Roadmap Next Economy

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METROPOOLREGIO
ROTTERDAM DEN HAAG

The Rotterdam The Hague Metropolitan Area (MRDH) is a voluntary association of 23 municipalities in a polycentric metropolitan network with approximately 2.3 million inhabitants. The region comprises two centre cities and various middle-size and small cities*. Since the1st of January 2015, the 23 municipalities form a governmental network organisation, working in a coordinated manner to improve accessibility and strengthen the economic business climate.

The MRDH has the ambition to be amongst the front runners as innovative, economic strong, sustainable and accessible region. It has all the necessary conditions to be a competitive innovative region: a diverse economic structure connected to the top sectors, strong entrepreneurial tradition, three top universites and various high education vocational colleges, strong international orientation, good balance between the cities and their surrounding open green areas.

The MRDH is part of the urban agglomeration in the western part of the Netherlands. This part of the country is the most densely populated region of the Netherlands with about 3.6 millions inhabitants. Together with its partners such as the province Zuid-Holland, the Economic Board Zuidvleugel and the regions of Holland Rijnland, Drechtsteden and Midden-Holland the MRDH focuses on the further development of the area as an international competitive and economic strong region.

**Municipalities of the MRDH: Albrandswaard, Barendrecht, Brielle, Capelle aan den IJssel, Delft, The Hague, Hellevoetsluis, Krimpen aan den IJssel, Lansingerland, Leidschendam-Voorburg, Maassluis, Midden-Delfland, Nissewaard, Pijnacker-Nootdorp, Ridderkerk, Rotterdam, Rijswijk, Schiedam, Vlaardingen, Wassenaar, Westland, Westvoorne and Zoetermeer.*

Context & Urgency

Our world is in transition. We no longer live in an era of change, but are witnessing the change of an era. We are on the verge of the greatest social and economic challenge since the 19th century. Global trends like climate change, geopolitical changes, increasing migration, growing inequality, natural resource depletion and the emergence of disruptive technological innovations are driving the transition to a systemic change. We need to anticipate this change that will fundamentally alter the way we manage, power and move our society.

This transformative change, described by Jeremy Rifkin as the Third Industrial Revolution, has profound consequences for the Rotterdam The Hague region. The next economy is based on a convergence of internet communication technology with new forms of distributed energy, which has strong impact on connectivity, mobility, energy production & consumption and the way the economy is organized. We move from a centralized, vertically organized and linear economy towards a distributed, collaborative and circular economy. This implies that an entirely new and digitized economic, social and knowledge infrastructure needs to be built up, comparable to what happened in the 19th century during the previous industrial revolution.

The urgency for our region is unmistakable. The potential of our region is strong as we have the knowledge, skills, infrastructure and institutions to anticipate the next economy. However, we do not sufficiently harvest this potential and turn it into economic profit and societal value. There is no other region in the Netherlands with such a gap between the potential and the realization in terms of underutilizing its human, economic and institutional capital. To illustrate this, during the period 2009 – 2015, annual growth of the regional product (-0.4%), per capita growth (-1.1%) and employment growth (-0.5%) were all negative and the unemployment rate (9.0%) is higher than average in the Netherlands (6.9%).

The OECD (2016) estimates that less than 50% of the economic potential of the region is utilized. This is attributed to the lack of collaboration between the public, private and knowledge sectors. But also to the lack of cross-overs between economic sectors, which is increasingly vulnerable as the digital and circular economy cut through the energy, chemistry, agri-food, health, logistics and manufacturing sectors. And perhaps most importantly, an overall strategy and orchestration for the region seems lacking, addressing fundamental questions how we earn our money and what kind of skills are needed in the next economy. The declining economic sectors in the region – traditional industry, logistics and public services – are still dominant, even though research has shown that every euro invested in the fossil dependent economy costs our society 2 euros, while every euro invested in the next economy yields 3 euros of added value, in terms of innovation, employment and economic structure (Planbureau voor de Leefomgeving, 2013). Recent survey-based research by INSCOPE (2015) shows that firms in energy, logistics and financial sector invest relatively little in radical innovations that will lead to future growth.

The Rotterdam The Hague region is vulnerable in terms of the large number of lower educated and unskilled people, but also in terms of energy use, pollution, the impact of climate change, health issues, water and overall quality of living. These issues need to be addressed by increasing the resilience of the region. Fortunately these challenges also present great opportunities. For instance, the circular economy will develop business models for recycling and upcycling materials that require a significant amount of unskilled or low skilled labour. The large scale retrofitting of the built environment to install the new digital, circular and renewable energy technologies will also require a tremendous amount of labour at various levels of skills. And the maritime industry in our region has a leading position in the delta & water technologies that are required around the globe to combat the effects of climate change.

The OECD (2016) emphasizes that the scale benefits can be improved by more intensive regional collaboration. Our region has competitive advantages that should enable us to seize the opportunities of the next economy when all forces in the region are mobilized: the track record in industry and manufacturing, the demographic advantages with a large reservoir of young people, the strong increase of entrepreneurs and start-ups working on the next economy, the concentration of businesses & knowledge institutions in clusters like clean tech, life sciences, recycling (waste) materials, data security and food and most significantly the port and greenport (agri-food & flowers) as international industrial and logistic hubs. This all adds up to a very powerful mix.

We acknowledge that we are entering the age of digital platforms. In order for these platforms to emerge successfully in our region we need to bring our IT infrastructure up-to-speed, enabling big data to flow and provide up-to-the-moment information for the emerging new business models.
For many economic sectors in our region digital platforms will emerge, e.g. energy, transport & logistics, health, food production and manufacturing. These platforms have the potential to significantly increase productivity and reduce transaction costs. Enabling these platforms will increase our region's competitiveness as a smart economic (cyber)space. At the same time we need to build resilience into the system to make sure these data flows can be exchanged in a safe and secure way.

We also realize we have stepped into the age of 'Paris & Parity'. We are witnessing the combined force of the Paris Climate Agreement and the price parity of renewable energy sources like wind & solar. Renewables are now competitive in price against fossil fuels, even at their current low prices (which may rise again as a result of the new OPEC agreement). This will inevitably ignite an enormous upsurge of both public and private investments in the deployment of these technologies. This will be the game changer and the Roadmap Next Economy aims to deliver some truly large-scale renewable energy projects that will provide a secure and attractive return on investment. These projects will all contribute to the build out of a smart energy grid in our region and will include large-scale retrofitting of the built environment, which will provide a significant amount of work in sectors like construction and engineering.

The next economy has many faces and shapes: a digital -, sharing -, bio-based -, circular -, maker-, robot- and gig economy. It is increasingly based on lateral relationships and small scale, locally organized networks of producers and consumers. It is also characterized by great uncertainties and disruptions: many traditional sectors will vanish and new sectors will emerge, offering opportunities for new business. But the transition towards the next economy will not only result in the disappearance of familiar technologies, services and concepts. It will also result in inconvenience and (financial) uncertainty. To reduce societal resistance against these changes, it is important to create an attractive perspective for citizens in the short term. This perspective should have obvious benefits that will compensate the negative impact of the transition. This means that non-technical and non-financial factors are equally important, aiming for great neighborhoods and working areas in the broadest sense. Without the necessary changes in the region's social infrastructure it will be difficult to appropriate the potential benefits of new technological innovations.

The urgent need to act is widely embraced in our region and the global trends give clear indications about what needs to be done. We have considered different scenarios to sketch the implications in view of the challenges we face. The differences between a maximum effort scenario (RNE scenario) and a business-as-usual scenario are the most salient. The RNE scenario requires a comprehensive approach to deal with these transformative changes, both seizing the opportunities and countering the disruptions. In order to do this the Metropolitan Region Rotterdam The Hague (MRDH) has taken the initiative to engage many regional stakeholders into a collaborative effort to work on an economic strategy that will enable us to retain our competitiveness and create a promising future for the people living in our region. An important aspect of this future is that it should belong to all of us, which means that the next economy needs to be more socially inclusive, presenting an alternative to the fast growing inequality that has been the result of our current 'winner takes all' society.

The most demanding question is how this should be done. How can we realize this transition, how can we create enthusiasm amongst citizens for this transition and what kind of impulses do we need to implement the required steps that need to be taken? To this end we need to distinguish financial, institutional, legal and mental impulses.

Financial impulses

Building up an entirely new infrastructure is costly. As we built the physical infrastructure in the 19th century (roads, railways, bridges, ports), we are now building the digital and circular infrastructure. Investing in digital communication platforms, fiber, big data, sensors, internet of things, smart logistics, smart mobility and multi commodity energy grid will cost roughly 50 billion euros over the course of several decades. This includes the incorporation and usage of IT-tools in education, which should have the highest priority.

Legal impulses

The next economy is at odds with traditional law. Many rules and regulations still prevent further penetration of the circular economy, according to research by the Ministry of Economic Affairs. A notorious example is the Waste Act, which prevents re-usage of waste as resource in circular processes. We should either abolish these laws, or introduce a regulatory free-zone or region, with rules to be determined for circular developing and building. Digitalization brings up new issues. Who owns the data in the cloud? Who is responsible for accidents involving automated vehicles? In short, the next economy requires a new legal framework.

Institutional impulses

More intensive collaboration is needed in our region between knowledge institutes, education institutions, companies and governments. Equally important is the collaboration with foreign top institutes and companies. To remain competitive, we need to bring more 'forefront knowledge' from abroad to our region on topics like robotics, blockchain, nanotechnology, artificial intelligence and quantum computing. We also need to arrange more connections between traditional, big companies and emerging start-ups. Preliminary research shows that start-ups play only a relatively small role in the innovation activities of established firms in the region (INSCOPE 2016). However, they do need each other badly in order to survive in the next economy.

Mental impulses

To become a real entrepreneurial region with a high quality of living and working a cultural shift is needed. Research done by Harvard Business Review shows that an entrepreneurial region is not so much characterized by the number of start-ups or entrepreneurs. It is more about whether the culture is conducive, stimulating and appreciating entrepreneurship, and whether risks are tolerated that are connected with entrepreneurship. The dominant culture in our region is rather conservative and risk-avoiding, which should be turned around completely if we want to establish a stimulating environment for entrepreneurship.

The transition to the next economy is a matter of perseverance. But the coming years constitute a momentum: are we catching up with the European top regions, or are we descending into the gray European middle? Perhaps the biggest challenge lies in working on an inclusive society, avoiding a divide like in the 19th century.

(Regional) Strengths
- Strong international network @ The Hague
- Port & logistics system
- Knowledge & industrial positions in IT, PetroChem, Agro/food, Maritime, Security, HTSM, Deltatech, Medtech

(International) Opportunities
- Energy conversion & storage
- Local Manufacturing
- Reliable Local Food Supply
- Safe Deltas
- Care robotics, e-health
- Safe Digital Trade
- Tourism

Weaknesses
- Low economic growth
- Fossil based industrial structures and business models
- Poor living quality
- Social Division

Threats
- Disruption in international energy market
- New risks due to climate change
- Care Cost and Capacity

TRANSITION PROGRAM

Each transition pathway:

- Attacks a weakness or threat
- Uses one or more regional strenghts
- While taking an (international) opportunity
- Thus stimulating growths and creating jobs

RNE-process

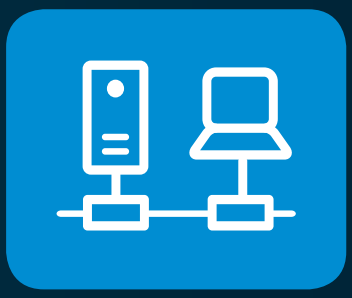
Our journey is called the Roadmap Next Economy (RNE). It includes an integrated assessment of the impact of relevant global trends, resulting in a long term strategy and highly adaptable action program for our regional economy that will stimulate the transition to the next economy, and create an attractive business environment for talents, companies and investors, new business and jobs.
The Roadmap Next Economy started in November 2015, commissioned by the Metropolitan Region Rotterdam The Hague (MRDH) and realized in collaboration with Jeremy Rifkin and his Third Industrial Revolution Consulting Group (TIR CG). The elaborate TIR CG report is the reflection of our collaborative work and the RNE draws its inspiration from this report, presenting it in a more condensed and prioritized way as the systemic framework for regional deployment in the coming decades.

The initial working method was based on the assumption that the generic themes that characterize the next economy (communication-, energy- and mobility internet, circularity and education & labor market) should be confronted with the specific economic sectors in the region (e.g. maritime & logistics, chemical industry, agri-food & flowers, health & life sciences, regional and global security & justice and manufacturing). Working Groups with representatives from various partners were set up for these themes and economic sectors. This process showed that the next economy is no longer vertically structured in pillars and sectors but horizontally structured and cross-sectoral. Therefore a convergence towards a more integrated, systemic approach was needed. We decided on five transition pathways as possible development lines for the next economy. Three pathways are about the physical infrastructure we need to build up for the next economy: the digital infrastructure for communication & mobility, energy and circularity. And two pathways are prerequisites for realizing the new physical infrastructure, facilitating the transition in terms of new forms of education, skills, labor market arrangements, and new business models, new products & services and new forms of collaboration. This approach has resulted in a coherent package of the following five intertwined transition pathways:

1. Smart Digital Delta

Towards zero marginal costs

This transition pathway encompasses all issues dealing with increased digital connectivity, big data platforms, smart logistics, smart mobility, sensors, internet of things, etc. It concerns all actions that need to be taken to establish a sophisticated digital infrastructure, which includes a new legal framework that builds trust in a digitized marketplace.



2. Smart Energy Delta

Towards zero carbon

This transition pathway encompasses everything dealing with connected smart energy systems, sustainable sources, conversion and storage technologies, energy savings, carbon capture storage, heat roundabout, all electric and hydrogen infrastructure. It concerns all actions that need to be taken to establish a renewable energy infrastructure in the region.

3. Circular Economy

Towards zero waste

This transition pathway encompasses everything dealing with the use and re-use of resources and waste streams within the region: recycling, upcycling, bio-based materials and clean technologies. It concerns all actions that need to be taken to realize a circular regional hub.

4. Entrepreneurial Region

Towards new productivity

This transition pathway deals with new business models, new products and services, new forms of collaborations like field labs on disruptive innovations, entrepreneurship from start-ups to scale-ups and a new regulatory framework. It concerns all actions that need to be taken to create an entrepreneurial culture and structure in our region.

5. Next Society

Towards an inclusive society

This transition pathway deals with new labor market arrangements, new skills and new forms of education, the commons, citizen cooperatives, bottom-up movement, social entrepreneurs and social innovation. It concerns all actions that need to be taken to build up a more inclusive society.

Smart Digital Delta

1. Digital Gateway to Europe

The necessity to transform the MRDH into a digital gateway is widely accepted. Digitization provides the means to virtually expand our economic growth, but also leads to intense global competition. It also allows for trans-sectoral and global distribution of data and optimization of processes. Expansion is enabled by digitization and it is essential that the region anticipates this by taking the necessary steps and stay ahead of the curve. The region has an outstanding performance in terms of ICT research & development, ranked 4th in Europa, but underperforms in terms of realizing business from this, only ranked 34th, adding up to an overall 17th position in Europe. We need to better orchestrate the innovation activities in the region and tie them more closely to economic sectors, thereby increasing focus and critical mass.

Investment in future telecommunication infrastructure is needed because it is evident that the networks of today are not nearly sufficient to face the internet traffic requirements of the next economy. Indeed, internet traffic is growing exponentially and it is already saturating the access networks as well as the optical core networks, a situation previously unforeseeable. To carry the traffic of the Internet of Things requires not only huge investments in infrastructure but also a fundamental re-design of the networks to manage the new levels of complexity and assure comparable levels of flexibility. This will be made possible by the emerging standardization of 5G networks, a completely new end-to-end system with unprecedented capabilities that are needed to enable the levels of connectivity that the next economy requires. 5G provides ubiquitous access to a wide range of applications and services with increased resilience, continuity, and much higher resource efficiency than possible today, while protecting security and privacy.

To enable the metropolitan region to be maximum competitive, the transition pathway Smart Digital Delta integrates it physically as well as digitally, starting from the region's dominant economic sectors. Smart Digital Delta concurrently provides the digital basis of further international expansion of companies. The multi layered digital technologies introduced by Smart Digital Delta function in a trans-sectoral and trans-governmental setting and respect the soft-values of its citizens. The technologies are based on a set of legal and political concepts allowing it to function, globally and digitally, in commercial, legal and personal transactions. The software systems support multiple legal domains and ownership concepts of data, goods and real estate. Active cyber security infrastructure allows defending a nation's basic data, e.g. the land registry, and the ability to enforce the law in the cyber domain. As citizens are required to become more flexible, mobile and sustainable, Smart Digital Delta supports citizens in their interactions with digital and real world systems for employment, mobility, finance, social and physical security, healthcare, wellbeing, sustainability and digital communities.

Participants of the Smart Digital Delta represent leading companies and institutions based in the region. As the impact of the transformation is broad, its scope is to first transform two of the region's main economic realms: the port and related industry and the Greenport (agri-food & flowers). Security & Justice is considered as a vital prerequisite for establishing a safe and reliable digitized trading system, while Mobility has been identified as a common subsector. Mobility of persons, cargo, energy and other city "flows" is key for an unhampered (free flowing) operation of the region. If the transition is successful and among the first in neighboring regions, the transition will stimulate the creation of digital on-line platforms that will propel the emerging impact and sharing economy within the urban realm. The ambition is to transform the region into an efficient, prosperous, global trading region, by maximizing the deployment of digital technologies.

Rapid participation of the citizens of the metropolitan region in the Next Economy is ensured by building upon existing initiatives and infrastructures, scaling them, making them secure and then stimulating new services on top of them. For instance by transforming the infrastructure that is already present within and in between the healthcare institutions into a secure Internet of Things (IoT) platform for healthy living. This will enable the build out of a large and active community of citizen participation that can be approached for participation in environmental data acquisition or mobility experiments later on. In itself the health data platform (with personal data passports) already creates a new industry in e-health, lifestyle, food & big (health)data.

Speed will be gained by simply putting the digital technologies in place. In order to create a compelling business climate, a secure data exchange infrastructure needs to be established, complemented with digital trading and legal functions, but also truck lanes have to be prepared for cooperative driving, automated cargo handling and automated government operations as automatic cargo checks, taxing and customs. The corresponding legal framework using new and complex technologies (e.g. blockchain) will set the rules of engagement for making contracts, establishing ownership of data and assets, lending money, participating in digital platforms, protection against cybercrime, etc.
Research shows that especially the strongest sectors in the region have the most to gain from digital technologies. This requires a systemic approach which is discussed in more detail below. This way of organizing allows to combine the results from projects that share a joint trajectory, realizing the ambition to become the "digital gateway to Europe".

2. System breakthroughs

The breakthroughs this transition pathway addresses are directly tied into the sectors that will use the results:

- A *digital port* implies an integral, digital logistic and manufacturing system
- *Growing as a service* requires geo-independent, local digitized agri-food & flower systems

But also from within the ICT sector, system breakthroughs are required. Most notably:

- A safe, reliable and traceable data exchange
- A digitized legal trade system

The transition pathway Smart Digital Delta is based on:

1. The idea that the digitization of *Maritime&Logistics*, *Food&Flowers*, *Security&Justice* and *Impact&Sharing Economy* will also expand other sectors.
2. The strategy that the digitization of a sector needs to be kicked off by an "enabling" project that sets the stage in order to spawn a series of other projects, that in turn allow for running a "carrier" project that is massive enough to transform the sector into one that is part of Smart Digital Delta. For instance: a digital port requires a secure, dense, high performance network, a scalable and secure data infrastructure, etc.
3. The notion that generic trans-sectoral digital infrastructures are presently lacking because:
   a. Secure digital data exchanges (secure extranets) are missing
   b. Secure digital marketplaces are missing
   c. There is no ability to settle disputes over digital data
   d. There is no way to check a digital transaction on its (international) legitimacy digitally
   e. There is no way to involve tax and customs in real time transactions

According to McKinsey this trans-sectoral digital infrastructure is key for the success of the IoT. The trajectory in [Figure 1], solves the trans-sectoral digitization issues directly:

- The enabling projects are depicted in from the center of the plan outward. These projects focus on developing game changing ICT, security and privacy functions
- The carrier projects are depicted in the outer rim. These projects focus on achieving specific breakthroughs in economic clusters. They work towards the dots on the horizon formulated in the ambitions of the different clusters.
- Quick wins in clusters are depicted on the rim of circle that represents the 2018 -2020 timeline

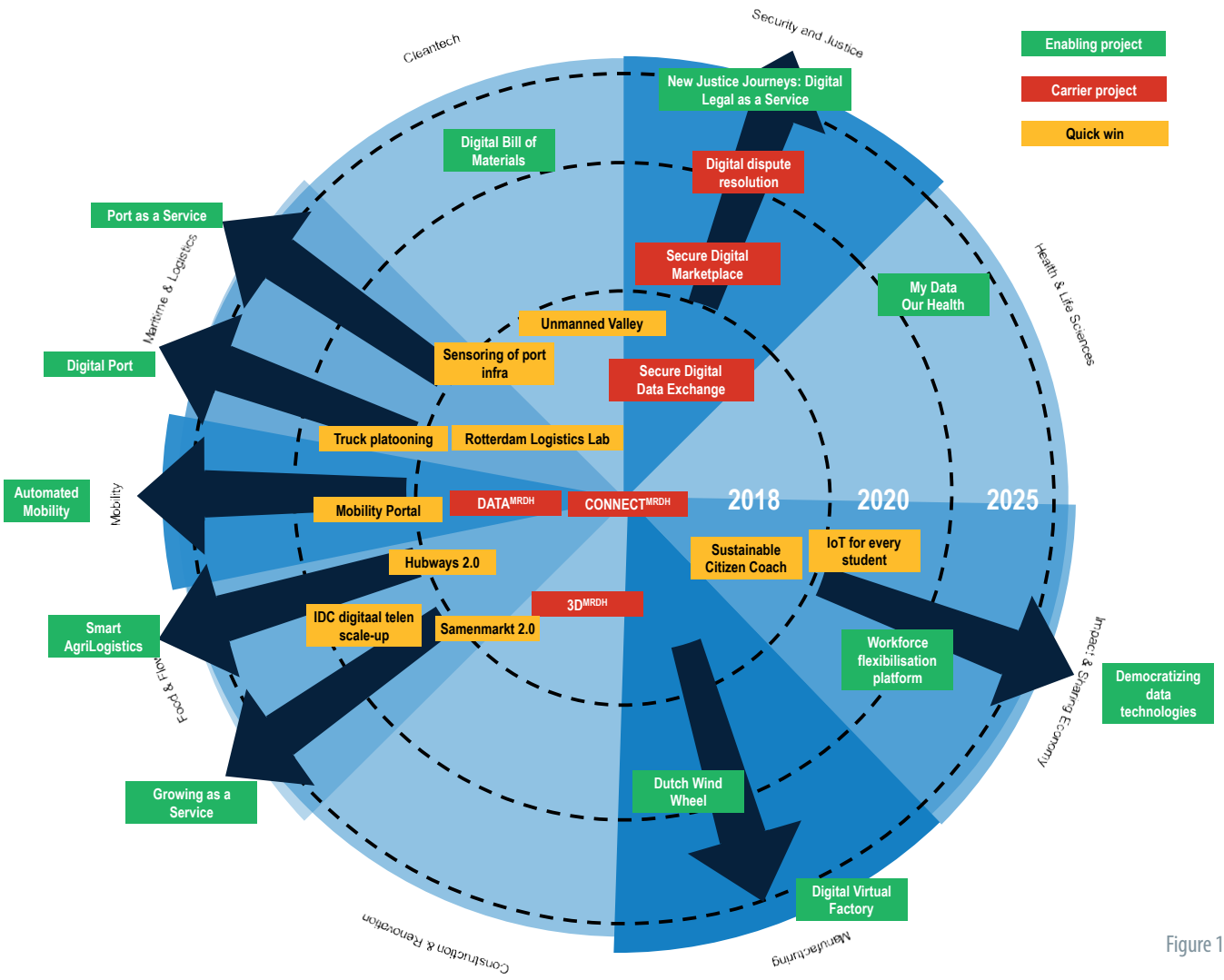


Figure 1

3. Projects

The enabling projects are typically relevant for multiple carrier projects, thereby explicitly creating a multiplier effect and scale-up potential. Five crucial enabling projects have been identified, that are interlinked with carrier projects in the key economic clusters related to this transition [see appendix 1].

