

# Handbook of Decarbonisation

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## Deliverable 6.6

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# Introduction

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*“Truly a visionary way to present research results. As a reader, you are swept directly into the future... [the Guide] provides a basis for the need for continued efforts from industry, the state and research, and inspires action.”*

— Eva Blixt, Jernkontoret (Swedish steel-producer’s association)

*“As a long term investor I always seek to try out frontier technologies as early as possible... this book takes that concept to a range of interesting applications, whilst extending the perspective further than most forecasts, which makes it both interesting and useful.”*

— Ludvig Nilsson, managing director, Jade Invest (Shanghai)

*“Definitely rewarding, refreshing and fun... you’ve put together a lot of intriguing yet realistic examples of concrete changes in city life [and] tell the tale of how different movements and motives can create the decarbonized future we want.”*

— Carina Borgström Hansson, WWF Sweden

The Deliverable (D6.6) that you are reading emerges from Work-Package 6 of REINVENT (<https://www.reinvent-project.eu/>), a Horizon2020 project whose aim is to explore the innovative possibilities for the decarbonisation of a number of basic industries in the European context. In REINVENT (WP6) we have written reports on how innovations scale (D6.1) and acquire momentum (D6.2); we have also summarised the insights from modelling decarbonisation (D6.5), and informed policy-makers on how transitions might be evaluated (D6.4). But in order to fully explore and communicate how a near-zero-carbon Europe could be realised, it was necessary that we advanced beyond the established methods.

The original description of D6.6 proposed a ‘Handbook of Decarbonisation’ that could contain ‘information about how to assess the impacts and implications of interventions’. Such a handbook would be built around the notion of ‘best practices’ which could facilitate the replication of innovation for decarbonisation. In industry and policy alike, ‘best practice’ implicitly refers to the tried and tested version of a procedure or product(ion) which has been shown to deliver optimal results. However, as we found throughout the REINVENT project, issues of variety and contextuality muddy the waters as to what ‘counts’ as ‘best practice’, and to how (and by whom) it can be used, whether as an inspiration or a blueprint for future action. REINVENT’s research on innovation for decarbonisation revealed a diverse array of socio-technical and political-economic phenomena, ranging from expensive state-supported experiments in the reconfiguration of a primary industrial production process (i.e. steelmaking, HYBRIT) to grass-roots hyper-localised reimaginings of the grocery retail business model (i.e. zero-waste stores). As shown clearly in the project reports on scale (D6.1) and momentum (D6.2), while the many transformative processes of socio-technical change can be shown to be related to one another conceptually, the sheer variety of innovations means that such relationships tend to be discussed in the abstract. This is a valuable finding in and of itself,

presenting new directions in which theoretical advances might be pushed in subsequent research—but in terms of providing practical guidance, whether for policymakers, entrepreneurs or social activists, it indicates that rather than there being a ready set of ‘best practices’ to which we can point for future transitions, what counts as innovation instead escapes easy definition or hard boundaries.

REINVENT’s research thus points to the need to move away from identifying prescriptive ‘best practice’, in favour of identifying and developing new forms of communication which are able to open up the wide array of innovation possibilities. Given that the journey to a decarbonised Europe has already begun, however slowly and tentatively, it made sense to explore in more detail where that journey is headed. By researching and exploring a zero-carbon Europe as if it were already achieved, we thus present that future as if it were a destination that we want people—citizens, industry representatives and policymakers alike—to travel to, or at least to visit. It is logical, then, that a handbook to a decarbonised Europe might take the form of travel guide, which can open up an imagined future to envision what kinds of innovation might manifest.

As such, Deliverable 6.6, which takes the form of a tourist guide to a fictional European coastal city in 2045, is a methodological and communicative innovation that allows us to grasp and illustrate technical transformations, as well as social and cultural ones. The Guide itself, which focusses upon the everyday practices that decarbonisation would reconfigure, is crafted through a collaborative scholarly process of knowledge-based speculation. It draws upon REINVENT’s insights from case studies, sector dynamics and modelling, but places these into a cultural context, into the everyday. When you read about Notterdam, you will get a better sense of how a post-fossil world might work and feel for ordinary people—and that in turn might open up new conversations about how we actually get there.

Deliverable D6.6 takes you directly to an imagined coastal city in a decarbonised Europe circa 2045. In this city, and its surroundings, the carbon footprint of basic industries such as steelmaking, plastics, meat and dairy farming, and pulp and paper production, are radically reduced. The core of the Guide’s content emerged from REINVENT research, but to make the imaginary Notterdam more coherent, we needed the city to be tied together in much the same way as any real city—which is to say by *infrastructures*, particularly those of transportation. As such, further workshops were held with participants whose expertise was more in the realm of urban mobility futures, both within the academy and beyond. (A full list of participants and contributors is to be found on the back pages of the Guide.) To demonstrate the foundations of research upon which the imagined future of Notterdam is built, we have provided an extensive set of endnotes (Page 57 – 80); the Guide itself refers to these endnotes through an easy-to-navigate numbering system. As a result, while the Guide is a form of imaginative speculation, it is always possible to go back to the knowledge basis of a specific section and trace the extrapolations made.

We also provide an elaborate description of the methodology through which the Guide was crafted (pages 48-56). In the first section we describe in more detail why we transformed our approach from one focused on identifying and sharing best practice to communicating new kinds of possibilities. It is important to find new ways of communicating that allow people to see the possibilities of innovation—after all, the term ‘innovation’ is related to ‘novelty’, and that which is truly novel must first be imagined before it can be realised. Our approach is a serious endeavour, then, as befits the subject matter—but it is also rooted in humour and play. It is well-established that playfulness is a gateway to creativity during a research process, but humour remains a somewhat undervalued medium, despite its potential for the accessible communication of research evidence to wider audiences. An informative document that also raises a smile is more likely to hold the reader’s attention.

In the second section, we provide a brief summary of the practical rhetorical affordances of the chosen form, and of the processes through which it was created. Much like a “real” tourist guide, the Rough Planet is a mosaic of multiple contributions which, when combined, provide a more complete (and plausibly imperfect) picture of decarbonisation-in-effect than scenario techniques or case study extrapolations could provide alone.

Deliverable 6.6 is thus not a work of prediction, but rather a much-needed exercise in exploration and speculation. It allows decision-makers, industry stakeholders and citizens to explore their future environment and (re)imagine their own lifeways, and the decisions that they will need to take in order to realize a zero-carbon Europe. The Deliverable as a whole fosters an impactful cross-sectoral discussion of the impacts and implications of decarbonisation—a discussion in which academics, policymakers, industry practitioners and citizens all have different contributions to make. (We have collected some early impressions from people who have read an advanced draft of the tourist guide, which are provided at the start of this document; the REINVENT website will be updated with more as they come in.)

Distinct from both Hollywood dystopias and the solutionist utopias of the technology industry, there is a clear need for imaginaries of the future which depict decarbonisation as it is likely to be seen by non-specialists: as culture, rather than as policy; as experiences, rather than industrial products and processes. The Rough Planet Guide to Notterdam is a fiction, but it is built upon the best truths we could find—and while it’s a tourist guide to a particular city and its surroundings, it signals clearly that there is more than one pathway to a post-fossil Europe.

The rest of this document contains REINVENT’s handbook of decarbonisation – The Rough Planet Guide to Notterdam.

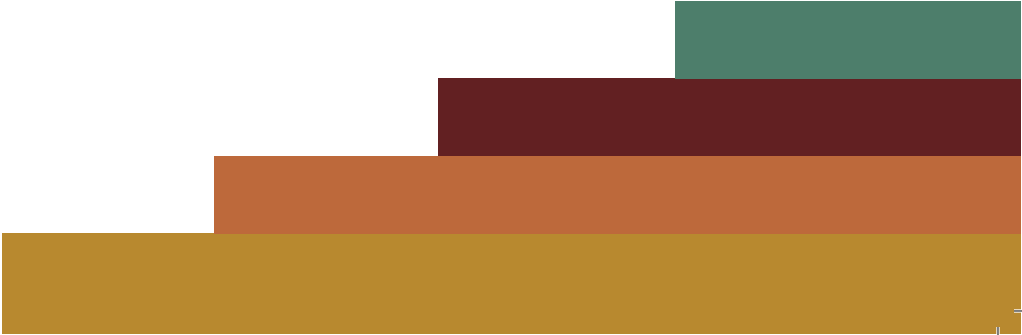




rough planet

# Notterdam

2045



# ***Hallo, en welkom in Notterdam!***

Thank you for buying this special limited print edition of the Rough Planet Guide to Notterdam for 2045. Your purchase gives you access to the full online version—now with updated AR and VR content to make planning your trip that much easier. (See the FAQ for a list of compatible spex and handhelds.) But we hope this souvenir edition—featuring a small selection of favourite locations and things-to-do, carefully curated by our staff writers—will provide a memento of your visit to this wonderful city, which we have all come to love.

The print edition is a celebration on two counts. The book you are holding is an entirely local production, and not just in terms of its content: made of paper sourced from the Zeiterbaan sustainable forestry zone (see page 20), it has been printed with care—and with specially-formulated plant-based inks!—by the good folk at Fiber Vibe, right here in Notterdam. (You can read about them on page 27.) Thus the book celebrates the closing of another production loop in the city—and the first truly carbon-negative edition of the Rough Planet Guide. (At least until we find a no-footprint server-farm to handle our online editions... watch this space!)

Furthermore, this edition marks 25 years since the first of the big pandemics: as some of you may remember, COVID-19 shut the world down back in 2020, if only for a little while. However, it's not the virus we want to celebrate—far from it! Some of us lost loved ones to COVID, or to the viruses that have come along since. But looking back, that year—with its travel restrictions, social upheavals and wild weather—seems to mark something of a turning point. Back then, Notterdam, much like the rest of Europe, was still deeply dependent on fossil fuels and the petrochemical industry. Don't get me wrong: even then it was a vibrant, exciting place to be. But that vibrancy had a footprint—a *really big* footprint.

There's still work to be done, of course—but this year the scientists and ethnographers of the IPCC are suggesting, cautiously, that we might just have managed to stay within the 1.5°C warming limit set out in the Paris Agreement of 2016. That's surely something to celebrate—for us at Rough Planet, for Notterdam, and for Europe and the world.

And when it comes to celebrating, well, you're in the right place! There's always a party happening somewhere in Notterdam—and if you can't find one, then you can start your own. It's easy: just get yourself a table at a bar or eatery, buy a round of milkbier, and raise your glasses. *Proost!* So have fun, and enjoy your visit... but don't forget to tell the places you go who sent you, OK?

Yours,

*Graeme P. Crowe, Editor-in-Chief, Rough Planet Notterdam / January 2045*

# Docklands

04-20

Three highlights from the writers' room:

1. Monument to the Death of an Idea (p.8)
2. Burning Mankind Festival (p. 11)
3. Barge-ing through: river tours on the Nrhine (p.16)

# Downtown

21-39

Three highlights from the writers' room:

1. Too Gouda to be true: Gourmet cheeses of Notterdam (p. 25)
2. Blag, borrow, swap: how to avoid buying stuff (p. 26)
3. Even better than the wheel thing: fast times at Fietsstraat (p. 30)

# Getting here, getting around

40-47

Three highlights from the writers' room:

1. Trans-Atlantic adventures: travelling from the Americas (p.42)
2. Notterdam's transport revolution(s) (p.44)
3. So... you came by car? (p. 47)

# Endnotes

48-83



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## Monument to the Death of an Idea

Undoubtedly the most iconic art piece in Not-terdam, the monument has a rich and riveting history which is detailed on page 9.

# Docklands

Q7, 11 D3.7, 5.4, 6.4

When one of our staff writers arrived in Notterdam by ferry from the UK in 2020, he tells us it took around half an hour in a taxi to get to the centre of the city—a 20km stretch of fossil-fuel refineries, automated cargo terminals, warehouses, car-parks and stockyards.

**Things have changed a lot!** The automated container port still runs twenty-four hours a day out in the mouth of the delta, of course. But much of the land along the south bank of the Nhine between Nesonburg and Nernis, once devoted to storing and refining fossil fuels, fell into disuse through the Twenties and Thirties, wiped out by the one-two punch of the Post-Pandemic Contraction and the Green nEU Deal.

The transition was slow at first, with artists and entrepreneurs taking the first pioneering steps, occupying and fixing up empty buildings: the Docklands offered affordable space for experimentation, which was (and still is) at a premium in Notterdam proper. Later, the floating farms in the delta created more opportunities for employment, and new techniques for remediating areas otherwise too toxic to use. Rusting refineries and storage tanks were torn down for scrap, and new communities sprang up to fill in the gaps; warehouses became laboratories, markets, circuses, and much more.

The industrial legacy of the Docklands can still be seen, of course—and remains a popular tourist draw. But while the centre of Notterdam offers a range of traditional and modern urban diversions, **the Docklands is where newness and strangeness is constantly a-bubble among the bones of the recent past.** There's no place quite like it—in Europe, and perhaps in the world.

***Hungry?*** Docklands has a thriving food scene, head to page 14 and feast your eyes on lab-meats, invertebrates and rescued BBQ.

***Bored?*** Take a tour up-river! From page 16, our staff writers have highlighted all the must-see spots along the river. You won't regret it.

***Adventurous?*** Attend the (in)famous Burning Mankind Festival! Get the inside story on page 11.

# Harbour Tours D3.7

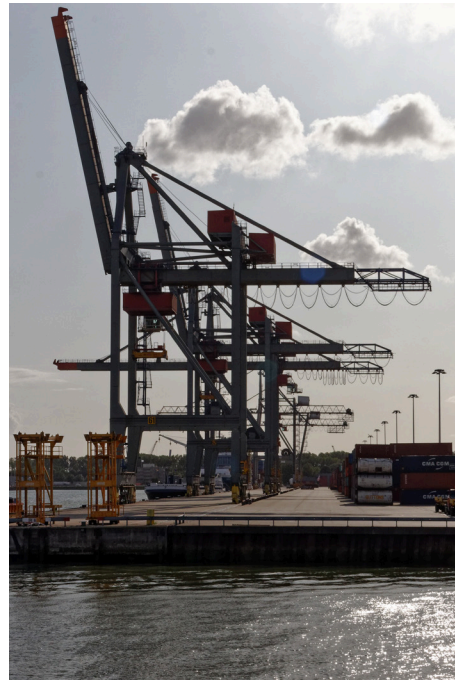
The best way to see the big landmark sites is by taking a harbour tour. **Different itineraries and guiding styles are available to suit every interest**, but below you'll find a handful of must-see favourites from our staff writers, and events to look out for if they coincide with your visit. (And if you want to venture further out of the city by boat, be sure to check out the inland options in the river-tour section further down).

The delta west of Rotterdam is one of Europe's most important logistic hubs, a strategic location for intermodal freight transport that connects the railways networks of northern and western Europe to the global sea-lanes. Enthusiasts of the green-technological sublime will want to make sure their tour itinerary includes the far reaches of the delta, where the container-port's robo loaders still dance twenty four hours a day.

You can't just wander around out there, though—while accidents are rare, keeping puny human meat-sacks out of the way of the autonomous loading machinery is a health and safety priority. (Tech-savvy travelers will notice that tour boats are fully controlled by the port's AI systems—though that's as much for reasons of logistical efficiency as for the sake of avoiding collisions out on the delta.) If you want a close-up experience, book a harbour tour that makes a stop at the visitor's centre,

whose Augmented Reality presentation of the container port's evolution won a number of prestigious documentary awards when first presented.

**Trainspotters may prefer to head straight for the redistribution terminal observation compound**, where goods destined for Rotterdam itself, as well as other nearby cities, roll out along the rails in long colourful lines. (Souvenirs and strong caffeinated beverages are available, but we strongly recommend taking your own lunch...)







## Industry

### NoDiss, ReShip

Q4, 6

D2.2, 3.3, 2.8, 3.6, 4.3

L9, 10

The hulking, pipe-tangled cluster of buildings on the north shore of the delta houses NoDiss Inc, one of Europe's largest disassembly plants. Originally built in 2031 to deal with scrapped cars, they now work on technological end-of-life services aimed at the recovery of components and recycling of materials.

The barges that once carried hundreds of tonnes of iron ore from here to steel mills in the Ruhr area are rare enough that seeing one is a special event; nowadays they carry hot briquetted iron shipped in from regions well-endowed with renewable energy and iron ore. Some is unloaded and processed in the Port mini-mill adjacent to NoDiss where steel quality is controlled by adding some virgin material.

NoDiss has become a global hub of the circular economy, and provided a vital source of new employment as the refineries and petrochemical plants closed down. The high-quality steel from the disman-

ting of those plants also passed through NoDiss, where it was recycled and channeled into new light-weight steel applications in construction, infrastructure and public transport in the Netherlands and beyond.

In the same area, you may well see some action ongoing in the dry-docks of the ReShip plant, which disassembles or repurposes coal, oil and gas tankers—a rebooting of a tradition of European ship building that began in the mid-2030s.

***“The barges that once carried hundreds of tonnes of iron ore from the port to steel mills in the Ruhr area are rare enough to make seeing one a special event”***





## History

### Rubber ducks and refugees Q2, 9 D2.3, 3.7, 4.3 P12 L1

**The Monument to the Death of an Idea** is usually described as a memorial to the Fossil Age and its profligate use of plastics; this is certainly what it has come to mean to most Europeans. But its origins are somewhat more contentious, and entangled with Notterdam’s long history of political art-activism and trade-union organisation.

The late Twenties saw a surge in the already significant numbers of climate refugees crossing the Mediterranean to escape drought, crop failures and political turmoil in North Africa and beyond. Holding facilities in locations such as Sicily and Lampedusa, now broadly considered by historians and sociologists to have qualified as concentration camps, became saturated, riven by disease and famine. Neo-nationalist blocs within the EU agitated for a blockade of the Mediterranean aimed at “detering” refugees and migrants, the implementation of which resulted in numerous sinkings and thousands of deaths.

One response to these events was **the formation of a powerful solidarity group within the Notterdam petrochemicals cluster**. Already on strike due to significant job losses, as the introduction of bioplastics and 3D printing resulted in consolidation by large firms and the closure of smaller combiners and compounders, workers seized control of multiple 3D printing operations on the morning of April 14th 2031 and, over the following

five days, printed a flotilla of boats from-petro-plastic and bioplastic.

By April 27th, outfitted and crewed by nearly a thousand Notterdam citizens, these “rubber ducks”, as they became known, had set off on the “long route home” around the French, Spanish and Portuguese coasts, before breaking the Frontex blockade at Gibraltar and returning over the following months with just under 14,000 refugees aboard.

The founding core of what has become the Monument was **a mass of rubber ducks cast from the materials of the decommissioned boats of the freedom flotilla**. Its explicit pro-refugee aesthetics and message attracted the ire (and vandalism) of far-right factions; in response, activists and artists from across the continent began bringing additional objects made from single-use plastics and adding them to the monument—a process that continues to this day, albeit much more slowly. If you have the time, consider scavenging for remaining plastic objects before you leave home. Nothing says “I’ve been to Notterdam” than adding to the monument.

Many activists argue that the Monument has become depoliticised with time, but regular demonstrations by groups from all across the political spectrum suggest that, while its meaning may be more mundane for many, it is still a vital symbol of not just the Fossil Age itself, but the persistent socioeconomic aftershocks thereof.

## Industry

### The Dieselpunk Territories L2 Nernis Refinery D2.3, 2.8 L15

Known as “**dieselpunks**”, Notterdam’s dwindling tribe of carbon hoarders still hold the former refinery site that they “liberated” in 2029. That year almost a hundred people, mostly men between the ages of 50 and 65, refused to participate in the mandatory amnesty of fossil-fueled vehicles. They commandeered the refinery, seized an incoming oil tanker, and declared themselves an independent state in secession from the EU.

At a meeting of the local Citizen’s Assembly it was decided, after much rancorous debate, that they should be left alone, permitted to keep their cars and the fuel aboard the tanker, which they refused to give up on pain of death. They have become an increasingly isolated and paranoid subculture, now rapidly dwindling in numbers as their members age and die off; their supply of oil is believed to be nearly exhausted, and few of their vehicles function due to the unavailability of spare parts and experienced mechanics.

The air downwind from **the Dieselpunk Territories** has unhealthy levels of particulate matter and one of the highest counts of asthma precursors, though much lower than the levels that were tolerated prior to the fossil fuel ban. **The dieselpunks** are physically harmless, but frustrating to talk to. Most Notterdammers reserve for them a sort of distant pity, and frown on attempts by religious or political groups to “convert” them to modern viewpoints.

Explore the installations that were used to process huge quantities of crude oil at what was once the largest refinery in Europe! Once a flagship asset of the notorious (and now defunct) Royal Dutch Shell Company, it did not adapt fast enough to changes in culture and consumption. It is now the largest museum in Notterdam: the maze of stainless steel pipes, the boiler and the heat exchangers have been partly deconstructed to expose the workings of this obsolete technology.

If all those technical terms mean nothing to you, never fear—you can learn it all at **Nernis!** Through its immersive exhibits, housed in the vast (and thoroughly decommissioned) oil-holding tanks, you can:

- Discover how oil was produced and processed (and how it used to smell!)
- Learn about the so-called “oil curse” that affected poorer states with large oil reserves
- See and touch plastic artefacts from the Fossil Era, and experiment with different plastics and their products

It’s more interesting (and less horrific) than you might think—though the exhibitions aimed at children do a good job of amping up the “gross” factor, and are a great way to let your little ones let off some steam on a rainy day.

## Event

# Burning Mankind festival

D 2.8, d3.6, d3.7, d4.3 P12 L12

Notterdam's notorious **Burning Mankind festival** is held annually in early August at the **Black Rock Park** close to the Noterdam docks. As much an experimental live-action roleplay session as a festival, it simulates life in a world where, rather than holding global temperature rise to 1.5 degrees, we allowed things to run away to something more like 4 degrees.

