ASSESSING THE VALUE OF TECHNOLOGY

GUIDANCE DOCUMENT

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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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FOREWORD

Technology is everywhere. It is an intrinsic part of our society and the living environment. Technological development can sometimes be so rapid that it catches society ‘off guard’. The debate then focuses on the direct advantages and disadvantages of certain innovations. The underlying considerations may be largely ignored.

The Council for the Environment and Infrastructure (Rli) wishes to explore the subject matter in greater depth. Technological developments are often difficult to predict, as are their longer term implications. The full effects may not become apparent for many years. Moreover, the development and application of new technology is very much context-dependent: culture, economic climate and legislation are all relevant. Technology changes society and vice versa. Technology can be of great value but it can also encroach upon existing values.

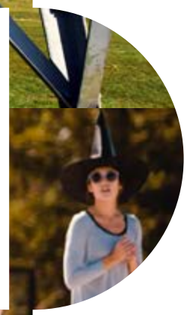
In this guidance document, the Council presents an analytical approach which helps to reveal the threats and opportunities of technology. We do not state who should initiate the analysis or reach conclusions, since this cannot be decided in advance. It can be years before the full effects of new technology become apparent. The Council has therefore produced this guidance document for the benefit of everyone who wishes to place technological developments in their broader perspective, whether public

sector authorities, private sector companies, societal organisations or engaged individuals.

Having established the broader perspective, each party will be able to form opinions with regard to specific technologies and their applications. Those opinions will inform further action. This document may also give rise to more generic approaches which create a favourable climate for technological development. It will then be possible to uphold the traditional, widely-endorsed societal values. The government has a specific role to play in establishing an appropriate balance between stability and continuity on the one hand, and innovation and adaptiveness on the other.

Technological development is ubiquitous; new applications are emerging by the day. Their consequences are far from predictable. No analysis can be definitive. The significance of technology must be re-examined on a regular basis, with the response of the various actors adapted accordingly.

This document is not a formal ‘advisory’ in the traditional sense. It does not present recommendations for government policy. Rather, it represents the Council’s contribution to a broad public debate about how society should approach technology and the choices that must be made.



1

TECHNOLOGY IN THE LIVING ENVIRONMENT

Technology is an intrinsic part of our society. This chapter begins by examining the implications of technology for the living environment. These implications differ according to context and perception, as described in Section 1.2. The scope of this guidance is determined by its terms of reference as described in Section 1.3. The final part of this chapter (Section 1.4) sets out the structure of the remainder of the document.

1.1 Technology: complex effects on society and the living environment

New technologies and applications come onto the market every day. We now have smartphones and apps such as Airbnb and Uber. Tomorrow we may well have robots that deliver pizzas and groceries, or buildings made of self-cleaning nanomaterials. We can already see rapid growth in the number of online platforms and big data applications which support the 'sharing economy'. In short, technology is establishing new relationships within society and within the human environment. In most cases, those relationships are beneficial and complementary. Technology creates new travel options or new ways in which to use our limited space. It facilitates alternative, more sustainable solutions. But there can also be adverse effects: greater pressure on public spaces, disruption of the labour markets or new forms of scarcity. Whether an effect can be regarded as positive or negative will often be a matter of perspective. Technology itself is never neutral. Its development and application will involve making choices, implicit or explicit, which determine the relationship between technology, society and the living environment.

Technology can be warmly embraced or it can cause friction. This largely depends on the existing regulatory mechanisms within society: the prevailing culture, legislation and forms of contract can facilitate or impede the adoption of a new technology. The underlying question is whether the technology concerned strengthens or erodes public values.

The effects are generally difficult to predict and it is equally difficult to assess their potential impact. When will they become apparent? At what level of scale? How will we recognise them? Who will benefit? Are the effects temporary or permanent? In this guidance document, the Council contends that not everything is as chaotic as it first appears. Several patterns can be detected and these enable certain effects to be identified on each of the various levels of regulatory mechanisms in our society. The Council offers a strategic and analytical approach to technology-driven developments.

In an earlier publication, *Survey of technological innovations in the living environment* (RIi, January 2015), the Council presented conclusions with regard to the main policy issues within its sphere of expertise. A number of these conclusions are relevant to the current document:

- Technologies change societal relationships through market shifts, the creation of new economic sectors, or changes to the production chains.
- The short-term effects of technology are generally overestimated, while the longer term effects tend to be underestimated.

- Technological innovation is driven to a significant degree by societal values, challenges and requirements. Conversely, technology influences social and moral values. The use of technology can alter people's values and the importance they attach to them.
- Technological developments demand a different type of assessment and ongoing re-evaluation.

Here, the Council is concerned with how the effects of technological innovation on the living environment can be analysed and evaluated. This guidance document proposes an appropriate response to the various developments.

1.2 Diffuse consequences and differing perceptions

New applications of technology can have various consequences for the living environment. Moreover, perceptions of those consequences will differ (see textbox, 'Examples of technologies which affect the living environment'). There can be direct economic consequences for companies or individuals, such as new sources of revenue, new customers, different competitors, greater convenience, enhanced efficiency and new experiences. There will also be broader effects for society at large, perhaps in the form of increased sustainability or less privacy. The assessment of the effects - whether predominantly positive or negative – will largely depend on the perspective of the assessor. The assessment process has several dimensions: a positive effect in terms of faster, more comfortable and cheaper transport may be offset by negative effects in other domains, such as loss of job security for transport workers or falling car sales. New issues can emerge as ICT companies take a more prominent role. The significance of data will change, as will the importance of privacy as consumers and producers come together on digital platforms (see Van Dijck et al., 2016; Hinssen, 2015; Kreijveld, 2014). There will be new dependencies and new vulnerabilities. The infrastructure must meet new, more stringent demands in terms of cyber-security and online access.[1]

Examples of technologies which affect the living environment

Solar panels represent a technological innovation which has been widely adopted in the Netherlands. There is reasonably high market demand and a legislative framework has been put in place. Nevertheless, further upscaling in pursuit of the national climate objectives may well raise new issues. How will widespread decentralised generation affect the form and function of the national grid? What arrangements are needed to ensure supply security and the continuity of the energy market? Spatial assimilation and aesthetic aspects must also be considered.

Airbnb has seen rapid growth from a niche player in the tourism market to a huge multinational organisation which is difficult to hold to account for the nuisance caused by its users, or for the effects of private short-stay rentals on local housing markets and the mainstream hospitality industry.

1 In this category, we are often concerned with new expressions of existing public values. In the case of the internet, for example, we must consider access to media, the reliability and integrity of both providers and users, as well as safety and security in the broadest sense of the term.

The ‘milking robot’ increases the farmer’s operational efficiency and may also reduce environmental impact. At the same time, ongoing industrialisation – of which the milking robot is just one manifestation – is changing the nature of the farm as an independent business. As a result, the relationship between the farmer and his setting is also changing.

The autonomous, or ‘driverless’, vehicle has the potential to greatly improve road safety. It may spawn new services and help to increase efficiency. To exploit the full potential requires more than technological development. New standards must be devised, legislation must be amended, and the physical infrastructure must be adapted. Most importantly, there must be a cultural shift if people are to be expected to give up control to a machine.

1.3 Questions and scope

This guidance document focuses on the changes which will be seen in society, and specifically within the living environment, further to the adoption of new technologies. It is not always possible to identify these changes in advance, nor to predict exactly when they will become apparent. We do not yet know whether there will be negative effects and we are therefore not able to plan remedial action. Some effects will take time to become apparent. The use of sensor technology and digital platforms may erode control over dataflows and impinge upon privacy but it will do so only gradually. In some cases, however, negative effects will become apparent far sooner. The absence of legislation governing the use of drones has already led to problems. Whether tension occurs between technological developments and regulatory mechanisms, is determined to a large extent by the scale and pace of those developments. If the tension becomes so strong that it causes the regulatory mechanisms to become ineffective, desirable developments may not achieve their full potential, or negative consequences may not be sufficiently limited.

The Council has formulated the following questions:

- What changes will the application of new technology mean for the economy and society at large, with particular reference to infrastructure and the human environment?
- What are the threats and opportunities with regard to public values, particularly those in the context of the living environment?
- To what extent are developments covered by existing regulatory mechanisms? Are those mechanisms sufficiently adaptive or is deliberate action needed?
- What implications do these questions have for the government and other stakeholders?

For each new technology or application, it is necessary to ask whether any government action is required and how the relevant decisions are to be made. There will be some instances in which a response is unnecessary, and others in which the government must act to restrain or perhaps

facilitate the development. It must be remembered that the government is not the only party able to intervene: public values can also be established and upheld by the private sector and the general public. In many cases, these stakeholders are able to act more quickly and efficiently. In other cases, however, it is for the government to safeguard public values, whether by applying legislative instruments or by creating the necessary conditions.

1.4 Structure of this document

This publication is in two parts. In the first, the Council introduces three concepts which determine the societal significance of technological development. Chapter 2 of Part 1 is concerned with patterns of change, while Chapter 3 examines public values and regulatory mechanisms. Ways in which the resultant changes can be systematically analysed and assessed are discussed in Chapter 4. In Chapter 5, the Council lists a number of points for attention when attempting to direct technological innovation, the aim being to safeguard public values in the living environment. Concluding remarks are presented in Chapter 6.

Part 2 considers the key themes in greater depth and detail, applying the theory to three case studies drawn from practice.

2

PATTERNS OF CHANGE CREATED BY TECHNOLOGY

Numerous researchers have described the social and societal changes which may be attributed to technological innovation (see for example Castells et al., 2005; Perez, 2002; Friedman, 2005). Based on the literature and a number of case studies, the Council has identified five recurring patterns which support the analysis of the economic and societal dynamic. This chapter presents a brief description of these patterns. Their implications for the regulatory mechanisms are described in Chapter 3.

1. Scale changes in space and time

Technology facilitates interactions at both the higher and lower spatial levels of scale. The result is greater scale diversity and a higher degree of integration between market and society. Borders and boundaries become arbitrary; the validity of traditional territorial political systems and administrative infrastructures is challenged. There are issues of legitimacy and jurisdiction. The effects of scale diversity can be seen in the energy sector, and particularly with regard to its efforts to ensure supply security. On the one hand, there are now many small-scale, local electricity producers. On the other, it has become necessary to interconnect the national grids of various countries.

Another aspect of the scale changes is the speed with which the regulatory mechanisms can adapt. They cannot always keep pace with rapid technological development. It is, for example, far simpler to adapt computer operating systems than it is to amend the relevant legislation.

Both aspects of the scale changes are demonstrated by Airbnb and Uber, organisations which have quickly achieved a global presence. Nevertheless, the effects of their business models are most apparent at the local level. This phenomenon has been dubbed ‘glocalisation’.

2. Sector convergence

Technological innovation often takes place at and across the traditional boundary lines between sectors. The result is a commingling, or ‘convergence’, of knowledge, technology and markets. There may be conflicts between the rules and conventions of the sectors involved. Difficulties are likely to emerge if large chemicals companies enter the crop enhancement market: the system of patent law traditionally applied in the chemicals sector is not compatible with the breeders’ rights observed by the agricultural sector.

3. More diffuse relationships between producer and consumer

Technological developments, especially the increasing use of digital platforms, are creating more diffuse relationships between producers and consumers. Consumers are now supplying products and services to each other: they have become ‘prosumers’. As a result, the basic principles of

the regulatory mechanisms have changed. In some cases, prescriptive regulations must give way to trust. Consider a meal-sharing scheme: should someone who prepares food at home be subject to all the requirements of the Netherlands Food and Consumer Product Safety Authority (NVWA)? Or is it enough to have a system of self-regulation based on rankings? There are now online user platforms which help to decide which medicines will receive marketing authorisation. What is their position in relation to the existing regulatory system?[2]

4. A new meaning of ownership

The trend of sharing (capital-intensive) material goods and digital information has implications for various aspects of 'ownership', including liability, responsibility and intellectual property rights. Sharing has been greatly facilitated by new digital platforms (see for example Kreijveld, 2014; Frenken et al., 2015). These platforms reduce the transaction costs for both the producer and the consumer. The way in which the various aspects are regulated has generally failed to keep pace with technological development. In the case of property which exists only in digital form, significant issues include the question of access – who is to be allowed to use and possibly monetise data?

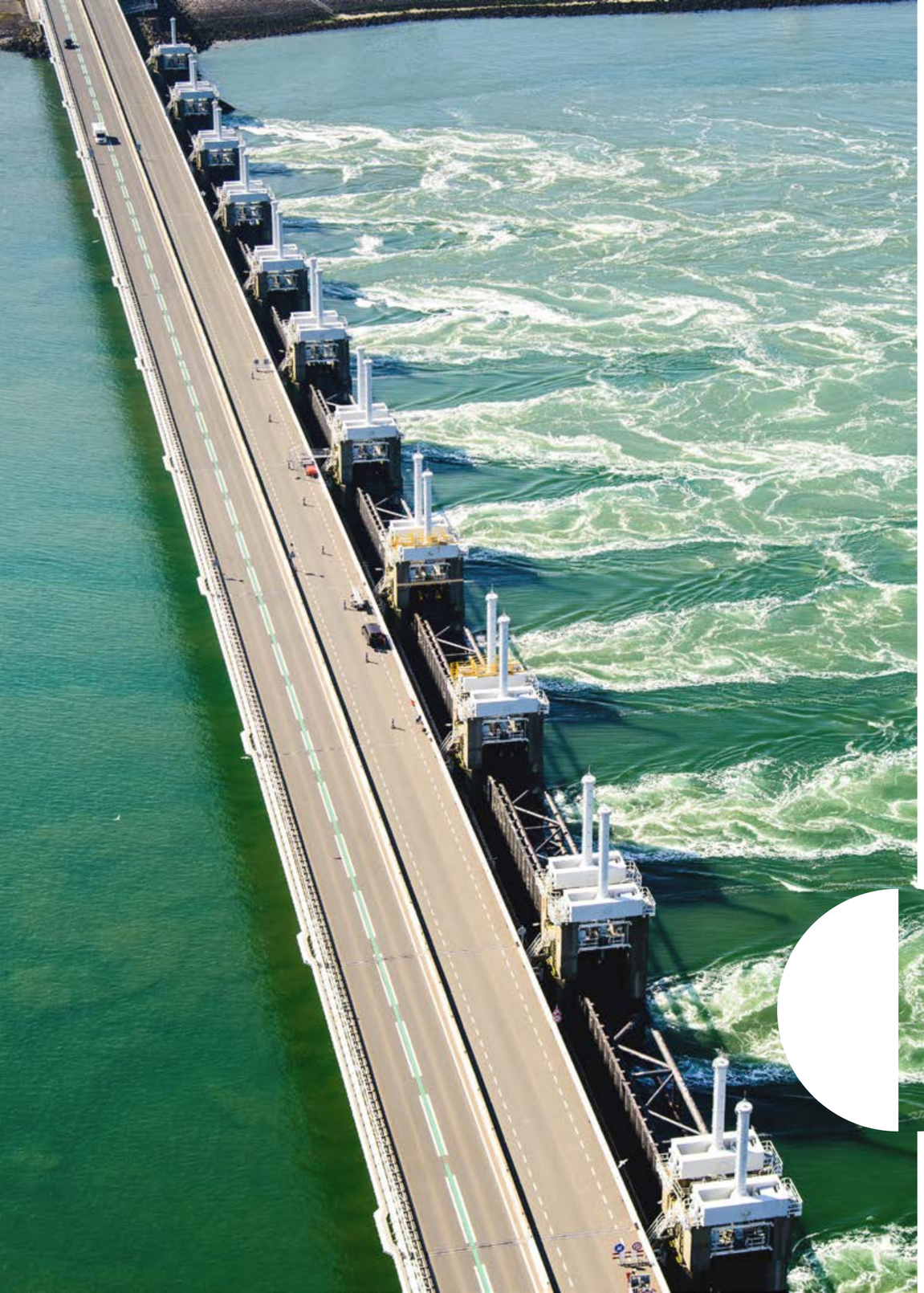
The emergence of new types of robot also creates a need for a redefinition of ownership and new protections. The latest robotic systems make decisions based on programmed algorithms. They actually learn from experience. The behaviour of the systems therefore changes over time, whereupon it is difficult to regulate liability or responsibility should anything go amiss.

5. New values models

Technology has greatly reduced the costs of communication. Markets now function differently. Information about the non-financial aspects of products and services can be readily shared, often at little or no cost. This too is a very significant development in that greater consideration can be given to the wishes, requirements and opinions of both consumers and producers when designing a new product or service. In some cases, an exchange of data takes the place of a financial transaction. The relative importance of the traditional financial instruments will therefore decline and this is likely to stimulate developments such as social and sustainable enterprise (see for example Bauwens, 2013).

This chapter contains numerous references to 'regulatory mechanisms', a term which is explained in Chapter 3 following a brief consideration of the nature of public values.

2 One example is 'Do-It-Yourself' medicine. Patients take responsibility for their own health and healthcare, perhaps even producing medicinal products at home. They share knowledge and experience with others within online communities.



3

PUBLIC VALUES AND HOW THEY ARE SAFEGUARDED BY REGULATORY MECHANISMS

The patterns of change described in Chapter 2 help to identify the public values which exist or are desirable, including any which are at risk. The patterns also shed light on the regulatory mechanisms which help to safeguard the public values. This chapter presents a brief consideration of these concepts. A more detailed discussion can be found in Part 2, Chapter 3.

3.1 What are public values?

In this document, the Council uses the term 'public values' to refer to all aspects of the living environment which are deemed to be of common interest and importance, a definition proposed by the Scientific Council for Government Policy (WRR) in a report published in 2000. Public values include for instance the cleanliness, order, safety and accessibility of the living environment.

