



ROTTERDAM. MAKE IoT HAPPEN.

The need for a transition of
Rotterdam port and city
towards the
Third Industrial Revolution.

Colophon

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The need for a transition of Rotterdam port and city towards the Third Industrial Revolution.

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Foreword

“That Rifkin is nuts” says Niek Stam, National Secretary Dockers Section at FNV Bondgenoten, a ports labor union, in newspaper de Volkskrant of October 7th: “... he should go working in the Efteling.” (a fairytale theme park) “An overrated capitalist guru” was another qualification of Rifkin.

This defensive reaction on the news that Jeremy Rifkin and his team were hired by the Metropole Region Rotterdam-The Hague is obvious, although a bit of a Pavlovian response. In his latest book, *The Zero Marginal Cost Society*, Rifkin foresees ‘the eclipse of capitalism’, the end of capitalism as we know it and he advocates a ‘Neo-Ghandian world—so, not very much ‘a capitalist guru’. Also in his latest book, he foresees a dramatic decreasing employment in manufacturing and logistics—two of the cornerstones of the port of Rotterdam—and of port labor unions. He sees a transition towards The Third Industrial Revolution, the coming together of the Communications Internet with the Energy and Logistics internet in a seamless intelligent infrastructure: the Internet of Things (IoT). But the port of Rotterdam is the champion of The Second Industrial Revolution, a revolution based on the discovery of oil, the invention of the internal combustion engine—the automobile became the ‘engine’ of the Second Industrial Revolution—and the introduction of the telephone. An economy based on oil belongs to the past. July 2008 was the moment were The Second Industrial Revolution peaked and crashed, with an oil price of \$147 a barrel, a crash directly related to the beginning of the Great Recession, according to Rifkin.

The Second Industrial Revolution was very important for the port of Rotterdam. A giant petrochemical complex emerged, closely related to a world scale refining complex. The handling of the raw materials of the Second Industrial Revolution—coal, ore, oil, oil products, chemicals—made the Port of Rotterdam the most important port in the world in the 1962-2003 period, very important for the Rotterdam identity. Also, for a very short period, Rotterdam was the largest container port in the world and still is by far the largest container port in Europe.

The port therefore is very important for the city of Rotterdam: a no-nonsense workers city. The city of Rotterdam however, showed a renaissance during the last years. Traditionally, the mayor of Rotterdam complained that Rotterdam headed the wrong lists: the poorest city of the Netherlands, the city with the lowest-schooled population, the highest divorce rate or the most *cafeterias* per 100.000 inhabitants in the Netherlands. In the last two years Rotterdam headed the right lists in papers, magazines and guides as The New York Times, Wallpaper, the Rough Guide or the Lonely Planet as a place not to miss, with icons like the Market Hall, the architecture of Rem Koolhaas or the thriving culinary scene.

Based on the continued strong dependence of the port of Rotterdam on oil and coal, on the continued production of large CO₂-emissions and other negative externalities related to the port, on the lack of agglomeration forces in the Rotterdam economy, on a mere mediocre economic track record, combined with a very active policy of important competitors of the port of Rotterdam towards the Internet of Things, such as the port of Hamburg, we very much endorse the need for a transition towards the Next Economy.

This pre-study presents a state of the art of the port and city of Rotterdam—so *not yet* of the larger Metropole region Rotterdam-The Hague—, the underlying economic reality of both the port and the city and of some of the problems and opportunities facing both the port and the city. The increased synergy between port and city is one of the most important opportunities for the future development of the Rotterdam region. This report also presents the reactions of Rotterdam stakeholders—both from the port and the city and from big traditional firms as well as startups—on the need for a ‘Rifkin-style’ transition, together with some do’s and don’ts.

The report therefore presents a broad overview of important issues related to the port and the city of Rotterdam, which we very much hope are of use for Jeremy Rifkin and his team!

Reading guide

1. *Introduction: Sense of Urgency*

Provides a basic analysis of The Third Industrial Revolution (TIR), the Internet of Things (IoT) & the Zero Marginal Cost Society (MCO). This chapter creates a sense of urgency for Rotterdam. The sense of urgency for future wealth and wellbeing and economic structure of the port and city of Rotterdam resulting from the analysis of Rifkin is key.

2. *The port of Rotterdam*

This chapter provides an analysis of the port of Rotterdam in 2015. It addresses areas of growth and of decline, facts and figures, strong points/weak points. This chapter is based on four sub-clusters of the port: (1) chemical, oil and process industries, (2) container handling and logistics service providers, (3) construction and the shipbuilding industry and (4) city-related employment: advanced port-related services. It is not a complete overview of the port, but points at current issues.

3. *The city of Rotterdam*

An analysis of the city of Rotterdam in 2015. The city has gained a new momentum and a strong feeling of self-confidence because of the recognition of outsiders (Wallpaper, NY Times, Lonely Planet etc.) But is this situation based on an underlying analysis of the urban economy? This chapter provides this analysis of the underlying economic dynamics of the city of Rotterdam.

4. *Port city synergies*

What are synergies between the port and the city? The chapter gives insight into the current (lack of) synergies but also provides the potential increase of synergies by stimulating crossovers and addressing the issue of lacking agglomeration economies of the regional economy.

5. *Vision on the Next Economy by Rotterdam stakeholders*

What is the impact of the Third Industrial Revolution for the Metropole Region Rotterdam-The Hague in 2040, and especially for the port and city of Rotterdam? This is the dominant question that will be answered in this chapter. The chapter is based on three workshops that took place in September 2015. In each of these workshops a distinctive group of experts has been invited. The goal of these workshops was to formulate a vision by *Rotterdam* stakeholders on priorities for the Next Economy.

6. *The impact of the Zero Marginal Cost society and Third Industrial Revolution on two scenarios*

This chapter presents an analysis of two scenarios, aimed at the main concepts in the work of Jeremy Rifkin. These scenarios are called 'Hydrogen Hub' and 'Makers City'. The scenarios have a different effect on the Rotterdam region and on the rest of the Netherlands, measured by value added and employment.

7. *10 actions for Rotterdam towards the Next Economy*

Based on the three workshops, the scenario analysis capturing the analysis of Rifkin and on the vision of the researchers, 10 clear, concrete actions are presented for the city and port of Rotterdam in the desired transition towards the Next Economy.

10 Policy actions bringing the Greater Rotterdam Region into the Next Economy

Introduction: a Rotterdam transition

This report has three important goals. First, it presents background information on the port and city of Rotterdam—and in particular on their relation and on synergies and crossovers between port and city. Second, it presents the ideas and visions of Rotterdam stakeholders on a transition of Rotterdam—some important sensitivities are provided. Third, it presents suggestions for 10 policy actions, considered of vital importance for executing the desired transition towards the Next Economy.

These 10 policy actions are the most important result of the project executed. Therefore, they are presented at the start of the report. In chapter 7 an extended version of these 10 actions is presented.

1. Involve the citizens of the Metropole Region in the transition to the Next Economy.

Involve citizens of the region and develop trust and accessibility. Make the citizens of the region a starting point of the transition. Stakeholder management is crucial for involvement in the transition process. Experiments with stakeholders are well suited for creating involvement—develop 3D-tech shops and -printerettes as demo's in 3D-clubs. These 3D-clubs can act as predecessor of cooperative common to develop skills and experience. Develop the technology of the built environment as mini power stations further in testing areas together with real estate developers and housing unions. Initiate projects to stimulate community involvement.

Stimulate community building in the port and city and encourage initiatives in community building. Stimulate the impact of prosumers for port and city and try to develop an attractive approach to facilitate prosumers. Stimulating access to new technology might increase the involvement of prosumers. This access to new technology should start at the primary-school level. Start by investigating what the Rotterdam citizens really need and are demanding for a transition towards the prosumer role.

2. The local governments must show active commitment and participation

Be a source of inspiration as a government by giving the right examples. Start as government by making use of solar cells on office buildings and start by making the town halls of different municipalities involved energy neutral.

The city is also very well suited to act as an independent and neutral party to facilitate co-operation for the sharing of information between different parties and the storage of information. In addition, the city government has a role of matchmaking and brokering between different parties to search for solutions, acceptable for all stakeholders.

3. Development of skills needed for the Next Economy

Encourage children at primary school level to choose for IT- and technical education and bring them into contact with certain basic software skills. Rotterdam is globally a sign-board for maritime-technical design and construction. This is not acknowledged at the moment and should become an important issue in labor-market initiatives.

Certain crucial skills are missing in the Metropole Region at the moment, such as software engineers and IT-professionals. This is a potential problem

for the development of the Third Industrial Revolution. ‘Learning capacity’ should be improved. New tools and technologies are available and should be introduced on Rotterdam schools, such as serious gaming and smart-IT platforms for co-operation and exchanging ideas. Business Universities (HBO’s) in particular should be part of this process. In general, the connection between education and the business community should be improved—in particular for SME’s.

4. Characteristics Metropole Region are a starting point for transition

Rotterdam is a leading energy, industrial and logistics port of the Second Industrial Revolution. This means that a transition towards a Third Industrial revolution is not easy and will demand a serious effort because of path-dependency and lock-in effects. Involve leader firms in the Metropole Region at the start of the process. Big ‘leader firms’ have much power to be able to change, have often the right mindset and usually manage large parts of supply chains. The port of Rotterdam is a producer and consumer of large amounts of energy. It is an attractive location to start experiments as a flexible energy hub to match peaks and lows in energy supply of wind and solar capacity.

5. Stimulate entrepreneurship and startups for promising segments

The creation of new business is important for realizing goals like diversifying the economy. Stimulate entrepreneurship and start-ups actively by increasing efforts related to breeding spaces (like Merwede-Vierhaven).

6. Pay special attention to SME’s

SME’s often lack time and funding to be part of economic development and transition initiatives, together with other important structural problems like lacking successors, ageing of the workforce and a critical need for qualified personnel. However, they are a very important part of the regional economy. Special attention should be given to a program to include them in the transition processes.

7. Stimulate linkages and crossovers between port and city

Increase the diversification of the regional economy. Stimulating crossovers between different segments in the port and city and between the port and city is an important means for diversification. The link between the port and the city is very important: the interconnectedness between the port and city is of vital importance for the creation of an attractive location of doing business for the advanced service providers, IT-firms or commodity traders. This demands a comprehensive approach going beyond issues like cheap housing or office development. The IoT is a global phenomenon and can happen anywhere in the world. Why should it happen in Rotterdam in particular? This demands the right combination of different assets needed: IT-infrastructure, human capital, port/city links et cetera.

8. Regional branding in accordance with the desired transition

Increasing the strength of the brand ‘Rotterdam’ is a priority, especially aimed at attracting foreign direct investment and according to new priorities as a result of the transition trajectory towards the Next Economy. “Geen woorden maar data” is an attractive slogan.

9. Governance adapted to desired transition

Search for the right governance structure for the Next Economy. Speed up the regulation process to respond to new opportunities is an important priority. It is very important that market regulation is not a hindrance of the growing energy internet. This needs flexible laws and procedures with respect to environmental effects. This also asks for innovations in regulation.

10. Clear leadership is needed for the transition process

Clear ‘leadership’ is very important in the management of the transition process of the Metropole Region. The articulation of a clear target is very important because this creates momentum and understanding in the local community. Develop a well-known icon for the transition, resulting in a positive image towards the region. Develop a dialogue where alternative visions on the future of the Metropole Region are discussed. This is a Rotterdam transition, not a Rifkin-transition.

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1. The Third Industrial Revolution

1.1 Introduction

In this chapter we present our interpretation of the work of Jeremy Rifkin, in particular his last two books, *The Third Industrial Revolution (TIR)* and *The Marginal Cost Society*. The relevance for the Metropole Region Rotterdam-The Hague and for the port of Rotterdam in particular will be indicated throughout this chapter. In the last part of this chapter, an overview of this report is presented.

The internet is everywhere

Technology changes fast nowadays with a huge impact on society. The rise of wireless internet—as Larry Ellison from the software company Oracle foretold decades ago (‘The internet is everywhere’)—has really occurred and affects our lives extensively. *Airbnb* is just one example of these changes.

The virtue of this new technology is that traditional and known business models become obsolete. Retailing is subject to profound change since consumers buy their goods in web-shops so there is less need to do *analogue* shopping in the inner city, the shopping mall or in the neighborhood. Consumers enjoy the benefit of time savings, but the trade-off is a higher vacancy rate in retail real estate at the cost of the owners and deprived consumer districts. However, the benefit for the consumer goes beyond that. The choice for the consumer is way larger, as well as in variety and geographical scope. Goods could be delivered from everywhere: the real advantage is that supply and demand are matched perfectly. Goods that were very hard to get in former decades are now readily available on the internet. This does not only apply to new goods, but perhaps even more to second hand goods. Goods that are technical sound but lost value for a person, could be resold or handed over to a new consumer for whom it has a value. Internet allows for the match between them. The only limit is the cost of transportation: especially ‘the last mile’.

Physical transport costs do no longer hold for the distribution of information. Since sharing knowledge raises the value, internet contributes to welfare. There are many more examples of this kind. To put it shortly, the economic base of a sector could change in a relatively short time span by the application of new technology. This is known as ‘disruption’ or ‘creative destruction’.

This disruption will without doubt affect Rotterdam, its city and its port. A key element of Rifkin’s analysis and view on the ongoing Third Industrial Revolution is—to put it shortly—‘the end of oil’. Fossil fuels will be substituted by sustainable energy. They will have a large impact on Rotterdam, since a large part of port-related economic activity is related to the trade, transport, storage and refinery of crude oil for European markets—especially for the German hinterland. The same logic applies to logistics and the rise of the ‘Internet of things’ (IoT). The rise of the information age will change the way the transport of goods will be handled.

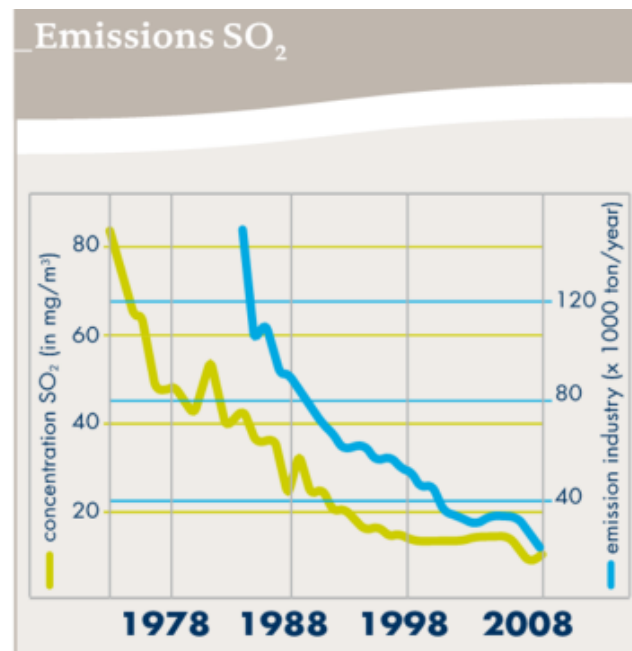
1.2 The 2008 crisis: the end of oil

The credit crunch in 2009 is pivotal in the analysis of Rifkin. Rifkin puts the credit crunch into the development of Postwar America. Abundant oil and net savings enabled the development of an extended road network, extensive suburbanization and extra mobility from the family home to the office. The development of the suburban middle-class is the sociological part of this development. The national government facilitated this framework by constructing a large scale highway network. Essential, however, is that the marginal benefit of the highway network came to a halt. It means that up to a certain point the supply of highways was sufficient. Extra road was no longer contributing to more wealth.

Figure 1. The port of Rotterdam was the largest port in the world in 1962-2004. Oil was at the basis of the spectacular industrial and logistics development of the port. This development however came with strong negative environmental effects.



Figure 2. Emissions SO₂ in the port of Rotterdam, 1978-2008: spectacular improvements achieved in port emissions but coming from very high levels. Source: Port of Rotterdam: Port Compass 2030 (2011)



Rifkin explains that this process of economic development was beneficial for the construction sector (homes and roads), the car industry and the oil companies. The banking sector was facilitating this by providing the needed credit. In the beginning however, there were net savings and a sound financial underpinning. During the nineties this economic development was halted because the financial means of American families were running out. Banks prevented that by relaxing credit constraints resulting into a credit bubble. So the process of building homes and roads and selling cars and fuel went on. It halted when the oil price hit record highs in the mid of 2008: US\$ 147. Record high oil-prices punched a hole in the credit bubble and the credit crunch—before that moment hidden under extra growth based on extra debt—became to be real. Demand fell worldwide.

Oil prices will fluctuate to the extent that they whether put a break on economic growth or be too low for investment in oil exploration. Uncertainty concerning the oil price will have a negative impact on investment; financial risk is too high. Reverse, revenues from oil could be way lower than expected, thereby wreaking havoc in national financial budgets among the oil countries. This contributes to worldwide uncertainty with a negative impact on confidence and business climate.

Rifkin stresses that oil is going to an end due to the volatile prices over time. Business models in the oil industry will not survive, as well as the exploitation of new oilfields. Moreover, the exploitation of nearly depleted oilfields is too risky. Shale oil is an alternative, but only for some ten years. In early 2015, Saudi Arabia changed its strategy from a stable price level to maintaining market share, resulting in the current very low oil price, aimed at putting the US shale gas and oil industry out of business because of the relatively high costs needed for producing shale gas. In the meantime, the crux of Rifkin's view on the 21st century in front of us, alternatives will be developed.

1.3 The Third Industrial Revolution

We are heading towards the Third Industrial Revolution, as Rifkin explains in two subsequent publications. The very idea of TIR is the coincidence between two, initially separated, technological changes. The first is an innovation in

communication and the second is an innovation in energy generation. Rifkin states that if internet and sustainable energy come together, we will face a tremendous change in our economic and social system. Changes in the communication network as well as in energy generation spark industrial revolutions, as they did in the 19th century. The first industrial revolution originated from the invention of the steam engine, based on coal, and gave rise to the train and rail infrastructural network and the steam based printing press. The Second Industrial Revolution was based on oil, the combustion engine, giving rise to the car and road network. It should be notified that inventors first tried to develop the electric car but shifted to the combustion engine. It was accompanied by the discovery of electric power and the dynamo, giving rise to communication networks as telephone, radio and television.

Rifkin sees the internet as the new communication network and solar energy at the core of the upcoming TIR. Internet seems obvious, but is not. The use of internet up to now is rather trivial. Our current understanding of the internet is that it provides information and communication services to the benefit of the consumer, in a way that the web-shop replaces the real shop. The benefit is that the array of choice is way larger than in the common physical shop; goods from all over the world are within reach.

Key in this concept is that the consumer is in charge. The deployment of internet that Rifkin has in mind—technically already being developed and being introduced step by step—is that it both collect information on the consumer and returns information back to the individual consumer fitting into his or her mind and demands. This is not necessarily the result of design, it develops spontaneously. For example, YouTube started as a website to upload and share personal videos and develops into a large video-clip library on an array of music and visual content. However, the choices and preferences of viewers is registered and based on that both return suggestions fitting into that preference. Information alike is used for marketers.

Figure 3: APM Terminals Maasvlakte 2 terminal is based on wind-power generated electricity. The new 2.7 million TEU annual capacity deep-sea facility is claimed to be the world's first terminal to eliminate container handling equipment emissions: an electric-powered personnel vehicle fleet and terminal electricity will be 100% sustainably-sourced.



The APM terminal on Maasvlakte 2— together with the RWG-terminal (visible in the background)—also sets a new global standard in the automation/robotization of crane handling-operations because of remotely operated container cranes.

1.4 Internet of Things (Ashton 1995)

Essential, with respect to the communication internet, is the return of information to the consumer. This phenomenon will develop too with regard to the use of energy, and— as Rifkin stresses—when this happens, the internet develops into the Internet of Things. Everything—cars, e-bikes, containers, washing machines and many more objects—has sensors and an IP address, so that large volumes of information (Big Data) are generated and processed. Because of these reciprocal and complex information flows, Rifkin re-introduces the concept of Internet of Things. Demand and supply of energy could then be better managed by information on consumer behavior and by forecasts on the supply of sustainable energy. The energy internet connects energy grids with information grids. In sum, Rifkin states that the IoT has three main components: the communication, energy and logistic internet. The logistics internet concerns the information on international transport of goods and containers.

The energy internet: solar power

The new energy source will be mainly solar in the TIR, but other sources contribute as well, such as hydrogen, wind-power and biobased gasses and materials. The exploitation of solar energy is still developing; every two years the installed capacity is doubling. Besides, the technology to capture solar energy is still advancing. The doubling of the solar capacity every two years, combined with innovation, leads to dramatic cost reductions and an exponential curve in the supply of this source of energy. This huge supply of electric solar energy will change our energy system in the TIR, Rifkin states. However, capturing solar energy will not be centralized, but decentralized, due to the nature of the supply of sustainable energy.

It is the stock of buildings—houses, real estate and public buildings—capturing and consuming solar energy first. Excess supply on the level of the individual building will be transferred by the power-grid to the demand-side. If aggregated supply is larger than aggregated demand, storage will match differences in supply and demand. The difference between supply and demand of electric power based on solar energy should be matched by hydrogen and biogas. However, further advances of technology to store sustainable energy is key in the development of

the new energy system. In the TIR, all transport will be electric too. The first electric cars are already introduced and the technology is still developing, especially with regard to energy storage technology.

In sum, Rifkin discerns five pillars in the development of the TIR:

1. transition to sustainable energy
2. transformation of buildings to mini energy power units
3. utilization of storage technology based on hydrogen and other technologies
4. energy internet coordinates between supply, storage and demand
5. all transport will be electrical.

1.5 Marginal cost = near zero

Information barriers no longer exist due to IoT in the TIR with dramatic consequences for markets and the economy. Production chains exist because different steps in the production of goods require different specializations, optimal scales and— especially—face different knowledge and experience with regard to prices and uncertainties on the expected demand by consumers and supply of raw materials. The TIR will in general result in more consumer surplus.

No one in the production chain has full information in the 21st century. For example, the advantage of brokers is lost. Their specialization is an information advantage, for example in housing markets, tourism and logistics. The role of housing brokers and travel agencies is limited due to better information to the consumer on the internet. Consumers can organize their holidays themselves. Agencies and brokers have no longer an information monopoly to make (excess) profit, since price differences are visible for everyone. Technological advancement and full information will wipe out any price difference. Middle men, used to reap the benefit of information on differences between the price of the supplier and the price the consumer is willing to pay, will disappear in the TIR. This will have important consequences for the Port of Rotterdam, 15 percent of added value is related to the work of middlemen, like shipping agents and forwarders.

Figure 4: In 2015 two new coal-fueled power plants started their operations in the port of Rotterdam (Eon and GDF Suez). The decision-making behind the construction is a very obscure process including issues like energy-independence and privatization of electricity markets in the Netherlands. However, these new power plants are part of the national ‘energy deal’ in the Netherlands and replace some older and less efficient coal fueled power plants.



Moreover, robots and 3D-printing will replace production of physical goods as we know it from the twentieth century. The optimal scale of production of the company is when marginal revenue equals marginal cost. If marginal cost goes to zero, only after the fixed cost, the marginal revenue is zero too. This insight is more than theoretical. It applies already for information in general and in the music industries; once a record or video-clip is made, sharing it creates value to consumers at zero cost. Internet caused a revolt in this sector already and the development of new business models in this industry is still going on.

The same will happen in the power industries. Once the fixed cost of photo voltaic cells are made in the TIR, the marginal cost of power is nearly zero. It should be stressed that the market production cost is zero indeed, but the exchange value (market value, economic value) might vary significantly. The need for exchange and storage due to difference in supply and demand of solar power will create a market and prices. Negative prices did occur already. Basically, energy will be free in the future because the price of solar cells is still decreasing because of technological innovation.

Collaborative commons

The manufacturing industries will experience fundamental changes too. Robotics will further develop and human labor will be displaced. Business models will undergo changes. Durables like washing machines, vacuum cleaners and cars will not be sold to consumers, but will be shared or borrowed to consumer groups. Ownership and responsibility shift. Such goods will be produced, shared and maintained by prosumers in a so called collaborative commons of consumers. Producers of electric cars will remain the owner of the car and will give the consumer a license to use. Maintenance will be done by a tracking system via the communication internet, and all cars—as all other goods—will have an own IP address. The producer will be responsible for recycling the car after it is worn out; a far better use of components will result. Maintenance cost will be minimized, as well as the possibility to re-use components. The common as a business model implies the end of the profit making company and capitalism.

This may look farfetched, but it is not. Car drivers stick to their brand, know their garage and often have a financial agreement with the producer. Lease agencies do

exist, as well as clubs for beautiful old timers. This external organization only need adaptations that are not that big or beyond imagination. Electric cars—in TIR the car is fully electric—will end their existence as a personal durable consumer good but will be shared in so-called ‘collaborative commons’, to be translated in Dutch as ‘cooperaties’ or ‘clubs’. Consumers are members of clubs sharing a common type of durable and pay a monthly fee.

1.6 Economics of TIR: end of capitalism

The prevailing social idea in TIR is optimal general welfare. Competition on technology will boost productivity up to a point in which marginal cost approach zero. If fixed costs were not counted, the cost of additional units becomes essentially zero, making the product nearly free. If that were to happen, profits would dry up. This process is in itself contradictory to capitalism. If profits dry up due to extreme productivity and full information in markets, capitalism will end. Rifkin points out that this idea has been observed in the economic science before.

Keynes already observed the consequence of advancing productivity: technological unemployment. The rate of displacing labor by new technology is higher than the rate of demand of labor for new needs. Employment might be an issue when extreme productivity occurs, but as Rifkin quoted Keynes: *‘Mankind is solving its economic problems’*. However, it should be stressed that the cost of living will go down tremendously due to free energy and the low cost of sharing durables in commons. An important point that Rifkin brings up is that monopolies in mature industries bring the development of TIR to a halt, since self-interest of monopolies leads to the creation of barriers to new entrants, often with the help of government.

1.7 The Third Industrial Revolution in the second best world

TIR has started

The entire idea of the TIR is, of course, appealing. On the one hand, we do already experience the development of TIR. Parts of IoT are already there: the communications internet did already shake up the media and contents industries.

Figure 5: Prefab house: climate ready with one-day construction time.
Source: VolkerWessels

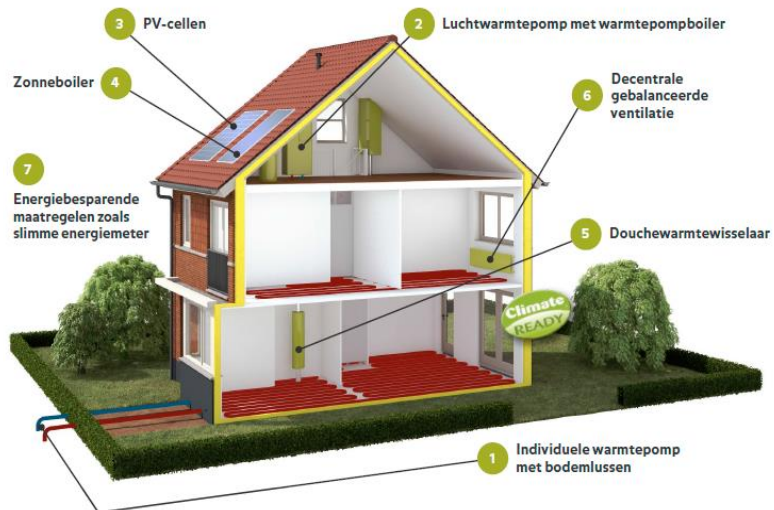


Figure 6: Solar Freezer: 'waterbed' stores solar energy.
Source: <https://www.youtube.com/watch?v=oPWemUa8ots>



Web-shopping is on the rise at a fast rate in the Netherlands: in the first six months of 2015 the expenditures by households in web-shops rose with 18 percent to 8 billion euro.

On the other hand, key technology is still not there (solar). Physical laws do not help yet; conversion of electric power into hydrogen has conversion losses. Reverting hydrogen into electric power is a conversion loss for the second time. It implies that electric power from solar energy should be *really* abundant.

Technological solutions for the grid are still to be developed, but, the first signs of TIR are already there in the Dutch construction industries. A constructor proved to be able to build an entire prefab house at a competing price, energy neutral, to be put in place by a transport and hoist company (figure 5). The building process, including demolition of the former house, took only a few weeks. Prefab building contributed to the energy neutrality due to the exact sizes for insulation. On site building is less exact, according to the constructor. He does not need subsidy or patents: let the competitor prove to do the same.

Capturing solar heat

The main energy source in TIR is electric power generated by solar energy. It requires storage capacity and new technology. However, solar energy has an enormous potential in heating and cannot be overlooked. The great advantage of solar heating is its abundance, even on average and low temperatures. Heat-pumps are very effective and efficient; the Solar Freezer, a Dutch invention (figure 6), makes use of a reservoir of water with a heat-pump extracting energy from it by cooling the water and submitting the heat into the house. The solar boiler on the roof collects energy that raises the temperature of the water in that reservoir. It has a huge commercial potential because it operates at a low temperature range (0-30C). Instead of using fossil fuels, this basically simple, but creative new combination of existing technology, makes use of three high tech components: the heat-pipe (invented for satellites by NASA) instead of the common solar heat collector, the insulation (also originally developed by NASA for use in orbit) of the water-reservoir and the advanced low temperature heat-pump. The idea is brilliant, because the system operates in a low temperature range.

1.8 Free energy and free access to information: some observations

Production cost versus market price

An important second thought is the idea of ‘free energy’ in TIR. This element is key in Rifkin’s TIR, but subject for further thought. Indeed, the marginal cost of energy, if technology to capture and redistribute solar energy is available to a reasonable cost for the initial infrastructure, is near zero. This especially applies if the fixed cost is low due to much better technology to capture sunlight. However, unless the technology and the cost of producing, the problem of the energy market is not the production of energy – fossil energy is already cheap. The problem is the specific fluctuation over the day, the week and the season of demand for energy. The unique selling point of fossil fuels is that they solve the storage problem. Solar energy, regardless of the low cost of producing it, is still no match for fossil fuels with regard to matching fluctuating demand. This is reflected by the difference between production cost and market price of solar energy. At night and in winter, solar energy is scarce and in summer at clear skies, prices are negative.

In any case, demand for energy will decrease per inhabitant. Insulation limits the difference between demand and supply of energy in wintertime to a large extent. The difference in demand and supply for energy between summer and winter is mainly caused by demand for heating purposes; the difference will be covered by insulation, storage of heat and the remaining part by heat-pumps.

Market prices will not go to near zero, even if the storage capacity of solar energy has the same characteristics as the technology to capture sunlight: marginal cost of zero. That assumes extremely low conversion losses. The fundamental issue is: if the marginal price of supply goes to zero, the demanded quantity will vary proportionally rise into the other direction. One might argue that this basic economic idea will not apply in TIR, but those who doubt this economic idea should remind that natural gas was already available at a marginal cost of zero (one eurocent for each m³ of gas) in the Netherlands. The result is known: a level of consumption of gas that is impossible to world market prices and a ‘Dutch disease’.

Figure 7: ‘Binnenvaart Kredietunie’: collaborative commons for investment in barges because traditional banks see the inland shipping sector not as an attractive market for financing and have large amounts of ‘bad debts’ in the industry.



Figure 8: Groundbreaking ‘waste-to-heat’ project in the port of Rotterdam. See: <https://nextcity.org/daily/entry/rotterdam-is-building-an-ingenious-carbon-slashing-heating-system>



“In the AVR Waste-to-Energy plant in the port, waste is converted into steam, heat and electricity through incineration. In the biggest waste-slash-power plant in Europe, residual warmth from surrounding port industries is collected and diverted into the “New Heatway” (*De Nieuwe Warmteweg*), a 26-kilometer-long double pipeline running from Rozenburg to the city center, redistributing the excess heat to homes and businesses along the way.”

Information, tacit knowledge and Baumol's cost disease

TIR assumes free access to information at zero marginal cost. This is already going on in full scale on the internet and by sharing books and newspapers. However, it only applies to codified and transferrable information. Knowledge required for production for high value added goods and services are, on the contrary, based on tacit knowledge. Examples are hair cutting, lawyers, or sophisticated construction projects. Services, especially those based on tacit knowledge, cannot raise the productivity level to extreme heights, rather, their productivity remains fixed. This problem, different rates of productivity levels among sectors, is known as 'Baumol's cost disease'. The outcome is that price of services grow at a higher rate than goods produced by ever faster and better machines, and are no match to robots.

The introduction of robots and the availability of energy at marginal cost of near zero will cause a shock in the demand for services. That demand will rise steeply. This is possible on the condition of income redistribution from the goods-producing industries—and their 3D-print followers for spare parts and niches—and that cost will decline steeply. Energy and labor cost in the goods producing sector go down significantly, so that a larger share of aggregate income will be spent on services.

The Cooperative Common is us

The 'cooperative common' should be translated in Dutch as a 'club', 'coöperatie' or 'schap' (as in 'waterschap'). Examples are the sports club, clubs for old-timers, local environmental clubs maintaining forests and specific landscapes, investor clubs and so on. Other examples are De Onderlinghe—mutual in de US, members insuring each other to share unbearable risk, or cooperation among farmers and ship-owners in inland shipping in the Netherlands (figure 7). AVEBE was a well known cooperation of farmers in the north of the Netherlands. AVEBE was an industrial customer of their yield and a good example of forward integration. Farmers did not sell their yield to traders, but to their own food processing

¹ <http://www.shell.us/about-us/projects-and-locations/shell-in-alaska/shell-in-alaska-news-and-media-releases/2015-media-releases/shell-updates-on-alaska-exploration.html>

industry. Lease companies do resemble a cooperative common. It should be taken in mind that profit making companies are descendants from former cooperative commons—the meaning of the word 'company' and 'common' is actually the same. Moreover, stocks are nothing else than a financing structure by a cooperative common: the Dutch 'first multinational' VOC was a cooperative common. Crowd-funding is an already long known phenomenon from that point of view.

Many kinds of cooperative commons do already exist in society. The economic analysis of it is the provision of so called 'club goods'. Club goods need an entrance fee or meeting another request to enjoy access to specific knowledge, social circle or any other benefit. The entrance fee reflects the scarcity of the social circle, knowledge or benefit.

