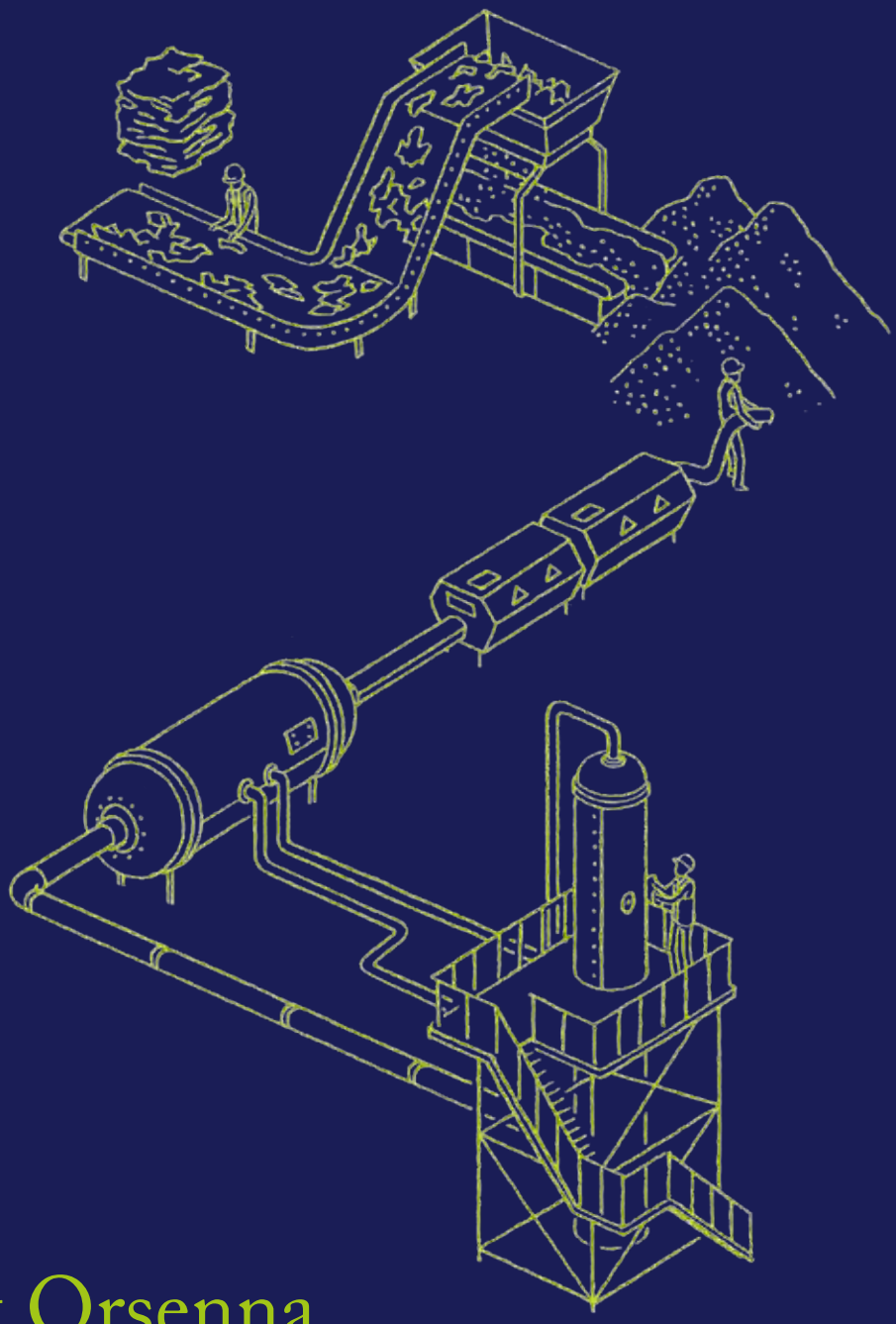
21 journeys to the countries of the new resource



Erik Orsenna

Illustrated by Thomas Vieille

21 journeys to the countries of the new resource

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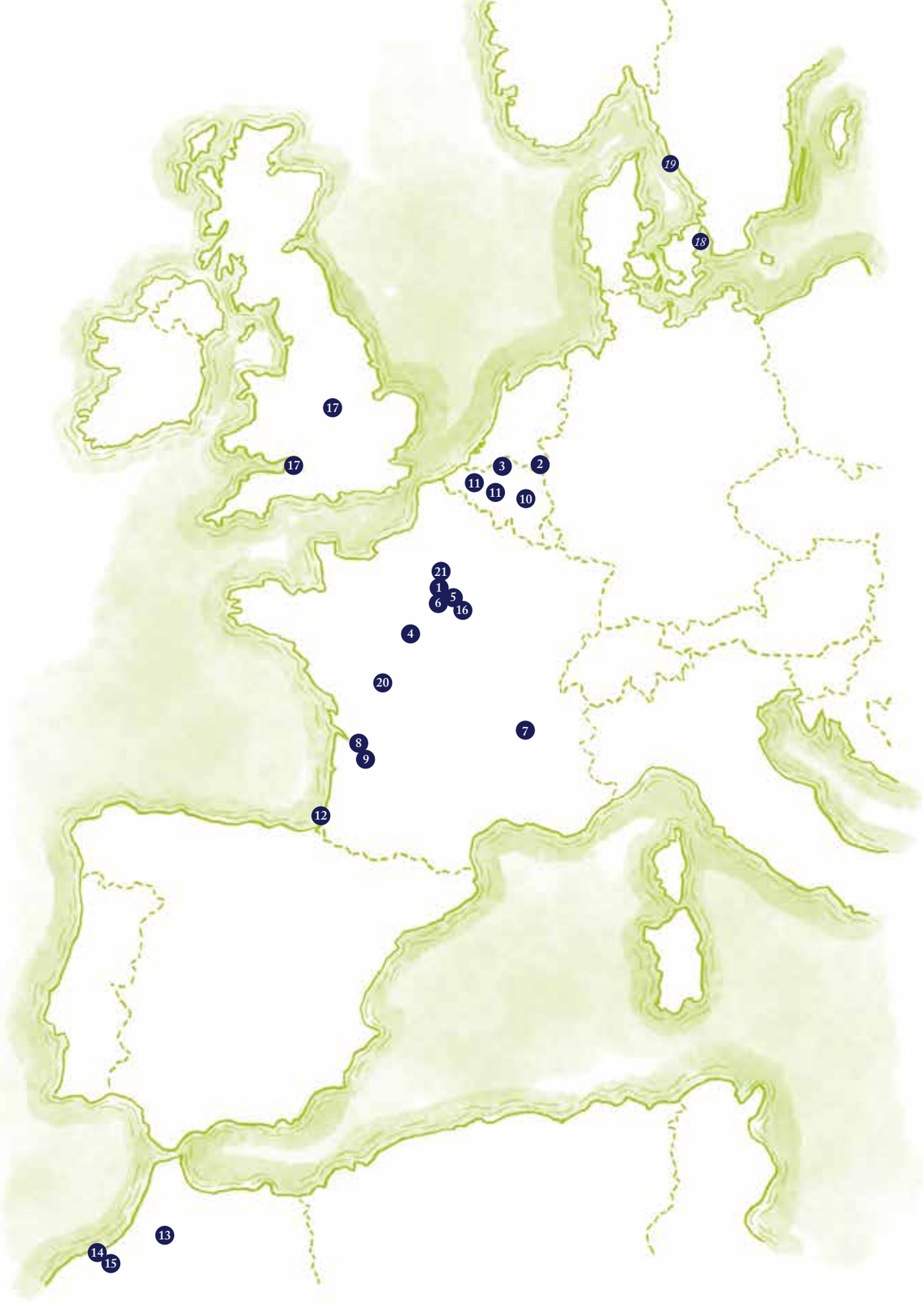
For one year, Erik Orsenna, the writer, economist and member of the French Academy, explored the circular economy inside and out. At SUEZ's invitation, he immersed himself in the places where waste is becoming a resource, meeting with the people who imagine a more sustainable future, every day. From Gothenburg and Bayonne to Antwerp and Casablanca, this book is the record of his journeys, with illustrations by Thomas Vieille.



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Journey No.1
Introduction

THE RESOURCE REVOLUTION

According to the dictionary, a revolution may be a complete rotation, such as the periodic return of a star to a certain point in its orbit, or a radical change, an upheaval. These definitions fully express the dual meaning of the resource revolution. A circular design that upsets former economic and societal models elevated in a linear logic and largely wasteful in terms of production and refuse. Each year, we – the consumers and economic players in the European Union – produce some 2.5 billion tonnes of waste, of which:

- 213 million tonnes of household waste;
- 270 million tonnes of waste from the manufacturing industries;
- 734 million tonnes of waste from the extractive industries;
- 821 million tonnes of waste from the construction industry.

France alone produces some 345 million tonnes of waste. Given that the trend to producing waste is more or less on the decline, because of the reduction in economic activity and improved management of consumption, and given that national and European regulations call for improvements in recycling, what are these new resources and what should we do with them?

ENABLING AT LEAST FIVE OF OUR OLDEST DREAMS

In general, restrictions make us more intelligent. Because they must struggle, in particular against scarcity of materials and energy, human beings invent solutions. In this way, they learn that they have powers of which they were unaware.

I. Never dying or Eternal Return or Eternal Youth

Recycling enables materials to have a second life. Paper produces paper and plastic produces plastic. All that's needed is to occasionally add some new fibres to the recipe to rekindle the dynamics, which have grown a little tired.

II. Imitating life and verifying Lavoisier

The straight line is an invention of man. No one has ever seen one in the mechanisms of life, where everything is circles and spirals and where nothing in life is lost, nothing is

created and everything is transformed. Bio-mimicry is this new discipline that looks to Nature for answers to our questions and models for our initiatives. At Croissy, near Paris, when I visited the International Centre for Research on Water and the Environment (CIRSEE), I saw how to activate certain bacteria to break down sludge produced from our waste and the efficiency of biological processes as soon as they are mobilized. At the same time, today's agronomics deploy an intensively environmentally friendly agriculture. In Montpellier, when I met with teams from the Amétyst Centre, I noted that the treatment and organic reuse of our bio-waste can be a new source of energy for our regions.

III. Changing lead to gold

Today, we reuse that which is obscure, humble, of no importance and has been abandoned. Never has alchemy been more modern and never has the philosopher's stone been more relevant. The Swedes adore white bread, which they buy in unreasonable quantities that they then throw out. The waste, if intelligently fermented, can be used to produce ethanol. That's why up there, near the Arctic Circle, cars run on white bread. Garbage cans no longer contain the shameful dregs of our existence; instead, they are a source of matter that must be used, after sometimes undergoing an astonishing transformation, where creativity is used to the fullest.
Yes, never has alchemy been more modern. Back at the CIRSEE – still in Croissy – young women who are both very well informed and very enthusiastic showed me their favourite machine - a compounder. It's the equivalent of the alchemists' oven. It can be used to produce plastic, after mixing secret blends. The raw material is plastic, any kind of used plastic. The perspective is now inverted. Before we wanted to know how to get rid of waste. Now we choose an objective. What product do I need? What kind of plastic or steel? In this way, we deduce how we choose and treat the waste we collect.

IV. Paying as little as possible for energy

Once a second life has been given to everything that has one, we arrive at nearly ultimate waste, some of which has not completed its mission, and still has a certain power. "Burn me", it says. But please don't use the furnace that I'm giving you to heat up the sky, which as the Intergovernmental Panel on Climate Change often says, doesn't need it. Use it to produce steam, which can be used to produce heat at a reasonable price. On the Bessières site, near Toulouse, I saw ten hectares of greenhouses that use combusted waste to give tonnes of tomatoes the nearly tropical climate in which they thrive.
But at CIRSEE, I also visited the MethaLab, a research unit dedicated to improving the methanation process. Even if we are not as well endowed as Qatar, the gas produced by our waste can help us to achieve energy independence.

V. Living but leaving no trace

On the Lambert site, near Narbonne, I saw former landfills transformed into a landscape. Who could believe that the green hills filled with birds were created by thousands of garbage cans that had been emptied there and integrated into nature, once the necessary precautions had been taken? One thing is certain. These surfaces will never be built. Some day, perhaps, the only green areas near cities will be former garbage dumps.

BUILDING A NEW GEOGRAPHY

To understand water, we must be aware of its different cycles. Similarly, to understand waste's role as a new resource, we must be aware of the path it follows, both nearby and far away. In all societies, to respect the "polluter pays" principle, waste collection is a local responsibility. It's not the job of neighbouring cities to clean up our roads and our air. The principle is simple: no waste is allowed to cross a border. But what borders? What is the most relevant space? In other words, when we speak of the circular economy, what is the size of the circle? Or rather, what are the sizes of the circles? In France, waste management was transferred from departmental to regional responsibility. But what if the waste has become a product or if it is being transformed into a resource?
China, where forests – and thus fibres – are scarce, is buying as much old paper as possible. And since the boats that have delivered its products would normally return to Shanghai empty, the return freight costs are non-existent. The same is true for hazardous products. Some countries, in exchange for payment that is more or less misappropriated by local authorities, welcome these products with open arms. So in addition to the highly local collection circles, there are other circles some of which are worldwide in scope.
Still, in a given space, things must be made consistent. The lack of a European energy policy is highly prejudicial to the region's economies, leading both to overproduction and a worrisome lack of investment. On the one hand, gas-powered plants are closing, while coal-burning plants are on the rise. To not add to the problem of overcapacity, wind turbines are left unconnected to the power grid, although they have been built with heavy subsidies.

ACTIVATING THE THREE TRANSITION DRIVERS: PRICES, REGULATIONS AND PERSONAL CONVICTION

The main obstacle to reusing material is the lack of sorting accuracy. How can it be improved? One example has been given by the sorting centre at Limeil-Brévannes, near Paris, where the sorting of yellow trashcans has been entirely reworked to isolate plastics that can be reused with the aid of optical sensors. Every society has its deep-seated logic that dictates its practices. Similarly, certain countries sort and recycle, such as Finland with a reuse rate of 94%. Others continue to shamelessly discard their refuse. In the United States, as one would expect, change is driven by money. If the waste can find a buyer, why deprive oneself of a potential profit? In Europe, change is driven by regulations, which will surprise no one. Did you know that more than half of the decrees issued by Brussels concern the environment and respect for the environment? So agendas are set, but with few sanctions for those who do not comply with them.
Waste must no longer be eliminated; rather it must become a resource or a source of energy. That's why European directives contain ambitious recycling objectives, with a 65% recycling rate for municipal waste by 2030 and a 70% rate for public works waste. They also call for a reduction in waste storage to 10% of municipal waste products while some countries are still at 70% or 80%. In addition, packaging and wood must be collected and reused. These objectives are what are driving government recycling policies. To achieve them, each country must introduce a 6- to 12-year action plan. But since it's better to do more with less, a European prevention policy calls for a 50% reduction in food wastage and marine waste by 2030.

On the shores of the Baltic Sea, people are motivated by personal conviction, a more affirmed awareness of the scarcity of resources, the fragility of our planet and individual responsibility.

Clearly, these drivers can be activated in combination. A price – even a symbolic one – given to well-sorted waste strengthens personal conviction because it recognizes people's usefulness as citizens. Furthermore, a regulation requires people to assess or to limit the quantity of carbon emitted, thereby leading to the establishment of a carbon market, which defines the price.

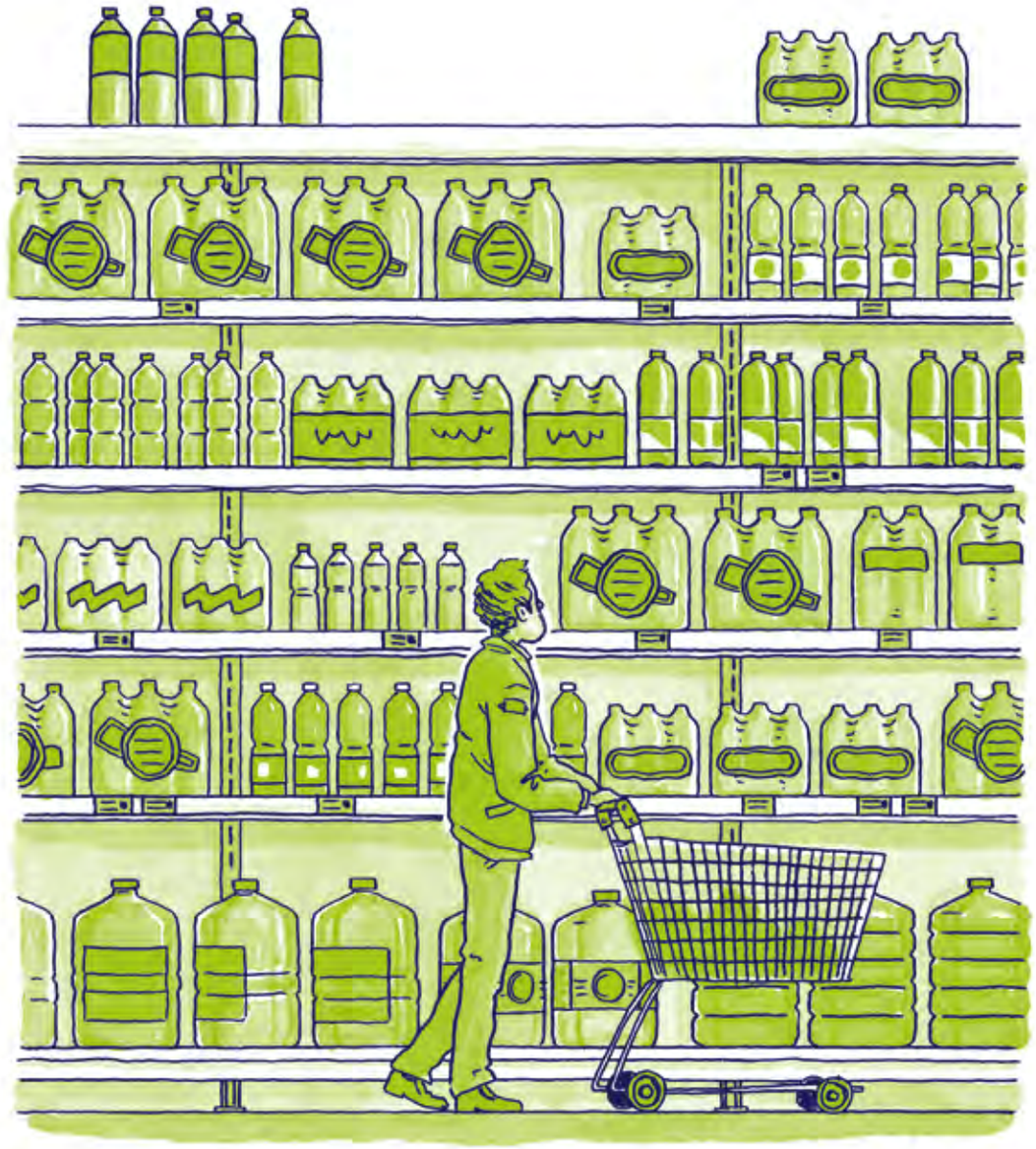
DRAWING UP A LIST OF FORGOTTEN WASTE (NEW POSSIBILITIES FOR REUSE)

The example of the aviation sector is especially striking, but why this general, on-going indulgence for this industry? A visit to Tarmac Aerosave in Tarbes (France) is especially instructive. The company brings together Airbus, SUEZ and Safran. With an estimated more than 20,000 airplanes in use and their life expectancy of 20 years, we should be taking about 1,000 of them apart every year. So where are they? Most are parked in airports in dry or desert regions, especially in the United States. They seem to be waiting for a new life, although an abandoned airplane will never be authorized to fly again. How can companies like Airbus and Boeing accept to know nothing about the future of their planes? When a dilapidated aircraft rented to an unscrupulous airline falls out of the sky, their reputation is tarnished. There is voluntary confusion about provisional parking (which includes maintenance) and scrapping. And when they are dismantled, as in the UK, these operations are carried out with no respect for the environment.
The same analysis could be applied to boats. Insurance statistics tell us that the most active are only used five days a year. Let them cling to their illusion of whatever adventure may await them. But what about the others – the tens of thousands of others – that are mountains of plastic that long ago were rotted by humidity?

PLANNING FOR THE SECOND LIFE BEFORE THE FIRST

As usual, the upstream doesn't care about the downstream. One example is plastic, our manufacturer's preferred packaging. Millions of tonnes of all sorts of plastic are thrown away each year. Recycling would make it possible to economize the oil used to manufacture new plastic while also ridding the planet of some of the most aggressive, long-lasting waste.
The users of this packaging continuously modify its features to bring down costs. The structure of certain bottles of milk is changed to avoid having to install an aluminium capsule on the bottle top. To support recycling, a tax is levied. This is astonishing for a neophyte in the area of waste like me. Why is there so little dialogue between a production company that focuses on manufacturing and a production company that focuses on recycling? And why hasn't the well-known eco-design process been further developed? Let's not be so naïve. What economic (or regulatory) model could motivate upstream producers to take into consideration downstream constraints?

Let me conclude my first note with two remarks. In my mission for the Compagnie National du Rhône on rivers around the world, I have noticed the on-going dominance of a carved-up vision of the world. Hydro-electricians talk to each other, as do navigation companies, irrigation managers and people who build flood-control dikes. They have no shared vision of the river, which is a vital, living being. The same observation applies to the economy of waste. It's the downstream players – the recyclers – who have a circular vision, systematic of mechanisms. They have to deal with the scattered state of upstream operations.
The second area of note is that no one knows about this world of new resources. As for water, we are children who have been twice spoiled: unaware of the work needed to take care of trashcans and ignorant of the many inventions to reuse them. As for water, we must tell this true story. The architecture of the factory in Issy-les-Moulineaux is symbolic. It's no more beautiful than the edifice itself, covered with wood and overgrown with vegetation. But the living works are buried, up to forty meters deep, as if we needed once again to hide what is left of products once they have been used. Although probably no one will ever follow up on my idea, I dream of visible factories that are proud to be seen.



Journey No.2
Geleen — Netherlands

FROM PLASTIC TO PLASTIC

Polymeerstraat 1. In the small Dutch town of Geleen, not far from Maastricht, which is well known for its treaty on the organization of Europe, a brand-new factory has been built. And to thank the company for its activity, the town has named the street on which the factory is built Polymeerstraat, the street of polymers. No other name could be more pertinent or more deserving.

Once upon a time, there were two friends and expert chemists, Huub Meessen and Marc Houtermans, who were well paid but unhappy in the companies that employed them. They felt that the time had come to recycle the mountains of plastic that we use. Despite the slowdown in growth and despite the weak – very weak – price of oil, the traditional raw material for plastic, the day would come when reason would win out. On that day, people would stop wasting resources and emitting ever-more CO_2. Out of this personal conviction was born a company named Quality Circular Polymers (QCP). It was soon joined by SUEZ. In a few months' time, one of the most modern European facilities for processing polypropylene and high-density polyethylene plastics was built. The production ramp-up would be as fast as the building-construction and machine-installation phases. In its first year, the factory processed some 20,000 tonnes of recycled plastic, out of a total capacity of 36,000.

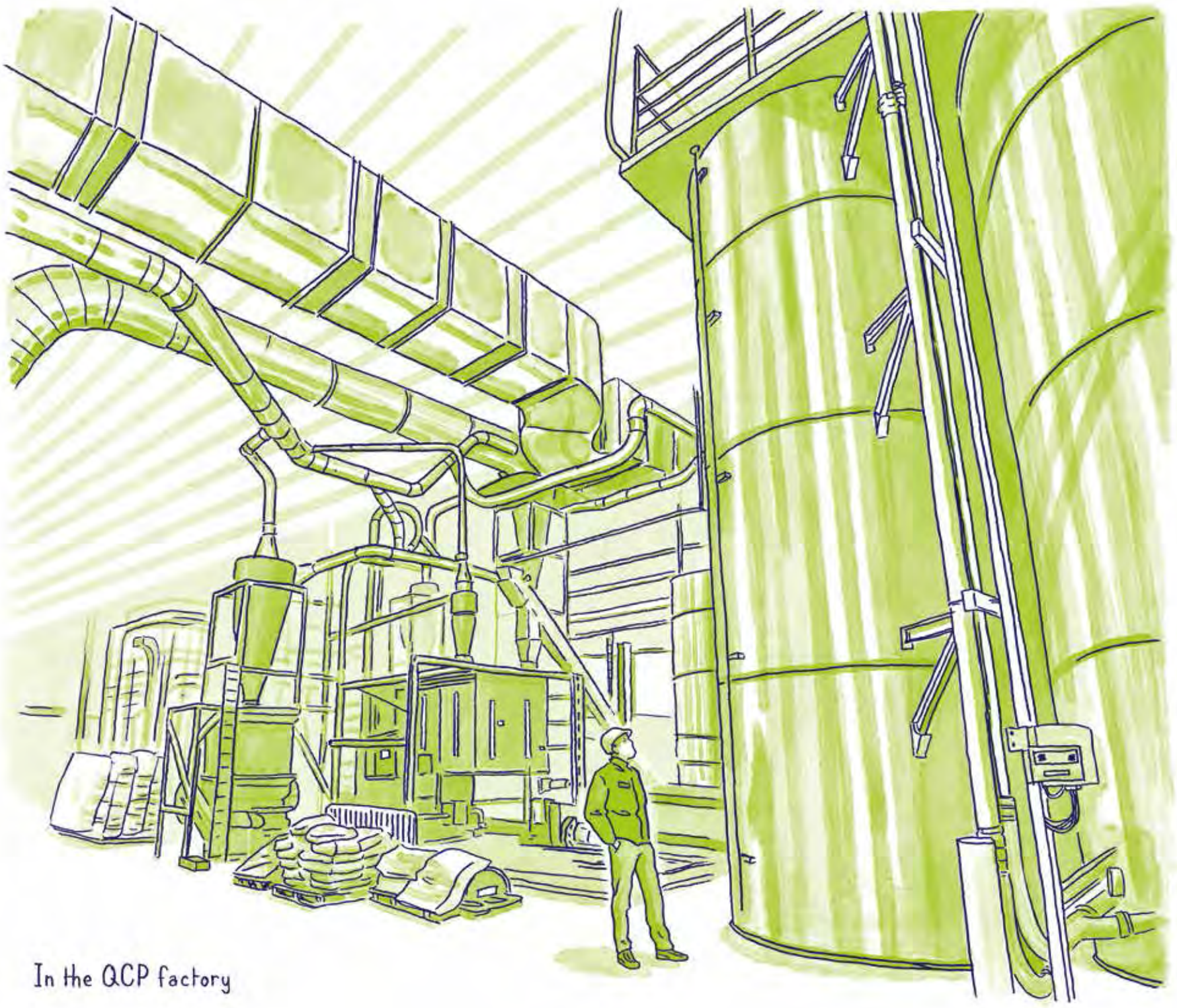
SUEZ is in charge of supplying the factory and the arriving cargo has already been sorted and "over-sorted": sorted to separate the plastic from the rest of the yellow trashcan contents, and most of all from the different sorts of paper; then sorted again, to retain only the polypropylene and the high-density polyethylene. Once unloaded, the plastics form two parallel chains, each a good half-kilometre in length.