While a particular aspect may indeed be a 'public value', this does not necessarily mean that it is the (sole) responsibility of the government, nor that there is any consensus with regard to its importance. Society as a whole, including the private sector and non-governmental organisations, is responsible for establishing and safeguarding public values. This can often be achieved through mutual agreements, self-regulation and cultural consensus (Frankowski et al., 2015; NSOB, 2013). If certain public values are not adequately represented, however, government intervention in the form of legislation or other statutory instruments may be justified.

Some public values are collective in nature: they are significant to everyone in society and must be implemented in a uniform, non-discriminatory manner. Flood defences protect everyone within a given area, while clean air is not a privilege reserved for any specific target groups. Many public values are pluriform in nature. There are diverse and sometimes divergent opinions regarding their relative importance and the manner in which they can best be achieved. In a democratic country such as ours, the 'overarching' public value is the protection of diversity. Solidarity and health are both pluriform public values, and both can be defined and pursued in various ways.

Public values are not static but can change over time. During times of economic crisis, many people will consider it important to maintain the affordability of housing. This public value will weigh more heavily than during protracted periods of prosperity. The emissions produced by industry and road traffic are viewed differently when set against firm climate objectives. Public values within the living environment must be weighed against each other and against the public values in all other domains, such as civil rights, employment and social security.

3.2 Safeguards provided by regulatory mechanisms

Economic and societal changes not only affect the relative importance of the public values but also the way in which they are to be achieved or upheld.

There are various regulatory mechanisms which exist to safeguard the public values.[3] They include cultural mechanisms (customs, conventions and ideologies), statutory instruments (legislation), formal arrangements (contracts, covenants and agreements) and everyday interpersonal interaction. All these mechanisms can regulate how technology is developed and applied, the behaviour of the various actors, and how the markets will develop.

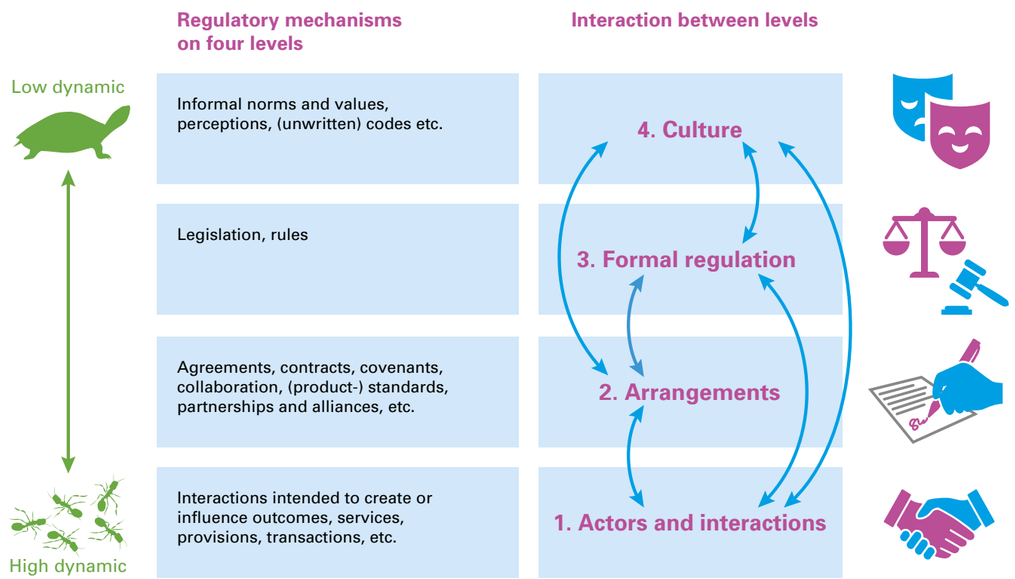
Interaction between technology and the regulatory mechanisms is complex. Technology can influence or disrupt the regulatory mechanisms, while those mechanisms may well rely on technology. Moreover, technology itself may create new regulatory mechanisms.

The regulatory mechanisms are to be seen on various levels or 'tiers', which are not necessarily hierarchical although they can be arranged according to the degree of dynamic (Williamson, 2000; Koppenjan and Groenewegen, 2005). See Figure 1.

The various levels are interconnected and influence each other. Rules intended to ensure road safety (Level 3, formal legislation) reflect perceptions regarding the acceptability of risk (Level 4, Culture) and also affect the formal arrangements such as insurance policies and their accompanying conditions (Level 2, Arrangements). Ultimately, the combination affects motorists' driving behaviour and the manner in which

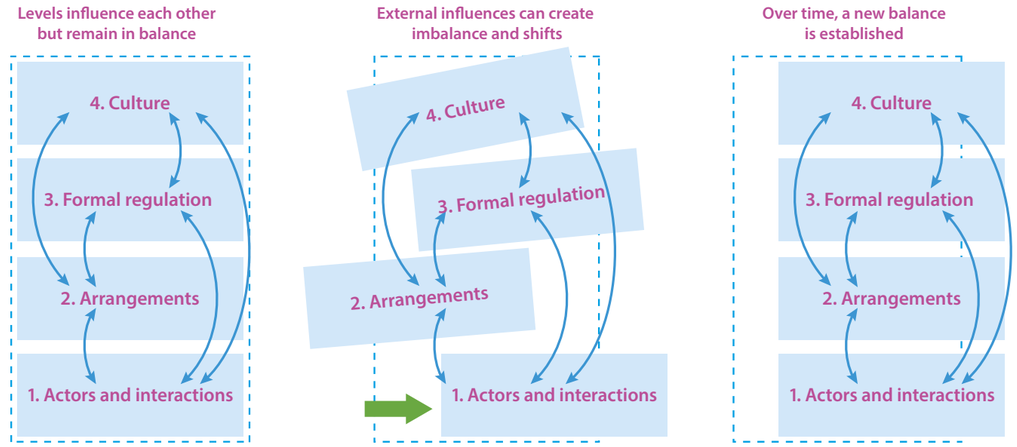
3 The disciplines of sociology and institutional economy often apply the term 'institutions'. This is defined and explained in Part 2. Because 'institutions' has a different meaning in certain contexts, the Council has opted to use the term 'regulatory mechanisms' throughout Part 1.

Figure 1: Regulatory mechanisms: a layered and dynamic structure



Adapted from Koppenjan and Groenewegen, 2005; Williamson, 2000

Figure 2: Shifting balance in regulatory mechanisms



financial responsibility is apportioned in the event of an accident (Level 1, Actors and interactions).

Regulatory mechanisms present something of a paradox. On the one hand they are generally robust and difficult to alter. They therefore provide stability and security. One the other hand, they are flexible and can adapt themselves to various external changes. This adaptive ability is most apparent on Levels 1 and 2, where change is relatively rapid. The process is generally somewhat more time-consuming on the other levels. For example, smoking in public places was considered entirely 'normal' in the Netherlands until the late 1990s (Level 4). Attempts to discourage smoking by means of voluntary agreements (Level 2) proved ineffective. Eventually, it was decided that everyone was entitled to a smoke-free working environment and binding legislation was passed (Level 3). Today, all public places are smoke-free. Smoking (except in designated areas) is regarded as inappropriate and unacceptable. This is the new cultural norm (a shift on Level 4).

Figure 2 illustrates how the regulatory mechanisms adapt in response to external factors. The rate of change differs between the levels but eventually a new balance is achieved. The dotted outline represents the former situation.

In Chapter 4, the concepts introduced thus far – patterns of change (Chapter 2), public values and regulatory mechanisms (Chapter 3) – are used to support an analysis of the effects of technology.

4

THE ANALYTICAL ASSESSMENT CYCLE

The development and adoption of new technology will have various effects on public values, including those which apply in the living environment. The effects will be extremely diverse and less than clear-cut. Some will be direct, others indirect. There will be positive and negative effects, some of which will be seen immediately while others will become apparent only very gradually or at a much later date. Perhaps they will be apparent to some stakeholders before others. To create a better understanding of this complexity, the Council has devised an analytical assessment framework. It considers the social and societal relevance of a technological innovation, the resultant patterns of change, and the effectiveness of the relevant regulatory mechanisms. The assessment cycle does not examine the technology in isolation but in its broader context. Effects beyond the technology's direct sphere of influence are also relevant. The assessment cycle requires the user to adopt various perspectives and to explore aspects of the technology itself, its use, market opportunities and creative design.

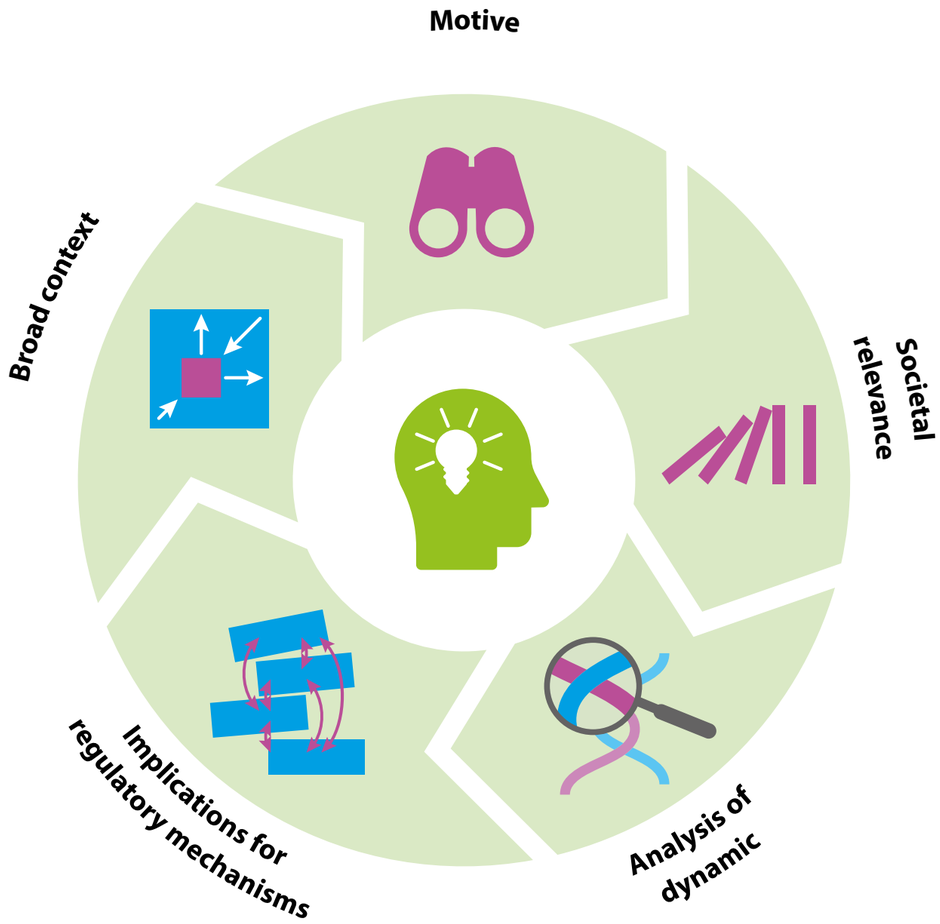
The steps in the assessment cycle are described in Section 4.1. Three practical examples are given in Section 4.2. The Council then emphasises in Section 4.3. that the normative assessment of the consequences and the development of an appropriate response must be undertaken separately; they do not form part of the analytical assessment cycle itself.

The decision to initiate an analytical assessment cycle can be taken by any of several stakeholders. A company that is developing a new technology may wish to ascertain its likely effects and thus gauge the level of social acceptance it will meet. Perhaps the government will decide to undertake an assessment, or will be asked to do so by parliament, advocacy groups or members of the public. When deciding whether or not to initiate the assessment cycle, government may find it useful to seek the support of a broad-based advisory committee, perhaps one appointed for the purpose.

4.1 Analysis as a cyclical process

The Council proposes an assessment process in which both the direction and impact of technological innovations are analysed. This process will create a better understanding of the opportunities for the further development of the technology itself and the realignment of regulatory mechanisms where necessary or appropriate. The assessment process involves five steps. At the outset, it is important to have adequate information about the developments, whether anticipated or already in progress. This calls for the knowledge, experience and creativity of a broad-based group of actors. The extent to which a new technology is to be applied in practice will determine its potential effect on the public values. Regulatory mechanisms, both formal (governmental) and informal respond accordingly. The degree to which they are effective in safeguarding the public values will vary over time, as will the desirability of further interventions (by the government or others). For this reason, the analytical assessment cannot be a 'one-off'. It must be undertaken as a recurring cyclical process. All five steps are shown in Figure 3.

Figure 3: Analytical assessment cycle for technological developments



1. Motive: state the purpose of the analysis

The first step is to ascertain whether an analysis of a certain technological development or application is needed or desirable. It may indeed be desirable since the application itself will create new opportunities to achieve the planned transitions in the living environment. Alternatively, there are likely to be certain implications for the living environment or for the relationships between the various actors. Themes and topics can be placed on the agenda by government, policy-makers, the business community, the research field or the societal midfield. It is important for all such actors to develop the sensitivity and organisational ability which underpin an effective response to technology-driven developments and their effects on society.

2. Determine the societal relevance: identify threats and opportunities

The second step involves identifying the threats and opportunities created by the adoption of a new technology. This is likely to reveal the possible consequences in terms of the underlying public values. Does the new technology offer a possible solution to societal issues, including those in the living environment? Will there be any additional effects, positive or negative, if the technology is rolled out on a (much) wider scale?

3. Analyse the dynamic: what patterns of change can be seen?
Chapter 2 introduced the concept of 'patterns of change'. The third step of the analytical cycle examines whether the application of a new technology is likely to create a pattern of change, and if so, how marked that change will be. This involves examining both the existing situation and the developments which may become apparent at a later date.

4. Determine which regulatory mechanisms are likely to be affected
Chapter 3 explains the four levels of regulatory mechanisms. The fourth step of the analytical process is based on the patterns of change identified in Step 3. It examines whether the regulatory mechanisms themselves will be affected by the patterns of change, or conversely whether they will determine those patterns. This step may also reveal ways in which change can be managed and the regulatory instruments made more effective.

5. Examine the broader context and the interplay with other types of development
In the fifth step, technological developments are viewed in a much broader context. Technological developments influence each other; they inspire new applications and combinations. Their impact therefore extends beyond the direct effects. Similarly, the regulatory mechanisms cannot be viewed in isolation. They offer frameworks which establish the direction of the developments, and they can be influenced by those developments. It is therefore appropriate to identify all relevant themes and topics, such as how new platforms actually operate or how certain technological developments will affect various economic sectors. This step can also involve a consideration of more fundamental issues, such as intellectual property rights, privacy and the nature of private enterprise.

An analysis based on an assessment cycle creates clarity with regard to what developments are actually possible and likely, the threats and opportunities they will bring, and whether positive effects will be stimulated or impeded by the current regulatory mechanisms. The normative considerations will become apparent, as will the options for an appropriate practical response.
In Section 4.2 we apply the analytical assessment cycle to three real-life case studies. Section 4.3 examines the normative debate that will follow the analytical assessment cycle.

4.2 The analytical assessment cycle applied to three case studies

In this section, we apply the analytical assessment cycle to three case studies relevant to the living environment. The question is not whether the technology itself is new, but rather how the effects of its application manifest themselves in practice. The case studies are discussed in greater depth and detail in Part 2. They have been selected to illustrate the general

principles of the assessment cycle. A complete analysis of each situation is beyond the scope of this publication.

4.2.1 The milking robot

1. State the purpose of the analysis

The milking robot incorporates several sensors and connects a dairy cow to global networks. The technology represents a further rationalisation of milk production and the dairy livestock sector. The ongoing penetration of the Internet of Things in agriculture raises various issues in terms of data ownership, the farmer's autonomy, cybersecurity and so forth.

2. Determine the societal relevance; identify threats and opportunities

Opportunities can be seen in terms of supply chain optimisation, increased efficiency (higher output with lower resource consumption), reduced environmental impact and increased public accessibility of the landscape. Moreover, the export of the technology and related services will create new opportunities for growth in the relevant sectors. At the same time, however, ongoing industrialisation and rationalisation may have adverse effects on animal welfare (cattle will spend more time indoors), as well as the autonomy of the individual farmer and the role of local networks.

3. Analyse the dynamic: what patterns of change can be seen?

Are there any scale changes? Further globalisation would accelerate the trend of consolidation within the dairy sector, with the supply chain under the control of a smaller number of (very) large companies.

Convergence: the dairy sector will become ever more dependent on the structures and providers of the ICT sector. This raises issues with regard to data ownership and cybersecurity.

A pattern of change that is not relevant in this example is the 'more diffuse relationships between consumer and producer', since the influence of the milking robot is restricted to the production chain itself.

Ownership: it is now increasingly common for the milking robot to be supplied and maintained by an external service provider rather than being purchased outright by the farmer. This arrangement raises questions with regard to the farmer's autonomy and the ownership of data. Can this data be shared with third parties such as the government or external consultants without the farmer's permission?

Values models: the milking robot and further development of the Internet of Things will facilitate new data analysis services, whereupon new knowledge-intensive activities can be marketed internationally by Dutch companies. The milking robot reinforces a business model in which the emphasis is on price and efficiency based on scale. This could detract from the viability of a model which is based more on the regional production of niche products. On the other hand, the ability to share data throughout the chain could improve the predictability of milk supplies, perhaps supporting the production of smaller batches of niche products.

4. Determine which regulatory mechanisms are likely to be affected

Level 4: Culture. At this level, the milking robot and further industrialisation may erode society's perception of the farmer as an independent entrepreneur, and that of the agricultural sector as the guardian of landscape quality (the iconic 'cow in the meadow'). This level will also see a discussion about animal welfare, with the burgeoning scale of the dairy sector seen as a matter of concern.

Level 3: Legislation. The milking robot facilitates more controlled interaction with dairy cattle in terms of their feeding regime, time outdoors and health monitoring. This will impact the manner in which dairy farmers demonstrate their compliance with animal welfare legislation and environmental legislation (such as that governing the disposal of slurry).

