Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

Pathways towards Post Carbon Logistics

Christoph Henseler, nexus Institute | TU-Berlin

22nd REFORMGROUP Meeting Salzburg 2018

Background of the GLI:X Project

GLI:X Green Logistics Indicators for Gauteng

- Project commissioned by the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety

Project Aims:

- Evaluate challenges and goals of stakeholders in sustainable urban logistics
- Assess different approaches to smart and sustainable urban logistic solutions
- Develop a system of indicators to enable quantification of target attainment

German Team:

- nexus Institute for Cooperation Management and Interdisciplinary Research
- GESI System Innovation

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

Building Partnerships for a Sustainable Infrastructure – ENVIRONMENTAL PROTECTION made in Germany

UNITY IN DEVELOPMENT

GESI SYSTEMINNOVATION

nexus Institute for Cooperation Management and Interdisciplinary Research

Outline

1. Trends
2. Technologies
3. Vision

4. Transport systems
5. Africa

Prolegomena on freight

1. Containers cannot vote

→ *Freight transport underrepresented in political/public decision making*

2. Containers cannot walk (and climb)

→ *need to be carried last meters*

3. Containers cannot talk

→ *Need to be accompanied all the time*

Trends and Drivers in Logistics

GLI:X Green Logistics Indicator for Johannesburg/Gauteng

Urbanisation
Global city integration
Smart Cities

Climate Change and Decarbonization

Online Retail

JIT logistics
Urban manufacturing
Industry 4.0

New Hardware
Electric vehicles
Cars, Buses
eBikes and Pedelecs
Hyperloop

3D Printing

Digitalisation
IoT
Smart devices/mobile computing
(intermodal) routing
automation

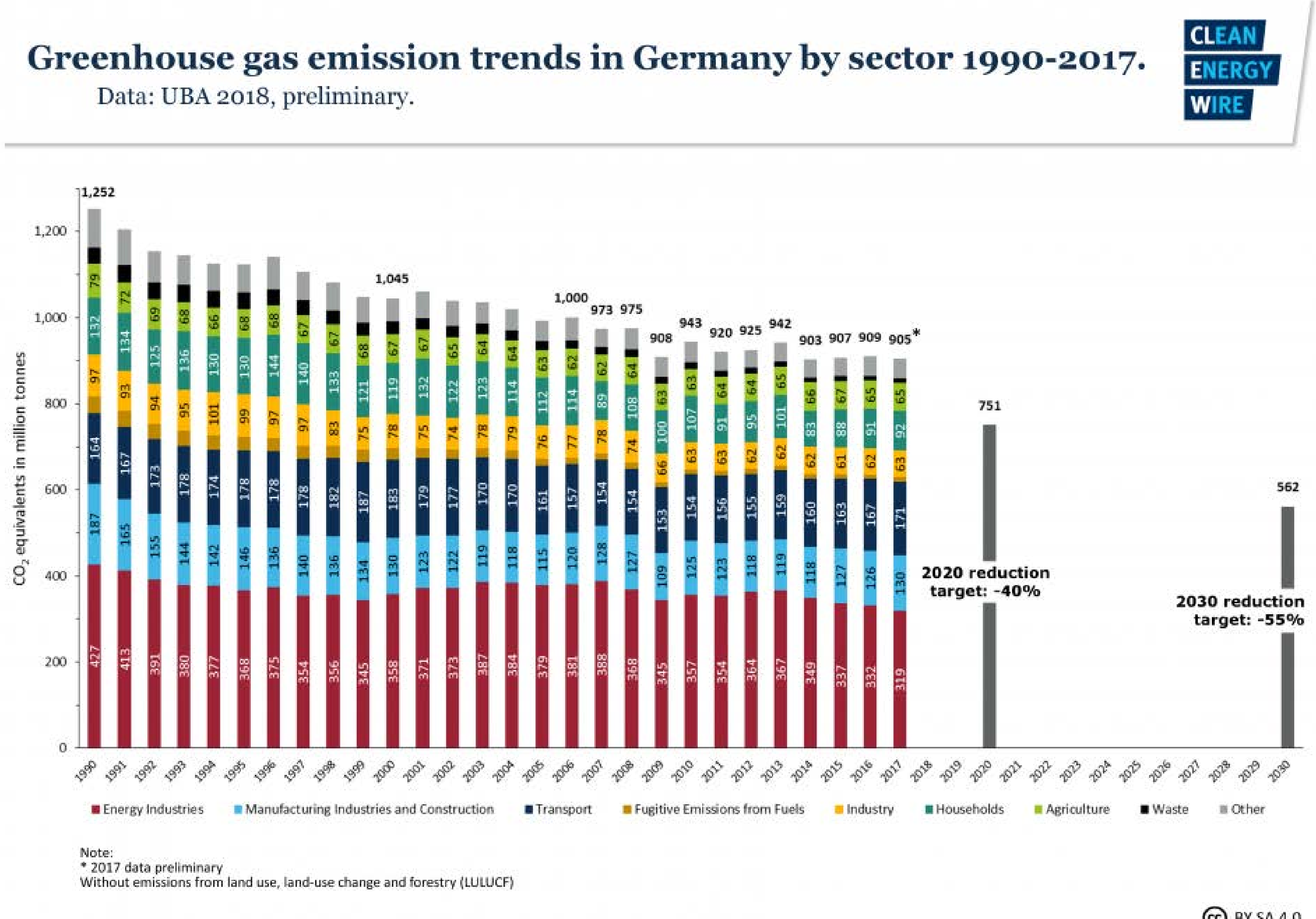
Convergence and futures
Autonomous driving
Smaller vehicles
- delivery drones
- UAVS

Π (Physical internet)