The first phase of this highly mechanized and somewhat agitated process is to change these bottle and bag cadavers into a multitude of charming little multi-coloured petals, averaging 2 to 3 centimeters. To successfully carry out this metamorphosis, it is necessary to get rid of all metallic and other intruders. The plastic has to be carefully cleaned, dried and cut up.

Then begins the second phase: cooking. Various (top secret) additives are poured into the compounders, where the petals await them. The poor petals think that they have been tortured enough, but they are fed into extruders,

a system of double screws that heated and mixed them. Their identity is gone since they had to be perfectly blended. Yes, the poor petals had become long grey strands of spaghetti, having been forced through a sieve. A little more courage, former petals! A final stage awaits you. Scissors would cut you up, transforming you into grey granules. You were thrown into large white bags and sent to a warehouse where you waited for a customer to call. Your holidays wouldn't last long. Too many people were interested in you. That's because your features, which were regularly checked, were exactly the same as those of your young colleagues created in refineries.

The industrial park where QCP set up operations is the second largest for chemicals in Europe, following Ludwigshafen in Germany. But I was fascinated by a large pile of brown material on the other side of a field. According to Huub and Marc, they were old farming tarps that were to be transformed into trash bags. In the surrounding area, more and more companies have decided to decentralize their production. They are being replaced by companies like QCP, which are involved in recycling. It's all very symbolic, don't you think?



In the QCP factory

Journey No.3
Antwerp — Belgium

FROM GLASS TO GLASS

The advantage of small countries is that you can cross them quickly. The disadvantage is that a wide range of activities has to be fitted into a small space. For a long time, human activities have been gnawing away at the countryside. The motorway is a succession of factories and warehouses that become more and more dense as we move westward. The reputation of the Flemish is well earned. They treat work as a religion and have a passion for trade. That's why they created Antwerp, Europe's second largest port and the world's 17th. Every year, 190 million tonnes move through the port, as do 9 million 20-foot equivalent containers. That's the same as Le Havre. After having taken a long taxi ride through this immense area that covers 130 square kilometres, after having crossed innumerable bodies of water, after having respectfully bowed to numerous giant cranes, after having saluted all sorts of boats, from the modest barge to the giant Panamax, I at last entered the improbable kingdom of glass. Not content just to operate mines and sandpits, the Belgian company – Sibelco – acquired a 50% share in the "Minérale" glass recycling plant in Charleroi. Thus began the partnership between Sibelco and SUEZ. To celebrate the arrival of the new millennium – as well as the new economy – SUEZ joined forces with Sibelco in 2000. Together, they decided to purchase High5, a small company ideally located in the centre of the port. The goal was to recycle the glass that arrived either by sea, mainly from the UK, or by truck from all over Belgium and northern France.

Before visiting High5, I needed some basic understanding of glass. First lesson. Did you know that there are three categories of glass? Hollow (bottles), flat (windows) and complex, often laminated because it is composed of several layers. One good example is windscreens. Second lesson. Did you know that glass is one of the materials best suited to recycling? First of all, we use less sand and silica, which are the basis of all glass produced. We also use less energy. The temperature of molten glass is around 1,550 °C. Replacing sand by cullet reduces the time needed to reach this temperature, so the oven uses less energy. The increase in energy savings, depending on the amount of cullet used, may amount to nearly 30% compared with using just sand. We should bear in mind that 1 tonne of cullet will produce 1 tonne of glass, while we need

1.25 tonnes of virgin raw material to produce 1 tonne of glass. As a result, there is a reduction in greenhouse gas emissions when cullet is used. For every tonne of cullet that is used, CO_2 emissions are reduced by 350 kilograms. Another advantage that cannot be ignored is that, unlike plastic and paper, glass can be recycled endlessly. There's no need to regularly add new fibres, like for paper and plastic, for the simple reason that glass doesn't contain any fibres. So there's no risk of them running out.

Third lesson. Mr. Orsenna, please look at these three piles of glass that we just received. Do you notice anything? I nod my head, since for once I can provide an answer. The glass on the left is much cleaner. My impression is confirmed and I am told that this raw glass waste comes from Belgium. Alas, the other two resources – which are much dirtier – come from France and England, where "people don't respect anything. They just throw everything into bags."

Once again, cultural differences – as well as differences in education – are confirmed. From resources that are so different in terms of quality, how does one manufacture a consistent recycled product? That's the challenge that the circular economy must meet day after day.

I try to say something that seems sensible to me:

— So you're going to treat these categories of waste differently?

— Nice try, Mr. Orsenna. Alas, no!

— So what's the point of sorting well?

— Everybody would have to sort correctly. As that's far from being true, the bad students cancel out the efforts of the good students.

— That's discouraging.

— Fortunately, technology repairs human weaknesses. You'll see.

And I saw. I saw the dirtiest and the most diverse flows one can imagine arrive on a conveyor belt. Bottles with their corks and jars of jam with their lids, all with their labels firmly glued on. I also saw rags, wood, magazines and pieces of metal, all of which came from trashcans. I'll skip all the cleaning and selection operations that have become familiar to me. The only thing that comes by on the conveyor belt are pieces of glass, a little bit larger than this morning's petals. It's like a stream of multi-coloured water.

— Now you're going to understand why our factory is the most modern in Europe.

The time had come for me to learn about this famous "technology that repairs human weaknesses."

At first glance, there's nothing impressive. Just large boxes, 2 metres long and 1.50 metres high, into which the stream of multi-coloured glass flows.

— We have 25 of them on four levels, Mr. Orsenna.

I'm surprised. Why are there so many of these magic boxes and why are some placed on top of others?

— To separate the colours. We're the only company that offers our customers a choice of four colours. Green, brown, which is called "amber", white and our latest creation "russet" which is already quite successful.

— Why all the diversity?

— Each colour corresponds to a quality of glass and meets a specific demand.

— And of course they are priced differently.

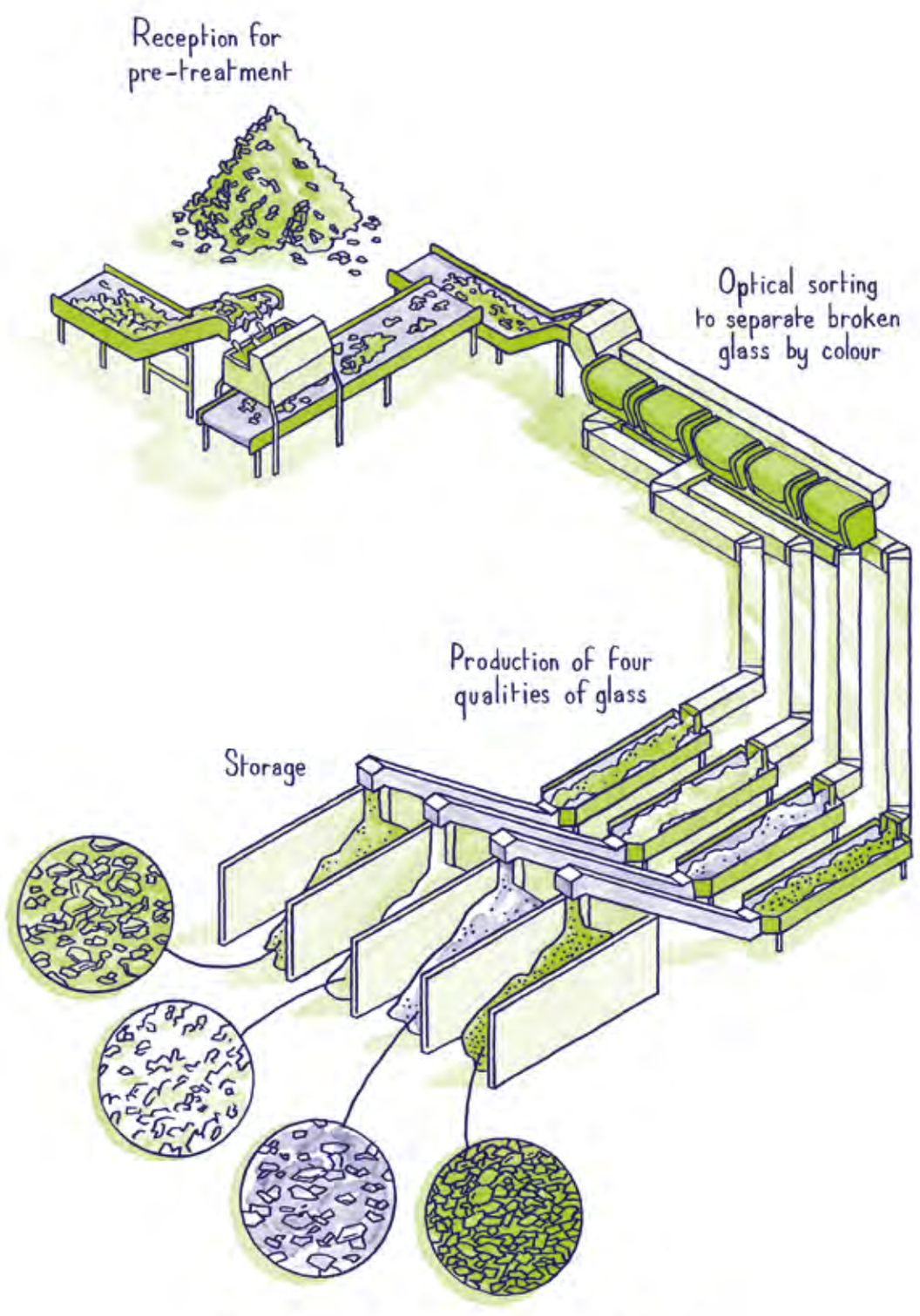
— Good guess, Mr. Orsenna.

— And let me guess something else. Something tells me that the white ones are the most expensive.

— Bravo. An average of 80 euros a tonne. For the other colours, the price varies between 40 and 60 euros.

The time has now come to explain to me the mechanism deployed in each of the 25 boxes.

— It's very simple in principle but very sophisticated for the application, parameters and maintenance. It has to do with optical sorting. A laser camera films the entering flow



Steps in the production of recycled glass

and the sorting is done by blasts of air. Each colour is thus pushed towards a particular canal. From one machine to another, the sorting becomes finer. The conveyor belt has been subdivided. I now see four streams of glass that are nearly homogenous in colour. Little by little, from one machine to another the white becomes whiter, almost pure white, just like the green, the brown and the "russet". Of course, I am entranced. I love technology.

— We have to tell you something else, Mr. Orsenna.

— Yes?

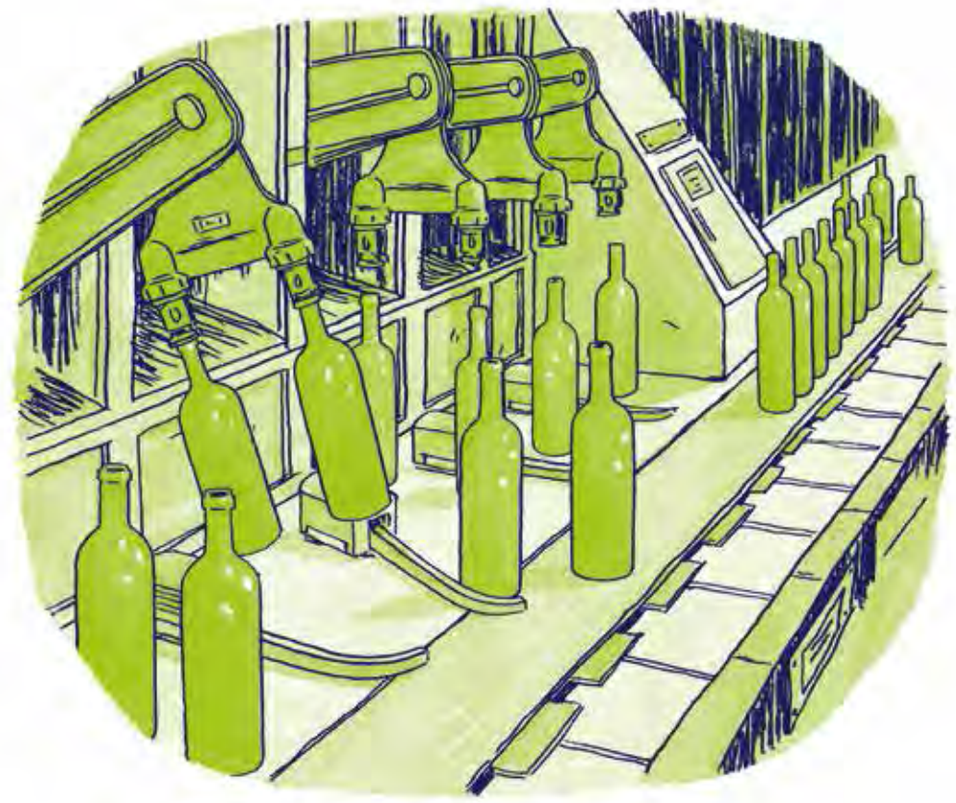
— Each of these optical sorting machines is worth 250,000 euros.

Despite my weak capacity for arithmetic, the calculation is quickly made: 7 to 8 million euros just for the machines. So that's the price we have to pay to offset human weaknesses in France and the UK.

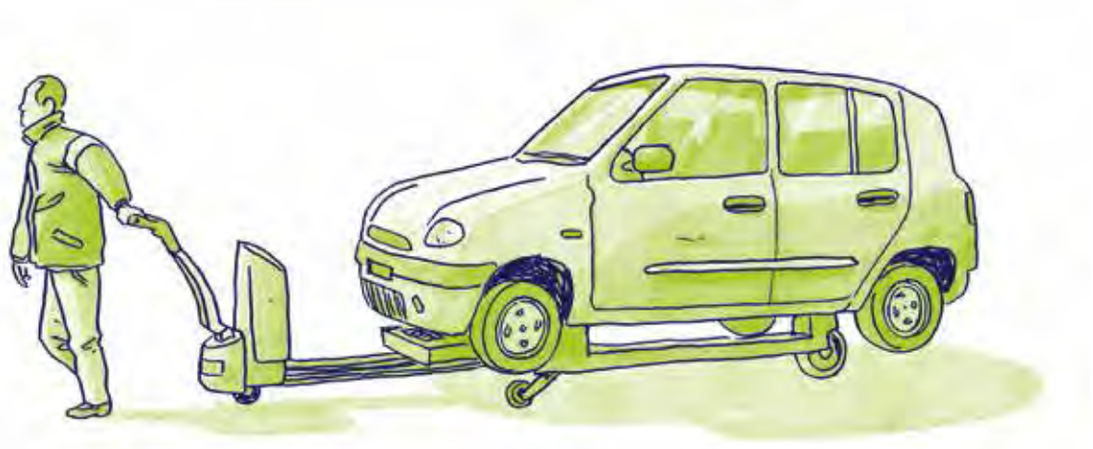
Later, I look at a map of Europe. In Sweden, Germany, Belgium and Switzerland, more than 95% of glass is collected in special rubbish cans. Just over 70% in France, as in Italy, 35% in Greece, Hungary and Slovakia, and 21% in Malta. A connection occurs to me: tell me how you respect waste and I'll tell you how you manage public finances. In this way, we could verify the theory according to which there are two opposing Europes – the virtuous one and the other one. Could our rubbish cans reflect our societies?

I leave Antwerp, mulling over these profound psychological, sociological, geopolitical thoughts, mixed with less vague data. The factory that I just visited each year receives 250,000 tonnes of glass of all quality. From this, 230,000 tonnes of cullet are produced, a raw material that makes it possible to manufacture 470 million new bottles. In short, here are the amounts saved compared with the traditional sand-based production of glass:

- 220,000 tonnes of sand, sodium carbonate and lime;
- 100,000 tonnes of CO_2, thanks to less burning of material containing carbonates;
- 321,000 MWh of energy, the amount used by 37,000 people in a year.



Recycled bottles production line



Journey No.4
Romorantin — France

THE MANY LIVES OF MOTOR VEHICLES

What becomes of our dear automobiles when age catches up with them or when accidents dent them or reduce them to rubble. To find out, you have to take an old train to Vierzon from the Austerlitz station in Paris. Then, you should count on a good half hour's drive on a road that borders the game-filled forest of Sologne. Welcome to Romorantin, a town that was most active back when the Matra factories were operating. You remember the factories. The ones that produced over a million cars in the glorious days of the great engineer Jean-Luc Lagardère and the great driver Jean-Pierre Beltoise.

Today, some 13 years after the factory's closing and the hard period of unemployment that followed, the town is still struggling to get a new start. That's where Indra decided to set up its business, which is to give a second life to vehicles that have reached the end of the road. The company has been around for 30 years, but when acquired by SUEZ and Renault (with each of the partners holding a 50% share), it got a new lease on life. 40 million euros in revenue and 170 employees divided between Lyon, the headquarters, and two deconstruction sites, one of which I was about to visit.

The vitality of Loïc Bey-Rozet, Indra's CEO, is almost immediately perceptible. The man is passionate, especially about cars. He has spent his entire career taking care of cars, either new ones, at Citroën and Fiat, or (badly) damaged ones, at Indra.

Producing is well and good, but what should be done with products that are no longer used?

The first case involves a car that has been in an accident. Either the vehicle is declared 'reparable" by an expert sent by the insurance company and a garage gets into the act. Or the damage is considered too serious, in which case, the insurance company sells the wreck, and Indra buys it.

In the second case, a car is just too old. Either you abandon it, anywhere, as many people in France do. Or you try to sell it, which is a more environmentally friendly solution. If nobody wants it, you ask for someone to come and take it away.

Let's look at some figures. In France, approximately 2,100,000 vehicles are registered each year. The end-of-life vehicle industry involves some 2,050,000 cars, which means we take what we produce off the road. However,

if we look more closely, we note that the number of end-of-life vehicles actually collected amounts to just 1,115,000. So what happens to the others? Half of them are exported and the other half – representing 500,000 cars – are recuperated illegally.

And that's where Indra comes into the picture. First, it has to find vehicles to take apart. As we explained earlier, this "raw material" comes mainly from insurance companies, car manufacturers and a unique Web site in France (goodbye-car.com) that enables individuals to get in contact with a legal car deconstruction facility.

On a large parking lot, dozens of vehicles are waiting patiently to be "treated". Some are just old, while the others are damaged, more or less seriously. Yes, one might say it's the waiting room of a rather special hospital. Two workers (two nurses?) walk up to a white Clio. They slide a forklift under it. I think of all the good times and bad times the car has been through with its owners: back and forth to work or the children's school, Sunday outings, kisses shared, domestic disputes and bad news gone over again and again. It's an emotional moment for me. Cars share our lives. What will become of them? Cars, like people, have to ask themselves the question: is there life in the hereafter? I am going to follow each step in the adventure closely.

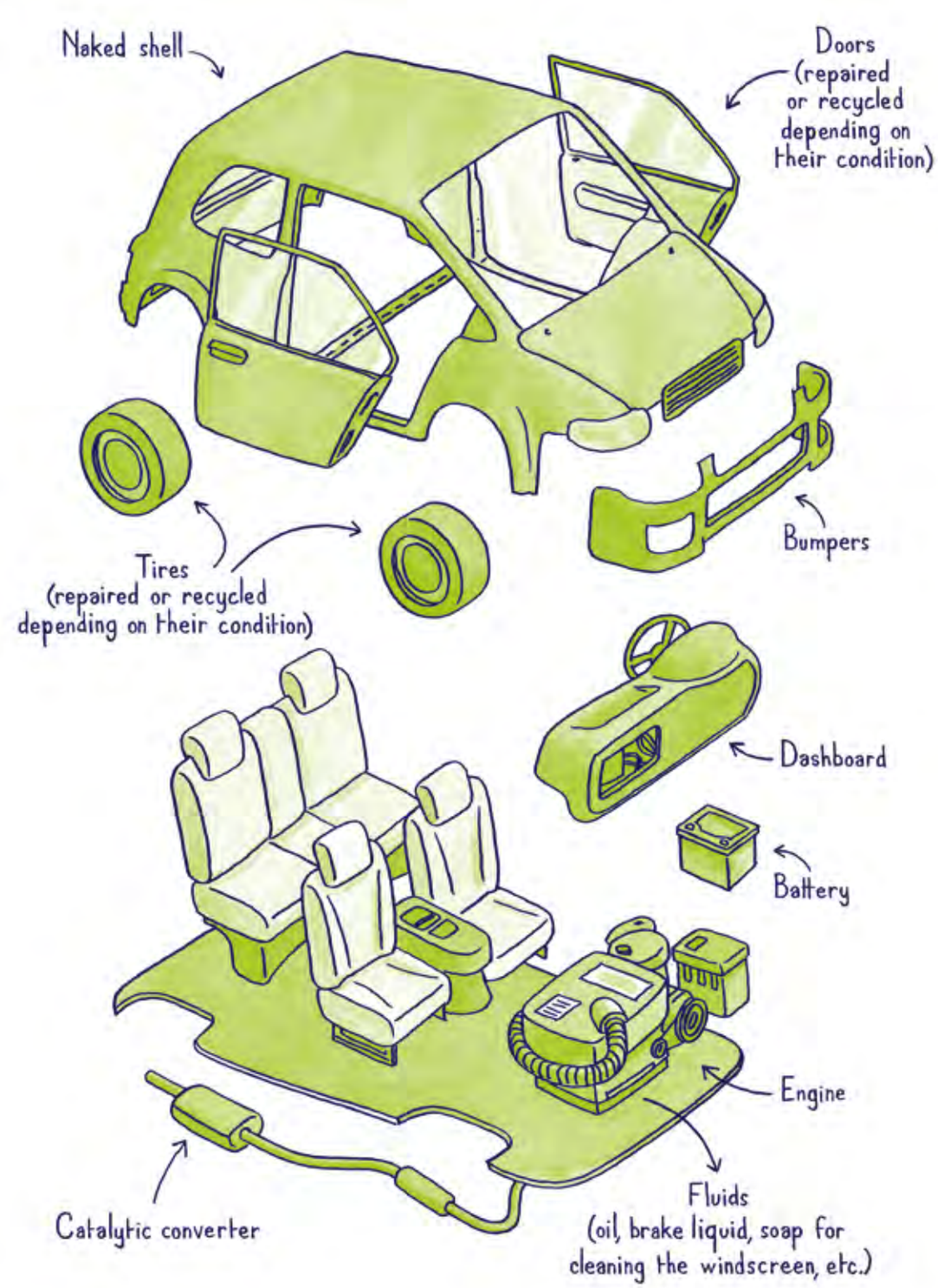
Careful! The poor little Clio must first be "secured". Everyone into the shelters! I don't know which button the worker/nurse just pushed but the two air bags just appeared. A second later there's a double explosion and the bags lie empty on the seats. The car fills with smoke. Because the smoke contains gas, it is pumped out by a large pipe that is slid into the vehicle over the front right window. The second step involves getting rid of "fluids", which means the oil, brake liquid, soap for cleaning the windscreen and the petrol, which is collected very carefully. As it cannot be resold, the Indra personnel will share it. In this company, people drive for free.

At last, the "deconstruction" process can begin. The warehouse where this strange series of operations take place is spotless. It's like an assembly line in reverse. The wheels are removed. They are stacked on the right if the tires are reusable and on the left if they are not. The bonnet is opened. Would you like a battery? By the way, electric vehicles require special precautions since their batteries can send shocks of 400 volts. Next, the doors come off and, like the wheels, are placed on the right or left depending on the condition of the sheet metal. Next to be removed are the bumpers, followed by the dashboard. Wires are carefully disconnected and little by little the Clio disappears. A sort of long yellow arm flips the car over, with no special tenderness. The worker – now a surgeon – comes forward with long-handled clippers and plunges into the car's mechanics. We hear two or three cracks, which must upset the Clio. The big yellow arm turns the car back over and lifts it up. There's another noise, not as loud. It's the engine which has just come off, fallen onto a forklift and quickly been taken away.

