

Electric Mobility as a green Transformation Anchor

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Electric Mobility as a green Transformation Anchor

1. Introduction PEM Motion
2. Changes in mobility & automotive industry
3. Focus on the Caribbean
4. Summary

Electric Mobility as a green Transformation Anchor

1. Introduction PEM Motion

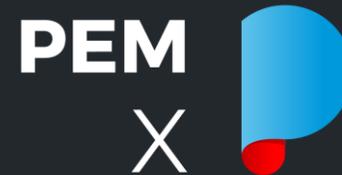
2. Changes in mobility & automotive industry
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We create innovation – and industrialize it!



Engineering and Consulting Services

- + >100 employees with 60% engineers
- + 8.8 m€ revenue PEM Motion Group in 2019
- + > 150 PEM Motion customers with 2/3 established companies and 1/3 young start-ups



Spin-Offs and JVs in the field of future urban logistics

- + 7 investments with >100 m€ company value
- + >180 employees within the PEM X network
- + Successful exits: StreetScooter (> 640 employees at exit), e.GO (> 450 employees at exit), StreetScooter Research (> 50 employees at exit)



Locations in 8 cities in Germany and North America



Köln



Frankfurt



Stuttgart



Berlin



Aachen



Monterrey, Mexico



Sacramento, California



San Luis Potosí, Mexico

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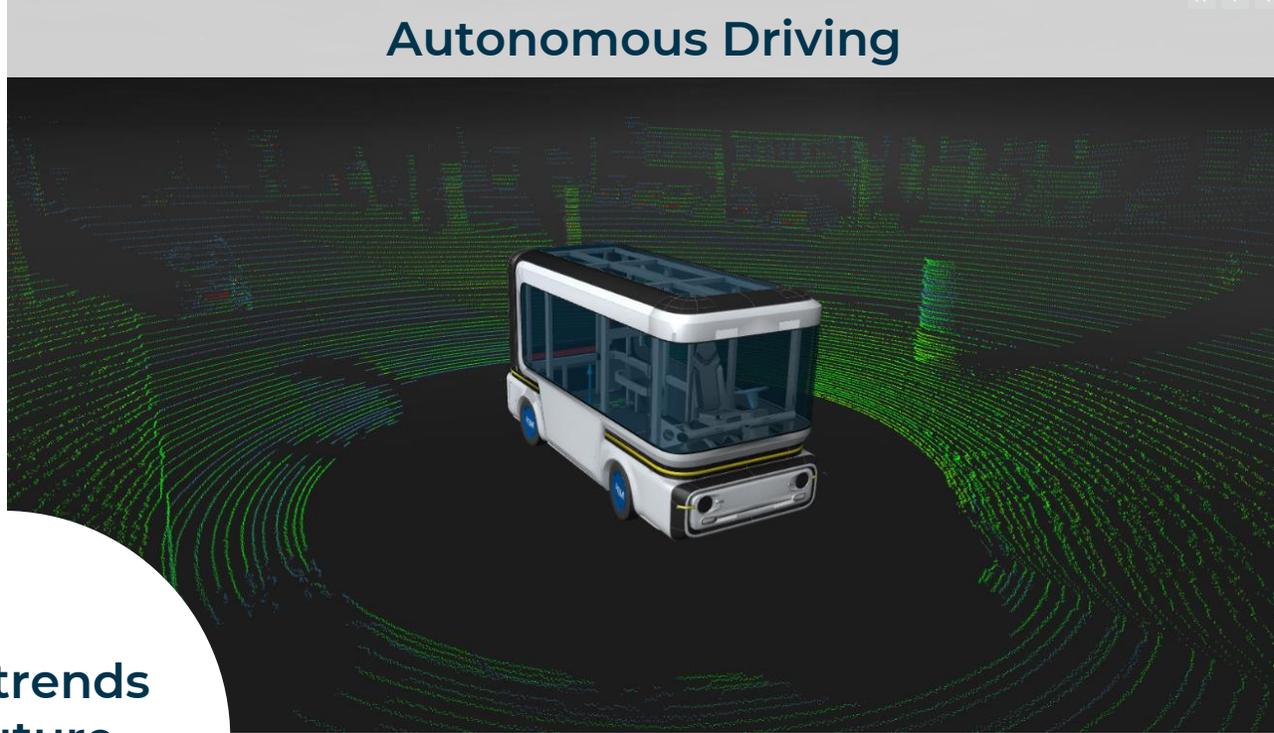
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E-Mobility