1.9 Rotterdam in the TIR

What implies the TIR for Rotterdam and its seaport? The main consequence is the revolution in energy supplies. On the long term, oil will be abandoned, according to Rifkin. Not because we go for the last barrel, but because of alternatives developed and because the exploration of new oil fields appeared to be too uncertain—see the Royal Dutch Shell case with respect to Alaska exploration and see the current debate on issues like the carbon bubble and stranded assets¹.

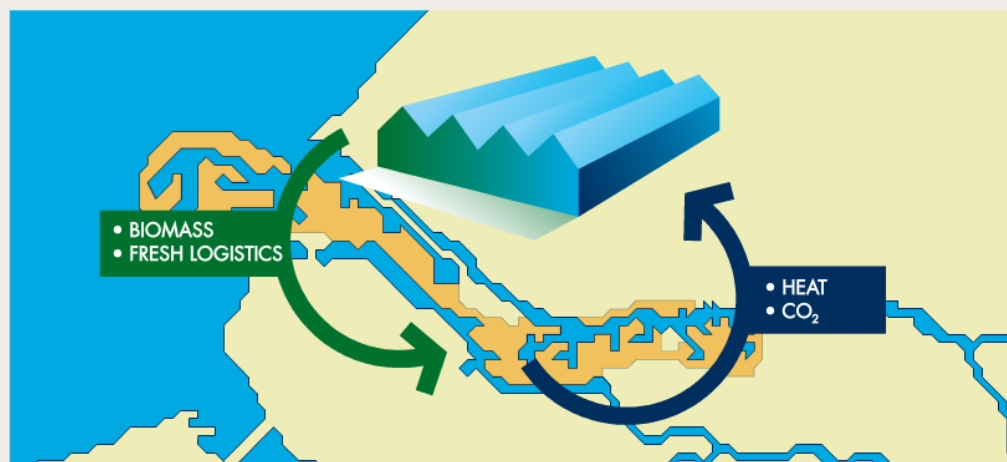
The oil market as such will mainly disappear; it might be assumed that some specific niches in the oil market will remain. Fossil fuels will be substituted by hydrogen, bio fuels and heat. The main strategic question is whether Rotterdam focuses on the energy industry – like refinery and trade in crude oil and derivatives and/or in industries demanding sustainable energy. These choices are key for the further development of the city and harbor. The answer depends on the tradability of energy. Energy will to a large extent be decentrally produced and consumed, so a key role for an intermediate harbor like Rotterdam is less likely or limited.

<http://www.theguardian.com/environment/2015/mar/03/bank-of-england-warns-of-financial-risk-from-fossil-fuel-investments>

Figure 9: The Greenhouse effect: linking port of Rotterdam-CO₂ to greenhouses in the region. Source: Port of Rotterdam Port Vision 2030. Port Compass (2011:70)

The port of Rotterdam is strategically well positioned with respect to the five Dutch Greenports. The Greenports are a concentration of activity in the fields of cultivation, trade, logistics, supply and knowledge development in the greenhouse horticulture sector. Neighbouring Greenport South-Holland represents around 60% of the total Dutch horticulture sector and is very important to the Dutch economy. Greenport South-Holland comprises the greenhouse horticulture and trade cluster for food production and ornamental plant cultivation in the Westland-Oostland, Zuidplas and Barendrecht areas, the tree growing cluster around Boskoop and the bulb cluster in the 'Dune and Bulb Region'. Greenport Venlo is further away but has good connections with Rotterdam, although the intermodal connection could be better. Strengthening the physical and substantive relationships, particularly between Greenport South-Holland and the nearby Rotterdam port complex, could provide added value to the Dutch economy.

At the moment, the port is particularly important to the Greenports in connection with the storage and transshipment of fruit and vegetables from overseas. Most European imports and exports of fruit and vegetables are still transported by road. In the future, more and more of this trade will be transported by ship, partly due to the increasing use of the reefer container. The development of Rotterdam Cool Port in the Waal-Eemhaven creates state-of-the-art handling facilities for temperature-controlled cargo in containers. It is expected that in 2020 around 12 million tonnes of fruit and vegetables will be handled in Rotterdam, of which 9 million tonnes is heading either to or from the Greenports. The Blankenburg tunnel is essential to the swift handling of these fresh flows.



The scale of the flows and containerisation also make it increasingly interesting to transport fresh cargo by inland vessel between sea terminals and the Greenports.

CO₂ is another important flow between port and Greenport. Plants need CO₂ to grow. A small proportion of the CO₂ produced by the industry is captured and transported by pipeline to the greenhouses. Currently, more than 0.3 million tonnes of CO₂ a year are taken from the port to the Greenport South-Holland. The potential is far greater, however, as annual demand will increase in the future to 1 million tonnes a year. European legislation gets in the way here: producers aren't allowed to deduct the CO₂ delivered to the Greenport from their emission ceilings.

Besides CO₂, the use of residual heat from industry has great potential in the Greenport. Important factors here are rising energy prices, the short distance between Greenport and port, and the ambition of reusing all residual heat in 2030.

Plant waste from the Greenport can be used as biomass for co-firing in power stations. The same organic material and higher-quality products can form the feedstock for the bio-based chemical industry. Knowledge development is the keyword here. Collaboration between Greenport, port and knowledge institutions has the potential for creating a global knowledge centre in bio-based chemicals.

Intermediate locations will in the TIR not be as important as they were in its predecessor. On the other hand, Rotterdam has, due to its scale, a comparative advantage to generate local sustainable energy.

Rotterdam has the capacity and technology to generate large supplies of heat, to be consumed in a short distance (see figures 8 and 9). Heat is not tradable, unlike biomass, bio fuel or hydrogen. Heat could only be used by local demand, for example agriculture (glass houses) or heating its housing stock at a very low cost. It is assumed that Rotterdam has a comparative advantage for large scale demand for sustainable energy. Not many sites in the world could provide that.

Rotterdam has an advantage for bio fuels and chemistry and hydrogen storage. These industries could develop in the Rotterdam area. The advantage of Rotterdam is more specific: it is the combination of different sources of sustainable energy. These flows come together and ashore in the Rotterdam area, and as a result, could be consumed in the urban area and its industries, be stored and or converted. An important feature of the sustainable energy supply in TIR is its diversity, whereas fossil fuels consist of three kinds: oil (fluid), coal (substance) and natural gas. The variety of sustainable energy flows in TIR requires nodes where the flows come together. Rotterdam is equipped to develop such a node for wind, solar PV, solar heat, algae production, bio chemical, biomass, hydrogen storage, heat storage, geothermal energy and there will be more kinds of sustainable energy. The ‘plug-and-play’ initiative for the biobased industry is a good example of the potential (figure 19). This initiative is a cooperation of the Port of Rotterdam Authority with utility providers E.ON (energy), Evides Industriewater (water), Stedin (network) and Vopak (storage). The port authority created an 80-hectare ‘Plug & Play area’ on Maasvlakte 2. The cooperation partners offer (main) services to businesses which want to set up facilities in the bio-based industry in the port.

3D printing: location patterns

Robotization and 3D-printing imply the return of the goods producing sector to the consumer market in processes called re-shoring: bringing production back home from China. Classic locational theory discern between three types of location choices: (a) near the site of raw materials, (b) near consumer markets or

(c) in between: the intermediate location. All three have their pro’s and con’s, but the intermediate location has specific advantages. Information from consumer markets as well as the availability of an array of raw materials are available on the same spot. That information on raw materials as well as market demand is a key advantage in TIR, because future demand and technological development is uncertain and could disrupt or surprise markets and companies. The one who can easily switch is king. At intermediate locations that’s a decisive advantage. It should be stressed that in these times, markets could appear and disappear quickly, due to new developments.

The current moderation of Chinese growth proves that perceptions could be fundamentally wrong. The growth of China and its downturn was not specifically the problem, the fact that markets—including the container industry—were convinced that ‘the only way is up’ was definitely wrong. Perceptions on future prices and expectations could be wrong. In such uncertain markets risks should be spread; variety of markets and alternatives are strategically important. Information on upcoming changes and alternatives is key to survive in these uncertain markets. That’s giving advantage to intermediate locations like Rotterdam.

This not only applies to raw materials, which is a good example to show what markets can expect in the future: rapid changes. Markets can vanish due to new technological development, and markets can be developed by such new technology and application. It applies to industrial production in general, such as the current practice of near-shoring in locations like East-Europe, Portugal and Turkey show—a development visible in the growth of container-ports like Gdansk (Poland), Piraeus (Greece), Sines (Portugal) and Istanbul (Turkey). 3D-printing and robotization are new stages in the development of more productive manufacturing industries into extreme productivity. Rotterdam offers an advantageous business climate for these new production activities.

This chapter has been written starting from the perspective of the work of Rifkin. In the next two chapters we change this perspective and introduce the port of Rotterdam and the city of Rotterdam. We present an analysis of the current development in the port and the (port)city.

Table 1: Performance of the ten most important seaports in Northwest Europe in 1893 and the development in selected years (million tons).

	1893	1906	1938	1970	1973	1990	2010	2014
Londen	14	18	42	64	50 ^a	58	48	45
Liverpool	8	11	12	29	23 ^a	23	32	31
Cardiff	7	10	.	4	3 ^a	2	3	2
Hamburg	6	11	26	47	52	66	121	146
Antwerp	5	10	24	78	73	102	178	199
Rotterdam	4	9	42	226	294	288	430	445
Bremen	2	4	9	.	.	30	69	78
Le Havre	2	3	9	60	88	54	70	67
Dunkirk	2	2	4	.	.	37	53	47
Amsterdam	1	2	6	21	21	31	91	98

[a] 1975, source: Kuipers (2015)

Figure 11: Kondratieff waves: broadly corresponding with the First and Second Industrial Revolutions as indicated by Rifkin. Source:

<http://makewealthhistory.org/2012/06/18/green-tech-the-6th-kondratieff/>

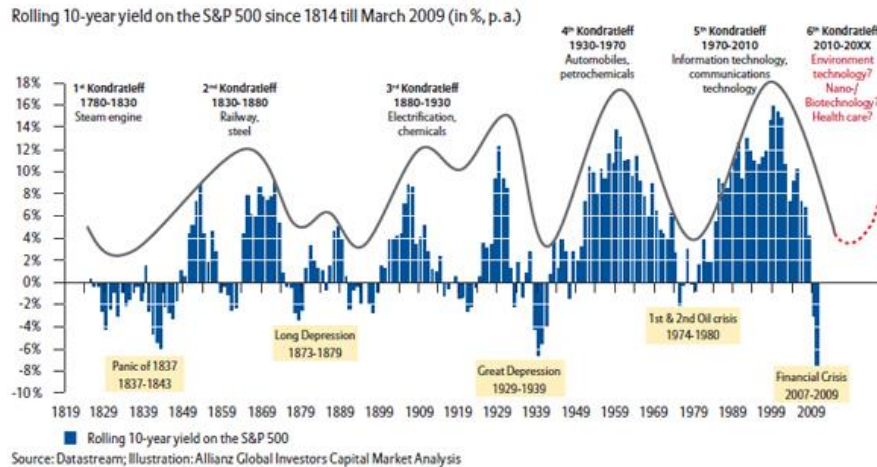
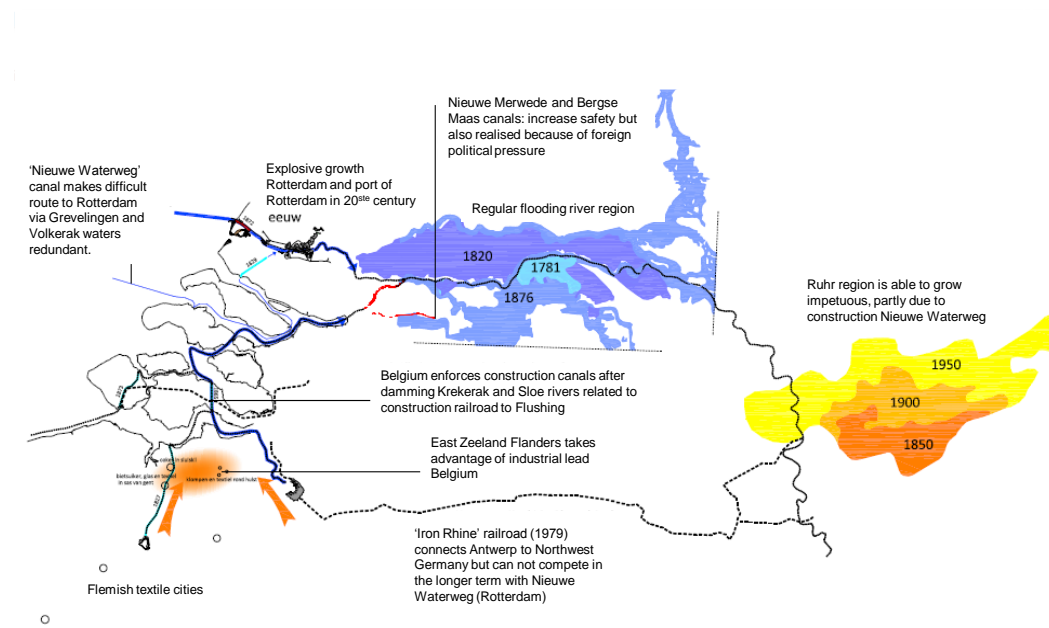


Figure 10. 1850-1900: driving forces and interventions in Rhine-Scheldt Delta.

Source: Meyer et al (2014:74)



2. The port of Rotterdam

2.1 Introduction: Rotterdam, a river port in the Delta

The port of Rotterdam is located in the delta where the rivers Rhine, Meuse and Scheldt flow into the North Sea. This delta has been called the ‘Golden Delta’ in the 1960s, referring to the economic miracle of the booming port cities in the period after the Second World War. However, the Rhine-Scheldt Delta already was an economic hotbed since the 1350s—so for nearly seven centuries the Delta is a powerful region in Europe.

Blussé² states that delta regions like the Rhine-Scheldt Delta or the Yangzi Delta have certain characteristics that make them the arteries of our society. The affluent river basins with their regionally dispersed cities drove the emerging global economy since the Middle Ages. Blussé studies river deltas and he found similar social structures, local-corporate institutions, specific outsourcing relationships and a corresponding ‘river society’ in these delta basins, including the Rhine-Scheldt Delta.

The river cities in the Rhine-Scheldt Delta were located at the intersections of two major international trade routes: a horizontal route from the German hinterland via the river Rhine to England and a vertical trade route from the Baltic area through the Zuiderzee to Flanders. The availability of excellent transport links enabled (over)production to be transported from the hinterland to the port cities in the Delta for further export abroad. These two trade routes grew in the sixteenth and seventeenth century into the engines of the Western European economy.

Despite this long tradition, the seaports of Rotterdam and Antwerp were at the end of the 19th century only the number 5 and 6 in the Northwest European ranking of seaports—Rotterdam is even behind Antwerp in terms of cargo throughput and

the ports of Zeebrugge and Gent were not in the top ten (table 1). Three important interventions were responsible for the growth of the ports of Rotterdam and Antwerp (figure 10). First, the construction of the Nieuwe Waterweg-canal in the period 1872-77 realized a direct connection between Rotterdam and the North Sea instead of the difficult traditional route to Rotterdam via the Grevelingen and Volkerak waters. Second, the canalisation of the River Rhine made Rotterdam the obvious seaport for the growing Ruhr region. Third, the construction of the Iron Rhine railway connected the port of Antwerp also to the Ruhr region. The port of Antwerp is an inland port having a connection to the sea via the Westerschelde estuary. This certainly is a disadvantage for the port of Antwerp because of the tidal movements. The inland location however is also seen as an advantage because of the close relation with exporting firms in the German hinterland—the position of Antwerp with the German hinterland has been strengthened in the last decades compared to the port of Rotterdam³.

The ports in the Rhine-Scheldt Delta grew very rapidly after the Second World War because of a wave of foreign direct investment into port related manufacturing. Especially the oil and petrochemical industry invested very heavily in the seaports of Rotterdam and Antwerp and in the smaller ports of Terneuzen and Moerdijk in the Delta. This investment was initiated by the invention of a large number of new chemical products in the 1930s and 40s⁴. Next to being very characteristic of the Second Industrial Revolution, the basic invention of petrochemical products based on oil is characteristic for the Fourth Kondratieff wave. The industrial investments in ports of Antwerp and Rotterdam were the results of the geographical localization of these petrochemical inventions. An integrated petrochemical cluster emerged after the Second World War, connecting petrochemical complexes by means of pipeline-infrastructure.

The industry sees the petrochemical cluster of the Rhine Scheldt Delta as part of a large ARRR-supercluster (Antwerp-Rotterdam-Rhine-Ruhr) in which the ports of

² L. Blussé (2011) *Aan de oevers van de grote rivieren: de Rijn en Yangzi delta's 1350-1850*, Leiden, Universiteit Leiden.

³ K. Paardenkooper-Süli (2014) *The Port of Rotterdam and the maritime container The rise and fall of Rotterdam's hinterland (1966-2010)*, Rotterdam: Erasmus University Rotterdam

⁴ R. Stobaugh (1988) *Innovation and competition. The global management of petrochemical products*. Boston: Harvard Business School Press.

Figure 12: Oil and oil related products are responsible for nearly 40 percent of cargo handled in the port of Rotterdam. This share is stable in the 2002-14 years.

Structure of throughput Port of Rotterdam 2002-2014 (measured in ton, percentages)

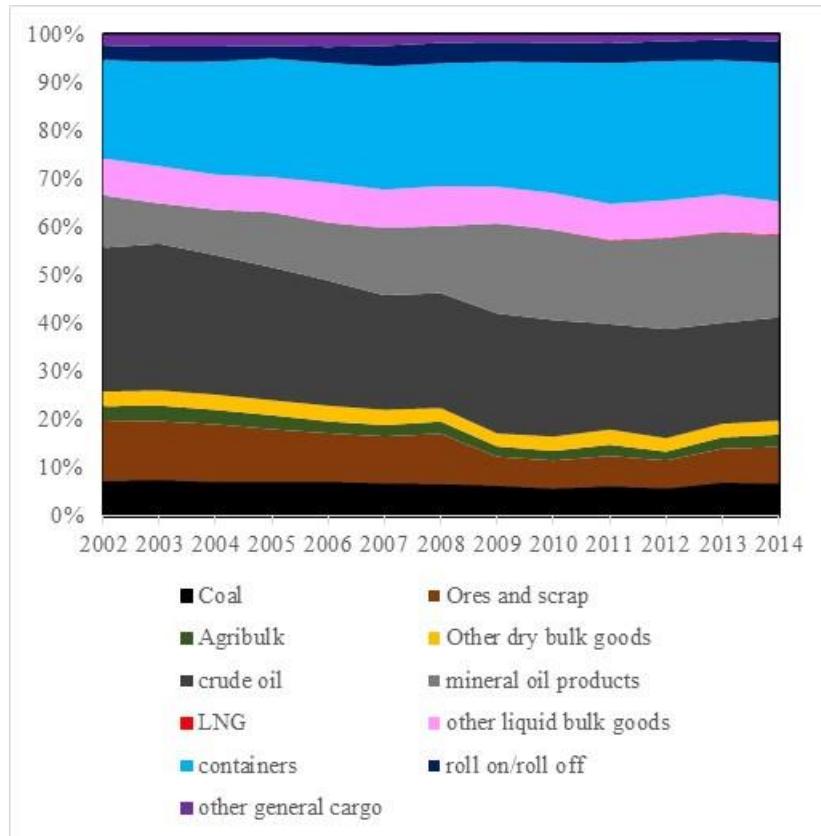
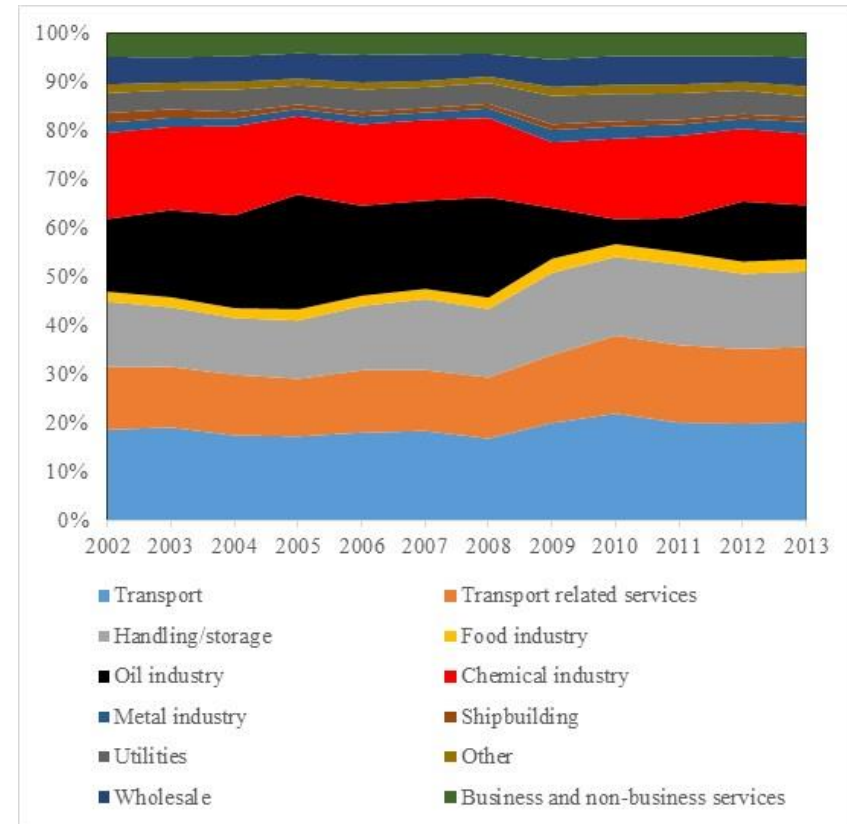


Figure 13: Added value realized by the oil and chemical industry in the port of Rotterdam fluctuates but peaked in 2007 at a share of 37 percent.

Structure of added value creation port of Rotterdam/larger Rotterdam-Rijnmond region, 2002-2013, percentages) (Source: Nijdam et al.2015)



Antwerp and Rotterdam are linked by pipeline infrastructure to the giant BASF-complex in Ludwigshafen in Germany and to the different productions sites in the Rhine-Ruhr region.

2.2 Rotterdam thrives on oil

“The port of Rotterdam thrives on oil” is a popular statement to characterize the dependence of the port of Rotterdam on oil and oil related products. Crude oil and mineral oil products together are responsible for 38 percent of throughput of the port of Rotterdam (measured in tons)—a share that is stable since 2002 (also 38 percent—see figure 12). However, the share of mineral oil products has increased from 11 percent in 2002 towards 17 percent in 2014 because of the strengthening of the competitive position of the port of Rotterdam as a storage and trade location for mineral oil products and because of increasing demand from the chemical industry. Including chemical products—increasingly transported in containers—, about half of the Rotterdam throughput consists of oil or is closely related to oil.

The oil and chemical industry are the dominant port-based industrial activities, together responsible for 26 percent of added value realized in the port of Rotterdam in 2013 (see figure 13). The share of added value realized by the oil and chemical industry however shows considerable fluctuation. In 2008—the year the Second Industrial Revolution peaked and the price of crude oil hit a record \$147 a barrel (Rifkin, 2014:54)—the added value also peaked at a share of 37 percent in the port of Rotterdam (Rijn- and Maasmond).

2.3 The Port of Rotterdam has four sub-clusters

Big changes in the price of oil therefore are very important for the port of Rotterdam and have an impact on most of the activities in the port. The port of Rotterdam has four dominant clusters: (1) chemical, oil and process industries, (2) container handling and logistics service providers, (3) construction and the shipbuilding industry and (4) city-related employment: advanced port-related services.

Chemical, oil and other process industries

The chemical, oil and other process industries together make up the first important cluster in the port. A high oil price means (a) high costs for purchasing oil and (b) a high price for energy needed for refining. Also for the chemical industry a high oil price is negative because of those two reasons, increasing the price of inputs.

Container handling and other logistics service providers

Next, the container industry is very important for the port of Rotterdam, in 2014 responsible for a share of 29 percent of total throughput (in 2002: 21 percent) and expected to become even more important in the future because of the impressive investments at Maasvlakte 2 in container infrastructure, being developed at the moment. This second cluster covers, next to the container industry, also other logistical activities like warehousing, bulk storage and handling or general cargo. A high oil price has a negative effect on the sector, because up to 70 percent of the costs of certain segments—like container shipping—is related to bunker fuel. The high oil prices of the recent past provoked the practice of slow and even super slow steaming, meaning a decrease in the speed of container ships from 24 to 17-21 knots (slow steaming) or even 15 knots (super slow steaming). Slow steaming has a large positive impact on the environment, reducing CO₂-emissions up to 50 percent, but increases pipeline inventory costs for shippers—especially for expensive goods. A high oil price also has an impact of the important oil-storage sector in the port of Rotterdam. In general, high prices mean a low utilization of assets. The current low price results in a very high utilization level since traders are waiting for price increases to be able to sell the oil.

Construction and specialized shipbuilding industry

The construction of offshore platforms, highly specialized vessels for dredging and the construction of marine infrastructures and other specialized shipbuilding activities is the third cluster in the port of Rotterdam. This cluster is also very sensitive to changing oil prices. High-oil prices result in a high demand for offshore platforms and for suppliers to the oil industry, so in contrast to the oil and chemical industry, high oil prices are positive for this sector.

Figure 14: A peak in 1973 that has been matched in 1997: more than two decades of stagnation in the port of Rotterdam measured by cargo handling. Throughput Port of Rotterdam 1962-2014, total throughput and throughput of containerized cargo (right ax), million tons, source: Dutch Statistics Office.

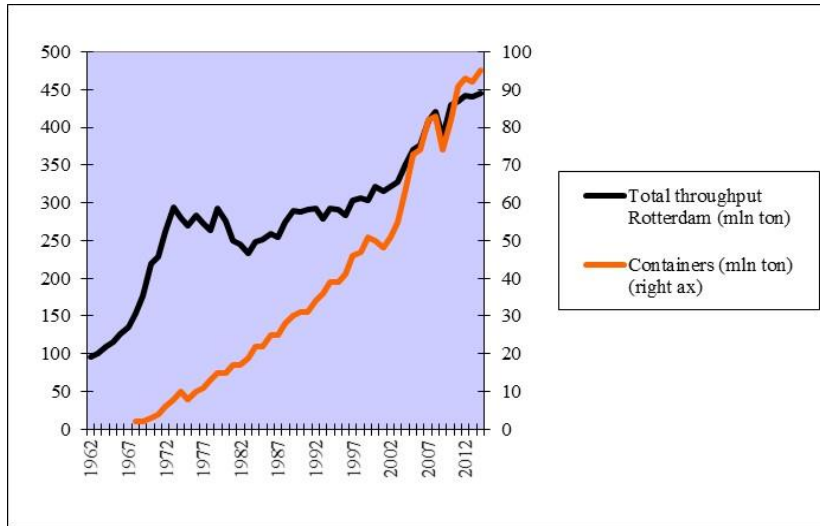
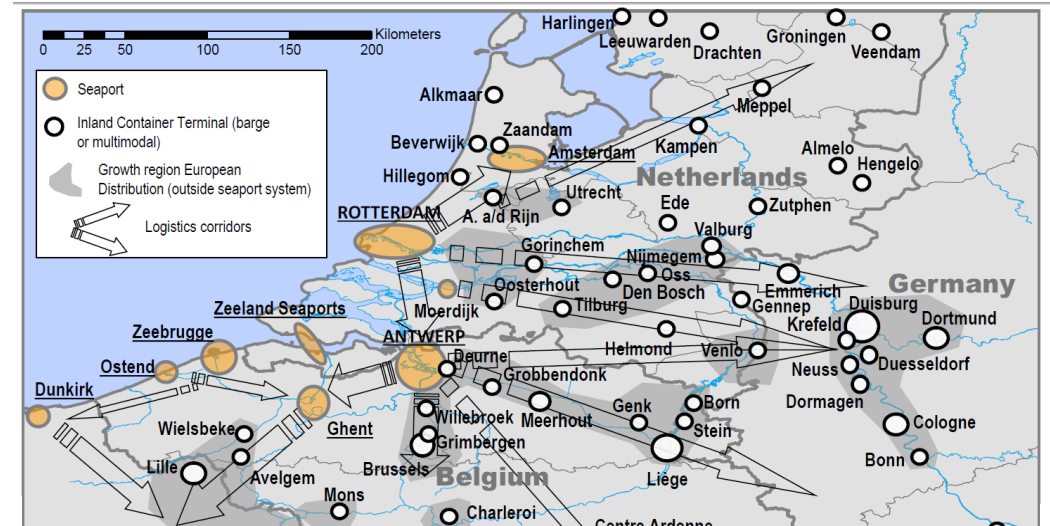


Figure 15: Mainports are the centers of broad logistics zones towards the hinterland.

Source: Notteboom, T. E., & Rodrigue, J. P. (2005). Port regionalization: towards a new phase in port development. *Maritime Policy & Management*, 32(3)297-313.



City-related employment

Finally, city-related employment is the fourth and last cluster in the port of Rotterdam. This cluster includes advanced producer services for the maritime industry—maritime law, financial services, banking, insurance, etc.—, shared service centers for both the maritime industry and the port-related oil and petrochemical industry, commodity traders, supply chain management and other port-related services like engineering and head-offices. A high oil price definitely means more trading activities and activities like hedging.

We present an overview of these four dominant Port of Rotterdam clusters in this chapter. For each cluster we present some characteristics, some dominant industrial trends—including elements related to their adaption to Third Industrial Revolution/Zero Marginal Cost Society principles—and an expectation for the future. In the next paragraph however, we present a short background of the port of Rotterdam as ‘Mainport Rotterdam’, the dominant identity of the port of Rotterdam in the period between 1988 and 2011.

2.4 Mainport Rotterdam: renewed self-consciousness

In the early 1970s the impressive period of investment in the oil and chemical industry starting from the 1950s in the port of Rotterdam came to an end. In the 1970s, further growth of the port of Rotterdam was limited because of heavy pollution and community attitudes against further growth of the port⁵. New investment by the chemical industry was transferred to the port of Moerdijk (Shell), some 40 kilometers south of Rotterdam, and to the port of Antwerp (Bayer, BASF). The Port Plan 2030 by the Port of Rotterdam gives an illustration of this pollution—the concentrations of SO₂ in the port were high and we can only guess at the uncharted territories in this figure (figure 2).

Throughput of the port peaked in 1973 with a volume of 294 million tons (figure 14) but because of two oil crises and the economic crisis of the early 1980s, this

⁵ Pinder, D.A. (1981) Community attitude as a limiting factor in port growth: the case of Rotterdam. B.S. Hoyle & D.A. Pinder (eds) *Cityport industrialisation & regional development. Spatial analysis and planning strategies*, Oxford: Pergamon Press, 181-199.

throughput declined to about 233 million tons in 1983. It took nearly 25 years to beat the record of 1973, in 1997 a throughput of 303 million tons was realized.

In the 1980s, the Mainport-concept provided the port of Rotterdam with a successful new growth strategy. In response to new priorities in (a) regional development aimed at strengthening economic clusters, to (b) societal demands for economic growth related to very high unemployment levels, (c) increasing globalization patterns amongst others related to increased containerization levels, (d) the unification of Europe into the European Union, (e) the logistics revolution and (f) new technological developments like IT (EDI), the seaport of Rotterdam and Amsterdam Airport Schiphol and the related logistics industry became spearheads for economic development in the Netherlands. The two ports were called ‘Mainports’ and the connected logistics industry was responsible for a national ‘Distribution-land’ identity, based on European Distribution centers and re-export of cargo produced in Asia (Japan, Korea, Taiwan) and the US.

A Mainport is defined as a big intercontinental transport hub with (a) an important hub-function in hub-and-spoke networks, having a high degree of connectivity, (b) is being very attractive as a business location, (c) is a center for international supply chain management and chain control and orchestration and (d) has strong indirect economic effects in the national economy, being responsible for the development of broad logistical zones outwards from the Mainports, devoted to distribution centers facilitation re-exporting activities (figure 15).

All these characteristics are true for the port of Rotterdam: being the largest port in Europe with a very strong position in container trades and being very connected to other container ports in the world, being a strong center for FDI in the Netherlands, being in the global top 10 hierarchy of global shipping centers, being the most prominent port in the Netherlands—the country with the best port infrastructure globally according to the World Economic Forum in 2015—and having a share in total Dutch GDP of 3-3.5 percent in the 1995-2013 period.

Figure 16: The Netherlands (NL) and Belgium (BE) grew into important countries for re-export: 45-55% of exports are re-exports (2009). Source: Duprez & Dresse (2013) *De Belgische economie in de mondiale ketens van de toegevoegde waarde. Een verkennende analyse. NBB, Economisch Tijdschrift*, september 2013, 7-22.