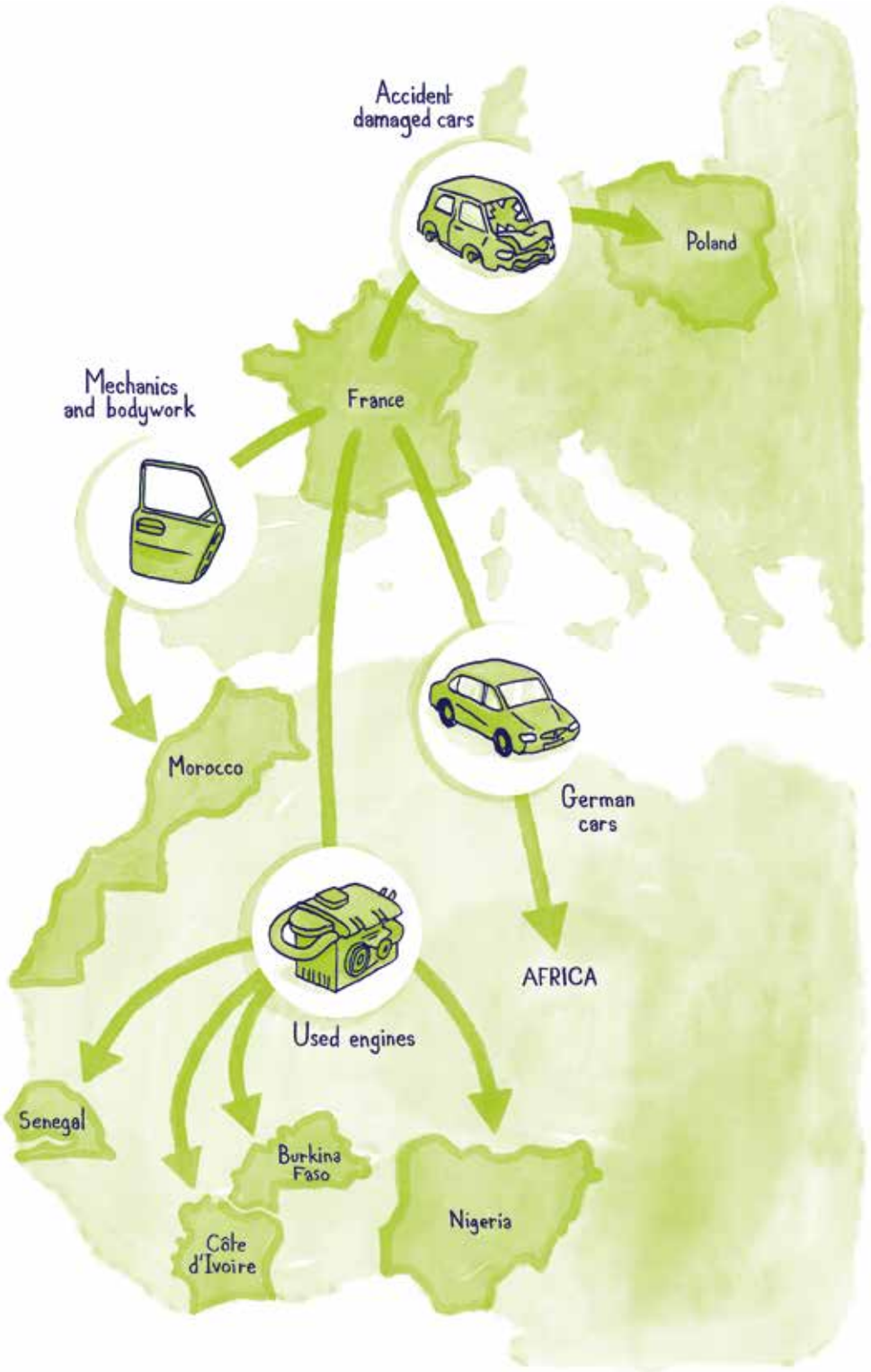
Special attention is paid to the catalytic converter. Apparently, it's the most expensive part of the car since it contains precious metals: platinum, palladium and rhodium.

The worker plunges once more, this time into the hole where the engine used to be. He proudly removes a handful of multi-coloured wires, which will also be sold for a good price. Goodbye, Clio! Everything that can be reused has been recovered. All that remains is your naked shell, which will join other shells – just as naked – in the back of a truck to be taken to a crusher, which will sell it for its weight in steel.

But all the spare parts (doors, tires, rear-view mirrors and engines) will be listed and put on a shelf in a giant warehouse.



What can be recycled from a car?



Where are used vehicles and their spare parts exported to?

After having consulted the catalogue on the Web, which gives as many details as possible, interested people can come look for the part. The savings they generate will make the journey worthwhile. For a new part worth 100, a recovered part of good quality will cost them 30 and only 10 in some cases.
Some sales involve entire containers of parts. Morocco, for example, likes car doors, which are sent to them by the dozen. Used engines are also highly coveted. They can sell for up to 500 euros, and supply is less than demand. Although I have little knowledge in this area, I learned that to check the condition of a motor you analyse the amount of water and filings in the oil. If the amount is high, this means that the engine is beginning to wear out and won't last much longer. But most of these engines are still in perfect working condition, a blessing for those that are handy. They will be installed on other cars. However, they may also travel to the heart of Africa, where loyal customers include Nigeria, Senegal, Burkina Faso and Côte d'Ivoire, to accomplish as many jobs as possible, beginning with gathering water at the pumps. In this way, they lighten women's workload. As everyone knows, men expect women to go to the pump and draw water, I like to believe that this will be the second life of our Clio's engine.
Damaged plastic parts are torn apart and sold to plastic processors who melt them down so that they can reuse the plastic.
Indra takes apart 20 cars a day. As we can imagine, this figure declines if the vehicles are seriously damaged, in which case the job is much more complicated. This deconstruction process is technical and hard to standardize. Every car is different and arrives in different condition. Research is needed to improve the pace of work as well as to ease the job of the workers. That's why Indra allocates more than 500,000 euros a year and registers patents.
The site's reuse rate currently exceeds 97%, which is better than the 95% objective called for by the European Commission. It's interesting to note that a motor vehicle is comprised of:
• 75% metal;
• 14% plastic, of various sorts;
• 4% rubber and elastomers;
• slightly more than 2% each for glass and fluids;
• less than 1% for natural materials.

Over time, Indra has developed a rare skill that enables it to get involved in the invention of machines, engineering and "turnkey" deconstruction facility solutions.

We should know that Indra doesn't work alone but has built a powerful network. In the same way that automobile manufacturers rely on dealers to sell their cars, Indra – the "deconstructer" – works with no fewer than 350 closely connected companies throughout France. Like Indra, these companies deconstruct motor vehicles and, to be accepted in the network, they must agree to work with Indra's specifications, methods and practices, beginning with its requirement for environmental respect. With its network of 350 centres, no fewer than 350,000 vehicles are collected every year, making it by far the largest network in France. The second largest, Caréco, has only 70 centres.

Today, the resale of spare parts represents one-third of the Indra deconstruction site's revenue. Another third comes from the sale of stripped down car bodies to the crusher. The industry's profitability depends on the price of new raw materials. When the price of metal is at a low point, as it is at the moment, there is less motivation to find one's resources at a recycling company. The final third of revenue is generated by the sale of damaged cars. Poland is specialized in repairing and selling them,

nearly everywhere around the world. Another national particularity that should be noted is that German cars are never destroyed. Given their legendary solidity, they are always repaired, in one country or another, before being re-exported, usually to Africa.

Motor vehicles' end-of-life gives us cause for concern for at least three reasons:
• the visual and health pollution caused by these thousands of wrecks, abandoned everywhere;
• the waste of materials that are gradually degraded whereas they could be reused;
• the danger posed by these vehicles if they are again used after hasty, poorly controlled repairs. Preoccupied by this question, France's Agency for the Environment and Energy Management has conducted a survey that has given us disturbing results. Out of an annual total of approximately 2 million used vehicles, 400,000 are exported.

When it's time to leave this clean, intelligent, useful factory, a dream comes to you. When designing cars, couldn't the engineers also think about recycling them when they have reached the end of their lives? In other words, is eco-design developing in the automobile industry? Car manufacturers are working at it but not forcing the pace of development, for at least two reasons. Technology, which is reducing costs even as it provides greater service, especially in terms of safety, doesn't always make recycling easier. One example involves windscreens, which are very much like *mille-feuilles* pastries. How can the glass be recovered?

We all like to think that recycling is the future our economy needs and the only way to push back the deadline that threaten us, which is running out of resources. Running out of raw materials, running out of fossil energy sources. But a company's bottom line respects its own rules. Because it sells at the market price, the company also needs to buy at the market price. But the market doesn't care about long-term concerns any more than it cares about how our societies should change. This is the responsibility of public authorities, who have the regulatory means to require companies to integrate this responsibility into their calculation. Setting a price for carbon emission is one example. Setting a minimum recycling rate for motor vehicles is another.

Syctom facilities

Journey No.5
Ivry-sur-Seine — France

WHAT SHOULD BE DONE WITH 700,000 TONNES OF HOUSEHOLD WASTE?

Right up against – one could even say "under" – Paris's ring road, the Ivry plant couldn't be any closer to the capital. It prolongs the new neighbourhood in the 13th arrondissement, which is overlooked to the west by the François Mitterrand library.

The first thing we have to know is that we, the 5.5 million people that live in the 84 communities of greater Paris, "produce" some 2.4 million tonnes of household waste a year.

The treatment of this enormous mass is entrusted to Syctom, the metropolitan agency for treating household waste. A total of 90 elected officials of the concerned communities decide which projects to pursue. Their objectives are applied by 120 government agents. To this team should be added 800 employees of various specialized centres that manage private companies on Syctom's behalf. Surrounding Paris, these plants are located in Issy-les-Moulineaux, Saint-Ouen, Romainville,… and Ivry.

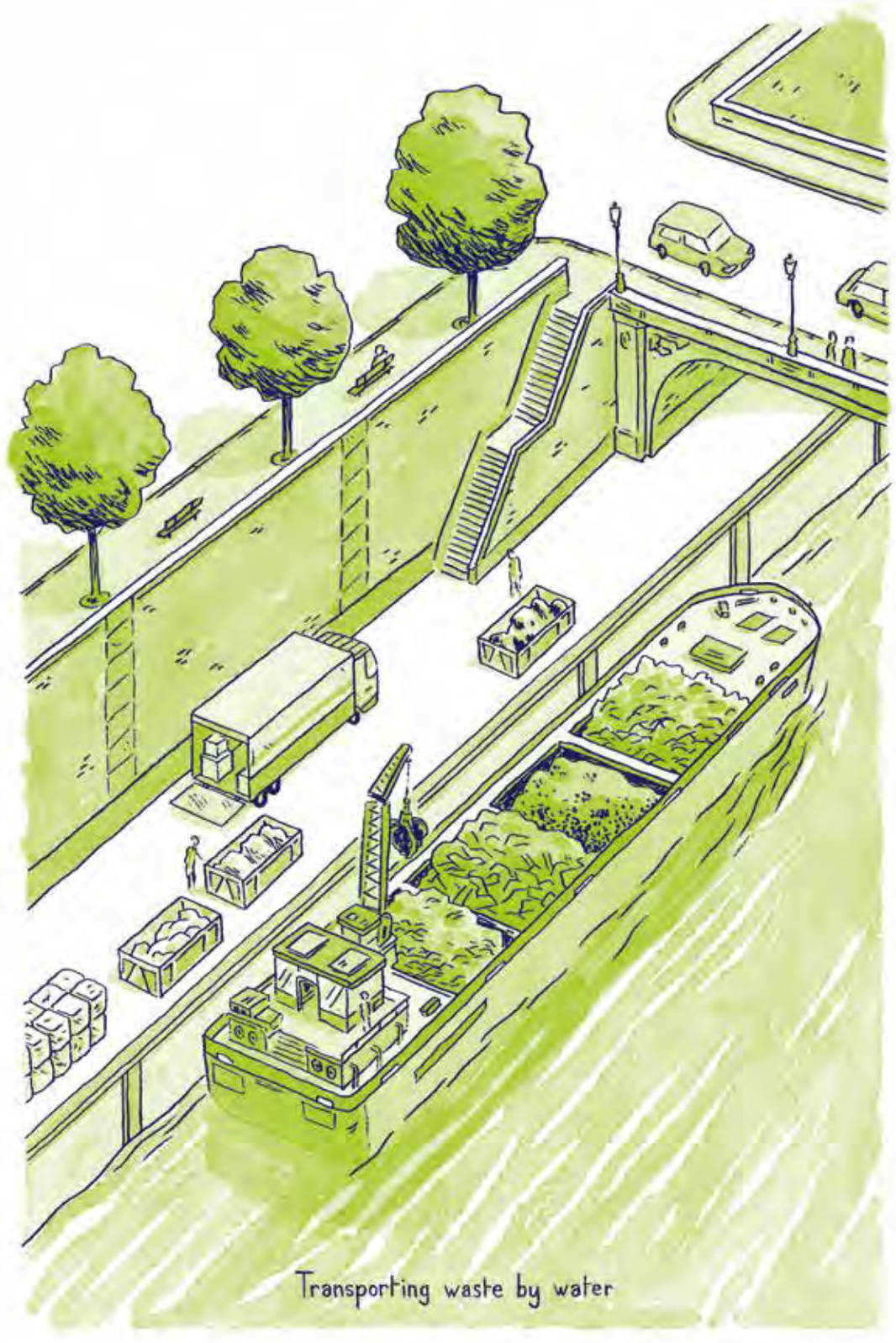
The contract signed with SUEZ concerns 12 Paris *arrondissements* and 14 cities located in the inner suburbs: in short, the waste generated by 2 million people. The Ivry-Paris 13th facility already has a long history behind it. It was first installed on the site in 1930 and connected to the district heating network in 1945. A new plant was built by Electricité de France in 1969. Regulations concerning the treatment of fumes were implemented in 1995, and new regulations were introduced in 2005. The facility received ISO 14001 certification in 2011. Following a call for bids won by SUEZ in February 2015, a brand-new plant will be built and brought on stream in 2023.

These few dates show that, contrary to what the ignorant may think, a facility is perpetually changing. This is confirmed by Robin's experience on the Roussillon chemicals platform (*Journey No.7*). You never build the same plant twice. Rather it is recreated for each site and changed constantly.

The Ivry team has 130 employees (of which only 10 women; the business remains highly masculine), representing five nationalities. There is a permanent focus on training: nearly 3,000 hours a year.

In this way, the site is able to treat an average of nearly 700,000 tonnes of household waste a year from Syctom member communities. In terms of treatment capacity, the facility is France's largest.

Most of the waste treated is recovered as energy.



Transporting waste by water

The plant produces:
• 130,000 MWh of electricity, of which 70,000 is delivered to the network (equivalent to the lighting needs of 35,000 homes);
• 1,000,000 MWh of thermal energy, enough to heat 100,000 homes.
The plant also reuses materials, with 13,000 tonnes of metal recovered each year and 120,000 tonnes of bottom ashes, which may be used, for example, in the production of roadbeds.
It should be noted that because Ivry is on the Seine, most of its products are transported by water, thereby keeping approximately 4,600 trucks off the road.
The environmental gains provided by such installations are impressive, with savings of 124,000 tonnes of oil equivalent and 340,000 tonnes of CO_2.
In addition, the plants are continually changing to reduce their impact:
• a 12% reduction in water withdrawal to comply with the constraints of the drought decree;
• ground protection by re-enforcing the bottom ash storage areas;
• ever more precise control measures for pollutant waste with the goal of constantly descending further below the norms.
The treatment process is well known. Materials move from the unloading dock to the collection pit; waste is mixed and homogenized and sent to the 2 furnace/heater units, which transform water into high-pressure steam, while the bottom ash is extracted. The plant also has a turbo-generator unit that produces energy from the steam produced. What's most impressive is the care given to treating fumes, using electro-filters to capture the dust, catalytic reactors to destroy the dioxins and nitrous oxides and a new cleaning treatment that removes polluting acids via a new filtration system. The cleaning process is completed by the injection of activated carbon and soda.

But everyone's thoughts are turned to the new plant, which is expected to rise to several challenges, beginning with that of continuing to provide service.
The project is very ambitious: to build a brand new waste recovery centre, using of course the most advanced techniques as well as imposing strict environmental standards, including fully integrating the plants into the urban fabric.
In other words, a model facility should be created, one of the new kind of plants of which we're not ashamed but that is proudly shown and visited by schoolchildren.
Long live industry!

Journey No.6
Vitry-sur-Seine — France

LIVE AND RELIVE THE PAPER

The name resonates like the affirmation of an ambitious goal: Cycléade, the recycling Olympics!
To reach the company in charge of this noble project, you have to leave Paris by the southwest, cross the town of Ivry, patiently wait out the traffic jams caused by the enormous worksites, reach the Seine and follow it until you come to a vast area covered with warehouses and vacant lots. The GPS is somewhat disoriented; it's better to head for the tall chimney of the former coal-burned power plant. That's where Cycléade is installed. It confirms the trend already observed in Holland: on the outskirts of our cities, industries are closing and moving farther away. The only ones that remain are those that need to stay close to their resources, namely companies that recycle; in other words, those that recover our waste.
Scarcely has he welcomed me when Jean-Marc Nargeot, the head of the facility, apologizes. It seems that part of me is going to suffer during the visit.
— What sort of suffering? Some kind of pollution? Will I have to climb up to places that my extreme dizziness won't like?
— Worse than that!
Despite my repeated requests, I learn nothing more for the moment. So I'm somewhat agitated as I listen to the presentation of the site's activities. It has two secondary but subordinate activities – wood and plastic – which is collected, pre-sorted and resold. But Cycléade's core business – its expertise, its *raison d'être*, and above all its pride – is paper, of which the plant receives 78,000 tonnes a year. Of this total, some 48,000 tonnes will be recovered, meaning sorted and divided into different categories corresponding to buyers' expectations.
I hold my head high. Paper. There may be many areas of which I am ignorant, but paper, my old friend paper, is a subject I know well, following my global enquiry/survey. So with a self-assured – rather pretentious – voice I ask him:
— How many kinds of paper do you treat and sell?
— All kinds.
— Which means?
— Around 60.
Well and good. It's better to swallow my pride. These people know more about the subject than I do. Let's continue the presentation, beginning with the visit. The warehouses cover

3 hectares "since most of sorting is done by sight, you have to see, which means spreading out the substance."

The first piles are comprised mainly of rolls of paper, which are the producers' remains. My guide's face lights up. This quality constitutes the recyclers' delight: homogeneousness and free of ink; this paper is nothing but white. Alas, there are not many paper factories. And since production lines are more and more efficient, the wastage rate is declining. The same holds true for the second source, which we call the printers' "scraps". Printers too effectively manage their raw material.
Mr. Nargeot makes a face. We imagine that he often dreams at night of disrupting his suppliers' machines. But his sadness doesn't last, because in the next warehouse there is a mountain, maybe 20 metres high and 50 metres across, a very colourful mountain, made of an unlikely accumulation of these small objects that I know so well, that are more or less thick, square or rectangular. In short, a mountain of… books. There it was at last, this famous "pulp" that I heard so much about and just as quickly forgot. Pulp in this instance means all the books not sold by the bookstore and sent back to the publisher, who doesn't know what to do with them, storage being so expensive. He prefers to sell them at a low price, even if he has to reprint them (a very remote possibility). So the book that has been pulped finds a new life.
— Fortunately for us, you writers write too much. Without you, what would I have to sell? Do you know how many books I receive every year? 15,000 tonnes! Not many of your colleagues come to see me. So when for once I have a writer here, I am sure to thank him.
Of course, I dive into the mountain, and of course, among two dozen copies of the labour code (now out-of-date because of the forthcoming El Khomri labour law) and two copies of volume three of *Fifty Shades of Grey*, I find my latest novel, just recently published: *The Origin of our Love*. There is no better lesson in humility than to visit a recycler. You who think that your writing is unique will find that you are worse than banal and anonymous in the crowd of the verbose. And you who have put your entire soul into your work (which naturally is indestructible) you see your work covered with pigeon droppings while waiting to be torn apart, crushed and mixed with shreds of people magazines and wallpaper.
For comfort, I want to take with me a very promising work called *Elsa, Nurse in a Harem* but my guide steps forward to stop me.
— The publishers would kill us. No books should leave the premises.
— In any case, not in the form of a book.
— I see that our writer friend is beginning to understand the business.
— But you know that a writer is also a recycler. He changes intimate dramas into best sellers.
— Seen from that angle…
And Jean-Marc holds out his hand for me to shake.
— Welcome home, dear colleague.

Another warehouse and another mountain, which this time, spares me. I immediately recognize these false newspapers that, despite your protests ("No advertising please") are slipped into your mailbox to present you the latest promotions from your region's supermarkets. Mr. Nargeot doesn't hold this waste in greater esteem that I do. Scornfully he says:
— Those are just brochures. Well, even a brochure can hope for a new life. The secret is in the mix. Our customers, those who buy the material, are paper manufacturers. They want special qualities and each one has his price. So we have to create this quality by mixing the sources. That's our core business, Mr. Orsenna. It's not just receiving the trucks, as we too often think, nor is it just compacting the waste and offloading it to the first person that comes along. We are sort of like chefs in a kitchen. We blend and assemble ingredients.

I nod my head. And it's even better that Jean-Marc talks like someone in a Michel Audiard film. I have always verified that when you like your business, you like to pronounce the words of your business, which are a source of gourmandise and pride.
Now that I've learned my lesson, we can move on to more noble paper but also another part of the business. In front of us, there is an enormous pile of all kinds of forms and sheets of paper.
— You can look at them. These archives are not protected.
Who could be interested in pay slips from 1990? Or rent receipts from May 1981?
— We get 5,000 tonnes a year and could have a lot more than that if we wanted. If ridiculous rules and people's obsessions didn't require us to keep everything. But I have much more interesting things to show you. Do you see that building over there?
He starts shouting.
— Can someone open the confidential warehouse for me?
We hurry and enter the holy of holies, which apparently is the pride of both our friend and all his employees. This is where sensitive documents are carefully and completely destroyed, those documents that are best not kept because – one never knows – malevolent people might some day, even in a few years' time, use them improperly.
The method of destruction is impressively rigorous and guaranteed. First, there are very special trashcans, made – as recycling requires – out of sugar cane fibres, and padlocked so that they are impossible to open. They also have an opening that is so deep that no one could even think of sliding their hand into it. A thousand precautions are taken as these trashcans are emptied into shredders. The resulting filaments are cut up and dispersed so effectively that the most patient busybody could never, even if he or she spent a thousand years, put together a sentence or a number that has been "treated" in this way.

I leave the place feeling reassured. Even if Google and the other Web giants refuse to give us – never, ever – any of the billions of data bits that they have collected, forgetfulness, the calm that it brings and oblivion exist, brought to you by Cycléade.