Autonomous Driving



**Megatrends
of Future
Mobility**



Connectivity



Shared Mobility

E-Mobility



Today's focus

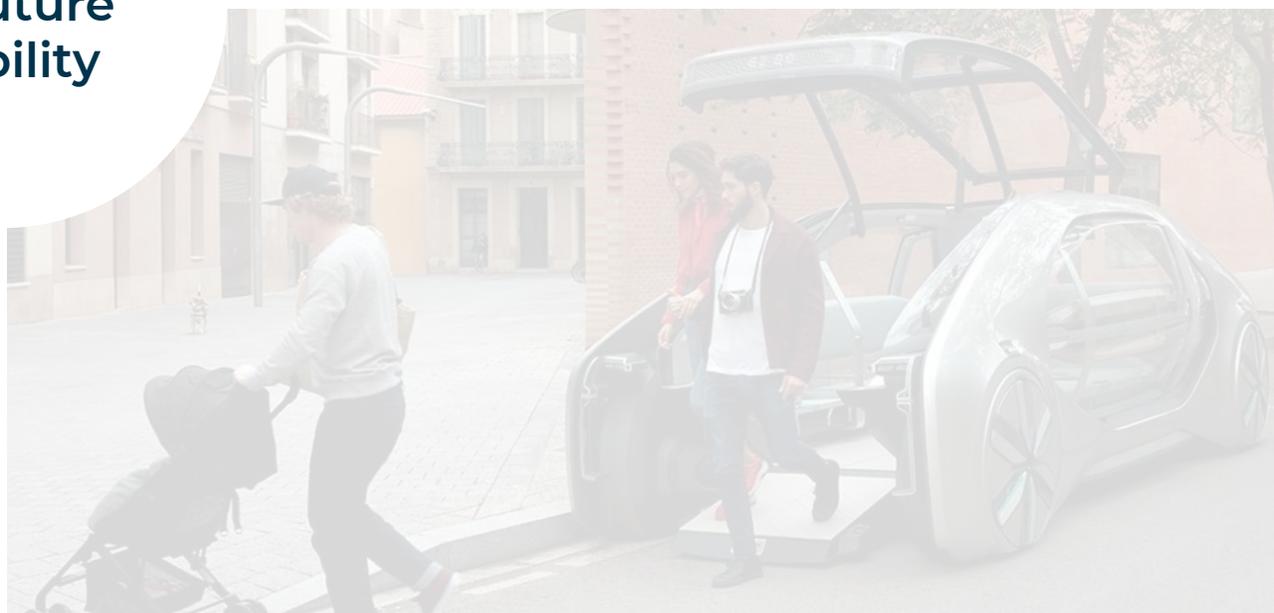
Autonomous Driving



Megatrends
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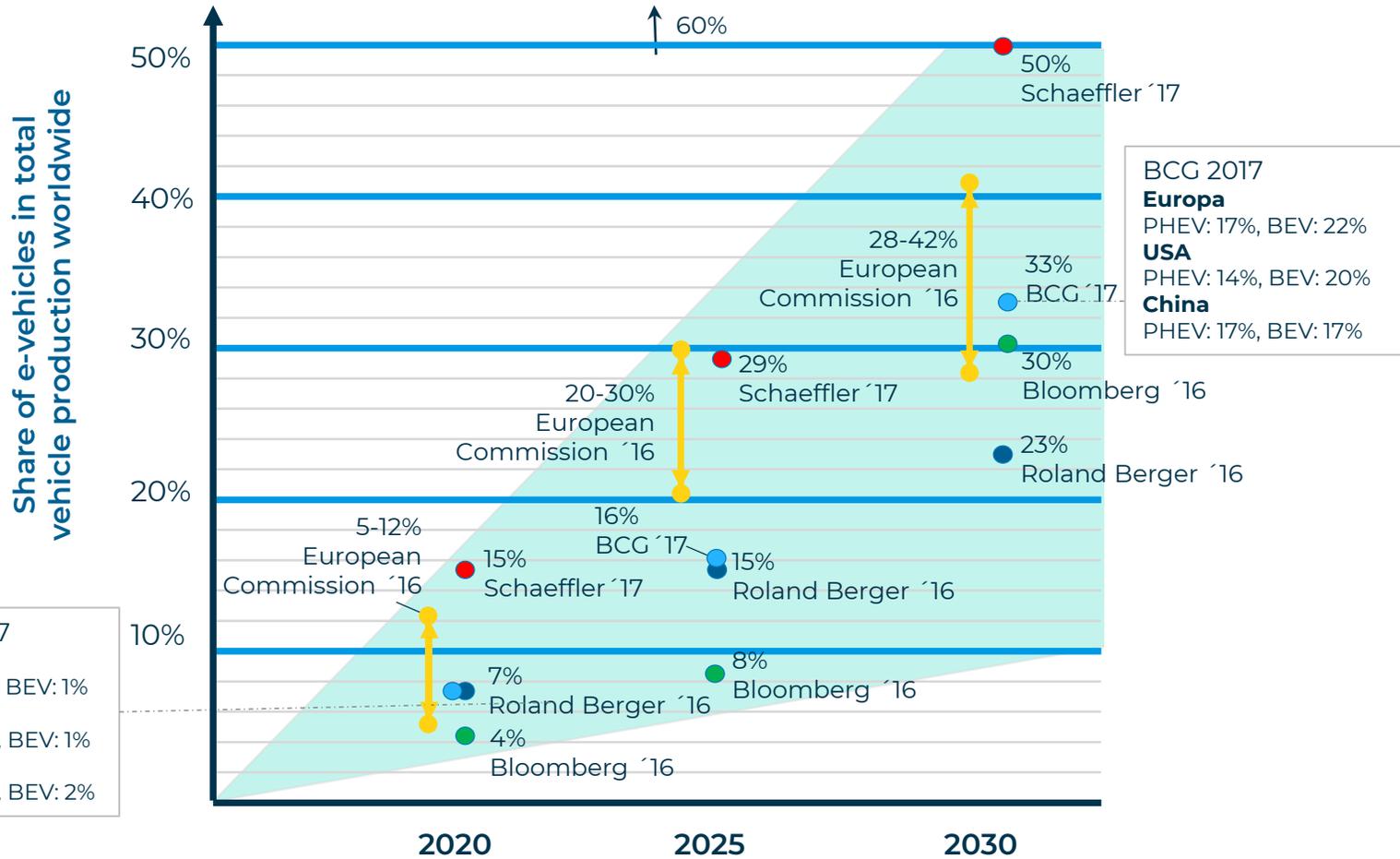


Connectivity



Shared Mobility

Megatrend E-Mobility – Forecast of the production



BCG 2017
Europa
 PHEV: 3%, BEV: 1%
USA
 PHEV: 4%, BEV: 1%
China
 PHEV: 4%, BEV: 2%

BCG 2017
Europa
 PHEV: 17%, BEV: 22%
USA
 PHEV: 14%, BEV: 20%
China
 PHEV: 17%, BEV: 17%

- ### Various influencing factors
- + Legal regulations, e. g. diesel bans
 - + Development of raw material availability, e. g. cobalt or manganese
 - + Number and availability of (charging) infrastructure
 - + Change in user behavior, e. g. shared mobility
 - + Application of state or local subsidies
 - + Greenwashing
 - + Price development (economies of scale)
 - + ...