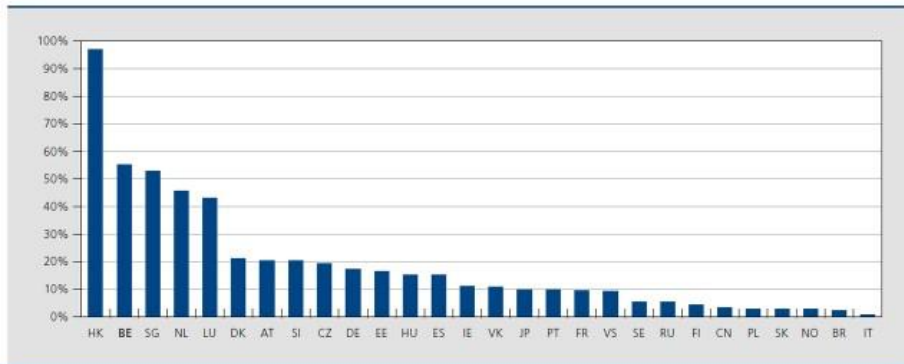
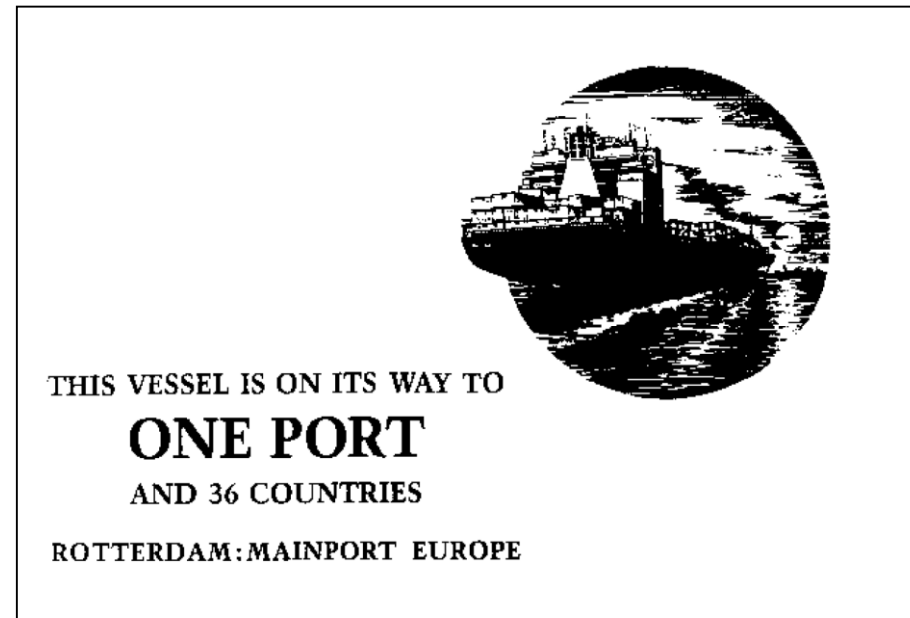


Figure 17: Mainport concept: initially, the Mainport was seen as a big container port (container-hub) with a strong concentration of intercontinental container traffic and hub-and-spoke operations. Source: advertisement Port of Rotterdam Authority in *Containerisation International*, February 1992



Growth of re-export is related to the presence of large container ports

The extensive growth of re-exports is a remarkable structural change in the Dutch and the Belgian economy related to the Mainport-infrastructure. Re-exports are associated in particular with the presence of large ports and countries that are at a crossroads of trade routes. Hong Kong, Belgium, Singapore and the Netherlands are countries with a structurally high share of re-exports in total exports (figure 16). Not coincidentally, these are countries with large container ports. The added value that by re-exportation activities is realized is to be applied therewith to a significant degree attributable to the presence of seaports, and by effects like the European integration. The value of re-export in the Netherlands has more than doubled in the period 2002-2014 from 100 to 192 billion euros export value and to a share of 46 percent of total exports (figure 16). So at the moment, nearly half of the value of Dutch export is re-export. In 1980 there was only a volume of 14 billion euros and a 20 percent share in total exports.

Re-export: large value of exports but low volume of added value

The Netherlands realized an added value of 15 billion euro by performing re-export activities on a total export value of 192 billion euro. This 15 billion euro is 2.3% of the Dutch GDP in 2011. This is in stark contrast with the added value achieved by the pure export of Dutch products: 110 billion euro on an export value of 205 billion euros. With one euro of re-exports only an added value of 7 to 8 eurocents is realized, whereas for the export of goods produced in the Netherlands 59 eurocents added value is realized—or even 66 cents based on new OECD / WTO figures⁶; much more attractive for the Dutch economy.

Re-export, the export of goods produced outside the Netherlands, stored in distribution centers and exported—often after ‘light manufacturing’ processes executed in distribution centers—is for 85 percent being directed towards the European Union. Re-export goods are imported especially from China.

⁶ Fortanier, F. (2014) *International trade study ING Economisch Bureau*, www.ing.nl/tradestudy.

Mainport concept: conceptual background for strong investment in infrastructure

The theoretical underpinning of the Mainport concept—ports as a national economic growth engine by means of powerful forward and backward economic linkages—resulted in important investment projects in the port of Rotterdam. The construction and the public funding of the 5 billion euro dedicated Betuwe-route railway infrastructure from the port of Rotterdam to the German hinterland and the construction of the 3 billion euro Second Maasvlakte were the result of the importance of the Mainport concept in national policy making.

There is a strong need for a new powerful port policy concept

In the last decade, the impact of the Mainport policy concept became less powerful. The port of Rotterdam did not use the concept in the long term port strategy towards 2030 (Port Vision 2030), the large investment in port-related infrastructure did not result in a stronger position of Rotterdam in the port hinterland, did not result in increased employment and value added of the port and the market share of the port of Rotterdam in the ports in the so called Hamburg-Le Havre range has not increased. Finally, the concept neglected the importance of port-city relationships.

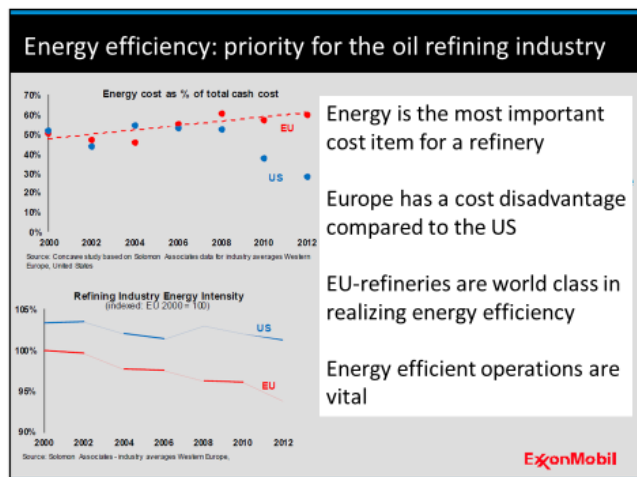
There is a need for a new policy concept replacing the Mainport-concept and replacing Mainport-based policy making. There is a need for a new port development concept⁷ that: (a) is driven by demands from the business users, (b) is flexible and adaptive, (c) is starting from common sense instead of dogmatism, (d) is not limited to the logistics industry and (e) is relevant for the European scale and starts by co-operation on the European level. The Third Industrial Revolution concept could be a solid underpinning of such a new policy concept.

The current developments in the four important segments in the port of Rotterdam also demand the need for new ways of policy making. We present the current situation briefly in the next paragraphs.

⁷ Koppenol, D.M. (2015) *De kracht van het mainportconcept. Een ontstaansgeschiedenis en toekomstvisie*. Den Haag: SMO.

Figure 18: High energy costs and fuel costs are a strategic disadvantage for the port of Rotterdam and the EU oil and chemical industry but provoked energy efficient operations in Europe.

Source: Exxon Mobil (Presentation Harro van Rhee, Rotterdam Energy Port Conference, July 2, 2014), and the Economist, November 15, 2014.



The price of making a plastic bottle

Nov 15th 2014 |

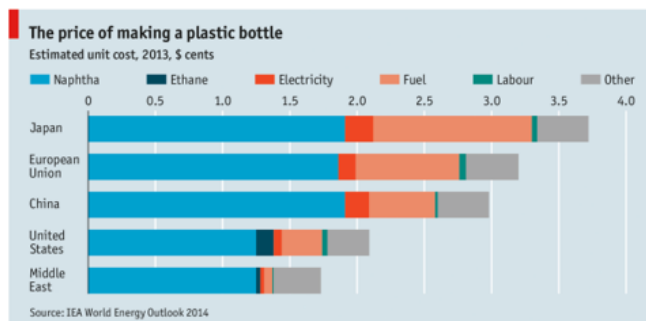


Figure 19: 'Plug-and-play' location for the biobased industry at the Maasvlakte, port of Rotterdam. Source: <https://www.portofrotterdam.com/en/business-opportunities/setting-up-a-business-in-the-port/establishment-biobased-plug-play>



2.5 Chemicals, oil and other process industries

Total industrial added value realized in the broader port of Rotterdam region in 2013 was 6.2 billion euro, 42 percent of total value added in the port region (14.8 billion euro). The petrochemical and oil refining industry dominate industrial added value with a share of 39, respectively 23 percent. Metal production with 9 percent, food with 6 percent and the shipbuilding (transport equipment) industry with 5 percent added value are less important. The process industries therefore are the most important industrial activity in the port of Rotterdam region.

A declining competitive position of the petrochemical cluster

The petrochemical cluster of the port of Rotterdam faces at the moment three important challenges. The first challenge is the declining competitive position compared to US and Middle and Far East locations. This is primarily related to higher costs for energy and feedstock in Europe, especially driven by the shale gas revolution—although at the moment this disadvantage has become relatively smaller because of low oil prices as indicated before. High energy prices resulted in much more energy efficient operations in Europe, compared to the US (figure 18). Increasing energy efficiency is a powerful strategy for stimulating the greening of the chemical industry. A more structural disadvantage of the Rotterdam petrochemical cluster is its age. The cluster has been constructed in the 1950-60s and the basic design of the petrochemical complex is outdated, implicating facilities of much smaller scale compared to new investments in China, the US and the Middle East.

Industrial ecosystem development

An important strategy to overcome the disadvantages of old facilities and high prices for feedstock and fuel is the integration of the chemical cluster by means of industrial ecosystem development⁸—the second challenge. The integration is realized on the site level where different firm are co-operating in co-siting developments. This means that an industrial site is not managed by a single

⁸ Hollen, R.M.A., F.A.J. van den Bosch & H.W. Volberda (2015) Strategic levers of port authorities for industrial ecosystem development, *Maritime Economics and Logistics*, 17 (1):79-96.

company performing all the activities but by a federation of different companies having different industrial activities as their core-function and often being a global market leader in this specific activity. These industrial activities and utilities are linked by flows of feedstock, energy and information. Linking these flows means that the amount of traditional rest- and by-products realized in most chemical processes is minimized. The result is also that global specialists are managing operations and are able to imply global standards and link the site to their global industrial networks. This industrial ecosystem development is also relevant for the port cluster as a whole and has also been realized on the level of the Rhine Scheldt Delta. For instance, the major facilities of ExxonMobil in both the ports of Antwerp and Rotterdam are connected by pipeline infrastructure and can be seen as a single industrial system—Exxon Mobil recently announced both in Antwerp and Rotterdam important investments projects of one billion US dollar in each port. This industrial ecosystem development may be further strengthened by circular economy practices as foreseen in the port of Antwerp, where a major 3.7 billion euro investment project has been announced transforming industrial waste to chemicals like green urea and green ammonia⁹—the latter raw material to be used as in input into the existing port cluster.

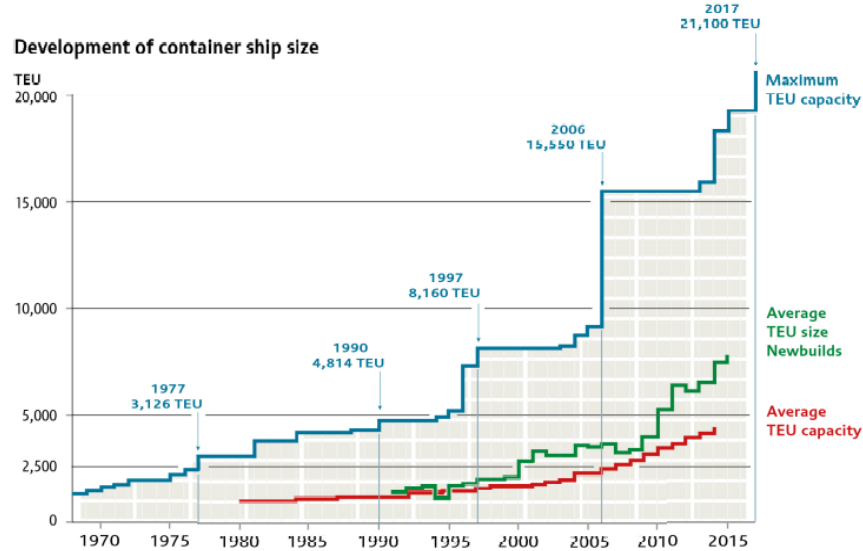
The biobased economy

The third challenge is the transformation from oil to biobased: biobased material used as a fuel and a feedstock. This also is an important challenge to become less dependent on volatile oil prices, because the price development of biobased material is much more stable. A strong concept in the biobased economy is the concept of the value pyramid. Biobased fuels are at the bottom of this pyramid. These fuels are characterized by large volumes but a low added value per volume unit. Specialized chemicals and pharmaceuticals based on biobased feedstock are at the top of the pyramid: usually produced in small volumes but having high added value per volume unit produced. At the moment, the port of Rotterdam is characterized by operations at the bottom of the biobased value pyramid.

⁹ <http://www.portofantwerp.com/nl/node/14135>. ERS preferred candidate for Delwaide dock concession, investment worth 3.7 billion euros in the Port of Antwerp

Figure 20: The ultra-large container vessel is the number one impact in the container industry: larger ships need corresponding terminals, canals and logistics concepts realizing economies of scale.

Source: OECD/ITF (2015) The impact of mega-ships. Paris: OECD/ITF.



Source: OECD/ITF based on data from Clarkson Research Services

Figure 21: The new geography of production—two examples of reshoring. Original US bicycle manufacturer Kent brings production facilities back to US.



Philips Electronics in Drachten, the Netherlands: production of shaving devices has been reshored from China towards the Netherland by using advanced robotics. Source: John Markoff: Skilled Work, without the worker, NY Time Aug.18, 2012



Five manufacturers of biodiesel, bio-ethanol and renewable diesel are located in the port—ADM, Neste Oil, Abengoa, Biopetrol Rotterdam and Dutch Biodiesel—making the port of Rotterdam a major biofuel producer for the European market. These biofuels are mainly used as fuel for the transportation industry. The next step is the use of these biobased raw materials as a feedstock for the chemical industry. To attract biochemical producers to the port, an industrial ecosystem—or co-siting location—approach has been created by means of a ‘Plug and play area’ concept (figure 19). Based on their existing assets, specialized utility companies E.ON, Evides Industriewater, Stedin and Vopak offer all the needed industrial utilities required, including electricity, steam and heat, process water, cooling water and wastewater filtering, tank storage for liquid and dry bulk, et cetera. This means that companies locating on the Maasvlakte do not need to invest in the installation of utilities and the necessary industrial infrastructure, meaning substantial cost savings.

Therefore, for the development of the port of Rotterdam chemical cluster four clear priorities are needed:

- a. increase the level of energy efficiency of operations
- b. increase industrial ecosystem development—including heat and CO₂-loops
- c. increase circular economy practices in the cluster and:
- d. develop biobased operations, preferably at the top of the value chain.

2.6 Container handling and other logistics activities

Container handling is, next to the oil and petrochemical industry, the other important activity in the port of Rotterdam. Rotterdam is the dominant container port in Europe and realized in 2014 a throughput of 12.3 million TEU (standard container unit). Hamburg and Antwerp, the numbers two and three, realized a throughput of 9.7 and 9.0 million TEU respectively. At the moment, two big new highly automated and relatively carbon-neutral container terminals are becoming in operation on the newly constructed Second Maasvlakte (figure 3): APM Terminals and RWG. Despite these new facilities, the port of Antwerp performed much better compared to Rotterdam in 2015, an increase of container handling by

7.4 percent in the first three quarters of 2015, compared to an increase of only 0.9 percent by Rotterdam. The recent turmoil in the container industry however could reverse these growth trends in the next years related to the impact of bigger ships, lower growth of the container market compared to historical figures, shifts in the European hinterland and innovations in container hinterland logistics concepts.

The rise of the ultra-large container vessel

The use of ultra-large container vessels by the leading container carriers on the Asia-Europe route is changing the port-scene dramatically (figure 20). These ultra-large vessels demand container-terminals and a hinterland-infrastructure able to handle these ships and their cargo efficiently. The port of Rotterdam has a strategic advantage related to:

- a. the location on the coast—instead of the inland locations of the ports of Antwerp (Western Scheldt estuary) and Hamburg (river Elbe)
- b. the availability of large-scale and energy-efficient inland waterway transport of containers to the German hinterland and to a network of inland terminals in the Netherlands and:
- c. container terminals designed to receive these ultra-ships—ECT Euromax next to the APMT and RWG-terminals.

These advantages make Rotterdam a first (and last) port of call for heavy loaded ultra-large ships. After unloading, the ships continue their journey to other ports in Europe to return to Rotterdam for a second call and to sail fully loaded back to Asia. This logic is of increasing importance in container operations and is expected to reverse the current low-growth trend by Rotterdam in the near future.

New logistics demand: lower demand for overseas container services

These bigger containerships are sailing at a slower speed, as indicated in section 2.2. Logistics demand however is characterized by fast response to changing market demands and technological obsolescence of products. Importing goods from Asia in supply chains with lead times of four to eight weeks is—especially for premium goods—not desired and transport by air is often considered too expensive. The result is—first—an increase in regional production systems: production in Turkey instead of China (near sourcing), bringing production back

Figure 22: Impact of 3D-printing on global supply chains: reduced need for deep-sea container transport. Source: Jones Lang Lasalle (2013).

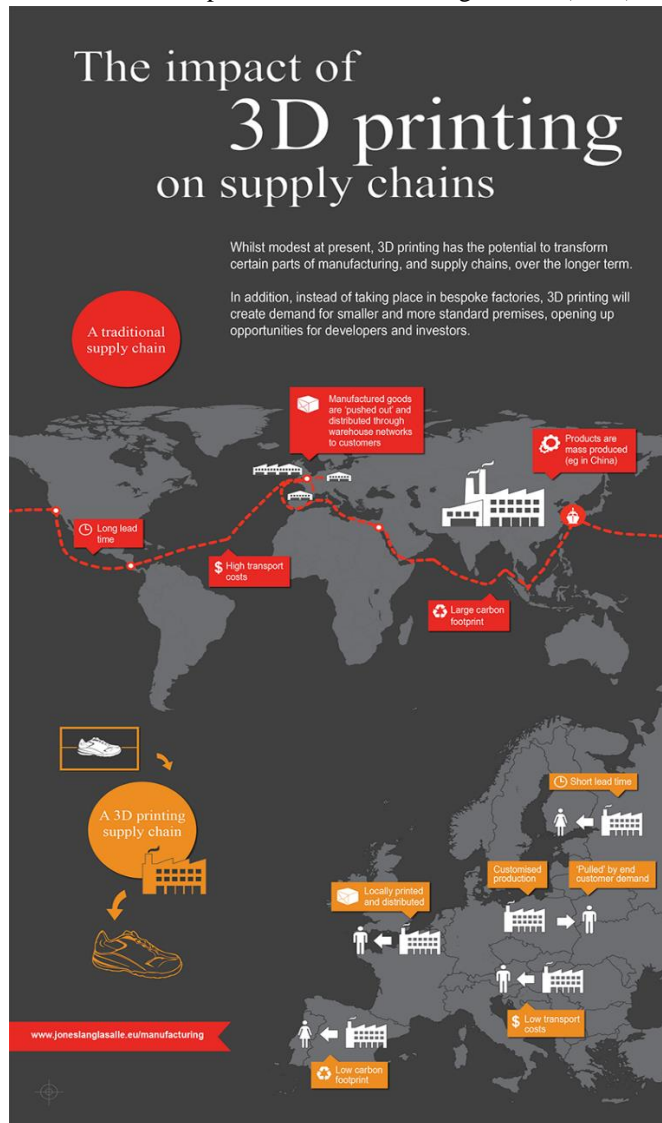
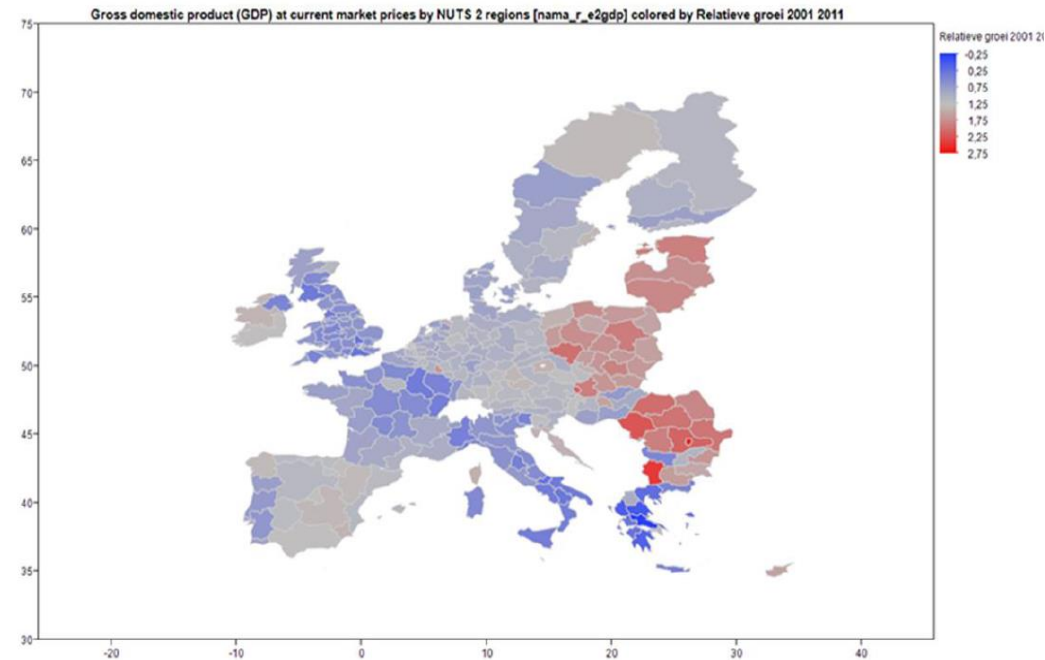


Figure 23: Shift of European center of gravity to the east: resulting in growth of container ports in Eastern Europe, like the port of Gdansk.

GNP NUTS-1 regions EU, growth 2001-2011 in percents (Growth 0-50%: dark blue, growth 200-250%: dark red) Source: Hintjens et al. (2015) Druk op het hinterland, Vlaams-Nederlandse Deltamonitor 2001-2013, Rotterdam/Antwerp.



to European countries but by increased use of automation/robotization (reshoring—see figure 21 for a US and Dutch example of reshoring, the Drachten case also illustrated in Rifkin, 2014:124) or by performing 3D-printing. 3D-printing means a large impact on the design of supply chains. Local printing and distribution and production to individual customer order results in short lead times, low transport costs and a low carbon footprint (figure 22). These concepts do not make use of deep-sea container transport. In addition, concepts like the sharing economy—“the transformation from ownership to access”—will mean less production and global trade of durable consumption goods like cars, an industry that’s one of the ‘engines of global supply chains’.

Second, the use of rail connections between China and Europe is growing. These connections offer the desired lead-times and also result in less deep-sea container transport. Especially recent close co-operation the UK and China might result in rail-container transport to the UK via the port of Rotterdam.

Hinterland port of Rotterdam is shifting to the east

The economies of Eastern European countries showed a much higher growth in the last decade than the West-European countries (figure 23). This means the center of gravity of economic activity is moving to the east. Not only GDP in the countries in Eastern Europe is growing, these countries are also becoming destinations for foreign direct investment in logistics assets with related re-exporting capacity. Although the absolute size of the logistics market is still small compared to the Netherlands and Belgium, this market is growing fast. One implication is the growth of seaports in Eastern Europe, like Gdansk in Poland and Piraeus in Greece, the last acting as an important hub in the East Mediterranean.

This eastward shift of the European hinterland will dampen growth of the seaports of West-Europe mainly because of new distribution patterns of European distribution centers. The port of Piraeus is an example of new investment by Chinese container carrier Cosco in terminal facilities and Chinese producers of consumer goods like Huawei with logistics facilities. Van der Putten concludes in his

research “The main relevance for the Netherlands of Cosco’s operations in Piraeus relates to the possibility of (parts of) future trade flows between Central Europe (including parts of Germany) and China being conducted via Piraeus rather than Rotterdam or other Dutch ports.”¹⁰ However, he considers it too early to draw conclusions regarding longer-term impacts of this development for trade flows.

Innovations in container services: synchromodal operations

Innovation in container service concepts towards the hinterland is an important strategy to stay competitive in container-ports like Rotterdam. In the port of Rotterdam, European Gateway Services (EGS)—a spin-off of leading container operator ECT—has developed the concept of synchromodal transport. Synchromodal transport may be considered an Uber-concept for the logistics industry. Synchromodal transport starts from using the idle capacity of available transport means to the hinterland of the port of Rotterdam. It matches available transport capacity with demand for transport services. A synchromodal control tower matches supply and demand by means of capacity available and demand characteristics—demand measured by indicators like desired cost level, carbon footprint or lead time required. The result is that spare capacity on the most sustainable and low cost transport option—inland waterway transport—is the start of the matching process. The result of synchromodal operations is a relatively high demand for inland waterway transport as compared to road transport—it is said that nearly 60 percent of synchromodal transport operations to the hinterland of the port of Rotterdam is performed by inland waterway transport.

In addition, EGS ‘pushes’ containers that are being handled on the ECT deep-sea terminals in Rotterdam towards a network of inland container terminals in the hinterland, called ‘extended gates’ (figure 24). An extended gate might be considered a virtual deep-sea container terminal, enabling services like customs clearing or container storage. EGS performs the ‘internal’ container terminal transport operation between the Rotterdam deepsea-terminal and the extended gate located in the hinterland. Because ECT handles very large flows of

¹⁰ F.-P. van der Putten (2014) Chinese Investment in the Port of Piraeus, Greece: The Relevance for the EU and the Netherlands. The Hague: Clingendael.

Figure 24: Network of extended gates of European Gateway Services, enabling synchromodal transport operations. Source: ECT.
 Bold red circle = extended gate.

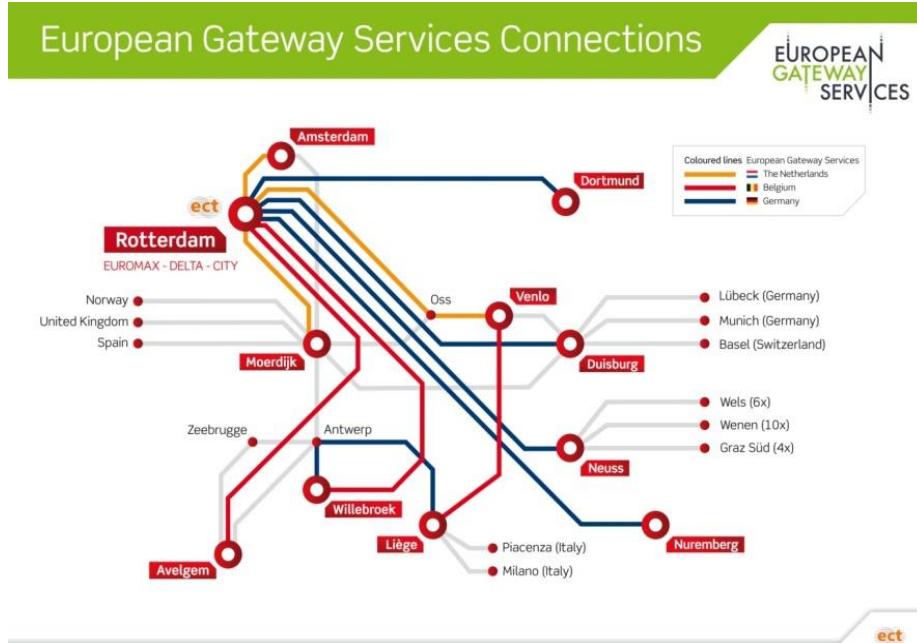


Figure 25: Remote container crane operations; instead of working alone on top of a container crane, the crane operators working on the Maasvlakte 2 terminals are working in an operating room. Source: YouTube: It's all about remote operations



containers on its deep-sea container terminals, it's able to realize a high capacity utilization on the container trains and barges used, thereby lowering transport costs. An important additional characteristic of synchromodal transport is that an extra alternative towards hinterland transport is being created, increasing service differentiation in container logistics—traditionally a weakness of the industry¹¹.

Innovations in terminal handling: enabling the internet of things

In addition to innovation in container services, technological innovation of the container system is an important development in the port of Rotterdam. The Greater Rotterdam region houses a number of innovative companies which enabled the introduction of the remote-operator ship-to-shore container crane at the terminals of APM Terminals and RWG on the Second Maasvlakte. Firms like TBA, located near the city of Delft, and ABB in Prins Alexander, a suburb of Rotterdam, developed the software and the automated systems for these remote operations. These innovations have the potential to be adapted in other major container ports around the world.

Companies like TBA and ABB are needed, together with other innovative companies in the region like CGI—an IT-firm working on issues like supply chain generation, intelligent cargo, transport management services and integrated ship management. Together these firms may design the logistics internet and the internet of things in the port of Rotterdam and they are working towards automated and driverless ships and other transport systems.

For the development of the port of Rotterdam container cluster therefore three clear development options are available:

- a. invest in the development of innovative new logistics services like synchromodal container transport, enabling service differentiation,
- b. invest in the development of new technology enabling the internet of things in the port and support the companies that are innovating and are developing these new technologies—make sure that the needed highly skilled developers by those companies are available in the region,

- c. invest in sustainable transport operations, electric transport/terminals and LNG/hydrogen. This demands technological innovations but also social and organizational innovations like synchromodal transport.

2.7 Construction and specialized shipbuilding

Construction and specialized shipbuilding is the third important cluster in the port of Rotterdam and has at its core one of the strongest clusters of the Dutch economy: dredging and the construction of marine infrastructures. Port infrastructure such as the Second Maasvlakte, but also the famous archipelagos in Dubai, were constructed by, amongst others, Dutch dredging firms like Boskalis and Van Oord. These two firms are at the heart of this dredging-cluster. The cluster has a global market share of about 30 percent and is considered one of the strongest clusters in the Dutch economy¹². Specialized maritime shipbuilding and construction companies like IHC are building the highly complex ships needed for dredging and marine construction.

An important characteristic of the Dutch maritime cluster are economic linkages between the different segments (see figure 26). Maritime suppliers and shipbuilding are at the core of the cluster with sales of both 1.7 billion euro to other parts of the cluster. Offshore, shipping and dredging are the most important sectors with a demand for goods and services of maritime suppliers and offshore. Also the offshore sector includes a number of world class construction firms like Heerema. The maritime cluster is very export oriented, 57 percent of total turn-over is exported, with shipping and dredging at the top position with an export share of 73 and 70 percent respectively (and fishing with an export share of 83 percent).

Employment in the maritime cluster as a whole grew in the years 2006-2013 by 4 percent, however employment in the maritime hotspots of maritime manufacturing in the Greater Rotterdam region declined since 2010 (figure 26). The Greater Rotterdam region has a strong image with respect to innovation in the maritime industry. An example is the Ampelmann innovation, a gangway that stays horizontal at sea enabling vessels to supply offshore platforms with goods during

¹¹ Boston Consulting Group (2012) Charting a new course. Restoring profitability to container shipping. Boston: The Boston Consulting Group Inc.

¹² B. Kuipers et al. (2010) SWOT-analyse & Innovatieagenda Maritieme Piek Drechtsteden. Rotterdam: Erasmus University Rotterdam/RHV.

Figure 25: The Dutch maritime cluster is highly interconnected. Internal cluster linkages and investment in assets within the Dutch maritime cluster, 2012

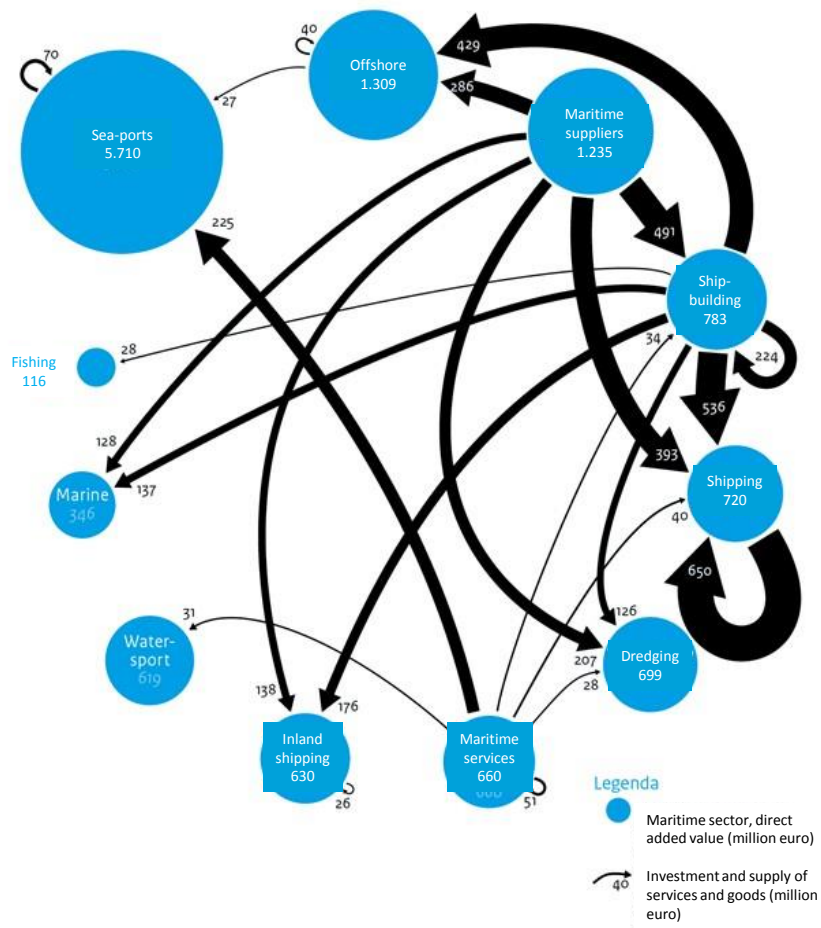


Figure 26: Employment in 'Maritime Hotspots' in the Greater Rotterdam region, number of jobs. Source: P. Bleuming & J. Kraaij (2015) Hotspots in the maritime industry, Nijmegen: BCI.

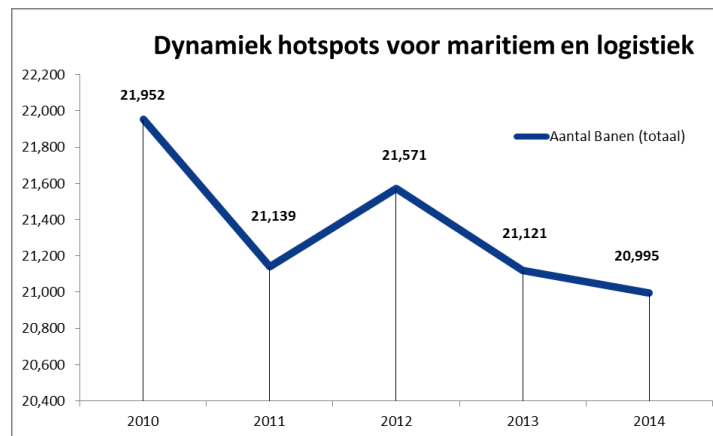


Figure 27: Ampelmann innovation, at RDM Rotterdam



rough weather. Ampelmann has a production facility in RDM Rotterdam. RDM Rotterdam is a hotspot for small scale ‘new manufacturing’, such as 3D-printing and prototyping—inspired by Brooklyn Navy Yard—and knowledge intensive maritime construction for the offshore-sector.

