FUTURE AHoy!
An infographic novel about sustainable transport

Based on the Agora study “12 Insights on Transforming Transport”

A unique hybrid between a graphic novel and an infographic presentation

Packed to the gills with information about transport

By Agora Verkehrswende and Ellery Studio
FUTURE AHoy!
An Infographic Novel About Sustainable Transport
DEAR READERS,

Since releasing "12 Insights into Sustainable Transport" in 2017, Agora Verkehrswende has published more than twenty studies detailing the essential building blocks of climate-friendly mobility.

This publication marks a significant departure from our previous work on sustainable transport. For one, it’s filled with cartoons and colorful illustrations. For another, it does not contain any new findings. Why did we decide to take a different approach?

The term "Verkehrswende" ("transport transformation") and the broad range of topics it encompasses have gained enormous polarity over the past three years in Germany. But there has been little progress in implementing policies that will make sustainable transport a reality. In Germany or other parts of the world, although it is becoming increasingly clear that the transport sector is one of the biggest challenges in climate protection.

So instead of another expert report, we have sought to reach a wider audience with an innovative genre: the "infographic novel." Part infographic, part graphic novel, it draws on our previous insights but re-packages them in a fun and accessible format. Its purpose is to raise public awareness of the problems that the transport sector poses for the climate while pointing to real solutions that can help fight global warming.

In realizing this ambitious project, we enlisted the help of Ellery Studio, a group of young designers, researchers, illustrators, and go-getters dedicated to making climate change understandable and illuminating prudent paths forward. We spent many gratifying hours with the Ellery team last year hatching ideas and storylines for this novel form of science communication. It was new territory for everyone.

"Future Ahoy!" is the result of our collaboration. We hope that it entertains, enlightens, and ultimately inspires. Its overriding message is that sustainable transport is a collective endeavor. If it is to succeed, each and every one of us must embrace a common purpose.

Christian Hochfeld and Marena Pützschler
Agora Verkehrswende
WHAT IS AN INFOGRAPHIC NOVEL?

WHAT THE HAY?
IS THIS AN INFOGRAPHIC OR A GRAPHIC NOVEL?
It’s both!

INFOPHIC
GRAPHIC NOVEL

IMPORTANT FACTS AND INFOGRAPHICS APPEAR IN BRIGHT PINK.

THE CONTEXT EXPLAINS THE BEST.

TO BE HONEST, I'M SKEPTICAL! IT’S A NATURAL INSTINCT FOR GERMAN BREEDS.

The facts tell the story

BLA BLA BLA

A CUTE COUPLE, DON'T YOU THINK?

WE CAN MAKE TRANSPORT SUSTAINABLE.

SUSTAINABLE TRANSPORT HAS BEEN A HUGE TOPIC FOR US RECENTLY.

I WAS EXTREMELY DOUBTFUL AT FIRST.
I DEFINITELY PREFER THINGS TO STAY THE SAME.

I WAS EXREMELY DOUBTFUL AT FIRST.
I DEFINITELY PREFER THINGS TO STAY THE SAME.

1. WHY IT IS NECESSARY P. 6
2. HOW IT CAN SUCCED P. 20
3. ALL'S WELL THAT ENDS WELL P. 64

HERE I AM WITH MY FAMILY.

DAD
DAUGHTER
NEWEST MEMBER OF THE FAMILY

GRAMPS
GRAMPS
DAD
DAUGHTER
NEWEST MEMBER OF THE FAMILY

IT'S A NATURAL INSTINCT FOR GERMAN BREEDS.

1. WHY IT IS NECESSARY P. 6
2. HOW IT CAN SUCCED P. 20
3. ALL'S WELL THAT ENDS WELL P. 64

THIS INFOGRAPHIC NOVEL EXPLAINS HOW IT CAN BE DONE.

SUSTAINABLE TRANSPORT

1. WHY IT IS NECESSARY P. 6
2. HOW IT CAN SUCCED P. 20
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CHAPTER 1

WHY WE NEED SUSTAINABLE TRANSPORT
It was hard to imagine thirty years ago! But now we have a healthy planet and a prosperous, emissions-free economy.

This could be the world of the future, but only if we manage to stop global warming!
In 2021, climate change continues to gain steam.

I’VE ALWAYS DREAMT OF BEING AN ASTRONAUT! ... BUT OUR PLANET SEEMS SO FRAGILE FROM WAY UP HERE.

THE EARTH HAS ALREADY WARMED BY 1°C. IF THIS TREND CONTINUES, WE ARE HEADED FOR BIG TROUBLE!

COOL IT!

WE HAVE TO TAKE ACTION NOW TO AVOID CAUSING CATASTROPHIC DAMAGE TO THE CLIMATE, TO NATURE, AND TO OURSELVES.

IN 2015 THE NATIONS OF THE WORLD SIGNED THE PARIS AGREEMENT, WHICH CALLS FOR GLOBAL WARMING TO BE KEPT BELOW 2°C, AND, IF POSSIBLE, BELOW 1.5°C. THE WORLD NEEDS TO ACT NOW!

GERMANY HAS ADOPTED AMBITIOUS TARGETS, AND IS SEEKING TO REDUCE EMISSIONS IN ALL AREAS OF THE ECONOMY.

