Meeting the Green Deal objectives by alignment of technology and behaviour
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Options for sustainable behaviour in food consumption and mobility

This study explores the prospects of aligning citizens' behaviour with the objectives of the European Green Deal in the domains of food consumption and mobility. Creating a climate-neutral and resource-efficient European economy requires a deep transformation of energy, mobility and food systems, as well as a change in production and consumption practices. Such profound change will impact both individuals and society. At the same time, the transition to sustainability will not succeed if people do not support it by adapting their behaviour and consumption patterns. This would imply change towards ‘sustainable behaviour’.

The study explores options for such sustainable behaviour, with a focus on mobility and food consumption. It identifies key challenges and possibilities in each domain and explores how technological solutions can help people adapt to sustainable behaviour in alignment with the objectives of the European Green Deal.
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Executive Summary

This study explores the prospects of aligning behavioural patterns with the policy objectives of the European Green Deal to spearhead Europe's 'green transition'. Creating a climate-neutral, resource-efficient, and overall sustainable economy requires a deep and comprehensive economic and societal transformation. This concerns key systems, such as the energy, mobility and food systems, as well as the overall production and consumption patterns.

Policies that pertain to such large-scale transformations will inevitably impact many European citizens. However, these transformations will not succeed without people's support. Transitioning towards sustainability requires changing how people eat, move, and heat or cool their homes. Sustainability is linked, to a great extent, to changing consumption patterns, which would imply people's behavioural change.

The study explores options for such a behavioural shift towards sustainability in two policy domains of the European Green Deal: food consumption and mobility. In both of these domains, the Covid-19 pandemic has accelerated the pre-existing behavioural trends and revealed deep-seated challenges and choices. The authors identify key challenges in each domain.

As far as food consumption is concerned, the study identifies that people's climate and environmental footprint comes especially from the consumption of animal products, the creation of food waste and, to a lesser degree, the consumption of imported and unseasonal food.

The main challenges identified in the domain of mobility are: increasing the efficiency of the system, strengthening the shift to modal choice practices, and transitioning to more integrated mobility solutions, such as 'Mobility as a Service' (MaaS). Finding the correct combination of different approaches to reducing the overall transport needs would be the main policy option in this domain, from the sustainability perspective.

Technology, especially data and digital solutions, are regarded as important enablers for aligning people's behaviour with policy objectives of the European Green Deal in the food and mobility domains. However, this enabling quality of technology to support sustainability is by no means automatic. The study points out that enhancing sustainable behaviour requires specific attention to technology, primarily digitalisation, and the support of the regulatory and policy frameworks.

The authors suggest several technology options for sustainable or 'green' behaviour. As far as 'greening' of food consumption is concerned, technology options include various digital solutions that can improve awareness, help people make sustainable choices more easily, and reduce food waste. Likewise, for sustainable mobility, the technological solutions include digitalisation as an enabler for shared mobility and for the emergent Mobility as a Service (MaaS) practices.
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1. Introduction

This study explores the role of citizens and consumers in supporting the implementation of the European Green Deal. It focuses on the ‘green transitions’ for food and mobility systems. The authors aim to shed light on the role of technology, including data and digital solutions, in encouraging sustainable behavioural patterns in these two domains.

Creating a climate-neutral, resource-efficient and generally sustainable economy requires a deep and comprehensive transformation in key economic and societal domains such as food and mobility. In particular, this involves a change in consumption patterns and their alignment with sustainability objectives. While efforts are being made by policy-makers at the European and national levels to tackle how goods and materials are produced, priced and distributed, production is only one side of the equation. The other side is consumption, which, to a great extent, boils down to how people live and move and what goods and services they consume.

The authors recognise that people’s consumption patterns play a major role in contributing to the success of the European green transition. However, this will require a shift in people’s behaviour towards sustainability. This also has implications for policy-makers and policy-making: it is important to use policies to support sustainable behavioural patterns and to take account of drivers and barriers behind behaviour change, for people to become the actors of the green transition.

The study addresses the consumption side of the equation by focusing on the behavioural aspects and by stressing the importance of anticipatory policy-making, i.e. factoring in behavioural aspects of policy design. The authors argue that it is critical to encourage sustainable behaviour in consumption, but it is even more important to anticipate the impact a policy or technology may have on behaviour.

From purchasing food for family meals, to choosing whether we drive or take a bus to work, from turning up the heat to lowering the air conditioner, from letting the water tap run to sorting cans and bottles—people make daily decisions and choices that have a tangible effect on sustainability. This also means that there are opportunities to guide people to make ‘green decisions’ that can enhance this effect.

Efforts to nudge people towards sustainability have been made. However, the Commission’s Joint Research Centre (JRC) report says, ‘explicit policy applications are still rare’. Among the most common policy initiatives based on behavioural input are those aimed at simplification of administrative procedures and forms, awareness-raising campaigns, and the use of ‘behaviourally-informed letters’ in various communications.

Bringing about a system-wide transformation is a major task. It requires the ‘greening’ of mobility and food systems, as well as the energy system as a whole. These two systems – mobility and food – have been selected as the areas of focus, due to: (i) their significant climate and environmental footprints, (ii) individuals’ possibilities to contribute to the greening of these systems, and (iii) the possibilities to use technological solutions to help people adapt to more sustainable food consumption and mobility patterns.


3 idem
When it comes to mobility, the European Green Deal has set the key objective to deliver a 90% reduction in transport-related greenhouse gas emissions by 2050. All transport sectors will have to contribute to a 55% reduction of greenhouse gas (GHG) emissions by 2030, compared to 1990 — the general target set for the EU's economy as a whole. Furthermore, the share of renewable energy in transport will have to increase to around 24% by 2030.

The Commission’s sustainable and smart mobility strategy was adopted in December 2020. The strategy proposes 82 initiatives around 10 flagship areas to transform the system and make it smarter and sustainable. At the core of the strategy are actions to make all transport modes more sustainable and to accelerate the uptake of zero-emission vehicles. Moreover, the strategy aims at developing better pricing signals and other incentives that would make people switch to sustainable modes faster and use digitalisation to offer ever more integrated mobility solutions.

The European Green Deal framework also highlights the need to improve food systems and calls for them to become ‘fair, healthy and environmentally friendly’. The European Commission’s ‘Farm to Fork’ strategy, adopted in May 2020, also recognises the role behaviour plays. The strategy acknowledges the need to move to a more plant-based diet, with less red and processed meat and underlines the importance of preventing food waste. It also puts forward a goal of halving per capita food waste at retail and consumer levels by 2030.

The European Parliament highlighted the importance of behaviour for the green transition in its resolution on the European Green Deal of 15 January 2020. With regard to sustainable use of transport, the Parliament ‘welcomed the proposal by the Commission to boost multimodal transport’. It also underscored the importance of interconnectivity between road, rail and inland waterways as a prerequisite for a ‘modal shift’ in mobility practice. The importance of a behavioural shift was also highlighted by the Parliament’s call on the Commission to ‘develop smart systems for traffic management and “Mobility as a Service” solutions, especially in urban areas’, as well as to make passenger transport by rail more attractive.

With regard to the food system, the Parliament underscored safe, healthy and good-quality food for all as a top priority, and welcomed the Commission’s ‘Farm to Fork’ strategy. In particular, the Parliament called for ‘sustainable consumption’ adapted to the limits of the planet. It welcomed the Commission’s intention to explore new ways to give consumers better information and called on the Commission to consider improved food labelling of certain foods.

This study argues that a certain alignment of the European Green Deal objectives with the behavioural patterns of European food consumers and the users of various transport services would be desirable, to achieve these policy targets by 2050. The methodology of exploring the link between policy and behaviour was inspired by the four-pronged framework found in the United Nations (UN) Consuming Differently, Consuming Sustainably report. This UN report highlights that the design process of a public policy needs to incorporate a deeper understanding of human behaviour. It suggests that behavioural insights can be applied to policy design in four steps. The first step is to diagnose the behavioural biases contributing to the problem that a policy aims to tackle. This is necessary for the identification of possible solutions or behavioural levers, on which effective policy interventions should rely. The second step concerns policy design and implementation. The third and fourth steps are policy evaluation and empirical assessment.

The present study follows the first three steps of this model, leaving the empirical testing outside its scope. The aim of the study is not to evaluate specific existing polices, but rather to assist anticipatory

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policy-making and provide scientific foresight regarding the European Green Deal and Europe's sustainability transition.

The first part of this study defines sustainable behaviour and discusses the role of individuals in 'greening' complex socio-economic systems, such as food and mobility. It also discusses how technological solutions can help educate and empower citizens to play a greater role.

The following sections look at prevalent behavioural patterns in the food consumption and mobility practice domains and examine the impact of the Covid-19 pandemic and digitalisation. For the analytical purposes of this study, the pandemic and the spread of digital technologies are considered as having an accelerating and enabling effect.

The global Covid-19 pandemic spanned most of 2020 and much of 2021, and has resulted in numerous lockdowns and other disruptions in Europe. It changed patterns of food consumption (for example, reliance on food deliveries and take-away food, home-cooking) and mobility (for example, reduced use of public transport and increased use of individual private or hired transport, including not only cars but also bicycles and scooters), at least temporarily. The proliferation of digital technologies has been playing an important role in behavioural trends by, for example, enabling consumers to optimise their behaviour according to their preferences and interests.

The second and third parts of this study explore the elements that contribute to people's food consumption and mobility practices in greater detail. The authors identify three challenging elements in each domain.

As far as food consumption is concerned, the authors point out that people's climate and environmental footprint comes especially from the consumption of animal products, the creation of food waste and, to a lesser degree, the consumption of imported and unseasonal food.

Regarding mobility, reducing people's climate and environmental footprint can be achieved by increasing the efficiency of vehicles, strengthening the shift to sustainable modal choice practices, and by transition to Mobility as a Service (MaaS). Reducing transport and mobility needs generally would be the most effective factor in the sustainability transition in this domain.

The challenges of adopting sustainable behavioural patterns differ between food and mobility systems. The possibilities for individuals to address these challenges also vary. Arguably, people can decide, for example, to consume less animal products, and reduce food waste and the consumption of imported and unseasonal food, even if political and financial incentives are missing. People's knowledge about sustainable food is growing, and they already have many options available if they want to consume food more sustainably. As a result, citizens can have a direct and immediate impact in improving the food system.

In mobility systems, getting people to contribute to sustainability requires investment in infrastructure, which takes time. It also means that public authorities and private players need to provide more integrated mobility solutions, such as MaaS. Finally, a change in behaviour requires significant investments from people, e.g. if they need to buy electric vehicles (while people may buy a new car in 3–10 years, they buy and waste food every day). Individuals, therefore, depend on external players such as investors, the public and private sectors, as well as policy-makers, to make sustainable mobility a viable option.

Technology, especially data and digital solutions, are regarded in this study as important enablers for aligning people's behaviour with the European Green Deal policy objectives in the food and mobility domains. However, this enabling quality of technology is by no means automatic. The study recalls that increasing sustainable behaviour requires full support from the EU’s policy and funding framework, combined with correct technological options.
The authors suggest several technology options to improve behavioural patterns. For improving food consumption, options include various digital solutions that can enhance awareness, help people make sustainable choices more easily, and reduce food waste. For mobility, technological solutions include digitalisation as an enabler for shared mobility, and emergent fully-integrated MaaS practices.

The final part suggests policy options for increasing people's role in the green transition, by improving the relevant governance framework and introducing the needed technologies. The study concludes with an observation that, although technology can be an effective enabler for sustainable behaviour, it does not have a default effect. A deliberate and effective inclusion of technology into policy design is necessary for the 'alignment' effect between behaviour and achievement of desired policy objectives.
2. Understanding sustainable behaviour

An analysis of all approaches to sustainability and sustainable behaviour, and of the burgeoning debate surrounding them, is out of scope of this study. For its aims, the study defines sustainable behaviour as largely corresponding to the definition of ‘green behaviour’, i.e. ‘behaviour that harms the environment as little as possible or even benefits it’. A more specific definition of sustainable behaviour as an individual choice can be found in the United Nations Environmental Programme reports, where it is defined as:

'sustainable lifestyle, or a way of living enabled both by efficient infrastructures, goods and services, and by individual choices and actions that minimise the use of natural resources, and generation of emissions, wastes and pollution, while supporting equitable socio-economic development and progress for all'.

In practice, there is no universal pattern of sustainable behaviour or a specifically sustainable lifestyle that fits everyone. Sustainable behaviour is also a dynamic pattern and may be subject to change depending on social or technological accelerators and enablers. The Covid-19 pandemic has been one such accelerator of several behavioural patterns that bear direct implications for sustainability. The section below points out the theoretical underpinnings for this study.

2.1. Behaviour and sustainability: focus on the individual

In 2015, the World Bank released their annual World Development Report ‘Mind, Society, and Behaviour’, which focused on the intersection of human behaviour and international development. It included multiple recommendations on the application of behavioural insights to areas such as poverty, health and climate change.

One of the central conceptual arguments of the report was the idea that human thinking and behaviour can be understood as unfolding on three interconnected planes. The first plane concerns the tendency of people to switch between automatic (narrow, intuitive, effortless) and deliberative (reflective, based on reasoning, complex) systems. This means that more often than not people do not behave according to a rational, levelled and deliberative calculation. Personal experience, intuition and various cognitive biases play a big role. The second plane concerns human sociality: the tendency to get influenced by how others think. The third principle is about thinking in terms of pre-existing models.

This understanding of human behaviour has opened up new opportunities for designing policies to achieve environmental, social or economic sustainability. Previous generations of policy studies relied on the idea of people being motivated almost exclusively by rational economic calculations of profit and maximising of utility. Later studies questioned the validity of this argument. If people are motivated only about getting maximum return on minimum investment, how long can such socio-economic system exist before it runs out if resources and become unsustainable? Gradually a new understanding emerged that sustainability of the system is linked in many aspect to sustainable
behaviour of people within this system. The 2015 World Bank report is just one example of this understanding slowly trickling down into policy-making.

How do people decide which product to purchase? How do they decide how to use vital resources like energy and water? How do they make decisions about reuse and recycling? Do they follow through or do they change their mind at the last minute? The answers to these questions are complex, as they are affected by many factors. Availability, access, price and quality of sustainable options are critical; but other, less visible factors, such as peer behaviour and cultural context, are equally important.