Level 2: Arrangements, contracts, etc. The milking robot and the Internet of Things will affect relationships within the chain, altering the negotiating position of the farmer in his dealings with both customers (dairy companies) and suppliers (the producers of equipment and materials). The large volume of data and improved predictability of production processes may give rise to more detailed and rigid contract terms which could restrict the farmer's ability to enter into agreements with other stakeholders such as local authorities, local communities or nature conservation groups. If farmers are prohibited or otherwise unable to transfer their data from one provider to another, 'lock-in' effects may be seen.[4]

Level 1: Actors and transactions. The milking robot will improve business efficiency and increase profit margins, at least at first. It is a new product which replaces existing milking equipment and introduces a new activity to the dairy sector in the form of data analysis. It is possible

4 A lock-in effect occurs when the choice of a new product or service is limited by the adoption of a similar or related product in the past. There is a high degree of customer-provider loyalty but the lock-in effect severely restricts competition and innovation.

that data will be accessed and used by actors other than the farmer himself. Dairy companies, for example, might use the data to support their production planning. The algorithms in the milking robot will increasingly take decisions that have traditionally fallen to the farmer. The robot will determine animals' feeding patterns, when they are to be (artificially) inseminated, and when they are to be slaughtered. As a result, the farmer may become little more than an agent of the chain parties, perhaps far less accountable for matters of environmental management and animal welfare.

5. Examine the broader context and interplay with other types of development

The milking robot can be seen as just one component in the further industrialisation and 'data-isation' of the dairy sector. Various aspects call for attention:

- The mechanisms which control the access to data enjoyed by the farmer, the IT provider and third parties. This is relevant to the broader debate about the use of data which is now a matter of concern in various contexts.
- The consequences of the shifts in influence and control within the chain, particularly the farmer's autonomy as an independent operator within the production chain. Will franchise-like models erode autonomy and, if so, would this cause problems?
- The consequences of the shift in influence and control in relation to the broader community. What part will farmers and the agricultural sector as a whole play in regional development? Will it remain possible to make local agreements with regard to water management, nature, landscape, ecology and suchlike?

An initial analysis of the milking robot using the proposed assessment cycle reveals that the positive effects of this technology will be accompanied by certain issues with regard to autonomy and farmers' ownership of their own production resources, including equipment, data, land and buildings. The image of the self-employed farmer, perhaps at the head of a family business, who can take independent decisions and to whom all the risks and rewards of the business fall, is no longer entirely in keeping with the actual situation. Will this image become obsolete? Exactly how the situation will develop is difficult to predict. As the changes emerge, it will be appropriate to begin a new assessment cycle. Some issues are already clear. The quest for solutions will involve the farmers themselves, nature organisations, local authorities, technology providers and the various actors in the supply, production and distribution chain.

4.2.2 Local generation of electricity using solar panels

1. State the purpose of the analysis

The widespread use of solar panels can increase the sustainability of energy provision, thus helping to achieve the

national and global climate objectives. However, solar panels alter the appearance of the buildings on which they are installed. Moreover, any significant upscaling will require modifications to the national infrastructure and grid management arrangements, because the peaks and troughs of solar energy production do not coincide with peaks and troughs in demand. Solar energy raises new challenges in terms of supply security and grid reliability. This form of decentralised production demands a high degree of flexibility.

2. Determine the societal relevance; identify threats and opportunities

There are clear opportunities, including the achievement of climate objectives and a reduction in the emissions associated with traditional fossil fuels. The threats can be seen in terms of grid stability, supply security and the aesthetic quality of cities and rural areas. There are also issues in terms of the fair division of costs and benefits.

3. Analyse the dynamic: what 'patterns of change' can be seen?

Scale changes: small-scale, local generation is gaining in importance alongside the traditional centralised national and international production.

Convergence will occur between the energy sector on the one hand and IT, architecture, transport, housing and spatial planning on the other. Energy policy has traditionally relied on geopolitical considerations.

More diffuse relationships between consumer and producer: the energy consumer becomes an energy producer.

Ownership: the consumer becomes (co-)owner of production facilities.

Values models: many consumers have already invested in solar panels or wind turbines, perhaps in the interests of sustainability or perhaps they wish to reduce reliance on the traditional providers. These are supplementary values over and above the financial interests of reduced costs and return on investment.

4. Determine which regulatory mechanisms are likely to be affected

Level 4: Culture. The Dutch public attaches great importance to supply security and grid stability, both of which can be affected by decentralised production based on the use of solar panels. Many citizens are keen to help achieve greater sustainability. They are clearly heeding the message of the government awareness campaign which used the slogan, 'a better environment begins with you'.

Some regard local generation as a means of becoming less reliant on the commercial energy providers.

Level 3: Legislation. The Elektriciteitswet (Electricity Act 1998) establishes an important role for grid management companies such as TenneT. The interests of energy consumers are represented by the Authority for Consumers and Markets (ACM) and the Energy Grids Users Platform (GEN). The Act includes provisions covering grid stability and supply security. Unfortunately, the legislation is not able to address the complexities created by the increase in local generation or the consumer's new role as producer. Neither can it make adequate allowance for the unpredictable nature of solar and wind energy in the Netherlands.

Level 2: Arrangements. Contracts between energy providers and consumers establish 'feed-in' tariffs: the amount payable in respect of electricity supplied to the grid, as well as the prices of electricity drawn from the grid. The national tax administration also produces guidelines. At present, TenneT's annual capacity plan includes only the output from the large producers, not that of small ones like the homeowners. If the grid managers must make modifications to the infrastructure, the local producers' financial contribution to the required investments is restricted to their role as consumers.

Level 1: Actors and transactions. The current feed-in tariffs form no incentive for 'prosumers' to contribute towards the costs of upgrading the networks. At present, costs are divided among all consumers. There are, however, direct relationships between producer and customer which help to increase affordability, sustainability, equity and social engagement at the local level.

5. Examine the broader context and interplay with other developments

Upscaling of local production to a level which makes any significant contribution to the transition goals will raise certain challenges with regard to the current regulatory mechanisms, such as:

- Division of responsibility within the energy infrastructure. Who is to manage performance, costs and risks? What market models are available? What technical issues must be resolved? These questions are particularly relevant to the development of central or local reserve capacity (the 'buffer').
- Direction by means of incentives based on the current regulatory mechanisms, such as feed-in tariffs and subsidies.
- Aesthetic assimilation: there will be new challenges for architects and designers.

There is interaction with potential technological developments in the field of electricity storage. As storage capacity increases, local generation will become easier to integrate with the existing systems.

An initial analysis based on the proposed assessment cycle reveals that the desired upscaling of technology to support localised energy production is likely to meet a number of obstacles. There are several fundamental questions with regard to who will be responsible for achieving the required level of flexibility, the equitable division of costs and risks, and the types of (technical) solution that are to be implemented. The government plays a very prominent role in the current arrangements, providing incentives for consumers, producers and grid managers alike. The freedom that each actor enjoys is another relevant consideration. The existing arrangements with regard to subsidies, feed-in tariffs and so forth have been applied on a trial basis. They can be seen as part of an experimental programme intended to identify problems and potential solutions. For those taking part, however, the purpose, duration and evaluation criteria of the experiments remain unclear.

4.2.3 The autonomous vehicle

1. State the purpose of the analysis

Both established manufacturers and newcomers on the automotive market are devoting time and resources to the development of autonomous vehicles: cars which can 'drive' themselves. The situation raises questions in terms of desirability, road safety, responsibility and legal liability. It may be necessary to modify the infrastructure. Reliance on passenger cars remains an obstacle to the achievement of environmental and climate objectives. This form of mobility causes congestion and makes a significant claim on space. Technological innovation can help to achieve the desire policy transition. However, much depends on the various 'driverless' concepts that can be developed and the choices that are made with regard to both the technology itself and the regulatory mechanisms (see also *Faster and Closer*, RIi 2016).

2. Determine the societal relevance; identify threats and opportunities

The implications of the autonomous vehicle are not yet entirely clear. Its introduction will certainly affect values such as (perceived) freedom of movement and autonomy, while there are also possible benefits in terms of road safety, sustainability (air quality and resource consumption), climate (the proposed vehicles are largely electric), accessibility and maximising the efficiency of space usage. This development can also be linked to the energy transition. Economic opportunities include new forms of service provision and the growth of the automotive sector itself.

However, there might also be a threat to road safety if, say, the use of autonomous vehicles is not adequately integrated into

the existing setting or if the technology is in any way unreliable. There may also be new environmental threats further to the disposal of batteries, which also pose a fire risk while in use. Lock-ins might occur further to an overly rigid demarcation of the technologies or if certain players are (inadvertently) allowed to develop a dominant position.

3. Analyse the dynamic: what patterns of change can be seen?

There are unlikely to be any marked scale changes because the automotive sector has always been international in nature. What will change, however, is the timescale on which innovations are introduced. New functionality can be added to a vehicle by means of a software or firmware update.

Convergence: there will be a marked degree of interaction with the ICT sector, as well as with electricity providers and the public transport sector.

More diffuse relationship between consumer and producer: it is possible that the chain will become shorter and communication more direct. In some new forms of service provision, the consumer may become the producer. There may also be hybrid, intermediate arrangements.

Ownership may be a consideration with regard to car-sharing and private lease arrangements. There may also be issues of privacy and data ownership.

Values models may be a consideration with regard to car-sharing schemes, and the generation of information concerning the individual's movements, use of public infrastructure, etc. The autonomous vehicle has the potential to increase 'cultural imperialism', since the algorithms applied by the developer may reflect specific cultural and ethical values.

4. Determine which regulatory mechanisms are likely to be affected

Level 4: Culture. Considerations on this level include the value that is attached to autonomy and the ability to make personal choices (as opposed to 'cooperative' driving in which the vehicle is controlled by external factors), concern for the quality of the living environment, and ethical questions in connection with road safety.

Level 3: Legislation. It will be necessary to establish a legal framework with regard to aspects such as liability. As more driving 'decisions' are taken by the vehicle itself (or external systems), the international standardisation of

technology and legislation will increase. There will also be issues with regard to data ownership and access.

Level 2: Arrangements. This level includes considerations such as the acceptance of the End-user Licence Agreement (ELA) for software or firmware updates. It is not yet clear how much influence the owner or the Netherlands Vehicle Authority (RDW) will have over the contents of an ELA. Further considerations on this level concern the data that the autonomous vehicle systems generate and the privacy of the user.

Level 1: Actors and transactions. Mobility behaviour is partly the product of willingness to share the usage of a transport resource, which in turn will depend on financial incentives and behavioural 'nudges'. The development of the technology itself can be an important factor on this level. The degree to which centralised control of vehicles becomes possible will have a significant influence on usage, congestion and space usage.[5] Some social groups, such as persons with a disability, are likely to enjoy greater mobility.

5. Examine the broader context and the interplay with other types of development

A verdict on the desirability of autonomous vehicles must be placed in the context of various objectives in connection with road transport versus other modalities. It is important to establish a link between this development and the current vision regarding the physical infrastructure. It is also desirable to identify the economic opportunities for the Dutch automotive sector, and to examine what new services might be developed (and which should be either incentivised or restricted). The issues raised by the introduction of autonomous vehicles are very similar to those further to the growing use of robots in various applications, both in terms of ethics (awareness of implicit norms within algorithms and learning systems) and legal liability.

An analysis of the autonomous vehicle using the proposed assessment cycle reveals that the longer-term effects of this technology are difficult to predict. Diverse and divergent objectives (at both the policy and individual level) jostle for priority. The autonomous vehicle represents the latest phase in an ongoing conflict of interests. All stakeholders need greater clarity about the requirements which can or should be imposed on the physical infrastructure, the algorithms and sensors on board the vehicle, and the operators of those vehicles. Experiments will be useful. The role of the ICT sector is a particular point for attention. The methods and practices of this sector will become ever more significant to mobility. In view of the

5 See the study of driverless mobility in various scenarios by the Knowledge Institute for Mobility Policy (KiM, 2015).

speed of international developments and the sheer volume of investments in driverless vehicle technology, it will be appropriate for the government to take a proactive approach in establishing and adjusting the course of developments at the national level.

4.3 The role of the analytical assessment cycle in the normative debate

To understand the significance of technology and the opportunities it creates for society calls for an open attitude and the ability to look beyond the boundaries of the individual sectors. All actors – government, the private sector, the societal midfield and individual citizens – should ask questions, organise the available knowledge and engage in experiments which explore the potential developments. This process will reveal the conditions that should be established in order to maximise the benefits and establish the price to be paid. The assessment cycle offers a useful analytical framework.

The assessment of the effects on public values and the identification of the regulatory mechanisms that should be applied form a normative question. The government also faces a political question: do the existing regulatory mechanisms do enough to safeguard the collective and pluriform public values? If not, there can be a number of causes. Perhaps the mechanisms are no longer adequate in terms of scope and effect. Perhaps there have been shifts in the importance which is attached to the public values themselves. Either eventuality should prompt a review and re-evaluation of the existing regulatory mechanisms in terms of the principles and conditions they established (the process) and the objectives they seek to achieve within the living environment (the content).

In many cases, not all effects of modifying the regulatory mechanisms will be apparent in advance. Society will respond to certain measures which will therefore have a ‘knock-on’ effect on other levels. The introduction of new legislation can meet with opposition, companies may impose new contractual terms and conditions, and consumers may change their behaviour. For this reason, the Council recommends the adoption of a process designed to increase resilience, together with experiments with various types of control framework. This forms the focus of Chapter 5.

5

POINTS FOR ATTENTION WHEN MANAGING DEVELOPMENTS

The application of technology has consequences for public values within the living environment. Those consequences will be largely unknown in advance.[6] The assessment cycle presented in Chapter 4 can be used to reveal the bandwidth within which the consequences are likely to be seen, the actors involved, and the challenges they create for the regulatory mechanisms. There will then be a clearer picture of the normative considerations which will underpin decisions about both the technology and the regulatory mechanisms. Those decisions will be taken within a complex setting. There are many actors and stakeholders, each of whom has specific interests and objectives. The exact nature of this setting is beyond the scope of this document but the Council nevertheless wishes to list some points for attention which will help to establish, achieve and safeguard the public values. They are given for the benefit of all actors but primarily the government.

Section 5.1 is concerned with the points for attention when establishing an appropriate balance between flexibility and stability. Section 5.2 considers shortcomings in the existing regulatory mechanisms which are due to the influence of technology (and the way in which it is used).

5.1 A balanced approach

Technological development is a driver of economic growth and social renewal. For many years, the Netherlands has been near the top of the international rankings for innovation. This is due to the high quality of its universities, its excellent infrastructure, an open culture and a stable legislative framework. It is nevertheless important to devote ongoing attention to the conditions required to maintain our international competitive position, and to continue utilising societal opportunities. At the same time, both the private sector and the general public appreciate a certain degree of predictability and stability. The challenge is therefore to find an appropriate balance between adaptiveness and stability. The government plays a prominent role in this regard. On the one hand, it contributes to stability by safeguarding legal certainty. On the other, it responds to new developments so as to maximise the opportunities or prevent potential negative effects. In this section, we offer various points for attention when seeking an appropriate balance.

The importance of knowledge and insight

Recognising and analysing signals increases awareness of technological innovations and their potential effects. Doing so calls for expertise in the form of knowledge, information and creativity. The necessary expertise is available in various sectors of society: government bodies, universities, the business community, societal organisations and individuals. Society is certainly creative when it comes to generating knowledge and devoting attention to the various topics. There are dedicated knowledge institutes, such as TNO, the Rathenau Institute and the universities. There are public debates, creative alliances, social media discussions and ‘Policy Labs’.[7]

6 For a useful consideration of ‘known unknowns’, see Steen, M. van der, Tijdig Bestuur – strategisch omgaan met voorspelbare verrassingen, Erasmus University Rotterdam, 2016 (in Dutch).

7 The Policy Lab programme is currently the subject of research and debate at European level (JRC, 2016). In a policy lab, relevant questions are investigated by a coalition of government, social and private sector parties. The involvement of various stakeholders who attempt to arrive at concrete solutions (a process known as ‘prototyping’) results in approaches which enjoy the broadest possible support.

Various stakeholders are able to contribute their knowledge and insights. All can help to formulate the public values which must be upheld. They also help to identify the patterns which emerge and the regulatory mechanisms which apply.

Experiments also produce the required knowledge. There are many technological applications whose effects become visible only at an advanced stage of development, once a certain level of scale has been achieved. Only then does the need for new or more effective regulatory mechanisms become apparent. The existing legislative frameworks are often too rigid to permit experimentation. In certain cases, varying from new arrangements for the electricity generation to the use of autonomous vehicles or spatial decision-making procedures, it is necessary for the government to establish the scope available for experimentation. To date, amendments to legislation have always been done on an ad hoc basis. The Council calls for a more generic legislative basis for experiments involving technological developments. This uniform foundation would then support temporary frameworks for the various applications of technology. The exact scope and period of experimentation is then defined in a structured, authoritative and transparent manner. Throughout the experiments, new knowledge with regard to the desired form of regulatory mechanisms will be generated. The factors to be established in advance include the objectives of the experiment, the geographical scope, the period, the participants, possibilities for objecting to the outcomes, and compensation for damage to private interests (where appropriate). It is important to devote attention to questions raised by society at large and there must be ample opportunity for civil initiatives.

Management by results

If one particular technology, or a specific form of that technology, becomes dominant there is a strong possibility of path dependencies or lock-ins which will decrease adaptive ability in the future. It is therefore advisable to avoid making technology choices (either implicit or explicit) prematurely. The government can help to ensure due consideration by ensuring that legislation intended to safeguard the public values does not focus on any particular (form of) technology, but addresses the objectives. In other words, there must be ‘management by results’. This will allow alternative solutions to be considered, which is clearly in the interests of flexibility. Also in its own purchasing and procurement policy, the government can focus on objectives and outcomes rather than on specific technologies.