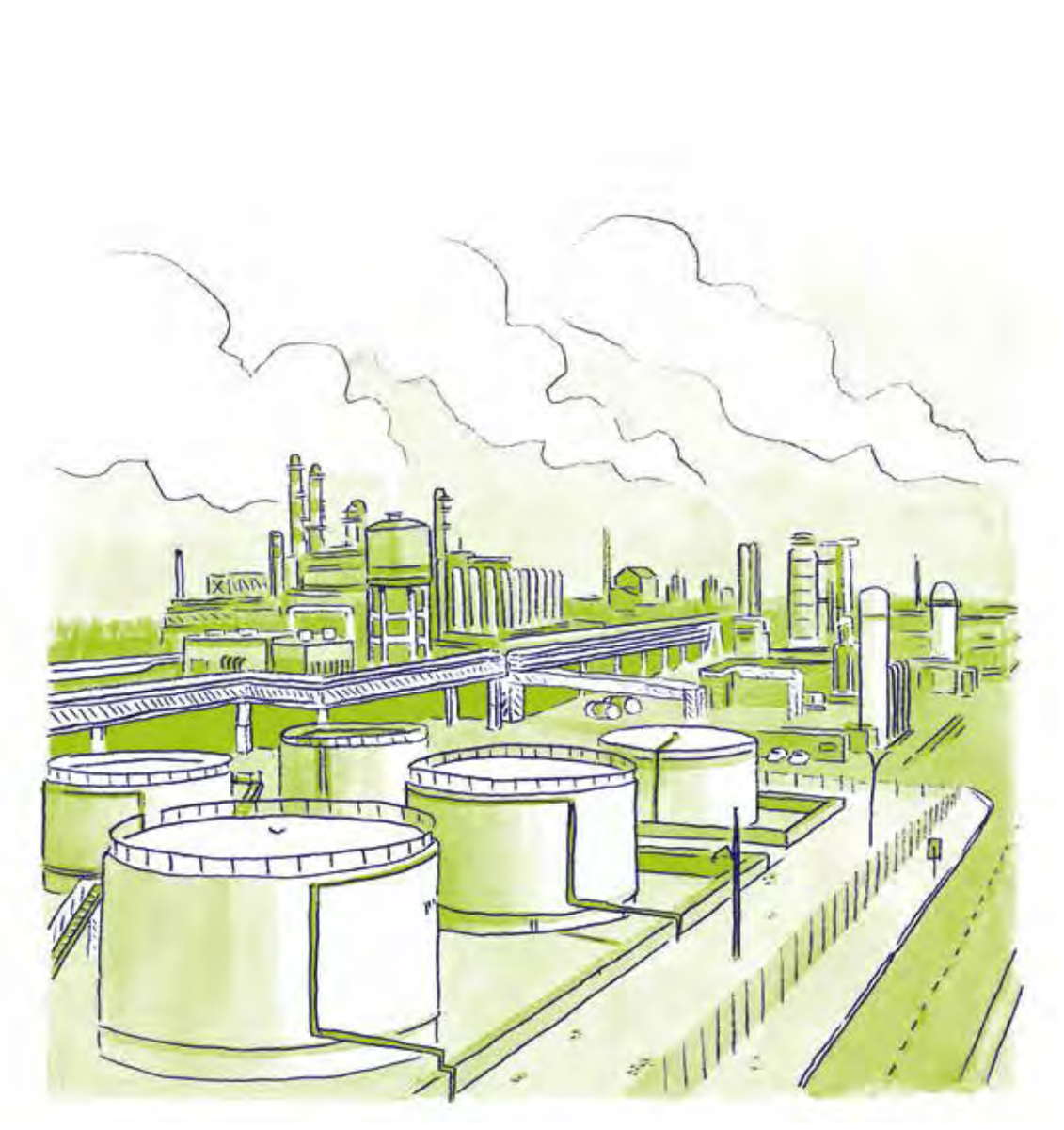
Don't believe that it is easy and safe to retreat your waste in this way. One day a fire broke out in one of the warehouses where plastic was stored. It took an entire night and 60 firemen to extinguish it. Everyone in the company still remembers Amar Merimi's courage. He alone knew how to drive the vehicle capable of picking up the burning bundles but to do so, he had to drive through a wall of flames, which he did several times. Meanwhile, the firemen watered the vehicle's tires so that they wouldn't burn or melt.
— The example of Amar is certainly the best we have but we all love our business, Mr. Orsenna. Recycling is a passion. Either you have it or you don't. It's immediately apparent. You love your truck and your raw material, you know your strengths and weaknesses. You're on intimate terms with your material and you're proud to recover and reuse it. For example, Jean-Pierre Fonseca, who is one of our team members, is the best in paper but he's also the best in your raw material, which is words. He started very young. Jean-Pierre didn't like school. His father had a truck and told him: "OK, you can come with me on my rounds." Jean-Pierre was 16 at the time and today he's 45. He's had the time to learn. I'm going to ask him. You'll be happy.

One week later, I receive my surprise, my gift. It's a list of paper-related words. They made me feel better about the pulp. Do you know what the scraps are? They are what fall from the paper cutters in printing shops. They can be "clear glue" or "extra clear without glue". And do you know what "perios" are? They are scraps from periodicals. And "white smooth wood"? The name refers to boxes of medication with no printing on them. And 5/7s? Low quality Afnor 7 paper. You want a more complete explanation? It is printing shop paper with seven layers. As for the shade of white, respectfully called "envelope white", it's the top of the line white, the brilliant white.
I imagine that I can hear the lovely song called *The Little Papers*, written by Serge Gainsbourg and sung by Régine and Jane Birkin:

"Let them speak
The little papers
Sometime
Cotton paper
I hope that one evening
Blotting paper
Will console you"

And don't forget that paper – good old paper – is on the cutting edge of today's circular economy. Paper is not only the most recycled material, with more than half of the paper worldwide made from used paper. It can be recycled up to seven times before new fibres need to be added.
Also, don't forget that paper itself is recycling. The oldest paper in the world was found in China. Dating from two centuries before Jesus Christ, it was made of mulberry bark crushed with old tissues and rotten fishing nets. Since then, nothing has changed. Paper becomes first and foremost a kind of soup. Then, you just need to dry it out.
Long live paper, the Patron Saint of Recyclers.

Traditional manufacture of paper pulp in China



Journey No.7
Roussillon — France

A CENTURY-OLD INDUSTRIAL ECOSYSTEM

Everyone is familiar with oil platforms, which seem to grow out of the sea and are battered by winds. But what about a chemicals platform? To learn more about this reality – certainly useful but threatening and necessarily foul-smelling – I travelled along the Rhône to the town of Roussillon, 45 kilometres south of Lyon via the motorway.

Having learned a little before the visit, I knew that these platforms were built during World War I and addressed the need to produce phenol quickly (used for the manufacture of powders and explosives to respond to German attacks).

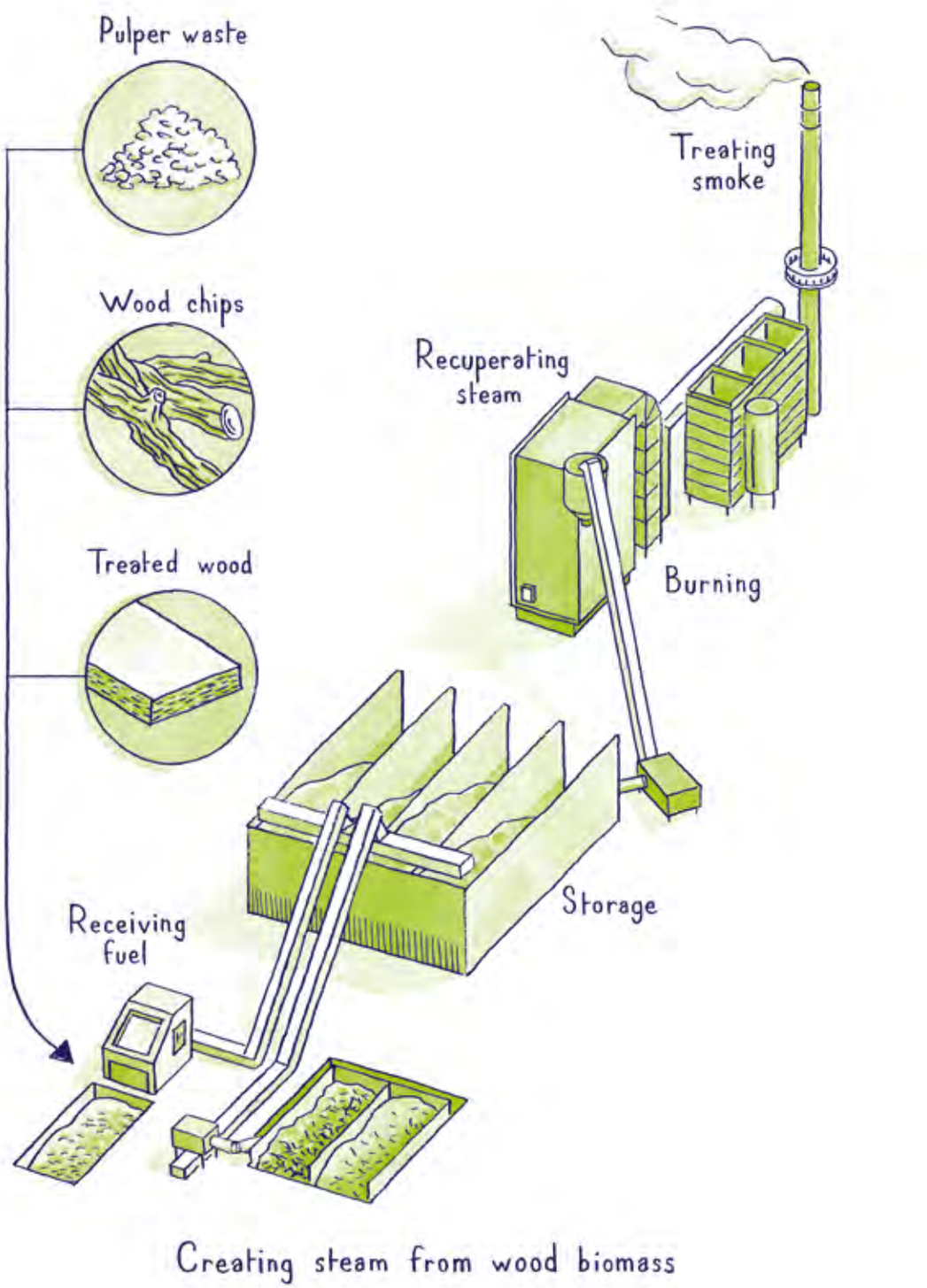
Indeed, we have had more attractive rendezvous but our relationship with the chemicals industry has always seemed highly hypocritical. It's not enough to say that right-minded people don't like the platform yet continue to use its products.

I was received by someone with the pretty name of Fructus, first name Frédéric, an enthusiastic and dynamic gentleman who is head of Osiris, a consortium covering 150 hectares that welcomes chemical companies and provides them with the shared services they need. These include energy, water, safety (site protection and fire-control measures), work place health, environmentally friendly waste treatment, multimodal transportation solutions involving waterways, roads and rail lines, and maintenance. Osiris also manages a high school that prepares students for a professional baccalaureate, with an option in procedures for chemistry, water treatment, paper and cardboard.

Around 20 companies have chosen the site, among them Solvay, Air Liquide, Blue Star Silicone, Dalkia (EDF group), Novacyl, Novapex, Adisseo and Evonik, where they manufacture food additives, fibres and textile, pharmaceutical products and cosmetics, pigments and paints, silicone and plastics. SUEZ decided to set up shop there to treat and recover more or less hazardous waste.

Installed in 2001, the first unit can receive 200,000 tonnes a year of unsavoury liquids, including very salty water, all sorts of solvents, organic and mineral acids, tars, sulphur waste and mercaptans, which are products added to gas to give it a smell and thus alert users of leaks.

From virtually everywhere – and sometimes traveling a long distance – these liquids arrive at the platform by truck, tank car or pipeline.



Creating steam from wood biomass

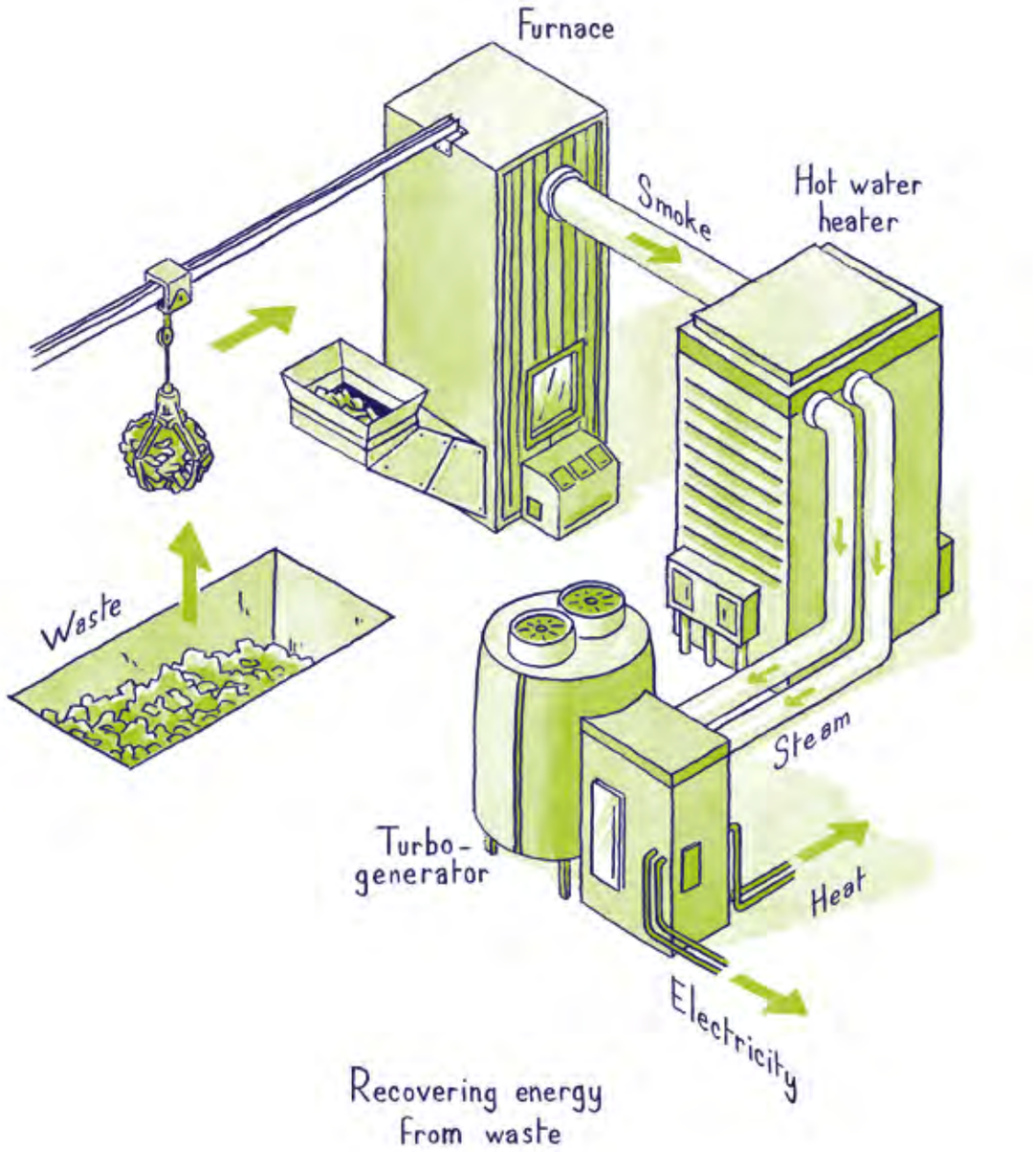
After the waste has been received and closely analysed, it is sent to the appropriate channel, either direct incineration or an evaporation-compression process. The latter will be followed by sludge treatment in a biological station or incineration if the concentrate is full of pollutants. The fumes generated from the incineration process will be carefully filtered before they are emitted.

Burning is good because it gets rid of toxic products but recovery is better. To do this, you first have to withdraw from the waste new molecules that could be of interest to companies present on the platform. You can also manufacture steam and electricity that can be sold to Osiris, which will market them to neighbouring companies. In this way, the platform is a fully-fledged industrial ecosystem.

As an active partner to this ecosystem, Robin, also part of the SUEZ group, is a more recently built plant that was inaugurated in November 2014. Its purpose is to produce steam from biomass. Not surprisingly, it has the support of France's Agency for the Environment and Energy Management (ADEME). Unlike the incineration furnaces, Robin's supply source is strictly regional, with a collection circuit that falls into a radius of 150 kilometres. Every year, trucks carry in 60,000 tonnes of all types of wood, whether from forests, driftwood or impregnated wood. It also accepts furniture thrown into household waste recycling centres as well as refuse from paper recycling.

This waste is burned with the same concern for emitting only clean smoke. The plant's energy performance is 85%. The steam produced supplies 15% of the platform's needs – 15,000 tonnes of oil equivalent – meaning that CO_2 emissions are reduced by 56,000 tonnes. We should bear in mind that the platform uses 1 million megawatt hours of energy per year. Robin's contribution is thus decisive for meeting the goal of using 27% renewable resources in 2020. Let's not forget that over the longer term, looking forward to 2050, greenhouse gas emissions for all of France must be reduced by 75%.

Frédéric Fructus
Director, Osiris consortium



Journey No.8
Bègles — France

SORTING IS ALREADY RECOVERING

Located in Bègles, Astria, every year since 1997, has sorted and recovered 300,000 tonnes of waste from the Greater Bordeaux area. The facility is in fact two factories in one. Every year, a sorting centre treats 50,000 tonnes of products gathered through a selective collection process. This includes door-to-door pick-up of the contents of yellow trashcans and public drop-off receptacles in household waste sorting centres. The centre integrates the most advanced technologies thereby enabling it to fulfil its three roles, which are sorting the waste, organizing it by category and choosing the packaging that will make transporting it as efficient as possible. To do this, the need for human intervention remains and the arduousness of the work shouldn't be overlooked. There's nothing exalting about standing for hours at a conveyor belt, picking out the undesirable elements. That's why a maximum has been done to automate the sorting process. All methods are used:

• The box remover sets aside the large boxes.
• The separator shakes up incoming products. Some bounce, others don't.
• The overband picks up ferrous metals using an electromagnet.
• Optical sorting makes it possible to recognize the visible spectrum of products. A small blast of air then separates the different types of plastic.
• Foucault currents are used to extract the aluminium.

The products are then compacted by category. All that remains to be done is to send them to interested customers.

The second part of the factory is the energy recovery unit; in other words, an incineration plant. It produces electricity that is sold to the network and meets the needs of 70,000 people. However, it also produces heat for the new buildings around the Bordeaux railway station. Every hour, day and night, 11 tonnes of waste are burned in each of the three furnaces. Traditionally, part of the steam produced in the hot water heater is sent to a turbo-generator while the rest is sent to the installations of the district heating network. Also traditionally, the bottom ash, the incombustible part of the waste, is extracted from the furnaces, cooled down with water and sent to a platform where it is transformed into gravel that is used in making roadbeds.

These processes are familiar to us. These waste disposal channels are often visited. This

fascination is each time brought to life in front of the burners – images of Hell fire – and nonetheless Astria remains in our memory. First of all because the factory, located in an exceptional setting, along the Garonne, facing vineyard-covered hills, is in itself especially beautiful. Just as beautiful as the Issy-les-Moulineaux factory but completely different. In Issy, it was decided to hide the installations under the wood and vegetation. In Bègles, the concept and the colour were chosen: white for the sorting section and red for everything that is burned. Like a miniature version of the Centre Pompidou at Beaubourg, the Bègles factory is impressive both day and night. And while there is no art on display, it creates value from society's rejects. Certain artistic currents – I'm thinking of Dubuffet and Arte Povera – would be interested by this metamorphosis.

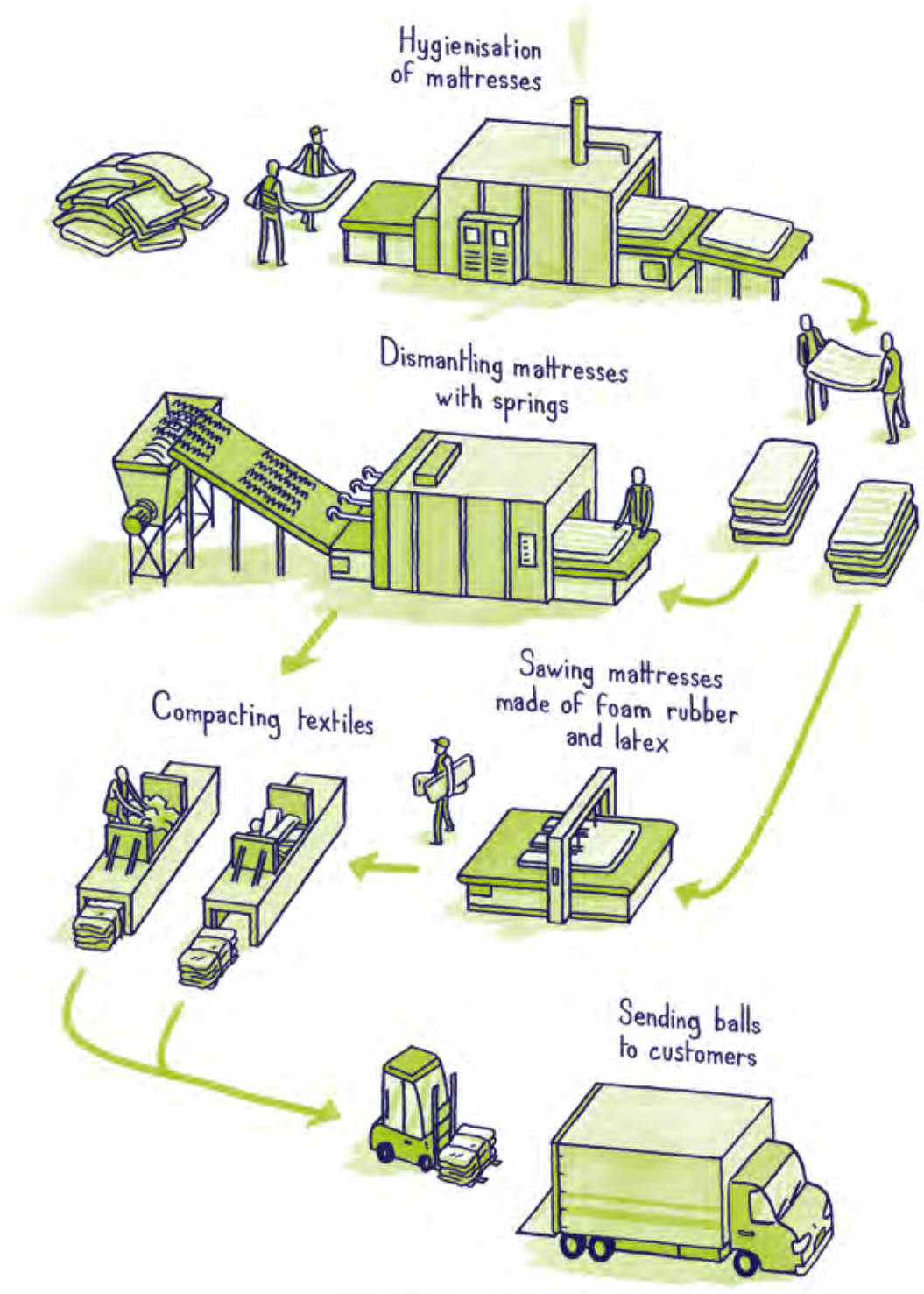
The second thing that is original about Astria is the personality of the town's mayor, Noël Mamère, who is a valiant, vigilant militant ecologist. This means that, for the fumes as for the emissions cast into the river, industrialists must meet especially demanding environmental standards. So, is Astria a model factory?

Journey No.9
Langon — France

MATTRESSES TO FIX ONESELF

The expression is amusing – platform for recovering end-of-life bedding - but the visit to the site is moving. That's because it introduces you to people whose lives have not been easy and who have found an opening that leads to a career path. Recycling, this concept that refuses wastefulness and forbids people from throwing things away, that promotes giving things a second chance, that is concerned about acquiring the best energy possible from everything and everyone, is a philosophy that concerns people as well as materials. The proof is in Langon, France.
I didn't know that every year 1.3 million tonnes of household furniture is abandoned, including 80,000 tonnes of bedding waste and at least 4 million mattresses and bed bases. And since I fall asleep as soon as I lie down, except when occupied by other activities, I have never paid attention to the structure of our mattresses.
A mattress is dismantled in three stages:
• Hygienisation, an ugly word to hide the fact that our night-time friends are most often dirty and stained with various excretions. There's no need to go into the details. In a special furnace, the mattresses are heated thoroughly to a high temperature. When they come out, one can only hope that they are decontaminated of all their little bugs, as well as yeast and fungi.
• "Targeted dismantling". Two lines have been installed, one for mattresses with springs (the most comfortable but the most resistant to deconstruction) and the other for those that are made of foam rubber. The first line is the most impressive. It includes a machine that roughly pulls out the chassis.
• The third step involves mattress sorting but above all "baling". Have you ever tried to compact foam rubber? Good luck! The presses can press all they want, the metal wires can try to encircle the foam rubber, but it escapes everywhere and puffs up.
Some 125 mattresses are thus treated every hour. At the end of this long and diverse combat, mountains rise up at the back of the warehouse. They are made of wool of all qualities, cotton, latex and even straw. Interested parties will just have to introduce themselves and 90% of the components will be recycled.

The facility in Langon is innovative not only because of its advanced technology. It allows dozens of people - nearly 40 a year - to find lasting employment opportunities. They are welcomed with special attention by a team managed by Véronique Martinez, a clinical psychologist who felt that she was at least as



Recycling mattresses

useful in this job as she had been formerly in her office. Taking mattresses apart doesn't require any complicated training. Rather, it provides the possibility of beginning a new life in an activity that is not lasting but which opens the door to other, more gratifying prospects.

The platform only opened in 2014, so it's still too early to draw any conclusions but the outlook is encouraging. The facility has already reached its breakeven point (if we don't take into account the initial investment of 2 million euros). Some 40% of the employees received training that qualified them for jobs and 60% of them left with high hopes. It should be noted that when they first came to the facility, more than half of them received minimum social benefits, 40% had been unemployed for more than two years and 14% were handicapped.

Véronique Martinez, Manager of the Occupational Integration unit

Landfill rate for municipal waste
(European Environmental Agency – 2014)

Journey No.10
Engis — Belgium

SUBSTITUTE COMBUSTIBLE

Coming from *la belle France*, as soon as the Quiévran, a fish-filled little river, is crossed, the traveller finds himself in a foreign land. The people there – or at least half of them – may speak the same language as you do, but you still find their habits surprising. First of all, imagine that instead of throwing out their waste any old way, the Belgians sort it, yes, they sort it in the many bins reserved for it, and they sort it with care and respect, both for those who collect it and for the second life that could be given to these odds and ends.

