DIGITALLY SUSTAINABLE

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Council
for the Environment
and Infrastructure

About the Council for the Environment and Infrastructure

The Council for the Environment and Infrastructure (*Raad voor de leefomgeving en infrastructuur*, Rli) advises the Dutch government and Parliament on strategic issues concerning the sustainable development of the living and working environment. The Council is independent, and offers solicited and unsolicited advice on long-term issues of strategic importance to the Netherlands. Through its integrated approach and strategic advice, the Council strives to provide greater depth and breadth to the political and social debate, and to improve the quality of decision-making processes.

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General secretary

Ron Hillebrand PhD

The Council for the Environment and Infrastructure (Rli)

Bezuidenhoutseweg 30
P.O. Box 20906
2500 EX The Hague
The Netherlands
info@rli.nl
www.rli.nl

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SUMMARY

Digitalisation and sustainability

As we move towards the green transformation, the Netherlands faces major challenges in multiple areas: energy, mobility, and use of raw materials, to name just a few. Looking at the challenges ahead, it is striking how little attention is being given to the relationship between the green transformation and the increasing digitalisation ? of society. The Dutch Council for the Environment and Infrastructure (the *Raad voor de leefomgeving en infrastructuur,* or Rli, which we will also refer to as 'the Council') has advised that government intervention regarding digitalisation will be an essential part of the green transformation, because today the digital world is inextricably interwoven into our physical environment. It is with good reason that the European Union frequently refers to the green transformation and the digital transformation of our society collectively as the 'twin challenge'.

The Council echoes the perspective expressed by the German WBGU[1] that there are two sides to this cohesion between the digital transformation and the green transformation. One is that data and digital technologies can be focused on promoting sustainability (albeit with the caveat that this can only succeed with the right data collection and data sharing). The other

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is that the digital transformation is changing our society in ways that will impact the green transformation. An increasingly digital society is changing the way we travel, work, live, spend our leisure time, and even how we look at the world. But none of that in itself necessarily creates a greener society; on the contrary, some of the novelties that the digital transformation brings us are just as likely to lead to more consumption, growth in resource-intensive industries and increases in greenhouse gas emissions.

Insufficient policy attention to the relationship between digitalisation and sustainability

Government policy devotes a great deal of attention to the economic opportunities that the digital transformation will bring. Increasingly, this goes hand-in-hand with the realisation that the digital economy will develop differently than the 'analogue' economy. In policymaking, there is increasing attention for the safeguarding of fair competition and protection of civil rights. But there are still no policy frameworks for digitalisation within the context of the sustainability goals, the Council observes in this advisory report.

By the same token, the policy being built around the green transformation hardly takes account of the digital world. The Council believes that legislation, the financial incentives and the supervision with regard to the green transformation is far too focused directly on activities and established parties in the living environment. But that policy also has to focus on new parties engaged in the development of digital platforms ?, data collection or digital services.

Digital platforms have a pivotal position in the living environment

Digital platforms connect supply and demand for goods, services, information and knowledge. Increasingly, these platforms are making the rules for how the market works in the living environment, and are more and more in control of the interactions that take place and services delivered. Based on this observation, the Council draws an important conclusion: as a result of this pivotal position, digital platforms can on the one hand have an impact on the quality of the living environment, and on the other are in a critical position to further the green transformation of society. Whether it's energy, travel or consumer goods, and whether you're on the supply or demand side, digital platforms have become indispensable and are increasingly dictating the conditions for the use of the living environment. The government's competition policy recognises the key position of digital platforms, but critically, the sustainability policy does not.

Knowledge gap in the public sector

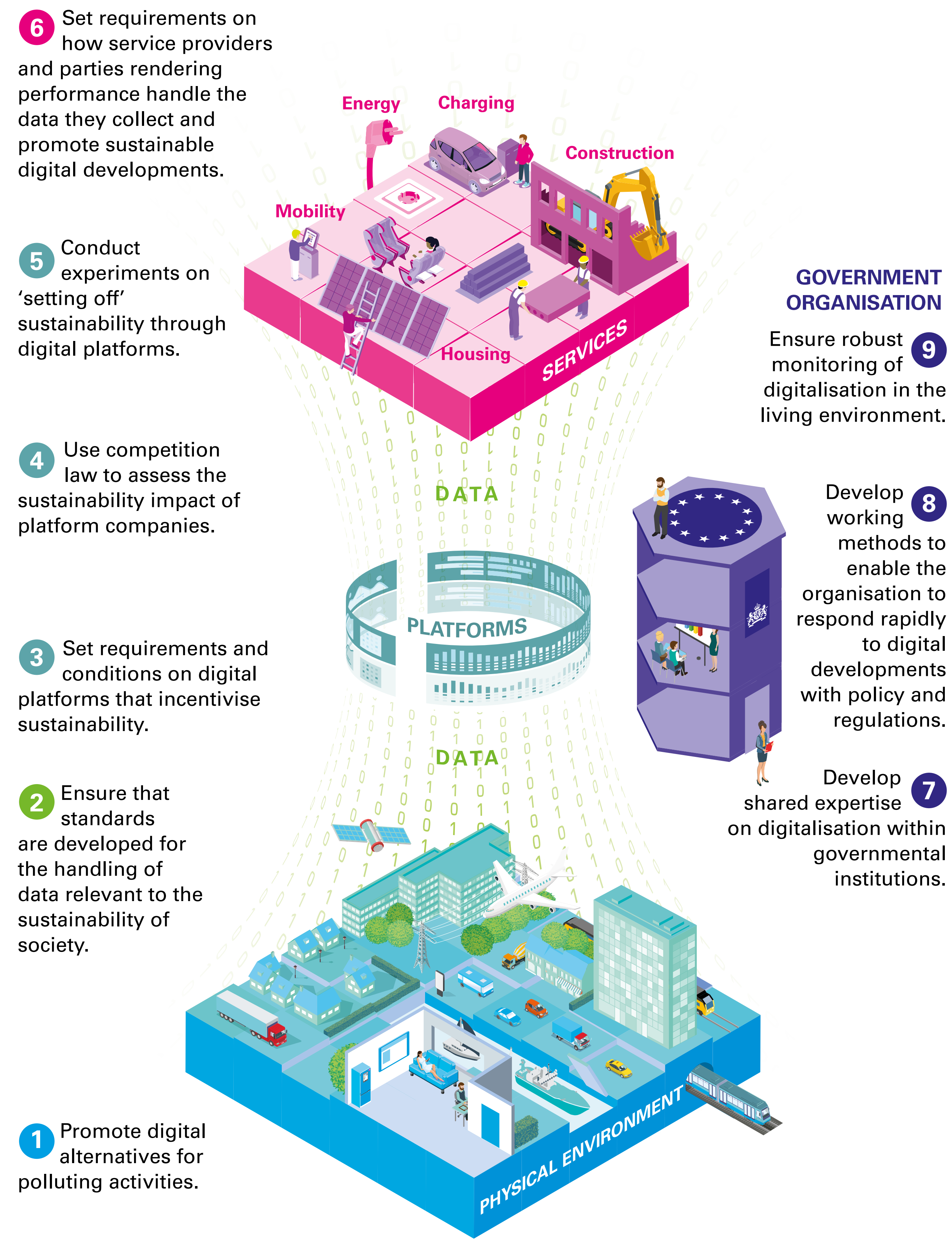
The ability to effectively manage the digital transformation for maximum synergy with the green transformation demands comprehensive knowledge of the digital domain. This means not only technical knowledge, but also knowledge of how digital markets work. Governmental agencies involved in the various aspects of the green transformation generally do not have enough of this type of knowledge, or that knowledge is fragmented across different departments of the organisation.

Conclusions

The Council concludes that the national government must incorporate its goals for the green transformation of the Netherlands into its digitalisation policy, where possible in close collaboration with the European Union. It should be clear that the digitalisation of society is about so much more than just economic opportunities and civil rights. The flip side of this conclusion is that in pursuing the green transformation, the government must fully utilise the potential of digital technologies. This will require a new look at the living environment: seeing not only the things that are happening in the physical environment itself, but also the supporting web of the digital world behind it. Active government intervention in building this digital side of the living environment will be a necessary part of building a greener society.

Recommendations for government

In this advisory report the Council makes six recommendations to the government for furthering the digital transformation in a way that will also advance the green transformation. The Council also proposes three interventions in the government organisation that will be necessary for success.



PART 1 | ADVICE

1 INTRODUCTION

1.1 Subject of this advisory report

The Netherlands faces a number of significant challenges in building a green living environment. It is a societal transformation that will require changes in our energy system, our use of resources and raw materials, the ways we live and travel, the way we produce our food, and on and on. These social, economic and ecological changes will all have their impact, and our living environment will have to be adapted to that impact in the coming decades. The United Nations' SDGs (Sustainable Development Goals) adopted in 2015 are designed to focus our efforts on achieving this. The Netherlands has endorsed these UN goals and incorporated them into national policy. For the living environment, targets have been formulated for aspects such as reducing CO_2 emissions, increasing efficiency in raw materials use, and building a more sustainable agricultural sector.

Up to now, little attention in the formulation of these targets has gone towards the connection between building a greener living environment and the ongoing and sweeping digital transformation of that same living environment. The Dutch Council for the Environment and Infrastructure (the *Raad voor de leefomgeving en infrastructuur*, in this advisory report 'the Council' or 'Rli') believes that this connection is of critical importance. This advisory report begins with, and builds on, that insight.

In the Council's view, to successfully reach the goals of the green transformation the Netherlands and Europe must get a better grip on the digital world underpinning our physical environment. This means the national government must incorporate the sustainability goals proclaimed by the Netherlands into its digitalisation policy. And, by the same token, the potential of digital technology must be leveraged to promote sustainability policy. This is also the stated ambition of the EU. The policy initiatives that make up the Green Deal, which the European Commission presented in 2019, refer to the transition to a sustainable society and a digital society as the 'twin challenge', and with good reason.

Manifold connections between digital transformation and green transformation

There are many ways that the digital transformation and the green transformation are interrelated (WBGU, 2019). In this advisory report, the Council distinguishes between two aspects. To start with, digitalisation can help with the achievement of sustainability goals. To take one example, consider the mobility sector. Today's digital technology enables us to link real-time data about the volume of traffic on the roads, weather conditions and the performance of roadworks, to which algorithms can then be applied to predict the utilisation of road capacity. Based on that information, steps can then be taken to promote the flow of traffic and reduce emissions of CO_2 and fine particulates.

At the same time, digitalisation is bringing about dramatic changes in the ways we structure our lives – changes that have an impact on the sustainability of our society. Here again, mobility is a good example. The coronavirus crisis made clear that the many and varied options for working and meeting online enabled large numbers of the working population to do a significant amount of their work from home, reducing the number of travel movements or allowing these movements to be shifted to different times. This improves traffic flow and reduces emissions caused by traffic. The Council makes a distinction in the digitalisation/sustainability relationship between, on the one hand, *the use of data and digital technologies for a greener society*, and on the other the broader development towards a society that is both digital and sustainable.

These two ways in which the digital transformation and the green transformation go together intersect similarly in our energy usage. Here, too, digital technologies are making advances in sustainability possible, in this case by increasing the efficiency of the ways we use electricity. Algorithms and artificial intelligence ? can optimise our devices' energy use. Like, for example, a 'smart freezer' that knows when chilling can be done most efficiently.

At the same time, the growth of the number of data centres and the increasing integration of digital technology into our daily lives is changing our very way of life: today, nearly every single person in the Netherlands has one or more digital devices, and they are all exchanging data with each other constantly. This, unlike the move towards online working, is having a detrimental impact on sustainability. Why? Because everyone sets their mobile devices to charge every night, and also because the increasing amount of data that they use means that the energy we need to drive that data keeps going up. Because of this, what our energy consumption is going to look like in the long-term future is, on balance, not at all easy to predict.

Living environment and digital world as a single cohesive system

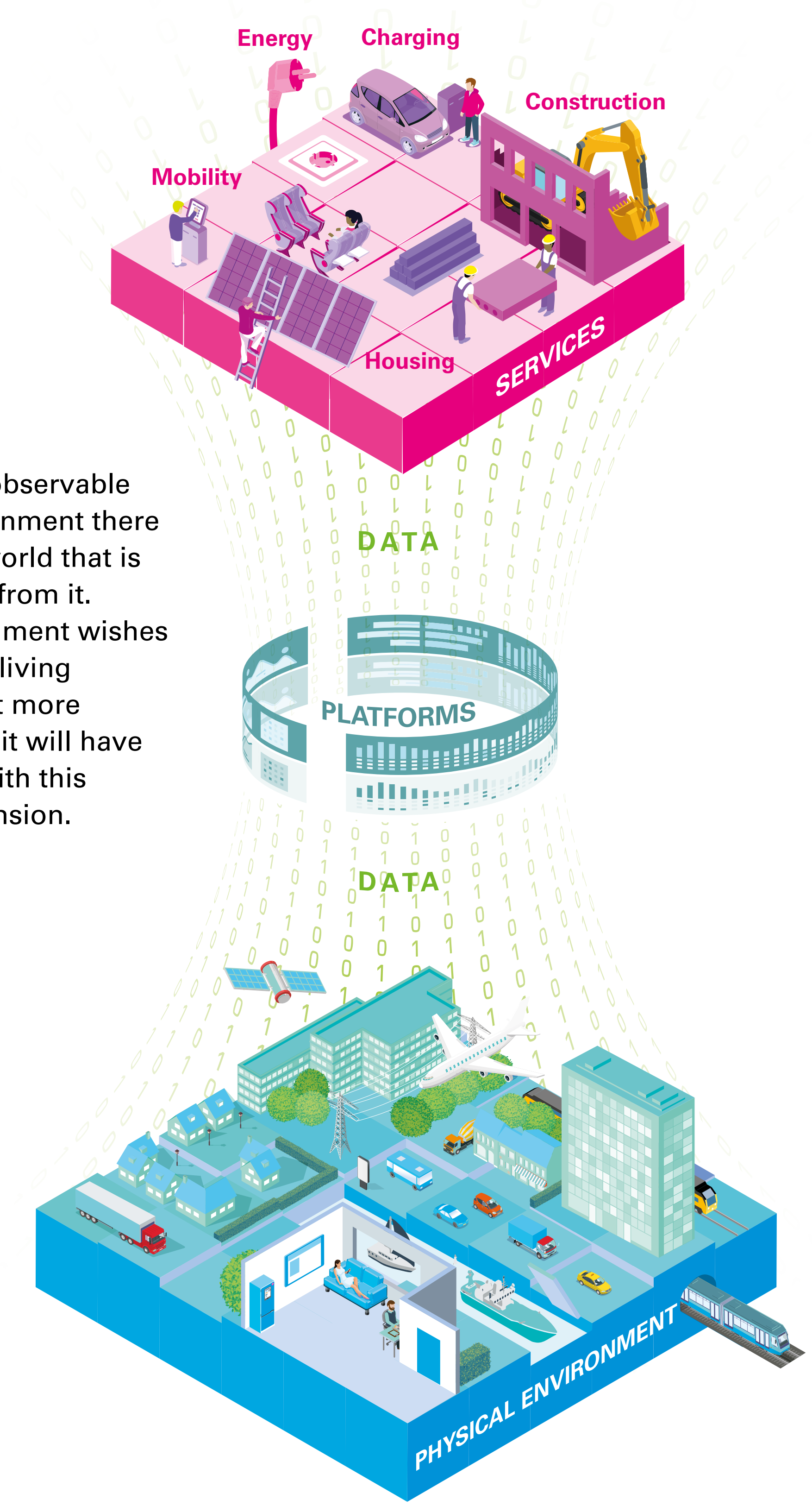
If we want to really understand the connection between digitalisation and the sustainability of the living environment, we need to see the living environment and the digital world as a single, cohesive system. Behind the living environment that we observe with our eyes lies a whole digital world that is hidden, but yet an inseparable part of the world we see. The figure shown below makes clear what components this system is made of and how they are connected to each other.

As figure 1 shows, there are four constituent layers of the digitalised living environment:

1. the *physical environment*;
2. the *data* that is collected about various components of the living environment;
3. the *digital platforms* on which this data comes together and where interactions are facilitated;
4. the *services* that are offered via the digital platforms.

In the first layer, the physical environment, makes up the ‘substrate’, as it were, on which the movement of people, goods and services plays out. Above this is the digital layer, which is filled with user data (such as passenger data, or the data on the use of charging stations for electric cars) and data on the environment (such as data on the available capacity on the electricity network or the composition of construction works). Increasingly, the available

Figure 1. The digitalised living environment



Behind the observable living environment there is a digital world that is inseparable from it. If the government wishes to make the living environment more sustainable, it will have to engage with this digital dimension.

data determines how we look at the living environment. When we go on holiday, for example, we now eschew the road map and our own geographic knowledge in favour of setting our destination in a navigation system.
On the platform layer, digital platforms use technological processing methods like algorithms and artificial intelligence to organise, analyse and correlate this data. They facilitate a great many activities in the physical environment: things like the energy supply, infrastructure management, public transportation, car-sharing, circular construction cycles, etc.
Finally, in the service layer, service providers (transport companies, energy suppliers, information suppliers like online timetable services, etc.) offer their services to consumers and business customers. These services, in turn, generate new data themselves.

The 'layer model' as shown in figure 1 makes it possible to analyse the interconnections between digitalisation and the physical environment in greater detail and identify at each individual layer where the leverage points are for furthering the green transformation. The Council will go into more detail about the layer model described here in part 2 of this advisory report.

1.2 Central question of the advisory report

In this advisory report, the Council will consider the manifold connections between digitalisation and sustainability challenges. As this suggests, the Council is not only looking at ways in which digital technology can benefit the green transformation in the living environment, but is also exploring the positive and negative impacts of increasing digitalisation on the sustainability of Dutch society. The Council wants to map out a situation under which the digital transformation and the green transformation can reinforce each other, and the role that governmental agencies can play in this process.

With that in mind, the Council's advice begins by looking at the following question: *'How are digitalisation and sustainability transitions related, and what possible, necessary and effective role can government play to ensure that digitalisation contributes to the necessary transition to a sustainable society?'*

1.3 Context

The consequences of a high level of digitalisation of society are not limited to sustainability issues. Digitalisation affects many more aspects of society, like economic prosperity, societal welfare, social cohesion and privacy, to name just a few. However, in this advisory report the Council looks specifically at the impact of advancing digitalisation on the sustainability of our living environment: on our energy use, our ways of living, working and travel, etc. As a result, the advice is focused specifically on the sustainability goals that pertain to aspects of the living environment. Issues like cybersecurity, digital literacy on the part of the public and commercial actors, and the government's optimising its own working processes with the help of digitalisation fall outside the scope of this advisory report.
Further, although this advisory report is directed primarily towards the relationship between digitalisation and the green transformation of Dutch society, it is important to be aware that the digital transformation and the

green transformation are both movements that transcend national borders; consequently, the Council will also look at relevant policy developments at the European level.

1.4 Structure

This advisory report consists of two parts. Part 1 contains the core of the advice: the results of the Council's analysis, the Council's conclusions from them and several recommendations to the government. This first section is structured as follows. First, the Council addresses the effects that increasing digitalisation is having and will have on the sustainability of Dutch society (chapter 2). The Council then looks at the ways in which digital technologies can be used to improve sustainability (chapter 3). Next, the Council considers the limited attention being given in national and European government policy to the role of digitalisation in relation to making the living environment more sustainable (chapter 4). Based on the outcome of this analysis, the Council formulates a number of conclusions (chapter 5). Finally, the Council makes specific recommendations for interventions that the government could use to facilitate the shift towards a digitalised society that would also achieve the goals of the green transformation (chapter 6).

Part 2 of the advisory report contains background information, evidence and analyses underlying the findings from part 1. This second section is made up of the following components:

- a list of the main points of European and national digitalisation policy
- a more detailed analysis of the fabric of an interwoven physical and digital world, using the 'layer' model discussed above
- a consideration of the role of digitalisation in the green transformation in the form of three case studies: the transition to a circular construction economy, the changing electricity system and increasing the sustainability of personal mobility.

In this advisory report, the Council must unavoidably use some technical terms and professional jargon. To help the reader, a glossary of terms is provided in the appendices. The terms found on the list are marked in the text of parts 1 and 2 of the report with a symbol, which you can click to go directly to the reference in the glossary.
Finally, the Council will highlight a few supplemental publications of third parties. Specifically, in drafting this advisory report the Council was particularly inspired by three essays:

- 'Value-driven digitalisation for the energy transition' ('Waardevol digitaliseren voor de energietransitie') (Masson et al., 2020);
- 'Digitalisation and the transition to a sustainable society: perspective from the mobility domain' ('Digitalisering en de transitie naar een duurzame samenleving: perspectief vanuit het mobiliteitsdomein') (Van de Weijer, 2020);
- 'The digital potential in creating a circular construction economy' (Chan, De Wolf & Koutamanis, 2020).

The Council has published each of these essays separately on its website. The authors of the individual essays bear all liability for their respective content.

2 A SOCIETY THAT IS BOTH DIGITAL AND SUSTAINABLE

Digitalisation is driving dramatic changes to our society. Those changes are making production processes more efficient and making our lives easier and more prosperous. But they do not necessarily make our society more sustainable, even if digitalisation is becoming a more and more decisive factor in the sustainability of our society. One of the most crucial elements in this is the role of the digital platform.

2.1 Influence of digitalisation on a sustainable living environment

Digitalisation is changing the living environment – but not necessarily in a sustainable way

As a result of digitalisation, the ways in which companies, consumers and the public sector interact are changing fast. New market structures, business models and behavioural patterns continue to emerge. Digitalisation offers a number of ways to clean up the production of goods and to make production processes more resource-efficient, in part by streamlining the business processes involved in it (UNCTAD, 2018; Ford & Despeisse, 2016; Herweijer et al., 2017). That means that there is certainly a potential for digitalisation to increase sustainability simply by improving efficiency. Despite this, the German advisory council the WBGU[2] (2019) sees little concrete evidence that potential sustainability-increasing effects are being achieved in practice and raises significant concerns as to whether, on balance, digitalisation is having a clearly positive effect on the sustainability of the living environment. According to the WBGU, the answer to that question is not at all clear.

In practice, digital technologies very often aggravate sustainability problems in the living environment, the Council notes. To take one example, the robust growth in the number of web shops has increased the affordability and availability of products so much that for the time being its primary impact is growth in the resource-intensive, waste-generating economy and an increase in greenhouse gas emissions - and this is not even to speak of the fact that online stores have been extremely successful in using data and algorithms to entice consumers to purchase more products than ever. This shows how companies are using digital technology to influence consumer behaviour both effectively and on a massive scale, so much so that they are in fact driving an increase in our society's consumption.

In other areas, it is not at all clear how advancements in the digital realm will ultimately have an impact on the sustainability of society. Here, consider the example of the increasing comfort and safety in cars that digitalisation brings. This may, in the future, ultimately lead to fully autonomous vehicles. That, in turn, could be an incentive for people to take longer journeys and avoid public transport, ultimately putting more cars on the road, with the result: deterioration of air quality caused by harmful emissions from cars and reduced traffic safety. But if these were emissions-free cars, and if another technological advance (say, large-scale use of digital platforms to maximize the efficiency of car-sharing) could effectively eliminate the extra road traffic, then we see how tech solutions can, in fact, counter their own negative effects.

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Digitalisation is also driven by interests other than sustainability

Some digitalisation processes in the living environment are developed with the goal of performing a public task - like the digitalisation of water management or the energy supply, for example. This type of digitalisation process serves a public interest. Many more digitalisation processes in society, however, serve a commercial interest. The development of digital technology is most often driven from within the private sector.
Attention to sustainability is not a given with digitalisation driven primarily by commercial concerns. Market parties are, by their nature, fixated on efficiency, maximising profit, boosting their competitive position and delivering services for which there is a demand. That is understandable, and in some respects has positive effects for large groups of people. Consider that numerous products and services have been made more affordable and more accessible by digital innovations, which has been a boost to prosperity. Additionally, technology-driven improvements in efficiency motivated by cost savings may increase sustainability. But

advancements in digital technology, data flows and platforms do not automatically lead to positive sustainability effects; they do not mean that goods and services are automatically produced in more sustainable ways. In construction, for example, digital platforms that match supply and demand for parts, materials and equipment can be an important part of creating a 'circular construction' cycle, and so improve sustainability in the sector. But in practice, many companies in the construction sector are still only using digital systems to optimise their own working processes and improve their individual competitive positions. For these, the idea of establishing a digital cooperation across the chain in order to promote circular construction would seem to still be a bridge too far, in part due to competition-related concerns (see part 2, section 3.1).
The WBGU has observed that positive sustainability effects are often merely by-products of digital advancements (WBGU, 2019).

There are notable exceptions: digital developments of private parties that do contribute to the sustainability of the living environment. In the Netherlands, for example, there are commercial digital platforms like Powerpeers and Vandebron that are matching supply and demand for sustainably generated energy (see part 2, section 3.2). Commercial interests are therefore not always contrary to sustainability interests - but for the time being, they seem to be in many cases.

2.2 Pivotal function of digital platforms

Digital platforms are giving us the opportunity to make connections between parties in more and more areas: from facilitating social interactions (Facebook, LinkedIn, Instagram), to economic interactions (Airbnb, Uber, Peerby), and even scientific interactions (Data Archive, the European Covid-19 Data Portal). They connect the demand with the supply of goods, services, information or knowledge. Just as importantly, digital platforms have the option to link user data to other data flows, like weather forecasts or geoinformatics. Together this linked data can then be used as the basis for things like navigation apps, public transportation journey planners and even restaurant finders. This should make clear how digital platforms are increasingly taking on a pivotal role in the digitalising society. And this is, in part, why the Council observes that they are also critically important for the green transformation of that society.

Digital platforms in this advisory report

In this advisory report, the Council defines 'digital platforms' as any combination of digital infrastructure consisting of internet, data centres and technological equipment (Blaschke et al., 2019) that enables multiple parties to exchange data. The technology comes together in a complex network that enables parties to interact with each other. Products and/or services are offered and then exchanged via digital transactions. The Council is referring to any parties that facilitate this type of interaction in the living environment, not just to the platforms of the big-name tech companies. Obviously, there are a great many parties facilitating the interactions in the living environment, not all of them household names. Some might be open platforms that provide access to anyone and everyone. But some are closed platforms, like Translink, which brings all the data from all public transportation transactions together.

The importance of digital platforms for increasing the sustainability of society follows from the fact that when designing and building their platforms and the algorithms they use (see sidebar), the platform parties make choices about the fundamental conditions and requirements to be set on the interactions that take place on them, and this has a direct impact on what services can be and are provided in the physical environment. And that, in turn, has consequences on the energy consumption, travel behaviour, consumption habits, etc. of the people who live in it. Take the example of a platform for car sharing: if it only allows providers of zero-emissions vehicles, this has an impact on the consumer's choice. Likewise, an energy platform that presents suppliers of green energy more prominently than those providing grey energy does the same.

In short, digital platforms are becoming increasingly important to increasing society's sustainability. From their pivotal position in the digitalising living environment they increasingly set the rules for market traffic and the conditions under which people have access to this living environment. This decisive role in the living environment can be compared to the 'gatekeeper function' that has been identified in European and national competition policy for platform companies that control access to the market (see part 2, chapter 2).[3]

Platforms and algorithms

Digital platforms are intensive data users. The transactions and interactions are made possible by the exchange and combination of data. Much of this data is processed by algorithms. Algorithms are essentially mathematical formulas, something akin to a computational 'recipe' that can be used to automate transactions. Broadly speaking, there are two categories: rule-based algorithms (the algorithm ? follows a set of rules defined by a programmer) and learning algorithms (algorithms that improve themselves using 'machine learning' ?). These algorithms are used to prioritise, classify, associate and filter data. This is how Uber is able to connect a person needing a ride with the nearest Uber driver, and how AirBnb displays the places to stay that match what the user is looking for.

The importance of digital platforms lies not so much in what they do (facilitating transactions is nothing new in itself, of course), but in the scale on which they do it. Digitalisation has made it possible to make connections on a much larger scale than ever before. Because digital platforms also make connections with each other and build on each other, they generate

3 Another analogy for the position of platforms can be derived from the 'hourglass model' that Akhshabi & Dovrolis (2011) describe for internet protocols. In this model, platforms can be seen as the narrowest point of the hourglass, through which all services, users and data must flow.

tremendous network effects (Keijveld, 2014; Van Dijck, 2016). The more users a platform has, the more value it has for both its operator and the users (Gawer & Cusumano, 2014). And the contribution a digital platform can make to sustainability increases accordingly.

3 USE OF DIGITAL TECHNOLOGY AND DATA FOR ACHIEVING SUSTAINABILITY GOALS

The use of digital technology and data will be indispensable for increasing the sustainability of our society. Digital platforms present opportunities to accelerate the green transition in many domains in the living environment. However, successful application of digital technology towards the green transition will require collection of relevant data of adequate quality and that this data can then be shared between governmental agencies, the private sector and the public. The Council observes that there is still a long way to go here.

3.1 Digital technology and data indispensable for achieving sustainability goals

The Council analysed the connection between digitalisation and the achievement of the sustainability goals for three different cases. These cases are: (a) the transition to a circular construction economy, (b) the changing electricity system, (c) increasing the sustainability of personal mobility.