Enabling projects

CONNECT MRDH: improving and coupling the existing MRDH network and IT infrastructure to support ubiquitous and secure IoT services. It requires large investments as infrastructure build out is a capital intensive undertaking. It will result in a secure, open and future proof ICT environment, e.g. Secure Extranets; Secure extranet IEX as a service; region-wide municipal fiber; region-wide WiFi; region-wide LoRa/LWPAN; dense 4G network for industrial and economic infra; 5G. Focus areas include campus areas and business and innovation districts in the region, e.g. Rotterdam Central District, The Hague Central Innovation District, International Zone The Hague, Merwe4Haven, Testbed Scheveningen and Vlaardingen.

DATA/3D MRDH: providing access to currently available (open) data within the region and make them accessible through dashboards. Based on the presented information and strategies, the metropolitan region can articulate effective policies and politics to achieve RNE goals. Introduction of sensors, actuators, secure extranets, secure transactions and online government services, dashboards show and inspire progress and provide the basis for a regional expertise that allows for business development in the field of digital systems and digital security. Also features a 3D MRDH ground truth database that interfaces with building information management (BIM) systems, environmental impact analyses tools. This allows for fully digital urban planning from the design phase onwards to impact analysis.

Secure Digital Data Exchange & National Cyber Testbed: region wide IT capacity for accessing IoT data across sectors. Data combined from sources such as sensors, infrastructures, companies, persons and governments. Constructed with a systems of systems view, the new IT capacity will allow to discover, access and combine data, supported by secure identification, context based access, localization and privacy compliancy. New competitive trans-sectoral data views are the result. Given the interdependencies and scale of the possible disruptions a national cyber testbed is a prerequisite. The National Cyber Testbed provides a platform where the architecture of the Secure Digital Exchange can be tested in a protected simulation environment. Moreover, the resilience of alternate architectures can be assessed.

Secure Digital Data Marketplace: create a region-wide IT capacity for developing services across sectors. Services that combine more basic services that access data sources from sensors, infrastructures, companies, persons and governments. Constructed with a systems of systems view, the new IT capacity will allow to discover, access and combine data and services with secure, monitored transactions, resulting in new competitive trans-sectoral services. Typically enhanced by new developments such as blockchain technology.

Digital Dispute Resolution: will democratize justice services through the creation of an online platform for resolving cyber- and digital world issues. It allows stakeholders to work together towards fair, agreed and effective solutions, with an internationally scalable approach that offers comfort, fairness and a structure based on cutting edge knowledge about conflict.

Carrier projects

Digital Port: digitalization and 'connectivity of everything' are two main elements for the Port of Rotterdam. The information about traffic, cargo, planning and port infrastructure is of huge value for optimizing transport and port management and thereby increase the added value of the port. Four activities relate to the Smart Digital Delta transition: Nautical efficiency (Port Call Optimization); Port Base (port community system); IoT for Logistics, Field lab Blockchain in Logistics.

Port as a Service: develops an implementation of the remotely managed robotized Port, including automated vessels, smart maintenance of port infrastructure, automated supply, port monitoring systems, logistics platforms. Major developments: crewless shipping and trucking/smart mobility, port monitoring (sensoring), scaling up Maritime Field Lab to a digital manufacturing port infrastructure, Rotterdam Logistics Lab (enabling logistics).

Automated/connected mobility: deals with IoT portal for Mobility in order to have a full-coverage high-quality and low-fee WiFi/xG grid available in the (sub)urban environment as a base for new mobility services and with automated transport (truck platooning, automated cooperative mobility, automatic guided and autonomous vehicles, driverless public transport)

Smart Agri Logistics: deals with the improvement of chain management, reduction of km's (scaling-up, return cargo, synchro-modality), sharing knowledge and information, track & trace, use of biofuels.

Growing as a Service: allows to pave the way for a new growth strategy of the horticulture sector by enabling to scale the existing domain knowledge to other regions through digital services. Growth models and growth improvement programs can be marketed as a Service, thereby linking remote growth to knowledge developed, stored and marketed from the region, including a digital market for (inter)national trade based on consumer behavior.

Digital Virtual Factory: to secure a frontrunner position for the region in reshored and pooled manufacturing/assembly of small series of high mix, high complexity products.

My Data Our Health: to democratize the consumer – healthcare professional relation and putting citizens in charge of the ownership of their own health data.

Short term projects

These enabling and carrier projects are ambitious and operate at a large scale. It will take time before we get there. To facilitate an incremental approach, we identified several smaller innovation projects that ultimately address the bigger ambition. By making full use of these projects we can build upon the already existing energy and success:

- Creating an open smart lamppost infrastructure testbed that allows for multiple sensors to be attached
- Provide Municipal WiFi in a test location
- Providing region-wide secure LoRa/LPWAN coverage
- The Fox Hole Production Lab for rapid prototyping of IoT devices
- Unmanned Valley, a large-scale testing facility that bundles initiatives such as "drone valley" and plans for a "high tech test center" that allows for data fusion from earth observation with many other data sources
- Creating several Freezones within the region with minimum restrictions to stimulate uptake of IoT services
- Create a security testbed and Living lab Area security at HSD Campus
- Create a FI-Ware Lab environment in the region
- Living Lab Automated Last Mile and real life testing ground for self-driving vehicles
- Speeding up implementation of Intelligent Transport Systems (smart management, smart traffic lights)

Short term projects related to carrier projects can be achieved by accelerating or upscaling ongoing activities in the various sectors, e.g.:

Port, Maritime, Logistic

- Rotterdam Logistics Lab, Integration of logistics data platforms (Smart Data Factory as federative system), Port Base, Neutral Logistics Information Platform, Next Logic
- Scale up existing experiment with Truck platooning
- LoRa/WiFi infrastructure pilot for the port
- Scale-up Fieldlab Maritime Industry (smart maintenance & aquatic drones research and testing program)
- Create a Fieldlab for crewless transport/ Logistics Lab
- Create a Fieldlab for Blockchain in Logistics

Food & Flowers

- Scale-up of the Digital Food&Flowers market: Samenmarkt/Bloomy Market initiative/project that focuses on creating a transsectoral demand/supply platform
- Scaling up the initiative that focuses on SmartAgriLogistics, including World Food Parc
- Scaling up "Innovation and Demonstration Centre (IDC) Digital Growing"
- Connect initiatives like FreshTeq.nl
- Extend experiments around "digital reality" driving consumer interaction

Mobility Portal

- Development of the mobility platform for Rotterdam and The Hague with use cases suggestions: dynamic traffic management incl. target group users (e.g. public transport, road side application, traffic control center), smart parking, event management (in-car and road side application), predictive traffic intensity and accessibility (smart routing, in-car application and road side)
- SURF STAD (Spatial and Transport Effects of Automated Driving)
  Initiative by Delft University of Technology together with knowledge partners like Erasmus University, TNO, SmartPort, Rotterdam University of Applied Science, private partners and practice partners like MRDH and the province of South-Holland with a €2,5 mln. budget

HTSM

- Support the Field lab Ecosystem and integrate and scale-up Field labs for digital manufacturing, in particular RoboValley, 3D-printing, ACA, Smart Integrator, Smart Maintainance of Ships, Blockchain in Logistics, Aquatic Drones and other digital revolutions (autonomous transport, MedTech, Big Data Hub, National Cyber Testbed)
- Support 'Slim Gemaakt', the regional platform for Smart Industry

Life Sciences, Health & Technology

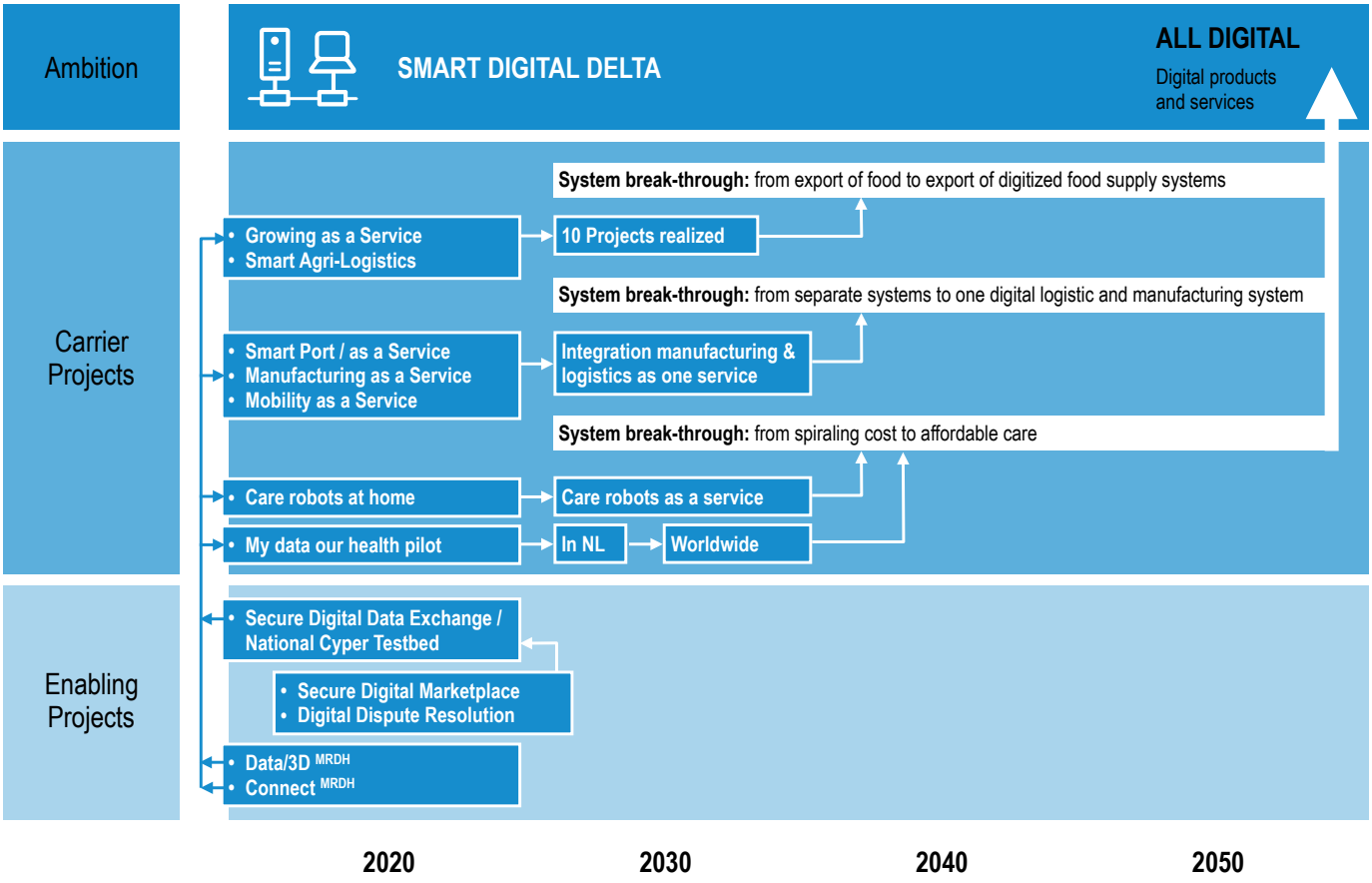
- Start a pilot with the IoT platform My Data Our Health, combining a virtual platform with real-life meetings of the participating community. My Data Our Health safeguards data ownership of citizens and patients by creating a legal entity in which participants become member of a cooperation. Thus they will control how their data can be used for research and/or commercial benefits

Impact & Sharing Economie

- Start a pilot with IoT for every student (LoRaPi phase 1) suitable for IoT applications. The prototype works on both the closed KPN network and the open Things Network (also accommodating blockchain software)
- Sustainable Citizen Coach, crowdsourcing energy efficient behavior/measures
- Developing The Hague Humanity Hub, scaling the standing support base for digital pioneers for peace and justice world-wide. The Hague Humanity Hub will focus on big data analytics. Closely related is the exploration of the development of a Stanford Peace Informatics lab

4. Synthesis

The systemic approach of Smart Delta Delta is summarized in the figure below, which illustrates the relationships between the various enabling and carrier projects and how they contribute over time to the overall ambition of reaching an 'all digital' region.



Smart Energy Delta

1. Energy transition

The metropolitan region sits at the crossroads of both challenges and opportunities regarding energy. The energy and climate targets are high, but there are also opportunities to build out a distinctive, exemplary energy region with a competitive business climate and export opportunities, supported by 'Paris & Parity', creating the momentum for large scale investments in renewable energy solutions.

Both energy savings, energy efficiency, renewable energy resources like biomass, solar and wind power, waste heat, and CO_2 capture & storage, will most likely comprise robust elements in our future energy system. Next to that, an increased share of fluctuating renewable energy sources like solar and wind power requires more and more (short and long-term) flexibility. In the near term this energy system requires a hybrid use of fossil and renewable energy sources and a multi commodity energy infrastructure network, dependent on the energy demand and supply of numerous energy options, their affordability and acceptance. This highly flexible, bi-directional and largely distributed energy system will drastically change over time and eventually largely depend on the demand and supply of renewable energy sources. The transition to a clean energy supply offers great opportunities for innovation, increasing competitiveness and the development of new economic sectors. Aligning infrastructure investments and government as launching customer will accelerate this development. A successful transition into a regional sustainable energy system will result in an attractive and livable environment, a competitive business climate and new energy businesses within the region. Using the momentum, speed (urgency) and scale of the region these businesses are developing the aforementioned new and affordable energy options into distinguishing products and services for a world market.

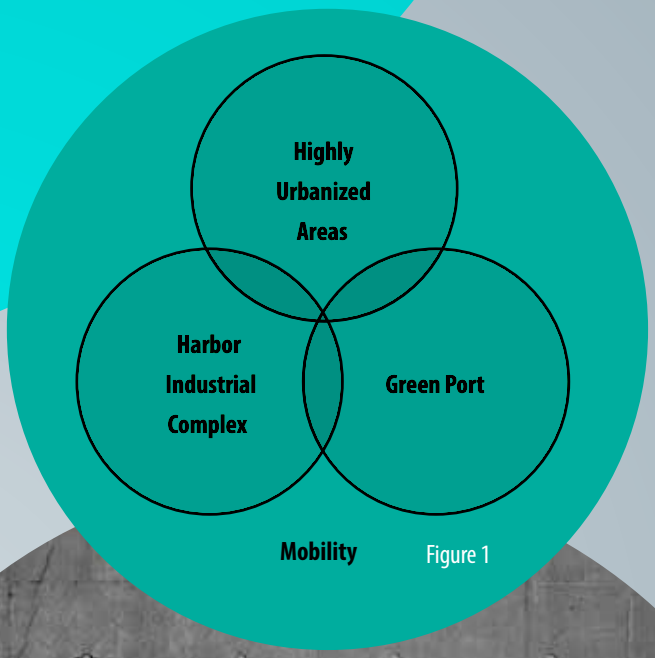
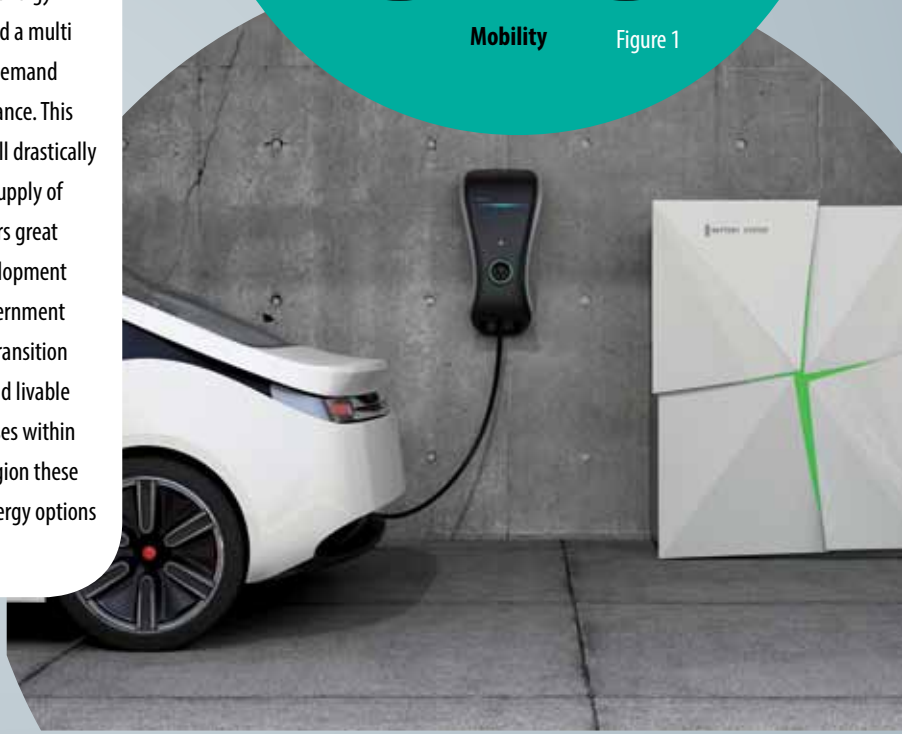


Figure 1



Looking at the region one can observe that it is composed of three specific but also highly interconnected realms: a large port industrial complex, a Greenport including smaller villages and highly urbanized poly-centric areas [Figure 1]. From an Energy Transition point of view these realms are all very much challenged as they are currently energy intensive and have a large installed base of real estate and infrastructure. They differ by nature with regard to the challenge, the stakeholders, and the availability of possible solutions paths. So what needs to be done when and how in these three realms needs to be carefully assessed and planned. Moreover in the region these realms are highly interconnected. Not only in terms of land-use and spatial planning, but also in terms of mobility and flows of people, goods & energy. This requires an integral, systemic approach. Mobility is an essential factor in Smart Digital Delta, at the same time it is an integral part of the energy transition in the region, as it still is for a large part fossil based and does contribute substantially to unwanted emissions.

Sufficient energy supply is a precondition for the energy transition and this will be realized through the use of a Smart Multi-Commodity Energy Grid, the enabling infrastructure to connect the different energy district grids that will locally arise, in order to make use of the flexibility of the various commodities, e.g. wind power at sea and on land, solar power on roofs and facades, industrial and geothermal heat, biomass, tidal power, blue energy, etc. To provide opportunities for application, new standards and protocols regarding flexibility and smart grid appliances need to be set. For the metropolitan region hydrogen could be a very important energy carrier, due to the long history of hydrogen production, distribution and use in the port area, where the most extended hydrogen grid in the world is located.

The Port Industrial Complex

The Rotterdam port is the largest outside Asia, encompassing the most extensive petro-chemically based industrial complex in North Western Europe with import, export, transit, storage and conversion of coal, mineral oil and natural gas/ LNG. In the port industrial complex innovation and research on decarbonization of chemical industry and fossil free fuels for the longer term are required, in combination with pilots for energy efficiency and carbon capture and storage for the short term. Obviously, a zero carbon economy will have profound consequences for the port in terms of transport, distribution, conversion and storage systems. The transition towards a carbon free society is formidable and unprecedented, but the port industrial complex has the required scale and chemically related technology base to facilitate the emergence of a post-fossil energy storage, conversion and distribution hub.