Balance in horizontal relationships

Public values are at risk when certain economic interests are given too much weight, resulting in the formation of monopolies or cartels. Conversely, public values are at risk when too little importance is given to social interests, such as sustainability, nature, consumer rights and employment rights. The government can intervene by regulating competition and enforcing the legislation which serves to protect societal interests, as in the inspections conducted by the Netherlands Food and Consumer Product Authority (NVWA).

One alternative to direct government intervention is policy intended to establish a more equal relationship between parties. This will render legislation more generic and increase the adaptive ability of the legislative and judicial systems. Take legal liability in accidents involving a motor vehicle and a cyclist for example. Article 185 of the *Wegenverkeerswet* (Road Traffic Act) establishes a general principle whereby the driver of the motor vehicle is deemed to be responsible for the accident and hence liable in law. The introduction of this legislation gave the cyclist a much stronger position and greatly reduced the number of situations in which the government was required to take action. The alternatives would have been more traffic lights (which the government would have had to install and maintain) or technical requirements for cars or bicycles (which the government would have had to enforce).

When considering data ownership, the Council notes that the individual citizen or business is often in a weak position compared to the large companies and government departments which generate or collect big data. That data is not restricted to personal information but also includes data which is specific to a certain business or location. The Council wishes to see the position of the individual strengthened, perhaps through the appointment of a 'data ombudsman' with statutory authority to arbitrate on complaints from members of the public. Such a move would establish a more equal relationship between parties without requiring any direct involvement on the part of the government. The data ombudsman would be an impartial and independent officer, able to initiate investigations and arrive at binding decisions.[8]

5.2 Shortcomings in existing regulatory mechanisms

As noted elsewhere in this document, technology and its applications will have various effects, both direct and indirect. As the three examples given in Section 4.2 demonstrate, the existing regulatory mechanisms are not always wholly adequate. We now consider the shortcomings identified by the Council. In some cases, the main problem is that the relationship between the parties has yet to be adequately defined. In others, there are new vulnerabilities which now call for attention.

Defining or redefining the relationships

The use of technology demands a re-examination, and in some cases the redefinition, of the relationships between the parties, whether government bodies, private sector companies, societal organisations or individual citizens. We have already touched upon this in the section on balancing the horizontal relationships. In some cases, new technological applications will create new relationships which have yet to be fully embedded within the existing regulatory mechanisms. To provide the necessary legal certainty, it may then be necessary to clarify matters of authority and ownership.

8 The European Union has ratified a new General Data Protection Regulation (EU 2016/679). When it comes into effect in May 2018 it will become the primary data protection legislation in all EU member states (Lowijs, 2015). Its implementation has consequences at the national level. Dutch legislation – notably the *Wet bescherming persoonsgegevens* (Wbp) – may complement but must not contradict the European provisions. When developing the idea of a data ombudsman, it will be essential to act in accordance with the General Data Protection Regulation.

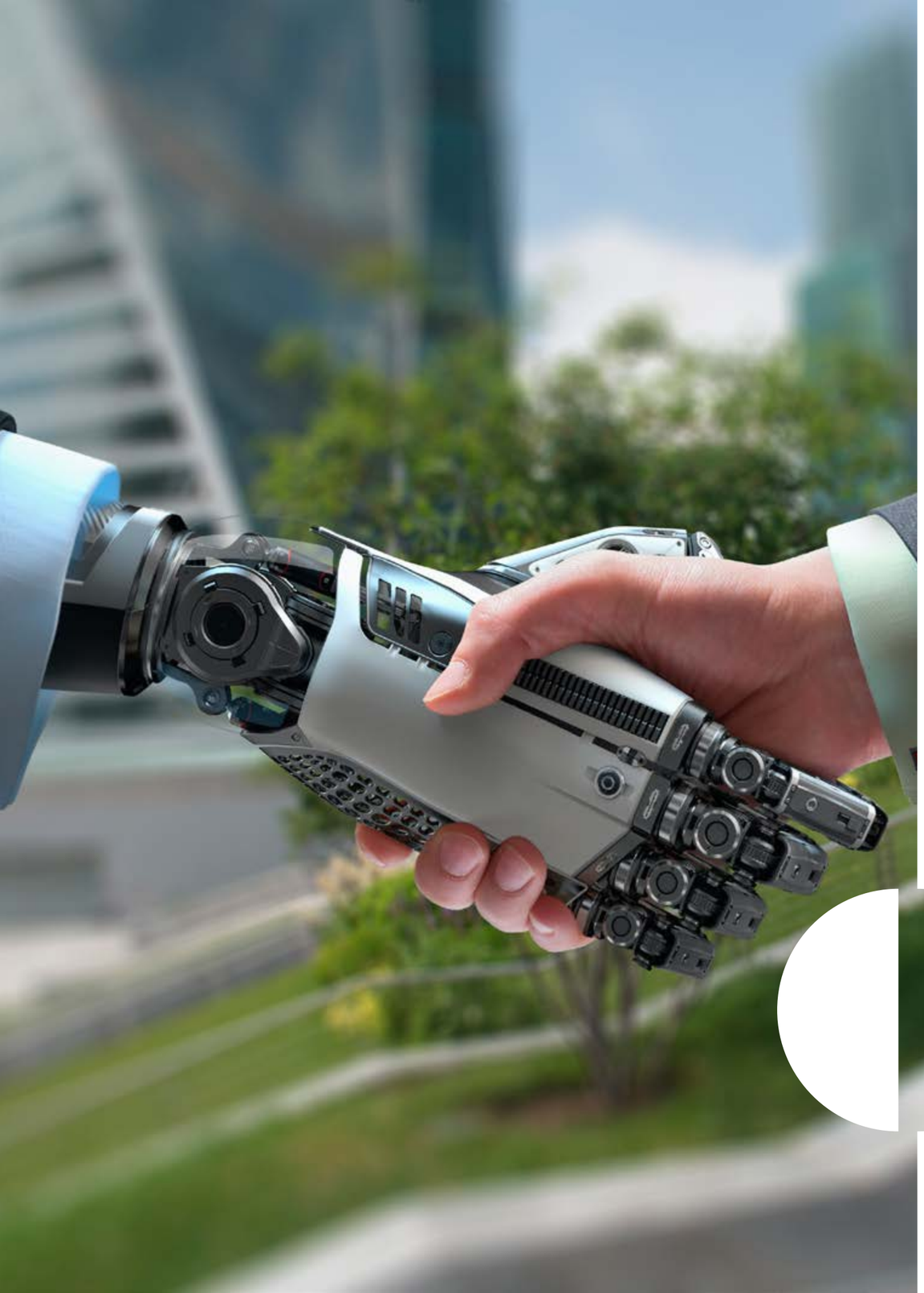
This will support effective enterprise and social harmony. Aspects which must be considered include responsibility for (the effects of) technological applications and insurance arrangements. Attention must be devoted to the fiscal and legal position of the 'prosument' and to the balance between intellectual property law on the one hand and open data on the other. At present, the positions are generally established on a case-by-case basis. In the Council's opinion, more generic arrangements are desirable.

Identifying and addressing new vulnerabilities

The ever-changing relationships between individuals, society and technology bring new vulnerabilities and dependencies. Points which call for attention include data and data integrity (accuracy, completeness and verifiability), and the strong – possibly excessive – emphasis that big data applications place on measurability. Technological developments have rekindled the age-old discussion concerning the relationship between man and machine. Many new technological applications are controlled by algorithms, an increasing number of which support *machine learning:* the subfield of computer science that gives computers the ability to learn without being explicitly programmed by a human operator. Considerable attention has been devoted to the technical possibilities but very less to the choices which the algorithms support. In essence, those algorithms interpret external signals to determine the action to be taken by the system. If it is not clear how this process works, the responsibility for the decisions falls either to the programmers of the algorithms, or to the systems themselves. How does this affect the relationship of trust between government, private sector and individuals? How are they to solve ethical issues such as inclusion and exclusion?

The Council distinguishes three types of vulnerability. The first relates to the availability of vital infrastructures for which new norms and standards must be developed. The second is concerned with accessibility. Technology demands certain skills on the part of its users. The more important technology becomes within society, the more important it will be for everyone to be equipped to participate fully. This demands adequate skills, the removal of obstacles, protection against monopoly-forming, and so on. The third vulnerability relates to verifiability: how are the public values and the relevant positions embedded within the technology, and specifically the algorithms, and what arrangements are in place to establish accountability?

Chapter 6 presents the Council's concluding remarks.



6

CONCLUDING REMARKS

New technologies will bring about a new economy and significant changes within society. Some commentators have used the terms ‘platform economy’ and ‘internet society’. The consequences of these developments are therefore to be seen within the Council’s domain: infrastructure and the living environment, in the broadest sense. It is useful to remind ourselves that these developments will not overwhelm us, but are – to a significant degree – the result of conscious choices. Sometimes it will be necessary to remove certain obstacles in order to allow a new technology to flourish. Alternatively, it will be appropriate to introduce conditions or restrictions to ensure that the new technology does not cause any serious adverse effects. It will be necessary to examine the impact of each new technology in both the short and the long term. This is an ongoing process which devotes close attention to the public values that are at stake.

By producing this guidance document, the Council is attempting to look beyond overly optimistic promises or paralysing caution. This document presents an analytical approach which can be applied by all stakeholders wishing to examine technological developments in a broader perspective. It will be of use to government authorities, private sector companies, societal organisations and engaged citizens. This analytical assessment method allows a more detailed examination of the potential effects of a new technology and the relevant public values. It should be undertaken as an ongoing cycle because the pace of technological development is so rapid that unexpected effects can become apparent at any moment.

The results of the analytical assessment cycle can provide input for the societal debate about the choices to be made with regard to technology and its applications, and about the regulatory mechanisms which will affect the application and its scope. That debate is normative in nature because technology often raises new questions about the division of responsibilities, costs and returns, and can result in a realignment of values.

This guidance document also considers a number of governance issues. It is clear that the approach to technology must seek to strike an appropriate balance between adaptiveness and stability. Given the major dynamic and the unpredictable effects of technology-driven changes, it is also necessary to define the new relationships which form between the various parties, and to identify any new vulnerabilities. Preparations can then be made to direct the technological developments in an effective manner, devoting due attention to the relevant public values.

PART 2 | ANALYSIS

THE THEMES IN DEPTH AND DETAIL

INTRODUCTION

In Part 2, the Council examines in greater depth the way in which the application of technology will change society and our economy. Some relevant concepts are explained and illustrated using case studies. Chapter 1 offers a general account of how the application of technology will create new forms of interaction in both the economic and social spheres. In Chapter 2, we present a number of patterns which support the analysis of the changes which may occur. Chapter 3 is concerned with the concept of 'public values' and the manner in which they are established and safeguarded using regulatory mechanisms or institutions. Finally, Chapter 4 presents some examples drawn from domains relevant to the living environment.

1

THE CONSEQUENCES OF TECHNOLOGICAL INNOVATION

1.1 What is technological innovation?

New technology – or more specifically its application in practice – changes the world. The effects can be seen in all spheres, physical, social and economic. This is particularly true of digital technology. New products and services come onto the market and create opportunities for the living environment, which can be made better, cleaner and more efficient. But they also create risks in terms of safety and security, environmental quality and privacy. There is an ever-changing field of actors: new players emerge, existing players withdraw. The relationships between them change, as do the 'rules of engagement' as the markets and market regulation adapt to the new circumstances.

When developments are particularly rapid or far-reaching, rules and arrangements will not be able to adapt to a sufficient degree. The existing mechanisms which regulate markets and safeguard public values will no longer be effective. This can seriously disrupt the existing order, although that is not necessarily a bad thing. Upheaval can prompt the development of new public values or remove unnecessary obstacles. It will then be necessary to undertake a fundamental re-examination of the regulatory mechanisms and institutions concerned.[9] Frequently cited examples of significant market disruptors include Uber, which has challenged the licensing system for taxis, and Airbnb, through which people rent out their homes to tourists.

9 Here, the term 'institutions' refers to all formal and informal rules and conditions which influence the behaviour of market players and make that behaviour (more) predictable. An institution may be in the form of binding legislation, but could also be a set of customs, conventions or agreements. We return to this point in greater detail in Chapter 3.

Technological developments alter the entire system of producers, consumers and market structures, and hence also affect the manner in which the markets and supply chains are organised. This is illustrated by the emergence of the 'network economy' and the 'sharing economy', both of which rely on digital platforms.

Technological innovation is a broad term. For our purposes, any consideration must include not only the development and application of new technology, but the impact of that technology in the economic and societal contexts. Technology is often the driver of far wider developments. The companies often regarded as the most innovative are those which develop entirely new applications. Examples would include PayPal and Netflix. The epithet 'innovative' is now less likely to be attached to companies such as Intel and Sun Microsystems, which focus on upgrading and improving existing technology (Hinssen, 2015). While technology shapes societal developments, the reverse is also true: Societal developments can drive the development of technology.

1.2 Technological innovation creates new interactions in the economic and societal spheres

In this section we examine the visions of two frequently cited researchers with regard to societal changes brought about by technology. It soon becomes clear how far-reaching those changes can be. We also examine other researchers' criticisms of these visions.

In *The new normal* (2010), Peter Hinssen asserts that the digital world should not be seen as a smarter, faster continuation of what has gone before. Rather, it brings entirely new rules and procedures. Communication, for example, becomes more concise, brief and 'to the point'. By contrast, the volume of information becomes almost infinite. It is possible to collect, collate, copy and distribute data at little or no cost, even though it is of significant (monetary) value to certain users. These new 'rules' influence the way in which we use products and services, and they influence our expectations, states Hinssen. Compared to past generations, people who have grown up in the digital era place less emphasis on privacy and the confidentiality of (personal) information. Transparency is the new norm. We now rely very heavily on the new systems we have created. Without a working digital network, practically all physical systems grind to a halt. Accountability for the quality of products, services and decisions is more absolute, since there is now immediate and transparent feedback. At the same time, contends Hinssen, perfection is no longer the ideal. Convenience and price are more important than quality: cheap, quick and easy are the new watchwords. Why be satisfied with twelve tracks on a CD when you can have over a hundred compressed MP3 files? Ownership of specific technology is no longer seen as important: it's all about connectivity and access. Absolute control is being replaced by bottom-up influence and self-correction, as demonstrated by Wikipedia. Products are in constant development, or as Hinssen puts it, "beta is the new".[10]

10 In the ICT world, the most recent test version of a product is known as the 'beta' version. Although not deemed ready for general market release, the product is often distributed among a large group of users who are asked to provide feedback. Some users prefer to have the latest test version rather than one which is known to be stable, since they appreciate the new specifications and features. Developers use the testers' feedback to resolve any problems before the actual market release.

Jeremy Rifkin (2014) examines the implications of digitisation and the internet for our economic systems. He states that the internet is responsible for a transformation: from a system comprising mostly communication applications to one which is used to control energy, logistics and so forth. This is the logical effect of the emergence of sensors and the Internet of Things. He predicts that the marginal costs associated with sustainable energy and logistics will fall significantly, just as those of communication already have. This will have major consequences for our economic system. The capitalist economy will give way to a new economy in which there is a greater role for collaborative communities, an umbrella term which Rifkin uses to embrace 'prosumers', the sharing economy and concepts such as open source and open knowledge. Sustainability will replace consumerism and cooperation will supplant competition, Rifkin predicts. Other commentators (including Eric Raymond, 2016) agree only to a certain extent. Physical products and the transport of food and other resources cannot be included in the 'zero-marginal cost' economy. The sectors differ according to the degree to which they are influenced by digitisation. Negroponte (1995) refers to this distinction as the difference between 'moving bits' and 'moving atoms'. Rifkin is also accused of overestimating the self-governing and self-cleaning ability of 'commons'.
The Council does not align itself with any one of these authors, but nevertheless concludes that the new applications of technology do indeed bring about changes in our economic system. Elements of the 'old economy' based on atoms can be seen as part of the new economy based on bits. The changes have consequences in terms of both producer and

consumer behaviour. They also affect the need for regulatory mechanisms and for a policy framework. Notable changes include the following.

- Transaction costs and marginal costs will fall significantly in several important economic subsectors.
- Data is readily available to all and is of greater significance.
- Many systems and products will be subject to ongoing development and optimisation even during use.
- Cooperative models will emerge alongside traditional competition.
- Technology will increasingly form the foundation on which society operates.
- Norms and rules will be integrated into the technology and its algorithms (often invisibly).

1.3 Key concepts: manifestations of the changing economy

A number of recurring concepts and terms are found in the various accounts of social and economic change. They include: platforms, the sharing economy, networks, and data. This section explains these terms.

Platforms

Digitisation and the emergence of the internet have made it possible to exchange information, ideas and digital products on a global scale and between all possible (groups of) stakeholders. A precondition of doing so is to have a common basis (and language) to support such exchange. We refer to that basis as the 'platform'. Kreijveld (2014) offers the following definition (here in translation): "a common basis of technologies and of technological, economic and social rules and agreements (such as standards), upon which several parties can cooperate in pursuing innovation and the development of supplementary technologies, products or services". In the current document, the Council uses the term 'platform' in a slightly broader context. The platform supports not only innovation and development, but also the implementation and use of technologies, products and services. Moreover, a platform not only facilitates exchange between persons or organisations, but supports communication between technological products and between humans and machines. A platform is not necessarily neutral: the manner in which it is structured will determine its potential effects on the living environment and infrastructure, and will determine the possibilities for management and adaptation. In his research, Kreijveld (2014) analysed the organisational forms and their underlying structures, revealing and categorising the relevant relationships of power and influence. It is clear that the organisation of the platforms is the result of implicit or explicit choices made during the design phase. Those choices result in differences in character ('programming') and in the positioning of the actors.