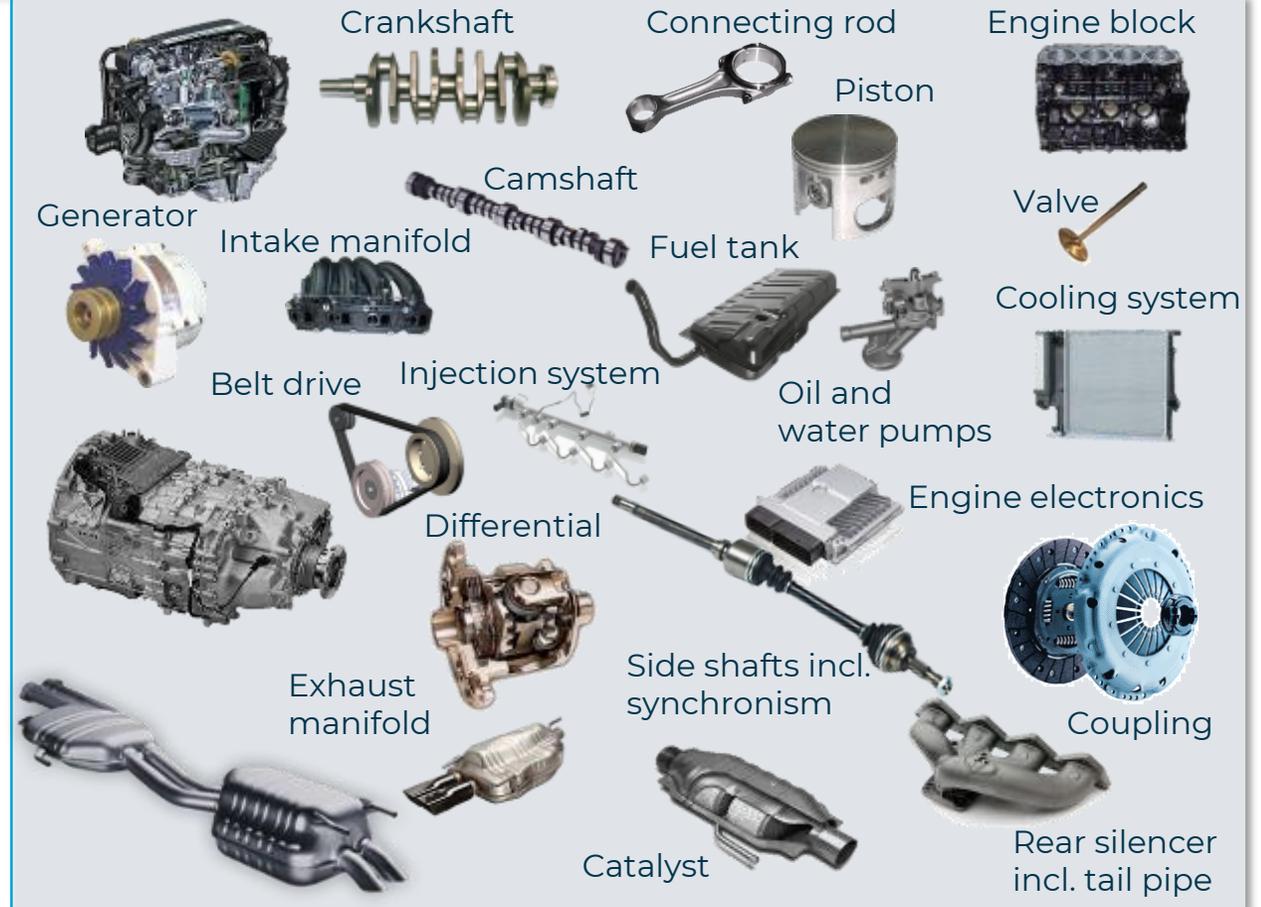
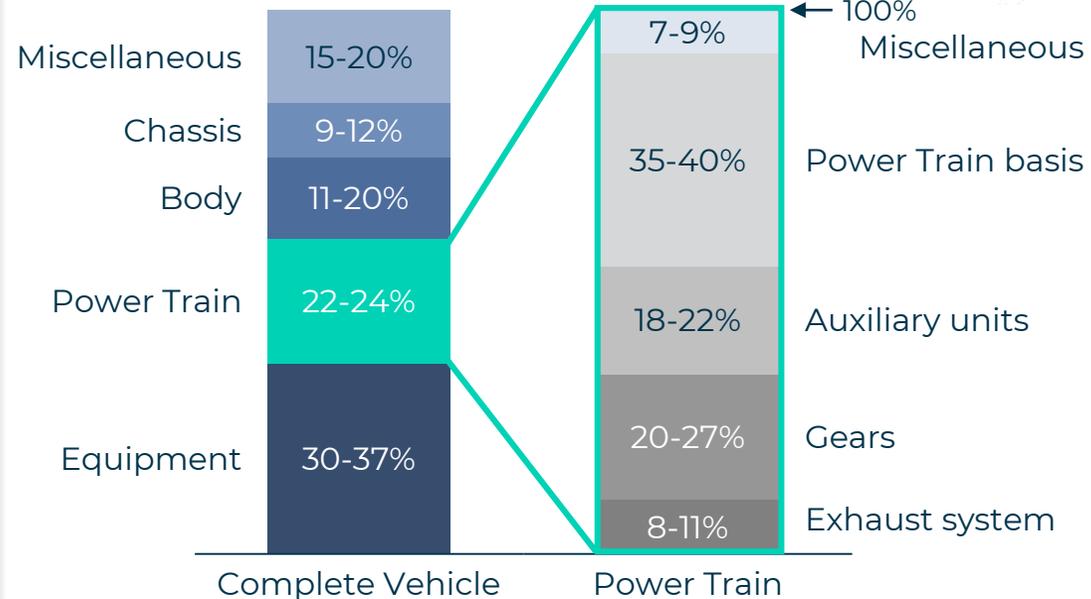
Source: RolandBerger (2016), Bloomberg (2016), European Commission (2016), Schaeffler (2017), BCG (2017), Thomas Reuters (2019)