At the moment, the market for construction and specialized shipbuilding is difficult because of decreased investment by the oil-industry. In the long run the construction and specialized shipbuilding cluster in Greater Rotterdam has excellent opportunities, related to:

- a. construction of large offshore wind-parks
- b. recycling of a large part of nearly thousand oil rigs in the North Sea and elsewhere, demanding highly specialized equipment and ways of working—the 2.5 billion euro vessel *Pioneering Spirit* of company Allseas, construction being completed in the Second-Maasvlakte lake, is a good example of this specialized equipment
- c. rising sea-level, demanding infrastructures for protecting urban areas located in the delta regions of the world—regions still growing very fast
- d. increased demand for container port infrastructure linking high-growth economies like Indonesia or the Philippines to the global trade system
- e. increasing demand for the construction of new infrastructures in the sea, from data cables linking internet-data centers to new gas-pipelines
- f. a demand for highly sophisticated service and maintenance concepts around the world, linking the large fleet of specialized dredging and offshore vessels by means of 3D-printers towards the technological base of the companies
- g. a demand for advanced coastal management, integrating ecological concepts and innovative ways of ‘living with nature’.

This means that the construction and specializing shipbuilding cluster will have a strong future demand for a wide variety of skills, ranging from technological skills in the design for the construction of new facilities to spatial design of coastal

regions. Delft University of Technology is a world class technical university, with a specialization in water management and the needed technological designer skills for the maritime industrial and services cluster.

2.8 City related employment serving the port and maritime business

Port and maritime industry related functions performed in an office

The last of the four sub-clusters identified in the port of Rotterdam is city related employment, serving the port and the maritime business. A number of typical office related management and service functions linked to the seaport are executed in the urban environment—although quite a lot of those functions also are performed deep inside the port area, next to production sites or logistics infrastructure, or the location of these office functions are dispersed in the Greater Rotterdam region. An important characteristic of this city related employment is that it is executed in an office and does not require a typical physical (port) infrastructure or assets. Most of these functions are footloose. We distinguish six segments; (a) head offices, (b) chain management, (c) advanced producer services, (d) commodity traders, (e) shared service centers and (f) other advanced services, like IT, engineering, advice, consulting et cetera.

(a) Head and regional offices

To become a maritime center, the presence of head offices and regional offices of the major shipping companies and logistics, trading and industrial firms is important. Rotterdam is in Europe, after Hamburg, the second container metropolis—or world container city—and internationally ranks 9th. Container headquarters exchange strategic information with logistics companies in other ports and exchange operational information¹³. The advanced demand by corporate headquarters in the maritime business is of strategic importance for the port-city. This demand goes beyond maritime services and includes strategic services such as corporate finance and management consulting.

¹³ A. Verhetsel & M. Balliauw (2015) *Maritieme containerwereldsteden: evolutie van het globale management netwerk (2006-2012)*. Tijdschrift *Vervoerswetenschap*, (51) #3,43-61. (www.vervoerwetenschap.nl)

Figure 26: 'De Eendracht' office building (the building on the right in the picture): control tower of the port of Rotterdam



Container hotspot in the center of Rotterdam

At the crossroads of the West Blaak and Eendrachtsweg, in the center of Rotterdam, is the office building 'De Eendracht' located. At first glance, a nondescript, typical 1970s building. Close observation of the façade delivers the letters MSC, the Mediterranean Shipping Company—after Maersk, the largest container carrier in the world. MSC has 315 employees in her office coming from many countries, which are involved in operational, administrative, sales and marketing functions related to container operations in the Port of Rotterdam.

Besides MSC, two other maritime companies are located in the office. First HDI Gerling, the second industrial insurer in the Netherlands and an insurer active in the transportation market. In addition to freight insurance, the focus is on the insurance of ships. Furthermore, the company Mark Lyndon has an office in 'De Eendracht'. This is a purchasing company for Chinese paper manufacturer Lee & Man and ships each month 200 thousand tons of waste paper in 16 000 TEU (standard containers), from Europe to China.

In this one office, four strategic port functions are located which are of great importance for the future of the port city of Rotterdam as a maritime center: (a) the head office function, (b) the chain management function, (c) high-quality maritime services and (d) commodity trading.

The region of Greater Rotterdam possesses a large number of head offices, not only in the container sector but also in other parts of the port economy as tank storage, hydraulic engineering and logistics services, such as the headquarters of companies like Vopak, Boskalis, Van Oord or the Broekman Group. The headquarter is therefore perhaps the most strategic relationship between the physical operations in the port and the urban environment.

(b) Logistic chain management

Second, the chain management function also is of great importance. Jeremy Rifkin sees chain management and managing logistics flows as the future of the port. Rotterdam must become the manager of the logistics internet in Europe¹⁴. An internet with intelligent containers moving by means of sensor-technology relatively independently on the networks in the most sustainable way possible. The integration of logistics, communications and energy in the Internet of Things is a future in which Rotterdam will become the global center of chain management—a goal that the Dutch TKI Dinalog knowledge organization already actively is pursuing.

At the moment, some 5 percent of total employment in the port of Rotterdam is related to this logistic chain-management function, especially forwarders, agents and other logistics middlemen are included. This share has been relatively constant during the last decades¹⁵. Despite the potential of Rotterdam as becoming the center or the ‘orchestration’ of the logistics internet, the traditional function of logistics middlemen is threatened because of expected transparency in logistics information flows.

(c) Advanced producer services: high ambitions for the city

In addition to the headquarters and chain management function, advanced, maritime services are located in the city of Rotterdam. Besides insurers also banking, lawyers, accountants, tax consultants, insurance adjusters and the like

have offices in the city. Especially in ship financing Rotterdam's worldwide position is strong, with a fourth place in a recent authoritative ranking. Overall Rotterdam occupies the tenth position as a center for 'maritime finance and law'. The Rotterdam maritime service providers have joined forces in 2015 in the Rotterdam Maritime Services Community, an organization giving an impulse to maritime service together with government and knowledge partners with the ambition to grow in the coming years and realize a rise in the maritime listings.

(d) Commodity trading: increasing integration of supply chain management with physical port assets

The company Mark Lyndon (see: figure 26) is both an example of a trader in commodities—old paper—and an example of a company realizing the circular economy on a global scale—the circular economy is focusing on waste prevention and recycling as much as possible.

A number of key commodity traders are located in Rotterdam: such as Vitol, Glencore, Cargill and Trafigura (figure 27); parties acting in energy, metals and agricultural bulk. The strategic importance of these commodity traders is that they are not only active in trading and organizing physical logistics, including transportation associated with trading volumes, but are increasingly active in the management of physical assets in the port, such as terminals and warehouses. Due to the size of their trade volume—the Rotterdam company Vitol had in 2014 a turnover of more than 250 billion euro—and the demand for highly qualified personnel and high quality services of the aforementioned advanced service providers, these traders play a very strategic role in linking port and city. Jacobs and Huijs¹⁶ state that these commodities traders can be considered as the ultimate cross-over between port logistics and the financial and economic activities in the city. Besides circular products, commodity traders are increasingly interested in products from the bio-based economy, such as biomass. Also for the transition to a biobased economy they play a strategic role.

¹⁴ Prepare yourself for a future without fossil fuels.' Perspectives #2, November 2013, 8-13.

¹⁵ B. Kuipers & T. Vanelslander (2015) De toegevoegde waarde van zeehavens. Antwerpen en Rotterdam: centra van hoogwaardige logistieke toegevoegdewaardecreatie? Tijdschrift Vervoerwetenschap (51) #3, 83-97. (www.vervoerwetenschap.nl)

¹⁶ W. Jacobs & M. Huijs (2015) havensteden als handelsplaatsen? Inzicht in de economische-geografie van de internationale grondstoffenhandel. Tijdschrift Vervoerwetenschap, (51) #3, 62-82. (www.vervoerwetenschap.nl)

Figure 27: Commodity traders: The Trillion Dollar club in the Netherlands. (section of larger listing) Source: Jacobs and van Dongen (2012) Amsterdam, smart port in global trade, Utrecht: Utrecht University.

Name	Turnover (in € billion, 2012) *	Commodities	Headoffice	Presence in the Netherlands (including holdings)	Port assets in ARA (Amsterdam – Rotterdam – Antwerp)
			Trading Desk	Presence in Netherlands of subsidiaries **	
Vitol Group	224.7€	Energy	Geneva, Rotterdam (legal entity)	Vitol Holding BV, Vitol Aviation B.V, Vitol Gas & Power B.V., Vitol Anchor Insurance B.V in Rotterdam	ATCP refinery in Antwerp VTTI : -Tankstorage in Rotterdam (EET), Rozenburg (Eurotank) , Amsterdam (ETA) and Antwerp (ATCP) -Pipeline Rotterdam – Antwerp (RotAn – under construction)
			Geneva, Londen, Singapore, Rotterdam, Houston, Bahrein	Petroned B.V. in Rotterdam: Trading in bunkerfuels VTTI (50% ownership Vitol Group) headoffice in Rotterdam:	
GlencoreXstrata	182.4€	Energy Metals Agribulk	Zug , Saint Helier (legal entity)	Glencore Grain BV in Rotterdam BioPetrol Rotterdam BV, BioPetrol Marketing, BioPetrol Finance in Rotterdam	Biodiesel refinery (BioPetrol) in Rotterdam; capacity 400,000 tonnes biodiesel and 60,000 tonnes pharmaceutical glycerine Pacorini Metals B.V: storage of metals in Rotterdam, Flushing and Antwerp SeaTank Terminal Port of Antwerp (49% JV with Sea Invest: storage of petroleum products)
			Zug (metals and minerals), London (oil and gas), Rotterdam (agri-bulk)	Renaisco B.V in Rotterdam: trading in grains, seeds and Latour Benelux BV in Rotterdam: trading in oil products ChemOil B.V. in Rotterdam: trading in bunkerfuels	
Cargill	98.6€	Agribulk	Minneapolis	Cargill B.V. in Schiphol-Rijk	IGMA Bulkterminal in Amsterdam Fruit juices installation in Amsterdam Soy- and cocoa processing in Amsterdam, Zaandam and Wormer
			Geneva, Hong Kong, Minneapolis, Amsterdam	Provimi B.V. in Rotterdam: trading in animal feedstock	
Trafigura	88.9€	Energy Metals	Luzerne Amsterdam	Trafigura Beheer BV in Amsterdam	Impala in Port of Antwerp: storage of metals Lease tankstorage capacity (gasoil and fuels) in Amsterdam and Rotterdam. 15.3% shareholding in Nyrstar (through the 100% subsidiary Urion Holdings Malta)
			Geneva, Singapore (iron ores), London, Houston, Johannesburg, Buenos Aires, Shanghai, Stamford and Lima	Puma Energy International B.V. in Amsterdam (holding)	

(e) shared service centers

A shared service center provides specialized services to different (operational) departments within the larger organization at a certain transfer pricing, examples are: procurement, customer service, marketing, supply chain management, (technical) knowledge development, IT and human resources. These functions are demanding a relatively well-educated workforce, especially service provision in a technical environment usually requires in-depth knowledge of production and product characteristics.

The shared service centers are relatively independent of the production and logistics operations performed in the port, but are in a large number of cases located in the offices near these operations. In addition, a large number of shared services is located in the city center—with the important location of Royal Dutch Shell at the Weena (figure 28) as the most striking location. The location inside the port area of these office activities has to do with historical developments, most production facilities are the first European settlement, or the biggest European branch of the company. In addition, it is related to the costs of doing business. The office locations in the port area are low cost-locations compared to a location in the city center.

Most of the shared service centers are located in Rotterdam because the Rotterdam location is the main office in the European network or the establishment was the first major settlement in the international expansion of the company. Many of these shared service centers can therefore be seen as a spin-off of the production and logistics activities.

But a location in Rotterdam is not obvious. Shared services are not tied to the production or logistics, but related to these activities—a clear difference. An important factor in the design of such shared service centers, is the composition of the overall cost structure of the execution of such services. Thereby, competition with locations having structurally lower costs is strong, such as Barcelona or Gdansk—an important shared service center of Kemira, a chemical firm, moved

¹⁷ <http://www.kemira.com/en/newsroom/whats-new/pages/Kemira-opened-its-EMEA-Business-Service-Center-in-Gdansk.aspx>

from Rotterdam to Gdansk¹⁷. The presence of available personnel is in addition an important consideration for the establishment of a shared service center in locations like Breda or Venlo. Finally the presence in important markets is also of interest for the location of a shared service center, for example a location in Germany. Rotterdam therefore has a multitude of competing locations for shared services.

However, Rotterdam also has a distinct advantage. Next to the concentration of large petrochemical production facilities and diverse logistics operations, Rotterdam maintains strict requirements on emissions, noise, energy efficiency and sustainability in general. During the years, a lot of knowledge has been developed on these environmental issues associated with business operations. It is expected that this knowledge of clean and energy-efficient production and sustainable logistics should be applied in the short term in the various sister sites in Europe and beyond. Shared service centers are expected to focus on the transfer of this knowledge. In addition, a lot of knowledge has been created of the management of 'brownfield sites'; the modernization of petrochemical plants from the 1950s/60s and practices such as industrial ecology and co-siting¹⁸.

The growth of shared service centers is to a large extent related to growth in the volume of manufacturing and logistics operations, but this is not a necessary relation. The attraction of new shared services is rather similar to attracting head offices and demands a dedicated and focused acquisition.

(f) Other advanced services

Finally, the city of Rotterdam houses a large number of advanced, knowledge intensive and port related advisory-, consulting-, IT- and engineering firms. The two universities in the region—Erasmus University Rotterdam and Delft University of Technology—are very important for these service providers. A lot of the employees of companies like the already mentioned firm TBA (section 2.6). Veneficus, a company transforming complex data-analysis to clear formats for strategic decision making, or maritime and port financial and strategy advisors

¹⁸ B. Kuipers et al. (2011) Rotterdam World Port City, Rotterdam: Erasmus Smart Port.

Figure 28: Shell office at Weena, Rotterdam

Source: www.tds-engineering.nl/projecten/erasmus-weena/



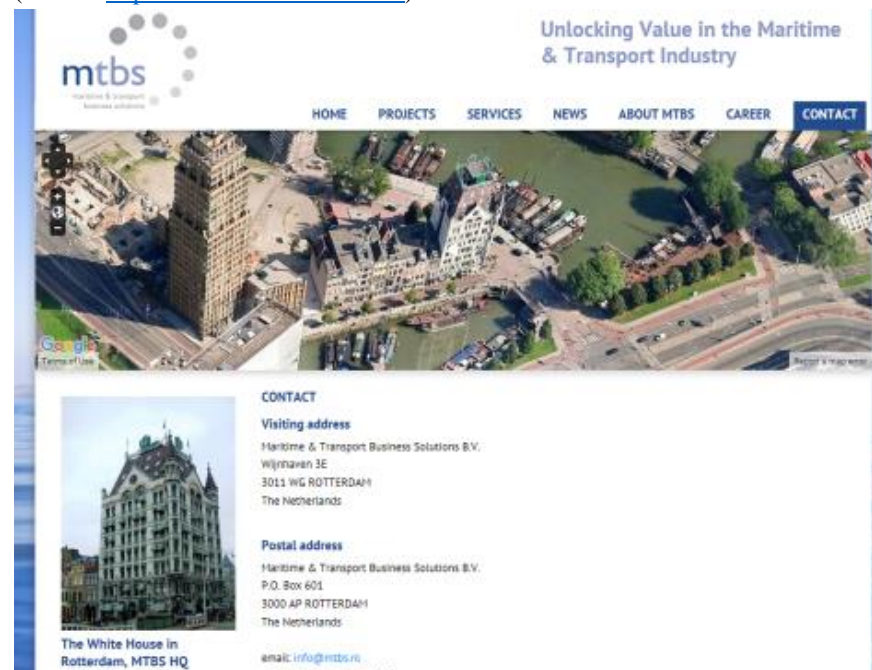
The office of Shell Nederland Verkoopmaatschappij (Shell Netherlands Sales Company) at the Weena opened its gates in May 2012. The 1,100 high quality sales staff that is employed here are involved with the purchase of raw materials and the transport and storage of Shell products, and partially control the production activities in Pernis. It is important that another 1,100—in part equally high-quality—jobs are indirectly associated with this office; lawyers, insurers but also typical urban service providers such as copywriters and advertising agencies.

(Source:

[http://evr2015.publizines.nl/files/8714/3194/9359/The third Maasvlakte can be found on the Weena.pdf](http://evr2015.publizines.nl/files/8714/3194/9359/The_third_Maasvlakte_can_be_found_on_the_Weena.pdf))

Figure 29: The White House: Europese first ‘skyscraper’ and home to a number of port and maritime research institutes, such as MTBS.

(Source: <http://www.mtbs.nl/node/890>)



“A well-known monument at the Old Port Area in the center of Rotterdam. This white and classical building is considered a land-mark amongst the modern skyscrapers that have been developed in the second-largest city of The Netherlands. MTBS is proud to call this office its *port-of-call*. A building with history and a story.”

like mtbs (figure 29) are alumni of these universities. Also advisory firms like Ecorys are spin-offs of Erasmus University. In addition, big engineering firms like Tebodin, Accenture, RoyalHaskoning DHV or Accenture have locations in Rotterdam.

2.9 Conclusion: Interaction between port and city

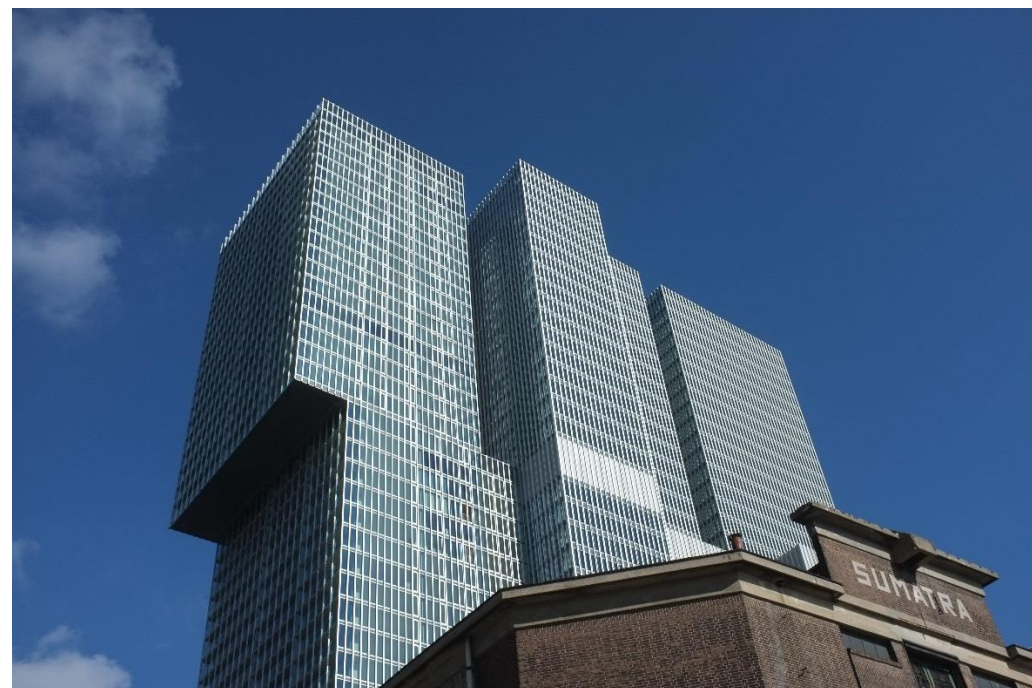
The moral of this story is that the advanced port-related functions in the city presented interact and that there is an integrated system between physical activity in the port and the office activities in the city. At the moment the city provides for about 1.6 billion euro of business services to the port, of which more than half can be characterized as advanced business services. The presence of the head offices in the city of Rotterdam of ship-owners, chain directors, advanced service providers and traders is a foundation for growth and renewal of the physical port.

To attract more of these services, the basic urban infrastructure of the city should be in order: attractive living and working environments and top-notch amenities to attract businesses. In the next chapter, we change our perspective and pay attention to the characteristics of the city of Rotterdam.

Table 2. Value added in the Netherlands, Randstad and metropolitan areas, 1995/2013, by period. Market prices 2013, growth rates in average annual percentage. Source: Randstadmonitor (2014).

	2013	1995-13	1995-00	2001-05	'06-08	'09-13
Nederland	642,9	1,8	4,1	1,2	3,4	-0,6
Randstad Holland	310,7	2,0	4,4	1,6	3,1	-0,7
Noord-Holland	126,6	2,2	4,2	2,1	3,2	-0,2
Zuid-Holland	135,7	1,5	3,9	1,2	2,9	-1,3
Utrecht	56,6	2,1	5,3	1,0	3,3	-0,5
Flevoland	11,3	3,5	6,7	4,3	4,2	-0,7
Randstad provincies	330,2	1,9	4,3	1,6	3,1	-0,7
Randstad Holland	310,7	2,0	4,4	1,6	3,1	-0,7
Noordvleugel	175,0	2,3	4,8	1,9	3,3	-0,3
Zuidvleugel	135,7	1,5	3,9	1,2	2,9	-1,3
Randstad buitengebied	19,5	1,6	3,3	1,3	3,2	-0,6
Metropolitan area Amsterdam	118,4	2,4	4,6	2,4	3,3	-0,2
Metropolitan area Rotterdam-Den Haag	94,9	1,5	3,7	1,7	2,6	-1,4
Greater Rotterdam area (Groot-Rijnmond)	52,9	1,6	3,1	2,2	3,0	-1,3
Urban region The Hague (Haaglanden)	42,0	1,4	4,3	1,2	2,1	-1,5
Urban region Utrecht	36,4	2,3	5,1	1,1	3,6	0,0

Figure 30: 'De Rotterdam' designed by 'starchitect' Rem Koolhaas. This building resembles the Rotterdam identity: very big, rather coarse and to some even intimidating direct.



3. The City of Rotterdam

3.1 Introduction

Rotterdam is heading the right lists

Rotterdam performs well. The intelligence unit of the Financial Times ranked European cities in a Top 25, with London on top. The top-25 has five Dutch cities: Eindhoven (3), Amsterdam (9), Rotterdam (14) and Utrecht (18). The Hague, the other large city in the urban region of South Holland, is lacking in the ranking. Rotterdam ranks high in the following components: infrastructure (3rd), human capital and lifestyle (6th). With regards to foreign direct investment Rotterdam ranks 9th among large European cities. Such a high ranking was also obtained in the most recent ranking of must-see cities around the world according to the Lonely Planet guide: Rotterdam ranks 5th. Tourism in Rotterdam was already on the rise recently.

The image of Rotterdam is of course mainly determined by the port. But, the Rotterdam-Delft-The Hague region is certainly well positioned and a breeding ground with regards to internationally known artists from several centuries: Willem de Kooning was born in Rotterdam, Vermeer lived and worked in Delft, Mondriaan was in his younger years a representative of a group of painters from the Hague (The Hague School) before he left.

The opening of the Markthal (market hall) improved the supply to demanding consumers and thereby improving the urban amenities and living environment in Rotterdam. The Cambridge Innovation Center opened a foothold in Rotterdam to provide capital to startup companies in the dynamic economy of the city.

Besides these positive findings on Rotterdam and the region, the level of GDP per capita and growth of GDP is not outstanding. Faster growing regions are the Amsterdam Metropolitan region and Eindhoven. In this chapter, we will shed some light on economic growth in Rotterdam region. The main conclusion is that agglomeration economies do not operate in full gear. In chapter 4, we will look in more detail at these agglomeration economies.

3.2 Rotterdam, a city in transformation

Rotterdam is the second largest city of the Netherlands, with a population of 623,956 people (2015). Together with the surrounding municipalities in the urban region of the city (Groot-Rijnmond) total population is around 1.4 million. The history of the city goes back to the 13th century but until the rise of the port of Rotterdam in the 19th century it became a large and important city. The city suffered heavily during World War II where the bombing on 14 May 1940 completely destroyed the city center. Post-World War II reconstruction has changed the face of the city, both on new and reconfigured space.

Nowadays, striking architecture gives shape to the most modern skyline in the Netherlands. The continued shift of the port activities towards the North Sea also gave space for new urban development in the city of Rotterdam. In the early 1990s the Erasmus Bridge created a large new connection between both riversides of the city. It was the start of the large urban developments near the river, especially on the head of the south side of the river.

A strong feeling of self-confidence in Rotterdam....

The transformation of the city is a continuing process. Last year the new Central Station was reopened, together with the launch of the iconic Markthall—the first indoor food hall in the Netherlands—and near the Erasmus Bridge ‘De Rotterdam’ arose, a brand-new Rem Koolhaas-designed building that is known as the vertical city (figure 30). The city has gained a new momentum and a strong feeling of self-confidence because of the recognition of outsiders.

...but not yet a ‘Triumph of the city’....

The shape of the city and the self-consciousness of its inhabitants are transforming, but what about its economy? So far, Rotterdam has not transformed into a flourishing 21st century urban economy. The economic structure of the city is still rather traditional and still depends heavily on port activities. The labor

Figure 31: Development value added in market prices, Netherlands and metropolitan areas, 1995/2013, 1995 = 100

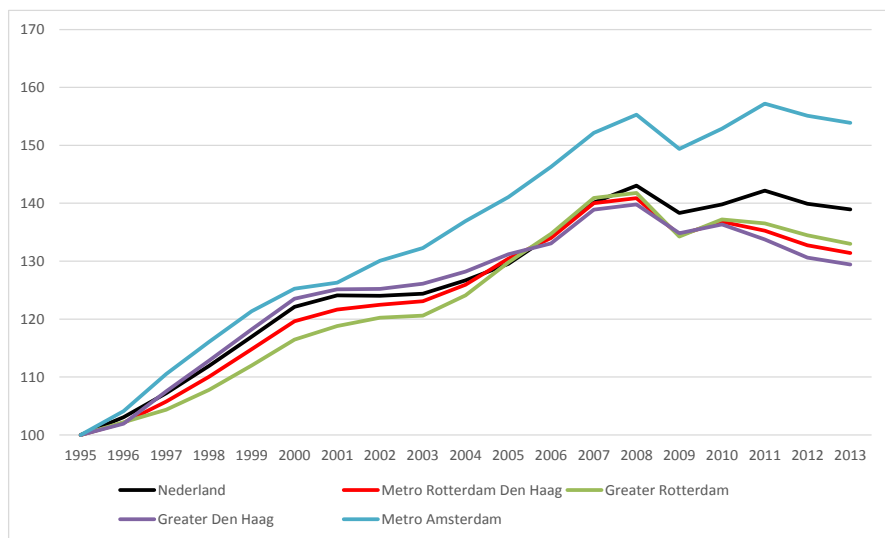
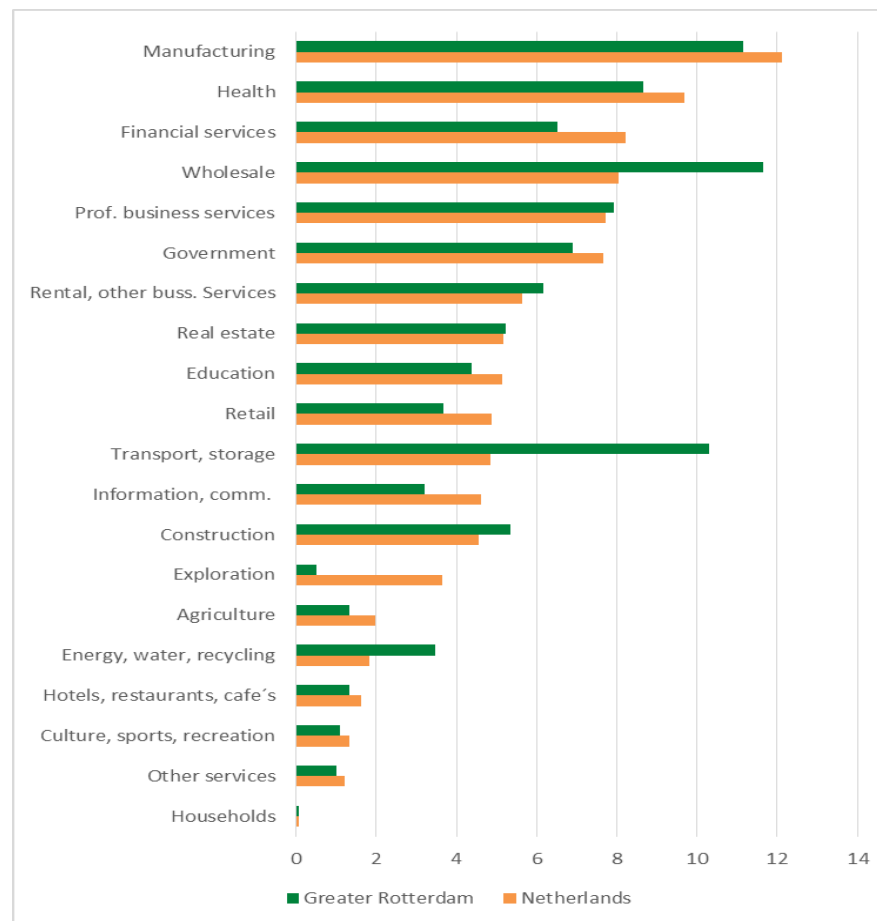


Figure 32. Share of sector in the total economy, Netherlands versus Greater Rotterdam region, 2013, sector as percentage of total economy. Source: CBS.



force is relatively low skilled and Rotterdam is the city with the highest unemployment in the Netherlands. Amsterdam, Utrecht, The Hague are celebrating ‘The Triumph of the City’¹⁹ where knowledge workers cluster and work in professional and social networks on new, innovative technologies and products.

3.3 Rotterdam as part of Randstad Holland: lack of growth

Rotterdam is part of ‘Randstad Holland’, the polycentric urban network of cities and agglomerations in the West of the Netherlands. Randstad Holland is about half of the economy of the Netherlands and has a total value added of 310.7 billion euro in 2013. Rotterdam belongs to the southern part of Randstad Holland. The Greater Rotterdam area, the urban region of Rotterdam (see table 2), has a total value added of 52.9 billion euro in 2013. The south part of Randstad Holland stays behind in economic growth. In the years 1995-2013, average annual growth of the economy was 1.5 percent (‘Zuidvleugel’), less than national average of 1.8 percent in the same period. In the same period, the north side of Randstad Holland, with the urban agglomerations of Amsterdam and Utrecht (‘Noordvleugel’) grew on average by 2.3 percent per year. This lack of growth in the South part of the Randstad—including the city of Rotterdam—is structural and is visible in the three sub periods in table 2.

Deep impact worldwide economic crisis

The Dutch economy is a small, open economy that depends heavily on international trade. The worldwide economic crisis that started in 2008 had a deep impact on the economy of the Netherlands. The Dutch economy suffered from a double dip in the period 2009-2013 and on average, the size of the economy decreased with -0.6% per year (table 2). The first dip was due to the international financial crisis. International trade dropped dramatically at the start of 2009 due to the credit crisis. International trade recovered quickly in the two years after, including Dutch export sectors in manufacturing.

Double dip because of debt crisis

The second dip was due to the debt crisis of governments, the private sector (especially the banking sector) and households. Government budget cuts and increase of taxes led to less domestic demand of households and the government. Households faced a long period of high unemployment risk, tax increase, and price drops on the housing market. Only recently, in the beginning of 2015, consumer confidence started to increase again. The second dip especially hit the private service sector (construction, retail, hotels and restaurants, business services).

Big impact for the Rotterdam economy

Also, the Rotterdam economy faced a double dip in 2009-2013. Of course, the first dip hit Rotterdam relatively hard in comparison with the national average due to high dependence of the port of Rotterdam on trends in international trade. The second dip however also has a more than average impact on the Rotterdam economy (see figure 31). Up to 2008 the growth of the Rotterdam economy was on the same level as the national average, but after the crisis Rotterdam and The Hague stayed behind.

The developments in The Hague can be explained by the government budget cuts. The second dip in Rotterdam can be explained by a relatively strong decrease in demand for both public services (public administration, education) and for the business service sector (finance, IT, real estate). The traditional sectors manufacturing, energy, construction and wholesale performed above the national average. Rotterdam also stayed behind in the period 1996-2003, the *hausse* period of business, IT and financial services in the Netherlands. Rotterdam was relatively less able to transform its economy into a service economy in that period. This growth pattern fits with the specialization of Rotterdam in goods and products with a low income elasticity.

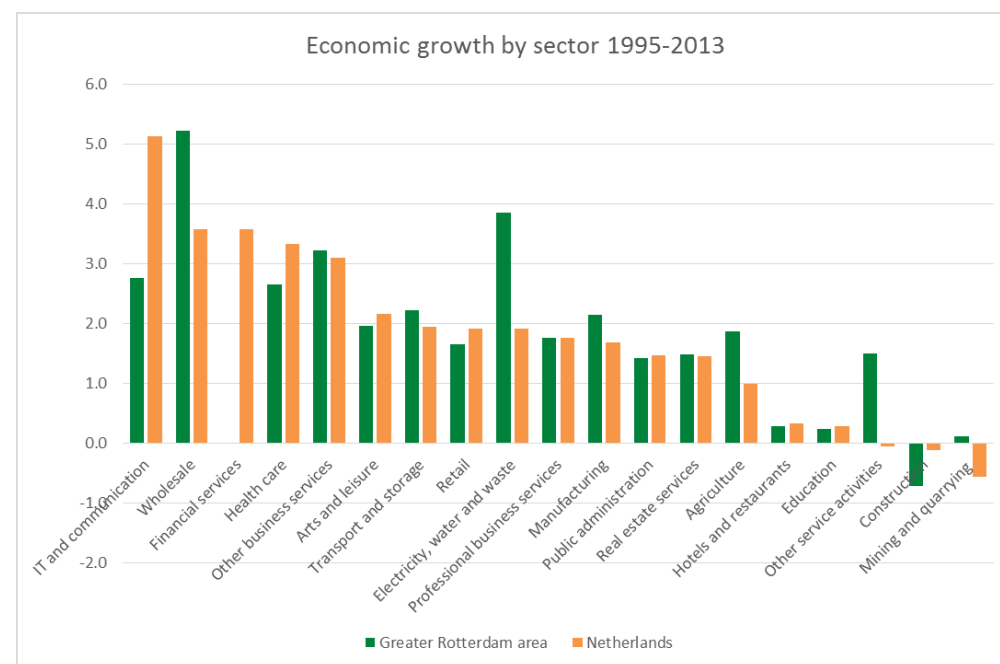
¹⁹ E. Glaeser (2012) *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier*, London: Penguin.