The Greenport

Dutch horticultural practices are world leading, with the highest horticulture production rate in the world and an impressive food and flower export position. The province Zuid-Holland accommodates the majority of the extensive and energy intensive Dutch greenhouse sector. Especially the CO_2 demand for crop growth is a complicating factor in the transition. If natural gas supply to the green house sector vanishes, other CO_2 sources need to compensate for that with corresponding infrastructures that will provide an unique opportunity to employ CO_2 as a resource. In the Greenport area the energy demand needs to be decreased and use of CO_2 free energy sources needs to be increased. With an increasing worldwide awareness for the relevance of affordable and sustainable food production, the regional greenhouse sector is highly motivated to take sustainable production very seriously in maintaining its leading role and market position.

The Urban Built Environment

As part of the province of Zuid-Holland the MRDH has two major cities areas – The Hague and Rotterdam – at 20 km distance from each other, surrounded by smaller towns and villages, counting for 2.3 million citizens on 3400 km2 surface areal. It is the most densely populated area in the Netherlands. The built environment is responsible for 30% of the region's total energy demand – and deserves an important focus for energy demand reduction and sustainable energy supply. Industrialization of retrofitting, massive introduction of solar PV and development of integrated solar panels, local energy storage and robust energy systems need to be created. In urban brownfield districts the gas infrastructure needs to be renewed, using all available options for energy efficiency and use of commodities (and electric vehicle transport). In urban greenfield districts the standard will be zero emission. Housing associations, infrastructure managers and municipalities will have to collaborate and activate citizens for energy efficient behavior and investments, e.g. with energy cooperatives (ESCO's). The engagement of all partners to pro-actively invest, develop, deliver and deploy energy savings and renewable energy production is required, while citizen involvement is absolutely essential. This will require a focus not only on energy, but also on the attractiveness of neighbourhoods in a much broader sense.

Mobility

Road transport obviously has its own – sector transcending – challenges in terms of emission reduction (CO_2, NOx, particulate matter). A full scale transition to electric transport and/or transport driven by sustainable fuels such as hydrogen reduces all local hazardous emissions from the transport sector towards zero. The energy transition in the transport sector brings cleaner air "for free". Importantly, future clean cars and ships carry large amounts of high value energy (electricity, hydrogen, or another sustainable fuels) over the roads and waterways that can be considered as an extra energy distribution system. Developments in the transport sector can profoundly influence our views on energy use and distribution.

Smart Multi Commodity Grid

A Smart Multi Commodity Grid is an energy system enriched with ICT solutions to enable strongly increased control and flexibility. It is a system in which gas, electricity and heat can interact and that is optimally adapted to integrate renewable energy. It enables the transition towards a renewable energy system and it is one of the essential pillars of the third industrial revolution as described by Jeremy Rifkin. The intermittent character of renewable energy sources requires a system where instead of a traditional top down energy infrastructure, the energy system becomes a true two-way system that is able to seamlessly match supply and demand under all conditions.

2. System Breakthroughs

The Rotterdam The Hague region aims to run entirely on renewable energy, without any carbon footprint. It maintains optimal living conditions while eliminating harmful environmental impact, contributing to and complying with (inter)national agreements on decarbonization. Looking at the region's specific realms we will have to focus on at least energy neutrality in the build environment for several 10.000's households on the shorter term, 100.000 energy neutral houses in 2025, ramping up to more than 300.000 houses by 2035. Zero-emission mobility for citizens and public transport must be achieved within the next 10 to 15 years. The effort for deep decarbonization of our energy intensive industry must start today with developing and piloting the required robust technology & systems followed by an accelerated large scale implementation. The usage of local renewable energy sources must be pursued more intensively and augmented with CO_2 compensation.

A linear step-by-step approach will yield far too little progress at too slow a pace for the MRDH to meet its objective to become a zero carbon region in 2050. So we strongly need to accelerate our efforts. Therefore, on top of the direct results of the Smart Energy Delta projects, we are also aiming for three systemic breakthroughs:

- Industrialized residential renovation and retrofitting
- A hyper flexible reliable energy provision
- A new networked energy market and related business models

To meet the requirements for the energy transition and by taking into account the realms and enablers, we have set transition targets that are summarized in [Figure 2].

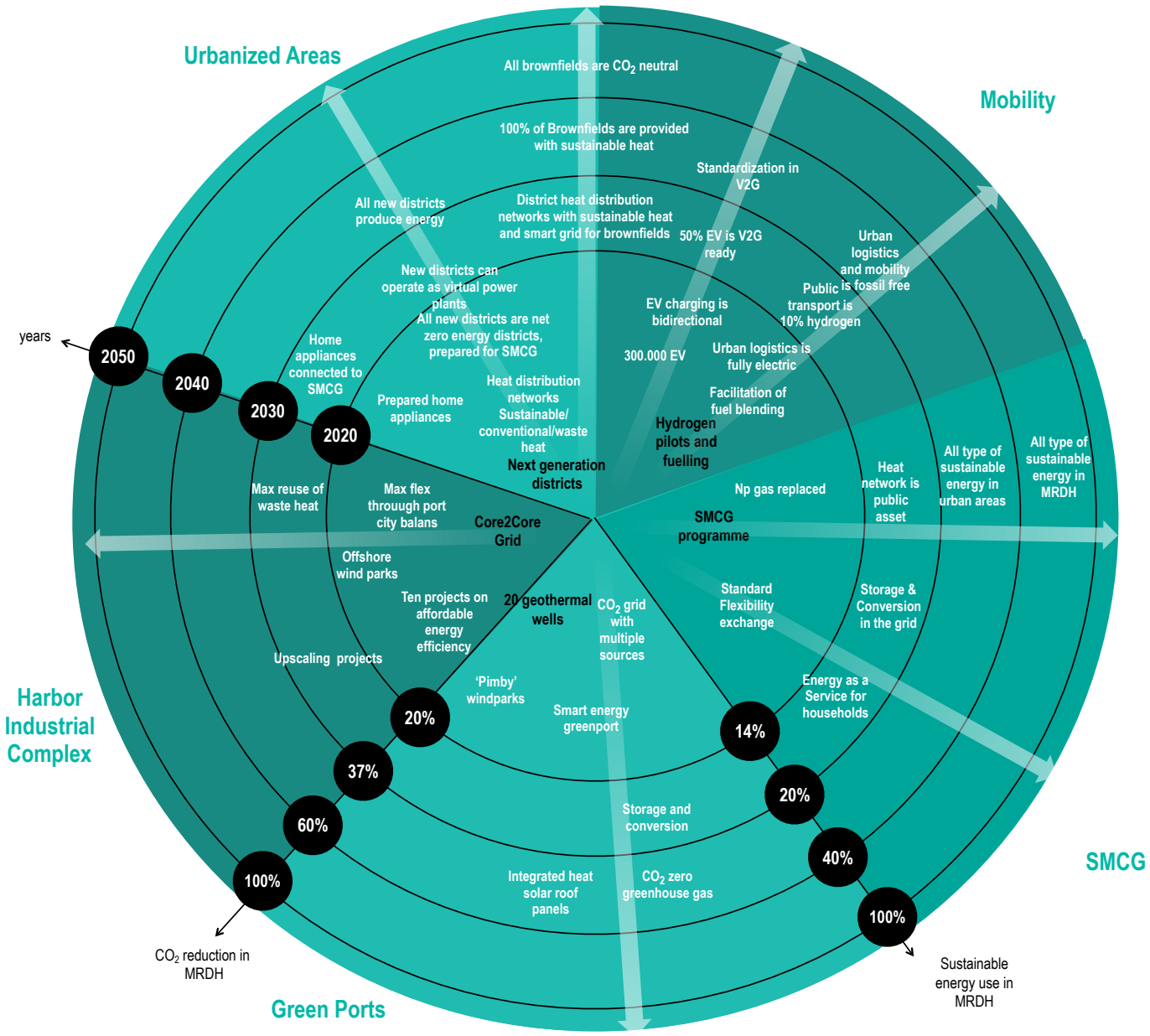


Figure 2

3. Projects

The projects of the Smart Energy Delta transition pathway are categorized according to the identified realms, while acknowledging that they are all interconnected as part of a systemic approach and will have a wider impact beyond these realms and even beyond this transition pathway.

The Port Industrial Complex

Projects within this realm involve increasing the industrial energy efficiency, accelerating the process of (deep) decarbonization as well as intensifying the production of renewable energy.

Carrier project Smarter & Cheaper: "Core to the Core Business" Grid

By sharing infrastructure, logistics, energy and utilities, and by exchanging raw materials, products and residual and waste materials, companies in the cluster can operate more efficiently than in standalone mode. This enables them to reduce their costs and strengthen their competitive position. The system builds onto the already existing infrastructure and enables innovation of the future steam supply. Some ten interested companies have formulated the objectives for a system of this nature, which is aimed at cost reduction (through means of economies of scale, lower investments, efficient generation, lower steam demand, shared backup facilities), supply reliability (fuel diversification, optimization of energy flows) and sustainability (CO_2 and NOx reduction). The organization model should guarantee a win-win for all parties and contribute to a business climate that attracts new investments due to competitive advantage and ignite innovation (e.g. power-to-steam, biomass as energy source).

Other projects:

- Urban – Industrial balancing act: hybrid energy system utilizing the Port Industrial Complex as balance for Rotterdam City to guarantee enough flex capacity
- CCS Rotterdam Storage and Capture Demonstration project
- Development off shore wind cluster in the port (incl. test and training facility)
- Development of a proposition for offshore wind farm assembly at Maasvlakte 2
- Implementation of rooftop solar at Maasvlakte 2
- Exploration of deep Geothermal wells in port area
- Short term: Smart Energy Business Parks
- Short term: Land-based Wind Turbines in the Greenport
- Short term: Solar PV on pipeline corridors
- Short term: Rooftop PV for Public Transport locations (starting with 4 Metro Stations)

The Greenport

Carrier project Faster & Smarter: Geothermal for the Greenport

Accelerating the use of Geothermal energy in the Greenport by means of facilitating at least 20 new geothermal wells in 2020 connected to the local and regional energy infrastructure.

Other projects:

- CO_2 Smart Grid
- Smart Grid Greenport (with showcases: Westland, Oostland, World Food Parc)
- Short term: Land-based Wind Turbines in the Greenport

The Urban Built Environment

Carrier project Faster & Cheaper: Next Generation Residential Areas ('8 districts')

In order to accelerate the transition towards zero net energy for existing urban districts we are implementing large scale retrofitting of residential areas, demonstrating that even districts and neighborhoods that are perceived as too difficult, can be transformed. This will take place in 8 pilot districts, starting in 6 already identified districts in Rotterdam (Bospolder/Tussendijken, Reyerdijk), The Hague (Moerwijk, Mariahoeve), Zoetermeer (Palenstein) and Westvoorne (Drenkeling, Rockanje, Oostvoorne).

Other projects:

- Going Dutch in the Urban Greenfield (Dutch Design meets Low Carbon Net energy Producing Districts)
- Buildings as sustainable energy sources (project '2.500 Energy Positive Terraced Houses')
- Short term: Cooperating housing associations
- Short term: My school Your Energy (a "Net Zero Energy as a Service" Solution for neighborhood schools)
- Short term: Green Village (smart energy field lab)

Mobility

Carrier project: Faster & Further: Hydrogen for Zero-Emission Public Transport

In 2020: 50-100 Hydrogen busses and 5-10 filling stations, 50 hydrogen cars using this infrastructure. In 2025: all new busses zero emission.

Smart Multi Commodity Grid

Enabler project: Faster and Smarter: Smart Multi Commodity Grid

The intermittent character of renewable energy sources requires a multi-commodity system, where instead of a traditional top down energy infrastructure, the energy system becomes a true two-way system that is able to seamlessly match storage, supply and demand under all conditions. A Smart Multi-Commodity Grid does not exclude energy sources and technologies, it reinforces them. The set-up varies per district: all-electric, heat/electric, gas/electric, DC networks, with or without storage (including electric vehicles) and conversion or other flexibility options. Different geographical and scale levels are determined: a large scale network for industrial / port / agribusiness activities (high temperature, waste heat, CO_2), a medium scale network (Agro farm producing energy for about 500 households) with biomass, and local, small-scale energy networks (potentially off grid or hub and spoke system) with solar panels, heat pumps and local storage.

Other projects:

- Virtual Power Plant MerweVierhavens (M4H)
- Heat infrastructure
- DC connecting Streetlights as Smart Grids, Sharing Renewable Energy on DC
- Short term: Power2Hydrogen station
- Short term: Only vehicle-to-grid charging poles

4. Synthesis

The systemic approach of Smart Energy Delta is summarized in the figure below, which illustrates the relationships between the various enabling and carrier projects and how they contribute over time to the overall ambition of reaching a zero carbon region.

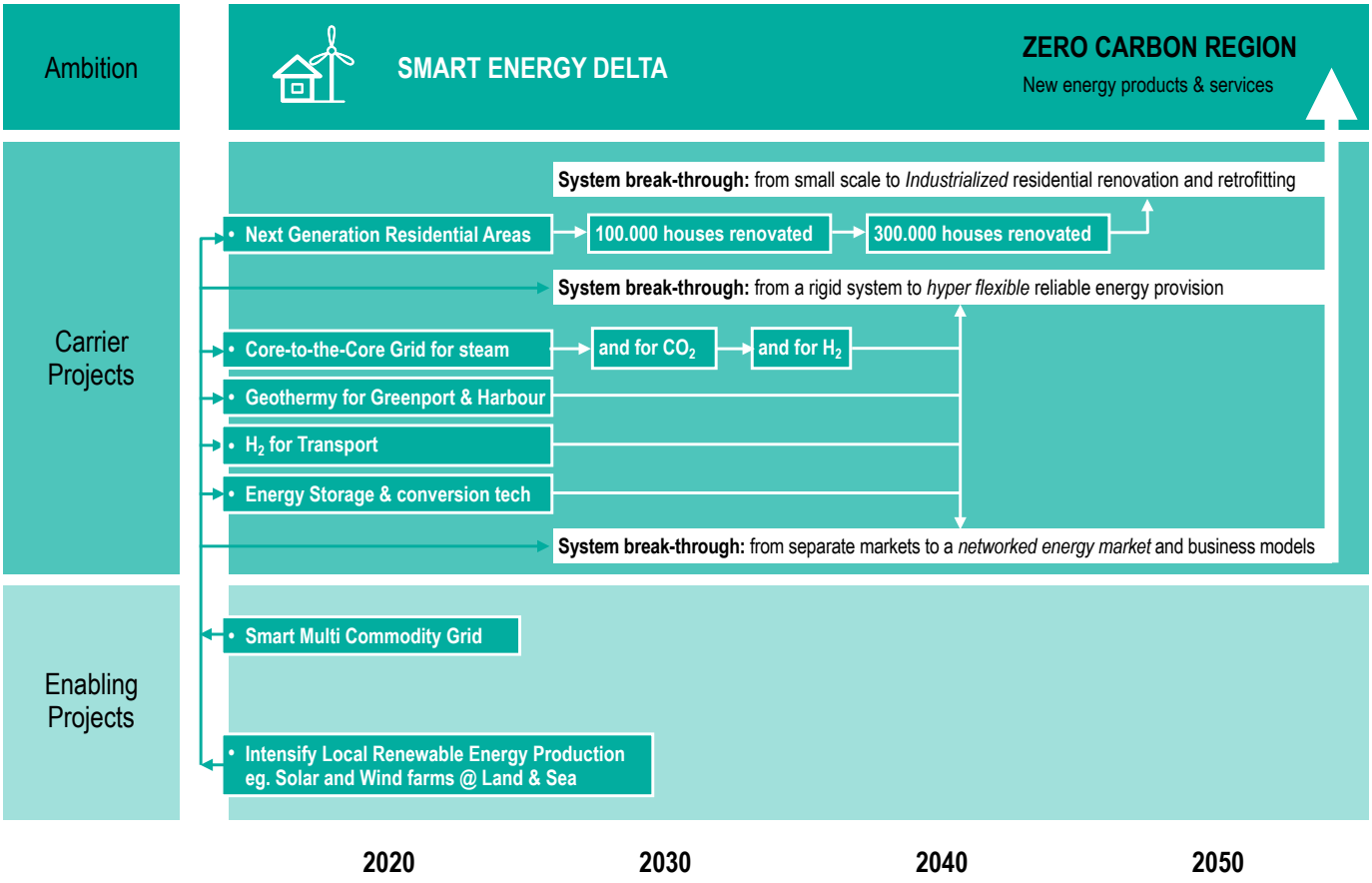


Figure 3

Circular Economy

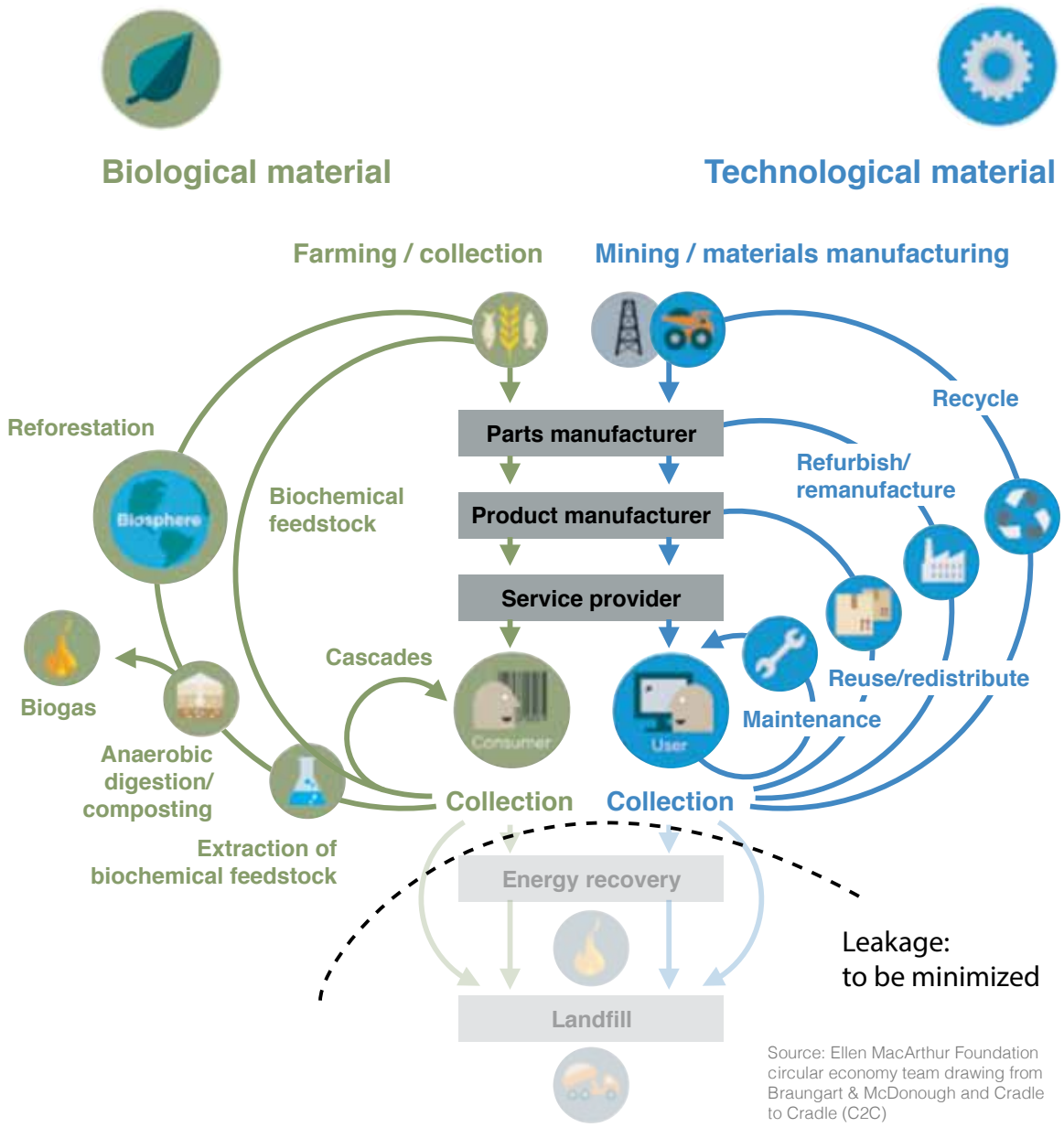
1. The circular paradigm

The transition to renewable energy is of utmost importance, but requires many materials and resources which in turn will exhaust the commercially extractable stocks. The reusability or re- and upcycling of technical materials and resources might therefore be an even greater challenge than the transition to renewable energy. The need for a circular economy is also given by the depletion of our natural resources, so we need to re- and upcycle our biological materials as they are being depleted or consumed at rates higher than can be grown.

In the context of the RNE circularity is defined as renewability of all natural resources: energy, water, biological and technical materials, air and top soil. This means that all resources either originate from a renewable source or can be renewed, whilst preventing negative effects on ecology, economy and society. This is an ultimate goal, a dot on the horizon for circularity. If achieved the result is effective: all resources can be renewed and used time after time with no waste as a result. All 'waste' streams are in fact resources, although often for other processes. The ultimate demand for circularity in 2050 can be formulated as follows:

Energy	*100 % renewable energy*
Water	*Water cleanable unto 'intake'*
Bio-materials	*Consume less as what can be grown*
Techno-materials	*Re- and upcycling for continuous (re)use*
Top soil	*Top Soil quality/quantity not diminished*
Air	*Air cleanable unto 'intake'*

The value of resources is preserved through high value reuse and recycling by which the life span of resources in the value chain is prolonged. Harmful emissions to soil, water and air are prevented as much as possible. In a circular economy chains are closed and waste is incinerated or left in landfills as little as possible. This is often graphically represented by the 'Butterfly' schemes [Figure 1]. This is a more pragmatic approach than the ultimate renewability goal above. It consists predominantly of a number of efficiency improvements. The result is often a 'less bad' situation, efficient but not necessarily effective.