Which areas of the economy are responsible for emissions? And how much carbon can be released in 2030? (Figures in million tons of CO₂ equivalents*)

THE FOCUS OF THIS BOOK!

10 11

DEFINITIONS CAN BE FOUND ON PAGE 76.
Germany’s goal is to reduce emissions in transport by 40-42% relative to 1990. It wants to reach this target by 2030.

Darn! I’m late for my meeting! I’ll take the car today. Otherwise I won’t arrive on time.

Last night I dreamt again. I was an astronaut...

Last night I dreamt again. I was an astronaut...

Grandpa, did you know that almost 20% of all emissions in Germany come from transport? I just heard it on the news!

Experts: Climate change, epigenetics

Would you like a ride to school, sweetheart?

No thanks, dad.

I’d rather ride my bike – it’s much healthier!

A strike! More climate hysteria!

Hmmm

Anyway, school is closed for a climate strike!

Experts: Climate change, epigenetics

Kids on strike! That never happened in the good old days!

Good old days? Ok Boomer...

In the good old days the situation wasn’t as serious.

Ok, boomers...
Cars and trucks cause more emissions than all other modes of transport combined...

Carbon emissions from all modes of transport in Germany for 2017 (in million tons of CO₂ equivalents)

<table>
<thead>
<tr>
<th>Mode of Transport</th>
<th>Emissions (Mt CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>1</td>
</tr>
<tr>
<td>Rail transport</td>
<td>1</td>
</tr>
<tr>
<td>Costal and inland ships</td>
<td>2</td>
</tr>
<tr>
<td>Domestic air travel</td>
<td>2</td>
</tr>
<tr>
<td>Road traffic</td>
<td>162</td>
</tr>
</tbody>
</table>

5 minutes later...

According to established standards for calculating emissions, international air and maritime traffic originating from Germany does not count toward national emissions.

1990

1.4 M trucks
30.7 M cars
82 HP average horsepower

1990 was less traffic. It was much easier to get around.

One thing is clear: Making road transportation climate neutral by 2050 will require radical change.

2017

2.9 M trucks
45.8 M cars
121 HP average horsepower

82 HP average horsepower

...and the amount of CO₂ emitted since 1990 has risen rather than fallen!

5 minutes later...

Back in the 1990s there was less traffic. It was much easier to get around.

One thing is clear: Making road transportation climate neutral by 2050 will require radical change.

But these aren’t the only sources of global warming.

HuH. what could be in here?

According to established standards for calculating emissions, international air and maritime traffic originating from Germany does not count toward national emissions.

One thing is clear: Making road transportation climate neutral by 2050 will require radical change.

Bigger and faster is not better for planet Earth.

82 HP average horsepower
Traffic injuries in 2018: 399,293 (including 3,275 fatalities)

Nearly 5 million Germans regularly lose sleep because of traffic noise.

Tailpipes release nitrous dioxide, a harmful compound that causes respiratory problems. 61% of dangerous emissions in German cities are caused by road traffic.

Conventional vehicles are almost totally dependent on petroleum, which has to be imported from abroad.

Less than 25% of land in Germany is unspoiled by a road or railway within a 5 km radius. Road and rail infrastructure disturbs ecosystems and eliminates areas for enjoying nature.

The external costs of road traffic to the environment and human health are estimated at $2 billion.

These costs are not born by the individuals who cause them but by society as a whole.

No thanks... that game is so last century.
Creating sustainable mobility encompasses a range of measures—including efforts to reshape attitudes and beliefs—that will encourage people to use more public transport, rely less on privately owned vehicles, and make more trips by foot or bike. It also involves shifting some freight from roads to rail and waterways.

To be sustainable, the transport sector must rely primarily on electricity for power and phase out combustion engine vehicles. Furthermore, the electricity for e-vehicle fleets has to come from renewable sources. Creating a sustainable transport system requires moving at full speed towards a clean-energy-based power sector.
Sustainable transport rests on two pillars. This section is about the first.
THE TRANSITION TO SUSTAINABLE MOBILITY WILL BEGIN IN CITIES.

AND NEW WAYS OF THINKING ARE A CRUCIAL FIRST STEP.

According to a study by the German Federal Environment Agency, over 90% of people believe that quality of life would improve if regional and urban planning sought to diminish dependency on cars.

In which city would you rather live?
In the postwar era, everyone loved the idea of car-centric cities.

The decisions of urban planners in the 1950s and 60s are why cars continue to dominate cities today.

Many cities are reaching the breaking point...

...because cars foul the air and ruin the climate...

...they take up more space than any other mode of transport...

Modal share* of journeys made in Germany with over 100,000 inhabitants.

12% of journeys are travelled with public transport.

50% with a car

14% with a bicycle

24% by foot

Terms are defined on page 76.

Street space required for the transportation of 15 people using various means of transport (based on the shared apartment analogy).
...cars take up a lot of space even when they are not being used...

On average, private vehicles are used just 1 hour a day.

**24 HRS IN THE LIFE OF A PRIVATE CAR**

- Midnight
- 1 am
- 2 am
- 3 am
- 4 am
- 5 am
- 6 am
- 7 am
- 8 am
- 9 am
- 10 am
- 11 am
- Noon
- 1 pm
- 2 pm
- 3 pm
- 4 pm
- 5 pm
- 6 pm
- 7 pm
- 8 pm
- 9 pm
- 10 pm
- 11 pm

MY FAVORITE THING TO DO IS CHILL OUT.