Transition to a circular construction economy

In the construction sector, increasing sustainability means striving for maximum use of renewable materials, reuse or recycling of materials and minimising construction and demolition waste, all with the goal of creating a closed-loop construction process. In view of the quantities of materials and resources involved and the large number of parties that play a role in the different phases of the production chain, creating this circular process will depend on digitalisation. For one thing, material flows can only be made truly transparent with a good digital registration system. And digital platforms are an indispensable link matching supply and demand of used materials and renewables in the construction industry on a large scale. Without accessible digital systems and reliable data, the parties will not succeed in finding each other and creating a more circular construction process (see part 2, section 3.1).

Changing electricity system

Similarly, in the energy sector, efforts to increase sustainability will not succeed without the use of digital technology and relevant data. This is because of the complexity of the process of generation and distribution of sustainable electricity from sun and wind. Because this energy is no longer generated entirely centrally, from a single power station, but also at multiple remote locations and by multiple parties, the situation is now one of two-way traffic between energy customers who are simultaneously energy suppliers. An additional factor is that the availability of solar and wind power depends on weather conditions, and therefore fluctuates, which makes matching supply and demand for energy even more complicated.

In such a complex situation, 'smart grids' ? (tech-driven energy networks) and digital energy platforms are needed to establish a balanced electricity system that can guarantee security of supply at all times (see part 2, section 3.2).

Increasing the sustainability of personal mobility

In the mobility domain, the Council likewise sees a strong relationship between digitalisation and the options for increasing sustainability. Digital technology not only makes vehicles more efficient, but the mobility-related data it can generate, combined with a wide range of digital services in the mobility domain, can make it easy for travellers to decide what is the most sustainable, fastest or cost-effective means of transportation available to them. Giving travellers a real-time view of their transportation options on a specific route can lead them to choose public transportation over a car or make decisions like opting for sharing, borrowing or leasing a vehicle. The rapidly increasing amount of available data and the ever-smarter data analyses are also giving us the ability to control the mobility system in new ways, like discouraging vehicles with unsatisfactory CO_2 emissions levels or regulating traffic safety and accessibility. Additionally, the ability to work online from home continues to eliminate the need for many commute movements (see part 2, section 3.3).

Conclusion

The analysis of the three cases (which are worked out in more detail in part 2 of this advisory report) makes clear that digital technology and data will be essential for the success of the green transition in the various

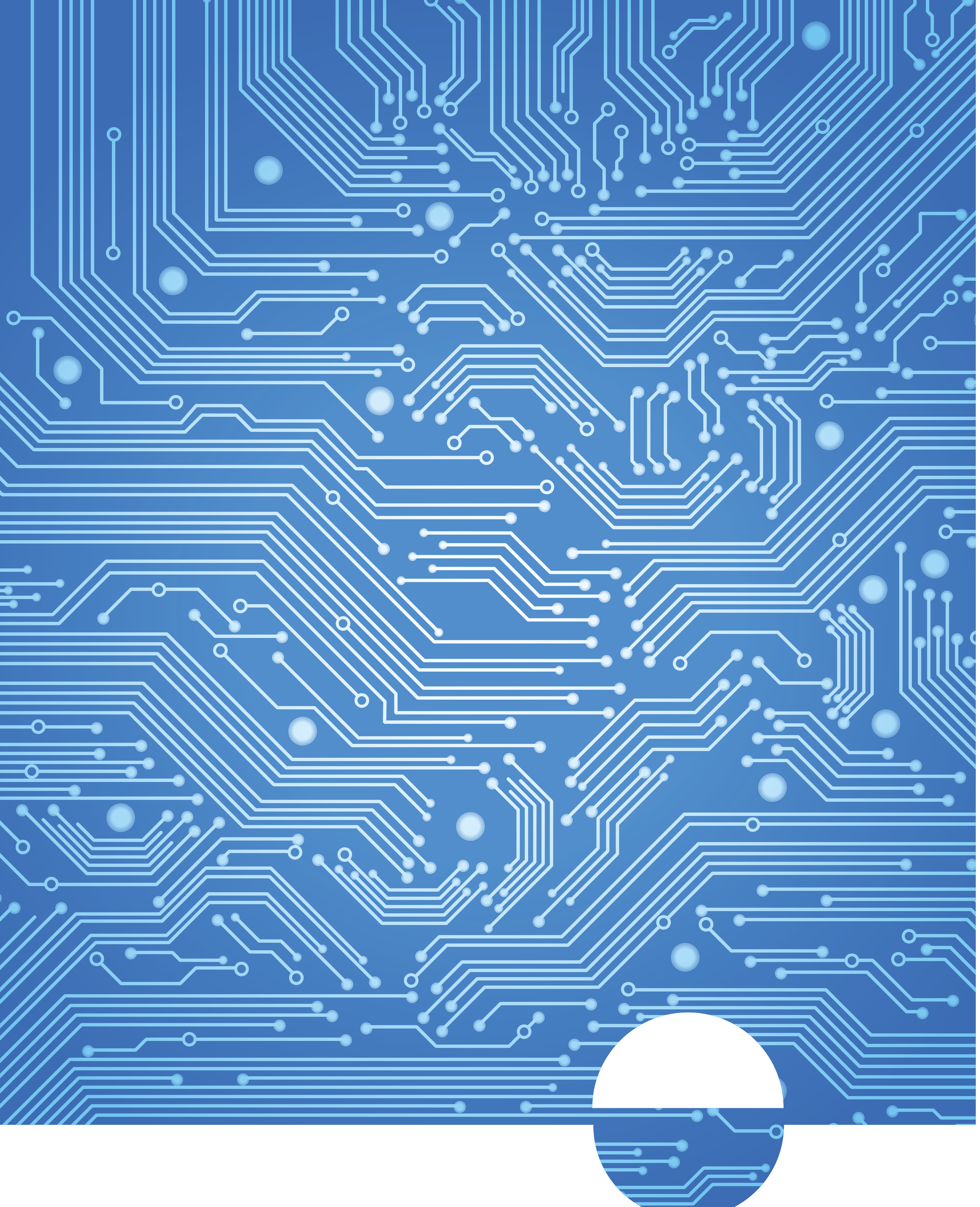
domains in the living environment, and in particular that the pivotal function of digital platforms will be a critical factor.
However, as the Council has already established (Rli, 2017), the exact impact of digital technology and data remains difficult to predict. In many cases, their impact will go beyond the expected direct consequences.
In others, it is clear that the expectations for the problem-solving power of digital technologies and data use are too high. For example, when smart energy meters for Dutch households were introduced in 2015, the assumption was that they would reduce household energy use by an average of 3.5%, because they would give people a better and more precise picture of their actual energy consumption. In practice, however, the way in which household energy users received feedback on their energy use was not very effective, as a result of which the average reduction was actually less than 1% (Vringer & Dassen, 2016).

3.2 Importance of data for sustainability goals

The availability of data about the living environment and its analysis through algorithms, machine learning and artificial intelligence presents opportunities to develop innovative answers for the sustainability challenges facing our country. For example, data on what construction materials have gone into an old building that is slated to be demolished can help architects and contractors to conserve resources and raw materials better, by allowing them to use as much of that material as possible in new construction. But for this to happen there must be data available for the materials in question on their condition and whether they can be readily extracted from the old building.

In other words, for this type of application relevant data about the living environment must be collected and shared between public and private parties, and between parties in the private sector that may have competing interests. However, both the collection and sharing of this data are not as yet happening to a sufficient degree. There’s a number of different reasons for this.
Sometimes, it is due to a lack of infrastructure for data collection (and data management), or that infrastructure has not yet adequately come together. On the technical side, the lack of interoperability of data and compatibility of data files is often an impediment. Another factor is that the standardisation required has not yet been achieved to an adequate degree.
In other cases, data sharing remains inadequate because of conflicting interests. It is quite common that governmental agencies wishing to use a company’s data in the performance of a public task meet with resistance: the company does not wish to release all its data, because this data is key to its business operations, earning model and competitive position. Likewise, when a company or governmental agency wishes to use data of members of the public for collective purposes, or purposes other than the purpose for which the data was collected, this very quickly causes an outcry, in this case because of privacy concerns.
As all this shows, we are not presently in a position to adequately collect data of sufficient quality and simply share it in a way that would facilitate the achievement of sustainability goals. This is why it is important to put

clear requirements and commitments into place as a first step. Companies, organisations and individuals must be assured that their data is being handled carefully and that the control of the data is properly regulated. This will be essential for building more support in society for data sharing in the service of increasing sustainability in the living environment.



4 DIGITALISATION AND SUSTAINABILITY IN GOVERNMENT POLICY

At both the European and national levels, increasing attention is being given to the major changes that digitalisation is setting in motion in society. Thus far, this attention has gone principally to the utilisation of opportunities for the economy, guaranteeing fair competition and the protection of civil rights. But this leaves the impact of digitalisation on the *challenge of making society more sustainable* an underexplored aspect of digitalisation policy. It is also notable that governmental agencies are still not taking enough advantage of the potential of digitalisation in their approach to the green transformation. The opportunities are not being recognised sufficiently; lack of knowledge about digitalisation and the effect of digital markets are hampering these agencies.

4.1 Sustainability not being highlighted enough in digitalisation policy

The digitalisation policies of the EU and the Dutch government are strongly oriented towards the utilisation of the economic opportunities that the digital transformation offers (see part 2, chapter 2). Generally, the focus is on productivity and efficiency improvements, promoting innovation and maximising earning capacity in businesses. Along with this, there is also increasing attention being given to protecting public values like fair competition and consumer protection, e.g. the development of policies that will make competition law applicable in a digital economy and prevent abuses of power by the digital platforms with a gatekeeper function (Dutch Ministry of Economic Affairs, 2020). In December 2020 the European Commission drafted a proposal for new European legislation in this area, the Digital Services Act package. Additionally, the focus in digitalisation policy is increasingly shifting to the protection of civil rights like privacy and personal autonomy (see part 2, chapter 2). The General Data Protection Regulation (GDPR) is an important foundation here.[4]

But when it comes to how digitalisation can have an impact on the sustainability of society, the government seems to have very few ideas. The significance of digitalisation for sustainability of society is often named in the same breath as the utilisation of economic opportunities. But as was described in chapter 2, in a digitalising living environment economic interests will not always automatically coincide with the interests of sustainability.

It should be noted that both the EU and the national government do endorse a number of international ethical frameworks that address the necessity to understand the impact of digitalisation on sustainability. The European Group on Ethics in Science and Technologies (EGESNT, 2018), for example, asserts the principle that artificial intelligence technology cannot be allowed to come into conflict with our duty of care for life on our planet and the preservation of a healthy environment for future generations. Also, this technology must be compatible with public values such as justice, solidarity and human dignity. But where these frameworks pertain to sustainability, they have not yet been incorporated as a concrete element of the digitalisation policy.

4.2 Little regard for the digital world in sustainability policy

In government policy for the physical environment, it has traditionally been standard practice to define frameworks from a sustainability perspective. Over the years this has created a cohesive system of rules and requirements, financial policy and monitoring for these frameworks. But this policy is focused primarily on the layer of the physical environment identified in figure 1 (see chapter 1), and the activities on the services layer rather than the platform and data layers. This means that up to now government sustainability policy has been targeted primarily at the traditional players in the living environment, such as infrastructure managers, transportation providers, energy suppliers and construction companies. The policy instruments that governments use in this process do not generally lend themselves to application towards the parties in the new digital economy, since these are parties that are fully engaged in digital activities like collecting data, operating a digital platform, etc.

4 Directive (EU) 2016/679 of the European Parliament and the Council (27 April 2016).

To understand this, consider the following example. When granting a public transportation concession, an authority can set requirements on the transportation company's ecological performance. But that authority will not conclude that the operator of a digital platform offering mobility services ? competing with that public transportation company should be subject to the same requirements. Moreover, parties like this platform provider will not be required to provide the data needed for effective interventions designed to promote the achievement of sustainability goals. The platform company is not seen as a 'primary service provider' with a clearly defined public-interest task. Another illustrative example is the CE mark required for admission of products on the European market. This mark guarantees that the product meets European standards ? in the areas of health, safety and the environment. But this approach is not particularly workable for the admission of digital products and services, which change so fast that a system for market admission can never keep up.

As things stand, the government has very little grasp of these new parties and products, and this is in part due to lack of attention to digitalisation in sustainability policy. This entails a number of risks, because the further digitalisation advances, the more the performance of traditionally public-sector tasks becomes dependent on these parties, their platforms and their data.

Experience has shown that in practice, platform companies have a tendency to become monopolies. This is not something that will be detrimental to sustainability per se, but it does make it just as likely that the algorithms used will be geared exclusively towards optimising the interactions on the platform or the business operations of, say, mobility providers or construction companies, and will not adequately address the sustainability of the living environment. Dominant platforms can become an impediment to more sustainable alternatives to the market if their algorithms are not designed to provide for sustainable operations; this may be the case if a new, sustainable platform is unable to access the historical data or if a dominant platform party systematically buys up all new and emerging platforms without continuing to develop their models.

The existing policy instruments available in current government sustainability policy are inadequate for regulation of parties in the new digital economy. This is because the dynamics of the digital layers in our society are different from those of the physical layers. The activities of digital parties often go beyond the existing bounds between countries and/or sectors. And their activities also develop at a much faster tempo than those of traditional parties. The time between the initial planning and the first use of a light rail connection will generally be years, whereas a digital mobility service can change entirely within a month, or become completely irrelevant within a year if its service is rendered obsolete by the arrival of a new digital service. The instruments that the government uses to regulate this type of digital party must therefore be able to keep up with this dynamic if they are to be effective. At present, they generally cannot. The way things work now, it takes a long time for legislation and regulations to come together, and regulation is often limited to individual, specific problems.

This does not mean that every existing instrument that the government has at its disposal is useless. The Council believes that government institutions do have access to options for defining frameworks, even for digital market parties, that can benefit the sustainability of the living environment.
After all, governmental institutions conduct tendering procedures, award concessions and permits and are responsible for the management of the physical environment, and in these roles have options to actively exercise governance with respect to sustainability goals.
For example, when granting permits or exemptions the governmental agency could set requirements on digital market parties that use the public space. One illustration of this approach can be found in the temporary permits for shared electric scooters in Amsterdam. In the permitting conditions (under the general municipal bylaws) for the sharing platform, the municipality required that the scooters offered be zero-emissions vehicles, and that specific data from the subsystems that would be relevant for policy and evaluation be shared with the municipality – things like user patterns, capacity used, locations, number of unique users, etc. (Municipality of Amsterdam, 2019). This shows that depending on the framework within which permits or exemptions are granted, additional 'green' or digital requirements can, in some cases, be set.
In tendering procedures, upon the award of contracts and in the event of sale or lease of land, the legal options available to governmental institutions to set supplemental requirements are even greater. Thanks in part to the EU regulations on 'Green Public Procurement', private law gives governmental institutions even more options to set conditions that promote sustainability. The Council has concluded that from the perspective of effective sustainability policy and practice, the option to apply this type of intervention is still being underutilised in practice.

Having said that, the Council also wishes to emphasise that in engaging in interventions directed towards the promotion of sustainability, governmental institutions must at all times keep sight of other public values that may be at stake, such as personal privacy and the accessibility and affordability of goods and services. As already noted above, the influence of digital technologies and the continuously developing field of data applications are often seen to go further than the intended direct effects on sustainability, and even their direct effects in general (Rli, 2017).

4.3 Digital platforms: leverage points for sustainability policy going unused

Due to their pivotal position in the living environment, digital platforms can offer leverage points for sustainability policy, both where it comes to risk management for a sustainable digital society and for the use of digital technologies to increase sustainability. At present, digital platforms that facilitate things like housing rentals, energy trading or mobility largely make their own rules for the services that are offered through them.
With that being the case, they have an influence on how the physical environment is used. From the perspective of digitalisation policy, there is currently a good deal of thought being put into the decisive role that large platform companies are taking on in the market (and rightly so). The fact that various types of digital platforms can (and do) have such a pivotal

role when it comes to the sustainability of our society and that this means that conditions need to be set on how these platforms operate remains an underemphasised aspect of digitalisation policy.

This pivotal position that platforms have offers governmental institutions a number of potential ways to promote sustainability goals, such as by enforcing price policy. The possibilities are abundant. If services offered on a platform have a negative environmental impact, accounting for this in the price of the services through the platform would be a relatively simple matter.
A softer government intervention would, for example, be requiring an energy platform to ensure that its search algorithms rank providers of renewable energy higher in searches by potential customers. Platforms can also help increase the transparency of the market. Staying with the energy sector, a platform could (for example) be obliged to make it clear where an energy supplier's power is coming from and who is using it.

At present, governmental institutions are not utilising this type of options. The Council has as yet found no instances of commitments made with, or rules imposed on, operators of digital platforms to increase their contribution to sustainability objectives. Consequently, the Council considers that governmental institutions are missing opportunities here. At the same time, the Council notes that such forms of behavioural influencing must always be applied with the requisite amount of due care. Behavioural influencing can only be directed towards the achievement of democratically legitimate objectives. And governmental institutions must at all times be transparent and open about the instruments they are using and the effects they intend to achieve with them (Rli, 2014).

4.4 Need for data sharing standards

Promoting sustainability with digital applications depends on relevant and usable data being collected and shared between public and private-sector parties, as well as amongst different parties in the private sector (see 3.2, above). Regardless of whether attention is actually being given to this in various different policy domains, the Council observes that government initiatives to promote data sharing can generally be understood to be in their infancy.

Promoting data sharing will require clearly defined basic conditions and arrangements on:

- the requirements (including, but not limited to, quality requirements) that data, data sets and algorithms used will need to meet;
- the definitions that must be included in the data;
- the objectives for which data and data sets may be collected, and the manner of their collection;
- the conditions for control over the data.

All these conditions and arrangements collectively can also be referred to as 'standards' for data sharing. This type of standard is intended to ensure that the data can be used for sustainability goals and that it is also transparent to the general public and consumers what purposes their data may be used for, what data analyses and algorithms may be used in it, and how their civil rights (e.g. autonomy) are protected in the process. Businesses, in turn, must be able to have confidence that the data they have collected is only being used for the agreed sustainability goals. Steps must be taken to ensure that confidential business data cannot be used by others to strengthen their competitive position.

In addition, monitoring and enforcement must be put in place to ensure compliance with standards. In view of the number and volume of the data flows, the scale on which this monitoring needs to happen can present a significant challenge. It is clear that the Dutch Data Protection Authority has its hands full with the monitoring of the General Data Protection Regulation of 2019.

Right now the first steps towards the development of standards are being taken in the MaaS ('Mobility as a Service' ?) pilots. The importance of arrangements and rules with regard to control over data and the objective for which data may be used is also seen in the policy for a European data economy. This European policy is oriented towards the development of 'data spaces' ? in which relevant data on specific policy fields is consolidated and can be shared under certain conditions (see part 2, chapter 2). Within these data spaces, which in effect constitute a European internal market for data, arrangements and rules of this type will apply. At present data spaces are being built for areas such as climate change, the circular economy, mobility and the supply of energy.

4.5 Need for knowledge development on the part of governmental institutions

The ability to effectively manage the data and platform layers of the living environment for maximum synergy with the green transformation demands comprehensive knowledge of the digital domain. Governmental agencies involved in the various aspects of the green transformation generally do not have enough of this type of knowledge, or that knowledge is fragmented across different departments in the organisation. This is entirely understandable, because the material is complex and lies in areas where developments happen at lightning speed (often beyond the government's view).

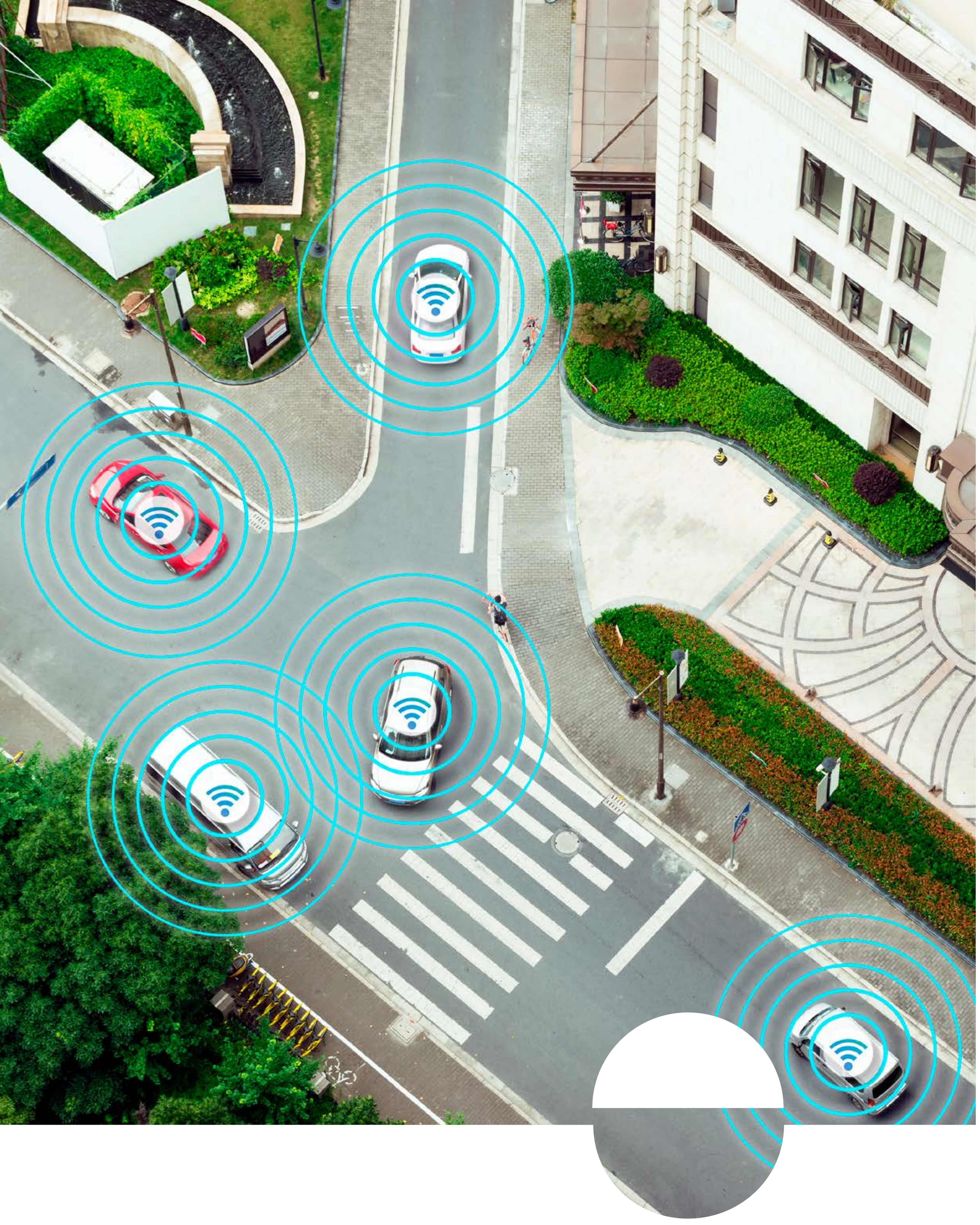
Still, the Council does observe that the attention to digitalisation is growing at all levels of government and that more and more expertise is being developed in this area. Despite this the Council sees that there are still significant steps forward needed to bring sufficient knowledge in-house, to embed this knowledge broadly at national government level and to improve the knowledge exchange between governmental institutions.

The required expertise comprises:

- technical knowledge concerning the functioning of digital technologies and how they can contribute to sustainability;
- knowledge about the functioning of the digital markets on which digital parties are active, and their effects and potential effects on the sustainability of society;

- knowledge about the potential forms of governance in the digitalising living environment.

After focusing on developing expertise in these areas, governmental institutions will be able to more readily identify the impact of digital developments on the living environment. They will then be able to use the right incentives to encourage market parties to utilise the opportunities to improve sustainability that digitalisation offers. In addition, knowledge development will help the government design and implement effective policy. Finally, expertise will be critical for allowing governmental institutions to act as an equal partner in discussions with digital parties in the monitoring and enforcement of compliance with policy.



5 CONCLUSIONS

Digitalisation policy is insufficiently oriented toward the sustainability of society

Digitalisation is changing society, and has a strong impact on the sustainability of the living environment. The Council sees it as essential for the governmental institutions at the European and national levels to devote more attention to this in their digitalisation policy. They must define frameworks for the digital transformation in order to minimise the negative impacts and facilitate digitalisation's contribution to the green transformation. At present, this is not yet happening.

For the time being, governmental institutions are focusing their digitalisation policies primarily on the economic opportunities and risks, the interests of the consumer and the protection of civil rights. These are areas in which policy is being developed at a rapid pace. Policy oriented towards sustainability aspects of digitalisation should come in supplement to these. This should also be achieved in part by making sustainability an aspect of the Dutch government's broad Digital Government Agenda, which strives to achieve a value-driven digital government (alongside inclusiveness, reliability and security). Sustainability, economy and civil rights can be extensions of each other, even if this may not always be readily apparent. In their designs for a sustainable digitalisation policy, governmental institutions must recognise that these interests can conflict with each other.

In the approach to sustainability goals, digital layers of the living environment are being neglected

The Council considers that the government will also have to take a more active approach to applying digital technologies toward achieving the end of increasing the sustainability of society. It is important to realise that the sustainability goals can only be achieved if relevant developments in the digital world are recognised and their potential is fully utilised. That will require governance at all levels of the living environment (see figure 1, chapter 1). The government's sustainability policy must therefore no longer be restricted to the layers at which our infrastructures, housing and industry are found and where the physical transport of persons, services and goods happens. Governance is also needed at the layer of the digital platforms that connect the providers and consumers of digital services, as well as the layer at which the user data and environmental data that these platforms use is found. In its sustainability policy, the national government has failed, and continues to fail, to devote sufficient attention to these two digital layers, even though they are both important elements of the public space. The government cannot neglect the role of these digital layers in the functioning of a more sustainable society.

The Council sees plentiful opportunities for the public sector to exercise governance of digitalisation based on the perspective of a sustainable society, but observes that these opportunities are still being used far too little. Both the national government and local authorities can act in their roles as legislator, client, permit-granting authority and administrator of the public space. They can exert their influence to ensure that data is shared for the benefit of promoting sustainability, because this is something that will not happen by itself. Additionally, they can promote sustainability policy focused on digital platforms. Due to the pivotal function these platforms have for the physical environment, rules and arrangements on the conditions under which transactions can be conducted on a platform have the potential to be very effective.

Cooperation at the European level is needed for governance of digitalisation for sustainability

Focused governance of digitalisation in order to create a sustainable digital society is entirely in keeping with the Dutch ambition to make the Netherlands a digital leader in Europe. But the Council believes that national policy efforts alone will not be enough. By their nature digital and sustainable developments happen in an international context, so naturally policy designed to foster sustainability in digitalisation will have to have an international orientation. This means that cooperation at the European level will be important. At present, we see that in the EU governance of sustainability and digitalisation is still happening in isolation (see part 2, chapter 1).

6 RECOMMENDATIONS FOR GOVERNMENT

A successful approach to the achievement of the sustainability goals will require both the Netherlands and Europe to focus more attention on the digital world that underlies our physical environment, and to direct policy towards this level. The national government must make the sustainability challenges that the Netherlands faces more explicit in its digitalisation policy. By the same token, the sustainability policy must be formulated to better take advantage of the potential of digital technology. Both of these things will require a new look at the living environment. The government must not only have a view to the physical environment and the observable services delivered and consumed there, but also the digital world underlying it. This dual view will reveal how directed interventions can be applied to facilitate the advancements in the digital realm that will answer to the necessity to make society more sustainable. The government's responsibility for a sustainable living environment does not change, of course, but digitalisation does change the leverage points for governance, has an impact on the effectiveness of existing instruments, and presents options for new ones.

In this chapter the Council makes six recommendations for interventions of this nature. As figure 2 shows, these recommendations are structured in groups corresponding to the layer model. Along with this the Council proposes three recommendations for changes in the government organisation that will be needed if these interventions are to be successful.