E-Mobility leads to big changes in automotive sector

Due to electric mobility a large number of mechanical components are displaced from the drive train...

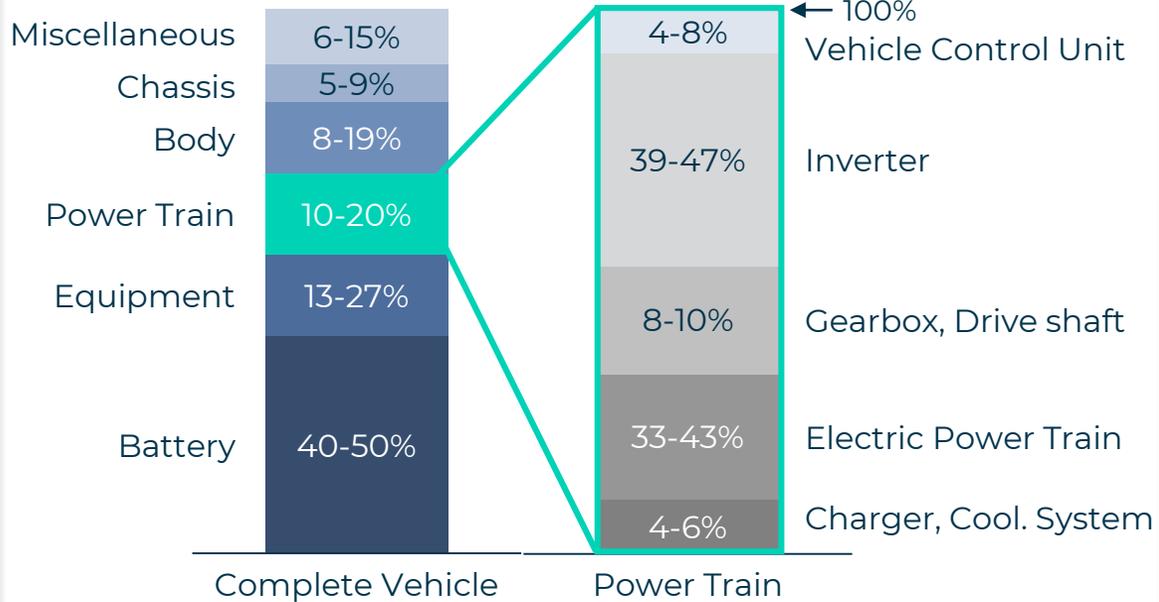
Cost structure of a conventional vehicle



E-Mobility leads to big changes in automotive sector

...and in addition a multitude of electronic components are used in the powertrain.