GLI:X Green Logistics Indicator for Johannesburg/Gauteng

Trends and Drivers

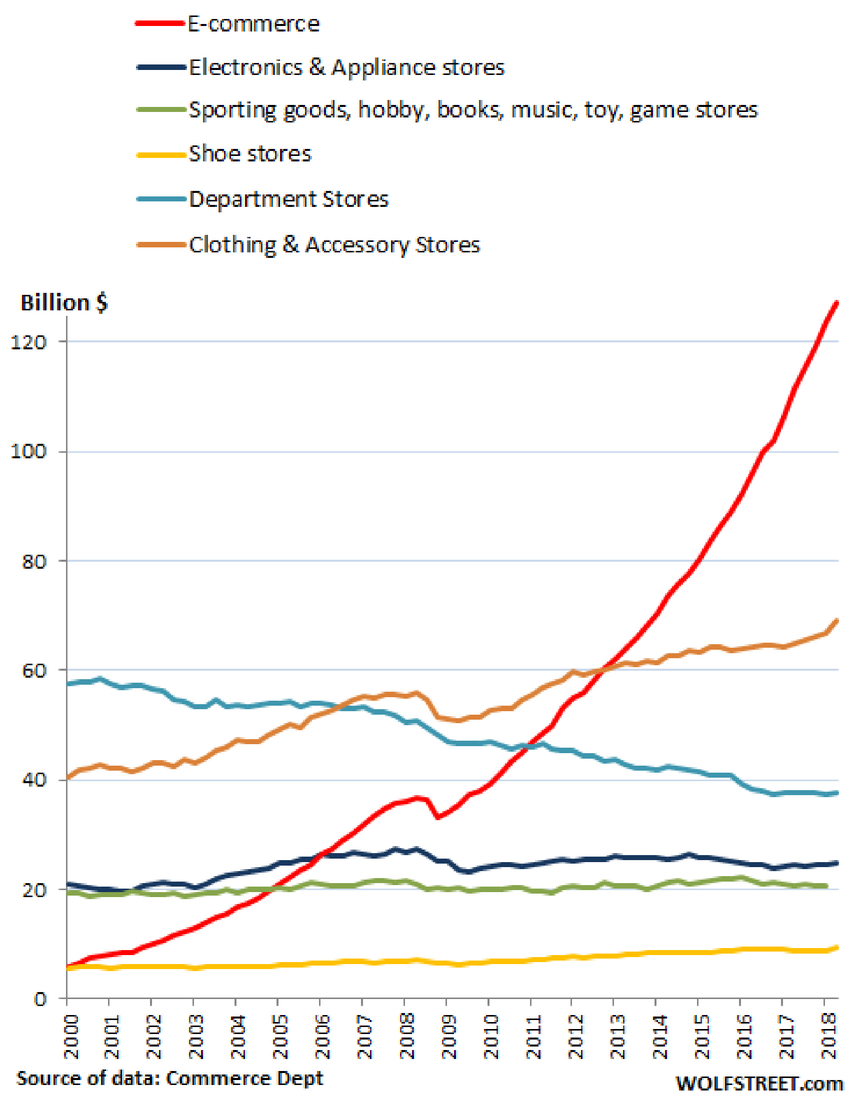
Carbon Footprint transport

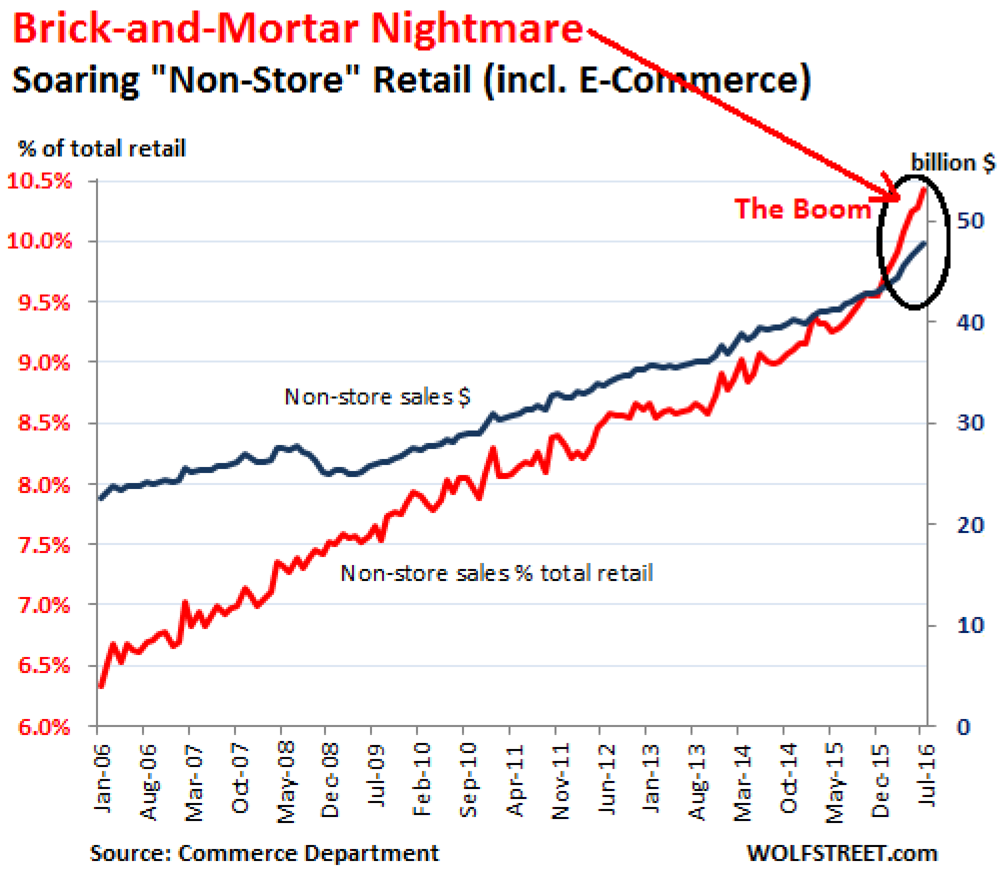


The rise of ECommerce

GLI:X Green Logistics Indicators for Gauteng

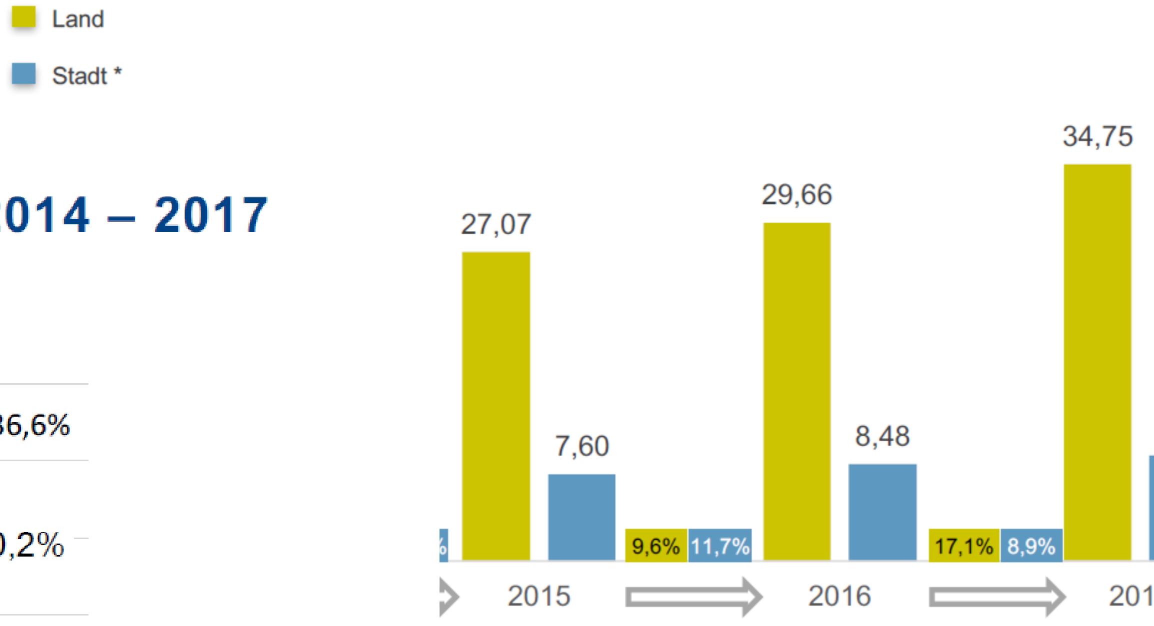
E-Commerce v. Mall Store Sales



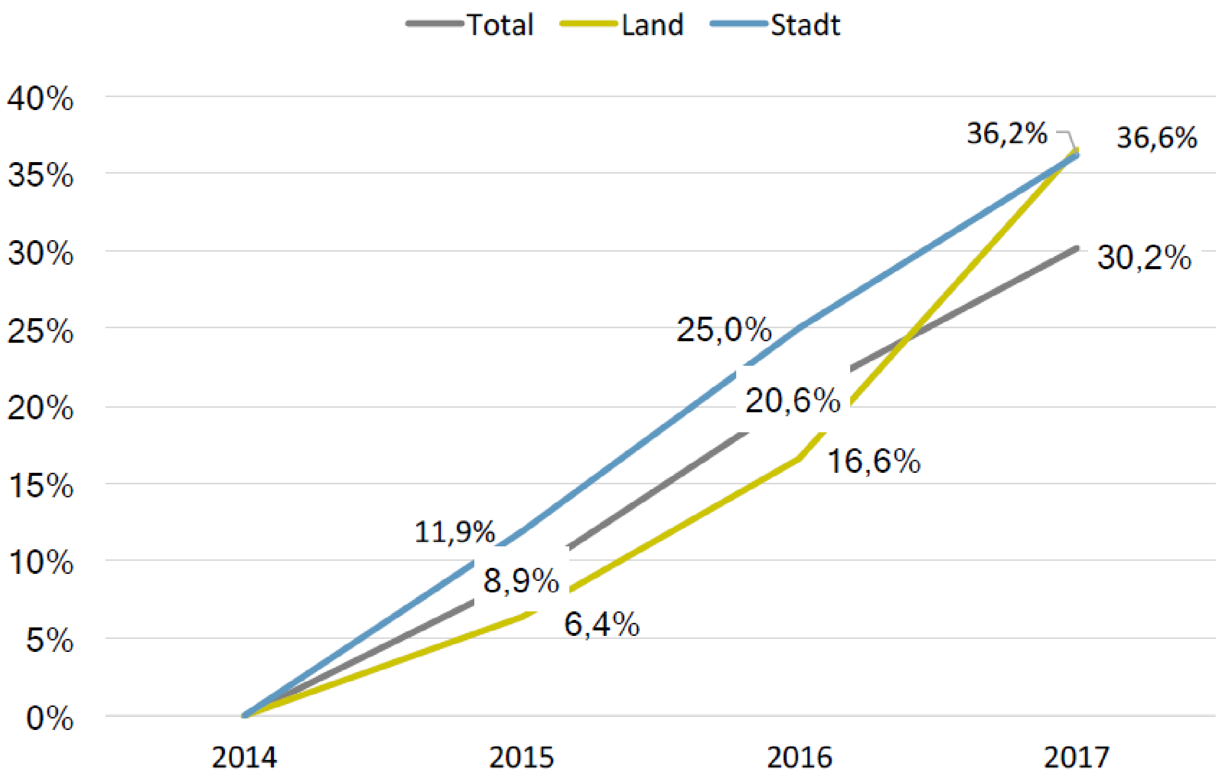


The rise of ECommerce

WAREN IM E-COMMERCE – HOCHRECHNUNG VOLUMINA NACH LAND/STADT: 2014 – 2017



WAREN IM E-COMMERCE – HOCHRECHNUNG VOLUMINA-WACHSTUMSRATEN NACH LAND/STADT: 2014 – 2017



30 | Land = Orte mit ≤ 50.000 Einwohnern I Stadt = Orte mit ≥ 500.000 Einwohnern I Basis: Umsatzangaben in Prozent ohne OMP Privat-Käufe

Source: bevh

Does Ecommerce reduce GHG emissions?