Attendees assemble a temporary village of shelters using architectural scrap and packaging waste. Energy is scarce; and food, made only from ingredients which might have survived in the local area, is strictly rationed (and thus traded for exorbitant prices). The festival has a global community of participants, many of whom set off from the Americas by boat weeks earlier; perhaps ironically, the festival is expensive to be involved in, and attracts people for whom its simulated privations are usually very distant. (Less privileged attendees counter that the real point of **Burning Mankind** is to experience a sense of community under harsh conditions).

During the week, attendees go down to the shore to pick up plastic litter, which they use to make zombie-sculptures. In recent years, the festival has attracted the controversial sponsorship of Dutch CCS firm De Koolstofafvangbroers, and on the final night of the festival, the junk sculptures are burnt in a huge ceremonial bonfire, before the remains are taken away to be stored underground. As a result, the counter-protest against the festival is be-

ginning to rival the festival itself. Whichever you decide to join, be careful, stay safe—and keep your mask on at all times!

**Dare you experience the  
4th degree of warming?**



**BURNING  
MANKIND  
FESTIVAL**

BLACK ROCK PARK  
BROUGHT TO YOU BY DE KOOLOSTOFAFVANGBROERS

## Feel the burn!

One of the more curious “art”-installations at Burning Mankind is the life-size elephant statue made out of scavenged plastic water bottles. It started as a fundraiser for elephant sanctuaries, but as the situation for African elephants improved, it is now simply tradition. If you have enough cash to attend the festival, be sure not to miss this centerpiece before it goes up in flames.

# Docklands dining

Q3 P8, 10

D2.5, 3.3/6.2, 6.1

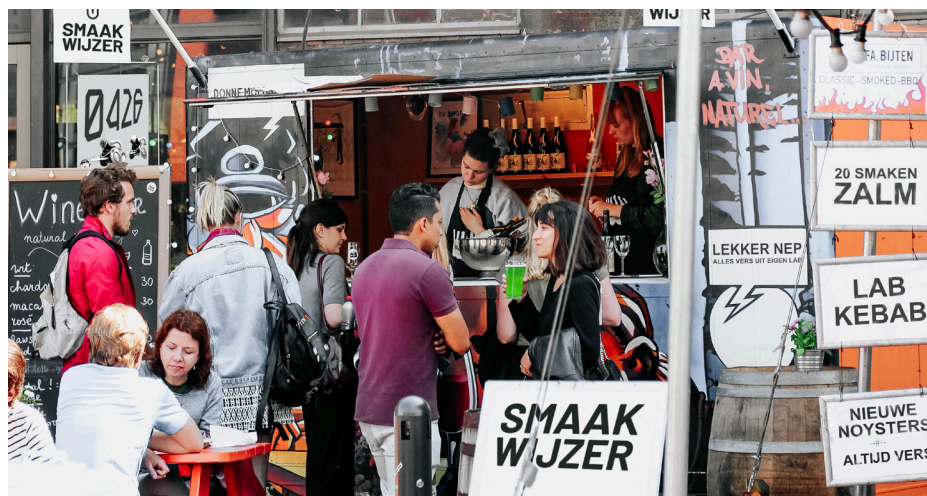
**Notterdam has long been a diverse city, and that's reflected in its food culture.**

While you can find all sorts of restaurants in the metropolis, the booming regenerated Docklands region is the crucible for the very latest experimental flavours and ingredients, as well as hosting more traditional and out-there favourites. No trip to the city is truly complete without an evening spent out here, taking in the smells and colours... it's where the younger locals hang out at the weekends, but you'll get more time and space to wander (and be more likely to get a table) during the week.

Visitors from further afield will know the cliché of the 21st century European diet, with its predominantly vegetarian base, supplemented with a large variety of plant-based meat substitutes, and a small-

er number of niche cultured meat products. **Eating food close to its site of production is a fashionable point of pride here**, as in other European cities, although mass manufactured milk products are still produced at industrial scales from soy and other crops.

However, animals are still raised for food both outside and inside cities, and Notterdam is no exception. Multi-use green spaces are used for limited (but crucial) agriculture and food production, which includes organic meat production from chickens and pigs. Beef production in particular follows the trend of agro-ecological methods, and as such generally takes place in rural locales with extensive rewilded prairie and grasslands—but in this case, Notterdam really is an exception.



### Not your grandad's dairy farm: the Meat-Packing District

Q3 D3.3/4.3, 3.6



Europe's largest urban dairy farm emerged from the collapse of the old global logistics industry that dominated the first few decades of the century. Around 2028, the European arm of a well-known global online retail firm (whose name we are forbidden from mentioning due to ongoing litigation in several territories) was brought into public control after years of agitation over inequality and poor working conditions, and of increasingly autocratic (and, some would say, cranky) ambitions of its owner, culminating in a globally-coordinated strike by its employees.

Things were arguably already changing, as global cities shifted towards sustainable models by becoming more compact and livable, thus increasing opportunities for smaller local businesses with lower packaging and shipping footprints. Whatever the causal pivot point may have been, this resulted in the abandonment of vast logistics installations which, while lawyers squabbled over questions of ownership and remediation, fell into disrepair.

As a community-owned project initiated by some of those former employees, **this particular warehouse site was ultimately reconverted into a small scale prairie/grassland island for cattle** which plays a number of sociocultural roles in the city. It is a form of memorialising experiment (or “zoo”) of previous food production techniques, a kind of cowboy-cosplay experience, and a social space for the teaching of old animal husbandry techniques, as well as hosting regular communal food festivals. The warehouse became cattle housing, with numerous smaller buildings constructed into its outer envelope, which was converted into an indoor/outdoor design with transparent bioplastic roofing, rainwater harvesting and solar heating; this design enabled the encroachment of the rewilding landscape into the building itself through its largely open eastern face.

**Tours aren't cheap** (nor is sustainable farming), **but they're worth every cent**—particularly if you manage to book a slot on one of the big food festival days.



# Eating out D3.6

*Staff writers pick their favourite food spots*

You could fill an entire book with **the best restaurants in the Docklands**—and even then you'd need to update it on an almost monthly basis. Your best bet is to just go and see what grabs you from whatever's currently open... but we've pulled out a **small selection of durable classics that are well worth your time and tastebuds**, assuming you're lucky enough to find a table!

## **Burgers, beer and bioreactors: Het Slachthuis**

Following the doubly-retro aesthetic of craft-beer joints from the Twenties, everything at **Het Slachthuis (The Slaughterhouse)** is produced and sold on site. “Meat” and “milk” are brewed in large tanks alongside craft beers, of which their famous milkbier—brewed using a remodified version of the yeast that is used to produce milk—is a city-wide favourite.

**The Slaughterhouse** is one of number of brewhouses affiliated to the MilkyBarKid Group—a Rotterdam community enterprise that took its name during a lengthy legal dispute with Cadbury/Mondelez, who had exclusive IP rights to a milk-producing yeast strain which they originally used to produce high-protein milkshakes. This case, and others like it were, eventually quashed with the passing of the 2038 EU Open Rights Directive (the so-called

“copyleft” law) that brought large swathes of EU Intellectual Property into the public domain and resulted in proliferating small-scale bioreactor set-ups. *Proost!*

## **From invertebrate to inverte-GREAT: “mystery meat” in Asiatown D3.3/6.4**

Notterdam's **Asiatown**, an early element of the reclamation of the disused docklands, is a popular spot for buying cheap trinkets made from recycled materials and the somewhat more controversial traditional Chinese medicine products—but also for its “mystery meats”.

As agricultural reconfigurations propagated across the continent, animal meat became expensive and *declass e*. With a long culinary tradition of eating insects, spiders and molluscs, East Asian restaurants and food outlets were quick to adopt to the new culinary landscape, offering a wide variety of invertebrate meat, cooked in ways that make it almost impossible to tell what you are eating.

Cultured meat hit a viable price-point towards the end of the 2030s, and demand for invertebrate meat waned accordingly. But **Asiatown's** “mystery meat” delicacies, made of jellyfish, earthworms and crickets, remained popular—not just among the East Asian diaspora, but also gourmands and sceptics of cultured meat. On

Fridays the **Mystery Meat Market** is open until late, and you will find vendors offering everything from black meat soup (黑肉汤) to deep sea noodles (深海面条). Do you dare to try them?

### “Nepveles is verser”: lab-meat dining

D3.3/6.4

You can get lab-grown meat anywhere in Notterdam—sometimes without even realising that’s what you’re getting, such as at the *kapsalon* vans dotted around **Down-town**. But the **Docklands** is home to the best cultured meats, grown by producers who view it less as a substitute and more as an artistic medium.

Down by the waterside on the western edges, you will mainly find seafood dishes prepared by the local *zeevruchtenlab* (“sea-food lab”). Many local pescatarians are fiercely devoted the restaurant **Smaak-Wijzerplaat**, where you can select from 20 different flavours with which to infuse your lab-grown salmon steak. In the eastern reaches, meanwhile, you will find some decent red meat restaurants. However, only some of those have their own labs—so if it’s freshness you’re after, keep an eye out for the sign *Eigen Laboratorium* (“in-house lab”).

### Straight to the point: Re-Skewer

An idea as simple as it is righteous: **Re-Skewer** is a barbecue restaurant which uses only food rescued from supermarkets and restaurants across the city. You can bring your own veggies (and beer!) if you like, or take a punt on the dish-of-the-day and enjoy the inventive and surprising combinations cooked by the rescue chefs.

*“You can get lab-grown meat anywhere in Notterdam—sometimes without even realising that’s what you’re getting”*



# Barge-ing through

*River tours along the Rhine* **D3.3/5.3, 3.6**

Boswell famously wrote that “when one is tired of London, one is tired of life”. Residents of Notterdam would counter that “**when one is tired of Notterdam, one should just get out of the city for a bit**”.

But why wait until you’re tired? There’s **plenty to see beyond the city limits**—perhaps you’ve an interest in cutting-edge industry and agriculture, or you hanker for the wide horizons of the rural. Or maybe you just like spending time on a boat, watching the world go by... Whatever your motivation, our staff writers agree that **a tour on the river is the best value expedition you can make**, both in terms of cost and variety.

Situated at the head of Europe’s longest navigable river, Notterdam is well-supplied with riverine tour operators catering to every interest. From here you might take ship on a biocomposite boat and journey deep into the continent, southwards through Germany, all the way to the foot of the Swiss Alps. Obviously, that’s considerably more than a day-trip, and so we’ve covered it—and many other big-river holiday options—in **a separate guide**.

If you’re sticking with Notterdam as your base, however, just one day of river travel can get you all the way to the border with

Germany, just east of Nijmegen—and there’s enough to see that you could occupy a good few days by making some stops along the way, or hanging out in the verdant peace of the Zeiterbaan zone near the border. **Check with tour operators regarding what’s available:** many sites are best seen at particular times of year, and new local festivals are constantly popping up along the riverside as this mode of travel gains in popularity.

Deals are often available on overnight accommodation and tours at various spots along the route. **Maybe you’ll return on a nightboat to save a day in transit, or return by bike along the same route as part of a guided peloton?** The total difference in elevation is only 20 meters... sure, there are some hilly bits, but you should be able to keep the battery charged if you keep pedaling on the flat!

## River Tour Highlights **D6.1 L22, 23**

There’s way, way more to see on the banks of the Rhine—from model farms to sustainable forests—than we could hope to cover, but here are some must-see favourites from our staff writers and seasoned travelers. Tours tend to start in the city harbour and head out into the delta before making their way inland.





## Floating Farms Q3 D3.7 L10, 14

After centuries of battling the sea in the delta west of Notterdam, the Dutch finally decided to turn a problem into an opportunity by embracing the delta area as it grew throughout the first half of the century.

Engineers and transitionists from the Netherlands and beyond have come together and combined their expertise to construct a solid surface on top of the Nrhine delta, making use of resources that their predecessors had written off as waste. By using lightweight plastics that float, their efforts allowed enormous amounts of affordable arable space to become available, right next to a city full of people in need of healthy, flexible employment options.

The **floating farm** concept radically reduced the need for complicated irrigation

systems, allowing farmers to maintain vibrant green pastures without complex irrigation systems: desalination, powered by tidal float-banks and solar panels, keeps the plants well watered without drawing upon the local water-table. Early experiments focused on cereal crops, but since the concept was proven, the Notterdamers have been unstoppable in exploiting this new opportunity, farming everything from ethical meat and dairy to plants destined to become fibres, fabrics and medicines. As a result, the country is nearing self-sufficiency on plant-fibre products, and a whole slew of new opportunities in chemicals production are starting to take shape on the nearby banks...

***“The Dutch finally decided to turn a problem into an opportunity by embracing the delta area as it grew”***

## Biorefineries Q5 D2.3, 2.4, 2.7, 3.6 L15

The boom in agricultural byproducts from both the floating farms of the Notterdam delta (**page 17**) and further upstream at the **Zeiterbaan zone** (**page 20**) has attracted entrepreneurs, and now a number of facilities are developing on riverside sites where the petrochemicals industry once ruled the roost. Being working businesses, often dealing with hazardous chemicals and machines, many of these sites are off-limits to tourists—but if you're into this sort of thing, a good pair of binoculars should mean **you can get your fix of the green-industrial sublime without leaving the comfort of your tour-boat.**

However, some tour operators make a point of stopping off at the wharf of the **Nalgaedam biorefinery**, which makes use of the unique conditions in the river mouth (as well as the power provided by the tide) in order to cultivate and harvest algae of the species *N. Futraplastica*. Originally focused on producing plastics for food packaging and blue paint pigment, **Nalgaedam** have diversified and become world renowned for their “noysters”, which are now being served at top restaurants. You can even buy a bag of them to take away—after soaking for ten minutes they taste just as fresh as in the biorefinery. As the locals say: *dat is lekker eten!*

## Nelderland: model farms and ecovillages Q3 D3.3, 6.3

Once you're east of Notterdam proper (and assuming you haven't been distracted by the historical delights of **Nordrecht**), you'll find your boat winding its way through the agricultural wonders of the **Nelderland**. Once busy with mono-

culture farming and hothouse fruit and flower production, this region is now host to scores of new model farms and circular-agriculture ecovillages.

Some dairy and cereal farming still goes on out here, of course—but you're as likely to find protein being produced in the form of invertebrates, beans or legumes, or familiar dairy substitutes such as oats and soya made side by side with more experimental offerings. Reforms in agricultural policy mean not only that what were once considered “**waste**” **products are reused as inputs for other production processes**, but also that **a majority of nutrient inputs come from urban waste collected in the cities and towns** (If you visit, you can contribute by dispensing your waste into one of the phosphorous collectors in the bathroom). Furthermore, the more hands-on nature of these methods mean that many more people are working the land than used to be the case, and being paid fairly for their work. That means you pay the true cost of the produce, of course—but **when food tastes this good**, you'll find it hard to object, especially when you can enjoy it without having to feel guilty!

Many of these farms and villages are attractive places to visit—and they compete to entice tourists with **permaculture workshops, food festivals, farm tours and seasonal produce markets** (the asparagus harvest in late March is sublime). We could list a dozen sites that are well worth a day (or even an overnight stay), but if you want to combine cutting-edge agricultural practices with an age-old Dutch tradition, there's really only one choice: **The Bollendorp circular cooperative**, detailed on the following spread.





## Noysters

Sure, they look pretty ugly—but it's not like real oysters are pretty, is it? Noysters taste better than they look. Are they also aphrodisiacs? We're not qualified to answer that...

## Zeiterbaan

Come for the famous treehouses, stay for the mellow arboreal vibes—take a leaf from the locals' book, and live life in the slow lane.



## Bollendorp circular cooperative

Renowned for its colorful fields of the classic tulips, **the Bollendorp cooperative** has much more to offer besides: come in mid-April to catch the flowers at their best, but there is plenty to enjoy all year. The fields teem with a vast variety of different crops, trees and flowers, and one of the knowledgeable local guides—all of whom work the farms themselves—will be glad to tell you how it all fits together.

The **Bollendorp village visitor center** runs regular workshops, too. Taste traditional low-calorie flower-bulb meals, arrange edible flower bouquets, and learn to heal common problems with medicinal flower oils. As always, numbers are limited for these popular events, so book in advance! Intensive agricultural internships are also available to applicants who can demonstrate a commitment to the cooperative's principles; ask on site for details.

***“Dutch design is justly famous, so perhaps it’s no surprise that the DIY Home movement began out here a generation ago”***

## Zeiterbaan sustainable forestry zone

D2.4, 3.3, 3.6, 3.7, 5.3 Q5

The **Zeiterbaan zone** used to be just another stretch of riverside polder near the German border, until carbon sink subsidies encouraged serious reforestation efforts; the trees also help keep the banks of the river stable. Of course, there’s lit-

tle that’s “natural” about this forest: the whole thing is managed carefully in accordance with the best ecological principles, and trees are harvested and processed in facilities that are close to being self-sufficient in terms of the chemicals they use. **Zeiterbaan** produces not just wood-pulp paper, but also fibres destined to become fabrics for personal and industrial uses, and the biomass that forms the backbone of biocomposite plastics, much of which is barged downstream to Notterdam and beyond. The pulpmills out here also produce more electricity than they use, as well as biogas. The facilities are off-limits to the public, but the forest itself is a **popular destination for walking, off-road cycling and—natuurlijk!—tree-climbing**, which has proven popular in a sport-crazy country that lacks boulders and mountains.

Dutch design is justly famous, so perhaps **it’s no surprise that the DIY Home movement began out here a generation ago**, as a rash of radical experiments in dematerialization. You can find some classic examples of DIY treehouses out here in the **Zieterbaan**, where families connected to the area or its industries were given permission to build within the forest on the condition that they adhered to strict building codes covering materials, space and energy efficiency.

Wandering is welcome, but we would remind you to **observe these private dwellings from a respectful distance!** Open-house events do occur, but if you’re really interested in learning more about the financial and personal freedoms of “house-free” living, see if the local society’s monthly meeting happens to coincide with your visit.

## Area

# Downtown Q11 D3.7

Notterdam is full of folk who remember the old days, and not without a certain fondness—but while there are still occasional demonstrations (with the inevitable merchandise stalls) by the Ordoliberal Popular Front, **most locals prefer Downtown as it is today.** The demise of Big Retail was in already well underway worldwide in the early 2020s, when the early pandemics provided a decisive tipping point. While many of the largest structures—such as the legendary Mall of America, and the Westfield of Stratford, London—have been torn down or entirely repurposed, **Notterdam’s approach to the collapse of consumerism offers a unique experience** that you’ve probably only seen in VR.

**Hungry?** Gobble up a piece of Gouda or try other local cheese specialties; we’ve done the research for you on **page 25.**

**Bored?** Experience the oddities of old mobility schemes at the Notterdam Museum of Mobility, detailed on **page 35.**

**Adventurous?** Slip into your stretchy bamboo and explore the thrilling cycling culture of Notterdam; go to **page 30** to get a head start.





## Adventure

# Retail therapy?

## *Things to see and do downtown*

There's plenty to see and do Downtown—see below!—but **don't discount the pleasure to be had from just hanging out and soaking up the street-scene.**

Nowadays Downtown is home to a large number of older people with a variety of care needs. While you enjoy a coffee and a slice of *appeltaart* in one of the many cafes, you will see many of them out and about, contributing to the vibe of the area. Their independence is made possible by a strong social care system and some surprisingly simple planning policies, as well as a variety of novel technologies, many of which were pioneered in the tech labs tucked away in old malls such as the **NK Center (page 24).**

The proximity of a **world class hospital, the conversion of several former malls to senior living solutions, and the co-location of start-up firms is part of the reason for the revival of this once-grim area.** The weed peddlers are still around as a reminder of the bad old days, but they've no need to play it tough any more, thanks to the EU's recategorisation of cannabis back in 2027. (We do suggest that you switch your mobile devices to their highest security settings, however, as this—like other busy parts of the city—is an identity-jacking hotspot.)



## Accommodation

### FaFa Hotel (€€) D2.3 P7 L 17

Ever dreamed of living out a teen movie from the 2010s, sitting around plastic tables with your friends, eating cheeseburgers and hot dogs and slurping giant milkshakes from plastic straws? A stay at **the FaFa Hotel** will totally feel like the real deal—fosh!

Located a stone's throw from the central train station, this iconic hotel is inside one of Notterdam's many old shopping malls. In an ironic homage to the Fast Fashion era, guests can stay in converted shop rooms, decorated with a great collection of original ads and window decorations.

Meals are served food-court style, with delicious modern interpretations of traditional fast food staples.

The experience would not be complete without some opportunities for shopping: **find your next favourite at one of the city's biggest indoor second-hand markets**, rummage through the hotel's **seven well-curated vintage stores**, or change things up at your favourite **clothing rental**—all the major chains are represented, as well as the hottest (and highest-priced) for-the-day fashions from eastern and southern Asian couture houses.

## Malls

### Stuffed animals: the former malls of Notterdam Q11, 12 L 16, 18

It can be hard to believe the amount of urban space that was given over to the sale of low-quality goods in the early years of the century—even more so when you factor in the sky-high rents and meagre wages experienced by the employees of those businesses. Many of those former temples to consumption have been torn down, but a number of Notterdam's most notable malls have instead been repurposed—both inside and out!

#### **Mowga Tower (€)**

**Climbing this old colossus will take twenty minutes of calf-stretching stairwells**, but it's well worth the effort—though elevators are available for the

differently able. The green roof offers a stunning view across the entire region, as well as a rain-harvesting landscape of native species that help to collect and purify rainwater for use in the levels below. (Note that on days **when the temperature is over 35C, the roof is closed to visitors** for their own safety.)