I PAY 40 TIMES AS MUCH PER SQUARE METER FOR AN APARTMENT AS A CAR PAYS FOR A PARKING SPOT.

WHY AM I BEING TREATED SO UNFAIRLY?

I HEARD HE EVEN KILLED AN OLD LADY CROSSING THE STREET.

CHILLING CAN GET PRETTY BORING, HOWEVER.

Out of 24 hours, I spend 17 hours in my car. A car pays significantly less than other users of urban space...

CHILLING CAN GET PRETTY BORING, HOWEVER.

Improving the quality of urban life is easy. We simply have to set new priorities.

...and...

Price inflation: Public transport versus parking meters


Month pass

Single ride

Meter fee per hour

TAKING A HIKE, BUDDY.

BUT I USED TO BE A VIP!

CLEAN CITIES CLUB

I USED TO BE A VIP!
MY CAR SHARING APP SAYS THERE ARE 32 CARS AVAILABLE.

BUT I WANT TO DRIVE MY OWN CAR.

ALWAYS MINE, MINE, MINE!

WHAT ABOUT SHARING INSTEAD?

THERE ARE SO MANY ALTERNATIVES TO OWNING YOUR OWN CAR!

KIDS THESE DAYS!

LETTING THE WIND WHIP AROUND YOUR EARS - NOW THAT'S FREEDOM!

DOES ANYONE WANT TO TRY?

NO THANX!

NOPE!

SORRY, IN A HURRY!

ALTERNA TIvES LIKE THIS MULTIMODAL MIX.

JUST TAKE PUBLIC TRANSPORT, ADD SOME BICYCLES WITH A DASH OF FOOT TRAFFIC, AND THEN MIX IN SHARING AND POOLING SERVICES.

Many people have difficulty changing their daily routines. This is where policymakers can help.

 Alternatives already exist ...
Policymakers need to create incentives to make sustainable mobility a reality.

“Push measures” should be enacted that make car ownership less appealing.

OH MAN, NOT CAR AGAIN...

MULTIMODAL MIX?

HMM... TASTY

“Pull measures” are designed to make other forms of transport more attractive.

WE CAN'T DO EVERYTHING THAT IS NECESSARY AT THE LOCAL LEVEL!

THE FEDERAL GOVERNMENT NEEDS TO HELP.

IF WE ONLY HAD ACCESS TO THE RIGHT TOOLS!
Our roads are becoming ever more congested with people and goods. The delivery of goods is essential for daily life, supplying us with food and other necessary items. However, delivery vehicles compete with cars, buses, and cyclists for scarce road space. Cities will face numerous challenges in this sector in the coming decades.

Despite the problems, we rely on deliveries more than ever before, as the following figures show:

Households are also ordering more online than ever before.

<table>
<thead>
<tr>
<th>Retailer</th>
<th>Coffee shop</th>
<th>Pharmacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5</td>
<td>6.5</td>
<td>12.5</td>
</tr>
<tr>
<td>15.5</td>
<td>25.5</td>
<td>46.5</td>
</tr>
</tbody>
</table>

Number of daily deliveries (trips) and shipments (dispatched goods) per business (in Wuppertal, Germany)

Average number of packages received per person each year.*

*Courier, express, and parcel services

I MAKE 42 STOPS A DAY. THAT MEANS I HAVE TO FIND LEGAL PARKING SPOTS 42 TIMES. THERE ARE HARDLY ANY DELIVERY ZONES - AND I ONLY HAVE 6 MINUTES PER STOP!

I HOPE SOME OF THOSE PACKAGES CONTAIN SAUSAGES...

ON MAIN THOROUGHFARES IN BERLIN, LIGHT AND HEAVY COMMERCIAL VEHICLES ARE RESPONSIBLE FOR 35% OF NITROGEN OXIDE EMISSIONS AND 1/3 OF HARMFUL PARTICULATE EMISSIONS!
Parcel shipping volumes are on the rise. The use of heavy trucks is also increasing. The carbon emissions of the entire branch are thus expected to grow rapidly.

**Automation + Digitalization**

Self-driving cars could revolutionize transportation.

- **Nico Rosberg, Formula 1 Racer**
  - "I've seen a few things in my day...
  - "I just ordered it by app."
  - "These self-driving cars can already drive better than me!"
  - "That's well and good for Nico Rosberg... but are self-driving cars also good for the environment?"

---

**Federal Government**

CITIES

- **Cities should take an active role in managing urban freight traffic.**
- **But they can't do it all by themselves.**

**Firms**

WE NEED TO ESTABLISH GREATER INCENTIVES FOR CARGO BIKES AND ELECTRIC VEHICLES IN URBAN FREIGHT TRANSPORT.

WE SHOULD DEVELOP FREIGHT HUBS CLOSE TO CITY CENTERS TO ALLOW BUNDLED LAST-MILE DELIVERY.

WE SHOULD CREATE MORE DELIVERY ZONES WHILE REDUCING PARKING SPOTS.

**States**

- **We need to establish greater incentives for cargo bikes and electric vehicles in urban freight transport.**
- **We should develop freight hubs close to city centers to allow bundled last-mile delivery.**

**Cities**

Parcel shipping volumes are on the rise. The use of heavy trucks is also increasing. The carbon emissions of the entire branch are thus expected to grow rapidly.