GLI:X Green Logistics Indicators for Gauteng

It seems so…

- Warehouses generally use less energy per square meter than retail stores, up to 16 times less in the case of manually operated warehouses. (Lovins 2001)

- collection of a book (or other small non-food item) from a shop by car in the UK can generate, on average, 24 times more CO_2 than a van delivery to the home. Shopping by bus can be 7 times more CO_2-intensive versus home delivery with a van. (Edwards , McKinnon 2009)

Last Mile transport mode	% last mile CO2 emissions
Shopping trip by car	87%
Shopping trip by bus	75%
Delivery by van	30%

…but it depends on…

Shopping Trip

- How many items bought
- Mode of transport
- Distance to shop
- Mode of transport

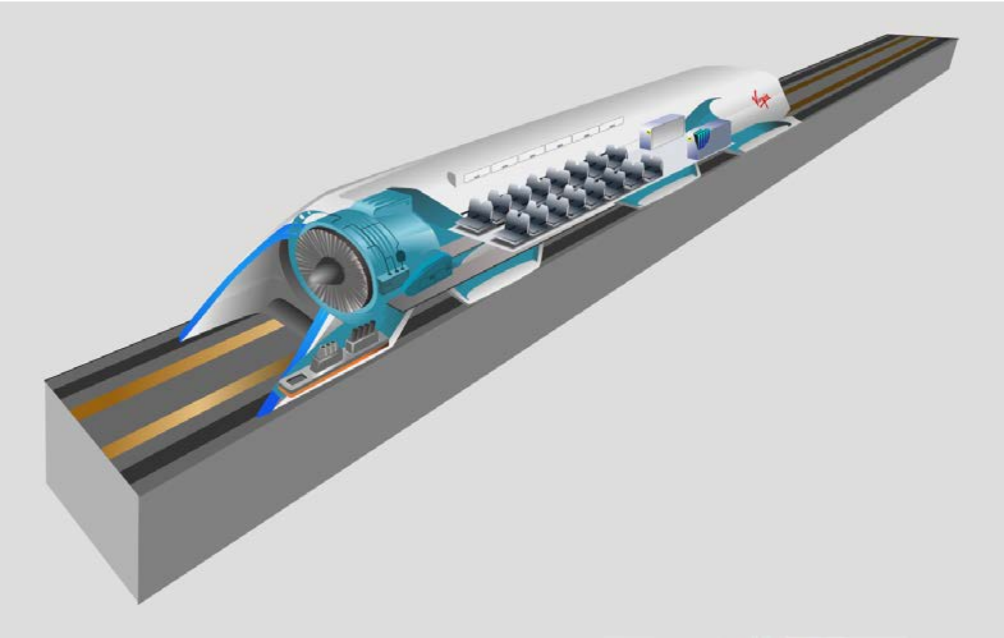
Home Delivery

- First delivery attempt successful
- Load of van
- (also: rural delivery 5 times more CO2 than urban)
- Distance to shop
- Real substitution

Technologies

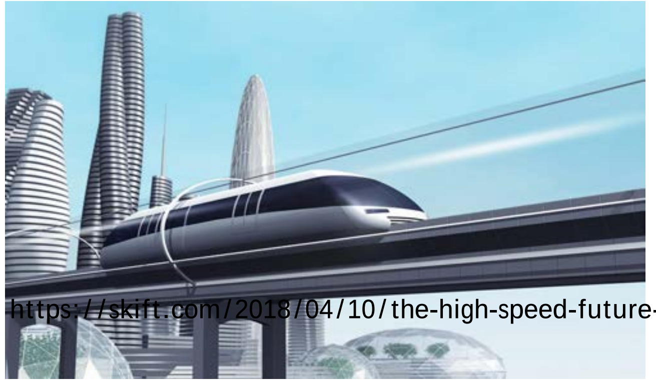
Hyperloop

https://www.wired.com/story/virgin-hyperloop-one-engineering/



https://en.wikipedia.org/wiki/Hyperloop#/media/File:Hyperloop_all_cutaway.png

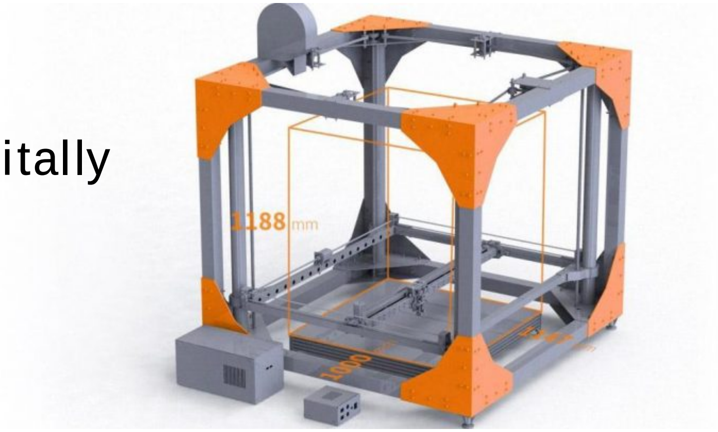
POD II from WARR TU-München, winner competition 2018



https://skift.com/2018/04/10/the-high-speed-future-of-the-hyperloop-and

3D Printer

- Decentralized production
- Transport material + send forms digitally
- Decouple transport of material
- from cocncrte need in time



