predict massive attacks within the next 10–15 years with the goal of destabilizing – or, even more dystopian – destroying democratic societies. More likely, though, are scenarios where individuals rather than states are targeted – similar to, e.g., WannaCry.<sup>212–215</sup> On the one hand, this threat will prompt more supranational collaboration on the EU level – potentially becoming a reason why the EU stays together.<sup>215</sup> On the other hand, it will create greater awareness of the threats that digital systems inherently bear, and hence to a more cautious approach with regards to data security, protection and storage.

## EURO-PESSIMISM

Studies show that European youth (especially those under 18) fear that in 20 years' time, the European Union will no longer exist, and that war between member states is at least possible.<sup>223</sup> This fear could be based in recent setbacks for the European Union – e.g. the vote for Brexit, the decline of social democracies, and the rise of nationalist movements (see Rise of Nationalist Politics), among others. Generally, experts consider the EU as a supranational

institution stronger than recent events might suggest. The reasons for this hypothesis lie in the consequences of a potential collapse of the union. It would be fatal on all levels, but mostly economically – today, the EU is the world's largest economy, and also the biggest exporter and importer.<sup>224</sup> This brings many advantages for the EU, especially when it comes to leveraging economic power for political ends (e.g. enforcing GDPR).<sup>215</sup> Rather than falling apart, experts suggest that member states would fight to change the nature of the organization (e.g. two-speed EU) to preserve this economic and political power.<sup>214,215,225,226</sup> International agreements, or, in the case of this report, the cohesion of the EU as a whole, have a major impact on practical and citizen-centered mobility

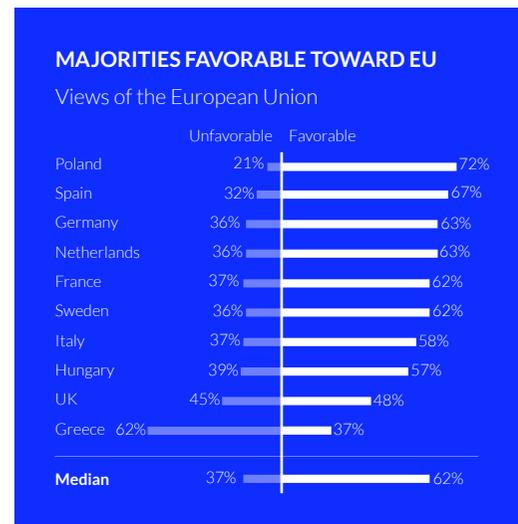


Figure 36: Greek citizens, in particular, have unfavorable views of the EU – although the median view is positive on balance.

solutions. From data security to airspace regulations – based on the hypothesis that the larger the union and the stronger the economy, the more weight to enforce their interests.<sup>215</sup> This is true for the alignment within the union, but also when it comes to standing up for European values outside of it. Figure 36 shows how attitudes to the EU vary among some of its member states.

If Euro-pessimism, together with nationalism, is a first sign of a diverging union, our lives could change dramatically. Mobility could be affected insofar as a more fragmented union would complicate the integration of mobility solutions over larger territories (i.e. more border control, less free movement of people, etc.). But, as experts suggest, this is rather unlikely to happen.

## RISE OF NATIONALIST POLITICS

Today's political agenda is no longer determined by social democratic parties, as it was for much of the 20<sup>th</sup> century. As experts observe, they no longer have a common cause to fight for.<sup>226</sup> Even though there is no clear global move towards rising nationalism, there has still been a rise of nationalist politics in some countries, expressed by the rise of new parties (e.g. AFD), the electoral success of nationalist candidates or a shift in the public discourse of established parties (see Figure 37). Further exogenous shocks could accelerate this trend; conversely, nationalism, inherently confrontational by its nature, can also exacerbate tensions and conflict.<sup>227</sup> The generally more conservative atmosphere is an expression

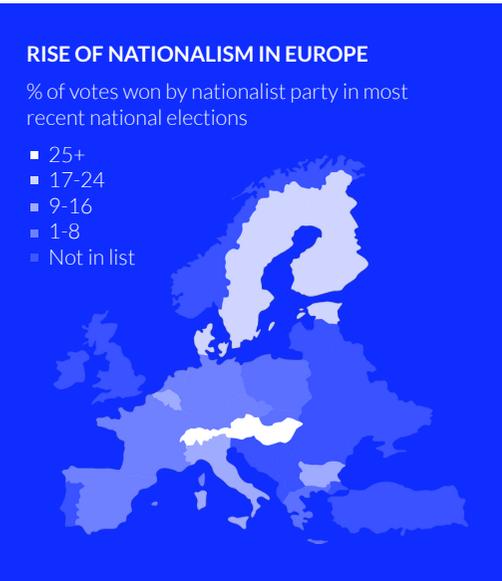


Figure 37: Nationalist parties during national elections.

of fear from people affected by a rapidly changing global environment, increasing digitalization and migration. It could potentially also be holding back the process of globalization and migration.<sup>226</sup> However, since globalization, digitalization and migration are not predicted to slow down significantly, the nationalist trend might only be stopped if less extreme parties identify a new, common cause that they can exploit to win elections (see also Green Wave).<sup>226</sup> Mobility could be affected insofar as more fragmented states would complicate the integration of mobility solutions over larger territories (i.e. more border control, less free movement of people, etc.).

## GREEN WAVE

Led by a global youth movement, public support for fighting climate change in the EU has gained momentum over the last months. Many European countries have witnessed a shift in their national and European politics towards a greener parliament – the latest example being Switzerland, which recorded a historic win for the green party during the elections of October 2019.<sup>228</sup>

In 2019, the EU adopted a regulation that forces manufacturers to meet stricter limits on carbon emissions for new cars and vans from 2025 on. The regulation will be stepped up from 2030. This should lead to a smooth and gradual transition towards zero-emission mobility, “[...] allowing for sufficient time to provide for an adequate reskilling and reallocation of workers in the automotive sector,” as the European Commission writes. The same is planned for the aviation industry.<sup>229,230</sup> With the support of a green parliament, the Paris Agreement (see Global Warming) could experience a revival with unforeseeable consequences for mobility, ranging from potential higher taxation of CO<sub>2</sub> emissions, to possible outright bans of independent mobility – always depending on societal and technical developments, of course.

## MIGRATION

Global migration streams, from refugees to workforces, are most likely to complement a shrinking population within the EU, so the overall population within the EU in 2040 will reach 525 million.<sup>6,231</sup> Forecasts in

studies show that this migratory influx will bring massive implications for European society (i.e. integration politics) and, hence, mobility as well.<sup>231</sup>

Generally, a growing population leads to more people moving, and distances and time spent travelling (i.e. for commuting) are growing.<sup>232,233</sup> This is reflected in the words of Gery Balmer of the Federal Office of Transportation in Switzerland: “Based on the estimations of the federal statistical office about how population will change over the years, the federal office for spatial development estimated how that will [...] influence transportation in general and public transport specifically. [...] We took the most likely scenario, known as the reference scenario. In this scenario, public transportation will grow over 50 percent by 2040 compared to today.”<sup>220</sup>

More concretely, in Switzerland, by 2040 more than 33 billion passenger-kilometers per annum will be reached.<sup>233</sup> If this is paired this with the potential (albeit rather unlikely) introduction of automated vehicles (see Autonomous Transportation), that could take people away from public transportation to individual transportation.<sup>234</sup> It is far from clear what the implications for mobility could be, as the following statement by Sigrid Pirkelbauer from the Federal Roads Office affirms: “We’re trying to anticipate what’s coming our way in traffic. However, the scenarios cover the entire spectrum from traffic collapse to the seamless integration of self-driving cars into our current traffic system. It is simply very difficult to say where we are heading and what measures need to be taken.”<sup>221</sup>

## EMERGING TECHNOLOGIES VS. LEGISLATION

Generally, legislative processes work slowly, and are reactive to new inventions or public advances. Moreover, there will be more regulations in the future: 50 new regulations emerged in the EU in 2019 alone.<sup>235</sup> Hence, future legislation is almost impossible to predict.

In the face of a rapidly changing technological environment, legislators need to find a balance between fostering innovative new concepts and ideas and hindering their development. Ideally, when a new product/service is in development, more individual and flexible laws help with exploration. Once the technology or business model is tested, more stable laws that follow the logic of already existing legislation and help to protect society fall into place.<sup>234,236-238</sup>

The hypothesis is that, via legislation, the widespread implementation of technological developments and new business models is slowed down (e.g. for legal reasons, automated cars are unlikely to hit the road before 2040;<sup>220,221</sup> Uber is facing resistance in many countries). Measures taken by governments can range from stronger regulations to more extreme scenarios such as banning certain new products or services outright, as the recent case of e-scooters has shown. In France, regulations were enacted to limit the top speeds of such scooters and assign parking zones in order to keep pathways free for pedestrians, with

penalties of up to €135 for violations. Meanwhile, in several US cities, requests were made to ban the scooters altogether for security reasons.<sup>239,240</sup>

Driven by new products and (digital) services in the mobility sector, transport will potentially become more and more integrated. People will most likely switch to using different mobility offerings in a modular way (e.g. shared bikes combined with “classic” public transportation such as trams or trains).<sup>220</sup> These Mobility-as-a-Service offerings will most likely need to be regulated differently, to allow for the integration of all kinds of services (private and public). Hence, implementation does not depend on feasibility alone.

## SEPARATISM

Separatist movements within Europe (e.g. Catalonia, Jura, Wallonia, Scotland) are usually especially active along cultural lines (i.e. language, religion) and in areas with a history of oppression. Such movements are strongly interconnected and supportive of each other.<sup>218</sup> They show high affinity for alternative (more decentralized) state organizations (see Decentralization).

These potential breakaway states might adopt blockchain and other digital technologies to create parallel digital governments.<sup>217</sup> The future development of such movements is extremely difficult to predict because of a complex interplay between national and, in the EU’s case, supranational laws – as well as powerful disincentives imposed by the respec-

tive “parent” states (e.g. Spain, Switzerland, etc.).<sup>218,241</sup> Still, the more fragmented, more local organization of society that separatist movements wish for could potentially spill over to a larger portion of society. As with the Rise of Nationalist Politics, the increasing demands for global mobility solutions might run into a barrier created by the effects of separatism.

## SECURITIZATION

Securitization, in the context of mobility, needs to be observed from two different angles. On the one hand, politics today is largely dominated by topics revolving around protection, control, security and the capacity of the state to act. Right-wing parties (e.g. AFD; ÖVP; Front National, etc.) that address these topics continue to attract voters across nearly all of Europe;

### WORLDWIDE SECURITY SPENDING BY SEGMENT, 2017-2019 (MIO. OF US DOLLARS)

Market Segment	2017	2018	2019
Application Security	2,434	2,742	3,003
Cloud Security	185	304	459
Data Security	2,563	3,063	3,524
Identity Access Management	8,823	9,768	10,578
Infrastructure Protection	12,583	14,106	15,337
Integrated Risk Management	3,949	4,347	4,712
Network Security Equipment	10,911	12,427	13,321
Other Info. Security Software	1,832	2,079	2,285
Security Services	52,315	58,920	64,237
Consumer Security Software	5,948	6,395	6,661
<b>Total</b>	<b>101,544</b>	<b>114,152</b>	<b>124,116</b>

Figure 38: Globally, spending on digital security is on the rise.

just recently, the AFD in Thüringen was able to win 23.4 percent of the votes.<sup>242</sup> The reason for this may lie in globalization and migration, which may appear to threaten people’s security, pushing them towards more defensive behavior.<sup>226,225</sup> This is closely connected to the Rise of Nationalist Politics.

On the other hand, digitalization and an emerging awareness of data security might potentially lead people to invest more in private security, especially in the digital realm (see Data Infrastructure and Governance), as expert advice would suggest<sup>212,213</sup> and market forecasts illustrate. In 2019, the security market is predicted to grow by 8.7 percent, to US\$124 billion.<sup>243</sup> (See Figure 38 for recent spending trends.) As of today, extensive private investments in information security products are not yet the standard.<sup>212</sup> It is unclear how this will evolve within society, as it depends on the outcomes and awareness generated through a public debate that has yet to begin.

Most likely, discussions around the data security of integrated mobility systems and automated vehicles will center on data privacy, automatic scanning of nearby vehicles (i.e. Teslas), automated synchronization with the cloud, etc.<sup>213</sup> For instance, if automatic cloud synchronization is to be forbidden, or the privacy rights of users better protected, there could be wide-ranging implications, with less personal data cur-tailing the potential for economic growth, etc.

## AGING VOTERS

Globally, life expectancy has been steadily increasing for decades, with 19 additional years of life added since 1960.<sup>244,245</sup> This trend is likely not to be broken anytime soon, as was confirmed by a recent study, and Europeans might live to be over 80 on average (e.g. in Switzerland or Spain, life expectancy is over 85 for both sexes).<sup>246,247</sup> Figure 39 shows the projected rises in old-age dependency ratios for selected countries.

Older individuals are said to be much more likely than the young to report pensions and healthcare as their first priorities. Protecting the environment, education and assisting the poor don’t figure in the top tier of their concerns.<sup>248</sup> Hence, the hypothesis is that aging societies may be more likely to support cuts to education spending alongside increases to pensions and policing, and also less likely to support the Green Wave.

Recent election results in Switzerland support this hypothesis: Over-65s would have voted for far more conservative outcomes than the ones ultimately chosen, and it was only significant youth turnout that shifted politics towards a greener, more liberal future.<sup>249</sup> Hence, in an ever-older society, liberal world-views are likely face growing resistance, unless young people can be mobilized. This could potentially lead to more skepticism and/or more conservative legislation with regards to areas such as clean tech, innovative new mobility concepts or other areas.

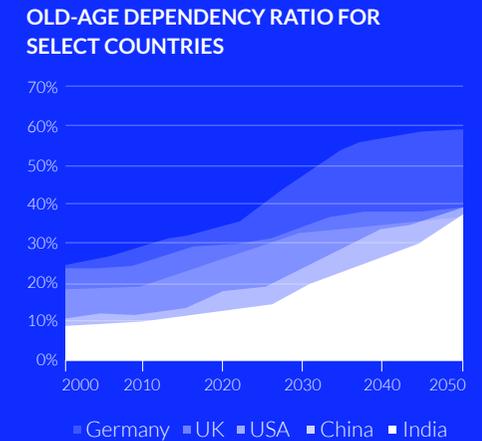
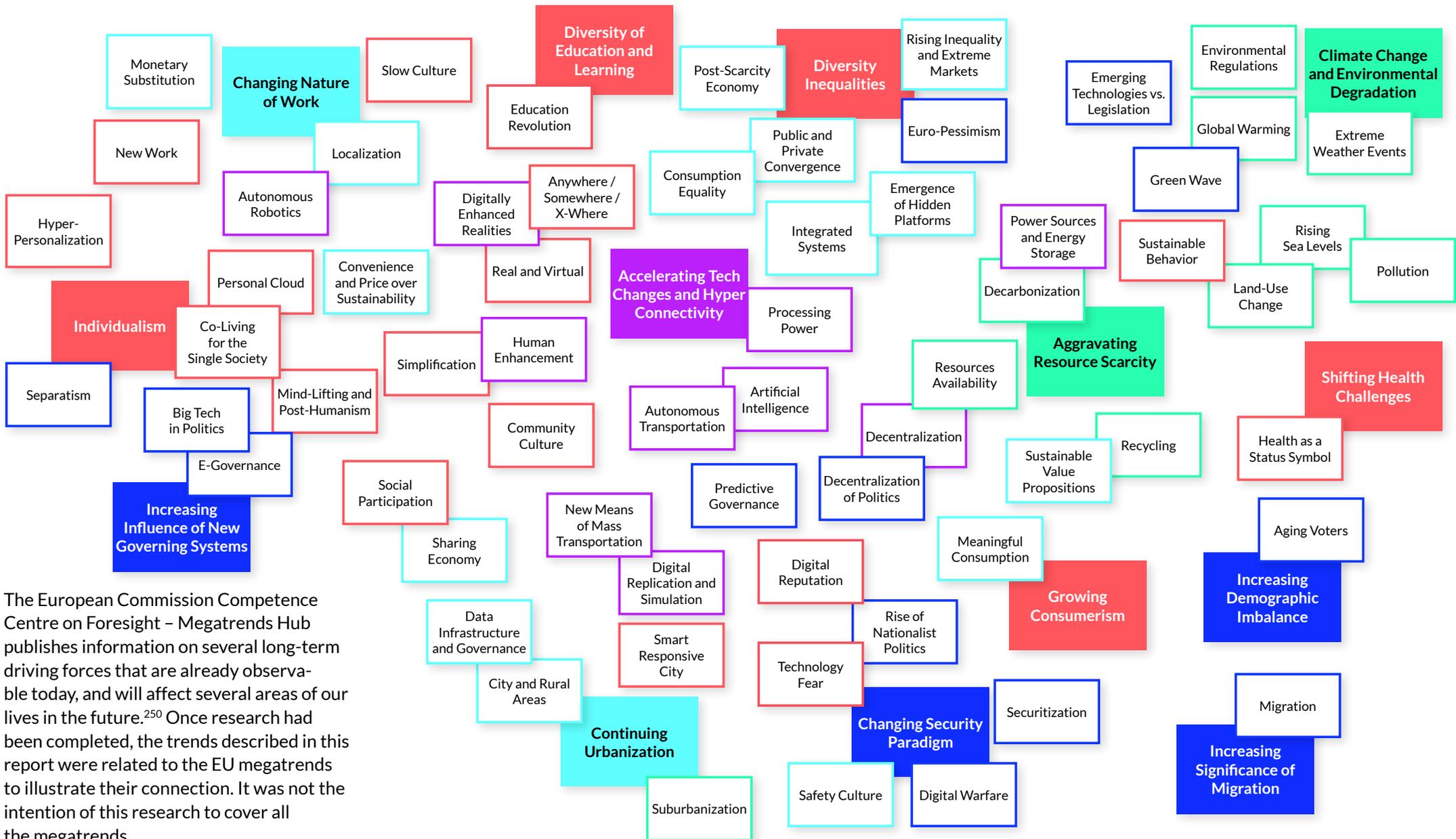


Figure 39: Society is getting older, increasing the old-age dependency ratio.