Table 3. Value added port of Rotterdam by sector, 2002/2013, basic prices, constant prices 2013. Growth rates in average annual percentages.

Source: Havenmonitor 2014.

Value added, prices 2013	2013	2002-08	2009-13	2002-13
Logistics	6.392	4,5	0,5	2,7
Transport	2.529	4,8	1,6	3,3
Sea shipping	181	3,5	-9,2	-2,5
Inland shipping	516	6,4	7,5	6,9
Road transport	1.618	6,4	1,6	4,2
Rail transport	89	-1,3	6,2	2,0
Pipes	125	-5,3	-0,6	-3,2
Services to transport	1.922	3,7	1,0	2,5
Storage	1.941	4,8	-1,1	2,1
Business location	6.112	3,7	0,9	2,5
Manufacturing industries	4.748	4,0	0,7	2,5
Food	318	9,2	-3,3	3,3
Oil	1.379	-1,3	10,7	4,0
Chemical	1.835	5,4	-1,2	2,4
Steel & metals	303	4,9	0,6	2,9
Transport means	123	-7,6	2,5	-3,1
Electric power	531	9,0	-8,2	0,8
Other	259	0,6	4,8	2,5
Wholesale	744	3,7	2,7	3,3
Business & other services	620	1,9	0,4	1,2
Rotterdam Rijnmond Sea harbor	12.504	4,1	0,7	2,6
Greater Rotterdam	51.997	3,0	-0,8	1,3
Netherlands	578.536	2,5	-0,3	1,3

Figure 27. Economic growth by sector in Greater Rotterdam area and the Netherlands, 1995-2013, in average annual growth of value added



3.4 Sector specialization of Rotterdam

Big impact of port-related sectors

To analyze the Rotterdam economy we look at the sector specialization of the Greater Rotterdam region in comparison with the Dutch economy (figure 32). Manufacturing, wholesale and transport and storage are top-3 largest sectors in the Greater Rotterdam region, based on the value added of 2013. These three sectors have sector shares between 10 and 12 percent and confirm the important role of the port of Rotterdam for Greater Rotterdam.

Largest national growth sectors are under-represented in the Rotterdam region

The top-3 largest sectors in the Netherlands are manufacturing, health and financial services. These three sectors are all relatively under-represented in the Rotterdam economy due to the dominant impact of wholesale and transport and storage. Also, the Greater Rotterdam region has a strong specialization in energy, water supply and recycling activities. Financial services and IT services are relatively under-represented the Rotterdam economy.

The value added of the port of Rotterdam for the Greater Rotterdam area²⁰ has an economic value of 12.5 billion euro in 2013, almost 25 percent of the total economy of Greater Rotterdam. In previous studies (f.e. TNO/EUR (2015)) it is shown that in terms of production value, the port of Rotterdam and the City of Rotterdam are almost of equal size. For the same level of output, the city of Rotterdam is able to add double the value added the port of Rotterdam adds. This can be explained by the economic function of the Port of Rotterdam as an international gateway of goods: a large amount of imports and exports, but a relatively small volume of added value creation.

Growth of the port outperformed the growth of the city in 2002-2012

The seaport activity in the Greater Rotterdam region shows a relatively high growth of 2.6 percent per year in 2002-2013 (table 3), twice the regional growth average of the region. Inland shipping, road transport, oil refinery and

manufacturing of food are the clusters in the port of Rotterdam with the highest growth volume. The growth takes place in whole value chain of the port of Rotterdam. Logistics, the business location cluster, and wholesale show a high growth volume. The port related business services show a modest economic growth of 1.2 percent per year in 2002-2013.

Between the two sub-periods 2002-2008 (high growth period) and 2009-2013 (low growth period) there are large differences due to the dramatic drop of international trade in the beginning of 2009. The economic activity of the port recovered in the years after 2009 and shows on average a growth of 0.7 percent per year in the period 2009-2013 (table 3). The total economy of the Netherlands and the Greater Rotterdam region decreased in the same period.

This section has shown that the region is highly specialized in transport and storage and wholesale. Also, the port of Rotterdam has been an important driver for economic growth in the region, both in the long run and after the start of the economic crisis of 2008. The impact of the Port of Rotterdam for value added growth is higher in comparison with employment growth due to productivity gains and capital investments.

3.5 Economic Growth in Rotterdam

In section 3.4 we focused on port-related activities in the Greater Rotterdam region. In this section, we take the sectoral composition of the Rotterdam economy as our starting point. Are there, besides the port, more economic clusters in the region that show high economic growth and/or economic specialization?

High-performing sectors in the Netherlands are lagging in Rotterdam

Figure 33 shows the sectoral growth pattern of Greater Rotterdam area and the Netherlands in 1995-2013. Five sectors show an average annual growth of more than 3 percent in the Netherlands: IT and communication services, wholesale,

²⁰ Port related activity in Zuidoost Zuid-Holland (Dordrecht region) and Shell Moerdijk (Province of Noord-Brabant) are excluded.

Figure 28: Sector growth and specialization in Groot-Rijnmond region, 1995-2013

Source: NEO observatory, based on CBS/LISA

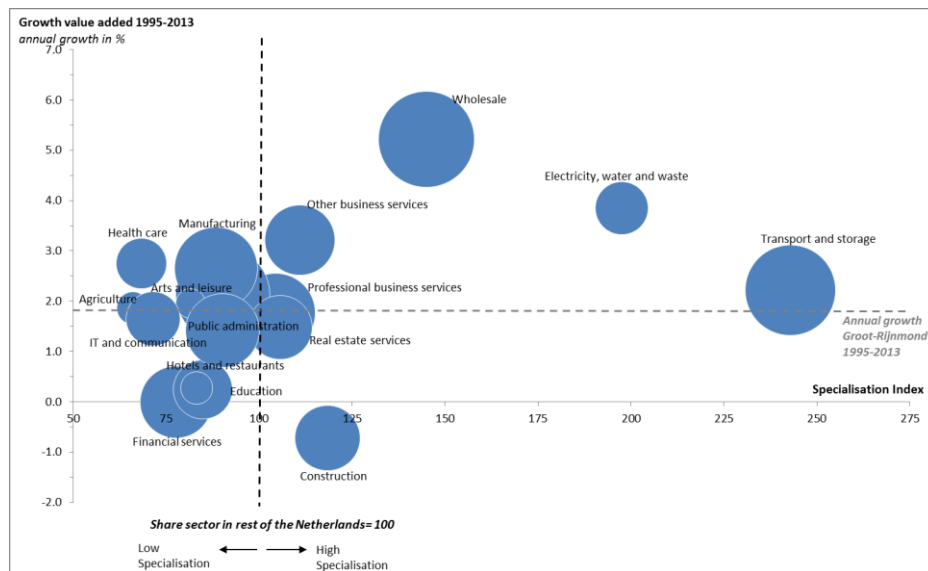
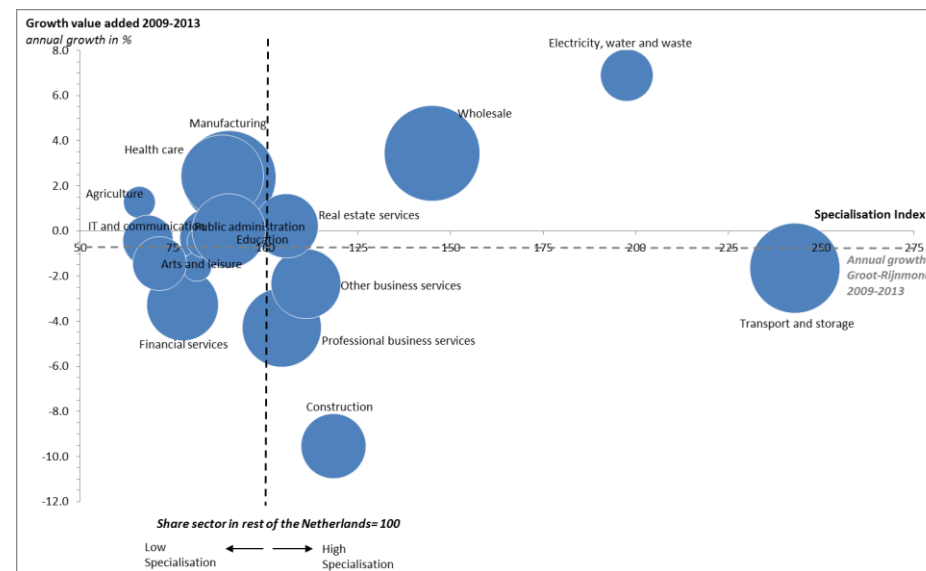


Figure 29: Sector growth and specialization in Groot-Rijnmond, 2009-2013

Source: NEO observatory, based on CBS/LISA



finance, other business services and healthcare. The greater Rotterdam area stays far behind in economic growth in IT and finance activities in the period 1995-2013, and also in health care. The greater Rotterdam region is a driver for national growth in wholesale. Other business services—employment agencies, cleaning, security, catering—show an equal growth pattern in Rotterdam and the Netherlands. Besides wholesale and other business services, electricity, water supply and recycling has been a growth sector in the Greater Rotterdam region in the period 1995-2013.

Figure 34 shows the economic growth in value added of about 20 economic sectors in combination with the specialization of the region in the sector (x-axis) and the size of value added (size of the sector dots). The specialization index is a Balissa-index that compares the relative size of the sector in the Greater Rotterdam economy with the rest of the Dutch economy. An index above 100 reveals specialization. A combination of high growth and specialization in a sector reveals comparative advantage of the region in the productions of goods and services of a sector.

The Greater Rotterdam region (Groot Rijnmond) shows a combination of high specialization (between 1.5 and 2.5 times the share in the economy as national average) and above average growth in three economic sectors:

- a. transport and storage
- b. electricity, water supply and recycling
- c. wholesale

Also, construction, professional services, real estate services, and other business services show a modest specialization. On the other hand, Groot-Rijnmond has low specialization in finance and IT and in consumer services (retail, hotels and restaurants, arts and leisure).

In the long run, no new sectoral clusters are clearly visible for Rotterdam to show comparative advantage. Health care and other business services show a high growth pattern, as in the rest of the Netherlands, but no clear specialization in Rotterdam. Of course, within sectors there can be niches for specialization. For example the chemicals sector within manufacturing in Greater Rotterdam.

What about the period after the economic crisis of 2009? In figure 35, a similar figure is presented of figure 34, only now with the growth pattern of 2009-2013. Economic dynamics in recent years show high growth in electricity, water and waste, wholesale, other business activities, health care and manufacturing. These sectors are promising, based on recent dynamics in value added. The transport and storage sector shows a decrease in value added of 1.6% per year. Also construction, finance and IT are hit hard by the economic crisis and do not show recovery.

3.5 Conclusion: Rotterdam offers goods & services with low income elasticity

Besides very positive observations and rankings of Rotterdam, the picture arising from long term economic development indicates that there is a task ahead. Economic growth in Greater Rotterdam deviates on the long term not much from the Netherlands. GDP in Greater Rotterdam increased on average by 1.6 percent a year over the 1995-2013 period, the Netherlands by 1.8 percent. The regional economy of Greater Rotterdam economy did not experience the strong growth development of the 1995-2001 period. That boom had to do with the strong growth of the financial sector, business services and the real estate boom in the Netherlands—but did not occur in Rotterdam. The regional economy of Rotterdam didn't supply these services or consumer services.

In general, the Rotterdam offers goods and services with a relatively low income elasticity. In economic upswings, Rotterdam lags behind, downswings do not affect the economy very strong. Labor market data show a relatively higher unemployment rate in the Rotterdam, and GDP per capita is relatively low. It is a highly capital intensive economy, but high value added services are not strongly developed in the region, such as IT services and finance. Health care also lags behind. The Greater Rotterdam region is specialized in transport and storage, energy/water/recycling and wholesale. These sectors are the main drivers of the regional economy. Moreover, agglomeration economies do not occur. The main economic relations of the region are with the rest of the world—due to the port—and expenditures within the regional economy are relatively small. Synergies between sectors within the region (crossovers) should be developed to generate income, expenditures and demand for labor.

Figure 36: Dominant segments in the regional economy of the Greater Rotterdam region are at a point of saturation.

Source: Weterings & Van Oort (2014)

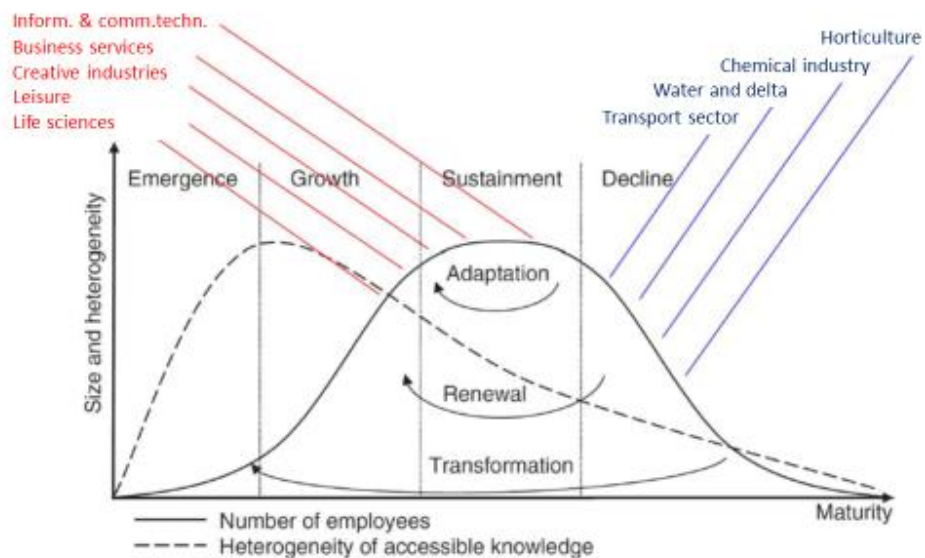
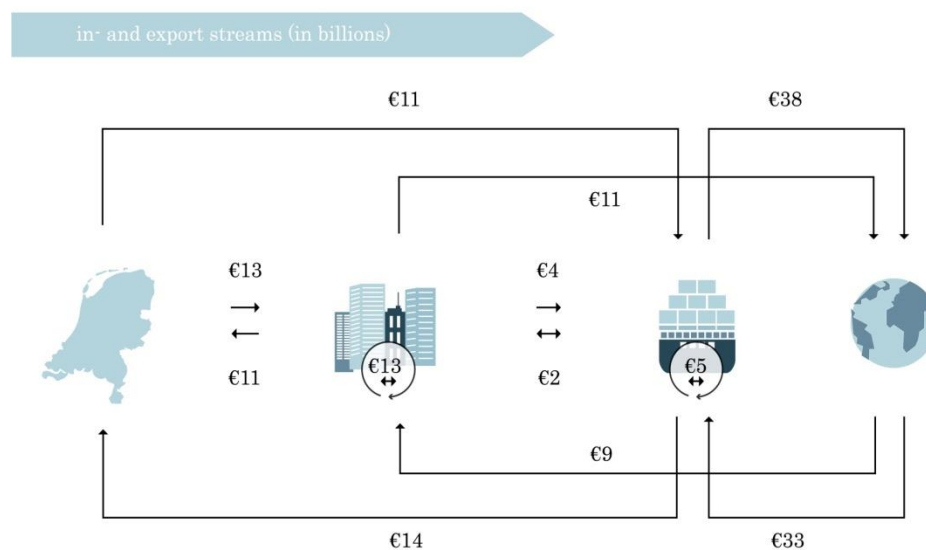


Figure 37: Only 4 billion euro is delivered from the city to the port: half of these deliveries are advanced business services (1.6 billion euro).

Input-output relations port and city of Rotterdam, billion euros 2008, Source: Manshanden & Kuipers, 2015.



4 Port-city synergies in Rotterdam²¹

4.1 Introduction: lack of agglomeration economies

An important characteristic of the Greater Rotterdam region, as presented in chapter 3, is that the level of regional economic growth was clearly below the growth of the Dutch economy as a whole in 1995-2013 (table 2) and that agglomeration economies did not occur. This means that the region is underperforming, given the large accumulation of economic activities in the Rotterdam economy, we would expect a much stronger growth in the Rotterdam region than growth at the same level as the Dutch average. Theory assumes that agglomeration advantages are available in extensive urban environments. These occur when numerous households and/or companies are found together, so that economies of scale arise. These include good infrastructure and a large labor supply. But the agglomeration advantages in Rotterdam remain limited because the diversity of industries is less evident due to the domination of the port cluster. In order to outperform the rest of the country, more branches of industry are required in the regional economy that grow at a faster rate than the national average.

Weterings and Van Oort²² also indicated relatively weak and poorly developed agglomeration effects in the Rotterdam region. They observed that the largest clusters in the Rotterdam region—transport & distribution, chemicals, horticulture and hydraulic engineering—are at a point of saturation (figure 36). The advice of Weterings and Van Oort is to look for agglomeration economies in the port for increased growth and innovation capacity in new combinations between sectors with innovation potential. An example of such a crossover is that between ‘industrial design’ and architectural and engineering firms. The port industrial cluster and the urban ‘design and technology’ cluster have clear knowledge connections with city-based service providers. In addition, advanced producer services, other business services and commodity trading are also crossovers

between port and city and have the potential for producing the desired agglomeration economies in the city of Rotterdam.

In this chapter, we elaborate on the cross-over of port and city and search for synergies between port and city.

The port of Rotterdam has an international, the city a national economic focus

At the moment this relation is weak (figure 37). The urban economy of Greater Rotterdam produced in 2013 a value added of 52 billion euro, the port was responsible for 13 billion euro of value added (table 3).

When analyzing input-output relations for the port and the city, it becomes clear that the port-economy has a strong international focus. Almost half of the total production value of 69 billion euro (48%) is imported: 33 billion euro (figure 31), and more than half the production value is exported: 38 billion euro (55%). These high import and export flows are responsible for the relatively low added value compared to total turnover (13 versus 69 billion euro).

The urban economy of Rotterdam has not a strong import/export focus with trade flows of respectively 12 percent (import) and 15 percent (export) of the total production value of the urban economy of 76 billion euro. The port of Rotterdam is a true export engine, the city of Rotterdam is mainly focused on the national economy—economic relations of 11 and 13 billion euro (figure 37)—and has also substantial internal deliveries.

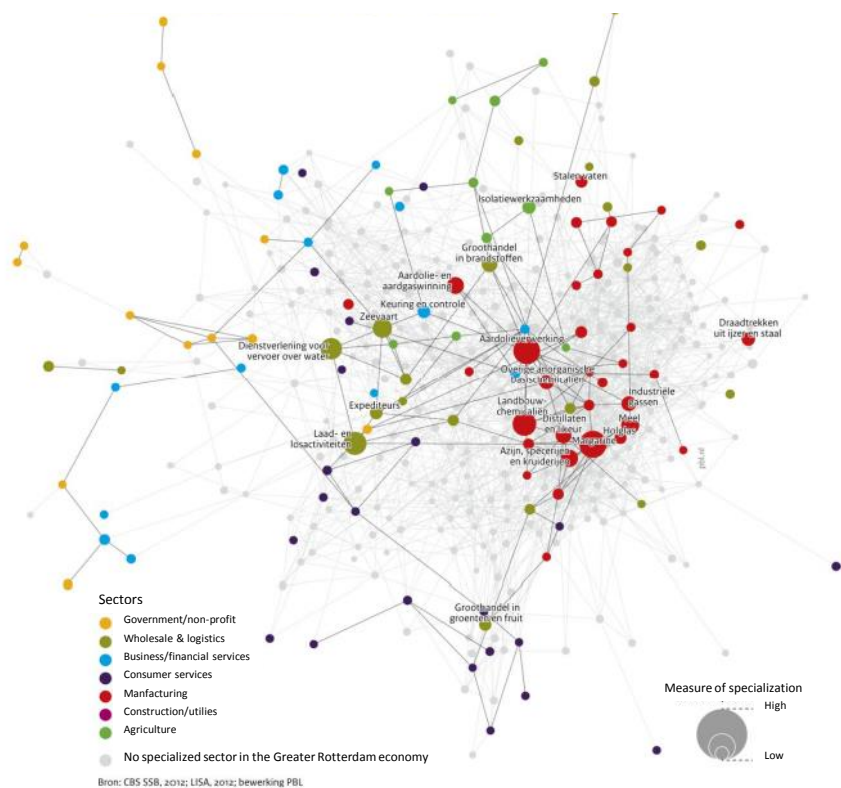
Alongside differences in size and export orientation, the relationship between city and port is characterized by relatively limited economic linkages between the two. With 4 billion euro, the city of Rotterdam delivers just 5 percent of total production value realized in the city to the port (figure 37). The port supplies even less to the city: 2 billion euro; 3 percent of total production value.

²¹ This chapter is based on a contribution by Prof.dr. Frank van Oort and dr. Wouter Jacobs of Erasmus School of Economics.

²² A. Weterings & F. van Oort (2014) Diversifiëring economie vergroot veerkracht regio Rijnmond, essay for Economische Verkenning Rotterdam 2014.

Figure 38: The Greater Rotterdam economy shows a heterogeneous economic structure. Different economic specializations in the Greater Rotterdam region are not very related, resulting in a low economic elasticity. Port activities (green) and petrochemicals and other industries (red) are an exception: they are well connected with respect to needed knowledge and skills.

Coherence between economic specializations in Greater Rotterdam region (COROP region Groot Rijnmond). Source: Weterings & Van Oort (2014)



A flourishing port translates not automatically into a flourishing city

The central message is that a flourishing port does not automatically mean that the city of Rotterdam will directly benefit from an increased demand for products and services, and vice versa. While the port of Rotterdam is much more sensitive to the outside surroundings than the city, domestic developments can be felt mainly in the city. It is therefore quite possible that port and city will develop separately. However, the main economic potential for both the port and the city is a mutual development into a maritime center, as indicated by the OECD²³. We agree with this potential and see these maritime cluster development as an important source for the development of agglomeration economies. Because of the importance of agglomeration economies for future growth of the Rotterdam economy, in the next section we pay detailed attention to the impact of agglomeration economies.

4.2 The impact of agglomeration economies

Lacking in most of Rifkin's analysis are the effects of agglomeration economies. One can argue that since the costs of information exchange and transfer have been reduced to nearly zero, the importance of face-to-face contacts for the exchange and diffusion of exclusive, tacit and customized knowledge actually increased²⁴. In a way this extends the argument of New Economic Geographers like Paul Krugman who have argued that when the costs of transportation drop this actually will lead to further geographical clustering of economic activity due to still high transaction costs (lower in agglomerations) and home advantages. Other New Economic Geography scholars²⁵ show why great cities started out as ports and continue to prosper even after their initial advantage (deep water access) became irrelevant. It was endogenous growth based upon increasing returns combined with the initial advantage of transport access that allowed port cities to lock-in self-reinforcing agglomeration economies. The success of cities such as London,

New York and Chicago—and more recently Singapore, Hong Kong, Shanghai and Dubai—is an illustration.

Three types of agglomeration economies are important:

- a. increasing returns to scale (cf. Krugman)
- b. localization economies: external effects resulting from concentration of similar type of industries
- c. urbanization economies: external effects resulting from concentration publically available amenities such as universities, schools, infrastructure, parks or government administration.

Dynamic urbanization economies: diversity and technological relatedness

Dynamic urbanization advantages are especially important. These advantages are associated with the benefits of concentration of a diversity of industries. This diversity results in inter-industrial cross-overs and 'new combinations' as a source of innovation and growth. These advantages also are called 'related variety' between industrial sectors²⁶.

Not all industries are closely (technologically) related and therefore are unlikely to make connections (e.g. hairdressing and chemistry). The Rotterdam region is an example of a region with a low internal relatedness between sectors (figure 38) Neffke et al (2011) looked at diversifying regions from the perspective of industrial technological relatedness. They found that regions diversify because of the entry of industries that are technologically related to the existing industries in the region and that regions refocus their economies by the withdrawal of industries that are technologically unrelated to other local industries²⁷.

²³ Merk, O. & T. Notteboom (2013) *Competitiveness of Port-Cities: the case of Rotterdam-Amsterdam, the Netherlands*, OECD Reg.Dev. Working Papers, 2013/08, Parijs: OECD.

²⁴ P. McCann & R. Ortega- Argilés (2014) Smart Specialisation in European Regions: Issues of Strategy, Institutions and Implementation", 2014, *European Journal of Innovation Management*, 17.4, 409-427.

²⁵ Such as: M. Fujita & T. Mori (1996) 'The role of ports in the making of major cities: self-agglomeration and hub-effect', *Journal of Development Economics*, 49(1), 93-120

²⁶ Frenken, K., Van Oort, F. and Verburg, T. (2007), Related variety, unrelated variety and regional economic growth. *Regional Studies* 41, 685-697.

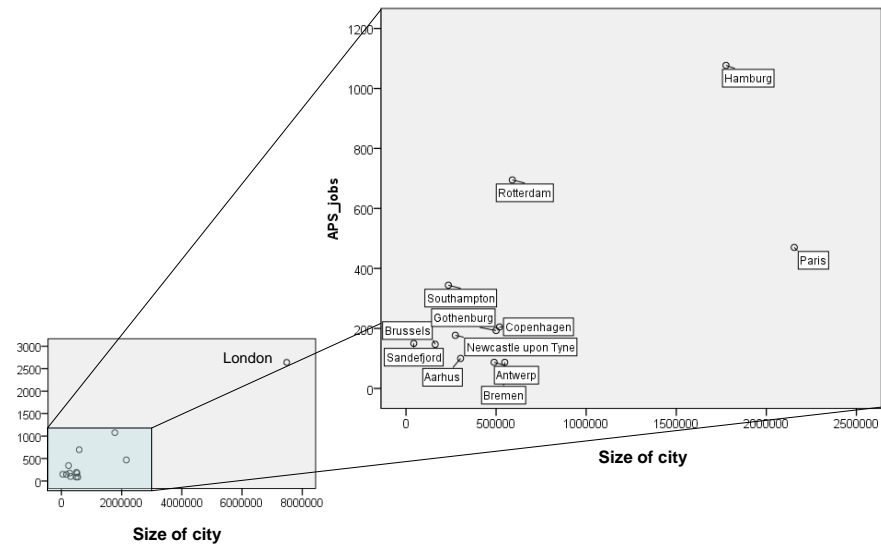
²⁷ Neffke, F., Henning, M. and R. Boschma (2011) How Do Regions Diversify over Time? Industry Relatedness and the Development of New Growth Paths in Regions, *Economic Geography* 87 (3): 237-266.

Figure 39: Borrowed size: small cities exhibiting some of the characteristics of a nearby larger city by ‘lending’ functions of larger cities and other agglomeration benefits, allowing it to perform better (borrowed performance) than when positioned in isolation.

Performance and functional dimensions of the borrowing size-concept
 Source: E.J. Meijers & M.J. Burger (2015) Stretching the Concept of 'Borrowed Size', GaWC Research Bulletin 442, <http://www.lboro.ac.uk/gawc/rb/rb442.html>

Dimensions of borrowed size		Connection size ↔ function	
		Less functions than expected given size	More functions than expected given size
Connection size ↔ performance	Performs less than expected given size	<i>Agglomeration shadow</i>	<i>Borrowed function</i>
	Performs better than expected given size	<i>Borrowed performance</i>	<i>Borrowed size (function & performance)</i>

Figure 40: London has by far the largest amount of jobs related to advanced producer services. The number of APS-jobs in Rotterdam is relatively high compared to the size of the city. Source: B. Kuipers et al. (2011) Rotterdam World Port City, Rotterdam; Erasmus University Rotterdam.



Urban agglomeration economies based on sharing, matching and learning.

The micro-foundations of urban agglomeration economies are based on sharing, matching, and learning mechanisms²⁸.

- a. *Sharing* benefits from indivisible and non-exclusive goods and tradable inputs, e.g. deep water access or specialized suppliers or, more recently, effects related to Zero Marginal Costs realized by information offered by apps, social media etc. Sharing residual energy is typical for Rifkin's analysis.
- b. *Matching*: labor market advantages of agglomeration. In an agglomeration the average worker can more easily find work that matches its skill-set.
- c. *Learning*: knowledge diffusion through labor mobility, imitation, entrepreneurship and other spill-overs is facilitated by spatial concentration.

Borrowed size: compensating for lack of scale

'Triumph of the City', the influential book by Edward Glaeser (2011) stresses the benefits of agglomeration found in large cities, in which the likelihood of the benefits increases with scale—mega-cities such as New York, London, Paris, Shanghai, Tokyo etc. The disadvantage of the relatively small scale of Dutch cities can be offset by the polycentric structure of the 'Randstad', the urban conurbation including the cities of Utrecht, Amsterdam, The Hague and Rotterdam. This can be realized by means of the concept of 'borrowed size'²⁹—provided there *is* something complementary to borrow, and that cities *want* to borrow from each other (figure 39).

²⁸ Duranton, G. and D. Puga (2004), *Micro-foundations of urban agglomeration economics*, NBER working paper series, working paper 9931.

²⁹ Van Oort, F., E. Meijers, M. Thissen, M. Hoogerbrugge & M. Burger (2015), *De concurrentiepositie van Nederlandse steden. Van agglomeratiekracht naar netwerkkracht*. Den Haag: Platform31.

4.3 Three types of port-city synergies

Three types of synergies are relevant to port-cities. The first is the location of a specialized maritime business services complex in the port-city. Although the link to physical port activities is not needed, in most maritime centers these links are available. The second type identified is the link of port-infrastructure with commodity traders. Although the city of Geneva is the most important location housing commodity traders at the moment, these traders increasingly diversify their operations into physical port activities. The third type of port-city synergies are related to the local availability of business service providers, understanding market fundamentals, facilitating transitions and managing the evolution of skill sets in anticipating industrial renewal, transitions and transformations.

(1) The location of a specialized maritime business services complex

Maritime business services—ship and trade finance, marine insurance, specialized legal practices et cetera—emerged historically in port cities like London, Amsterdam, Rotterdam, Hamburg, Oslo or Genoa, close to the trading and shipping activities they supported. The most important maritime business services hubs are currently London, Singapore, New York and Hong Kong and, to a lesser extent, Oslo, Rotterdam, Copenhagen, Shanghai, Athens-Piraeus and Hamburg³⁰ (figure 40-42). What is important is that all these cities have a strong maritime profile—be it a large port or a large ship-owners community. While the presence of daily operations in a port generates demand for these specialized services, not all these services are in real-time demand, nor do the services providers require a presence nearby the physical-operations of ports—indicating the importance of maritime complexes in cities like Paris or Madrid (figure 41). Financing a ship is a relational process performed in offices of banks and that of the ship owner's management. Insurance of ships and cargo is left to specialized brokers that need access to underwriting capital and to skills that understand risks.

³⁰Menon (2015) *The leading maritime capitals of the world*, report commissioned by Nor-Shipping and Oslo Maritime Network, Menon Publications 15.

Figure 41: Global hierarchy of maritime service centers.

Source: Jacobs (2009) World port city networks. Exploring the geography of advanced producer services in the global shipping industry, Rotterdam: Erasmus School of Economics.

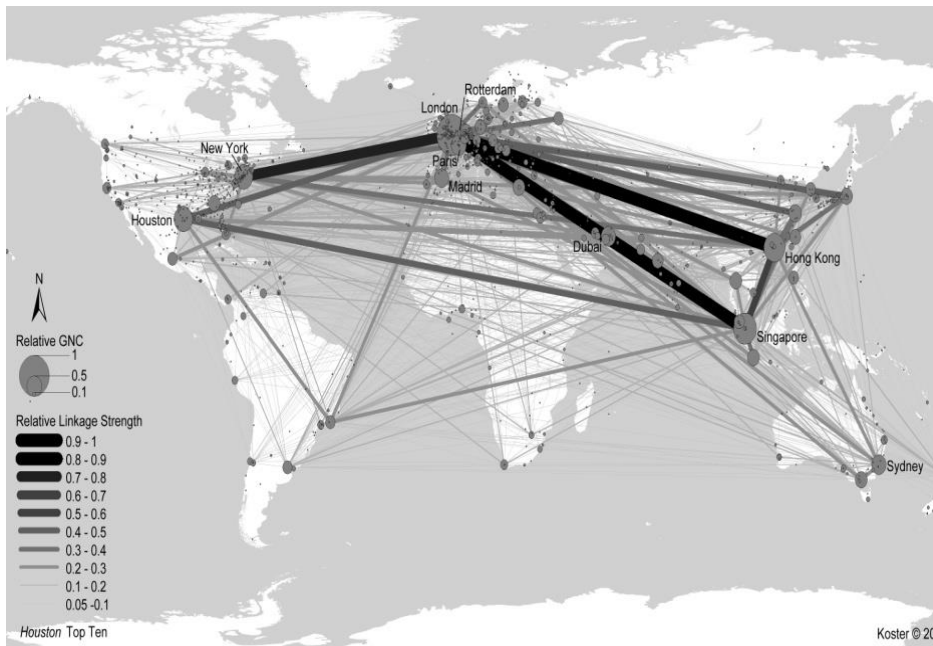
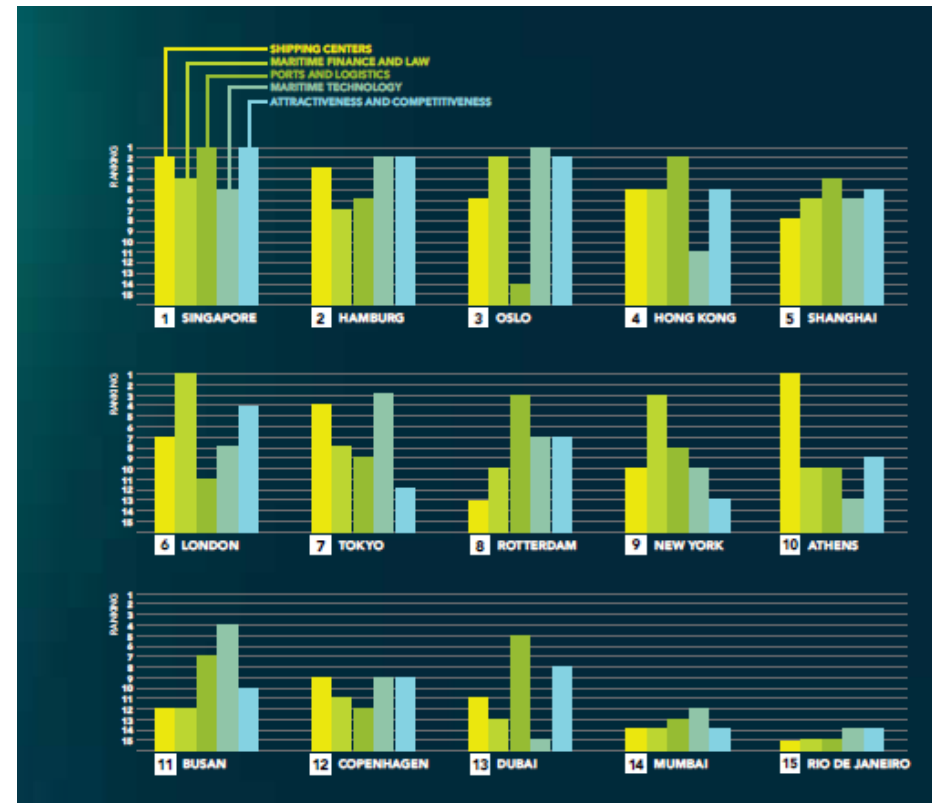


Figure 42: Rotterdam is the #10 Maritime Capital in the world. Rotterdam performs very well as a ports and logistics center but also has a strong position in maritime technology and attractiveness and competitiveness.