BigRep

RepRep

Envision Tec

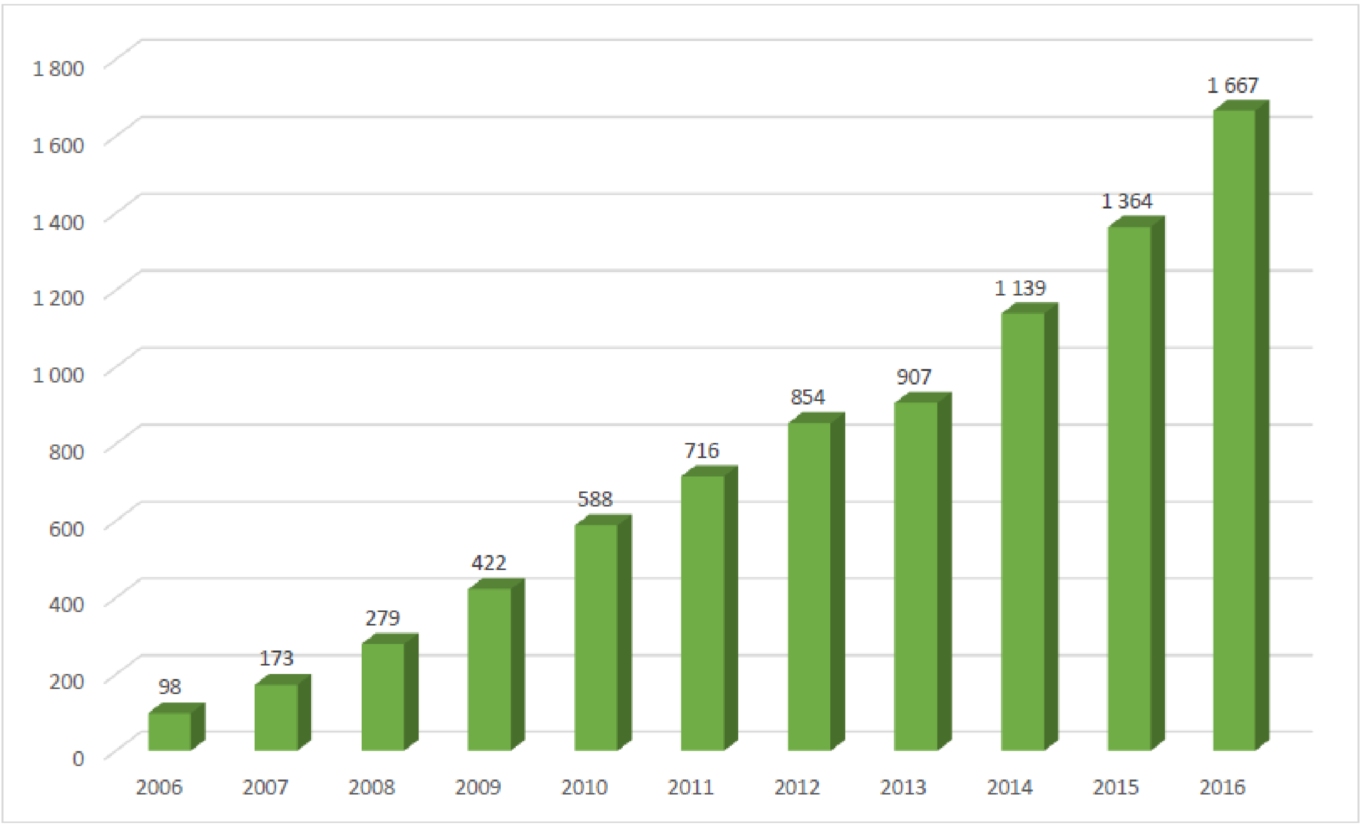
SLM

Electric Vehicles

Source: Deutsche Post

E- (cargo) bikes,

EUROPEAN EPAC SALES[15] (EU 28)
(1,000 units) 2009 – 2016



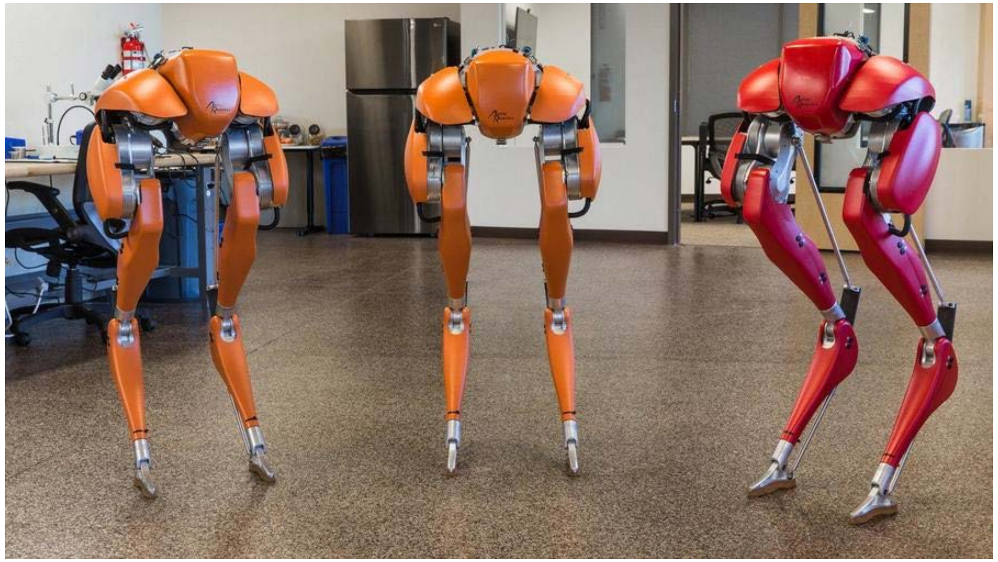
Source: conebi

Smaller (autonomous) vehicles

GLI:X Green Logistics Indicators for Gauteng

Developments

- Mobile computing
- + Ubiquitous internet
- + (cheaper) batteries
- + (cheaper) electric motors
- + AI steering
- + AI navigation
  - → No driver needed
  - → Smaller sizes economical



Containers learning to walk

IOT

GLI:X Green Logistics Indicators for Gauteng

- Ubiquitous internet
- Miniature mobile sensors,
- Miniature internet connected devices
- Continous tracking