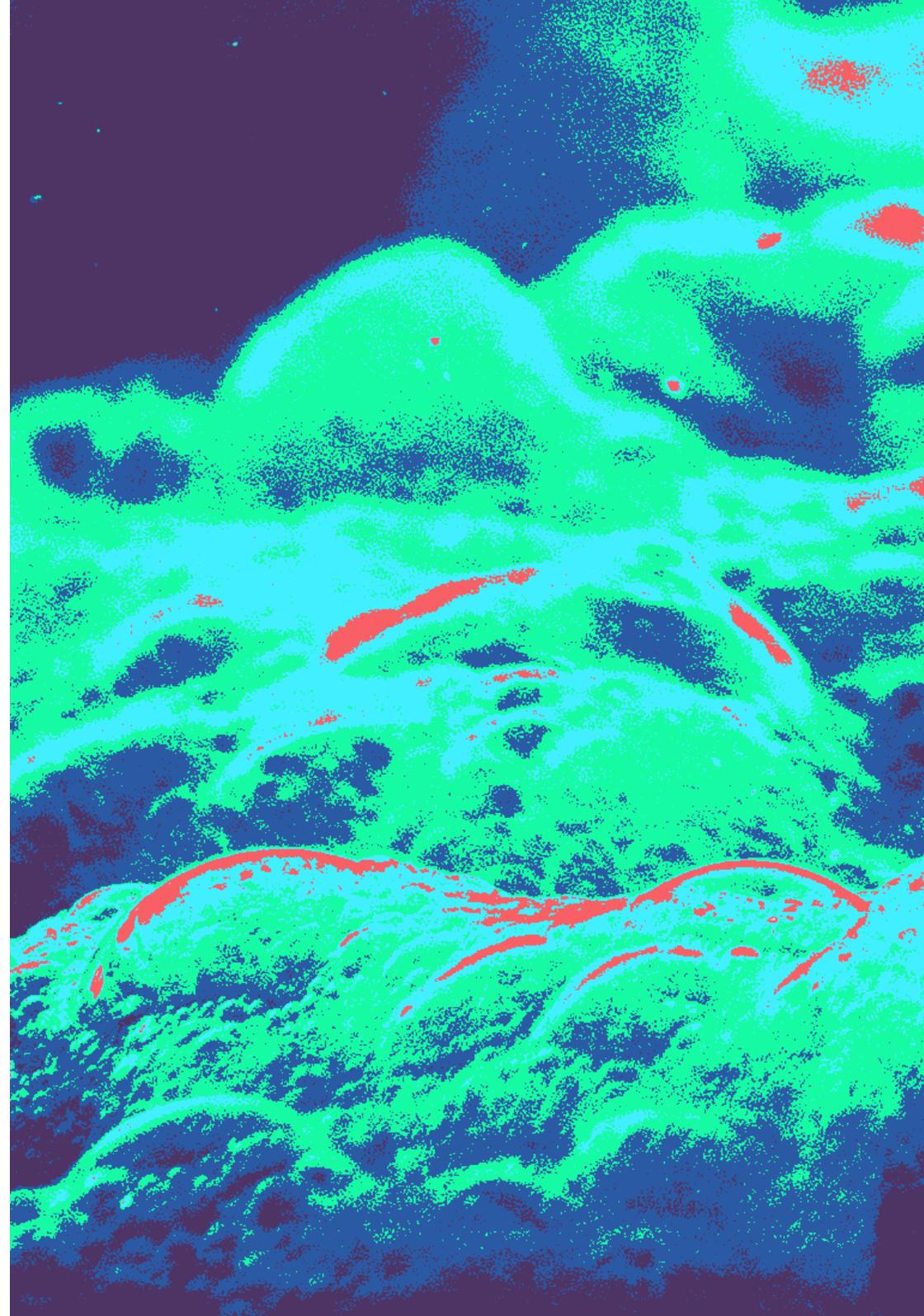
# MEGATRENDS



The European Commission Competence Centre on Foresight – Megatrends Hub publishes information on several long-term driving forces that are already observable today, and will affect several areas of our lives in the future.<sup>250</sup> Once research had been completed, the trends described in this report were related to the EU megatrends to illustrate their connection. It was not the intention of this research to cover all the megatrends.

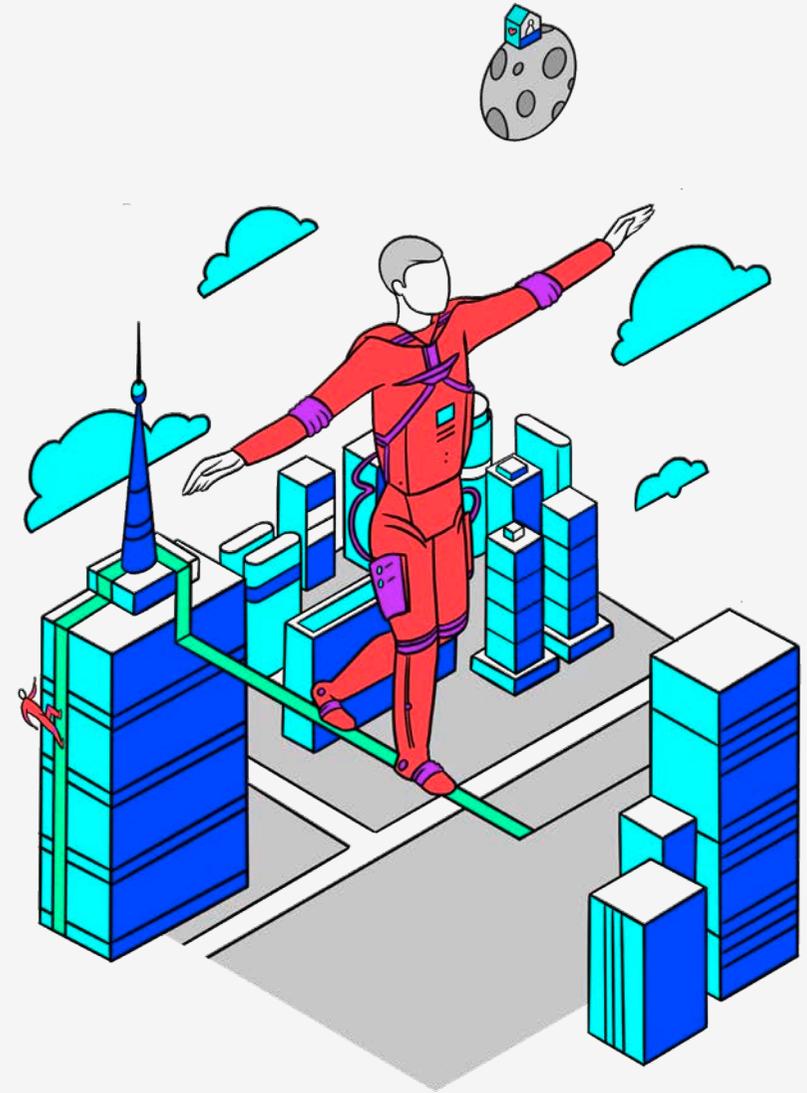
# SCENARIOS

The following stories illustrate four potential scenarios about how we will experience mobility by 2040. Of course, none of them will materialize exactly in this way. However, altogether they draw a picture and exhibit significant artefacts people will recognize then. They provide the foundation to imagine, dream and mentally travel to the future. This helps to ideate, prototype and test solutions for tomorrow and build empathy for the people moving around in a world that is hard to imagine today.



# HUMAN+

The first brain-computer interfaces hit the market in 2037. They allowed direct, bi-directional communication between human brains and external devices, and even restored some sensory perception to those who lacked it due to physical disabilities. Implanted chips extended the brain's capacity and connected it to the internet. Soft wearable exosuits appeared that enhanced physical abilities such as walking, jumping and gripping, while extending the tactile perception of reality. Alongside advancements in data transmission, these advances made teleoperation viable – so repair technicians or surgeons could do their highly specialized work remotely. Humans were on their way to becoming cyborgs, permanently connected to devices that enhanced their mental and physical capability.



## CONTEXT

- In the 2000s, a range of physical devices and digital apps brought health and lifestyle together in new ways.
- The 2020s saw the first concepts that enabled humans to transcend the limits of their natural capabilities.
- Microchip implants connected individuals with information on external databases and allowed for personal identification, disclosure of medical records, access according to security settings and automatic payments.
- By the 2030s, implants could record the levels of drugs within the human body. GPS capabilities allowed the spatial and time-based tracking of individuals.

Roland, 26, is a true cyborg native. A life-long geek, he's one of those early adopters who look for every way they can optimize their daily lives through technology. At 26, he's also a real go-getter, and has already founded a successful company.

The key to Roland's achievements is his never-ending monitoring of his personal health. It's been five years since he got his electronic healthcare chip implanted; it was supplied and subsidized by his healthcare provider. The health chip is permanently connected to an interactive, AI-based coach, dedicated to optimizing Roland's productivity by offering recommendations on diet, nutrition, exercise and sleep. Everything is grounded in health data collected from Roland and his fellow early adopters.

Roland's ultra-healthy meals are diligently prepared by his trusty AutoChef – a sophisticated kitchen device linked to his virtual coach that works rather like a 3D printer for food. The fridge and larder are automatically restocked by an autonomous robot delivery service while Roland is busy at work; all he has to do is carry the goods – packed in reusable containers, of course – from the doorstep to the kitchen. During the daytime, in order to boost productivity, Roland takes dietary supplements based on nutrients, vitamins, minerals and anti-oxidants that are naturally found in fruits, vegetables and nuts, as well as fish and dairy products. In the evenings, to enhance sleep quality, the AutoChef thoughtfully provides dishes that are higher protein and lower in fat. Whenever he can, Roland follows his coach's recommended bedtimes. Once, he even left a concert early so his weekly sleep stats didn't take a hit.

Roland's friends can't get their heads round all this, but they've long given up trying to talk him out of it. For them, what makes life worth living is the joy of eating great food and a glass of fine wine, around a table, in the company of old friends. Roland loves a good dinner too – but only on special occasions. When it comes to his day-to-day routine, he's all about control. His smart home is full of interconnected devices that independently share data and shape the environment to his needs. Temperatures, air quality and light levels are adjusted in response to weather conditions and Roland's own activity,

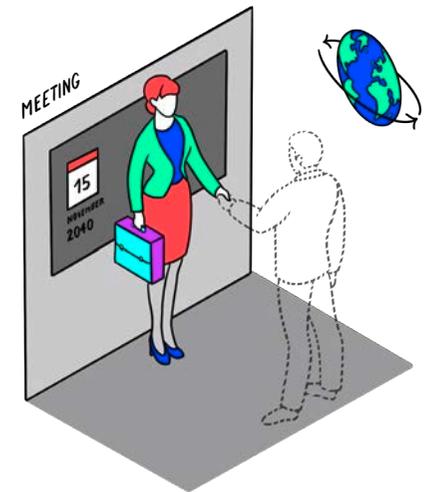
while housekeeping, grocery shopping and maintenance are all taken care of automatically.

Humans have always striven to augment their capabilities. They have fashioned glasses and telescopes, hearing aids and noise-cancelling headphones, bicycles and cars, crutches and wheelchairs, cranes and excavators. At the beginning of 2000s, contact lenses, augmented hearing aids, fitness trackers and a myriad of wellness, optimization and sport apps brought health, lifestyle and gadgetry together in new ways. Around the same time, scientists discovered how to augment brain activities to suppress the symptoms of neurological diseases.

The 2020s saw the first concepts that enabled humans to transcend the limits of their natural capabilities. Microchip implants connected individuals with information on external databases, and allowed for personal identification, disclosure of medical records and access to buildings, departments or rooms according to security credentials. They also enabled automatic payments, fostering the development of a cashless society.

Even though his parents strictly opposed the technology due to concerns over privacy and identity theft, Roland got an ID chip implanted as soon as he turned 18. He was already seriously into optimizing his time and his way of life, and the well-established implant technology was perfectly in tune with his goals. Now he could share data on his movements with individuals and AI entities – in fact, selling his personal data

allowed him to generate the seed capital for his first company. For Roland, data is an asset to be monetized like any other, and he firmly believes there's no real downside to doing so. Others, meanwhile, are far more mindful of the value of their data and their digital reputations, realizing how fragile they can be in the wrong hands. Newly founded NGOs carefully evaluate companies' data policies and actively warn citizens of potentially harmful agreements.



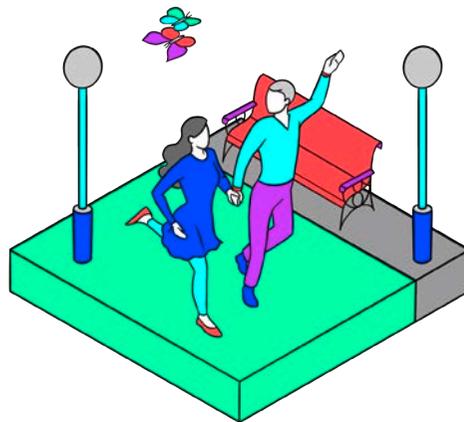
Three years ago, Roland went a step further and became one of the first people to implant the free Google Mind chip. Now he had a permanent connection from his brain to the internet, which dramatically expanded his information retrieval abilities. In Roland's view, interfaces for the manual input and optical perception of data are yesterday's tech. With iGoogle in place, he can access information in an instant, translate his

thoughts into multiple languages and connect to others in a truly virtual space. Without leaving his couch, he can travel instantly to virtual locations around the world.

Since VR technology cannot yet replicate reality in all its sensory richness, soft exosuits are still used to transfer tactile information. However, exosuits do much more than this. Through micro-servo technology and sensors placed on the wearer's muscles, they can also enhance their strength, agility and coordination, up to and even beyond the limits of the human body. In the workplace, this allows a single worker to take on heavy tasks that might have required two people or a machine to accomplish. There are exciting leisure options too – for example, although Roland's balance has never been so great, in his exosuit he can walk a tightrope, or find out how it feels to walk on the moon. Finally, exosuits can sometimes restore people with serious injuries or disabilities to full mobility, even allowing those who have been lifelong wheelchair users to walk normally for the first time in their lives.

Such heavy augmentation of the body has led many to question what it really means to be human. If everything is effortless, and actions are as easy as thoughts, has life become more like watching TV? Where is the fulfillment that comes from working hard, overcoming challenges and receiving a fair reward? If there is no longer any pain, is there really any gain? Is it really human beings who are doing all these wonderful things, or just machines?

Roland's working day is shaped around meetings, presentations and one-on-one conversations with clients around the globe. Depending on the technology that his counterparts have available, they either join him in a VR or AR meeting room, or he delivers a presentation by appearing as a holographic projection. These virtual solutions enable Roland to completely eliminate wasted traveling time. For important meetings, however – and especially when rapport, empathy, collaboration and creativity will add value – people still go to the trouble and expense of physical travel. Team-building sessions, strategic brainstorming and job interviews, for instance, are frequently still held face-to-face. As the technology gradually replaces real meetings, the doubters maintain that meeting physically is never a waste of time or resources, since only direct interaction allows a true connection.



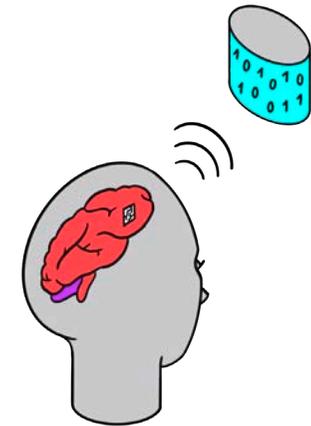
By 2040, the only thing holding virtual reality back from perfection was the absorption capacity of the human brain.

Researchers advancing the development of invasive brain-computer interfaces were expected to make external devices such as VR glasses, headphones and soft exosuits obsolete, while extending sensory information in the realms of smell and taste. As well as allowing anyone to enter a perfect virtual realm, this technology promised a new world of experience for people born with sensory defects, or those who had lost the use of one or more senses following accident or injury.

Technology may have changed human nature over the last 20 years, but it still can't replace a human being. Six months ago, Roland's girlfriend Rita was selected to spend three months at a base on the moon, as part of a program created by Virgin Galactic and the Apple/Google consortium to explore the implications of long-distance space travel and life on other planets. Public and private companies alike are working on special missions to populate other planets, even though interest among the general public in long-term off-world living is negligible. While Rita is away, Roland can see and chat to her in VR, and even exchange some tactical sensation through their exosuits – but no suit can take the place of a person, or the thrill of romance.