The creation of a platform entails making choices with regard to:

- Accessibility: from completely open to completely closed. To what extent are the platforms or markets accessible to other players? In other words, are those players able to develop an alternative platform or enter the same market?

- Division of power and profit: centralised or distributed. How are power (authority) and profits to be arranged. Is there a single director 'in charge', a group of administrators, or a collective of equal partners?
- Objectives: from pure profit to social responsibility. Is the platform designed to maximise profit, or does it pursue social and societal objectives?
- Decision-making structures: from vertical to horizontal. How are developers and users involved in decision-making? Who determines if and how the systems and algorithms are to be developed further? How is their input sought? Is there a process of democratic consultation or does the loudest voice always win? Are participants true collaborators or is there (an element of) competition?
- Compatibility: can users move from one platform to another with ease? Can they establish interfaces between platforms? This determines the likelihood of monopoly-forming and aspects such as the networking effect of the platform.

A platform may develop over time, whereby certain choices are revisited and revised. The platform's character is therefore not static. Because the platform is entirely digital it can evolve rapidly, the changes unnoticed by outside observers.

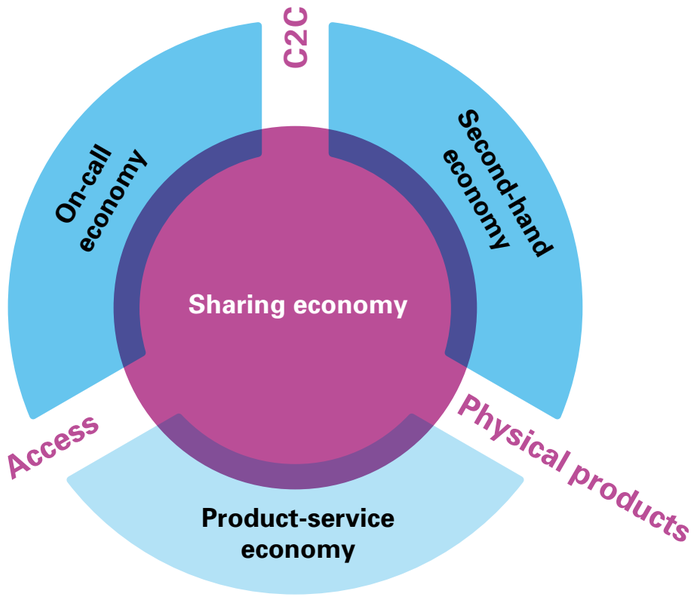
The sharing economy

Platforms play an important role in communication between the providers of products and services and the people who wish to avail themselves of those products and services. The platforms are a new marketplace. Because information about supply and demand can be exchanged instantly, the transaction costs associated with specific products and services are drastically reduced. This supports the 'sharing economy'. According to Frenken et al. (2015), the sharing economy is the phenomenon whereby consumers allow each other to use their possessions when they themselves are not using them. This may or may not involve the exchange of money. Strictly speaking, the sharing economy is a manifestation of collaborative consumption. It offers an alternative to the outright purchase of a new product. Other forms of collaborative consumption include the 'on-call' economy, the second-hand economy, and the product-service economy (see Figure 4).

Frenken's definition of the sharing economy has three key elements:

- All transactions are consumer-to-consumer (C2C) rather than business-to-consumer (B2C). The latter falls within the product-service economy (one example being B2C car rentals).
- There is temporary access to property rather than any permanent transfer of ownership, as would be the case in the second-hand economy represented by Marktplaats.nl and its parent company eBay, for example.
- Transactions relate to (under-utilised) consumer goods rather than personal services, which form part of the on-call economy.

Figure 4: The sharing economy as a form of collaborative consumption



Frenken et al., 2015

Many initiatives which are often described as part of the sharing economy actually fall under one of the other categories. Airbnb, for example, does not distinguish between individuals who rent out their own private home and commercial landlords who own several buildings and run a hotel-like operation through the Airbnb site (which is subject to licensing restrictions in the Netherlands). In addition to facilitating the loan of privately-owned vehicles, the carpooling site MyWheels also maintains its own fleet of hire vehicles (as in the Greenwheels model). UberPOP can only be regarded as part of the sharing economy if the driver would have made the same journey even without passenger(s) in the car. If not, it is a taxi service like any other. UberPOOL is more complex: the first person to contact the driver is entering into a transaction as part of the on-call economy. Basically, he is ordering a taxi. However, by offering the spare seats in the vehicle to others, he is indeed taking part in the sharing economy. (The additional passengers have a legal relationship with the first passenger but not with the driver.) According to Frenken et al. (2015), these differences are important when assessing developments and may also be relevant to government interventions.

The network economy

Information technology is responsible for the creation of global networks in which individuals, companies and organisations are interconnected. In turn, these networks have spawned an economy in which flexible, ever-changing configurations of companies and organisations are formed. In the network economy, value creation is no longer confined to vertical, linear chains which are dominated by the small number of companies who control production resources and intellectual property rights. Increasingly, value creation relies on horizontal partnerships and outsourcing arrangements between organisations at various levels, whose cooperation is supported by joint platforms. It is not the scale of production but that of the network which now determines economic success. These developments were first identified some twenty years ago by authors such as Castells (1996) and Kelly (1998). The network economy has since coalesced and matured,

particularly over the past ten years, supported by the increase in the availability of information and data, the introduction of inexpensive sensors, and the emergence of the Internet of Things (Hinssen, 2015).

The hierarchy within the network is not determined by control over production resources but by the degree of connectivity. The structure of the networks includes a number of 'hubs' at which the majority of connections converge and through which supply is matched to demand. Barabási & Bonabeau (2003) refer to 'scale-free networks'. The development of the hubs is partly the result of organic growth around existing points of convergence, and partly because new entrants are drawn to the points at which there is greatest ongoing activity (the phenomenon known as preferential attachment). On the global scale, examples of major hubs include Google and Facebook. Specialist online marketplaces (such as the Dutch site Vandebron, discussed elsewhere in Part 2) can also take on the role of a hub within the network economy.

Although some hub organisations are large and have significant financial resources, they do not necessarily control the network. To influence the network at all requires a knowledge of both the hub itself and of the nature of all connections. To use Hinssen's words, "It takes a network to fight a network".

The data economy

The development of the data economy relies on two key concepts: big data and the Internet of Things. The term 'big data' refers to very large and complex datasets that are compiled from sensors, internet transactions, statistics relating to email traffic, video downloads, clickstreams and other digital sources. The datasets can be analysed to reveal patterns, trends and associations. The Internet of Things refers to the interconnection of computing devices and sensors which are embedded in everyday objects. They can exchange data with the network and with each other. Each device produces only a small volume of data which takes up very little bandwidth. When the data is combined and collated, however, the result is a body of information which can support quite complex applications (see Rathenau Institute, 2015, etc.).

Small quantities of data from a single source have only limited significance. When data from several sources is combined, the resultant dataset is of far greater value particularly if the user is able to apply advanced analytical techniques.

Big data enables processes to be described and analysed in detail. It supports accurate forecasts and predictions, thus enabling resources to be deployed with maximum efficiency. The possibilities are virtually endless. In the commercial sphere, big data can support product development and targeted marketing. It can help to optimise agricultural production. There are also numerous non-commercial applications, such as traffic management, water management and crowd control at public events. Possession of a large volume of data is an important economic asset. The share price of internet giants such as Google and Facebook is largely based on the value of the data they have collected (and will continue to collect).

The data economy also brings certain risks. The algorithms used to process data are a form of 'black box'. They conceal the underlying mechanisms whereupon pure knowledge gives way to interpretation. Placing one's trust in the analysis of available and measurable data can result in non-measurable information being completely ignored. This results in tunnel vision (see for instance Meijer, 2016). In the Netherlands, the Scientific Council for Government Policy has conducted an in-depth study of the government's use of big data to support safety and security policy (WRR, 2016). According to Helbing (2016), today's society is too complex to allow government control based on mass surveillance and big data. Any attempt to travel this path would be seen as a serious abuse of power and would incite public unrest. Another, not unimportant, consideration is data ownership. The value of data is enjoyed by the party who collects it, and that value is rarely if ever returned to the source of the data. Access to large datasets might also lead to an undesirable concentration of power. Last but not least, there is the question of privacy(see textbox, 'Privacy as dilemma').

Open data and concepts such as open source can help to assuage these concerns. When several parties have access to the same data, it becomes possible to test the algorithms and the validity of the analysis results. Alternative algorithms can be developed as a cooperative venture. This will promote creativity and innovation while also increasing objectivity.

Privacy as dilemma

Many applications of technology raise concerns with regard to personal privacy. Modern information technology allows large quantities of data and information to be collected and analysed at very little cost to support the development of new products and services. The larger the volume of data, the higher its value.

People tend to take an ambivalent attitude towards data sharing. In general, few people object to their information being recorded if this will have a positive effect on the quality of the products and services they receive. Netflix and Amazon, for example, maintain detailed information about their customers' viewing and reading preferences. The information can be used to support targeted marketing. Many applications request access to the user's current location so that they can offer traffic information or locate amenities in the area. Sharing information about one's driving style can result in lower insurance premiums. Many people automatically give permission for this type of data to be shared in return for access to some online service.

However, there are contexts in which the collection and use of personal information is more problematic. An internet search for certain symptoms may suggest that the user has a particular health problem (even though he could be doing research on a friend's behalf). If coupled with location information, there is a significant risk to anonymity. Information relating to personal views and values, political affiliations,

religious beliefs and sexual preferences can also be contentious, especially outside one's own cultural context.

Without specific knowledge of the situation, the use of data and information can lead to conclusions which are based on correlation rather than causality. Meijer (2016) warns that such conclusions are unduly influenced by certain measurable or observable factors while other, equally relevant circumstances are ignored. This form of 'profiling' results in tunnel vision. Moreover, the information maintains a value even outside the context in which it has been provided, and is a tradeable asset. The person providing the data is unlikely to benefit from this trade. Who actually owns the data? The use of personal information for any unauthorised purpose, especially where there is no ability to influence the process, causes dissatisfaction and dissent about unrestricted data collection by third parties.

2

FIVE PATTERNS OF CHANGE ATTRIBUTABLE TO TECHNOLOGY

The application of technology, and particularly that of digital technology, is responsible for many changes within the economic and societal contexts, as described by Castells et al. (2005), Perez (2002), Friedman (2005) and several other researchers. Some distinct patterns of change can be identified. They form the focus of this chapter, together with their consequences in terms of the efficiency and effectiveness of the existing regulatory mechanisms. Modifications to those mechanisms may be required. The Council identifies five relevant patterns:

- Scale changes in space and time
- Sector convergence
- A more diffuse and direct relationship between producer and consumer
- A new meaning of 'ownership'
- New values models.

2.1 Scale changes in space and time

The scale on which organisations and markets take shape and on which they conduct their activities is changing due to various factors, including network effects (see Part 2, Section 1.3: 'Network economy'). We see a process of 'glocalisation': simultaneous shifts to both the lower and higher levels of scale. For example, large international organisations such as Airbnb and Uber, for whom geographic boundaries are no longer relevant, are active at the local level and apply different business models according to the city concerned.

The electricity market is another good example of scale changes. Localised generation (using solar panels and wind turbines) and storage mean that there is now a restructuring of the market with this lower level playing a more important part. The infrastructure, including the grids and storage facilities, must be adapted accordingly. At the same time, there is an ongoing expansion of scale as international energy markets become ever more closely intertwined, both in the technical sense (grid interconnection) and in the legal sense of consolidation through acquisitions and mergers (see Part 2, Chapter 4).

The timescale within which the processes take place is becoming ever shorter. Information and monitoring data are available on demand. Grid management can be undertaken in real time. Even as a new product is being launched onto the market, its replacement is often already in development. Alternatively, the product will have been designed as a learning system which is automatically updated while in use. Examples include the software of computer operating systems, or the driverless functionality of the new Tesla vehicles (see Part 2, Chapter 4).

Overall, we see increasing variation of scale and far greater interdependence between the various levels of scale. Boundary lines are increasingly arbitrary in nature. This places the regulatory mechanisms under pressure. It challenges the traditional territorial political systems and administrative infrastructures. In some cases, regulatory mechanisms do not have adequate geographic coverage. Perhaps they are not finely meshed enough or fail to allow for local differences. Conversely, they

may be too small in scale (whereupon legal systems are pitted one against the other). At the same time, technology itself introduces the very flexibility that administrative arrangements need if they are to adapt to the variation in scale. It is technology which allows new forms of democratic decision-making.
The sheer speed of the changes also places the regulatory mechanisms under pressure. This will be the case if modifications to software and operating systems are introduced before their effects (in terms of security and privacy) are clear. In any event, some 'solutions' are not considered acceptable in an open democracy such as the Netherlands. The blanket internet censorship applied by some totalitarian regimes has no place here.

2.2 Sector convergence

It is not only the physical boundaries that take on a new meaning. The boundaries between sectors will also become less distinct. Many technological developments take place at the meeting point between sectors. There will therefore be a convergence of knowledge, technology and markets. A notable example in the domain of infrastructure and the environment is the development of autonomous vehicles, a process in which ICT companies (Google and TomTom) are both the competitors and partners of established automotive companies (Mercedes, Nissan and GM), with new entrants waiting in the wings (Tesla, Google and Apple).

Commingling can also be seen in the energy sector. In addition to the introduction of new technologies (which can be seen as replacement of existing sources, i.e. substitution), new players are emerging. Private individuals offer storage capacity (home batteries or the battery of an electric car). Companies in the agricultural sector utilise spare capacity in a way which would not be financially viable for traditional producers. They may, for example, install solar panels on their buildings or run a generator using biomass derived as a by-product of other processes.

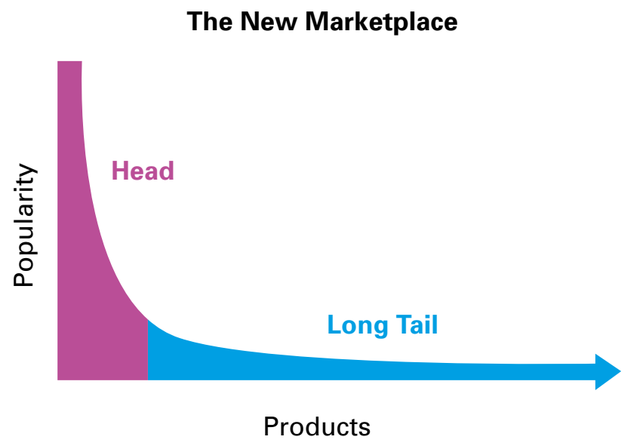
Sector convergence also extends to the regulatory systems. Chemicals companies, for instance, have long been active in developing pesticides and fertilisers. More recently, they have turned their attention to the crops themselves and have sought to protect new cultivars by means of patents. This is a departure from the traditional system of breeders' rights, under which a grower may use others' products as the basis of new strains or varieties, and can only claim any form of ownership rights in respect of his 'own' seeds (*VPRO Tegenlicht*, 2013). The two systems are not compatible and the situation is likely to play out in very complex court cases involving the chemicals, biochemicals and agricultural sectors.

2.3 More diffuse and more direct relationships between producer and consumer

We now see several markets on which the relationships between producers and consumers have become far more direct. The chains are shorter. In some instances, consumers supply products and services to each other. This is known as peer-to-peer (P2P) or consumer-to-consumer (C2C) commerce, as opposed to the traditional business-to-consumer relationship (B2C) (see Frenken et al., 2015). The roles are not always clear, whereupon it becomes convenient to use the term 'prosument'.

The (more) direct relationship between producer and consumer creates opportunities for the personalisation of products or services. The producer (whether a company or a prosument) can better match supply to demand, while the consumer is better able to make his or her wishes known. This interaction is supported by technological developments. There is widespread use of digital platforms which bring the supply and demand sides together with low transaction costs. The marginal costs are also kept in check, even for low production runs (of books, clothing, artworks, jewellery, accessories, etc.) by new technologies such as Print on Demand (POD) and 3D printing. This creates opportunities to tap hitherto unviable niche markets, with new business models based on small-scale supply to meet small-scale demand. Anderson (2006) named this phenomenon the 'long tail' (see Figure 5).

Figure 5: The long tail



Digital platforms also empower users and allow them to organise themselves into 'communities' which are independent of any geographical context or constraints (Hinssen, 2015). Producers no longer develop standard products which they 'impose' on the market. Rather, the communities help to determine what products should be available and in what form. They may organise demand for the product, or might even provide investment for its development costs (through 'crowdfunding').

The direct relationship between producer and consumer can also create a blurring of roles whereby the consumer becomes a producer. This can be seen in car-sharing (MyWheels and Snapcar), ride-sharing (UberPOP), short-stay housing (Airbnb), tool-sharing (Peerby) and meal-sharing

schemes (Thuisafgehaald, Eetumee). The new relationship also serves to safeguard quality, as consumers and producers give each other feedback in the form of reviews.

The more diffuse relationship between producer and consumer can also undermine the effectiveness of some formal institutions and regulatory mechanisms. When people cook meals in their own kitchen, it is difficult for the NVWA to conduct the usual hygiene inspections. Perhaps it will be possible to satisfy the changing expectations of consumers by means of an assessment system. Can rankings and reviews replace centralised regulation? If someone earns money by allowing others to use his car, should he pay tax? If a household generates more energy than it uses, does it become an 'energy producer' in the meaning intended by existing legislation?

As the private and commercial spheres overlap, many more such questions must be answered. In fact, the Tax and Customs Administration has already established standpoints on many of the issues involved and has done so without waiting for any broader political discussion to take place. Attempting to reconcile various interests within a single instrument, whether a fiscal measure or the inspection of a kitchen, makes such a discussion rather more complex than it would appear.