→Easier intermodal routing

Containers learning to walk

Urban Logistics 2030

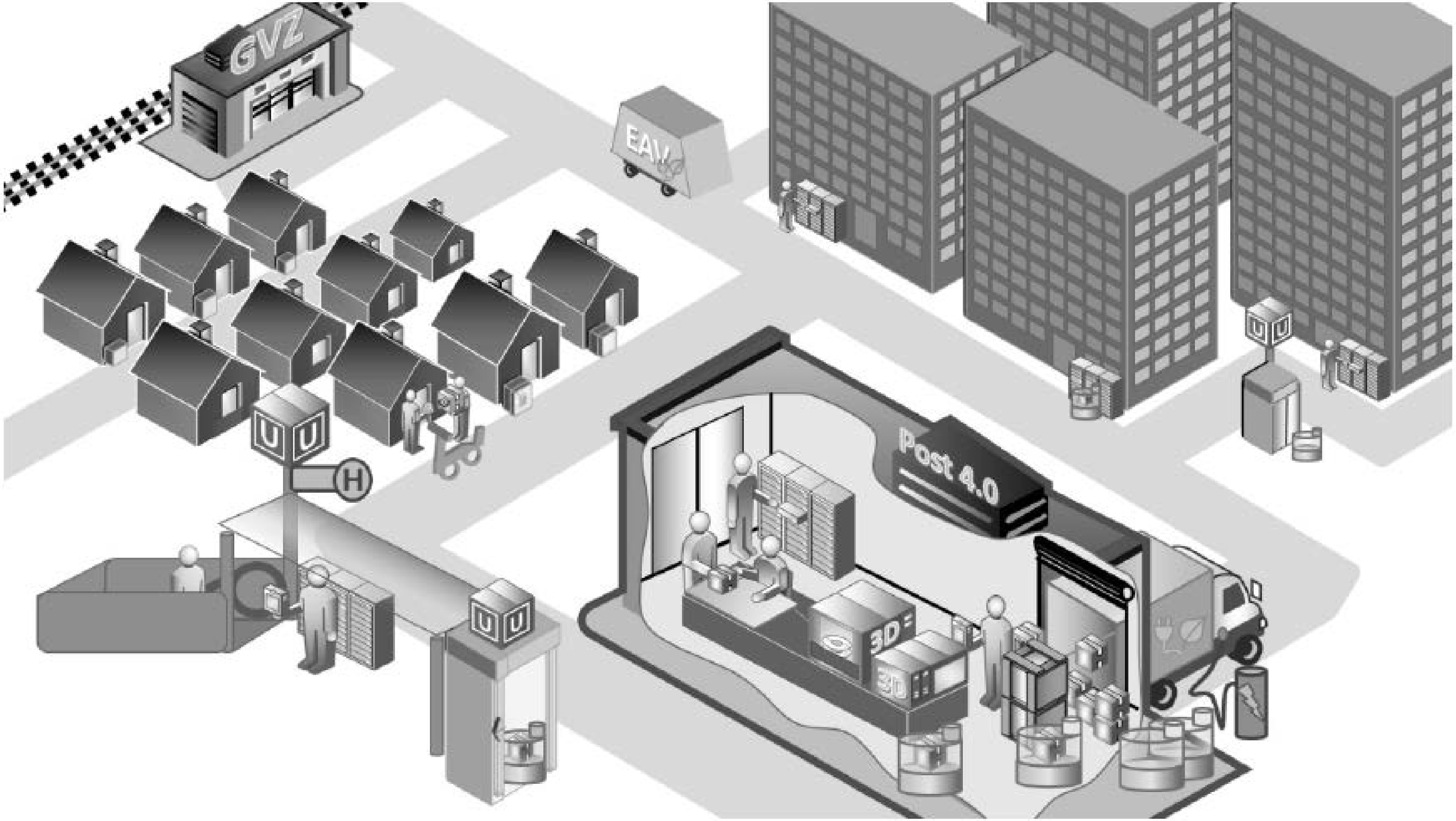


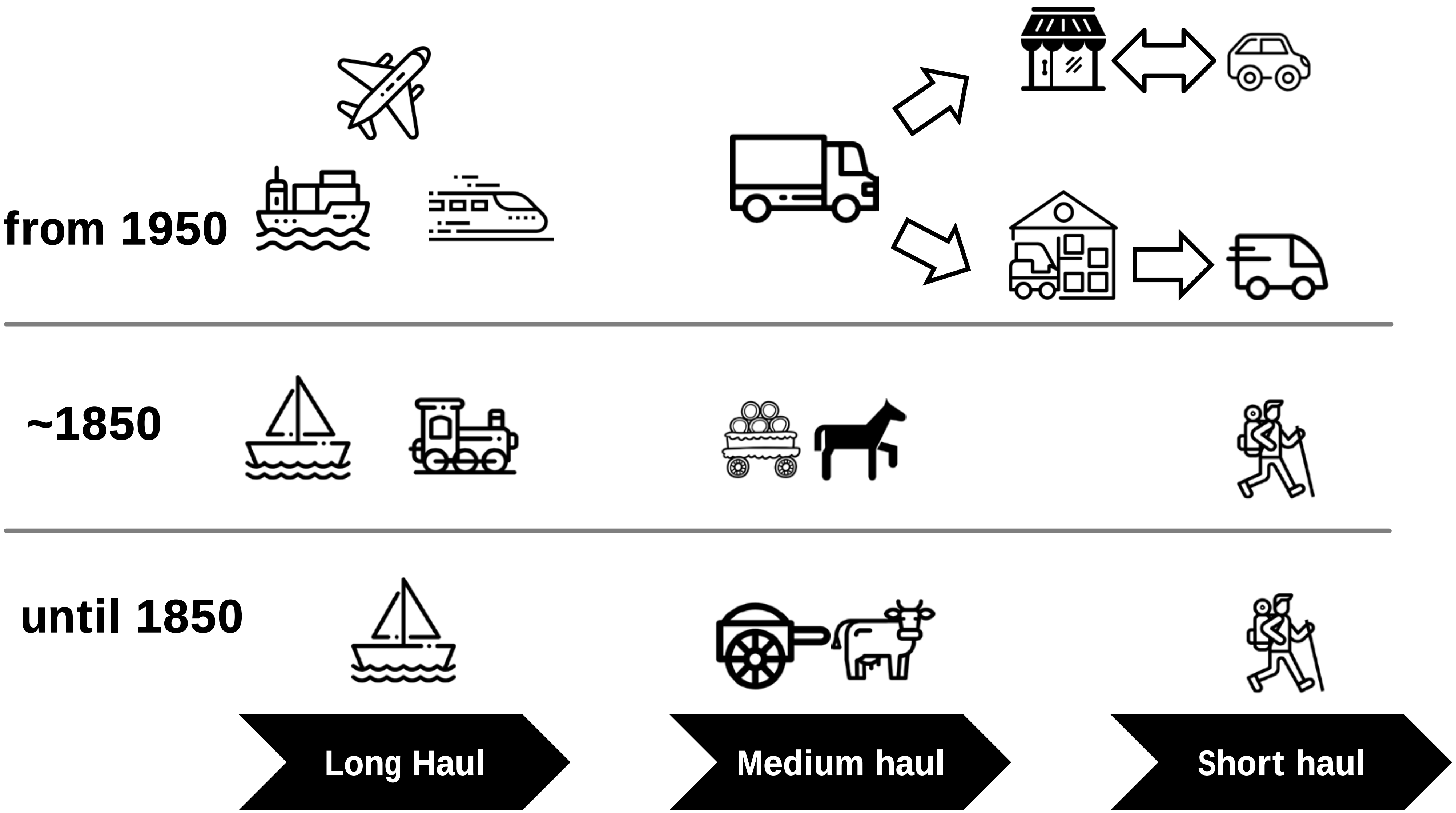
Fig. 4: Visualization of the Vision of Urban Logistics in the Year 2030 (as presented on mobil.TUM 2016)

Source: Kunze 2016

Transport Systems

Transport Systems

GLI:X Green Logistics Indicators for Gauteng



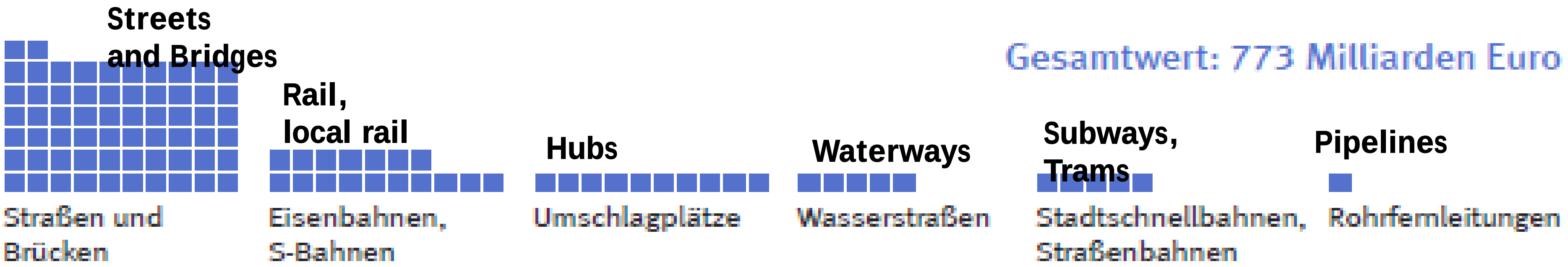
			
	Walking	**Rail**	**Road (Truck)**
Vehicle	–	Train	Truck
Track Infrastructure	Trails	Rail network	Road network
Energy Infrastructure	Food	Electric Grid	Fuel Distribution
Other		Train Station	
Flexibility	High	Low	High
Speed	Very low	High	Medium
Load	Very low	High	medium
Cost Infrastructure	Very low	High	High
Cost Vehicles	none	high	Medium

Investment in Infrastructure

- High Investment costs
- Long investment cycles
- Follow-up maintenance
- → strong path dependency

Wert der Verkehrsinfrastruktur 2010

Brutto-Anlagevermögen in Preisen von 2000, in %



Ein Quadrat entspricht einem Prozent

Quelle: Verkehr in Zahlen, BMVBS (Hrsg.).

Statistisches Bundesamt, Verkehr auf einen Blick, 2013

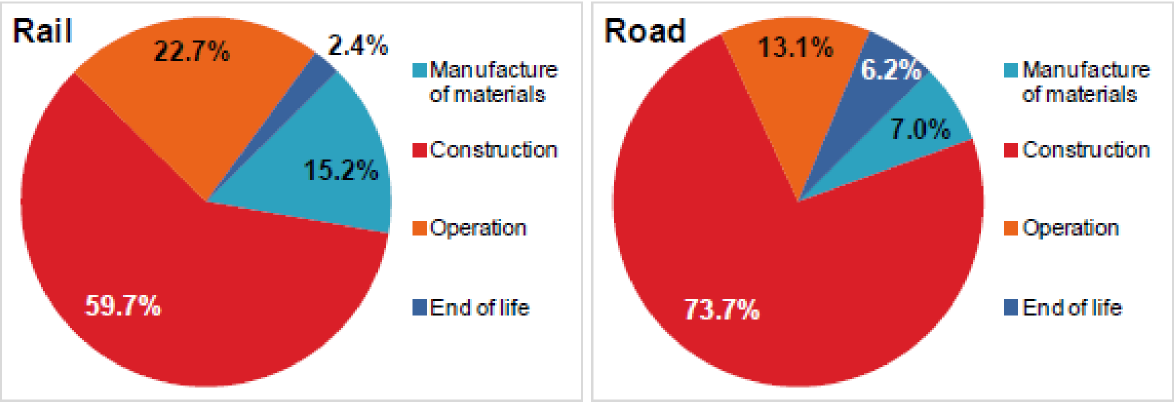
Total Value German Transport Infrastructure: 773 billion EUR

Source: destatis

GHG Emissions Infrastructure

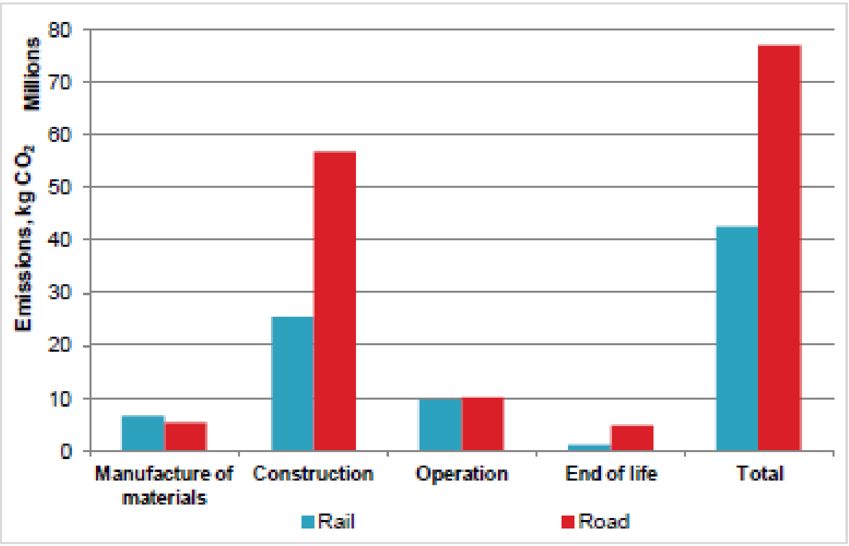
Green Logistics Indicators for Gauteng

Figure 3.17: Total CO_2 emissions for rail and road infrastructure (%)



Source: Adapted from Claro (2010)

Figure 3.16: Total CO_2 emissions for rail and road infrastructure (kg CO_2)



Source: Adapted from Claro (2010)

Figure 3.1 GHG emissions during 40 years of service life of a 13 m wide road in Sweden (adapted from Stripple, 2001).

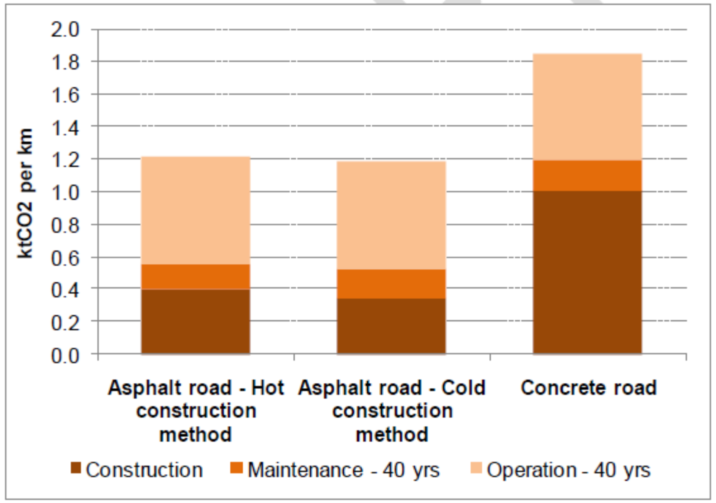


Table 1. Infrastructure life-cycle emissions ($tCO_{2e}\ km^{-1}\ y^{-1}$) of the road construction.