Source: Ellen MacArthur Foundation circular economy team drawing from Braungart & McDonough and Cradle to Cradle (C2C)

Figure 1

The potential of the circular economy is great, both in terms of creating new jobs and contributing to sustainable development. When shifting to a circular economy we can generate at least 80.000 new jobs in the Netherlands (Rabobank, 2015; McKinsey, 2015; TNO, 2013) and thousands of new jobs in the MRDH. We are, however, still in an early, pioneering stage of the transition to a circular economy. Although good progress is being made in re-use and recycling of materials in some industries we are but at the beginning of a much wider approach to secure our future material needs. It starts with 'Design for disassembly', a very first step allowing re-using components and/or repairing products. But it doesn't stop there; we should be able to separate materials and even substances so we can recycle or even upcycle them. This requires the input of energy, which of course in turn should be renewably generated. Nevertheless various successful initiatives have been undertaken, albeit on a relatively small scale. This has been underscored recently by two important advisory boards of the Dutch government (Planbureau voor de Leefomgeving, 2016; Raad voor Leefomgeving en Infrastructuur, 2015). The Dutch Cabinet responded with a vision and ambition to realize a circular economy in the Netherlands by 2050. Overall, the promise and potential of the circular economy is widely acknowledged.

The region is ambitious and wants to become one of the first fully circular regions in the world. Densely populated regions as the metropolitan region have good starting conditions for the circular economy (PBL, 2016; CEDelft, 2016; Superuse, 2016). The region's economy is still linear just as the rest of the Netherlands and Europe. Yet more and more circular elements become visible, such as diverse start-ups via Yes!Delft, diverse initiatives under the label "070", the project Cirkelstad, the Circularity Center in Rotterdam and Blue City 010. These niche circular initiatives need to be scaled up within the region. As first region in the world the metropolitan region wants to map the resources, materials and waste within the region, indicating opportunities for the circular economy. That will yield concrete business cases within a few years. Mapping of resources and waste streams within the region will take place at different aggregation levels: at the level of households, business areas, cities and the region as a whole. In anticipation of this several industrial circular projects will be initiated.

For households the circular economy can be made concrete at the micro-level by valuing resources that used to be considered as waste. Collecting household waste in our municipalities is rather fragmented and – from the citizen's perspective – largely passes over their heads. However, when we value waste and organize waste collection close to home we can make a big resource jump. We can even make local products out of the won resources. At the level of industry a coalition of companies will start a pilot project that converts waste into resources for chemical products (Waste to Chemicals), based upon which the first European factory can be realized in the region.

At the level of business areas, resource stream analyses demonstrate that millions of euros can be gained and added to these areas if circularity is implemented. A study for the Binckhorst business area showed 20 million euros of added monetary value for this business area if circular economy principles would be implemented. Waste will be upgraded to new resources and products rather than being burnt, which will save costs, yields employment and reduces CO_2 -emissions for companies. A resources broker might establish connections between existing and new companies.

Resource city scans in Amsterdam and Glasgow underscore the huge potential to severely reduce material use and greenhouse gas emissions on the one hand, and realize economic growth and employment on the other. By organizing the construction sector in a circular manner a huge amount of material, CO_2 -emission reduction, additional jobs and value-creation can be realized yearly. This can be implemented through smart design of buildings, efficient separation of residues, re-win and re-use of materials and the establishment of a resource bank.

And with regard to regions, first explorations show a significant added value of circularity. For the province of Zeeland a first circular investigation indicates approximately 2000 additional jobs (CE Delft, 2016), under the condition of a pro-active role of the regional government regarding circular procurement and issuance of land for circular companies.

Above all a paradigm shift is needed to replace the concept of 'waste' by one of the perception of 'valuable resources'. This value has to be perceived by all inhabitants, social organizations, public and private companies and economic activities. Continuous education must help us with this change of mind as well as retraining the people needed to redesign our products and processes to allow the recycling and upcycling of components, materials and substances.

Many workers are needed as the process of regaining the materials from 'waste' is more labour intensive than creating them from 'virgin' materials. Vocational and higher educational institutions will have to process large numbers of skilled workers, whereas the cooperation with universities and knowledge institutes must be safeguarding required technological advances to replace fossil based technologies.

In all clusters biological and/or technical materials in the form of systems, components or just materials are being used. Knowing the location, condition and availability through the use of Intelligent Asset Value Drivers we are far better able to recycle these. Whether it is in shipbuilding, oil & gas rig-decommissioning or in the built environment, material passports and sensor technology should be developed for this.

2. System Breakthroughs

In light of the fact that the development of circular business models is still in its infancy, this first yield of project ideas and initiatives will be followed up with a more comprehensive, in-depth, cross-sectoral analysis of possible business opportunities. This analysis will be available early 2017 and will be closely connected with a similar analysis for bio-based business models. Both analyses are conducted by Cleantech Delta, in close collaboration with the business community.

The circular industry projects are closely connected to the fossil based industry that needs to transition to alternative non-fossil resources in the coming decades. Both the Waste to Chemicals (W2C) and Bio Refinery projects represent technologies to accommodate this transition, while simultaneously creating new business models. Carbon Capture Usage (CCU) can be seen as another important game changer, used in many processes in food (e.g. beverages, decaffeinate, cholesterol removal), in industry (e.g. synthesis polycarbonates, Power to gas) and in thermodynamic cycles (e.g. welding, biodegradable packaging, polyurethane, algae + water treatment).

The circular greenhouse horticulture projects are aimed at obtaining high quality crops, growths and active ingredients/molecules for pharma, cosmetics, food-industry and agro-chemistry. It is a combination of more than 10 projects, some of which are clear enablers (extract library and bio refinery). Each individual project by itself may be small, but combined they potentially represent a system breakthrough.

The circular urban projects are relatively small but demand driven, engaging citizens and households, and characterize new business sectors. The joint focus on household waste and on various sectors (Building Industry, Port and Industry, Business Grounds) could potentially turn this into a system breakthrough.

3. Projects

The projects of the Circular Economy transition pathway are categorized according to the previously identified realms: Industry (Port Industrial Complex), Horticulture (Greenport) and Urban Built Environment. The majority of the projects have to do with initiatives on Materials, both technical and biological. All projects are interrelated as part of a systemic approach and will have a wider impact beyond these realms and even beyond this transition pathway. Finally the enabling project Circularity Indicators serves as a prerequisite for circular business practices.

Material Resources in the Industry

Carrier project: Waste to Chemical (W2C)

A private sector consortium headed by chemical firm AkzoNobel has selected Rotterdam as the preferred location for building a methanol production facility based upon waste streams. Other partners include waste company Van Gansewinkel, AVR, French company Air Liquide and Canadian technology company Enerkem, supported by the Port Authority Rotterdam, the city of Rotterdam, the Province Zuid Holland, InnovationQuarter and Cleantech Delta. The project involves an investment of approximately 180 million euro. Production should start in 2018, aiming to chemically recycle 250.000 tons of waste into 90.000 tons of syngas and methanol, which can be used for a variety of chemical products (e.g. fibers and glues).

Carrier project: Bio Refinery

A private-sector consortium headed by chemical firm DSM will be performing a study into the feasibility of a biochemical plant in Rotterdam, in collaboration with the Port Authority Rotterdam. The members have brought together a total budget of 16.2 million euro to this end, including just short of 10 million euro in EU grants. The project involves the conversion of various wood types (e.g. spruce, poplar and scrap wood) into ethanol, butanol and other chemicals. The study will examine whether a plant of this kind fits into Rotterdam's present cluster. The consortium members view Rotterdam as a promising location for these new production chains – mainly thanks to the expected synergy with existing activities in Rotterdam's port area.

Carbon Capture Usage

CO_2 is often just seen as waste and as a greenhouse gas. However many applications exist in industry, greenhouse horticulture, water purification, algae growth etc. The technology is already developed and can be applied for various sectors within a few years. In projects 'CO_2 Smart Grid' and 'Leasing Carbon Capture and Usage technology contributing Circular Economy' attention is given to the use of CO_2 as a resource. Carbon Capture Usage can be seen as a game changer, taking the linear approach one step further by reusing the captured CO_2 as a valuable resource, instead of storing it in depleted gas fields. Opposed to Carbon Capture Storage which costst energy and money, Carbon Capture Usage can be made profitable.

Decommissioning of Oil- and Gas platforms

There are many oil and gas platforms located in the North Sea that need to be demolished in the upcoming decade. The Port Authority Rotterdam explores the possibilities for developing such a decommissioning cluster together with leading private companies like Keppel Verolme and Van Oort, with a special focus on recycling the valuable materials.

Upscaling the development of steam infrastructure and other waste streams in the port

The possibilities to exchange waste and steam between different industrial companies are explored in the upcoming years by a special envoy who has been assigned to make the industrial complex more efficient, circular and bio based.

Material Resources in Greenhouse Horticulture

A route to a Sustainable Future for Greenhouse Horticulture

The traditional products from Greenport like cucumbers, tomatoes, sweet peppers and ornamentals are, although high in yield, less attractive from an economical point of view. A transition to even higher productivity and high quality products for pharma, cosmetics, food-industry and agro-chemistry provides well needed earning capability, combined with a contribution to the transition to a non-fossil based industry. The transition to high quality crops can be combined with 'Overseas Greenhouses'. Using Dutch knowledge and experience, entrepreneurs can invest in places with more favorable climates and where the consumers are. It potentially reduces the energy component of growing in The Netherlands and the air freight. If we use (available) internet and IoT technology we can upgrade this market to 'Growth as a Service'. New 'High Productive Biomass' (including algae) can be the feedstock for new or renovated oil-refineries 'Converting Oil-Refineries into Bio-Refineries'. Other technologies allow adding value to this feedstock or rest materials 'BioBased Business with plant ingredients from the Greenports', Extract Library and 'Verwaarden alle reststromen' or in building blocks for Pharmacy 'Kas als apotheek' or direct in 'Personalised food'.

Material Resources in the Urban Built Environment

Improved collection Household Waste

As soon as people are financially rewarded they are prepared to separate various "waste" flows and bring them to collection points. This not only increases the efficiency of collecting valuable resources but it also brings the message across that what was previously called waste in fact represents value! This concept of collecting various resources can be extended to include collecting products whether or not broken which nowadays may only be offered as waste but in fact represent a certain value. These products can be offered at selected stations where adequate compensation for the residual value is given and where the product can be repaired / maintained and be brought back into the economic circuit. This obviously generates low to medium skilled labour. 'Urban Mining' and 'Afval loont' are two initiatives which even might work together and for which a possible roll out into the entire region is part of the proposals.

Improving material reuse in selected areas

In many sectors "waste" resource flows can be redirected into input flows for other processes. It is rather difficult however to bring the various parties together as the perceptions differ greatly. For one party it is a waste stream but for the other it is the input for a process with demands on quality, quantity, availability and reliability which are not automatically shared by the supplier. The described initiatives within various sectors can bring valuable contributions to the RNE objectives, e.g. 'Tipping point Circulaire bouw-metropool' in the Building Industry, 'Circularity Center' for Port and Industry, 'ResourceCity' for reactivation of outdated business grounds, 'Puls Up' with their system of "Oogstkaarten" (Harvesting cards) to identify available materials and finally 'Blue City', which acts as an incubator for circular startups. It is aimed at business development and interaction with the city (located in a landmark building in Rotterdam). Establishing Blue City as a circular Field Lab will further contribute to regional upscaling of 'circular-by-design' principles.

The enabler: Circularity Indicators

A project between amongst others ICCE, LIST, TU Delft, Lateral Thinking Factory and getZED is looking into the possibility to improve on existing circularity indicators. The existing indicators are actually quite linear, not taking the quality of various flows into account. For energy this can be done through the use of Exergy, for the other resources like water, biological and technical materials similar parameters will have to indicate the quality level of various flows.

Various

A variety of projects are brought in by the business community: 'Sailing heat' provides an alternative to heat roundabouts through the use of Phase Change Materials, 'Smart Tiles' as an energy harvesting paste, 'Recolour' for recycling and reprocessing unused paint, an expertise center for remanufacturing ('Reman-centre'), the salvage of materials for left alone boats and ships ('Weesbootjes') and a pilot for the reuse of dredging silt (baggerslib) as material for bank protection ('Oeverbeschoeiing van baggerspecie: GeoWall'). Many of these project initiatives will be subject to further research and development as viable business cases in the course of the RNE deployment. The projects 'Blue House' and 'Zero medicines, hormones or multi resistant bacteria emitting Hospitals' contribute to a better water quality in the region.

4. Synthesis

The systemic approach of Circular Economy is summarized in the figure below, which illustrates the relationships between the various enabling and carrier projects and how they contribute over time to the overall ambition of reaching a 100% circular economy.

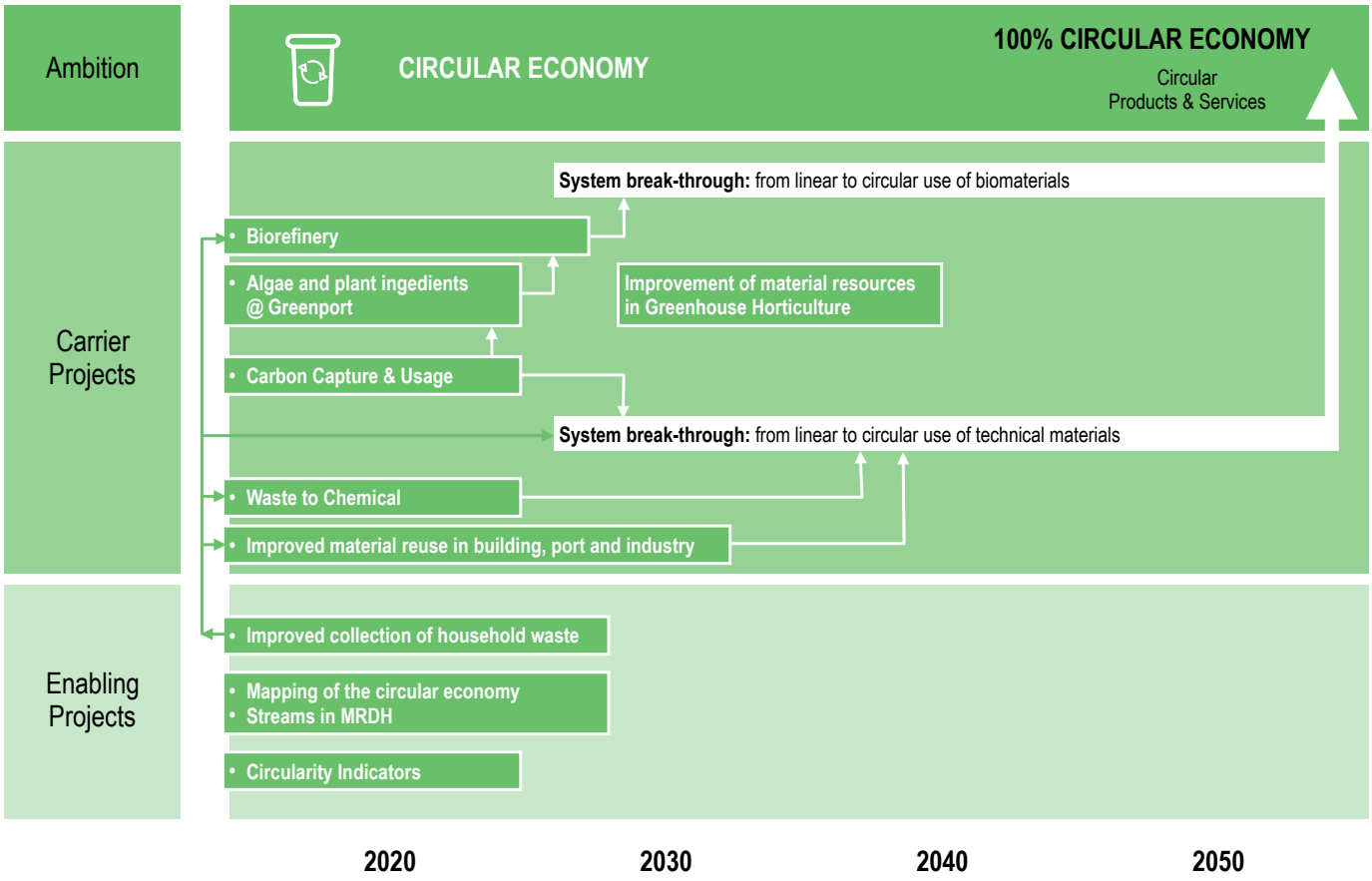


Figure 2

Entrepreneurial Region

1. Competitive Entrepreneurial Ecosystem

The Next Economy is characterized by a radically different economic structure. It will be dominated by laterally organized networks instead of vertically integrated structures operating in specific sectors. Therefore the Rotterdam The Hague region needs to focus on stimulating innovations across and beyond sectors, which will most likely trigger new value chains, business models, products and services. This will require an environment where entrepreneurs and scale-ups can quickly grow, where testing and deployment of innovations can thrive in a dedicated investment climate. This must be assisted by a government that is entrepreneurial at all levels: policy, legislation, permit authorization, purchasing, investments in infrastructure, education and coaching. In short, the conditions for entrepreneurs should be optimized.

In order to do this, the region needs to build upon the existing and growing sparks of entrepreneurial spirit. This will enable an ecosystem in which all actors, entrepreneurs, investors, financial institutions, corporations, knowledge institutions and government operate in an entrepreneurial way towards meeting their own distinctive objectives, like job creation, knowledge generation, product acquisition, talent retention, wealth creation, etc. All stakeholders must be able to benefit if an entrepreneurial ecosystem is to be resilient and self-sustaining.

The relationship between entrepreneurship and economic growth is complicated. There is no hard evidence that increasing the number of start-ups, offering financial incentives or establishing co-working spaces and incubators will necessarily stimulate economic development. However, successful entrepreneurial ecosystems around the world show a combination of:

- Entrepreneurial culture: 'soft' factors like personal and institutional leadership, entrepreneurial orientation and risk tolerance; create a local vibe and entrepreneurial dynamism with tolerance for ideas and "weirdness"; care for and connect the entrepreneurial initiatives and persons in business, government, education and institutions (institutional innovations). Ensure an effective branding that attracts talents, businesses and inventions
- Entrepreneurial structure: 'hard' factors like institutions and infrastructural support; utilize network effects by ensuring intense contacts within the concentrated and dense MRDH agglomeration; use current strengths of the region (its DNA) by cross-fertilizing strong sectors
- Entrepreneurial practice, which concerns venture-friendly markets, incentives, dedicated finance and a benevolent regulatory framework, enabled by an entrepreneurial government

The next economy aims for an inclusive economic growth, which requires a balanced approach to technological and social innovations. Social innovation means investing in people and their skills, in new ways of managing/leading, new organizational forms, new/smarter ways of working and/or new ways of co-creating value with external stakeholders. This effectively bridges transition pathway Entrepreneurial Region with transition pathway Next Society [Figure 1]:

Social enterprises and businesses that seek to combine economic success and societal added values are referred to as "impact economy". These activities increasingly find their way in the emerging sharing economy, in which on-line platforms provide the democratized context for peer-to-peer collaborations, spanning a wide variety of crowd-based networks, from purely commercially driven to purely idealistic and all stops in between. This creates an exciting, hybrid economic space for which the rules of engagement are still in the process of being established, but in which consumers will act progressively as prosumers, thereby gaining more economic independence. There are indications that demand-side economies of scale (a.k.a. 'the network effect'), increased usage of spare assets ('idling capacity') and supply-side differentiation enabled by these peer-to-peer platforms might actually induce inclusive economic growth (increased variety = increased consumption = economic growth).