2.4 A new meaning of ownership

Technological innovation is changing the meaning of 'ownership' in many ways. The aspects which must be redefined include responsibility, liability, accessibility and the use of non-physical property such as digital files. The changes have an impact on the way in which the institutions or regulatory mechanisms function, as illustrated by the following examples.

When sharing physical goods ('atoms': see Part 2, Section 1.1), ideas and data ('bits') it will be necessary to make agreements with regard to who is permitted to use them and matters of liability or accountability.
For instance:

- What arrangements are in place to control access to, say, a car or apartment?
- Who is responsible for any unexpected adverse impact caused by the provision of a service, such as the nuisance created by large numbers of tourists staying in Airbnb accommodation?
- Who is responsible for the system of reputation rankings for Snapcar users?

In the case of autonomous, learning systems, it can be difficult to define aspects such as responsibility, liability and access. Suppose a care robot begins to show undesirable behaviour after a number of years in use. Perhaps it becomes uncooperative or even aggressive. Who is responsible and who is legally liable: the manufacturer, the owner or the robot itself?

Who can rectify its errant behaviour? The same considerations apply to other types of robot now in development (for security, transport, deliveries, etc.) and to autonomous, driverless vehicles.

Within the sharing economy, a decisive factor is the degree to which people are willing to share their property with third parties. The mix of rational, economic, social and emotional factors which determine that willingness can be seen as a cultural regulatory mechanism.

Data, knowledge and information are forms of virtual property, which is a separate category. Here, the overriding consideration will be access. Is use to be confined to one particular party, i.e. exclusive? Who decides this? If, for example, physical items such as cars or agricultural machines are connected to the Internet of Things, the producer often claims sole rights to the usage data they generate. If an exclusive right is granted, there is only one party able to develop new services based on the data and to monetise that data. This leads to a form of lock-in. If the data can be shared by several parties, however, there will be more opportunity for competition and innovation. The value of the data will therefore be enjoyed by a far greater number of actors. In the most extreme case, data, information and knowledge will be freely available to all: open source, open knowledge and open data. This creates maximum opportunity for creativity and social enterprise. The challenge will be to find a mechanism whereby the 'author' can be fairly rewarded for his efforts, and to find ways of generating funds to support further development.

2.5 New values models

The development of the patterns described thus far is supported by changing societal values models (sustainability, sharing, social enterprise and transparency). Conversely, the four patterns create opportunities to strengthen the cultural and societal values models.

The development of local electricity generation, for example, is driven by people's desire to contribute to sustainability. The changing significance of ownership as seen in the sharing economy or the growing popularity of private lease constructions, appears to be due to a shift in attitudes: people do not necessarily want to own something but are content if they can have access to it when needed.

The importance of data, information, knowledge and services increases in the sharing economy. They share a common characteristic: all can be used by an unlimited number of people and all can be reproduced at little or no cost. There will be a proportional decrease in the importance of scarce capital goods and indivisible resources. The concept of scarcity as the basis principle of valuation may continue to apply to the 'atoms' but not to the 'bits'. Economic value in the world of the bits is an expression of the degree to which a particular actor has access to the data or information networks and to social capital. The result will be a different economy in which the value of 'shareable' products and services supplants that of tradeable assets (Hinssen, 2015; Rifkin, 2014). Examples of business models which illustrate this development include services which are free to users, being

funded by advertising (Spotify, Metro, Facebook) or through the sale of data. That sale may be explicit, as in the case of Crop-R, a management package for the arable farming sector. It may also be implicit: the Google user ‘pays’ with data about his search behaviour and interests.

In the open knowledge and open source concepts, knowledge and information are treated as social, shareable ‘resources’. Depending on the business model in which these resources are applied (commercial or not-for-profit) there may be some *quid pro quo* for the use of the resources but not necessarily in the form of a financial payment. This ideological approach is the basic principle behind the Linux operating system and the online encyclopaedia Wikipedia. Companies based on social enterprise do not set out to make a profit but mainly to achieve social objectives. Examples include a cafe staffed by young people with Down syndrome (Downey’s Coffee and Tea in Amersfoort), the ‘care farms’ which organise recreational activities for people with disabilities, and Starters4Communities, a training and work experience organisation. Many of these initiatives start small and operate ‘under the radar’ for some time, which allows them opportunity to develop and test new ideas.

3

CHANGING PUBLIC VALUES AND THE ROLE OF REGULATORY MECHANISMS

The patterns described in Chapter 2 offer a starting point for the further analysis of the dynamic that technological innovation introduces to the economic and societal spheres. This chapter examines the changes that can occur, those which should be allowed to take their natural course based on various interests, and those which should be managed or influenced by means of regulatory interests.

It is important to remember that the introduction of a technology can cause effects which extend beyond its own application. The introduction of a driverless vehicle is not only a matter for the consumer and the competing car manufacturers, but has consequences for road safety and space usage. The ongoing growth of Airbnb not only affects the tourist accommodation market but also the housing market. It can erode the quality of life in some neighbourhoods, and creates new requirements in terms of fire safety inspections. In short, the application of technology impinges on various general interests in the living environment. This chapter examines what is meant by general interests and public interests, who is responsible for safeguarding those interests, and the regulatory mechanisms used to do so. Public values play an important part in assessing the impact and desirability of technology-driven change.

3.1 Public values in the living environment

The literature uses various terms to refer to matters which affect society as a whole. Some authors refer to 'values' while others prefer 'interests' or 'matters' (see also NSOB, 2013; Teulings, Bovenberg and Van Dalen, 2003; WRR, 2000). In many cases, the choice of terminology seems to rely on convention. Economists, for example, are more likely to refer to 'interests' while the public governance field tends to use the term 'values'. The word 'interest' implies some benefit for a particular party, while 'matter' is rather too vague for most purposes. The problem with 'value' is that there is no agreed definition, demarcation, interpretation or perception. Nevertheless, the Council has opted to use the term 'value' in this publication, partly because of its conveniently dual purpose: it can refer to (a) financial value or to (an) ethical or moral value.

The word 'value' is usually preceded by an adjective: 'general' values, 'social' values or 'public' values, in order to distinguish various types of value. In a report produced by the Scientific Council for Government Policy (WRR, 2000), for example, we read (here in translation): "...those *social* values that we all consider the responsibility of government to protect as *public* values". However, the government is not the only actor responsible for the public values. In the current publication, the Council has opted to use the term 'public values' in contrast to those which are purely individual or private in nature.

In several synthesis studies concerned with public values and public interests, the two terms are often applied directly to the processes of public governance. They imply a judgement of quality, as explicated using words such as 'accessibility', 'legitimacy' and 'solidarity'. The studies generally conclude that any attempt to arrive at a typology or hierarchy will fail due to the complexity and controvertible nature of the subject matter (see for

example Rutgers et al., 2008; Zeger van der Wal et al., 2015; Williams et al., 2011; M. Smit, 2010).

With the foregoing in mind, the Council uses the term ‘public values in the living environment’ to refer to those values considered to be of general importance and which are manifest within the living environment. In essence, there are two categories of public values: collective and pluriform. Public values which are collective in nature are important to everybody and must be realised in a uniform, non-discriminatory manner. Flood defences protect everyone, for example, while clean air is not reserved for any particular target group. Many public values are pluriform. This means that there are various opinions, not necessarily mutually exclusive, regarding how they should be implemented. In a democracy such as ours, it is important to uphold the right to hold differing opinions. This in itself is an overarching public value. Solidarity and health are examples of pluriform public values. Both can be pursued in various ways. The perceived importance of public values is not static but can change over time. During the recent economic crisis, the affordability of housing took on greater significance for many than would be the case during a protracted period of relative prosperity. When firm climate objectives are in place, the emissions caused by industry and traffic are seen in a different light. The following section is concerned with who decides the public values and who is responsible for achieving them.

3.2 Public values as a shared responsibility

The government is often regarded as the custodian of public parties. The Council notes that private sector companies, societal organisations and individuals also have a role to play. Insurance companies and hospitals are among the market players involved in maintaining public values (NSOB, 2015). Since the 1990s, the Dutch government has pursued a policy of privatisation (or more accurately reprivatisation) of nationalised industries such as energy generation and distribution, the railways and some components of the healthcare system. To support the debate about privatisation, the Ministry of Economic Affairs and the Ministry of Finance commissioned a report on ‘the economy of public interests’ (Teulings, Bovenberg, Van Dalen, 2003). Its focal points are external effects, market failures and government failures.

Other research publications include a WRR report (2012) about the realisation of public values. It focuses on the effects of privatisation in terms of freedom of choice, solidarity, accessibility, quality and affordability. The WRR contends that private sector companies and societal organisations should accept even greater responsibility for matters of general public interest. Societal organisations and private individuals are also an important source of public values. One example is the Netherlands Internet Domain Registration Foundation (SIDN), a not-for-profit organisation which administers all internet addresses ending in .nl. In short, the task of identifying, defining, pursuing and protecting public values falls to government, the private sector and the general public alike.

An example is given in the textbox below.

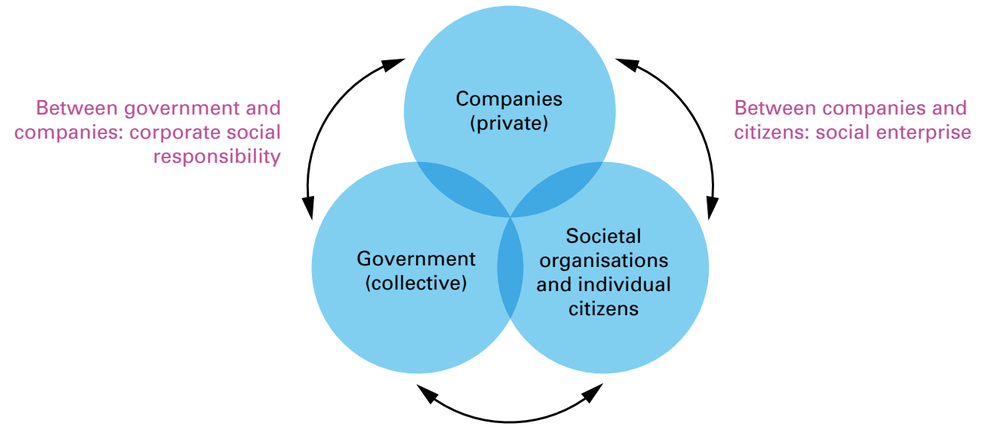
Placing climate protection on the public agenda

One example of a public value being placed on the agenda is the attention devoted to climate-neutral energy provision. This is a topic which scientists and societal organisations have been promulgating for many years. One societal organisation which has been particularly active in this regard is Urgenda. Its activities have resulted in this public value being adopted within the private domain (in the form of cooperation between various companies and a national campaign to promote solar panels) as well as in the collective domain (legal action against the Netherlands itself). By ratifying the 2015 Paris Agreement, the Dutch government has committed itself to various long-term environmental and climate objectives. Several private sector organisations have also openly endorsed the public value of climate protection.

Public values develop over the course of time. They can gain or lose strength and persuasive ability. The relationships between government, market and society are constantly changing. Figure 6 examines various phenomena in the context of these dynamic relationships, such as those between:

- Companies and government: competition in the public transport sector, private schools.
- Government and societal organisations/individuals: withdrawal of some welfare provisions, library closures, reduced subsidies for culture and nature, compensated by initiatives such as Leeszaal Rotterdam West, Verhalenhuis Belvedère, sponsorship of cultural organisations and the National Forestry Commission, which now manages commercial facilities in partnership with other parties.
- Individuals/societal organisations and private sector companies: energy cooperatives, collective disability schemes for the self-employed.

Figure 6: Changing relationships between government, the private sector and citizens



RIi, adapted from NSOB, 2013

Changes within society alter the way in which public values are realised by government, businesses and private individuals. Technology plays a role: it is not neutral as we saw in Chapter 1 of Part 2 with regard to platforms. The manner in which technology is applied, is allowed to develop or is subject to restrictions, will affect the ease with which public values will take shape. We now consider the role of institutions and regulatory mechanisms in shaping public and private values.

3.3 Regulatory mechanisms and institutions

When considering the economic and societal changes brought about by technological innovation (and its manifestations: see Part 2, Section 1.2), as well as the role of public values, the Council uses the term 'regulatory mechanisms'. In sociology, the literature often refers to 'institutions' (see for example Scharpf, 1997; Koppenjan and Groenewegen, 2005). Regulatory mechanisms or institutions enable the behaviour of actors and the interactions to be influenced. They make behaviour more predictable. Regulatory mechanisms take various forms, from binding legislation (laws and statutes) to cultural customs and conventions, contracts and agreements. Where the term 'institutions' is applied in this context, it must not be taken to mean 'organisations which form part of, or act on behalf of, the government'. To avoid confusion, the term 'regulatory mechanisms' was used throughout Part 1 to reflect the fact that interactions are subjects to various influences, not all of which emanate from the government. In Part 2, the Council has opted to align itself with the literature and therefore uses the term 'institutions'.

The role of institutions in creating and safeguarding public values

Public values can be rather general in nature, even abstract (Rutgers, 2011). As a result, it is not always easy to define or promote them in everyday practice. Public values are made explicit by means of policy plans and vision documents. Concrete activities are then devised in pursuit of those values, varying from fiscal measures to legislative instruments, and from product development to supervision by some regulatory body. This is how public values are embedded into society.

Society itself can be seen as a complex social system in which various actors collaborate in various configurations. Social systems need institutions or rules (formal or informal) in order to coordinate and guide the actors and their activities. This avoids the depletion or excessive use of common assets, while also reducing strategic uncertainty with regard to others' behaviour. (Will they participate, will they make agreements and will they keep those agreements?) (Koppenjan and Groenewegen, 2005).

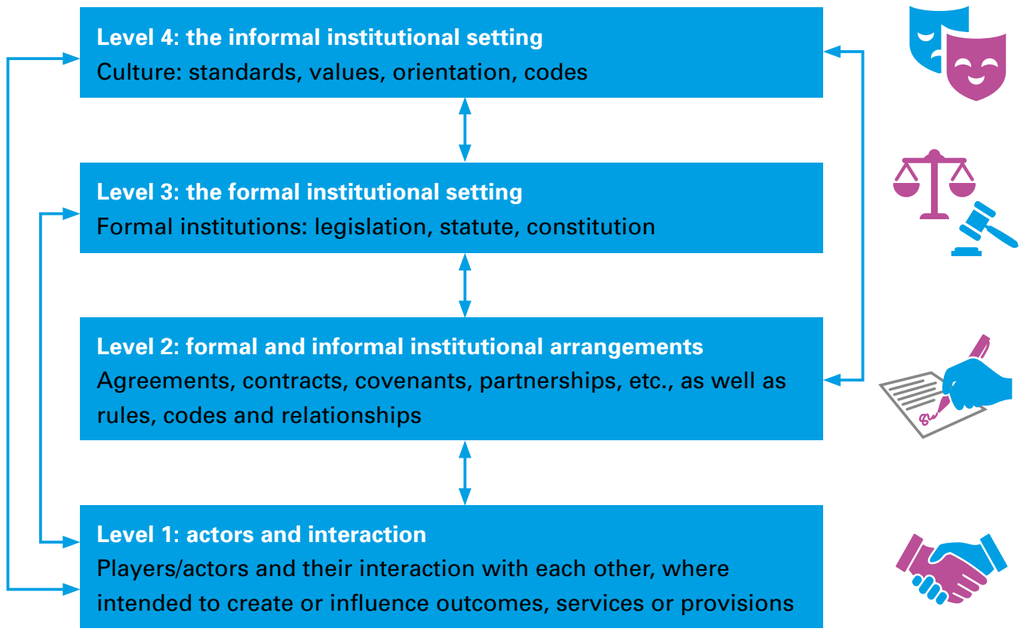
According to Scharpf (1997), institutions form "a system of rules which structure the actions which a group of actors is able to take." Institutions, or rules, ensure that the use of resources is in balance. There is equilibrium between taking (direct personal interests) and giving (the common interests). Institutions also make other actors' behaviour more predictable, and they promote the attainment of collective aims and objectives. Institutions are based on public values, i.e. values that are considered to be in the general interest (see Rutgers, 2011 and others). Institutions can differ in character and can be either formal or informal. They can be found

in both the public and the private domain (Koppenjan and Groenwegen, 2005).

Stratification of institutions and linkage of values

Within the institutions we see various levels, each of which represents a specific type of rule. Koppenjan and Groenewegen (2005) distinguish four levels, as shown in Figure 7.

Figure 7: The four level model of institutions



Koppenjan and Groenewegen (2005), after Williamson (2000)

The four level model brings institutions of varying types together in a single framework. A relationship is established between cultural beliefs of Level 4, which can relate to forms of address, the integrity of living, the significance of the family or the community, and personal interaction, as seen on Level 1, as well as current legislation (Level 3) and arrangements (Level 2).

The purpose of institutions is to safeguard public values. In many cases, a single institution will serve to promote several public values simultaneously. Take fuel duty, for example, which is intended to influence the use of motor vehicles (the public value of 'accessibility and mobility'). The imposition of duty can reduce the total emissions caused by road traffic (the public values of 'sustainability' and 'health') and is also a source of income for the national exchequer (and therefore supports many other public values).

Robust yet flexible: the paradox of institutions

In general, institutions are robust. They are, after all, intended to create stability and predictability. Paradoxically perhaps, institutions must adapt if they are to remain congruent with those on other levels. There is also a continuous pressure to change, perhaps due to:

- new technological systems (e.g. Tesla's introduction of a car with self-driving capabilities)
- undesirable outcomes (e.g. nuisance caused by tourists in Airbnb apartments)

- scale changes (e.g. mobile roaming charges have become a European rather than a national issue)
- undesirable processes (e.g. fraud in the construction industry).

Institutional arrangements are constantly adapting but they generally do so very gradually, one step at a time, to fulfil their purpose in terms of providing stability and predictability.