That's why Roland recently signed up for a trial of the latest advanced brain-computer-interface chips. This next generation can fully replicate reality across all five senses, with no need for any additional interfaces. As part of the space exploration program, Rita has also had a prototype chip

implanted before her lunar expedition. Now, Roland and Rita hope to connect with each other in an alternative realm that replicates physical reality down to the tiniest detail. Finally, they will meet as a couple in the virtual world.



## OPINIONS

"Each different aspect has huge potential to improve people's lives. It could level the global playing field."

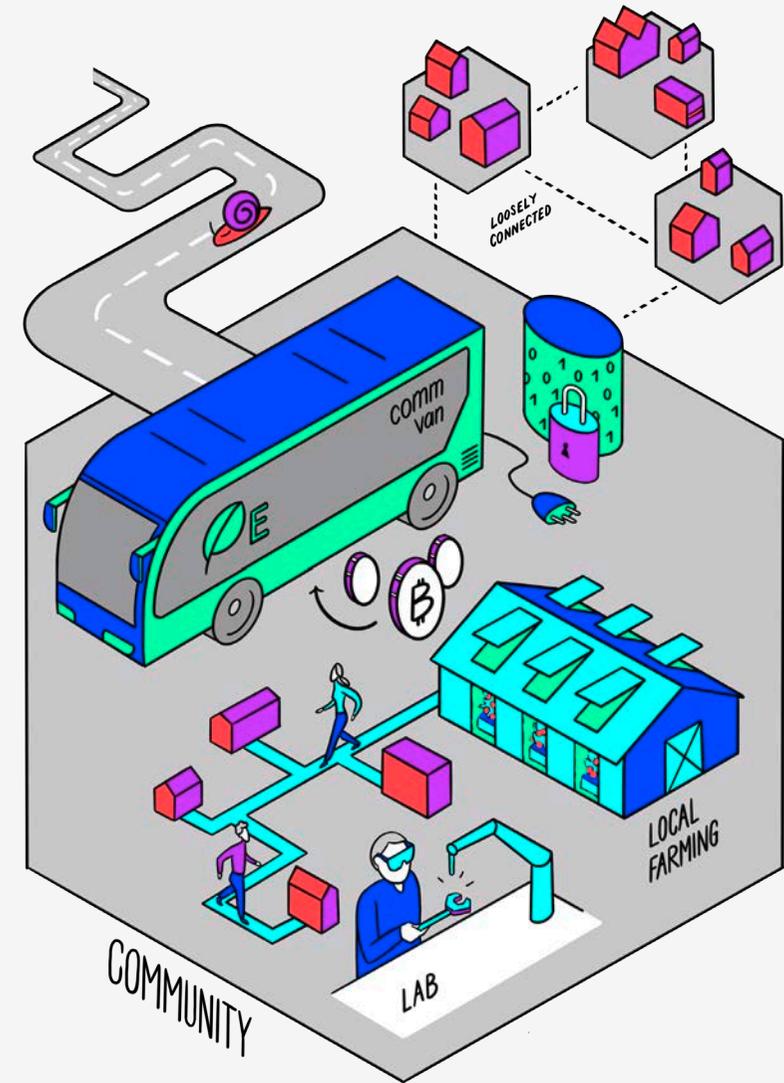
– Oliver Schweizer, Student

"Although AI can help us live in a better environment, which is good for health, I still hate everything being under control. If we lose our freedom, a longer life seems to have no meaning."

– Zhuoyi Liang, Student

# ECOTECH ARCHIPELAGO

In 2028, northern Portugal was swept by raging wildfires whipped up by savage winds. The resulting damage to crops and rural supply chains created a long-lasting and catastrophic food shortage in the capital, Lisbon. The government, unprepared for the disaster, was slow to respond, provoking widespread civil unrest. These events highlighted the fragility of Europe's infrastructure, and its vulnerability to climate change. European entrepreneurs decided to look for a better solution. Increasingly, they opted to move out from the cities to rural areas, where they founded communities that leveraged automation and decentralized technology to become self-sufficient. Over the decades that followed, this movement gradually went mainstream, replacing the centralized infrastructure of the past.



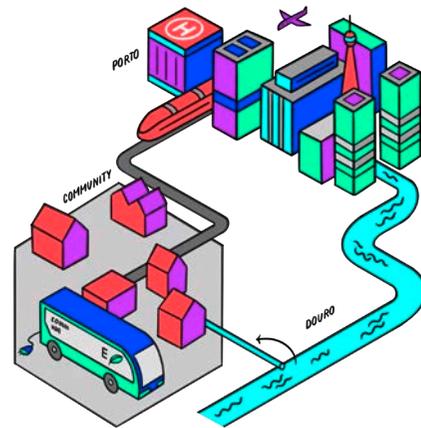
## CONTEXT

- The extreme weather events of the 2020s caused several humanitarian disasters, including urban famines resulting from supply-chain disruptions.
- Members of the “Green Wave” generation were radicalized into action – some constructively, others destructively.
- A range of different decentralized systems emerged, including currency, farming, work, communities, etc.
- The EU implemented a strict regime of taxes on CO<sub>2</sub> emissions.
- The most significant security threat from terrorism became the hacking of smart systems, which had the potential to disrupt entire cities, or even countries.

Today is Nathalie’s 15th birthday. She was born and raised in Novo Rumo, an EcoTech Village close to the River Douro in rural Portugal. Nathalie likes to hang out with her friends, out in the countryside and at the village’s tech-hub. At the hub, she enjoys learning about engineering, building interesting devices or writing new programs – activities that partially substitute formal schooling. Overall, her schooling is partly local, partly digital, and organized more by projects than by traditional academic subjects. Nathalie has recently applied to the High-Tech Apprenticeship, which involves travelling from village to village meeting various mentors and participating in different projects along the way. Through these collaborations, she hopes to learn about different technologies

and how they can be applied to solve the challenges faced by her community.

When Nathalie was little, she remembers Novo Rumo being a lot smaller, with just a handful of families and basic dwellings scattered within sight of the river. At that time, there wasn’t much food to be found in the local area. For many members, that was the whole point of living in such a community, but she remembers all the parents being upset. In fact, her father was so unhappy that he left the village, alone, to find a better place to live. However, it wasn’t long before he came home to his family. As he told them: it was the same story everywhere. Nowadays, the self-governing community of Novo Rumo receives several applications for new memberships every week.



Anyway, after a few years, things started to get better. The waterwheel and solar panels meant there was always enough power for the village and the greenhouses produced more and more different fruits,

vegetables and crops. Nathalie remembers her 10th birthday as a big party where friends from other villages came to meet her grandparents, who made the trip out from Lisbon for the first time.

Novo Rumo was one of the first Eco Tech villages set up by a pan-European group of pioneering entrepreneurs. After what is now known as the Lisbon Famine of 2028, they decided to live up to their environmental and decentralized ideals by founding new rural communities. Every village agreed to abide by the same set of values, or rules for living:

- Take care of nature as it is the source of life. Do not waste it.
- Knowledge and technology serve life. Life should not serve technology.
- Live slowly, as life is finite.
- Trust and respect yourself, and others who may be different from you.

Although there is a central governing body for all EcoTech villages, it is largely ignored by individual communities, while also being tolerated by national governments. The communities are self-regulated, with transactions affected through smart contracts that enable traceability and build trust. Village inhabitants freely choose and apply for their membership, actively choosing to live by the same values and tackle the same challenges. Inevitably, there is some conflict – but it is relatively rare, since communities are based on shared values and can sustain themselves. They grow to the limits of their collective interests, and quickly exclude those who violate their norms.

Over time, more EcoTech communities were established, and a network of villages along the Douro began to join together to form what became the “EcoTech Archipelago”. They are far enough from the river to be safe from floods, yet still close to water supplies for emergencies such as forest fires. Essentially, they are a decentralized yet connected group of small local settlements, governed and managed with digital technology and living according to their own emergent subset of laws, values, voting systems, etc. Each village produces its own food and energy, at the highest levels of efficiency but also with great awareness of the environment. Some essential one-off products are manufactured on a local, shared 3D printer using recycled plastic.

Villages engage and trade with other villages and cities, but always maintain a balance to ensure that every village is resilient to global infrastructure issues. To regain control of their privacy and protect the personal data of their inhabitants, the network has pioneered the decentralized web, which is evolving in parallel to the centralized internet. While the national government tolerates such autonomy, it was a recurring issue of dispute. The villages trade with a set of local digital currencies that are only used for physical goods and food production. These currencies are indexed to the national government currencies, which villages use when they need to exchange physical goods or digital services with smart cities. As the villages were founded by technologists and entrepreneurs, a large part

of the local economy depends on remote work carried out for select companies and organizations that hold the same values. On the other hand, EcoTech villages have also become a fashionable destination for corporate training, and often host innovation retreats for teams coming from cities across the EU to work on temporary projects.

For Nathalie's 15th birthday, her parents have booked the village's shared e-camper through CommVan, a platform for hyper-local car rentals, and are taking her to visit her grandparents in Lisbon for the first time. The 390km journey takes about a day, because her parents choose the least energy-consuming route and have planned some impressive stops. But Nathalie doesn't mind – she likes visiting other villages and admiring the landscape along the way. Her father tells her about when he was younger and nobody cared about the environment. Trips like this would only take a few hours. Nathalie thinks it would be exciting to travel so quickly, but she can't imagine why anyone would want to harm the environment.

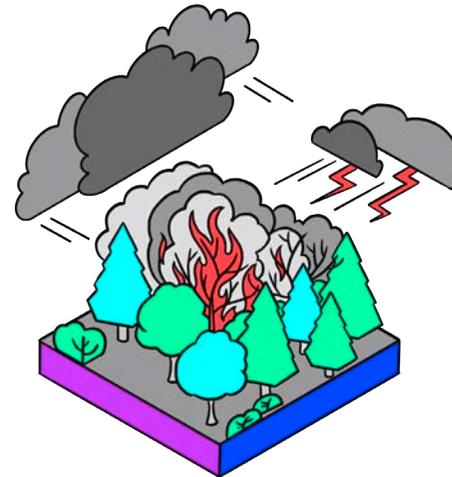
Nathalie's parents have warned her that the city will be a world away from Novo Rumo. When the time comes, she feels an unfamiliar mix of excitement, curiosity and fear. On the approach to Porto, she notices that the road is nearly empty, with just a few little cars that zip past them at incredible speed. Now, as they make their way through the suburbs, more and more small cars appear, until eventually the traffic is gridlocked, crawling along even more slowly than their e-camper did on the dirt tracks near

their village. Apart from the cars, everything is big – big buildings, big shops, big houses, big bridges. Everyone wears a serious expression and hurries wordlessly along the sidewalk. There's no birdsong, no insect chirps – only a relentless whirring from the drones that hover and dart overhead. Nathalie's dad says they're for "security". She wants to ask him what that means, but then she's distracted by the huge, shimmering shop windows, full of so many things she's never seen before – unless it was on a screen. She's never seen so much in so little space and time. But there's one thing she just can't understand: why do her parents hate the city so much?

At the time of Nathalie's trip to Lisbon, the average Portuguese child is still socialized in structures that predate both the natural disaster and the resilience movement. People still travel by plane and buy avocados grown on the other side of the world. Meanwhile, EcoTech village inhabitants live by strict values that have yet to take root among the general public. However, awareness is growing all the time, and the concerns of the movement – which some compare to those of 1960s hippies – are starting to spill over to the average Portuguese. On the other side of the coin, community dwellers are sometimes judged harshly by outsiders, who accuse them of isolating their children and denying them the opportunities that the world of 2040 could offer.

Nathalie's grandparents both grew up in Lisbon, and are fiercely proud of their city and its heritage. It has been more than 15

years since their daughter decided to give up on her trendy lifestyle, her excellent job at Google and her beautiful apartment in the Alfama neighborhood. She and her family departed a year after the Lisbon Famine of 2028, which resulted from a rare combination of extreme heat, raging wildfires and strong winds. The effects were severe – even worse than those of the earthquake in 1755, which left a long-lasting scar on Lisbon's history. The fires disrupted much of Lisbon's food supply, and within just four days, there was almost no food to be found in the city.



Wildfires prevented help getting through by land, and even though emergency support was attempted from the Atlantic ocean and by air, the powerful winds made this impossible too. Rioting and looting went on for weeks, fights broke out over food, and a few unfortunate citizens died of starvation. In fact, feelings ran so high that the unrest

continued even after food supplies resumed.

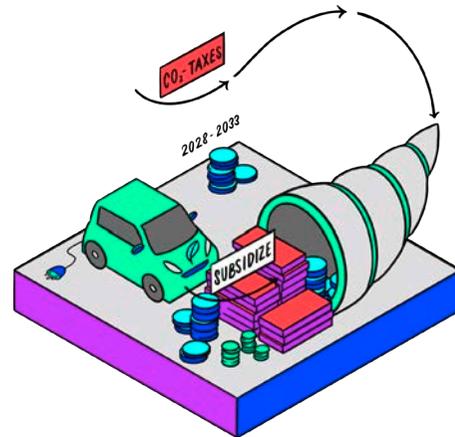
Nathalie's family has always been well off, so as soon as the situation calmed down, her grandparents drove over to their summer home and stayed there for a few months until they felt safe again. Nathalie's grandfather still complains that he lost a fortune in the Famine. Nathalie's parents, meanwhile, who both worked for Google, stayed put, as the company offered free meals to all of its employees and the option to live temporarily on campus. Realizing the seriousness of the situation, Nathalie's parents teamed up with some colleagues and tried to organize help. The company's head of security objected, saying it would only cause more trouble. But her parents, as Nathalie very proudly recalls, disobeyed and snuck out of campus to distribute supplies. The destruction, desperation and danger they saw had a lifelong impact on their politics, values and worldview. For their generation, nothing would be the same again.

Hot on the heels of the food crisis came a political one. All across Europe, voters abruptly turned against their governments and the policies – or lack of them – that had led to the famine in Portugal. This drove changes in policy, infrastructure and security quicker than any Europe had experienced since the end of World War II. While the changes took a heavy toll on most of Europe's lower and middle class for a while, the majority accepted that they were necessary, and endured them with relatively little unrest. Over a period of five years, taxes were imposed on CO<sub>2</sub> emissions, increasing the

cost of flights, fuel-based cars and imported goods that carry a heavy ecological footprint. Similar actions had been taken as early as 2021. However, since global warming was still continuing, and emissions targets were far from being met, these existing policies had to be dramatically strengthened. In Portugal, the government sank big subsidies into the transition to green energy, sharply accelerating the development and adoption of alternative energy sources, synthetic fuels and high-capacity batteries. Radical changes in transportation and public-services infrastructure achieved immense efficiency gains, although they also raised some new risks and inevitably meant sacrificing some freedom of choice. Terrorism, which had been almost entirely eradicated, resurfaced in the form of action against public and private institutions that were perceived as guilty of enabling, ignoring or responding too slowly to the climate crisis. EcoTech Villages like Novo Rumo were initially blamed for these attacks, which made life difficult for Nathalie's parents for a few years.

At the same time, Europe's cities started to rethink their resilience. Scientists were certain that local farming was less efficient, since economies of scale and scope did not apply. Therefore, creating only small local farms would merely serve to increase greenhouse gas emissions. At the same time, monocultures located far away didn't just destroy biodiversity, but also led to long, "dirty" supply chains. Ultimately, governments heavily subsidized regional food production and also invested more into local and urban

farming. The heart of this policy was enabling and empowering people to care for a small share of their own food supply.



Eventually, the e-camper pulls up outside Nathalie's grandparents' apartment in Baixa/Lisbon, which has been in the family for generations. Nathalie has rarely seen her grandparents, and has never set foot inside their home, or even one like it. She doesn't quite understand what work her grandfather once did, but she knows her grandparents are retired and now dedicate their time to philanthropy. Nathalie likes her grandparents and the stories they tell about their work, but she can't understand why they choose to live a "grey life". Nathalie once asked her grandmother about this, and her reply was that there are different ways of being good and helping people or the planet; their way was just different from that of Nathalie's parents. However, walking through her grandparents' home for the first time is quite a surprise for Nathalie, as she

compares it to the austerity of her own upbringing. Having seen so much in such a short time, she no longer knows what to think. She feels repulsed, yet also intrigued. And she wonders, for the first time in her life, if her parents might not be right about everything.

### OPINIONS

"I see this as a tiny micro-niche for idealists, but irrelevant for society at large. It's 'ideologically' green – driven by idealism rather than technological forces."

– Claudio Feser, Senior Advisor at McKinsey & Company

"Small, self-sufficient economies will never be more efficient. It is just wrong; a silly utopia. Whether we like it or not, economies of scale – whether in agricultural production or any other type of production – are linked with efficiency."