After soaking your eyes with far horizons, head downstairs to soak your body in the pools and saunas of the tropical house. Powered by a seasonal combination of solar, thermal or wave energy, this part of the Mowga is open all year round: transport your senses (if not your body) to an exotic getaway destination, with different rooms



## Sales!

Everything must go! Experience the authentic anxiety of consumerism in Nhine's simulated sales. But be warned: the Black Friday Memorial has been known to induce traumatic flashbacks in Millennial visitors.

recreating (and preserving) examples of lost ecologies from equatorial regions long since lost to rising tides and temperatures. Further down again, the hydroponic floors produce a wide variety of herbs, spices and vegetables which sell to tourists and locals alike from the **ground-floor market-hall**, which also features a romper-zone for the kids (subject to pandemic status levels), a number of fix-it booths and retro-tech swap-shops, a yoga studio and a library.

## **Nhine (€€€)** P7 L 16, 18

**Nhine** is a small mall, originally built in the Nineties, painstakingly turned into a time-capsule that returns you to 2008, the last days before the first Big Crash. Stroll through racks and racks of clothes and homewares, featuring all those big defunct brands that your grandparents reminisce about every Christmas. Go to the fitting room and try on a dozen different outfits, pick a few, then “pay” for them the with the plastic card you’re given on admission. You even get to carry your purchases in fancy bags as you head towards the food court, where you can pretend to order from their old menus amid the authentic stench of overused cooking oil and high-fructose corn syrup.

## **The Green Gnome (€)**

After you’ve scared your stomach (and your fitness monitor) with **Nhine’s** recreation of the culinary bad-old-days, **The Green Gnome** can calm it back down again. A rotating roster of eateries make their home here, all of which source their produce from the agroponics beds and greenhouses that have been retrofitted into the upper levels of the old mall in which they are located.

## **NK Center (€)**

While its interior has mostly been given over to an assortment of urban manufacturing and other lighter industries, the sloping roof of this ugly old monster offers seasonal delights. On sunny summer days, hire a blanket or deck-chairs and eat a picnic lunch among the wildflower colours of the lush meadow; if you don’t bother the bees, they won’t bother you! And if you’re lucky enough to be in town for one of the ever-more-rare snowfalls, early risers have a chance of schussing around on what is perhaps the most dramatic urban ski-slope on the continent, if not perhaps the planet. Equipment hire comes with the admission price, as does insurance.



## Gastronomy

### Too Gouda to be true? Gourmet cheeses in Notterdam

Q3 D2.5, 3.3/6.3, 3.6 P8

A visit to Notterdam is not complete without having tried some of local delicacies. Here are our recommendations **for the best regional cheeses**:

#### **The connoisseur's choice: deli counter and café De Kaasschaaf (€€€)**

Located on the top floor of luxury department store **De Bijenkorf**, this is opulent deli sells Gouda, Boerenkaas, and other flavours you may remember from times gone by. The quality is as high as the price tag, reflecting the dwindling quantities of these old favourites still available for sale. Try them one more time before they are gone forever.

#### **A mind-altering experience: Cheese Dreams factory tour (€€)**

Possibly Notterdam's most famous export product: **Cheese Dreams**. While it will not actually change your state of mind, this weed-based cheese is now exported to over a hundred countries. Join the gaggle of tourists and take a one-hour tour of the company's factory in **Kazendrecht** to discover how a small Notterdam cheese brand went on to become a world favourite.

#### **Cheesy goods**

At café De Kaasschaaf, the cellar is lined to the roof with cheeses, there are even some exotics aging away. Theft was a big issue at first, which is why you are now sniffed up and down by a cute (but dangerous) Dalmatian named Kurt. So don't even think about swiping that Comte...

#### **Dare to be different? Kaasmix (€€)**

"Kaes" made from algae harvested off the country's coast, "boterbloemkaas" made from buttercups and other wildflowers grown in **the Nestland region** just to the west of the city, or "Tsjies" from chestnuts grown at **Zeiterbaan**; the regional cheese scene is booming. Slightly off the beaten track, **Kaasmix** is a specialist shop that sells them all, and has highly knowledgeable staff to help you choose between its dozens of different offerings.



## Event

### De Dodelijke Roelstolrace

Wheelchair racing is Notterdam's **unofficial city sport**. Following sweeping planning reforms under the Universal Design Act in the 2030s, activist wheelchair users decided to evaluate the city's implementation in the only way conceivable: by betting on who could get the across town the fastest.

Initially intended as a critical intervention in the urban planning process, it eventually turned into all-out carnage! **Customised chairs bedecked with neon LEDs,**

**costumes, fundraisers, brawls... this unique event really has it all**, but is not without some risks for would-be spectators. It's taken place on April 29th every year since the first time, but you'll need to ask around carefully if you want to catch wind of the starting point, which moves every year in order to avoid the authorities putting a stop to the chaos before it starts. (We've heard rumours that it might start somewhere in Het Kleermakerswijk this year, but don't blame us if it's somewhere else, OK?)

## Advice

### Blag, borrow, swap: how to avoid buying stuff Q12 D3.7 L17, 21

Seasoned travelers, accustomed to weight-based tariffs on baggage, will be pleased to hear that **Notterdam is generously provided with places to borrow hardware that's expensive to carry around** (or indeed to own at all).

The original—and, according to locals, the best—is **Circularity**, a sprawling and anarchic buy-or-borrow store where you can rent pretty much anything you might need while in the city. Their selection of vintage hoverboards and monowheels is legendary, and offer a distinctive (and daredevil) alternative to the municipal scooters.

Notterdam residents buy, sell and swap all manner of domestic hardware through **Circularity** and similar smaller stores all over the city, and the repair service is second-to-none. From electric grills to gaming consoles, holoprojectors to hi-fi systems, it's all here—and serious retro fanatics will lose hours (and perhaps thousands of euros) in the justly-famed **Hall Of the Twentieth Century**.

(Be sure to check your home nation's environmental legislation before splashing out on a vintage CRT TV... it would be a shame to get it all the way home and then not be allowed to plug it in.)

## Books

### Modern Vintage: Notterdam's print district Q5 D2.4

Futurists have been predicting the death of the printed book for well over a century, but Notterdam's so-called “print district”—really just a couple of streets—is the local iteration of the perpetual disproof of those predictions.

Of course, publishing and production has changed a great deal—and the **various stores specialising in particular topics and genres** are testament to the long-promised maturity of print-on-demand technologies. You can have a custom binding of almost any book ever published—and, it is rumoured, a few that never were published, or never should have been—whipped up to your specifications and delivered to your accommodations within twenty-four hours. **Books printed in Notterdam are arguably an even better sink of carbon than those elsewhere**, given that the sustainable paper they use is produced just a day up-river in the **Zeiterbaan zone** (see page 20).

Bookworms are browsers by nature, so we won't bore you with too many suggestions—but here are a few favourites from the bibliophiles among our staff writers:

#### **Fiber Vibe (€)**

New and obscure books printed on site; specialises in local authors and Dutch-language poetry.

#### **Letters op Papier (€€€)**

Dutch books only, with an emphasis on history; also collectible first editions of Dutch novels.

#### **Pulp Fiction (€€)**

The local branch of the global chain, justly famed for their constantly changing collection of vintage books that have stored carbon (and great stories!) for more than 50 years.



## Clothes

### Het Kleermakerswijk: the tailoring district Q2, 12 D3.3/4.1, 3.6 L17

Built in the 17th century, **Het Kleermakerswijk** is a warren of narrow streets among the canals of the city's historical center, dotted with countless cafés, repair shops, vintage stores, boutiques and—of course—tailors.

For visitors from further afield, this focus on reuse and repair options might seem unusual. It can be attributed in part to Rotterdam's strict ordinances on the sale of newly-produced goods, which resulted in an extraordinary boom of second-hand trade and “do-it-yourself” options that put even the lively flea-markets of other European cities to shame.

You can still get new clothes here, of course. Makers in the classic bespoke tradition exist alongside more modern automated tailoring and technical fabrics. While their work is never cheap, it will last you for many years (and may come with a guarantee to prove it).

#### **3Dtrend (€€€)**

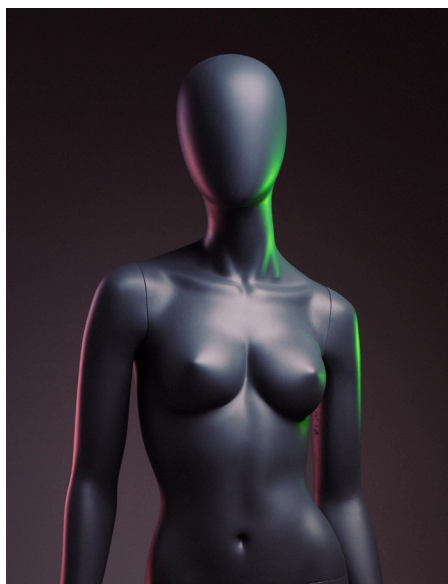
Somewhere between the thrift stores and the techno-bespoke tailors lies **3Dtrend**, which uses LIDAR scanners salvaged from old games consoles alongside the very latest fabrication systems to produce clothes that fit just the way you want them to.

**3Dtrend** offer original pieces, but have carved out their own niche with their unusual deftness for altering and restoring existing items, and for working with salvaged or antique fabrics in new cuts and

styles. You can get your last-decade denim tweaked up for today's look, or turn a thrift-store counterpane into a one-of-a-kind dress—or, if your bank account can stand it, take pot luck on the latest visions of whoever is their latest guest designer-in-residence.

#### **Rijg de Naald (€€)**

**Rijg de Naald** (“Thread the Needle”) is a local veteran, an implausible but reliably popular hybrid of retro tailoring and boogie bar. Known as much for its ferocious cocktails as its Twen-Cen disco decor, this is the place for those who want to buy some wide-flared pants and show them off on the dancefloor immediately afterwards. Disco ain't dead, baby—it's stayin' alive right here in Rotterdam!



## Advice

### Guide to zero-waste shopping

Q9 D3.6, 3.3/4.3, 6.1 L4

For those of you who still have old-school supermarkets back home, **Notterdam's enthusiastic embrace of zero-waste retail is going to come as something of a shock.**

Born of the environmental activism of the Teens and Twenties, the first few zero-waste stores set themselves up in alternative enclaves such as Malmö, Barcelona and Edinburgh, and built up devoted local followings. However, they refused to expand into new branches and chains, opting instead to form networks of mutual support, providing new start-ups in other cities with tips on integrating themselves into their own local food-landscapes. The network grew, got better at lobbying, and became more visible to people increasingly interested in buying stuff that was locally produced and sustainably packaged. By 2030, most major European cities had a zero-waste store; by 2040, as agricultural reforms gained traction, most neighbourhoods had one of their own.

Here in the Netherlands, some of the big players in retail saw the writing on the wall, and decided to join the revolution rather than fight it. You can't go far without passing an **Albert Heijn Zero**—though the die-hard ecohipsters wouldn't be seen dead in one, preferring to patronise one of the many specialist independents.

For the uninitiated, the basic set-up is the same: **stores carry predominantly locally and regionally-produced organic food**, which in some cases may have trav-

eled less than a kilometer before reaching the shelves. Foodstuff of more exotic provenance—mangoes, avocados and lychees, for example—is highly unlikely to feature! (But if your credit account can handle it, it's just a short bike-ride out to **the Far-away store in Neijenoord, which specialises in imported items from all over the world, including coffees and tea.** Needless to say, it's also zero-waste.)

For locals, it's a point of pride to turn up with a bag full of vintage jars and tubs, which may have been in the family for decades. Newcomers needn't worry, however: **pay a deposit, borrow whatever containers you need, fill it up, and off you go.** Drop off your empties—after you've rinsed them!—at any other store, or at the PANT machines dotted around the city, to get your deposit back.

As well as their key role in food provision, the non-chain zero-packaging stores are often also the political and social centres of their neighbourhoods. Hanging out with a coffee is **a great way to meet the locals and get to know what's happening in the city.**

***"It's a point of pride to turn up with a bag full of vintage jars and tubs"***



## Cycling

### Even better than the wheel thing: fast times at Fietsstraat

D3.6, 6.1, 3.3/5.3

P9

L22

Most visitors to Notterdam are content to rent a bike, whether it's one of the ugly but comfortable municipal options, or whatever's on offer at their hotel. But some come here just to buy a bike, or in search of parts and accessories for the one they arrived on—**Dutch cycling technology has always been top-notch**, and Notterdam's closeness to international shipping connections makes it a prime location for the very best manufacturers.

Whether you're buying or dreaming, **Fietsstraat is the place to go**: from rusty old beaters to reconditioned classics, from commuter comfort to race-ready road-rippers, you can find them all here, or just cruise the street on your own machine to show it off to the discerning crowd. Here's just a handful of the hottest bike boutiques in the city:

#### **FourWheelsBad (€€)**

A former courier-bike repair cooperative turned manufacturer, **FourWheelsBad** now ship their Big Bertha biocomposite cargo-bikes worldwide. The store on Fietsstraat has demo models of everything from their current catalogue, plus some rare classics and the occasional experimental frame. We hear that recumbents are due for a comeback...

#### **Christiania Calling (€)**

A distributor for the justly famed Danish bicycle brand, **CeeCee's** also carries classic Dutch designs, and always has a good range of elegant refurbis in store. Biocomposites, bamboo and laminated paper options are available.

#### **Rusty's (€€€)**

As the name implies, **Rusty's** is mostly for collectors only: not many folk would ride one of their beautifully refinished all-steel machines given the commodity price on ferrous recyclables. But some say you just can't get the same strength and momentum from laminates... and others are honest enough to admit that when it comes to having a pimped-out ride, bare steel is more ostentatious than gold. At Rusty's, you can look all you like, but don't touch unless you're buying—fingerprints are how corrosion starts. One last bit of advice: if you come to show off your own steel machine, you'd better have some serious locks for it. Bike theft has declined hugely across the Netherlands in the last few decades, but it's not unheard of—and raw steel is the biggest prize of all. ID tags and GPS won't make a difference; that thing will be into a smelter before you can even ChattApp the Notterdam police with the details. Don't risk it!



## Rusty's

This isn't Rusty in the picture; this is Luuk, the long-term store manager. Rusty hasn't been seen for over a decade... some say he spends all his time in a canal-side loft full of antique bikes; others say he pedalled off to Utrecht one afternoon and never came back. But Luuk refuses to reveal the secret, so we may never know.

## Outing

# Get a move on! L22

## *Exploring the Linear park*

Traveling with kids? One can struggle to find places that will keep your little monsters entertained while providing you with opportunities for more sedate forms of relaxation. Lucky for you, Notterdam's legendary **Linear Park**—following what was once the former east-west route of the A20 highway through the northern quarters of the city—has something for everyone, and more besides.

You don't even have to do tourist stuff! The Park is immensely popular with locals, whether for **walking or cruising on bikes, picnics, impromptu concerts and other performances, or just hanging out and people-watching**. There's easy access from a few dozen rail, tram and subway stops, and all the major north-south bike highways connect to it somewhere; you

could easily spend a whole day wandering here, if not a whole week.

**Leave the kids at one of the many supervised playzones, check out some cultural activities, or just bask in the sunshine** (weather permitting). The air is clean and clear—but those with allergies would be well advised to wear pollen-filters from early March through to late July, as the fruit trees and wildflowers can assault the most sturdy of sinuses! (And as we've said elsewhere: leave the bees alone, and they'll leave you alone too.)

**The Linear Park** will take you past enough sights and activities to fill a guidebook in its own right (which is why we're working on one right now), but as always, here are a few highlights from our staff writers:

## Nature

### **Neunux Tunnel Nature Reserve** L6, 13, 22

**The Neunux Nature Reserve** was established after the radical downsizing of the motorway system, which left this underpass—and others like it—empty for years, visited only by graffiti artists and muralists. One such spraypainter with an interest in ecology noticed that the bats which had colonised the tunnel were of a species previously assumed to have been extinct, and the underpass was quickly secured as

an SSI and given the status of an urban nature reserve. Now **over two dozen threatened species of bats and other animals proliferate in the tunnel**, and every year a few hundred of them are released to other locations as part of the national rewilding programme. The reserve only permits 500 visitors per day to ensure the integrity of the environment, so buy your ticket well in advance!



## Linear Park

Watch where the locals sit to identify the best spots... but don't try to "reserve" one with a beach towel or folding chair. This isn't the Costa del Sol!



## Museum

### Blast Furnace Museum Q4 D2.2, 3.3/3.2, 3.6, 4.2

For industrial nostalgists, a visit to the **Notterdam Blast Furnace Museum** is a must. One of Europe's best preserved coal-based ironmaking sites, the museum's award-winning five-senses VR tour will take you on a journey through the heyday and downfall of one of the biggest industries of the Fossil Age.

Choose between a variety of tours for the whole family, or live a day in the life of a steelworker in the 2010s. Experience the fiery glare of liquid iron, the roaring noise of the machinery, and the feeling of heat and dust on your skin! Then treat yourself to some artisanal charcoal ice cream, a charcoal facepack, or one of the many other themed treats at the museum's café and spa.

For a bit of contrast, arrive early and make time to visit the nearby hydrogen-steel plant to see just how much things have changed. A guided tour (including the electrolyser and electric arc furnace) is 50% off for BFM visitors. Free shuttle-bus included!

***"Experience the fiery glare of liquid iron, the roaring noise of the machinery, and the feeling of heat and dust on your skin!"***



#### **Petrol-fuelled leafblower**

Voted Most Ridiculous Idea by Museum visitors... five years running! (Nonetheless, the weekly demonstration day is incredibly popular, particularly with men of a certain age.)

## Museum

### Notterdam Museum of Mobility L22



A photo from the Museum's archive; the original machine can be seen on display in the museum, alongside over a century's worth of iterations of powered scooters.

The **Museum of Mobility** lies just south of the **Linear Park** by the **old City Zoo**, just south of the **Overschie** district. Its angular retro-modernist form was built upon the site of a former **Schiekanaal** industrial park using the concrete and steel recovered during the deconstruction of the A13 overpass, which crossed the old motorway at this location.

The big draw for kids (and adults) is the **collection of vehicles from the last two centuries**, many of which sit out in front of the museum itself. From early steam locomotives to pioneering high-speed electric trains, from horse-drawn wagons to gas-guzzling trucks, if it could move goods or people, then there's probably an example here! The Museum's free AR app provides great explanations and supplementary materials, but you'll want to **catch at least a few of the live demos with human explainers if you can**; these jobs attract the finest young performers and communicators in the region. There's plenty more within: in addition to various mobility machineries, such as the original proto-

type of the Otto Engine and a selection of petrol-powered scooters from the early 20th century (see above), there's a strong selection of other devices which exploited the seemingly endless power-source of fossil fuels to other ends, some of which make no sense at all. (The petrol-powered leaf blower has been voted Most Ridiculous Idea by the museum's visitors for five years running; see facing page.)

In the eastern wing, a large hall is devoted to **an immersive exploration of Rotterdam's particular history as a hub of global commerce and shipping**, and doesn't shy away from the colossal importance that oil and other fossil fuels once played in that story. An award-winning combination of cutting-edge VR and older immersive techniques will transport you back in time to the sights, sounds and smells of 20th century industrialism at its noisy, dirty peak. **It's sobering stuff, but relentlessly popular**—arrive early to beat the queues, particularly if pandemic precautions are in effect.



# Now hear this!

## *Live music in Notterdam*



Notterdam's sonic scene has plenty to offer, thanks to a **vibrant community of musicians and artists**. The busking sites across the city are hotly contested, and distributed by lottery to ensure fairness, but things are a bit more *laissez-faire* where there's more space to work with: the **Linear Park (see page 32)** is frequently host to a few dozen spontaneous concerts and jam sessions, with every genre from avant-jazz through nu-nu-rave and retro-rock regularly represented. **Do tip musicians whose work has brightened your day: if you can afford to travel, you can afford to support the arts, too.**

As elsewhere, Notterdam's venues were devastated by the crashes and pandemics of the Noughties, Teens and Twenties. Only the largest ones managed to struggle on, thanks to increasingly strident corporate sponsorship deals, until rising energy prices made their light-shows and audio rigs too expensive to run. The **Notterdam**

**Ahoy arena** in the **Zuidplein** district was one such fallen giant; it got a second lease of life when a local entrepreneur bought up the deserted shell, coated the roof with solar panels, and started putting on shows once again. If you're in town in mid-April, the Ahoy is a focal venue for the annual **Nollapalooza festival**, which pays well enough that international acts from across the continent can afford to make a rare in-person appearance.

Of course, most gigs star local acts, but **many bars and clubs also screen live performances from other venues all over the world**, complete with state-of-the-art crowd-feedback technologies. The best way to enjoy your favourite bands from overseas, as well as the great heritage acts, is to catch a show by one of the city's many talented covers bands: The Beatles have a world-wide reputation already, but we recommend catching Lady Gogo before she gets too famous...

## Sports

# Cool runnings L12

## *Schaatsbaan Kanaal*

No visit to Notterdam is complete without an hour or two gliding around on the **Schaatsbaan Kanaal**—the world’s largest ice skating rink, in the form of a 1200m traditional canal which passes through some of Notterdam’s most eye-pleasing areas, such as the reconstructed windmills of **Prinsenlaan**. The Schaatsbaan was inaugurated in 2048 in order to reinstate the city’s proud tradition of ice skating. **Kept ice-cold through the use of cutting-edge heat-pump technologies**, the Kanaal is open all year around, including Sundays and most national holidays.

In early February each year the Notterdammers come together to celebrate **Koud Vermist**, a national holiday for remembering the cold. On this day, skaters dressed in traditional costumes gather for a day of ice skating, pole-sledding, and other icy entertainments. Ice skates and outfits can be rented on several locations along the canal, where you can also indulge in some Dutch treats. The entrance by **Prinsenlaan** also provides ice skating classes, curling classes and an exhibition on the history of ice skating in the Netherlands, including specimens of real ice. Entrance fees start at €8 for adults, and €3 for children under 15.