The academic literature on sustainable behaviour points out the following factors that help understand behavioural patterns: the importance of context, the importance of non-conscious processes such as habits, and the importance of values and beliefs.¹⁰

As was mentioned above, rational economic accounts of behaviour fail to recognise the extent to which our actions are shaped by the social, physical, political and cultural context. Encouragingly, the battle for hearts and minds is slowly being won. For example, pro-environmental attitudes are now common across much of Europe (Steenjtjes et al., 2017). This is helping to raise the ambition across the EU policy agenda (Carrington, 2019).

However, few citizens are independently giving up their cars, overseas holidays or beef burgers. It would also be naïve to expect fishers, farmers, poachers and loggers to compromise their livelihoods willingly. Clearly, there is more to behaviour change than awareness and attitudes, highlighting the problem of a widely observed value–action gap (Kollmuss & Agyeman, 2002). The reasons for this gap are myriad and complex, although two broad categories are worth highlighting: insincerity of our values, and barriers to acting on them.

First, pro-environmental values are frequently in tension with self-interest. This creates cognitive dissonance,¹¹ and guilt for habits we are unwilling to forego. Guilt can be a powerful motivator for action; but we also have a tendency to resolve this dissonance not by curbing our unsustainable behaviour, but by ignoring the issue (wilful ignorance), or employing various acts of psychological fudging.

These acts of psychological fudging include motivated reasoning (rationalising towards a convenient and ego-serving, rather than logical, conclusion), moral licensing (excusing ourselves for flying because we recycle) and biased social comparisons (inflated convictions that ‘I do more than most’ and deferring responsibility to government/industry/other countries) (Barkan et al., 2015).

In other words, our behaviour reveals that our concern for cost, profit, convenience and enjoyment frequently outranks our concern for the planet, despite our ability to maintain sincere environmental values and a sense of integrity (Shalvi et al., 2015; Gino et al., 2016).

Second, even where intentions are sincere, we may fail to act due to various psychological and practical barriers. These include hassle, a lack of options, lack of know-how, upfront cost barriers, lack of willpower, lack of self-efficacy (belief that we can make a worthwhile difference), procrastination, forgetfulness, ineffective planning, ingrained habit and various cognitive biases that favour a ‘do-

¹⁰ Shove, 2009: This sensitivity to context is best explained by dual-process models of cognition, which define two parallel systems of mental activity. One is slow, reflective, cognisant and deliberative. This system mostly resembles rational choice, although, more accurately, it is boundedly rational, operating under limited information and cognitive bandwidth, and usually aiming to satisfice (find a good enough solution) rather than to optimise (Simon, 1972). The second system, which dominates more of our decision-making than we tend to realise, is fast, largely automatic and driven by intuitive processes such as ingrained habit, emotion and heuristics (mental shortcuts) (Kahneman, 2011).

¹¹ See, for example Festinger L. (1957), A Theory of Cognitive Dissonance, Stanford University Press.
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nothing’ strategy, including loss aversion, present bias, uncertainty-aversion, inertia and risk-aversion.

These factors constitute the second major element of the value–action gap (Webb & Sheeran, 2006). Although they often seem trivial, they can be highly impactful. They thus require great attention when designing interventions and campaigns to help bridge the divide between good intentions and action. For example, helping people plan better to reduce food waste, removing the hassle of switching to a green energy tariff, providing easy substitutes to medicinal wildlife products, or providing timely reminders and tips for reducing water consumption are all strategies which can help turn green aspirations into green actions.

The key question remains whether we can figure out ways by which people fall into a new, more sustainable norm, and create a feedback loop where everybody’s actions reinforce the new norm.

2.2. Behavioural aspects in sustainable food consumption and mobility: focus on the system

The previous section looked at the behaviour at a level of the individual, where social and economic considerations play an important role. This section looks more closely at the systemic level.

As the latest ‘European Environment: State and Outlook 2020’ report of the European Environmental Agency (EEA) points out, encouraging behavioural change ‘will require more fundamental transformation of the systems such as food, energy and mobility’.

These core production-consumption systems account for much of humanity’s burden on the environment, in terms of resource use and harmful emissions. They also comprise a complex web of socio-economic, technological, institutional and cultural elements’. According to the EEA, behaviour and lifestyle are interlinked with jobs, infrastructure, technology and public policies across multi-functional socio-economic systems (Figure 1). Food and mobility systems (together with the energy system) have substantial environmental impacts, while at the same time they are essential for supporting European societies.13

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Boxes 1 and 2 below illustrate the climate and environmental footprints of European food and mobility systems.

**Box 1: Socio-economic food system**

Food is a basic human need. A healthy diet is a key component to our health and well-being. At the same time the food we produce and consume has also a significant environmental and a climate footprint. How food is grown, stored, processed, packaged, transported, prepared, served, eaten – or not eaten and thrown away – impacts climate and the environment.

Our food systems are one of the key drivers of climate change and environmental degradation. While this study focuses on consumption, consumer choices can have direct impact also on other parts of the food system, influencing such aspects as to what food will be produced and how. Thus, it is worth considering the impact of the food system as a whole, including also production, processing and transport, on climate and the environment, while exploring ways for consumers to accelerate the green transition.

A quick glance at agricultural production demonstrates that people’s choice of a diet has climate and environmental footprint. Half of the world’s habitable land is used for agriculture, and often with little consideration for sustainability (Ritchie and Roser 2019). Food production is responsible for 21-37% of global greenhouse gas emissions (see e.g. Poore and Nemecek 2018; Gilbert, 2012, FAO, 2020a; McKinsey & Company, 2020), and a significant source of air and water pollution. Moreover, agriculture accounts for 70% of global freshwater withdrawals (Ritchie and Roser, 2018), and requires also other resources from soil to energy. Over 29,000 out of the 32,000 species are evaluated to be threatened with extinction (at least partly) due to agriculture and aquaculture (IUCN, 2020).14

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14 See IUCN Red List of Threatened Species, The IUCN Red List Of Threatened Species. Available at [https://www.iucnredlist.org/resources/summary-statistics#Summary%20Table](https://www.iucnredlist.org/resources/summary-statistics#Summary%20Table) for the list of species facing extinction and [https://www.iucnredlist.org/search](https://www.iucnredlist.org/search) for species that are threatened by agriculture. [Accessed 30 November 2020]
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According to the European Commission’s ‘Farm to Fork’ strategy, in the EU, agriculture accounts for 10.3% of the GHG emissions, of which around 70% is produced by livestock farming. Nutrients and pesticides used in agriculture pollute land and water. Ammonia emissions from livestock waste are a significant source of air pollution (EEA, 2017). Agriculture also contributes to growing water scarcity: it uses more than 40% of freshwater in the EU (EEA, 2018). Thus the food people consume and waste matters for environment and climate.

Box 2: Socio-Economic Mobility system

Transport is a crucial enabler for our economy and society but involves big health and environmental challenges.

The GHG emissions related to transport (excluding international aviation and maritime navigation) increased by 23% between 1990 and 2018, bringing the share of transport in total emissions in the EU from 15% to 22%, with the road sector counting for 72% of transport emissions. It is the only economic sector in which GHG emissions are higher than in 1990. Transport in the EU still relies on oil for about 93% of its energy needs, and since 2014 the oil consumption has been following an upward trend at an average rate of 1.9% per year.

Transport is responsible for 39% of NOx emissions, a contributor to air pollution, which is a major health concern. In addition to NOx, small particulate matter is a serious challenge for air quality. The mobility system is also one of the main sources of noise pollution with about 113 million Europeans affected by daily average noise levels of 55db or higher (EEA, 2020; EC, 2020b).

For passenger transport, cars remain the dominant mode of transport, with a share of 71.7% in 2018, and even 80% if you only consider land transport.

In terms of resource use in the mobility system, Europe accounts for a fifth of the global production of motor vehicles, and between 7 and 8 million tonnes of waste in the EU comes from used vehicles each year. Shipping this waste outside of the EU can cause pollution if it is not treated appropriately in the recipient countries. Meanwhile, the current trend and push for electric vehicles could reduce GHG emissions but may also lead to an increased (unsustainable) demand for (critical) materials for batteries.

Transport also contributes to loss and fragmentation of natural habitats with significant impacts on ecosystems and biodiversity. It takes up valuable space and creates many physical barriers for all sorts of species.

In these complex systems, policy interventions can lead to trade-offs and unexpected side-effects. It is therefore important for policy-makers to utilise a mix of instruments including regulatory and economic instruments, as well as a mix of incentives and enforcement instruments to encourage more sustainable decisions.

In policy debate, there is a tendency to focus on technology and regulation as a solution to making the supply side more sustainable. Much less attention is given to social and psychological factors influencing the user, or the diverse roles and actions of people. The existing systems and structures that surround people affect people’s behaviour, for better or for worse.

There are many different approaches to supporting behavioural change, from awareness raising and education to regulation. It is widely recognised that nudging, positive reinforcement and gentle persuasion can contribute to achieving wanted results. It has been suggested that optimistic and engaging messaging coupled with pleasant images and enjoyable experiences may have stronger and more lasting impact than messages that shock, demand sacrifice or are framed in terms of loss.

Influencing behavioural patterns requires understanding of factors that affect human behaviour (including barriers, drivers and effective points of intervention). People can have individual, social or
material/financial barriers to changing their consumption patterns - and these can also act as drivers for change.

Nudging and changing individuals' behaviour requires acknowledging and building on their personal motivations, attitudes and knowledge. It is easier to adopt a certain behaviour if it corresponds to one's motivation or beliefs. Using incentives and focusing on the positive impacts of one's action can be a strong influencer. Sustainable food consumption comes with many considerations: saving money, staying healthy, preventing diseases, reducing one's climate and environmental footprint, or caring for animals.

Behaviour is often shaped also by one's 'social context': cultural norms, relationships, and interactions with other people. 'What others are doing' and 'what is socially acceptable' greatly influences human behaviour.

Moreover, different target groups can be influenced by different 'messengers' or 'authorities': teenagers by fellow friends; parents by their children. If at a canteen or at a dinner with friends more people choose vegetarian options, it becomes socially more acceptable. And if children provide suggestions for reducing food waste at home, it is likely more effective than general campaigns for preventing food waste.

Changing behaviours also requires addressing the material and financial barriers and drivers. For example, one's wish or need to save money can be used to incentivise one to reduce food waste. Also it is easier to encourage people to consume healthy vegetarian options when such options are actually available. The ultimate goal should be to make sustainable, desired behaviour easy for people to adopt.

Moreover, whether different interventions are effective depends on the context. It can be more effective to remind people to avoid food waste when they are buying food, for example, in a cafeteria than carrying out general food waste prevention campaigns on streets. Also it can be more effective to bring about lasting change when people's lives are disrupted, for example, when they move or change jobs. The Covid-19 crisis has caused great disruption, and provides a perfect occasion for changing habits as many are trying to cut costs or cooking more at home.

In general, it makes sense to focus on changing an action rather than an attitude. Trying to bring about impact should start with preventing unsustainable practices or consumption (e.g. over-consumption of animal products or buying too much food) rather than mitigating the effects (e.g. off-setting the emissions or donating surplus food to charities).

2.3. State of play and trends in food consumption and mobility

Both people's mobility and food consumption practices are changing. At the same time, it is possible to identify factors within the system as well as individual, social or material/financial barriers that can hamper changing their patterns – or act as drivers for change.
People's mobility patterns

Demand for transport and mobility services is expected to grow considerably. The European Commission expects an increase of 42% for passenger transport and by 60% for freight transport by 2050, compared to 2010 (EEA, 2020; EC, 2017). This rapid growth in demand will have a negative impact on environmental sustainability. However, the patterns of transport demand will probably change due to longer-term trends such as urbanisation and the ageing society in Europe. Together with the strong increase of single-person households without children (an increase by 18.7% between 2010 and 2019 (EC, 2020d)) these have the potential to impact European mobility system profoundly.

Many people have developed habits that derive from having combustion-engine vehicles. This enables them to live in certain places and organise their activities on the basis of the possibilities made available by their car (Robinson, 2018). According to a recent Eurobarometer survey, 59% of those who use a car for daily transport are ready nevertheless to switch a significant part of their daily mobility to environmentally friendly modes of transport, as long as it does not cost more (according to 55% of those people). But, the less urbanised the area, the more likely people say it becomes that there is no alternative to taking a car: 46% of those living in a rural village compared to 25% of those living in large towns (European Commission, 2020e).

General figures tend to hide a lot of diversity across Europe, but also within countries, e.g. in terms of transport modes, share of renewable fuels or car ownership. For instance, France became over the years increasingly car dependent, especially in peri-urban and rural areas. Conversely, citizens in larger cities reduced car ownership and use, and switched to multimodal and intermodal solutions (Aguilera and Rallet, 2016). Whilst in some cities car use is still prominent, in other places such as Copenhagen, commuting by bike has become the norm. The personal context and local policies therefore matter.

Similarly, car use is not equally dominant in all income groups. As an individual's income rises, so does their environmental footprint. According to a recent study by Oxfam and the Stockholm Environment Institute, globally, the 1% richest emit twice the amount of CO₂ emitted by the 50% poorest, with a carbon footprint that is 100 times higher (Garric, 2020). In the UK for instance, those in the lowest quintile (20%) of household income have the highest frequency of walking, cycling and bus use, and the lowest frequency of car use, of all income groups (Whittle et al, 2019).

People may have various motivations for their travel choices – such as health, social and environmental considerations; financial limitations; or time constraints. Some will choose sustainable mobility solutions because they care about the environment, but most will do so because they are more convenient, cheaper or healthier. Social and psychological factors, related to people’s behaviour, or the diverse roles and actions of the user, are often underestimated in policy debates (Whittle et al, 2019).

Interventions to foster low-carbon mobility choices include both ‘hard’ and ‘soft’ measures. Infrastructures need to be reconfigured to reduce actual and perceived barriers to behavioural change. Informational and social interventions are required to ensure individuals try to become familiar with these new technologies and modes.