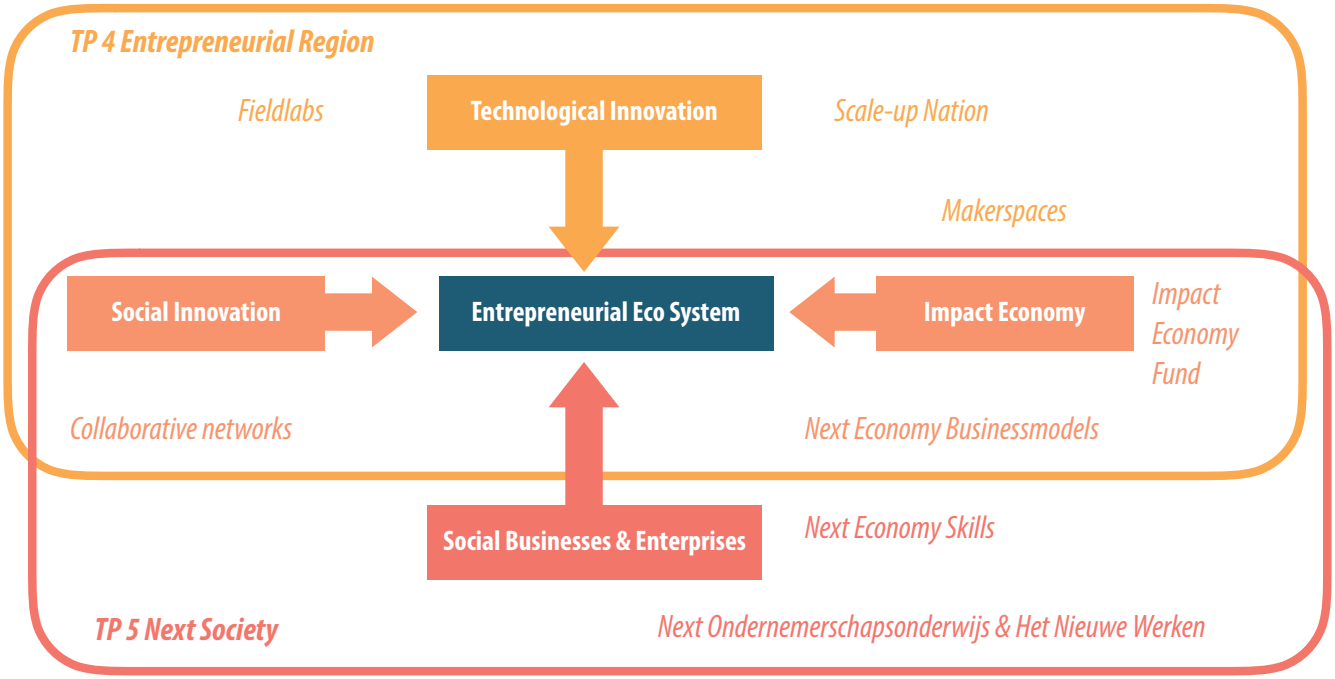


Figure 1

Regional context

The metropolitan region has a huge potential, yet its current economic growth is only average as compared to other Dutch regions and below average compared to other European regions. Several factors are often mentioned in this regard:

1. **Concerning entrepreneurial culture:**
   a. Many entrepreneurs show a focus on technology and product innovation, where soft factors as sales & marketing and human resources receive insufficient attention
   b. Insufficient capital and investor readiness at entrepreneurs, limiting growth and thus limiting the number of start-ups
   c. The region is not known for or branded as an innovative and growing region, although the facts prove differently
   d. Vested interests and power structures in the region are still centered around the traditional big companies rather than around emerging start-ups and scale-ups
2. **Concerning entrepreneurial structure:**
   a. Insufficient cooperation and co-creation between sectors and in production chains, insufficient networking between public and private organizations and entrepreneurs
   b. Insufficient insight in innovative solutions and state-of-the-art science in the region
   c. Insufficient valorization of public R&D and patents in the knowledge institutes
   d. Mismatch of supply and demand on the labor market, e.g. in IT and engineering
   e. Lack of structural international cooperation with other strong innovation hotspots which allow for exchanging ideas, talents, products and services
3. **Concerning entrepreneurial practice:**
   a. Insufficient amount of private investments in R&D and in implementing innovations;
   b. Entrepreneurial incentives and regulatory framework operate differently on a local scale slow down rather than stimulate economic growth.

The region is successful in attracting talents (TU Delft, EUR, HR) and starting companies, but less so in retaining the talents and start-ups that are inclined to leave the region if they want to scale up, searching for skilled talents in other regions, often abroad. Yet, things are moving forward and the province of Zuid-Holland contained 648 scale-up businesses, 23% of all Dutch scale-ups, most of which are concentrated in MRDH. The foundation of MRDH and InnovationQuarter shows that on a policy level the urgency to join forces, invest and innovate is not only felt but acted upon. Networking organizations such as Clean Tech Delta, The Hague Security Delta, Medical Delta and Holland Instrumentation have been formed in recent years, growing rapidly and starting to co-operate. YES!Delft has grown in ten years into a European top incubator. Other incubators are formed and also growing (CIC, ECE, ESA-BIC, etc.) and cooperating. Investments funds of InnovationQuarter and RoboValley (100 million euro each) give opportunity to public as well as private investments and aid in improving investor readiness, resulting in a venture capital investment increase by a factor 7 from 2014 to 2015.

The metropolitan region is quite a-typical as a region. Its largest assets (port and logistics, petrochemical industry, Greenport) are still largely dependent on fossil fuels, space consuming and add relatively little value. The potential of younger industries like Life Sciences, High Tech Systems and Materials (HTSM) and ICT, is not yet optimally realized and their potential to open up the traditional sectors is still insufficiently employed. Many hidden champions in these new industries have as yet insufficient influence on policy. An analysis of top-sectors in The Netherlands shows that all of them have a focal point in the province of Zuid-Holland, i.e. the greater metropolitan region. Even HTSM, traditionally linked to the Eindhoven region, in fact is concentrated more heavily around Delft, the TU Delft and TNO being top generators of HTSM-companies. The co-existence of all sectors in the region has long been regarded as a disadvantage due to a supposed lack of focus and mass. However, it could be an asset when all these sectors have considerable mass as well as increasing focus. In a world where cross-overs between sectors give rise to the new innovations, this diversity should be embraced and employed to stimulate cross-overs, as is currently done in, for instance, "dare-to-cross".

The overall conclusion is that the entrepreneurial culture in the Netherlands in general and in the Rotterdam The Hague region in specific can and needs to be significantly improved. A society where people have a license to fail, where creativity and ambition are respected and rewarded and where people invest rather than save their capital is not built overnight. It can be stimulated only by indirect means and will take at least one generation to come to full effect.

2. System breakthroughs

The following four actions can serve as system breakthroughs in realizing a truly competitive entrepreneurial ecosystem, provided that the concerning projects are implemented simultaneously:

1. **Scale-up Program**, as one of the measures to stimulate individual entrepreneurship in addition to the effects of the existing start-up and accelerator programs
2. **Field lab Ecosystem**, to stimulate cross-over innovations, between companies and sectors, as well as with R&D and educational institutes, also contributing to individual entrepreneurship, with 'strange attractor' Dutch Wind Wheel as brand and trademark for the entrepreneurial region
3. **Prototyping Program**, teams of (young) pioneers, makers, designers, tinkerers and common citizens working together on scalable projects and initiatives that have a positive impact on society
4. **Entrepreneurial Government**, with specific and targeted actions to slash current rules and regulations that limit radical innovation, to synchronize the local application of rules and regulations and to stimulate entrepreneurship in innovative ways.

3. Projects

Scale-up Stimulation

Much is already being done on stimulating start-ups, but new business in existing companies and scale-ups deserve more attention. Figure 2 gives an overview of the roles of different organizations and different (regional) financial instruments in the various phases. The process starts with the formulation of an idea (ideation). This can be inspired by business intelligence (market pull) and R&D-results and patents (technology push). Existing network organization such as Clean Tech Delta, Medical Delta, The Hague Security Delta, Greenport and Holland Instrumentation play an important role in organizing matching events, recognizing technology needs and bringing R&D experts and entrepreneurs together.

The real growth potential and employment opportunities come with scale-ups. A regional program partly inspired by the Scale-Up Nation initiative, needs to be set up to ensure fast growth of scale-ups in relevant market segments. A basis for the investment program may be found in the 'Road to Capital' initiative that is currently being developed by Innovation Quarter, ECE, YES!Delft and Venture Café. Projects are envisaged on: 'investor readiness' of both young companies and young potential investors, a scale-up program and active enhancement of the relations between entrepreneurs and investors.

Short term:

- Organize cross-over events
- Continue to stimulate networks
- Prof-meets-CTO

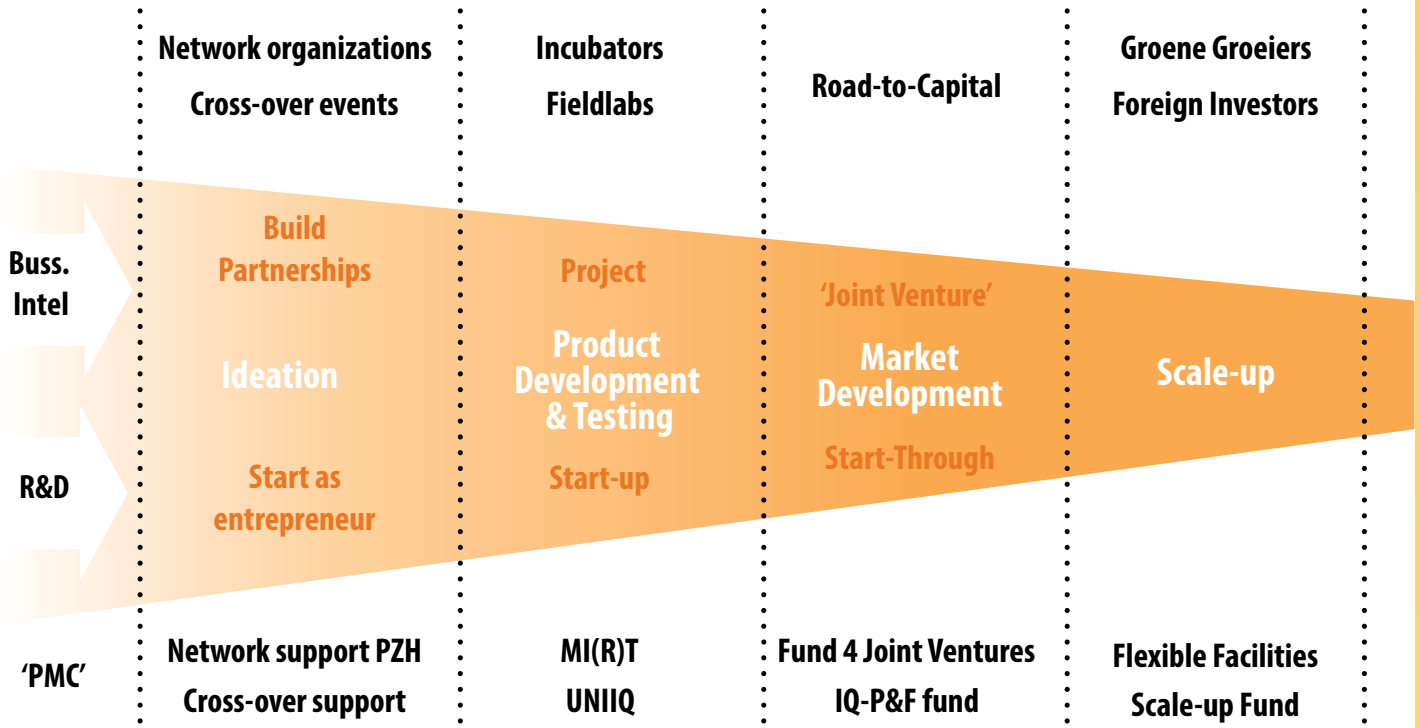


Figure 2

Field Lab Ecosystem

Field labs are open access facilities for developing, testing, demonstrating and validating new – disruptive – technologies (e.g. robotising, 3d printing, big data processing and sensor technology), products and innovations. A Field Lab ecosystem aims to improve and elaborate the cross-sectoral innovation, practical education and quadruple cooperation between end users, companies, R&D and government, as well as to remove the obstacles that stand in the way of innovation. Field labs will help to establish a more collaborative, distributed, open and laterally scaled approach to entrepreneurialism.
A collaborative network of field labs, makerspaces, innovation districts, multi-stakeholder living labs and free-zones for enabling experimentation and R&D in real world circumstances creates an environment in which the deployment of technological innovations is stimulated, scaled up and translated into real business (cases) and job opportunities. Sixteen of such initiatives are currently bundled in the Field Lab Infrastructure, supported by a nine point program by MRDH, provincie Zuid-Holland, InnovationQuarter and TNO. This includes a Field Lab Fund, a Field Lab Support System and programming across and beyond sectors. The Field Labs each address different large international markets that resonate with our current industrial and know-how basis. There is a responsibility for the region to address the international market potential and support the existing critical mass and focus that are already available in our region.

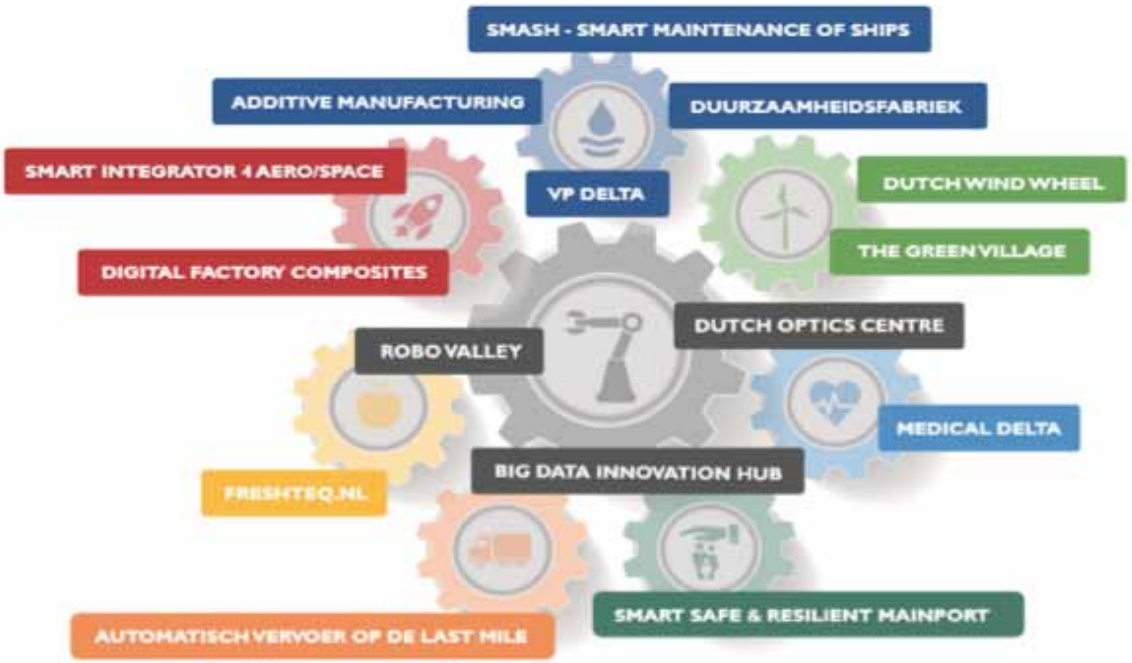


Figure 3

Figure 3 illustrates the current situation, as more initiatives are popping up and can be supported by this infrastructure. Examples include a High Tech Maritime & Smart Industry Campus (RDM Campus and Schiedam); a public/private Port Internet of Things Faculty (part of KPN IoT Academy) and a Circular & Biobased Research & Education Centre (related to Circular University Delft). However, too many initiatives in a scattered landscape will compete for the limited available funds, therefore more focus is needed. The possible merger of existing field labs on closely related topics is being considered in order to increase the critical mass. At the same time we must realize that technological innovation is a moving target, which requires an open mind to accept new significant initiatives that can be added to further complete the landscape. Therefore we will jumpstart a Field lab for Blockchain, perhaps the most promising technology for the Next Economy: it facilitates complex distributed networks in a transparent manner; it can be the enabler for the Internet of Things, big data and algorithms as a service; it can be the backbone for next logistics and circular material chains; it may be the joint neutral broker for decentralized energy and it delivers new transaction, financing and business models in all sectors. Being in the international forefront of this development will be of vital importance to the competitiveness of the region.

Dutch Wind Wheel

The cumulative force of the collaborative cross-sectoral field lab approach may even result in 'strange attractors' in our region, that will have a strong 'pull effect' on creative pioneers from all over the world and contribute to substantial clustering of talents. Such initiatives may prove to be the catalysts for new innovations across and beyond sectors. The first example of an initiative that shows all the characteristics of a strange attractor is the Dutch Wind Wheel.

This project encompasses many of the innovations that are being developed in the various field labs and has the potential to become a visual icon for the next economy of historic proportions. It will stimulate tourism and create new jobs. And most importantly: it will become the brand and trade mark of the region. Realization of the Dutch Wind Wheel is projected in 2025.

Dutch Wind Wheel

Prototyping

Next to building an infrastructure and transforming our dominant sectors, the next economy needs a forefront. An emerging movement of makers, creatives and grassroots networks already lives and breathes the next economy. By developing radically new technologies, collaborative models and skills they provide our ecosystem with scalable and open business cases (e.g. LoRaPi), crossover opportunities for other RNE programs (e.g. Field lab Blockchain) and effective bridges between entrepreneurial region and next society (e.g. The Hague International Center for Civic Hacks).

This new movement does not match traditional support structures and the region Rotterdam The Hague is one of the first regions globally to specifically invest in its crucial role. The Prototyping Program aims to boost the number of pioneers and radical innovations, to create a strong and growing movement and to fully utilize this pioneering potential for the regional economy.

Short term

- Establish the Prototyping Program as a new element within the ecosystem: scouting, initiating and supporting radical innovations from makers, creatives and grass roots networks.
- pilot for a community based Prosumer Sharing Station (as a kind of Field lab for the collaborative commons) to empower common citizens to maximize the impact of their assets

Pilot region for a Next Economy Transition Act

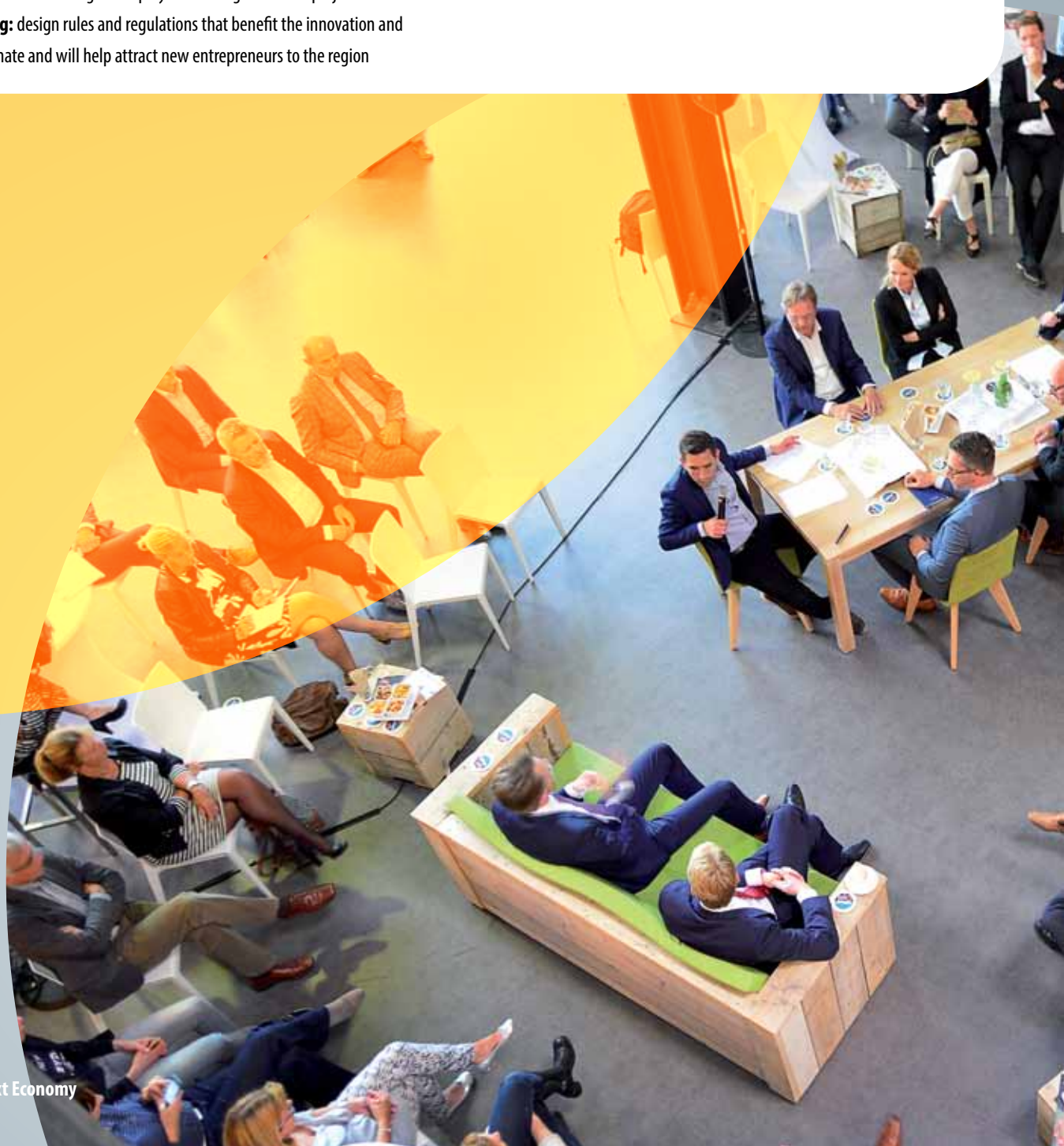
The existing regulatory framework is at odds with the next economy, as it is still based on the linear, carbon economy. The government should act in a more entrepreneurial manner and the time seems right for a new regulatory framework that will stimulate innovation and accelerate the transition, culminating in a Next Economy Transition Act (comparable to the Crisis- en Herstelwet from a decade ago). We aim to bring all government levels – local, regional, national and European - together in a Legal Intervention Team to work on the following issues:

1. **Slashing:** quickly displace, bypass or (temporarily) circumvent existing rules standing in the way of transitional activities
2. **Smarting:** design smart laws that are in step with a digital, carbon neutral, circular, entrepreneurial and inclusive society
3. **Synchronizing**: synchronize the execution of existing rules (procurement, building permits, environmental rules, etc.) in the region, significantly improving and accelerating the deployment of regional scale projects
4. **Stimulating:** design rules and regulations that benefit the innovation and business climate and will help attract new entrepreneurs to the region

The metropolitan region will be the "real life testing ground" for a new regulatory framework benevolent to innovation and transition. This can be accomplished by an agreement (like 'Eindhoven Pact') on specific rules & regulations, by a more general, regional arrangement based on a prolonged RNE City Deal agreement or – ultimately – as the pilot for a National (perhaps even European) Next Economy Transition Act.