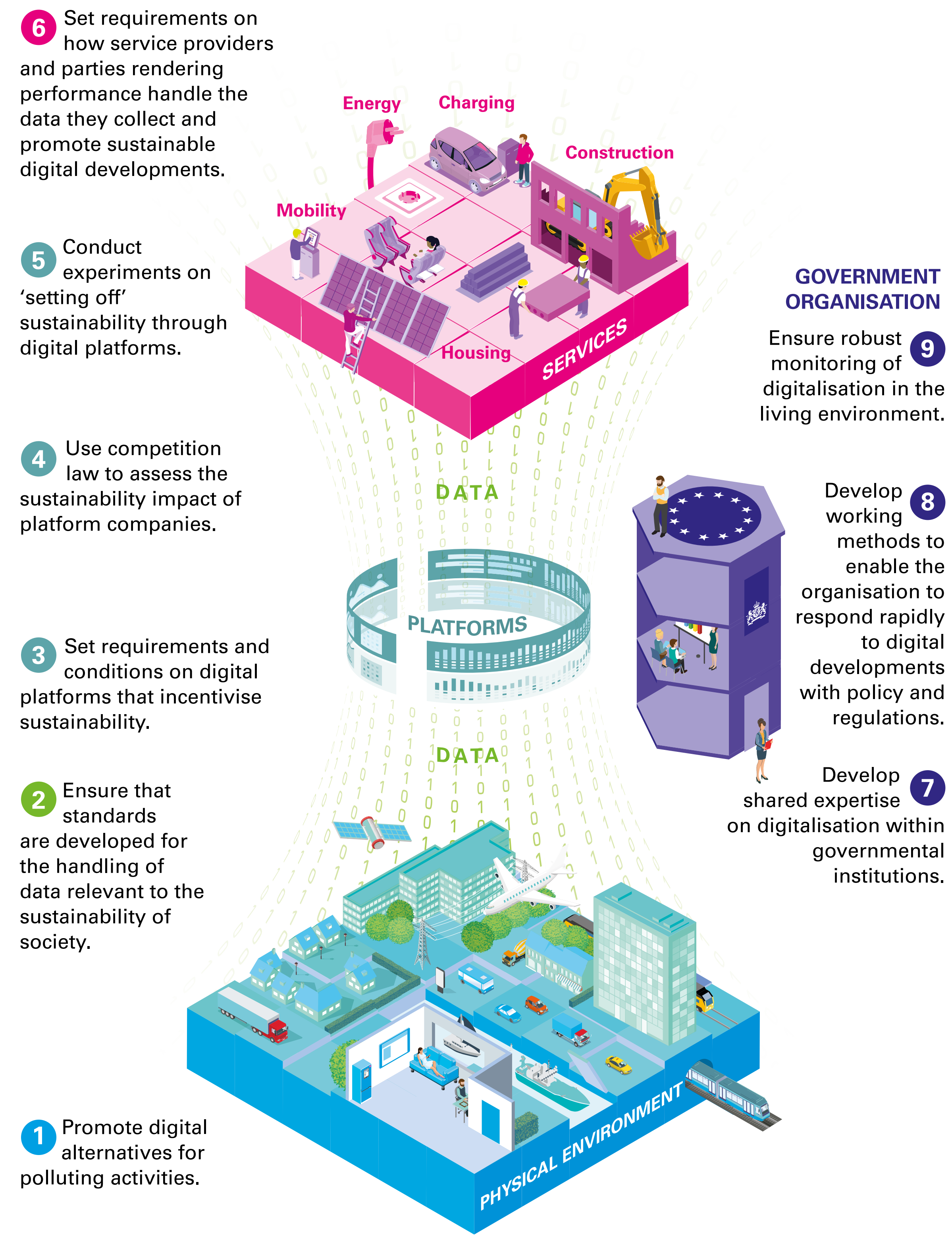
The nine recommendations from figure 2 are explained in more detail in the paragraphs below (6.1-6.5).

6.1 Intervention at the layer of the physical environment

Recommendation 1. Promote digital alternatives for polluting activities.

The national government can promote more sustainable use of the physical environment by encouraging and enabling the use of digital alternatives. One concrete example would be to continue to promote telecommuting/ online working from home, which in 2020-2021 became something of the 'new normal' for an extended period of time as a result of the COVID-19 pandemic. Online working from home brings significant sustainability gains in the mobility domain, both in terms of environmental impact (emissions of CO_2 and fine particulates, as well as noise pollution) and in terms of consumption of the physical space and accessibility; of course, there must also be an assessment of potential negative effects (such as increased energy consumption in the home). The COVID-19 pandemic demonstrated clearly that online working from home is a realistic and

Figure 2. Summary of recommendations for a more sustainable digitalised living environment



feasible option, and that previous objections to working from home are no longer relevant (Van de Weijer, 2020; Rli, 2019). One way to further promote online working from home would be to improve the digital infrastructure so that every Dutch home has access to a fast and stable internet connection. This could be supplemented by additional tax rebate schemes or other financial incentives. Further, the government could lead by example with a progressive approach to the working-from-home arrangements for its own employees.

6.2 Intervention at the data layer

Recommendation 2. Ensure that standards are developed for the handling of data relevant to the sustainability of society.

The national government must ensure that broadly supported standards for the quality, use and analysis of environmental data (such as data on the composition of construction works or the available capacity on the electricity network) and user data (such as passenger data or data on household energy consumption) relevant to the sustainability of society are adopted. Where necessary, the national government must also enforce the application of these standards. For example, with reference to making the electricity system 'smarter' for the purposes of the energy transition, standards to allow devices, infrastructure and parties to communicate and to register the environmental impact of energy sources and devices are needed (see part 2, section 3.2). The standards will have to prescribe what information is registered, how it is shared and what analyses of it are permissible. By way of enforcement the government could embed this type of standard in legislation, for example in the upcoming Energy Act.

The national government need not formulate this type of standard itself. The national government needs to enter into partnerships with both established and new market parties, and with private individuals and social organisations where relevant. The Council also sees an active role for the government in setting requirements on the standards by virtue of the fact that these standards will contribute to increasing sustainability. The Ministry of Infrastructure and Public Works, for example, is currently gaining experience with designing standards for data exchange in the area of mobility. In a few pilot projects, transportation companies and service providers are sharing data to be used in Mobility as a Service apps and to optimise the mobility system. Here, the ministry is acting as an intermediary for the purposes of standards development (see part 2, section 3.3).

Drawing on the knowledge and expertise of organisations such as NEN and the Netherlands Standardisation Forum would seem to be an obvious choice here. Along with this, the national government should actively engage with the European initiative for setting up European data spaces (see part 2, chapter 2). Here there is an opportunity to, as national government, also be involved in standards for data use and analysis at the European level that will actually support sustainability transitions (or at least not be counterproductive to them).

6.3 Interventions at the platform layer

Recommendation 3. Set requirements and conditions on digital platforms that incentivise sustainability.

The Council thinks that the national government must leverage the pivotal position of digital platforms in the physical environment for the benefit of the sustainability of society. This can be done by setting requirements and conditions on the transactions and interactions that take place on the platform and by prescribing that these must be incorporated into the algorithms used. The government, for example, could apply tax advantages to homes used for holiday rentals and offered on a digital platform if the home has a good energy label. And the government could prescribe that in the material registers the environmental characteristics of materials must be stated in a manner that is transparent to all.

Such requirements and conditions can only be meaningful if they are enforceable. The national government must therefore consider, for each individual digital platform that develops into a pivotal position in the living environment, whether existing legislation within and/or outside the sector are sufficient, or whether they need to be supplemented. The latter will not always be possible without significant effort. For this reason the Council believes that in due course, a European regulation must be drafted, in observance of the European treaties and existing EU legislation, to better facilitate setting conditions on digital platforms to promote sustainability. This would build a powerful legal foundation to support the acceleration of the sustainability transitions in our digital society. This would be along the same lines as the GDPR, which currently serves in a similar way as the legal basis for our data protection, and the way that European procurement law and competition law now protect the functioning of the market and enforce consumer protections in our country.
Given the speed of developments in digital platforms, such a regulation must be primarily composed of principles and target regulation designed to create a framework of governance for sustainability (see recommendation 8), even if the digital technology changes. This would be, for example, clauses oriented towards achieving the desired outcome – along the lines of the rules drafted for the automotive sector to limit the total emissions from the car fleet rather than emissions by individual car type. Such a framework would create more future-proof regulation. The Council calls upon the national government to take an active role on this issue in European policy development.

Digital platforms do not always offer sufficient leverage points on which to base governance of sustainability. In some cases existing platforms do not lend themselves to effective governance, or it is simply that in the specific area no digital platforms have emerged as yet with a wide enough user base, as in the case concerning the circular construction economy (see part 2, section 3.1). In such cases the Council recommends that the relevant governmental institution itself, together with the service providers, platform developers and users, create a platform based on rules that promote sustainability. These platforms can then function as an intermediate layer in the market on which transactions and interactions can take place.

The government can require that services (or other platforms) use this platform and achieve the progress on the sustainability goals by means of commitments, rules and requirements.

Government initiative for an 'intermediate layer'
For the agricultural sector, the national government is working within the 'Precision Agriculture 4.0' top sector programme for sharing agrodata. Increasing sustainability is not the primary motivation for the initiative, but that does not mean that its infrastructure cannot be used for this purpose. The idea is to provide a digital platform that arable farmers can use to decide for themselves what data they share with other companies in the value chain and under what conditions. The project, which runs from 2019 to the end of 2023, will investigate what data infrastructure is needed for this.

Recommendation 4. Use competition law to assess the sustainability impact of platform companies.

Following recommendation 3, the Council believes that competition law offers options to incorporate the aspect of sustainability into the assessment of platform companies. On this point the government can use reference points from developments in competition law that are designed to assess ex ante whether platform companies pose a risk of abuse of power (see part 2, chapter 1). As a consequence of network effects, platform companies have a tendency to drift towards becoming monopolies.

In the Council's view, the ex-ante assessment can and must include a consideration of the impact that the dominance of platform companies can have on the development of sustainable alternatives on the platform layer. Although European (and Dutch) competition law is primarily oriented towards eliminating barriers to competition in the interest of consumer protection, according to the Council the European treaties in this area of law (and the shared values set out in them) justify a broader interpretation of the concept of consumer protection.

Recommendation 5. Conduct experiments on 'setting off' sustainability through digital platforms.

The Council considers it would be worthwhile for the government to conduct experiments to gain insight into how sustainability effects could be 'set off' via digital platforms in practice and what consequences this can have.
Digital platforms amass tremendous amounts of data on the living environment and the sustainability effects in it. In many cases, this is data that is more precise and more detailed than the government's own data. Moreover, digital platforms often give rise to pricing effects that then become visible to users. In combination with the tremendous computing power of digital platforms, this presents options like:

- assigning a limited 'CO_2 budget' to people or organisations for their activities that are associated with CO_2 emissions, and exercise monitoring of their actual emissions;

- assign people digital mobility rights that they can use behind the wheel, in the train or on public transportation (potentially differentiated by factors such as commute hours, etc.), and which people who do not wish to use them or who need more of them because of the above-average mobility needs can trade them on a digital platform;
- on the basis of environmental impact, make adjustments in the pricing by which data on the environmental performance of products or services can be used in order to factor environmental impact into the price.

6.4 Interventions at the services layer

Recommendation 6. Set requirements on how service providers and implementing parties handle the data they collect and promote sustainable digital developments.

The national government and local authorities conduct public procurement procedures, award concessions and permits, and are fully or partially responsible for the management of the physical environment. From this wide range of positions they have the option to set requirements on service providers to incentivise the use of data from the physical environment to move the development of digital platforms in the right direction. The Council recommends using these options to promote sustainability, and has the following in mind:

- In line with the European directives on 'Green Public Procurement', when tendering concessions, governmental institutions can set requirements on how the service providers handle the data they collect so as to allow this data to be used in sustainability policy. In the Netherlands, for example, provinces (and a few municipalities) grant public transportation concessions to (public) service providers. In the course of providing the service, data on travel movements is generated. Based on legislation such as the European PSI directive[5], the tendering authority can require the service provider to make this data available and analyse it so that it can be used to promote sustainability goals.
- Likewise, in line with the European directives for Green Public Procurement, authorities can use procurement procedures in the built environment to encourage the establishment of data standards for a circular construction economy. Both the national government and local authorities, as owners, have the responsibility for the maintenance and management of many buildings, constructions and infrastructure works. The contracts with the implementing parties can be drafted to include conditions specifically on the handling of the data in the construction, use and demolition phases, with the goal of supporting a circular construction economy. Additionally the Council believes that governmental institutions should use their commissioning role to, as 'launching customer', stimulate the creation of circular digital platforms, for example by explicitly embracing them or setting conditions on them.
- Wherever possible, when granting permits governmental institutions should set sustainability requirements on data, data use and data analysis. See, for example, the permitting conditions on the

5 Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information.

scooter-sharing programme in Amsterdam (see section 4.2). In some cases, upon an application for a local area permit the municipality can define requirements on what data must be supplied and what standards the data must conform to. These standards can be designed to promote data-sharing in the construction chain so as to stimulate reuse of materials and efficiency in raw materials use.

- Municipal authorities and other public sector bodies, in their position as manager of the public space, should make arrangements with companies, organisations and the public on required conditions and 'ground rules' for the use of sensors and the collection and use of data in the public space. This could also involve development of public-law instruments like a sensor data regulation with a permit or reporting requirement for the placement of sensors in the public space or a sensor register (VNG, 2019). Of course the municipality is bound in this to the legal and ethical frameworks governing the use and reuse of data (Custers, 2019). This means, for example, that a municipality cannot oblige a company to make its collected data available to anyone if doing so would compromise the company's earning capacity (VNG, 2019).

6.5 Interventions in the government organisation

Recommendation 7. Develop shared expertise on digitalisation within governmental institutions.

In order to successfully implement recommendations 1-6, governments must have expertise in and knowledge of digitalisation. Without adequate knowledge and expertise, digital developments that are of significance to the sustainability transitions cannot be effectively recognised, developed and incorporated into policy development.
Governments can expand their technical knowledge and expertise by recruiting experts such as data analysts and tech industry developers. In addition, in the Council's view it is important to develop knowledge on how digitalising markets and the platform economy work. Building up both knowledge areas is essential if the government is to be an equal discussion partner for market parties and civil society organisations.

While it is true that you will often find the right knowledge available (to some degree) in the various ministries, it tends to be fragmented across the civil service. The Council considers it of vital importance to set up teams within the ministries in which to concentrate the available digital knowledge. Then, these teams must form a knowledge network spanning the ministries, along the lines of the Behavioural Insights Network Netherlands in which teams exchange knowledge and experience in the behavioural sciences. Because at this point there is also a good deal of relevant knowledge and experience accrued in the organisations of local authorities, such a network should also extend to other layers of government as well.

Recommendation 8. Develop working methods to enable the organisation to respond rapidly to digital developments with policy and regulations.

Where the digitalisation of our society will go and what impact digital systems, applications and services will have on the sustainability transformations or other aspects of the living environment is not easy to predict. This is why government has to be able to respond quickly to changes with fast, flexible and effective policy development. For this the Council sees the following possibilities.

- Use instruments that can provide a flexible response to potential data developments and the associated uncertainties. The Council highlights three instruments that are particularly suited for this task:
  - *Principles-based regulation and goal regulation*. With this instrument, the government does not set hard-and-fast rules, but rather formulates a principle to which parties must adhere (Burgemeestre et al., 2009). Because a principle has a less rigidly defined scope than a legislative rule, the regulation can be applied to various different techniques and/or developments. One example: not dictating what data must be entered in a building's material passport, but instead establishing that for every building, there must be sufficient information available to allow subsequent parties to reuse the building. The provisions must be focused on the intended result, so the concrete details can change over time with the digital developments. Here, the government must still maintain a role in the concretisation of the directive by staying in dialogue with market parties on what is possible and what is not. Market parties must be accountable for their actions based on these principles.
  - *Experimental legislation*. This is legislation with a fixed end date and a clear goal or package of goals that will be assessed for effect on the end date. The result is legislation that is proven to be effective, because it was first tested on a small scale and its results assessed; this approach also allows more robust solutions to be chosen if the experiment shows that this is necessary. This type of legislation offers the ability to anticipate changes and developments. It gives governments the option to gain experience with new developments, and can help make legislation more future-proof. This way, the government gets the time and leeway to gain experience with new digital developments and see how they can promote sustainability goals, while at the same time allowing measures to be developed that continue to protect public values. Initiating legislation on a small scale also makes the process easier for the government to manage, and does not require new systems or entire departments to be set up right away. If successful, the government can then scale up at a manageable pace.
  - *Ex-ante impact assessment*. This instrument comprises an investigation into the effects of a change in policy or legislation before the change is implemented (Collovà, 2015). If the expected effects do not conform to the intended objective of the intervention, the proposal in question can be adapted or a different intervention can

be considered. In the Netherlands, this ex-ante impact assessment has already been used as a component of the Integrated Assessment Framework for policy and regulations (IAK). It is also a frequently used instrument at the EU level. This type of pre-assessment is extremely useful when considering legislation for the digital realm in particular. Given the speed of digital developments, the result of an assessment in hindsight will often come too late to effectively adjust the policy.

- Continuously monitor whether the policy is actually achieving the intended sustainability goals. Utilise the available data to assess the effects and results of policy on an ongoing basis. Use the insights gained to provide accounting for the ongoing policy, substantiate new policy choices or reconsider previous decisions. Investigate whether there are any leads to follow from current developments in accountancy, taking into account the general welfare or the UN's Sustainable Development Goals. Examples of such innovations in accountancy include integrated reporting[6] and the system of environmental economic accounting (SEEA).[7] These types of broader forms of accounting can be used to monitor the contribution to sustainability goals, but also to monitor the use and reliability of algorithms by companies and public sector parties.[8]

6 See https://integratedreporting.org
7 See https://seea.un.org
8 See https://www.nba.nl/globalassets/projecten/visie/kennisgroep-accounttech/accounttech-verkenning-wat-if-algoritmes.pdf

Recommendation 9. Ensure robust monitoring of digitalisation in the living environment.

The Council believes that a digital sustainable society will require development of more robust monitoring of digital platforms, both on the national and European levels. The same applies for the algorithms and standards used on these platforms and how the collected data is used. Governance of digital platforms and other relevant parties from a perspective of promoting sustainability, as the Council argues for in recommendations 3 and 4, will require one or more robust regulatory authorities with a mandate powerful enough to intervene and make changes.

At present there is no institution tasked with monitoring the sustainability of digital platforms (recommendation 3). An institution that would appear to be an obvious choice as regulatory authority for the living environment is the Human Environment and Transport Inspectorate (ILT). The broader supervision of platform companies from the perspective of competition law (recommendation 4) could be tasked to the Authority for Consumers and Markets (ACM), in collaboration with the ILT as required.

The development of data standards (recommendation 2) is something that the Council believes, as already stated, governmental institutions should take up in consultation with market parties and the public, ensuring that the horizontal relationships between the participants are kept in balance (Rli, 2017). Establishing an ombudsman position to which participants can present complaints will be an important resource for the parties in weaker positions. Compliance with these standards will then require forms of auditing that will be applicable on a wide scale, comparable to the procedure surrounding (for example) ISO standardisation.

6.6 Towards a digital sustainable society

In the foregoing the Council has emphasised that it is essential in the transition to a sustainable society that governmental institutions devote more attention to the digital world that underlies our physical living environment. This means that government intervention is also needed in the digital layers of our public space. There is, as already outlined in chapter 1, a clear, manifold cohesion between the digital and green transformations of the living environment: digitalisation can facilitate the achievement of sustainability goals, and digitalisation is bringing sweeping changes to our society, which in turn have an impact on our society's sustainability.

In the recommendations above, the Council advises that government policy should be focused on both aspects of this manifold cohesion. Recommendations 2 and 5 pertain to the use of data and digital technologies for the achievement of sustainability goals; recommendations 1 and 4 concern the broader transition to a society that is both digital and sustainable; and recommendations 3 and 6 pertain to both. The Council expects that these recommendations offer a framework for action to governmental institutions in taking the first steps towards achieving a digital sustainable society.

PART 2 | ANALYSIS

STRUCTURE

The structure of this part 2 is as follows:

- Chapter 1 presents a list of the main points of European and national digitalisation policy.
- Chapter 2 highlights the layer model introduced in part 1 to address how the physical and digital worlds are interwoven.
- Chapter 3 covers the role of digitalisation in sustainability transitions on the basis of three selected cases: (a) the transition to a circular construction economy, (b) the changing electricity system, and (c) increasing the sustainability of personal mobility.

Finally, part 2 concludes with a list of references cited in parts 1 and 2.

1 EUROPEAN AND NATIONAL DIGITALISATION POLICY

This chapter describes the European vision and priorities in the area of digitalisation and what elements of it have already been implemented in concrete policy (1.1). This is followed by a description of the Netherlands' own ambitions with respect to digitalisation, including the steps the national government has taken in this area so far (1.2).

1.1 European policy priorities and actions initiated

1.1.1 EU vision of digitalisation

The European Union (EU) is a world leader in policy and regulations relating to digitalisation, and is very active in this domain. The EU also has a particularly strong influence on international standards for digital (online) platforms and personal data. This influence is sometimes referred to as the 'Brussels effect' (Bradford, 2020).

The EU is engaged on the subject of digitalisation because it wants to structure the transformation to a digitalised society in accordance with European values. The goal is to, within Europe, be able to define a uniquely European set of rules and standards of the digital age based on those values, rather than having to follow the rules and standards of others. In this, the focus is on data, technology and infrastructure. In these areas the EU wishes to become a role model for the worldwide digital economy. Although at present the number of digital innovations coming out of the EU remains relatively modest (with most coming from the United States and China), ultimately the European Commission strives for digital sovereignty, guided by the needs of Europeans and the 'European social model' (European Commission, 2020a).

In the EU's vision, the digital transformation must benefit society, business and the environment ('people, profit, planet'). In this vision, digital technology is human-oriented, creates a fair and competitive digital economy, and contributes to an open, democratic and sustainable society. In concrete terms, this means that digital technology has to support people in their personal development, freedom and equal participation in society. Companies have to be able to compete on a level playing field and work together in a market digitally unified and just as seamless as the physical market. Technologies such as artificial intelligence must be human-oriented and trustworthy. Citizens must be able to have confidence that their rights are being protected. The vision is described in the European digital transformation strategy 'Shaping Europe's Digital Future' (European Commission, 2020a).

1.1.2 European priorities

One of the European Commission's six priorities for the 2019-2024 period is 'a Europe fit for the digital age' (European Commission, 2019a).[9] In the coming years, the Commission will be focusing its digitalisation policy on three foundational pillars: (1) technology that works for the people, (2) a fair and competitive digital economy, and (3) an open, democratic and sustainable society (European Commission, 2020a). Initiatives within this strategy are underway on a wide variety of subjects: artificial intelligence, data strategy, online platforms, digital industry, cyber security, digital skills, supercomputing and connectivity. The policy on each subject must make a contribution toward the comprehensive goals.

In the European initiatives, attention seems to be primarily focused on:

- the development of *trusted artificial intelligence*;
- the creation of structures for the *utilisation of the potential of data*; and
- the *regulation of online platforms and digital services* to strengthen the internal market.

In the following, the Council takes a look at what the European Commission's policy plans comprise with respect to these three subjects.

Trusted artificial intelligence

In the European policy efforts, the attention to artificial intelligence is obvious. The European Commission is a proponent of human-centric

9 See also: https://ec.europa.eu/info/strategy/priorities-2019-2024/

and trustworthy artificial intelligence compatible with European values (European Commission, 2019b). The policy and the legislation in this area are still currently at the beginning of the policy cycle (see box).

How Does the European Policy Cycle Work?

The European policy cycle has six phases. The first phase is the *agenda-setting and preparation* of the policy. Member states and European institutions, but also citizen groups, lobby groups and others, put topics on the agenda. Products from this phase are green books (discussion documents to promote the thinking process, to which governmental bodies and other organisations can respond), white books (discussion documents with more concrete proposals for action), guidelines (nonbinding decisions on the main outlines of a policy area), communications (policy proposals, often giving an impetus to legislative proposals) and actual proposals for concrete legislation. Documents from this phase are of primarily political significance and serve to facilitate coordinating actions, governance and evaluation or preparation of new policy.

The second phase is about *negotiations*. Here, the legislative proposals of the European Commission are the subject of discussions between the Commission, the Council of Ministers and the European Parliament. This leads to adoption of policy and regulations in the form of (for example) regulations, directives or decisions. This is then immediately followed by review of whether legislation at the European level is truly necessary, or whether the subject matter could just as well be regulated at the national level (subsidiarity test).

The third phase is the *implementation*. After a legislative proposal is adopted by the Council of Ministers and the European Parliament, in most cases it is then worked out by the Commission in various ways in the form of implementing rules or guidelines.

Then, it is up to the Member States to complete the sequence of phases by: *conversion into national legislation and regulations* (phase 4), national implementation by national and subnational authorities (phase 5) and the *accountability* on the implementation of the policy to the national parliaments in the Member States (phase 6).

(Sources: Rli, 2015a; Kunst, 2013; European Commission, 2014).

The white paper on artificial intelligence (European Commission, 2020b) contains proposals for the development of artificial intelligence in Europe in two 'building blocks':

1. a policy framework with research, education and investment agendas for a European 'ecosystem of excellence' to stimulate the development of artificial intelligence.
2. a regulatory framework for trustworthy artificial intelligence that protects the public and their rights in an 'ecosystem of trust'.

A future legislative framework is meant to ensure that fundamental rights and consumer rights are protected and that the public can reasonably trust artificial intelligence.

Potential of using data

The European data strategy (European Commission, 2020c) has the goal of making Europe the worldwide leader in a fair and competitive digital economy. Critically, this will require an internal European market for data, or European 'data space' in which companies of all sizes can compete and digitalise on an equal footing, and within which the personal rights of the public are protected.

The European Commission's data strategy is designed to create this internal data market. The underlying principle is that data must be able to flow freely within the EU and between sectors, while complying with the rules on privacy, data protection, and competition. Likewise, the rules for access and data use must be fair, practical and clear. Further, it is vital that there are clear and reliable mechanisms for data management in accordance with European values.

There are still a number of problems that, for the time being, are preventing the establishment of an internal market for data:

- Data flows are not yet free enough (a) from the government to companies, civil society and science (government-to-business, or 'G2B'), (b) from business to business (B2B), and (c) from business to the government (B2G).
- There are unequal power relationships in markets. Both access to data and the capacity to utilise it is unequally distributed. Major online platforms have disproportionate access to data and influence on the rules of the game. That puts pressure on market competitiveness.
- Right now, the potential that data offers is not being utilised optimally due to failings in standardisation, exchange, aggregation, etc.
- Other problem areas are: the data infrastructure and the data technology, which must be made qualitatively better and more independent; the rights of individuals and companies that are not yet fully secured; the digital skills and digital literacy of the public, which is still lacking; and the overall level of cyber security which is not yet at the required level.

The European Commission's strategy for data has a number of potential tracks for solutions, two of which are particularly striking. The first of these tracks is a cross-sectoral *governance framework for data access and use*. This must set out what data can be used in which situations and what interoperability requirements and standards must apply within and across sectors. The result needs to enable fast international use of data. In November 2020, the EC presented an initial proposal for a data governance ? regulation, the Data Governance Act (EC, 2020d). It sets out measures to reinforce the trust in data exchange, facilitate the reuse of public sector data, and give people and businesses more control over their data. A bold move is the proposal to appoint neutral intermediaries to facilitate between data holders and data users. The regulation sets conditions on these intermediaries to guarantee the neutrality of their services.[10] In 2021, there may be a proposal for a data act to arrange the relationships between actors in the data economy, with the object of

10 The data intermediaries (parties providing data exchange services) will have to be neutral and trustworthy. The proposal would therefore ensure that certain parties that could use the data themselves, such as cloud services, data consultancies, advertisers, etc., would be excluded from this role.

encouraging horizontal data sharing between sectors.[11] The regulatory approach to governance must, ideally, be characterised by flexibility, differentiation and regulatory experiments. The Commission has the expressed intention of using as little ex-ante regulation as possible (European Commission, 2020c).

A second important solution track in the Commission's data strategy is creating *European data spaces in strategic sectors and areas of general interest*. This is something different than the market regulation concept of 'the European data space' as a unified digital market. It is more of a concept for the organisation of data in the internal market, relying principally on standardisation, interoperability and data quality. The data spaces can be used for exchange, aggregation or analysis, and they can be run on various types of platform with a wide variety of rules. This means that the architecture of data spaces will differ per sector. The Commission is envisioning a federal-like system in which existing public and private platforms are interconnected. The idea is to, as much as possible, build on what is already in place.

There must be data spaces for a number of different economic and policy sectors[12], including:

- the Green Deal, with data concerning climate change, the circular economy, pollution, biodiversity, deforestation and regulatory compliance;[13]
- the mobility sector, with data on passenger transportation and goods transport in all modalities of the transportation system (road, rail, water, air);[14]
- the energy sector, with metering and energy consumption data of consumers.

The degree of 'maturity' of these sectors in the area of data differs, but in each sector there is a need for a basis for fair competition on the data market.

The data spaces must be created in a size that will allow the development of new products and services. Setting up data spaces can facilitate the development of a European data economy and artificial intelligence in accordance with European standards. The data spaces can also reinforce the position of small and medium-sized enterprises in comparison to large companies with stronger data positions.

11 An intermediate step as part of the open data directive is an 'implementing act for high-value datasets' intended to open government data to access to small and medium-sized enterprises in particular.
12 In addition, there must be data spaces for agricultural, industrial, health, financial and skills data and government services. This list can be expanded.
13 The data space for circular applications will be focused on priority areas from the action plan for the circular economy: construction, packaging, textiles, electronics, ICT and plastics. New developments must include digital 'product passports' and advancements in architecture and governance (2020), sector-based data strategies (2021), establishment of a sustainable product policy with product passport (2021) and mapping resources and tracing of waste flows (2021).
14 The Digital Transport and Logistics Forum is working on a concept of 'federated platforms' intended to interconnect public and private platforms.

Regulation of platforms and digital services
Establishing a fair and competitive digital economy will require not only rules for data, but also rules for online platforms and digital services. The EU is currently leading the world in regulating online platforms, and wants to maintain this position by expanding the liability of these platforms.