Indeed, the lack of interoperable recharging infrastructure and payment systems are currently barriers that slow down the uptake of hybrid or full electric vehicles. This is in addition to the more psychological ‘range anxiety’¹⁵, and the slow speed of battery recharging compared to filling a tank with petrol. For longer-distance travel, the difficulty of combining various transport modes or the

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¹⁵ In fact, the vast majority of daily trips fall well within the range of electric cars, and the performance of batteries is expected to grow fast in the coming years.
lack of cross-border ticketing is an impediment to international rail transport. Similarly, the availability or lack of high speed services or night train connections may have a huge impact on people's travel preferences.

The choice of transport mode to travel to a city will very much depend on the type of first/last mile solutions available: are the public transport connections good? Is there a multimodal mobility hub? Is the city safe for walking and cycling?

Information is also key. Many people want to behave sustainably but do not know how to do it. The lack of possibilities to calculate one's environmental footprint is a point in case. Even today there is no specific and universally accepted framework for calculating and reporting on CO2 emissions for transport. Combined with the lack of access to all sorts of data, this makes it difficult to develop mobility services or inform people better with tailor-made information.

The lack of credibility of some existing information can also be a barrier to switching to cleaner solutions. Pollution output in a test environment and in real life can diverge. The same applies to fuel consumption between what is communicated and what the users actually experience in reality.

Finally, the misalignment of taxes, fees and charges is a crucial obstacle to behavioural change. These should be consistent with our long-term societal objectives. For example, by internalising external costs much better and giving the right price signals to users.

**People's food consumption patterns**

While global consumption of animal products, including meat and fish, continues to grow, food consumption patterns are changing in high-income countries – including in Europe. Environmental and health concerns are already contributing to a transition from animal products towards alternative protein sources, and red meat is increasingly substituted with poultry and fish. The market for meat and dairy alternatives has seen a double-digit growth annually. Consumers' interest in organic-plant-based food is also on the rise. As the market demand for more sustainable food grows, this comes with a double benefit: It is increasingly attractive for the food industry to be part of the transition and, with more choice available for consumers to choose from, this makes it easier for them to choose more sustainably.

Another important trend to consider is the creation of food waste. In the EU about 50% of food waste is created in households. There are a variety of reasons for this, including poor planning, not valuing food, impulsive shopping, purchasing more than one needs, preparing too much food, and food spoilage. Moreover, people often disvalue food as they are disconnected from how food is produced.

Labelling is also a challenge: 67% of respondents to a Euroconsumers' survey on food waste noted that they do not properly understand the information behind 'use-by' or 'best-before' dates, and 62% strongly agree that labels should be modified to indicate if the food is still edible. 10% of all food waste derives from people not understanding what expiration dates mean.

Recent surveys show that more Europeans are changing and are interested in changing their food consumption patterns. In a recent survey by the European Consumer Organisation (BEUC) slightly over 40% of consumers say they have stopped eating red meat or have cut it down due to environmental concerns. Moreover, two thirds of consumers indicated their openness to changing their eating habits for environmental reasons, with many willing to waste less food at home, to buy more seasonal fruit and vegetables, and to eat more plant-based foods. A large majority

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Meeting the Green Deal objectives by alignment of technology and behaviour

of European consumers are also aware of the impact of food waste, and 77% of the respondents to the Euroconsumers’ survey said they were taking measures and wish to do more to prevent food waste (Euroconsumers, 2020).

General barriers to changing food habits include price, marketing, and lack of information and knowledge that would make it easier to choose sustainable options. It is also important to recognise that consumers are only one of the players. The wider food environment also matters in helping people make healthy and sustainable choices. What is actually offered in supermarkets or restaurants as well as the availability of practical support can be enablers or barriers to change.

Moreover, policies and regulation (e.g. Common Agricultural Policy, regulation on expiration dates, rules on food donation) can enable or hinder sustainable food consumption. For example, the current subsidy schemes for agriculture, for example in the EU and the US, distort the market, and contribute to keeping the prices of, meat and dairy products for example, artificially low. Moreover, the EU’s failure to enforce its ‘polluter pays principle’ and internalise the costs of agricultural (including meat and dairy) production for climate, environment and human health in the prices of these products means that consumers are not given true price signals. If food produced in the EU and beyond would integrate costs for climate, environment and human health, this would arguably encourage consumption of more sustainable food products.

While these barriers are real, much can be done even without the system’s support for sustainable food consumption. Changing energy systems and getting people to shift, for example, to using electric cars might take years because of financial and structural constraints, including lack of infrastructure. However, people are much more free to choose different foods or prevent food waste, if they so wish. These are decisions that require will power, but which people could take without significant additional investments and with little effort.
3. European Green Deal: Food

The European Green Deal framework recognises food systems as one of the core areas for action, if the EU is to achieve climate-neutrality by 2050. To support this thinking, the European Commission published a ‘Farm to Fork’ strategy in the spring of 2020. It aims to respond to people’s growing demands for healthy and environmentally friendly products. It recognises the importance of agriculture, fisheries and aquaculture in supporting sustainable food systems. It also recognises a role for consumers in contributing to the transition. It presents the need to move to more plant-based diets, with less red and processed meat, as well as the importance of preventing food waste.

Empowering consumers to play an active role in the sustainability transition requires improving access to information that can be used to make sustainable food choice and reduce food waste. To make it easier for people to choose healthy options and make informed decisions, the Commission proposes a mandatory harmonised front-of-pack nutrition labelling system.

The ‘Farm to Fork’ strategy also recognises the importance of food-waste prevention. The Commission aims to halve per capita food waste at retail and consumer levels by 2030. An important step in this direction is the proposed plan to step up efforts to measure food waste: improving data collection on food waste is the basis for monitoring progress. The Commission also plans to propose legally binding targets to reduce food waste across the EU.

The European Parliament welcomed the plan for a sustainable food strategy in its resolution on the Green Deal in January 2020. It highlighted the need for using natural resources more efficiently, while supporting the agricultural sector. The Members of the Parliament reiterated calls to reduce pesticide dependency, and the use of fertilisers and antibiotics in agriculture. Moreover, they wanted higher animal welfare standards and an EU-wide food waste reduction target of 50%.
4. European Green Deal: Mobility

Achieving a climate neutral Europe by 2050 will require a drastic reconfiguration of the mobility system. People's role in the green transition cannot be underestimated and needs to be supported by improving relevant governance framework and development and deployment of relevant technologies and infrastructure. The European Green Deal has set the key objective of delivering a 90% reduction in transport-related greenhouse gas emissions by 2050. All transport sectors will have to contribute to the 55% reduction of GHG emissions by 2030 compared to 1990, and the share of renewable energy in transport will have to increase to around 24%. It is in this context that the higher 2030 ambitions will force us to accelerate the transformation, way beyond incremental changes.

Already during the Juncker Commission (2014-2019), a large number of policy measures have been launched after the adoption of the European strategy for low-emission mobility (2016)\(^\text{17}\), followed by three mobility packages in 2017 and 2018.

The European Commission's impact assessment in support of the new 2030 targets expects that an intensification of policy measures will be required in the very short term, with further improvements in the transport system efficiency and a shift towards more sustainable transport modes. This includes clean and efficient private and public transport; the increase of the shares of public transport and active mobility – such as walking and cycling; and the development of automated, connected, and multimodal mobility (EC, 2020b).

In its recently adopted sustainable and smart mobility strategy, the European Commission recognises that digitalisation will become an indispensable driver for the modernisation of the entire system, making it seamless and more efficient, while further reducing emissions\(^\text{18}\).

The Commission also acknowledges that more alternatives need to be made widely available in a multimodal transport system, and that the right incentives will have to be put in place to drive the transition. This includes measures to better price environmental externalities, and ways to facilitate multimodal travel and increase access to relevant information to make better informed and more sustainable choices.

To achieve these objectives, many existing policy frameworks will be revised - ranging from adapting emission performance standards for vehicles and new provisions on charging infrastructure to a new framework for intermodal transport or on access to car data to mobility services - whilst research, innovation and investment efforts will be enhanced. No less than 82 regulatory and enabling initiatives have been announced and will be rolled out as of 2021. To make it tangible, the sustainable and smart mobility strategy includes various milestones to be achieved by 2030, 2035 and 2050 respectively. Some are very concrete, such as the ambition to have at least 30 million zero-emission cars in operation on European roads. Others are still vague, such as the objective to have 'automated mobility deployed at large scale by 2030' (EC, 2020c).


\(^{18}\) Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the Regions: Sustainable and Smart Mobility Strategy – putting European transport on track for the future (COM 2020) 789, p 2.
5. Covid-19 as an accelerator of behavioural trends

The Covid-19 pandemic, with its global economic and societal repercussions, has been a shock to the economy and society in Europe.

5.1. Impacts on food

The negative impacts of the pandemic have been felt heavily in the food sector. The pandemic has brought to the fore the intertwined supply chains vulnerable to disruptions and raised questions about the resilience of European food system and food security at times of crisis. Disruptions in supply chains can result in food loss and waste, including fruits and vegetables, fish, meat and dairy products (FAO, 2020c; Athwal, 2020). Fluctuations in food supply chains and limitations of mobility have raised interest in local food. At the same time, given the economic fallout and social impacts of the pandemic, food donations and food banks are playing a growing role in helping the low-income groups.

Covid-19 has led to unprecedented changes in consumption patterns. The confinement and physical distancing measures may possibly have lasting impacts on food consumption due to people cooking more at home and ordering deliveries. The number of people avoiding food waste grew during confinement, and was aided by better planning of meals and grocery shopping, increase in home cooking, and more frequent reuse of leftovers from previous meals (Euroconsumers, 2020). However, it would not be surprising if consumers stockpiling food has also led at times to wasting food.

It is yet difficult to assess to what extent the current temporary change in consumption patterns may lead to permanent changes in food consumption. However, the pandemic provides an opportunity for policy-makers and businesses to guide and enable citizens and consumers to adopt more sustainable and healthy habits. These habits could last beyond the pandemic and also support the ‘green recovery’. Many people may have already discovered that habits with a smaller climate and environmental footprint are possible.

5.2. Impacts on mobility

Covid-19 has impacted the mobility and transport systems in many ways. Mobility needs dropped drastically. This has resulted in some short-term environmental benefits such as large decreases in air pollutant concentrations, greenhouse gas emissions, and a significant reduction in noise levels – especially in cities. But, most of these gains will most probably be undone as economic activity gets stronger again (EEA, 2019b).

Deeper changes are happening nevertheless. The crisis produced rapid shifts in the labour markets and some of these are here to stay. Entire organisations have switched to teleworking, as videoconferencing and virtual events are replacing face-to-face gatherings.

According to a recent survey by Eurofound, nearly half of the employees worked at home at least some of the time during the pandemic. Of these, over a third reported working exclusively from home. Most were urban-based, white-collar and well-educated service-sector employees (Eurofound, 2020).

The OECD comes to similar conclusions and finds that 30% of workers could telework across the OECD countries, but the likelihood decreases for workers without tertiary education and with lower levels of numeracy and literacy skills (Espinoza, 2020).

It is very likely that Covid-19 is a game changer and will lead to growth in teleworking after the crisis, with 78% of employees indicating a preference for working from home at least occasionally (Eurofound, 2020).
These developments may have huge consequences and can offer an opportunity to reshape the world of work sustainably. Remote work can substitute for labour mobility as it becomes feasible for employees to be productive without being in the office. As a result, companies can hire employees virtually from anywhere and may need less office space. It also reduces the need to commute, thereby decreasing congestion and traffic flows more generally (EC, 2020a; McKinsey Global Institute, 2020). Likewise, business travel has almost been reduced to zero. One can expect some of the travelling to resume, but not to achieve the same levels as before the crisis any time soon. For many business contacts, virtual calls, videoconferences or hybrid events are likely to become the new norm.

The Covid-19 crisis has also accelerated the digital revolution in our training and education systems. As schools and universities closed during the lockdown, technologies enabled continuity. This triggered discussions on whether distance learning can contribute to efficiency and inclusiveness (EC, 2020a). This, among many other changes, may also have important consequences for the mobility system. The lines between peak and off-peak hours may blur with the potential to further alter congestion problems, and the pollution associated with it. The extent to which this will become an environmentally positive trend will hugely depend on the ability of sustainable transport operators to offer tailor-made solutions and sufficient capacity adapted to changing demand patterns.

It is worrying to see how public transport systems are struggling with the effects of the Covid-19 crisis. Even though journeys drop worldwide, it is clear that public transport is most affected. Lack of trust, combined with distancing rules, has led to reduced use of public transport in many cities by 50% to 70% (Aloi et al, 2020). The Paris public transport agency (RATP) is expected to have lost at least €2.6 billion of revenues due to the crisis. (Béziat, 2020; Cosnard, 2020).

Technologies can play an important role in reassuring the public by providing indications on the concentration of passengers, on the type and environmental footprint of vehicles, and on waiting times and punctuality. Other measures may include diversified opening hours for schools, offices and services to manage better transport demand. But this would require a close cooperation between local authorities, economic actors, transport providers and other relevant stakeholders (Coppola and De Fabiis, 2020; Gaglione, 2020).

Shared mobility has also been heavily affected. According to a recent survey by McKinsey and Company, ride-hailing companies in many places have experienced a 60-70% decline in passengers during the crisis. Only 5-8% of respondents to the survey think that car sharing, ridesharing or shared micromobility are safe to use. The results of the survey suggest that for a stronger return to shared mobility additional safety measures would need to be put in place (Andersson, 2020).

In sharp contrast, the use of personal transport solutions such as private cars, bicycles and scooters has been growing fast. In many cities, measures were introduced to remove lanes and allocate more space to cyclists and pedestrians, lengthen crossing times for pedestrians, and or reduce speed limits for vehicles (EEA, 2019b; Aloi et al, 2020). This resulted in a cycling boom in many European cities, such as in Paris where cycling has increased by 67% during the first 8 months of 2020 (Cosnard, 2020). In Brussels the number of cyclists has doubled in one year time (Renson, 2020). In Switzerland, the number of kilometres cycled since early March has risen by 175%, and in Copenhagen bicycle sales doubled in April and May 2020 compared with the same months a year earlier (The Economist, 2020a).