Author	Country/Year	Lifespan (y)	$tCO_{2e}\ km^{-1}\ y^{-1}$
1. Park	Korea/2003	20	447
2. Carlo	Spain/2010	50	160
3. Loijos	USA (Massachusettes)/2011	40	10–162

Table 2. $tCO_{2e}\ km^{-1}$ of road construction of some studies.

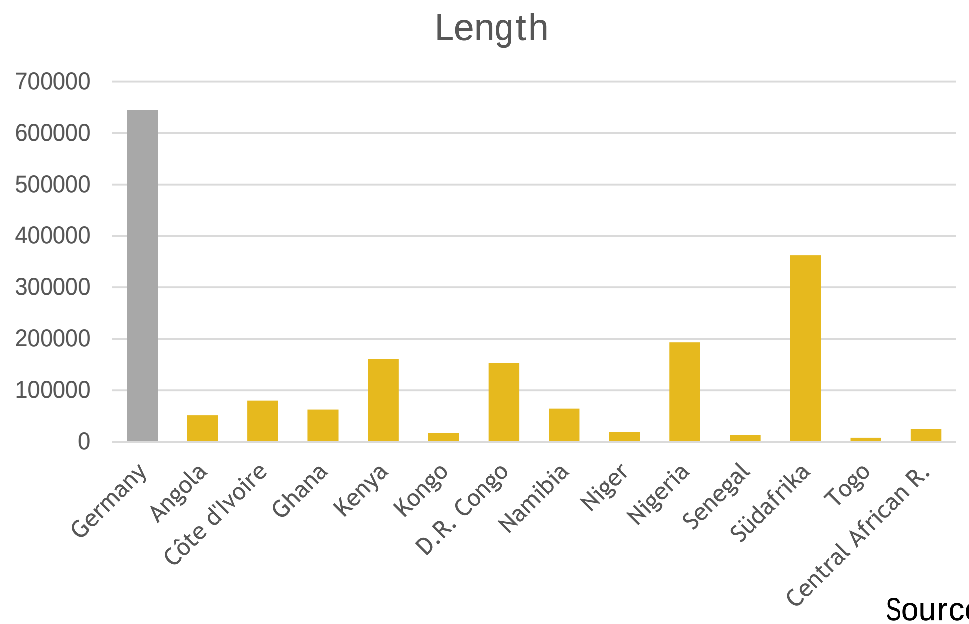
Author	Country/Year	Lifespan (y)	$tCO_{2e}\ km^{-1}\ y^{-1}$
1. Mroueh	Filand/2000	50	6–12
2. Stripple	Sweden/2001	40	50–62.5
3. Athena Institute	Canada/2006	50	1–25.3
4. Birgisdottir	Denmark/2006	100	26.7
5. SUSCON	Greece/2006	50	18.8
6. Milachowski *et al.*	Germany/2011	30	56.5
7. Barandica *et al.*	Spain/2012	50	177–1006
8. Huang	UK India/2012	25	35.9–385