An initial, concrete move in this direction can be found in the 'Digital Services Act' package.[15] This package of legislation, intended to modernise the current legislative framework for digital services, is currently in the negotiation phase of the European policy cycle. On 15 December 2020 the Commission presented the components of the package, and in particular the Digital Services Act and the Digital Markets Act. These build on the previous European legislative framework, the e-Commerce Directive of 2002. The legislative package is intended to guarantee the digital security of users of digital platforms and other online intermediary services, while at the same time stimulating innovation and competition. The package has two main pillars:

1. With the Digital Services Act, the Commission intends to clearly establish the responsibilities and statutory obligations of digital services. This is intended to secure the rights of users and minimise the risks to the maximum possible extent. Effective governance is needed to ensure compliance with the rules.[16] One of the main reasons for this section of the legislative package is the presence of illegal content on online platforms, including statements on social media deemed to be criminal in nature.
2. With the Digital Markets Act, the Commission wishes to draft ex-ante rules for the large online platforms, those that are understood to have a gatekeeper role. The rules are intended to ensure that the way the platforms operate remains fair, while keeping the internal market open and competitive. A new market intelligence tool is being created, to keep up with the rapid pace of development in the digital sector and identify anti-competitive activities. This portion of the legislative package is designed to address the problem of dominant online platforms upsetting the level playing field in the internal market.

Further, the Commission intends to update the competition guidelines to keep them relevant in a digitalising world. At present the Commission is examining the effectiveness of the way the rules are currently applied, and in the period 2020-2023 will be performing a 'fitness check' on the relevance of the rules for the digital age (European Commission, 2020a).

1.1.3 Steps at EU level so far

In the following, the Council outlines the steps that the European Commission has taken so far in the three areas discussed above.

Trustworthy artificial intelligence
EU policy on artificial intelligence is currently somewhere in the middle of the policy cycle; little has been set down in terms of policy and regulations, although the broad outlines are already clear. The white paper on

15 See https://ec.europa.eu/digital-single-market/en/digital-services-act-package
16 Each Member State must appoint a Digital Services Coordinator, with these all reporting to a European Board for Digital Services. Coordinators may require platforms to share data needed to apply the rules.

trustworthy artificial intelligence builds on previous, not yet legally binding steps. Taking an agenda-setting strategy, the Commission has explained the socio-economic aspects and the need for more investment in artificial intelligence in the EU (European Commission, 2018a). It has also drafted a coordinated plan with a framework for tying the national strategies for artificial intelligence together (European Commission, 2018b). Additionally, an expert group has published ethical guidelines (European Commission, 2019c).[17]

Potential of using data

With respect to data issues, the EU is already further along. Much necessary legislation and regulations have been drafted, both at the European and national levels. Since 2014, the EU has been taking regulatory steps to facilitate the development of the digital economy. The General Data Protection Regulation (GDPR)[18] defines frameworks for the use of personal data. The Regulation on the free flow of non-personal data[19] promotes the free exchange of all other electronic data. There are also sector-specific regulations and directives for data access that apply specifically to car manufacturers,[20] payment services,[21] smart utility meters,[22] electricity network data[23] and intelligent transport systems.[24] The Open Data Directive[25] sets targets for open government data. The Digital Content Directive[26] gives contractual rights to users of services that supply data themselves.

Regulation of platforms and digital services

At this point the EU has also taken some steps towards regulating platforms. To begin with, in 2015, as part of its Digital Single Market Strategy the European Commission conducted an investigation into the role of platforms which considered, in part, the sharing economy and online intermediaries (European Commission, 2015a). The Commission identified the growing importance of online platforms in the digital economy and concluded that Europe is not yet fully reaping the benefits of the platform economy. Therefore, the Commission resolved to create a better environment for platform innovators and a balanced regulatory framework. In 2016, it formulated four principles to do this (European Commission, 2016):

1. A level-playing field for comparable digital services (audiovisual media).
2. Ensuring that online platforms conduct business responsibly, in order to protect fundamental values.
3. Fostering transparency and ensuring fairness in order to foster innovation and user trust.
4. Keeping markets open and non-discriminatory to foster a data-driven economy.

17 It should be noted that this guideline does not have the status of an official position of the European Commission.
18 Regulation (EU) No 2016/679.
19 Regulation (EU) No 2018/1807. Contains a prohibition on data location requirements (restrictions on where data can be processed or stored).
20 Regulation 715/2007 as amended by Regulation 595/2009.
21 Payment Services Directive 2015/2366.
22 Directive 2019/944/EC for electricity and Directive 2009/73/EC for gas.
23 Regulation (EU) 2017/1485 and Regulation (EU) 2015/703.
24 Directive 2010/40/EU.
25 Directive (EU) 2019/1024.
26 Directive (EU) 2019/770.

The first regulatory move by the European Commission focused on the relationships between platforms and companies. The regulation setting out rules on 'platform-to-business' (P2B) relationships came into force in July 2020. The P2B regulation includes rules for no-cost dispute resolution, transparency on general terms and conditions, the ranking of search results and the treatment of proprietary products on the platform versus the products of other providers. These rules are intended to ensure a fair, transparent and predictable digital market.[27] The P2B Regulation applies to platforms on which enterprises established in the EU offer products or services. The P2B Regulation also established the EU Observatory on the Online Platform Economy to monitor developments in the online platform economy.

The Commission also presented the Digital Services Act at the end of 2020.

1.2 Dutch policy priorities and interventions deployed

As an EU member state, the Netherlands has a hand in the shaping of EU legislation and policy, and is at the same time obliged to implement it; this includes, of course, the European legislation and policy rules on digitalisation outlined above. But the Netherlands also pursues its own digitalisation policy intended to extend from and be compatible with the European frameworks. The summary provided below is intended to demonstrate that this national digitalisation policy and regulations linked to it are focused on taking advantage of the potential economic benefits and benefits to society that digitalisation represents. To put it another way, the central pillars of policy are 'people' and 'profit'. As yet, the third pillar, 'planet' – the ecological aspect – has not truly been an area of attention.

27 Regulation (EU) no. 2019/1150.

1.2.1 National priorities

Since 2018, the government's ambitions and objectives for the digital transformation in the Netherlands have been bundled in the Dutch Digitalisation Strategy (EZK, 2018). Beyond this, a number of various policy dossiers offer their own digitalisation-related actions. The national strategy does not comprise any new policy or regulatory developments, but is primarily intended to summarise the national government's ambitions and provide a list of the current initiatives, including acceleration programmes, implementation agendas, strategies and investments in innovation and data access (EZK, 2018; 2019a; 2020a).[28] Many of the initiatives are focused on sector-specific goals.

The current ambition is threefold:

1. The Netherlands wants to become the 'digital leader' in Europe (coalition agreement 2017-2021). In fact, being leading in the application of tech-based transformation is understood to be critical to the preservation of national prosperity (EZK, 2018). With its high-quality digital infrastructure and a well-educated workforce, the Netherlands already has a good

28 Examples include the Netherlands Cyber Security Agenda (NCSA), the Digital Connectivity Action Plan, NL DIGIbeter, the Digital Government Agenda, NL DIGITAAL, the Data Agenda Government, the SME Action Plan and the Digital Inclusion Action Plan.

starting position, which it intends to maintain. The Netherlands is taking up this leading position by, in part, positioning itself as a 'living laboratory' for responsible digital innovation in Europe (EZK, 2018; 2019a; 2020a).[29]

2. The Netherlands wants to create an 'inclusive' transformation, with a focus on increasing the digital skills of both citizens and companies, and under the guiding principle that everyone must be able to participate.[30]
3. The Netherlands wants to build a foundation of trust for the national digital economy by protecting privacy and safeguarding digital security, promoting fair competition, and applying new technology with all due care, and by establishing clear arrangements on data sharing from the outset. This foundation for the digital economy should, in the government's view, increase the trust in the digitalised society on the part of the public and the private sector. Here the national government is following the broad outlines of the European Digitalisation Strategy (Tweede Kamer, 2020a; 2020b; 2020c).

In the Dutch Digitalisation Strategy, the national government commits to taking advantage of the potential economic and social benefits that digitalisation offers. The government identifies eight social goals, including agricultural practices for sustainable and safe food supply, smart and sustainable mobility, and a flexible and renewable energy system.[31] Achieving these goals will require an inter-sectoral and inter-departmental approach with the collective support of the private sector, researchers and civil society organisations (EZK, 2019a).

Dutch Digitalisation Policy: the Role of the Ministry of the Interior and Kingdom Relations

The Ministry of Economic Affairs and Climate Policy is focused on capitalising on the economic opportunities that digitalisation represents. But the Ministry of the Interior and Kingdom Relations also plays an important role in digitalisation policy. The latter ministry is focusing on the core themes of 'digital inclusion' and 'e-government', with attention to digital services, digital data security and open government. The overriding policy here is found in the 'Digital Government Agenda: NL DIGIbeter', which, like the national digitalisation strategy, is updated annually.

The Ministry of the Interior and Kingdom Relations is also responsible for the Digital System for the Environment and Planning Act (DSO). Together with the Association of Netherlands Municipalities, the Ministry of the Interior and Kingdom Relations has drafted a manifesto setting out a vision for an e-government in the post-pandemic world (BZK & VNG, 2020).

29 The Netherlands currently has a large number of living labs operating (EZK), 2019a). These are incubators for innovation and experimentation in digital technology. The activities in the living labs revolve around big data analysis, 5G applications, smart industry and support for small and medium-sized enterprises (SMEs).

30 Like the EU, the Netherlands recognizes that within the economic domain SMEs need support to achieve the digital transformation and that this requires particular attention.

31 The other goals are: a transparent and accessible e-government, a higher quality of education, improved quality of life through care, an innovative and flexible industry and digitally skilled SMEs.

On the subject of ‘digital inclusion’, since 2019 the Ministry of the Interior and Kingdom Relations has been working with the Digital Living Alliance, a PPP, on a variety of current issues. Significant legislation in this area includes the Digital Government Act (*Wet digitale overheid*) and the Modernisation of Electronic Governmental Traffic Act (*Wet modernisering elektronisch bestuurlijk verkeer*).[32]
The Ministry of the Interior and Kingdom Relations is also engaged in a number of policy dossiers relating to the physical environment, such as the circular building economy and energy transition in the built environment. Chapter 3 of this part 2 provides a more detailed discussion of the digitalisation aspect of these policy dossiers. Naturally, other governmental departments are also involved these developments, and the account of these two ministries’ involvement presented here is far from complete.

1.2.2 Steps at the national level so far

Artificial intelligence
In the national policy efforts, a significant amount of attention is devoted to artificial intelligence. The government’s plans to become a leading player in Europe in the development of artificial intelligence are described in the strategic action plan launched by the government in October 2019 (EZK, 2019b). The basis of the government’s national policy on artificial intelligence is this action plan in combination with the policy letter on the subject (Tweede Kamer, 2019a) and a letter on safeguards against the risks presented by government data analysis (Tweede Kamer, 2019b).
The national government wants to accelerate the development of trusted artificial intelligence in order to capitalise on the potential economic and social benefits that the technology offers and to establish safeguards for public values and human rights. The Dutch approach is defined by a number of guiding principles: public-private partnerships, international cooperation, profiling the Netherlands as a leader in applications benefiting people and society, and an inclusive approach that puts people first (EZK, 2019b).[33] This puts the Netherlands firmly behind the European ‘human-centric’ approach (Tweede Kamer, 2019a). The government is also advocating the use of European ethical guidelines (EZK, 2019b), but recognises that additional measures will be needed to keep the Dutch government’s policy coherent and in line with the human-centric approach (Tweede Kamer, 2019a).

Data sharing
Another area of the Dutch policy efforts in digitalisation is data sharing between companies (EZK, 2019c). Here, the Ministry of Economic Affairs has expressed three basic principles:
1. Voluntary data sharing is preferable.

32 The Digital Government Act (*Wet digitale overheid*), which will enter into force in 2021, is intended to ensure that Dutch public and private sector can rely on secure and trustworthy digital contact with governmental and semi-governmental organisations. The legislative bill for electronic governmental traffic, which will enter into force in 2022, entitles private citizens to correspond with administrative bodies electronically in a manner stipulated by the administrative body.

33 Public-private partnerships are placed in the Netherlands AI Coalition, a broad partnership of organisations working together to build knowledge and applications in artificial intelligence.

2. Data sharing will be made compulsory, if necessary.
3. People and businesses retain control of their data.

One of the conditions under which data sharing could be made mandatory is where a demonstrable public interest is threatened, such as fair competition, freedom of choice or reduction of CO_2 emissions. As such, the national government sees its role in establishing data sharing as preferably a facilitative one, and regulatory only where necessary. At the cabinet's initiative, in January 2020 the government established a data sharing coalition for data sharing and data access. Within this coalition, parties from various sectors are working towards establishing generic agreements to facilitate data exchange between sectors. The expectation is that with the experience gained, a generic system in the form of operational, technical and legal agreements could be in place by mid-2021 (EZK, 2020a).

National Policy Initiatives on Data Sharing in Mobility, Transport and Agriculture

Since 2018, the national government's policy for digitalisation in the living environment has been focused in part on data sharing in the mobility, transport and agriculture sectors.

For example, the government is working in seven national pilot projects with public-private partnerships on an open and decentralised 'Mobility as a Service' ecosystem for passenger transportation that will help people choose between a range of transport modalities (car sharing, public transportation, shared bicycles, taxis, etc.). In them, transportation companies and service providers are sharing data to be used in MaaS apps and to optimise the mobility system.

The Digital Transport Strategy (IenW, 2018a) presents some initiatives for the transport sector, including the development of a basic infrastructure for decentralised data exchange between companies and governmental institutions in the transportation sector starting in 2025. Digitalisation of information flows and improved data exchange should make the transportation chain more transparent for governmental institutions, improve efficiency of government spending, support innovation, ease the administrative burden on businesses, and help achieve the transition to a more sustainable multimodal transportation system. The idea is not to create a single data platform, but rather a system of agreements with specifications in order to make data interchangeable in a platform-independent way. Here the government is building on what already works in exchanges between companies. The government knows that the development of basic infrastructure was hindered for years for lack of an independent party that could pull through (IenW, 2018a). The Ministry of Infrastructure and Public Works (IenW) now wants to take on a proactive role.

For the agricultural sector, the national government is working within the 'Precision Agriculture 4.0' top sector programme for sharing agrodata. The idea is to provide an agricultural data facility that farmers of arable land can use to decide for themselves what data they share with other companies in the supply chain. The project, which runs from 2019 until the end of 2023, will investigate what data infrastructure is needed for this.

Competition Law

Like the European Commission, the Dutch government sees the need for better instruments to regulate platforms. Specifically, the government wants to set limits on the gatekeeper role that platforms can attain and keep the regulatory tools in the area of cooperation applicable to online platforms (Tweede Kamer, 2019c). The government advocates granting a commissioner within the European Commission the regulatory powers to intervene ex-ante in platforms with a gatekeeper function. The Netherlands has profiled itself as a leader in Europe with a proposal for a gatekeeper regulatory instrument (Tweede Kamer, 2020d).

Further, the Netherlands calls for a review of the European guidelines for the application of competition law, so that the major role that data currently plays in the economy is a factor in the determination of when a party has a dominant market position.

Finally, the Netherlands is making efforts to adjust the European merger thresholds so as to ensure that more concentrations of companies in the digital domain fall under the rules of merger controls. At present, mergers involving an amount of turnover in excess of a certain threshold must be reported to the regulator, but in the digital economy this is no longer a particularly effective indicator.

Governance of digitalisation from a political perspective

The Temporary Committee on the Digital Future concluded that the digital transformation requires momentum from the political sector but that this has not yet sufficiently materialised. The way the Dutch parliament is handling the subject is fragmented, as a result of which not all risks and opportunities are being addressed. The fact that so much regulation is being developed at the European level complicates the Parliament's fulfilment of its supervising role of the cabinet. Greater attention to the interrelationship between digital changes, knowledge of European developments and a better understanding of the needs of local and regional authorities would improve the situation. Provincial and local authorities also need clear frameworks for the responsible pursuit of the digital transformation (Tweede Kamer, 2020e).

Local authorities

In recent years, the Association of Netherlands Municipalities (VNG) has identified the social and economic effects of digitalisation.[34] The VNG notes that action by public administration is needed in a society where the market is increasingly being driven by large tech companies and data platforms. In an environment of fast-moving developments in tech, governmental institutions can easily lose their grip on tasks of public values. In addition, many municipalities are also faced with ethical questions about their own use of digital applications such as data analysis and responsible public-private partnerships, for example in 'smart city' projects. Many of these come down to the question of what data municipal authorities can use for what purposes. To address this, the VNG has drafted 'Principles for the Digital Society' to define the frameworks and ambitions for public data collection and analysis (VNG, 2019).

34 See Van Est et al. (2018); an essay drafted for VNG by the Rathenau Instituut.

2 PHYSICAL AND DIGITAL DIMENSIONS OF THE LIVING ENVIRONMENT: A LAYER MODEL

Digitisation is the conversion of analogue information into a format that can be processed by an electronic device (e.g., a computer). The term 'digitalisation' broadly refers to the processing and communication of information using computing resources and digital applications.

The Rathenau Instituut has identified eight key technology areas that we refer to as digitalisation: robotics, the Internet of Things (IoT), artificial intelligence, biometrics, persuasive technology, digital platforms, virtual and augmented reality, and big data and algorithms (Van Est et al., 2018). With the rise of these technologies, more and more aspects of the physical world are being connected with the digital world all the time, and everyday life is becoming increasingly data-driven. The process of digitalisation is an ongoing process of digital technologies and data being used in new and innovative ways to create market or public value in the living environment (see box).

Three Ways in Which Digitalisation Creates Value in the Living Environment

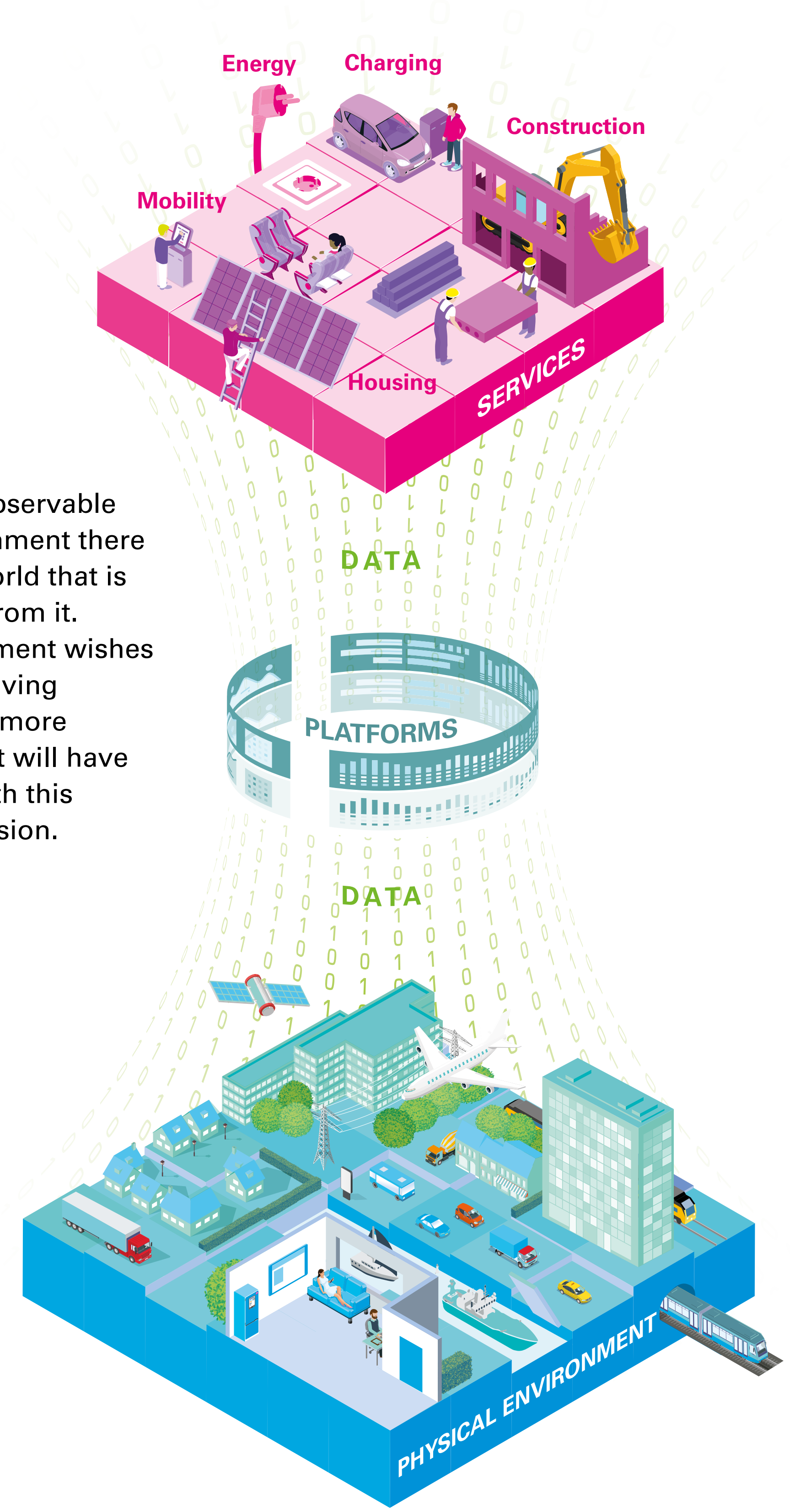
1. *Innovations in data handling*. Data is of inestimable value for solving thorny social issues like the energy transition. To put this another way, 'data-driven insight' is indispensable for tackling the type of challenges involved in the green transition. Data-based innovations that can be applied to them are: new methods of data collection (e.g. with sensors), data organisation, data exchange (e.g. linking data sources) and data interpretation (e.g. with artificial intelligence or machine learning techniques).
2. *Innovations in technology and infrastructure*. This refers to optimising existing technologies (for example, improved solar cells and more efficient wind turbines), the development of new technologies (like 'smart power grids') and connecting devices to digital infrastructure via IoT. These technical and infrastructural innovations have their impact on social systems, as we see in developments like the emergence of digital platforms that match the supply and demand for electricity.
3. *Innovations in Product Development*. The digital transformation in the sustainability domain drives the development of new products and services. The delivery and purchase of these services happens on digital platforms. This connects the provision of services in the physical world with the digital world.

In the following section, the Council presents a conceptual model that can be used to represent the interrelationship between the physical and digital dimensions of the living environment.

For the analysis of the interrelationship between the physical environment and the digital world and the importance of data and platforms, the Council uses a conceptual layer model (see figure 1). In reality, the layers depicted in the model cannot be completely separated from each other; however, the model can be useful in giving us a picture of the interactions between the physical environment and the digital world and identifying the points where stimulation of sustainability transitions can start. The layer model can also be used to analyse the best approaches to governance of digitalisation that will benefit the sustainability of society.

An explanation of each of the layers in the model is given below.

Figure 1: The digitalised living environment



Behind the observable living environment there is a digital world that is inseparable from it. If the government wishes to make the living environment more sustainable, it will have to engage with this digital dimension.

2.1 Physical environment

The physical environment layer comprises the underlying physical foundation (including the water system and the biotic system), the infrastructure networks on which the movement of people, economic services and goods happens (including the management processes governing these movements), and human activities such as living, working and travelling. Likewise, hardware that is the basis of digitalisation is also part of the physical environment: fibre-optic cables, 5G transmission masts, smart devices and any sensors capable of collecting data (everything from sensors on motorways that monitor road use to sensors in steel structures that measure load and wear).

The functioning of the physical environment is increasingly dependent on digital applications. The Dutch rail infrastructure company ProRail, for example, uses a variety of systems to manage and direct the traffic on its railway network; without them, it would not be able to perform traffic control safely and adequately. Likewise, digital systems are indispensable for the Department of Public Works' management of water systems, main roads and waterways.

At the same time, the physical environment is in many cases the foundation on which digital applications (and their earning models) are built. For example, Google Maps' route planner is based on the physical road network, and Airbnb and Booking.com can only exist by virtue of the availability of residences and holiday accommodations.

Interweaving of Physical Environment and Digital Applications
When smart appliances in and around the home are connected to the electricity grid, parties other than the energy suppliers and network managers are given the ability to influence household energy consumption 'behind the meter' ?. Examples include 'smart living' packages or electric cars that use algorithms to determine when energy is used, stored or returned to the grid.

2.2 Data

Sensors and other instruments collect data from the physical environment, and measure things like the intensity of the use of networks or the state of maintenance or quality of the living environment. The platform and service layers also generate a wide variety of data, such as passenger data from public transportation or data about the availability of hotels and holiday accommodations. This collected data can be processed and organised, thus creating information. If this information is then interpreted, this creates 'expertise knowledge', i.e. knowledge on which decisions (human or automated) can be based. In short, data makes up the backbone of digitalisation, as it were: it connects the layers of physical environment, platforms and services identified in the model.

Access to reliable data of good quality and good capacity to process this data are critical elements for the transition to a sustainable society. Looking at the movement toward a circular economy, for example, data on products and materials in buildings can be used to identify contamination in waste flows, apart from the fact that reusing materials would obviously be made much easier for the players in the construction industry if data on types of materials and their quality was accessible. Another illuminating example can be found in household electricity consumption. The digitalisation of the electricity system produces data that can provide insight into the moments at which devices are switched on and off in and around the home. This data can be the basis for targeted management of energy consumption.

It must be kept in mind, of course, that the use of this type of data for sustainability purposes might be at odds with other public values such as privacy, security, equal power relationships and personal autonomy. At both the national and European levels, there are laws that regulate the handling of data, such as the GDPR (governing the collection and use of personal data) and competition law (which regulates the playing field of the market).

2.3 Digital platforms

In recent years, the functioning of systems in the physical environment has gradually become more and more dependent on digital platforms. There are different types of digital platforms, each with different functions and structures. In general, these can be described as online networks that facilitate social and economic interactions between users and providers, and by doing so connect supply and demand for goods, services, information or knowledge (CBS, 2018; Kenney & Zysman, 2016). Data about the environment and user data are, metaphorically speaking, the oxygen fuelling this online social and economic traffic (Van Dijck et al., 2016).

What are the Characteristics of a Digital Platform?

Digital platforms are based on digital infrastructure, which is made up of the internet, data centres and various technical equipment (Blaschke et al., 2019). This is the basis that makes the exchange of data between parties possible. Then, there is also the hardware and software on which the platforms run. The technology comes together in a complex network that enables parties to interact with each other. Products and/or services are offered and then exchanged via digital transactions. Algorithms and artificial intelligence determine the best possible matches between supply and demand. Platforms can be open or closed. Open platforms are accessible to all, while closed platforms are open only to selected users or parties.

In itself, facilitating the matching of supply and demand is not a new business activity. Traditional platforms like credit card companies have long been doing this (when they perform as the intermediary between customer and any of various different banks). But digitalisation has been a tremendous advancement in structuring and scaling of platforms. Moreover, instead of a bilateral relationship between supplier and user, digital platforms create a multilateral relationship: between provider, platform and user. This also creates a reallocation of the risks and returns, depending on the platform's earning model. To take examples like Uber or Airbnb, part of the revenues shift to the platform, while most or all of the risks remain with the service providers (which may have been existing providers in some cases, while in others they are new).

Digital platforms can be connected to each other to form 'ecosystems' (see, for example, Kreijveld, 2014; Van Dijck, 2016). This can produce network effects, by which access to other users and additional innovations grows exponentially (Gawer & Cusumano, 2014). The rise of digital platforms shows that the boundaries between the digital and physical worlds are becoming increasingly blurred (Yablonsky, 2018). For example, physical goods or services can now be exchanged digitally. It is striking to note that many platforms have very few physical assets of their own, and are able to rely virtually exclusively on digital technologies to operate their services (Kennedy, 2015).

Along with parties in the private sector, government organisations are also creating platforms. We can identify three different types of platform: public, private and public-private. Public platforms are owned by government organisations. The government's objective with such platforms is to strive to create public value and advance public interests, for example by enhancing the democratic process, increasing transparency, managing the physical environment or releasing public data for the benefit of society. Public platforms empower citizens by giving them a transparent and open society (Van Dijck et al., 2016). Perhaps the best-known example at the national level is Estonia, where residents have access to all information through a single portal and all government services are arranged through an online point of contact. By contrast, private platforms have a commercial interest. But they can nonetheless still serve public interests, for example, in the way Uber has made the taxi market more efficient and affordable for consumers. One fundamental question is how governments can be allies and controllers at the same time. These roles are difficult to keep separate in the platform society, because in this ecosystem there is no separate public space in isolation from the platform society (Van Dijck et al., 2016). The answer could be found in cooperation with private parties on public-private platforms, along the lines of the Dutch platform *Gezond Stedelijk Leven*, a data and knowledge hub for healthy urban living. As an independent and open platform, both public and private organisations come together with city residents on it to work toward solutions for a healthy urban environment.

These days, digital platforms are a central information base for the physical environment. They bring together data about users' interactions, transactions and relationships and the objects of transactions (goods, services and/or information or knowledge) – data essential for the functioning of physical systems and access to them. Moreover, the platforms can play an active role in driving the transactions.
On the demand side, for example, platforms can drive new ways of consumption (CBS, 2018). Using available data and algorithms, platforms can 'nudge' to achieve desired outcomes like more, or less, or more sustainable consumption.
On the supply side, platforms can be an incentive for suppliers to develop innovative concepts that build on the platform. The algorithms and artificial intelligence used in platforms set the rules of transactions in the market. This means that digital platforms also present opportunities to contribute to sustainability. Consider, for example, a multimodal transport system that allows the user to choose the most sustainable form of transport in the given situation, or systems that can balance the production and consumption of sustainably generated electricity. The bottom line is that digital platforms have the potential to facilitate communication, collaboration and innovation.