These developments are actually an acceleration of the ongoing upward trend of ‘soft’, i.a. non-car mobility in our urban areas. In fact, an increasing number of cities have developed, in recent years, climate and mobility strategies that discourage the use of combustion-engine vehicles and promote walking and cycling. Even before the Covid-19 crisis, the sales of e.g. electrically assisted bicycles in Europe were growing by 23% growth in 2019 (The Economist, 2020b).
However, it is not clear what will the long-term effects of the pandemic on the mobility system be. Car use and ownership is a case in point. On a more general level, questions of whether Covid-19 will accelerate or reverse the trend towards further urbanisation remain unanswered. Digitalisation allows people to live and work away from big urban hubs. The lockdown experience has shifted demand – at least temporarily – towards apartments with large terraces outside of city centres, with more space and gardens (De Tijd, 2020). This, in turn, may increase dependency on the car for many more people in future.
6. Digitalisation: Technology as an enabler

6.1. Focus on food systems

Agricultural practices and food systems as a whole are changing because of technological solutions – including digitalisation. This creates significant possibilities also for using digital solutions to enhance sustainable food consumption.

Collecting and managing data is one of the most important starting steps for achieving and monitoring progress. Data is generated in different stages of agricultural production – for example, with the help of smart sensors – with the aim of improving knowledge and providing predictive insights in farming operations. Data management can be a driver for greater sustainability and help farmers produce more sustainable food with fewer resources. Collecting, managing, and sharing agricultural data – for example, on the use of pesticides – is the basis for informing, educating, and empowering retailers and consumers to make sustainable choices. It is also key for understanding and addressing problems like food loss and waste.

Digital technologies like artificial intelligence (AI) can help manage this growing amount of data. Digital solutions can be used to support more sustainable farming, including organic production and carbon sequestration. They can also help limit the use of pesticides and fertilisers, and improve animal welfare and reduce waste. Satellite imagery, sensors, the internet of things (IoT), automation, drones and robots can support precision farming, the sharing of information, better monitoring and surveillance of farming practices, and thus compliance with environmental rules.

Digital solutions help connect stakeholders in the food system. As a result, it is no surprise that, as agricultural supply chains have faced disruptions during the Covid-19 pandemic, many farmers have benefited from online platforms and apps (Gravis, 2020). These have enabled farmers to sell their products to consumers directly.

Digital and technological solutions also play an important role in other parts of the food system. They can help to improve how food is stored, processed, packaged, transported, prepared, served, eaten, and not wasted. With a focus on consumers, solutions like apps and online platforms can help improve people’s awareness and knowledge on sustainable food consumption, and change mentality and attitudes towards food and food waste. Numerous apps are already used to give people tools and thus empower them to make more sustainable choices and tackle food waste. These solutions are also helping to create communities of change and connect stakeholders, while also enhancing trust.

Consumers are increasingly open to using technologies to improve food consumption. For example, 55% of the respondents to a recent Euroconsumers’ survey said that they are very willing to use new tools such as digital apps and websites to be connected with grocery stores and purchase daily food surpluses at a reduced price (Euroconsumers, 2020).

That said, digitalisation does not automatically lead to greater sustainability. If data and digital solutions are just geared to make traditional agricultural practices more productive, this could actually amplify the negative impact of unsustainable farming practices. It is essential to build on data and steer digital solutions to address the existing challenges in the current food system.

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19 For a more detailed discussion, see the STOA study on the Future of Crop Protection in Europe (February 2021)
6.2. Focus on mobility

Similarly, the mobility system is being significantly reshaped by a combination of the rapid uptake of digital technologies and ever tougher environmental requirements. These developments are forcing manufacturers to rethink their offerings and develop new business models, thereby experimenting with novel mobility services and partnering up with new players entering the scene from outside the transport sector.

For most people, especially in urban areas, this offers a whole range of new possibilities. A growing number of smartphone applications do share real-time information and offer the most optimal solutions to get around.

Emergence of new mobility solutions disrupts some segments in the market, such as the taxi sector – challenged by app-based ride-sharing companies. Bike sharing and other micromobility schemes become so more attractive and easy-to-use thanks to the hyper-connected environment we are in. In addition, technologies and new forms of cooperation enable people to make use of different mobility providers through one single platform. This leads to a mobility environment that is increasingly tailor-made and customised.

Furthermore, vehicles themselves become more automated and integrated with their street and road environment and with other vehicles. This can have huge benefits in terms of efficiency, comfort and safety. But the speed at which these technologies will mature depends a lot on social acceptance, and the wide diversity of traffic rules or issues like liability will be addressed.

Similarly to the trends in food consumption, these developments are based on the ever growing availability of data and how they are processed, shared (or not), and used by entrepreneurs or governments. They have the potential to contribute to a more sustainable transport system, but this is not granted. Sometimes, people may switch to less sustainable modes or travel more kilometres than before. It requires therefore governments to incorporate sustainability in the design of policies, and develop and promote sustainable alternatives, and people to be much more aware of the impact of their travel behaviour on the environment.
7. Sustainable behaviour: Food consumption

Food is essential to our economies, societies and of course to the growing global population. However, there is also an understanding that the current system of food production and consumption is not sustainable.

The science of what constitutes a sustainable food system is established. In the words of the UN's Food and Agriculture Organisation (FAO), a shift to more sustainable diets and food systems would require mostly plant-based diets; focusing on seasonal and local foods; reducing food waste; consuming fish from sustainable stocks only; and reducing red and processed meat, highly-processed foods, and sugar-sweetened beverages (FAO, 2010).

According to World Resources Institute, meeting the future food needs without producing more would require not only consuming fewer animal products per person, but eliminating nearly all meat consumption globally. Moreover, it would require eliminating all food loss and waste, and consuming food to only meet one's personal nutritional needs (World Resources Institute, 2019).

However, even though the scientific evidence is growing, much remains to be done to close the gap between information and action. Although Europeans are aware of the impact of food habits on climate and environment in general, as consumers, they tend to underestimate the environmental impact of their eating habits and often make irrational decisions (BEUC, 2020; Camilleri et al, 2019; Guibourg and Briggs, 2019; Onwezen, 2019).

Excessive consumption of animal products as well as food wastage have been identified as key drivers for unsustainable food consumption – and as these are behavioural habits that people can change – it is worth taking a closer look at these areas. Moreover, it is often suggested in the media, for example, that people should consume more seasonal and local foods, and thus also the impact and possibilities with such decisions will be considered. These assessments will be followed up by an overview and evaluations of how technology, namely digital solutions, can support people in making more environmentally- and climate-friendly decisions on food.

It should be noted that this chapter focuses on sustainable food consumption from the perspective of climate and environment. However, consumers' choices will naturally have also wider implications. As will be noted under the section on animal products, ideally consumers' diets should be good for climate, environment, and their own health. As will be noted under food waste, there should be a strong not just environmental but also an economic incentive for action. Moreover, the arguments for local and seasonal food go well beyond just climate and environmental considerations.

7.1. Challenge 1: Over-consumption of animal products in Europe

A significant part of agriculture emissions derive from keeping livestock: cattle, pigs, sheep, and chicken and growing food for them (see figure 2). According to FAO estimates, the livestock sector accounts for 14.5% of the global GHG emissions and is the main source for agricultural emissions (FAO, 2013). Increasing consumption of animal products, converting land to feed livestock, fertiliser usage, and direct emissions from animal farming are driving these emissions. As a major producer – and consumer – of meat and dairy, Europeans have a major role in driving these agricultural emissions (Bellarby et al, 2012).
Looking at the situation only in the EU: most of the European agriculture land is used for growing livestock and feed for the animals – rather than just growing plant-based food directly for human consumption. According to Commission’s ‘Farm to Fork’ strategy, 68% of all agricultural land is used for animal production. According to the European Commission, two thirds of EU’s cereal production fed to animals. (European Commission, Cereals).

According to Commission’s ‘Farm to Fork’ Strategy, in the EU, agriculture accounts for 10.3% of the GHG emissions, of which around 70% is produced by livestock farming. It has been evaluated that lower livestock production would drastically reduce Europe’s nitrogen as well as GHG emissions (Westhoek et al, 2014), and in this context it is worth noting that the agricultural GHG emissions in the EU have already been decreasing over the years due to reduced use of nitrogenous fertilisers, and a reduction in livestock numbers (Eurostat, 2019). At the same time, these reductions have been offset, at least in part, by increased production and imports from outside the EU (Eurostat, 2019). While there is a debate on whether GHG emissions related to livestock may be more or less damaging compared to emissions from energy, industry, transport and other sectors (National Geographic, 2019; Oxford Martin School, 2019), it worth noting that the sector’s footprint is not limited to climate.

Livestock production – and thus consumption – has also a significant environmental footprint. The nutrients and pesticides used for producing animal feed pollute land and water. Ammonia emissions from livestock waste area significant source of air pollution (EEA, 2017). Agriculture also contributes to growing water scarcity: it uses more than 40% of freshwater in the EU (EEA, 2018), with a significant share used for livestock production (Vanham et al, 2013). Animal farming is also a major driver for biodiversity loss.
While the full impact of fish and seafood production on climate and environment is less known and discussed, research shows that also especially commercial fishing has a significant footprint. It has been evaluated that industrial fishing could impact the ecosystems in over 55% of the ocean area (Kroodsma et al., 2018). Commercial fishing is degrading ocean habitats and disturbing marine sediments, which contributes to climate change. It has been estimated that fishing boats that trawl the ocean floor with big nets to catch fish release as much carbon dioxide as the entire aviation industry (Sala et al., 2021). While aquaculture does not have similar direct impact on climate and it helps to address challenges with commercial overfishing, it can also negatively impact the environment by affecting biodiversity and degrading, for example, the quality of water (EEA, 2021 and Cretu 2016).

The World Resources Institute has studied the overall resource-intensity of different food products. Figure 3 shows the combined climate and environmental footprints for different food products, and visualises the high impact of animal-based foods, compared to plant-based food, on land use, water consumption and GHG emissions. According to the study, a sustainable food system would require people to shift from eating meat to vegetables and legumes. (World Resources Institute, 2019).

**Figure 3: Resource intensity of animal-based foods compared to plant-based foods**

Second, a recent study by the University of Oxford has especially focused on assessing the GHG emissions of different food products (Poore and Nemecek, 2018). As shown in Figure 4, the impact of even the lowest-impact animal products normally exceed those of vegetable substitutes. For example, producing a glass of dairy milk results in almost three times the GHG emissions of any non-dairy milks.
Third, the Eat Lancet Commission brought together nutritionists and other experts to consider an optimal diet that meets the goals for health and sustainability. Their extensive research led to recommendations for creating a sustainable food system and dietary guidelines that would be beneficial for human health, the climate, and the environment. The Eat Lancet Commission suggests that for this aim, we should aim to double the consumption of plant-based foods and substantially limit foods from animal sources (EAT Forum, 2019). Figure 5 illustrates their suggestion for an ideal diet good for planet and the people.

Source: Carbon Brief, 2020
Similar conclusions have been made in several other studies. (see e.g. ScienceDaily, 2020; Swedish Food Agency). Most notably, according to the World Health Organisation (WHO), a healthy diet that has a lower environmental impact includes a wide variety of foods with an emphasis on plant-based foods (fruits, vegetables, whole grains and pulses). While it can include some sustainably sourced fish/shellfish, it should be limited in meat, especially red meat and processed meat products (WHO, 2018).

There are several existing digital solutions that can help educate, influence, and empower people to adopt diets that would be better for their health, environment, and the climate.

7.2. Challenge 2: Food waste

According to the Food and Agriculture Organisation, globally, around 30% of food that is produced for human consumption is lost or wasted every year. Global carbon footprint of food loss and waste equals at least 8% of all global GHG emissions caused by humans. If food waste was a country, it would be the third largest emitter after the US and China.

Figure 5: A diet good for plant and people

Source: The Eat Lancet Commission on Food, Planet, Health.
In the EU, around 88 million tonnes of food are wasted every year, which is equivalent to 173kg per person and 20% of all produced food (Stenmarck, 2016). This is not just a cost for the environment, a waste of resources, and a missed opportunity to improve food security: it is also an economic loss. According to the European Commission, monetary value of the food that Europeans waste is estimated to be 143 billion euros annually.

Food waste is created across the value chain, from farm to consumer. (e.g. FoodPrint) For example, at a farm level, food may not be harvested because of damage by weather or diseases. Farmers may end up throwing away edible food if it does not meet market conditions, or even because of its wrong shape or colour. While processing and packaging can help to preserve foods, during storage and transportation inadequate facilities and temperature deviations can lead to food being wasted.

In restaurants, a lack of inventory overview, over-ordering, and incorrect shelving contribute to waste. Retailers again are affected by consumers’ varying shopping patterns, which can fluctuate greatly on the basis of the weather. Moreover, when retailers are left with surplus food, they often find it impractical or costly to distribute it.

This said, consumers also play a major role in addressing and creating food waste. (e.g. FAO, 2019; European Parliament, 2013) In the EU about 50% food waste is created in households. There are a variety of reasons for this, including poor planning, not valuing food, impulsive shopping, purchasing more than one needs, preparing too much food, and food spoilage.

As will be demonstrated below, several digital solutions already exist that can help people play a greater role in addressing food waste not only in their homes, but also at a farm, restaurant and retail level.

7.3. Challenge 3: Importing food with high climate and environmental footprint

As a guidance, as shown in Figure 6, what one eats tends to be much more important than how far food has travelled from or what kind of packaging has been used. For most foods, transportation and packaging account only for a small share of the climate footprint. As written above, significant share of GHG emissions are related to land use change, farm emissions, feeding animals and catching fish by bottom trawling that releases CO2 from marine sediments. However, as consumers are often encouraged to eat local and seasonal food, it is worth to consider the climate and enviromental rationale behind these suggestions.
First, while consuming animal products always has a much bigger climate and environmental (including land use and fresh water consumption) footprint than plant-based foods, the global averages for climate and environmental footprints of products do not always tell the full story.