**Unregulated growth is more harmful to the industry than beneficial.**

**Cities should take an active role in managing urban freight traffic.**

**But they can't do it all by themselves.**

**Federal Government**

- "Thank God it's a convertible."
- "Cheers!"

"It drives all by itself!"

**Firms**

- "I've seen a few things in my day..."

**States**

- "These self-driving cars can already drive better than me!"

**Cities**

- "That's well and good for Nico Rosberg... but are self-driving cars also good for the environment?"

---

- "That's well and good for Nico Rosberg... but are self-driving cars also good for the environment?"
- "I just ordered it by app."
- "These self-driving cars can already drive better than me!"
- "That's well and good for Nico Rosberg... but are self-driving cars also good for the environment?"
Self-driving cars could create heaven on earth...

...if they are integrated into public transport, particularly for the first and last mile...

...and if they are shared for the transportation of numerous passengers...

...then we could reduce the size of the vehicle fleet by 97% without limiting personal mobility. This would free up the massive amounts of space currently used to park vehicles while also slashing energy consumption and emissions.

...or they could unleash infernal forces...

...if everyone wants to own their own car...

...if long-distance trips become more frequent because people can read or sleep while travelling...

...and if we let self-driving vehicles drive on their own, in order to avoid paying for expensive parking spots...

...then there will be more vehicles on the road and less public space for non-vehicle related uses. Furthermore, distances travelled, energy consumption, and emissions will continue to rise.
IN RURAL AREAS
SUSTAINABLE MOBILITY LOOKS DIFFERENT

Nearly one quarter of Germans live in rural areas.

German population (2015):
18.7 M in cities
34.2 M in suburbs and towns
29.3 M in rural areas

THE TRAIN IS PACKED AGAIN...

DAILY COMMUTERS IN STUTTGART 250,000

THE COUNTRYSIDE IS SO IDYLIC!

THE TRAIN IS PACKED AGAIN...

OH NO... I’M GOING TO BE LATE AGAIN.

WHAT? THE NEXT BUS DOESN’T COME FOR AN HOUR!

...frequent trips mean very few passengers per vehicle

...but infrequent trips mean low availability

As a result, the share of trips taken with a car is twenty percentage points higher in rural areas.

People living in rural areas are much more dependent on cars than city dwellers...

Modal share in villages and small towns in Germany (2017)

Car 70%
Bike 7%
Public transport 5%
Walking 17%

That’s the cost of dating a country bumpkin!

Because public transport is often inconvenient or unavailable.

...and then walk to pin from the bus stop...

OH GREAT, NOW WE’RE STUCK IN A TRAFFIC JAM. MAYBE WE SHOULD HAVE TAKEN THE TRAIN?

JUST TO GET TO THE TRAIN STATION, YOU HAVE TO TAKE A BUS TO THE NEXT VILLAGE.

That’s horrible!

As a result, the share of trips taken with a car is twenty percentage points higher in rural areas.

People living in rural areas are much more dependent on cars than city dwellers...

...because public transport is often inconvenient or unavailable.

The countryside is so idyllic!
With ambitious investment and new mobility services, public transport in rural areas can be made more convenient.

Private cars will remain important for the foreseeable future. What matters is that they are electric.

2. With ambitious investment and new mobility services, public transport in rural areas can be made more convenient.

3. Encouraging a shift to different modes of transport is possible in rural areas as well as in the city.

- Good bike paths
- 'Expressways' for cyclists
- Parking infrastructure

29% of commuters travel less than 5 km to work.

20% of commuters travel 5-10 km to work.

What is needed to make cycling more appealing:
- Bookable by app
- Self-driving cars
- Small & flexible
- No fixed routes
- Efficient occupancy
- Passengers can be picked up on-the-fly and en route

Let it rain baby!

How awesome! My own charging station, using electricity I generated at home!

No one in the city can say that!

I can’t wait to take this guy out for a spin tomorrow!

Thanks to the sun, and my initiative!

Efficient occupancy

Politicians

Biking that distance is easy, and it’s healthier, too!
I loved model trains when I was little. I did too! Some things never get old!

WHEN I WAS LITTLE.

I did too! Some things never get old!

WHY DON’T WE TRAVEL MORE OFTEN BY TRAIN?

IT WOULD BE MUCH BETTER FOR THE CLIMATE!

EVERYONE USED TO TAKE THE TRAIN. BUT THEN THE WORLD WENT CAR CRAZY.

From road to rail

Comparison of greenhouse gas emissions between road and rail (in gram CO2 equivalents per passenger or ton kilometer, 2017)

Comparison of energy consumption between road and rail (in megajoules* per passenger or ton kilometer*, 2017)

Rail transport is climate friendly...

Today, most trains run on electricity instead of diesel. As renewables generation rises, rail becomes increasingly climate friendly.

87% of rail traffic is electric

13% is diesel

Rail is also much more efficient for freight transport.

Trains emit much less carbon than cars.

...in part because of lower wheel friction and improved aerodynamics in relation to cars and trucks.

Energy sources in rail transport (2017)
Since rail travel is very climate friendly, the government aims to double the number of train passengers in Germany by 2030.

**BUT HOW?**

An innovative timetable system and better coordination between regional trains can dramatically improve the efficiency of the rail network. Travellers will be able to get anywhere they want with greater ease. This will require the expansion of the rail network and the construction of new stations.