This makes digital platforms not neutral intermediaries, but players that actively shape the functioning of the actors they connect. With the increasing importance of digital platforms for our society, they are also having more and more of a say in how society functions (Fijneman et al., 2018; Klous & Wielaard, 2018). Yet they are still subject to comparatively little regulation, certainly in comparison to parties active in the physical environment. In a platform economy, the responsibility for the quality of public services is less clearly regulated than in a traditional arrangement, even though digital platforms that are commercial (and often international) already manage essential public services and the data related (Frenken et al., 2017). Similarly, platforms face very little regulation in the area of competition, even though it is becoming increasingly clear that (due to the network effects just discussed) the platform economy is largely governed by the law of the jungle (Fijneman et al., 2018). The monopolisation that tends to result can have negative consequences for public values like sustainability, accessibility and affordability, and economic development and innovation.

2.4 Digital services

At the service layer of the living environment, various providers provide services to users and user groups. These may be private individuals, consumers or companies. Traditional examples of service providers are transportation companies, energy suppliers or information providers (such as 9292OV, a digital platform that provides a popular public transportation planner in the Netherlands).

The rise of digital platforms has changed the way services are provided, both in terms of the type of services offered and the type of providers active in the market. And in many cases, digital platforms are also both service providers and the platform. Network effects enable them to expand the reach of their services. Take Google Maps: it provides route information as a service, but also acts as a platform for supply and demand of other services, such as restaurant reservations. Other examples of digital platforms that also function as service providers are Uber and Lyft. The bundled energy services ('smart living packages' ?) of Google, Apple, Amazon and others also fall into this category.

Digital technology can be used to develop new sustainable services, like sharing or leasing systems for mobility services. The government can also make services offered on digital platforms more sustainable, for example by tracking the environmental impact of services and imposing costs on negative impacts.

Traditionally, the government has used the incentives at its disposal for the benefit of the transition to a sustainable living environment mainly in the public and semi-public services sector: e.g. promoting sustainable public transport services, green energy offerings, etc. The government uses regulation and financial instruments to incentivise, in order to promote public values (including sustainability goals). In some cases, the government may even be the owner of the service provider.

3 DIGITALISATION AND SUSTAINABILITY TRANSITIONS: THREE CASES

The Netherlands faces a number of major sustainability challenges that will have a major impact on the living environment: the energy transition, food transition, the transition to a circular economy and climate adaptation, to name just a few. Here, the Council presents three cases that demonstrate the role that digitalisation plays in increasing the sustainability of society. These three cases do not address every sustainability challenge. The two main themes in the cases are the energy transition and the circular economy. The box below shows the broad policy outlines for these two themes. Each case describes the relevant challenges in more detail.

Sustainability Policy: Broad Outlines

Energy transition

One of the ways to fight climate change is reducing (and, possibly, storing) greenhouse gas emissions. In 2016, the Netherlands, signed the Paris Climate Agreement on behalf of the Member States of the EU. The agreement entered into force in 2020. The signatories (nearly all countries in the world) agreed to keep global warming to well below 2°C as compared to the pre-industrial age, with a target of no more than 1.5°C of warming.[35] The EU leads the world in the ambitions of its climate policy, with its Member States having set themselves the target of reducing emissions by at least 55% by 2030 and becoming climate-neutral by 2050.[36]

Like the other signatories, the Netherlands is implementing the Paris Agreement at the national level. The Climate Act ('*Klimaatwet*', 2019) established targets in Dutch law: a 49% reduction in CO_2 emissions by 2030 (as compared to 1990 levels) and a 95% reduction by 2050.[37] The Climate Act is geared towards a percentage reduction in emissions (alongside the target of making electricity generation fully climate-neutral by 2050) rather than sub-targets such as shares of renewable energy or energy efficiency. In other words, the act defines an end goal while leaving the 'how' (the path to get there and the final picture) open. Dutch climate policy revolves around emissions reductions, and both energy saving and renewable energy sources are seen as good options.[38] The Climate Act also stipulates that the government must produce Climate Plans. The first plan covers the 2021-2030 period and broadly outlines how the government intends to meet the targets set out in the Climate Act (EZK, 2020b). In 2019, the Council of State concluded that climate policy is robust, but not yet robust enough. It was clear that additional measures would be necessary to meet the 49% reduction target in 2030 (Raad van State, 2019). Further implementation of the Climate Act is set out in the Climate Agreement (2019), which sets out ten-year commitments between government, the private sector and civil society organisations. The Climate Agreement sets targets for individual sectors and describes measures to reduce emissions. The individual sectors are the electricity sector, industry, mobility, the built environment, agriculture and land use. The national agreements under the Climate Agreement will be put into practice in 30 Regional Energy Strategies covering the entire country.

35 1.5 °C is the target because it is generally accepted that any warming above that will mean disastrous climate consequences. The consequences of a temperature increase of 2°C will be severe.

36 In December 2020 the European Council agreed to an EC proposal to increase the target for 2030 from 40% to at least 55%. The Netherlands supported the initiative to increase the ambition (Tweede Kamer, 2020f; Eerste Kamer, 2020). Additionally, the EU had set a target of 20% emission reductions by 2020.

37 Beyond this, by the end of 2020 the Dutch government was obliged to reduce emissions by at least 25% from 1990 levels. This was decided in a 2015 court ruling that became known as the 'Urgenda verdict', which was upheld on appeal in 2018 and on cassation in 2019, in a suit launched by the climate advocacy group Urgenda arguing that the government was not living up to its responsibility to protect citizens against the effects of climate change.

38 The European targets for reductions in energy consumption and growth in renewables are not directly translated into national targets. This means that Member States can determine their own contribution, although a minimum share is expected. The EU expects at least 26% from the Netherlands in 2030. The Netherlands has set a target of 27% renewables (EZK, 2020b). The EU as a whole aims to, by 2030, have reduced energy consumption by 32.5% (EP, 2012) and increased the share of renewables to at least 32% (EP, 2009).

Circular economy

The increasing demand for raw materials and growth in waste flows are putting ever-increasing pressure on the environment and the climate. Preventing the depletion of the world's resources will require a transition to a circular economy in which extraction of raw materials is reduced, economic production is geared toward reuse, and waste flows are as small as possible. The Netherlands has committed to being a circular economy by 2050. By 2030, primary raw materials consumption[39] must be reduced by 50% (IenM & EL&I, 2016). For more about the national policy, see the case study on transition to a circular economy (section 3.1 in this part 2).

The European Commission first produced an action plan to accelerate the transition to a circular economy in 2015 (EC, 2015b). To put a new impetus behind the concept of circularity, the Commission released a new action plan in March 2020 (EC, 2020e). The plan is intended to lead to a coherent product policy framework, waste reduction and a well-functioning market for secondary raw materials. It puts more focus on the whole cycle, including the design phase, where the bulk of a product's environmental impact is decided. The action plan identifies a few priority value chains where most raw materials are used but also where the potential for circularity is high: electronics and tech, batteries and vehicles, packaging, plastics, textiles, construction and buildings, food, water and nutrients. The new measures should in part ensure that sustainable products become the norm in the EU and reduce the waste that the EU generates.

European Green Deal

2019 saw the presentation of the European Green Deal, a programme to combat climate change, transition to a circular economy, restore biodiversity and reduce pollution (EC, 2019). It includes the ambitions of making the EU climate-neutral by 2050 and decoupling economic growth from resource consumption. The transition must also be equitable and inclusive, and preserve the EU's competitiveness in the long term. The Green Deal sets out an action plan and financing plan with a set of measures in all sectors of the economy, but primarily in transportation, energy, agriculture, mobility, industry and infrastructure. Its measures are focused in part on support for innovation, cleaner, cheaper and healthier transportation, a zero-emissions energy sector, energy-efficient buildings and cooperation on global environmental standards. As part of the Green Deal, the EC has proposed a European Climate Act to establish the objective of climate neutrality by 2050 in law.

39 Minerals, fossil resources and metals.

3.1 Transition to a circular construction economy

3.1.1 Challenge

The Dutch government strives for efficient and sustainable use and reuse of resources, materials and products. To this end, it has the intention of converting the linear economy into a circular economy. A circular economy is 'an industrial system that is restorative or regenerative by intention and design. It replaces the "end-of-life" concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.'[40] The goal is to create a fully circular economy in the Netherlands by 2050. An interim target for 2030 to reduce primary raw materials consumption by 50% has been set (IenM & EL&I, 2016).

The government-wide programme 'Netherlands Circular in 2050' identifies the construction sector as one of the priority sectors in the transition to a circular economy (IenM & EL&I, 2016), along with agriculture, the petrochemical industry and the food industry. The construction sector is one of the biggest producers of waste in our economy, but at the same time it stands out for its relatively high rate of secondary use of materials (through recycling). In 2016, 38% of total materials used in construction was made up of secondary materials (Berkel et al., 2019). Achieving a fully circular construction economy will depend on reuse of materials at a higher level. This will require a significant change in the material flows in the construction sector. At the same time, it is important to keep the material flows stable and reliable.

40 Ellen Mac Arthur Foundation, 2013.

3.1.2 Digitalisation in the transition to a circular construction economy

Digitalisation is seen as an 'enabler' for the achievement of a circular economy (Antikainen et al., 2018; WBGU, 2019). Of course, making the economy circular will primarily require changes in materials use, design, demolition, logistics and many other things. Digitalisation is what will make these required changes *possible*. It is what will provide the necessary information, help to match the supply and demand of materials, facilitate maintenance and repair, improve product design, and support the collaboration between partners in the value chain. An explanation of each of these points and the key supporting role that digital technology plays in it follows.

Information

Closing circles in a circular building economy is primarily an information problem (Henning & Holger, 2017). Construction companies need detailed and up-to-date information on the status of construction works and the components, materials and raw materials used in them (Van Megchelen, 2017). Where are the materials needed? How suitable for reuse are they? Digital technology can be used to build an information base that contributes to a reliable insight into the use of raw materials and products (Transitieteam circulaire bouweconomie, 2020). For example, digital materials registers can record the materials that have been used in a building, and sensors can provide information on the condition of those materials by registering the load on a building element over its life span. The availability of that information facilitates the reuse of materials. Waste flows can be made transparent, the quality can be determined and the ownership of materials can be established. With sufficient incentives in place, this information can promote reuse of materials and create a market for secondary raw materials (Chan, 2020). This shows how raw materials databases ? can be an important part of the transition to a circular construction economy (SER, 2018). Developing this economy is also one of the pillars of the European 'Buildings as Material Banks' project.[41]

Matching supply and demand for materials

Digital technologies can further promote circular economies by facilitating trade in secondary raw materials and products (Henning & Holger, 2017). Digital platforms enable suppliers and buyers of materials to find each other. This makes the reuse of materials significantly easier. For private individuals, platforms like ebay.com are the most familiar. But similar platforms are emerging in the construction sector all the time; Madaster,[42] Excess Material Exchange,[43] INSERT[44] and New Horizon[45] are a few examples of such platforms, and these are expected to play an increasingly important role in the reuse of secondary materials (Chan, 2020).

Extending the lifespan of materials

Digitalisation can also help simplify maintenance, repair and replacement of materials. Data analysis can be used to predict when preventive maintenance is needed to extend the lifespan of a product. Additionally, digital technology (e.g. Internet of Things) can be used to monitor the condition of products, materials and devices in order to develop better maintenance schedules based on this information (Bressanelli et al., 2018). Digital technology also facilitates the delivery of 'product-as-a-service' ? applications by which building materials are not bought, but rather leased over the product lifespan. This principle is already being applied outside the construction sector, for example in aircraft engines (see box).

Product-as-a-Service for Aircraft Engines

Rolls Royce has developed the 'Power by the Hour' programme it offers for its aircraft engines. In this programme, aircraft manufacturers do not buy engines, but pay for the availability of an engine. This makes effective engine maintenance crucial. This has prompted Rolls Royce to install digital technology in its engines that provides real-time data that is automatically analysed. This programme is the result of over twenty years of experimentation and research, primarily led by a major buyer of aircraft, American Airlines (Johnston, 2017).

Improve product design

Currently, many products in the construction industry are not yet designed for a circular economy (Arnoldussen et al., 2020). Digitalisation offers opportunities to improve on this at the product design stage (Ellen MacArthur Foundation, 2016; Material Economics, 2018). Artificial intelligence delivers improved understanding of material cycles, production processes, supply chains, use and consumption patterns

41 See www.bamb2020.eu/about-bamb
42 See https://madaster.com
43 See https://excessmaterialsexchange.com
44 See https://insert.nl
45 See https://newhorizon.nl

and the interdependencies between them. This information helps to design products that are readily used and reused throughout the chain. Data analysis can also provide insight into the use and performance of construction products in practice, so that the design can be adapted for more efficient use of raw materials (Material Economics, 2018; IenM & EL&I, 2016). The expectation in the manufacturing industry is that there is still much to be gained from this approach (Neligan, 2018).

Support of cooperation between chain partners

A successful circular construction economy requires new partnerships in the production chain (SER, 2018). For materials to be truly reused effectively, chain parties must take into account the entire production cycle, all parties in it and their production processes (Scherpenzeel & Korbee, 2018). However closely architects, builders and contractors may have worked together during the construction of an object, at the reuse phase they will also have to take account of parties in other parts of the value chain, such as the facility services responsible for maintenance and the demolition services providers who will be recovering the materials at the end of the life cycle. Digital tools can help provide support in the resulting complexity. These include digital collaboration platforms, better communication, logistical coordination of material flows and connecting supply chain partners (Antikainen et al., 2018; Chan, 2020).

3.1.3 Digitalisation in the circular construction economy using the layer model

Digitalisation will change the way the construction sector handles raw materials. But how exactly? To offer a better picture of this, here we describe the interrelationship between the digital and physical worlds for the flows of raw materials in the construction sector, based on the layer model described in chapter 2 of this part 2.

Physical environment

Raw material flows and the buildings in which raw materials and construction materials are used constitute the physical basis for a circular construction economy. These raw material flows consist in part of primary materials, but also to a large degree of secondary (reused) materials 'harvested' during demolition activities. The digitalisation of the construction sector is leading to physical materials at this layer being altered to make them 'digitally readable' by barcode, QR-code or RFID chip[46]. These added features connect digital information to the physical object. The physical object then carries that information throughout its life cycle; this includes information about its origin, its environmental impact, etc. This allows physical materials to be tracked digitally throughout their lifecycle. It is also possible to make materials that interact with both the digital and physical environment through the use of IoT technology. For example, the tint of the glass of electrochemical windows can be changed remotely (Granqvist, 2014).

46 RFID: 'Radio frequency identification'.

Data layer

The data layer in the construction sector consists of available data on aspects such as the quantity, type, condition, quality and method of installing construction materials. This data is collected during the construction of a building or during its lifetime. This can be done by manual inventories or by installing sensors on or in building materials. This allows bricks or concrete to register the load they are bearing (Jabir & Gupta, 2011), or a wooden frame to be monitored for its state of maintenance (Jongeleen, 2016). Sensors can provide real-time, detailed information about the condition of a material and allow that information to be read remotely.

Digitalisation offers new opportunities not only for collecting, but also for recording, this type of data:

- 'Building Information Models' (BIM) are being used to create digital 3D renderings of buildings. This allows the various parties involved in the construction of a building to work together in a single, unified, virtual model (Chan, 2020; Sante & Doelen, 2016). This goes much further than simply geometric data. It can include product numbers of building elements, materials or settings for climate control. The model can then be used during the construction phase, as well as for management and commercial operation (Chan, 2020).
- A related development is the 'digital material passport'.[47] A materials passport is a register of materials linked to a specific, identifiable object, for example a building or a building element (Transitieteam circulaire bouweconomie, 2020). Digital materials passports not only provide information about what materials are in a building, but in many cases how those materials are integrated into the building and what their quality is. With the emergence of materials passports, Platform CB'23 (2020) sees a new role for 'passport builders' in the construction world. They set up the data structures in which information on materials is maintained, manage that data and make it accessible.
- Taking this one step further brings us to the creation of 'digital twins'. A digital twin of a building is a model in which the data of the building is saved in so much detail that it becomes effectively a virtual copy of the reality. It differs from a structural model such as a BIM in that the digital twin is updated in real time based on the physical environment, and the physical environment is modified based on the digital twin (Kritzinger et al., 2018). This makes it possible to detect or predict problems or monitor the effect of current or future alterations adaptations for the purpose of building management and maintenance (Marr, 2020; Chan, 2020). Making the digital twin concept work requires a continuous data flow between the physical and the digital reality.
  Digital twins also make it possible to digitally combine separate systems from the physical world into one integrated model. For example, a weather model can be merged with a maintenance model for a façade to provide a more accurate schedule for repair and replacement.
  Digital twins are used for a variety of purposes, including for urban architecture and planning. They give policymakers more of a basis for implementing measures in areas like traffic, the environment and

47 This development is referred to as 'adjacent' because BIM is often the basis for the creation of a materials passport, as it is (for example) with Madaster.

safety than would be the case if only static data models were used. In addition, simulations can be shared with residents to inform them of a construction plan and to show what the result will be (Minsky, 2020). For example, the French software company Dassault Systèmes developed a digital twin of the city of Singapore (Marr, 2020). Another example can be found with General Electric, which has built digital versions of its wind farms that can help map the environment and determine what is the most efficient turbine for the wind blowing in a particular location. The physical version of the turbine can then provide feedback to make its operation even more efficient (Marr, 2020).

Advantages of Digital Twins

Oracle (2019) summarises eight benefits of digital twins:

1. *Real-time monitoring and remote control*. A digital twin can be viewed from anywhere and the system can be controlled remotely.
2. *Efficiency and security*. The expectation is that digital twins automatise processes as much as possible and that robots will perform the unsafe and repetitive tasks.
3. *Better maintenance schedules*. Because the digital twin is linked to the physical components via sensors, the status of machines can be monitored. Additionally, artificial intelligence can be used to predict when a machine might fail and require maintenance. Problems can be identified before they arise (Marr, 2020).
4. *Scenarios and risk analyses*. A digital twin can compute what-if situations without modifying any aspect of the physical object. Within the closed system, countless possibilities can be tested to find the optimum result (Qi & Tao, 2018). This eliminates the need for real-world testing of new developments, and saves costs accordingly.
5. *Better cooperation and more synergy*. More autonomy and availability of information means that teams can be engaged more effectively and smarter cooperative relationships can be established.
6. *More efficient tools for decision-making*. The real-time information produced by the digital twin makes it possible to make decisions faster.
7. *Personalised products and service*. The digital twin monitors historical transactions, which means it knows the preferences of stakeholders. Digital twins also track market trends and keep tabs on the competition, thus better serving the stakeholders.
8. *Better documentation and communication*. Real-time information ensures that all stakeholders are aware of the correct information. This promotes communication and increases transparency.

Platform layer

In the circular construction economy, several types of digital platforms have emerged in recent years. The first type is materials registers like Madaster, which log data and make this data accessible.[48] These are platforms that compile information on materials from and for various parties in the construction world. On the platform, parties can register information

48 See https://madaster.com

about buildings and the materials used in them at various phases of the construction process. With Madaster, the platform can check the quality of the data, enrich it by linking it to other databases and perform calculations for the user. These services need not necessarily be carried out by Madaster. Other parties can also offer their services on the platform, such as parties that issue certifications or calculate environmental impact. In this way the data platform is connecting users with data about materials with parties that can do something with that data.

There are also digital platforms that match supply and demand for residual materials and create new markets for secondary raw materials. Today, products are already being ‘harvested’ from buildings and stored. Underlying this is a complex system of logistics and a tremendous demand for storage space. Digital platforms can answer to these needs by providing an environment where the supply and demand side of secondary materials can find each other and conclude transactions. The primary advantage is that the transactions on materials can happen before actual demolition begins, meaning that materials do not have to be stored or disposed of as waste. In addition, the use of digital technology reduces transaction costs between parties and makes it possible for parties that would not otherwise have found each other, due to geographic or organisational obstacles, to connect. There are already a number of these kinds of construction marketplaces active or in development, such as the Excess Materials Exchange[49] and INSERT.[50]

49 See https://excessmaterialsexchange.com
50 See https://insert.nl

Services layer

The combination of data flows and digital platforms has led to the emergence of new service providers in the construction sector: parties that use the data and convert it into valuable services. There are, for example, parties that, on the basis of materials data from a building, recommend alternative materials with a lower environmental impact[51] or that map out the degree of circularity of a building.[52] Services like these can change the way buildings are designed, built, managed and demolished. The vision of a circular construction economy is one in which designers and contractors are able to respond to the expected supply of materials during construction, so as to build up the lowest possible cost and with the least waste. The predictive value of data analysis of material flows can lead to the right materials choices. The same applies to property owners who may decide to demolish a building if there is a high enough demand for the materials used in it.

Furthermore, as already indicated, the ‘product-as-a-service’ model can help in the transition to a circular building economy. In the construction sector, product-as-a-service is on the rise for high-tech materials and products such as lifts and climate control systems (Sante, 2017). And new possibilities for this model are still being sought, for example at the Delft University of Technology, where research is being done into leasing entire façade systems.[53] If a larger market for secondary materials develops, such

51 See https://newhorizon.nl/material-balance/wearthy-scan
52 See https://www.gprsoftware.nl
53 See https://www.tudelft.nl/en/architecture-and-the-built-environment/research/projects/green-building-innovation/facade-leasing/facade-leasing-pilot-project-at-tu-delft

services may also become interesting for simpler materials like bricks or window frames, because these materials acquire a monetary value after use that is easily quantifiable. This will require a workable registration of ownership of these materials, and digital applications offer a good solution for this.

3.1.4 Obstacles

As explained in the previous section, digitalisation offers numerous opportunities for making the construction economy circular. At the same time, the Council has identified a number of obstacles, which are explained below.

At present, there are few incentives in the physical environment that would encourage the construction sector to develop and use digital technologies to create a circular construction economy. Although extending the lifetime of materials and promoting reuse where possible is a public goal, it is not something seen as commercially viable in today's linear construction economy. In other words, it is not yet in the construction companies' interest to transition to circular construction, so developing or using digital technologies to contribute to this transition is not yet interesting. Developers, owners and users of buildings are still setting few demands on the circularity of a building; and where they do, these prove to be difficult to translate into requirements that are compatible with the techniques used in the construction industry. Moreover, the supply of and demand for secondary materials is still quite low, because few buildings are constructed in a manner that allows disassembly, and the logistics and organisation for the processing of secondary materials are far from simple under current conditions (Chan, 2020). This lack of supply and demand is a significant impediment to the scaling up of digital platforms, because for these platforms success depends on being a marketplace that matches supply and demand (Chan, 2020; Transitieteam circulaire bouweconomie, 2020). In addition, the construction sector does not yet have a digital 'ecosystem' that allows innovations to flourish. Most companies are too small to invest by themselves, and do not have the necessary digital knowledge and/or necessary resources. In many cases, the standard is still two-dimensional drawings on paper, and this is what many developers and building owners ask for (Chan, 2020).

More specifically, the Council sees a significant obstacle at the data layer: the lack of usable and accessible data on materials in the construction sector (Chan, 2020). The organisation and culture in this sector do not support the collection and sharing of data. In practice, construction companies, technicians and demolition companies often do not collect or save data, or where they do, it is not in a way that is compatible with the logic of digital registration. Digital registration may require all bricks used to be registered, whereas on the job site the only important metric is the square metres of brickwork. In the current situation, the digital registration of information on materials and products is, more than anything else, a burden for the various parties in the construction process, while for most of them there is no clear picture of what the benefits are. Switching to digital registration would require an investment from construction companies that would likely not pay off (unless management and maintenance is also included in their contract), because the potential reuse of materials only comes into play at the end of the lifetime of the building, when the construction company is long since out of the picture. That puts the potential profit generally in the hands of other parties: maintenance contractors or demolition services. The latter, for their part, maintain that they do not need data on the raw materials in a building to effectively separate and recycle the materials. And similarly, for the building owner (whether private or public), the benefits are not necessarily clear in advance.

Another reason that there is still little material data available in the construction sector is that there are still few shared standards for dealing with digital data. This makes the exchange of data, as well as the interoperability between the various technologies, difficult. While there are international standards, for example the ISO standard 19650 (established in 2018) or the guideline that Platform CB'23 is working on for recording information on materials (Platform CB'23, 2020), in practice different information standards are used at each stage of construction or information is recorded in closed systems, which prevents it from being shared (DigiDealGo, 2019). Besides this, during the life cycle of a structure (from planning to recycling) the various players each have different information needs (DigiDealGo, 2018). While parties seem to want to improve their own sub-processes in the lifecycle of a structure, they exhibit little willingness to invest in partnership and digital connections that could lead to optimisation and acceleration for any other parties.

Finally, the Council sees that most digital developments are oriented towards new construction. There are few digital developments and databases that focus on the existing building stock, even though that is where the bulk of the materials in our construction economy are to be found (Chan, 2020). The lack of digital registrations on older buildings makes it difficult to determine what materials are in these buildings. Achieving a fully circular building economy will require that the existing building stock is entered into the digital ecosystem of material databases, digital twins and product-as-a-service applications.

3.1.5 Risks of digitalisation in the service of circular construction

Digitalisation is a necessary part of the transition to a circular construction economy. This will completely change the construction sector and the material flows within it, and have a positive impact on the sustainability of the sector. At the same time, it may present risks to other public values. In the following, the Council will highlight a few of these potential risks.

Pressure on competitive positions

The Council recognises that in some cases the need to share data has an impact on the competitive position of companies. It should be clear that when parties share data about their use of materials, they are to some degree sacrificing a competitive advantage: firstly, because registering this data represents an investment in time and money, one that the construction company itself does not enjoy the benefits from; secondly, because the information they are registering could be of benefit to their competitors. It is

therefore understandable for a company to fear that sharing data about the materials they use will be detrimental to their position in the market.
The increasing importance of data may mean that in the future companies will face even more pressure on their competitive positions, and parties with a lot of data on material flows (such as digital platforms) will be in a position to gain a dominant position in the market. It should be clear that a platform party that does not make its data freely available can make other parties (such as contractors) dependent on it.

Complications from changing business operations
The use of digital technologies to make the construction economy circular demands quite a lot from parties in the construction industry. Material registration, data sharing and using digital platforms to find secondary materials are all things that complicate 'normal' work for construction companies. The adjustments needed entail that construction companies must adapt to the working methods of digital parties. This may have benefits for the functioning of the construction chain as a whole, but this may not be the case for an individual construction company. Moreover, it demands different skills and knowledge from the people working in construction. In some cases, retraining may be required.

More difficult market access for small parties
Moving with the digital transformation means that parties in the construction sector must ensure that they have the right software, knowledge and people. Because smaller parties have fewer financial resources, getting all that together can be a challenge and present a high bar for entering the market. As a result, they often become more dependent on other, larger parties.
Likewise, the rising importance of digital platforms can be a growing obstacle to market accessibility for parties in the construction industry. When material flows are managed by just a few digital platforms connecting supply and demand, these platforms are in a position to choose from the available material flows and decide who does and does not have access to these flows. At present, this selection mechanism by platforms is not currently an issue in the construction sector (being that there are no large digital platforms in this sector as yet), but we do see it emerging as an issue in other sectors (Tweede Kamer, 2020d). This will be illustrated in the cases discussed below.

Vulnerabilities surrounding transparency and security
Digitally registering materials and making this data available will make the use of materials in construction more transparent. It will make clear who is using what materials in which buildings. On the one hand, this is a positive development from a sustainability perspective: it makes verification easier, and parties can be held accountable for their use of materials. But on the other hand, digital registration can give rise to new forms of fraud and manipulation, especially where reuse of materials in buildings represents a monetary value (in which case, manipulation of the registration of materials would pay off). Any digital system has a certain degree of vulnerability to hacking or other forms of attack. Along with this, the possibility of software design errors presents a risk of system disruptions (Rli, 2018). Therefore, dependencies on digital systems entail certain risks.

3.1.6 Key points for the government

The foregoing analysis demonstrates that digitalisation is necessary for the transition to a circular construction economy. But the digital developments needed to achieve digital registration of materials will not happen by themselves, even if only for the simple reason that most private parties in the construction sector currently have little interest in making the necessary investments. Additionally, the digital developments required also represent risks to a number of public values. Therefore, the Council observes that the transition to a circular construction economy calls for an active role on the part of the government. In the following, the Council outlines a number of possible key points for the active government role required.

Promoting the registration of data

The Ministry of Infrastructure and Public Works (Tweede Kamer, 2018b) has indicated that it intends to make a decision on whether to make a materials passport mandatory for buildings by the end of 2020. The introduction of this obligation would represent a significant incentive to begin registering the data on materials (Transitieteam circulaire bouweconomie, 2020).
This would, however, require shared standards for materials registration: agreements on formats, data sources and their interchangeability (Transitieteam circulaire bouweconomie, 2020). The government has a number of options to promote this. The most direct way would be for the government itself to develop such a registration system (or to put its weight behind a promising development in the market) and then prescribe this system as a standard. The government could also opt for a less prescriptive approach: it could make the choice in consultation with market parties, and formulate clear conditions for the type of data and its reliability and accessibility. This would eliminate the need for a single system of registration; market parties could use any system that meets the defined conditions, so long as interoperability is guaranteed. For the development of these standards, the national government could glean much from the knowledge gained in the European project 'Buildings as Material Banks' (BAMB).[54]
To promote the use of a standard or conditions as referred to here, the government could prescribe their use in legislation, for example by amendment to the Building Decree (Bouwbesluit) or insertion in in the forthcoming Quality Assurance Act.[55] Another option would be to require the use of certain standards when applying for a building permit. The current Environment and Planning Permit for new construction and renovations requires submission of construction drawings and mandatory calculations, and these must be based on certain standards. In a manner analogous to this, the government could set requirements for materials registration.