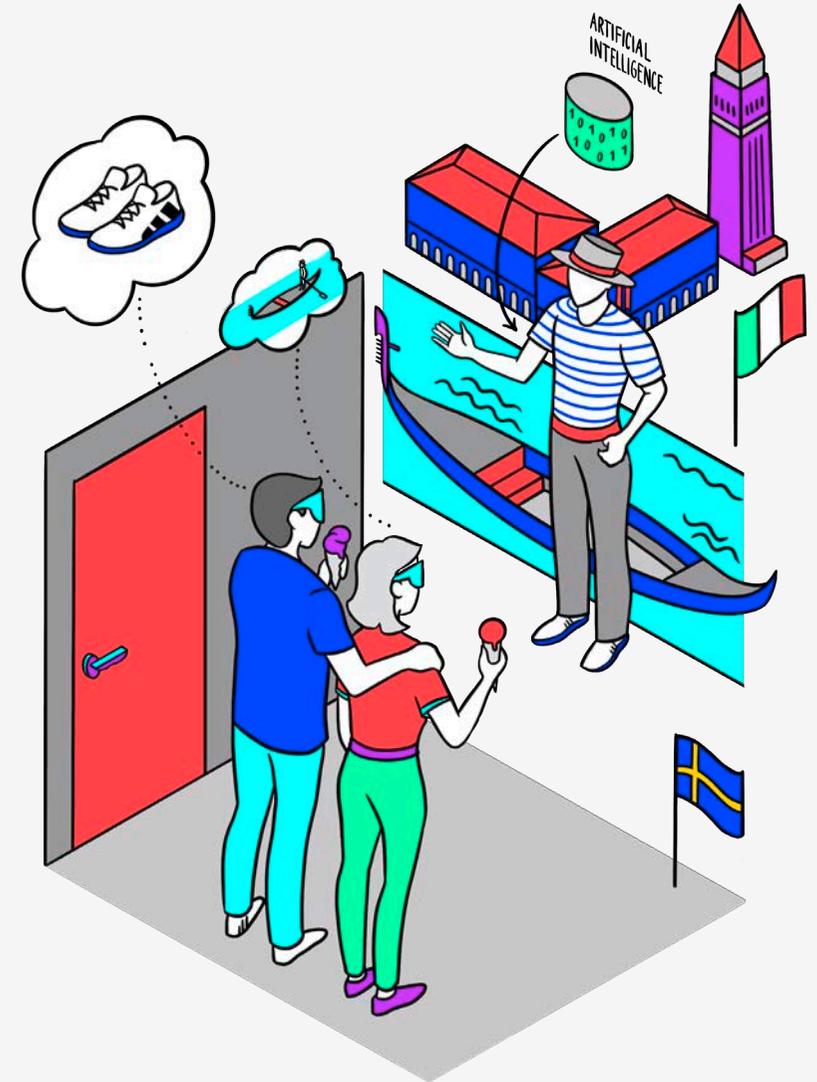
– Michael G. Jacobides, Professor at London Business School

"I like that they support 'Live slowly as life is finite.' I would definitely like to try this out for a couple of months."

– Bojana Nenezic, Student

# DIGITAL VENICE

Over the past 20 years, an ever-expanding area of Venice has spent an increasing number of days per year submerged beneath the waves. Eventually, the local government had to implement drastic measures, with the help of the UN. For decades, the effects of climate change were predicted accurately and in detail by scientists, but played down by politicians and the private sector. The result of this inaction has so far been reflected most visibly in increased flooding and extreme weather catastrophes around the globe. While robust measures are now in place across Europe, it is unclear whether these will be sufficient. Lifestyles have changed for everyone.



## CONTEXT

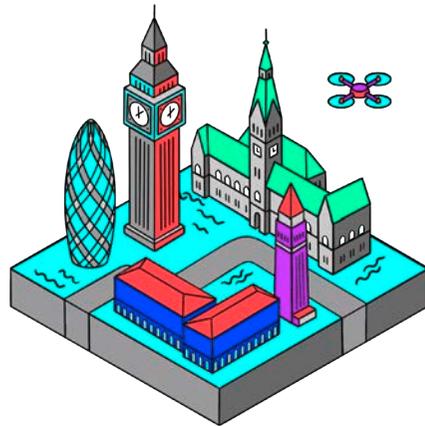
- In a radical move, governments imposed punitive taxes on CO<sub>2</sub> emissions throughout the EU, and banned CO<sub>2</sub>-producing technology.
- Tourism, once a common activity for Europeans and a major source of revenue for many cities, has largely disappeared, replaced by digital travel.
- Through virtual reality, most individuals can visit digital real-time replicas of an increasing number of cities around the world.
- New forms of digital economy have emerged, all clustered around this new digital tourism.

Mark is 25. He grew up in Herräng, a coastal village near Stockholm, surrounded by the natural beauty so distinctive to Sweden. During the summer, he enjoys hiking and sea swimming. However, the Scandinavian winter is long, and the hours of daylight all too short. In his teenage years, when Mark was too young to go out to the city on his own, he spent the long dark evenings alone at home, playing virtual reality (VR) games remotely with his friends.

Mark had always dreamt of big city life and traveling to far-flung places. After leaving school, he moved to London, where he spent a couple of years working as a lighting technician in a small theater. In his free time, like most of his generation, he would travel and learn about the history of Europe and the world. Of course, he also had his fair share

of fun, enjoying the local nightlife and savoring the feeling of freedom his life-style brought him.

However, 12 years ago, Mark's long-distance lifestyle came to an abrupt halt. In 2028, new carbon-neutral regulations saw the cost of air travel skyrocket, almost overnight. Mark tried switching to driving, but it was a short-term fix at best. He was forced to sell his car cheaply for scrap, because it was fuel-based and hence banned under the new legislation. Even train tickets became absurdly expensive, as demand spilled over from other means of transport that were now unviable or unaffordable.



The bottom line is that physical travel, especially over longer distances, is out of reach for Mark – and almost everyone else. Plane and ship manufacturers are investing millions in research and development for hydrogen and artificial-fuel solutions, and actual products will be launched in the market by 2041. However, policy makers

took their radical action long before that – surprising those observers who thought they would always take the safe, soft option in the interests of economic and political stability.

One of Mark's top travel destinations was Venice. Italy's "floating city" had suffered from flooding for more than a century, and it had got steadily worse every year. For example, in the early 1900s, the famous Saint Marcus Square would be flooded for around four days a year. By the early 2000s, this had increased to about 40 days a year. Rising sea levels were partly to blame, but the real villains were the deadly storm surges, which were pushing much further inland than ever before, leaving a trail of destruction in their wake. Experts from the ENEA (the Italian National Agency for New Technologies, Energy and Sustainable Economic Development) had been looking at flooding for decades, and had predicted that the Mediterranean would rise by up to 140cm by 2100, swamping 285 kilometers of coastline in the northern Adriatic, including stretches of the Italian coast. In 2030, it became clear that their predictions had been optimistic. Had it not been for drastic measures, and an outpouring of resources from the UN and other organizations around the world, Venice would have been lost to the ocean by 2035.

Although most of Venice was saved as an island surrounded by flooded plains, it has been fully evacuated but for engineers and technicians, who work around the clock to secure it and its treasures. For now,

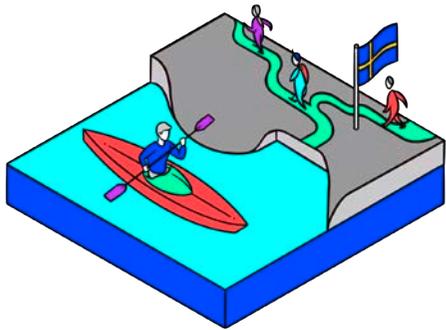
a limited and tightly controlled fleet of drones is the only window on Venice for the rest of the world.

Areas that were less well known, or less historically vital, were not so lucky. By 2100, more than 3,000km<sup>2</sup> of coastal plains bordering the northern Adriatic will be flooded, including 33 areas of Italy. This continuous loss impacted the environment, local infrastructures and around eight million local inhabitants, prompting a huge wave of internal displacement within Italy.

Meanwhile, similar disasters were befalling northern European cities such as London, Amsterdam and Hamburg, which all suffered major damage, disruption and loss of life as their rivers burst their banks, flooding busy urban areas. Along with the catastrophe known around the world as the "Flooding of Venice", these events finally pushed European governments into immediate and decisive action against climate change.

Taxes on CO<sub>2</sub> emissions were increased heavily, and soon afterwards, all carbon-positive technologies were banned. However, electric transport had yet to be widely adopted. One of the hardest-hit industries is transport and tourism: for most citizens, long-distance travel through Europe is no longer affordable. With travel now a luxury, everyone – rich and poor alike – has had to make some major compromises. The European tourism sector, which accounted for over half the global industry, has suffered significantly over the past few years. Visitors to Venice, who had numbered 20m in 2020, declined sharply. Other popular

destinations such as Paris, Amsterdam, Rome and London saw a big rise in unemployment, and a new type of poverty arising from the eroding tourist sector.



As an alternative to traveling, Mark has started to fill his evenings with VR games again, just as he did as a teenager. His girlfriend Agnes, who previously shared his passion for traveling, can't understand this hobby, and has even begun to question their relationship. However, they both still enjoy travelling locally, so they go for weekend hikes or kayaking in the nearby rivers, or head to friends' houses to play board games. While Mark and Agnes see themselves as environmentally conscious, they now realize how much of their free time, and even their short-term life goals, previously revolved around carbon-based technology. Life was what happened in between trips: starting a new semester, or returning to work after a vacation, was made more bearable by the thought of the next journey. Now, the globe-trotting generation who started with InterRail and graduated to EasyJet are grounded – apparently for good.

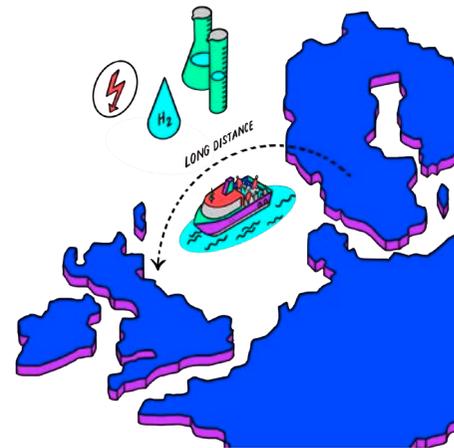
But what if there was an alternative to physical travel? Over the past 20 years, technologies such as artificial intelligence, smart sensors and batteries have all developed rapidly, allowing new designs of autonomous drones that can operate continuously. Originally used in military and surveillance applications, drones now represent a lifeline for the tourism industry.

In the beginning, autonomous drones could fly anywhere, anytime. However, they were soon restricted by regulations. Legislation also aimed to reduce the environmental impact of drones' significant processing power and energy consumption, as well as addressing safety concerns, noise and visual pollution. Now, as the reliability and safety of drones becomes clear, regulation is allowing the technology to thrive.

The tourism sector, desperately seeking a means of survival, started experimenting with new ideas. High unemployment sparked creative thinking, and cities supported new tourism ideas much as others had supported startups in the past. One of the more successful concepts was to make a digital real-time replica of a tourist destination that could provide tourists with an immersive VR experience. Through these "virtual visits", people from anywhere in the world could pay a modest fee to "visit" a city remotely without leaving their homes.

Over time, cities have developed their own add-ons to adapt or extend the virtual visit experience. Virtual avatars, powered by artificial intelligence, guide "visitors" through the digital city, adjust the tour to personal

preferences and respond to tourists' requests, actions and preferences. Some avatars are simply styled as citizens of the host city, while others are recreated historical figures, actors, or fictional characters from the local area. These characters bring a much-needed human touch to the visit, turning it from a passive, cinematic fly-through into an interactive, conversational experience. Other cities have added group travel, so couples and families can all "travel" together.



In some ways, digital tourism is even better than the real thing. Instead of browsing a website or a guidebook, you can take a five-minute "taster" trip to see if you like the destination. There's no queuing, and you can always find a bathroom, or a taxi. You don't have to learn the local language unless you want to, since tours and can be provided in the traveler's own native tongue – as can local signage and newspapers. You can "travel" to your destination instantly, stay for

as long as you want and split your "vacation" over multiple evenings at home. The only downside is that if you want to try the local food, you have to cook it yourself!

Once Venice had been stabilized, autonomous drones began generating the digital recreation by scanning and replicating the city in real time. They worked independently of any other repair or maintenance work, were unaffected by weather conditions, and had no impact on other drones, devices or people on the ground.

The new mode of "travel" created new opportunities for cities throughout Europe, and began to compensate for the decline in physical tourism. In the case of Venice, it makes a valuable contribution to the costs of restoration too. Digital tourism has also created completely new types of work. Remote workers can act as guides for city tours or museum visits, or provide tuition in how to make local dishes or try out local crafts. New digital experiences are being created every day, and Europe is once again accessible to all – in digital form, at least.

Businesses have sprung up offering to complement the virtual tour with tangible and sensual elements, creating a virtual/physical hybrid. SensTrav replicates selected areas of major European cities physically, so that people can interact with physical objects during their virtual travels. With this service, Mark and Agnes can open the door to Saint Mark's Basilica while looking at it through VR glasses, then sit down to enjoy an Italian ice cream.

Now Mark and Agnes can travel together even further, and more often. They don't need to dedicate a full week to visiting a city – for example, they can pop over to the Louvre on a weekday evening after work. VR, Mark's youthful hobby, has become a source of entertainment, sharing and learning for everyone. Even though Agnes is still planning a real-world long-distance trip to Colombia in about four years, she's getting into virtual travel in the meantime. It's something really different. She loves it!

Since Mark knows European history pretty well, and wants to learn more, he starts working part-time as a tour guide. He still spends his mornings as a lighting technician, then in the evenings he develops pre-programmed tours of Stockholm, his home city, or Venice. Tourists who want an interactive and personalized tour can make an appointment for him to join them and chat as they make their way around the virtual city.

The Sinking of Venice changed the lives of Mark and many other travelers forever. But today, digital tourism has brought new, more positive changes. Mark now gets to visit many more cities than he did before. However, his traveling time is zero, so he can get to know several cities per week without harming the environment. Travel is not just affordable again, but even profitable, as Mark now makes part of his living from it, so it's improved his quality of life. From time to time, he can even enjoy a real-life travel experience – just not as often as before.

## OPINIONS

“The idea of virtual substitutes for mobility is one that is certainly overplayed, and has been overplayed for the last 40 years. People will not stay still because of the climate; it is the other way around. Because of the climate, people will start moving around faster and faster.”

– Nikolaos Kastrinos, Policy Officer at European Commission

“Taxation – there are two flaws with that. One is that even with all the flooding, if a government sees major potential job losses and industrial decline, I don't think they are going to impose CO<sub>2</sub> taxes as astronomical as you describe. And the other thing is, how much of the CO<sub>2</sub> is actually coming from personal travel?”

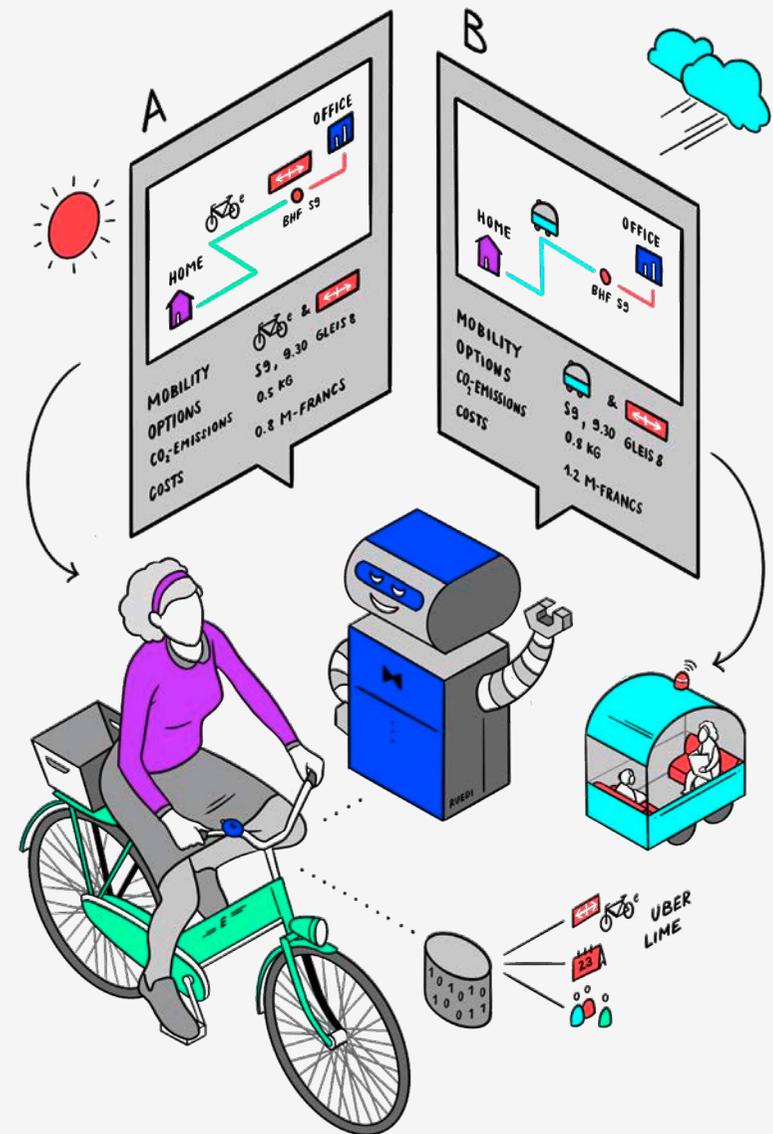
– Anja Schulze, Professor at University of Zurich

“I would like to interact with the people I meet, not only with the ones I already know. And the feeling of sharing my emotions with 'people' who aren't really people scares me.”