**THE APP TELLS ME EVERYTHING.**

New mobile solutions make it easy to find connections and departure times when planning multi-leg journeys with different modes of transport.

Because rail is the greenest way to move freight, companies should transport most goods by train, with trucks used only when necessary at the very beginning and end of a journey.

**REFORM THE RAILWAY TOLL SYSTEM**

Rail tolls are ultimately paid by passengers in the form of higher ticket prices. Rail travel would be more competitive if public subsidies were available for rail network operators.

**OPTIMIZE THE RAIL NETWORK**

Policymakers must enshrine rail network optimization into law with guaranteed funding.

**CREATE A LEVEL PLAYING FIELD**

If each form of transport was required to bear its own environmental and climate costs, rail would be much more price competitive than other options.

**AN APPEAL TO GOVERNMENT**

Life should be as full as possible!

Trains, not so much.

You make me expensive!

The Railmap 2030 shows how this can be done.
Sustainable transport rests on two pillars. This section is about the second.
WE NEED ALTERNATIVES TO GASOLINE AND DIESEL

Even if we change the way we travel and use more bicycles and trains, we won’t be able to do away with cars and trucks entirely. To ensure that the transport sector is environmentally sustainable, we need to power it with renewable energy and create more efficient vehicles.

BIOFUELS ARE NOT THE ANSWER

Transport energy by source in Germany, 2017
94.5% fossil fuels
5.5% electricity and renewables

WHY DON’T WE SIMPLY KEEP OUR OLD CARS AND POWER THEM WITH BIOFUELS, WHICH CAN BE SUSTAINABLY PRODUCED?

I HEARD YOU CAN EVEN PRODUCE BIOFUELS FROM GARBAGE, LIKE IN BACK TO THE FUTURE 2!

THAT WOULD BE AWESOME!

YES, THAT WOULD BE GREAT... BUT THERE SIMPLY ISN’T ENOUGH BIOWASTE.

IF WE CONTINUE TO POWER OUR CARS WITH GASOLINE AND DIESEL, WE WON’T BE ABLE TO STOP GLOBAL WARMING!

GREAT IDEA!

THERE SIMPLY ISN’T ENOUGH LAND AVAILABLE TO GROW FOOD FOR THE WORLD’S POPULATION...

...AND TO CULTIVATE CROPS FOR CONVERSION INTO BIOFUELS.

SLURP

I HEARD YOU CAN EVEN PRODUCE BIOFUELS FROM GARBAGE, LIKE IN BACK TO THE FUTURE 2!

THAT WOULD BE AWESOME!

YES, THAT WOULD BE GREAT... BUT THERE SIMPLY ISN’T ENOUGH BIOWASTE.

...TO PROTECT FLORA AND FAUNA IN NATURAL HABITATS...

...TO PROTECT FLORA AND FAUNA IN NATURAL HABITATS...

I HEARD YOU CAN EVEN PRODUCE BIOFUELS FROM GARBAGE, LIKE IN BACK TO THE FUTURE 2!

THAT WOULD BE AWESOME!

YES, THAT WOULD BE GREAT... BUT THERE SIMPLY ISN’T ENOUGH BIOWASTE.

IF WE CONTINUE TO POWER OUR CARS WITH GASOLINE AND DIESEL, WE WON’T BE ABLE TO STOP GLOBAL WARMING!
I heard you can produce gasoline and diesel using renewable electricity. What a bunch of hocus-pocus! I heard that the other day. The problem is that it’s still way too expensive.

I read about that other day. The problem is that it’s still way too expensive.

Synfuels inefficient and too expensive

I’ve heard about that other day. The problem is that it’s still way too expensive.

What a bunch of hocus-pocus!

How much energy do various types of vehicles require to travel a distance of 100 km?

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Energy Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery-electric vehicle</td>
<td>15 kWh</td>
</tr>
<tr>
<td>Fuel-cell vehicle</td>
<td>31 kWh</td>
</tr>
<tr>
<td>Conventional vehicle (with power-to-gas)</td>
<td>93 kWh</td>
</tr>
<tr>
<td>Conventional vehicle (with power-to-liquid)</td>
<td>103 kWh</td>
</tr>
</tbody>
</table>

Indeed! Direct consumption of electricity is far more efficient!

Ay caramba! Synthetic fuels require a lot of wind power!

Direct power consumption is the most efficient

Witches and knights – my kind of story!

Come on! Or are you chicken?

The literary masterpiece ‘Don Nimbyxote’ tells the story of a knight-errant and his squire Sancho SUV-Panza and their desperate fight against the ferocious giants known as wind turbines.

How to produce vehicle fuels from renewable electricity, water, and carbon dioxide:

Renewable energy

Water

Electrolysis

Hydrogen

Renewable energy

It may look complicated, but it’s already doable!

Power-to-gas

Methanisation

Methane

Carbon dioxide

Fischer-Tropsch synthesis

Gasoline, diesel, kerosine

Power-to-liquid

We’re electric vehicles

Indeed! Direct consumption of electricity is far more efficient!

The key to clean-energy transport and the best strategy for cars.
BUT... are there enough raw materials for everyone to drive electric vehicles?