Another way to promote the registration of data on materials is for the government to call on the construction sector to use certain standards on a voluntary basis. For example, the government could ask the construction sector to establish a code of conduct for how construction industry parties

54 See www.bamb2020.eu/about-bamb
55 The Quality Assurance Act will go into effect on 1 January 2022. It imposes new requirements on the burden of proof and liability on parties on the construction side. For example, a builder must present a compliance file demonstrating its compliance with regulations (Eerste Kamer, 2017).

should handle data on the materials they use. The government could then promote the use of such a standard by prescribing it in public tendering procedures. Other public-law parties, such as housing corporations, could do the same. The purchasing power of these major parties can have a significant effect (Chan, 2020).

Finally, the government can choose a more facilitative role. It could, for example, offer financial incentives to parties in the construction sector to actually get started with registering materials and exchanging data. This is something the government is already doing, in the form of the Environmental Investment Rebate (MIA) and the Arbitrary Depreciation of Environmental Investments (VAMIL) (Tweede Kamer, 2020g).

Promoting accessibility of data

Registering the data on building materials is not enough in itself; the data must also be accessible to third parties, to allow them use it to create the value that will give rise to a circular construction economy. In this, data platforms are a crucial link, by virtue of their function of connecting data demand and data supply. It is important that the accessibility of this type of platform be the same for all parties in the construction sector. This does not mean that all data on material flows must be freely accessible to everyone, but it does mean that there must be transparent agreements (standards) on who has access to what data and when. Here again, the Council sees a role for the government: it could provide incentives for parties to reach agreements and adhere to them. One way of doing this would be to organise an open process between parties in the value chain, building owners and the government. There are already a number of initiatives aimed at improving data exchange in the sector. For example, in the DigiGo initiative construction sector parties are working together on a uniform data exchange system dubbed the Digital System for the Built Environment (DSGO).[56]

Accelerating the circular economy with targeted charges and savings

A functioning digital ecosystem with materials passports and data platforms gives the government new opportunities to accelerate the transition to a circular construction economy. After all, by using data from material passports the environmental costs of any material can be calculated. Based on that data the government could introduce surcharges or savings incentives to encourage or discourage the use of environmentally friendly materials and materials that are harmful to the environment, respectively. If the government should decide to go this route, it would mean that every building will have to have a materials passport with reliable, transparent and complete information. This is something that would have to be taken into account when developing these materials passports.

56 See https://www.digigo.nu/dsgo/default.aspx

3.2 Changing electricity system

3.2.1 Challenge

In 2015, the Netherlands joined virtually every other country in the world in signing the Paris Climate Agreement, and thereby committing to the ambition to reduce CO_2 emissions by 80 to 95% (as compared to 1990 levels) by 2050 (Verenigde Naties, 2015). The agreement also comprises the commitment to limit the warming of the Earth's temperature to below two degrees Celsius.[57] This will require dramatic reductions in greenhouse gas emissions and replacement of fossil energy sources by renewable energy sources. In the Netherlands, governmental institutions, civil society organisations, businesses and knowledge institutions have been working together for some time (since the signing of the Dutch Energy Agreement in 2012) to stimulate energy efficiency, growth in the share of renewable energy in the Netherlands and the progress towards a carbon neutral society.

In the project Integrated Infrastructure Outlook 2030-2050 (*Integrale Infrastructuurverkenning 2030-2050*), currently being conducted by Dutch grid managers with input from the Ministry of Economic Affairs and partners in industry, energy companies and the sustainability sector, future scenarios for the energy transition are being drafted.[58] All of these are based on an abundant supply of electricity on a large scale. Many processes that now depend on fossil fuels may be electric in the future.[59] This will mean multiple functions becoming more dependent on electricity and electricity taking on a much larger role in our energy demand (Hollander et al., 2017). Innovations will be needed to facilitate the distributed generation of electricity, smooth out peaks and troughs in the availability of wind and solar, better coordinate supply and demand, and be smarter in our use of electricity or (via conversion) other energy carriers ? such as hydrogen. Infrastructures for the supply and return of decentrally generated electricity need to be connected to each other (TKI Urban Energy, 2019). Without such innovations, the energy transition will run up against limits: physical and financial limits to grid expansion, limits on the security of supply, and limits to the affordability of the electricity system. In the following section, the Council describes the implications of this tremendous challenge.

3.2.2 Digitalisation in the new electricity system

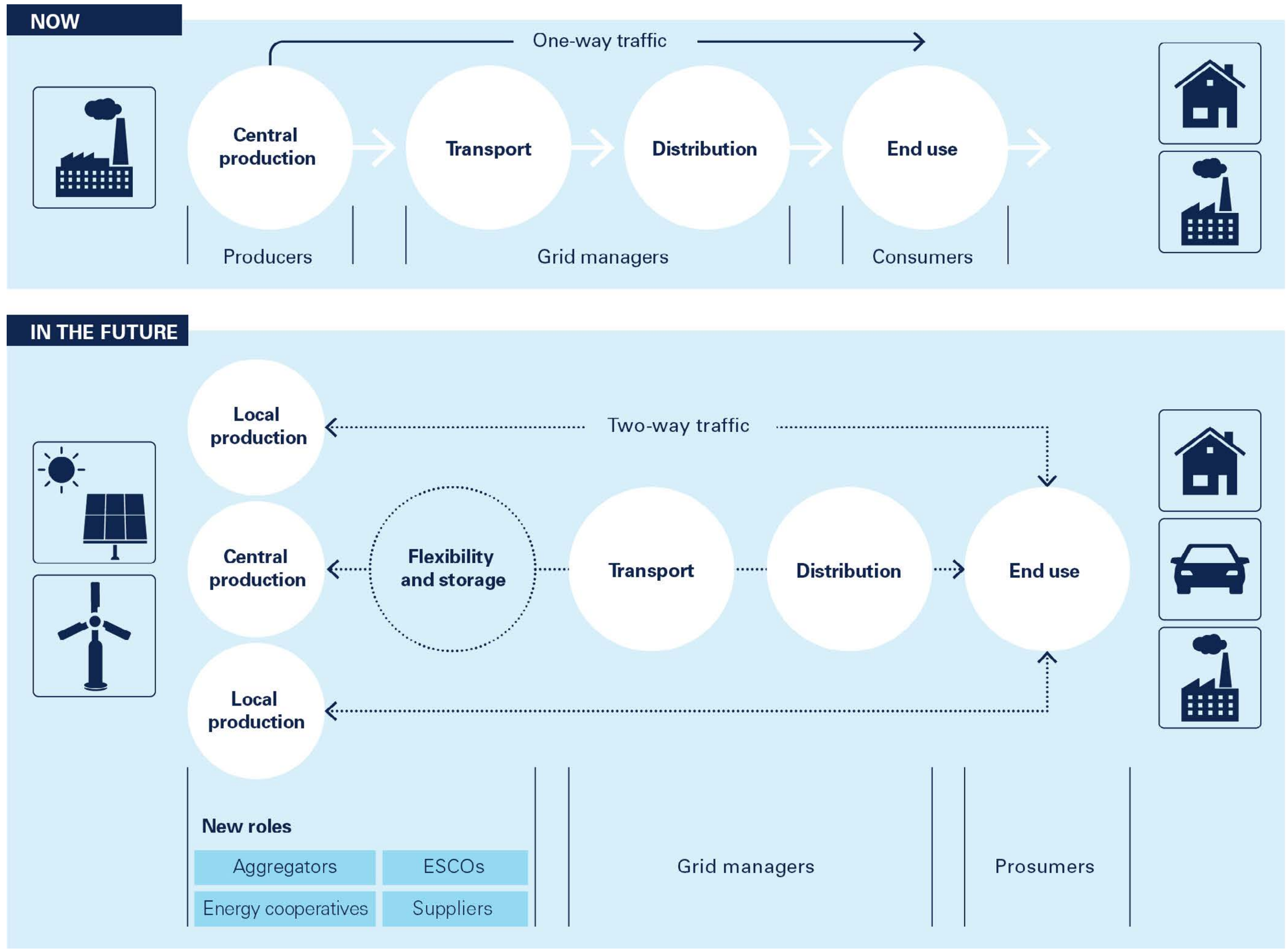
Wind and solar energy are often generated decentrally, and their output (yield) can be variable. Both of these things make it more difficult to match supply and demand than the traditional model. But that traditional, demand-driven, top-down energy market model has to shift to a mechanism driven by both demand and supply, in which storage and conversion between energy carriers and direct trading of energy will become more important (Aazami & Post, 2017). Conversion and storage technologies convert electricity into another form of energy or into energy carriers (for example, the conversion of electricity into hydrogen or green

57 SDG 13: https://www.sdgnederland.nl/sdgs-2/doel-13-klimaatverandering-aanpakken/
58 See also https://www.rijksoverheid.nl/documenten/rapporten/2020/03/31/klimaatneutrale-energiescenarios-2050
59 See also https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/energie-besparen/industrie/elektrificatie-industrie

gas (Power2Gas), or from electricity into heat (Power2Heat)), creating more flexibility between production and consumption of sustainable energy. Electric car batteries, for example, are used for temporary storage of electricity. Conversion and storage provide flexibility and thus security of supply.

This transition will make the energy market less transparent, in part due to the entry of new parties that in many cases will be playing multiple roles simultaneously (Rli, 2018). Where previously energy traffic was only one-way, from central production, soon there will be two-way traffic between central and local production (see figure 2). Consumers are becoming producers of energy, or 'prosumers'. Digital technologies such as artificial intelligence, machine learning and sensors can generate data about the energy being generated and consumed, and can help to match supply and demand.[60]

Figure 2: Changes in the Energy Value Chain



Source: Berenschot, 2017

60 See also https://www.rathenau.nl/nl/digitale-samenleving/hoe-duurzame-energie-en-digitalisering-samenhangen

Examples of Digital Innovation

- Google has been experimenting with self-learning algorithms that predict how much power wind farms will generate, even more than one day in advance.
- Meanwhile, various parties are developing 'smart charging' for electric vehicles: algorithm-driven flexible charging and discharging at the optimal moment, so that for example an electric vehicle charges fully or partially when the costs are low and/or when the supply of sustainable energy is high. This can help better match the demand to supply and prevent peaks in demand. In a pilot project, the Ministry of Infrastructure and Public Works has set up a number of smart charging lots to accelerate the development of charging infrastructure and to test smart charging. Another example is Flexpower Amsterdam, which is experimenting with variable charging speeds.

Allowing all the 'smart' elements of the electricity system (car batteries, refrigerators, thermostats, inverters, etc.) to communicate with each other may help guarantee grid stability and coordinate supply with demand at any time of day (Rli, 2018). The various components of the energy system are connected to the internet and then linked to coordinate production, storage and demand. All the shows that in the energy system, the virtual and physical worlds are increasingly converging.[61] Artificial intelligence plays an important role in this, because it involves the analysis of large amounts of data from millions of sensors, which is done by algorithms. Such analyses can be a part of the real-time analysis of the physical power grid to keep it in balance. This becomes critical when the power system is a two-way exchange of electricity and information between generators on the one hand and electricity consumers on the other. Locally, peaks can be smoothed out by having smart devices communicate with each other and with the grid, and based on the information gathered distributing the demand for energy more efficiently (Hollander et al., 2017). Connecting power electronics to the internet makes it possible to intelligently switch, control and transform large electrical capacities. Digital technology will thus play a critical role in the new electricity system.[62]

There are signs that the increasing use of digital applications and growing information flows will ultimately increase absolute energy consumption (Masson et al., 2020). At the same time, smart algorithms and artificial intelligence can make energy consumption on the whole more efficient, which could limit the increase (Jones, 2018). Consequently, whether the bottom line is that digitalisation will cause an increase or decrease in energy use is not a question that is presently easy to answer (WBGU, 2019).

61 See also https://www.rathenau.nl/nl/digitale-samenleving/een-duurzaam-energiesysteem-complex-om-te-beheren

62 Digital technology is seen as indispensable for being able to meet the climate targets (Klimaatakkoord, Nationale Digitaliseringsstrategie EZK, 2019; TKI Urban Energy (2019), WBGU, 2019; Hollander et al., 2017; Kool et al., 2019).

3.2.3 Digitalisation in the electricity system using the layer model

What would a socially responsible convergence between energy and digitalisation look like? To answer this question, we must first identify the public values and goals that we as a society want to strive for (Van Est et al., 2018; Masson et al., 2020). It is clear that electricity fulfils an important public utility function. This is why the electricity system is strongly regulated by the government. On the subject of this regulation, the current cabinet has expressed five central principles: ‘clean’, ‘safe’, ‘reliable’, ‘affordable’ and ‘spatially workable’ (Tweede Kamer, 2020h). In the Netherlands, the digitalisation of society is regulated far less, although it can be said that the government’s comprehensive digitalisation strategy explicitly states that the way in which digital applications put public values such as privacy, security, transparency of algorithms and equal power relations under stress must be a focus of attention (EZK, 2018).

In the following, the Council analyses the interrelationship between the digital and physical worlds for electricity, based on the layer model described in chapter 2 of this part 2.

Physical environment

In the coming decades, our physical environment will be changing in several respects as a result of sweeping electrification and the crucial role digitalisation will play in it:

1. There will be major changes in the energy infrastructure. These changes will be seen in production (example: more solar panels and wind turbines), in the electricity grid and the nodes within it (example: more ‘smart’ transformer boxes), in the sensors (example: more ‘smart meters’ ?) and in the equipment that consumes energy (example: more refrigerators, thermostats and electric cars with internet connectivity). In a digital electricity system, all these components are connected via the internet. A digital electricity system like this can optimise the use of the current infrastructure to eliminate the need to further reinforce the grid. This is desirable for the purposes of achieving the goals of reducing carbon emissions in an affordable way, and comes with the positive side effect of reducing the use of raw materials (and so increasing sustainability). The current electricity grid will have to be adapted in other ways, however: for example, there will have to be intermediate stations that collect electricity from smaller energy producers and distribute it, also known as ‘virtual power plants’ ?. Also, additional sensors will be needed to coordinate between production, storage and conversion. Additionally, components from the physical world will need to be upgraded with computing power and communication functionalities. There is already a requirement that all new charging infrastructure for electric cars must be ‘smart charging’’-ready, for example.
2. Many devices will be performing better in the new system, because digitalisation provides the ability to diagnose and optimise the functioning of equipment in real time. To take one example, analysis of production and output data of a wind turbine can increase efficiency by 20%. Other devices will have the capacity for self-diagnostics, so malfunctions will be detected and solved faster – a critical part of guaranteeing security of supply.

3. Because they are digitally connected to the electricity net, physical devices are going to be receiving feedback from the digital world constantly. We will therefore see the physical world of energy production and consumption permanently connected to the world of transactions and services. In that way the analysis of current digital data electricity will enable instant adjustment of supply, demand and storage (Kool et al., 2017). Consider an electric car with a smart charging battery that limits its own demand for power when pressure on the grid is high, or even returns energy to the grid when production from sun and wind is low. Through a system of digital services, the car owner (or an intermediary) can then be offered compensation for providing this flexibility.

Before the changes described here can become a reality, there are still software and hardware issues to be considered. To start with, devices can only communicate with each other if there is some form of standardisation (for example, arrangements on incremental increases in wattage). Looking at where *standardisation* and normalisation are now, the Council observes that there is much room for improvement. Secondly, investments in the software used to manage the electricity grid will be needed, to adapt it to collect and process all the necessary data and control the energy demand. Finally, responsibility for and monitoring of *the quality of essential digital facilities and their management* must be addressed.

Data layer

The achievement of sustainability goals through large-scale electrification will depend on processes in the data layer of the living environment (Masson et al., 2020). A digitalised power system requires minute-to-minute data collection, sharing, and interpretation, and that this process be effectively controlled. Data about the energy consumption of consumers is collected through smart meters and sensors in the electricity grid. This data is not only seen by the consumers themselves, but is also shared with grid operators and energy suppliers (albeit on a daily rather than real-time basis). This produces data-driven insights, which algorithms and artificial intelligence can use to match the demand for electricity with the supply.

The digitalisation of the electricity system will also make another type of data available: data on energy consumption ‘behind the meter’ (i.e., which appliances and devices in the home are using the electricity?). As more and more devices with internet connectivity enter the home, we learn more and more about this. This data can be used by parties in the energy sector to improve their services (for example, better matching supply and demand), but it can also be used for other purposes. Presumably, it can provide insight into consumer preferences, meaning that this is data that represents significant financial value; but of course, it is important to be aware of the privacy implications and act accordingly. Thus, the whole process surrounding the handling of data demands careful governance. At present, there are no regulation in place for how to handle this ‘behind the meter’ data on energy consumption.

Without reliable data on the production and consumption of electricity, implementing the necessary changes in the electricity system will be impossible. The information being received by the Authority for Consumers and Markets (ACM) from market participants indicates that the quality[63] of the grid operators' data is still not adequate to provide advanced and reliable services to consumers (ACM, 2019). Measurement data is still unavailable all too often, sometimes due to device failures or even the smart meter being switched off.[64] This is hampering the development of new business models tailored for the energy transition, like flexible supply rates. The ACM also notes that market parties remain very much in the dark about how data governance is currently organised and what it may look like in the future. Who is allowed to access what energy data, and under what conditions?

Platform layer

In the changing electricity system, digital platforms play an important role (Masson et al., 2020), because continuous and fast coordination between the various parties (suppliers and customers) in the chain of electricity production and consumption is needed. Platforms make these transactions possible, in diverse and often innovative ways that are only possible in the digital realm.

63 The ACM defines quality as both the accuracy and completeness of the data.

64 Vattenfall and Eneco report having no data for "2% to 6%" of their customers (source: Het Financieele Dagblad, 16 December 2019).

On 'aggregator ? platforms', private individuals and companies with solar panels or other energy-generating equipment can offer their energy surpluses directly to consumers. This makes platforms suitable for connecting the growing numbers of energy sources scattered across the country, and introducing their energy into in the energy system (Masson et al., 2020). With these types of transaction the platforms can make a positive contribution to the sustainability transition, particularly in combination with direct connections to internet-connected energy devices in the home. The platforms can read these devices, analyse the data and then control the devices through algorithms (Sioshansi, 2020). Ultimately, this results in more flexible and better distributed electricity, which makes energy consumption at the local level more efficient.

In the Netherlands, companies like Powerpeers and Vandebron use a centralised approach for their platforms. They collect the energy supply from many small parties and let consumers choose who they want to receive electricity from. Other platforms like HanzeNet take a decentralised approach, facilitating people in entering into transactions among themselves without the intervention of a central authority. Prosumers can use these digital platforms to gain a foothold in the market and sell their surplus energy to customers. They have a number of different options to do so, depending on the platform: they can offer their electricity on the standard energy market or make it available for specific applications, such as charging electric cars (Kool et al., 2019).

Examples of Platforms

- Grid operator Enexis has created 'Buurkracht': a digital platform on which local residents can register to save and generate energy together locally.
- There are roaming platforms to ensure that electric cars can charge at any charging point, regardless of the brand of the charging point or the driver's charging subscription. Such roaming platforms facilitate things like payment processing. To do this, the platform handles the data exchange between operators of physical charging stations, charging service providers and providers of adjacent services like navigation. This way, roaming platforms create a digital and cross-border charging network (RVO, 2019), an essential component of an open and accessible charging network.[65]

Two of the biggest requirements that electricity platforms must meet to contribute to the green transition are: (1) they must facilitate a structure of relationships between parties that leads to the desired (i.e., sustainability-promoting) transactions, and (2) they must have adequate hardware and software connected to an underlying technical infrastructure. For now, the level of technology available would appear to be adequate; the real question is whether the structure of relationships on the existing platforms is actually contributing to sustainability goals. Are the developments in demand, supply and storage demonstrating the desired value development? The answer will be found in the development of the services on the platforms. If that development is inadequate, the solution may be a different relationship structure, for example with new electricity providers.

65 Here in the Netherlands (as elsewhere in Europe), we are working hard on creating international, barrier-free roaming, but universal coverage is not yet a reality. In the evRoaming4EU project, a number of EU Member States including the Netherlands are facilitating the development and use of international roaming based on open protocols. There are already standards and (open) protocols that enable roaming (RVO, 2019).

Services layer

The use of data from the energy sector is yielding a wide range of new services and revenue models revolving around the acquisition and exploitation of data from the energy market (Rli, 2018). Behind them are, for example, parties that give customers insight into their energy consumption or that map metering points. There are also parties using data from the energy market to speculate on the energy market: purchasing energy at a low price, temporarily storing it and selling it when the price is high. These latter services in particular are generally offered through digital platforms.

Increasingly, the big tech companies like Google, Apple and Amazon are making forays into the energy market (Hollander et al., 2017), providing bundled services (like 'smart living' packages) in the areas of lifestyle, energy, mobility, entertainment and news. They are also the providers of the associated hardware: data centres, solar farms (e.g. Google Energy), cables, and peripherals (smart thermostats, etc.). In comparison to these parties, the current parties in the energy market like grid operators have less capacity, less expertise and fewer resources at their disposal. Because they have digital knowledge and global ICT platforms, the big tech companies are in a position to become the dominant players on the power grid of the future (Van Est & Dekker, 2019).

With the increasing number of new services in the electricity market, and with digital platforms coming and going all the time, grids have gradually become highly dynamic and complex, with fragmented chains of services (Hollander et al., 2017). And this entails a risk: security of supply could be threatened, or even the capacity to achieve the electrification that the green transition will require. The Council argues that for services in the energy market to function properly, a number of aspects must be in balance:

1. Digitalisation must support the development of services that focus on sustainability goals.
2. Diversity in services and competition most be driving forces.
3. Beyond simply increasing supply, security of supply through reliable services is an essential public value.

Achieving the desired speed of electrification will require a significant acceleration of the development of services. Monopolisation is a risk if services are or can only be offered by major tech companies.

3.2.4 Risks of digitalisation in the service of the sustainable energy supply

Digitalisation of the electricity system will be indispensable for achieving the sustainability goals in the post-transition energy landscape. However, the engagement of digital technologies may also pose risks to public values other than sustainability. Unequal power relationships may arise in the energy domain between the public, businesses and governmental authorities. Likewise, exclusion, loss of privacy and security, lack of control over technology, and reduced autonomy of users can also constitute serious risks (Rli, 2018). In the following, the Council highlights a number of these risks.[66]

Unequal power relationships, reduced autonomy and invasion of privacy
The grid managers that administer the physical electricity grids are public parties. They have access to large amounts of data, and that data is used in part for system management. This primarily refers to 'before the meter' data, which is subject to strict government regulation. However, because the components of the energy system are increasingly connected to the internet and interlinked, data 'behind the meter' is also becoming increasingly important, including for grid management. At present it is primarily the big tech companies that have insight into and access to the data behind the meter.

Only if the government now anticipates the developments taking place will it be able to keep control of the energy supply in public hands (Masson et al., 2020) and provide good governance for the green transition. According to the Council, this is also important in view of the protection of individual civil rights, including privacy and non-discrimination. Because the handling of data behind the meter is still only weakly regulated, the government cannot properly guarantee the civil rights of its citizens at present.

66 The Council bases its observations on Kool et al. (2017).

Offering Bundled Services Gives Companies Insight into Data 'Behind the Meter'

When the production, storage and consumption of electricity are digitally linked, all elements of the energy system are intertwined. This gives the big players the opportunity to gain control of the market by developing bundled services within a closed system. Things like the choice of a thermostat then determine the energy supplier or grid manager, or create a 'vendor lock-in' for other hardware (Aazami & Post, 2017). Additionally, this then gives the market party insight into the consumption data behind the meter: how often the refrigerator opens and closes, what times the washing machine runs, when the computer is turned on, etc.

When companies get access to data behind the meter by offering bundled services, this not only has implications for the privacy of the customers in question; it also limits the 'portability' of their user data. This is because the specific standard used to store user data in one system may mean that this data cannot simply be transferred to another (competing) service provider. The Rathenau Instituut sees this scenario as a vulnerability to economic power concentration; it also identifies risks to national democratic control over our power grid in this context (Rathenau Instituut, 2019). The upcoming Energy Act aims to address these risks by means of clear agreements on data exchange and the handling of data (Ministerie van EZK, 2020c). This refers primarily to before-the-meter data.

Following on from this is the risk that once market power is concentrated in the hands of the large tech companies, smaller parties will then be locked out of entering the electricity market altogether. In such a situation, there will be no guarantees of consumer access at affordable prices. This raises the question of whether the government's stated principles of safe, reliable, affordable and clean can be met without government regulation (Van Est & Dekker, 2019). The new Energy Act makes proposals for keeping the electricity market open to new and/or small parties (Ministerie van EZK, 2020c).

Control of the electricity system becoming more complex

Another risk that may arise with far-reaching digitalisation concerns the manageability of the electricity system. The Council observes that as digitalisation progresses, a different organisation of the electricity system is developing, with a much more fragmented playing field, many more players and different services than was previously the case. This refers not only to players currently operating 'in front of the meter' but also players who are active 'behind the meter'. As a result, manageability is decreasing, because there is no central responsible party to be identified; all parties are needed to make the software and data flows work (Hollander et al., 2017). This is making it increasingly difficult to fulfil the responsibilities of the electricity system and, by the same token, to achieve the sustainability goals.

Lack of control over technology and algorithms

Digitally connecting household electrical devices to the internet gives commercial parties more opportunities to manage energy consumption in homes. This connectivity is based on digital technology and algorithms. Automated decision-making by algorithms and the unforeseen 'behaviour' of autonomous systems ? can lead to undesirable outcomes, for example if all the electric cars in a neighbourhood automatically start charging at the same time because prices are favourable, but the capacity of the local electricity grid is insufficient to support them all. In addition, in many cases Dutch and European legislation does not apply to products from vendors outside the EU, so the requirements that such products must meet are not completely transparent.

Loss of safety, reliability and accessibility

The ongoing digitalisation process is also creating new vulnerabilities in the electricity system (Rli, 2018). Cybercrime, for example, presents a risk of deliberate disruption of a digitalised power grid. But software design errors can also be a lurking threat to the power supply.

In addition, public values such as reliability (security of supply) and accessibility (affordability) of the electricity supply may be compromised if behind-the-meter data is used by commercial parties to make the price of electricity dependent on time, location and user. This is already being seen in the United States, where, for example, in California there is less power available during peak hours for people with cheaper energy contracts (Hollander et al., 2017).

3.2.5 Key points for the government

At present, the digitalisation of the electricity supply is subject to limited government regulation. As the previous analysis has shown, this creates weaknesses and risks. The government has to find ways to manage these problems and risks. In the following, the Council discusses a number of options for governance at each layer of the digitalised living environment.

Governance in the physical environment

In the coming decades the electricity grid will have to be adapted to cope with the large-scale electrification of the economy. Here there are manifold opportunities for the government to manage the process.

To begin with, the government can clarify what the sustainability goals require in terms of change. Achieving these goals will require a significant acceleration. Drafting scenarios, making choices based on them, and then communicating these choices in a transparent manner is the logical way forward. The changes needed relate to both equipment and hardware. On the hardware side, more sensors and 'virtual power plants' are needed, for example. Such investments will require trust on the part of investors. The government can increase this trust by using data to provide insight into the potential, in order to stimulate the development, and can also invest itself.

The standardisation necessary to give devices the connectivity to effectively coordinate supply and demand is also a jumping-off point for the government to consider. The government could place the responsibility with the parties concerned, but could at the same time act as a regulator, in the sense of actually overseeing and regulating how they fulfil that responsibility. Finally, the government, which (lest we forget) is itself an important player in the physical infrastructure, can have a direct and active input into the design of networks. The requirement that new charging infrastructure be 'smart charging'-ready is a good start.

Governance for data quality and data governance

At present there are no sufficient guarantees of a sufficient level of data quality, and further, the governance around data is limited. To begin with, the government could focus on further developing its concepts of data governance. This could start with clarification of the responsibilities and ownership of data. In addition, standardisation and interoperability should also be points of attention, as the handling of data must be governed by agreements. In an interoperable system, market parties must agree on and use standards and (open) protocols ? to connect infrastructure and services. Here the government can play an active role in bringing the parties together on this, for example, through open spaces and ecosystems. But the government can also take regulatory action where necessary, for example on data exchange.

Finally, there is a supervisory and regulatory role by the government in the area of privacy and security. Governance here should focus on ways to keep the power relationships between the public, businesses and governmental institutions in balance, and on ways to guarantee inclusiveness, fairness, privacy, control over algorithms and user autonomy.

Governance towards the required conditions for digital platforms

The electrification of the economy will take shape in part through transactions on digital energy platforms. To ensure that the activities of the platforms have the intended positive effect on sustainability goals, the government can exert influence in two directions.

Firstly, it can set preconditions with which platforms must comply. These must be related to both technical aspects (quality and safety) and legal aspects (price conditions, conditions on types of transactions).