A consequence of this mindset, which is quite bizarre for the visitor from France, the people bury scarcely 3% or 4% of what they throw out. The rest is recovered as either energy or new products. You are astonished to learn that these good habits are shared by the neighbouring countries, those that, to simplify, we call "of the North." It seems that on our old continent of Europe, the farther South you go, the more people yield to the laziness of burying their waste. The figure is nearly 30% in Italy and more than 50% in Spain.

Another very strange habit of the Belgians, who are decidedly very different from us, is that they accept to share their knowledge. Let me explain. A Frenchman, by definition, knows his business better than anyone else, including another Frenchman. A consequence for the circular economy that interests us is that a French company – for example SUEZ – tends to want to do everything, from collection of waste to the marketing of recycled materials. Belgians live in a country that is rather disorganized from an administrative and linguistic perspective that can only be understood if one has, perhaps, a thousand-year-old knowledge of the Talmud. While the Frenchman continues to believe in Reason, or I should say continues to believe himself rational despite practices that every second prove him wrong, the Belgian wisely sees Reality itself in the surrounding mess. To survive, you must constantly negotiate, listen to the other person's point of view and understand each other.

Another consequence for our circular economy is that the Belgian likes to work with others. Instead of doing everything alone, he prefers to work with the user, considering – rightfully – that customers know what they need better than anyone else.

This is explained to me, clearly and with conviction, vitality and pertinence, by Eric Trodoux, Chief Operation Officer Benelux/Germany. In this way, dozens of joint ventures

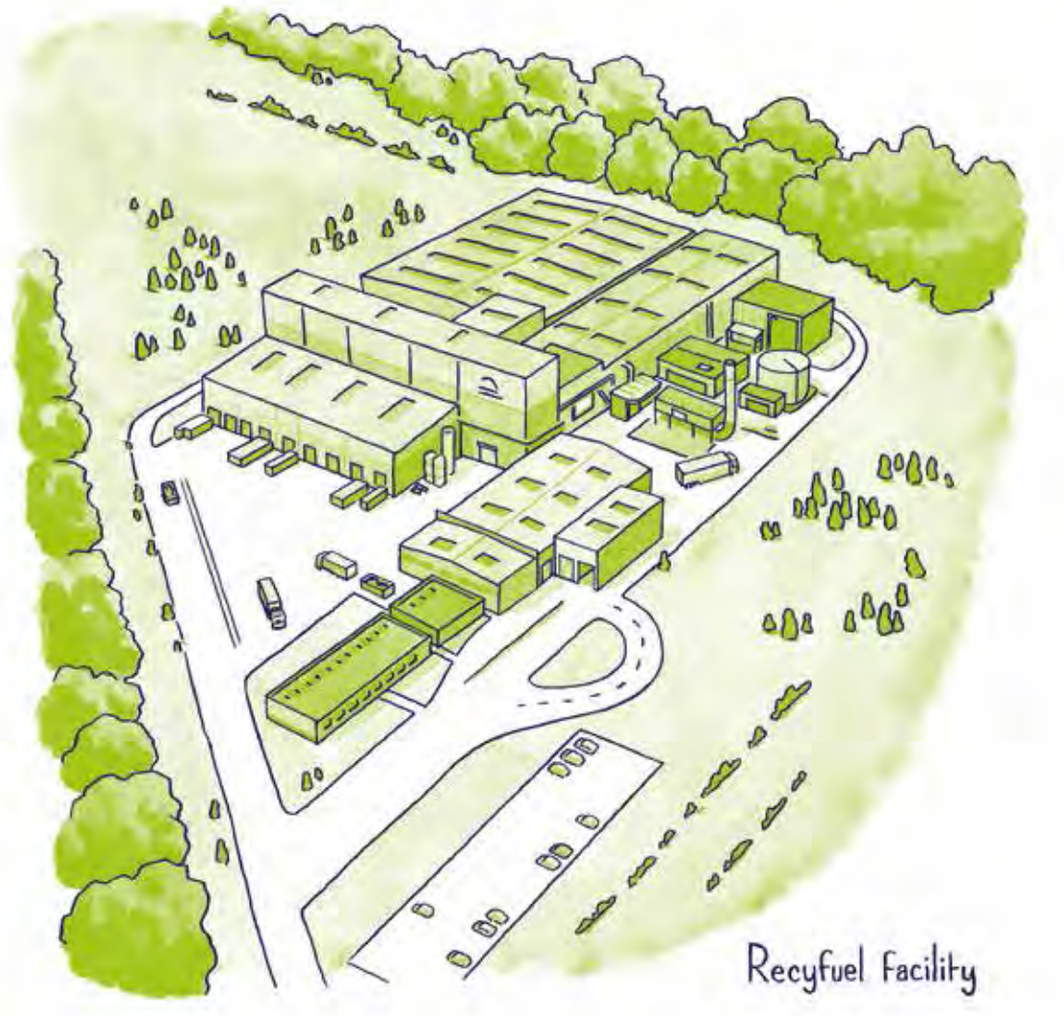
have been created, like multi-coloured flowers in the grey fields of not just Belgian waste but also waste from Luxembourg, the Netherlands and Germany. Recyfuel is one of these joint ventures. Created in 1999 on the banks of the Meuse, in the Engis industrial park not far from Liège, the company is equally owned by SUEZ and CBR (the cement maker Heidelberg). Be careful with the word "fuel". It doesn't mean diesel fuel here, but combustible. So Recyfuel means recycled combustible, or to be more precise, a Solid Recovered Fuel.

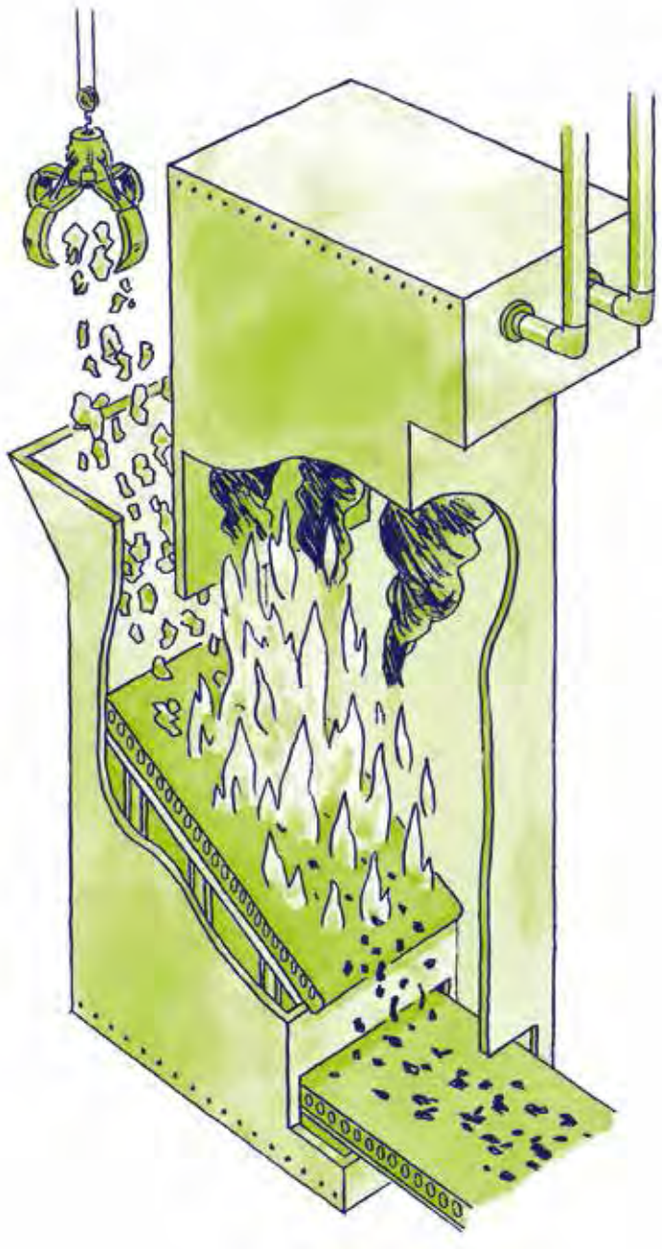
The factory is almost brand new, having opened in 2010. Its principle is simple. Every year, it receives 90,000 tonnes of so-called "hazardous" waste, including cans of paint, various oils, inks, resins, contaminated packaging, soaps, detergents and cosmetics. These products arrive in all forms: liquid, solid, saturated and doughy. A first control is carried out to see if the load will be accepted or not. If the laboratory decides that treatment can not be done for a given reason (for example, too many heavy metals), the shipment is sent back to where it came from. But in the vast majority of cases, the procedure begins. Would you like the recipe? It could be useful if some day you decide to become an environmentally friendly cement maker – in other words, a large consumer of combustibles that do not contain carbon or oil.

- Pour the truck's cargo into the pits.
- Using grappling hooks, begin cooking the mixture, adding thousands of tonnes of sawdust at the right time and in the right places.
- Stir the heterogeneous mixture well.
- Crush it under high-pressure nitrogen to avoid any risk of explosion.
- Sift it.
- Run it under magnets to remove ferrous metals.
- Sift it again.
- Filter and reassemble the plastics.

This recipe will give you 135,000 tonnes of substitute combustibles a year, as well as a good amount of metals that can be recycled. And that's why, ladies and gentlemen, thanks to an impressive team, led by the even more impressive Florence Humblet, Recyfuel is a profitable and useful company. This joint venture strategy is passionate because it addresses one of the most difficult questions of the circular economy: where does one fit into the circle? When should we stop recycling and let others take over? Each raw material is a world unto itself. Copper doesn't follow the same laws or involve the same people as aluminium or plastic.
How can recyclers know and penetrate all of these worlds? At what moment should they pass the baton?

The other question concerns hazard. What is the logic behind what we might call "the hazardous economy"? Contrary to our dreams, all operations involve some shadowy activity. Any change in the state of the world, any production of "something", has its counterpart in terms of pollution and diverse threats of potential hazards. Only those who do nothing are guilty of nothing. And yet, the Gospel teaches us the severity with which we must punish sins of omission.
If ridding a community or a company of its waste is a service that must be remunerated as such, ridding it of its "hazardous" waste in a necessity and an urgency that involve special skills, which have their price. Waste is thus a "niche" that, more than the treatment of things thrown on the scrap heap, must generate (justified) profits. So there's the rub: the more we know about recycling, meaning about recovering "hazardous " waste, the less others will listen to us when we ask to be paid for this "good riddance" service.





Journey No.11
Grimbergen and Ghent — Belgium

A GOLD MINE IN BOTTOM ASH

What is bottom ash? It's the residue in an incinerator. It's what's left when everything else is burned, because you never burn everything. Fire never burns everything. In a traditional growth economy, we think we've come to the end of our efforts when, after burning, there is bottom ash left. This dark substance was long thought to have no value. It just marked the end of the production chain. But in a circular economy, the question remains: what should we do with this residue of residues?

The first answer is provided by Valomec, a company that is wholly owned by SUEZ and located in Grimbergen, in the suburbs of Brussels, on the banks of a canal that goes to the sea. The facility's annual treatment capacity is 200,000 tonnes. It's important to bear in mind that after burning a tonne of household waste, we are left with 200 kilograms of bottom ash. When you know that the biggest incinerators burn 1 million tonnes of waste a year, it's easy to calculate the amount of bottom ash that remains.

An initial sorting, by hand, separates the largest objects, such as pots, tools, bicycle wheels and revolvers, that didn't burn and – one wonders how – made it through the intermediary selection process. Thus begins a long obstacle course for the bottom ash, during which it will be crushed, sifted, separated from its iron particles in a magnetic field, separated from its non-ferrous metal elements by other magnetic currents and counter-currents and cleansed, using a pneumatic process, of other elements that resisted the fire.

From a waste residue, bottom ash, we are able to create four materials, each of which is valuable:

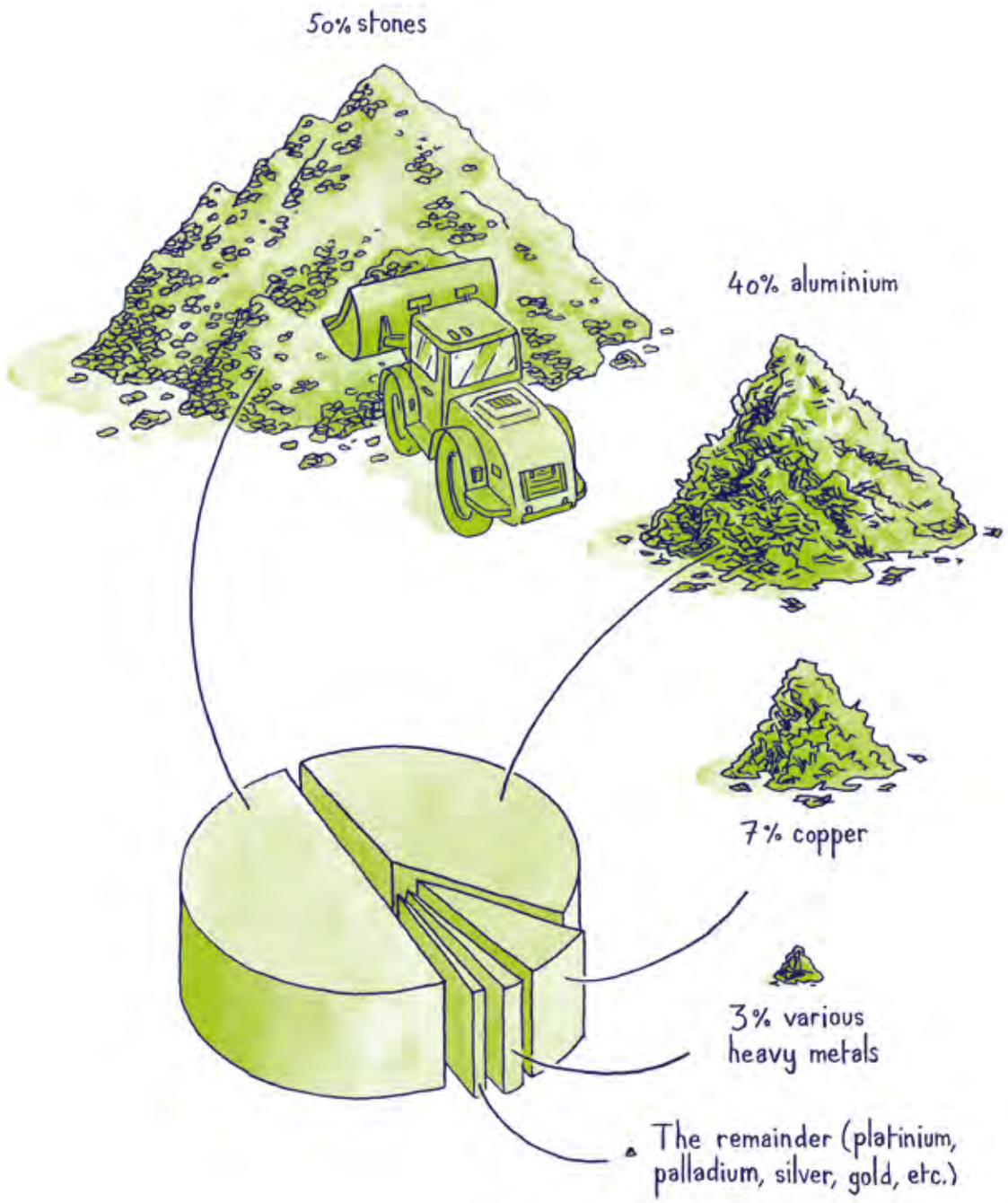
- granulates of different sizes that are mainly used in road construction;
- ferrous metals;
- non-ferrous metals;
- plastics.

Until recently, the mixture of non-ferrous metals was sold as is to specialized companies. SUEZ decided to get into this new business, which looked highly promising. That's why a new company was created, called Valomet, and set up near Ghent. It too is on the banks of a canal to address future logistical issues. A pilot factory was built that so closely met expectations, with an immediate contract to supply heavy and copper-bearing metals to Umicore, that the decision was made to build a fully-fledged plant on the site.

Karen De Boeck is manager, in particular, of this project. Her career path is noteworthy. After advanced studies in literature, which should have led her to become a teacher, she took a turn toward the world of raw materials, a reorientation that I am the first to be able to understand. She became a miller, the manager of a mill for the Soufflet group. The first thing that's hard about this business – before manufacturing flour – is to get rid of the small stones that are inevitably picked up when the cereal is harvested. You're only supposed to keep the grains. To do this, vibrating tables and a system of blowers are used, the same that will be used to separate light metals, like aluminium, from heavy metals, like copper.

In 100 kilograms of bottom ash residue, already treated by Valomac, that arrives at Valomet, you find 50 kilograms of stone. But for the same quantity of bottom ash, we're able to extract 40 kilograms of aluminium and 10 kilograms of various heavy metals, including 7 kilograms of copper. There is also platinum, palladium, silver and gold. In a tonne of bottom ash, one can find up to 250 grams of gold - 100 on average – or ten times more than the amount of pure metal in a working mine. This provides further proof, if any were necessary, that recycling can be a gold mine. Aluminium, found in such a large quantity, is sent to a Dutch company, called Roba. The mix of heavy metals is sold to Umicore, which knows how to carry out the treatments needed to separate the metals. As for the 50 kilograms of stones found during the process, they will not be thrown out. Rather, they will return to Valomac to undergo a new process, during which new, recoverable metals will necessarily be found.

The exemplary treatment of glass by High5 in Antwerp had already impressed me, I was beginning to guess that Belgium and the neighbouring countries were really in the *avant-garde* of the circular economy, and Recyfuel, Valomac and Valomet confirmed my initial feeling. The originality of each of these facilities proves that in recycling, no recipe is valid everywhere. The secret of success stems from teams, in which more and more women hold positions of responsibility, from prime locations (logistics is the daughter of geography), from good relations with political authorities (in order to obtain authorizations), and from a thorough understanding of the comparative advantages of operating alone or in partnership.



Composition of 100 kilograms of bottom ash

Journey No.12
Bayonne — France

RESELL YOUR BOTTLES

In France, every year, we use 310,000 tonnes of PET plastic bottles. The good news is that we recycle a little more than 55% of them, representing some 170,000 tonnes. A lot of the credit should go to the SUEZ facility in Bayonne. Its story is even more exemplary in that the facility came back from the brink and was in fact rescued.

Once upon a time, from 1981 to 2000, there was a manufacturer of audio cassettes that had 400 employees. But its owner – Japan's Sony – hadn't anticipated the shake-up caused by the arrival of compact discs. A Dutch company was chosen to reconvert the site and a full-scale recycling business was launched. Among the recycled products were tires, ink cartridges, electronic waste and plastic bottles but in the end, only plastic bottles were recycled and SUEZ took control.

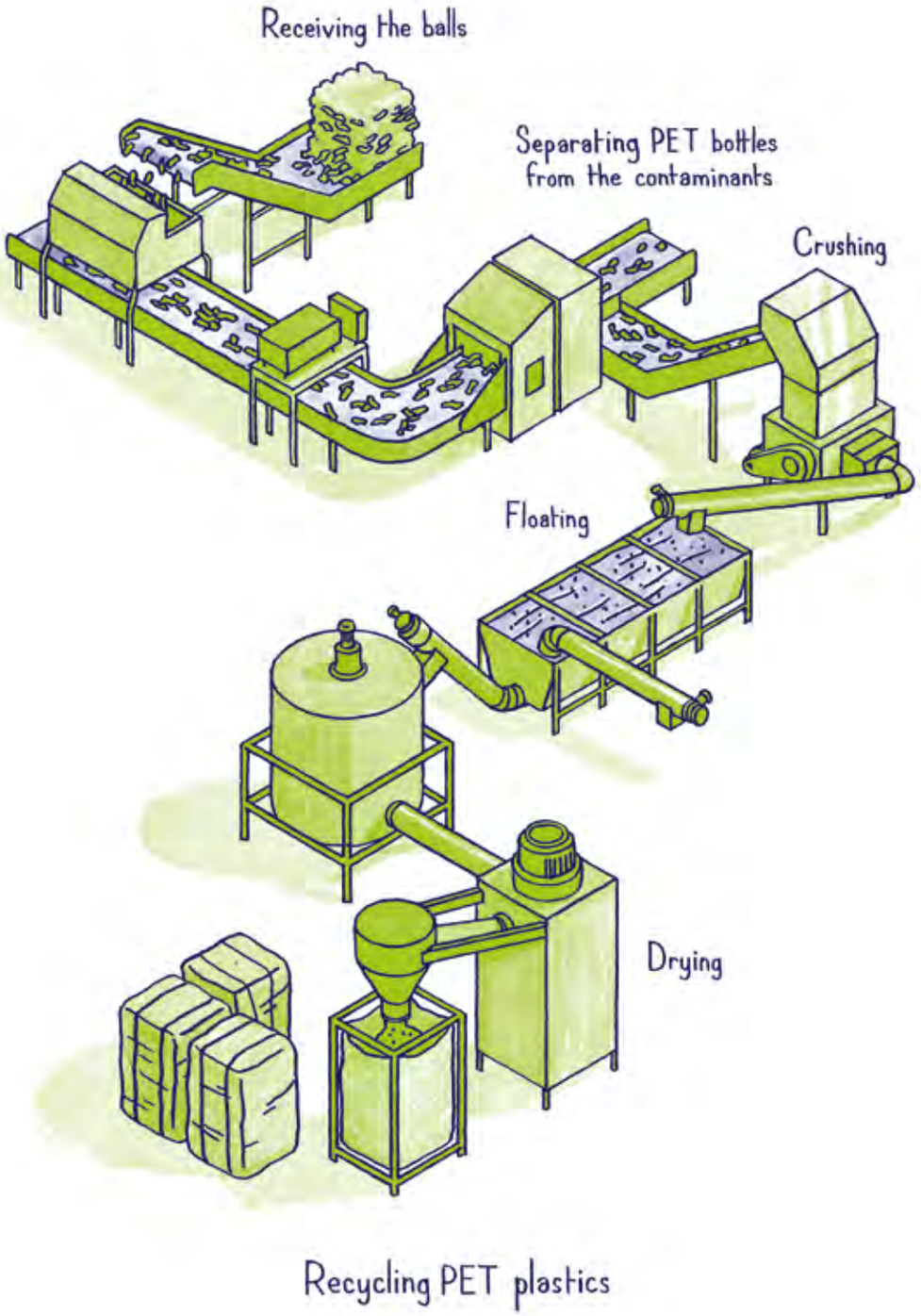
Today, 33 people work on a four-hectare site. The plant receives on average a little less than 20,000 tonnes of bottles a year, from which it generates a little less than 15,000 tonnes of "flakes". These are the pretty little pieces of plastic divided into two categories: "clear bluish" and "mixed colours". The difference between 20,000 tonnes and 15,000 tonnes is mainly due to labels, misplaced cardboard boxes, diverse waste and bottle caps, which are treated separately and delivered to a particular clientele. So how do we get these charming flakes?

I recommend the visit. Apparently, the 33 employees at the Bayonne factory are all militant recyclers and natural teachers. They want to explain their business in order to more effectively share it. Philippe Boulanger, the director, confirmed that there are many visits, in particular from municipal authorities. From a walkway located high above the factory floor, you can follow the bottles as they travel along their path. They arrive from sorting centres compressed into balls encircled with iron. Once the homogeneousness of the balls has been verified, they are opened and spread out on a conveyor belt. The first step is to sort them. A high-technology machine separates the wheat from the chaff. The desirable bottles are sent by a blower towards the right circuit. The rest are rejected. A medical term is used to define the rest: "the contaminants." These include PVC, Tetra Pak®, and metals.

And that's when you get angry. Why are the manufacturers delaying instead of embracing, once and for all, the principle of eco-design? Why, when they can dream up a product and its packaging, aren't they thinking about the end-of-life product and packaging, when the time comes to give them a new life? If they only embraced this long-term, responsible vision, they would make life much easier for recyclers. What a nightmare! These intruders in the bottles, these aluminium caps, steel covers and PVC labels. You want an example? Some names? How about that mineral water, highly appreciated on the banks of the Arcachon Bay, called Abatilles. Its taste is worthy of all the praise it gets. But why give it a PVC capsule? For sure, it makes it look like a bottle of wine but ruins the efforts of those who want to give it another destiny. The same holds true for this new fashion of making containers opaque. Everyone knows that opaque containers make it much harder to treat incoming flows. You want another example? When PET is treated, the presence of PVC can be seen by black dots, since the temperatures at which they melt are different. To such an extent that the customer refuses the batch. What does Eco-Emballages do? This institution, highly useful and willingly fussy in its regulations, couldn't it penalize those companies that are dragging their feet on eco-design?

Let's calm down and admire – as it deserves – the rest of the path followed by our friends, the bottles. A final control is carried out, this time by people. The time has now come to bring on the water, lots of water. The bottles need to be washed at the same time as they are crushed and the labels are taken off. It's also time for them to say goodbye to their caps, which are much lighter. They float on the surface of the tub whereas the pieces of the bottles – the famous flakes – sink to the bottom. They need to be washed again, in hot water, to remove the remaining glue. They must be sifted in order to not keep scraps that are too small and to give the whole the homogeneousness it needs. All that's left to do is to dry the flakes and run them through the field of a Foucault current to remove the remaining metal. Out of the loop flow two streams, one "clear bluish", the other "mixed colours". They will then be poured into big bags. A final quality control is carried out to guarantee to customers that the features needed for their business have been respected.