Source: Menon (2015)



What explains the dominance of London?

London's dominance is secured through some unique immobile assets such as the Lloyd's Market allowing the underwriting of all kinds of global risks associated with shipping and trade, the Baltic Exchange that reports maritime freight prices, the presence of the majority of the mutual insurance clubs for ship owners (P&I Clubs), a strong financial services cluster with specialists in shipping, a legal cluster based upon the jurisdictional advantage of English maritime law in international shipping contracts and of commercial law in standardized ship sale forms. So for London, it is especially the agglomeration of skills (and capital) and decision-making power of clients that explains the persistency of its maritime services cluster compared to the presence of a deep-water port. Nonetheless, other successful places such as Singapore, Hong Kong and Hamburg still have large successful ports and the nearby presence can generate benefits for business services in learning about new types of cargo handling activity, new types of processing and storage etc. (figure 36).

(2) The presence of commodity traders: the success of Geneva

The second activity having potential to increase port-city synergy and develop the desired agglomeration economies is the presence of commodity traders. Similar to business services, much of the trading merchants concentrated historically in transport hubs and gateways such as New York or Chicago. However, the location of trading desks nearby the actual physical flows it coordinates is not necessary anymore, considering the position of the landlocked city of Geneva as the leading commodity trading hub and the continued importance of London. Other major trading hubs are more recently developing in Asia (Hong Kong, Singapore, Shanghai) and the Middle East (Dubai), all are important seaports as well. This seems to confirm the evolutionary trajectory of American and European port cities.

But, what explains the success of Geneva? Several factors are responsible—amongst others: agglomeration factors:

- a. *Fiscal regime*: Geneva and other Swiss cantons offer generous tax incentives to commodity trading firms. In addition, wealthy individuals, such as traders, can make receive customized tax exemptions. Although tax incentives are

considered a necessary factor, it is not a sufficient one. More important success factors are:

- b. *Political Neutrality*: this has benefitted Geneva since the late 19th century with the influx of French traders seeking markets in British controlled colonies and later during the world wars and Cold War. It has attracted traders from across the world—Egyptians in the 1950s, Iranians in the 1980s, Russians in the 1990s and Arabs and Chinese in 2000s—in search of political security. The best example is Marc Riche who fled the US and laid the foundation for the major commodity houses Glencore, Trafigura and Mercuria.
 - a. *A favorable time zone*: location in CET allows for trading on Asian and North-American markets in 1 day.
 - b. *Access to capital*: Switzerland is home to many specialized banks and private wealth. This capital is needed as underwriting credit for trade finance constructions and adds liquidity into the commodities trading and derivatives market.
 - c. *Agglomeration (of skills)*: the ultimate driver of the success of Geneva as a trading hub are agglomeration benefits. It is estimated that the cluster employs 10,000 people and that around 500 companies are active in commodity trading and related business. It hosts specific skills in trading (paper and physical), in contracting, in trade finance, in managing risk and more and more in shipping & logistics. So there is a clear matching and learning advantage of being present nearby your peers, competitors and suppliers. As noted, such agglomeration economies also spur entrepreneurship through spin-outs, spin-offs and start-ups. Three examples illustrate this entrepreneurial dynamism.
 - First, Trafigura is founded by former employees of Marc Riche who left the firm (to be named Glencore) after the buyout of Marc Riche.
 - Second, Swissmarine is a spinout of Cargill's ship charter division and now transports 103 million tons of cargo annually.
 - Third, Quadra Commodities is a start-up of the former Australian Board of Wheat representatives that were based in Geneva to market their products, but started for their own.

Figure 43: Global oil trading hubs.

Source: W. Jacobs & M. Huijs (2015) havensteden als handelsplaatsen? Inzicht in de economische-geografie van de internationale grondstoffenhandel. Tijdschrift Vervoerswetenschap, jaargang 51 (3) 62-82. (www.vervoerswetenschap.nl)

The ultimate question is: will the commodity trader be 'creatively destroyed' as a result of the Third Industrial Revolution or will the commodity trader be best equipped to reap the benefits of it?



Port-city synergy: traders are increasingly linked to physical port infrastructures

The unique combination of skills in combination with trust, reputation and access to information is crucial for a trader to be successful. Traders need continuous information on geographical differences between supplies (storage), demand, price fluctuations, currency appreciations, the weather, risks etc.

Yet traders also hold positions in the physical handling of commodities performed in ports. Many traders have port-logistical assets (warehouses, tanks) and production facilities (refineries and smelters). Optimizing the operational side of these activities needs to be carefully coordinated with positions held by the trading desks. In terms of manufacturing, traders can add technical expertise regarding commodities processing and transformations to their skillset while simultaneously being able to enter new product-mixes or ‘new combinations’ of commodities (e.g. biofuels, LNG).

Impact of the Third Industrial Revolution: creative destruction traders?

Ultimately the question is: will the commodity trader—one of the oldest professions in the world—be ‘creatively destroyed’ as a result of the Third Industrial Revolution? Or will the commodity trader be best equipped to reap the benefits of it? Indeed while energy can be collectively produced and stored in the urban built environment and can be connected to world market through the energy-internet, at this moment other valuable commodities such as sugar, copper, nickel, rare earths, cocoa, potash cannot be transported by the internet or a smart energy grid. It is also highly unlikely that neighborhood collectivities can successfully trade against professionals employed at trading houses due to lack of scale, skills and intelligence on behavior of global market prices. Therefore, we expect commodity traders being still important in the Next Economy and a potential force in increasing port-city synergies.

(3) The enabling function of business services providers for transitions

The third type of port-city synergies are related to the local availability of business service providers, understanding market fundamentals, facilitating transitions and managing the evolution of skill sets in anticipating industrial renewal, transitions and transformations.

The international competitiveness of Dutch regions is strongly related with its capability to accommodate technological and economic transitions. The Dutch economy drives on a unique proposition of facilitating international trade through (a) a well-established manufacturing industry that (b) thrives on the import-export capacities of the mainports and (c) on an urbanized knowledge-based business services industry. This urbanized knowledge-based business services industry can facilitate commercially international transactions and synthesize industrial application of technologies on a global scale.

Rifkin suggests the availability of chances for urban economies for innovative and sustainable development using new and emerging technologies that locally and globally change the economic playing field. Picking up on this, there is considerable policy speculation on transitional concepts like bio-based energy, the circular and recycling industry, smart distribution, the clean-tech sector, smart production, biotechnological modified agriculture and new maintenance models for offshore industries (Rifkin 2011). Within these concepts, a variety of applications are aggregated, ranging from specialised niche markets (with appealing examples like FairPhone, EcoWatches, VirtualPlatform and AquaticDrones), to general purpose technologies like ICT-led services, robotization and mechanisation that make existing economies more efficient, to finally game changers like biobased derivatives related to energy and agriculture.

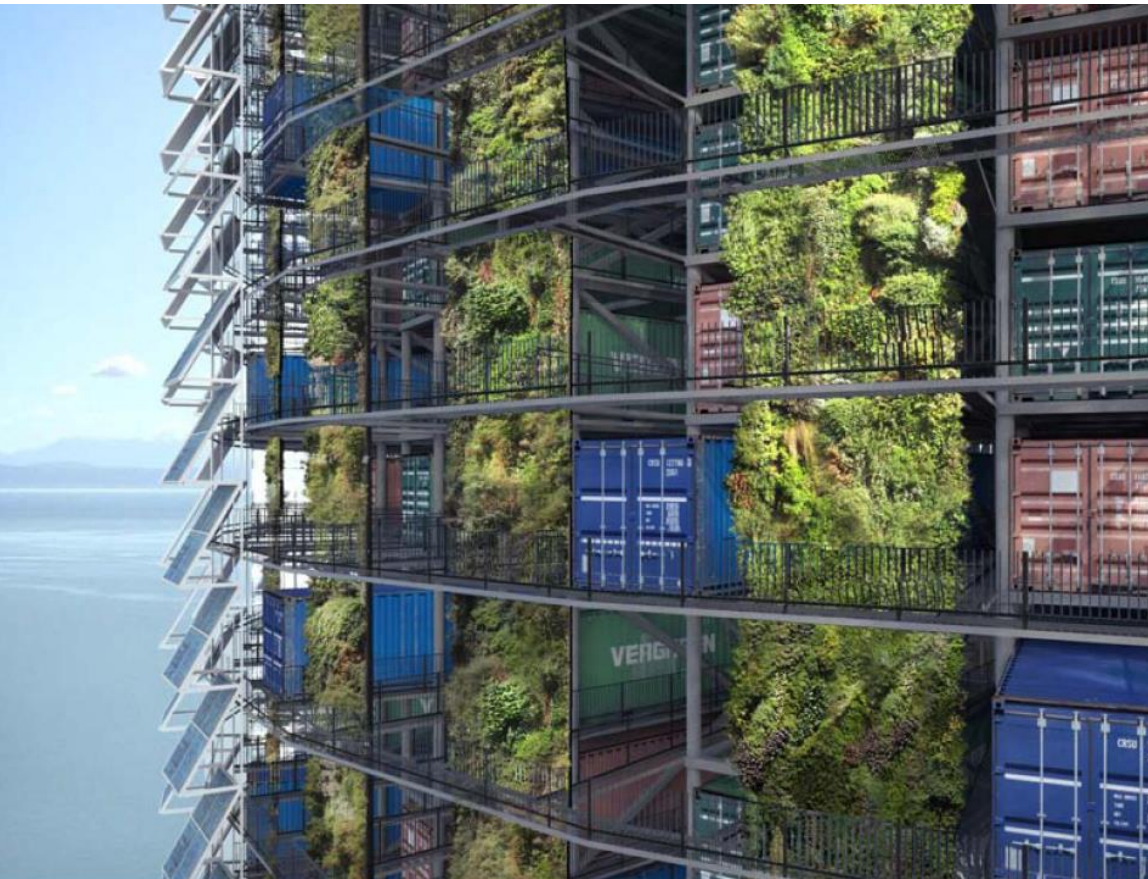
Such transitions and game changers are presented as technical realities and possibilities, but often in isolation of a business services industry that needs to cognitively understand its clients’ fundamentals and to facilitate these transitions morally, commercially and financially. In doing so, the business service provider co-evolves into new (possible global) niche market leadership itself.

Transitions can have serious economic and societal implications.

The competitive positions of for instance the chemical industry, oil refineries and freight distribution are under pressure. Employment changes of character or employment disappears. Existing positions in value chains are threatened—but new positions can also be gained. New professions emerge, with larger dependency on services and economies of scope instead of scale. Product- and cluster lifecycles evolve ever faster, causing dynamics but also uncertainty.

Figure 44: Port-city crossovers in Rotterdam; architects designing the container terminal of the future in close cooperation with container-industry experts. Designing skills combined with container handling insights.

Source: Casanova and Hernandez and Erasmus University Rotterdam (2012).



Crossovers and innovation focus on new niche markets—sometimes in line with the current strengths in (top)sectors, but sometimes deviating from these. Two challenges particularly come to the fore in the international literature of transitional innovation.

- The first concerns the observation that innovative transition processes take place in space, and are in some places more successful than in other³¹, suggesting that often neglected spatial conditions foster or hamper development processes.
- The second challenge concerns the multilevel governance structure that ideally should accompany innovative transition processes, involving stakeholders from various spatial, sectoral and functional levels³². Spatial embedding and conditions and governance will be at the heart of our project.

Every region wants to sort itself favourably for new opportunities for growth and innovation, especially after the recent years of austerity. Investments aiming for this are burgeoning: from campus development, cluster strategies, R&D development, initiating economic development boards, amenities provision for knowledge workers, venture capital provision, Foreign Direct Investment attraction, to city marketing. But not everyone can be a winner.

What does it take for urban regions to become successful in diversifying and restructuring its existing economic structure, in order to reap the benefits of transitions while avoiding the drawbacks?

Transitional innovations small and large: skill-relatedness

Economic and innovation sciences provide us with some important clues as how to answer this question for the Netherlands. The character of innovations and transitions are determining its success. Most innovations are incremental rather

than radical in character, and are fuelled by crossovers between existing and skill-related specializations in clusters, regions and cities³³. Recent research on cross-over potentials of Dutch clusters suggests that labour mobility, skill-intensity and skill-relatedness are crucial determinants of their future diversification and innovation capacities³⁴. Companies and employees from skill-related branches of industry have overlapping knowledge bases, facilitating intercompany communication in shared knowledge, frames of reference and applied technology. The fact that this overlap is only partial means that there is room to learn. Other forms of innovative knowledge transfer, like R&D cooperation and spin-offs, are highly correlated to human capital and skill stocks. Such an evolutionary perspective on recombination and diversification helps identifying local opportunities for specialised niche markets and applications of general purpose technologies that we already know. But for game-changing transitional innovation, previously unrelated technologies and complementary skills may be needed that not automatically evolve from a region's or cluster's current specialisations³⁵.

Mainport & metropolitan economies in tandem

Especially larger economic regions seem better equipped for such diversification and adaptation of new technologies. Their locally larger and diversified specialisations portfolio enables better matching and connecting to each other – linking economies of scope with economies of scale³⁶. Larger regions also profit from agglomeration advantages, ranging from labour market sharing, the provision of services, knowledge spill-overs from nearby universities and entrepreneurship, and lower search and transaction costs for subcontracting and contracted supplies (Glaeser, 2012). Recent research suggests that the largest chances of transitional renewal in Dutch regions are in the North wing (Amsterdam Metropole Region) and South wing (the Metropole Region

³¹ Coenen, L., P. Benneworth & B. Truffer (2012), "Towards a spatial perspective on sustainable transitions". *Research Policy* 41: 968-979.

³² Smith, A., J.P. Voß & J. Grin (2010), "Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges". *Research Policy* 39: 435-448.

³³ WRR (2013), *Naar een lerende economie. Investeren in het vermogen van Nederland*. Amsterdam: Amsterdam University Press.

³⁴ Van Oort, F., A. Weterings, L. Nedelkoska & F. Neffke (2015), *Ruimte geven aan economische vernieuwing. Een onderzoek naar arbeidsmobiliteit en skill-gerelateerdheid in Nederland*. Den Haag: Ministerie van I&M.

³⁵ Castaldi, G., K. Frenken & B. Los (2015) Related variety, unrelated variety and technological breakthroughs: an analysis of US state-level patenting. *Regional Studies*: 767-781.

³⁶ Frenken, K., F. van Oort & T. Verburg (2007), "Related variety, unrelated variety and regional economic growth". *Regional Studies* 41: 685-697.

Rotterdam-The Hague) regions of the Randstad, although complementary specialised clusters are also present in other regions, like Brainport Eindhoven and FoodValley Wageningen (Van Oort e.a. 2015).

Crossover skills and knowledge that is needed for transitional change are complex and diverse. The creation and exploitation of bio-fuels for instance needs expertise from present day chemical industry, agricultural production and horticulture, micro-biological research, health science R&D and enabling service providers³⁷ (Janssen 2015). Local stocks of employees combining these skills are natural ambassadors of such crossovers—but also are rare. It is suggested that the complementary economies of the mainport (production and distribution oriented complexes of the Amsterdam and Rotterdam ports) and metropolitan regions (Amsterdam and Rotterdam-The Hague, focused on services and offering spatial conditions for knowledge-intensive development) have large networked opportunities for embedding the future crossovers needed for (small and large) innovation and transitions (Merck 2014, Van Oort et al. 2015).

4.4 Conclusion

Alongside differences in size and export orientation, the relationship between Rotterdam city and port is characterized by relatively limited economic linkages. With 4 billion euro, the city of Rotterdam delivers just 5 percent of total production value realized in the city to the port. The port supplies even less to the city: 2 billion euro; 3 percent of total production value realized in the port. The central message is that a flourishing port does not automatically mean that the city of Rotterdam will directly benefit from an increased demand for products and services, and vice versa. While the port of Rotterdam is much more sensitive to the outside surroundings than the city, domestic developments can be felt mainly in the city. It is therefore quite possible that port and city will develop separately. Agglomeration effects in the Rotterdam region are relatively weak and poorly developed. The largest clusters in the Rotterdam region—transport & distribution, chemicals, horticulture and hydraulic engineering—are at a point of saturation.

³⁷ Janssen, M.J. (2015), *Service innovation in an evolutionary perspective*. Dissertation, Eindhoven University.

Increased growth and innovation capacity in the region can be obtained by new combinations between sectors with innovation potential. The port industrial cluster and the urban ‘design and technology’ cluster have clear knowledge connections with city-based service providers. In addition, advanced producer services, other business services and commodity trading are also realizing crossovers between port and city and have the potential for producing the desired agglomeration economies in the city of Rotterdam.

Three types of synergies are relevant to port-cities.

- a. The first is the location of a specialized maritime business services complex in the port-city. Although the link to physical port activities is not needed, in most maritime centers these links are available.
- b. The second type identified is the link of port-infrastructure with commodity traders. Although the city of Geneva is the most important location housing commodity traders at the moment, these traders increasingly diversify their operations into physical port activities.
- c. The third type of port-city synergies are related to the local availability of business service providers, understanding market fundamentals, facilitating transitions and managing the evolution of skill sets in anticipating industrial renewal, transitions and transformations.

Transitions and game changers are presented as technical realities and possibilities, but often in isolation of a business services industry that needs to cognitively understand its clients’ fundamentals and to facilitate these transitions morally, commercially and financially. In doing so, the business service provider co-evolves into new (possible global) niche market leadership itself. For game-changing transitional innovation, previously unrelated technologies and complementary skills may be needed that not automatically evolve from a region’s or clusters current specialisations. Especially larger economic regions seem better equipped for such diversification and adaptation of new technologies.

5. Vision on the Next Economy by Rotterdam stakeholders

5.1 Introduction

What is the impact of the Third Industrial Revolution for the average inhabitant of the Metropole Region Rotterdam-The Hague in 2040? This is the dominant question that will be answered in this chapter.

This chapter is based on three workshops that took place in September 2015 (see Appendix for attendees). In each of these workshops a distinctive group of experts has been invited. In the first workshop entrepreneurs active in the ‘new manufacturing’ and experts in transition management working in the city of Rotterdam, together with members related to the Rotterdam Maritime Service Community, were present. The second workshop was devoted to energy issues and to the dynamics of the energy internet. In the third workshop the container-industry was the dominant theme. In the workshops a diverse composition of experts was pursued with members from the (port) business community, academia and policy-makers.

The goal of these workshops was to formulate a vision by Rotterdam stakeholders on priorities for the Next Economy, anticipating the advice prepared by Jeremy Rifkin and his team, and to formulate policy actions, needed for a successful transition process (chapter 7). This chapter is solely based on the workshops and the views stated by the experts, no additional information in this chapter has been added by the authors apart from the highlighting of certain issues and the concluding remarks.

5.2 Issues

Rotterdam identity: oil, scale, arrogant...difficult to match with Next Economy

The identity of the port and city of Rotterdam is very important. “Make it happen” is the current slogan of the city, indicating a ‘do-mentality’ and ‘makeability’. This Rotterdam identity is in addition very much characterized by ‘being the largest/biggest.’ The port of Rotterdam is driven by economies of scale. This is very difficult to match with the decentralized Third Industrial Revolution—which is about performing activities in a very small, diverse, creative and connected way.

Oil is central in the DNA of the port of Rotterdam.

It is recognized that ‘oil’ is central in the DNA of the port of Rotterdam. Especially refining and low value added activities like storage, transport and the production of base chemicals—instead of ‘performance’ chemicals—are characteristic of this DNA. Large scale transport is also an important part of the port of Rotterdam-DNA.

In addition, Rotterdam is arrogant: there is a big confidence in Rotterdam that petrochemical clusters may decline in importance in Europe, or even disappear altogether, but that Rotterdam will be the last cluster remaining. This because of its scale and excellent logistics infrastructure. The same is true for Rotterdam as a container port: it is not part of the Rotterdam mindset that there is a future possible in which Rotterdam will not be Europe’s largest container port, having the advantage of superior maritime accessibility for larger and larger ships (as is presented in chapter 2 of this report).

...but also problem solving capacity and experimenting are part of the DNA

‘Problem solving capacity’ and ‘experimenting’ are also part of the Rotterdam DNA. In the past, ambitious projects with an uncertain outcome have been started, such as digging the Nieuwe Waterweg canal or the development of the first robotized container terminal by ECT and US container carrier Sea-Land.

Possible futures, transitions and scenarios

Jeremy Rifkin sees the Zero Marginal Cost Society and Third Industrial Revolution as a very possible and attractive future. However, there are always new disruptions and therefore, the world is too complex for only one or for two scenarios. It is important to distinguish between policies to be taken anyhow—‘no regret actions’—and more risky policy-actions, however actions not being irreversible is an important condition for future oriented policy making.

Sense of urgency for a transition is not yet present in the port of Rotterdam

Transitions are a gradual process and the challenge is to let a transition ‘breathe’ during its implementation. A very important question related to transitions is the pace of the transition and the question to what extent include vested interests in the port in this transition. Current programs including these vested interests—like the Rotterdam Climate Initiative—do not convince. The sense of urgency for a transition in the port of Rotterdam is not yet present. The main question therefore is: how is the sense of urgency to be developed? What really drives a forceful transition of the port?

To realize a transition, stakeholder management is very important.

To be able to realize a transition, stakeholder management is very important. The drivers or incentives of people and firms to be included in the transition is a very important starting point: what are these incentives and opinions, how will stakeholders behave? In addition, big firms have much power to be able to change and usually manage large parts of supply chains. So it is needed to include these large firms very actively in the transition process.

Include the citizen in the Metropole Region in the transition

To what extent are the citizens of the Metropole Region related to this transition? Do they have the right mentality for a transition? This is the same question as ‘who is the prosumer of the future’? Is the lawsuit of Urgenda against the Dutch government with respect to CO₂ really an issue for the average citizen—doing his shopping of ‘pop-chicken’ at the ‘kilo popper’? Is the drive in the Netherlands for instance comparable to the positive German mindset with respect to the German energy transition (Energiewende)?

It is advised to start experiments with stakeholders in living labs/game situations to see how people react in new situations and to gain information on how to effectively organize transitions. How to include outsiders in transitions for instance.

3D-printing: not yet on the agenda of most port stakeholders

3D-printing is seen as a very promising technology. However, it is a technology waiting for breakthrough developments before the start-up phase is realized. The 3D-printing revolution will have a serious impact on the port of Rotterdam because goods will be produced on individual customer order in the neighborhood or even at home by ‘prosumers’. This means that production of large quantities of goods for possible consumers and large quantities of goods that never will be sold—and dumped in less developed markets—will be replaced by the production of individualized goods. The globalization model of China (or Asia) as the ‘workshop of the world’ will be undermined by 3D-printing. This will have serious consequences for the container industry. The effects of concepts like near-sourcing, re-shoring, the circular economy or 3D-printing on future volumes are not on the agenda of most of the players in the container industry—however, with certain exceptions, such as Ben Vree, director at APM Terminals.

Regional welfare will increase by the 3D-printing model.

The distinction between prosperity and welfare is very important. Regional welfare will increase by this 3D-printing model, because welfare is not measured by the size of material flows, but by customer satisfaction and by independency. Because of positive welfare effects, combined with much more efficient material flows and less waste, the 3D-revolution should be encouraged by government policies.

What makes a prosumers and is driving collaborative commons networks?

At the moment, prosumers are very much associated with owners of solar panels or people using—or already possessing—a 3D-printer, having a kitchen garden or building their own house. But what really identifies a prosumer from a consumer? What is a first step in the development towards becoming a prosumer? An important issue is the way in which an individual citizen of the Metropole Region will become part of complex networks associated with collaborative commons and the IoT. This demands certain personal skills and attitudes.

The question is what type of skills will be needed by the average citizen to become part of the Third Industrial Revolution or become a real prosumer. What are the related skills demanded by the Next Economy?

This asks for ‘maker-skills’, self-organizing skills or the possession of networking capabilities instead of traditional values related to traditional blue or white-collar work. Think of skills like social-entrepreneurship and challenging people. Also, skills that enable people to handle change.

Also, the rules of the game, the governance structure or etiquette needed to participate in collaborative commons networks are important. Social transparency is seen as an important condition to participate in collaborative commons networks.

The rise of prosumers might be stimulated by giving people actively access to new technology, like 3D-printing. Governments have a responsibility in stimulation access to technology, especially at primary school level. By giving access to technology, a positive effect on the number of start-ups is expected.

Preferences of individual citizens are leading. Preferences are changing fast.

The preferences of individual citizens are leading. These preferences are changing fast. There is a real drive of the younger generation to get rid of the carbon economy. The traditional pride of many inhabitants of the city of Rotterdam with respect to Royal Dutch Shell—one of the important employers of the Metropole region with offices in The Hague and Rotterdam, the big refinery and related petrochemical facilities in Pernis and the important Projects and Technology Head Office in the city of Rijswijk—is not self-evident anymore for the younger generation.

Losers of the Third Industrial Revolution

A large number of jobs will disappear in the Third Industrial Revolution, think of the middlemen in the port-economy, like shipping agents, forwarders and other information brokers. An effect of a revolution or new paradigm is that certain functions become obsolete. What are those functions? And will they easily be absorbed by new functions?

Who are the have-nots and outsiders in the Third Industrial Revolution?

The construction of the IoT has a very large demand for construction labor. After the networks have been constructed, new technological revolutions will emerge. The expectation also is that the amount of leisure time in the future will increase and that the concept of prosumers will blur the distinction between work and leisure time. The increased promise of extra leisure time—and even a Leisure Society—was also a very 1970s theme, that has not been realized yet.

Governing the city in 2040: a leading role for cities is expected

A lot is expected from cities (or Metropole) governments in the future. But how is the local government functioning in 2040? What are the means and expected earnings of cities? Is employment-policy a task for cities in 2040? However, because of the decentralized nature, a leading role for cities is expected.

Models like ‘the entrepreneurial state’ are seen as attractive. But is the state or the local level best equipped for this entrepreneurial drive? The German ‘Energiewende’ is seen as a powerful example of the entrepreneurial state. But what is the relation between the city government and the national—or even European—government level? Is it possible to design a local energy-policy, conflicting with national policy goals?

Long term consistency of policymaking however is an important condition for policymaking by all government levels.

There is indeed a need for a broad definition of urban complexes, instead of limiting the city to the legal city borders, a much broader regional concept is needed like the ‘Metropole Region Rotterdam-The Hague’ or even better ‘The Randstad’ region, including Amsterdam, to be able to compete on a global scale.

Port stakeholders are unable to see that IT-innovations are changing the business environment much faster than expected.

Governing the port in 2040

The port of Rotterdam is seen as very conservative and stakeholders are still stressing the importance of traditional infrastructure. The port stakeholders are unable to see that IT-innovations are changing the business environment much faster than expected. Key-decision variables in the port are still very traditional.

The Port of Rotterdam continues its thinking in increasing the amount of ‘tonnes and TEUs’ for the port instead of increasing added value for the port. The discussion on “types of cargo-flows desired or not desired for the port” is not yet an issue. At the moment transition-professor Jan Rotmans is working for the Port of Rotterdam Authority, the prime target is producing a culture-change in the port, including the Port of Rotterdam Authority.

Most strategic decision making concerning the port is located in head-offices in the US or Asia

Decision-making regarding the port of Rotterdam is concentrated in corporate headquarters abroad or elsewhere in the Netherlands. Container terminal operators ECT and APM Terminals have owners in Hong Kong and Denmark—APM Terminals has its global corporate headquarters in The Hague—, Exxon Mobil is US-based and Shell has its global headquarter in The Hague and London. This means that business leaders do not live in the city and that the ‘local buzz’ with respect to senior port managers is limited. Also, close and informal corporation between senior port management and the local government is difficult because of this absent corporate decision power in the city.

Port governance is focused on traditional investment projects well suited for the Second Industrial Revolution.

In addition, current port governance is very much focused on traditional investment projects well suited for the Second Industrial Revolution but not for the Third. In addition, the IoT is a global phenomenon, with an impact much wider compared to the geographically bounded span of control of the Port of Rotterdam Authority. The Port of Rotterdam Authority is a possible party to invest in the new infrastructure demanded by the IoT (sensors).

A pro-active Port Authority is needed showing dare and entrepreneurship

Especially, a pro-active Port Authority is needed, showing entrepreneurship and dare towards the development of a new IoT-infrastructure—a quality missing at the moment. The Port Authority is seen as the most suited party to manage this infrastructure and to stay neutral as an IoT-infrastructure manager.

Will there be a role for forwarders?

Big forwarders are also suited for the management of the logistics internet because they are able to integrate chains and stop the fragmented nature of chains, especially with respect to data-management. Rifkin, however sees the role of middlemen like forwarders and shipping agents disappear because chains will become totally transparent so data may be shared by all the parties in maritime logistics networks.

At the moment, middleman—forwarders—are defending their positions in maritime chains and their own partial interests with respect to counteract information sharing and transparency. These middleman have a very strong position in maritime chains—the ‘merchant haulage’ managed chain is by far the dominant model. They are working very much based on ad-hoc contracts and are hiding their data-sources. Therefore, it is expected by the industry that the position of middlemen/forwarders will remain strong. Despite the conservative attitude of these parties, the central position of middlemen in maritime chains makes that they are judged as being best equipped as maritime chain managers in the coming decades.

The sense of urgency for the IoT in the port of Hamburg is much higher.

The Hamburg Port Authority sees a role in the pro-active development of the Internet of Everything, a cooperation together with Cisco. In Hamburg, there is a focus on small shippers to stimulate business opportunities related to the IoT. This

focus on SME’s is important. But there is also potential to improve other business processes by SME’s in the port, such as the back-office activities before giving priority to the IoT. The sense of urgency for the IoT in the port of Hamburg is much higher compared to Rotterdam because of big losses in container throughput and because of the problems related to the problematic connection to the sea via the River Elbe. In addition, Hamburg is a hot spot for the forwarding world, because of the corporate head office (and university) of a big forwarder like Kuehne+Nagel.

The port in 2040: skills, skills, skills.

The port of Rotterdam is very dependent on the state of the global economy and world trade. Seaports are always following broader economic trends and are rarely able to influence important economic developments. The service providers in the port region are facilitating the important supply chains moving through the seaports and are connecting different related parties.

Important skills are scarce: such as software engineers and IT-professionals

The diversity of different disciplines that is available in the city of Rotterdam—finance, law, creative class, government, academia—is an important strength for the development of a maritime cluster. However, certain crucial skills are missing, such as software engineers and IT-professionals. This is a potential problem for the development of the Third Industrial Revolution: there is a need for very high talented professionals in the port—next to professionals with more professional skills (MBO/HBO). The region is however lacking such a talent pool. The new wave of the Third Industrial Revolution should be accompanied by a new wave of highly skilled port talents.

Developing the right skills and a wide range of skills is very important. High-skilled jobs are both located in the port area and in the port-city. The link between physical assets and certain port-related functions usually based in the city—commodity traders or shared service centers—becomes increasingly important.

The knowledge-intensity demanded by commodity traders is increasing and they are demanding this wide range of skills. When commodities and raw materials are becoming scarcer, supply chains increasingly stay closed because of supply security issues.

A very important skill demanded in the port area is increasing efficiency in operations by means of smart solutions. Operational excellence resulting in more (energy-) efficient operations has been a priority in—especially—the port-industrial complex during the last decades. But also, increasing the efficiency in logistics supply chains by smart logistics design is a strong capability of the Rotterdam area.

Agglomeration economies related to skills are crucial for the Next Economy

The global-local connection is important and agglomeration economies related to skills are crucial for the Next Economy. Becoming a ‘raw-material or gas roundabout’ is important to be able to produce new combinations in commodity trade and receiving information advantages. ‘Proximity’ is an important condition for realizing these agglomeration effects.

Skills for commodity traders are for instance concentrated in Geneva related to—next to a large number of traders being localized in this city—fiscal opportunities, the political-neutral status of Switzerland and the local availability of human capital (see chapter 4). With respect to Geneva as a place for doing business, the high-costs associated with the city and the lack of a creative and swinging urban environment are becoming a disadvantage for Geneva. This means opportunities for both Rotterdam and The Hague. Rotterdam is perceived as an increasingly attractive city because of the vital logistical infrastructure available—increasingly owned by commodity-traders. The Hague is seen as a competitor for Geneva as the global city for ‘peace and justice’.

Skills are also a very relevant issue in the container terminal industry, an example of a type of port-activity demanding much more highly-skilled personnel together with much more sophisticated software than in the past. The processes are becoming increasingly complex. The question however is, how to add high added value to container operations in the port region.

A Silicon Valley for the container industry?

The port of Rotterdam houses some important firms in the automation of container terminals around the world, such as TBA, ABB or Navis. Also, Delft University of Technology and Erasmus University are very strong in research in container operations. There seems to be potential for bundling this knowledge into a strong regional spearhead (proximity).