4

CASE STUDIES TO ILLUSTRATE THE PATTERNS OF CHANGE

The patterns of change within the economy place the existing institutions (regulatory mechanisms) under some pressure. We have already seen many examples of institutional adaptation, both formal and informal. In this chapter we example whether the same patterns are visible within three case studies relevant to the living environment, the public values that are affected, and the institutional issues that must be addressed.

The case studies illustrate how changes can be systematically analysed. The Council does not claim to have undertaken an exhaustive consideration, nor do we attach any policy conclusions to our findings. The examples are no more than snapshots in time. The insights they provide appear valid today but may be overtaken by future developments. The timescale on which that is likely to occur remains unclear.

4.1 Technology in the agrifood sector: the milking robot

Technological developments, including those in the realm of ICT, have the potential to make the food chain smarter, more productive and more sustainable. It will become possible to increase the efficiency and sustainability with which resources are used, while reducing food wastage and losses at the end of the chain. Technological developments will also change the nature of the farm itself, which will become a link in a highly industrialised food production chain.

Agriculture is evolving into precision agriculture, a farming management concept in which crops and animals are given precisely what they need at any given moment. ICT and advanced analysis techniques monitor the situation, support decision-making and implement the necessary measures (Bos and Munnichs, 2016). In biotechnology, new developments underpin selective breeding methods whereupon new plant strains and breeds of animal can be introduced far more quickly than in the past.

The supply and processing industry surrounding agricultural production has long been active on a global scale. Precision agriculture has not changed this. Large multinationals not only control the physical capital goods in the sector but are also the key players in collecting and processing data. To a significant degree, they manage the business activities of the individual farm. Globalisation and concentration have altered the power positions within the chain. This has consequences in terms of how the farmer chooses to operate his business, but can also affect the relationship between the farmer and his physical setting: the region in which he operates. What freedom (formal or actual) will he have to make agreements at the regional level with regard to matters such as water management, landscape quality, agricultural nature management or public access? The significance of technological developments can be seen to extend far beyond the agricultural production chain itself.

The challenge, for the sector and for society as a whole, is to make optimum use of the opportunities that technology presents, while ensuring that all relevant public values are upheld. In this section, we examine the patterns of change and the effects on public values further to one particular development, the introduction of the milking robot.

The introduction of the milking robot represents an important technological development within the dairy farming sector. The modern milking robot incorporates a large number of sensors and connects the individual cow to global networks. This technology illustrates how precision agriculture is being supported by the Internet of Things. The milking robot has helped to rationalise milk production. Its use is relevant to various policy domains, including animal welfare, landscape (the 'cow in the meadow') and the production and disposal of manure and slurry. The robot not only assumes some of the farmer's workload but it collects data about the health and productivity of individual cows. This data can be used to optimise the feeding regime or to determine whether the cow should be inseminated, and if so, using what semen. Because the supplier of the milking robot has access to this data, which is processed using proprietary algorithms, that supplier knows exactly how the farmer is running his business. Depending on the usage rights arrangements for the robot and the data, whoever has access to that data (at individual and aggregated level) can control the milk production chain and the decisions taken. The milking robot also promotes the further industrialisation of the milk production chain, which could have consequences in terms of land access and usage.

4.1.1 Analysis: what patterns can be seen?

First pattern: scale changes in space and time
The milking robot measures the milk yield of each cow and uses various sensors to collect data about the condition of the animal: body temperature, presence of antigens, quality of milk, et cetera). Armed with this data, the farmer can determine the optimum management regime for each individual animal.

The supply industry operates internationally, with leading players such as DeLaval of Sweden and the Dutch company Lely. They supply the physical equipment and develop new services based on both individual and aggregated data, as collected by the robots. The influence of these large players continues to increase (Ge and Bogaardt, 2015).

Second pattern: Sector convergence
The milking robot and its use of sensor technology brings the ICT yet further into the dairy farming sector. The production chain can be seen as an application of the Internet of Things, which raises certain issues with regard to big data. The data collected in the milking shed is not only used by the individual dairy farmer but supports the optimisation of the entire chain (customers and suppliers, as well as accountants and government agencies), partly because output can be predicted with greater accuracy. Various agricultural companies and ICT startups have developed software intended to facilitate business operations through the exchange of knowledge and information. One example is the open data app 'Boer & Bunder' (see www.boerenbunder.nl).

The business model of the agricultural supply industry is also changing. Data, and the knowledge generated by its analysis, is an increasingly important business asset which can be bought and sold. The more international the company's operations, the greater its ability to compare countries, regions, growing conditions and suchlike. This supports an increasingly diverse range of products (hardware and software) and services. Companies in the potato processing industry can now monitor their contracted suppliers in real time. PepsiCo, producers of Lay's crisps (marketed as Walker's in some countries), does so using Dutch technology.

Third pattern: more direct relationship between producer and consumer

Having detailed information about production at the level of the individual animal creates countless opportunities for product differentiation. It becomes possible to target certain niche markets, such as that for regional products. However, this does not represent any reversal of roles within the chain: the consumer does not have any role in production. The third pattern of change does not therefore apply.

Fourth pattern: a new meaning of ownership

The milking robot is increasingly regarded as a service provided by the supplier rather than a physical asset which is purchased and operated by the dairy farmer. As a result, the farmer's position becomes unclear. How much autonomy does he enjoy? How far do his responsibility and legal liability extend? Various issues are raised concerning the collection, sharing, storing and transfer of data. Who actually owns the data that has been collected by the sensors attached to the farmer's cows? Is the knowledge which results from this data protected by patent? Can the data be used by third parties, such as consultants or a dairy cooperative? Or should consultancy services be the domain of the company which supplies the milking robot system, as part of its 'total package'?

Fifth pattern: new values models

The milking robot and the further development of the Internet of Things create possibilities for new data analysis and other knowledge-intensive activities which can be marketed as a Dutch export product. Such developments support a business model in which the emphasis is on price and efficiency advantages gained through consolidation and scale, whereby a more regional model based on niche products is likely to be less successful. On the other hand, sharing data throughout the chain could make supply levels more predictable, which would enable spare capacity to be devoted to the production of smaller batches of niche products.

4.1.2 Effects within the living environment

The introduction of the milking robot has brought about some positive effects within the dairy supply chain, including higher productivity (supporting economic growth and food security), the optimisation of resource usage, and reduction of environmental impact (more sustainable food provision). Magnin (2016) states that big data and advanced analyses will empower the chain to tackle various challenges, including innovation and modernisation, optimisation of production, increasing overall transparency, reducing food wastage and improving the transport infrastructure. The Dutch private sector has played a prominent role in the development of the robots, as well as other sensor technology and software products. These high-end products and services have significant export potential.

At the same time, further industrialisation can have negative effects on landscape quality, animal welfare, the autonomy and identity of the individual farmer, and local networks. Social cohesion and regional development may suffer.

Constant observation ensures that the health of dairy cows is protected to the greatest extent possible. Similarly, their welfare is enhanced if they are milked as needed rather than at set times. Nevertheless, the further optimisation of the cow as a 'production unit' could have negative consequences for both health and welfare.

4.1.3 Institutional issues

The dynamic within the dairy sector creates certain challenges for the institutional context, which can be examined using the four-level model introduced in Section 3.3. The following account does not claim to be exhaustive.

Level 1: actors and transactions

The milking robot increases efficiency and the dairy farmer's profit margins (at least at first). It is a new product that replaces traditional milking systems and introduces new activities based on data analysis. It is possible that the data will be processed by parties other than the farmer himself, such as processing companies which use it to optimise production planning. Increasingly, it is the algorithms built in to the robot which determine the animal's feeding regime, when they are to be inseminated and when they are to be sent to the abattoir. As a result, the farmer becomes merely the agent of the other actors in the chain. He may become less accountable for matters of environmental responsibility and animal welfare.

Level 2: formal and informal institutional arrangements

The milking robot and the Internet of Things have consequences in terms of the relationships within the chain. The farmer will occupy a different position in his dealings with customers (the dairy processing companies) and suppliers (the producers of equipment and materials). The large volume of data and the

greater predictability of production processes may prompt the chain parties to enter into extremely detailed contracts. The farmer's autonomy and ability to make agreements with third parties (local authorities, local residents, nature organisations) will then be restricted. Lock-in effects may occur if the farmer cannot transfer his data between providers.

Digitisation creates the prospect of 'smarter', more effective agricultural policy (Poppe et al., 2016). Agreements must then be made with regard to the availability of data used to support the implementation of that policy. The milking robot and the Internet of Things can provide information about grazing time, the use of antibiotics and the precise location of areas treated with pesticides. Technology offers more accurate assessments of emissions levels. All such information can be used to enforce the 'greening' requirements introduced by the 2013 CAP reforms provided agreements are made about standards, ownership, privacy and the availability of data (Sykuta, 2016).

Level 3: the formal institutional setting (legislation)
The milking robot can influence compliance activities further to animal welfare and environmental legislation. The processes of globalisation and concentration could create new monopolies, some transnational in nature, whereupon legal action may be required to determine if there has been any breach of competition law. There are also questions with regard to the ownership and usage rights of data which has been collected on the farm.

Level 4: the informal institutional setting (culture)
The milking robot, and by extension the further industrialisation of agriculture, may change the way in which society regards the dairy sector. The farmer will increasingly be seen as merely the agent of a huge multinational chain. This does not chime with the traditional ideal: the farmer as independent businessman with his roots firmly in the region. The character and appearance of the modern, highly rationalised farm cannot be reconciled with the common perception of its role as the bastion of scenic quality: the iconic image of the 'cow in the meadow'. To treat animals as nothing more than production resources impinges on deep-rooted cultural and ethical standpoints which respect the 'freedom' and 'naturalness' of living creatures.

4.2 Localised electricity generation

Traditionally, the Netherlands' electricity provision has relied on the combustion of fossil fuels in large-scale power stations. Output is then distributed by means of high-voltage and low-voltage networks which together form the 'national grid'. The Dutch government (like those of other countries) actively intervenes in the energy market with a range of instruments including taxes, levies, subsidies, exemptions and price-capping. The government has also involved itself in the organisation of the

energy market by nationalising the distribution infrastructure while leaving actual production and commercial exploitation in the hands of market parties. The government has worked to uphold public values by subsidising energy efficiency measures, facilitating research and investment in renewable resources, and by actively promoting the international position of large companies (DSM, Tata Steel) and entire economic sectors (glasshouse-based horticulture).

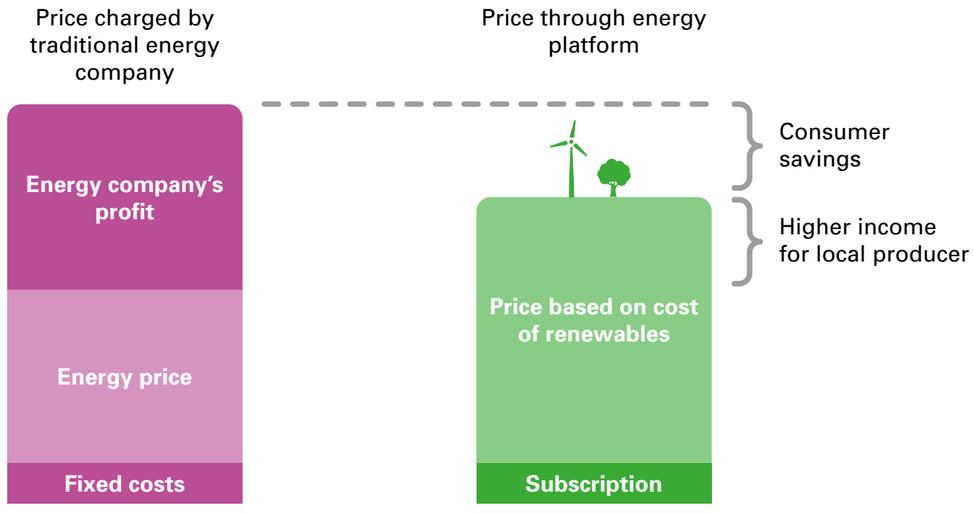
The transition to a more sustainable energy system has bolstered the importance of small-scale, localised production. Reducing CO_2 emissions is widely seen as a matter of urgency, which has strengthened society's resolve to abandon fossil fuels in favour of cleaner alternatives. These developments are supported by the governments' 'top sector' policy, ongoing scientific research and various incentive programmes such as the SDE+ subsidy scheme. A general framework is provided by national and international agreements, such as the SER Energy Agreement for Sustainable Growth, and the 2015 Paris Agreement. The generation of electricity using solar panels, wind turbines or bioenergy can readily be undertaken at the local level. Over the past twenty or thirty years, these methods have become more robust and less expensive. The prospect of not having to rely on the large utility companies, or on remote regions or other countries, has prompted many individuals and groups to explore what is possible closer to home, perhaps even on the rooftop of that home.

This change in the manner of producing electricity is known as the 'energy transition' and involves both technological and social developments. We see the emergence of parallel market organisations: the centralised, fossil fuel-based system continues to operate alongside the decentralised system based on renewables.

It is not only the supply side of the electricity market which is subject to changes. We now see differentiation on the demand side too, with a growing number of intermediaries active in the marketing of renewable energy. Online platforms play a significant part. One example is Vandebron, an online broker established in 2013, through which consumers can purchase their electricity directly (in the legal sense) from named local producers.[11] Vandebron (the name translates as 'from the source') is not just a different form of consumer or producer cooperative. Consumers can state their preferences with regard to the method of generation, region of origin or a specific producer. In practice, the electricity brokered through the site is generated using wind energy, solar energy and biomass. Suppliers who operate through online platforms such as Vandebron ensure that supply matches demand. If necessary, they purchase extra capacity from other (sustainable) energy providers. This is therefore a different business model (see Figure 8) and a different organisational structure of market parties (Figure 9).

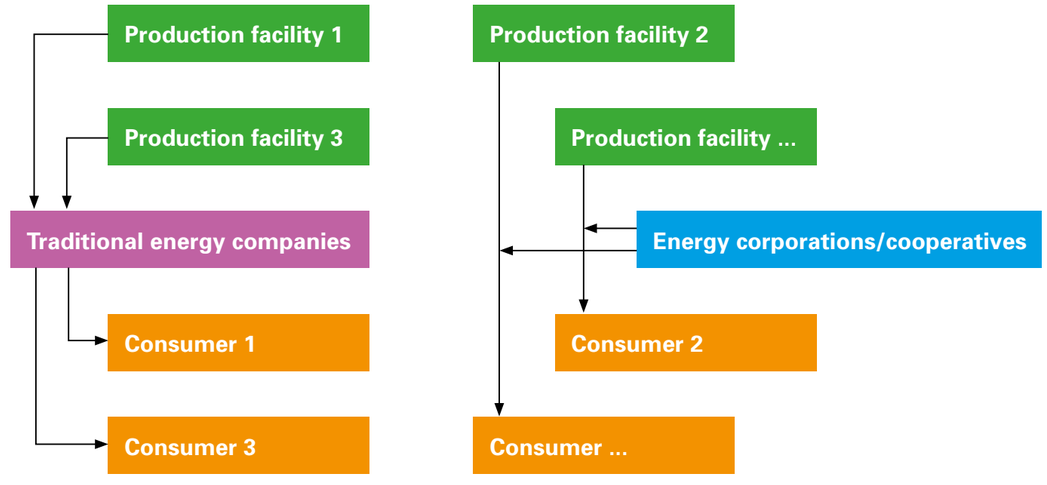
11 'Directly' does not mean that there is a cable running between the point of generation and the consumer household. The current runs along the same copper wires as all other electricity.

Figure 8: Business model of energy providers



Adapted from www.vandebron.nl

Figure 9: Direct relationship between energy producers and consumers



In terms of infrastructure, the traditional arrangement was for electricity to be transported from the large centralised power stations via the high voltage grid and a number of substations, eventually being 'stepped down' and distributed to consumers through the low voltage grids. While this still takes place, it is no longer the only possibility. Increasingly, electricity is both generated and consumed at the local level, using solar panels, wind turbines or 'behind the meter' (BTM) systems. As these variable sources account for an increasing proportion of overall production, and as the scale of production and distribution diminishes, it becomes more difficult to balance supply and demand. Fluctuation on the supply side results not only from the unpredictability of wind and solar energy, but also the nature and size of 'spare' generating capacity. On the demand side, much will depend on the adoption of electric vehicles and electric heating systems, with the gradual phasing out of gas as a source of domestic energy. Storage capacity can minimise the imbalance between supply and demand, thus reducing the need for spare generating capacity. Local generation and storage (e.g. in the batteries of electric vehicles) also reduce the required transport capacity of the distribution grid.

The developments create a need for a new form of electricity grid. The required network will not only transmit electricity 'in two directions' but also information. Providers and consumers will continuously exchange information about the current output and demand, and about anticipated output and demand at various points in the (immediate) future. Smart grids, smart meters and local storage capacity all play a significant role in optimising production and efficiency. New services which help the consumer to monitor and control consumption are already being launched in the Netherlands. They include Eneco's TOON, a smart thermostat which also controls lights and appliances, and Google's NEST, which combines a smart thermostat with a household security system.

4.2.1 Analysis: what patterns can be seen?

First pattern: scale changes in space and time

There will be greater variation of scale. The emergence of local generation and storage will prompt a reorganisation of the market, with the centre of gravity shifting to a lower level of scale. The infrastructure will also adapt accordingly, with more robust local and regional smart grids. At the same time, an expansion of scale can be seen as international energy markets become increasingly interconnected, both in the literal, technical sense and in the legal sense as the result of consolidations, acquisitions and mergers. It is now possible to view the energy system on a European scale. Solar panels predominate in the south, bioenergy has taken off in the east, while onshore and offshore wind energy is a major production source in western and northern Europe. Balancing supply and demand is an issue at both the higher and lower levels of scale. Local conditions and circumstances must also be taken in to consideration. This creates a substantial information requirement, which in turn will raise issues of privacy, transparency and perhaps a debate about digital identity.