So just what is the purpose of the flakes? What is the second life of our dear friends, the bottles? Their first new destiny is to become bottles again, but only for 2%. For more than 60%, they will be transformed into sheets that are used to manufacture containers. A quarter of them will become fibres, meaning textiles



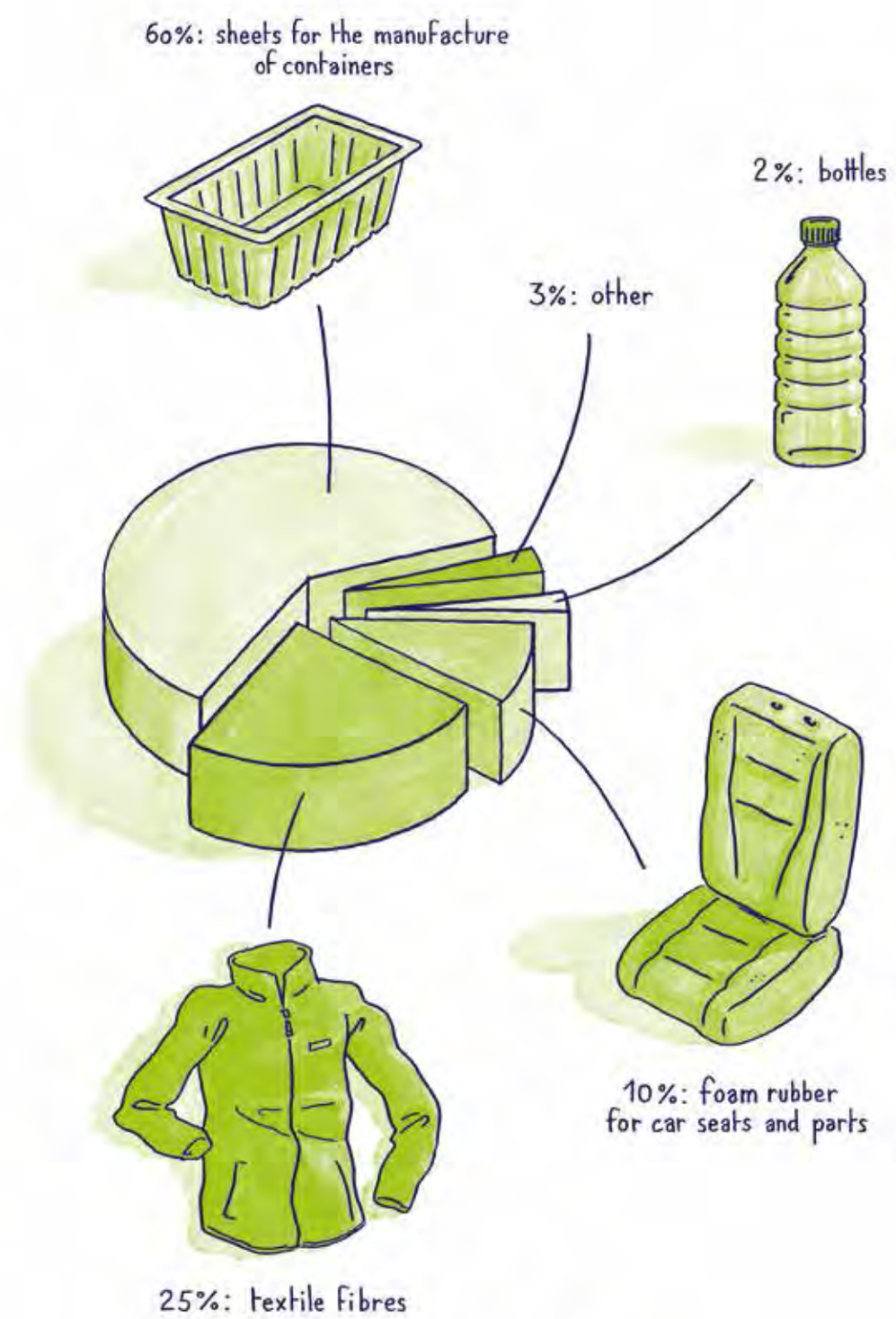
Recycling PET plastics

in the long run. Most of our fleece jackets are made of former bottles. And 10% of them will be reborn as foam. Foam that can be extremely solid thanks to its honeycomb structure. And with this new material, we can build seats and car parts. In this way, the loop closes on the circular economy.

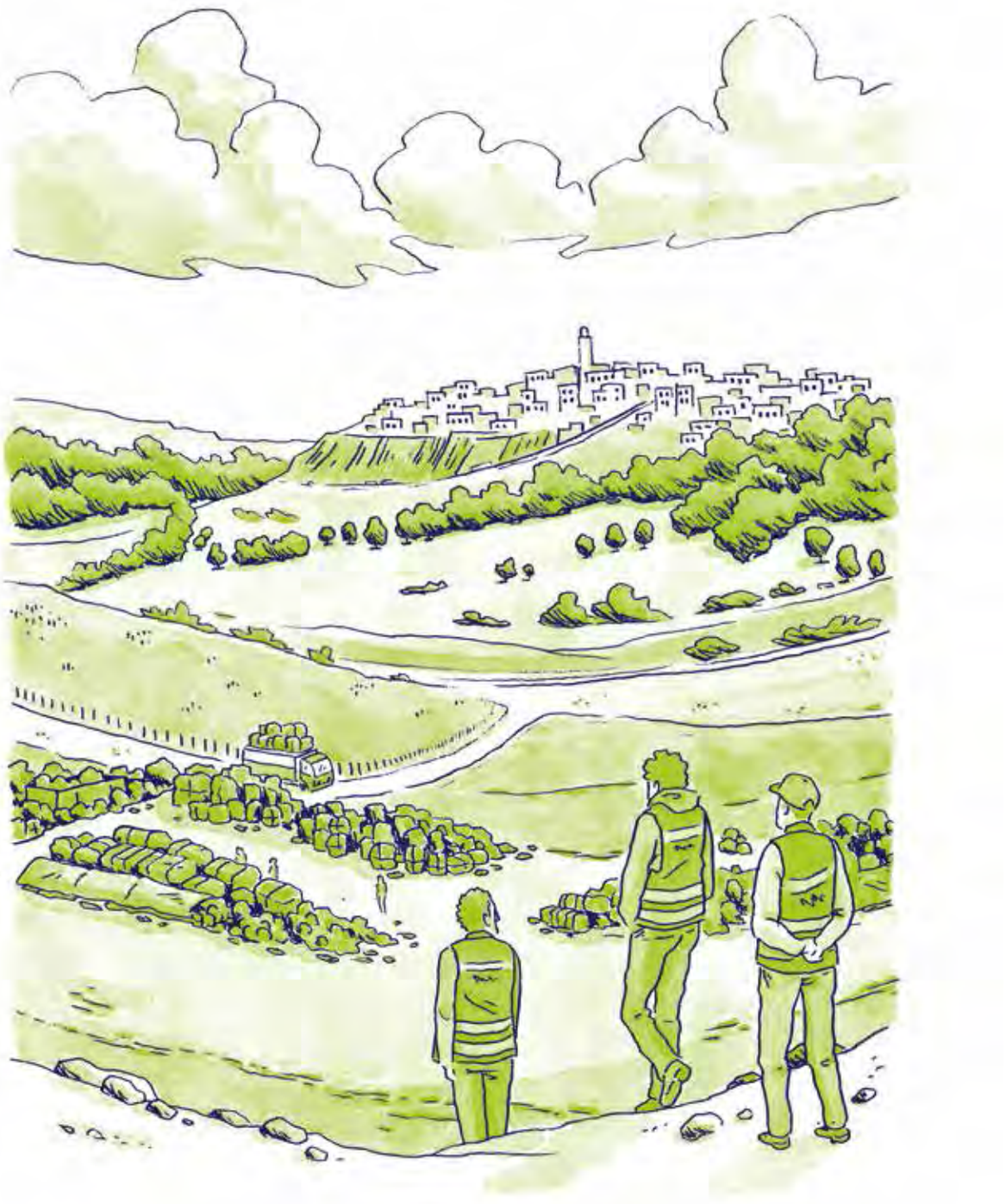
The energy that is most striking when you visit the factory is the energy of the people that work there. It is an energy with a special quality, that comes from pride; the pride of having successfully given a new life to a factory in distress; the pride of knowing that the future is, of course, the resource revolution; but also the pride of having achieved – today – profitability. The workers with the most seniority used to work for Sony. They know that a factory is fragile.

170,000 tonnes of bottles recycled every year is all well and good, but 140,000 remain. 140,000 tonnes scattered in the surroundings, or incinerated as "recovered energy," for want of other, more helpful uses. That's when a certain François Fabiano got involved. His idea was simple. Why not install booths, sheds of a sort, on supermarket parking lots where people could leave empty bottles in exchange for a discount voucher to be used in the neighbouring store. The advantage for the shopkeepers is to win the customer's loyalty without any major investment, by only providing a little space and electricity. The advantage for the consumers is the possibility of getting rid of their bottles and a modest financial motivation (1 or 2 eurocents per bottle, a symbolic amount but consumers have the certainty that the bottles will be recovered). The advantages for the environment are recycling and less visual pollution, since the bottles are directly deposited in a container, which is regularly taken to the nearest sorting centre. The booth costs 60,000 euros.

A company has been created. It's called Réco, a contraction for reward and ecology. SUEZ plans to acquire a 70% stake in the company in the near future. And today, 100 booths have been installed throughout France, each of which gathers an average of 2,000 bottles a day. That's a daily total of 200,000 bottles. A survey has recently been conducted showing that three-quarters of these bottles would not have been collected without this system. I went to see the first of these booths, in the pretty little town of Saint-Pée-sur-Nivelle, in the Basque country. Before going into the Intermarché, we went to deposit our bottles and receive in exchange a small gift. In keeping with the general good mood, the booth was hailed as a "good idea". The only regret is that there aren't more of them: "My mother lives in Bordeaux. Why aren't you there as well?" Delighted, François Fabiano raises his arms toward the sky: "When I think of everyone who in the beginning didn't believe in my project!"



The second life of bottles



Journey No.13
Meknès — Morocco

THE RAGMEN'S FUTURE

In Morocco, not far from Meknès, there once was a hill where the only law was the law of the jungle. Once upon a time, there was a rubbish tip that was rightfully called "unauthorized", which it was, like most of the other tips, in most countries of the world.

Every morning, just before dawn, 200 ragmen gathered at the tip, where they waited for the arrival of trucks filled with waste from the city. Every time one of the trucks delivered its load, the ragmen ran to it and began to scuffle, time and time again. The idea was to carry off, as quickly as possible, everything from the pile of steel, cardboard and plastic that could be resold. The expression – to fight like ragmen – became commonplace. Fights were often violent, and the hospital often took in men who had an eye poked out or their cheeks ripped open by hooks, which were not used exclusively for sorting.

Once upon a time, there was a municipality that decided to put an end to this wildness, because the times had changed. Morocco has been chosen to host the COP22 global climate change conference in the fall of 2016. Environmental concerns, which yesterday were absent, are more and more urgent. A respect for nature is no longer the monopoly of the countries of the North, as the South realizes that it pays the heavier price for our planet's disorders. People are starting to realize that it is time to stop wasting resources, of which we are beginning to understand their scarcity. This explains the country's commitment for 2030 to reduce by one-third its greenhouse gas emissions and generate half of its energy needs from renewable sources.

Prior to then, Meknès buried its waste, any way it could, or burned it, without taking any precautions. Recycling, carried out in an anarchical way, was left to the ragmen, about whom nobody cared. They were seen as the dregs of society, and always had been. What's more, they lived in shantytowns where no one ever went, close to the tip. "Birds of a feather stick together" was what people thought.

Two nationwide goals were set for 2020: to close all unauthorized tips and increase the overall recycling rate to 20%. That's why the city of Meknès launched a call for bids with three objectives: take charge of the 200,000 tonnes of diverse waste produced each year; refurbish unauthorized tips, which smell badly, release toxic fumes, and create streams

of leachate, the waste "juice" that flows toward the neighbouring river; and rationalize the collection of everything that can be recovered. Immediately, one question came to mind: what should be done with the ragmen? They existed, even if they were outcasts. Violence was to be expected if they were suddenly refused access to the place that they had been operating, in their own way, for generations. How would they earn their livelihood? Wasn't there the danger that they might take to attacking trucks in the city?
In its proposal, SUEZ reserved a key role for these despised people. The proposal also had other strong points, including international experience and highly technical skills in the treatment of all sorts of waste. But it was this social concern that won the support of the town.

I met Mr Ahmed El Gaoud, the President of the cooperative, which replaced the jungle. Its name – Attadamone – means solidarity in Arabic. That's the word that is written in grey on the ragmen's fluorescent yellow vest. Below that is another, simple expression that describes their business: waste sorter.
— Before, we would kill for a small piece of iron. Now, we work together, and we don't steal from each other anymore. When someone is sick, he is replaced and we help his family. We have had computer courses and some people are learning to read. The cooperative organizes everything. In the beginning, not everybody wanted to come. Some people were suspicious. They had always been alone and they preferred it that way. Now, everyone comes. We're stronger. We're going to negotiate with the wholesalers who buy what we have to sell. They're not organized, like we are, so we should be able to command a better price.

I take advantage of the situation to ask him if they earn more than before, in the days of the jungle.
— Overall, I would say about the same. The strong earned more and the weak earned nothing. Now, everything is shared. It's more regular. It's better to have peace.
The vice-president of Attadamone talked to me of pride. Before we used to look at our feet; our eyes were always turned down. But now, we hold our head high. We have dignity. I explain to them that we also use the word "pride" to speak of a group of lions: a "pride" of lions. They are delighted to learn this. We have pride and we're going to attack the wholesalers. They're going to be afraid.
Later, when I talk with the city authorities, they tell me about the problems they had starting the cooperative. A lot of people have an interest in keeping an "informal" arrangement. I'm talking about Naples and its local mafia, the celebrated *camorra*, which controls the waste market. My friends cry out in protest. No, no, we haven't got any mafia in Morocco, just interests.

From the top of the tip, I can watch the sorters at work. Next to me, a squadron of storks shares my interest. The space is clearly shared. On the right, the trucks deliver the waste. In the centre are two areas where the waste is sorted approximately before the fine sorting begins. I watch as enormous bundles pass. We can barely see the legs of the people who are carrying them. On the far left, there are many bundles; this is the site reserved for the famous "wholesalers". Further away, a brand-new, large, yellow warehouse is waiting to welcome the sorters. Instead of working directly on the ground, without protection against the weather, a study is being conducted whereby the waste will come to them on tables.

Brice Mégard tells us his version of the project, which he's passionate about. It's all his. Since the beginning, he's supported it with the head engineer, the representative of the city.
— Of course, we could have automated the system. But what would we have done with the 170 former ragmen? There are some investments that engineers like but which are not economically profitable and are disastrous from a people perspective.
I tell myself that he has just summed up the logic of the three pillars of sustainable development: the social, the economic and the environmental. If one of the three is missing or too small, the balance of the whole system is in danger.

As if he could read my thoughts, Brice takes me to the platform where the leachate is treated. It's a nauseating liquid that is especially abundant because Moroccan waste is very rich in organic matter. A double filtration system is used, the first involving a membrane bioreactor and the second using inverse osmosis. The concentrates then pass through a lime-washing unit, followed by a thermal treatment. I listen attentively because I find these purification techniques fascinating. I find it moving when man imitates the mechanisms of nature.
Brice then shows me black tubes coming out of the ground here and there. They serve to evacuate the biogas created by the buried waste. For the moment, this gas is burned off – a pure loss – but soon, very soon, it too will be recovered. I point to the factories below. He explains to me that they are brickworks. I remember visiting a few of them in Bangladesh, where they are so necessary since the country is on a delta and thus has no stone. Thank goodness for bricks! They enable us to house 150 million people. And I know the energy needed to cook the earth from which the bricks are made. And so, I rightly guess the goal of the tip: to give the neighbouring factories the opportunity to do away with coal and diesel fuel. Unquestionably, I'm starting to think in terms of a circular economy. Brice looks at me with a new friendly regard. This gas could also be used to produce electricity.

In the distance, we can see other chimneys. They are part of an enormous cement factory. Couldn't it too receive energy from the tip? Brice is less optimistic. It's too far and there is too deep a valley to cross. He shakes his head. Let's move forward in stages. I'm inclined to agree with him.

What's the end of the story? The tip has a treasure that stems from the city's foresight. Lot by lot, some 57 hectares have been purchased in the immediate vicinity of the centre and all allocated to the tip. What should be done with this land? The team has many ideas, including covering a good part of the site with solar panels. That's why Meknès will soon be cited as an example of a responsible city, on the cutting edge of the kingdom's new economy. This is sweet revenge for a city that will never put up with the disdain of Fes, which at its best is condescending. Didn't Moulay Ismail ibn Sharif, a contemporary of Louis XIV, choose Meknès as his capital? So the wheel turns, just like the circular economy.

Journey No.14
Casablanca — Morocco

CONNECTING

There are three young men, and their business is connecting. In other words, providing families with water, meaning life, and sanitation, meaning access to hygiene. Their names are Souad, Othman and Kaoutar.

Connecting people is not easy when urbanization is proceeding at a fast pace. In and around Casablanca, homes are sprouting up nearly everywhere, like mushrooms, with no general well-established plan and no real anticipation of infrastructure needs. So for want of staying ahead of this movement, or of being able to forecast it, we must follow it. It's important for the most basic needs of the concerned people, who can be counted by the tens of thousand.
Our three young men are used to it. They know how to focus on the essentials. They have connected shantytowns. They have connected "informal habitation areas," meaning shacks that are consolidated little by little. For lack of anything better, they provide them with the essentials, but it's becoming harder and harder to accompany the incredible development of Greater Casablanca, especially since the concept of business is winning out over the concern for a common good. What could be nobler that to want to offer real roofs to people who have lived all their lives crowded under sheet metal? However, the best intentions are sometimes left behind when faced with the reality of means and the urgency of situations. Thus, it's easier to understand why apartment buildings are increasing, by blocks of 20 or 50, without offering places for communal living: no squares or terraces where people can gather and talk, like in the village. We understand better why the new neighbourhoods of Casablanca are among those with the fewest green spaces in the world. We understand better why no system of evacuation has been planned for rainwater, except for the ditches carved into the ground, just along the façades, which turn into cesspools when the first rain comes. And where is the transportation? In these brand-new buildings, how are women and children going to live, often alone? For better or for worse, many husbands prefer to live in downtown areas where jobs are.

To listen to these three young men talk about their day-to-day struggles to "connect" others, we understand better the human dimension of this new economy, which we call circular. Doesn't reintegrating excluded

or marginal people mean bringing them or bringing them back into the circle of society, with all its rights and obligations, or giving them back their fully-fledged dignity as citizens? Recycling so-called "raw" materials is well and necessary, but not sufficient. A true circular vision means doing everything possible to give others a second chance, at every stage of their lives. Connecting them instead of abandoning them. Connecting them instead of sending them into exile. These new cities are so far removed from people's habits. "Modernity" can also be a sort of exile, a break with one's identity. Connecting also means continuing and not breaking off.

These young connectors are three of the 3,600 employees of Lydec, a private company in which SUEZ holds a 51% stake. In 1997, the company signed a 30-year contact with the city of Casablanca to manage the distribution of electricity and drinking water, sanitation services, and more recently, public lighting systems, one of the best ways to combat an ever-threatening sense of danger.

How does one finance the necessary infrastructure? We're familiar with the generally accepted rule that "water must pay for water." But here, the people are poor. Nearly half of Lydec's customers are invoiced at the least costly, most advantageous rate. This means water that is paid at less than its cost. The other half of the customer base – more well-to-do and thus able to pay higher invoices – can't compensate for this. So it's the sale of electricity that can subsidize water, but for how long? Urban development, especially when accelerated and poorly disciplined, calls for enormous investments.

Interventions of the Lydec teams

Journey No.15
Casablanca — Morocco

CLEANING UP THE SEA

The authorities could no longer stand to see wastewater thrown back, just as it was, into the ocean. The stench and the pollution repelled anyone who came close to the shore between Dar Bouazza (to the south) and Mansouria (to the north); this meant that more than 70 kilometres of coast had been abandoned. An initial antipollution plant had been built at El Hank. A second – with the lovely name of Eaucéan – had recently opened at Sidi Bernoussi and had been inaugurated by the King in May 2015.

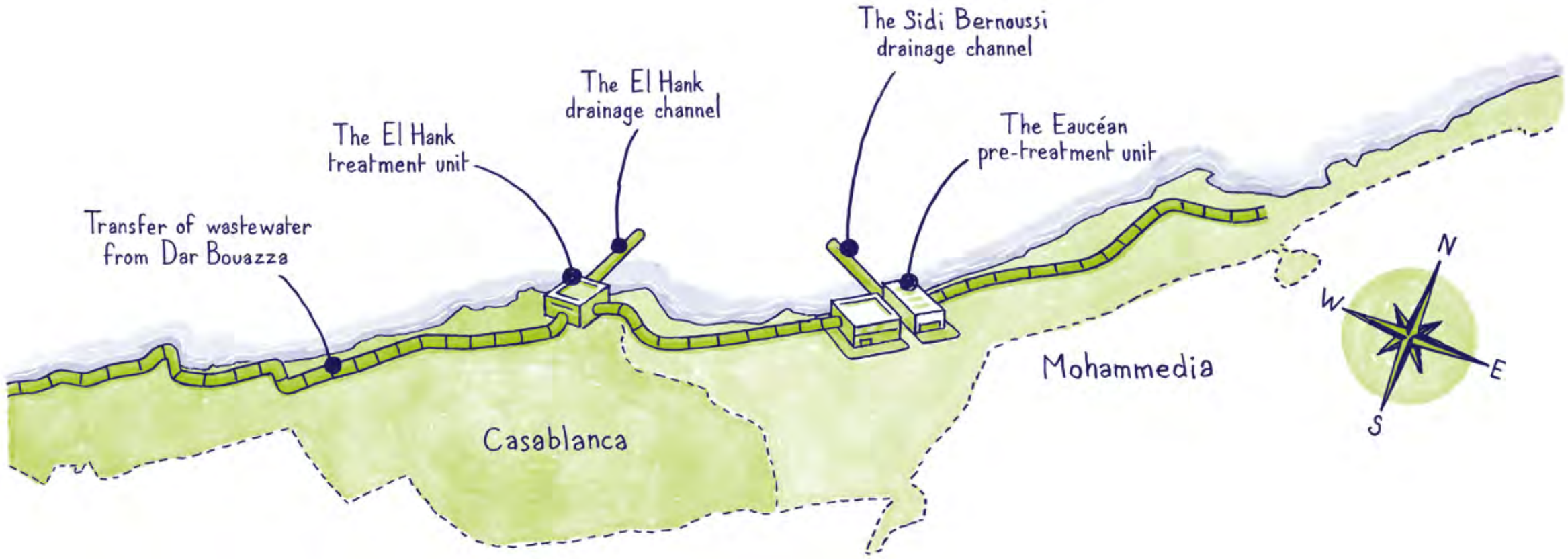
The principle is simple. Underground galleries receive the wastewater, both domestic and industrial, which is especially abundant in this area where factories are concentrated. This water – whether dirty or very, very dirty – is directed toward the Eaucéan plant where it is pre-treated. This means that the largest waste is removed, compacted and sent to the tip; sand is also removed and grease and oils are suctioned off. All that remains is the biological part of the treatment. This task will be carried out by the ocean and the currents that stir it up. An enormous tube has arrived from Norway; it is divided into three pieces each of which is pulled by a tugboat. Once assembled, the tube – nicknamed emissary – will be 2.5 kilometres long. One end is connected to the plant, and the other extends out to sea; it is solidly weighed down so that it will not move during the winter storms. In this way, some 250,000 cubic metres of wastewater are treated every day; the objective is 400,000 cubic metres.

But how can pollution control be carried out if the sea is too far and the canalizations that could take us there are too costly? Water treatment plants have been built in the heart of new habitation areas, like in Medounia, a new city within the city that is home to more than 25,000 people. Those who fear bad smells need not worry. The most delicate nostrils will find nothing abnormal because the air is also treated. Here too, like at Eaucéan, waste is sorted but after the treatment the water is sent to an aeration tank containing "activated" sludge, which contains bacteria that love to devour organic matter. Soon, there will be no trace of carbon, nitrogen or phosphorus. That's why – I'm telling you – the air smells like a rose (or nearly so). However, the purification process is not finished. The water now flows through several modules of membranes that

measure 0.04 microns and capture the smallest of micro-organisms. Such a facility makes it possible to treat nearly 4,000 cubic metres of wastewater every day.

And that's how Lydec has become a major force in sustainable development in Greater Casablanca. Further proof of this came on Monday, October 26, 2015, during a symposium on the resource revolution. The Wali, the mayor of Casablanca and the head of the cabinet of one of the most important ministers, in charge of energy, mines, water and the environment, wanted to discuss with us the future of this enormous city. How does one build a metropolis and how does one manage the demographic pressure which is heightened by the growing attractiveness of Morocco's leading economic centre, while at the same time financing all the necessary networks, reintegrating people who have been excluded, enabling citizens to express their expectations, and forging closer ties with fast-growing African neighbours?

A trip, even a short one, makes it possible to plunge into this jungle of interlinked questions. Morocco's ability to continue to serve as an example in a rapidly changing Africa will depend on complex responses provided quickly.