Industrial variety is weak in the Metropole region

Nearness of important inputs is a very important characteristic of successful economic clusters like Silicon Valley: think of access to people with the right skills, to ongoing innovation, flexibility and to investment capital, together with a very competitive and entrepreneurial local atmosphere. In addition, Silicon Valley is home to competences to be used in a wide array of markets and industries. This last quality is missing in the port of Rotterdam. The variety of industries is rather limited in the region, next to the container and logistics industries only the oil and chemical process industry is localized in the region, making the economic base rather small.

Crossovers between port and city

Knowledge based qualities are—to a certain degree—available in the container industry in the Metropole Region. There is also a link in the region—or even a crossover—between service providers for the container industry and commodity traders in the city. Finally: the availability of local container operations and—next to localized knowledge—localized experience is very important.

Lack of IT- and software specialists however is another weakness of the region compared with cities like Utrecht. There is a strong competition for students with the right skills between the port-related service providers and other industries, like big financials. This demands active policy making in primary schools to link students to IT-jobs and to port related functions.

Developing a campus or another suitable location for these high-end service providers to the container industry should be located near Delft University of Technology to link the firm to future employees with the right skills. The industry has a strong relation with academia and several firms are offering internships and give guest lectures.

Also the link with the city is very important: the interconnectedness between the port and city is of vital importance for the creation of an attractive location of doing business for the advanced service/IT-firms. This demands a comprehensive approach going beyond issues like cheap housing.

The future of oil is too risky and volatile for a sustainable future of the region.

Rotterdam is addicted to oil. Oil and related petrochemicals were, are and will be very important for the wealth of the Metropole Region. But the future of oil is too risky and too volatile for a sustainable future of the region and has important geopolitical relations.

The increasing demand for energy is the underlying problem, not the demand for oil. This continued demand for energy in Europe offers important future challenges for the logistics function of the port with respect to biomass and alternatives.

Rotterdam, the sustainable energy hub of the future

It is very important for the port of Rotterdam to remain a logistics energy hub in the future. But this has to become a sustainable hub. Hydrogen is a possible future for the position of Rotterdam as energy hub and also Rotterdam has potential as a biomass hub related to large scale transport and needed storage for biomass.

This large and increasing demand for energy makes decentralized energy-prosumers not a real option for the future, because of small and fragmented

supply. The price-uncertainty related to oil however is less an issue for wind and solar energy, an important advantage for both sources of energy compared to fossil fuels.

Develop alternatives and at the same time diminish dependency on oil

Western-Europe will remain dependent on oil because of a continuous demand for energy. Demand for oil will only gradually decrease in Western-Europe. Also new activities like 3D-printing often use oil-based raw materials as an input. This remaining importance of oil in the coming decade is not only negative, it offers the region a serious chance for developing serious alternatives, without a sudden regional-economic shock. Developing strategies based on this gradual transition—think of mixing biomass with fossil or think of developing networks to transfer warmth (or cold) from (or within) the port industrial complex to the city or to the greenhouse region of Westland—therefore is very important in the next decade.

The real sense of urgency is not yet present in the port of Rotterdam and it is uncertain what the driver behind the sense of urgency will be.

Transition and changing power relations

It is observed that also within ‘big oil’ and within the chemical industry a new mindset is emerging towards sustainability and transitions and that sustainable solutions for the medium long term actively are discussed. However, the real sense of urgency is not yet present in the port of Rotterdam and it is uncertain what the driver behind this sense of urgency will be. Is this the debate related to the carbon bubble and stranded assets? Is it the 2 degrees Celsius limitation of global heating related to the rising sea-level? The Rifkin case of Nord Pas de

Calais with the foreseen closure of a nuclear plant is a much more clear need for transition in the region compared to the Rotterdam case.

This transition is about a change in power relations.

This transition is about a change in power relations between the traditional vertically organized multinationals—the Rotterdam establishment—and the decentralized lateral energy networks of the Third Industrial Revolution. At the moment, the power of lobbyists from parties like Greenpeace and other green organizations rivals the power of traditional industry lobbyists for the oil industry. This change in power relations is also an issue within organizations.

Business models adapted to zero marginal energy costs

In the end, because of the importance of oil, the transition should be fundamental instead of a gradual transition, including new business-models. These new business-models are of vital importance for energy-companies and energy-intensive firms located in the port. Rifkin's statement related to 'free energy' is very important in this respect. What are the business models related to free energy? What is the impact of government subsidies? There is definitely a need for fair prices or effective CO₂-pricing instruments. However, marginal costs are not total costs and in the energy tariffs there are network costs related to the transport of energy (by network-provider Tennet in the Netherlands). The earnings models of the new offshore wind-parks still are traditional and not adapted to dynamic supply/demand relations.

Service operators in the port of Rotterdam already see commercial opportunities in the energy transition related to service contracts for offshore wind-parks. Also other service companies see demand from sustainable activities rising and earnings from the traditional petrochemical clients decreasing.

The possibilities for exchange-mechanisms between micro-plants by making use of smart grids is the real issue. The linking of all prosumers with smart energy meters is a logical consequence of the energy internet, but not the main challenge. Smart energy-meters might be very important for organizing societal support.

Governments are needed to initiate and stimulate the development of networks.

In lateral energy networks, government influence is not needed. All prosumers have their own energy networks of solar panels—sometimes owned, often by being a member of cooperating commons networks. Governments are needed to initiate and stimulate the development of these networks.

The development of the energy internet might be stimulated by providing a neutral/independent energy system, including a 'smart energy ombudsman' and independent storage.

An important result of the energy internet and the link with the port of Rotterdam might indeed be the local availability of very cheap—free—energy in the city of Rotterdam. This is a very important advantage of Rotterdam for its inhabitants.

Social innovation in the energy sector

Another important link for the city is social innovation in the energy sector. The 'Green Roof project' (Groene Daken programma) is an example of a social innovation, involving citizens and creating prosumers. This social dimension is very important and should be linked to social capital available in urban quarters with respect to sustainable solutions. Housing associations should be linked to these localized projects.

An important start is demand responsiveness and flexibility with respect to the energy internet. Demand control is more important than the storage of energy. During 80 percent of the time, free energy will be possible, during 20 percent

energy will be very expensive because of peak-demand. This asks for demand control.

The specific Rotterdam energy situation

The specific Rotterdam situation asks for the decoupling between port and city. A sustainable city and a fossil port (or vice versa) are possible. The dynamism between port and city is different. The big users of energy in the port environment have a need for continuous energy—without interruptions—and are not easily to include in the smart energy internet. However, the process industry in the port might be able to profit from demand control by means of smart factories with flexible energy demand. These factories are being designed at the moment.

In general it is expected that network costs will increase in the future because of the need for much more spare capacity because of the possible fall out of wind and solar energy and the needed flexibility/spare capacity for peaks in demand. Storage is expected to become too expensive, due to the large investment needed—demand response is seen as the superior option. The future energy mix is an important issue: gas-fueled energy plants may be installed as spare- and flexible capacity, especially for big industrial users. This flexible energy hub-function might be an important future function of the port of Rotterdam. It is important to define the need for flexibility: what is the need in a season, a day, an hour?

The dare to experiment is a typical characteristic of the port.

In general, there is tension between the search for economies of scale from the European energy infrastructure and the small decentralized networks of the Third Industrial Revolution. Designing experiments to connect these two energy systems is typical for the port of Rotterdam. The dare to experiment is a typical characteristic of the port—think of the experiments of ECT and their robotized container terminal. In Rotterdam the government/port authority, traditionally, is very active as a facilitator.

The low oil-price is a problem for the bio-based economy demanding a pro-active government stimulating investment.

The current low oil-price is a big problem for the biobased economy. This demands a pro-active government with respect to stimulating investment in biobased capacity, like wind-energy. The government should be an initiating and investing party in bio-ethanol capacity in the port of Rotterdam. This is an important building block in stimulating the biobased economy in the port—at the moment however not economically feasible because of the low oil price.

Rotterdam has a tradition in ‘contrarian investment’, such as the Nieuwe Waterweg and the robotized ECT container terminal, as mentioned before.

The development of advanced biobased-chemicals is lacking in the port of Rotterdam and is performed in the hinterland of the port and in other ports like Gent, Bergen op Zoom and Terneuzen. The refining of biobased fuels is important, but this is an activity low in the biobased value-pyramid. Low-value activities—like refining—however are a core competence of the port of Rotterdam.

Rotterdam as a container hub in the Third Industrial Revolution

The container was very important for facilitating the fragmentation of value chains and for the globalization process. The globalization of production is at the moment at its top, the globalization of consumption is still at the beginning.

Rotterdam entrepreneurs cannot easily perceive a future without continuous growth of container throughput. A world in which a future dominated by decentral production or smaller/faster ships is not possible. The container industry is conservative and innovations and new themes for business development are emerging very slowly—at the moment ‘supply chain finance’ is emerging as a new theme.

The automated/robotized functioning of container terminals is fully underway. The bigger issue however is the connectedness between port and hinterland. At the moment this connectedness is not functioning as it should. Within maritime data-networks and flows, it is observed that data provided by inland shipping works at a different pace with data produced on a daily basis instead of real-time.

The processes in the container system at the moment are not functioning in a smooth flow: during the handling of the containers, the performance is measured in minutes but when the container has been moved to the stack it may be stored for several days. The business models at the moment are not based on transparent chains, but still are sub-optimized.

The need for co-operation in the chain to realize total transparency is lacking.

The organization of the physical processes in container chains are highly developed. What is lacking is data-handling, the need for transparency and the need for co-operation in the chain to realize total transparency. This however is a long term goal. Also the administrative handling/back-office activities related to container chains are very much in need of renewal and optimizing.

Electricity is the future of Rotterdam as a container hub: electric power for electrical AGV's and container cranes. This enables new business models, for instance with respect to the use of batteries.

Crossovers between port and city

Crossovers between the economy of the port and city are weakly developed in the Metropole Region Rotterdam-The Hague. In contrast, the availability of crossovers is an important strength of the Metropole Region Amsterdam. This gives Amsterdam a much bigger potential for cooperation between different stakeholders.

This lack of crossovers between port and city is explained by the fact that the majority of the managers working in the port of Rotterdam is living in the vicinity of Rotterdam and not in the city itself (in addition to decision power being located elsewhere). In Amsterdam, living in a 17th century house at one of the famous canals encourages the mix between representatives of the business, creative and communication and media clusters in the city. This mix is also strengthening overall decision-making in the Amsterdam region between (air-)port and city.

RDM Rotterdam is 'Rotterdam's best kept secret' and illustrates crossovers between port and city.

The RDM Rotterdam (formerly known as RDM Campus and including RDM Center of Expertise of Rotterdam University of Applied Science) is 'Rotterdam's best kept secret' and is an excellent illustration of the crossovers between port and city. RDM Rotterdam is a hot spot for small scale 'new manufacturing', such as 3D-printing and prototyping—inspired by Brooklyn Navy Yard—and knowledge intensive maritime construction for the offshore-sector. RDM is the birthplace of the famous Ampelmann-innovation.

RDM Rotterdam is not very visible in the city and also not very well connected to the rest of the city: this potential 'hot spot' for the Next Economy has been tucked away and transport-infrastructure is insufficient. RDM has been noticed abroad and Brooklyn Navy Yard has been inspired by the RDM concept (see: <http://newlab.com/>).

The connection between hot spots like RDM and other parts of the port and urban economy—and in particular other hotspots like the Merwe-Vierhaven-area (M4H), focused on facilitating start-ups—might become a new priority for the port and city in the Third Industrial Revolution, replacing traditional concrete port infrastructure, like roads, pipelines and tunnels.

In addition, leading innovative firms vital for realizing the Third Industrial Revolution in the port are located in the fringes of Rotterdam. TBA is located in Delft, ABB and CGI are located in Rotterdam-Alexander, Navis has an office in the Waalhaven port area.

Crossovers result from the interaction between port and city, but also between different skills and levels—a senior development officer working for a multinational firm in the port might be inspired by a high-tech startup initiated by a 20 year old college drop-out. It is very difficult to realize this type of crossovers in the port of Rotterdam because the big firms in the port and in particular the Port of Rotterdam Authority are seen as “unapproachable bastions” for SME’s or startups. It is only very recently that the innovation and development managers working for the big firms in the port have discovered an innovation hot spot like RDM Campus, resulting in a number of promising pilot projects.

Big firms in the port and in particular the Port of Rotterdam Authority are seen as “unapproachable bastions”.

5.3 Analysis

The three workshops resulted in a broad vision on the transition needed in the port and city of Rotterdam. We see two clear lines in the discussions reported above. First, the strong heritage of the Second Industrial Revolution in the Rotterdam region as opposed to the need for a Third Industrial Revolution. The importance and the continued investment by the traditional oil and petrochemical industry in the region, the opening in 2015 of two coal-fueled power plants in the port is a development limiting the possibilities for a transition. On the other hand, there is a clear agenda towards sustainability and towards the concepts as been presented by Rifkin, such as the energy-, communication and logistics internet combined in the Internet of Things. In addition, the development of the circular and biobased

economy are clear priorities both in the port and the city. However, the development of the circular and biobased economy is not growing as fast as expected and the transition towards these concepts also is uncertain.

The second uncertainty is related to the level of integration between the port and the city. In chapter 4 the current lack of synergy between the port and city has been illustrated. It is also uncertain if this synergy will increase in the future of whether the two separate economic systems of Rotterdam port and city will also be a characteristic of the future Rotterdam economy.

These two uncertainties are used to create four scenarios, presented in chapter 6. Two scenarios are used for a detailed analysis of the impact of the Third Industrial Revolution for Rotterdam: a scenario where centralized energy production remains very important, but based on Hydrogen, and a scenario where a Makers City housed by prosumers will be the dominant future of the port and city of Rotterdam.

Finally, in the workshops, ten priorities for the transition agenda have been formulated. These priorities are presented in chapter 7.

Table 4. The Netherlands in 2040 in four scenarios (Welvaart & Leefomgeving)

	Global Economy	Strong Europe	Transatlantic Market	Regional Communities	unit
<i>level in 2040</i>					
Demography and economy					
Inhabitants	19.7	18.9	17.1	15.8	Million
Number of households	10.1	8.6	8.5	7.0	Million
BBP per capita	221	156	195	133	index 2001=100
Ageing (population above 65)	23	23	25	25	%
	Global Economy	Strong Europe	Transatlantic Market	Regional Communities	unit
<i>mutations compared to 2002</i>					
Home					
Single-family dwelling	+1.9	+1.1	+1.0	+0.3	million
Multiple-family dwelling	+1.2	+0.6	+0.5	+0.1	million
Industrial areas					
Industrial plants	+43	+18	+23	-3	%
Offices	+34	+19	+16	+1	%
Informal work locations	+46	+27	+25	+7	%
Mobility					
Passenger transport	+40	+30	+20	+5	%
Transportation of goods in ton km	+120	+40	+65	-5	%
Congestion hours	+70	+0	-10	-70	%
Agriculture					
Agriculture area	-15	-15	-15	-10	%
Greenhouses	+60	-15	+5	-45	%
Number of dairy cows	+25	-5	-5	-15	%
Number of pigs	-5	-55	-5	-55	%

Energy					
Use of energy	+55	+10	+40	-5	%
Use of coal	+195	+40	+155	+35	%
Stock of natural gas	-95	-85	-85	-75	%
Share renewable energy (electricity)	1	34	2	24	%
Environment					
CO2 emission	+65	-20	+30	-10	%
Chronic illness due to particulate matter (PM10)	+22	+5	+26	+1	%
Waste (total)	+100	+44	+53	+11	%
Nature and recreation					
Nature areas (reserves)	+20	+25	+18	+22	%
Sport and recreation areas	+75	+48	+33	+18	%
Areas with low nitrogen deposition	+0	+53	+3	+51	% point

Source: Welvaart en leefomgeving

6 The impact of the Third Industrial Revolution on Rotterdam

6.1 Introduction: two visions on the social-economic future of Rotterdam

The main question is how the Third Industrial Revolution (TIR) will affect the common inhabitant of Rotterdam and what are related key issues for policymakers. An important question to be addressed is how TIR will affect the regional economy and the demand for labor of Rotterdam.

In this chapter we present the results of our input/output and scenario research to the consequences of TIR for the regional economy and the demand for labor. The publications *The Third Industrial Revolution* and *The Marginal Zero Cost Society* provided plenty of assumptions on the future development. Moreover, the workshops with representative key persons of the Rotterdam community—see chapter 5—provide additional information and perceptions on the future of Rotterdam. These insights are valuable since they are developed with technological change in mind. We have bundled these insights and results from the Rifkin publications and the workshops into two visions on the socio-economic future of Rotterdam.

The visions are not opposed to each other, but are variations within TIR-development. By doing so, key issues for policy makers are identified and key elements of the impact of TIR on the average Rotterdam citizen come in sight.

Continuing on the outcomes of previous research

In this project we extend our preceding study ‘Koersen op de toekomst; Samenhang Stad en Haven Rotterdam in 2040’. In that project four future scenarios for Rotterdam haven been developed in four different external contexts.

These are derived from the long term scenarios for Europe and the Netherlands up to 2040 (CPB/MNP/PBL 2006), the current standard for policy analysis in the Netherlands. This standard provides consistent parameters on economic development, sectors, population, world trade and so on. All four scenarios have world trade as starting point, since the Netherlands is a small and open economy. The results for city and port of Rotterdam in the scenarios were heavily influenced by world trade scenarios because of the impact of the port of Rotterdam.

Technology as the main driver, instead of world trade

In this project, however, we are dealing with a different driver of change instead of world trade: technology. It is a very different technology as a result of TIR that drives the regional economy and its institutions—see the preceding chapters. For example, more and more organizations and key opinion leaders are getting convinced that Rotterdam will anyhow be part of the Third Industrial Revolution. The new energy-communication infrastructure will arise there of all places.

In the next section, we will first extend of the common ground for the two visions. Second, we will give key information on the choice of the base scenario (Strong Europe) out of the four possibilities provided by CPB/PBL 2006. Within this scenario Strong Europe we have developed two types of TIR—we have taken different key elements out of TIR and the workshops, and combined with economic theory, this is elaborated into two scenarios.

The external economic development: uncertainties behind policy scenarios

Dutch planning bureaus have developed long-term scenarios up to 2040 for the Netherlands³⁸. The long-term effects of current policies have been assessed, given

³⁸ CPB/MNP/RPB (2006). *Welvaart en leefomgeving - een scenariostudie voor Nederland in 2040*. Centraal Planbureau, Den Haag. See also: www.welvaartenleefomgeving.nl

the international economic and demographic context of the Netherlands. The results, both quantitative and qualitative, serve as a reference for policy-makers involved in spatial planning, housing, natural resources, infra-structure, and the environment. By exploring how land use and various aspects of the living environment may develop on the long run (2040), the study shows when current policy objectives come under pressure and which new issues may emerge.

Two critical factors of uncertainty stand out:

- a. to what extent nations and international trade blocks will cooperate and exchange, are they giving up some of their cultural identity and sovereignty?
- b. how will governments balance between market forces and a strong public sector?

These international political choices determine four possible scenarios for the Netherlands:

- *Global Economy*: emphasis on international global cooperation and private responsibilities.
- *Strong Europe*: emphasis on international European cooperation and public responsibilities.
- *Transatlantic Markets*: emphasis on national sovereignty and private responsibilities.
- *Regional Communities*: emphasis on national sovereignty and public responsibilities.

The study builds on earlier work by CPB (2003, 2004) and RIVM et al (2004, 2005) in which these scenarios were translated into four development paths for the Dutch economy and demography. In the current project, the resulting economic and population scenarios, including their international contexts, were elaborated for application to the built and natural environment. This required both conceptual thought and extensive integrated modeling, e.g. regarding the coherence and consistency of all different aspects of regional economy, internal migration, urbanization, environmental pollution and so on. The modeling framework generated quantitative indicators to illustrate the scenarios and support the conclusions.

'Strong Europe', closest to the context of the Third Industrial Revolution

The 'Strong Europe' scenario assumes high immigration in Europe, successful European integration, world trade with more strict environmental regulations. An international effective environmental and climate proof policy will arise. The public sector is dominant and entrepreneurial on the grand challenges of our time. It assumes an effective and strong government. Economic growth is modest due to trade-off with a better living environment and role of governments on economic markets. A relatively large part of prosperity is non-monetary: it is beyond GDP.

Strong Europe is the long term scenario that is closest to the context of the Third Industrial Revolution. So, we assume that the transition of Rotterdam towards the Third Industrial Revolution takes place in the context of the Strong Europe scenario for the Netherlands.

Strong Europe assumes (see table 4)—besides a relatively low rate of growth of world trade (not shown in table 4)—:

- a. an orientation on European trade flows and
- b. the implementation of sustainable ways of manufacturing and energy production. This is reflected in
- c. low volumes of ton-kilometers of transport (low rate of growth of world trade),
- d. decrease in the volume of greenhouses,
- e. the number of pigs is cut by more than half,
- f. the use of energy rises slightly compared to the other more bullish scenarios (Transatlantic Market and Global Economy),
- g. a clear absolute lowering of the emission of CO₂ and
- h. the strongest increase of nature areas.

Based on those characteristics we have chosen a sector growth pattern from Strong Europe and projected the Strong Europe-parameters on our regional input output model for the year 2040. The numbers of Strong Europe in the preceding study (Koersen op de toekomst, 2015, p 53 and further) were a reference point. However, our assumptions for the Strong Europe scenario differ from the 'Koersen op de toekomst' project in several respects.

- a. First, in this study we made additional assumptions on the internal structure of the economy. The use of technology changes inputs; crude oil as an energy source is substituted—whether by biomass, or by wind, solar, seaweed, algae, or the building stock as micro power plants and so on.
- b. Second, instead of making exogenous assumptions on the development of port and city as in the preceding study, we now make assumptions on the growth rate of sectors. The change of relationship between port and city are a consequence of changes in the sectoral composition and the intermediate deliveries by the sectors.
- c. Third, our basic scenario Strong Europe from CPB/PBL provides us with growth rates for sectors and other key parameters for the regional input-output framework for 2040. This scenario, although it has some characteristics of the TIR as Rifkin describes, misses an important feature. That is *demonetization*. If people start to share ownership of goods and services, market transactions disappear, as well as formal jobs. If market transactions disappear, the value of it expressed in euro or whatever currency, disappears from the National Accounts since it is no longer counted as such. This implies that the monetary expression disappears, but not the value of it. For example, this happens if a woman, fully engaged in the household, starts to perform a formal job and hires a nanny. Then, GDP rises twofold: the monetary value of her formal labor, and the value of the payment to the nanny. The former non-monetary value of work in the household is appearing into the GDP then. In our analysis we assume we are limited by our base economic scenario Strong Europe from the CPB/PBL 2006, that is not taking the idea of demonetization into account. So, we have to assume that the monetary value of it remains. Then we avoid a main issue too: if the monetary expression disappears, the value of the intermediate delivery also disappears, although the value of it remains. The same applies for the labor market: the formal job disappears, but work itself remains. Moreover, we assume that technological shocks in TIR will indeed destroy jobs, but that new needs and new formal jobs will appear too.

- d. Fourth, the size of the technological shock in the future is not known and is set at 5 billion Euro. This is not large, but gives information on the redistributive effects on the regional economy. It is the redistributive effect within the Strong Europe scenario that provides us information on the different future's.

High investment in IoT-infrastructures

Our starting point however is that the Third Industrial Revolution will strike in Rotterdam. A new integrated energy and communication infrastructure will arise in the Greater Rotterdam area, but what kind? The Third Industrial Revolution needs very high investment in the new IoT energy infrastructure. These investments will either take place *bottom-up* by cost-effective investment in new energy systems by all kinds of stakeholders in Rotterdam (people, business, buildings, port, city etc.) or *top down*, by the current oil companies transferring themselves into sustainable energy providers. The system itself changes significantly compared to nowadays.

The two scenarios produced will take place in the same international and national context. Rotterdam is in transition, the rest of the Netherlands acts mainly according to the Strong Europe parameters. Also, the world acts according to an existing policy scenario for the Netherlands, which is Strong Europe. Both scenarios are welfare neutral. That is, welfare will be the same, only the way we obtain it. The goal of the scenarios is to give a glance of the structure of the economy of Rotterdam. Which sectors will benefit? What is the future role of the Port and City of Rotterdam? How will they integrate?

The starting point for this report is the successful transition to the Third Industrial Revolution. In the next section, we will present the two scenario's on which we project different levels of technological advance and integration.

Table 5. Hydrogen Hub scenario: value added in City and Port, Strong Europe & Hydrogen: Energy Conversion Storage Hydrogen Hub

	Scenario 2040		Impuls "Top down"		Multiplier		
	<i>Strong Europe</i>		<i>Direct</i>		<i>Indirect</i>		
	City	Port	City	Port	City	Port	Rest of NL
	<i>Million Euro</i>						
Agriculture	615	0	33	0	6	2	15
Manufacturing	3.249	8.785	1.486	95	105	68	162
Energy, Water and waste	1.786	1.154	805	719	137	58	1.196
Construction	3.345	17	25	0	8	1	10
Consumer Services	6.980	24	44	0	11	1	13
Wholesale	7.186	1.464	25	5	5	1	8
Transport and storage	670	13.969	0	9	1	1	3
Business services	15.275	0	1.651	0	479	48	426
Rental, other business services	4.483	226	71	4	17	2	15
Public Administration	3.393	609	9	2	3	1	3
Education	2.961	0	8	0	1	0	1
Health care	7.121	0	6	0	1	0	1
Total economy	57.064	26.247	4.165	835	775	185	1.852
<i>Distribution indirect effect (total = 100)</i>					28%	7%	66%

6.2 Scenario 1—Hydrogen hub: Energy Conversion Storage Hydrogen Hub

Vision

Keywords: top-down, economies of scale, economies of scope, agglomeration economies, sustainable energy hub, hydrogen, relative centralized energy system, business services, financial center, research & development, energy cascade

Technology energy system: hydrogen hub

The main driving force is that the energy producing companies and oil refining companies appeared to be able to transfer themselves into providers of sustainable energy and by doing so the oligopolistic structure of the energy market prevails. Therefore, energy producers are still able to reap the benefits of economies of scale of the port of Rotterdam. The basic characteristics of the Rotterdam economy remain intact and are extended into TIR. The production of sustainable energy makes use of the port as an intermediate location between production and consumer markets. The port of Rotterdam provides North-West Europa with energy—mainly electricity. Basically, this is a top down concept.

Rotterdam: energy storage and conversion hub of North-West Europe.

Rotterdam develops into the energy storage and conversion hub of North-West Europe. Hydrogen as an intermediate energy source requires scale. This is pressurizing the prosumer. In this variant of TIR, 75% of energy demand in North-West Europa will be fulfilled by the large scale central conversion and storage hub. The other 25% will be realized by decentral capacity using *prosuming* households, companies and real estate. Hydrogen cars take the market for mobility. The energy system itself should be conceived as a cascade. The Rotterdam energy conversion and storage hub is the sole top, and smaller providers under it provide complementary energy.

A basic change in the energy system in the future is the switch from a single source to a multiple source system. Fossil fuels do have the advantage of high energy density (joule per liter), of storage and transportability. In the future, it will be a multiple source energy system with hydrogen and electric power as transfer modes.

Hydrogen will become the core of the substitution in the Rotterdam energy sector. The value added is the exchange and conversion to various form of energy from and to hydrogen. Hydrogen is only used as intermediate energy commodity for storage purposes to absorb fluctuations of energy demand over the day, week, and year. Hydrogen is not transported due to its natural explosive character.

Supporting services: logistics, financial services and Science & Technology

The main characteristic is the extension of the energy sector with economies of scope, besides economies of scale. Conversion, storage and transfer to consumer markets and deliveries to industries in North West Europe are facilitated by the port. This requires logistics and handling of various kinds of biomass. Based on the logistic capabilities, supply of land and storage capacities, new LNG and biomass investment in the port and network development in physical assets by commodity traders located in the port-city, together with banking and business services, Rotterdam develops into an agglomeration of energy supplies in multiple forms. Instead of crude oil, biomass is handled in large quantities. That may be any biomass: waste from agricultural production, but also seaweed from the nearby North Sea.

This energy storage and conversion hub has two main extensions into the urban part of Rotterdam region. First, key knowledge is delivered by TU Delft, Erasmus University Rotterdam and other knowledge institutions in the region such as TNO in Delft, Wageningen University and the business universities. So, a large energy science park and a community of R&D investment will develop in the region. They invent conversion and storage technology. Second, energy needs different supply routes to Rotterdam and into the consumer markets.

Finance

From a macro perspective, marginal costs of energy are approaching zero, but over the day and year scarcity will vary, so prices will vary. The supply of various sustainable sources is uncertain. Proximity to markets is therefore necessary and the financial services to provide this will be developed in Rotterdam. Biomass markets will develop and that creates a financial market for payments, clearing, and derivatives like futures to hedge against unexpected developments. So the oil

Figure 44. The Energy Conversion Storage Hydrogen hub in scenario 1

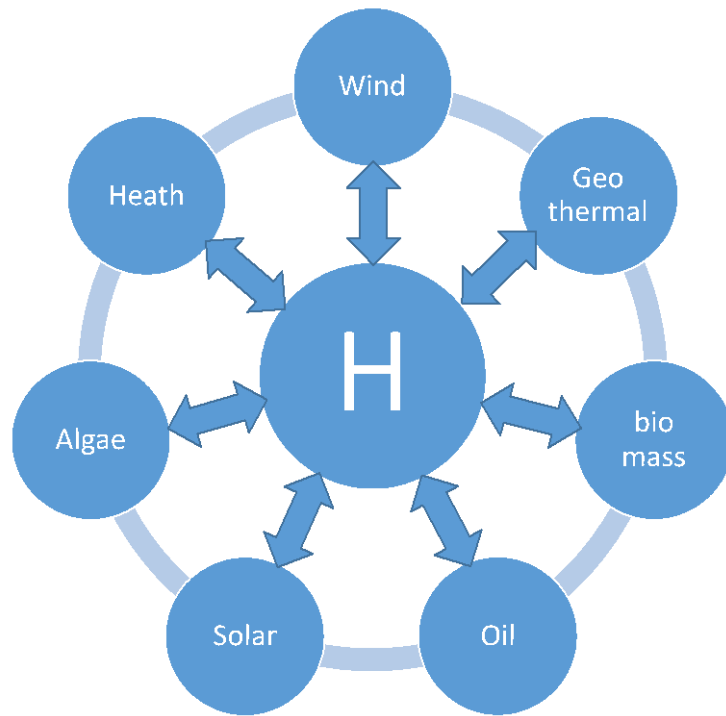
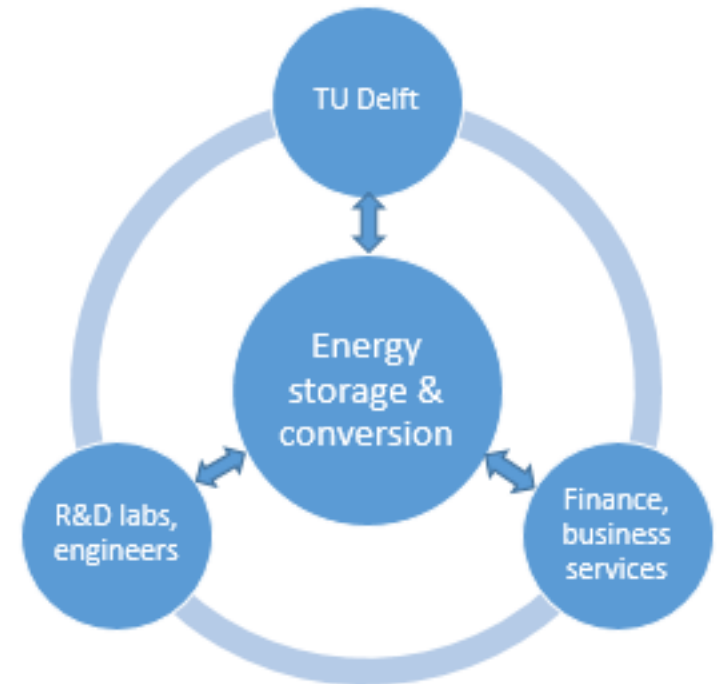


Figure 45. The Energy Conversion Storage Hydrogen Hub into TU Delft. R&D and financial support services; an agglomeration



trading and clearing, with derivatives to hedge uncertain future developments, will be replaced by multiple flexible deployable energy commodities from different sources. Commodity trading activities will develop in the Metropole Region near conversion industries, knowledge institutions and logistics infrastructure.

Forward linkages

The problem of conversion is energy loss. Heat losses can be captured and used in a competing way. Conversion losses are conceived as an abundant supply of thermal energy. That thermal energy is used and consumed whether in households for heating purposes or in glasshouses. The Heat Roundabout can only be developed locally since heat has to be consumed near the source and is already part of the Zuid-Holland energy strategy.

Agglomeration and urban form: port and city have large mutual benefits

The agglomeration arises due to synergy between the energy conversion and storage hub, the R&D and engineering to fulfill, maintain and develop it, and financial services to make it economically feasible. Consumer services do thrive as a consequence from demand by professional business services and financial sector. The port and the city have large mutual benefits.

The city extends its twentieth century character as a CBD with a clear CBD as working spot, extensive suburbs and a new Port Business District in the 4Haven area. All knowledge intensive port related services cluster in new buildings of the Rotterdam Skyline (IT, law, tax, finance and trading, merger and acquisition, headquarters). A new bridge is constructed west bound: a demonstration to the new smart industry premises in the former obsolete industrial sites in the port.

Assumptions Hydrogen Hub: demand impulse

The driving force in this production of energy is substitution of imports of crude oil, coal and natural gas by sustainable domestic resources. Most of it concerns market transactions; monetary value of the power and energy sector remains intact. The demand impulse of 5 billion consists of an large of 1,5 billion euro in the energy sector, 1,5 billion euro in the public utilities sector and 1,5 billion euro in the Rotterdam financial sector. This impulse, appeared to have an urban nature: the direct effect goes mainly to the City of Rotterdam.

Results: Hydrogen-scenario: Energy Conversion Storage Hydrogen Hub

The main result is that the energy utilities (part of energy, water and waste) get the largest extra indirect benefit of the transition of Rotterdam. It is the consequence of two intersecting factors: Rotterdam is no longer importing energy from the rest of the world but uses domestic sustainable sources instead. This benefit goes to the rest of the Netherlands (two-thirds).