WHERE BATTERIES GET THEIR JUICE

LITHIUM IS AVAILABLE IN SUFFICIENT QUANTITY FOR ELECTRIC VEHICLES.

SHORT-TERM SUPPLY BOTTLENECKS COULD OCCUR, HOWEVER.

WORLDWIDE LITHIUM RESERVES ARE ENORMOUS, ENOUGH TO MEET GROWING DEMAND

LITHIUM MINING IS OFTEN ASSOCIATED WITH POOR LABOR CONDITIONS AND ENVIRONMENTAL DAMAGE.

THAT'S WHY ITS EXTRACTION HAS A BAD REPUTATION.

THIS LOOKS FAMILIAR...

14,000,000 t
Reserves

240,000 t
annual demand in 2050

25,000,000 t
Resources in the ground

120,000,000 t
Resources under the sea floor

400,000 t
annual demand in 2030

7,000,000 t
Reserves

GO LOOK FOR COBALT SOMEWHERE ELSE!

WORLDWIDE COBALT RESOURCES ARE ALSO ENORMOUS RELATIVE TO ANNUAL DEMAND.

BUT HALF OF ALL COBALT MINING TAKES PLACE IN CRISIS-RIDDEN COUNTRIES SUCH AS THE CONGO.

WE SHOULD TRY TO RECYCLE AS MUCH AS POSSIBLE. DESPITE THE LARGE QUANTITIES AVAILABLE, (IN THE FUTURE, I WILL WORK WITH LESS COBALT.)

TO PROTECT PEOPLE AND THE ENVIRONMENT WHERE MINING TAKES PLACE, WE NEED:

- Mandatory due diligence for cobalt (via cobalt’s inclusion in the EU regulation for conflict minerals)
- Partnerships that support sustainable mining
- Collection and recycling targets for cobalt and lithium in the EU’s battery directive
In Germany, electric cars are already more climate friendly than their conventional counterparts.

**BUT...**

aren't electric cars much worse for the environment than conventional cars during manufacturing?

The carbon footprint of an electric vehicle is higher "at birth".

**CO₂ FOOTPRINT**

- **7.5 t**
- **13.2 t**

Battery production for electric vehicles consumes a lot of electricity, however. This is particularly troublesome when the electricity is generated using fossil fuels.

I was dropped years ago.

I've travelled 150,000 km since I was born!

Including emissions from production!

With age, however, e-cars have an advantage.

After 150,000 km the electric vehicle has lower cumulative emissions, however.

Diesel

16% more emissions than an e-car

Gasoline

24% more emissions than an e-car

Calculations are for a standard compact class car.

In Germany, electric cars are already more climate friendly than their conventional counterparts.
The greater the share of renewables in the power system, the more climate friendly electric vehicles become.

The adventures of Don Nimbyxote continue...

Policymakers must create incentives that accelerate the switch to electric cars.

The greater the share of renewables in the power system, the more climate friendly electric vehicles become.

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We need flexible charging that accommodates current grid capacity and generation levels.

It’s simple: charge me whenever there is an abundance of renewable energy, but don’t charge me so much as to overload the power grid. Does that make sense?

Charging based on grid capacity

I charge as long as I am not overloading the grid. This helps stabilize grid power flows.

Charging based on grid capacity and generation levels

When output of renewables is high, the price of power falls, and I can charge ahead of time, but those in a hurry receive priority in order to prevent the grid from overloading.

Charging based on generation levels

I charge when power is cheap. Regardless of the problems it creates.

Electricity storage is difficult. The less power that needs storing, the better.

One at a time please. Otherwise the grid will overload!

INFLExIBLE CHARGING WITHOUT SUSTAINABLE MOBILITY:

ALL CARS ARE CHARGED SIMULTANEOUSLY AT THE MAXIMUM RATE

6 PM ON A WEEKDAY

I need you again soon! At 9 PM I need to drive 100 km.

I’ve been booked for a trip starting in a few minutes. I need a fast charge.

6 PM ON A WEEKDAY

FLEXIBLE CHARGING WITH SUSTAINABLE MOBILITY

OK, I will let the other cars charge up first.

OK, I will charge at the maximum rate!

I need you again tomorrow morning at 7 AM to drive 22 km.

INFLExIBLE CHARGING WITHOUT SUSTAINABLE MOBILITY:

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HEAVY TRUCKS EXPERTS ARE STILL DEBATING HOW BEST TO POWER THEM

SYNTHETIC FUELS

POWER-TO-GAS
POWER-TO-LIQUID

TROLLEYTRUCK

ELECTRICITY FROM RENEWABLES

FUEL CELLS

BATTERY

ELECTRICITY FROM RENEWABLES

A TRUCK TOLL THAT FLUCTUATES BASED ON CARBON EMISSIONS WOULD CREATE INCENTIVES TO REDUCE EMISSIONS IN ROAD FREIGHT AND USE MORE EFFICIENT VEHICLES.

CARBON TAXES ON FUELS ARE NOT ENOUGH.

GERMAN CARBON TAXES ON FUEL

IF DIESEL IN GERMANY BECOMES MORE EXPENSIVE, THEN I'LL TANK UP ELSEWHERE.