– Anna Menasce, Student

# SWISS FLOW

The year is 2042. As a result of the “Green Wave” of the 2020s and the rise of the Green Party in Switzerland, private transport is now taxed at such a level that it has become the preserve of the rich, or those who need it for professional purposes, who receive subsidies. Advances in technology have allowed the creation of a modular but seamlessly integrated transportation system. Thanks to a national digital currency, along with the involvement of the old Swiss Federal Railway (SBB) in the nationwide transport network, traditional Swiss reliability has extended to every part of life. However, the idea of punctuality has largely become a thing of the past, replaced by an effortless flow from A to B, available to everyone, on demand.



## CONTEXT

- The “Green Wave” of the 2020s had a profound impact on Swiss politics.
- Transportation has been seamlessly integrated into the Swiss Mobility System (SMS), and is now managed by a single state-owned organization.
- All transport services are streamlined and hyper-individualized.
- For the sake of security and efficiency, the public has voted to grant the state full control over their personal data.
- Digital currency is used to join up all private and public services.

Maya is 67 and lives in the outskirts of Zurich with her husband Magnus. She has two adult children who now live with their respective families in Bern. Maya has a life-long passion for the arts, and her only income now comes from giving private piano lessons. Although some of her fellow tutors now teach remotely, through digital channels, Maya still prefers to commute every day to her city-center studio, or travel to her pupils’ homes. Wealthier clients, in particular, still prefer one-to-one tuition, and are able and willing to foot the bill for it. However, most novice pianists now take their first steps digitally, picking out a simple tune under the watchful eye of a tutor who may be hundreds or even thousands of kilometers away.

Over her two decades as a piano tutor, Maya has built close ties with her clients, and she loves the way face-to-face interaction enriches and inspires her day-to-day work.

Business was brisk for many years, but now her financial situation is looking increasingly shaky. Earnings are up and down, the rent for her studio is increasing and in-person tuition is increasingly seen as a luxury, which is eroding her customer base.

Looking to save money, one of the first expenses that Maya cut was car ownership. Not only was it financially unsustainable; it simply didn’t make sense as public transportation improved. Now, as she rides the quiet electric tram into downtown Zurich, Maya has come to appreciate her newfound hours for reading, listening to music or just sipping a cappuccino from the buffet on the tram. Nevertheless, from time to time, she still misses the solitude, independence and feeling of power that she only got from driving a car. Driving wherever she wanted took her back to the freedom she knew in her youth, when nobody could tell her what to do, or make her feel guilty.

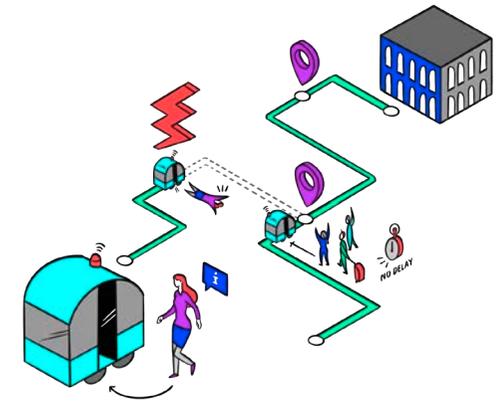
Maya’s son, Mark, is an ETHZ computer-science graduate who now works at the state-owned SBB. He is passionate about big-data analytics, and has played an important part in developing the operating system that combines the multiple data points that are now gathered from practically every Swiss citizen, day in day out. These include people’s GPS location, speed of motion, average travelling time and calendar, as well as the various transportation modes they use, such as autonomous micro-buses and e-bikes around city centers, self-driving cars for the suburbs and trains for inter-city journeys. The system even integrates air-

port data, such as arrival/departure gates, flight delays and the ratio of local passengers to tourists, in order to estimate and anticipate demand for different transportation systems. It also connects to autonomous aircrafts, which are now permitted for medical emergencies and limited private use. By combining all these data sources, the system manages the country’s mobility needs, predicts and solves a wide range of problems and helps to provide new insights into how individuals move around, within the city and beyond.

By the year 2040, SBB was far more than a provider of mobility infrastructure. It was Switzerland’s most important integrator for all public services, and a wide range of private ones as well. At the same time, other mobility providers such as ride-hailing services, scooter companies, exoskeleton rentals and semi-car-ownership services had moved upstream. However, they also integrated SBB data points to build train rides into their calculations, or consider the location of city buses, metros and trams. All now offer trip-based pricing covering the entire route from A to B, relying on a micro-payment concept. Competition is now confined to dimensions such as overall seamlessness, reliability, and a platform’s ability to match passengers’ preferences with the features offered by different vehicles.

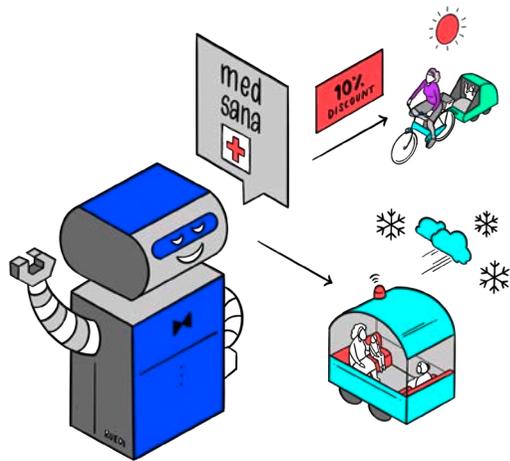
This integrated system helps to inform both policymakers and the design of societal interventions, so they can offer incentives for people to act in line with community, political, economic and environmental goals. Such

behavioral influence was willingly granted to the state through a highly contested nationwide referendum in the late 2020s, under the banner of “Societal Policy”. Those opposing argued against unrestricted surveillance and policing, and the resulting loss of personal freedom. Those in favor convincingly defended the benefits in terms of a safer society and a more efficient and productive lifestyle.



One example of people making lifestyle changes is Maya’s daughter, Francisca. She used to take the microbus to pick up Gina, her seven-year-old daughter, from school. However, since she started using the SMS, it has become crystal clear that taking an e-bike, while certainly slower, is far better for her mental and physical health – which she tracks through her many wearable devices. In fact, the SMS can instantly provide reliable estimates of the temporal, social, environmental, physical and mental impact of alternative means of transportation, allowing Francisca to choose the one that’s best for her. For several

months she really struggled to make a change, even though she fully understood the benefits. Her problem was that she loved riding on a warm, cozy bus; wrapping up for an exhausting winter bike ride just didn't hold the same appeal. However, MedSana, Francisca's health insurer, recently reduced fees for those committing to moderate regular exercise. Now, she uses the e-bike for school runs more often – but on a frosty morning, or after a late night, she still takes the lazy option.



On certain days, Francisca's new routine is disrupted by the crowds attending a town-hall meeting at a nearby government office. During these events, the social impact of her occupying two government employees' spots on the microbus is too high, while the cost of a private mobility vehicle is exorbitant. Therefore, she and Gina usually pass the time at a local playground, saving themselves a tidy amount of M-Francs

("mobility-francs"). Gina usually argues that this saving would be best allocated to the purchase of an ice-cream.

M-Francs were originally introduced by SBB 15 years ago, as a pilot built on blockchain technology to allow customers to buy tickets and everyday products at train stations. A few years later, the Swiss National Bank – seeing how popular the pilot was with local firms – overcame its initial reluctance to roll out the "Digital Franc" (as it was then known) on the same platform. However, a few badly managed advertising campaigns led to public ridicule of the German connotation of the D-Franc. SBB itself was new to the concept, but still did its best to shore up public trust in digital banking. By then the public had become accustomed to the idea of the "M-Franc", and its use in branches of the well-known Migros retail chain gave it a higher profile nationwide.

SBB pays Maya 1000 M-Francs on January 1 every year. These payments are allocated directly to every Swiss resident based on age, family composition, economic situation and the general environmental status of the country, in order to offset high transport costs and redistribute the proceeds of high taxation. Maya's savings and business accounts are now directly linked to her personal M-Account, which is in turn connected to her personal identity. All payments and financial transactions in Switzerland now utilize M-Accounts, which feature orange branding in an echo of the long-gone printed pay-slips that only

older generations can still recall. M-Francs can be exchanged instantaneously and are accessible at any time, at any location.

Maya made her first M-Franc payments in 2028. At first, she was skeptical about the new technology, preferring to use currency that still retained some link with hard cash. However, since her clients were starting to ask if they could pay with M-Francs, and she already used the SBB app with no problems, she slowly started to switch over. When the new currency had first appeared, and was receiving extensive media coverage, she had had several discussions with Mark and Francisca about it. Mark, naturally, was extremely upbeat, and helped her get started, while Francisca shared her nagging doubts. Now, however, M-Francs have become a part of Maya's everyday life.

As SBB further integrated other services and the "Societal Policy" referendum passed into legislation, Maya became more and more anxious about the idea of tracking everyone's information, which was an inevitable consequence of the system. However, her misgivings turned to excitement when she discovered that she could actually "follow" her children's journeys, thanks to the integrated GPS tracking. In itself, location tracking was nothing new. But by utilizing the data aggregation of transactions, speed of movement and non-relatable body movements, Maya's digital assistant would now alert her if either of her children was in danger. In autumn 2036, for example, Francisca stumbled and fell while getting

off a self-driving microbus carrying heavy shopping bags. This event immediately triggered a notification in Maya's smart headphones that included the number of the bus, the mobility operator and the exact location – as well as a rough outline of Francisca's health condition, based on her wearables' sensor data. As it turned out, apart from a few painful bruises, Francisca was fine. Her fellow passengers immediately stopped the bus to make sure she was OK, and it was less than a minute before her mum called to check on her. In the meantime, other buses were re-routed to the passengers that the bus involved in the accident was scheduled to pick up. Not only were they saved from any delay, but they didn't even notice the change.

Furthermore, Mark's and Francisca's accounts are synchronized with those of their families to ensure a preset range of data is constantly shared. This constant, real-time information sharing makes them feel safer and more in control. For their part, their kids are much more relaxed, since they don't have to worry about telling their parents about every little unexpected change to their schedule. Everyone's calendars are in sync and up to date, all day long.

However, not everyone is happy being a cog in the machine. Mark's son, Gerard, has just turned 14, and he's utterly sick of being watched and controlled every second of the day. What he wants is a little more privacy – on his first secret dates, for instance. So he sometimes asks a friend

to carry around his smartphone so he can evade his parents' surveillance for an hour or two.

Like most inhabitants of Zurich, Maya relies on SBB on a daily basis. In practical terms, whenever she needs to move from A to B, she simply requests a ride via voice control. This triggers the SBB app, even if Maya's phone is not to hand. Ruedi, her personal virtual assistant, automatically organizes her trip based on her location, time constraints, preferred traveling style (e.g. eco, standard, leisure or turbo) and order history.

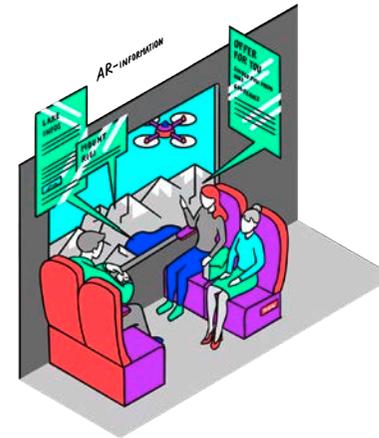
When SBB first introduced this technology 10 years ago, Maya had her doubts. She wanted to talk to a real life person, not some invisible robot. And besides, couldn't she just book tickets herself? Today, however, she chats away to Ruedi without a second thought. He greets her in the morning, talks to her via the interface of any vehicle she uses and thanks her at the end of every journey. What she really likes is the way he gets to know her a little better every day. For example, he's recently learned that every other Tuesday Maya leaves her house at 8:00am instead of her usual time (7:00am) to meet her friends at the book club. He also knows that she enjoys cycling to the station on sunny mornings; the sunshine helps to wake her up. So whenever the weather forecast is good, an E-bike is delivered to Maya's front porch half an hour before she usually leaves. However, what Maya really loves is the choice. She can

choose the design and features of every bike for every journey – or even ask Ruedi to pick a color that coordinates with today's outfit.

While these benefits have made life easier for Maya and many like her, not everyone has done so well. As artificial intelligence replaces humans, the wider economy is suffering, and unemployment among highly educated workers is on the rise. This is especially true for professions where people performed routine tasks – such as doctors operating x-ray machines, or lawyers scanning paper contracts. Such changes have triggered significant turbulence within Swiss society, and have led to the “Wednesday protests”, where disgruntled workers gather in city squares to chant their demands for “more humans, fewer machines”. Others reluctantly concluded that they had no choice but to silently accept the new reality, and gradually became more and more accustomed to machines and human-machine relations – even romantic ones, in some cases. As a result of higher unemployment, more people stay home on traditional working days. With fewer workers, more transport options available and travel spread throughout the day, rush-hour traffic congestion is a thing of the past.

Maya, who's always been careful with her money, generally travels on “Discount mode” – as Ruedi well knows. To see her mother who lives in a remote retirement home in the mountains of Graubünden this forces her to take the train to the nearest station on the countryside. This is new to

her since she sold her beloved car. En route, the carriage windows keep her occupied with history and background on the peaks, lakes and villages she passes. On her arrival in Graubünden, where traffic is sparse and demand lower, Maya has a three-minute wait until her autonomous pod – ordered by Ruedi in advance – arrives to carry her the last 22 kilometers. Private pods are pricey, but there's just no other way.



When autonomous flights first appeared, some dreamt of automated quadcopters that they could board in the outskirts of any city to reach remote rural locations – like Maya's mothers home in Graubünden. But while they are now common in the Middle East, only the very wealthiest Europeans can afford them. In Switzerland, they travel between specially built hubs on demand, reaching most major cities in less than half an hour. Given the energy demands of air travel and strict regulations to avoid

visual pollution, the hop from Geneva to Zurich now costs more than a return flight to the United States 20 years ago. Therefore, the market is modest – but it is still perfectly integrated into the digital mobility universe.

Overall, Maya is very content with the service provided by SBB. Since the service is backed by the government, she's confident that it's 100% reliable. She also enjoys the level of customization to her environmental, financial and personal preferences. Nevertheless, she sometimes fears that she has lost a part of her freedom. When she says something like this, her children accuse her of being selfish and old-fashioned – so she generally keeps her feelings to herself. It's probably better that way, after all.

## OPINIONS

“I'm happy about seeing a response to climate change and using price to change people's behavior to shared and more sustainable means of transport, while retaining flexibility.”

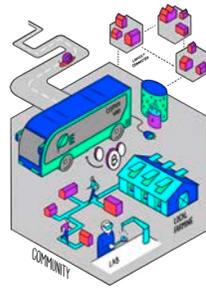
– Elizabeth Weirich Benet, Student

“I would absolutely hate the idea of being controlled all the time, and would probably still want to have a private bike to stay independent.”