Cost structure of an electric vehicle



Inverter (DC-AC converter)



Vehicle Control Unit (VCU)



Electric Powertrain



Gears



Drive shafts



Charger



Cooling System



Comparison: Number of parts required

Combustion engine
~2500 parts



versus



Electric engine
~250 parts

Source: <https://e-auto-journal.de/elektromotor-vs-verbrennungsmotor/>

Our vision



Cut the total cost of last mile logistics by 50%

Aachen Ecosystem for Hardware Innovation

Campus for Sustainable Mobility by PEM



Ramp-Up Factory Aachen

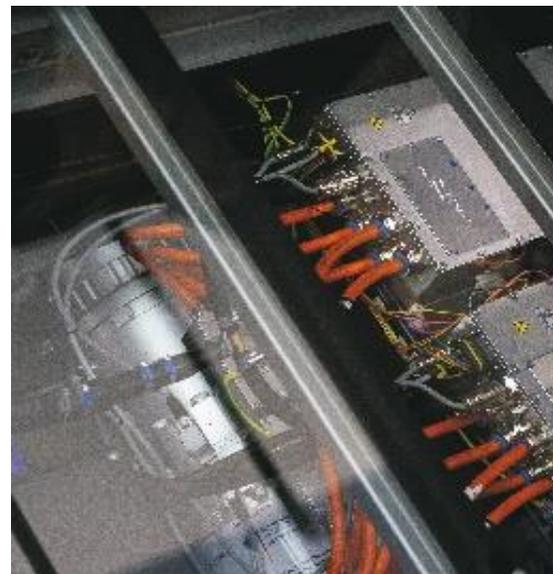
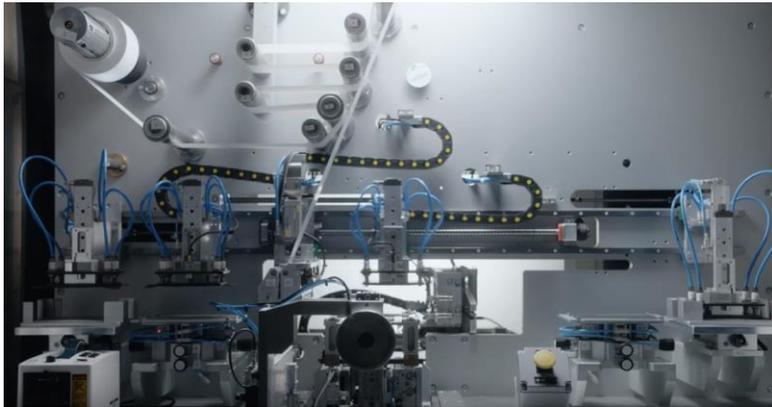


Electromobility Laboratory (eLab)



PEM Motion Offices & Production Space





Solutions to cut costs in last mile logistics



1st base camp in Bochum to create central logistic hubs in cities



Automated vehicle scanner to reduce damages and insurance costs



H2 infrastructure and modular fuel cell range extender (in development)



Multi storage delivery stations with blockchain secured locking (in development)



Digital out of home advertisement with modular screens



B2B mobility solutions from bike sharing to individual car sharing apps



New last mile trailers with automated follow me function



Individual solutions for specific use cases can be engineered quickly with a broad technology base

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The Caribbean share several conditions...