Treating wastewater on the Casablanca coastline

Journey No.16
Ivry-sur-Seine — France

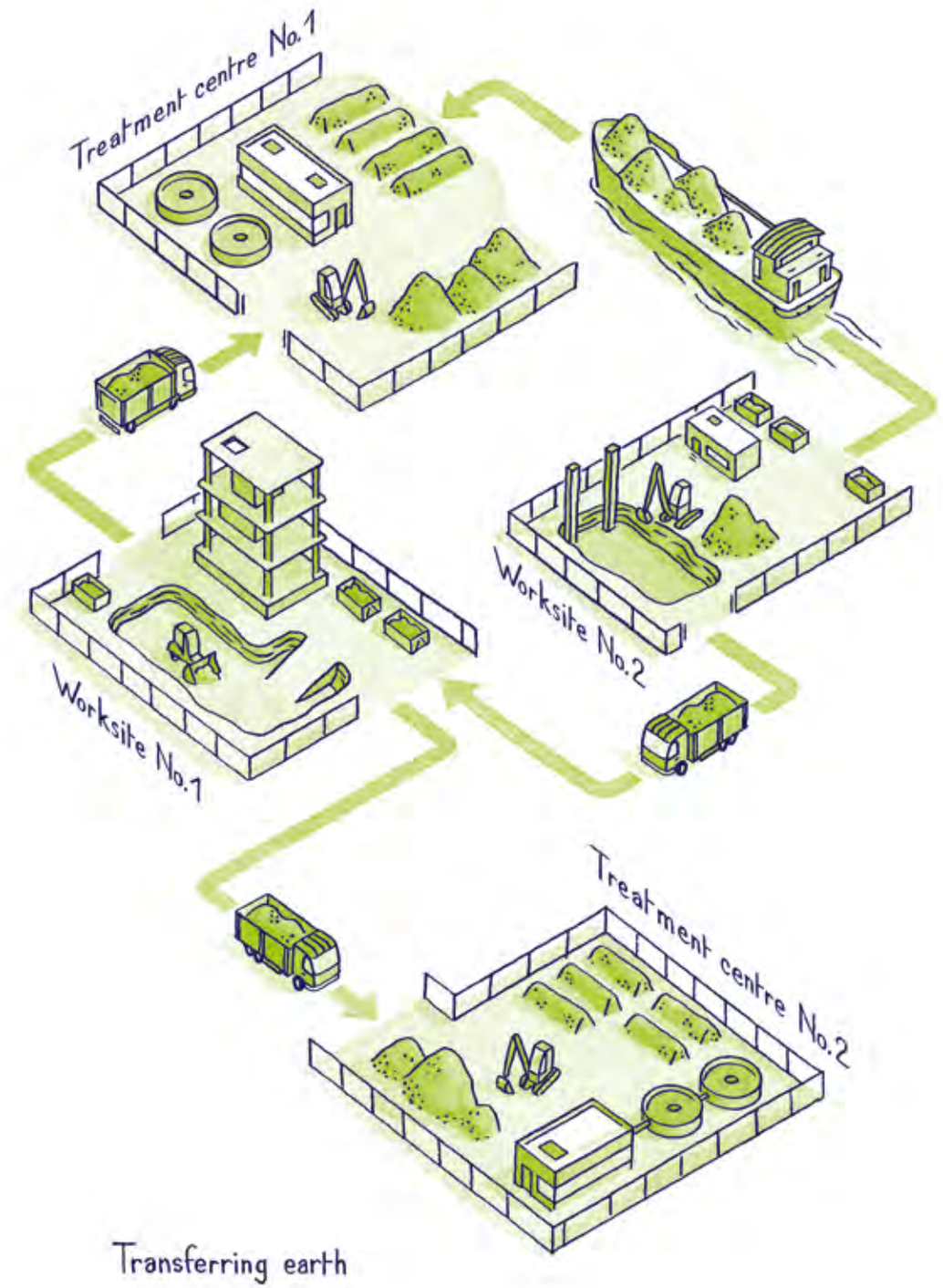
EARTH TRADER

His name is Emmanuel Cazeneuve and he's 37 years old. Remember his name because this young man has understood everything. He began his career in public works, where he quickly noted that worksite managers were left to their own devices. The worksites were, in a way, autistic. Focused on the job at hand, they communicated little with the outside world, whereas managers must constantly resolve a wide range of problems, all of them unforeseeable, and resolve them quickly, because delays are costly. I had learned from my extensive conversations with Patrick Bernasconi, back when he was the President of the National Federation of Public Works, that the best projects were those that lasted the shortest time.

Now, building often means destroying first and you have to dig into the ground before you raise the floors. So what do you do with all the earth accumulated in this way? You can, of course, contact the major recycling companies, but they are sometimes slow to respond while your need is urgent. Why not offer the earth to other neighbouring worksites that, on the contrary, need it as backfill?

In fact, there are two markets: that of uncontaminated soil, which has market value and is sold for the best possible price. But there is also the market for polluted earth, which you have to get rid of as cheaply as possible. However, to get rid of certain earth that is highly contaminated, you have to pay up to 100 euros a tonne. This is where Emmanuel's simple idea comes in: create a platform that puts in contact suppliers and demanders of these different categories of earth, which can be exploited for economic gain. No sooner said than done. In 2014, Soldating was launched, via Emmanuel's company, Hesus. A community of worksite managers was gradually built up, thanks to the magical power of digital solutions. The principle is simple: free access to the platform and remuneration on the volume of earth reallocated. The first principle is mutual trust.

As one might expect, the established recycling powers view Emmanuel with a very critical eye because he dares to circumvent traditional procedures, slowness and arduousness. Efforts are made to dissuade him. He is threatened. He is told that pressure will be put on his potential customers to convince them not to sign with him. But Hesus couldn't care less about these threats



and continues. The future is there, to the extent that companies will soon be under regulatory constraint to recycle at least 70% of their construction material. That's why the most far-sighted traditional recyclers are beginning to look at Hesus with interest. The accusation of "uberization" misses the mark. The platform responds to needs that were previously unsatisfied:

• Simplicity and speed. Nothing could be easier than getting on the platform. With a few clicks, the interface can be seen, as can the worksites that might be interested. A few more clicks and the transaction is done.

• Logistics. Hesus owns no trucks but nonetheless takes care of transporting the earth.

• Security. Buyers want to know where the earth comes from and its composition. That's why Hesus created Soltracing, through a joint venture with a Flemish company. In Flanders, where earth is precious, all excavated material is reused. Thanks to Soltracing's technology, Hesus' customers will be constantly informed of the quality of their purchases. Another security aspect: Hesus guarantees payment. The company's first phase can be considered as quite successful, with 15 million euros in revenue. To speed its growth, Hesus needs to extend the range of services offered to worksite managers. For example, why not offer to deliver food that is better than what is usually served on the worksites? Above all, Hesus needs to increase the number of customers, meaning worksites listed on the earth-exchange platform. At present, the platform comprises 30 of the 360 worksites signed by Hesus in 2016, thus indicating significant growth potential for the coming year.

Journey No.17
Rugby and Bristol — Great Britain

THREE ENGLISH LESSONS

On a recent trip to England, I learned three lessons.
Regulations, so often criticized, play a key role in improving behaviour. In terms of waste recycling, Great Britain was a real problem child. Four changes have taken place and the first three allowed the country to make up a lot of ground. The fourth may cause the country to lose what it gained. In 1996, the United Kingdom introduced the country's first environmental tax: a tax on waste sent to landfills, suggested by John Gummer, the conservative government's Secretary of State for the Environment. Rather than pay the tax, it was thus preferable to recycle. At the same time, land prices soared to such an extent that no one still thought it reasonable to increase the amount of land used for landfills. Added to this real-estate logic was the well-known phenomenon of Nimby: we are defenders of the planet, and therefore recycling, but, please, build your factories somewhere other than in my garden. Did you know that, with no land to be found near London, rubbish from the entire west of the capital and neighbouring towns is being transported every day, via a train one-third of a mile long, to a factory near Bristol for treatment? Finally, the European Union was imposing recycling rates of 50% by the year 2020 (on a country which had not even reached 10% in 2000). Evidently, Brexit should provide the opportunity to escape all the constraints "imposed by the Brussels bureaucracy," this one in particular. By definition and by function, the market deals only with the present. When the price of petrol remains desperately low, only carbon pricing can help prepare for the future. Two plants make it possible to verify these remarks, which are grounded in plain common sense. In England, SUEZ has long been a major operator in the collection of waste and the operation of energy-from-waste facilites. These plants illustrate the Group's desire to go a good deal further by developing a truly circular economy.

The first plant can be found in the Midlands or, to be precise, in Rugby. A cement plant, the largest in the United Kingdom, is its closest neighbour. This immediate proximity is no coincidence. It is the SUEZ plant which, as part of a 25-year contract, supplies the cement plant with over 50% of the (very large) quantities of energy it needs and which represent about a third of its costs. The originality of this long-term partnership lies in the type of energy being

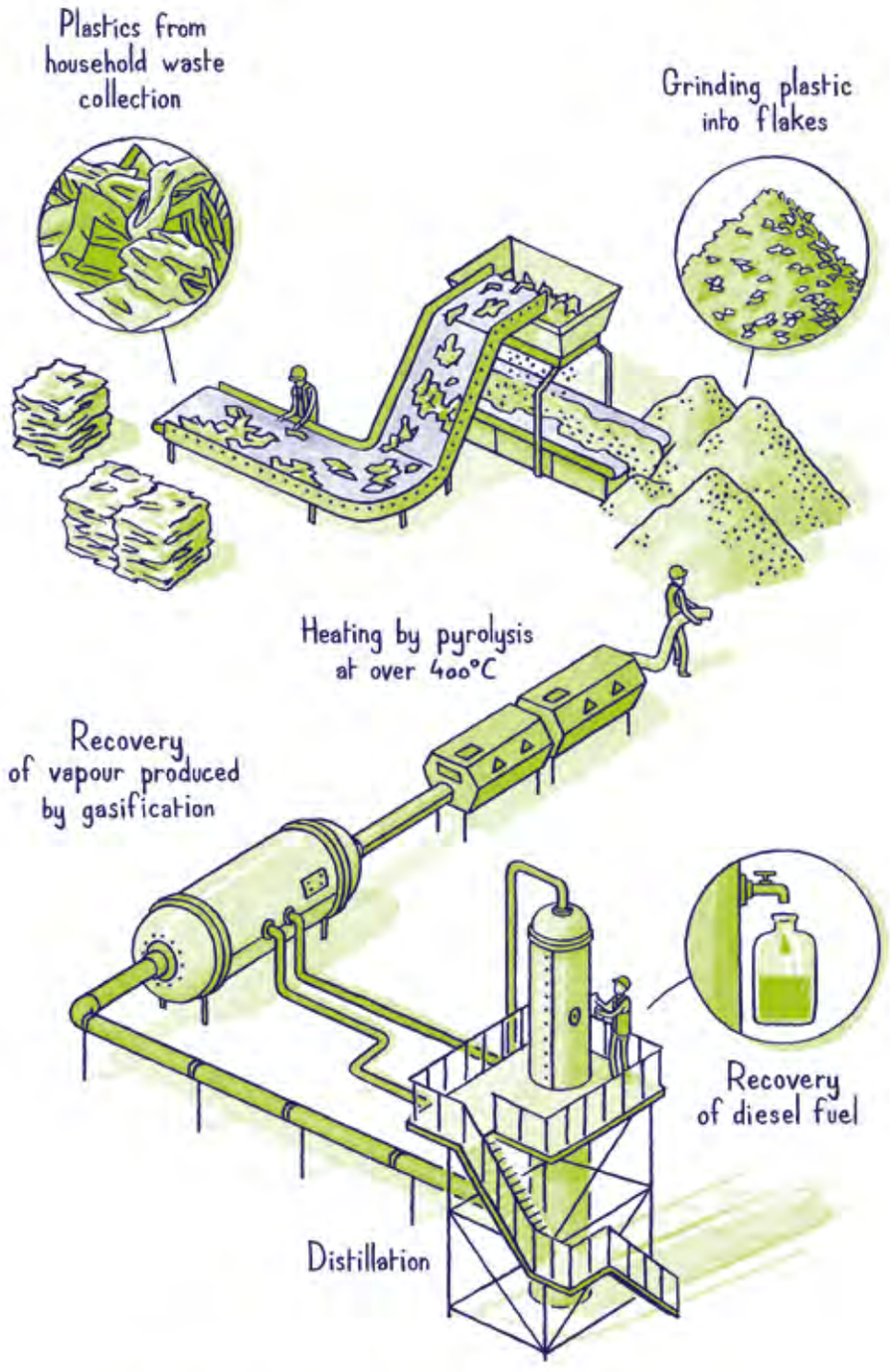
supplied: a very special fuel, one might say especially "sustainable" as it is derived from waste. This waste is collected throughout the whole of central England and comes from all sources: municipal (rubbish), commercial (supermarkets) and industrial. The resulting fuels are known as Solid Recovered Fuel (SRF). It is capable of providing an advantageous substitute for coal. Containing less than 15% moisture, SRF has real calorific capacity. 1.4 tonnes of SRF produce the same energy as 1 tonne of coal.

SRF is pleasant to the touch: soft, light, and clean (a rare quality in a fuel). Its advantages justify the name it has been given: Climafuel. This site at Rugby, which represented an investment of 18 million pounds, employs 55 people and produces 200,000 tonnes of SRF every year, as well as 100,000 tonnes of the usual by-products: ferrous and non-ferrous metals, plastics, papers, etc. Commercial waste is collected and pre-sorted before entering a state-of-the-art transformation line. As well as providing energy, this treatment of waste reduces the amount of land area allocated to landfills.

This is how, in Rugby, a very advanced kind of technology has helped to overcome the timidity of politicians as well as poor market conditions. In Rugby, the future is already present, I mean that the transition already works: it is the new resources, issued from recycling, that create energy. Without any help from subsidies, and profitable: two conditions for this plant to be considered "sustainable".

In South Gloucestershire, on the Severn Estuary, the technology used by the plant in Avonmouth is even more cutting-edge than the one in Rugby, and, doubtless, unrivalled worldwide. And the plant has taken on a formidable, even divine, task. It proposes nothing less than to reverse the course of Creation: instead of doing the same as everyone else and making plastic out of petroleum, it has the opposite ambition: to produce petroleum from… plastics. The concept is justified: every plastic is a chain of polymers made from monomers of petroleum. If you manage to break this chain, you discover the petroleum. That's why the Avonmouth plant, with its entangled tubes, those long pipes rising to the sky, looks like a refinery. Of course, it's a refinery… in reverse.

Today, from plastics, it's possible to produce a whole range of fuels with qualities "almost" identical to those of petroleum-derived products. The whole difficulty arises from this "almost". In terms of logistics, it's the challenge of the "last mile" which is the hardest one to overcome. I don't doubt for a second the ability of researchers to overcome this challenge. The operation has yet to be made profitable. With barrel prices at consistently low levels, a raw material will always be cheaper than a recycled material. Unless we put a price on that enemy of our environment, CO_2.



Transformation of plastic waste into eco-fuel

Journey No.18
Helsingborg — Sweden

RENOVATING A HOSPITAL

No sooner have we sat down in the Audi, than we know we've arrived in a different – I mean wise – country. The man who welcomes us is called Ulf Gustafsson. According to the business card he's just slipped to me, following a vigorous handshake, he holds the crucial position of commercial director. But for now, he blows into a small machine connected to the dashboard: an integrated breathalyzer. In the time it takes to count to three, the car starts. Had he drunk even just a little, we would have been left stranded. In Sweden, car engines are allergic to alcohol.

And now, it's time to head for the regional hospital.

— We've been awarded the contract to manage all the waste of this immense work site, Ulf tells me proudly.

The huge grey building overlooks the cemetery. One good thing about the circular economy is that the unlucky patients won't have to travel far to reach their final destination. Long live short trips! I won't joke for long because here is Jessica, the development engineer for the entire project.

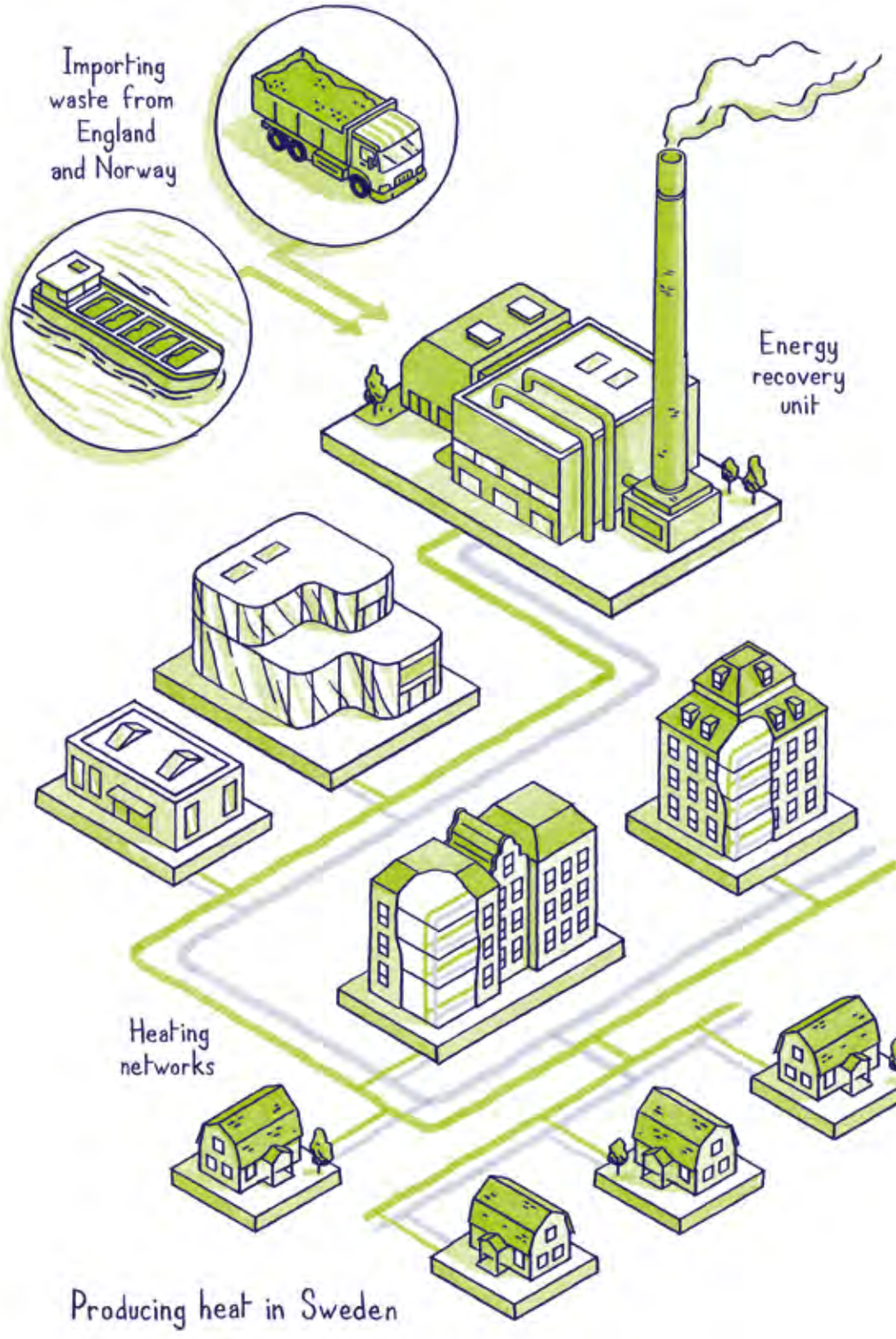
If you were Scandinavian, you would know that PEAB is a leading construction company, with 14,000 employees, 5 billion euros in revenue, and operations in Sweden, Norway and Finland. The company is SUEZ's partner in developing a new, more "sustainable" way of building, notably through the systematic treatment of construction and demolition waste. We know that a European directive will require us to recycle 70% of this gigantic mass of waste by 2020, in other words tomorrow. Thanks to the collaboration between SUEZ and PEAB, progress has been made. In just six years, the recycling rate has risen from 59% to 83% and the goal is to go far beyond that.

In this respect, the worksite of the regional hospital is exemplary. More than 40,000 square metres to be renovated, interfering as little as possible with the smooth running of services (which continue to receive the same numbers of patients), while an extension is in progress on the piece of land just next door. Jessica describes to us the complexity of the safety procedures, the waltz of the trucks and the logistical headaches. We don helmets, protective shoes, fluorescent vests, and we're off on our visit. Ripped-apart hospital floors hang down from

the wood, gypsum, metal reinforcements, cardboard and plastics. All materials are divided by cranes and dispersed willy-nilly into skips by SUEZ personnel present on the worksite in order to be as close as possible to the source of waste.
But how much time and money could be saved if the various types of waste were separated upstream, as far upstream as possible! The best example is gypsum, the plasterboard from which most of the partitions are made. They and they alone are neatly assembled; nothing easier than recycling them. Of course, a second, more precise, sorting-out will be done later for some of the waste. And the recycling rate for this enormous renovation project will reach 93%, meaning that almost no resource is wasted.

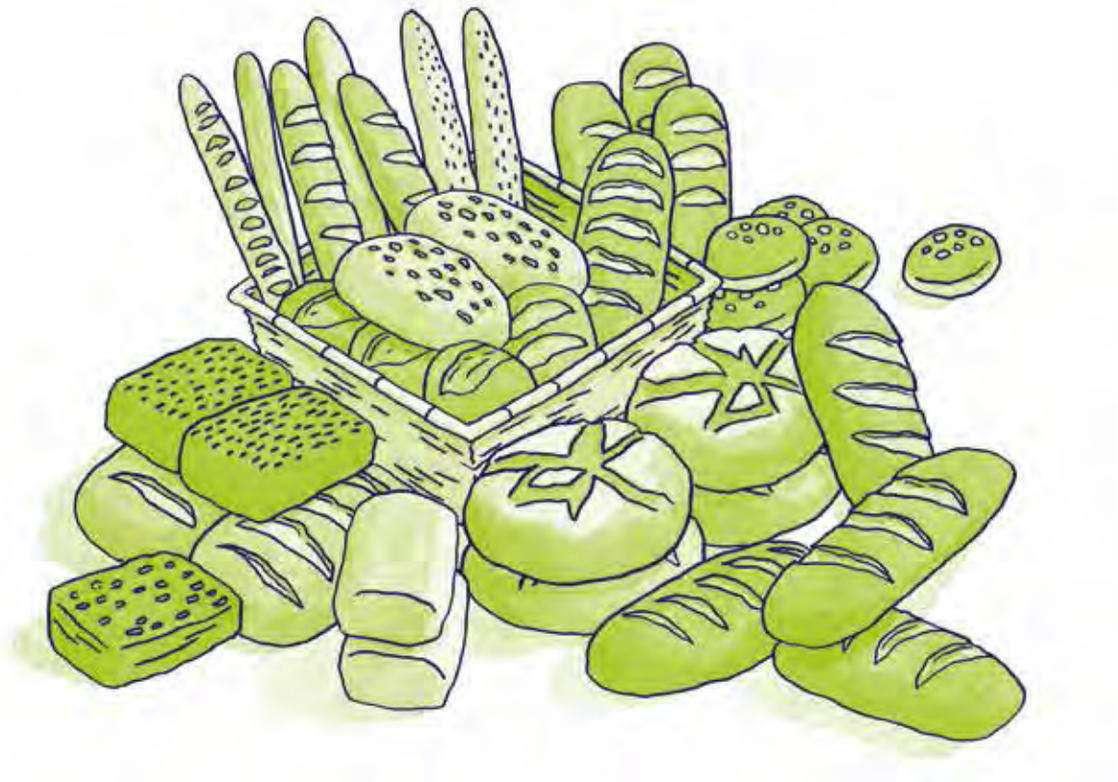
On taking my leave of Jessica, it struck me that the Helsingborg hospital site was a perfect allegory of our society. A society that, too, was sick. That also had to be renovated. While sticking to deadlines and budgets of course, but without forgetting that this society lived on, with fragile human beings that must not be made to suffer from the changes being made. The dinner that was to follow with Mårten Widlund, the head of SUEZ in Scandinavia, would confirm that this region of the world is showing us the way… complete with all the contradictions that await us.