POWER-TO-GAS
POWER-TO-LIQUID

POWER-TO-LIQUID

TROLLEYTRUCK

ELECTRICITY FROM RENEWABLES

ELECTRICITY FROM RENEWABLES

BATTERY

ELECTRICITY FROM RENEWABLES

LARGE SHIPS AND AIRCRAFT THESE VEHICLES PROBABLY CAN'T BE ELECTRIFIED

AT SOME POINT IN THE FUTURE, WE WILL PROBABLY NEED CARBON-FREE SYNFUELS FOR AIRPLANES AND SHIPS.

IF DIESEL IN GERMANY BECOMES MORE EXPENSIVE, THEN I'LL TANK UP ELSEWHERE.

YES! SUMMER VACATION IS COMING SOON.

WHAT ABOUT THE CANARY ISLANDS? THE FLIGHTS ARE CHEAP.

I'D PREFER NOT TO FLY.

MAYBE IN THE FUTURE AIRPLANES AND CRUISE SHIPS WILL RUN ON ELECTRICITY.

THAT'S STILL A LONG WAY OFF.

IF DAD'S NEW GIRLFRIEND IS COMING WITH US, THAT'S FINE WITH ME. I LIKE HER.

FLYING DOES MAKE IT HARD TO TAKE THE DOG... WHAT ABOUT A CRUISE SHIP INSTEAD? DOESN'T THAT SOUND GREAT?

UNFORTUNATELY CRUISE SHIPS ARE ALSO TERRIBLE FOR THE ENVIRONMENT.

UNFORTUNATELY CRUISE SHIPS ARE ALSO TERRIBLE FOR THE ENVIRONMENT.

CERTAINLY SPEAKS HER MIND...

WE'RE JUST TOO FAT.

I'M A LIGHTWEIGHT BY COMPARISON.

THAT'S STILL A LONG WAY OFF.

THIS NEW GIRLFRIEND CERTAINLY SPEAKS HER MIND...

UNFORTUNATELY CRUISE SHIPS ARE ALSO TERRIBLE FOR THE ENVIRONMENT.

CERTAINLY SPEAKS HER MIND...

AT SOME POINT IN THE FUTURE, WE WILL PROBABLY NEED CARBON-FREE SYNFUELS FOR AIRPLANES AND SHIPS.

WE'RE JUST TOO FAT.

I'M A LIGHTWEIGHT BY COMPARISON.
What is the CO² footprint of my trip?

<table>
<thead>
<tr>
<th>CO² equivalent kilograms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train</td>
</tr>
<tr>
<td>973.9</td>
</tr>
<tr>
<td>73.9%</td>
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</tbody>
</table>
CHAPTER 3

USHERING IN THE AGE OF SUSTAINABLE TRANSPORT

Looking to the future
Polluters should pay for the damage they cause to the environment. By taxing activities that emit carbon, we can discourage pollution while encouraging cleaner alternatives. In this way, carbon pricing can help create climate-friendly transport powered by clean energy.

**A Horror Scenario**: A woman with low-income who lives in a poorly insulated house in a remote location, requiring long commutes.

OH NO! I THINK I SEE MYSELF!

**To ensure that carbon pricing is fair, the revenues it generates should flow back to citizens through (1) uniform per capita redistribution, (2) a reduction in the electricity tax, and (3) a hardship fund.**

That’s called energy poverty.
The auto industry is facing the greatest upheaval in its history. Manufacturers who resist change will end up losing out. The future belongs to companies that embrace the development of environmentally friendly vehicles and services.

Electric drivetrains are less complex than their conventional counterparts, and hence require less manpower to build. If 40% of new cars are electric in 2030 and 20% are hybrid, the German automotive sector will have 84,000 fewer employees.

In the ‘business as usual’ scenario (continued manufacturing of conventional vehicles), some 87,000 jobs will disappear by 2030 due to greater mechanization and productivity increases.

German companies sell more cars abroad than they do at home. Demand for electric vehicles in foreign markets, especially in China, is growing rapidly. If Germany cannot cater to this demand, massive job losses in the German car industry are likely to result.

However, only 59,000 jobs will be lost because of e-vehicles. The other 27,000 jobs will disappear regardless of the types of vehicles we produce, due to productivity improvements and further automation. It is also important to consider that the industry currently employs 840,000 people.

If car and bike sharing enjoys success as a business model in Germany, some 200,000 new jobs could be created. However, this would likely reallocate demand for jobs and skills across regions.

German companies sell more cars abroad than they do at home. Demand for electric vehicles in foreign markets, especially in China, is growing rapidly. If Germany cannot cater to this demand, massive job losses in the German car industry are likely to result.

START

Should we manufacture electric vehicles for climate protection?

YES

NO

Electric drivetrains are less complex than their conventional counterparts, and hence require less manpower to build. If 20% of new cars are electric in 2030 and 40% are hybrid, the German automotive sector will have 84,000 fewer employees.

In the ‘business as usual’ scenario (continued manufacturing of conventional vehicles), some 87,000 jobs will disappear by 2030 due to greater mechanization and productivity increases.

2016 automobile production and sales figures of Germany car makers

Share of global automobile production by German companies

68 69
250 BILLION EUROS?! 

Between now and 2050, investment costs could total 250 billion euros.

How much will sustainable transport cost?

And the money we spend on the transformation will help protect us from the disastrous effects of runaway climate change.

And fire! Climate change

WE CAN AFFORD SUSTAINABLE TRANSPORT

I read today that Germany spends 43 billion a year on defense alone.