Short term

- Set up the multi government Legal Intervention Team and select and propose 3 Smart Laws, 3 synchronizations and 3 stimulations that can be implemented quickly



4. Synthesis

The systemic approach of Entrepreneurial Regionial Economy is summarized in the figure below, which illustrates the relationships between the various enabling and carrier projects and how they contribute over time to the overall ambition of reaching a competitive entrepreneurial ecosystem.

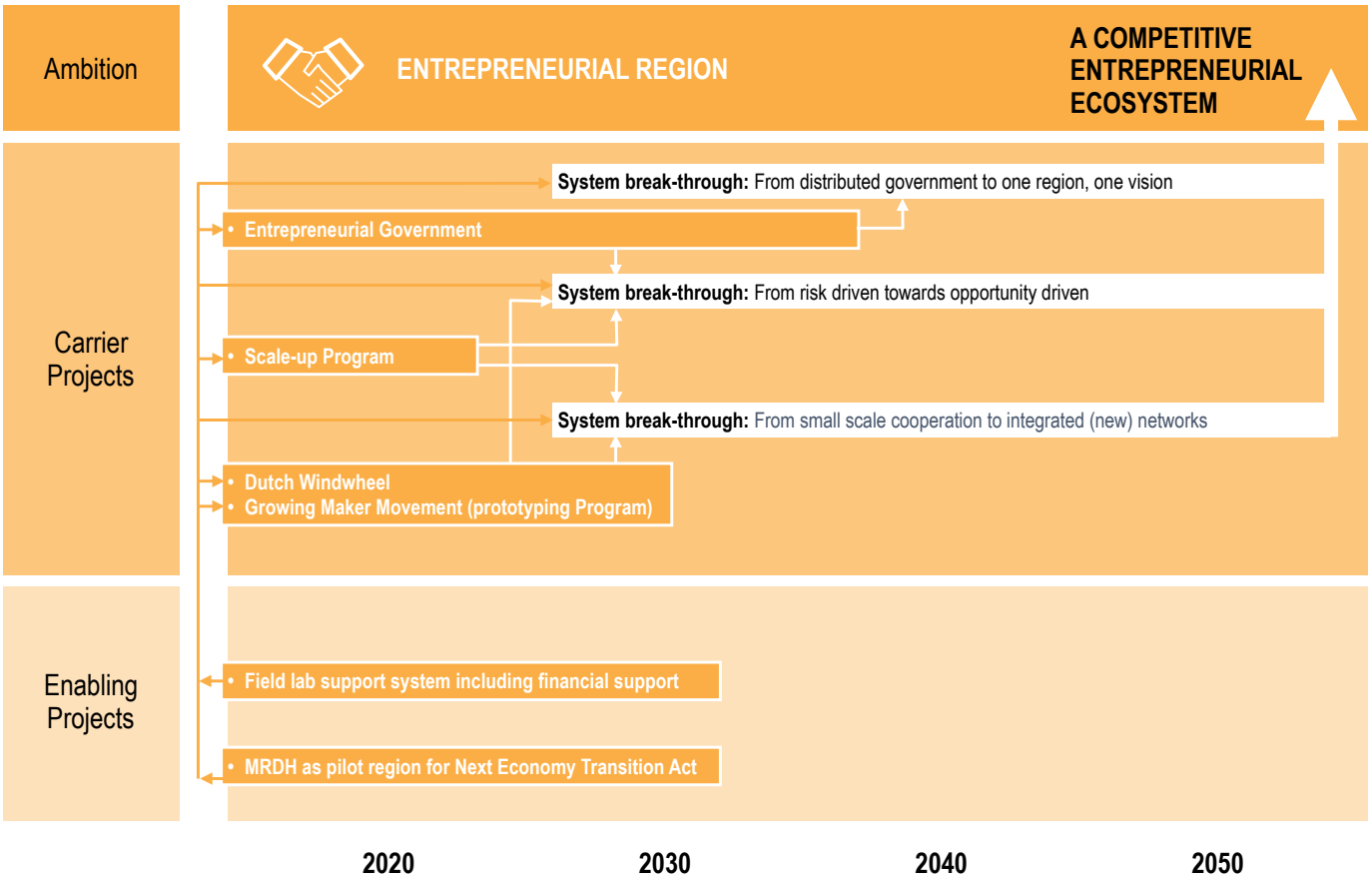


Figure 4

Next Society

The economic paradigm shift will obviously have a tremendous impact on society. While the social and cultural aspects of the next economy are not strictly part of our assignment, the RNE would not be complete if we do not address the societal consequences that are inseparable from an economic system change. For that reason we formulated a fifth transition pathway Next Society, which focusses on the regional labour market and the educational system. It does not pretend to offer a comprehensive transformative vision on the societal and cultural changes that might take place, nor will it provide the ultimate solution to (un)employment issues. However we will illustrate some key characteristics of the next society, such as collaborative sharing platforms, new organizational forms, new ways of managing, working, training and learning and their specific impact on the regional labour market and the educational system.

1. Transforming the labour market

The labour market situation in the metropolitan region is relatively unfavorable. The growth of employment in Rotterdam and The Hague lags behind the other major cities in the Netherlands as well as cities in Europe. This is a structural phenomenon, due to the fact that the main economic sectors in the region – industry, logistics and public services – are declining, while sectors that have seen growth, like business services, are not strongly represented in our region. The most recent MRDH facts on GDP and employment levels are illustrated below:

	2015	2009-2015
	level	average % p.yr.
Population (x1000)	2.298	0,7
GDP (billion)	101	-0,4
GDP/CAP (x1000 per inhabitant)	44	-1,1
Employment (x1000)	1.195	-0,5
Participation (% of population 15-74)	68,6	-0,7
Unemployment (% of population 15-74)	9,0	3,9
R&D (% of GDP)	2,0	0,3

Source: NEO Observatory

This trend will not fundamentally change within the current economic structure so we need to build a new one, phasing out the traditional fossil based industry and scaling up niches emerging in the next economy. The conditions for new business models, products and services can also bring opportunities for new employment, provided new developments can be spearheaded faster and on a larger scale than elsewhere, thereby developing a competitive edge that will attract talents and business to the region. Even within the existing dominant economic structure and labour market situation the following observations need to be considered:

• Innovation is crucial

Modern economy is driven by the need for innovation, by developing and introducing new products, processes, services and business models in order to be competitive. The emerging transition to the next economy sets off innovations that are both exponential and disruptive, therefore the focus should be on radical innovation rather than incremental innovation.

• Business organizations change

Permanent change forces businesses to change their organization towards being more adaptive and flexible (exponential organizations), as well as their workforce towards new capabilities and skills ('21st century skills'), forming strategic alliances and operating in meta-organizations and other (digital) networks as part of one or more value chains. Existing functions will become less important, workers have changing assignments and the hierarchy of business needs to become more flexible.

• Labour and employment relations will change

The variety of strategic alliances and collaborative networks has changed the form of employment contracts from a steady long term commitment towards more loose and temporary, short term contracts and engagements. Production processes also have an impact on labour relations, as do the changing attitudes of employees themselves, who no longer prefer lifelong commitment to steady jobs.

• Work changes

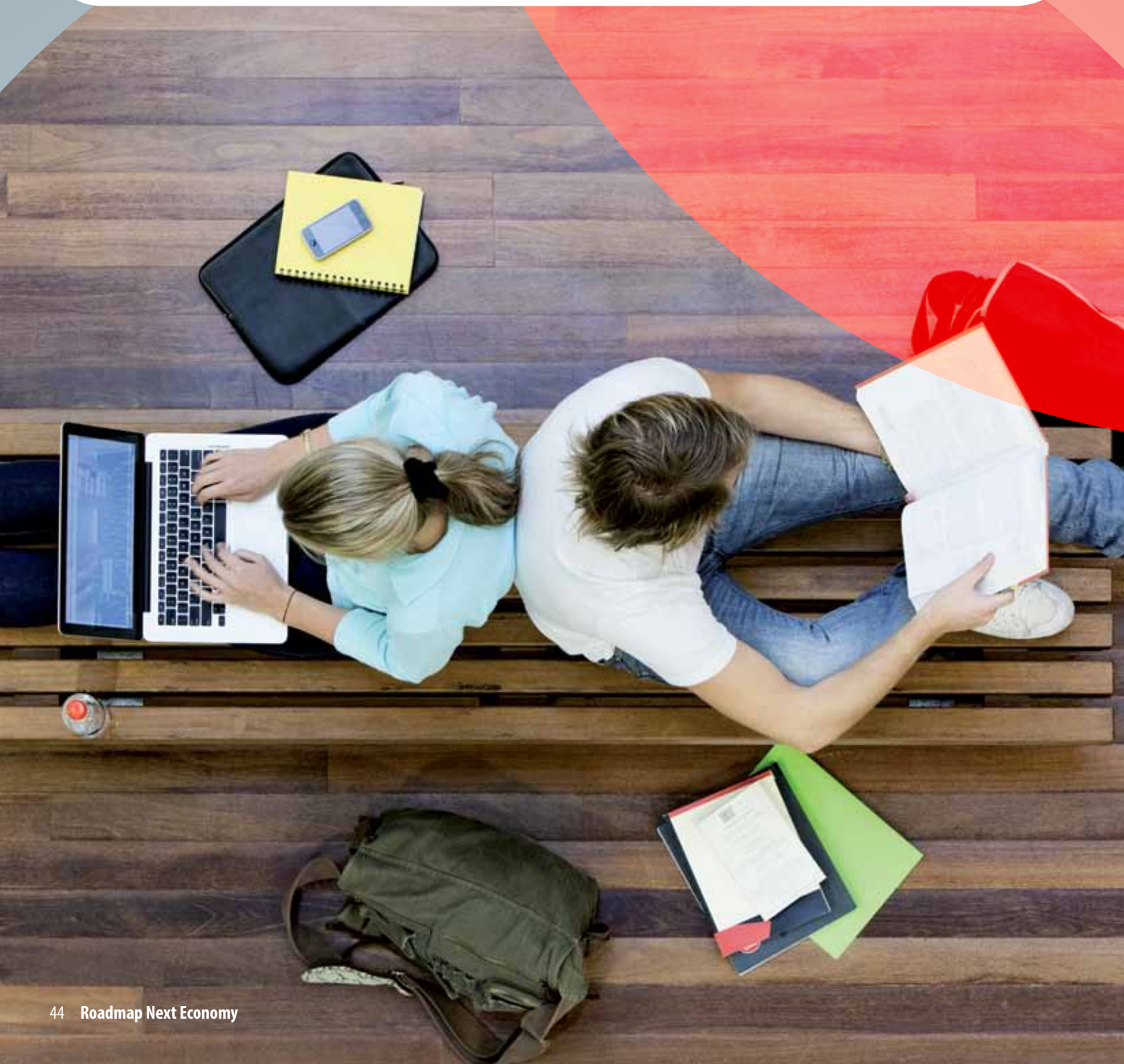
The traditional model of steady jobs in paid employment is giving way to a more dynamic model with looser assignments and much less job security. People will get multiple small jobs and will frequently change jobs. The contents of many jobs are changing as well and there will certainly be more focus on ICT and soft skills, e.g. collaborating and self-steering.

Simultaneously we see the growing importance of the emerging sharing economy, characterized by:

- The impact of underutilized capital through the usage of 'idling or spare capacity' (e.g. time, space, transportation vehicles, appliances, unused skills, etc.)
- Changes in consumption towards increased variety and different models of access through the usage of peer-to-peer sharing platforms
- Shift towards on-demand economies of scale, a.k.a. the network effect (increasing the value of a product by increasing its usage)
- Democratization of economic opportunity that promises inclusive growth

The on-demand or 'gig' economy creates new opportunities and unleashes innovations, but also raises questions about workplace protection and what a decent job will look like in the future. The immediacy of labour supply and the near zero transaction costs through sharing platforms makes work much more granular and potentially more efficient. As we move into an economy where work is decomposed and done by 'taskers' around the world, (micro)entrepreneurs perform multiple gigs and freelancers operate in fluid self-employment, the traditional definitions of employment are muddled. We need to develop labour policy on different levels that anticipates this ongoing transition and moves past the false dichotomy of 'employee' and 'contractor' to redefine how we categorize productive work.

There are two contradictory views on what the future of work might look like. There is the dystopian view, predicting a race to the bottom ('sharing the scraps'), with the big revenues going to the corporations that own the software and the scraps going to on-demand workers with low wages, elimination of benefits and high levels of insecurity. There is also an utopian view, that describes the future of work as increased flexibility, fluidity, innovation and creativity, in which individuals will be empowered (micro)entrepreneurs who take control of their own destinies. Both sides have some elements of truth and the way this will eventually work out will strongly depend on political choices. In any case the next economy will have a disruptive impact on middle and lower class jobs, as is already going on in the USA and Europe. Great transitions in the past, like in the 19th century, have led to growing social inequality. This implies that we need to reinvent the notion of solidarity in order to prevent a societal divide. A new regulatory framework or even a new 'social contract' is needed for the emerging next economy to become an inclusive society. There is no doubt government is obliged to take a leading position in this strongly political debate.



These trends and developments need to be translated into a labour market strategy that connects social and economic policy. For this we propose several measures to be developed:

1. The lower educated deserve better opportunities for learning and work

The lower segment of the labour market has several major problems: job exclusion, job displacement (lower skilled jobs are taken over by better educated people who cannot find jobs in the middle segment) and the insufficient use of lower educated people's talents.

The short-term strategy has to focus on improving the perspectives for the unemployed. It is unlikely that a substantial part of this group will ever be able to find work by their own, which suggests the need for an alternative. For this there seem to be two options: a basic income or so-called participation jobs. Both options have their advantages and drawbacks, but within our region the second option seems to be preferred. There is a track record of similar arrangements in the past (Banenpool, Melkertbanen) and the next participation jobs need to be based on new methods for activating welfare benefits as a means of income supplement, in order to support re-integration towards regular jobs. The region should use the City Deal arrangement with the national government to receive an experimental status for this approach. To stimulate learning, adults should have access to appropriate learning tools for basic skills and digital skills.

For the longer term attempts should be made to incorporate social policy into economic policy, e.g. by making local job creation for the unemployed a requirement for procurement procedures, making arrangements with specific economic sectors ('job carving') or expanding the service sector ('time banking' of the Belgian experiments with the 'service voucher'). Dedicated programs for training on the job, digital skills and other craft-related skills that are expected to be required in the Next Economy also need to be developed , i.e.:

- Education and vocational training based on the approach of talent development
- Increase labour market opportunities in collaboration with the business community, preferably working and learning combined
- Open access to training materials for basic skills and digital skills

2. The middle educated need to work on their development and education

Large parts of many jobs in the middle segment are routine and will fundamentally change or will be replaced by digitalization. This suggests:

- Employability scan for everyone
- Availability of training budgets in order to learn the skills for other work
- Lifelong learning system on a regional scale across and beyond sectors
- An E-portfolio for all young people

3. Attracting new talents

A flourishing and dynamic economy will attract talented people from outside. Cities and regions are competing in setting the most attractive conditions, a.k.a. the war on talent. This calls for a dedicated strategy, which includes all the aspects that make up an attractive city or region. These are the usual location conditions, like proper housing, attractive cultural climate, available jobs and education facilities. Recently the importance of proper elementary education is recognized as one of the key elements in this set of requirements. For this we need to emphasize the importance of:

- Investigating the location conditions for new talents with a closer look to the role of elementary education
- Transparent digital platforms of supply and demand on the labour market

4. Workforce Incubator

Technology enables reordering of work and tasks in radical new ways. This provides an opportunity to create models that tap into the potential of people that are now being considered bystanders of our economy. If we do this smart (and consciously) enough, we can use technology to distribute labour in ways that not only mobilizes our unused capacity but also upgrades the productivity and added value of our professional population as a whole. This requires targeted interventions in both sectors and specific business models, introducing system innovations in our current work processes. We will need (social) entrepreneurs who are able to combine new data technology with new finance structures, who master workflow management and who are also able to operate at street level. We will need traders that build new businesses and breakers that open up systems for them. This can work for the port, care, government and the manufacturing industry.

Short term project

- Establish a Workforce Incubator, with a specific focus on (social) entrepreneurs that use new technology to mobilize our unused workforce.

5. The Sharing Economy Toolbox

In order to stimulate inclusiveness the local government should take the initiative to facilitate common citizens in gaining access to the emerging sharing economy and acquire the ICT, social and entrepreneurial skills that are needed to engage in and benefit from these peer-to-peer platforms, e.g. by setting up a health data cooperative platform My Data Our Health (as described in Smart Digital Delta) or experiment with Prosumer Sharing Stations (as described in Entrepreneurial Region).

And perhaps the housekeeping book of ordinary citizens should also be re-examined in view of the sharing economy, addressing the question how the increasing use of spare capacity and performing on-demand tasks through digital platforms and selling resources like waste and surplus energy would balance against the cost of living.

This is a very complex topic and it is obvious that more research and more comprehensive instruments are needed to address the issues the labour market has to deal with in the coming years.

2. Transforming the educational system

A well-organized interaction between education, business and government is an important key to enable people to acquire the skills that are required on the labour market. For this we propose the following actions, which together add up to a breakthrough in the educational system.

1. Accelerating within our schools

New technologies are developing exponentially and require a new skill set, for which innovative education is needed: in subject content, didactics, educational surroundings and the use of technology. As this transition affects both students and teachers, we are going to work on the next skills, the next methods and the next teacher.

Next Skills

Developing high quality and relevant skills; activating skills and supply to the full extend in the labour market; putting skills to use in workplaces and communities.

- Personal skills: digital skills, learning to learn, self-organizing capacity, teamwork, creative & design thinking
- Professional skills: design-thinking; problem solving, co-creation, multi-disciplinary teamwork
- Entrepreneurial skills: spotting opportunities, , innovative mindset, 'Why not' mentality
- New tech and T-shaped professional: commitment to new specializations and liberal, personalized education

Next Methods

- Development of talents and personalized learning based on the needs of students and working practice.
- Pedagogics and teaching methods: education approaches to stimulate students to develop their motivation and their will to learn and achieve success.
- Maker education: digital design learning, new maker education, a challenging learning environment as part of and in addition to education.
- Hybride constructions: the border between education and the workplace is becoming vague.
- Formal and informal learning: not only in school but also in social situations (contextual-, social learning and valorisation of informal learning)
- New technology – is not only a topic but also an instrument in education
- Blended learning and Massive Open Online Courses(MOOCS) – a balance in on – and offline learning; use, self-develop and integrate them into individual curricula.
- Entrepreneurial ecosystems: for example pre-start-up education, hackathons, pressure cookers, battles and innovation labs

Next teacher

- Volume issue: threatened shortage of practical teachers and technically specialized teachers
- Quality issue: from unqualified to qualified, teaching grants, teachers register, professional development and certification
- Investing in new knowledge, skills, attitude and change of role: from knowledge transfer to coaching and supervision and facilitator of learning processes
- Prepare teaching staff to shape the transformation of education, the content as well as the organisation
- Professionals in front of the class: practical experiences and digital didactic skills

Targets up to 2030:

- Innovative learning environments and shared facilities in Living labs & Field labs
- Developing MOOCS and on-line professional education by higher education institutes
- Delivering T-shaped (liberal educated and specialized) professionals, green collar and equipped with 21st century skills
- Task- and labour analyses for designing next economy profiles

Carrier projects 2017-2020:

- Entrepreneurial mindset & skills
- 21st century skills: building an Effective Skills strategy in de metropolitan region
- Regional Academic Expertise Centre for primary, secondary, vocational and higher education

2. Branching out into society

The professional reality is changing so rapidly that connecting education with the labour market is no longer a simple task. Part of the skills that the market is currently looking for did not exist five years ago. The key word is therefore lifelong learning. Retraining, additional training and refresher training are no longer luxuries but essentials. To absorb shifts in the market (overcapacity in sector X, under capacity in sector Y), but also to keep skills within sectors up to date. Accordingly, education needs to position itself as a social partner. The region and its inhabitants, activities and problems become an educational environment in itself. Teaching is done in the neighborhood, in companies and in maker spaces; education's input is needed for the great challenges in the region.

Lifelong learning

- Retraining, additional training, refresher training and re-integration: public & private collaboration in education and employment market issues
- Connection issues: between education and the employment market, including working while you learn and learning while you work
- Basic skills for the lower educated and digital skills for all adults

Active participation

- Resilient City Campus: contribute to new, bottom-up learning environments including through social entrepreneurship and 'neighborhood learning'.
- Major societal challenges: articulation of demand for senior secondary vocational education and higher professional education as social innovation partners.