Of all the European countries, and doubtless all the countries of the world, Sweden is among the most advanced in terms of recycling, with a set of fairly radical laws, which have brought about the conversion of an already widely shared environmental awareness into tangible actions. Environmental awareness is made possible by political choices. These include a tax on landfilling, a law that forbids the landfilling of recyclable materials and organic waste, ambitious recycling objectives for the country as a whole and strict regulations with regard to producers' greater responsibility. So landfilling has been reduced to a minimum while recycling and the circular economy have become the new standards in the northern countries. Regulations are used to maximize the economic reuse of waste, and those that still want to landfill their waste are invoiced, which is an expensive proposition, calling for at least 70 euros a tonne. The objective, therefore, looks beyond recycling. The aim is to reduce, as much as possible, the mass of waste. The logic of the circular economy is also a return to the source. From the very conception of an object, its second life is a source of concern. This is the *raison d'être* of eco-design. Recycling, taken to the extreme, is part of the trend, observed everywhere, of new modes of development. Companies are earning less and less by selling their products, which may be energy, drugs, water or cars, and more and more by offering services that allow us to consume less energy (energy efficiency), fewer drugs (prevention), less water (through new irrigation techniques, network rehabilitation projects, etc.) and fewer cars (thanks to new rental systems).
In general, they are replacing volume with value. Would virtue be suicidal? I ask Mårten how, given these conditions, he plans to grow his business. His answer is clear (and good for the planet). Since the collaboration with PEAB has been so successful, we must go forward, integrating more and more partners into the loop. Let's make the circle bigger. Let's also involve the chemicals industry; which uses our recycled raw materials and the furniture industry, for example. It too has waste that could be more effectively treated, before being reduced or recycled for use in the production process. In this way, SUEZ becomes… a consulting firm specialized in… waste reduction and the production of secondary raw materials. Upstream, always



upstream… at the risk of decreasing the scope of its original business ever further.
— But Sweden could become an example, a showcase of the new world.
— Provided that we receive enough material. Our incineration plants are without a doubt the most advanced and the least polluting. Thanks to them, we heat half of our homes with hot water. This represents a considerable savings in a country as cold as ours. But these plants operate as much from the generation of household waste as from the supply of outside waste, mainly from Norway and Great Britain. What will happen if we further improve our recycling rate and if our friends follow the same path as ours and minimize their refuse at the same pace? Of course this scarcity won't occur overnight. Despite our efforts, we, the Swedes, the good pupils, are always producing more waste. But an entrepreneur that is committed to sustainability must look far ahead.
— And what you see "far ahead" doesn't frighten you?
— I'm only afraid of people who believe in permanence. Why would the world we have known last forever? What's more, we know very well that it has to change for future generations. Who would dare complain about playing an active role in its metamorphosis? This metamorphosis involves both need and will: the needs of the planet and the will of the people who inhabit it.

Hospital renovation project in Helsingborg



Journey No.19
Gothenburg — Sweden

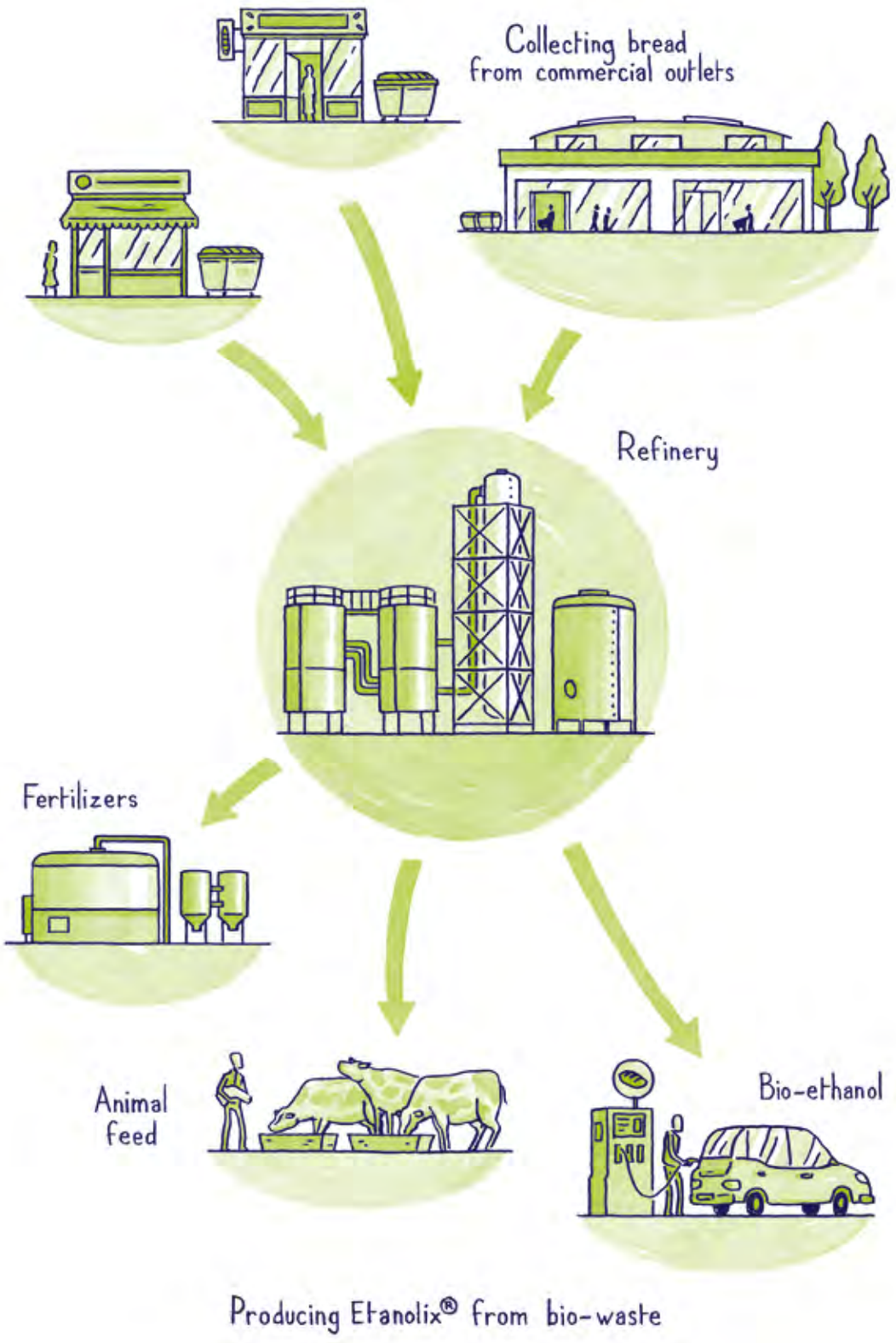
FEEDING YOUR CAR BREAD

There was a big surprise awaiting me on the banks of the North Sea, one cold December morning. Nothing looks less like a bakery than the factory that is about to receive me, a mix of grey tubes and large cylinders. Welcome to St1. In less than 20 years, the company has made a name for itself in the production and distribution of hydrocarbons. Kim Wiio, the young boss, wanted to free his company from the grip of fossil fuels, so his engineers set to work. They came to the following conclusions.

If the first generation of biofuels, issued from agricultural products (sugar cane, corn) raised criticisms that could be viewed as legitimate (pressure on arable land, therefore on food crops), the use of waste was an interesting, indisputable, and yet little explored possibility. Potentially, half, yes half, of the bread produced by manufacturers is thrown away by supermarkets because it no longer has the quality customers want. Now bread contains sugar, a base, as we know, for ethanol, which can be used as an additive for gasoline in proportions of 5-10% depending on the country. To give a rough idea of the large quantities involved, the weight of the crumbs alone that result each year from the slices of a single manufacturer can reach 1,500 tonnes. Once the sugar has been extracted from the bread, fats and proteins remain. These are highly appreciated by breeders for feeding their animals, in particular their pigs. Thus, another recycling loop would be created: agriculture produces the cereals that produce the bread that feeds the animals. This process, once fully developed, would produce far less CO_2 than any other source: 40 times less than fossil diesel, 25 times less than regular gasoline, but also 15 times less than by using corn and five times less than if the origin is cane sugar.

Convinced by these arguments, St1 executives are investing in the construction of a bioethanol production unit. To reduce costs and transportation-related environmental impact, it was decided to install this state-of-the-art technology in a large refinery near Gothenburg on Sweden's west coast. Thus, each year, the plant produces 5 million litres of Etanolix®, this new kind of ethanol, from bread formerly thrown away or burned.
To the best of our knowledge, no other factory in the world uses this source of waste to

produce energy. St1 has thus forged a partnership with SUEZ, which supplies the bread thanks to sophisticated collection circuits, mainly involving supermarkets, grocery stores and bakeries. Given the strong symbolism of bread in France and the taboos that surround the "throwing away" of bread, would such an initiative be accepted? As for the Swedish environmentalists, they have always strongly supported this innovation, above all because of the project's circularity.



Producing Etanolix® from bio-waste

Journey No.20
Poitiers — France

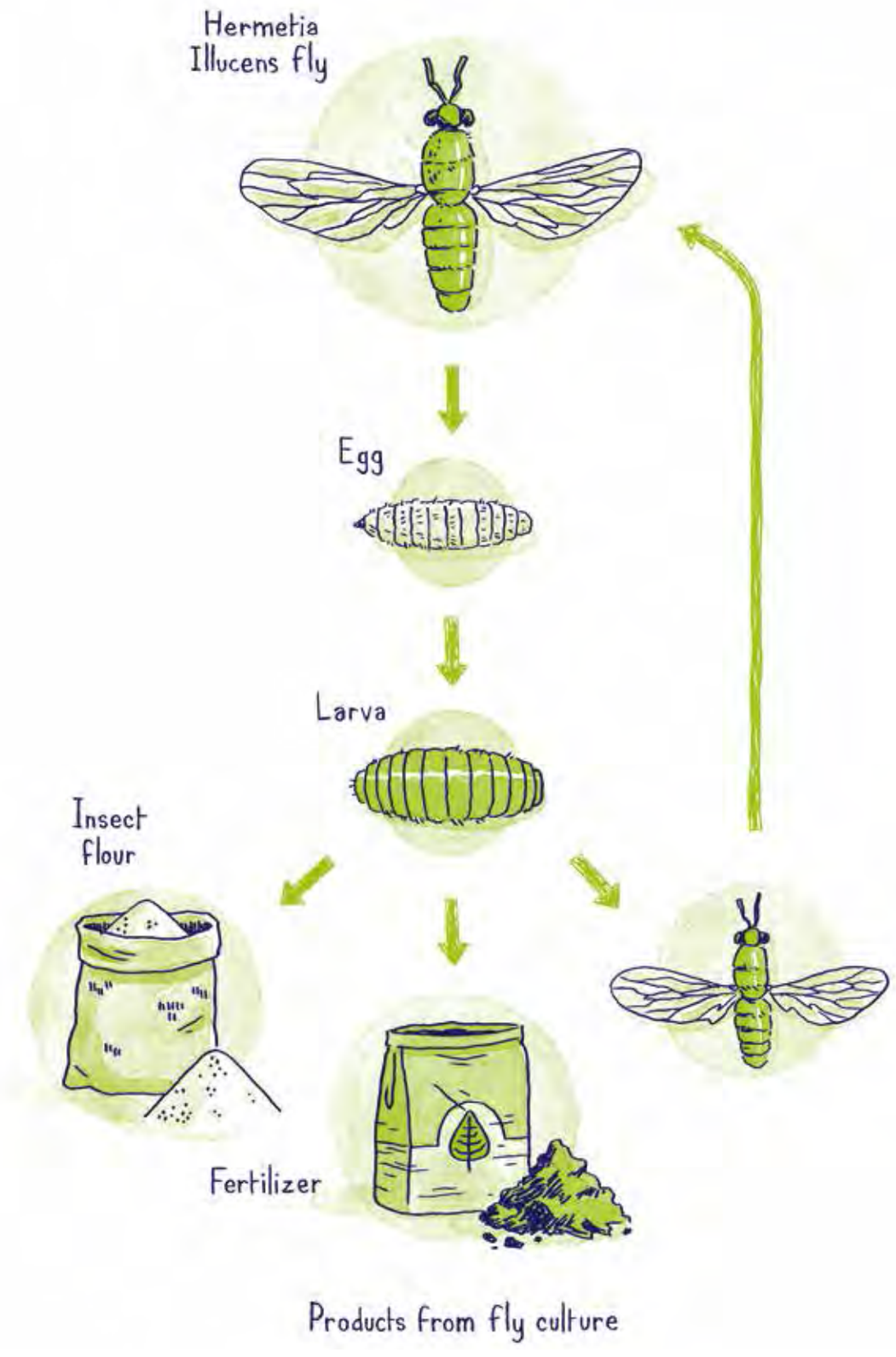
THE FLY SOLUTION

Once upon a time, there were two engineers, named Jean-François Kleinfinger and Raphaël Smia, who wanted to save the planet. Advanced studies and a real talent for mathematics are not always enough to prefer a useful life and a long-term concern for the environment to the easy fortune offered by high frequency trading. These two high-quality individuals began by preparing a realistic report on the situation of our Earth, which would soon have 10 billion inhabitants and one-third of the food it produced thrown out without being consumed. How can we respond to this dual challenge: a lack of protein and an enormous waste of food, which is also a source of pollution (bio-waste)?

The only solution possible was to call on insects. After all, they're just animals much like the others, but their remarkable efficiency enables them to use materials that other animals cannot. But before inviting them into our plates, why not begin by feeding them to our animals? Chickens and fish naturally enjoy them when they have the opportunity. So to conclude, we have to start raising insects as quickly as possible, but which species should we choose? Not to offend our two engineers; they knew absolutely nothing about entomology, but they learned a lot very quickly. They chose a species of fly – *Hermetia illucens* (or black soldier fly) – that delights in eating bio-waste. Other advantages of this little insect include its natural presence in France; it also represents no health risk or risk of transmitting parasites and a very small risk of dissemination; it grows rapidly and eats all manner of matter; its larva can supply protein and an entire range of other sub-products. So the decision was made, still to save the planet, to "manufacture" these black soldiers on an industrial scale.

Our two friends set up shop in a vacant cowshed in 2013. Yes, Nextalim – the future of food, the food of the future – was born in a vacant cowshed, an entirely logical location if you think about it. Didn't our two engineers decide to transform themselves into livestock farmers?

Gradually, their knowledge became more refined. Public and private financing was found to support this incredible adventure. The cowshed where they began was soon abandoned for a laboratory, then a plant located in one of Poitiers's industrial parks. Poitiers was chosen in particular for its proximity to Futuroscope, which teaches the general public to know and



like the future, a highly useful mission in our old country, where people are often convinced that "things were better before" and "risk is the enemy."

The two engineers at once found allies in the territory, people driven by the ambition of moving their region forward and the conviction that no one would do it if they didn't. And so economic players from all sectors decided to support the industry. They included Bellanné, which wanted to produce new animal feed that used fewer imported resources, SISTer, which federated the region's players around innovative waste channels, the Alteora hotel, the leading supplier of raw materials, Valagro, which invented recovery methods, Futuroscope, regional authorities and many others who decided to join forces with the goal of helping the industry to get started.

Our two engineers were joined by seven other impassioned young people, often with excellent diplomas and driven by the same desire. They developed more and more sophisticated processes. The start-up gradually became an example of our well-known circular economy, based on one simple rule: to imitate, as closely as possible, the cycles of Nature. Decidedly, Lavoisier was right when he said: "nothing is lost and nothing is created, but everything is transformed."

Let's sum up the path followed. At the beginning the waste arrived in the plant; it included bio-waste of 100% vegetal origin, mainly fruit and vegetables – more or less damaged – as well as bread and other edible but unconsumed vegetal substances. That's why such a company needs to have a strong local presence. We cannot imagine nationwide collection of this waste, treated in a single plant. The tightest possible network is needed. Once the waste is gathered, it is crushed to make a sort of soup…that is very tasty…to maggots. Colonies of fly eggs are placed on it and larva soon emerge from it. These are the maggots, well known to fishermen and to our garbage cans when left too long out in the sun. The feast begins. It's a fascinating spectacle. Day and night, they move because they're eating, swarming, digging and swelling. Once your initial reticence has been overcome, you dare to plunge your hand into the mixture, where your boldness is rewarded by a pleasant tickling sensation, followed by a gentle heat. There's no need to heat the bins: the furious activity of the gluttonous larva provides an ideal temperature.

As we can well imagine, the maggots must evacuate what they eat. Their excrement is preciously recovered to make fertilizer, which will replace chemical products. A small portion of the larva is removed. They will become flies and soon lay eggs, thereby guaranteeing a perpetual supply of eggs. The rest of the larva will then be cleaned and made ready for "transformation". In other less politically correct words, they will be crushed because they contain a treasure, the matter for which we have a growing need: protein and oils with a very interesting nutritional profile, and which could even have natural antibiotic properties. We're going to develop the foodstuffs that, beginning now, will feed the animals. Did you know that to obtain 4 kilograms of farmed fished, you need approximately 2 kilograms of flour, mainly derived from fish in the wild? So when fish breeding is presented as a remedy to overfishing…

Insects can be a rich source of protein for fish meal in aquaculture. The EU Commission has voted to open the aquaculture feed market for insect derived protein from July 2017.

In the future, we could predict that we – people – would accept to eat insects. After all, what's the difference between insects and sand shrimp? They too have heads and legs and we eat them with pleasure, accompanied by a nice little white wine. Insect bars have opened in Asia, and they're a big success.

These nice little larva also open the way to so called “green” chemistry. Lubricants are just one example. Speaking of chemistry, we should bear in mind that insects themselves are little refineries. By treating them, we cut out a lot of intermediary steps.

Investors are interested in Nextalim for all of these reasons and since the company needs funding in order to develop, negotiations are underway with potential financial as well as industrial partners.

The battle of taste is not the only one being waged. We’ll need time to accept the eating of insects. In the shorter term, regulations will have to be straightened out. Why not, for example, accept meat-based waste for larva? A full range of studies has shown that they would get fat faster. But people remember mad cow disease, avian flu and contaminated blood. If there’s one area in which the principle of precaution must be applied, it’s in the area of health. How can we be absolutely sure to block the movement of pathogens from one species to another? Our two engineers remind us that their larva are even further away from cows than are fish in the classification of the animal kingdom, proof that this food of the future is truly innocuous.

Some 8,000 years ago, in the Fertile Crescent between the Tigris and the Euphrates, agriculture and livestock breeding were invented. The era of hunters and gatherers had come to an end. A revolution of the same order of magnitude is maybe getting underway. In any case, food production has to change. Demographic pressure, soil fatigue and the scarcity of water will require us to do so.

Journey No.21
Saint-Denis — France

THANK YOU, *RIPEURS*!

Let there be no mistake about it. This 21st trip – the last – is in fact the first in order of importance, for a very simple reason: without waste collection, there would be no circular economy. If no one picked up our waste, how would it one day become a resource? The people who collect what we throw out we have long called garbage men – *éboueurs* in French – meaning those who, in a strict sense, remove the sludge – *la boue*. You will note the disdain in the term. We prefer *ripeurs*. *Riper* is an old French verb that means polish or move a load, slide it along.

Wednesday, the 1st of March in the city of Saint-Denis.
It's five o'clock in the morning. Paris isn't awake yet, nor is Saint-Denis. Everyone's sleeping. Except for a bakery, across the way. I can see its yellow light. I smell bread, which comes to me in whiffs. I must be dreaming because, for the moment, I'm pacing back and forth between two full garbage cans in front of 23, rue Danielle Casanova (a heroine of the Resistance). The rain has stopped. The second piece of good news is that the truck has arrived. It's a big, white box on wheels, covered with lights, all sorts of rear view mirrors, and an incredible collection of film cameras. It sort of looks like a cash transportation vehicle. That's entirely normal, when you think about it, because our waste is a source of wealth. The back of the truck, which is manufactured by Iveco, is like a piece of a factory, with an automatic tailgate, a garbage can elevator, buttons, alarms and microphones. In all, it costs 250,000 euros.

The driver jumps down from the cab: "Good morning. My name is Abdelouahd Machaalah. You're familiar with Morocco? I'm from the southern part of the country." He introduces me to the two other members of the crew. That's the word used. This high-tech truck is like a boat, floating on a sea of waste. The other crew-members are Harouna Sambake and Al Hassane Drame. The former is from Mali (Bamako, but his family is in Kayes) and the latter is from Senegal. It turns out that these two countries are my other homelands. If Abdelouahd (the driver) hadn't intervened, the round never would have started. We had so much news to exchange. Morocco, Mali and Senegal… Does this mean that all of the *ripeurs* are immigrants? It would seem that in this sector too, they're not "taking

bread out of the mouths of the French," who are not squabbling over this work even if it is rather well paid (considerably above the minimum wage) but is nonetheless difficult. Although the magic truck makes the job easier, there is still much to do. I will see it with my own eyes.
It starts to rain again, as if the sky wanted to teach me something about life. My new friends laugh it off: "OK, it's wet, but it's not cold today and you don't slip on the sidewalks. You should have seen the weather last week!" Scarcely two hours later and I'm ready for the scrap heap and all I did was follow my new friends. It wasn't me who rolled the garbage cans up to the back of the truck, or who picked up everything that fell out of them, or who lugged the large 660-litre bins, of which there were sometimes ten or more for a single apartment building, with wheels that locked, with bins that threatened to tip over and could only get past poorly parked cars with difficulty. It wasn't me who had to separate the polluting waste, like the cans of paint. I could go on, but I'm not telling everything. The odour, in particular, and we were in winter. Imagine what it's like in summer, with the rats and the dogs fighting over every scrap.
— Sorting depends on the area. As you can see, everything is mixed together here. No green or yellow garbage cans. Just the one. That doesn't help us, either here or at the tip.
— What about these piles on the ground?
— The unauthorized piles? That's someone else's job. The city teams come later with their light trucks. The mayor cannot do it all. A clean city is everyone's responsibility.

"Unauthorized piles. Unauthorized piles." I repeat the expression over and over again. Then another manner of writing comes to me: the unauthorized state, which in French is pronounced the same. I remember two figures: a family of four "produces" nearly 2 tonnes of waste a year. And for an area like the one we're in – Plaine Commune – the overall collection and cleaning budget exceeds 48 million euros.
The day is breaking and everywhere people are greeting the *ripeurs*, shaking their hands and offering them a cup of coffee. Apparently, they are well liked in the neighbourhood. People ask them to do all kinds of favours.
— I hope that everyone remembers them when it's time to give out New Year's gifts.
— Oh, it's not Versailles or Neuilly here, but we get by. Except when fake *ripeurs* get their first and take the pot. It's easy to dress up as a *ripeur*.

For some time now, my friends have been worried.
— You look tired.
— Don't you want to stop?
— It's normal. Writing isn't a physical activity. I have my pride and my professional conscience as a reporter. I want to try to go on a little further, in particular because I'm ashamed. They've just told me how old they are: 55 and 57. They send a good part of what they earn – probably half – back to their families in the home country. They still have five or six years to go before they retire. Then they'll be able to enjoy the sun.

Ten minutes later I give up. I'm a wimp, having twisted my foot on the broken wheel of a child's bicycle. I somehow climb into the driver's cab. The Moroccan proudly shows me his dashboard. A few years ago, I told the Airbus story for a book so I don't feel disoriented with all the screens, warning lights, indicators and joysticks. From the driver's seat, we could look down on the roadway and see everything. I admired it all, then asked how much waste we had already collected.
— Barely a dozen tonnes. We'll continue a little before we go back to the yard. We're going to get started right away.
— How long does a round take?
— Six to seven hours. We don't have the Marseille system here.
— The Marseille system means: as soon as the work is done, you go home. Right?
— Exactly. There are risks when you want to do everything too quickly. We respect our schedules.

Maybe I'll meet them again one day – Abdelouahd, Al Hassane and Harouna – in their respective villages, enjoying a well-deserved rest on their doorstep. We'll remember our peals of laughter from this morning.
— Do you remember the kalashnikov?
— You bet I do. It was a beauty.
— And it was just sleeping so peacefully in the garbage can.
— Like a baby.
— For a machine gun, what could be a more comfortable bed than plastic bags?
— You see? Sometimes it's better not to sort waste.
— There are all sorts of new resources in garbage cans.
— You can say that again.
— When the police finally came, they didn't even seem surprised.
— Yeah, they've seen everything.
— In any case, long live the *ripeurs*!
— Without them – without us – there would be no circular economy.
— And rats would rule the city.
And since there are no *ripeur* robots yet. They'll need us to do the job for a long time to come.

CONCLUSION

These 21 journeys had one and the same goal, which is to help us sketch the portrait of the economy of the future.
An economy in which *waste* is becoming *a resource*, an economy that is *several times circular*, meaning that it is made of several loops, some of which are very local and others are larger. Loops that are symmetrical, overlap and nurture each other. A *concrete* economy that makes the *territories* and the *geography* important, this science of *interactions*. It's a *dynamic* economy that showcases *on-going innovation* and thus people.

While this portrait of the future may seem clear to us, the path we must follow to reach it is much more uncertain. With oil prices low, how can we promote the use of recycled products simply because the raw materials are less costly. After making my journeys, I am convinced that only a strategy of responsibility that is general and determined will enable us to speed the development of this new economy.
• For manufacturers, who must accept and plan for recycling, beginning in the product design stage. It's time to make room for eco-design.
• For consumers who want to sort what they throw away.
• For political authorities who must agree on clear regulations and *a significant and gradually changing price for carbon*.

As an incorrigible traveller, since I'm curious to the point of making myself ill, I didn't limit myself to 21 journeys. Here are two other news items, coming from two other countries. One is terrible. It's about the collapse of a landfill near Addis-Abeba, the capital of Ethiopia. I'm familiar with the place. Many people live on this mountain of waste and 110 of them died there last week.
The other news item is heart-warming. I've just come back from Paraguay, where I heard a magnificent orchestra made up of young people from the shantytowns of Asunción. They only play on instruments that they have recuperated, using boxes for violins and large containers for string basses. Listen to them on YouTube: *Los Reciclados*. Their slogan is truly beautiful: "*Give me your waste and I'll make music with it.*"

I would like to begin by thanking the people I met during these 21 journeys. Thanks to them, this book now exists.

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