(Heavily padded bright orange trousers are available for rent in case you’ve never encountered ice before. If you’re going to embarrass yourself, at least do it in style.)







# Rise above, rise again

*Neijenoord, the Venice of the North* L20

Don't fight the water, learn to live with it: that's the motto of **Neijenoord**. Now resembling a northern-Euro remix of Venice, **Neijenoord** was recently threatened by frequent floods, while a massive tidal barrier project underwent the inevitable delays and lawsuits.

***"Don't fight the water, learn to live with it: that's the motto of Neijenoord."***

**Neijenoord** is now a show-case for flood-plain communities around the world. **Once a residential working class area, Neijenoord developed into a vibrant neighbourhood of Syrian, Somalian and Sudanese migrant communities** in the early Twenties, who organized themselves after the devastating floods of '37 and '38 and demanded their right to co-design the district's regeneration plan.

Visitors are made very welcome in **Neijenoord**, which has proven its resilience to floods many times over, and is currently being studied by city planners from New York, whose own experiments with flood

walls have proven only partly successful.

**The Afro-Dutch fusion street food is a true culinary one-off**, and the community culture centre documenting the neighbourhood's history is well worth a visit. Why not kick off your weekend at **the floating market**? It starts at 8am on Friday mornings, and runs until everything's sold. Do bring swim gear for the famous "dip n' dip", a local classic consisting of self-harvested oysters and fries dipped in delicious algae-cheese.

If you're up for getting your hands dirty and making a difference, schedule your visit to the city around the flood season, when the **Neijenoord** communities organize a support mission where volunteers can provide emergency relief to those in

### Did you know?

Neijenoord can claim to have been the nail in the coffin of the now-shunned "Zwarte Piet" parades, after a 2028 protest march by the Traditional Nationalists ended up in hot water—well, cold water, really—as it tried to pass through the neighbourhood. Look out for the commemorative mural!





## Train station

All roads lead to Rome, it used to be said... so maybe all rails lead to Notterdam? Hyperbole aside, millions of people pass through this station every year, from as far away as Mumbai, Beijing and Cairo. Perhaps you'll be one of them?

# Getting here, getting around

Time was that Amsterdam was the big tourist draw in the Netherlands, with Notterdam a distant second—but that started to shift even before the pandemics of the Twenties changed the way we thought about travel. Now a hugely popular destination for overland Eurotourists, and an alternative gem for international connoisseurs making that once-in-a-lifetime trip to the Old World, **Notterdam draws visitors from far and wide**. In this section, we'll explain what you'll need to do to become such a visitor, and how to get around the place one you're here.

## Travel

### Hello, neighbour: travelling from within Europe L23

For fellow Europeans, the fast and comfy option is taking a train from one of the **European High-Speed Transit** hubs: **Paris, London, Berlin, Stockholm, Milan, Madrid and Prague** are already connected, and there are promises that the network will expand further in the next few years. In the meantime, getting to your nearest **EHST** hub is a matter of connecting across your national rail network. (Bear in mind that **jurisdictions outside the EU may offer challenges to those seeking to book their trip as a single unified ticket**—sorry, British friends!)

**Don't forget the night-trains**, either—why waste a day of your holiday allowance on travel when you could just wake up in Notterdam on day one? The **EHST** terminal is a fair way out of the city, as it serves

not just Notterdam but the other major cities in the region, but your ticket will include a local rail transfer into the city.

The more budget-conscious—or those who just prefer life in the slow lane—should look at the **XEC** option. The **Cross-Euro Coach network** may be slower than trains, but it's faster than you might think, thanks to their slick fleet of swift and comfortable electric vehicles—particularly on routes where they get access to priority lanes. Plus **the network covers many smaller cities, enabling door-to-door travel without any modal switching**. (The major interchanges have improved vastly, too—though the coaching inns aimed at those unwilling to travel by night still favour low cost over comfort.)



## Sail-assist passenger liner

Ahoy there, Amerikanen! Sailing across the Atlantic is super slow, but surprisingly affordable. Traveling on a real skinny shoe-string? Some lines will even let you work your passage... but you'll be wanting a good rest when you arrive.

## All points East: traveling from China (and beyond)

The long-promised Eurasian high-speed rail link is still a long way from being finished—and given the ongoing trade conflicts between Russia and China, we may be waiting many more years still. That said, the Russian railways are much improved, and travelers confident of their language skills (and their diplomacy) might be able to book a route comprised of shorter trips; ask your local travel agency for a quote. Alternatively, **long-haul rail connections can be made via India and the Middle East**—though this way round will eat up three days of your schedule, rather than the one day promised by the Eurasian HST link. But why not stop off at a few spots along the way?

For the real high-rollers, there's **the weekly direct flight between Beijing and**

**Paris**, from where an EHST train to Rotterdam will take just a few more hours. Given fossil-free long-haul flights are still a decade away (at least), this will cost a lot of money once you factor in the carbon taxes—taking the train the long way round would be far cheaper, assuming you can spare the time.

## Trans-Atlantic adventures: traveling from the Americas

Not since the great pandemics has it been this easy to cross the Atlantic—though the affordable options, courtesy the **growing network of green fuel-cell and sail-assist passenger liners now criss-crossing the mighty ocean**, are not for those in a hurry. But whether you're departing from New York, Rio de Janeiro or any port in-between, your ferry will bring you right into Rotterdam's bustling international port district, ready for adventure!



# Infra-city travel tips L22

So you've arrived, got settled into your accommodations, and you're ready to see the sights. But how best to get around?

## Advice

### On yer bike: moving between districts

When in Notterdam, you travel like a Notterdammer—which is to say you walk, cycle, or make use of the public transport system's various mobility services. **Walking and cycling are easy and affordable, not to mention traditional and healthy:** you can rent a bike from most hotels, or from one of the many rental agencies, who can also provide other forms of pedal-powered transport more suited to families. Or just grab one from the municipal racks, link your phone for payment, and get moving. For those with different mobility needs, or with further to go in a shorter time, the city's transport network—comprising trams, electric buses and autoblobs—is comprehensive and affordable, if a bit crowded during certain periods (see page 46).

**Moving bulky goods around? Hire a cargo bike,** or pay someone else to move it for you—but don't take the first price you're offered, and always ask to see the badge given to authorised service providers. (It's a big city, and things have been known to go missing...). The canals are packed with solar freighters, which load and reload at distribution hubs around the city. At these locations you can **get rid of your recycling, and also pick up personal deliveries:** most local shops are part of the network, and will let you choose a delivery point for collecting your goods the same day. (It is still possible to travel by canal as a passenger, but given how well-optimised the system has become, you will need to pay your way by mass, as if you were a piece of freight.)

***“Don't walk in the bike lanes! Seriously, don't.”***



## History

### Notterdam's transport revolution(s) L7, 22

Notterdam's history is closely connected to changing modes of transport, and the last few decades have seen many significant shifts.

The section of the harbour district devoted to goods transport has shrunk by almost 50% since 2020, with the free space turned over to mixed-use urbanism, with homes and small businesses living side by side. The ships that ply the harbour are fuel-cell powered or sail-assist, some fully autonomous, and the logistics and distribution systems—where Rotterdam has long been a leader—are similarly efficient.

**Private car ownership is incredibly rare**, and those autonomous vehicles which are permitted are exclusively available on shared models in the less-crowded outer districts, such as the Docklands: the accident rate for private vehicles in city centres was deemed too high, much as in other European cities. Only licensed taxi-

blobs—which can be very expensive—are allowed to work the urban core.

**Micromobility is regulated on both modes and numbers**, and run by the city's traffic monitoring AI. This holistic approach made Rotterdam a world leader in mobility efficiency, and reduced traffic accidents to zero in the last couple of years.

It wasn't easy, however. Once fossil fuels were banned, the carbon tax revenue decreased—though collectivised mobility has reduced the damage to road surfaces, meaning that maintenance costs have fallen too. Many of the newer infrastructural systems have been funded by the issuing of green bonds (see below). The biggest challenge is resource scarcity: **an energy-intensity mobility tax was introduced to manage electricity demand**, so that fossil-free and non-electric mobility is by far the cheapest way to get around.

## Finance

### Environmental investment: green bonds for the sustainable city

Notterdam's transformation from a city propped up by petrochemicals to a leading sustainable municipality wouldn't have been possible without **changes in infrastructure and governance, but also in the obscure realms of finance**. Rotterdam was a proving-ground for *de groene schuldscheinen*, better known outside the country as "green bonds".

It's no surprise it happened here: the oldest surviving investment vehicle in the world is a bond that supports the upkeep of a canal! But early in the 21st century, mainstream investment bonds contained a mixture of holdings, including fossil fuels and related industries. The early "green bonds" dropped the fossils, but their portfolios were still broad and general. It wasn't until the "green+" standard emerged, restricted

## Advice

# Money and mobility: budgeting for travel

Most travel needs within the city can be met with foot-power, **you can get around on €5/day for bikes and scooters**, or considerably less if you rent for a week at a time. Regional travel is more expensive, with charges based on distance (and sometimes mass); European visitors will be familiar with such systems from their own countries. Non-EU residents can estimate a travel budget by assuming that **most public transport comes at a cost of €0.5/km**, while share-ride blobs typically break down to around €1/km when fully utilized. Riding alone in a pod will cost at least €5/km.

### How to pay L21

Thanks to the introduction of **EUMaaS**, the once-controversial **EU-wide Mobility-as-a-Service system**, EU residents just need to bring their **Travel Assurance Card (TAC)**, which will work in Rotterdam just as well as it does back home. *Remember the TIC TAC rule: bring your Travel Insurance Card and your Travel Assurance Card!*

**Guests from further afield will be issued with a temporary TAC** when they pay their visitors fee. Affectionately known as the “NutterCard”, this gives you access to all local transport services: bike rental, e-scooters, public transport, share-ride pods and distribution services.

### Don't forget your e-waste! L8

Dutch industry is hungry for minerals and metals. If your own country lacks the appropriate disposal systems, you can defray your transport costs by bringing old hardware and durables and exchanging them for transport credits at a recycling hub anywhere in the city. You'd be surprised what still has value to the circular economy. Granddad still got a stash of old car batteries he's saving “for when things go back to normal”? One of those could get you enough credit to travel for free for a year!

(Don't forget to declare it before traveling, though. You wouldn't want to be mistaken for a smuggler, would you?)

to businesses with carbon reduction as a core part of their mission, that the transformation really got rolling—with some help from institutional investors, particularly churches, who demanded more ethical options from financial service providers.


While the green+ principles of reuse, reductions and renewability are widespread


across Europe, the global financial war is not yet over—as evidenced by the enduring scandal of so-called “black bonds”, held and administrated in jurisdictions with a more lax attitude to emissions. They're not *entirely* illegal, and it's rumoured that some European investors still hold some... but if you're one of them, we don't advise you talking about it in public!


## Advice


### Rush hour(s)

Notterdam is big, densely populated, and very busy; as such, you'd be advised to **avoid peak traffic periods**. Given that there are so many of them, that can be a challenge for visitors, but you'll soon get a feel for it—and the app that connects to your TAC can advise you. Some local particularities to be aware of:

 If you're out in the Docklands, **don't try to compete with stressed commuters** looking for a charging station near their workplace between 7 and 8am. They'll win.


 When roaming around Downtown, those without what our British friends call “sharp elbows” should **avoid the bike and scooter rush**, which tends to tail off around 9 am.


 If you're visiting the commercial district, **avoid siesta time around noon**, as the Notterdammers struggle to get out of the city centre. The addition of green spaces has helped somewhat, but when the heat-island effect kicks in, it gets too hot to move. **Find a cafe, get a cold drink, and sit it out under an awning.**


 In pretty much every neighbourhood, food delivery traffic remains steady between 6 and 8pm. This shouldn't cause you too much trouble if you **stay out of the red commuter lanes**, but nonetheless, look out for couriers rushing the last mile on lesser streets. Those commissions don't earn themselves!


### Transport Etiquette


This should go without saying, but the steady stream of tourists through Notterdam's A&E wards suggests it doesn't, so: **Don't walk in the bike lanes! Seriously, don't.** They won't stop! And if your blood tests over the limit for alcohol or THC at the hospital, you'll pay a fine to the city before your cast has fully set.

 If you don't cycle much, or are unfamiliar with the cycling culture of the Netherlands, **stay in the green bike lanes**. The red lanes, which take up the majority of central street space, are for fast riders only. Notterdammers tend to get annoyed with tourists dawdling on the commuting network.

 **Don't leave e-scooters or rental bikes outside designated drop-off/pick-up areas.** The fines are hefty!

 **Don't make a mess in ride share pods.** Your dad doesn't work here! Fines of up to €1000 apply if you leave rubbish in the pod.

 **Use the underground bike garages** for safe and efficient storage when you're not using your bike. It's a free service, paid for by your visitor tax, so make use of it.

 **Don't bogart the charging stations!** They're for everyone to share, and no one likes a “100 percenter”.

## Advice

### So... you came by car? L22

Far be it from us to suggest that traveling to Notterdam in a privately-owned vehicle is a foolish move—we'd be wasting our time, not least because the Notterdammers will do it far more effectively than we can, from the moment you arrive to the moment you leave. **For those of you sufficiently wealthy (or crazy) to try it, here are some vital tips for survival.** It's only fair to warn you that nothing is going to protect you from the disdain of the locals... but we figure you're probably used to that back home.

Our advice is to use one of Notterdam's swanky "car escort services": not only is it the only sane way to secure parking spaces, but they also provide top-notch option for getting around the car-free urban core while your beautiful machine is in furlough. We recommend **Car(e)-Free** or **Libre**, both known for their prompt responses and various add-on services (such as taking care of laundry, hotel check-in etc.) They're not cheap—but if you've got a car, that's probably not a thing that worries you. But be sure to book in advance: **driving up to the city limits unannounced will get you a crash-course in Dutch bureaucracy you'll never forget.**

## Travel

### How do I go beyond the city limits? L22

Most Notterdammers would probably reply to this question with another question: why would you want to? But sure, there's things to see beyond the predominantly urban network of rail stations—and if you're not taking a mode of travel that's part of the adventure (such as the popular river tours; see page 16), how are you going to get there?

The simple and affordable answer would be to **take a bus; again, your TAC app can get you almost anywhere in the country you might want to go**, and even beyond (though international trips within Europe are faster by train, and not much more expensive). The braver and more

adventurous might choose to **upgrade your rental bike to an e-assist model**, and head out on the bike-highways—it's a beautiful country, after all, and it's not like there are many hills to de-juice the battery (or your legs, if you're hardcore).

But if you've absolutely got to go somewhere really remote, and you can't (or won't) take the slower communal options, then hiring an autopod is probably your only remaining option. As noted above, this won't be cheap, even if you manage to pack it out to full occupancy—but it's still cheaper than taking your own, because the tolls for unlicensed vehicles are waaaaay huge. Don't say we didn't warn you!



# Methodology

The book you are reading emerges from work-package 6 of REINVENT (<https://www.reinvent-project.eu/>), a Horizon2020 project whose aim was to explore the innovative possibilities for the decarbonisation of a number of basic industries in the European context. In order to explore and communicate how a near zero carbon Europe could be realised, it was necessary that we advanced beyond the established methods. Our tourist guide to a fictional European coastal city in 2045 is a methodological and communicative innovation that allows us to grasp and illustrate technical transformations, as well as social and cultural ones. The book, which focusses upon the everyday practices that decarbonisation would reconfigure, is crafted through a collaborative scholarly process of imaginative speculation.

It should be noted upfront that the Rough Planet Guide was fun to make—not just for the core production team, but for the people who contributed to the workshops in which the articles were first germinated—and (we hope) fun to read as well. Fun is perhaps all too easily associated with a lack of seriousness, with the making of jokes—and there is admittedly some humour herein! But from a methodological perspective, this book may also be taken as a playful rejoinder to the idea that transitions research must be dry, factual and humourless in order for it to be serious.

This methodological statement explains why we have chosen this particular form, and how we went about producing it. In the first section, we discuss the rhetorical objectives of the Rough Planet format—i.e. the story it seeks to tell, and the techniques it uses to do so—in the contexts of the REINVENT project, as well as the techniques of futuring upon which it is built. By drawing upon design fiction and other emerging paradigms of critical futures research, the Guide aims to replace the passive optimism-for-change of traditional “promissory” technology and policy futures with the active (and contingent) hope-for-change of subjective and practice-oriented sociotechnical speculation.

In the second section, we provide a brief summary of the practical rhetorical affordances of the chosen form, and of the processes through which it was created. Much like a “real” tourist guide, the Rough Planet is a mosaic of multiple contributions which, when combined, provide a more complete (and plausibly imperfect) picture of decarbonisation-in-effect than scenario techniques or quantitative models could possibly provide.

It is our hope that the resulting Rough Planet Guide may foster an impactful cross-sectoral discussion of the impacts and implications of decarbonisation—a discussion in which citizens might participate on an equal footing with academics, industry practitioners and policymakers.

## 1 – Hopeful speculations: designs upon a decarbonised Europe

The founding impetus for the approach which resulted in the Rough Planet Guide was the idea that new forms of communicative outputs from transitions research might allow broad audiences to envision (and thus actively engage with) the socially transformative possibilities presented by innovation(s), without being either prescriptive or programmatic about the technical details.

The intention was thus transformed: from the initial goal of communicating extant best practices in industry and policy (which are likely to be superseded before any substantive and significant decarbonisation transformation has been realised), we turned instead to the imaginative exploration of the consequences of those best practices—to seeing, quite literally, what might result from the innovation(s) thus normalised

The "might" in the preceding sentence is important, because the future is a moving target, and predictions are of little value (if not actively unhelpful) precisely because of their implicit confidence in outcomes which are inherently uncertain. As such, it was clear that we needed to draw upon methodologies of futuring, and in particular upon methodologies that went beyond the supposed objectivity of, for instance, traditional scenario-based approaches to the depiction of possible futures. Futuring is always inescapably speculative—and it occurred to us that by foregrounding that speculative aspect, and thus embracing the subjectivity of sociotechnical change as it actually manifests in the lived experience of ordinary citizens, we might thereby popularise not only the underlying challenge of decarbonisation itself, but also the myriad pathways which might be followed in our attempts to meet that challenge.

The Rough Planet Guide makes use of strategies and tactics from the field of speculative and critical design, which are perhaps better known outside the academy by the term "design fiction"<sup>1</sup>. To simplify hugely: design fiction is a way of exploring and explicating a possible future through the making of "prototypes" of products or services which are imagined to meet a "use case" which might exist in said future (Auger, 2013).

The practice of speculative design is already sufficiently broad that the process can take many forms across many media. Some speculative designers work primarily through the manipulation of images and video (e.g. Revell, 2012; Superflux, 2015), while others make concrete (if frequently non-functional) mock-ups of products or services to be put on display; some design fictions use a single (and potentially implausible) object to take the viewer into their imagined future (e.g. Oliver, 2012), while others have begun to work with fully immersive installation-environments in which the functionality of the

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1 At this point we would like to extend our apologies to scholars and practitioners in the design disciplines: we have been obliged for the most part to execute this project without the benefit of any substantive hands-on training in design, and to hire in genuine design expertise where opportunity and budget allowed, such as the Guide's illustrations. All of which is to say, while we have made our best efforts to stay true to the theoretical and ethical paradigm of critical design, the nuts-and-bolts results will likely look painfully "un-designerly" to trained and experienced designers!

designed objects or environment is as fully realised as possible (e.g. Superflux, 2019). Despite the variety of methods and techniques, the core methodology is consistent, and draws to some extent on the cinema-theoretical notion of the “diegetic prototype” (Kirby, 2010): a designed object which does the work of worldbuilding, of describing material aspects of the world being depicted on screen without recourse to expository dialogue or narration.

Design fiction is frequently used as a critical medium: it’s less about the proposal of products and services which the designer believes will or should exist in the future, but rather a way of telling a story about life in a particular future through the consideration of objects which might be presumed to exist in that context. By way of example, the “transparency grenade” (Oliver, 2012) is technologically impossible as a “product”, but by imagining and (partly) materialising that impossibility, it performs a critique of a potential future saturated by surveillance; the immersive installation *Mitigation of Shock* (Superflux, 2019), meanwhile, is explicitly a commentary upon climate change and its likely reconfigurations not only of commercial agriculture, but also of individual food practices.

Design fiction is thus often engaged with very serious themes and topics, but it engages with them in a manner that often includes an element of playfulness. The resulting tension between the seriousness of the issues being critiqued, and the playfulness of the creative and imaginative process, is manifest in the prototypes themselves: it is necessary that they take themselves sufficiently seriously as artefacts which exist in a time which has yet to arrive, but not so seriously that they appear to be acts of prophecy, prediction or hoaxing). The immersive “cognitive dissonance” of science fiction (Suvin, 1972) is the theoretical foundation beneath the methodology: by depicting (and thus narrating) an imagined future through the production of artefacts imagined to be native thereof, design fiction makes use of the human instinct for and attraction to subjective story and material detail in order to perform an imaginative displacement of its audience into futurity.

Crucially, the imaginative narrative approach avoids the cognitive and linguistic trap of the future tense as it functions in many languages of the Global North, and in particular the Germanic family (of which English is arguably the most widespread member): rather than asserting that things “will” or “should” be a certain way in times to come, and thus implicitly promising or predicting those outcomes, design fiction—like science fiction before it—instead portrays a possible future as a *fait accompli*, and depicts it from the subjective present-or-past-tense perspective of its inhabitants. While theoretical debates around design fiction practice are still very much ongoing, it has been argued that the depiction of a future as if it were the narrator’s (or designer’s) present lived reality makes use not just of the long-standing human affinity for story, but also of the cultural and narratological expectations created by the increasingly mainstreamed rhetorics of science fiction across multiple media (Raven, 2017). In other words, such futures-as-presents strike a bargain with an audience which knows it is being told a story

rather than being gifted a prophecy, and thus engender a willing and suspension of disbelief in that audience, while simultaneously sustaining the underlying understanding that “this is just a story”.