The climate and environmental footprints for some food products differ across the world and depend greatly on production methods (UNIQUE, 2018; FAO, 2013). For example, variations in GHG emissions of livestock across the world can be explained by different production profiles that affect emission intensities for products as well as by different species (see Figure 7). According to these estimates, European beef and milk has much lower emission intensity compared to those from Latin America or South Asia, for example.
As another example, the origin of soya has an environmental footprint. It has been evaluated that around 20% of soya exports (that is mostly used for animal feed) and at least 17% of beef exports from Brazil (Amazon and Cerrado regions) to the EU may have links to illegal deforestation. (Feed Navigator, 2020; Food Service Footprint, 2020). Regarding commercial fishing, some areas in the world have been identified as having especially big impact on climate. It has been assessed that areas where carbon stocks and anthropogenic threats are highest because of the carbon emissions that are released when dragging heavy nets across seabed, include China, Russia, Italy, UK, Denmark, France, the Netherlands, Norway, Croatia and Spain (Sala et al., 2021 and Guardian, 2021). As commercial fish from these coastal areas risks having a very high climate footprint, buying locally sourced fish does not automatically imply a more sustainable behaviour.

Moreover, organic and conventional farming have different impacts on climate and environment (Ritchie, 2017; FAO, 2012). While organic food is not always automatically better for climate and environment - due to for example greater land use -, it has several benefits. Organically-managed soils are often not only efficient sinks for CO₂ but they are more resilient to water stress and nutrient loss, and thus can counter soil degradation. Organic agriculture does not pollute water like conventional agriculture, and it is also less damaging to biodiversity and can even support conservation and survival of pollinators. As it can be more difficult to transport organic food products for long distances and store them for long periods, they are often seasonal and more local.

Second, food that travels across the world can require more energy for its transport, refrigeration, and storage. It often requires more (single-use plastic) packaging to increase durability and keep it fresh. Moreover, it can contribute to food waste as a notable amount of food is lost during storage and transit.

In addition to these climate and environmental considerations, local and seasonal food is often fresher and more nutritious. It can be cheaper and some consumers may see it as a way to support local farmers and communities. Moreover, it is often easier to know where the local food comes from and how it has been produced.
7.4. Technological options

Technological and digital solutions can do a lot to support behavioural change. They can help to make sustainable choices be it consuming more climate- and environmentally-friendly food products, or reducing food waste - easy, attractive and social. They can help create awareness about needed measures, connect farmers and consumers, help people to reconnect with food, empower people, incentivise sustainable behaviour and diets, enhance trust and transparency, and help prevent food waste.

Digital solutions can support all generations in making more sustainable choices. However, the potential of empowering younger generations is arguably limitless. They are already digitally savvy and alert to use digital tools to act on climate, protect the environment, and make sustainable food choices.

7.4.1 Creating awareness

**Labelling.** Consumers should be empowered to choose healthy and sustainable food easily. It is clear that people need guidance in these efforts. They tend to underestimate the greenhouse gas emissions from food; and can find it extremely difficult to evaluate environmental, climate, and health considerations together.

Labels can help, but the current system with numerous different labels can be very confusing and needs to be improved. Ideally food labelling would build on a score system that would capture health, environment, and climate impacts of the given food product.

An agreement on the necessary elements for environmental and climate footprints, and nutrition scores as well as collection of relevant data, is work in progress. Bringing the environment, climate and health considerations together under one label may sound unrealistic today, but it is needed. AI could play a key role in turning the relevant data sets into information. Moreover, for example, QR codes can be used to provide interested consumers further information about the reasoning behind the labels.

**Footprint calculators.** Digital tools like general carbon footprint calculations of behavioural choices (e.g. Sitra’s lifestyle test) or even more specific modelling for food choices (e.g. BBC diet carbon calculator) can play a major role in educating, informing, influencing, and empowering people to make more choices that are good for climate and the environment.

Such tools can also be used to share information about positive trends to a wider audience, and create peer pressure to reduce one’s footprint. They can also be used to measure outcomes and influence policy-making. For example, data from Sitra’s lifestyle test results could be used to guide policy-makers to take measures to support people in their sustainability efforts.

**Virtual farming.** Some NGOs are using virtual reality (VR) experiences to demonstrate what intensive farming means for animals like pigs (Whittleton 2016). In a similar manner, VR could help show people life on a sustainable farm. Such experiences can bring people closer to food and educate children about the origins of their food. They can help reduce the existing ‘farm-to-fork’ disconnect; and help people to value food, increase interest in sustainable plant-based options, and reduce food waste and consumption of processed foods.

**Databases and checklists.** For example, Good Fish Guide provides a database of sustainable seafood (ethically-sourced and not from over-fished and endangered supplies). One can search for the name of a possible purchase; and the app provides details on the species, its origin, and a sustainability rating. The app has been created by the Marine Conservation Society.
**Websites and tools for awareness raising.** The Food and Agriculture Organisation (FAO) has developed educational packages for schools on reducing food waste, which are available behind QR codes on their website (FAO, 2020b). Too Good to Go has collected on their website information and advice to help consumers to understand better challenges related food waste. It also contains information about food labels and expiration dates, thus helping people to address food waste.

**7.4.2 Connecting farmers and consumers**

**Digital platforms and apps for connecting farmers with consumers.** Several digital platforms and apps help shorten supply chains and connect farmers with consumers. CrowdFarming is an online platform that allows people to buy food directly from farmers. Belgian platform eFarmz provides a platform for buying bio-products, while the app Lowco maps local and low-carbon artisanal producers. These solutions are not limited to Europe: Mandi Trades is an app that helps farmers connect directly with consumers in India (Poovanna, 2016). Such solutions can help people to value food but also help reduce food waste at a farm-level.

**Blockchain-enabled connections.** Blockchain-enabled solutions can allow small-scale farmers interested in sustainable farming to connect with each other and with consumers (e.g. Sergey, 2018). This allows farmers and consumers to bypass intermediaries, like large agri-business corporations and retail chains, and connect with interested consumers directly.

**7.4.3 Making sustainable consumption easy**

**Apps** like the U.S.-developed HowGood can help consumers make better choices when shopping for food. Their algorithm rates over 200,000 products on 60 indicators of sustainability.

**Websites** like Riverford Recipes allows consumers to choose recipes on the basis of different vegetables.

**7.4.4 Incentivising sustainable home cooking**

**Recipes and ingredients delivered home.** Several digital platforms and service providers like eFarmz, Foodbag.be, HelloFresh, and 15gram Foodbox have emerged to help consumers eat healthy and more sustainably at home. Many also focus on using local and organic food.

These services can help reduce emissions by streamlining supply chains and distribution, portioning the ingredients one needs for each meal thus reducing food waste, providing attractive vegetarian options for cooking, and reducing packaging as food comes more directly from farms (e.g. Heard et al, 2019).

It is recognised that pre-ordering food can result in people choosing more sustainably. If coupled with appealing descriptions for plant-based dishes, this can increase the attractiveness for plant-based dishes (Turnwald et al, 2017). These kinds of services with attractive recipes for sustainable dishes could make it easier for people to choose the most sustainable meal as the default choice, and form sustainable habits.

**7.4.5 Enhancing trust**

**Tracking and tracing via blockchain.** As people’s demands on the food they consume are increasing – as they seek higher quality, locally sourced, fairly traded and/or sustainably grown food – also the need for greater transparency and trust in food supply chains grows. Consumers want to know that the food they buy is what it claims to be. They want to trust the information on the packaging. This requires ensuring that the relevant information is trustworthy and flows from farmers to processors, distributors, retailers and finally to consumers.
Blockchain-enabled solutions are already used to increase transparency and trust in food supply chains. Related solutions can help verify different claims on food, including whether it is organic, sustainably grown, transported under right conditions, and thus of the required quality.

My Story is an example of blockchain-enabled solution that allows consumers to learn details about a product, including its environmental and social impact. The Belgian foodcareplus is developing a blockchain for food systems which will enable the tracking and monitoring of food throughout a supply chain. Receiving real-time data (RTD) on food (e.g. outdoor temperature during transportation) is important for retaining the quality of food and saving energy and resources.

Walmart, Auchan, and Carrefour are either using or have announced their intention to use blockchain to trace their food products, which can be used to identify and redirect surplus stocks to those in need while avoiding waste (Willemse, 2019).

### 7.4.6 Making sustainable consumption fun, social, and attractive

Several apps, platforms, and websites are helping to make sustainable food consumption easier. They are adding into it a social element that can attract especially younger generations to adapt more sustainable behaviours. For example, AWorld in support of ActNow app incentivises people to reduce carbon footprint via daily actions like eating more plant-based meals. Users can track their progress, and the app also provides tips and quizzes. ActNow is the United Nations' global campaign to raise awareness, ambition and action for climate change.

Noshplanet lists cafés and restaurants with high-sustainability credentials. It enables people to review their food, and encourages them to recommend more destinations for its database.

Happy Cow is a platform with reviews of vegan and vegetarian restaurants. These kind of apps can create awareness on sustainable options and make them more prominent.

### 7.4.7 Using economic incentives to avoid food waste

Data, apps, online platforms, and other digital tools can help provide both retailers and consumers with economic incentives to avoid food waste. Digital solutions can help retailers prepare and adapt to consumers’ fluctuating food consumption patterns. Moreover, several solutions exist for tapping into people’s interest to savemoney, while also helping to address food waste.

As weather conditions affect consumer purchases, Frivind analyses the effect weather has had on past sales, and forecasts how it may affect business in the future. It combines the analysis with sales and visitor data to predict future sales, helping grocery stores to stock up on products according to the weather – thus limiting food waste.

SIRPLUS uses an online platform to sell surplus, expired, and deformed groceries for up to 70% less than its usual price. This reduces food waste.

Too Good To Go, originally a Danish initiative, also helps redirect surplus food to interested consumers. The mobile app connects retailers, restaurant owners, and consumers with each other; and facilitates the distribution of surplus food. The initiative is supported by around 1,900 stores in the UK alone. They have estimated having saved so far, around 800,000 meals have been saved, which equals to around 2 million CO₂/kg.

Similar online platforms or apps could also be used by, for example, importers to connect faster with consumers. These solutions could help importers to get revenue and consumers to save money, while helping to address food waste.
7.4.8 Avoiding food waste by tapping into people's desire to help others

**Several applications provide tools for people to tackle food waste.** FoodCloud app and a digital platform facilitates the donation of surplus food from retailers to local charities in UK and Ireland. Charities are automatically notified about unsold food surpluses, and they can collect the surplus food from retailers and distribute it to those in need. The network comprises major retail chains, 3,200 supermarkets, and 9,500 charity partners.

The Foodlist app is another tool for donating food for charities. Businesses with surplus food can provide local charities basic information about the food and details for pick-up.

The German Foodsharing app offers people a chance to give or collect leftover food in their local area. Those who wish to donate can list the items they have spare, and those who need them can find the listing and collect the produce. OLIO is another British online app that shares surplus food as well as non-food household items, by connecting not only citizens to local businesses but also neighbours with each other.

7.4.9 Avoiding food waste via reminders and recipes

**Digital solutions can help people to avoid creation of food waste in their households.** The Keep-it shelf life indicator is attached to the packaging of foods and shows the remaining shelf life of temperature-sensitive products like fresh fish, poultry, and red meat. The indicator displays remaining shelf life days enabling both retailers and consumers to be correctly informed about a product's safety and longevity.

Kitchen application gives reminders of food one has at home and lets one filter recipes based on the ingredients at home. In a similar manner, TotalCtrl Home app helps consumers to keep track of all of the food in their household. It sends the user notifications when products are about to expire. It can also generate recipes based on what the user has in the kitchen. The Love Food Hate Waste app gives the user directions and possible recipes on how to use potential leftovers.

Green Egg Shopper app (not in use anymore) has helped users to manage their groceries, with the aim of reducing food waste and overbuying. Customers were able to enter the use-by dates of their purchases, and the app offered advice on when, and how, to use them. The app also offered a price-tracking, and an annual report on expenditure.
8. Sustainable behaviour: Mobility

8.1. Comprehensive and deeper structural changes are needed

The share of the transport sector in total GHG emissions is increasing. At the same time demand is expected to further grow in the decades to come.

This makes it a formidable challenge for all stakeholders involved to manage the transition towards climate neutrality. There is no simple fix to make our mobility system sustainable and compatible with our long-term societal objectives. A wide range of policy tools will have to be activated jointly, new technologies and business models will have to be deployed, and people will need to become increasingly aware of how they can contribute to sustainable mobility behaviour.

In essence, there are three types of very challenging approaches that can make our mobility system more sustainable and reduce its environmental impact, and they should be combined (EEA, 2019a).

Firstly, we need to improve the efficiency of the vehicles and transport equipment more broadly, and use cleaner fuels. In addition, vehicles should be used more efficiently, e.g. by reducing speed.

Secondly, a shift towards more sustainable modes is needed. This approach also includes the combination of modes with an overall reduction of the environmental impact as a result.

Thirdly, we should look at the drivers that trigger mobility, and avoid transport of goods and people when possible.

Each of these approaches include behavioural aspects. Combined with the exponential growth of smarter technological opportunities and new business models, these have the potential to move the mobility system on a more sustainable track. Figure 8 shows the different factors influencing decision-making of transport users.
Crucial for behaviour change is that it requires people to become aware of their current and past behaviour, as well as about the existence of possible and past future alternatives. Tools that actively support people in engaging in a more sustainable lifestyle are therefore critical (Weiser et al, 2016), and that is where technology plays a very important role.

8.2. Challenge 1: Increasing efficiency of vehicles and fuels

Improving the efficiency of all types of vehicles requires significant research and innovation. It also requires regulatory pressure to reduce the environmental footprint of vehicles, fuels, and related technologies. But it also includes powerful choices made by people, such as driving behaviour or eco-driving, choosing to buy a car or not, and to increasing the occupancy rate of vehicles.

Car ownership in the EU has increased substantially over the years: from 342 cars per 1000 inhabitants in 1990 to 507 in 2016 (EEA, 2020). Even though new cars are much more efficient in terms of CO₂ emissions, growth in travelled distance and the increased average weight of vehicles have excessively offset efficiency gains (EPSC, 2016).