The government can also take initiative by creating its own platform functions to promote the achievement of sustainability goals or to protect other public values.

Governance for the offerings and market position of digital service providers

Digital services are inextricably linked to platforms. The government can provide additional guidance in this area by incentivising the purchase of specific services that promote sustainability. Further, by monitoring digital services and preventing monopolisation, the public sector could help ensure that the power relationships in the market remain in balance and that the market remains open for smaller service providers.

Conclusion

The above points are starting points, each of which require different roles on the part of the government: targeted incentives, becoming a producer itself, regulation, organisation, supervision & monitoring, facilitating.

A variety of instruments will be appropriate for these roles. All in all, governance toward digitalisation of the electricity system can be made more robust by:

- drafting clear scenarios for achieving the sustainability goals for electrification and security of supply and being transparent on how the government chooses from among them;
- strengthening the government's own direct role, particularly in the physical layer and platform layer of the economy, by linking its own facilities with private facilities;
- focusing on governance at all levels of the economy and raising the profile of the government's own role (e.g. through supervision & monitoring);
- promoting digitalisation by e.g. facilitating open data spaces, regulating the exchange and handling of data where necessary, providing funding and incentives for certain services and investments.

Electric Charging: Market Roles and Physical-Digital Infrastructure

Accessible electric charging and smart charging for electric vehicles can be a major contribution to the transition to emissions-free mobility and a sustainable electricity system. In the Netherlands, a market has emerged for charging infrastructure and services; this market works based on concession, permit and contract models.[67] The most common model is the concession model (70% of public charging stations) (Elaadnl, 2020), under which one or more operators are granted exclusive placement rights in one or more municipalities for a specific period. The municipalities and provinces invite tenders, provide funding and set requirements. Private parties handle the operation and services.

Charging electric vehicles requires more than just the physical charging stations. Digital platforms that allow users to access charging services are also essential components of the charging infrastructure. The most significant roles in the charging services market are those of charging station operator, charging service provider, roaming platform,[68] energy supplier and local authority as concessionaire, permitting authority or client (NKL, 2020). Almost all electric car drivers in the Netherlands use

67 In a permit model, multiple parties can apply to install and operate charging points. In the contract model, the municipality itself is the operator and only the delivery, placement and management are purchased (at periodic intervals) during each contract. This model is found in a few municipalities (including The Hague, Zoetermeer and Rijswijk).

68 There are roaming platforms to ensure that electric cars can charge at any charging point, regardless of the brand of the charging point or the driver's charging subscription. Such roaming platforms facilitate issues like payment processing. To do this, the platform handles the data exchange between operators of physical charging stations, charging service providers and providers of adjacent services like navigation. In this way, roaming platforms create a digital and cross-border charging network (RVO, 2019).

a system of subscription or registration with a charging service provider. Charging services are almost entirely digital. Charging service providers provide the payment system and supplemental digital services such as information on location and availability.[69] They enter into contracts with public charging station operators to handle payments (RVO, 2019). Alongside subscription and registration systems, electric car drivers can also charge 'ad hoc'. This means that the user pays directly to the charging station operator without the mediation of a charging service provider. This is not yet an option at all publicly accessible charging points despite commitments from the sector to make it so (NKL, 2020).

The European T&E Recharge EU plan for the development of charging infrastructure sets a number of goals (Transport and Environment, 2020). These include simple and non-discriminatory access to charging points for all users, with fair and transparent pricing and based on standard protocols for interoperability between vehicle, charger and central management system. Additionally, the charging infrastructure must be suitable for smart charging and be smoothly integrated into the electricity grid. The goal is an open charging network, in which charging station operators and energy companies can also create infrastructure in less profitable locations, multiple charging service providers can connect, and new services such as smart charging can be developed.

69 The charging service provider may also be the charging station operator and energy supplier. However, charging service providers are not tied to specific physical charging points as charging station operators are. Some service provider passes will be accepted everywhere, but not all. Additionally, charging service providers have close ties with the grid managers and system operators (RVO, 2019).

The Council observes that in practice, parties are combining several market roles: charging station operators also provide charging and energy services, for example. This leads to large platforms with a lot of market power, which have access to a lot of data and can set the standards for their own services. One result is that data-sharing between charging service providers and operators is insufficient; not all charging service providers have the necessary data or energy supply capabilities to offer services to every vehicle driver that can guarantee sustainable energy use or smart charging.
Charging station operators are already exchanging some data automatically via open protocols (the OCPC), but only selectively with certain partners. In the Netherlands (as elsewhere in Europe), we are currently working hard on creating international, barrier-free roaming, but universal coverage is not yet a reality.[70] Moreover, parties can decide for themselves who they share their data with via roaming platforms. This situation has the effect of making new services only an option for large players, because there is no open market, only contractual agreements between the market parties. This therefore also presents a risk of the market consolidating into only a few international players.

The government is already taking regulatory steps for a more active approach to consumer protections and linking charging services with navigation. These steps are focused on price transparency and better

70 In the evRoaming4EU project, a number of EU Member States including the Netherlands are facilitating the development and use of international roaming based on open protocols. There are already standards and (open) protocols that will make roaming possible (RVO, 2019).

user information. An amendment to the Infrastructure (Alternative Fuels) Decree to do this has been announced.[71] The goal is to require charging station operators of publicly accessible charging points to share user information about charging points (Tweede Kamer, 2020i).[72] This data includes location, occupancy status and ad hoc charging price (without subscription). Users must be able to consult this information via apps or websites. This data must also be available to commercial developers of apps and systems like navigation services. In terms of the technology, the charging systems are ready for this. The change primarily entails that some charging station operators will have to exchange more categories of data.[73]

A next step, which has not yet been planned, would be to move towards a market regulation that allows choosing one's own energy supplier or opting for smart charging, as the T&E Recharge plan envisions.

71 This step follows from the implementation of Directive 2014/94/EU of the European Parliament and of the Council on the deployment of alternative fuel infrastructure (OJEU 2014, L 307). This directive is intended to enhance energy security for transportation and reduce the environmental impact of fossil fuels. The Infrastructure (Alternative Fuels) Decree implements this Directive.

72 See: https://www.internetconsultatie.nl/gebruikersinformatie_oplaadpunten

73 The market is also taking steps under the leadership of industry association eViolin to develop an annual progress benchmark, a complaints desk and a guide for concession authorities on installing charging points.

3.3 Increasing sustainability of passenger mobility and accessibility

3.3.1 Challenge

Although the Netherlands has extensive infrastructural networks for cars, public transportation, railways, bicycles and pedestrians, accessibility problems still exist in this country. Until the coronavirus crisis broke out in March 2020, road and rail congestion was steadily increasing, as were people's mobility needs in general. The expectation is that after the crisis, more people will be working from home (at least partly) than before it, but that nonetheless we will return to steady growth in mobility needs.

And this mobility will have to be clean. The national Climate Agreement sets concrete targets for the mobility sector for 2030. The focus in policy is on electrification and smart and efficient use of the mobility system, along with, to a lesser extent, the promotion of clean, advanced fuels. There is also an ambition to reduce emissions of particulate matter and other air pollutants from mobility and to further reduce noise pollution from traffic (Rijksoverheid, 2020). Sustainable mobility is also understood to mean safe mobility, this in part in reference to traffic safety.

In addition, over the coming decades the Dutch government wants to reach a point where accessibility in the Netherlands is guaranteed[74], even as mobility increases. The ambition is the Netherlands as network of

74 Accessibility is the degree to which various locations for activities can be combined in terms of time and space. The more activities that can be performed in an area within a given time, the better the accessibility. This does not necessarily mean movements through the physical space; in other words, accessibility is not the same thing as mobility (Rli, 2017b).

interconnected cities and regions, supported by a fast, sustainable and comfortable mobility and transportation system. Innovations of all kinds must ultimately enable everyone to move about smoothly, with a minimum of harmful emissions and nuisance (Rijksoverheid, 2020). Thus, the challenge is to create an integrated mobility system for travel by car, public transportation, bicycle and on foot. The goal is a system that revolves around the traveller and makes traffic and transportation safe, affordable, reliable and with predictable journey times and travel alternatives.

3.3.2 Digitalisation and more sustainable personal mobility

The world of mobility is going digital. The car has evolved from a mechanical device to a 'data-producing embedded software platform', and we meet our mobility and transportation needs by turning to various online applications that rapidly match supply and demand (Van de Weijer, 2020). Digitalisation in the rail sector is expanding as well, in part because of the introduction of ERTMS,[75] experiments with automatically running trains and a passenger service that is increasingly digital. Digitalisation has also given rise to a whole range of new sharing systems for passenger mobility, such as shared bicycles, shared electric mopeds and shared electric scooters.

These developments not only increase the ease of use for the traveller, but also have the potential to help meet the government's challenges for the mobility sector described in the foregoing. Of course, digitalisation does not automatically make mobility sustainable, but it is an absolute requirement for integrating the components of the multimodal mobility system in order to give the traveller a reliable and predictable journey and to make safer traffic and reduce emissions.

Better provision of information

Digitalisation has set society off on a movement towards an increasingly reliable and predictable mobility system for travellers. In the past, the collection and provision of traffic information was reserved to the government. But today, we have become accustomed to getting our traffic information from market parties like TomTom, Google and Waze. This information is collected using 'floating car data'[76] (Van de Weijer, 2020). Likewise, in public transportation, digital information is also making it easier for passengers to keep abreast of current traffic conditions, the best route for the intended journey, departure times and ticket prices. An increasingly common feature even allows comparison of the CO_2 emissions of different travel options.

The developments in these technologies are showing no signs of slowing down; each new generation of car gives drivers more and more information, about the maintenance status of infrastructure, slippery conditions, accidents ahead, etc. while on the road. Similar systems are even appearing in some smart bikes and on sensor-equipped bike helmets.

75 ERTMS is the European Rail Traffic Management System.

76 GPS data from smartphones and navigation systems in moving cars, devices that are sending out location information on a constant basis. This accumulated data gives a picture of the current traffic flow or congestion.

Improving traffic management

Because travellers now commonly have access to reliable navigation systems, they are increasingly adjusting their travel behaviour based on real-time information. One possible direct consequence of this development could be that traffic may start to behave like a self-managing system and distribute itself better over the available capacity of the mobility networks. This would mean a change in the government's role in traffic management. It is clear that existing traffic management techniques are becoming less important. Roadside systems ?, for example, which are very expensive to construct and maintain, are fast losing their added value because the information from sensors in cars is more reliable and travellers are more inclined to follow their own navigation system and the personalised information it provides.

Digital technology also offers the opportunity to improve rail traffic management. The roll-out of systems such as ERTMS, for example, can make a significant contribution to increasing the intensity of use of the existing rail network (Rli, 2020b).

Less mobility

For large parts of our economy, working remotely online has become possible thanks to digitalisation. The coronavirus crisis has shown that in practice, the obstacles to working from home and online meetings are fairly minimal; previous objections to working from home and resistance by employees and employers alike have proven unfounded. All in all, the crisis has triggered a shift towards more flexible working hours and workplaces. This is symptomatic of the fact that the greatly increased digital accessibility of citizens has and will continue to have far-reaching consequences for mobility on the physical infrastructures. In its advisory report *Green recovery* (Rli, 2020a), the Council advised the government to seize this momentum and shift its emphasis away from investment in infrastructure and toward the maintenance, replacement, modernisation and sustainability of existing infrastructure.

Demand-driven mobility

The digitalisation of society has set off a movement towards mobility services that bring together the demand of travellers and the supply of travel options in smart ways. One important concept within this development is 'Mobility as a service' (MaaS). MaaS is passenger mobility via an online platform for searching, comparing, booking and paying for various mobility services (KiM, 2019). It gives users real-time access to transportation options and combinations of transportation options via an app.[77] Although most mobility apps do not yet offer complete integration of functions and supply, mobility services do already have the potential to match supply and demand for specific target groups or for specific areas. Demand-driven mobility such as MaaS can play an important role in reducing car use in cities, keeping sparsely populated areas accessible and keeping people mobile without access to a bicycle, car or public transportation (Van de Weijer, 2020). Under the direction of the Ministry

77 In practice, there are several different models. Sochor et al. (2018) identify five levels with varying degrees of integration of functions: information provision only, without integration (0), integration of information such as a journey planner and price information (1), bookings and payments (2), services such as bundles or subscriptions (3), and integration of societal goals (4). IenW's seven national pilots are set up for full integration up to and including level four.

of Infrastructure and Public Works (IenW) seven national pilot projects have been launched since 2019. IenW intends to use MaaS to help achieve societal goals such as CO_2 reductions, better utilisation of available capacity in the multimodal mobility system, traffic congestion problems and affordability. It is therefore clear to IenW that in optimising the mobility system, MaaS must be a benefit not only individual users but also society at large.

Shared mobility

The digitalisation of society has also spurred the development of mobility sharing platforms. Before digitalisation, this generally took the form of companies renting vehicles, like cars (business-to-customer, b2c). But now, there are myriad ways in which people can access shared vehicles provided by organisations. You no longer need to pick up and drop off the vehicle at a central point; instead, you can find many spread out across the city and available at any time of the day.

In the Netherlands you will find numerous examples of b2c shared mobility for cars, bikes or scooters. Digitalisation has also made it much easier for consumers to share vehicles or rides with each other directly (peer-to-peer, P2P ?). Two prominent p2p-sharing platforms are SnappCar (p2p) for cars and Blablacar for ridesharing.

What the ultimate impact of the development of shared mobility will be on the achievement of the sustainability goals is still uncertain. On the one hand, the expectation is that shared mobility will lead to fewer vehicles being used and thus to reduced CO_2 emissions and more efficient use of space. But there is also a risk of the opposite effect arising, in that vehicles may be used more intensively (Rli, 2017b).

Focused governance for sustainability goals

Passengers, vehicles and infrastructures are generating more and more data, much of it extremely useful. Beyond optimising traffic management, the government can also use this data to stay in control of the overall mobility system, its sustainability effects and its various other aspects. This data can be used, for example, to develop instruments that encourage people to make more sustainable mobility choices. If more people opt to use a shared mobility modality, this can be expected to result in significant reductions of CO_2 emissions (Replogle & Fulton, 2014).

In addition, the government can use the mobility data to develop pricing instruments, for example models that allow individuals to pay for use of the car (rather than for owning it) or to tax the environmental impact of mobility; but beyond this, more information/communication-oriented instruments, like 'rush-hour avoidance', can be used more accurately with the aid of mobility data. It should be noted that the seven national MaaS pilot projects were set up partly with a view to new ways of data-driven governance toward the achievement of societal goals, including sustainable transport (Tweede Kamer, 2018a). The government realises that the achievement of the potential sustainability and accessibility benefits of MaaS will require cooperation and transparency in the MaaS ecosystem and active commitment from governmental institutions (Tweede Kamer, 2018b).

Improvement in traffic safety
The majority of traffic accidents in the Netherlands can be attributed to human error. Digital technologies that can help drivers, also known as advanced driver assistance systems (ADAS), can help reduce this type of accident. These systems use cameras and sensors to analyse the environment and draw the driver's attention to dangerous situations or, in extreme situations, intervene where necessary. Equipping cars with ADAS has been a growing trend for some time (Van de Weijer, 2020). Although the use of ADAS does entail some risk compensation by drivers, at the end of the day these systems significantly increase safety (IIHS-HLDI, 2019).

The government can also take advantage of ADAS technologies. The traffic data that these systems collect can be used to make analyses about actual risks, which can be used to better assess what road safety measures are most effective (IenW et al., 2018).

3.3.3 Digitalisation in personal mobility using the layer model

Digitalisation will transform passenger mobility, and the use of digital technologies can help the government to meet the sustainability challenges for the mobility sector. In the following, the Council analyses the concurrence of mobility tasks and the digitalisation of mobility at the various layers of the living environment, based on the layer model described in chapter 2 of this part 2.

Physical environment
Infrastructures are the physical basis of mobility. Collecting a large amount of data about when infrastructure maintenance is needed can enable predictive maintenance ? to be done on the infrastructure, as is already happening in the rail sector. With predictive maintenance, data collected by digital sensors is used to calculate the optimal maintenance interval, i.e. not too early (when it is not yet necessary) but also not too late (when maintenance issues create unsafe situations). This reduces costs and prevents failures. With digital technology and the data it generates, the use of materials in maintenance can also be made more sustainable and efficient (see also the case study on the circular construction economy in section 3.1 of this part 2).

The vehicles on the infrastructure are also part of the physical environment. The fact that more and more cars are being equipped with smart digital technology is a relevant factor for the design of the physical living environment, and specifically the design of the infrastructure. Experience shows that smart vehicles ? benefit most from simple infrastructure.

Digitalisation also offers opportunities to regulate access to infrastructure in new ways. This is being done on the Dutch road network, albeit still on a limited scale, for example delivery vehicle access to city centres. But elsewhere, like in central London or on French motorways, digital sensors are being used extensively to reduce traffic congestion by pricing access to infrastructure.

Data layer

The digitalisation of the mobility domain goes hand in hand with the explosive growth of data and data flows. It is not only about data on actors (users and service providers), but about environmental data generated by various sensors, including those in vehicles. Data is collected at all layers of the layer model. Organising and processing the data happens on the data layer.

Data collection and data exchange are increasingly essential for the functioning of the mobility system. User data and environmental data are needed to match the demand for and supply of mobility, improve services, increase efficiency and manage infrastructures. User data and environmental data are also essential for setting up business models for services. The development of mobility services such as MaaS, for example, is extremely dependent on the availability of good traveller data.

'Digital twins' that can be built based on environmental data (see the circular construction economy case study in section 3.1 of this part 2) have great predictive value for the functioning of the mobility system (Van de Weijer, 2020). Exchange of and access to usable data is therefore essential for the reliable functioning of the mobility system for many reasons, not least of which to guarantee the accessibility and sustainability of mobility.

It is important to keep in mind, however, that privacy and security considerations affect the availability of data, particularly when it comes to traveller data. This is illustrated very clearly by the situation surrounding the 'OV-chipkaart', the Dutch national public transportation card. In the Netherlands, all public transportation transactions are processed by Translink, as issuer of the OV-chipkaart. Translink manages the data on travel movements (and the use of products and services) and compiles this into travel patterns. This gives Translink a cross-sector view of every traveller, including origin and destination, modalities used, travel times and distances travelled. Translink does not share this data with commercial parties, however, which is also important from a privacy perspective.

The Council observes that data is increasingly at the heart of the business models of market players in the mobility domain. Parties with access to a lot of data, particularly user data, have the advantage of being able to better adapt their services to changing usage patterns and needs. This makes data increasingly valuable (McKinsey, 2016).

Platform layer

In the mobility domain, there are now various types of digital platforms active, and these are increasingly determining the functioning of the entire mobility system.

- We have already referred to platforms such as Google Maps, OV9292 and MyRoute, on which travellers can find information about routes and travel times and which they can use to navigate in real time during their journey. These platforms combine route and traffic information obtained from a variety of sources. More than a source of information for the traveller, they are also integrated with other mobility platforms and services.

- At the same time, moving vehicles are increasingly developing into digital platforms themselves. They are connected to each other and exchange data with each other and the environment: traffic conditions, road conditions, weather conditions, etc. These vehicle platforms are also a target group for providers of software such as infotainment and driving task support systems (McKinsey, 2020).
- Another type of digital platform brings the supply of and demand for vehicles together. There are, for example, various sharing platforms where people can borrow a car from private car owners (such as SnappCar or MyWheels). Then there are various commercial sharing platforms for vehicles, such as Greenwheels (cars), Share2Use (various vehicles), Bird (electric scooters) and Jump (electric shared bicycles). There are also digital platforms that bring together supply and demand for journeys. Perhaps the best-known are Uber and Lyft, platforms that provide drivers on call. They also offer the possibility to integrate other services, like parcel delivery.

But many digital platforms in the mobility domain do not limit themselves to offering information or matching supply and demand. More and more integrated mobility services are being provided. Uber and Lyft, for example, not only link supply and demand for movement, as already described, but also make it possible to reserve and pay. And the NS Reisplanner of the Dutch rail company not only contains real-time travel information for trains, but also information about onward journeys and other facilities at the destination, plus the option of purchasing a train ticket. The Mobility-as-a-Service pilot projects go even further, connecting various modalities and making them accessible to the traveller, including booking and payment functions.

Services layer

The combination of data flows and digital platforms changes how traditional traffic services work. Today, we can hardly imagine travelling by taxi, public transportation or train service without some digital technology being involved. Even a trip in your own car will virtually always be accompanied by the use of a navigation app by default.

This digitalisation has produced a whole range of new services, often fully integrated and almost impossible to separate from the platforms described above. Car and bike sharing, MaaS and route navigation are all mobility services that are inextricably linked to the underlying platforms.
The development and functioning of digital mobility services is highly dependent on functionalities in the physical environment (smart vehicles and an infrastructure adapted to them) and the data layer (flexible data collection, data use and data exchange). Without these functionalities, digital mobility services cannot develop optimally. And without accessible platforms, the services themselves will likewise not be accessible.

3.3.4 Obstacles

The Council observes that personal mobility is already changing as a result of the digital developments outlined above. Having said that, the Council also notes that in practice the digital possibilities are still mainly being used to optimise existing mobility systems and transport modes, and that new, multimodal concepts aimed at sustainable mobility have yet to really take off. Widespread use of fully integrated MaaS concepts, for example, is still a long way away. And a mobility platform like Uber has, at least so far, been little more than an optimisation of the existing taxi system, the primary distinction of which is mainly the different arrangements for employees. Further development and scaling up digital applications that could make mobility more sustainable is therefore needed. Here, the Council does see one significant obstacle: the still *limited exchange of data* between parties.

It is not only the operation of digital platforms and mobility services that depend on the availability of large amounts of reliable mobility data; so too does effective government governance of emissions, safety and accessibility. This data needed is now collected via services and sensors and logged on a large scale. And this is increasingly part of the business model, particularly in the automotive industry (Van de Weijer, 2020). Although the data is there, it is not always available to parties and governments in the mobility domain that could benefit most from it. Translink, for example, does not share passenger data for commercial purposes (as already noted).[78] But commercial providers of transportation and mobility services consider this data necessary for improving their services, on aspects like the strategic placement of bicycles or taxis, for example. And for governmental institutions, it is sometimes difficult to obtain the data they need for the achievement of their mobility and sustainability objectives. Whereas once most data on infrastructure and mobility was in the hands of the government, many data flows are now in the hands of private parties, and the government now buys this private data or exchanges it for other data, like data about the deployment of emergency services.

Experience has shown that the cooperation needed for smooth data exchange still does not happen by itself (or quickly enough). Providers of public transportation, shared mobility, digital interfaces and applications still do not partner readily and share very little data amongst each other (Nikitas et al., 2017). Most parties are reluctant to make their data available, either for competitive reasons or because of concerns about the privacy and safety of the public (Van de Weijer, 2020). Moreover, from a commercial point of view most established parties work to develop their own standards for data collection. This means that ultimately these large, established parties have little to gain from exchanging data.

For some purposes data exchange can be made mandatory. Car manufacturers are already obliged (under the European ITS Directive 886) to share some vehicle data relevant to road safety with governmental institutions and third parties (primarily data about things like braking behaviour and shock absorber deflection).[79] This data can be used for reporting on road safety. The reality is not always as cooperative, however,

78 Steps are being taken to streamline the accessibility of public transportation data. To take the example of Translink, in April 2019 Translink and Statistics Netherlands signed a letter of intent on cooperation in the areas of statistical applications of OV-chipkaart data in the public interest, privacy protection and data processing methods (Tweede Kamer, 2019d).

79 Types of data for which access is regulated by European regulations include: maintenance and management information, safety-related traffic information and accident data for emergency services and accident analysis (Ecorys, 2020).

and even this mandatory data sharing is not always happening.[80] Beyond this there is no similar government regulation for sharing data on accessibility and vehicle emissions.

The insufficient availability of data is a particular problem for multimodal digital services such as MaaS services. These types of mobility service requires more intensive data exchange between transportation service providers to determine the best journey for a traveller. The government is doing everything it can to promote the sharing of data, from pilot projects to agreements with the automotive industry at the EU level.[81] It is also important to note that in the Delta Plan 2030 all public transportation companies committed themselves to developing a system of agreements for Mobility as a Service in the coming two years, particularly about standards for access, use and sharing of data. A decision on statutory provisions for making passenger data available is still expected (Tweede Kamer, 2019d).

3.3.5 Risks of digitalisation for sustainable mobility and other public values

Sustainability

Making mobility more comfortable with digital applications can be detrimental to the achievement of sustainability goals. Consider that as cars take over more aspects of driving from the driver, long journeys and driving in traffic jams will become more comfortable, so there will be less incentive to avoid such journeys; drivers will then be more inclined to take the car instead of more sustainable public transportation modalities (Van de Weijer, 2020). However, the flip side of this is that digitalisation of cars will mean increased efficiency and a more sustainable driving style.

We see a similar two-sides-of-the-coin dynamic when it comes to digitalisation and accessibility. Digital mobility services can lower the threshold on access to mobility. Although this is good for accessibility, it can also have a knock-on effect and lead to an increase in the total number of physical trips, potentially raising infrastructure pressures and increasing harmful vehicle emissions.

Autonomy and freedom of choice for travellers

Data and platforms facilitate increasingly better and more tailored mobility services, putting travellers and their needs in the proverbial driver's seat. At first glance, this would appear to increase their autonomy. But platforms don't just facilitate mobility; they also, to some extent, control their users (Van Dijck et al., 2016). The platform may, for instance, choose not to include cycling as a modality in its travel advice but make the choice to include a taxi service. This form of control is primarily dictated by the business models of platform services. Here again, this can have both positive and negative effects on the sustainability of the mobility choices made.

80 The International Data Task Force was established by the European Commission in 2017 to work with the sector to accelerate the process and develop notification practices.
81 See https://www.rijksoverheid.nl/actueel/nieuws/2019/06/03/eu-landen-en-autofabrikanten-delen-informatie-voor-meer-verkeersveiligheid

The public's access to the mobility system
More and more digital mobility services are offered through platforms, and more and more travellers are using digital platforms to access these mobility services.
This makes digital platforms crucial to the accessibility and affordability of the mobility system for most individuals. It also means that people need to have the 'digital skills' to be able to use a digital platform; a lack of such skills is an obstacle to access. In addition, price increases determined automatically (by algorithms), say for travel at peak hours, may limit access to mobility for lower-income households. By the same token, price reductions during off-peak hours can increase access.

Market power
The influential position that platforms enjoy also represents a risk to access to the market for mobility services by other parties. The administrator of a MaaS platform or Google Maps has the power to influence who can connect to which services or which services are most visible to platform users. On no account can we assume that these choices will always be dictated by what is best from a sustainability or accessibility point of view. Quite the contrary, in most cases commercial interests will be the deciding factor. This means that the market power of platforms can limit the availability of services that benefit the government's sustainability and/or accessibility goals.

The influential position of platforms can also come at the expense of the competitive position of (generally smaller) service providers on the same platforms. There is little to stop platform operators from using the user data they collect, both from the services and the travellers on their platform, to offer a better service themselves and to compete with other services on the platform. The platform operator is then in a position to maximize the visibility of its own service on the platform. This makes competing with a platform operator's service extremely difficult. When the platform operator and the main service provider on the platform are one and the same, the risk of a self-reinforcing 'winner-takes-all' situation arises (Van de Weijer, 2020).

Changes in market power relationships driven by digitalisation also come up when the question arises of who has influence on the use of physical infrastructure and to what degree. There was a time when the Department of Public Works (*Rijkswaterstaat*) was the only party controlling the use of the road, with its traffic indicators and signage; but today, the influence of the digital route information services for motorists cannot be ignored. Now, the choices that providers of digital route information services make in advising users, for example in finding the fastest route, are of major influence on road usage (Van de Weijer, 2020).

With the MaaS pilot projects, the Ministry of Infrastructure and Public Works is working with the regions to create an open MaaS ecosystem in which public and private parties cooperate and which provides a level playing field for market parties. The goal is to create a combined public-private ecosystem of MaaS platforms with shared standards for data exchange. The Council concludes that a successful introduction of MaaS will require flanking policy, including the external effects of digital platforms, vertical integration ?, data exchange and a level playing field. The pilot projects will monitor social impact, sustainability, market development and consequences for policy and governance options (Tweede Kamer, 2018b).

Privacy

Data about a person's travel behaviour can say a lot about the person's life. This is why this type of data is extremely privacy-sensitive. The collection and sharing of this data raises questions about ownership, compensation and what manufacturers or service providers may do with this data (Van de Weijer, 2020). On the subject of the navigation data obtained from cars, the General Data Protection Regulation (GDPR) stipulates that the driver of a car must have control over what happens to this data. But that is still not the case in practice; it is still primarily the manufacturer or supplier of the navigation system that manages this data.

3.3.6 Key points for the government

Digitalisation offers many opportunities to make our mobility safer, cleaner and more accessible. The analysis in the previous sections shows that these opportunities are already being developed, in many cases through initiatives by commercial parties, but that this approach can lead to tensions with various public values. These tensions arise principally because the (primarily legitimate) commercial interests involved in digital developments are prone to clashing with the societal interest in a sustainable, accessible and reliable mobility system. It is therefore a legitimate question of whether developments in the digital realm will automatically lead to the most desired outcome for society. Clearly, the government has a role to play in intervening in these developments where necessary. In the following, the Council outlines a number of possible key points for the active, intervening government role required.