This contrasts strongly with the use of the prophetic and predictive future tense, ubiquitous not only in political rhetoric but also in marketing (assuming one makes a significant distinction between those genres), which often—and often quite deliberately—make a promise that what is described will inevitably come to pass, provided the audience responds appropriately to the accompanying call-to-action. Design fiction, for the most part, makes no such promise, instead inviting the audience into the contemplation of possibilities: “*if* this came to pass, *if* this object existed, *then* what might it be like to live in that world?” This is what we mean when we describe the Rough Planet Guide as both speculative and practice-focussed, in the sense of the latter term as it is used in the literature of social practice theory (Shove, 2003): as a speculative artefact, as a prototype, the Rough Planet Guide is intended to displace its “real” audience (i.e. its readership in the present) into the shoes of its *supposed* audience of a tourist in 2045, and offer them the opportunity to walk around in them for a while.

The Rough Planet Guide is thus perhaps closer to science fiction literature than to design fiction proper, given its strong reliance upon text as the vehicle for portraying the decarbonised Europe we aimed to explore; however, the overarching strategy is essentially the same. The innovation on our part is the decision to make our “future artefact” a tourist guide to a fictional (but based-on-fact) European city circa 2045—more specifically, a *particular* 2045 (whose realisation is, sadly, far from assured or inevitable) in which the 2°C targets of the Paris Agreement have been met through the coming-to-fruit of not only the REINVENT case-study innovations, but also of many other such changes.

Thus we deploy speculative design to engage with an aspect of sociotechnical change which is as yet poorly served by the theories which dominate both academic and policy literatures, namely the day-to-day consumption and mobility practices of ordinary citizens (Shove, 2010), in which always-already reconfigured technologies and infrastructures are entangled and implicated, but which often go all but unacknowledged. While speculating about the “best practices” required to nurture and manage sociotechnical change at the systemic scale is, as discussed above, a leap of intellectual faith made from a place of poor footing, speculating on *the reconfiguration of everyday practices*—in a manner which a) assumes that those transitions and transformations *have already begun and are always-already ongoing*, while remaining incomplete, contested, and unevenly distributed in timespace, and which b) *explores the street-level consequences of those transitions and transformations* from the perspective of citizens of (or visitors to) a city in which they are unfolding—is both better founded and more useful. Such speculation is better founded because the objectives of everyday practices—the ends to which they are the means—are historically consistent, even when the sociotechnical systems enrolled in their performance are not (Shove, 2007); such speculation is more useful because a focus on everyday practices moves the discourse of decarbonisation away from

specialist concerns (e.g. the availability of resources and reagents, or the granular detail of policy implementation), and toward issues that *matter*, materially and emotionally, to non-expert citizens in the context of adapting to climate change.

Or, more simply: the Rough Planet Guide declines to answer the unanswerable question of “how do we make the decarbonisation transition happen?,” in favour of instead exploring a question with as many answers as there are citizens, namely “how might we live in a successfully decarbonised Europe?” The former question is the province of those individuals who (for the most part, we must assume) already understand the necessity of decarbonisation; it is less a question than a guiding principle, an orienting *koan*<sup>2</sup> for the always-ongoing work of research and policy. The latter question, however, is the province of those individuals *and everyone else*—a much larger constituency, whose understanding of the necessity of decarbonisation often comes either from dystopian depictions of an unlivable future of climate collapse, or utopian promises that some new technology or policy will fix everything. As such, thinking through the polyphony of the latter question actually helps us think more clearly about the former, not least because it makes it clear that there is *more than one pathway* to a post-fossil Europe.

Aside from its (much debated) merits as entertainment, the genre of dystopia offers examples of futures which we would prefer to avoid—but it is rarely inspirational, or encouraging of action. Technological utopianism, meanwhile, was a founding prop of the twentieth century and its metanarrative of progress; as such, it has been discredited by not only the very public failure of “progress,” but also by its adoption as the dominant (and, of late, ubiquitous) rhetoric of the technology industry and its supporting cast of marketing agencies, consultancies and pundits (Raven, in press). In other words, after many years of solutionist technological utopian discourses which have consistently failed to come to fruition, citizens have come to distrust prophetic promises on principle, even as they flinch from the dystopian future of climate collapse.

What is notable by its absence is a type of *narrative of futurity* (see Raven & Elahi, 2015) in which climate change is depicted as *both* a real, urgent issue, *and* as something that we can and will adapt to: a narrative in which ordinary citizens can observe (and thus relate to) non-heroic characters doing the everyday things that they will still want and need to do in the future, climate-changed or otherwise. What is missing, in other words, are stories in which we “stay with the trouble” rather than imagining it fixed (Haraway, 2015): stories that are *neither* dystopias of climate disaster, *nor* utopias of technological solutionism, but rather stories in which the more useful elements from *both* generic forms are combined, so as to depict a world whose ordinary imperfections and recognisable practices might convince a mass audience that not only is such a world plausible (given the failed promises of technologies and policies past) but, crucially, is also a somewhere (or *somewhen*) in which they might imagine themselves and their friends and descen-

2 The *koan* is a practice in Zen traditions of Buddhism, a riddle without an answer intended to highlight the inadequacy of purely logical reasoning in a context where values hold as much sway as material things, if not more. Arguably the best known koan is “what is the sound of one hand clapping?”



dants living lives recognisably contiguous with the ones they already have.

It bears emphasising that the sort of narrative of futurity that the Guide represents an attempt to realise is less a genre of future than a *method of sociological futuring* (Levitas, 2013); furthermore, it is explicitly and avowedly *not* an optimistic narrative. Rather, it is a narrative of *hope*: counter to the passive expectation of improvement inherent to optimistic speculations (as commonly found in the glossy utopian renderings of finance and technology, which reach their peak expression in the bland homogeneity of the “smart city”—see Raven, in press), hopeful speculations recognise not only that the world might be better, but also that *betterment is unattainable without a substantive social change in the world as it currently exists* (Vint, 2019). Or, more bluntly: where an optimistic and “promissory” future assumes that it will all work out for the best, a hopeful future recognises the reconfigurations of the social sphere required for any significant change to be realised—as well as the collective labour and dreaming that such social reconfiguration requires.

## **2 – Affordances and application: how the Guide works, and how we worked the Guide**

We are not aware of any other substantive engagements with climate change and decarbonisation which make use of the tourist guide format. This became all the more surprising the longer we worked with it, given that the affordances of the tourist guide as a medium—its rhetorical capabilities, if you like—turn out to provide ways around some of the shortcomings of more established ways of depicting the future.

The rhetorical capabilities of a given medium may be thought of as the sorts of story that it is best suited to tell, and/or the forms of argumentation or information delivery to which it is best suited. These capabilities, as they exist in media which are already familiar, provoke in response certain expectations from their audience: by way of a highly reductive example, the affordances of a broadsheet newspaper are oriented around the delivery of informative and timely information about current events, accompanied by commentary thereupon; the association of those affordances with that form has therefore created an expectation that the content of a broadsheet newspaper should be factual and authoritative. This expectation has been exploited and undermined in recent years, and regrettably not always with the best of intentions, but that exploitation is illustrative: the audience's expectations, their existing relationship with the medium in question, can be made into a channel or package within which a designer or narrator's chosen stories and ideas might be disseminated<sup>3</sup>.

The communicative capabilities of a tourist guide are remarkably useful in this regard. First and foremost, the expectations that accompany it are exactly those of exposition:

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3 The issue of exploitative and “hoaxy” uses of certain media forms has been a source of ethical anxiety in design fiction since its earliest days (Sterling, 2013), but it bears noting that this closeness to techniques of deception and/or outright deceit is also the source of the strategy's impact and power.

you expect, indeed want, a tourist guide to tell you about the highs and lows of a particular location with which you are otherwise unfamiliar, and perhaps also to provide some historical backstory that explains how it got that way, and why. By contrast, science fiction literature and cinema alike tends to be derailed by expository material, which breaks the narrative “spell” created through the experiential arc of the point-of-view characters; meanwhile design fiction inverts this arrangement by focussing on a given object which purports to exist in an imaginary future, but as such limits the potential for describing in detail the contextual world in which the prototype supposedly came to exist. There are many more advantages to the guidebook format, which include:

- **Efficiency**—combines prose, pictures, data, maps, diagrams; compresses detailed description of cities into a fairly limited page-count
- **Accessibility**—guidebook format comes with the expectation of pithiness, accuracy, familiarity: not a format made for expert readers; more demotic; information at a human scale, told from a human perspective
- **Situatedness**—organises elements of complex transitions into recognisable and familiar spatial structures
- **Flexibility**—allows for box-outs and sidebars to supplement spatially-organised info with context and systems-level back-story, thus providing temporal depth and social scale to balance the spatial breadth
- **Collaborativity**—highly suited to collecting together work from multiple contributors in multiple disciplines, addressing multiple topics in multiple locations

Advantageous as it certainly was, the guidebook format was far from an easy option—though as noted above, it was fun, in the way that only challenging work can be!

The kernels of the individual “articles” in the Guide—the sites and experiences they describe—were produced in series of workshops. Researchers assigned to H2020 REINVENT WP6 began the process by creating open-ended prompts for creative writing, which asked the simple sorts of questions that a prospective tourist might want answered about a city they intended to visit, such as: *What are the interesting sights? What’s good to eat, and where might I find it? What cultural events are on offer? How do I get around the city?* These prompts were often (though not exclusively) linked to specific cases or themes in the REINVENT project.

The workshops, initially involving researchers from the REINVENT team at project meetings, began with a short imaginative exercise based on improvisational theatre to take participants out of the empirical mindset of the mainstream of the project, and into a more creative, speculative space; prompts were then picked by or assigned to participants, who were given a short time (~20 minutes or so) to get down a response to the prompt which was informed by the assumption that the imaginary city of Notterdam has seen the REINVENT decarbonisation innovations, among others, come to fruition.

The core of the Guide’s content came from REINVENT researchers (and later other ac-

ademics and students) but it soon became apparent that in order to make the imaginary Notterdam more believable and coherent, it would need to be tied together in much the same way as any real city—which is to say by *infrastructures*, particularly those of transportation. As such, further workshops were held with participants whose expertise was more in the realm of urban mobility futures, both within the academy and without. (Please see the back pages of the book for a list of participants and contributors.)

Once a suitable number of articles had been drafted, an editorial process of collation, structuring, polishing and referencing began. This process was necessary to successfully conjure the look and feel and structure of a guidebook, in order that it would be instantly recognisable as being of that genre; but it was also necessary to take the workshoped ideas and rewrite them in such a way that the guidebook had a “voice” which was not just self-consistent, but consistent also with the (friendly, but somewhat irreverent and insider-ish) style common to actual tourist guides. At the same time, we secured some external design expertise to produce images which would make the guidebook a lively and attractive document<sup>4</sup>, illustrating the changes and innovations in the imaginary city in such a way that the viewer is reminded at all times that it is a work of imagination and extrapolation, rather than the promissory prophecy of an architect or developer’s renders and models.

Finally, with reference to the connections between the creative prompts, the resulting articles, and the cases and themes of the project—as well as to leading-edge research in topics adjacent but not directly germane to REINVENT itself—an extensive set of end-notes was assembled and linked to the guidebook articles, in order that a reader might go easily from an imaginative speculation to its factual foundation. (Those references can be found on the pages following this statement.)

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We hope that the Guide is as informative and fun to read as it was to make, and that it will serve the original intention of the project work-package for which it is the culmination: a guide to *realised* decarbonisation (if not the exact process of its realisation), and an exploration of the impacts and implications not only of the case-study innovations, but also of the countless other hopeful efforts already underway to remake the world (and our lives within it) along lines more amenable to sustained thriving for human and non-human actors alike. Despite its seemingly fact-based form, we believe that the *Rough Planet Guide to Notterdam 2045* presents more questions than it provides answers—and we further believe that this practice of stimulating questioning and discussion around the shape of our shared future, among as wide an audience as possible, is the closest thing to a “best practice” for guiding and supporting decarbonisation that we could possibly provide.

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4 Sincere and heartfelt thanks to Sjeff van Gaalen of Structure & Narrative for his wonderful work on the Rough Planet’s “photographs”, as well as for advice on lay-out and aesthetics, and local knowledge of the actual city on which Notterdam is roughly based.

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# Endnotes

We've provided these endnotes in order to demonstrate the foundations of research upon which the imagined future of the Rough Planet Guide to Rotterdam is built. We have grouped the references into sections for ease of navigation, with the most accessible and directly relevant material toward the top, and the deep-dive and off-piste material toward the end. Citation details for academic publications have been simplified for ease of reading (with apologies to colleagues who are sticklers for one or another citation style), and direct web links are provided wherever possible—though regrettably not every publication is freely accessible to the public. Of course, they *should* be... and perhaps, in Rotterdam, they *would* be!

## **Q** Decarbonisation Portal ([reinvent-project.eu/decarbonisation-portal](https://reinvent-project.eu/decarbonisation-portal))

The REINVENT Decarbonisation Portal is a top-level clearing-house for communicating the project's main findings. Designed to be accessible and comprehensive to a wide range of audiences, it poses and answers thirteen questions about decarbonisation through a friendly and clear web interface. It is thus the ideal place to start for the reader who wants to know more about how we might get to a world like that depicted in the Rough Planet guide. The first question is an overview of decarbonisation trajectories more broadly, containing links to carry you through into the deeper investigations of the other questions.

### **Q1 What will make deep decarbonisation a reality?**

Questions 2 through 5 address decarbonisation in the context of each of the four REINVENT industrial sectors: Plastics, Meat & Dairy, Steel, Pulp & Paper.

#### **Q2 Can we live without plastic?**

#### **Q3 How far toward the Paris goals would moving away from meat & dairy take us?**

#### **Q4 Are new technologies able to create low-carbon steel?**

#### **Q5 Can pulp & paper pioneer decarbonisation and help other industries?**

Questions 6 through 9 explore the role of various actors in the decarbonisation dynamic: Industries, Governments, Investors and Consumers.

#### **Q6 Is the industry ready for change?**

#### **Q7 What can governments do to make a difference?**

#### **Q8 Do institutional investors hold the key for a low-carbon future?**

#### **Q9 Are consumers and movements pushing for decarbonisation of basic materials?**

Questions 10 through 13 explore the logics underpinning decarbonisation processes: Energy Efficiency, Demand Reduction, Circular Economics, and Financing.

#### **Q10 Will making industrial processes more energy efficient lead to decarbonisation?**

#### **Q11 Can we go to deep decarbonisation without reducing demand?**

#### **Q12 Would circular economy approaches secure a way toward decarb?**

#### **Q13 Is there a finance gap for decarbonisation, and how can we close it?**



## **D** Project Deliverables

As a large and complex project, REINVENT has produced many outputs or “deliverables” to disseminate its findings; a complete listing can be found at [www.reinvent-project.eu/documentation](http://www.reinvent-project.eu/documentation). Not all of the deliverables are included in these endnotes; we decided it would be better to narrow the field somewhat for the sake of accessibility, though readers should feel free to explore any document they like at the web address above.

Furthermore, not all of the deliverables included in the endnotes are cited directly in the text of the Guide. Of those that are not cited directly, they are listed for two reasons: either a) because while they do not have a direct connection to any particular piece of the Guide, they may still be of interest to a reader determined to dig into the details of decarbonisation, or b) because they effectively connect to every article in the Guide, to the extent that citing them on every page would have seemed a little ridiculous. (This is particularly the case with D3.6, a report on the dominant drivers of low-carbon innovation—in terms of the Guide, at least, this is perhaps a central REINVENT text in terms of its influence, focussing as it does upon the causal factors of innovation more broadly, rather than on specific innovations or changes.) For each deliverable, we have provided a brief overview of its contents here in the endnotes; they are all available in full from the project website.

## **Meta**

### **D1.1 Decarbonisation state-of-the-art review**

Our aim is to understand both the extent of inertia in the energy-intensive economies and the potential for innovation. Here we provide an overview of the extent to which the research community has engaged with this challenge. As there is no one field of research from which this challenge is being addressed, it can be viewed as a transdisciplinary research problem where the knowledge required to advance our understanding and create the solutions required for deep decarbonisation is dispersed between the sciences, social sciences, humanities and practitioner communities. In this review, we draw on five bodies of work—studies of socio-technical transitions, technological innovation, scenarios and integrated assessment, climate governance and value chain analyses—to map the current knowledge base and provide an assessment of the key areas where new contributions are required to advance our understanding.

## **Sectors & Innovations**

### **D2.1 Decarbonisation innovations database**

This database consists of 109 leading global innovations in the plastics, paper, steel, and meat & dairy sectors, helping these industries move towards decarbonisation. These cases cover technical, social, economic or institutional innovations that reduce the carbon intensity of at least one of these four industries. The innovations showcased are relatively new, yet already up and running, and highlight how carbon reduction activities are being integrated throughout the value chain—covering production, consumption, waste/recycling and finance. The type of information gathered about each case relates to the innovation’s development, the actors behind the innovation, its decarbonisation potential, and how it is financed, as well as information relating to the drivers of the innovation and its social, economic and environmental co-benefits and/or disadvantages.

## **D2.2 Sector report: climate innovations in the steel industry**

This report presents decarbonisation strategies for the steel sector organised around five entry points: emission efficiency, material efficiency, product-service efficiency, service demand reduction, and energy efficiency. The production of iron for primary steel-making is the largest energy consumer and source of greenhouse gases in the sector. New technologies and ways of making steel present opportunities to substantially reduce the emissions from primary steelmaking, for example, using hydrogen as an energy carrier; however, they are insufficient for deep decarbonisation, and action needs to be placed across the value chains. The increased use of scrap for secondary steel-making, presuming the use of fossil-free electricity, could lead to decarbonisation, but this option is limited by the amount of scrap steel in circulation. Material efficiency, e.g. the use of light-weight steel component design, is another possibility. Finally, reduction of demand for steel, and/or its substitution by other materials (e.g. timber in construction) offers another avenue for decarbonisation.

## **D2.3 Sector report: climate innovations in the plastics industry**

This report identifies three pathways for decarbonisation of the plastic industry: reduced use of plastics, use of recycled plastics, and use of bio-based plastics. As the decarbonisation pathways are contested and challenged both on technological and other grounds, the issue of (political) power is central. The formation and use of coalitions to support and/or counteract certain developments is important, as political regulation of this highly globalised and diffuse sector has proven to be a struggle in the past. The plastics industry has a strong lock-in to the fossil industry, but new actors outside the plastic industry, as well as consumer groups, are creating pressure for the sector to move towards a future that is both circular and independent of fossil resources.

## **D2.4 Sector report: climate innovations in the paper industry**

This report shows how decarbonisation of the pulp and paper industry may be achieved through energy efficiency, fuel switching and electrification, assuming decarbonised energy supply; on this front, substantial improvements have been made over recent decades. Two other decarbonisation pathways also show potential: one is the transition to biorefineries, and the emergence of a bioeconomy where several products other than pulp and paper are produced (e.g. liquid fuels, lignin, textile fibres and bio-composites); the other is the transition to a closed-loop carbon production, whereby biogenic CO<sub>2</sub> becomes an important feedstock through carbon capture and use (CCU). For the biorefinery pathway, the industry must develop in new directions, operate in new markets, and form partnerships with other actors. The bioeconomy pathway is relatively unexplored, but it bears noting that biogenic CO<sub>2</sub> will remain a scarce resource unless demand for organic compounds, in particular liquid fuels, is reduced considerably. Furthermore, the bioeconomy pathway requires large amounts of emissions-free electricity for hydrogen production, and implies completely new value chains and collaborations between the forestry, energy and chemicals industries.

## **D2.5 Sector report: climate innovations in the meat and dairy industry**

Although greenhouse gas emissions can be reduced significantly, fully decarbonising the meat and dairy sectors is challenging. This report groups the decarbonisation pathways for the sector into three categories: improving emission and energy efficiency; reducing food waste; and reducing meat and dairy consumption. Emissions and energy efficiency strategies should target enteric fermentation, N volatilisation, feed and agricultural-input energy use, and manure management; focussing on emissions related to energy use is a necessity, as CH<sub>4</sub> and N<sub>2</sub>O emissions are inherent to the biological processes involved in meat and dairy farming. Reducing food waste has the potential to reduce total demand and hence emissions without reducing consumption—but for

truly deep decarbonisation, dietary changes are needed, whereby meat and dairy consumption is reduced through replacement with alternative sources of protein.

### **D2.6 Sector report: climate innovations in finance**

This report provides a cross-sectoral analysis of the role that low-carbon finance plays, and can play, in decarbonising sectors. It is primarily conceptual in nature: it first defines, and then discusses the separate but related concepts of climate finance and low-carbon finance, identifying knowledge gaps and identifying routes toward understanding the potentials and limitations for innovations in the financial sector to contribute to the decarbonisation of these other REINVENT target sectors.

### **D2.7 Innovation biographies**

Innovation biographies reconstruct the narrative of an innovation process from its conception to implementation by analyzing territorial knowledge dynamics across time, space and individuals. The ultimate purpose is to be able to uncover how knowledge is moved through time and space, capturing the importance of critical events, contextual settings and collaborations for innovation processes. As a research tool, innovation biographies analyze these processes and dynamics from a micro-level perspective. Thus, the innovation biographies provide in-depth analysis of both agency by actors central to the innovation, and the role played by contextual dimensions; they focus on a variety of sectors, as well as on different stages of the value chain. The biographies include: Oatly (meat and dairy / production); Green Protein Alliance (meat and dairy / consumption); Ojah (meat and dairy / production); cardyon (plastics / production); and LignoBoost (paper / production).