Initiatives such as Vandebron help small-scale initiatives establish a toehold in the market. The development of smart grids, storage capacity and self-sufficient projects which need not be connected to the national grid are appropriate to the local level.

Second pattern: Sector convergence

Homeowners install solar panels on the roof. Farmers and water management authorities may operate a biogas fermentation facilities, while a zoo might generate part of its own electricity requirement from various waste flows. These are all situations in which 'spare' capacity is put to use in a way which would not be economically viable for the traditional producers. Energy provision becomes integrated into the citizens' daily life or the business operations of organisations in various sectors. They become new entrants on the energy market, as do those who store energy in home batteries or electric vehicles. There is

convergence with the mobility sector, the most obvious example being the charging infrastructure for electric vehicles.

Third pattern: more diffuse and direct relationships between producer and consumer

The large-scale centralised generation of electricity has relied on ‘anonymous’ power stations which are built, maintained and run by equally anonymous energy companies. Small-scale generation which creates a one-to-one relationship between consumer and producer (as facilitated by Vandebron) creates a different form of involvement in the energy system. It can remove certain obstacles and objections, such as those related to spatial assimilation. But it can create difficulties because current legislation was not designed with small-scale production in mind. How should value added tax be charged? Who pays for building and maintaining the infrastructure? What about energy tax?

Given the ready availability of solar, wind and bioenergy technology, which has become very much less expensive, new parties are now assuming the role of producer in the traditional energy sector. Their output may be intended solely for their own use, but they might also act as a provider. Households, farmers, cooperatives and residents’ associations have become active on the supply side of the market.

Some consumers cannot afford to invest in the necessary technology and therefore remain reliant on the traditional large-scale energy companies. There are new issues to be faced when attempting to divide the investment and operating costs of the large-scale facilities in an equitable manner.

Fourth pattern: a new meaning of ownership

Increasingly, production resources are in the hands of consumers or companies which do not form part of the traditional energy sector. There is a growing volume of usage and production data being exchanged between the various parties. This raises issues with regard to the ownership of the data and privacy, as illustrated by the introduction of the ‘smart meter’.

Fifth pattern: new values models

Alongside the financial considerations, the transition to renewable energy is based on certain ideological motives. People wish to contribute to sustainability, ensure supply security, and achieve self-sufficiency. The new providers may operate as a private party, perhaps with a feed-in contract with a traditional provider, or their contribution to output may be a ‘sideline’ of some other type of business, as in the case of a farm which generates electricity from biomass.

4.2.2 Effects within the living environment

Local generation of electricity does go some way towards the attainment of climate and environmental objectives. There may be a positive impact in terms of reduced emissions of CO2, NOx and fine particulate, with the benefits seen at both local and regional level.

There are also negative effects at the local level. Both solar panels and wind turbines make a space claim and can impinge on aesthetic quality. Wind turbines produce noise which some may experience as a nuisance. The more direct relationship between consumer and producer may serve to reduce the perception of nuisance. If (or rather when) local generation achieves significant proportions, there will be another effect in that modifications to the infrastructure and grid balancing arrangements will be needed to ensure supply security.

4.2.3 Institutional issues

Many public values are represented by the energy system. The following changes are likely to occur.

Level 1: actors and transactions

In recent years, the production of electricity has come to be regarded as a ‘standard’ business activity which is separate from the management of the utilities infrastructure. On Level 1 of the four-level model, this means that there will be greater competition. The traditional consumers now take direct responsibility for meeting at least part of their own energy requirement.

Level 2: formal and informal institutional arrangements

On Level 2 there will be new forms of contract, such as those which allow parties to produce or purchase electricity regardless of current prices. (In the glasshouse-based horticulture sector, for example, the current gas price determines whether a cogeneration plant is to be operated and the electricity it produces supplied to the grid.) In the domestic setting, technologies such as NEST and TOON will monitor both consumption and production to ensure accurate billing.

If local generation becomes the norm, modifications to the infrastructure will be required. In the interests of supply security and grid stability, TenneT produces an annual capacity plan to which the large-scale producers must adhere. This plan is an institution on the second level. In future it must take account of the increasing contribution of local generation. Appropriate agreements with regard to the division of costs between the large-scale and small-scale segments have yet to be made.

Level 3: the formal institutional setting

The Electricity Act 1998 establishes an important role for grid management companies such as TenneT and its regional counterparts. The interests of energy consumers are represented by the Authority for Consumers and Markets (ACM) and the Energy Grids Users Platform (GEN). The Electricity Act establishes firm requirements with regard to grid stability and

supply security. Current legislation is not able to address the complexities created by the increase in the number of localised generation points or the consumer's new role as producer. Neither can it make adequate allowance for the unpredictable nature of solar and wind energy in the Netherlands. Consensus has yet to be reached with regard to taxation or the way in which infrastructural development will be planned. Because it is necessary to share production and consumption data, privacy is also likely to become a point for attention.

Level 4: the informal institutional setting (culture)
Changes can also be seen on Level 4. Global warming will encourage the pursuit of the energy transition. In the past, many households invested in solar panels or wind turbines because they wished to contribute to sustainability or wanted to become less reliant on the traditional providers. The technology has now moved on and in the current economic climate, this type of investment is also financially attractive. Whether solar panels and wind turbines are aesthetically acceptable is another question to be considered at this level.

In a sense, supply security is also a cultural issue. Dutch society attaches great importance to supply security and grid stability. Localised generation using solar panels can have implications for both, since it will demand modifications to the infrastructure in order to ensure ongoing compliance with the established standards (Level 2). The alternative would be to lower those standards and pass responsibility to individual citizens and companies (a Level 4 change).

4.3 The emergence of electric mobility and driverless vehicles

Many technology-driven changes will be seen within the domain of passenger transport and personal mobility. Here, we examine two interrelated developments: the growing popularity of electric vehicles and the introduction of autonomous vehicles, otherwise known as driverless cars. Both have possible implications for infrastructure and the living environment.

If vehicles with internal combustion engines are phased out and replaced by electric vehicles, there will be positive effects in terms of air quality and environmental noise (see TNO, 2015). Because electric vehicles have battery capacity, they can play a part in balancing supply and demand, thus increasing the sustainability of energy provision (see nrc.next, 2016, House of Representatives 2016b).

Autonomous vehicles are likely to have implications for both car ownership and use. Traffic flows will become more efficient, new forms of logistic service will be introduced, and new parking solutions will emerge (KiM, 2015). Overall, there will be a positive effect in terms of road safety, although various technical and ethical issues must be addressed (see for example Hagenzieker, 2015). The effects seen in practice will largely depend

on the form(s) of autonomous mobility that are eventually adopted.[12] Choices must be made, not only with regard to technology but also in terms of appropriate regulatory mechanisms (RIi 2016). The developments will undoubtedly bring about change within the mobility market and will raise challenges for the institutional setting.

4.3.1 Analysis: what patterns of change can be seen?

First pattern: scale changes in space and time

The automotive industry has long operated on the global scale, offering standard products which may have regional differences in their specifications. In the context of this case study, the changes in timescale are more important. As ICT becomes more dominant in the functionality and characteristics of vehicles, product innovations and new specifications can be introduced far more quickly, sometimes by means of an online software update.

Second pattern: Sector convergence

A notable effect of the introduction of electric vehicle has been the (further) convergence of the ICT and automotive sectors. The former is no longer merely a supplier to the latter. It has become the instigator of new products and may eventually become the dominant player on the automotive market. The ICT market is responsible for technological innovation and the integration of new technologies. It is also introducing a new approach to the design process and product development. There is now far greater interaction with the end user. In some cases, open source components have been introduced, with ongoing development while the vehicle is actually in use by means of online updates to firmware and software. “Beta is the new.”

Convergence with the electricity market is illustrated by the charging infrastructure and the use of electric vehicles to store electricity that has been locally generated. The vehicle’s battery capacity, perhaps linked to a smart grid, can be used to balance supply and demand, and to compensate for the fluctuations inherent in wind and solar energy. Further growth in the use of electric vehicles might be restricted by the capacity of the national grid. This encourages the development of small-scale generation, storage and a new form of energy infrastructure based on smart grids (Sbordone et al., 2016). TenneT is currently trialling a grid balancing system at a higher level of scale. It is doing so in partnership with NewMotion, a provider of charging infrastructure (nrc.next, 2016). Achieving standardisation of charging facilities and grids is a both a technical and an institutional challenge.

12 The Society of Automotive Engineers has defined six levels of automation in driverless vehicle technology, from ‘no automation’ (Level 0), to ‘full automation’ (Level 5). This refers to the degree to which the vehicle observes and interacts with its surroundings, and is able to make decisions without human intervention (SAE, 2016).

Third pattern: more diffuse and direct relationships between producer and consumer

The convergence of the ICT and automotive sectors will also bring about the reorganisation of the chain between producer and consumer. Diagnostics, feedback and upgrades will be conducted over the internet rather than in the garage. The dealer network's role will decline in importance. Companies such as Tesla will increase innovation capacity by allowing access to patented developments on the basis of reciprocity. External developers and users would then be able to influence product development and product specifications. As a result, and by virtue of the flexibility and adaptive nature of the concept, product innovation will be extremely rapid. Tesla might then be regarded as the manager of a central platform through which third-party developers can offer their new apps, subject to certain quality requirements.

Another example of changing roles will be seen in the charging infrastructure. There will be charging points at which power is provided by one of the traditional large-scale producers, but it will also be possible for the owners of electric vehicles to charge them using electricity which they generate themselves. Many intermediate or hybrid arrangements, such as cooperatives, are also possible.

Fourth pattern: a new meaning of ownership

At present, the initial purchase price of electric vehicles is higher than that of conventional alternatives but the running costs are lower. They are therefore particularly suited to shared usage schemes which can be supported by digital platforms (Frenken, 2016). If the vehicles can also operate autonomously, the handover from one user to the next will be that much simpler. High initial investment with low costs of ownership will give a boost to private lease arrangements.[13] The leasing companies form a potential new channel through which the private market can be influenced by means of government policy.

As in other sectors, data flows will become greater in volume and more important. Information must be recorded and exchanged with regard to the usage and condition of the vehicle, and about specific locations and movements. Because more maintenance can be undertaken online, and because the charging system will also be linked to the internet, manufacturers will also have access to the vehicle's usage data.

Fifth pattern: new values models

The growing popularity of electric vehicles is partly due to the financial incentives offered by government. For some people, however, it also reflects a desire to reduce the adverse

13 According to projections, the number of private lease contracts will increase from 17,000 in 2014 to around 100,000 in 2020 (ING Bank Economic Bureau,2015).

environmental effects of mobility. The development of autonomous vehicles will not have the same effect and does not have any clear relationship with other values models. The driverless car does however raise certain issues in connection with values such as privacy (of the data which is generated and shared), user autonomy, and ethical considerations further to the algorithms applied.

4.3.2 Effects within the living environment

The development of electric mobility and autonomous vehicles will have various potential effects, many of which will impact on public values. Some of those effects will be seen within the living environment.

Mobility: driverless or partially automated vehicles could have various consequences in terms of traffic flows. They might give rise to new logistics services such as the self-driving taxi. They may reduce the space required for parking. They could increase or reduce the volume of traffic within the living environment. Similarly, they could have either a positive or a negative effect on road safety. If vehicles are able to communicate with each other and the roadside infrastructure, it will be possible to use road capacity more efficiently.

There may also be behavioural effects. The low marginal (energy) costs of electric vehicles could encourage their use, thus increasing congestion and the parking space requirement. On the other hand, the relatively high purchase price in combination with low running costs make the electric vehicle eminently suited to various forms of shared usage (Frenken 2016). This is even more true of driverless vehicles.

Environmental effects will also occur. As vehicles with internal combustion engines are replaced by those with electric drives, emissions of atmospheric pollutants (NOx, fine particulates) will fall. There will also be a reduction in the carbon footprint and environmental noise. According to TNO (2015) total CO_2 emissions (including those during manufacture) are up to seventy per cent lower for an electric vehicle operating on ‘green’ electricity (generated from renewables) compared to the average petrol-driven car. Even if the vehicle is run on standard ‘grey’ electricity (generated using fossil fuels), its lifetime CO_2 emissions will be some thirty per cent lower. One potential negative environmental effect is that there will eventually be a large number of batteries to be processed as waste.

Another consideration is that the new market players have no interest in maintaining the fossil-based energy sector, which may accelerate the phasing out of the internal combustion engine. The oil companies will see their influence wane, while that of electricity producers and distributors will increase.

Safety and risks: according to TNO (2015), electric vehicle technology raises no significant safety risks. Autonomous vehicles, on the other hand, do present certain new road safety risks and issues of liability. An entirely automatic, driverless vehicle operating on the public highway has all manner of implications, particularly with regard to interaction with other

road users (Hagenzieker, 2015). As a result, it may be necessary to restrict such vehicles to a dedicated part of the infrastructure. There are also ethical issues to be addressed. If a collision has the potential to harm either the occupants of the vehicle or other road users, whose safety has priority?

Data and privacy: autonomous vehicles will generate far more digital data than their conventional counterparts. Manufacturers and network managers will be able to draw on information about the use and condition of the vehicle, points of departure and destination, road conditions, interactions with other vehicles or objects, and so forth.

4.3.3 Institutional issues with regard to public values

The considerations with regard to institutions and regulatory mechanisms are as follows.

Level 1: actors and transactions

On this first level, the growing popularity of electric vehicles and the introduction of autonomous vehicles can affect user behaviour. The lifetime costs of an electric vehicle are lower than those of a conventional alternative. This may encourage greater use, which can result in increased congestion on the roads and greater demand for parking places. The Knowledge Institute for Mobility Policy (KiM) has examined the development of autonomous vehicles and identified four basic scenarios. The main variables relate to the level of automation – how much of the driver's responsibility does the vehicle actually assume – and the degree to which ownership and use are shared (KiM, 2015). If there is a high degree of both automation and sharing, mobility will take on the nature of a service. Some vehicles will then replace traditional public transport modalities. Both environmental impact and space claims will be reduced, which offers opportunities for improving the quality and liveability of the physical domain. If shared usage fails to take off, private car ownership will remain relatively high, as will the space claim made by the vehicles. It will nevertheless be possible to use the infrastructure more efficiently in either scenario. If a lower degree of automation is achieved, conventional public transport services retain their importance. There will be positive effects in terms of both logistics efficiency and road safety, but little or no effect in terms of the physical structure or the volume of traffic on the roads. Shared usage will have some effect on vehicle sales and the parking space requirement, but this effect will not be as marked as in the full-automation scenario.

Level 2: formal and information institutional arrangements

An important consideration on this level is the development of the charging infrastructure. Electricity may be supplied by a traditional producer but it will also be possible for individuals to charge their vehicles using electricity that they generate using their own solar panels. Various intermediate or hybrid arrangements such as cooperatives are also possible. The fiscal regime is different for each of the various groups of providers.

The system of granting operating licences for charging facilities can also raise certain issues (as demonstrated by the parliamentary discussion on this topic in 2016). Standardisation of charging facilities is a challenge in both the technical and institutional contexts.

The traffic infrastructure and all traffic management systems must be modified in line with the algorithms which will be developed for autonomous vehicles (or which develop over time as part of self-learning systems. The use of driverless vehicles on the road will demand a re-examination of the concept of liability and the extent to which it can be insured.

Level 3: formal institutional setting

Various issues are relevant to legislation. The use of driverless vehicles calls for a new legislative framework at the international level. At present, the rules of the road are determined by each country. Where decisions are made by vehicles themselves, or in interaction between vehicle and infrastructure, it will be necessary to achieve international standardisation, or at least European standardisation. The Netherlands wishes to lead the way and has already run a number of experiments, including trials of driverless buses on the Ede-Wageningen route and of self-steering cars on the A2 motorway. In the United States, self-driving Waymo cars (developed by Google) are already operating on the public highways, while Uber and Ford have formed a partnership to develop driverless taxis. Singapore, California, Norway and Japan are regarded as the international trailblazers in the field.

Because ICT plays a dominant role in the functionality and characteristics of the vehicles, product innovations can be introduced very quickly, sometimes by means of an online update. This calls for appropriate regulatory instruments.

It will be necessary to streamline legislation and fiscal arrangements, including incentive programmes, to ensure that the interests of all relevant policy domains – mobility, sustainability and energy – are served and to prevent any erosion of government revenues from either sector. The current system of fuel duties, for example, has various objectives: to generate revenue, reduce CO2 emissions and – perhaps more as an effect rather than an objective – to discourage vehicle usage and hence limit both congestion and the parking space requirement. In the case of electric vehicles, tax revenue will largely rely on the energy levy, the rate of which will vary according to the overall consumption of the party operating the charging point. When calculated by energy yield, the tax burden will be higher than that of fossil fuels.

As in other sectors, data flows will increase in size and importance. The data will relate not only to the usage and

condition of the vehicle, but also to locations and general road conditions. Because some maintenance and upgrades will be undertaken online, manufacturers will have access to the vehicle's usage data (which can also be drawn from the integrated charging network). It will therefore be necessary to examine how the ownership and use of the data is to be regulated by means of formal institutions.

Level 4: the informal institutional setting

The cultural mechanisms on which the further development of electric and driverless mobility relies include the importance that is attached to personal choices in individual transport (as opposed to 'guided' driving), the value attached to the quality of the living environment, and various ethical issues in connection with road safety. The adoption of both electric mobility and autonomous vehicles will be quicker in some countries than in others. This is due to cultural differences (e.g. the level of confidence in people or technology) as well as differences in the institutions and legislation (Pacific Institute for Climate Solutions 2015, Fearnley et al. 2015).

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APPENDICES

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