Develop standards to promote data exchange

As outlined in section 3.3.4, the upscaling of digital applications that could make mobility more sustainable is currently impeded by the fact that the exchange of data between market parties is still very limited. Shared standards for registering data and making it available can be valuable here. Beyond standards for data formats, it is primarily about agreements on what data is to be shared between parties and under what conditions. These standards and agreements are not currently being put in place because the existing parties have little commercial interest in sharing their data.

This is exactly where the government should direct its action: together with the market, it can work on standards that transcend the interests of one party, but benefit the overall sustainable development of the mobility domain. Agreements to promote data sharing can then help new, small parties to gain access to the right data and the market. This will be a limiting factor on the market power of large parties with a lot of data and an impediment to market consolidation. The agreements can also ensure that governments have access to the right data to facilitate governance for sustainable mobility. The Ministry of Infrastructure and Public Works has already started to develop standards as an intermediate step in further developing MaaS (Tweede Kamer, 2018a).[82]

Taxing environmental impact

Digital platforms and mobility services make it possible to track who is using what means of transportation and what travel movements they are making. With this information, the government has a tool to charge the environmental impact of a travel movement, to a very precise degree, in the form of a tax. In practice, it can do this by taxing platforms and mobility services by the type of travel movement they facilitate. A kilometre travelled by train (and therefore powered by green electricity) could be taxed less heavily than a kilometre travelled in a car powered by fossil fuels. At the other extreme, a trip on a rental bike could even be subsidised by the government. The use of this data may, however, be at odds with the guarantees of privacy that users can expect; this is a point for attention.

Digital traffic management

The government could also tie in with market parties' digital applications to improve traffic management and increase traffic efficiency. Route planners and platforms that match supply and demand are increasingly determining the use of the physical infrastructure. Entering into public-private partnerships with these parties can enable the government to use these resources for traffic management, which can improve accessibility. Road works and speed indications, for example, can be indicated digitally in route planners. And platforms that offer various modalities can encourage users to take the train or travel by bike while roadworks are happening. The same applications could also be used to promote transportation with less environmental impact. Instead of the fastest route or the cheapest transportation provider, the government could instruct platforms to display the option with the lowest emissions.

Open platforms for transportation services

Equal access to mobility platforms for travellers is a condition for ensuring equal access to mobility. If the importance of transportation platforms continues to grow, travel via platforms will have to be affordable and available to all, even in places where it is less commercially interesting. It is important for service providers to also have equal access to these platforms in order to maintain fair competition. In order to ensure both of these things, the government can impose accessibility and availability requirements on existing and new platforms.

The government could also develop its own platform offering mobility services for travellers. This could be an open platform that all mobility services can join to offer their services on and that all travellers can use to plan, book and pay for their journeys. Such an open platform set up by the government could take a number of different forms. The platform could, for example, be developed by a public authority set up for the purpose, or it could be a contract put out to the market. One could also consider a

82 For example, with the international Transport Operator to MaaS Provider working group. This initiative on the part of the Ministry and Dutch shared transportation providers has developed an Applicable Programming Interface that facilitates data exchange between service providers and transportation providers. These interfaces can also be used to make the transportation offered available in systems other than those of the company itself.

smaller-scale approach by which the government limits itself to establishing a set of agreements and rules that guarantee the interoperability of platforms in the market.

With a regulated platform the government can set requirements for the emissions and safety of the mobility services offered on the platform. Then, participation in the platform could be limited to only parties that meet these requirements. In essence, this does not differ all that much from how the government already imposes requirements on the use of the road infrastructure it owns.

A government-regulated platform also presents the option to establish a system of licenses and concessions. This could, for example, mean that a service provider will only be licensed to operate on the platform if it meets certain requirements, and that a carrier will only be granted a concession for a particular route if that mobility service is offered to passengers on the government-regulated platform. This would allow the government to make use of the influential position of platforms as a connector between mobility services and travellers.

Encouraging working from home to reduce kilometres

Digitalisation not only offers opportunities for improving accessibility and for policies to incentivise emissions-free transport; it also offers a chance to reduce travel-related environmental impact by encouraging people to not travel at all. Increasing the opportunities to work from home and meet remotely significantly reduces the number of travel movements. This is something that the coronavirus pandemic has clearly demonstrated. Promoting this may be the biggest sustainability gain from digitalisation (Van de Weijer, 2020). The government can take various steps to do this, such as improving the digital infrastructure, encouraging employers to facilitate working from home, and setting a good example by facilitating this for its own employees.

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APPENDICES

GLOSSARY

Platform/digital platform A technological (digital) infrastructure that facilitates and organises interactions and transactions between individuals and organisations by linking demand and supply for goods, services and/or information and knowledge. Data is the fuel in this process (CBS, 2018; Van Dijck et al., 2016).

Behind the meter The part of the electricity grid on the user side of the electricity meter. This refers to the collection of appliances in a house or building that consume or produce electricity.

Aggregator A party, device or system that bundles (aggregates) and resells supply or demand in the market. The term is used in the electricity domain primarily to denote a party that bundles and sells the flexibility of small-scale energy consumers and suppliers.

Algorithm In its simplest form, an algorithm is a mathematical formula that is used to automate transactions. Broadly speaking, there are two categories: rule-based algorithms (the algorithm follows a set of rules defined by a programmer) and learning algorithms (algorithms that improve themselves using 'machine learning').

Augmented Reality (AR) A live representation of physical reality through special glasses or a screen in which the environment has been digitally altered or elements have been digitally added to it. An example would be a three-dimensional projection of a building on an empty plot of land. This is to be distinguished from a Virtual Reality environment that is entirely computer-generated and in which physical interaction is possible.

Autonomous systems Systems that can function independently, without human intervention, on the basis of algorithms. These systems function by following choices made in the design or during configuration.

Big Data Large amounts of varied, unstructured data generated from electronic activities, often with high velocity. The data can take different forms, such as numbers, text, audio or video. It may be sourced from social media, production processes of companies, or other sources. Structured or unstructured data is also generated in the physical environment by a variety of sources, for example digital user applications such as navigation systems, cameras and sensors in objects.

Building Information Model (BIM) Used to create a digital model of a building that contains information about the building. It often starts with a 3D model of the physical properties of the building. This allows different parties involved in the construction to work on a single digital model of the building (Chan, 2020; Sante & Doelen, 2016). A BIM may incorporate a variety of information, such as building elements, materials, system settings, etc.

Data-driven Refers to processes in which insights from data analysis play a prominent role. Actions in areas like decision-making or production and management processes are based on the collection, organisation and interpretation of data. An example of a data-driven process is using data analysis to predict how road maintenance can be done most effectively and efficiently.

Data governance The complete body of rules, responsibilities, agreements, standards, procedures and resources that define and determine how data is handled. In practice, this includes things like exchange mechanisms, agreements and technical or nontechnical standards for data quality. It may pertain to rules within a single organisation, agreements between several organisations that exchange data, or super-sector regulations such as the GDPR. Data governance determines to a large degree how data can and should be used and the underlying principles of this use.

Digital Twin A digital copy of a physical product, service or ecosystem. The digital copy and the physical element are interconnected, so that changes to the physical element are reflected in the digital copy in real time. A digital twin is used to perform virtual simulations. In addition, it can be used to assess and predict future scenarios (Qi & Tao, 2018).

Digitalisation The Council defines digitalisation as the development and application of digital technologies and data. These digital technologies and data have far-reaching direct effects and indirect effects on society, the economy and individuals. The Council distinguishes between the use of digital technology for specific purposes (such as the achievement of sustainability goals) and the broader changes that digitalisation brings about in society (with their impact on sustainability).

Energy carriers Substances such as hydrogen, coal, natural gas and petroleum that contain energy that is released through combustion. Energy carriers are used to store or transport energy.

European Rail Traffic Management System (ERTMS) A digital safety system in trains and railway infrastructure that enables train and infrastructure to communicate with each other. ERTMS will be implemented over the next ten years and will replace the old (analogue) safety system with signals. It will become the international standard for train safety both within and outside Europe.

Data space A collection of linked data/databases structured in accordance with a common architecture. A data space brings together data from different sources and of different formats and makes them accessible and suitable for reuse. It can be used for exchange, aggregation and analysis. It is a broad concept and the architecture (technical and organisational) may differ. For example, the European Commission envisions a system for European data rooms to connect existing public and private data platforms.

Green gas Gaseous energy carriers of biogenic (non-fossil) origin, generated in a sustainable way. An example is biogas from fermentation of biomass or landfills. In the Netherlands, green gas is refined to natural gas quality and injected into the natural gas network.

Raw materials database A digital collection of data on raw materials in products, semimanufactures, infrastructure, etc. The information may include quantities, volumes, where the materials are located and their quality. The information in a raw materials database may come from materials passports.

Internet of things (IoT) The development by which smart physical objects are connected to the internet and to each other so that they can communicate or exchange data. One example would be a coffee maker that turns on when the alarm goes off in the morning. The objects may be lampposts, bridges, vehicles and smartphones, or components thereof. These IoT components generally have sensors, computing power and communication capabilities. This creates networks of objects that can monitor, analyse and manage the environment. A specific type of IoT is the *Internet of Energy* (IoE) in which objects that consume or produce electricity are connected and communicate about electricity use. This may include energy services.

Interoperability The ability of systems or devices to work together, communicate and interact. As an example: various telecom providers are interoperable. You can use your KPN number to call a Vodafone number.

Artificial intelligence Artificial intelligence is referred to when devices or software applications perform tasks that normally require human intelligence. These are usually systems (such as machines and software) that themselves exhibit intelligent behaviour by analysing their environment and - with a certain degree of independence - taking action to achieve specific goals. Artificial Intelligence can include algorithms used to learn autonomously, i.e. without guidance, from data and input. This is called machine learning. By also learning from its own mistakes, an AI can produce increasingly good results.

Charging service provider (also referred to as Mobility Service Provider (MSP)). A party that is the primary contact for users of charging points for all services related to electric charging. A charging service provider provides the payment system and supplemental digital services such as information on the location and availability of charging points. However, charging service providers are not tied to specific physical charging points as charging station operators are. They enter into contracts with public charging station operators to handle payments (RVO, 2019). The role of charging service provider is fulfilled by various parties including car manufacturers. The service provider may also be the charging station operator and energy supplier.
Charging Station operator Is responsible for the technical and administrative management, maintenance and operation of charging stations. Administration includes things like access to the charging station and payment processing arrangements with charging service providers. Administration and technical maintenance may be placed with separate entities (RVO, 2019).

Machine learning A form of artificial intelligence in which systems based on algorithms learn from processed data and use it to improve their performance. There are two forms. In *supervised* machine learning, a human teaches the algorithm the conclusions to draw from data. The algorithm is then trained using a dataset that has been pre-labelled, with the correct output specified. This is the most common form of machine learning. In *unsupervised* machine learning, an algorithm learns to recognise patterns independently. It trains itself based on data without labels or pre-specified output.

Materials passport A form of register of materials linked to a specific, identifiable object, for example a building or a building element (Transitieteam circulaire bouweconomie, 2020). It makes clear what materials have been used in a building and in what quantities, including information on quality, location and financial and circular value.

Mobility service A service that facilitates and supports a traveller and their journey. These services may range from conventional services, such as car and bike hire, traffic information and route planners, to newer digital services such as real-time route information and car sharing (Rli, 2018). Familiar examples of digital mobility services include Google Maps, Uber, Lyft, SnappCar, and (in the Netherlands) 9292OV and the NS app.

Mobility as a Service (MaaS) A service that facilitates passenger mobility by offering an online platform with options for searching, comparing, reserving and paying for various types of mobility services. The platform provides up-to-date and relevant information about those services to the traveller, typically via an app. The concept represents a shift from privately owned transportation to mobility that is offered as a service.

Grid stability An effectively functioning electricity grid must be stable at all times. This is the case when energy production and consumption are in balance. When this is not the case, energy production must be adjusted upwards or downwards. This is something the grid managers are responsible for. Grid stability is a critical factor for the reliability of the electricity supply.

Peer-to-peer trading (P2P) Trade between parties that are equal or of similar type. For example, the sharing of vehicles for payment or consumers trading electricity with other consumers.

Persuasive technology Technology designed to influence people and encourage desired behaviour.

Platform economy An economic system in which transactions and interactions are conducted via digital platforms.

Portability The property or ability to receive the personal data or other data that an organisation has, with the option to transfer it to another organisation. This is also referred to as the 'right to data portability'.

Predictive maintenance Maintenance on infrastructure or objects, by which sensors and data are used to predict when the maintenance will be required. This allows the maintenance to be performed before failures occur.

Product-as-a-service An arrangement by which a physical product is provided to a consumer as a service. The consumer may use the physical product as long as the arrangement is in force, but the supplier remains the owner of the product and is responsible for its functioning.

Protocol In the context of this advice, this refers to established rules and agreements on the handling and exchange of data.

Public value(s) This refers to aspects that are considered valuable to society and worthy of recognised collective attention. Broadly, these can also be collectively referred to as 'public values'. They can be defined as 'the collective image of what society perceives to be valuable' (Talbot, 2006), 'and established in a way that is legitimate and inspires trust among the society' (Moore, 1995). What these public values are is not predetermined and fixed, but rather is the outcome of an ongoing political process. In the Netherlands, it is ultimately the democratically elected parliament that decides what issues merit collective attention (WRR, 2012). These may be public values that transcend domains, such as equal opportunities for all or living in a safe environment; other public values may be focused on a specific domain. For example, the cabinet has defined five key public interests in the energy sector: ‘clean’, ‘safe’, ‘reliable’, ‘affordable’ and ‘spatially workable’ (Tweede Kamer, 2020h).

QR-code An image composed of black and white squares, which provides a physical representation of a digital link to a website (URL). The QR-code can be read with the camera on a smartphone or tablet, upon which the underlying link is opened. QR is an abbreviation for ‘Quick Response’.

Radio frequency identification (RFID) A technology that involves reading information from a physical object equipped with a tiny chip (RFID chip, also known as a tag or label) from a (generally very short) distance. RFID chips can be attached to objects for various purposes, such as to packages in order to trace and track them during shipping.

Driving task support system Systems that support the operation of a vehicle, for example steering, accelerating and braking. These are generally automated or partially automated electronic systems that use software to make driving a car more comfortable and safer. Examples include lane keeping assistance and adaptive cruise control. Many vehicles are equipped with *Advanced Driver Assistance Systems (ADAS)*. An ADAS observe the surroundings of the vehicle via sensors and can take over the control of the vehicle and driving direction or warn the driver about dangerous situations.

Secondary materials Reusable materials obtained from dismantling products or objects, such as buildings. In the construction industry, this may include steel beams, wooden sections, assembly systems, etc.

Sensor An electronic or mechanical device or component of a device that collects information from the environment. A thermometer is an example of a sensor.

Smart vehicle A smart vehicle communicates with its environment via the internet and digital information and communication technology. This includes data about location, driving behaviour, status of systems, etc.

Smart meter A digital meter that collects data on energy consumption from consumers at the household level. The meter gives consumers insight into their energy consumption and can be read remotely by grid managers or other authorised parties. Smart meters are the next-generation technology replacement of analogue meters.

Smart Charging Smart charging can be one-way or two-way. Smart charging with Grid-to-Vehicle (G2V) technology is designed to respond solely to electricity *demand*. With Vehicle-to-Grid (V2G) technology, vehicle batteries can also feed power back into the grid and thus act as a buffer for the local network. This allows buffer capacity to be used to prevent peak loads on the network, for surpluses to be stored, or for power to be shared with other vehicles on the local network that need to be charged sooner.

Smart Grid An electricity system that continuously influences the demand for electricity according to the supply. An example would be a network of household appliances that limits electricity demand when supply is low. A more advanced smart grid may also involve digitally controlled multi-directional traffic between different components, as with a car battery that returns stored energy to the grid.

Smart Living Package A smart living package is a technology or a combination of technologies that allows sensors and digital devices in a home to communicate with each other via the internet, WiFi, Bluetooth, etc., allowing household appliances and features to be controlled digitally.

Standard Recognised and established agreements, specifications or criteria. Compliance with a standard is not mandatory unless stipulated as such contractually or by law. Standards are generally arrived at through a process of broad-based cooperation.

Vertical integration An economic process by which multiple steps in a production chain, e.g. production, distribution and sales, are controlled by a single party. This can have negative effects on competition.

Virtual Power Plant A cluster of decentralised (local) power generation systems (wind, solar, batteries, etc.) that are centrally and digitally controlled to deliver energy in a coordinated way. In this model, the various sources act as a single power plant.

Virtual reality (VR) A digital simulation of a virtual environment that can be experienced by a user. In many cases, the user can experience the virtual environment visually or audiovisually by wearing a headset that allows him/her to look around in the digital simulation. Some also support interaction with the digital simulation, for example by moving.

Roadside system A system that analyses passing cars on roads and reports the average speed, traffic intensity, vehicle category etc. to a traffic centre. This information is then used for various purposes, such as traffic jam reports and other forms of traffic management via the signal boards above the road. The road authority can also use these systems to communicate traffic jam alerts, collect traffic information or make conditions safe for roadworks.

Winner-takes-all principle The principle that one party (the winner) conquers the market and then makes it effectively impossible for others to compete with it. The leader’s advantage only gets bigger and can never be surmounted by competitors.

RESPONSIBILITY AND ACKNOWLEDGEMENTS

Composition of the Council committee

Prof. dr. P. (Pieter) Hooimeijer, hoogleraar sociale geografie en planologie aan de Universiteit Utrecht; raadslid tot 1 augustus 2020 (commissievoorzitter)

Drs. P. (Pallas) Agterberg, raadslid vanaf tot 1 augustus 2020; directeur Strategie Alliander

S.P. (Sybren) Bosch MSc, Consultant Copper8; junior-raadslid tot 1 augustus 2020

Ir. G.Ch.F.M. (Staf) Depla, strategisch adviseur (publiek-private samenwerking), voorzitter Startfoundation, voorzitter Mijnraad

Prof. dr. S. (Sander) Klous, Universiteit van Amsterdam, professor Big Data Ecosystems for Business and Society / KPMG, leider van het Big Data Analytics-team

Drs. J. (Jeroen) Kok, Director Payment & Mobility Rebel Group; raadslid tot 1 augustus 2020

Prof. mr. dr. S.H. (Sofia) Ranchordás, Rijksuniversiteit Groningen, adjunct-hoogleraar Bestuursrecht en Digitalisering

Composition of the project team

Drs. B.N.S.M. (Bart) Swanenvleugel (projectleider)

R.M. (Rosa-May) Postma MSc (Res), projectmedewerker (vanaf 1 september 2020)

Ir. M. (Milan) Rikhof, projectmedewerker

S.J. (Stefan) Vaupel Kleijn, project-assistent

M. (Mathijs) Veenkant MSc, projectmedewerker

Consulted experts

Diana van Altena, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties

Stijn van Balen, Rijkswaterstaat

Dirk Barneveld, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties

Petra Bassie, Vereniging Nederlandse Gemeenten

Tineke Beuker, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties

Jan van den Bos, Inspectie Leefomgeving en Transport

Pablo van den Bosch, Madaster

Dirk van Brederode, Vereniging Nederlandse Gemeenten

Kees van der Burg, Ministerie van Infrastructuur en Waterstaat

Frank Burggraaff, Inspectie Leefomgeving en Transport

Geiske Bouma, Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO)

Onoph Caron, Stichting Elaad NL

Maayke-Aimée Damen, Excess Material Exchange

Roxane Daniels, Vereniging Nederlandse Gemeenten

Tom Demeyer, Stichting Waag | technology & society

Diana van Dorresteijn, Vereniging Nederlandse Gemeenten

Henk Dijkstra, Ministerie van Economische Zaken en Klimaat
Ervin Ehlert, Rijkswaterstaat
Yvette Entius, Gemeente Den Haag
Rinie van Est, Rathenau Instituut
Albert Faber, Ministerie van Economische Zaken en Klimaat
Wouter Fellendans, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Gerrie Fenten, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Valerie Frissen, SIDN Fonds / Universiteit Leiden
Sandor Gaastra, Ministerie van Economische Zaken en Klimaat
Janneke Gerards, Universiteit Utrecht
Stijn Grove, Dutch Data Center Association
Jaron Haas, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Joost Hoekman, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Esther 't Hoen, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Guus de Hollander, Planbureau voor de Leefomgeving
Joost Huurman, Centraal Bureau voor de Statistiek
Noor Huijboom, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Johan Jacobs, Ministerie van Infrastructuur en Waterstaat
Caspar de Jonge, Ministerie van Infrastructuur en Waterstaat
Esther Keymolen, Tilburg Law School
Tim Kies, Vereniging Nederlandse Gemeenten
Paul Knoppers, Gemeente Utrecht
Linda Kool, Rathenau Instituut
Fons Kop, PricewaterhouseCoopers
Roald Lapperre, Ministerie van Infrastructuur en Waterstaat
Finn van Leeuwen, Gemeente Amsterdam
Arjan Levinga, Rijkswaterstaat
Petra Loeff, Rijksinstituut voor Volksgezondheid en Milieu
Max van Meerten, Gemeente Den Haag
Lars Meindert, Ministerie van Economische Zaken en Klimaat
Henk Meurs, Radboud Universiteit Nijmegen / Adviesbureau MuConsult
Eric Mink, Ministerie van Infrastructuur en Waterstaat
Martine Meijers, Vereniging Nederlandse Gemeenten
Maarten Piek, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Willem Poterman, HanzeNet
Bram de Rijk, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Erik Schmieman, Ministerie van Infrastructuur en Waterstaat
Soschanne Schurink, Ministerie van Economische Zaken en Klimaat
Socrates Schouten, Stichting Waag | technology & society
Gijs van Schouwenburg, Inspectie Leefomgeving en Transport
Han Slootweg, Enexis
Jeroen van der Tang, NL Digital
Erdogan Taskesen, Rijkswaterstaat
Joost Tennekes, Planbureau voor de Leefomgeving
Bert Timmermans, Ministerie van Infrastructuur en Waterstaat
Tino de Velder, Vereniging Nederlandse Gemeenten
Peter Paul Verbeek, Universiteit Twente
Peter Verkoulen, Dutch Blockchain Coalition
Gerdien van Vreede, Vereniging Nederlandse Gemeenten
Marieke van Wallenburg, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Sophie Wiedijk, Ministerie van Economische Zaken en Klimaat

Expert meeting, Theme Identification Digitalization, January 23rd 2020
Josee van Eijndhoven, Erasmus University Rotterdam, Drift
Albert Meijer, Universiteit Utrecht
Sofia Ranchordás, Rijksuniversiteit Groningen
Jan-Willem Wesselink, Future City Foundation

Expert meeting, Digitalization and Energy (group 1), April 23rd 2020
Erwin Bleumink, Surfnet
Lars Falch, Powerpeers
Cees Huisman, Energie-Nederland
Lars Meindert, Ministerie Economische Zaken en Klimaat (toehoorder)
Han Slootweg, Enexis & Technische Universiteit Eindhoven

Expert meeting, Digitalization and Energy (group 2), April 23rd 2020
Machiel Bolhuis, Eneco
Elke Klaassen, ICT-Group
Gerard Smit, Universiteit Twente
Willem Strabbing, ESMIG (BE)

Expert meeting, Digitalization and Mobility (group 1), April 30th 2020
Hans Jeekel, Technische UniversiteitEindhoven,
Corien Prins, Tilburg University
Paul Rooijmans, Tranzer/Lynxx
Iskander Smit, Info.nl
Erdogan Taskesen, Rijkswaterstaat
Chris de Veer, Provincie Noord-Holland

Expert meeting, Digitalization and Mobility (group 2), April 30th 2020
Anne Durand, Kennisinstituut voor Mobiliteitsbeleid
Eric Mink, Ministerie van Infrastructuur en Waterstaat (toehoorder)
Rob van de Velde, Geonovum

Expert meeting, Digitalization and Circular Economy (group 1), April 30th 2020
Maikel Kishna, Planbureau voor de Leefomgeving
Socrates Schouten, Stichting Waag
Wouter van Twillert, CB’23 / Actieteam Paspoorten voor de Bouw
Esther van Zimmeren, Universiteit Antwerpen

Expert meeting, Digitalization and Circular Economy (group 2), April 30th 2020
Pablo van den Bosch, Madaster
Jamilja van der Meulen, Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO)
Gerard Roemers, Metabolic
Stef Voermans, CB’23

Departmental Contact Group
Diane van Altena, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties
Frans Lips, Ministerie van Landbouw, Natuur en Voedselkwaliteit
Lars Meindert, Ministerie van Economische Zaken en Klimaat
Eric Mink, Ministerie van Infrastructuur en Waterstaat
Maarten Piek, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties

Anne Reitsma, Ministerie van Landbouw, Natuur en Voedselkwaliteit
André Rodenburg, Ministerie van Infrastructuur en Waterstaat
Gijs van Schouwenburg, Inspectie Leefomgeving en Transport
Soschanne Schurink, Ministerie van Economische Zaken en Klimaat

Essayists
Paul Chan, Alexander Koutamanis & Catherine De Wolf, Technische Universiteit Delft
Eef Masson, Romy Dekker & Rinie van Est, Rathenau Instituut
Carlo van de Weijer, Technische Universiteit Eindhoven / Masvasta BV

External reviewers
Frans Feldberg, Vrije Universiteit Amsterdam
Jeroen van den Hoven, Technische Universiteit Delft
Corien Prins, Tilburg University

OVERVIEW OF PUBLICATIONS

2021

Hydrogen: The missing link. ['Waterstof: de ontbrekende schakel']. January 2021 (Rli 2021/01)

2020

Access to the city: How public amenities, housing and transport are the key for citizens. [Toegang tot de stad: Hoe publieke voorzieningen, wonen en vervoer de sleutel voor burgers vormen]. September 2020 (Rli 2020/06)

Stop Land Subsidence in Peat Meadow Areas: The 'Green Heart' Area as an Example. [Stop bodemdaling in veenweidegebieden: het groene hart als voorbeeld]. September 2020 (Rli 2020/05)

Green Recovery. ['Groen uit de crisis']. July 2020 (Rli 2020/04)

Changing Tracks: Towards Better International Passenger Transport by Train. ['Verzet de wissel: naar beter internationaal reizigersvervoer per trein']. July 2020 (Rli 2020/03)

Soils for Sustainability. ['De Bodem bereikt?!']. June 2020 (Rli 2020/02)

A Grip on Hazardous Substances. ['Greep op gevaarlijke stoffen']. February 2020 (Rli 2020/01)

2019

Towards a Sustainable Economy: The Governance of Transitions. ['Naar een duurzame economie: overheidssturing op transities']. November 2019 (Rli 2019/05).

Desirable Tourism: Capitalising on Opportunities in the Living Environment. ['Waardevol toerisme: onze leefomgeving verdient het']. September 2019 (Rli 2019/04).

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Aviation Policy: A New Approach Path. ['Luchtvaartbeleid: een nieuwe aanvliegroute']. April 2019 (Rli 2019/02).

The Sum of the Parts: Converging National and Regional Challenges. ['De som der delen: verkenning samenvallende opgaven in de regio']. March 2019 (Rli 2019/01).

2018

Warmly Recommended: Towards a Low-CO_2 Heat Supply in the Built Environment ['Warm aanbevolen: CO_2-arme verwarming van de gebouwde omgeving']. December 2018 (Rli 2018/07)

National Environment and Planning Strategy: Litmus Test for the New Environmental and Planning Policy ['Nationale omgevingsvisie: lakmoesproef voor de Omgevingswet']. November 2018 (Rli 2018/06)

Accelerating Housing Production, While Maintaining Quality ['Versnellen woningbouwproductie, met behoud van kwaliteit']. June 2018 (Rli 2018/05)

Better and Different Mobility: Investing in Mobility for the Future '[Van B naar Anders: investeren in mobiliteit voor de toekomst']. May 2018 (Rli 2018/04)

The Healthy City: Delivering Health Through Environmental and Planning Policy ['De stad als gezonde habitat: gezondheidswinst door omgevingsbeleid']. April 2018 (Rli 2018/03)

Sustainable and Healthy: Working Together Towards a Sustainable Food System ['Duurzaam en gezond: samen naar een houdbaar voedselsysteem']. March 2018 (Rli 2018/02)

Electricity Provision in the Face of Ongoing Digitalisation ['Stroomvoorziening onder digitale spanning']. February 2018 (Rli 2018/01)

2017

A Broad View of Heritage: The Interactions Between Heritage and Transitions in the Physical Environment ['Brede blik op erfgoed: over de wisselwerking tussen erfgoed en transities in de leefomgeving']. December 2017 (Rli 2017/03)

Energietransitie en leefomgeving: kennisnotitie. December 2017 (Rli 2017) [only available in Dutch]

Land for Development: Land Policy Instruments for an Enterprising Society ['Grond voor gebiedsontwikkeling: instrumenten voor grondbeleid in een energieke samenleving']. June 2017 (Rli 2017/02)

Assessing the Value of Technology: Guidance Document ['Technologie op waarde schatten: een handreiking']. January 2017 (Rli 2017/01)

Colofon

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Saskia van As, Tekstkantoor Van As, Amsterdam

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Livewords, Maastricht/Amstelveen, The Netherlands

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Jenneke Drupsteen Graphic design, The Hague, The Netherlands

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