## **Pathways & drivers**

### **D2.8 Climate innovations and new pathways for decarbonisation**

The analysis of manufacturing and heavy industry futures in a climate constrained world frequently focus on technological innovations in the early stages of the value chain, thereby assuming certain significant changes are plausible, desirable, or necessary throughout the rest of the value chain. Complex questions about production, consumption, competing interests, different ways of organising resource management, and value chain integration are thus closed down in favour of questions about efficiencies and investment opportunities. This report deploys the notion of pathways in order to approach transition governance in a way that not only appreciates the dynamics of sociotechnical change, but also acknowledges that those dynamics will themselves change as decarbonisation transformations unfold and evolve. The pathways explored in this report are: i) production and use optimisation; ii) electrification with CCU; iii) circular material flows; and iv) diversification of bio-feedstock use. Each pathway comes with both opportunities and obstacles.

### **D3.3 Decarbonisation case studies**

These 18 in-depth case studies examine climate innovations across the four REINVENT sectors. The cases were selected according to a set of selection criteria (see D3.1, D3.2) designed to ensure that the case study portfolio represented a comprehensive mix of innovations and interventions in key sectors. The criteria covered aspects of innovations' carbon significance, spread across value chain stages, being of different types of innovations, linkages to other work packages, scale-up and transformative capacity, but also feasibility of study within the time and resource budget available. The case studies are collected in a single document, which we have listed and summarised below. Individual articles within the Guide often reference one or more particular cases, using the

numbering system provided here; the number after “D3.3 /” indicates the subsection of the report where the relevant case study can be found.

## **Steel**

### **D3.3 / 3.1 Castrip**

Strip casting is an innovative process that combines two steel-finishing steps, casting and rolling, into one. There have been variations of this concept; the Castrip process is a twin-roll strip-casting process, in which liquid steel is directly cast between two rolls, thus usually requiring only minimal additional finishing, depending on the application. This significantly cuts down on energy usage and thus on carbon emissions and energy costs, as well as the capital costs and physical space required for on-site hot rolling. This opens smaller-capacity steel mills up to new possibilities: these so-called ‘mini mills’ would normally have to outsource the hot-rolling process due to capital and space restrictions. By operating an on-site strip caster they can have the benefit of producing higher value-added products, while cutting down on both process and transport emissions.

### **D3.3 / 3.2 HYBRIT**

HYBRIT (*Hydrogen Breakthrough Ironmaking Technology*), is a development project piloted in Sweden. Its aim is to implement fossil-free steelmaking in all stages of production—from iron-ore extraction, through pelletisation and reduction (iron-making), to the final steelmaking (in electric arc furnaces). For this to be possible, fossil free electricity production is needed, which will be used for hydrogen production (for the direct reduction of iron ore), for the electric arc furnaces (for melting of sponge iron and adding materials, most notably carbon, to make steel), and for parts of the mining and processing of iron ore (pelletisation).

### **D3.3 / 3.3 Voluntary Certification Schemes**

The building sector is a major consumer of steel, and this case study focuses on the role this sector can play in reducing emissions from steel. The role that industry-led, voluntary standards can play in fostering a reduction of ‘embedded emissions’ in construction is analysed. BREEAM 2018 New Construction certification scheme, operational in the UK, is a voluntary scheme that assesses the environmental impact of new commercial buildings. One of the nine categories that the scheme assesses is the impact of building materials, which is the focus of this case.

### **D3.3 / 3.4 MX3D**

With the pedestrian bridge project in the city of Amsterdam, MX3D and its partners have showcased the technical and design potentials offered by Wire Arc Additive Manufacturing (WAAM) steel processing in the construction sector. WAAM combines industrial welding robots, wires for welding and software that translates CAD designs of objects into the movement of welding robots that allow to build large objects.

### **D3.3 / 3.5 DOCOL Light Steel**

DOCOL steel is a range of steel grades produced specifically for automotive applications. The design objective for all DOCOL steels is to reduce the amount of steel needed for a given part while increasing overall vehicle strength. This is achieved through proprietary improvements in steel manufacturing which give superior material properties that are tuned specifically for individual applications through collaboration with the automotive manufacturers.

## Plastics

### D3.3 / 4.1 Tierra

The Deterra jacket is an example of an outdoor jacket made from castor oil and recycled textile fibres. It has no fossil-based components: threads, fabrics and buttons were either designed away or replaced with bio-based and natural components. The Tierra case shows that fossil-free fabrics are a possibility within today's textile sector: if you can make a sturdy outdoor jacket, you could make most garments.

### D3.3 / 4.2 Enerkem Rotterdam

Enerkem (Canada) has developed a fluidised-bed gasification technology to produce syngas from (hydro)carbon wastes (e.g. biomass, mixed municipal solid waste/MSW, plastics). One commercial plant has been in operation in Edmonton (Alberta) since 2015. In the Enerkem process, the syngas is converted to methanol, which is then used as a precursor to make ethanol or produce other (intermediate) chemicals for plastic feedstock.

### D3.3 / 4.3 Zero-Waste Grocery Stores

The purpose of the zero-waste grocery store is to sell retail goods, primarily in bulk, without the use of plastic or other single-use packaging. They are laid out with inventory and displays which support the use of containers brought from home by the shoppers, e.g. providing a scale to weigh containers and the products. They are frequently financed through crowdfunding, and emphasise their connections with the local neighbourhood; the focus is on building relationships with local consumers and suppliers, using social media and blogging to build customer base, and using membership or loyalty programmes to retain them.

### D3.3 / 4.4 Carbon2Chem

Carbon2Chem is a project at the intersection of the German steel and chemical industries, based on the core idea that unavoidable CO<sub>2</sub> emissions from one production process might serve as the raw material for another carbon-based process, resulting in a reduction fossil raw materials usage in the chemical industry. Blast furnace gases contain, among other things, hydrogen and nitrogen, but carbon is also present in large quantities in the form of carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). Carbon, hydrogen and nitrogen are the basis for many chemical products. As such, the exhaust from a steel mill is refined or conditioned into syngas (synthesis gas) with the help of renewable energy; the syngas then becomes a precursor feedstock for basic chemical products (e.g. fertilisers, methanol, polymers).

## Pulp & Paper

### D3.3 / 5.1 Äänekoski Biorefinery

The Äänekoski bioproduct mill is a replacement for an old pulp mill. When planning to renew production at the Äänekoski mill, the decision was made to expand significantly, become independent of fossil resources for the operations, and create a biorefinery ecosystem around the mill which was open for diversification in collaboration with partners or through joint ventures. The bioproduct mill uses wood (mainly softwood) to produce kraft pulp and a range of byproducts—some of which have been produced in pulp mills previously, e.g. turpentine, tall oil and electricity, and some which are less conventional to the sector, e.g. biogas and sulphuric acid.



### **D3.3 / 5.2 Lime Kiln Conversion**

Lime kilns are a key process step in the chemical recovery system in kraft pulping. The new powder-fired lime kiln at SCA Östrand replaced two oil-fired lime kilns. The new kiln is primarily fuelled by wood powder from ground pellets, but also uses gases from the mill, and has oil as a back-up fuel option in case of problems. The wood fuel pellets are supplied by SCA's own wood pellet factory BioNorr in Härnösand, which is only 40 km away.

### **D3.3 / 5.3 DuraSense**

Biocomposites are composite materials, usually consisting of a bio-based fibre mixed with a plastic; they are used in a range of applications, such as automotive panels and upholstery, noise insulating panels, and indoor furniture. In an effort to diversify into new products, Stora Enso developed DuraSense, which is a biocomposite made of cellulose fibres, wood particles, and a plastic—which may be a bio-plastic, a recycled plastic, or from direct fossil production.

## **Meat & Dairy**

### **D3.3 / 6.1 Friesland Campina's Green Schuldschein**

FrieslandCampina is the first non-German issuer of a 'green' Schuldschein (a form of investment bond), through which it raised €300 million of investment as part of its funding diversification strategy; it is the first "green" debt instrument issued by a dairy company. FrieslandCampina controls approximately 75-80% of the dairy market in the Netherlands; emission reductions within its value chain have the potential to contribute significantly to emission reductions of the Dutch dairy sector as a whole.

### **D3.3 / 6.2 Green Protein Alliance**

The Green Protein Alliance (GPA) is a multi-stakeholder partnership, which consists of firms from the complete supply chain of plant-protein products, and partners including the Ministry of Economics, the Dutch Nutrition Centre and NGOs. It aims to change the protein consumption balance in the Netherlands to 50:50 protein (plant:animal) by 2025 by providing a space for sector organization activities, including setting sector-wide product standards, inspiring product development partnerships and new product market introductions and implementing consumer awareness campaigns and education initiatives. [See also P10 below]

### **D3.3 / 6.3 Oatly**

Oatly produces oat-based dairy analogues for an international market. Through a patented enzyme process, they manufacture an oat-base, which is then processed into a diverse set of products (milks, yoghurts, cream etc.). The technical innovation came in the early 1990s, but it was not until 2012 that Oatly really took off when a new CEO decided to expand beyond the niche market of lactose-intolerant consumers by reframing their products as an environmentally and ethically superior product to regular dairy.

### **D3.3 / 6.4 Cultured Meat**

Cultured meat (also in-vitro meat, lab-grown meat, clean meat) is an example of the new field of cellular agriculture. Currently, no cultured meat products have become available for consumers—but large amounts of venture capital are flowing into companies such as Memphis Meats and Mosa Meats, who continue to lower the per kilo costs of their products. Given the strict secrecy of these actors, where proprietary technologies and processes are key, there are currently only estimates—albeit very spectacular ones—of the decarbonisation potential of cellular agriculture.

## Finance

### D3.3 / 7.1 Fossil-free Churches

Churches have been at the forefront of divestment campaigns, and their actions may serve as an indication of where others will follow. Faith-based actors currently adopt a mix of two approaches: some favour divestment (i.e. withdrawal of investment from high-carbon companies), while others favour engagement with these companies in an attempt to encourage them to align with the Paris Agreement targets. Divestment has heretofore largely adopted a sector-based approach, focussing on upstream fossil fuel companies.

### D3.3 / 7.2 Triodos

The Organic Growth Fund is an investment fund offered by the Dutch ethical bank Triodos; it is one mechanism through which the bank finances investment in green sectors, especially companies operating in the agricultural value chain. The OGF seeks to provide long-term capital to a small number of companies operating in the sustainable consumption arena, primarily in the food sector. It invests in companies across the value chain, from ingredient sourcing to distribution and retail.

### D3.6 Drivers of low-carbon innovation report

Drivers and barriers to low-carbon innovation can be both technical and non-technical. Key cross-sectoral influencing factors at the investment stage include cost and duration of R&D, public funding, governmental support, and savings against setbacks. In the production phase (material procurement, production, distribution), innovation is also affected by economic and infrastructural factors, such as the price and availability of ‘green’ energy and input materials.

Innovations are also strongly influenced by factors such as internal organisation, the personal motivation of the actors involved, the networking of (local) actors, and cross-sector cooperation—all of which can impact in either a positive or a negative way. On the consumption end of the value chain, meanwhile, growing consumer demand for “green” products is an increasingly strong driver for innovation.

Furthermore, a wide range of influencing factors are not specific to any one stage of the value chain, but can affect innovation at any stage. These include political framework conditions (e.g. prevailing standards and regulations, expected future regulations, international targets) as well as regional effects, public awareness and stakeholder pressure.

This report presents an evidence-based scheme of non-technical drivers and barriers of innovations, and potential influencing factors for future low-carbon innovations, based on other reports and case-studies produced within the REINVENT project.

### D3.7 Assessment of broader impacts of decarbonisation

The report aims to qualitatively assess the implications of decarbonisation for societal development through the development of a set of four archetypal innovation pathways for each of the sectors under study. Innovations are mapped along two axes, resulting in a quadrant diagram highlighting archetypal innovation pathways for sector development out to 2050. These pathways enable the identification of future potential environmental, economic and social impacts of each pathway and map out expected implications relating to the decarbonisation potential, maturation of identified innovations, and developments of social norms and expectations. The report thus

opens up the question of which technologies are needed for decarbonisation, inviting a much wider discussion on how societal development for zero emissions can be achieved, and what it could look like.

## **Modelling**

### **D4.1 Existing visions and scenarios**

Scenarios are analytical tools used to explore possible future developments and study the diversity in perspectives on long-term systemic change. This report deploys a scenario meta-analysis technique to compile prevailing views and assumptions around decarbonisation strategies for industry; thus acting as a “stock-take” of previously-considered transformation pathways among both industry stakeholders and academia.

### **D4.2 EU decarbonisation scenarios for industry**

This report provides an initial set of decarbonisation scenarios for the EU as a whole, considered in a global context, with an emphasis on the four REINVENT sectors. These scenarios, which have a strong focus on technologies and technology change, are developed by the models in the REINVENT project, and are compared to the existing scenarios discussed in deliverable D4.1.

### **D4.3 Decarbonisation pathways for key economic sectors**

This report describes deep decarbonisation pathways for the steel, plastics and pulp & paper sectors. (NB: meat & dairy is not included in this analysis, as the WISSE model at its heart does not cover the agricultural sector.) These pathways explore how these energy intensive sectors, which are responsible for a lion's share of the EU's industrial GHG emissions, can become climate neutral by 2050, and how their cumulated emissions to that date can be reduced in order to stay within the limits of a 1.5°C scenario.

## **Policy & economics**

### **D5.4 Policy brief—synergies and coordination of synergies**

Governance activities centred on exchange and collaboration are important to move industry decarbonisation forward. Mutual trust is crucial to cross-actor governance activities—the right balance between confidentiality and transparency must be found when creating exchange formats.

Many actors lack the resources necessary to organise or partake in exchange and collaboration processes. Taking their needs into consideration when designing exchange formats is crucial. Intermediaries functioning as a platform for exchange seem to be particularly well suited to carry out multi-stakeholder collaboration and should be strengthened. Civil society must be truly involved in exchange processes, not just as a box-ticking exercise but early in the process and in a way that is representative of different interests.

The benefits and drawbacks of technology openness need to be re-evaluated regularly and on a case-by-case basis. Sometimes the promotion of a specific technology may be necessary in order to move decarbonisation along.

## **Understanding processes of sociotechnical change**

### **D6.1 Scaling theories of change in REINVENT case studies**

This report brings together a collection of case studies conducted as part of the REINVENT proj-

ect, and attempts a synthesis of the findings gathered thereby with regard to the conceptualisation of scale and scaling as phenomena pertaining to innovations of various types. This is achieved by focussing analytical attention on the heretofore overlooked political, geographical, economical, and material dimensions of decarbonisation transformations, through the deployment of a multifaceted analytical framework which emphasises the materiality of the carbon-intensive society as currently constituted, so as to seek new pathways for decarbonisation, and open up the more indeterminate narratives of transformation to be found beyond the usual sites and domains of study in this field.

## **D6.2 Building momentum for decarbonisation**

In the majority of research on sociotechnical transition and/or transformation, attention has been largely directed to the means through which novelty is generated in the face of dominant, 'locked-in' socio-technical, institutional and cultural high carbon systems. Yet, as the REINVENT case-studies illustrate, generating novelty is not sufficient. Instead, low carbon interventions and initiatives need to acquire their own momentum and durability.

Taking this approach in turn changes how we approach the question of the worth or significance of specific initiatives. Rather than asking (only) about their direct impact on reducing greenhouse gas emissions, the analytical challenge is to understand their potential for catalysing decarbonisation, either in terms of disrupting existing systems or through gathering sufficient momentum such that they become newly established. In this report, we first expand on the concept of momentum and its significance as a means of understanding the dynamics of decarbonisation, before turning to consider how far the case-studies investigated in REINVENT can be considered as having the potential to generate momentum, and with what consequences for how we understand the possibilities for decarbonisation across the REINVENT sectors.

## **Policy & assessment**

### **D6.4 Policy brief—assessing low-carbon transitions**

This brief proposes a conceptual model for different types of low carbon transition assessments, and how the different assessment types interrelate to each other. The model takes its starting point in a perspective that recognises an important role for policies for realising low carbon transitions. It does not, however, restrict itself to policy evaluation per se, but also includes other knowledge-building processes. Three different assessment categories are identified and presented: monitoring; policy evaluation; building domain knowledge.

The conceptual understanding assumes that the assessments are expected to be of policy relevance for low carbon transitions. It means that overarching assessment criteria are affected, but not necessarily determined by, political priorities, targets and policies.

## **P EXTERNAL PROJECT PUBLICATIONS**

In this section we have listed publications created as part of the REINVENT project, or adjacent to it, which have been published in traditional academic journals. The text accompanying each publication's full citation is drawn from its abstract, with occasional editing for clarity and brevity.

### **P1 Industrial policy for well below 2 degrees Celsius: The role of basic materials producing industries**

“The well below 2 degree Celsius target sets a clear limit to future greenhouse gas emissions and thus strict boundaries for the development of future industrial processes and sourcing of feedstock. [...] A new industrial policy is needed, one that respects the necessity of zero emissions and integrates this with the traditional goals of competitiveness, jobs, economic growth and industrial development. We argue that the recent turn in industrial policy towards green growth and resource efficiency does not fully recognise this necessity nor the policy implications of zero emissions in the basic materials industry. An industrial policy for well below 2 degrees Celsius requires an additional turn—a turn towards long-term target-oriented strategies with a focus on zero emissions in basic materials production.”

*Nilsson L.J., M. Åhman M, V. Vogl and S. Lechtenböhrmer (2017) “Industrial policy for well below 2 degrees Celsius – The role of basic materials producing industries”, in Proceedings from LCS-RNet 2017, Wuppertal Institute. (web: [https://www.researchgate.net/publication/323258567\\_Industrial\\_policy\\_For\\_well\\_below\\_2\\_degrees\\_Celsius-The\\_role\\_of\\_basic\\_materials\\_producing\\_industries](https://www.researchgate.net/publication/323258567_Industrial_policy_For_well_below_2_degrees_Celsius-The_role_of_basic_materials_producing_industries))*

### **P2 Assessment of hydrogen direct reduction for fossil-free steelmaking**

“In this paper, we propose and assess a potential design for a fossil-free steelmaking process based on direct reduction of iron ore with hydrogen. We show that hydrogen direct reduction steelmaking needs 3.48 MWh of electricity per tonne of liquid steel, mainly for the electrolyser hydrogen production. If renewable electricity is used the process will have essentially zero emissions. Total production costs are in the range of 361–640 EUR per tonne of steel, and are highly sensitive to the electricity price and the amount of scrap used. Hydrogen direct reduction becomes cost competitive with an integrated steel plant at a carbon price of 34–68 EUR per tonne CO<sub>2</sub> and electricity costs of 40 EUR/MWh. A key feature of the process is flexibility in production and electricity demand, which allows for grid balancing through storage of hydrogen and hot-briquetted iron, or variations in the share of scrap used.”

*Vogl, V., M. Åhman and L.J. Nilsson (2018) “Assessment of hydrogen direct reduction for fossil-free steelmaking”, Journal of Cleaner Production, 203 (DOI:<https://doi.org/10.1016/j.jclepro.2018.08.279>)*

### **P3 Comparing future patterns of energy system change in 2 °C scenarios to expert projections**

“Integrated assessment models (IAMs) are computer-based instruments used to assess the implications of human activity on the human and earth system. They are simultaneously also used to explore possible response strategies to climate change. [...] To test whether projections by IAMs diverge in systematic ways from projections made by technology experts we elicited expert opinion on prospective change for two indicators and compared these with the outcomes of IAM studies. [...] IAMs and experts were found to be in relatively high agreement on system change in a business-as-usual scenario, albeit with significant differences in the estimated magnitude of technology deployment over time. Under stringent climate policy assumptions, such as the internationally agreed upon objective to limit global mean temperature increase to no more than 2 °C, we found that the differences in estimated magnitudes became smaller for some technologies and larger for others. Compared to experts, IAM simulations projected a greater reliance on nuclear power and CCS to meet a 2 °C climate target. In contrast, experts projected a stronger growth in renewable energy technologies, particularly solar power.”



van Sluiseveld, M.A.E., M.J.H.M. Harmsen, D.P. van Vuuren, V. Bosetti, C. Wilson and van der Zwaan, B. (2018) “Comparing future patterns of energy system change in 2 °C scenarios to expert projections”, *Global Environmental Change*, 50 (DOI: <https://doi.org/10.1016/j.gloenvcha.2018.03.009>)

#### **P4 A review of technology and policy deep decarbonization pathway options for making energy-industry production consistent with the Paris Agreement**

“The production of commodities by energy-intensive industry is responsible for 1/3 of annual global greenhouse gas (GHG) emissions. The climate goal of the Paris Agreement, to hold the increase in the global average temperature to well below 2 °C above pre-industrial levels while pursuing efforts to limit the temperature increase to 1.5 °C, requires global GHG emissions reach net-zero and probably negative by 2055–2080. Given the average economic lifetime of industrial facilities is 20 years or more, this indicates all new investment must be net-zero emitting by 2035–2060 or be compensated by negative emissions to guarantee GHG-neutrality. We argue, based on a sample portfolio of emerging and near-commercial technologies for each sector (largely based on zero carbon electricity & heat sources, biomass and carbon capture, and catalogued in an accompanying database), that reducing energy-intensive industrial GHG emissions to Paris Agreement compatible levels may not only be technically possible, but can be achieved with sufficient prioritization and policy effort. We then review policy options to drive innovation and investment in these technologies. From this we synthesize a preliminary integrated strategy for a managed transition with minimum stranded assets, unemployment, and social trauma that recognizes the competitive and globally traded nature of commodity production.”