Similarly, it is estimated that an average car is parked 92% of the time and, when the car is used, fewer than two of its five seats are occupied (Ellen MacArthur Foundation, 2015). Moreover, mobility captures an impressive 13% of an average household budget. Around 30% of this sum is used to purchase vehicles, around half is spent on the operation of personal transport equipment (e.g. to buy fuel for the car) and the rest is spent for transport services (e.g. bus, train, plane tickets) (EC, 2019). Privately owned cars are therefore very expensive and inefficient assets.
Drastically increasing the occupancy rate by sharing vehicles is thus a promising avenue, especially if the vehicles are fuelled by clean technologies. In Belgium alone, the car sharing scheme Cambio has already attracted 46,000 members (Cambio website, 2020).

Switching to cleaner vehicles or not, however, can depend on how the vehicle is perceived by an individual as representative of his or her self-identity, or on social influences. (Whittle et al, 2019). Shifting to carbon neutral vehicles requires that people feel ‘connected’ to them. The launch of an increasing number of new models will therefore become important to attract more customers. Obviously, the penetration of these novel vehicles can strongly increase if the switch is made easy for people and the vehicles’ introduction is facilitated by the development of the necessary infrastructure or business models such as home charging, roadside and fast charging, the availability of fleets, and battery replacement models (Robinson, 2018).

Despite all these challenges, a strong acceleration of electric vehicles sales is ongoing. In the third quarter of 2020, almost one in 10 passenger cars sold in the EU was an electrically-chargeable vehicle (9.9 %), compared to 3.0 % during the same period last year (ACEA, 2020). In France, for instance, electric and plug-in hybrid cars had a market share of 9.4 % during the first 8 months of 2020, a multiplication by 5 compared to same period a year ago (Normand, 2020).

Not only the type of vehicles people use is important, but also important is the way the vehicles are used. In fact, even small changes in people’s behaviour can lead to significant reductions in carbon emission, at a far lower cost than many alternatives. According to Dietz (2009) a combination of easy implementable measures such as slower acceleration or adhering to speed limits could save up to 7.4 % of US national carbon emissions. The International Energy Agency’s most recent Outlook also emphasises the importance of behavioural change to be able to reach net-zero emissions on time in its high-ambition scenario. Reducing speed limits by 7 km/h can contribute to a 23 % reduction of the 2 gigaton of CO₂ emission reduction needed by 2030. Switching to the ecodriving mode or keeping air conditioner at least 3°C warmer in summer can contribute to another 6 % and 9 % respectively of the needed efforts (IEA, 2020).

In the longer term other developments will contribute to more efficiency. Vehicles are gradually including ever more automated features, and may in a not so distant future drive autonomously on our roads. With the arrival of technologies that allow more connectivity, vehicles have begun to communicate with each other and with the infrastructure. This has made it possible for vehicles to work together, share information, and become ever more ‘cooperative’ automated vehicles.

The technology needed to get vehicles to drive themselves has yet to be perfected, but it has improved enormously over the past few years, and is becoming increasingly reliable. Such autonomous vehicles could reduce pollution because they are likely to be electric or fuelled by hydrogen in future. And they will drive more fuel- and energy efficient, as they will most often navigate at optimum cruise speed without exceeding speed limits.

The condition is that they should not replace high-capacity public transport and that is why it is important that automated and autonomous driving technology also has the potential to make public and shared transport more attractive, safe, and reliable, (EEA, 2019b). Some argue that the emergence of autonomous vehicle will undermine the logic of car ownership for many people, reduce drastically the number of vehicles on the roads, and boost ride-hailing in particular by eliminating the cost of the driver that accounts for about 60 % of the cost of ride-hailing (The Economist, 2018).

These developments raise new concerns about safety, cyber-security, liability, and inequality. As with all AI systems, autonomous vehicles can have unintended biases, such as pedestrian detection biases based on skin tone and culturally determined patterns of dress, or may not sufficiently take into account the nuances of how body language translates into intended action in different cultures. AI requires therefore tailored solutions adapted to local contexts (Sovacool and Griffiths, 2020).
8.3. Challenge 2: Switching to other modes and/or combining sustainable modes as much as possible

Replacing combustion engine vehicles over time by carbon neutral alternatives will not be sufficient to address a wider number of externalities related to the mobility system – such as material use and congestion.

A mobility mix that internalises better the wider costs to planet and society should be developed in parallel. The most powerful tool policy-makers have is pricing. A transformation of the mobility system should therefore address the existing imbalances and adapt taxation, charges, and fees in accordance with the polluter-pays or the user-pays principle (Figure 9). This will have to be combined with a careful assessment of the distributional outcomes of a tax shift. The integration of social considerations and the development of alternatives to ensure good access to mobility services for everyone, will be key in this regard.

**Figure 9: Degree of internalisation for EU - Total costs, taxes, charges**

Source: van Essen et al, 2019

A specific challenge relates to work-related travelling. A recent study found that in Europe, nearly 6 out of 10 cars are registered through the corporate channel (Lopez, 2020). Company cars, which are most often larger vehicles than the average, are everywhere. They are heavily subsidised and attractive to both and employees, who also travel more kilometres as a consequence.

In this context, a switch towards public transport and soft modes such as walking and cycling, or a combination of more sustainable modes will become crucial. Next to pricing, it is the digitalisation of our economy that offers new perspectives to drastically increase the efficiency of the overall mobility system.

There are indications that a change is already happening in the mind-set of people. For example, license-holding and car-ownership are stabilising or even declining after decades of steady increases, especially amongst young adults (Robinson, 2018; Whittle et al, 2019).
Technology can support people to transform their habits and make them switch to more sustainable solutions. Public transport journeys can be made more convenient by providing real-time information on e.g. near-term arrival predictions or delays, connections, schedules, as well as possible functions of booking ticket and payments. Furthermore, by comparing the efficiency of different modes in terms of time spent, costs or environmental performance on a single route, uncertainties associated with mobility such as traffic jams and delays can be reduced while making alternative solutions to the use of a private vehicle more attractive and competitive (Asitha and Hooi Ling Khoo, 2020; Aguilera and Rallet, 2016).

Technology is extending the range of activities that can be performed on route, and this is most relevant for public transport. Nowadays, people have access to content and are able to communicate and coordinate with others while travelling, expanding the possibilities of interaction through access to social or professional networks. Reducing travel time may therefore not any longer be the only guiding factor in people’s travel choice (Aguilera and Rallet, 2016).

Technology-enabled business model innovation is increasingly seen as a means to develop sustainable solutions. Some ideas are not new. Shared mobility for instance (e.g. carpooling or even hitchhiking) exists since many years, but contracted consistently and sharply over time. It is the hyper-connected environment that made its organisation and provision much easier. It modifies operating conditions of existing services such as taxis (e.g. Uber, Didi, Lyft and others) and enables new mobility services to flourish, made possible by the real-time coordination of providers and users via digital platforms. Smartphone applications can not only fulfil simultaneously the roles of multiple existing technologies. They also reduce some of the coordination costs of running these services, foster the creation of dynamic matching services, and reduce the monetary cost associated with travel by sharing resources (Brazil and Caulfield, 2013; Aguilera and Rallet, 2016). In addition, payments, locking, and unlocking of vehicles is made easy (EEA, 2019).

All of this results in different forms of shared mobility. Business models can offer monomodal (using a single transport mode), multimodal or intermodal (a service that combines transport modes within a single trip) mobility solutions. They can also be divided into those that offer sharing a vehicle or bicycle during a particular slot, and those that offer sharing a journey. Some are business-to-consumer, others peer-to-peer (EEA, 2019b; Sarasini and Linder, 2018; Whittle et al, 2020).

Not all these models lead automatically to more sustainable mobility. In San Francisco, for example, it is estimated that approximately 20 percent of the kilometres travelled by Uber and Lyft drivers are without passengers (Bliss, 2018). Long distance ride models, such as Blablacar, on the other hand, may capture share from the train over intermediate distances (Aguilera and Rallet, 2016).

The effectiveness of applications and smart mobility solutions is conditional on the availability of green transport alternatives, and how easy it is to access these (Creutzig et al, 2016). In big cities, these are relatively numerous. In less dense areas, however, this becomes more complex and may require specific government intervention to help create the critical mass needed. This could be done by introducing regular ridesharing ‘lines’, that could be subsidised by authorities, replacing public transport services that are more expensive and less efficient (Aguilera and Rallet, 2016).

In any case, the promotion of soft modes – especially for shorter distances – remains the most effective way to drive sustainability. Almost half of car trips in cities are of less than five kilometres and this can be avoided. Bicycle sharing schemes or other forms of micromobility are also on the rise, especially in urban areas. Although this is without doubt a positive trend, the environmental impact of for instance bicycle sharing may be limited, as users seem to be predominantly previous pedestrians or public transport users (EEA, 2019b). The use of bikes could, however, be made increasingly attractive by providing specific and tailor-made and/or city-specific information on performance, routes, community infrastructure such as bike shops and cycle cafés, and aid with bike maintenance and repair, amongst other things (Schwanen, 2015).
What can be even more impactful is that cities increasingly develop together with their partners mobility nodes where people can switch easily from one mode to another. New offerings are also entering the market and have the potential to attract new categories of users. For example, the Dutch company Cargoroo developed an e-cargo bike sharing offering that allows parents to carry children without too much effort, and facilitates deliveries across towns.

A more recent development is the emergence of Mobility as a Service (MaaS). MaaS is a mobility intermediary and one-stop-shop that integrates different types of existing mobility services as part of a single, seamless offering that is made available to users via subscription-based smartphone applications. It has the potential to provide tailor-made mobility solutions fitting the needs of individuals and households. This is a critical success factor (Karrlson, et al, 2020). It can also make the cost of mobility more transparent and increase the efficiency of the use of the available capacity of different transport networks (Sarasini and Linder, 2018).

There exist different levels of integration. MaaS usually includes ticketing and payment when one smart card or ticket can be used to access all the modes taking part in the service and one account is charged for the use of those services. MaaS can provide a mobility package whereby customers can pre-pay for a specific amount (in time or distance) of a combination of mobility services. It can also consist of ICT integration whereby a single application or online interface can be used to access information about the modes and support planning, reservation, and provide travel information and route adaptations where necessary (Kamargianni et al, 2016). The integration therefore can range from basic – where only information across modes is integrated – to full integration, with full informational, operational and transactional integration across modes for all journeys (EEA, 2019b) (see Figure 10).

One could argue that the higher the level of integration, the more it is appealing to citizens, as they can reduce the complexity of using a variety of transport modes (i.e. different payment methods, subscriptions, different mobile applications for each operator, lack of integrated information, etc) that often discourages people from using them.

The key challenge is to develop a system that benefits all involved actors (Karrslson et al, 2020). Indeed, the difficulty is not only to integrate the booking, payment and operating systems of all the relevant providers, but also to persuade especially private companies to take part in the first place and share data and real-time information on customers (The Economist, 2016). Blockchain technology could become a useful tool to enhance transparency and trust between mobility providers.
Meeting the Green Deal objectives by alignment of technology and behaviour

Figure 10: Different levels of MaaS-integration

Examples of MaaS companies that are relatively well integrated include the Finnish company Whim (Whimapp website, 2020) that offers pay-as-you-go 'multi-modal' packages that bundle monthly travel requirements at a single price or the Swedish company Ubigo (Ubigo website, 2020).

However, as the European Environment Agency points out, to be able to satisfy user needs, the first assets needed are infrastructure and vehicles, next are mobility services, information services and transaction services. Only when all these elements are available, can MaaS provide further added value (EEA, 2019b).

Similar to MaaS, also between mobility hubs and for longer distance transport, the level of integration between modes and operators could be enhanced to facilitate the use of multiple modes in an efficient way.

Box 3: Can MaaS contribute to a more sustainable transport system?

The extent to which MaaS can contribute to more sustainable mobility remains unclear.

Some warn of exaggerated expectations because it could also lead to modal shifts towards less sustainable modes with more vehicles on the road, if these smart mobility solutions are not accompanied by a culture motivated to share or measures to decrease car use (EEA, 2019b). That is why some argue that car- and ride-sharing should be part of the package, but made less accessible by adapting the pricing framework or by developing car-free and parking-free zones. Cars should primarily be used for emergencies and as neighbourhood feeders to mass-transit systems (Alyavina et al, 2020).

On the other hand, one can argue that MaaS could bundle less popular modes, such as bike sharing and car sharing together with public transport, with the hope that this will result in the uptake of these modes. It can also reduce the cognitive effort needed to use public transport (Sarasini and Linder, 2018).

MaaS can clearly reduce the need for personal car ownership, improve resource utilisation rates, and increase vehicle occupation. But this needs to go hand in hand with the use of clean vehicle technologies such as hybrid and electric drives, biofuels, fuel cells, and autonomous and connected vehicles in a manner than can further reduce ecological impacts (Sarasini and Linder, 2018). MaaS can also have a longer term impact. If younger people who do not currently own a vehicle are able to solve all their door to door journeys, they may delay or abandon purchasing a vehicle in the long run (Matyas and Kamargianni, 2019).
8.4. Challenge 3: Reducing overall transport and mobility needs

Obviously, the cheapest and most effective way to reduce emissions and air pollutants, is to reduce the need to move people and goods. As already emphasised in the chapter on the impact of the Covid-19 crisis, developments such as telework and videoconferencing, but also e-commerce and delivery services or e-government are accelerating the transformation of our education systems, shopping behaviour and 'way of life' more broadly.

Urbanisation is another important trend in Europe. It is expected to increase from 74% at present to about 83.7% in 2050. This implies that more people may be exposed to air pollution and noise generated by traffic, but it also has the potential to create positive opportunities. The proximity of people, business and services allows for shorter journeys to work and more opportunities to walk, cycle and use public transport (EEA, 2019b). Distance travelled per person is also up to seven times lower in relatively compact cities compared to sprawled cities, with the potential to reduce GHG emissions by 20-40% in more compact developments (Creutzig et al, 2016). This clearly points at the importance of smart urban planning and good sustainable infrastructure, as key enablers for smart mobility choices.

From an environmental perspective these trends could deliver positive outcomes, but only if they are accompanied by measures that address a number of unintended consequences. The environmental footprint of e-commerce, for instance, is rising due to the distance travelled to deliver the goods. But also because customers are offered to return purchased products for free or at a very low cost.