Targets up to 2030:

- Developing flexible, short modules for additional, re- and post education
- Designing and developing community based education ecosystems, e.g. in collaboration with maker movement
- Constructing a learn-work ecosystem 'at the speed of business'
- Implementing flexible courses per sector, focusing on new skills and entrepreneurship

Carrier projects:

- Life Long learning programs
- Digital skills for the lower educated
- Resilient City Campus: educational ecosystem within the community
- Social innovation and inclusion: West Practice Rotterdam

3. Teaming up with businesses

Students are best prepared for the real world by working in it; companies can benefit from the design and innovation power of students. For this reason, there is much to be gained in intensive collaborations between companies and educational institutes. There are various models:

- Citylabs, Techlabs & Fablabs: Research, design and manufacturing: companies and students innovate together, design proofs of concepts, do prototyping, produce one-offs
- Centers of Expertise & Centers for Innovative Craftsmanship: cross-overs with businesses in close-related working fields
- Incubators & Accelerators: support the step from being a student or researcher to being an entrepreneur (e.g. YES!Delft, Metropolitan Startup Lab, CIC, ECE, World Startup Factory, iMPACT booster)
- Business Campuses & Field labs: shared facilities and applied research institutes.
- Communities of Practice: experimenting with new concepts and business models, and learning from them

Targets up to 2030:

- Initiating and funding (international) cross-over projects in game changing technologies and scalable implementations
- Engage students for innovation, new design, products & services
- Initiating and facilitating practical research in the context of Field labs
- Instigating incubators, accelerators and valorization institutes in collaboration with region
- Organizing innovation Labs and innovation teams (agile and scrums)
- Setting up shared facilities

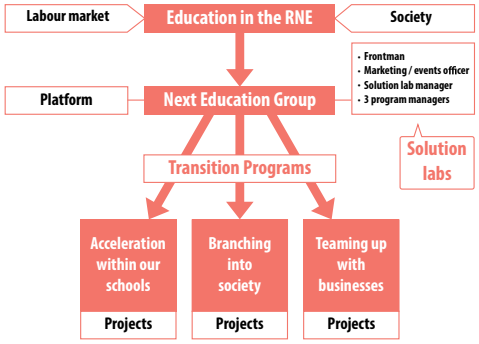
Carrier projects:

- Establishing a regional Campus network of eight campuses with (sector specific) field labs, incubators, accelerators and valorization institutes
- Development learning & working programs based on the Co-Op Programs in co-creation with business corporations
- Realization of Big Data Retail Centre, in order to create open data for consumers and business partners in the retail sector and presentation on relevant platforms.

3. System Breakthrough

The Next Education Group

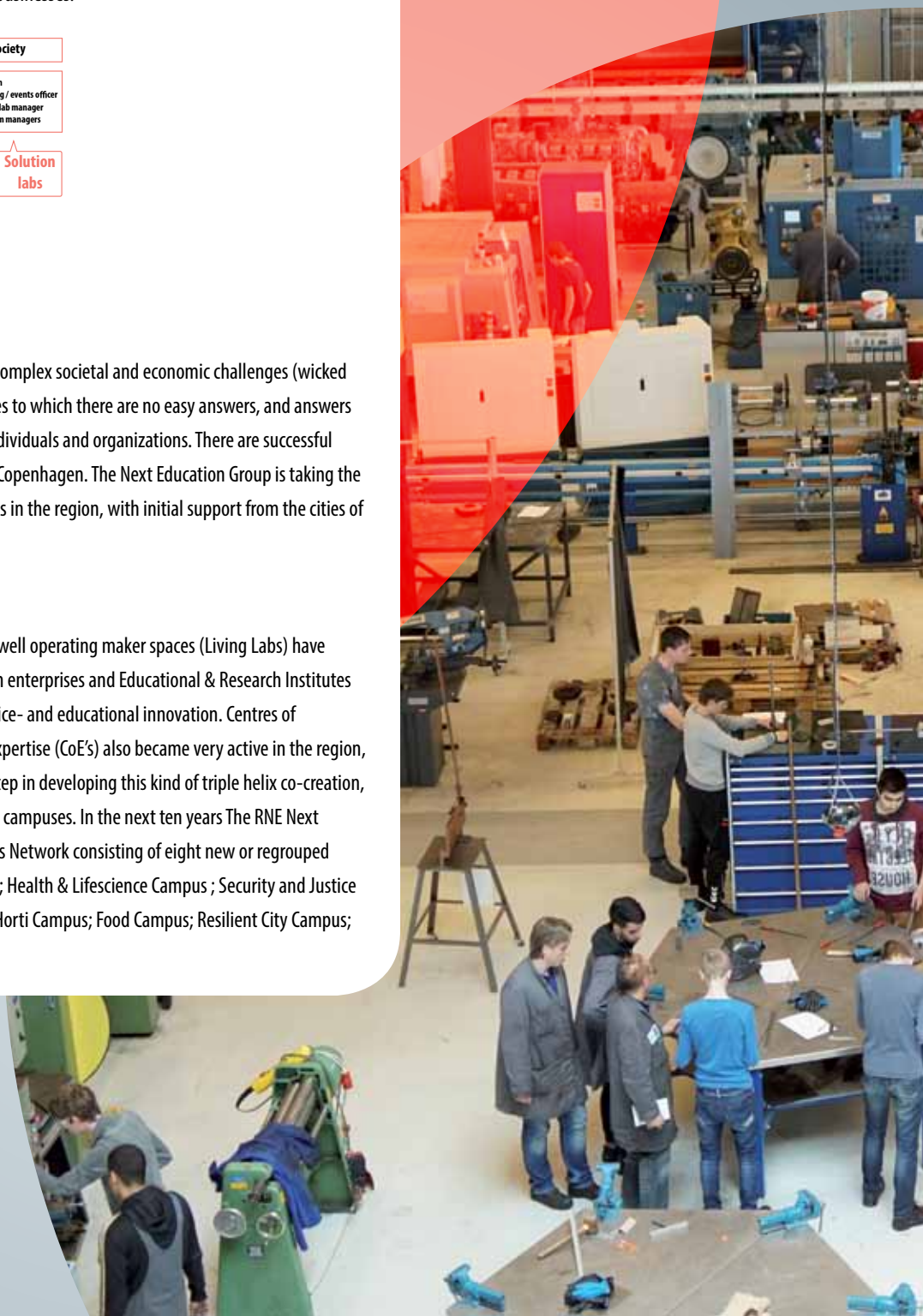
A system breakthrough will be made by the initiative of 10 vocational education institutes to team up on a single platform. They are prepared to share their current projects, activities, campuses, etc. and jointly launch new projects within the context of the RNE. The group's mission is to turn the challenges and wicked problems of the next economy into initiatives in and with education. In terms of physical infrastructure and an organizational approach, this Group will build on the Centers of Expertise (CoEs) and Centers for Innovative Craftsmanship (CIVs) that have been set up by the Universities of Applied Science and the Regional Vocational Education/Training Centers (ROCs). The Next Education Group will develop into a network organization to which Colleges, ROCs and businesses in the region will contribute in kind and in cash to the creation of programs that will lead to the 'next professional', according to the three dedicated actions: accelerating within our schools, branching out into society and teaming up with businesses.



A 'Solution Lab' is a team committed to tackling complex societal and economic challenges (wicked problems) that require system change. Challenges to which there are no easy answers, and answers that demand action from different disciplines, individuals and organizations. There are successful examples of this model in cities like Toronto and Copenhagen. The Next Education Group is taking the initiative to set up the first pilots for Solution Labs in the region, with initial support from the cities of Rotterdam and The Hague.

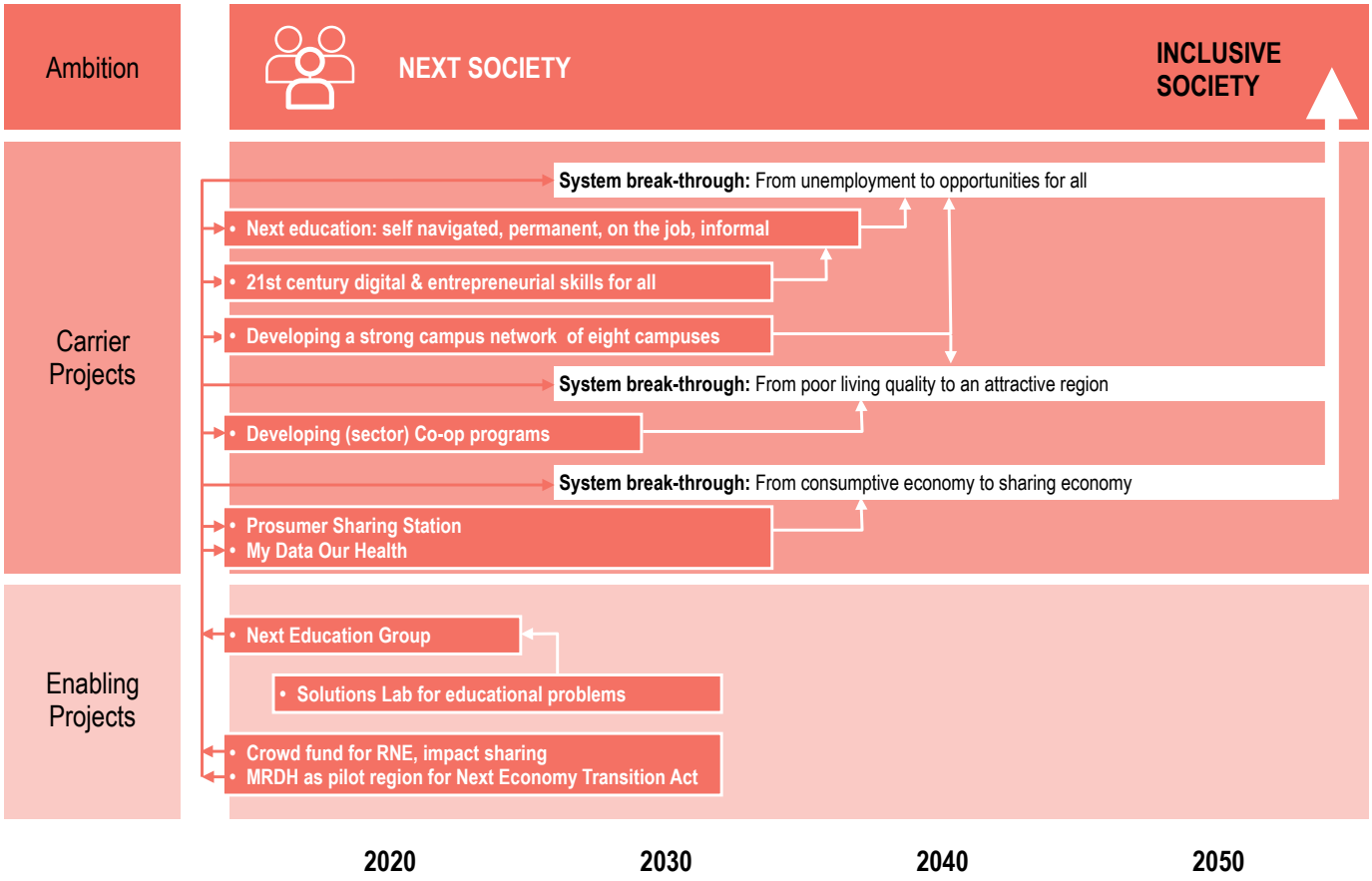
The Regional RNE Campus Network

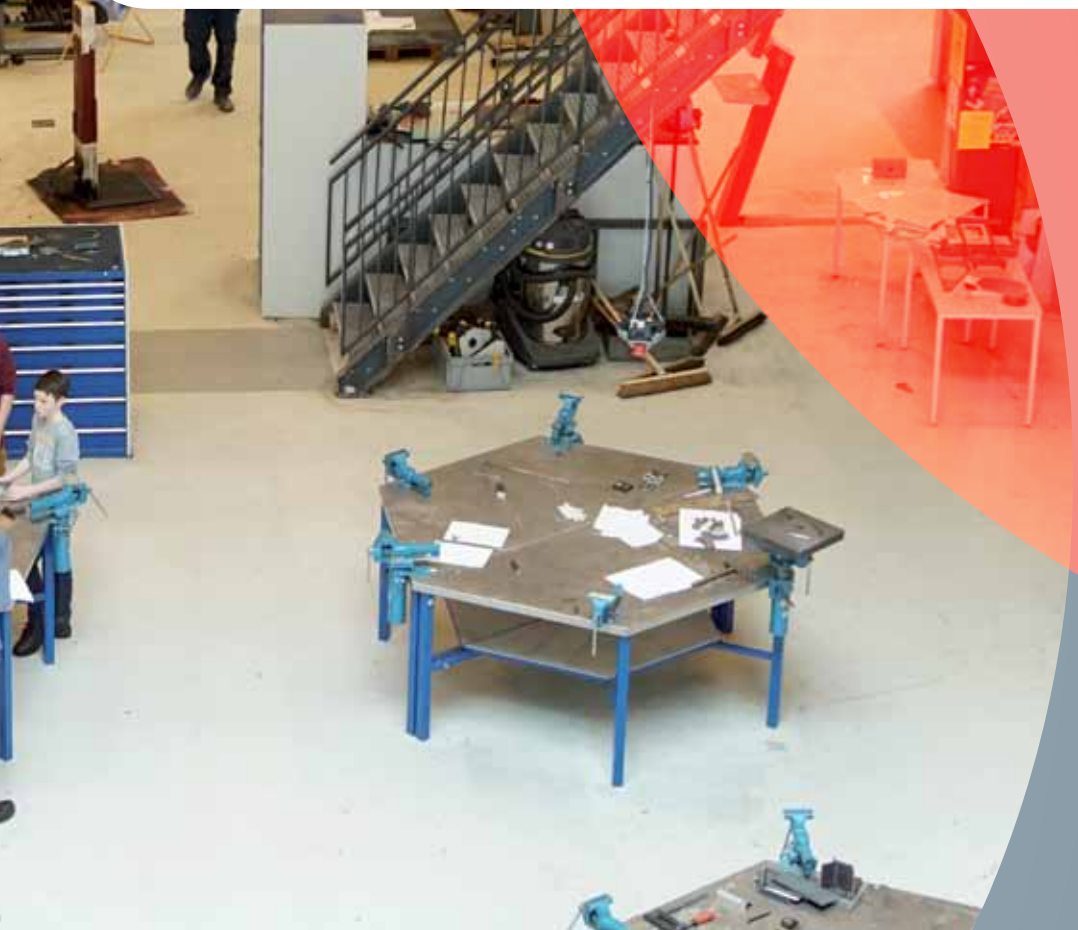
Over the past twenty years a lot of inspiring and well operating maker spaces (Living Labs) have been developed in the region. Small and medium enterprises and Educational & Research Institutes worked and still work together on product-, service- and educational innovation. Centres of Innovative Craftmanship (CiV"s) and Centres of Expertise (CoE's) also became very active in the region, working on the same objective. To make a next step in developing this kind of triple helix co-creation, we aim to set up a RNE regional network of eight campuses. In the next ten years The RNE Next Education Group wants to realize the RNE Campus Network consisting of eight new or regrouped campuses: Maritime and Smart Industry Campus; Health & Lifescience Campus ; Security and Justice Campus; High & Smart Tech Campus; Greenport Horti Campus; Food Campus; Resilient City Campus; Entrepreneurial Campus.



4. Synthesis

The systemic approach of the Next Society is summarized in the figure below, which illustrates the relationships between the various enabling and carrier projects and how they contribute over time to the overall ambition of reaching an inclusive society.





Next Steps

1. Systemic approach

The RNE summary is a concise document, based on much more elaborate papers on each of the transition pathways, reflecting months of collaborative hard work with many participants from government, knowledge institutes and business community, guided by Jeremy Rifkin and his TIR CG team. There is a large TIR CG white paper report available for reference, containing a multitude of ideas and suggestions, many of which are already found in the RNE, while many other ideas will provide inspiration for further project initiatives in the future.

The collaborative work of the regional teams and TIR CG has resulted in an integrated systemic approach [Figure 1], in which the five transition pathways address the specific challenges and requirements of our region:

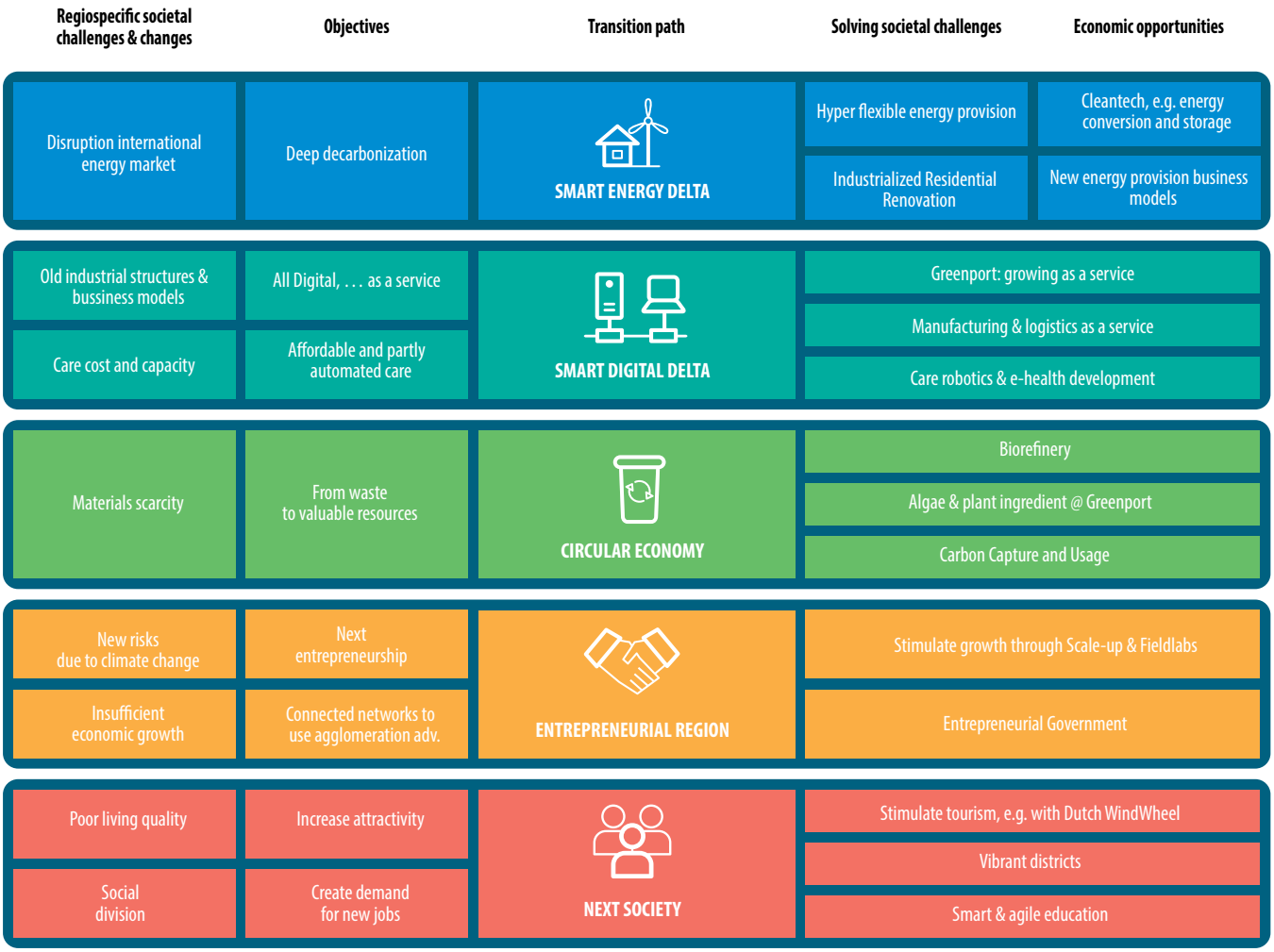


Figure 1

The various objectives have been translated to enabling and carrier projects in each of the five pathways that collectively will contribute to the system breakthroughs that are required to help solve the societal challenges and seize upon the economic opportunities. The systemic approach aims to keep track of the content and sequential relations between short term projects, enabling projects and carrier projects within each pathway, thereby accelerating and maximizing the impact in their deployment.

While the five pathways cannot be seen separately in view of the overall economic transition, they are presented as distinctive fields of work and might otherwise run the risk of evolving into separate programs with their own projects. The deployment of the RNE will therefore provide a flexible, organic working method in which the cross-over relations between the five pathways will be held in check. The most obvious cross-over relations have been identified in the figure below, but this will be continuously updated as the deployment of the RNE unfolds.

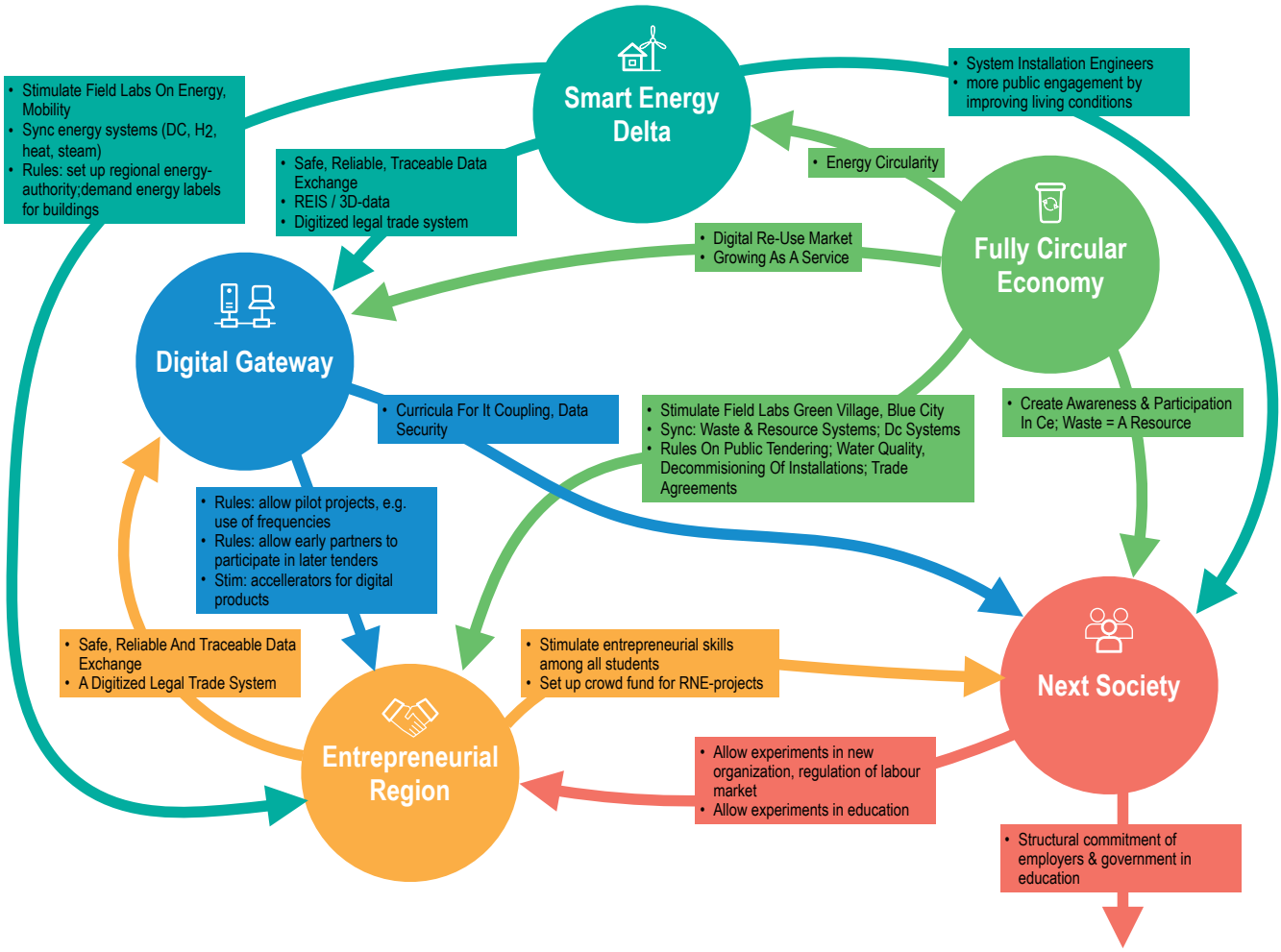


Figure 2

2. Targets and indicators

Figures 3 and 4 show the declining GDP and employment figures within the Rotterdam The Hague region, lagging behind most other regions in Europe. This underscores the urgent need for the actions that are proposed in the RNE.