– Hanna Basche, Student



**HUMAN+**



**ECOTECH ARCHIPELAGO**



**DIGITAL VENICE**



**SWISS FLOW**

**SOCIETAL TRENDS**

- Anywhere, Somewhere, X-Where
- Real and Virtual
- Mind-Lifting and Post-Humanism
- Health as a Status Symbol
- Hyper-Personalization
- Personal Cloud

- Community Culture
- New Work
- Slow Culture
- Sustainable Behavior

- Anywhere, Somewhere, X-Where
- New Work
- Digital Reputation

- Simplification
- Slow Culture
- Sustainable Behavior
- Technology Fear
- Hyper-Personalization
- Personal Cloud

**TECHNOLOGICAL TRENDS**

- Decentralization
- Digitally Enhanced Realities
- Digital Replication and Simulation
- Human Enhancement

- Autonomous Transportation
- Decentralization
- Power Sources and Energy Storage

- Autonomous Robotics
- Digitally Enhanced Realities
- Digital Replication and Simulation

- Artificial Intelligence
- Autonomous Transportation
- New Means of Mass Transportation
- Decentralization

**ECONOMIC TRENDS**

- Public and Private Convergence
- Data Infrastructure and Governance
- Integrated Systems

- Meaningful Consumption
- Localization
- Sharing Economy
- Monetary Substitution

- Emergence of Hidden Platforms
- Integrated Systems
- Post-Scarcity Economy

- Sharing Economy
- Cities and Rural Areas
- Monetary Substitution

**ENVIRONMENTAL TRENDS**

- Global Warming
- Rising Sea Levels
- Pollution
- Extreme Weather Events

- Environmental Regulations
- Extreme Weather Events

- Global Warming
- Rising Sea Levels
- Land-Use Change
- Environmental Regulations

- Environmental Regulations

**POLITICAL TRENDS**

- E-Governance
- Big Tech in Politics
- Predictive Governance
- Securitization

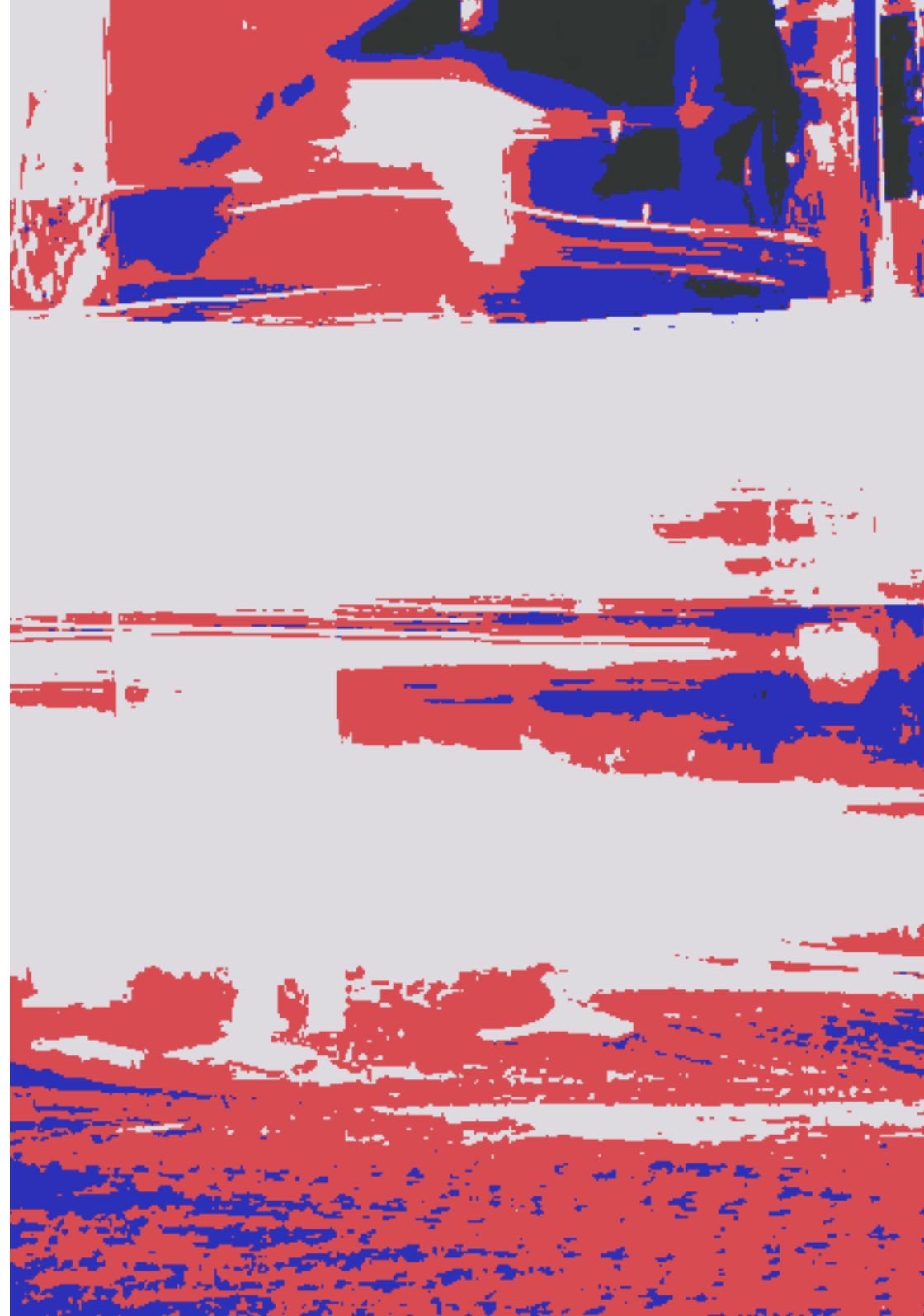
- Decentralization of Politics
- Digital Warfare
- Green Wave
- Separatism

- Migration
- Securitization

- Predictive Governance
- Green Wave
- Separatism
- Securitization

# REFERENCES

A strong emphasis on transparency allows the path taken by this research to be universally understood and retraced. Therefore, the following references allow the reader to pinpoint the sources used in this study and credit the contributors. They include primary data such as interviews, event reports and workshop documentation, as well as secondary data from desk research. The sources of illustrations and images are given at the end.



# LITERATURE

1. Eurostat. Eurostat regional yearbook 2017 edition. <https://ec.europa.eu/eurostat/documents/3217494/8222062/KS-HA-17-001-EN-N.pdf/eaebe7fa-0c80-45af-ab41-0f806c433763>. Published 2017. Accessed Dec 12, 2019.
2. Eurostat. Urban Europe – statistics on cities, towns and suburbs – working in cities. [https://ec.europa.eu/eurostat/statistics-explained/index.php/Urban\\_Europe\\_-\\_statistics\\_on\\_cities\\_towns\\_and\\_suburbs\\_-\\_working\\_in\\_cities#Commuter\\_flows](https://ec.europa.eu/eurostat/statistics-explained/index.php/Urban_Europe_-_statistics_on_cities_towns_and_suburbs_-_working_in_cities#Commuter_flows). Published 2016. Accessed Dec 12, 2019.
3. Lock S. Number of international tourist arrivals worldwide from 2005 to 2019, by region. <https://www.statista.com/statistics/186743/international-tourist-arrivals-worldwide-by-region-since-2005/>. Published 2019. Accessed Dec 13, 2019.
4. European Commission. Special Eurobarometer 472. <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=2ahUKEwiFrpaAsojnAhULZVAKHRT-1BRAQFjABegQIAx-AB&url=https%3A%2F%2Fec.europa.eu%2Fcommfrontoffice%2Fpublicopinion%2Findex.cfm%2FResultDoc%2Fdownload%2FDocument-Ky%2F82432&usq=AOvVaw3UlxuZQ-oGY>. Published 2018. Accessed Dec 12, 2019.
5. Eurostat. Disability statistics. [https://ec.europa.eu/eurostat/statistics-explained/index.php/Disability\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php/Disability_statistics). Published 2015. Accessed Dec 12, 2019.
6. Eurostat. Population on 1st January by age, sex and type of projection. [https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=proj\\_18np&lang=en](https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=proj_18np&lang=en). Published 2019. Accessed Oct 17, 2019.
7. Schmitt G. Interview on Sept 27, 2019.
8. Schetsche M. Interview on Oct 1, 2019.
9. Bergman MM. Interview on Oct 4, 2019.
10. Hunger P. Interview on Nov 26, 2019.
11. Liggieri K. Interview on Sept 18, 2019.
12. Wilson Andrew. Anywheres and Somewheres | Blog | Think Theology. [https://thinktheology.co.uk/blog/article/anywheres\\_and\\_somewheres](https://thinktheology.co.uk/blog/article/anywheres_and_somewheres). Accessed Oct 31, 2019.
13. Happy Pigeons Co-Living. Happy Pigeons Co-Living. <https://www.happypigeons.com/>. Accessed Oct 27, 2019.
14. Horx M. Somewheres & Anywheres. 2019. <https://www.zukunftsinstitut.de/artikel/wohnen/somewheres-anywheres/>. Accessed Oct 27, 2019.
15. Stockholms Stad. Welcome to the world's smartest city 2040 – City of Stockholm. <https://international.stockholm.se/governance/smart-and-connected-city/welcome-to-the-worlds-smartest-city-2040/>. Accessed Oct 27, 2019.
16. envirocar. enviroCar.org. <https://envirocar.org>. Accessed Oct 27, 2019.
17. bikeable. Bikeable. <https://bikeable.ch/>. Accessed Oct 27, 2019.
18. Bikecitizen. Bike Citizens – Discover and share the joy of cycling with our cycling app. <https://www.bikecitizens.net/>. Accessed Oct 27, 2019.
19. European Commission C. Citizen Science for Urban Environment and Health | Cities-Health Project | H2020 | CORDIS | European Commission. <https://cordis.europa.eu/project/rcn/219217/factsheet/en>. Accessed Oct 27, 2019.
20. Sciforce. What is inside of Augmented Reality? – Sciforce – Medium. <https://medium.com/sciforce/what-is-inside-of-augmented-reality-96ef03b37ada>. Accessed Oct 27, 2019.
21. Heinzman A. Google Glass Isn't Dead; It's the Future of Industry. <https://www.howtogeek.com/400963/google-glass-isnt-dead-and-its-the-future-of-industry/>. Accessed Oct 27, 2019.
22. Vision Direct. How Smart contact lenses could totally change your perspective | Vision Direct UK. <https://www.visiondirect.co.uk/blog/smart-contact-lenses>. Accessed Oct 31, 2019.
23. Sandelowsky R. Interview on Oct 2, 2019.
24. Raptopoulos A, Damm D, Santana P, Ling M, Baruchin I. Transportation using network of unmanned aerial vehicles. <https://patentswarm.com/patents/US20140032034A1>. Published 2013. Accessed Sept 13, 2019.
25. Köhler F. Interview on Oct 4, 2019.
26. Bazzana S. Interview on Oct 19, 2019.
27. Spero Ventures. A conversation with Scott Heiferman, Founder & CEO, of Meetup.

- <https://medium.com/@SperoVentures/a-conversation-with-scott-heifer-man-founder-ceo-of-meet-up-f46b6d97d569>. Accessed Oct 27, 2019.
28. Grigoras OA. Sharing Is The New Owning - A Shift In The Consumer Behavior - deemly. <https://deemly.co/blog/sharing-owning-consumer-behavior/>. Accessed Oct 27, 2019.
  29. Neye C. Interview on Oct 17, 2019.
  30. Brandes U. Interview on Oct 2, 2019.
  31. RSPB. The RSPB Wildlife Charity: Nature Reserves & Wildlife Conservation. <https://www.rspb.org.uk/>. Published 2018. Accessed Oct 27, 2019.
  32. Patients like me. Live better, together! | PatientsLikeMe. <https://www.patientslikeme.com/>. Accessed Oct 27, 2019.
  33. Raddick MJ, Prather EE, Wallace CS. Galaxy zoo: Science content knowledge of citizen scientists. *Public Underst Sci*. 2019;28(6):636-651.
  34. Schetsche M. Interview on Oct 1, 2019.
  35. Regalado A. What's new and what isn't about Elon Musk's brain-computer interface. MIT tech review. <https://www.technologyreview.com/s/613974/neuralink-whats-new-and-what-isnt-elon-musks-brain-computer-interface/>. Published 2019. Accessed Sept 6, 2019.
  36. Neuralink. Neuralink. <https://www.neuralink.com/>. Accessed Oct 27, 2019.
  37. Liggieri Kevin. Die anthropophile Technik und wir | ETH Zurich. <https://ethz.ch/de/news-und-veranstaltungen/eth-news/news/2019/08/blog-liggieri-anthropophile-technik.html>. Accessed Sept 16, 2019.
  38. Powell C. Cyborgs will replace humans and remake the world, James Lovelock says. <https://www.nbcnews.com/mach/science/cyborgs-will-replace-humans-remake-world-james-lovelock-says-ncna1041616>. Accessed Oct 27, 2019.
  39. Cronin D. Startups: Don't believe the Hype. 2019. <https://www.zukunftsinstitut.de/artikel/startups-dont-believe-the-hype/>. Accessed Sept 11, 2019.
  40. Deloitte. Contingent Workforce | Deloitte | Human Capital Services | Article | Insights. <https://www2.deloitte.com/global/en/pages/human-capital/articles/contingent-workforce.html>. Accessed Oct 27, 2019.
  41. Knights Digital. Speeding up innovation in a corporate environment. <https://www.digitalknights.co/blog/innovation-in-a-corporate-environment>. Published 2019. Accessed Oct 27, 2019.
  42. Loh J. Interview on Sept 30, 2019.
  43. Savage M. Rise of robots 'could see workers enjoy four-day weeks' | Money | The Guardian. <https://www.theguardian.com/technology/2018/oct/13/rise-robots-four-day-working-week>. Accessed Oct 27, 2019.
  44. Zukunftsinstitut. New Work Glossar. 2019. <https://www.zukunftsinstitut.de/artikel/mtglossar/new-work-glossar/>. Accessed Oct 27, 2019.
  45. Lev J. Interview on Sept 19, 2019.
  46. Callisonartkl. The Future Commute | Future of Work. <https://www.callisonrtkl.com/future-of-work/the-future-commute/>. Accessed Oct 27, 2019.
  47. Karpischek S. Interview on Nov 21, 2019.
  48. Welschlinger T. Neo-Ökologie – Stadt Zurich. [https://www.stadt-zuerich.ch/prd/de/index/stadtentwicklung/stadt-der-zukunft/handel-im-wandel/meinungen\\_stimmen/Neooekologie.html](https://www.stadt-zuerich.ch/prd/de/index/stadtentwicklung/stadt-der-zukunft/handel-im-wandel/meinungen_stimmen/Neooekologie.html). Accessed Nov 1, 2019.
  49. Gantenbein L. Interview on Oct 15, 2019.
  50. Mewes G. Interview on Oct 17, 2019.
  51. Welschinger T. Personal Interview on Oct 4, 2019.
  52. Linz M. *Suffizienz Als Politische Praxis*.; 2015.
  53. Lutz E. Interview on Nov 1, 2019.
  54. Stevens P. Citi: "Flight shaming" getting traction, could cost airlines billions. <https://www.cnbc.com/2019/10/24/citi-flight-shaming-getting-traction-could-cost-airlines-billions.html>. Accessed Oct 27, 2019.
  55. Neo-Ökologie: Die Märkte werden grün. 2019. <https://www.zukunftsinstitut.de/artikel/neo-oekologie-die-maerkte-werden-gruen/>. Accessed Nov 1, 2019.
  56. Macharis C. Interview on Sept 26, 2019.
  57. OECD *Environmental Outlook to 2050: What Could the Environment Look like in 2050?*; 2012.
  58. Hofstetter P. Personal Interview on Oct 4, 2019.
  59. Umwelt Bundesamt. Rebound effects | Umweltbundesamt. <https://www.umweltbundesamt.de/en/topics/waste-resources/economic-legal-dimensions-of-resource-conservation/rebound-effects>. Accessed Nov 1, 2019.
  60. Hiltz SR, Turoff M. Education goes digital. *Commun ACM*. 2005;48(10):59. <http://portal.acm.org/citation.cfm?doid=1089107.1089139>. Accessed Oct 27, 2019.
  61. Donnelley T. Council Post: Why Your Digital Reputation Matters And How To Influence It. <https://www.forbes.com/sites/forbesagencycouncil/2018/05/07/why-your-digital-reputation-matters-and-how-to-influence-it/#3eaf-669b49a5>. Accessed Oct 27, 2019.

62. Schoefs S. The currency of Shared Mobility is “Reputation” | Global Fleet. <https://www.globalfleet.com/en/smart-mobility/europe/features/currency-shared-mobility-reputation?a=SSC01&t%5B0%5D=Uber&t%5B1%5D=AirBnB&t%5B2%5D=We-work&t%5B3%5D=Car-sharing&t%5B4%5D=Europe&curl=1>. Accessed Oct 27, 2019.
63. Nadine. Interview on Sept 25, 2019.
64. Pring-Mill D. Hyperloop Projects May Be Uniquely Vulnerable to Terrorism | The National Interest. <https://nationalinterest.org/feature/hyperloop-projects-may-be-uniquely-vulnerable-terrorism-21781>. Accessed Oct 27, 2019.
65. de Geus B. Interview on Oct 3, 2019.
66. Härdtner J. Interview on Oct 10, 2019.
67. Euronews. Single society: A third of EU homes contain just one person | Euronews. <https://www.euronews.com/2017/09/05/people-living-alone-europe-solo-living>. Accessed Oct 31, 2019.
68. The Guardian. Nearly one in seven Britons could live alone by 2039, study shows | Society | The Guardian. <https://www.theguardian.com/society/2019/apr/04/nearly-one-in-seven-britons-could-live-alone-2039-stud-shows>. Accessed Oct 31, 2019.
69. de Bruin M. Personalization is dead, long live hyper-individualization. <https://www.the-future-of-commerce.com/2019/01/09/what-is-hyper-individualization/>. Accessed Oct 27, 2019.
70. McKinsey. The future of personalization and how to get ready for it | McKinsey. <https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/the-future-of-personalization-and-how-to-get-ready-for-it>. Accessed Oct 31, 2019.
71. Engemann C. E-Identity: Wer garantiert das digitale Ich? 2019. <https://www.zukunftsinstitut.de/artikel/e-identity-wer-garantiert-das-digitale-ich/>. Accessed Sept 25, 2019.
72. Eliot L. Declining Birthrate Likely To Swing Upward Via Advent Of Self-Driving Cars. <https://www.forbes.com/sites/lan-ceeliot/2019/10/27/declining-birth-rate-likely-to-swing-upward-via-advent-of-self-driving-cars/#353bc-c68387a>. Accessed Oct 27, 2019.
73. Quantified Self. What is Quantified Self? | Quantified Self. <https://quantifiedself.com/about/what-is-quantified-self/>. Accessed Oct 31, 2019.
74. Seba T. Interview on Oct 16, 2019.
75. Pezous A. Interview on Oct 10, 2019.
76. Farge Y. Interview on Sept 24, 2019.
77. Schimpel U. Interview on Oct 4, 2019.
78. Siegwart R. Interview on Sept 25, 2019.
79. Bostrom N. *Superintelligence. Paths, Dangers, Strategies*. Oxford: Oxford University Press; 2014.
80. Simic S. Interview on Oct 4, 2019.
81. Michel J. Interview on Sept 26, 2019.
82. Hörl S, Becker F, Dubernet TJP, Axhausen KW. Induzierter Verkehr durch autonome Fahrzeuge. 2019. <https://www.research-collection.ethz.ch/443/handle/20.500.11850/346381>. Accessed Oct 10, 2019.
83. Doll C. Interview on Sept 25, 2019.
84. Grandl G, Cachay J, Ross H, Salib J, Ostgathe M, Doppler S. The Future of Vertical Mobility Sizing the market for passenger, inspection, and goods services until 2035. *Porsche Consult*. 2018. <https://fedotov.co/wp-content/uploads/2018/03/Future-of-Vertical-Mobility.pdf>.
85. Axhausen K. Interview on Oct 11, 2019.
86. Mueller T. Event about the Perspective on autonomous driving on Sept 4, 2019.
87. Cusumano M. Interview on Sept 27, 2019.
88. Monier P. Interview on Oct 8, 2019.
89. Fourie P. Interview on Sept 27, 2019.
90. Saymudinov M. Interview on Oct 16, 2019.
91. Sancho R. Interview on Oct 15, 2019.
92. Gandecki M. Interview on Sept 27, 2019.
93. Shell J, Aung M. Interview on Oct 13, 2019.
94. Vogt D. Interview on Oct 10, 2019.
95. Schaffner C. Interview on Oct 9, 2019.
96. Cass S. Solar power will make a difference-eventually. *Technol Rev*. 2009;112(5):93-94. <https://www.technologyreview.com/s/414792/solar-power-will-make-a-difference-eventually/>. Accessed Oct 26, 2019.
97. Shell J. Interview on Oct 13, 2019.
98. Turner G, Alex C, er. Limits to Growth was right. New research shows we’re nearing collapse. *Guard*. 2014:1-6. [https://www.theguardian.com/commentisfree/2014/sep/02/limits-to-growth-was-right-new-research-shows-were-nearing-collapse?CMP=fb\\_gu](https://www.theguardian.com/commentisfree/2014/sep/02/limits-to-growth-was-right-new-research-shows-were-nearing-collapse?CMP=fb_gu). Accessed Oct 26, 2019.
99. Turner GM. Is Global Collapse Imminent? *MSSI Res Pap No 4*. 2014:22. <https://sustainable.unimelb.edu.au/publications/research-papers/is-global-collapse-imminent>. Accessed Oct 26, 2019.
100. Jancovici J. Averting systemic collapse or managing it? <https://www.youtube.com/watch?v=oy-94Igdz3w&feature=youtu.be>. Published 2019. Accessed Oct 1, 2019.
101. Hunt T. What Happened to Peak Oil? | Greentech Media. <https://www.greentechmedia.com/articles/read/what-happened-to-peak-oil#gs.6sxpqy>. Published 2016. Accessed Oct 1, 2019.
102. Jancovici J. Averting systemic collapse or managing it?