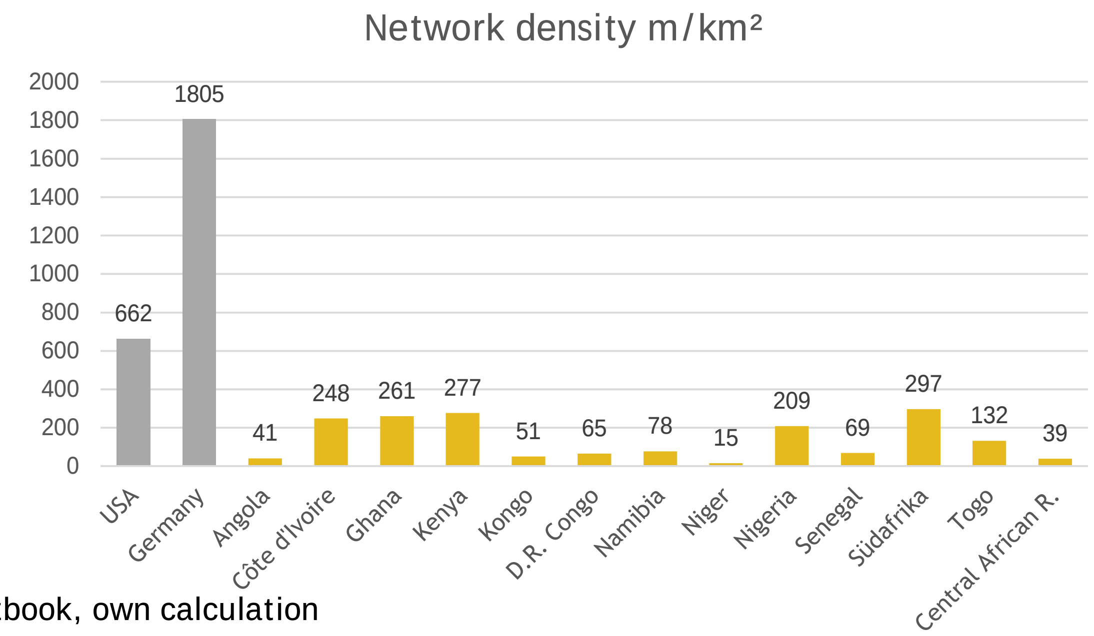
Source: EU-Transport-GHG-2050

Source: Dimoula/Kehagia/Tsakalides 2016

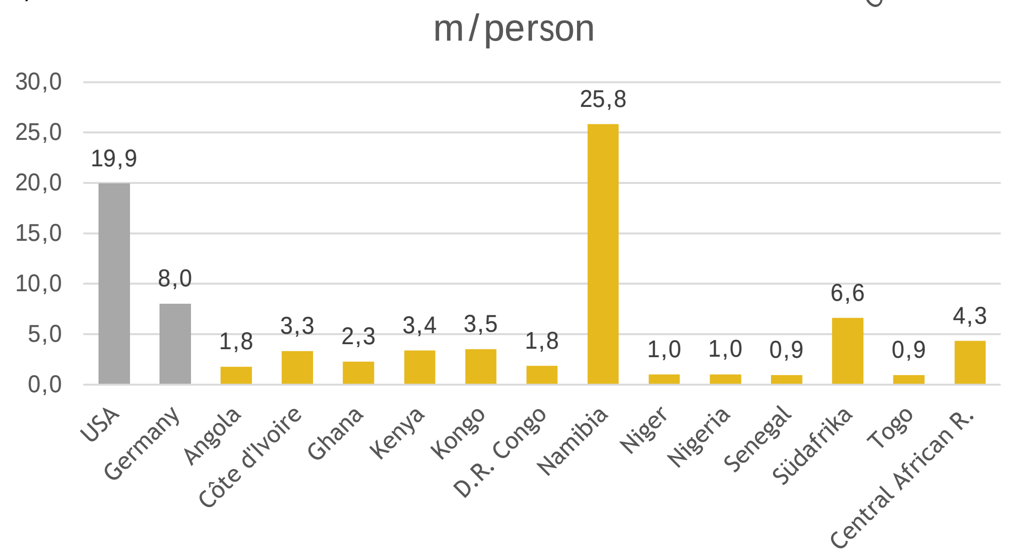
Africa

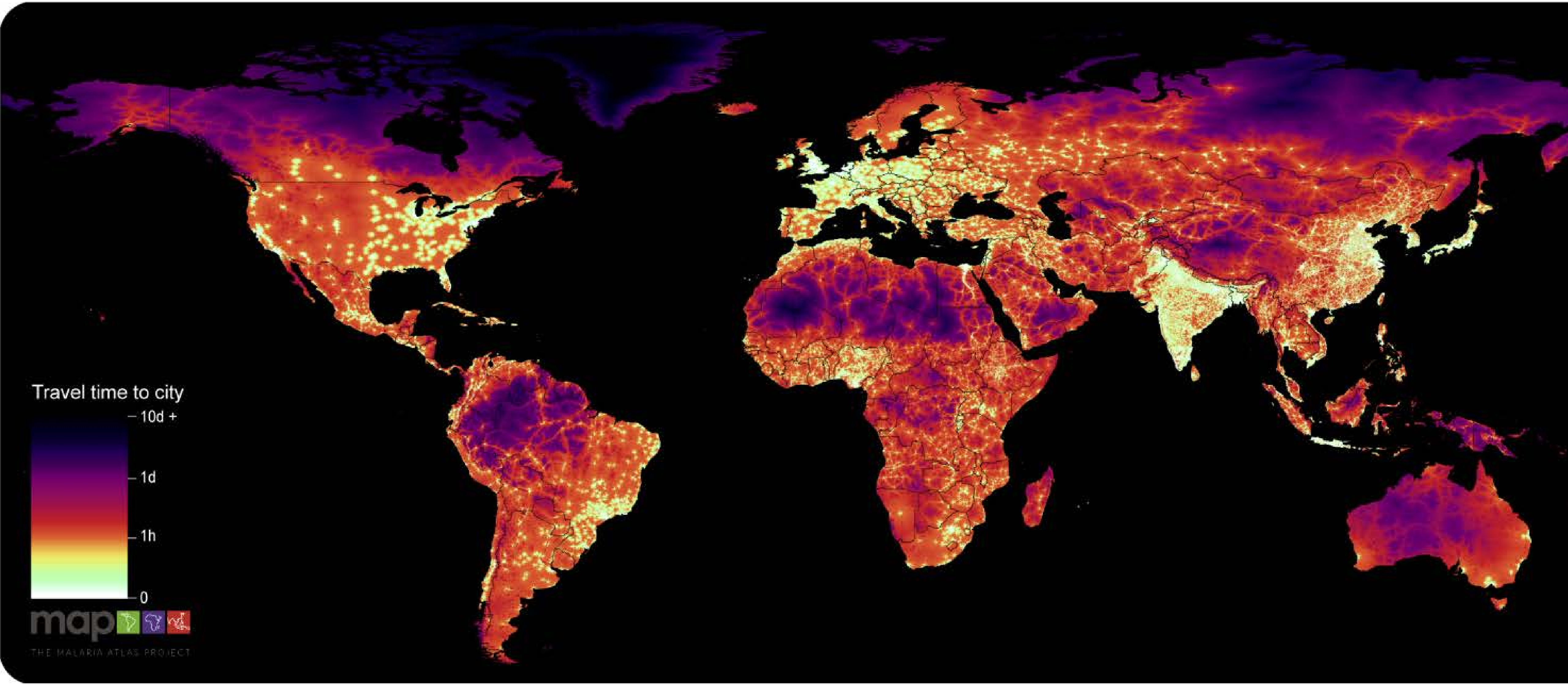
Street lengths





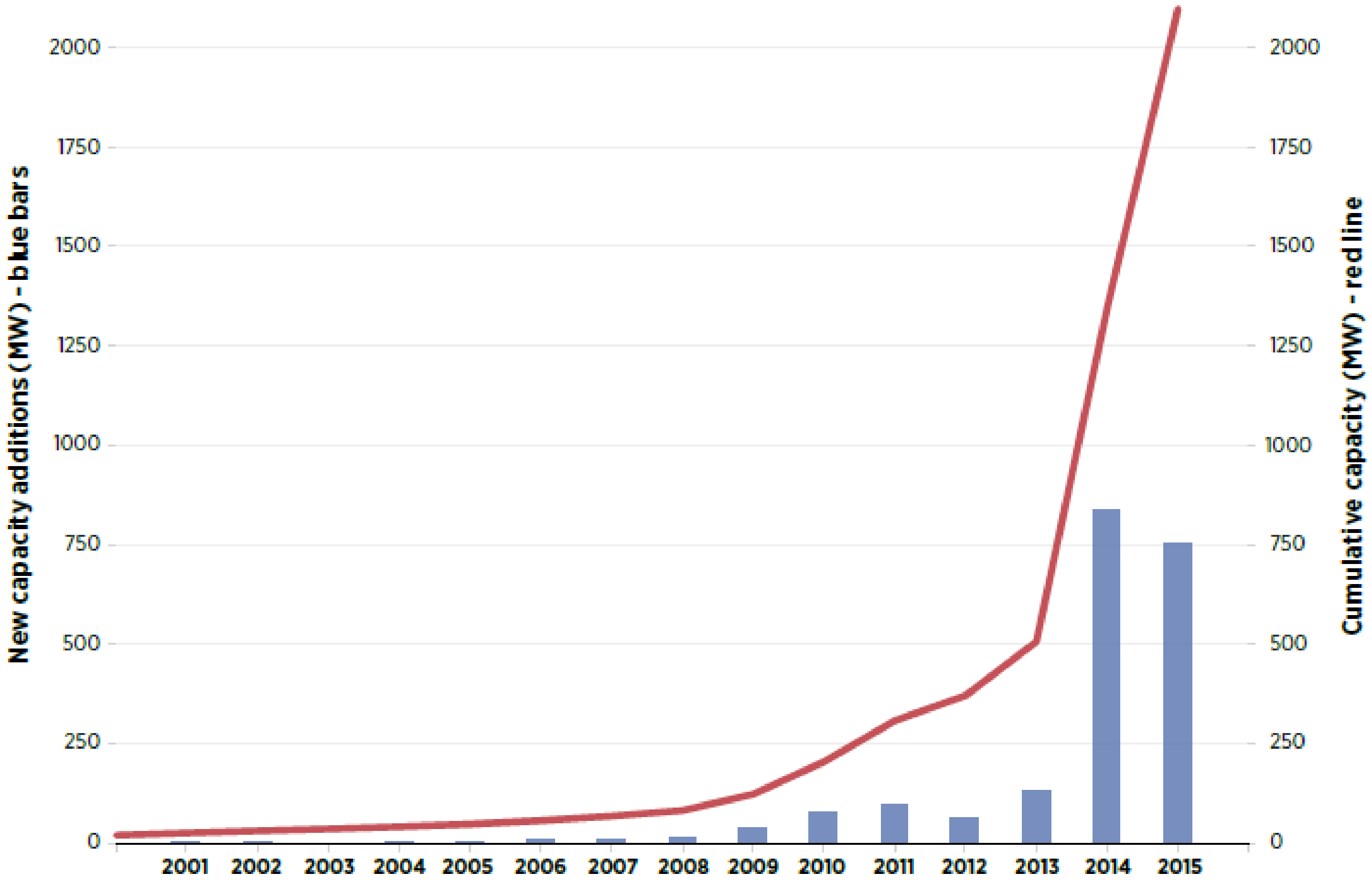
Source: CIA factbook, own calculation





Source: Malaria Atlas Project

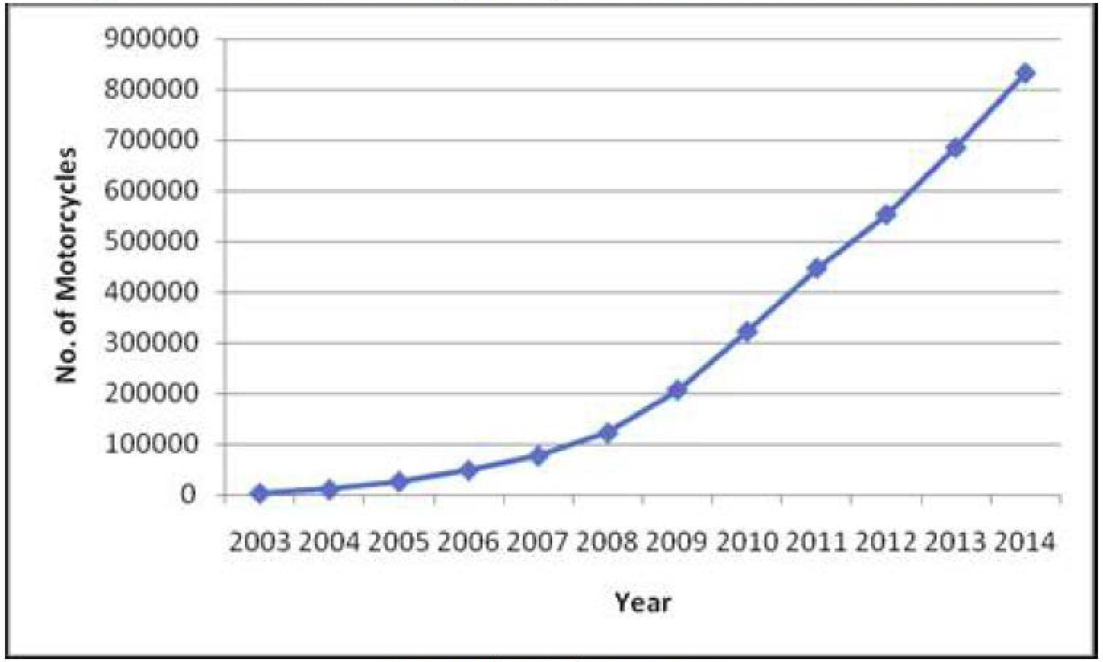
Solar Power in Africa



Source: IRENA, 2016a

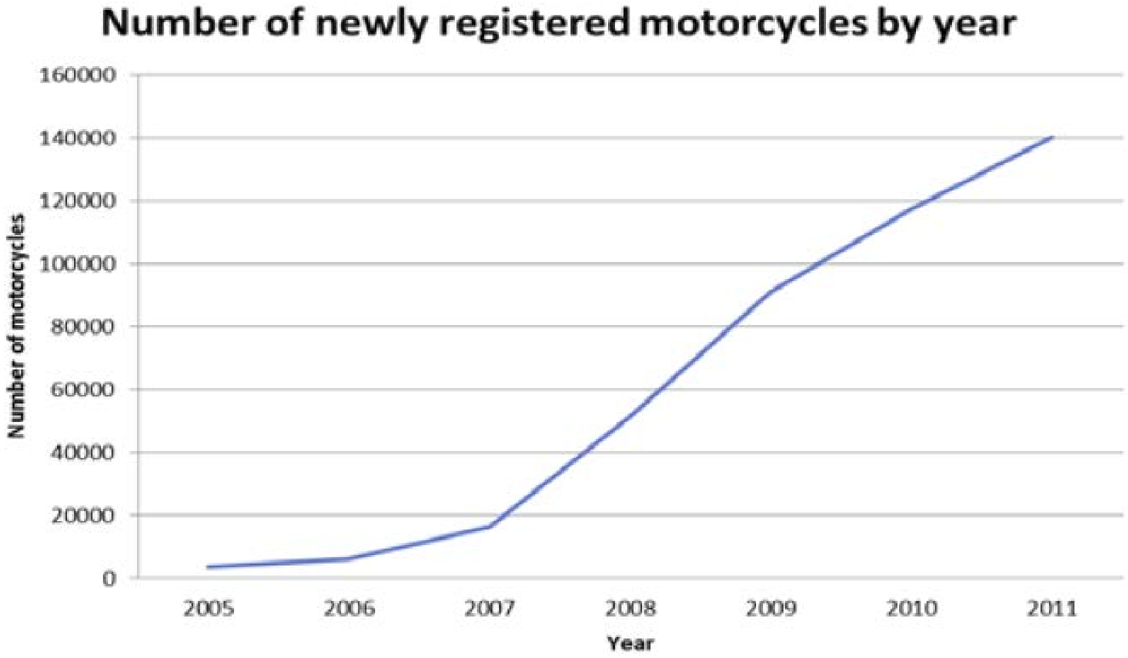
Motorcycle Market Africa

Figure 1. Number of motorcycles registered in Tanzania, 2003 to 2014



From: Bishop and Amos, 2015

Tansania



Kenia

Source: WHO

Off-Grid Solutions

GLI:X Green Logistics Indicators for Gauteng

Photo: mobisol

TABLE 4: STATUS OF OFF-GRID SOLAR HOME SYSTEM MARKETS IN SEVERAL AFRICAN COUNTRIES AND BANGLADESH

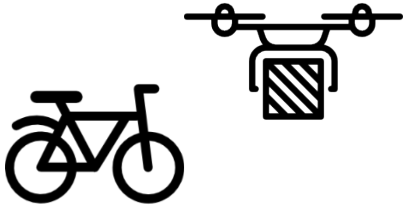
Country name	Year	Number of SHS	Population (million)
Bangladesh	2016 (April)	4 000 000	161
Kenya	2010	320 000	47
South Africa	Est.	150 000	55
Morocco	Est.	128 000	34
Zimbabwe	Est.	113 000	16
United Republic of Tanzania	Est.	65 000	51

Source: IRENA, 2015b

Source: IRENA