Annual growth of Gross Regional Product per capita (average 2009-2015)

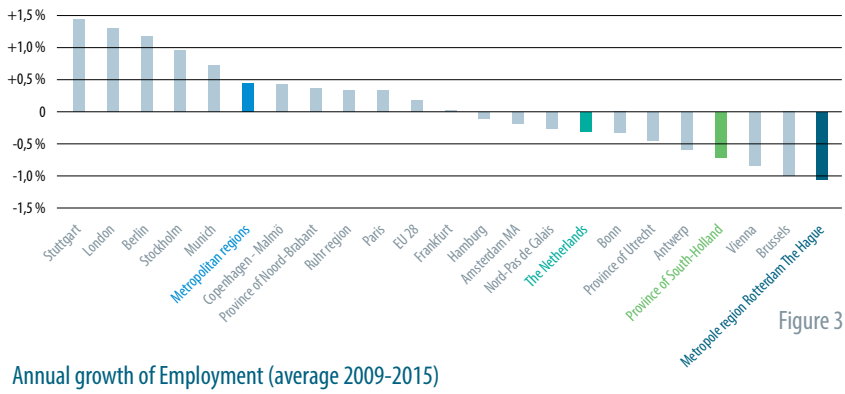


Figure 3

Annual growth of Employment (average 2009-2015)

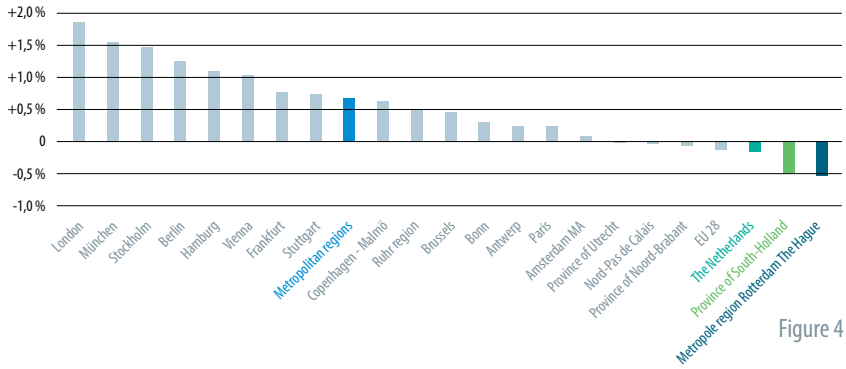


Figure 4

For a more detailed analysis of targets & indicators there is a separate appendix available by NEO Observatory on www.mrdh.nl/rne.

3. Resilience

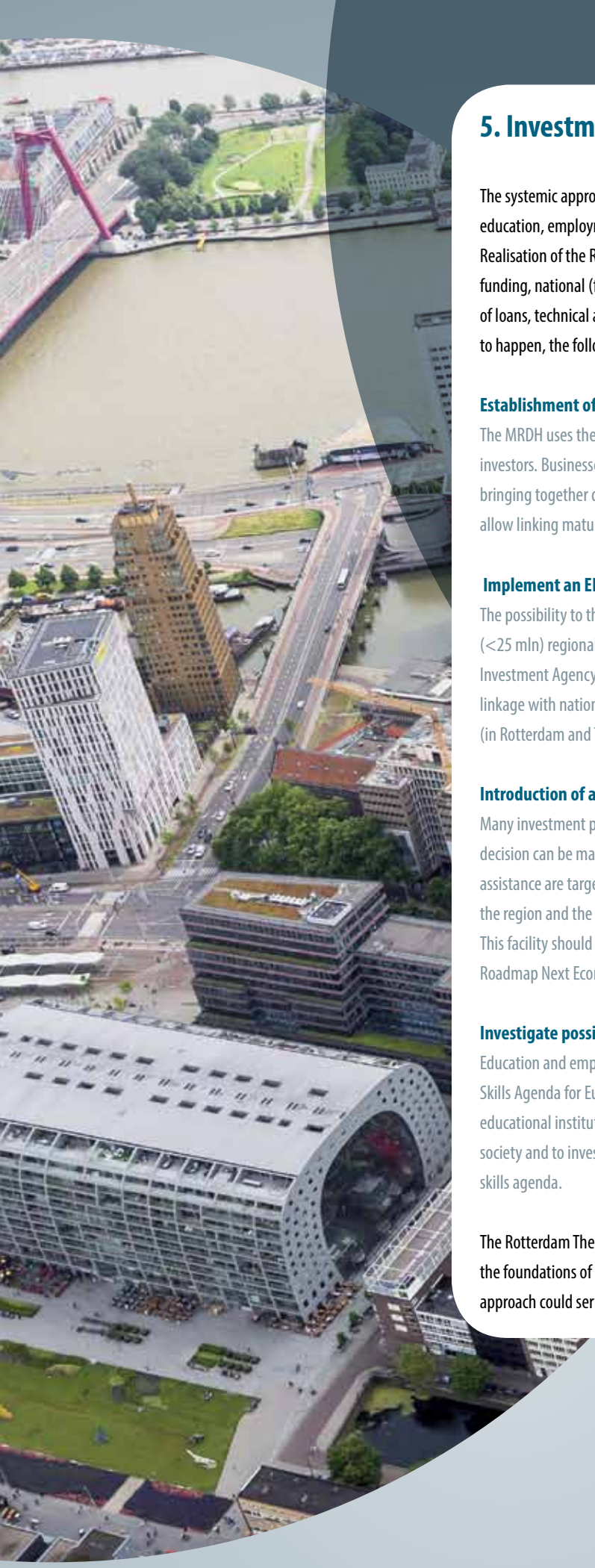
There are many geopolitical changes that influence global economic trends. One of the most important ones is the shift of economic and political power towards China, adding up to what is often described as the emergence of a new world order. While this may have great opportunities, e.g. the 'One Belt, One Road' concept for global trade, it may also change the cultural climate, with implications for institutions like the World Bank and The Hague Court of Justice, for global trade and investment agreements like TTIP, for the availability of energy and key mineral resources, for mass migration and ultimately for western values like freedom and democracy and global safety (see separate appendix (www.mrdh.nl/rne) "Tien geopolitieke ontwikkelingen die de MRDH tot aanpassing dwingen", by Rob de Wijk (HCSS).

With so many current and upcoming changes within the next decades it is of the utmost importance that our region becomes more resilient. Therefore the RNE process has to be organized in such a way that it contributes to the overall resilience of the region and its actors. The seven aspects central to this aim will be inherent qualities in every part of the RNE process: reflectiveness, resourcefulness, robustness, redundancy, flexibility, inclusiveness and integrativeness. All processes and projects will regularly be 'scanned' for their level of resilience. Applying this methodology to the economic system of the Rotterdam The Hague region raises the question how to define a resilient economy. This can be described as an economy which has the capacity to adequately react to particular shocks, long term stresses, small and large transitions and to reshape and adapt itself with qualities that surpass the previous ones (see separate appendix (www.mrdh.nl/rne) "Towards a resilience next economy - Applying the Resilience Lens and Resilience goals to the Roadmap Next Economy MRDH").

4. Governance Strategy

The projects that will be deployed under the RNE umbrella have to be supported by the private business community, the knowledge community and the public sector (the triple helix), as these projects need to contribute to a variety of objectives, like new business creation, job creation, contribution to the regional business & innovation climate and societal benefits. This requires a governance structure that reflects the public/private partnerships that need to be established, making optimal use of the existing business and scientific networks that have already contributed to the collaborative effort that has resulted in the RNE. The business and knowledge communities will lead the deployment, while government will play an important role as facilitator, launching customer and demanding client.

To support and facilitate the RNE process in the next 1 – 1.5 years, a small organization will be set up under the aegis of the preferred triple helix governance platform. The main tasks are to facilitate the RNE implementation based on the systemic approach which implies flexibility and adaptability, widening the international collaboration with other regions, planning & control, monitoring, validating project proposals, stimulating cross sectoral collaboration, widening the regional coalition of the willing & able, funding and communication (including expanding awareness and community engagement). This will be established in close collaboration with the National government, the provincie of Zuid-Holland, the MRDH and government agencies like InnovationQuarter. This temporary organization will operate in anticipation of a more definitive structural embedding in the region, which should be the joint decision of all triple helix partners involved in the RNE deployment.



5. Investment strategy

The systemic approach ensures that the interconnectedness of global trends and their effects on education, employment, innovation and energy/climate in the region are taken into account. Realisation of the RNE strategy and deployment requires synergy between European policies and funding, national (financial) instruments, regional cooperation and private investments. The right mix of loans, technical assistance, guarantees and grants is needed to bring projects to the market. For this to happen, the following actions must be pursued:

Establishment of a regional investment platform

The MRDH uses the Roadmap Next Economy to make the region more visible to (international) investors. Businesses and investors would benefit from an easily accessible investment platform bringing together different types of funding. Setting up such a Regional Investment Platform will allow linking mature medium (>25 mln) to large scale (>100mln) projects to potential investors.

Implement an EIB Framework Loan for the region

The possibility to the EIB Framework Loan Instrument would enable funding of a range of smaller (<25 mln) regional projects within the RNE context. Close cooperation with the Netherlands Investment Agency for EFSI (a possible precursor to a Dutch national promotional bank) ensures linkage with national (public) banks and institutional investors. Existing JESSICA funds in the region (in Rotterdam and The Hague) are logical prospective lenders within such a framework loan.

Introduction of a (novel) facility for Programme Development Assistance

Many investment projects face specific barriers that need to be overcome before a final investment decision can be made. Existing EU facilities for technical assistance and project development assistance are targeted at individual projects. What is needed for the RNE is an agreement between the region and the European Commission on a (novel) facility for Programme Development Assistance. This facility should cover the broad themes (e.g. energy, climate, bio based, circularity) of the Roadmap Next Economy.

Investigate possibilities for funding of transforming the educational system

Education and employment in the context of the Roadmap Next Economy is strongly linked to the new Skills Agenda for Europe. Additional funding is required to drive the required change in education by educational institutes. Adequate funding allows them to team up with businesses, branch out into society and to invest in the skills, methods and teachers that are necessary to implement the new skills agenda.

The Rotterdam The Hauge region has the unique opportunity to rebuild the fabric of the region on the foundations of the next economy with all relevant partners on board. In the next few years this approach could serve as a model for European and perhaps even global regions.

6. International context

Together with the region Hauts-de-France, MRDH is being endorsed by EU vice-president Maroš Šefčovič, responsible for the Digital Europa agenda, as the role model for the deployment of the EU's next economy objectives in all member states. The objective of the EU is to stimulate and expand the cross-regional collaboration between the regions in Europe that are actively engaged in the transition to the next economy. This context will provide our partners with the opportunity to present their solutions elsewhere in Europe. It will also give our region a frontrunner position in inserting new funding and financing strategies. And finally it will provide opportunities for the business partners in our region to expand their market with proven concepts realized in the RNE deployment.

7. Communication strategy

The RNE will be here for the long haul and will require a consistent and long term engagement from as many people as possible. Not just professional partners involved in the deployment of projects, but most of all the citizens in our region that should be able to participate in the roadmap and take benefit from its impact. And perhaps this impact will even stretch beyond our region, as the MRDH has been singled out by the EU as one of the leading regions in Europe in making the transition to the next economy.

The next economy is all about digital connectivity, therefore we aim to launch a digital RNE Platform that will cater for people involved or interested in the roadmap: professional teaming up to work together on projects and business cases, young entrepreneurs looking for access to networks involved in next economy innovations, social entrepreneurs looking for way to start initiatives that can have social impact in our communities and improve the livelihood of ordinary people and more. In short a platform for all the people who want to make the most of the future: the RNE community.

Synthesis

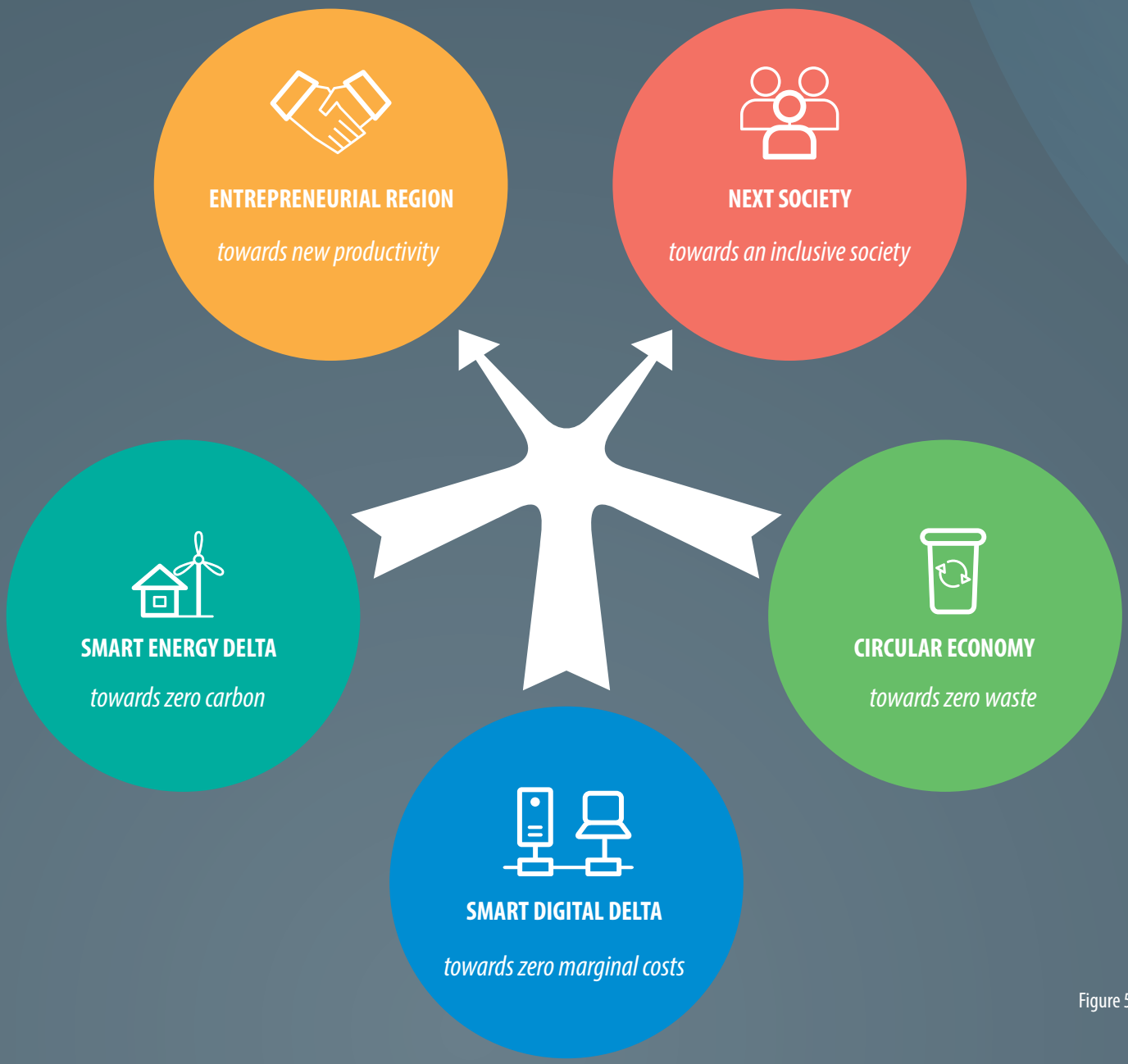


Figure 5

The next economy provides a unique challenge and opportunity for the metropolitan region. In this roadmap we have addressed three key questions. The first question is whether the Rotterdam The Hague region is ready for the next economy? The answer is both yes and no. The strengths of our region are our assets, the physical, economic, institutional, and human capital, which are outstanding. We have the people, knowledge, institutes, companies and infrastructure, all of high quality in one region. We need, however, to use this capital in a much more effective manner, creating much more growth, innovation and jobs. Another challenge is the fossil heritage of the region. For us the transition to a fossil-free economy is a break with our history, more than in other European regions. This marks a formidable challenge, comparable with the rebuilding process after the Second World War.

Main drivers for the region, the Mainport & Greenport, still rooted in the fossil economy, are heavily investing in radical innovation, gradually transforming into main drivers for the next economy.

The second key question is what do we earn our money with? We have explored five transition pathways to the next economy that potentially contribute greatly to growth, innovation and to a new economic structure in the region. The coherence amongst the transition pathways is obvious, see [Figure 5]. The first three (digital, energy, circular) represent the technological infrastructure ('hardware') for the next economy. The last two (entrepreneurial, next society) represent the social infrastructure ('software').

The development of the software (people, skills, networks, etc.) is at least as important as the hardware (technology, R&D, IT, etc.): 75% of the success of innovation is due to social innovation rather than technological innovation.

To realize the most sophisticated hardware and software for the next economy, a huge investment is needed. A rough estimate is that about 50 billion euros is needed in the next decades (until 2050). These investments will lead to a highly competitive region, a European top region in terms of productivity, innovation, inclusive growth, and job creation, with a high quality of life. The estimated amount of jobs created under these conditions is about 125.000 in the short term, until 2025, and about 250.000 in the long term, until 2050 (see appendix by NEO Observatory for a more detailed analysis on www.mrdh.nl/rne). These figures exclude the substitution effects of jobs in the traditional economy that could be lost in the transition. Also excluded are jobs created from growing tourism, business services and from fast developing niche markets as climate and sea level rise adaptation.

The final key question is how can we implement and safeguard this roadmap? This demands a smart, systemic approach. A whole palette of projects is part of the roadmap, systemically ordered into enabling projects and carrier projects and a few icon projects, for which concrete business cases will be developed and implemented. This systemic approach requires an evolutionary form of planning: combining long-term goals with a medium-term strategy and short-term actions. This type of planning needs to be mimicked in an evolutionary governance structure for the roadmap, leading the roadmap in an organic manner for many years without being institutionalized.

The roadmap is not just a report, study, assessment, or blueprint, it is a living document, embodying a living, evolutionary process. It will be implemented step-by-step but not in a blueprint manner and will be continuously adjusted when new insights appear.

Memorizing the various impulses mention ed in the introduction, the financial impulses are most obvious, as denoted above. We need a substantive amount of money to build up an entirely different digital, energy, circular infrastructure. This is a prerequisite for competing with other European regions in the next economy and adequate financial impulses will give our region temporary economic advantage. However, being faster doesn't imply a structural difference, but being smarter and more strategic does make a structural difference. Therefore the other impulses are of utmost importance. Smart legal impulses can remove the final regulatory barriers for the next economy. The metropolitan region needs to become a pilot region for a new regulatory framework that stimulates radical innovation. This can be arranged by a specific regulatory arrangement, 'the MRDH Pact', eventually culminating in a Next Economy Transition Act. Institutional impulses are key for exploiting the potential of our region. In particular connecting traditional economic activities and companies to emerging next economy activities from start-ups and scale-ups, is of vital importance. The new institutional grid for the next economy demands connectors, pending between the traditional and emerging economy. And perhaps the greatest challenge is the mental impulse needed. We need to think and act at a higher scale level, viewing our region as an organic entity, a city in itself, rather than a collection of municipalities. It also demands a cultural shift, towards a more conducive, risk-accepting culture, stimulating entrepreneurship. We need to work on a big, imaginative story for the metropolitan region, one that can be split up into dozens of small narratives linked to practical projects. A blend of top-down and bottom-up. Transitions are always the result of human activities, frontrunners and change agents who pave the way for a larger group of people. It often starts at a bottom-up level, and if successful, accompanied by a top-down strategic governance strategy. This demands a long breath, consistent leadership, and mobilization of all the available capital in our region. We have a mission and a great plan. Making it happen is the ultimate challenge we are facing.

Appendix 2: List of partners

We are thankful to the following persons who contributed to this Roadmap Next Economy. This list has been compiled with the utmost care, however we cannot completely rule out the possibility that some people who have made a contribution are not mentioned on this list. For this we offer our apologies.

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