The 'greening' of delivery vehicles can contribute to more sustainable practices. Likewise, new business models can reduce some of the redundant trips. Bringme Box, a Belgian company, has developed a smart parcel box for contactless deliveries that scans parcels and groceries, signs for deliveries and sends the recipient a message, even if not at home or in the office where the boxes are placed (website Bringme Box, 2020).

There are also indications that telework does not necessarily reduce the number of kilometres travelled as much as could be expected. Even though it reduces traffic during peak hours, this seems to be partially compensated by a rise in kilometres travelled for non-work related activities. In addition, at least in Belgium, teleworkers appear to be disproportionally commuting by train to the workplace (Laine and Daubresse, 2020). These developments require a deeper, comprehensive assessment, and should be complemented with other policies in order to achieve the positive impact hoped for.

8.5. Technological options

Availability of infrastructure and plurality of transport options, as well as a good functioning market with pricing and correct taxation are clearly crucial for improving sustainability of the transport system. But, as indicated throughout the previous chapters, technology is key to address the identified challenges, and help people transform their mobility behaviour. Driven by digitalisation and automation, the impact of technology on our daily life is expected to further accelerate in the near future. If managed well, this can make the mobility system much more sustainable. A short summary of the main technology options.

8.5.1 Awareness raising and persuasion enabled by technology

People need to become more aware of their behaviour and environmental impact, and of alternative solutions.
There are multiple ways to nudge users on a personalised level to adopt more sustainable transport habits. In most instances, behavioural change is observed as a series of stages which individuals progress through in order to reach a new habitual behaviour. Different communication means should be applied to help people get to the next stage or avoid relapsing to a prior stage (Weiser et al, 2016).

Nudging techniques include behaviour feedback to make people aware of their mobility habits, social comparison, goal-setting, gamification, personalised suggestions or challenges (Anagnostopoulou et al, 2018). For all these techniques, technology has increased the possibilities exponentially.

Smartphone applications enable many more interactive, collaborative and participatory approaches. They can, for instance, provide real-time, user-specific and location-based feedback, provide change interventions, and offer an overview of the available route options. Messages can be instructional, motivational and/or supportive, and with or without interaction with others (Weiser et al, 2016). The effectiveness of these will depend on peoples’ motivations, beliefs, goals in life, but also on the situational context. Ideally, therefore, these interventions are to be tailored to a person’s individual context (Banerjee, 2017).

8.5.2  New business models expanding the options

As highlighted before, digitalisation offers possibilities for a whole range of new players to enter the mobility market with new offerings. These offerings can be sharing schemes for very diverse transport modes, from bikes and steps to cars, and shared journeys.

Some new entrants disrupt existing markets, such as taxis, and force these to adjust and digitise or disappear. Even though these trends appear first in the bigger cities, we can see that these novel business models increasingly also reach smaller towns. In more remote areas, it seems that these mobility solutions require a form of cooperation with the public sector to make this economically viable.

8.5.3  Ever more integrated mobility solutions

While having a wider choice of options could have a positive impact, that same complexity of choosing and combining these options can be challenging. In order to reduce complexity, availability of data, interoperability, and the design of new forms of cooperation between public and private mobility providers would need to be improved. This would also require nudging cooperation among transport companies that compete on the market and are not always willing to collaborate, share information and expose their business models. The same applies to longer-distance travel, where operators are not always eager to offer integrated or intermodal ticketing options.

8.5.4  Cleaner and automated, connected and cooperative vehicles

The technology developments in the automotive sector are evolving rapidly. Due to a steep decline in the cost of batteries and economies of scale, the tipping point at which the purchase of electric cars becomes cheaper than that of internal combustion engine cars, is expected to happen in just a few years. Combined with lower maintenance costs and cheaper electricity prices compared to fossil fuels, this may become an attractive proposition for an increasing number of users.

But the speed at which the switch to cleaner vehicles will happen also depends on other issues such as the performance of batteries or availability of recharging infrastructure. This also applies to public transport offerings where the replacement of buses by electric or hydrogen alternatives is accelerating.

This trend coincides with increased automation and connectivity that could lead to driverless and at a later stage also unmanned mobility solutions. This can revolutionise the whole mobility system by
making it more efficient and maybe also cheaper, but it will only be sustainable if mass transit systems are not outcompeted by a myriad of smaller vehicles.

8.5.5 The digital society transforming our daily life

Finally, it is important to emphasise once again that also developments outside the mobility system are impacting our travel behaviour. The rise of teleworking and teleconferencing, e-commerce, and the success of streaming platforms such as Netflix and Disney is having an ever bigger impact on our daily routines and transport demand patterns. It is, however, unclear at this stage, whether these trends will contribute to a net decrease of transport needs, or, instead an increase.
9. Policy options

Efforts to change human behaviour – whether on the individual, household or aggregate scale – can result in limited or unexpected results. Policy-makers have many tools to influence behaviour, including regulations, such as bans, rules and industry-wide standards; economic incentives, such as taxes, subsidies and other price changes; and education and information, such as environmental labels on products, and outreach and marketing campaigns. While all these tools are essential for changing consumption patterns, a deep understanding of consumers’ behaviour is also crucial. Policy efforts do not always result in the expected outcome.

Helping people play an active role in the transition towards more sustainable food systems requires getting the basic governance structures right. It means creating the enabling conditions for people to contribute. It requires building on the possibilities that technology, including digital solutions, can play in enhancing more sustainable food consumption. These efforts can only be realised if the existing gaps and barriers in the current policy and incentive structures are addressed.

Likewise, transport is a complex system where many trade-offs and unexpected side-effects from isolated interventions occur. A mixture of multiple instruments is therefore needed, including transport supply instruments, as well as regulatory and economic instruments to achieve synergies in terms of effectiveness, acceptability, financing, enforcement (Vieira et al., 2007) and sustainability. These need to be combined with the introduction of new business models and behavioural nudging.

9.1. Consumption of foods with a smaller climate and environmental footprint: Role for regulation and financial incentives

The Commission’s European Green Deal proposal and the sectoral strategies for food and biodiversity aim at setting a framework for a more sustainable and prosperous economy and, in this context, for future-proofing European agriculture, fisheries and aquaculture. However, much remains to be done to create the right food environment for people, one which would encourage consumption of healthy food with a lower impact on climate and the environment.

The EU’s common agricultural policy (CAP) has a major role in providing support and a direction for European agricultural production. As the EU subsidies impact prices, CAP spending therefore has direct implications for consumer choices. Consequently, it could be of paramount importance that the CAP contribute to the creation of a more sustainable food system, under the new multiannual financial framework (MFF) for the EU during 2021-2027.

As one-third of the EU budget is reserved for the CAP, how and where this money is spent matters enormously. The EU has supported production and consumption of animal foods for decades, at a great cost to people’s health, climate and the environment, as well as to the economy and society (Hedberg, 2020).

While agricultural subsidies are formally separated from production today, that is, there is no direct support for meat production, for example, past figures describe the scale of the challenge. According to Commission data (from 2015), up to 90% of cattle farmers’ income comes from subsidies (EC, 2018b). While the production of dairy and feed for animals is less dependent on public money, many of these farms are also on permanent ‘life support’. In contrast, European vegetable and fruit farmers operate, compete, and earn a living on the market, with little to no income support from the EU (EC, 2018b). Moreover, the EU has actively used taxpayers’ money to advertise meat-eating (EUMonitor, 2019; Politico, 2020) and offer dairy products to school children (EC, 2018c) – worth €100 million –
again in 2020. This support means that the EU has kept the prices of animal products artificially low, thus promoting livestock consumption.

While there will still be livestock production and consumption in the EU in the years to come, more effort is needed to create a safe operating space for livestock, to ensure that production and consumption patterns do not undermine people’s health, climate, and the environment (e.g. Rise Foundation, 2018; European Court of Auditors, 2020).

Taking note of the scientific evidence and the EU’s climate and environmental objectives, more could be done to reform and modernise the support of European farmers and agriculture to encourage a shift towards more sustainable (plant-based) food system. While the CAP remains directed towards subsidising especially intensive meat and dairy production and consumption, the focus could be encouraged to shift to providing Europeans access to affordable healthy food with a reduced climate and environmental footprint. The CAP could be used to develop a competitive European agricultural sector that produces nutritious and sustainable food that contributes to people’s well-being.

If used well, the CAP and other financial instruments can help increase affordability and accessibility to healthy and sustainable food. The first step could be to scale down and, ultimately, stop subsidising practices that harm the climate, the environment, and people’s health. This can be coupled with promoting research on alternative proteins, for example, and possibly taxing unhealthy and unsustainable food to disincentivise their consumption, as well as subsiding healthy and sustainable food.

Even though the European Green Deal and the sectoral strategies include efforts to modernise the CAP, the EU and national policy-makers do not appear ready to implement the changes needed. There are great risks that the CAP will continue to undermine and even contradict the goals set under the Green Deal and also hinder people’s possibilities to adopt more sustainable food consumption patterns. The Commission’s CAP proposal from 2018 has been strongly criticised for not being in alignment with the Green Deal (e.g. Client Earth, 2020). However, the European Parliament voted in October 2020 to further weaken the proposal. It voted, for example, against the Commission’s proposals to cut subsidies for intensive industrial farming and proposals on the protection of grasslands and peatlands, a major reservoir of GHG emissions.

Originally part of CAP, another instrument for financing food system improvement is the common fisheries policy (CFP). It aims to provide long-term support for fishing communities and promote sustainable management of fish stocks. Over the years, however, it has been heavily criticised for subsidising overfishing, and failing to provide for sustainable and viable fishing, healthy marine ecosystems and biodiversity conservation (e.g. WWF, 2018).

With seas being the world’s largest carbon storage and having a huge potential to help in the fight against climate change, it is clear that more needs to be done in the EU and globally to protect marine ecosystems and biodiversity. In addition to the CFP, global goals and co-operation on protecting oceans is needed. An important milestone will be the UN Biodiversity Conference (COP 15) in Kunming in the autumn of 2021, which aims at providing a new framework for action, including a target to protect 30% of both ocean and land by 2030.

If the EU continues to support food production that is detrimental to the European Green Deal, biodiversity, and climate action, it becomes extremely difficult and costly for consumers to adopt dietary habits with a smaller climate and environmental footprint.

In addition to the policy and financial framework provided by the CAP as well as the CFP, policy-makers need to do more to inform, empower, guide, and encourage consumers to adopt more sustainable and healthy diets. Simple interventions like labelling can help address consumers’ weak understanding of the food system and can stop the underestimation of their food-related climate and environmental footprints. Thus, the development of front-of-pack nutrition and sustainable
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Food labelling should be a high priority, in an effort to increase consumer awareness and transparency around food products.

At the national level, for example, schools can play an important role in informing and guiding children and their parents in sustainable diets. Education campaigns, as well as public procurement for school food, can be used to promote more sustainable and healthy diets with special emphasis on plant-rich diets.

9.2. Addressing food waste: Creating the needed policy framework for action

Citizens and consumers can play an important role in reducing food waste just by planning meals better, using leftovers, and storing food properly. However, empowering people to play a greater role in these efforts would benefit from a framework which encourages, guides, and enables sustainable behaviour. For example, consumers' difficulty to differentiate between 'use by' and 'best before' markings or legal barriers to food donation are basic issues to be addressed.

The Commission's proposal for a 'Farm to Fork' strategy recognises the need to tackle food loss and waste. As suggested by the EU Platform on Food Losses and Food Waste, there are many actions that could be taken to reach this goal.

A basic action point could include integrating food loss and waste reduction as part of strategies and programmes for food policy and climate action. Also, improving the use of date marking to better differentiate between 'use by' and 'best before' dates could help consumers. Improving rules for food donation could remove one of the main barriers to food donation schemes. Moreover, improving the availability and quality of data on food loss and waste levels and their related impacts is the basis for understanding the scale of the problem and a way to measure progress in tackling the issue.

While reducing food loss and waste is an integral part of the EU's 'Farm to Fork' strategy, and thus an important piece in the governance puzzle, the creation of a possible framework for action is at its initial stage. Recognising and building knowledge on the scale of the challenge and measures required, as mentioned above well as their implementation, requires political willingness and commitment to act. A clearer governance structure and incentives such as the expected legally binding targets for reducing food waste across the EU can help strengthen people's role in addressing food waste.

9.3. Smart government fit for smart mobility

Smart mobility solutions, such as fully integrated MaaS models, must overcome a range of institutional barriers to deployment. This will only work if a system benefits all actors involved, including private operators.

This could require a new form of governance, with new forms of collaboration and multi-stakeholder activity between different types of actors from the public sector, industry, and civil society. It also calls on entrepreneurs to demonstrate the legitimacy of their innovations in terms of wider social and political expectations. Otherwise, their offerings would not be included in public-private schemes, such as MaaS (Sarasini & Linder, 2018).

To be really supportive of a more sustainable transport system, these smart solutions should also be designed in a way that they incentivise the use of the most environmentally friendly combination of modes.

Similarly, the uptake of smart mobility may be hugely facilitated by the creation of mobility nodes where people find different transport options in a single place. Local and regional authorities would
have to work together with all the relevant transport providers to make that happen. In more remote areas, new business models allow public authorities to cooperate with private transport providers to develop offerings that would otherwise be too expensive. In more densely populated areas and for longer distance transport, public transport can also be made more attractive by offering good internet connections, allowing users to make good use of their time in the bus, metro, or train.

To enhance trust, a labelling scheme for mobility (or integrated sustainability) applications could be introduced. Such a scheme could help raise awareness and support the credibility and effectiveness of sustainable smartphone applications.

Another area where public authorities can use technology to promote sustainable mobility is incentives, ranging from taxation to fees and charges, which can be tailored to individual objectives, for example, smart road pricing that adapts the fee to the type of vehicle or the time of the day the road is used.

Work-related taxation frameworks could be adapted to help employers and employees choose more sustainable mobility solutions. Instead of advantageing the use of company cars, more complex mobility solutions, such as a ‘mobility budget’, can be designed with the help of sustainability-based technologies. This individual budget, provided by the employer to cover (work-related) travel expenses, could allow employees to select and pay for transport equipment or services from a range of options, including a (shared) company car, (shared) bicycle, bus, and train. A bonus for sustainable options would encourage them to become more multimodal (Zijlstra & Vanoutrive, 2018).