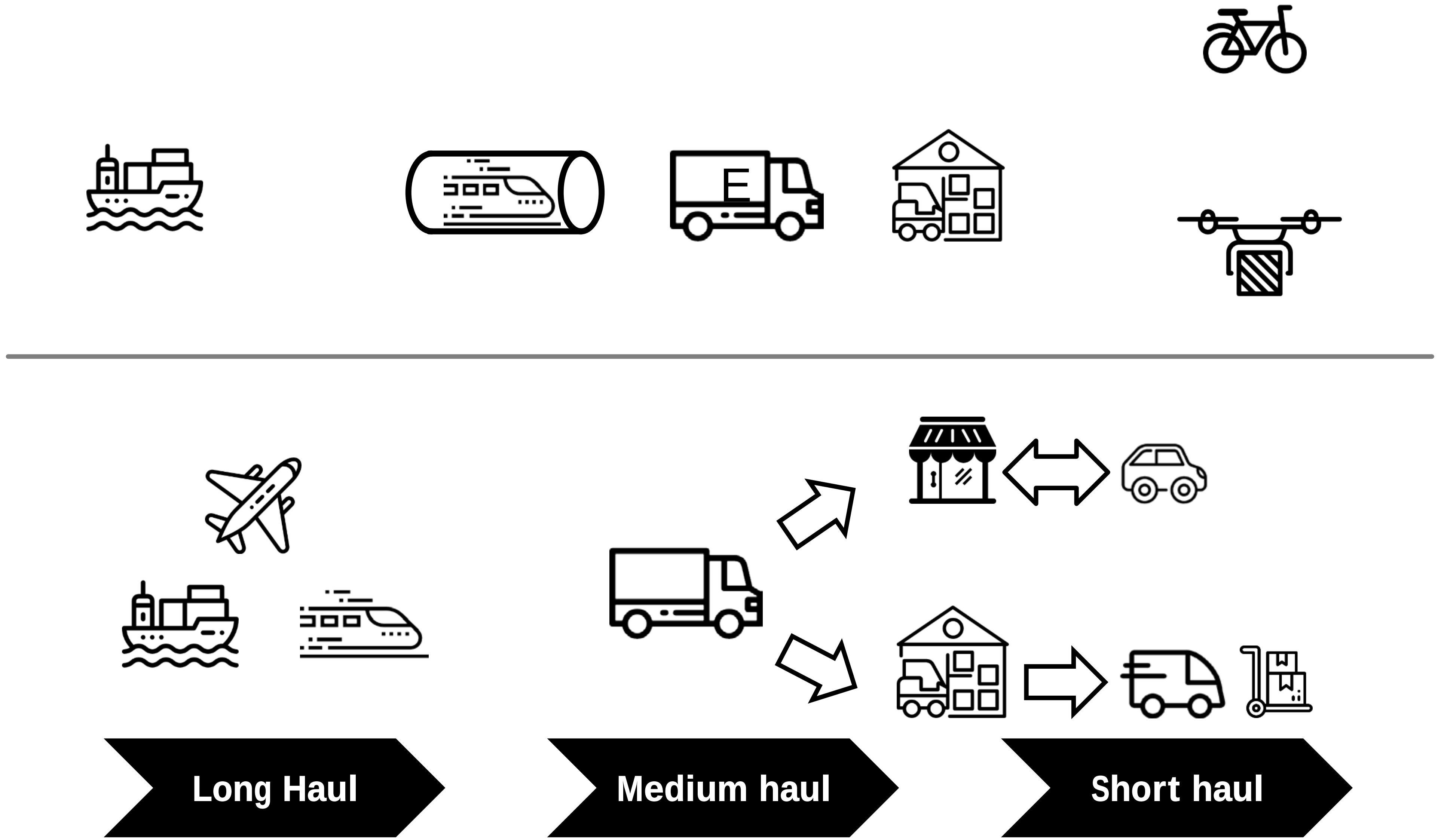
Offroad E-Cargo-Bikes?

source: anywhere.berlin

				
	Walking	**Rail**	**Road (Truck)**	**?**
Vehicle	–	Train	Truck	eCargo Bike/UAV
Track Infrastructure	Trails	Rail network	Road network	Trails
Energy Infrastructure	Food	Electric Grid	Fuel Distribution	Off-Grid PV
Other		Train Station		
Flexibility	High	Low	High	High
Speed	Very low	High	Medium	Low
Load	Very low	High	medium	Low
Cost Infrastructure	Very low	High	High	Very low
Cost Vehicles	none	high	Medium	Low

Transport Systems

GLI:X Green Logistics Indicators for Gauteng



Conclusion

Urbanisation
Global city integration
Smart Cities

Climate Change and
Decarbonization

Online Retail

JIT logistics
Urban manufacturing
Industry 4.0

New Hardware
Electric vehicles
Cars, Buses
eBikes and Pedelecs
Hyperloop

3D Printing

Digitalisation
IoT
Smart devices/mobile computing
(intermodal) routing
automation

Convergence and futures
Autonomous driving
Smaller vehicles
- delivery drones
- UAVS

Π (Physical internet)

Autonomous Last Mile
New Urban Logistics

Forget Roads!
Chance for a new freight transport paradigm/system?