- <https://www.youtube.com/watch?v=oy-94lgDz3w&feature=youtu.be>. Published 2019. Accessed Oct 1, 2019.
103. Terree A. EMPA tour during ETH Mobility Week. 2019. <https://www.empa.ch>.
104. Beck C. Interview on Oct 5, 2019. 2019.
105. Novak P. Interview on Oct 16, 2019.
106. Terree A. Visit of the AWE EU 2019 Conference. 2019. <https://www.awexr.com>.
107. Sumner R. Interview on Nov 19, 2019.
108. Cairns S. Future Cities: Actions. Annual Conference. 2019.
109. Hofbauer G, Anita S, Engelhardt S. The Digital Transformation of the Product Management Process: Conception of Digital Twin Impacts for the Different Stages. *Int J Innov Econ Dev*. 2019;(5(2)):74-86.
110. K uchler A. Interview on Oct 3, 2019.
111. Schulze L. Interview on Oct 9, 2019.
112. Strautmann J. Interview on Oct 9, 2019.
113. Zihlmann W. Interview on Oct 17, 2019.
114. European Strategy and Policy Analysis System. *Global Trends to 2030: The Future of Work and Workplaces*.
115. Maloney W. Interview on Oct 8, 2019.
116. Oancea O. Challenges of pricing luxury in commercial aviation-will first class disappear? *J Revenue Pricing Manag*. 2016;17.
117. Tsuru M. Interview on Sept 17, 2019.
118. European Commission. *Global Europe 2050*. 2012.
119. European Committee of the Regions. Reflecting on Europe: How Europe is perceived by people in regions and cities. 2018.
120. Russel J. Europe's ride-hailing companies aren't scared of Uber | TechCrunch. <https://techcrunch.com/2018/11/29/europes-ride-hailing-companies-arent-scared-of-uber/>. Published 2018. Accessed Sept 29, 2019.
121. K uchler A. Interview on Oct 3, 2019.
122. Seixas J, Sim oes S, Dias L, Kanudia A, Fortes P, Gargiulo M. Assessing the cost-effectiveness of electric vehicles in European countries using integrated modeling. *Energy Policy*. 2015;80:165-176.
123. Beck C. Interview on Oct 5, 2019.
124. KPMG. Accelerating Mobility. 2019. <https://assets.kpmg/content/dam/kpmg/bm/pdf/2019/01/Accelerating-Mobility.pdf>. Accessed Sept 26, 2019.
125. Kane M, Whitehead J. How to ride transport disruption –a sustainable framework for future urban mobility\*. *Aust Plan*. 2017;54(3):177-185.
126. M unzel K. Interview on Oct 1, 2019.
127. Los B. Interview on Oct 18, 2019.
128. Bain M. Consumer culture has found its perfect match in our mobile-first, fast-fashion lifestyles. <https://qz.com/359040/the-internet-and-cheap-clothes-have-made-us-sport-shoppers/>. Accessed Oct 14, 2019.
129. budgettraveller. 15 budget bus companies to check out on your next trip to Europe. <https://budgettraveller.org/the-cheapest-way-to-travel-across-europe/>. Accessed Sept 29, 2019.
130. Terry HP, Sachs G, Powell D, Jarman F. *The Future of Mobility Ride-Hailing and New Businesses to Fuel \$7tn+ Global Mobility Market*. [www.gs.com/research/hedge.html](http://www.gs.com/research/hedge.html). Accessed Oct 25, 2019.
131. Today U. Porsche, Boeing flying cars: Is this the vehicle of the future? <https://eu.usatoday.com/story/tech/2019/10/16/porsche-teaming-up-with-boeing-on-flying-cars/40315231/>. Accessed Oct 26, 2019.
132. Meeting of the DSI Challenge Area Mobility at University of Zurich on Sept 12, 2019. 2019.
133. Puschmann T. "Konsumenten schaffen ihre eigenen digitalen Wahrungen" | Netzwoche. <https://www.netzwoche.ch/news/2019-05-26/konsumenten-schaffen-ihre-eigenen-digitalen-waeh-rungen>. Accessed Oct 26, 2019.
134. Corwin S, Dinamani A, Pankratz D. Toward a mobility operating system: Establishing a lingua franca for urban transportation. 2019.
135. City of Chicago. Roadmap for the Future of Transportation and Mobility in Chicago. 2019.
136. Cusumano MA. *The Business of Platforms: Strategy in the Age of Digital Competition, Innovation, and Power.*; 2019.
137. Barro J. Uber's Plan to Lose Money on Each Ride, Make It Up in Volume. <http://nymag.com/intelligencer/2019/04/ubers-plan-to-lose-money-on-each-ride-make-it-up-in-volume.html>. Accessed Sept 29, 2019.
138. Weinzierl M. Space, the Final Economic Frontier. *J Econ Perspect*. 2018;32(2):173-192.
139. Cook J. Consensus on consensus: a synthesis of consensus estimates on human-caused global warming. *Environ Res Lett*. 2016.
140. Pachauri RK, Meyer L, Hallegatte France S, et al. *Climate Change 2014 - Synthesis Report*. Gian-Kasper Plattner; 2015. <http://www.ipcc.ch>. Accessed Oct 1, 2019.
141. van Vuuren DP, Edmonds J, Kainuma M, et al. The representative concentration pathways: An overview. *Clim Change*. 2011;109(1):5-31.
142. Knutti R, Arblaster J, Dufresne J, et al. *Long-Term Climate Change: Projections, Commitments and Irreversibility.*; 2013.
143. United Nations. *Paris Agreement.*; 2015.
144. Karlsson-Vinkhuyzen SI, Groff M, Tamas PA, Dahl AL, Harder M, Hassall G. Entry into force and then? The Paris agreement and state accountability. *Clim Policy*. 2018;18(5):593-599.

145. Wanner H. Interview on Oct 17, 2019.
146. Negative emissions technologies. <https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/climate-target2050/negative-emission-technologien.html>. Accessed Nov 6, 2019.
147. Climeworks. Capturing CO<sub>2</sub> from Air. <https://www.climeworks.com/co2-removal/>. Accessed Nov 6, 2019.
148. Patt A. Interview on Oct 16, 2019.
149. Tollefson J. IPCC says limiting global warming to 1.5 °C will require drastic action. *Nature*. 2018;562(7726):172-173.
150. Tollefson J. Is the 2 °C world a fantasy? *Nature*. 2015;527(7579):436-438.
151. Centre for Climate & Energy Solutions. Global Emissions | Center for Climate and Energy Solutions. <https://www.c2es.org/content/international-emissions/>. Published 2019. Accessed Oct 1, 2019.
152. Gruber Canada S, Guinder V, Hallberg R, et al. *IPCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*. Hamish Pritchard; 2019.
153. Dangendorf S, Marcos M, Wöppelmann G, Conrad CP, Frederikse T, Riva R. Reassessment of 20th century global mean sea level rise. *Proc Natl Acad Sci U S A*. 2017;114(23):5946-5951.
154. Climate Change: Global Sea Level | NOAA Climate.gov. <https://www.climate.gov/>
- news-features/understanding-climate/climate-change-global-sea-level. Accessed Nov 4, 2019.
155. Kopp RE, DeConto RM, Bader DA, et al. Evolving Understanding of Antarctic Ice-Sheet Physics and Ambiguity in Probabilistic Sea-Level Projections. *Earth's Futur*. 2017;5(12):1217-1233.
156. Climate change, impacts and vulnerability in Europe 2016 – European Environment Agency. <https://www.eea.europa.eu/publications/climate-change-impacts-and-vulnerability-2016>. Accessed Nov 4, 2019.
157. European Commission Joint Research Centre. Europe needs coastal adaptation measures to avoid catastrophic flooding by the end of the century – ScienceDaily. <https://www.sciencedaily.com/releases/2018/08/180813125230.htm>. Accessed Nov 4, 2019.
158. Keystone. Switzerland to become climate neutral by 2050, says government - SWI swissinfo.ch. [https://www.swissinfo.ch/eng/climate-crisis\\_switzerland-to-become-climate-neutral-by-2050--says-government/45191102](https://www.swissinfo.ch/eng/climate-crisis_switzerland-to-become-climate-neutral-by-2050--says-government/45191102). Published 2019. Accessed Nov 3, 2019.
159. Darby M. Which countries have a net zero carbon goal? <https://www.climatechangenews.com/2019/06/14/countries-net-zero-climate-goal/>. Published 2019. Accessed Nov 3, 2019.
160. Welschinger T. Interview on Oct 4, 2019.
161. Swiss eMobility. Neuzulassungen: +154% bei den batterieelektrischen Autos - Swiss eMobility. <https://www.swiss-emobility.ch/de/news/aktuell/meldungen/45-Zulassungszahlen-Alternativantriebe-154-bei-den-batterieelektrischen-Neuwagen.php>. Published 2019. Accessed Nov 3, 2019.
162. Volkswagen. E-Mobility is the future | Volkswagen Newsroom. <https://www.volkswagen-newsroom.com/en/stories/e-mobility-is-the-future-5326>. Published 2019. Accessed Nov 3, 2019.
163. Kolodziejczyk B, Horngren T. Is carbon recycling the next sustainability trend? | World Economic Forum. <https://www.weforum.org/agenda/2019/09/carbon-recycling-sustainability-sunshine-solar-co2-emissions/>. Published 2019. Accessed Nov 3, 2019.
164. Reller A. Interview on Nov 11, 2019.
165. Gould T, McGlade C. Crunching the numbers: are we heading for an oil supply shock? <https://www.iea.org/newsroom/news/2018/november/crunching-the-numbers-are-we-heading-for-an-oil-supply-shock.html>. Published 2018. Accessed Nov 3, 2019.
166. Ruiz P. The Fuse | IEA's WEO Presents Three Futures of World Oil Demand - The Fuse. <http://energyfuse.org/ieas-weo-presents-three-futures-of-world-oil-demand/>. Published 2018. Accessed Oct 1, 2019.
167. CRM Alliance. Critical Raw Materials – CRM Alliance. <http://criticalrawmaterials.org/critical-raw-materials/>. Published 2014. Accessed Nov 3, 2019.
168. Chen A. Where will the materials for our clean energy future come from? – The Verge. <https://www.theverge.com/2019/2/15/18226210/energy-renewables-materials-mining-environment-neodymium-copper-lithium-cobalt>. Published 2019. Accessed Oct 2, 2019.
169. By the Numbers: The Value of Tropical Forests in the Climate Change Equation | World Resources Institute. <https://www.wri.org/blog/2018/10/numbers-value-tropical-forests-climate-change-equation>. Accessed Nov 5, 2019.
170. Van Der Werf G, Morton D, Defries R, et al. CO<sub>2</sub> emissions from forest loss. *Nat Geosci*. 2009;2(11). <https://escholarship.org/uc/item/52n993mq>. Accessed Nov 5, 2019.
171. Deforestation and Forest Degradation | Threats | WWF. <https://www.worldwildlife.org/threats/deforestation-and-forest-degradation>. Accessed Nov 5, 2019.

172. Brazilian Amazon deforestation surges to break August records | Environment | The Guardian. <https://www.theguardian.com/environment/2019/aug/27/brazilian-amazon-deforestation-surges-to-break-august-records>. Accessed Nov 5, 2019.
173. Morris B, Dickie A, Seymour F. *The Global Debate about Biofuels and Land-Use Change Ending Tropical Deforestation: A Stock-Take of Progress and Challenges.*; 2018.
174. Empa - Communication - Most biofuels are not "green". <https://www.empa.ch/web/s604/biofuels>. Accessed Nov 5, 2019.
175. Biofuels and food security | IFPRI : International Food Policy Research Institute. <http://www.ifpri.org/publication/biofuels-and-food-security>. Accessed Nov 5, 2019.
176. Herold A. *EU Environment and Climate Change Policies State of Play, Current and Future Challenges Policy Department for Economic, Scientific and Quality of Life Policies Directorate-General for Internal Policies.*; 2019.
177. European Academies Science Advisory Council. *Decarbonisation of Transport: Options and Challenges.*; 2019. [www.easac.eu](http://www.easac.eu). Accessed Nov 3, 2019.
178. C40 Cities. C40 : Green and Healthy Streets. <https://www.c40.org/other/green-and-healthy-streets>. Published 2019. Accessed Nov 3, 2019.
179. Hofstetter P. Interview on Oct 4, 2019.
180. European Commission. European Structural and Investment Funds 2014-2020. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX-52017DC0283>. Published 2017. Accessed Nov 3, 2019.
181. European Commission. Developments and Forecasts on Continuing Urbanisation | Knowledge for policy. [https://ec.europa.eu/knowledge4policy/foresight/topic/continuing-urbanisation/developments-and-forecasts-on-continuing-urbanisation\\_en](https://ec.europa.eu/knowledge4policy/foresight/topic/continuing-urbanisation/developments-and-forecasts-on-continuing-urbanisation_en). Published 2019. Accessed Oct 1, 2019.
182. European Commission. *The Future of Cities: Opportunities, Challenges and the Way Forward.*; 2019.
183. Cortinovis C. Interview on Oct 30, 2019.
184. Rafferty JP. urban sprawl | Description, Causes, Environmental Impacts, & Alternatives | Britannica.com. <https://www.britannica.com/topic/urban-sprawl>. Published 2019. Accessed Oct 4, 2019.
185. European Union. *Cities of Tomorrow.* 2011. [http://ec.europa.eu/regional\\_policy/index\\_en.htm](http://ec.europa.eu/regional_policy/index_en.htm). Accessed Nov 1, 2019.
186. Gaub F. Challenges and Choices for Europe. *Eur Strateg Policy Anal Syst.* 2019;(Apr).
187. Charles A. Interview on Nov 13, 2019.
188. Bühler L. Interview on Oct 10, 2019.
189. Berg S. Types of Pollutants. <https://sciencing.com/types-pollutants-5270696.html>. Accessed Nov 2, 2019.
190. Bundesamt für Raumentwicklung. Perspektiven des Schweizerischen Personen- und Güterverkehrs bis 2040. 2016:169. <https://www.are.admin.ch/are/en/home/transport-and-infrastructure/data/transport-perspectives.html>.
191. Bradford A. Pollution Facts & Types of Pollution | Live Science. <https://www.livescience.com/22728-pollution-facts.html>. Accessed Nov 2, 2019.
192. Butt EW, Turnock ST, Rigby R, et al. Global and regional trends in particulate air pollution and attributable health burden over the past 50 years. *Environ Res Lett.* 2017;12(10). <http://stacks.iop.org/1748-9326/12/i=10/a=104017?key=crossref.bc64d-d6aa09e5969ceea0653e8f66e65>. Accessed Nov 2, 2019.
193. Tomlinson C. Oil industry's future not as bright as government expects - HoustonChronicle.com. <https://www.houstonchronicle.com/business/columnists/tomlinson/article/Oil-industry-s-future-not-as-bright-as-13579097.php>. Published 2019. Accessed Oct 1, 2019.
194. Larkin A, Hystad P. Towards Personal Exposures: How Technology Is Changing Air Pollution and Health Research. *Curr Environ Heal reports.* 2017;4(4):463-471. <http://www.ncbi.nlm.nih.gov/pubmed/28983874>. Accessed Nov 3, 2019.
195. Andrews J. How a pollution eating "tree" is cleaning cities' air. <https://cities-today.com/how-a-pollution-eating-tree-is-cleaning-cities-air/>. Accessed Nov 2, 2019.
196. Bishop A, Davis N, Davoine D, et al. The Future Availability of Natural Resources: A New Paradigm for Global Resource Availability. 2014. [http://www3.weforum.org/docs/WEF\\_FutureAvailabilityNaturalResources\\_Report\\_2014.pdf](http://www3.weforum.org/docs/WEF_FutureAvailabilityNaturalResources_Report_2014.pdf). Accessed Sept 27, 2019.
197. Press A. Delhi restricts cars in attempt to lessen pollution | World news | The Guardian. *The Guardian.* <https://www.theguardian.com/world/2019/nov/04/delhi-restricts-cars-in-attempt-to-lessen-pollution>. Accessed Nov 4, 2019.
198. Nagasjima M. *Japan's Hydrogen Strategy and Its Economic and Geopolitical Implications.*; 2018. [https://www.ifpri.org/sites/default/files/atoms/files/nagashima\\_japan\\_hydrogen\\_2018\\_.pdf](https://www.ifpri.org/sites/default/files/atoms/files/nagashima_japan_hydrogen_2018_.pdf). Accessed Nov 3, 2019.