Bataille C., M. Åhman, K. Neuhoff, L.J. Nilsson, M. Fischedick, S. Lechtenböhmer, B. Solano-Rodriguez, A. Denis-Ryan, H. Steibert S.Waisman, O. Sartor, S. Rahbar (2018) “A review of technology and policy deep decarbonization pathway options for making energy-industry production consistent with the Paris Agreement”, *Journal of Cleaner Production*, 187 (DOI: <https://doi.org/10.1016/j.jclepro.2018.03.107>)

#### **P5 Actors, decision-making, and institutions in quantitative system modelling**

“Increasing realism in quantitative system modelling with respect to the representation of actors, decision-making, and institutions is critical to better understand the transition towards a low-carbon sustainable society. Yet, studies using quantitative system models, which have become a key analytical tool to support sustainability and decarbonization policies, focus on outcomes, therefore overlooking the dynamics of the drivers of change. We explore opportunities that arise from a deeper engagement of quantitative systems modelling with social science. We argue that several opportunities for enriching the realism in model-based scenario analysis can arise through model refinements oriented towards a more detailed approach in terms of actor heterogeneity, as well as through integration across different analytical and disciplinary approaches. Several opportunities that do not require major changes in model structure are ready to be seized. Promising ones include combining different types of models and enriching model-based scenarios with evidence from applied economics and transition studies.”

De Cian, E., S. Dasgupta, A.F. Hof, M.A.E van Sluiseveld, J. Köhler, B. Pfluger and D.P. van Vuuren (2020) “Actors, decision-making, and institutions in quantitative system modelling”, *Technological Forecasting and Social Change*, 151 (DOI: <https://doi.org/10.1016/j.techfore.2018.10.004>)

#### **P6 Pluralizing and problematizing carbon finance**

“Growing emphasis on finance as key to decarbonization requires social science research that critically attends to the emergent and diverse forms taken by carbon finance. First, we pluralize research into carbon finance, building on existing work to identify four main forms: carbon mar-

kets; ecosystem services; natural capital investment; and, capital allocated to low-carbon enterprises and projects. Second, we propose that research should problematize the processes through which carbon is variously translated into financial value. Illustrated with reference to low-carbon investment in electricity generation, our agenda thereby extends from the difficulties of producing carbon-as-commodity to the uncertainties of constituting carbon-as-asset.”

*Bridge, G., H. Bulkeley, P. Langley and B. van Veelen (2019) “Pluralizing and problematizing carbon finance”, *Progress in Human Geography*, 44 (4) (DOI: <https://doi.org/10.1177/0309132519856260>)*

### **P7 Politics and the plastic crisis: A review throughout the plastic lifecycle**

“This article surveys the politics of plastics through a reading and analysis of more than 180 scientific articles in the fields of environmental science and environmental studies. Despite the many benefits of plastics, the global plastic system is increasingly being recognized as the source of severe environmental problems. [...] Our consideration of plastic flows reveals increasing politicization towards the latter end of the life cycle, that is, plastic as waste and pollution. Turning to plastic objects, we observe different forms of mobilization, and varying connections between flows and objects, which allow for multiple interpretations of what is at stake. In the closing section, we consider two recent trends in the plastic governance discussion that take a more holistic view of the plastic crisis: attempts to construct (a) a circular plastics economy and (b) global plastics conventions or treaties.”

*Nielsen, T.D., J. Hasselbalch, K. Holmberg and J. Stripple (2019) “Politics and the plastic crisis: A review throughout the plastic lifecycle”, *WIREs Energy and Environment*, 9 (DOI: <https://doi.org/10.1002/wene.360>)*

### **P8 Meat, dairy, and more: Analysis of material, energy, and greenhouse gas flows of the meat and dairy supply chains in the EU28 for 2016**

“To decarbonize the European Union, protein consumption must transition to diets low in meat and dairy which will drastically change the material and energy flows in current meat and dairy supply chains. [W]e structured the meat and dairy supply chains [of the EU] into a connected set of transformation nodes and distribution nodes. The former are processes transforming inputs into outputs, whereas the latter distribute the outputs to other processes using them as inputs. Currently, livestock play a central role in agriculture and other industries through the consumption of 271 Mt fodder crops, 108 Mt grain, 85 Mt grazed biomass, 49 Mt oil meal, and 16 Mt feed by-products. This feed is transformed into 64 Mt dairy and 35 Mt meat which ensures that the EU28 is a net exporter of meat and dairy while providing 25 Mt of by-products. This production also leads to 435 Mt CO<sub>2</sub> eq. with the main contribution from beef cattle (35%), dairy cattle (32%), and swine (20%). Thus, the lower GHG intensities of dairy products compared to meat do not imply a low contribution to the total emissions. By mapping the material, energy, and GHG emission flows, we have created a baseline suitable for identifying potential supply chain changes and their related GHG increase or decrease resulting from the protein transition.”

*aan den Toorn, S.I., E. Worrell and M.A. van den Broek (2019) “Meat, dairy, and more: Analysis of material, energy, and greenhouse gas flows of the meat and dairy supply chains in the EU28 for 2016”, *Journal of Industrial Ecology*, 24 (DOI: <https://doi.org/10.1111/jiec.12950>)*

### **P9 Effects on the manufacturing, utility and construction industries of decarbonization of the energy-intensive and natural resource-based industries**

“Decarbonizing the energy-intensive and natural resource-based industries is possible but may

substantially increase the cost of production. Whether such cost increases will reduce economic welfare depends on how the downstream industries respond to the higher cost for intermediate goods. In this paper, we explore how downstream industries in the EU15 responded to upstream carbon technology shocks and prices shocks during the period 1998–2014. Our results show that downstream industries do not respond to technology shocks directly but that they do respond to price shocks. A 5 percent upstream price increase is followed by a 4 percent increase in capital investments, 3 percent increase in productivity and a 4 percent reduction in the carbon intensity among manufacturing industries. The utilities and construction industries respond primarily by increasing prices and reducing wages. Prices increase by approximately by 1 percent and real wages fall by approximately 2 percent following a five percent upstream price increase.”

*Andersson, F.N.G (2020) “Effects on the manufacturing, utility and construction industries of decarbonization of the energy-intensive and natural resource-based industries”, Sustainable Production and Consumption, 21 (DOI: <https://doi.org/10.1016/j.spc.2019.10.003>)*

### **P10 Understanding the protein transition: the rise of plant-based meat substitutes**

“Even though the food system is responsible for a significant part of global greenhouse gas (GHG) emissions and a transition to a sustainable food system is needed, the growing body of literature on sustainability transitions has paid little attention to the food processing sector. We expect transition dynamics in the food processing sector to differ from the typical dynamics portrayed in transitions literature due to particularities in required technological knowledge and government intervention. To better understand dynamics in the food processing sector we apply the Technological Innovations Systems (TIS) framework to an in-depth case study of the plant-based meat substitutes industry in the Netherlands. Results illustrate that, contrary to many other transitions, consumers and changing informal institutions are the driving forces of this process. We show how strengthening cognitive and normative legitimacy can lead to growing markets for sustainable products.”

*Tziva, M., S.O. Negro, A. Kalfagianni and M.P. Hekkert (2020). “Understanding the protein transition: the rise of plant-based meat substitutes”, Environmental Innovation and Societal Transitions, 35 (DOI: <https://doi.org/10.1016/j.eist.2019.09.004>)*

### **P11 Financing net zero: How can investment meet the climate challenge**

“Achieving net zero carbon emissions requires the engagement of the finance system to address climate considerations in more strategic ways. In December 2019, the Royal Geographical Society [UK] hosted a discussion forum, Financing net zero: how can investment meet the climate challenge, where geographers met with experts from the finance and investment sectors to explore these challenges in more depth. Our briefing report summarises the action needed by government, the financial sector, business and the third sector to meet the scale and pace of change needed.”

*Bulkeley, H. and B. van Veelen (2020) “Financing net zero: How can investment meet the climate challenge”, Royal Geographical Society event report (DOI: <https://www.rgs.org/geography/advocacy-and-impact/impact/financing-net-zero/>)*

### **P12 Making visible, rendering obscure: reading the plastic crisis through contemporary artistic visual representations**

“Modern society without plastics is difficult to imagine. Yet the global plastic system is linked to a multitude of problems of a scope that is hard to grasp and address. In short, we are facing a plastic crisis. This article explores the role of art in stimulating critical reflection about plastics and anal-

yses how it contributes to making the plastic crisis increasingly visible. Plastic-related artworks mostly focus on ocean pollution and do not pay due attention to other aspects of the plastic crisis. At the same time, they creatively communicate clear and emotionally charged messages. Art has the potential to play an important role in coming to grips with the plastic crisis if it succeeds in adopting a broader understanding of the problem.”

*Chertkovskaya, E., K. Holmberg, M. Petersén and J. Stripple (2020) ‘Making visible, rendering obscure: reading the plastic crisis through contemporary artistic visual representations’, Global Sustainability, 3(e14) (DOI: <https://doi.org/10.1017/sus.2020.10>)*

## **L OTHER LITERATURES**

As discussed in the methodological statement, while the Rough Planet Guide takes the REINVENT sectors and innovations as its starting point, it was necessary to go beyond them in order to create a more complete and “fleshed-out” imaginary future. The following references are intended to ground some of those speculations and demonstrate that they have some basis in existing products, processes, and social dynamics, even if our extrapolations of them are (for the most part) hopeful.

### **L1 Fossil fuels and extremism**

Authored by Andreas Malm and the Zetkin Collective, the forthcoming book **White Skin, Black Fuel: On the Danger of Fossil Fascism** will be published by Verso in 2021.

“Two trends intersect in the present: rising temperatures and the rise of the far right. What happens when they meet? In recent years, the far right has done everything in its power to accelerate the heating [...] On the brink of breakdown, the forces most aggressively promoting business-as-usual have surged—always in defense of white privilege, against supposed threats from non-white others. Where have they come from? The first study of the far right in the climate crisis, this book presents an eye-opening sweep of a novel political constellation, and reveals its deep historical roots. Fossil-fueled technologies were born steeped in racism. None loved them more passionately than the classical fascists. As such forces rise to the surface, some profess to have the solution—closing borders to save the climate. Epic and riveting, *White Skin, Black Fuel* traces a future of political fronts that can only heat up.” (DOI: <http://lup.lub.lu.se/record/3b29b5dd-026d-471b-aae7-9eb3c597116e>)

### **L2 Climate imaginaries**

The academic literature on imaginaries is extensive and still growing, but this paper is perhaps a canonical moment in the conceptualisation of climate imaginaries:

“[Climate imaginaries] are shared socio-semiotic systems that structure a field around a set of shared understandings of the climate. Climate imaginaries imply a particular mode of organizing production and consumption, and a prioritization of environmental and cultural values. We use this concept to examine the struggle among NGOs, business and state agencies over four core climate imaginaries. These are ‘fossil fuels forever’, ‘climate apocalypse’, ‘techno-market’ and ‘sustainable lifestyles’. These imaginaries play a key role in contentions over responses to climate change [...] however, climate imaginaries only become dominant when they connect with wider popular interests and identities and align with economic and technological aspects of the energy system to constitute ‘value regimes.’”

- Levy, D. L., & Spicer, A. (2013). **Contested imaginaries and the cultural political economy of climate change.** *Organization*, 20(5) (DOI: <https://doi.org/10.1177%2F1350508413489816>)

See also: [climagination.org](http://climagination.org), a project which shares some personnel (and goals!) with REINVENT.

### L3 Plastic bags: policies and publics

“The plastic carrier bag epitomises many of the features that have transformed plastics into a material that defines our contemporary modern culture. The versatility, durability, strength and low cost have made it into an indispensable companion for consumers. In parallel with plastic becoming an increasingly contested material, the plastic carrier bag has emerged as a controversial object in many jurisdictions. This paper explores where, how and to what extent public authorities in different cases across the globe regulate plastic carrier bags [...] Far from being a simple issue, public policies on plastic carrier bags highlight the complexity of governing plastics.”

- Nielsen, T. D., Holmberg, K. & Stripple, J. (2019a). “Need a bag? A review of public policies on plastic carrier bags—where, how and to what effect?,” *Waste Management*, 87 (DOI: <https://doi.org/10.1016/j.wasman.2019.02.025>)

See also: Hagberg, J. (2016). “Agencing practices: a historical exploration of shopping bags”, *Consumption Markets & Culture*, 19(1) (DOI: <https://doi.org/10.1080/10253866.2015.1067200>)

### L4 Shortening supply chains in agri-food systems

“Short food supply chains (SFSCs) rely primarily on local production and processing practices for the provision of food and are, in principle, more sustainable in social, economic and environmental terms than supply chains where production and consumption are widely separated. This book, co-edited by REINVENT’s Agni Kalfagianni, reviews and assesses recent initiatives on this topic. In theoretical terms, it draws on and advances two key concepts, namely, place (particularly embeddedness in local economic networks and communities) and governance (particularly in addressing sustainability concerns in an inclusive and socially just manner). Empirically, the book examines a diverse set of SFSCs such as small-scale entrepreneurship, farmers’ markets, community supported agriculture and grassroots and solidarity networks. The main examples discussed are from Europe and North America, but the issues are applicable in a global context.”

- Kalfagianni, A. and S. Skordili (eds.) (2019) **Localizing global food: Short supply chains as responses to agri-food system challenges.** London: Routledge.

### L5 Critiquing carbon-as-commodity

“This article proposes the idea of the trickster figure as a way to account for the shifting material, and cultural properties of carbon in the cultural politics of climate change. Combining scientific understandings of allotropy in chemistry – describing the property of certain elements to manifest in various highly diverse forms – and the insights of Caribbean trickster stories, trickster carbon enables novel understandings of the multiple workings and effects of carbon as a material and cultural element. Rather than granting ‘carbon’ a singular seemingly-scientific meaning or reducing carbon to a singular problem that master human agents can ever definitively trap or sequester, this notion allows us to view carbon’s unique ability to shape-shift in a variety of contexts and for myriad agendas. [...] As an ambivalent and paradoxical figure, trickster carbon offers a powerful method of cultural way-finding through the urgent concern of climate change.”



- Girvan, A. (2017) “Trickster carbon: stories, science, and postcolonial interventions for climate justice”, *Journal of Political Ecology*, 24(1). (DOI: <https://doi.org/10.2458/v24i1.20981>)

## L6 Resisting environmental gentrification

Dynamics in urban property development, or rather the lack thereof, can be influenced by the (re)emergence of rare species in liminal or abandoned locations. This paper discusses a precedent from Malmö, Sweden.

“The Limhamn quarry, Kalkbrottet, in Malmö, Sweden [...] has been subjected to processes of environmental gentrification threatening to make the quarry into a gated ecology. City ecologists, drawing on national traditions in support of common green space, working with a spontaneously appearing unique flora and fauna, have countered the environmental gentrification process by seeking nature protection status of and public access to the quarry [...] by more fully integrating the history of industrial work, rogue subjects who now frequent the quarry illegally, and new immigrants who may find a familiar physical landscape in the quarry, the site could become meeting place for “others” and force against environmental gentrification.”

- Sandberg, L. A. (2014) “*Environmental gentrification in a post-industrial landscape: The case of the Limhamn quarry, Malmö, Sweden*”, *Local Environment*, 19(10). (DOI: <https://doi.org/10.1080/13549839.2013.843510>)

## L7 The problematic promise of electric vehicles

“Governments and municipalities are anticipating that a widespread shift to BEVs will significantly reduce transport-related carbon emissions and, therefore, augment their nationally determined contributions to emissions reduction within the Paris Agreement. However, matters are more complicated than they may appear. There is a difference between thinking we can just keep relying on human ingenuity to solve problems after they emerge and engaging in fundamental social redesign to prevent the trajectories of harm. [...] If the transition is a form of substitution that conforms to rather than shifts against current global scales and trends in private transportation, then it is highly likely that BEVs will be a successful failure. For this not to be the case, then the transition to BEVs must be coordinated with a transformation of the current scales and trends in private transportation. That is, a significant reduction in dependence on and individual ownership of powered vehicles, a radical reimagining of the nature of private conveyance and of public transportation.”

- Morgan, J. (2020) “*Electric vehicles: the future we made and the problem of unmaking it*”, *Cambridge Journal of Economics*, 44(4). (DOI: <https://doi.org/10.1093/cje/beaa022>)

**L8 Bicycle utopianisms**W“Bicycle Utopias investigates the future of urban mobilities and post-car societies, arguing that the bicycle can become the nexus around which most human movement will revolve. Drawing on literature on post-car futures, transition theory and utopian studies, this book imagines a slow bicycle system as a necessary means to achieving more sustainable mobility futures.”

- Popan, C. (2019). *Bicycle Utopias: Imagining Fast and Slow Cycling Futures*. Routledge. ISBN 9780367582241

## L9 The global footprint of plastics production

“Over the past four decades, global plastics production has quadrupled. If this trend were to continue, the GHG emissions from plastics would reach 15% of the global carbon budget by 2050. Strategies to mitigate the life-cycle GHG emissions of plastics, however, have not been evaluated on a global scale. Here, we compile a dataset covering ten conventional and five bio-based plastics

and their life-cycle GHG emissions under various mitigation strategies [...] aggressive application of renewable energy, recycling and demand-management strategies, in concert, has the potential to keep 2050 emissions comparable to 2015 levels. In addition, replacing fossil fuel feedstock with biomass can further reduce emissions and achieve an absolute reduction from the current level. Our study demonstrates the need for integrating energy, materials, recycling and demand-management strategies to curb growing life-cycle GHG emissions from plastics.”

- Zheng, J., & Suh, S. (2019) “**Strategies to reduce the global carbon footprint of plastics**”, *Nature Climate Change*, 9(5) (DOI: <https://doi.org/10.1038/s41558-019-0459-z>)

### **L10 Where does all that plastic go?**

“Plastics have outgrown most man-made materials and have long been under environmental scrutiny. However, robust global information, particularly about their end-of-life fate, is lacking [...] we present the first global analysis of all mass-produced plastics ever manufactured. We estimate that 8300 million metric tons (Mt) as of virgin plastics have been produced to date. As of 2015, approximately 6300 Mt of plastic waste had been generated, around 9% of which had been recycled, 12% was incinerated, and 79% was accumulated in landfills or the natural environment. If current production and waste management trends continue, roughly 12,000 Mt of plastic waste will be in landfills or in the natural environment by 2050.”

- Geyer, R., Jambeck, J. R., & Law, K. L. (2017) “**Production, use, and fate of all plastics ever made**”, *Science advances*, 3(7) (DOI: <https://doi.org/10.1126/sciadv.1700782>) (See also L14 below.)

### **L11 Prospects for recyclable bio-based plastics**

“A transition to a sustainable plastics system requires not only a shift to fossil-free feedstock and energy to produce the carbon-neutral building blocks for polymers used in plastics, but also a rational design of the polymers with both desired material properties for functionality and features facilitating their recyclability. Biotechnology has an important role in producing polymer building blocks from renewable feedstocks, and also shows potential for recycling of polymers. Here, we present strategies for improving the performance and recyclability of the polymers, for enhancing degradability to monomers, and for improving chemical recyclability by designing polymers with different chemical functionalities.”

- Hatti-Kaul, R., Nilsson, L. J., Zhang, B., Rehnberg, N., & Lundmark, S. (2020) “**Designing biobased recyclable polymers for plastics**”, *Trends in biotechnology*, 38(1) (DOI: <http://doi.org/10.1016/j.tibtech.2019.04.011>)

### **L12 Global temperature shifts**

“This study shows the negative health impacts of climate change that, under high-emission scenarios, would disproportionately affect warmer and poorer regions of the world. Comparison with lower emission scenarios emphasises the importance of mitigation policies for limiting global warming and reducing the associated health risks.”

- Gasparrini, A., Guo, Y., Sera, F., Vicedo-Cabrera, A. M., Huber, V., Tong, S., ... & Ortega, N. V. (2017) “**Projections of temperature-related excess mortality under climate change scenarios**”, *The Lancet Planetary Health*, 1(9) (DOI: [https://doi.org/10.1016/S2542-5196\(17\)30156-0](https://doi.org/10.1016/S2542-5196(17)30156-0))

### **L13 Biodiversity impacts of climate change**

“Distributions of Earth’s species are changing at accelerating rates, increasingly driven by human-mediated climate change. Such changes are already altering the composition of ecological communities, but beyond conservation of natural systems, how and why does this matter? We review evidence that climate-driven species redistribution at regional to global scales affects ecosystem functioning, human well-being, and the dynamics of climate change itself. Production of

natural resources required for food security, patterns of disease transmission, and processes of carbon sequestration are all altered by changes in species distribution. Consideration of these effects of biodiversity redistribution is critical yet lacking in most mitigation and adaptation strategies, including the United Nation's Sustainable Development Goals."

- Pecl, G. T., Araújo, M. B., Bell, J. D., Blanchard, J., Bonebrake, T. C., Chen, I. C., ... & Falconi, L. (2017) "Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being", *Science*, 355(6332) (DOI: <https://doi.org/10.1126/science.aai9214>)

#### L14 Oceanic plastic pollution

"Plastic debris in the marine environment is widely documented, but the quantity of plastic entering the ocean from waste generated on land is unknown. By linking worldwide data on solid waste, population density, and economic status, we estimated the mass of land-based plastic waste entering the ocean. We calculate that 275 million metric tons (MT) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million MT entering the ocean. Population size and the quality of waste management systems largely determine which countries contribute the greatest mass of uncaptured waste available to become plastic marine debris. Without waste management infrastructure improvements, the cumulative quantity of plastic waste available to enter the ocean from land is predicted to increase by an order of magnitude by 2025."

- Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., ... & Law, K. L. (2015) "Plastic waste inputs from land into the ocean", *Science*, 347(6223) (DOI: <https://doi.org/10.1126/science.1260352>)

#### L15 Biorefineries: the state of the art

"Several key findings can be obtained from the literature. First, investing more resources in R&D will not help to enable biorefineries to cross the 'valley of death' toward greater commercial investments. Second, while the importance and need for entrepreneurship and the engagement of small and medium-sized enterprises (SMEs) is generally acknowledged, there is no agreement how to facilitate conditions for entrepreneurs and SMEs to enter the field of biorefineries. Third, visions for biorefinery technologies and products have focused very much on biofuels and bioenergy with legislation and regulation playing an instrumental role in creating a market for these products. But there is a clear need to incentivize non-energy products to encourage investments in biorefineries. Finally, policy support for biorefinery developments and products is heavily intertwined with wider discussions around legitimacy and social acceptance."

- Bauer, F., Coenen, L., Hansen, T., McCormick, K., & Palgan, Y. V. (2017) "Technological innovation systems for biorefineries: a review of the literature", *Biofuels, bioproducts and biorefining*, 11(3) (DOI: <https://doi.org/10.1002/bbb.1767>)

#### L16 The death of the mall

The decline and geographical redistribution of retail stores, particularly large malls, is a large and complex topic, and well beyond the scope of REINVENT. However, the trend itself is clearly visible to laypersons across most of the Global North, and almost all contributors to the project felt that it was likely to continue; the pandemic-related restrictions on the use of public space, ongoing at time of writing, seem to not only support that extrapolative assumption, but strengthen it. See also:

- Delage, M., Baudet-Michel, S., Fol, S., Buhnik, S., Commenges, H., & Vallée, J. (2020) "Retail decline in France's small and medium-sized cities over four decades. Evidences from a multi-level analysis", *Cities*, 104 (DOI: <https://doi.org/10.1016/j.cities.2020.102790>)
- Helm, S., Kim, S. H., & Van Riper, S. (2020) "Navigating the 'retail apocalypse': a framework of consumer evaluations of the new retail landscape", *Journal of Retailing and Consumer Services*, 54 (DOI: <https://doi.org/10.1016/j.jretconser.2018.09.015>)

## L17 From fast fashion to thrift stores

Alternatives to “fast fashion” include the nascent business model of the “clothing library”:

“The shift towards fast fashion leads to shorter practical service lives for garments. Collaborative consumption is an alternative way of doing business to the conventional model of ownership-based consumption, and one that can potentially reduce the environmental impacts of fashion by prolonging the practical service life of clothes. [...] to achieve environmental gains, it is important to substantially increase garment service life. Moreover, the results quantitatively demonstrated the potential risk of problem shifting: increased customer transportation can completely offset the benefits gained from reduced production. This highlighted the need to account for the logistics when implementing collaborative consumption business models.”

- Zamani, B., Sandin, G., & Peters, G. M. (2017) “**Life cycle assessment of clothing libraries: can collaborative consumption reduce the environmental impact of fast fashion?**”, *Journal of Cleaner Production*, 162 (DOI: <https://doi.org/10.1016/j.jclepro.2017.06.128>)

See also:

- Albinsson, P. A., & Perera, B. Y. (2018) “**Access-based consumption: From ownership to non-ownership of clothing**”, in *The rise of the sharing economy: Exploring the challenges and opportunities of collaborative consumption*, Praeger. ISBN: 978-1440851865

The ever-resilient world of second-hand and thrift stores likewise presents possibilities, whether for re-use or repurposing:

- Irick, E. M., & Eike, R. (2020) “**Analysis of the availability of second-hand clothing as the raw materials for repurposing**”, *Sustainability in Fashion*, 1(1) (DOI: <https://doi.org/10.31274/susfashion.11421>)
- Dassen, F. Q., & Lombardi, L. (2020). **Ownership is so last year! An investigation of the relationship between consumer characteristics and attitude towards rental of second-hand clothing**. (Masters Thesis) (<http://lup.lub.lu.se/student-papers/record/9017472>)
- Machado, M. A. D., de Almeida, S. O., Bollick, L. C., & Bragagnolo, G. (2019) “**Second-hand fashion market: consumer role in circular economy**”, *Journal of Fashion Marketing and Management: An International Journal*, 23(3) (DOI: <https://doi.org/10.1108/JFMM-07-2018-0099>)

## L18 Adaptive reuse in architecture and planning

So-called “adaptive reuse” of old buildings is a civilisational habit that is arguably as old as architecture itself; the contemporary mode is often tied up with preservationist instincts as well as commerce. The term “stuffed animal” for old industrial buildings re-filled with “digital” businesses was popularised by sf writer and design critic Bruce Sterling in the early 2010s; it is presumably a détournement of a derogatory term from architecture criticism. (See e.g. Parreno, C, 2017, “**Architectural preservation as taxidermy: Patriarchy and boredom**” in *Architecture and Feminisms*, pp. 91-98, Routledge).

Given the decline (or perhaps just the shifting to an online modality) of big-store retail described in noted in L16 above, the preponderance of malls in urban centres, and the difficulty/expense of removal and replacement (for both environmental and economic reasons), the reuse of malls to such an end seems like a plausible extrapolation.

## L19 From green roofs to urban agriculture

The use of green roofs for purpose of detention and/or retention of rainfall in urbanised areas sufficiently well-established as to not really need referencing. The use of such roofs for agricultural purposes, and urban farming (whether “natural” or hydroponic), is perhaps a little more contentious—but the following sample of a growing literature (pun very much intended) demonstrates that our speculations have their feet on the ground of the present.

“... important aspects for the vertical hydroponic system include the growing medium, pots, electricity demand, the transportation of raw materials and product deliveries. By replacing plastic pots with paper pots, large reductions in GHG emissions, acidification impacts, and abiotic resource depletion are possible. Replacing conventional gardening soil as the growing medium with coir also leads to large environmental impact reductions. However, in order to further reduce the impacts from the system, more resource-efficient steps will be needed to improve impacts from electricity demand, and there is potential to develop more symbiotic exchanges to employ urban wastes and by-products.”

- Martin, M., & Molin, E. (2019) “**Environmental Assessment of an Urban Vertical Hydroponic Farming System in Sweden**”, *Sustainability*, 11(15) (DOI: <https://doi.org/10.3390/su11154124>)

See also:

- Su, Y. L., Wang, Y. F., & Ow, D. W. (2020) “**Increasing effectiveness of urban rooftop farming through reflector-assisted double-layer hydroponic production**”, *Urban Forestry & Urban Greening*, 126766. (DOI: <https://doi.org/10.1016/j.ufug.2020.126766>)
- Bahers, J. B., & Giacchè, G. (2019). “**Towards a metabolic rift analysis: The case of urban agriculture and organic waste management in Rennes (France)**”, *Geoforum*, 98 (DOI: <https://doi.org/10.1016/j.geoforum.2018.10.017>)
- McDougall, R., Kristiansen, P., & Rader, R. (2019). **Small-scale urban agriculture results in high yields but requires judicious management of inputs to achieve sustainability**. *Proceedings of the National Academy of Sciences*, 116(1) (DOI: <https://doi.org/10.1073/pnas.1809707115>)
- Ruff-Salís, M., Petit-Boix, A., Villalba, G., Sanjuan-Delmás, D., Parada, F., Ercilla-Montserrat, M., ... & Gabarrell, X. (2020) “**Recirculating water and nutrients in urban agriculture: An opportunity towards environmental sustainability and water use efficiency?**”, *Journal of Cleaner Production*, 121213 (DOI: <https://doi.org/10.1016/j.jclepro.2020.121213>)

## L20 Sea-level rise and flood adaptation

Sea-level rise due to climate change is clearly going to be a problem, particularly in a coastal port on a delta like Rotterdam:

- Kulp, S. A., & Strauss, B. H. (2019) “**New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding**”, *Nature communications*, 10(1) (DOI: <https://doi.org/10.1038/s41467-019-12808-z>)

What responses will be most effective remains an open question, but the involvement of (or take-over by) citizens in such processes is surely a trend worth watching for (and supporting): “... a major knowledge gap in comparative costs and benefits of alternative adaptation strategies and indicate that coastal climate adaptation needs to be tailored to local characteristics and use a combination of different structural and non-structural measures to be effective.”

- Dedekorkut-Howes, A., Torabi, E., & Howes, M. (2020) “**When the tide gets high: A review of adaptive responses to sea level rise and coastal flooding**”, *Journal of Environmental Planning and Management*, 63(12) (DOI: <https://doi.org/10.1080/09640568.2019.1708709>)

See also:

- Newman, G., Shi, T., Yao, Z., Li, D., Sansom, G., Kirsch, K., ... & Horney, J. (2020) “**Citizen science-informed community master planning: Land use and built environment changes to increase flood resilience and decrease contaminant exposure**”, *International journal of environmental research and public health*, 17(2) (DOI: <https://doi.org/10.3390/ijerph17020486>)
- Stephenson, J., Barth, J., Bond, S., Diprose, G., Orchiston, C., Simon, K., & Thomas, A. (2020) “**Engaging with Communities for Climate Change Adaptation**”, *Policy Quarterly*, 16(2) (DOI: <https://doi.org/10.26686/pq.v16i2.6480>)



## L21 E-waste

E-waste is starting to rise up the political agenda, as well as the academic one. Regarding this and all other forms of municipal waste, strong policies and messaging within the EU would make a difference:

“... our results revealed that the level of reducing and reusing behaviours insignificantly influenced waste generation. Thus, countries seeking to minimize waste generation should also pay more attention to the promotion of sustainable consumption and production. Meanwhile, the relationship between recycling behaviour and waste generation was positive and statistically significant. Analysing the determinants of waste management behaviours, attitude to personal waste generation significantly contribute to all waste management behaviours. Meanwhile, attitudes to general waste management significantly but negatively influence waste reducing and recycling behaviours. Thus, only these respondents who understand that they personally contribute to waste problem, more perform waste management behaviours. Furthermore, the efforts to reduce waste significantly influenced only recycling behaviour while attitude to resource efficiency insignificantly determined all waste management behaviours, revealing that people in the EU have a lack of knowledge about the relationship between waste reduction and resource efficiency.”

- Minelgaitė, A., & Liobikienė, G. (2019). “**Waste problem in European Union and its influence on waste management behaviours**”, *Science of the Total Environment*, 667, pp86-93 (DOI: <https://doi.org/10.1016/j.scitotenv.2019.02.313>)

However, the economics of e-waste recycling are still pretty lousy, meaning that the appeal of “outsourcing” the results of our wasteful lifestyles to developing nations has yet to diminish, even as the barriers to doing so are starting to form:

“... scrap computers are the only equipment with enough intrinsic value to justify the domestic recycling without requiring any external subsidy. Furthermore, the importance of such subsidy, of regulations and monitoring are discussed, principally for e-waste with an intrinsic value smaller than computers. The results indicate that labor accounts for more than 90% of the cost of first stage recycling in Australia, which can be extrapolated to countries where labor is expensive. Finally, in the interest of achieving a better waste management worldwide, this study provides arguments to encourage a better monitoring of the recycling processes undertaken internationally and/or the promotion of downstream recycling processes in developed countries.”

- Dias, P., Bernardes, A. M., & Huda, N. (2019). “**Ensuring best E-waste recycling practices in developed countries: An Australian example**”, *Journal of Cleaner Production*, 209, pp846-854 (DOI: <https://doi.org/10.1016/j.jclepro.2018.10.306>)

Hence the need for policies and incentives at the source of the waste-chain:

“... implementing an economic incentive based on the electronic bonus card system (EBCS) has several benefits compared to existing incentives. It compensates the consumers for the transaction costs of proper collection and satisfies the consumer perception of EoL EEE as having a residual value. However, application of the EBCS motivation technology will require the cooperation of various stakeholders, including electronics producers and national and international authorities”

- Shevchenko, T., Laitala, K., & Danko, Y. (2019) “**Understanding consumer E-waste recycling behavior: introducing a new economic incentive to increase the collection rates**”, *Sustainability*, 11(9) (DOI: <https://doi.org/10.3390/su11092656>)

## L22 Urban mobility transitions

Urban mobility is a truly vast literature, too deep to even brush across here. However, many of the mobility visions in the Rough Planet Guide came via experts in mobility futures, particularly the consultancy Trivector in Lund, Sweden (to whom many thanks for a fun and informative workshop session in early 2020).

The base assumption at work throughout the Guide's imagined future is that we don't lack for technologies or policies that could achieve the goal of decarbonisation; indeed, the Guide contains few, if any, technologies which are not already in existence, if not yet widespread in some cases. The real challenge is rolling out and successfully implementing these changes in the teeth of a substantial array of vested interests in not just the fossil fuels industry, but its allies downstream. This will require innovations in governance as much as in technology, if not more so:

"... The management of any substantive, disruptive transition such as that to Smart Mobility is challenging for the policy system per se; for countries with MLG systems, the task is made more complex still by the need to achieve sufficient policy alignment between different tiers and entities of governance to implement new policy instruments in practice. The specific instruments of transport pricing and roadspace reallocation provide clear examples of these challenges and pointers to how implementation questions might be resolved in an MLG framework."

- Docherty, I. (2020). "Crafting Effective Policy Instruments for 'Smart Mobility': Can Multi-level Governance Deliver?"; in *Shaping Smart Mobility Futures: Governance and Policy Instruments in times of Sustainability Transitions*. Emerald Publishing Limited. (ISBN: 978183982651) (For more on Multi-level Governance, see D6.1 and 6.2 above.)

The Guide's future consciously eschews the solutionist assumption that personal fossil-fuel vehicles can be swapped out for personal electric vehicles, on the basis that while decarb concentrates on the reduction of carbon emissions, it would be a false economy to decarbonise through a reliance upon the (equally extractive and ecologically destructive) technologies of electrical generation and storage. (See also L7 above). Mass transit is of course the established and justifiable answer to this very old issue, though the privatisation of mass transit systems has done much damage to its reputation in recent decades—a trend which shows signs of reversing. The notion of dormant vehicles offers further avenues to explore:

"... without thinking clearly about these aspects of the future, plans for sustainable, smart cities could fall into a similar trap as in historical versions of automobility and parking, that is, of overlooking dormant vehicles and the ways they shape and are shaped. Rather than parking conveniently disappearing from cities, it is instead likely to change in various respects [... this] paper argues for inverting urban mobility futures to identify the new forms of dormant vehicles associated with them, and consider their implications for land use, space and place."

- Spurling, N. (2020) "Dormant vehicles: inverting urban mobility futures", *Land Use Policy*, 91 (DOI: <https://doi.org/10.1016/j.landusepol.2019.02.031>)

Ditto for sharing models, though ideally deployed by municipalities (rather than by "disruptive" start-ups burning through venture capital in search of an acquisition and stock buy-out):

- Marsden, G., Anable, J., Bray, J., Seagriff, E. and Spurling, N. (2019) **Shared mobility: where now? where next? The second report of the Commission on Travel Demand**. Centre for Research into Energy Demand Solutions. Oxford. ISBN: 978-1-913299-01-9

To reiterate: the Rough Planet Guide takes a stance we see as being hopeful rather than optimistic. Private vehicle ownership could very realistically continue to decline in line with the generational cohort effects currently observed, i.e. Millennials and younger increasingly doing without—but only if policy and regulation is designed in such a way to prevent their recapture by the vehicle manufacturing sector. (The long-term influence of pandemic fears, currently pushing a resurgence of private car purchases in some nations, remains to be seen.)

### **L23 Long-haul mobility futures: rail, sea, air**

The case for air travel being extremely carbon-intensive is solid, but—prior to the pandemic, at least—air travel was still growing, if perhaps a little less slowly than before. But the flygskam (“flight shame” in Swedish) phenomenon in the Nordic nations and beyond could be seen as a “weak signal” of changes which may yet go mainstream under the combined weight of pandemic restrictions and demographic shifts. Awareness of the impacts is helping, but the sheer inertia—and relentless cultural presence—of air travel helps to sustain it:

“...internalized knowledge about climate change and the impact of air travel is crucial for instigating behavioral change. Awareness evokes negative emotions leading to a personal tipping point where a decision to reduce or quit flying is made. However, the process is often counteracted by both personal values and political structures promoting air travel. Even individuals with a strong drive to reduce flying feel trapped in social practices, norms and infrastructures. Hence, we argue that personal and political spheres interact complexly and to reduce flying at larger scales, interventions are needed across spheres, e.g., change of norms, effective policy instruments and better alternatives to air travel.”

- Jacobson, L., Åkerman, J., Giusti, M., & Bhowmik, A. K. (2020) “**Tipping to Staying on the Ground: Internalized Knowledge of Climate Change Crucial for Transformed Air Travel Behavior**”, *Sustainability*, 12(5) (DOI: <https://doi.org/10.3390/su12051994>)

The Rough Planet’s future is one that expresses a hope for a substantive reduction in air-travel over the short-, medium- and long-haul routes; we have hinted at some sort of fossil-fuel ban or taxation, or a combination thereof, that might keep passenger planes (mostly) on the ground. We have further assumed that promises of electric-powered aircraft on the one hand, and slower-but-less-impactful alternatives such as airships, will retain their status as futurological pipe-dreams, and not come to fruition. Grounding the aircraft will not remove the need or desire for long-distance travel, however—and in Europe, rail travel as a direct swap for short- and medium-haul flights is ecologically speaking a no-brainer. The numbers look good for Australia:

- Robertson, S. (2018). “**A carbon footprint analysis of renewable energy technology adoption in the modal substitution of high-speed rail for short-haul air travel in Australia**”, *International Journal of Sustainable Transportation*, 12(4) (DOI: <https://doi.org/10.1080/15568318.2017.1363331>)

Europe, with its far greater density and even distribution of urban nodes (not to mention a well-established rail system), would likely do even better. Of course, much investment and expansion of rail infrastructure would be required for it to happen—but flygskam (particularly prevalent among academics, to go by the sheer number of papers autocritiquing air travel to conferences) is already provoking a renaissance in night-train routes across Europe.

“The European high-speed network already offers an alternative to intra-European air traffic for short distances (500–1000 km). High-speed traffic has so far been limited to daily connections. By making targeted use of the overnight jump, the train could also be an alternative to air travel for distances of up to 2000 km.”

- Rüger, B., & Matausch, P. (2020). “**High-Speed Overnight Trains—Potential Opportunities and Customer Requirements**”. In *Sustainable Rail Transport*. Springer. ISBN: 978-3030195212

The challenge here is finding the capacity for the projected increases of both passenger and freight mobility by rail, as the latter has in recent years eaten up a lot of slack in network capacity. Nonetheless, the physical infrastructural work required may seem quite appealing to nation-states reeling from the econo-political impacts of the last two decades: neoKeynesian it may be, but building railways can mobilise a greater number of workers of a greater variety than building aircraft. Again, as expression of hope, we have assumed this effort to have been made, alongside improvements in road-based long-haul mass transit.

There is surprisingly little literature (outside of the historical disciplines) on transAtlantic and other long-haul ocean liner routes—but that gap perhaps represents an opportunity, whether for scholarship, for business, or for imaginative extrapolation. Here we have engaged somewhat in a classic futures tactic: of going backward in time in order to see what might come next. 75 years ago, air travel was incredibly rare and expensive, while long-haul passenger shipping was commonplace—and predicated on the understanding that if you wanted to go a long way, it would take you a long time (unless you were incredibly wealthy). Thus, if we saw a return to a post-ww2 pricing on air travel, the economics of long-haul ocean liners might open up again... and, thanks to the pandemic’s impacts, particularly on the demographics most likely to go on cruise holidays, there’s an awful lot of out-of-work cruise liners on the market right now.

Solar power, sail-assistance and alternative fuels could lower their emissions, too; compared to container freight, which maximises the mass on board, passenger transport should require much less energy. It still won’t be cheap, of course... but the point is that, really, it shouldn’t be. Much of the most obvious literature on “green shipping” seems to focus on hydrogen-powered options; however, hydrogen as a fuel or power source—much like nuclear fusion—seems to have been self-reportedly “on the verge of a breakthrough” since the 1970s, while old-fashioned sail power and photovoltaics are well-understood. Hence we chose to imagine the revival of ocean liners using technologies that seemed plausible in the present.

# Thank You

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And finally, thank you for reading the Guide—because no imaginative creation is truly complete until an audience engages with it. We hope we've shown that imagining decarbonised futures is a project that can—and should—be shared.

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# Things to pack

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# Itinerary

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## *Hallo, en welkom in Notterdam!*

Thank you for buying this special limited print edition of the Rough Planet Guide to Notterdam for 2045. We hope this souvenir edition—featuring a small selection of favourite locations and things-to-do, carefully curated by our staff writers—will provide a memento of your visit to this wonderful city, which we have all come to love.

There's still work to be done, of course—but this year the scientists and ethnographers of the IPCC are suggesting, cautiously, that we might just have managed to stay within the 1.5°C warming limit set out in the Paris Agreement of 2015. That's surely something to celebrate—for us at Rough Planet, for Notterdam, and for Europe and the world.

This book is a tourist guide to an imagined coastal city in a decarbonised Europe circa 2045. We made it in order to communicate and explore the findings of REINVENT Decarbonisation, a Horizon2020-funded project aimed at exploring the possibilities for radically reducing the carbon footprint of basic industries such as steelmaking, plastics, meat and dairy farming, and pulp and paper production.

As you will see, we went a little further, too. The Rough Planet Guide declines to answer the question of “how do we make the decarbonisation transition happen?”, in favour of the question “how might we live in a successfully decarbonised Europe?” Thinking through the polyphony of the latter sheds new light on the former, not least because it makes it clear that there is more than one pathway to a post-fossil Europe.

This book is not a prophecy or promise, but it is a possibility. This book is not optimistic, but it is hopeful. This book is a fiction... but it is built upon the best truths we could find.



Utrecht University