Finally, public authorities could use nudging techniques in their policies and programmes to incentivise people to adapt their mobility behaviour. In Singapore, for example, a pilot programme using app-based gamification is used to reward commuters with credits depending on travel time to manage overloads on the public transit system. It contributed to a shift of over 7% from peak hours. Commuters could earn one credit if they made a trip during peak hours and three credits when they travelled off peak. The credits could be redeemed at a fixed exchange rate or for other rewards (Ashita & Hooi Ling Khoo, 2020).

9.4. Ensuring reliable data management for food and mobility

Better management, including use of data as well as data-driven digital solutions can enhance knowledge and information sharing needed for making and adopting more sustainable food consumption and mobility patterns. As shown above, numerous data-driven digital solutions already exist, that help inform, influence, and empower citizens and consumers with their food and mobility choices.

Processing and analysing data can turn them into valuable information and even knowledge, which can also support policy and investment decisions. Collecting and analysing data about people’s willingness and barriers to change behaviour can guide policy-makers in taking measures that reflect people’s needs and wishes.

However, it is important to recognise that the data-driven digital solutions are only as good as the data they use. For example, as long as there are no agreed comprehensive and reliable data sets for climate and environmental footprints for different food products, this will have implications on the reliability of digital footprint apps.

Thus, improving access to reliable data and enhancing collection, processing, and analysis of relevant data is key. However, many barriers to improving data and information sharing in the food system still exist. Access to data can be limited, conditional or prohibited, due to a lack of interoperability between data sets or concerns over the personal and business-sensitive data. For example, in the case of small-scale farms, it can be difficult to separate farmers’ private from business
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data, which can complicate data privacy considerations. Also, national or subnational rules can affect access to public authorities’ or private actors’ data.

Ensuring access to relevant data and interoperability between relevant data spaces could be central to the Commission’s work in a new common European agricultural data space. To make sure that farmers provide relevant data, the CAP payments could be used as a leverage to improve access to environment-related data (e.g. on the use of nitrates as fertilisers): the payments could be conditioned on farmers providing the needed data. Smart contracts, coupled with tokenisation, could also be used to incentivise farmers to share relevant data.

The rapid expansion of available data is making it easier to understand people’s transportation choices. Big data mining could help identify additional factors that explain our travel decisions and uncover the underlying decision mechanisms (Chen et al., 2016; Di Dio et al., 2018).

High-quality, reliable data and robust models are central to the development and appraisal of transport planning and policy. This requires an assessment that integrates different types of datasets, such as GPS tracking, smart ticketing, network connections, and multi-media.

Mobility-related apps owe their usefulness and effectiveness to the ability to provide real-time, location-based information, which is only possible if they are connected to wider constellations of data exchange and communication (Schwanen, 2015). Schwanen (2015) argues, however, that data tracking needs to be combined with other methods, such as in-depth interviews, to understand how users interact with the apps and what consequences this can have for physical mobility patterns.

The possibilities to collect and use real-time data from users, vehicles, and other sensor-based technologies are increasing rapidly. Combined with ICT as the key enabling technology, this creates numerous new business opportunities (Sarasini & Linder, 2018).

A wide range of mobility apps has been launched in recent years, but most mainstream apps focus only on time efficiency or pricing and do not necessarily include environmental considerations. It could therefore be made easier for app developers to get access to environmental data and for users to become more aware of the benefits of using sustainability applications. To begin with, this requires a good calculation and reporting framework for CO₂ emissions in the transport sector.

In addition, local, national, and European environmental agencies and the scientific community could cooperate to provide easy access to relevant environmental data, in order to stimulate their inclusion in applications. Public authorities at different levels could help make this happen, but they could also benefit from using and interpreting the data to improve their own mobility policies.

The real challenge lies in the way data are shared. For new entrants in the market, the aim is to capture value from the range of mobility support services, not in order to monetise those services directly, but to collect navigation data that can be used as inputs into new services, such as mobility-related solutions, or that can be sold to other operators for commercialisation (Aguilera & Rallet, 2016). The real value of these data thus arises once processed. Only then does it open possibilities for system integration (such as improved multimodal services), influencing travel behaviour (through improved understanding of route choice and departure times, together with direct messaging, either to collective, the individual, or sub-groups), and traffic management (Harrison et al., 2020).

Competition is fundamental for access to mobility data. That is why refusing to share data is economically rational and constitutes a powerful barrier to construction of seamless mobility-related services. This also explains limitations and ambiguities of Open Data policies that require a long process of partnership construction. Other challenges include: the need for specific skills, capabilities, and inter-disciplinarian practice; quality and standards; as well as ownership and privacy issues (Harrison et al., 2020). There is a need to design a policy framework that promotes access to raw and processed data to facilitate more integrated mobility solutions.
9.5. Developing and deploying digital solutions to encourage more sustainable behaviours

As demonstrated above, improved use of data and the ongoing development and uptake of digital solutions can contribute greatly to enhancing sustainable behaviour. They can be used to encourage more sustainable food consumption and mobility practice, to enhance sustainable diets or address food waste.

One cannot expect that relying on digital technologies alone will provide an easy fix to mobility practice or enhance sustainable food consumption patterns. However, looking ahead, there is great potential to use data and various digital solutions to understand and address the complex challenges. Policy-makers have tools to steer digitalisation, so that data management and digital solutions help support climate action, environmental protection and to enhance sustainable prosperity.

Effort would be necessary to incentivise and improve sharing of data and information that can support the creation of more sustainable mobility and food systems and help people play an active part in these transitions. The EU’s financial support could be conditioned on beneficiaries making data of public interest (i.e. relevant for the protection of the climate and the environment), available to the Green Deal and other relevant data spaces. For example, the EU’s financial support to farmers could be made conditional on their disclosure of data relevant for a ‘common European agricultural data space’. Moreover, the EU could continue to develop common standards for data collection and sharing at the EU, Member State, subnational, and corporate levels. The EU could also improve relevant data analysis, including AI.

More investment would be necessary to create the digital solutions that can help people improve their mobility and/or food consumption patterns. For a start, citizens and consumers could be given access to basic infrastructure such as the internet. More investment would be necessary to create the digital solutions that can help people improve their mobility and/or food consumption patterns. For a start, citizens and consumers could be given access to basic infrastructure such as the internet. Moreover, the MFF and especially the Digital Europe Programme, Horizon Europe, InvestEU, and Connecting Europe Facility could be used to develop and deploy digital solutions (e.g. AI and blockchain), which can help accelerate more sustainable consumption patterns.

In these efforts, it is essential to keep the climate and environmental footprint of digitalisation in mind. Data and digital solutions can only become real enablers for a transition towards sustainability if they also become more sustainable. This would require addressing the energy consumption and sources of energy for data centres, but also the sourcing of materials for ICT products, their durability and recyclability, as well as management at the end of their life-cycle.

The EU could also invest in people’s capacities to benefit from digitalisation. They could also provide the skills and the know-how to use relevant digital solutions. While apps can help connect, inform, educate, and empower citizens and consumers, the apps market can be complex and overwhelming for them to navigate.

Making a sustainable choice, including on food, should be an easy and default option. The window of opportunity to influence consumers is small: most people spend an average 10 to 20 seconds when deciding on a purchase. Labels and apps can help in the process, but they must also be supported with scientific and coherent evidence. Using AI to manage and bring together large datasets, combining information on environmental footprint with information on health impact of

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food products, and translating this information into easily readable 'labels' or QR-codes could be extremely beneficial for consumers when making purchasing decisions.
10. Conclusions

In recent years, we have seen a significant turn towards sustainability in the EU, both in terms of embedding climate and environmental considerations into various policy objectives and in terms of rising interest in sustainability in society at large.

In 2019, the European Commission published a vision for economic development centered around green growth and sustainability – the European Green Deal. At its core, the European Green Deal is about achieving climate neutrality by 2050. This was followed by the launch of sectoral strategies, such as the 'Farm to Fork' strategy (May 2020), which considers food consumption, and the sustainable and smart mobility strategy (December 2020). From 2021 onwards, the Commission is expected to propose measures to implement these strategies, while launching new legislative proposals in alignment with the Green Deal framework.21

As far as the popular interest is concerned, a recent Eurobarometer survey shows that 94% of citizens in the EU say that protecting the environment is important to them. Additionally, 91% of citizens stated that climate change is a serious problem for the EU. According to 83% of those surveyed, European legislation is necessary to protect the environment22.

When the Covid-19 pandemic hit the EU and the world in 2020, there were serious concerns about how this may impact the Green Deal agenda and the focus on climate action. However, the EU was quick to see sustainability and resilience of the European economy and society as guiding principles to the post-Covid-19 recovery. As a result, European policy-makers, civil society, and industry are now actively looking for the best strategies to safeguard the 'green recovery' from the pandemic.

As the EU remains committed to creating a competitive and sustainable European economy and empowering citizens to play a role in this transition, the central question this study has attempted to answer has been:

'How can individuals support the objectives of the European Green Deal, with a focus on improving food and mobility systems? How can technology be used to guide, nudge and help individuals change and adopt more sustainable behaviour and consumption patterns?'

This study attempts to give some tentative answers to these questions, by considering food consumption and mobility. It addressed the behavioural patterns that are particularly pertinent to sustainability.

The study points out the enabling role of technology, and it identifies several options for improving food consumption and mobility practices. The authors of this study would like to point out, in particular, the potential of using data and various digital solutions for a better understanding of the complex barriers to sustainable behaviour and for addressing these challenges more effectively.

Policy-makers have tools to steer digitalisation, so that data management and digital solutions can support the Green Deal objectives and strategies. Conversely, improved data management and digital solutions can enhance information and knowledge-sharing, as well as raise awareness of measures needed. They can help inform and empower people to adopt more sustainable behaviour and benefit from digitalisation.

21 For example, the Fit For 55 legislative package (covering energy-related aspects of Green Deal, such as energy performance of buildings, land use, energy taxation and emission trading), and a Carbon Border Adjustment Mechanism.

It is worth recognising that technologies will not be a 'silver bullet' for improving mobility practice or for enhancing sustainable food consumption patterns. Technologies, even those that were reviewed in this study as specifically beneficial to sustainability, can help achieve only as much as the people themselves are committed to act.

Moreover, technologies are not the only tool we have and should not be used at the expense of strong policy and regulation, but are nevertheless an important part of the solution (United Nations Environment Programme, 2020). Technological solutions can only function if supported by broader socio-economic systems. This requires good governance and a supportive regulatory and financial framework, as well as ensuring access to affordable sustainable choices and to basic digital infrastructure such as the internet.
References


Aguilera A, Rallet A, Connected mobility changes in travel practices, Réseaux, 2016, 6, 17-59.

Aloi A, and others, Effects of the COVID-19 Lockdown on Urban Mobility: Empirical Evidence from the city of Santander (Spain), Sustainability, 2020, 12.

Alyavina E, Nikitas A, Tchouamou Njoya E, Mobility as a service and sustainable travel behaviour: A thematic analysis study, Transport Research Part F, 2020, 73, 362-381.


Béziat E, Bus, metro... le transport public en difficulté, Le Monde, 2 September 2020.


Bringme Box [Internet]. Available from: https://www.bringme.com/ (accessed: 19 October 2020)


Meeting the Green Deal objectives by alignment of technology and behaviour


De Tijd, Coronalockdown veroorzaakt rush op huizen met tuin, 26 September 2020.


Euroconsumers, Press Release Food waste: consumers are ready for change: Ambitious engagement from both consumers and businesses is needed, 2020. Available at https://assets.ctfassets.net/iapmw8ie3jie/SCH4CT9C69elWKRDMm01u/f70528f1a1f320932910e1285183809/Press_Release_on_Food_waste_Survey.pdf [Accessed 30 November 2020].


European Commission, Towards Low-Emission Mobility. Driving the Modernisation of the EU Economy, 2016, European Political Strategy Centre Strategic Notes, 17.


European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Sustainable and Smart Mobility Strategy – putting European transport on track for the future. (2020) 331, 2020c.


European Commission, Report Transport and Mobility, Special Eurobarometer 495, 2020e.


Meeting the Green Deal objectives by alignment of technology and behaviour


European Court of Auditors, Biodiversity on farmland: CAP contribution has not halted the decline, 2020. Available at https://s3.eu-central-1.amazonaws.com/euobs-media/0b10da05b962cb1a51b53f976cf2c788.pdf [Accessed 4 December 2020].


Meeting the Green Deal objectives by alignment of technology and behaviour


Harrison G, Grant-Muller S, Hodgson FC, New and emerging data forms in transportation planning and policy: Opportunities and challenges for ‘Track and Trace’ data, Transportation Research Part C, 2020, 117, 102672.


Onwezen M, Irrational consumer choices, presentation at the European Parliament 'Farming without agrochemicals' workshop on 06 March 2019


Renson I, Corona-angst duwt ons massaal in de auto, De Standaard, 14 October 2020.


The Economist, Transport as a service. It starts with a single app, 29 September 2016.

The Economist, Autonomous vehicles are just around the corner, *Special Report*, Reinventing Wheels.

The Economist, How lockdown converted the world to cycling, and the speedbumps that lie ahead, 21 May 2020 (2020a)

The Economist, The pandemic is giving e-bikes a boost, 1 August 2020 (2020b)


Whimapp [Internet]. Available from: https://whimapp.com/ (accessed: 19 October 2020)


This study explores the prospects of aligning citizens’ behaviour with the objectives of the European Green Deal in the domains of food consumption and mobility. Creating a climate-neutral and resource-efficient European economy requires a deep transformation of energy, mobility and food systems, as well as a change in production and consumption practices. Such profound change will impact both individuals and society. At the same time, the transition to sustainability will not succeed if people do not support it by adapting their behaviour and consumption patterns. This would imply change towards ‘sustainable behaviour’.

The study explores options for such sustainable behaviour, with a focus on mobility and food consumption. It identifies key challenges and possibilities in each domain and explores how technological solutions can help people adapt to sustainable behaviour in alignment with the objectives of the European Green Deal.