Hydrogen-scenario reflects the current structure of Rotterdam economy

Within the Rotterdam urban region, 28 percent goes to the city, and 7 percent goes to the port. These results follow the actual, nowadays intermediate structure of the port, city and the Rest of the Netherlands. The impulse itself appeared to favor urban industries, but these have mainly national and international markets and backward linkages. It implies that the Energy Conversion and Storage Hydrogen Hub will generate energy as it does today, but will not benefit the average Rotterdam citizen to a large extent. The value will still remain in the same value chains as they are today, only based on another technology. The impulse is also not affecting the logistics sectors to a large extent: extra demand is outpaced by extra productivity. The impulse in the financial sector is resulting in a slight extra value added in consumer services: those are the office purchases around the corners in lunchrooms. It reflects the current structure of the Rotterdam economy. The entire urban region is not that smaller than the Amsterdam one, but the sum of intermediate deliveries within the metropolitan area is half of the other city in the north.

Table 6. Makers city scenario: Value added in City and Port, Strong Europe, Makers City and Prevailing Prosumers

	Scenario 2040		Impuls "Bottom Up"		Multiplier		
	Strong Europe		Direct		Indirect		
	City	Port	City	Port	City	Port	Rest of NL
	<i>Million Euro</i>						
Agriculture	615	0	8	0	1	1	4
Manufacturing	3.249	8.785	189	100	59	18	139
Energy, Water and waste	1.786	1.154	76	50	19	6	90
Construction	3.345	17	9	0	3	0	3
Consumer Services	6.980	24	897	2	234	29	269
Wholesale	7.186	1.464	324	66	69	19	101
Transport and storage	670	13.969	29	606	86	53	195
Business services	15.275	0	1.713	0	413	42	400
Rental, other business services	4.483	226	221	7	53	7	49
Public Administration	3.393	609	86	16	26	5	28
Education	2.961	0	68	0	9	1	9
Health care	7.121	0	532	0	72	9	53
Total economy	57.064	26.247	4.154	846	1.044	190	1.341
<i>Distribution indirect effect (total = 100)</i>					<i>41%</i>	<i>7%</i>	<i>52%</i>

6.2 Scenario 2—Makers City and Prevailing Prosumers

Vision

Keywords: bottom up, economies of scope, agglomeration economies, buildings as mini power plants, relative decentralized energy system, consumer services, collaborative commons, energy matrix

Technology energy system: solar energy

The main driving force is the rapid and competing development of technology for capturing and storing solar energy in various ways. The micro power plant takes the market and makes energy nearly free after the initial investment. Electric cars take the mobility market. Excess supply of solar power is stored in decentralized hydrogen cells. Big Oil & Natural Gas appeared not to be able to compete with the abundant supply of cheap electricity.

Rotterdam loses its position as a large scale energy hub based on crude oil and there will not be a substitute. Rotterdam is no longer providing energy to the North West European heartland. The energy system is a matrix. Heat for greenhouses is provided by using smart greenhouses and by geothermal energy. It develops into a harbor for biomass and electric power, but only for the own metropolitan region and the entire Randstad Metropolitan Area. A share of 75 percent of total energy demand in the port and city is generated by the built environment of houses, companies and real estate. The other 25 percent is generated by a complementary energy system to cover shortages. The Port of Rotterdam is still a hub, but for the common transport functions and transfer only. Conversion is not needed. Wind energy from the North Sea gets ashore in Rotterdam—but also on other places—and is being converted or stored in modern batteries on a daily and weekly basis. There are no large heat losses due to conversion, so there is no abundant supply of heat for homes and glasshouses, but that is not a problem because they provide heat themselves by solar energy.

Supporting services: software specialists, designers, creative industries

The prosumer prevails in the Makers City: in between the strong metal products industries in the region and the prosumer, collaborative commons from numerous SMEs, creative individuals, software engineers develop around the 3D printing

technology. These collaborative commons developed out of learning platforms. Knowledge on using 3D printing and Smart Industry 4.0 develop and produce a variety of consumer goods and specific on-demand durables. Producing consumer goods develops in Rotterdam. This especially thrives on economies of scope. It is the variation of skills doing the job. Also, raw materials are obtained by recycling and sophisticated technology. Collaborative commons demand all kinds of services mentioned before. In the Makers City, labor intensive customized products and services prevail. There is no extra synergy between the port and the city. Bio chemicals is the other main industrial commodity, but bio chemicals as a substitute for oil. The port is characterized by a high level of robotized handling of containers. There are no extra connections between port and urban functions, except for the current strong R&D-parties related to container software development and automation.

Consumers have way lower energy bills and transport is cheap too. So consumers have more time and money at their disposal. The gain in productivity by cheap power disappears into relatively expensive labor and skill-intensive products and services. Tourism and the consumption of arts are strongly on the rise. In Rotterdam Central Station, it is not only the port being pictured on the main wall, also pieces of Vermeer, Willem de Kooning, Mondriaan, Escher and Mesdag are projected.

Forward linkages

Collaborative commons converted the Rotterdam crude oil sector into a bio chemical sector. The role of crude oil for the energy market is diminished, but substituted by bio chemicals from knowledge of Wageningen University and collaborative commons. The abundance of the collaborative commons in the Rotterdam area as a experimenting collaborative commons Makers City attracts numerous industrial companies to the area. Reshoring prevails, thereby affecting the logistic and flow of containers into a slow development. Since goods are more durable produced and consumed in collaborative commons, the life span of consumer goods as well as durables is doubled. Since time to use 3D print machines is scarce too, we rather share goods and design them for a longer time span.

Table 7. Employment (FTE) in City and Port, Strong Europe Energy Conversion Storage Hub

	Scenario 2040 Strong Europe		Impuls "Top down" Direct		Multiplier Indirect		Rest of NL	
	City	Port	City	Port	City	Port		
	Agriculture	4	0	0	0	0		0
Manufacturing	13	9	6	0	3	0	3	
Energy, Water and waste	6	2	3	1	2	0	6	
Construction	36	0	0	0	0	0	0	
Consumer Services	85	0	1	0	0	0	0	
Wholesale	35	5	0	0	0	0	0	
Transport and storage	26	46	0	0	0	0	0	
Business services	91	0	10	0	4	0	3	
Rental, other business services	64	1	1	0	0	0	0	
Public Administration	33	3	0	0	0	0	0	
Education	33	0	0	0	0	0	0	
Health care	102	0	0	0	0	0	0	
	529	67	21	2	10	1	12	
<i>Distribution indirect effect (total = 100)</i>					<i>44%</i>	<i>2%</i>	<i>54%</i>	

Table 8. Employment (FTE) in City and Port, Makers City and Prosumers Prevail

	Scenario 2040 Strong Europe		Impuls "Top down" Direct		Multiplier Indirect		Rest of NL	
	City	Port	City	Port	City	Port		
	Agriculture	4	0	0	0	0		0
Manufacturing	13	9	1	0	2	0	2	
Energy, Water and waste	6	2	0	0	0	0	0	
Construction	36	0	0	0	0	0	0	
Consumer Services	85	0	11	0	2	0	2	
Wholesale	35	5	2	0	1	0	1	
Transport and storage	26	46	1	2	1	0	2	
Business services	91	0	10	0	4	0	3	
Rental, other business services	64	1	3	0	0	0	0	
Public Administration	33	3	1	0	0	0	0	
Education	33	0	1	0	0	0	0	
Health care	102	0	8	0	1	0	0	
	529	67	37	3	11	1	10	
<i>Distribution indirect effect (total = 100)</i>					<i>51%</i>	<i>2%</i>	<i>47%</i>	

The Makers City, already known as a liberal city opening up TIR, and known for its excellent restaurants and food supplies, attracts all kind of consumer services to comply the culinary wishes of the inhabitants and the visitors staying in the Makers City, helped by Airbnb. This also applies to health and care. Personal related consumer services thrive to meet the demands of individual well-being. Due to the time available, people consume and communicate more, art and sciences are being consumed in lifelong learning. Creative industries flourish, especially in 3D printing collaborative commons networks.

Agglomeration and urban form

Agglomeration economies arise due to the sum of economies of scale and of scope. Consumers in Rotterdam have lower energy bills due to specific comparative advantages of Rotterdam The Hague Metropole Region. This generates a large and varied market for services to the collaborating commons and services to the consumers/prosumers. Urban form is adapted to that into a concentration of people living in the city instead of suburbs. Living and working goes together. The difference between public and private space is something from the late twentieth century. The city has developed primarily as a place for consumption, meeting, leisure and museums. The new bridge is eastbound, connecting Kralingen and the Erasmus University with Rotterdam Zuid. This generates a powerful impulse to Rotterdam Zuid: students start to live there, and consumer expenditures will flow to Rotterdam Zuid.

Assumptions Makers City

The main assumption in this scenario is opposite to the former one. Since the prosumers and the Makers in the City prevail, and nearly all energy is produced by interacting micro power plants in the houses and buildings, they have extensive savings on energy. It is assumed that this generates an impulse of 5 billion euro according to their known consumptive behavior. The expenditure by households on energy goes to 25 percent of their original expenditure in the Strong Europe scenario. Also, some extra demand of 100 million euro goes to the metal products sector to reflect the demand for 3D printing tools. In general, the impulse goes to various sectors. If consumers have extra money to spend, they purchase more healthcare, business services (mortgage) and consumer services.

Results Makers City: high impact on city of Rotterdam

Although the rest of the Netherlands has the largest benefit of the impulse of the Rotterdam consumers, this benefit is smaller than in the first scenario. Business services and the consumer services are the winners; the city of Rotterdam has a relatively large benefit; 40 percent of the indirect impact goes to the city.

The mechanism is that prosumers, collaborative commons and makers require services, and that extra consumption goes to services. It is reflected that these consumption-goods and services are purchased in the rest of the Netherlands, and that the backward linkage are also favoring the rest of the country. However, since services are produced and consumed on the same location and time, a large part is produced in Rotterdam itself.

The transport sector gets an impulse due the demand of transport of persons resulting from rising demand of the city—interactions in the city rise. The software industry, robotizing the port do also work for the 3D printing industries and the energy matrix. Therefore, business services experience a large indirect effect.

6.3 Effects on labor markets

The Hydrogen hub scenario affects the labor market in terms of extra FTE demanded, stronger within the city than in terms of value added. The main reason is the effect on extra demand for business services in the Hydrogen scenario in the city of Rotterdam; nearly 10 thousand FTE. The Hydrogen scenario demands lots of sustainable energy sources for the rest of the Netherlands, so the absolute effect of this scenario goes to the rest of the Netherlands: some 12 thousand extra FTE.

The Makers City scenario, with a relative large share of extra value added in the City of Rotterdam, has the largest impact in terms of extra labor demand in Rotterdam: 51 percent of the entire national effect, more than 11 thousand jobs in the City of Rotterdam, with 10 thousand in the rest of the country. The distribution of extra jobs over the sector differ—the distribution of the extra FTE over city, port and rest of the country is roughly the same. In the Makers City, there are extra jobs in a larger variety of sectors, whereas in the Energy Hub it is only in

three capital intensive sectors of business services. In the Makers City, it is the urban services, business and consumers services, and some in urban wholesale and transport activities that benefit.

6.4 Conclusion

This chapter presented two scenarios for the Greater Rotterdam region for the year 2040. The baseline scenario is the so-called Strong Europe scenario as it was developed by the CPB/MNP/RPB in 2006, but is still in use. This scenario resembles most characteristics from the TIR—for example lower CO₂-emissions. Within this baseline scenario for 2040, two sub-scenarios have been developed based on the publications of Rifkin and the results of the three workshops with representatives of the Rotterdam community.

Key assumptions

It should be reminded from the introduction of this chapter (see page 71) that some important assumptions has been made. It is the redistribution giving information within a given economic framework. That framework, the Strong Europe base scenario from CPB/PBL 2006, is not taking demonetization into account. It is assumed that the monetary value as well as the work, whether it is formal or informal, remains intact. By this assumption the intermediate deliveries remain—they do not disappear, only the monetary expression in the national accounts.

Two scenario's: Hydrogen Hub and Makers City

These ideas have been bundled in two main scenarios; Hydrogen hub: Rotterdam as an Energy Storage and Conversion Hub of sustainable energy sources, and Rotterdam as a Makers City (and Prevailing Prosumers).

- The first scenario is characterized as follows: top down, economies of scale and scope, capital intensive, aimed at the harbor, relatively centralized and acts as an energy hub of North-West Europe with the needed financial and knowledge services. Some 25 percent of energy is generated by decentralized micro power plants.

- The second scenario is bottom-up, economies of scope, 3D-printing, strong cooperative commons, decentralized, labour intensive, aimed at the city, and Rotterdam acts as an energy provider for the Randstad region only. Some 75 % of the energy is generated by micro power plants.

In both scenarios an economic impulse of 5 billion euro is assumed in different sectoral characteristics, following the publications and the workshops.

Hydrogen hub: impact on the Dutch economy

It is concluded that in a future in which Rotterdam acts as a Hydrogen hub, a large benefit goes to the rest of the country. In the rest of the Netherlands the energy sources are generated—and the value and employment. Rotterdam only processes it, and distributes. The main effect for the city is the demand for labor, since knowledge and business services are needed to develop the technology to process energy, and the financial services are there to hedge the uncertainties in the sustainable energy market and finance and clear the market transactions.

It is assumed that in this scenario, a relative large share of value is transacted in markets (no presuming or whatsoever). In general, the regional economic impact resembles the current structure of the fossil fuel oil complex with a large effect on the rest of the country, but with a somewhat strong effect in urban services. That is due to the structure of the impulse.

Makers City: impact on the Rotterdam region

In a future with Rotterdam as a Makers City and Prevailing Prosumers, a relative large share of value added accrues to the city of Rotterdam in a different variety of services. That is due to the rising income and demand of the companies in Rotterdam and more expenditures to urban services and amenities like health, art and food. The overall impact on the labour demand is somewhat higher than in the first scenario. That difference in labour demand is relatively small.

It is the assumed financial and knowledge services in the first scenario that pulls the labor market in the city. The same applies to all kinds of software engineers in that scenario. In the second scenario that characteristic also appeared. 3D-print

communities need software specialists too, as do the container and logistics services in Rotterdam.

The TIR favors agglomeration economies in the Rotterdam region

A conclusion seems to be that TIR favors agglomeration economies. It could also be seen as reverse: the coming of TIR needs urbanism. In both scenarios this is clearly visible. The Makers City scenario favors the city of Rotterdam indirectly for 41 percent (table 6), in the Energy Hub scenario it favors the city for 28 percent (table 5). Leakages are imminent in that scenario, which is a characteristic of nowadays too.

In itself it does not matter for the structure of the Rotterdam economy whether it is based on the fossil fuel industries or sustainable industries, like hydrogen.

In terms of extra labor demand, the benefit occurs in the Makers City too, with 11 thousand indirect FTE in the City of Rotterdam. That is due to demand to a variety of urban services and amenities. However, the extra demand for labour in the city in the Energy Hub scenario is in the same order of magnitude: 10 thousand. That is due to the assumption of the development of a strong financial and knowledge component in that scenario. These activities result in a strong indirect effect that is beneficial for the Rotterdam labour market too.

A general conclusion is that taking the benefit from agglomeration economies is easier in the TIR than it was in the Second Industrial Revolution.

7 10 Policy actions bringing the region into the Next Economy

7.1 Introduction

In the three workshops performed the experts invited had the opportunity to formulate at least two policy actions vital for the transition towards the Next Economy/Third Industrial Revolution. These policy actions have been discussed in the workshops and have been selected and prioritized into a top 10 by the research team, together with members of the project team.

The policy actions proposed here are an input for the transition process and discussions. Some obvious themes are missing, some actions might not be considered a priority, et cetera. But this dynamic list of policy actions needed for the transition is very much of use for the transition team, because it presents the ideas and priorities of important stakeholders in the region—and therefore are an indication of actions which might be strengthened by the team of Rifkin, because local support is available.

7.2 10 Policy actions proposed for the transition to the Next Economy

1. Involve the citizens of the Metropole Region Rotterdam-The Hague (MRDH)
2. The local governments must show active commitment and participation
3. Development of skills needed for the Next Economy
4. Characteristics Metropole Region starting point for transition
5. Stimulate entrepreneurship and startups for promising segments
6. Pay special attention to SME's
7. Stimulate linkages and crossovers between port and city
8. Regional branding in accordance with the desired transition
9. Governance adapted to desired transition
10. Clear leadership is needed for the transition process.

1. Involve the citizens of the Metropole Region in the transition to the Next Economy.

1a. Involve citizens of the region and develop trust and accessibility

Make the citizens of the region a starting point of the transition. This means a broad policy package starting with issues like skills, co-operation and making the need for and the advantages of the transition clear for the population of the region. This implicates the development of trust and an organization that is accessible for initiatives out of the region and the port. No doorstep!

1b. Stakeholder management is crucial for involvement in the transition process

To be able to realize a transition, stakeholder management is very important. To include the drivers or incentives for people and firms in the transition is a very important starting point. Also information is needed on what the incentives and opinions of stakeholders are and how they will behave in the transition process.

1c. Experiments with stakeholders are well suited for creating involvement

It is advised to start experiments with stakeholders in living labs or in game situations to see how people react in new situations and to gain information on how to effectively organize transitions with local stakeholders involved. And how to include outsiders in the desired transition for instance.

- i. Develop 3D-tech shops and -printerettes as demo's in 3D-clubs as predecessor of cooperative common to develop skill and experience with 3D printing for manufacturing industries
- ii. Develop the technology of the built environment as mini power stations further in testing areas together with real estate developers and housing unions
- iii. It is very important that the city does not act as an outsider but joins experiments and also continuously learns from participating in new initiatives. Jointly participating firms and citizens.

1d. Initiate projects to stimulate community involvement

Stimulate ‘community building’ in the port and city and encourage initiatives in community building. Regional energy co-operations might be encouraged and facilitated by the local government—think of pre-financing projects initiated by commons together with energy companies.

1e. Stimulate prosumers-initiatives: access to new technology

Stimulate the impact of prosumers for port and city and try to develop an attractive approach to facilitate prosumers before other cities see this opportunity. Stimulating access to new technology might increase the involvement of prosumers. This access to new technology should start at the primary-school level.

1f. Differentiate and focus toward target groups/prosumers

For a transition towards the prosumer role, start by investigating what the Rotterdam citizens really need and are demanding. Search forerunners in the transition process. The identification of specific target groups in the Metropole Region is also an important starting point.

Effects expected

Active involvement of the population of the region is an important condition for the successful transition. This involvement should be an open, inspiring and inviting program were the citizens of the region become convinced of the need for a transition and are encouraged to form bottom up collaborative commons initiatives.

Organization

The different municipalities in the MRDH-region should propose a program to connect the transition to their citizens. The organization of this program should be as bottom-up as possible. The emergence of collaborative commons initiatives should be encouraged and supported. This is seen as a priority for the project.

2. The local governments must show active commitment and participation

2a. The local government is important as initiator, facilitator and matchmaker in the transition

Be a source of inspiration as a government by giving the right examples. Start as government by making use of solar cells on office buildings and start by making the town halls of different municipalities involved energy neutral.

The local government has an important function to initiate experiments—for instance in the energy infrastructures—,

- being a matchmaker between industry, city and science,
- adapt the schooling system to the needs for participating in the TIR,
- stimulate access to new technology by citizens and school-going children,
- act as a launching customer—develop the energy-neutral town hall: lead by example—et cetera.

The city is also very well suited to act as an independent and neutral party to facilitate co-operation for the sharing of information between different parties and the storage of information. In addition, the city government has a role of matchmaking and brokering between different parties to search for solutions, acceptable for all stakeholders.

Effects expected

Active involvement of the local government and leading by providing examples is also seen as an important precondition for stimulating citizens and private parties. Being a launching customer in the installment of solar cells on public buildings, using smart energy meters is vital. Important in this respect is that as a government you do everything yourself as well, of what you are demanding from the population and from the businesses in the region.

Organization

A clear list of priorities for local and regional governments should be created and monitored. It is very important that governments are monitoring their behavior towards sustainable performance goals.

3. Development of skills needed for the Next Economy

3a. *Skill-development for the Next Economy: maritime/technical schooling*

Develop the skills needed for the Next Economy. This means in particular to encourage children at the primary school level to choose for IT- and technical education and bring them into contact with certain basic software skills. Rotterdam is globally a sign-board for maritime-technical design and construction. This is not acknowledged at the moment and should become an important issue in labor-market initiatives.

3b. *Invest in highly skilled port talents for the Third Industrial Revolution*

Certain crucial skills are missing in the Metropole Region at the moment, such as software engineers and IT-professionals. This is a potential problem for the development of the Third Industrial Revolution: there is a need for very high talented professionals in the port—next to more professional skills (MBO/HBO). The region is however lacking such a talent pool. The new wave of the Third Industrial Revolution should be accompanied by a new wave of highly skilled port talents. This is a prime task for the region, together with the knowledge infrastructure/universities. Initiatives like SmartPort fail to address this issue at the moment.

3c. *Introduce tools in school well suited for the Next Economy*

‘Learning capacity’ should be improved. New tools and technologies are available and should be introduced on Rotterdam schools, such as serious gaming and smart-IT platforms for co-operation and exchanging ideas. Business Universities (HBO’s) should be in particular part of this process.

3d. *Start projects to strengthen the connection between education and business*

In general, the connection between education and the business community should be improved—in particular for SME’s. There are some potential smart software solutions available to link schools and businesses. But also traditional approaches, like the learning/working company-approach should be continued.

Effects expected

‘Skills, skills, skills’ is the answer of some of the advanced businesses working in the port and city with respect to priorities for the Next Economy. Schools, universities and lifelong learning initiatives should be equipped with the right skills to be able to attract foreign direct investment and to give the companies already present in the port a competitive advantage. Skills development is at the heart of the aimed transformation.

Organization

At the moment there is only a poor understanding of the skills demanded. This asks for a close co-operation between the triple helix: government, business and knowledge infrastructure to formulate a skill development-program. The MRTH-organization should initiate a deeper investigation into the skills needed for the Next Economy.

4. Characteristics Metropole Region are a starting point for transition

4a. Characteristics Metropole Region are the starting point of the analysis.

The characteristics of the Metropole Region are a starting point for the analysis. Rotterdam is a leading energy, industrial and logistics port in the Second Industrial Revolution. This means that a transition towards a Third Industrial revolution is not be easy and will demand a serious effort because of path-dependency and lock-in effects.

4b. Involve leader firms in the Metropole region at the start of the process

Big 'leader firms' have much power to be able to change, have often the right mindset and usually manage large parts of supply chains. So start with these large firms in the transition process. In addition, also innovative firms and industry leaders have a potential for successful contributing to the transitions demanded.

Develop scenario's with leader firms in the energy sector based on certain what if-situations, for example a situation in the Netherlands were the rest of the Dutch domestic natural gas volume stays in the ground because of the risk of earthquakes; what are the effects for the Rotterdam economy?

4c. Link the Rotterdam DNA to energy transition experiments

The port of Rotterdam is a producer and consumer of large amounts of energy. It is an attractive location to start experiments as a flexible energy hub to match peaks and lows in energy supply of wind and solar capacity. Neutral data-storage and the creation of flexible mechanisms to match peaks are important. Rotterdam could become an important European link between decentralized and large scale centralized energy capacity. Also, startups in this field could be encouraged by the local government.

4d. Knowledge management in sustainable energy innovations

Develop Rotterdam as a node for a variety of sustainable energy flows and connect the Rotterdam knowledge infrastructure—Erasmus University, Rotterdam University of Applied Sciences—with the strong centers of Wageningen University (biobased!) and Delft University of Technology (hydrogen amongst others).

4d. Developing a neutral/independent energy system by means of a 'smart energy ombudsman'

The development of the energy internet might be stimulated by providing a neutral/independent energy system, including a 'smart energy ombudsman' and independent storage.

4e. Information transparency offers chances for collaboration

Future information transparency results in interesting initiatives for collaboration, for instance the joint purchase of energy and utilities in the region or in the port.

Effects expected

By starting the analysis and the project with leader firms and dominant industries in the port—petrochemicals, containers, big energy producers—the size of the effects will be significant. These large firms often have been part of trajectories that produced disappointing results and a certain inertia in the past. Also most of the important firms are branches of larger firms with headquarters abroad, limiting the level of autonomy. This certainly limits the effects expected. Especially by including these firms in projects like heat- and CO₂-loops, industrial ecology and further increasing energy efficiency they could produce valuable results.

Organization

Together with industry associations, big firms in the port should be included in the project. The MRDH-project organization should formulate a specific program aimed at big firms in the port.

5. Stimulate entrepreneurship and startups for promising segments

5a. *Stimulate entrepreneurship and start-ups: try to focus on promising segments (land-water interfaces and the circular economy are examples)*

The creation of new business is important for realizing goals like diversifying the economy. Stimulate entrepreneurship and start-ups actively by increasing efforts related to breeding spaces (like Merwede-Vierhaven).

- It is the interface of land and water-management which offers very important development potential. This should be the central focus of policies for focusing start-ups.
- The circular economy also offers big potential in the future. However, the circular economy demands new business models and innovations. Policymaking therefore should not be limited to technological innovations, but should also give a clear priority to social innovations contributing to new business and financial models.

Effects expected

New bottom-up initiatives by prosumers and collaborative commons are driving the renewal of the port. Without startups and experiments the effects of the desired transition will be limited. This also is seen as a ‘must do’ policy action.

Organization

A large number of initiatives already is visible in the MRDH, such as Yes!Delft, Rotterdam Center of Entrepreneurship, Rotterdam Science Tower, Cambridge Innovation Center, Merwede-Vierhaven, Port XL, et cetera. These initiatives are very valuable, should be strengthened and bundled and should be linked to the project.

6. Pay special attention to SME’s

6a. *A focus on SME’s is very important in the transition to the Next Economy.*

SME’s often lack time and funding to be part of economic development and transition initiatives, together with other important structural problems like lacking successors, ageing of the workforce and a critical need for qualified personnel. However, they are a very important part of the regional economy. Special attention should be given to a program to include them in transition processes. This might be organized by linking them to related leader firms and to involvement in the form of mini-clusters: a leader firm with a number of preferred SME-suppliers.

6b. *Improvement of SME-business processes to adapt to IoT*

Most SME’s have a strong track record in technological innovation but social and organizational/managerial innovations have not received much attention and may form a barrier for broader transitions. There is potential to improve other business processes by SME’s in the port, such as the back-office activities before giving priority to the IoT.

6c. *Solve barriers for co-operation perceived by SME’s*

The big firms in the port and in particular the Port of Rotterdam Authority are seen as “unapproachable bastions” for SME’s and for startups, despite certain programs. They are bureaucratic and often not very interested in SME’s and in their initiatives. This acts as a barrier for involvement by SME’s.

6d. *Start projects to strengthen the connection between education and business*

The connection between education and the business community should be improved in general, but in particular for SME’s, by developing links between schools and businesses. For SME’s successful trajectories from the past, like the learning/working company-approach, should be reinforced.

Effects expected

SME's are very important for the growth and development potential of the regional economy. Because of the specific situation of SME's there is a need for special attention in the transition process.

Organization

Also with respect to SME's, a large number of initiatives already is happening in the MRDH region, such as: MKB Nederland/Zuid-Holland, MIT (MKB Innovatiestimulerend Topsectoren) Zuid-Holland, Regionale Ontwikkelings Maatschappij (ROM), Innovation Quarter, Kansen voor West (Taskforce Duurzame Greenport Westland, Yes!Delft, Kennisbruggen Zuid-Holland, Kennisnetwerken en innovatie in clusters/Clusterregeling Zuid-Holland), Port XL, et cetera. As said before, these initiatives are very valuable, should be strengthened and bundled and should be linked to the project.

7. Stimulate linkages and crossovers between port and city

7a. Diversification and crossovers are important conditions for the transition

Increase the diversification of the regional economy. Stimulating crossovers between different segments in the port and city and between the port and city is an important means for diversification.

7b. Linking the port with the city is vital and demands a comprehensive approach

The link between the port and the city is very important: the interconnectedness between the port and city is of vital importance for the creation of an attractive location of doing business for the advanced service providers, IT-firms or commodity traders. This demands a comprehensive approach going beyond issues like cheap housing or office development.

7c. Develop the right combination of assets for the transition

The IoT is a global phenomenon and can happen anywhere in the world. Why should it happen in Rotterdam in particular? This demands the right combination of different assets needed: IT-infrastructure, human capital, port/city links et cetera. But also the development of the right mentality in the region where the potential of the Third Industrial Revolution is perceived by the population of the region and—especially—by the youth.

Effects expected

Strengthening the links between the port and the city has important positive effects, such as illustrated in chapter 4—especially related to increased agglomeration forces. This however already is part of current policymaking by both port and city of Rotterdam and should be strengthened and adapted towards the desired effects needed for the transition into the Next Economy.

Organization

Link this to current programs by the city, the port of Rotterdam and the Rotterdam Maritime Services Community (RMSC). The MRDH-organization might strengthen current priorities by bundling them.

8. Regional branding in accordance with the desired transition

8a. *Regional/city branding is vital for realizing the transition*

Increasing the strength of the brand ‘Rotterdam’ is a priority, especially aimed at attracting foreign direct investment—for instance more related to advanced producer services or knowledge intensive shared service centers (supply chain management for instance) and according to new priorities as a result of the transition trajectory towards the Next Economy. “No words but data” (“Geen woorden maar data”) is an attractive recent slogan, initiated by the VPRO-television documentary Tegenlicht, on the logistics future of the port of Rotterdam—a documentary including Jeremy Rifkin.

‘Guts’ and ‘Entrepreneurship’ are seen as important characteristics of the Rotterdam DNA/Rotterdam brand, instead of oil or containers.

The current slogans ‘Innovate. Accelerate. Make it happen’ or ‘Smartest Port’ already are attractive but lack clarity: make *what* happen?

Effects expected

The brand of the city of Rotterdam and its port should be in accordance with the desired transition towards the Third Industrial Revolution. If Rotterdam maintains its position as an icon in the oil-based Second Industrial revolution, this will encourage investment based on the traditional strengths of the port instead of the desired investment in the biobased and circular economy and in advanced port related services.

Organization

The Port of Rotterdam Authority and Rotterdam Partners are existing organizations responsible for the branding of the port and the (port)city.

9. Governance adapted to desired transition

9a. *What is the right governance structure for the Next Economy?*

Search for the right governance structure for the Next Economy. Consider the city-state as an alternative. An important issue is related to the scope of city or Metropole Region governance when a contradiction is emerging with national government issues. This demands courage and self-confidence.

In addition, the Metropole Region should develop links with the national government and with the EU in the Rifkin-process.

9b. *The needed regulation and governance structure must be in place in time*

Speed up the regulation process to respond to new opportunities is an important priority. Innovative applications like drones for instance fail to be introduced at a fast rate because of inadequate regulation.

It is also very important that market regulation is not a hindrance of the growing energy internet. This needs flexible laws and procedures with respect to environmental effects. This also asks for innovations in regulation.

9c. *Regulation for new real estate*

Regulate that all new real estate will be energy neutral. As stated before, the local government is very important to act here as a launching customer/example.

Effects expected

Without the right government structure in place, a time consuming, bureaucratic and disappointing result is expected. The governance structure should be designed according to the principles of the Third Industrial Revolution.

Organization

The introduction of a new governance structure is not an easy task. This asks for an independent path where public administration experts should propose new initiatives. An initiative should be taken by the MRDH-project organization.

10. Clear leadership is needed for the transition process

10a. Clear leadership in the organization of the transition process is vital

Clear ‘leadership’ is very important in the management of the transition process of the Metropole Region. Certain parties involved have not shown leadership in the demanded transition in the past and therefore should not be made responsible for leading the desired transition.

10b. Formulate a clear transition target and a roadmap towards this target.

The articulation of a clear target is very important because this creates momentum and understanding in the local community. How to organize the road towards this target is a very important challenge. What are the actions needed, what is the pace of the process, how does the process fit into the current port and urban processes? The challenge is not confined to the technological domain, but also the societal aspect is very important.

10c. Develop a well-known icon for the transition, resulting in a positive image towards the region

Develop a firm/project/individual as ‘icon’ for the transition towards the Next Economy—a ‘Daan Rosegaarde-type’ of ambassador.

10d. Develop a dialogue where alternative visions on the future of the Metropole Region are discussed

Develop a dialogue with Rifkin and do not accept his vision as the only development path possible. Choose alternative visions for the future—so do not limit the analysis to biobased, wind and solar power, but search for a broad perspective and several different scenarios. This is a Rotterdam transition, not a Rifkin-transition.

Effects expected

A clear and transparent process—no “back rooms”—is very important for involvement in the transition of both citizens and business stakeholders.

Organization

MRDH-organization must make this leadership as its core value.

Annex 1: Workshop participants

Workshop 1: September 16, 2015 – Las Palmas

Aki Ackerman, (EXCEPT)
Mark Bode, (oa Basematters, Beards & Suits)
Jasper Groen, (Van Steenderen MainportLawyers/RMSC)
Wouter Jacobs (Erasmus Universiteit Rotterdam)
Janjoost Jullens (Wolfpack)
Roel van Raak (Drift/EUR)
Vincent Wegener (RDM Makerspace)
Menno Huijs (Gemeente Rotterdam)
Walter Manshanden (NEO Observatory)
Olaf Koops (NEO Observatory)
Onno de Jong (EUR)
Bart Kuipers (EUR)

Workshop 2: September 21, 2015 – Las Palmas

Ruud Melieste (Havenbedrijf Rotterdam) (from 16:45)
Leon Straathof (Cofely-gdf Suez)
Rick Bosman (Drift)
Hans van't Noordende (Deltalinqs)
Remco Verzijlberg (TU Delft)
Mattijs Taanman (Wolfpack)
Jacqueline Giesen (ENGIE)
Peter Troxler (Hogeschool Rotterdam)
Hans Scheepmaker (Gemeente Rotterdam)
Menno Huijs (Gemeente Rotterdam)
Walter Manshanden (NEO Observatory)
Olaf Koops (NEO Observatory)
Onno de Jong (EUR)
Bart Kuipers (EUR)

Workshop 3: September 22, 2015 – Erasmus University Rotterdam

Aljosja Beije (BeScope)
Martijn Coeveld (TBA)
Frank van Oort (ESE)
Maurice Janssen (STC)
Larissa van der Lugt (EUR-RHV)
Menno Huijs (Gemeente Rotterdam)
Walter Manshanden (NEO Observatory)
Olaf Koops (NEO Observatory)
Onno de Jong (EUR)
Bart Kuipers (EUR)