That would be 17 billion a year for sustainable transport!

How many bones can you buy for 250 billion?

It’s not much when you consider what we spend on other things.

Yes, but it won’t protect you from a proud dad!

The German government awards environmentally harmful tax breaks in the transport sector amounting to 28.6 billion euros annually. In purely mathematical terms, the abolition of these tax breaks would be more than sufficient to fund the investment necessary to transform the sector.

Value of environmentally harmful tax breaks, (2017), in euro billions:

- Jet fuel is tax free: 11.8 billion
- Big and expensive cars get the highest tax break: 5.1 billion
- Tax breaks for company cars: 3.1 billion
- Commuter deductibles: 7.4 billion
- Diesel privilege: 0.2 billion
- Miscellaneous: 0.1 billion

In particular, we should eliminate tax breaks that encourage harmful emissions. Investment in sustainable transport will also allow us to reduce energy expenditures.

But how are we to pay for all that? Money doesn’t grow on trees!

No, we simply need to stop wasting money in other areas!

In particular, we should eliminate tax breaks that encourage harmful emissions.
SUSTAINABLE TRANSPORT IS GOOD
NOT JUST FOR CLIMATE PROTECTION

WHO SAYS YOU CAN’T TEACH HUMANS A FEW NEW TRICKS!

I THINK THEY’RE CATCHING ON!

NOW THEY JUST NEED TO LEARN HOW TO DRIVE...

...SO WILL ROAD SAFETY!

AIR QUALITY WILL IMPROVE...

THERE’LL BE MORE SPACE FOR BIKE PATHS AND OTHER NICE THINGS.

TADA!

THEN IT’LL BE GOODBYE, BIG OIL!

ONCE WE ARE NO LONGER DEPENDENT ON OIL, GERMANY CAN ACHIEVE ENERGY SELF-SUFFICIENCY.

EVEN WITHOUT CLIMATE CHANGE...

... A SUSTAINABLE TRANSPORT SECTOR WOULD MAKE MANY THINGS BETTER

BOTH IN CITIES...

...AND IN THE COUNTRY.

SUSTAINABLE TRANSPORT IS GOOD NOT JUST FOR CLIMATE PROTECTION
MY DREAM HAS FINALLY COME TRUE!
Agora
Greek for “gathering place” or “marketplace”, the central public space in ancient Greek city-states where ideas were exchanged and debated.

CO₂-equivalents
A unit of measurement for standardizing the climate impact of different greenhouse gases. It refers to the magnitude of the greenhouse gas effect as expressed in CO₂.

Agora
Refers to the amount of energy required to transport one ton of goods one kilometer in megajoules.

Modal share (AKA modal split)
The percentage of travellers using a particular type of transportation.

Multimodal mix
When different means of transport (car, bus, bicycle) are combined in a single journey.

NIMBY
NIMBY (short for “not in my back yard”) describes the opposition of residents to a planned development — such as an airport, a low-incoming housing project, or, as in our case, a wind turbine — that they would otherwise support were it not being built so close to their homes.

Passenger transport
While the term “passenger” is normally used in English to refer to an individual transported in a vehicle that he or she does not operate, the OECD defines “passenger transport” as any form of transport of people by road, rail, water, or air.

Power-to-gas
Also abbreviated P2G, this refers to a process for producing gas from electricity, which can be stored and used to power vehicles.

Power-to-liquid
Refers to a process for producing liquid fuel from electricity. Hydrogen is first split from water via electrolysis, and then converted into synthetic fuel via Fischer-Tropsch synthesis.

Greenhouse gases are all gases that raise the temperature of the earth’s atmosphere. They include carbon dioxide (CO₂), methane (CH₄), and chlorofluorocarbons (CFCs).

Verkehrswende
A German neologism inspired by the term “Energiewende” (literally, “energy transition”), it is a compound word meaning “transportation transition” (transport, transition, turnaround). It refers to the transformation of the transport sector toward greater sustainability (pronunciation: Fair-cares-ven-duh).

WHY WE NEED SUSTAINABLE TRANSPORT

Reason #1 for Sustainable Transport: to Protect the Planet

15 BMU (2018): Klimaschutz in Zahlen

Reason #2 for Sustainable Transport: to Improve Quality of Life

18 (2019) Agenda Verkehrswende: Transforming Transport to Ensure Tomorrow’s Mobility: 12 Insights into the Verkehrswende

SUSTAINABLE MOBILITY

The Transition to Sustainable Mobility will Begin in Cities.

Agora Verkehrswende is a Berlin-based think tank that conducts in-depth research on mitigating climate change in the transport sector. The arguments in favor of a Verkehrswende – a sweeping transformation of the transport sector toward sustainability – are numerous and compelling. Yet so far action has failed to materialize, persuading us to ask: What can we do to increase public awareness for this important issue?

You’re holding the answer in your hands. This infographic novel shares our insights in a new format designed to reach a wider audience and engender broader public support for sustainable transport. The storyline follows a family of three generations, from the young and idealistic to the old and cantankerous, as they grapple with issues related to the climate and the future of mobility. They discover that sustainable transport is not just good for the climate, but also an opportunity to positively reshape how we live and work together.

Agora Verkehrswende is a joint initiative of Stiftung Mercator and the European Climate Foundation.

Ellery Studio drives transformation at the intersection of innovation, knowledge and design.