199. Plastic recycling: uneven progress in Europe / Data news / News / Home – edjnet. <https://www.europeandatajournalism.eu/eng/News/Data-news/Plastic-recycling-uneven-progress-in-Europe>. Accessed Nov 25, 2019.
200. Climate KIC. AI and robotics could revolutionise municipal waste sorting. <https://www.climate-kic.org/innovation-spotlight/ai-and-robotics-could-revolutionise-municipal-waste-sorting/>. Accessed Nov 2, 2019.
201. Rehan M, Nizami A-S, Rashid U, Naqvi MR. Waste Biorefineries: Future Energy, Green Products and Waste Treatment. *Front Energy Res.* 2019;7:55. <https://www.frontiersin.org/article/10.3389/fenrg.2019.00055/full>. Accessed Nov 1, 2019.
202. Hundertmark T, Mayer M, McNally C, Simons TJ, Witte C. How plastics waste recycling could transform the chemical industry. <https://www.mckinsey.com/industries/chemicals/our-insights/how-plastics-waste-recycling-could-transform-the-chemical-industry>. Accessed Nov 2, 2019.
203. PPMC. Context of Transport Climate Action. <http://www.ppmc-transport.org/using-pyrolysis-oil-a-2nd-generation-biomass-to-liquid-advanced-biofuel-for-transport-in-the-netherlands/>. Accessed Nov 2, 2019.
204. European Commission. European Strategy for Plastics in a Circular Economy. <https://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy-brochure.pdf>. Published 2018. Accessed Nov 2, 2019.
205. European Commission. Addressing pollution and climate change | Knowledge for policy. [https://ec.europa.eu/knowledge4policy/foresight/topic/continuing-urbanisation/online-resource/urban-strategies-addresses-pollution-climate-change-challenges\\_en](https://ec.europa.eu/knowledge4policy/foresight/topic/continuing-urbanisation/online-resource/urban-strategies-addresses-pollution-climate-change-challenges_en). Published 2019. Accessed Oct 1, 2019.
206. California drought patterns becoming more common | NSF - National Science Foundation. [https://www.nsf.gov/news/news\\_summ.jsp?cntn\\_id=137911](https://www.nsf.gov/news/news_summ.jsp?cntn_id=137911). Accessed Oct 31, 2019.
207. Fischer EM, Knutti R. Observed heavy precipitation increase confirms theory and early models. *Nat Clim Chang.* 2016;6(11):986-991. doi:10.1038/nclimate3110
208. Guerreiro SB, Dawson RJ, Kilsby C, Lewis E, Ford A. Future heat-waves, droughts and floods in 571 European cities. *Environ Res Lett.* 2018;13(3).
209. Robine JM, Cheung SLK, Le Roy S, et al. Death toll exceeded 70,000 in Europe during the summer of 2003. *Comptes Rendus - Biol.* 2008;331(2):171-178.
210. U.S. Global Change Research Program. Transportation | National Climate Assessment. <https://nca2014.globalchange.gov/report/sectors/transportation>. Accessed Oct 31, 2019.
211. Rodrigue J-P. Climate Change and its Potential Impacts on Transportation in The Geography of Transport Systems. [https://transportgeography.org/?page\\_id=9427](https://transportgeography.org/?page_id=9427). Accessed Nov 4, 2019.
212. Fred. Interview on Oct 7, 2019.
213. Hoffman T. Interview on Oct 7, 2019.
214. Vaartnou O. Interview on Sept 24, 2019.
215. Klimburg A. Interview on Sept 27, 2019.
216. Schönenberger E. Interview on Oct 17, 2019.
217. Tarkowski Tempelhof S. Interview on Oct 11, 2019.
218. Boillat P. Interview on Oct 16, 2019.
219. Klimburg A. *The Darkening Web: The War for Cyberspace*.
220. Balmer G. Interview on Sept 27, 2019.
221. Pirkelbauer S. Interview on Oct 10, 2019.
222. Kostopoulos L. *The Role of Data in Algorithmic Decision-Making A Primer.*; 2019. [www.unidir.org](http://www.unidir.org). Accessed Sept 5, 2019.
223. Dennison S, Leonard M, Lury A. Policy Brief What Europeans Really Feel: the Battle for the Political System. 2019;(May). [https://www.ecfr.eu/page/-/what\\_europeans\\_really\\_feel\\_the\\_battle\\_for\\_the\\_political\\_system\\_eu\\_election.pdf](https://www.ecfr.eu/page/-/what_europeans_really_feel_the_battle_for_the_political_system_eu_election.pdf).
224. Meyers J. Here's everything you need to know about the world's free trade areas | World Economic Forum. <https://www.weforum.org/agenda/2016/05/world-free-trade-areas-everything-you-need-to-know/>. Accessed Oct 29, 2019.
225. Alioth M. Event about Brexit on Oct 7, 2019.
226. Steinbrück P. Event about Social Democracy in Europe on Sept 30, 2019.
227. Bieber F. Is Nationalism on the Rise? Assessing Global Trends. *Ethnopolitics.* 2018;17(5):519-540.
228. European Greens. Historic election victory: Swiss Greens make big gains in parliamentary elections | European Greens. <https://europeangreens.eu/news/historic-election-victory-swiss-greens-make-big-gains-parliamentary-elections>. Accessed Oct 25, 2019.
229. European Commission. Reducing CO<sub>2</sub> emissions from passenger cars | Climate Action. [https://ec.europa.eu/clima/policies/transport/vehicles/cars\\_en](https://ec.europa.eu/clima/policies/transport/vehicles/cars_en). Accessed Oct 25, 2019.
230. European Commission. Reducing emissions from aviation | Climate Action. [https://ec.europa.eu/clima/policies/transport/aviation\\_en](https://ec.europa.eu/clima/policies/transport/aviation_en). Accessed Oct 25, 2019.

231. Lanzieri G. *Fewer, Older and Multi-cultural? Projections of the EU Populations by Foreign/National Background.*; 2011. doi:10.2785/17529
232. Bundesamt für Statistik (BFS). Personenverkehr. <https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/personenverkehr.html>. Published 2017. Accessed Oct 30, 2019.
233. Bundesamt für Raumentwicklung. Verkehrsperspektiven 2040: Entwicklung des Personen- und Güterverkehrs in der Schweiz. 2016.
234. Mullen C. Interview on Sept 30, 2019.
235. EUR-Lex. Legal acts – statistics. <https://eur-lex.europa.eu/statistics/2016/legislative-acts-statistics.html>. Published 2019. Accessed Oct 23, 2019.
236. Farner M. Interview on Sept 20, 2019.
237. Martínez CF, Hodgson F, Mullen C, Timms P. Creating inequality in accessibility: The relationships between public transport and social housing policy in deprived areas of Santiago de Chile. *J Transp Geogr.* 2018;67:102-109.
238. Pooley CG, Horton D, Scheldeman G, Mullen C, Jones T, Tight M. “You feel unusual walking”: The invisible presence of walking in four English cities. *J Transp Heal.* 2014;1(4):260-266.
239. SRF. Boom sorgt für Chaos - Wie Paris versucht, E-Scooter in den Griff zu kriegen - News - SRF. <https://www.srf.ch/news/panorama/boom-sorgt-fuer-chaos-wie-paris-versucht-e-scooter-in-den-griff-zu-kriegen>. Accessed Oct 29, 2019.
240. Leefeldt E. CBS News: Electric scooters are igniting new laws, liability concerns and even “scooter rage.” <https://www.cbsnews.com/news/electric-scooter-backlash-leads-to-new-laws-and-scooter-rage-july-2019/>. Published 2019. Accessed Oct 25, 2019.
241. Birnbaum M. Catalan separatists counted on support from the E.U. But they got the cold shoulder. – The Washington Post. [https://www.washingtonpost.com/world/europe/catalan-separatists-counted-on-support-from-the-eu-but-they-got-the-cold-shoulder/2017/11/01/62df9380-be6b-11e7-9294-705f80164f6e\\_story.html](https://www.washingtonpost.com/world/europe/catalan-separatists-counted-on-support-from-the-eu-but-they-got-the-cold-shoulder/2017/11/01/62df9380-be6b-11e7-9294-705f80164f6e_story.html). Accessed Oct 25, 2019.
242. SRF. Landtagswahl in Thüringen - Historischer Wahlsieg für die Linke – die AfD schlägt die CDU - News - SRF. <https://www.srf.ch/news/international/landtagswahl-in-thueringen-historischer-wahlsieg-fuer-die-linke-die-afd-schlaegt-die-cdu>. Published 2019. Accessed Oct 29, 2019.
243. Moore SKE. Gartner Forecasts Worldwide Information Security Spending to Exceed \$124 Billion in 2019. <https://www.gartner.com/en/newsroom/press-releases/2018-08-15-gartner-forecasts-worldwide-information-security-spending-to-exceed-124-billion-in-2019>. Accessed Oct 29, 2019.
244. Nguyen D-Q. Ageing trends go global - SWI swissinfo.ch. [https://www.swissinfo.ch/eng/by-the-numbers\\_a-greying-planet-from-north-to-south/42207298](https://www.swissinfo.ch/eng/by-the-numbers_a-greying-planet-from-north-to-south/42207298). Accessed Oct 23, 2019.
245. Winkler H. How will ageing populations affect politics? <https://www.weforum.org/agenda/2015/06/how-will-ageing-populations-affect-politics/>. Accessed Sept 4, 2019.
246. Foreman KJ, Marquez N, Dolgert A, et al. Forecasting life expectancy, years of life lost, and all-cause and cause-specific mortality for 250 causes of death: reference and alternative scenarios for 2016–40 for 195 countries and territories. *Lancet.* 2018;392(10159):2052-2090.
247. United Nations Department of Economic and Social Affairs. *World Population Prospects 2019.*; 2019. <https://population.un.org/wpp/>. Accessed Oct 25, 2019.
248. Winkler H. In aging societies, will young liberals become old conservatives? <https://blogs.worldbank.org/europeandcentralasia/aging-societies-will-young-liberals-become-old-conservatives>. Accessed Oct 23, 2019.
249. Thelitz Nikolai KJ. Wahlen 2019 – die grössten Überraschungen | NZZ. <https://www.nzz.ch/schweiz/eidgenossische-wahlen-2019/wahlen-2019-die-groessten-ueberraschungen-ld.1504461>. Published 2019. Accessed Oct 23, 2019.
250. European Commission. Competence Centre on Foresight - Megatrends Hub. <https://www.nzz.ch/schweiz/eidgenossische-wahlen-2019/wahlen-2019-die-groessten-ueberraschungen-ld.1504461>. Published 2019. Accessed Oct 23, 2019.

# FIGURES

1. Citizens will engage directly and digitally in the urban planning process (Source: Harry Woodgate)
2. Citizens increasingly play a part in shaping their own environment (Source: SciStarter, 2018)
3. Jobs in food preparation, construction and cleaning are most vulnerable to automation (Source: OECD, 2018)
4. Consumers want transparency about their groceries' origins (Source: Nielsen, 2019)
5. Europeans are increasingly willing to pay for sustainability (Source: Nielsen, 2014)
6. 60 percent of adults across all age groups always trust online reviews as much as personal recommendations (Source: BrightLocal, 2018)
7. Single-person households are expected to grow most strongly in Europe (Source: Euromonitor International, 2014)
8. Hyper-personalized offerings treat every customer differently based on data from the Personal Cloud (Source: Capgemini, 2016)
9. Wearables at different positions at the body provide data for the Personal Cloud (Source: Forrester, 2014)
10. AI will significantly advance, but it is unclear whether it will surpass human intelligence<sup>79</sup>
11. Among European countries, The Netherlands is the most accepting of autonomous car (Source: KPMG, 2019)
12. These autonomous pods could be a new means of mass transportation (Source: Business Insider, 2015)
13. Passenger rail travel is expected to grow steadily, even though new modes of travel will arrive on the market (Source: Sustainable Mobility Project)
14. Comparison of flying vehicles with current car-based transport solutions (Source: Porsche Consulting)
15. An autonomous robot picking up a glass from a table (Source: zdnet.com, 2019)
16. Global demand for renewables is expected to rise slowly (EIA International Energy Outlook, 2013)
17. Digital replications of the real world allow easy prototyping and testing, as well as simulations (Source: Siemens)
18. The "digital twin" will gain importance across a range of business fields<sup>109</sup>
19. Human enhancement will help people with injuries and even disabilities to regain their strength (Source: ETH Zurich, 2017)
20. As smartphone possession increases, consumer expenditure on recreational and cultural services is also set to grow strongly, especially in markets where digital stress levels are highest (Source: Euromonitor International, 2018)
21. Sustainability is an increasing driver for paying a premium (Source: Conference Board and Nielsen, 2018)
22. People of employment age, in particular, are willing to spend money to save time (Source: Euromonitor International's Lifestyle Survey, 2017)
23. The increasing collaboration of the UN with non-governmental organizations reflects the convergence between the private and public sectors (Source: UN Economic and Social Council, 2013)
24. Hidden platforms impact the adoption of new mobility modes (Source: UK Department for Transport, 2016)
25. People share their own cars mainly in order to save money, and for environmental reasons (Source: Transportation Research, 2019)
26. The middle class will dominate by 2030 (Source: World Data Lab, 2019)
27. Motor-vehicle death rates are expected to plunge globally (Source: Sustainable Mobility Project based on Koornstra, 2003)
28. The mobility of the future will rely on a broad set of data points, which might be coordinated by governments (Source: Roland Berger, 2018)
29. Since electricity and heat are the main sources for GHG emissions, the energy sector also exhibits the greatest potential for reduction by 2030. Transport ranks in fourth place. (Source: UNEP, 2017)
30. Historic sea-level rise reconstruction and projections to 2100 under different emission scenarios. The worst-case scenario of 2.4m increase within this century would be physically possible with major contributions from melting ice in Antarctica. (Source: U.S. Global Change Research Program, 2017)
31. An oil-supply shock is expected for 2025 (Source: IEA, 2019)

32. Premature deaths caused by air pollution in Europe, by country  
(Source: European Environment Agency, 2018)
33. Meteorological, hydrological and climatological events are steadily increasing  
(Source: Münchener Rückversicherungs-Gesellschaft, 2016)
34. How technologies evolve in the face of regulatory processes  
(own illustration based on Gartner Hype Cycle)
35. The UK has the most advanced E-Government system  
(Source: United Nations, 2016)
36. Greek citizens, in particular, have unfavorable views of the EU – although the median view is positive on balance  
(Source: Global Attitudes Survey, 2018)
37. Nationalist parties during national elections  
(Source: BBC, 2019)
38. Globally, spending on digital security is on the rise  
(Source: Gartner, 2018)
39. Society is getting older, increasing the old-age dependency ratio  
(Source: United Nations, 2008)

All other graphics featured in this report fall under the Creative Commons licence.

Photos not specifically referenced belong to Spark Labs or Spark Works. The photo referring to events was taken by Alessandro Della Bella of ETH Zurich.



Spark Labs, a lab at the department of Management, Technology and Economics of ETH Zurich, is focused on research and education of Human-Centered innovation.

Spark Labs, ETH Zurich  
Weinbergstrasse 56-58  
8092 Zurich  
Switzerland

[www.sparklabs.ch](http://www.sparklabs.ch)



Spark Works is Switzerland's leading strategic innovation company. We provide customer research and advisory services using a human-centered approach.

Spark Works  
Bären-gasse 16  
8001 Zurich  
Switzerland

[www.sparkworks.ch](http://www.sparkworks.ch)