- + High **renewable energy potential** throughout the Caribbean
- + **Short distances** due to limited space (especially on smaller islands)
- + Favorable **legal conditions**
 - + Specific renewable energy and transportation targets
 - + Reduction or elimination of import duties and taxes
- + High utilization of **government and commercial fleets**
- + Especially vulnerable to the consequences of **climate change**

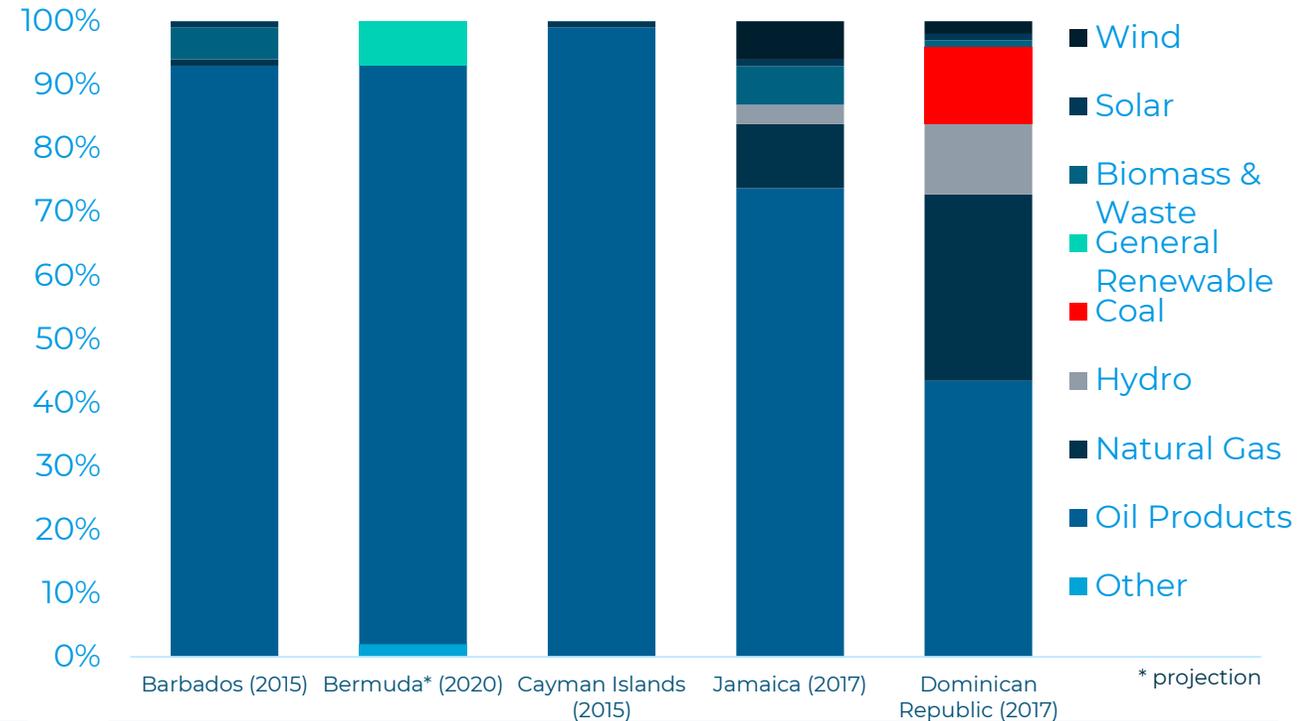


Access to renewable energies as well as political incentives can accelerate the transition to sustainable mobility in the Caribbean

Source: "Electrified Islands", Viscidi et al., 2020

... but are also faced with challenges

- + High consumption of and dependency on **fossil fuels (e.g. power generation)**
- + Concerns about declining government revenues over missing taxes
- + Lack of comprehensive **charging infrastructure**
- + Market not mature enough yet to serve all requested conditions
- + Lack of **trained personnel**
- + Missing **public awareness**
 - + Credibility doubts do exist and there is still convincement necessary that EVs will sell



The Caribbean are still strongly dependent on fossil and lack of general education about electric mobility

Source: "Electrified Islands", Viscidi et al., 2020

Potential actions facilitating the transition to E-Mobility



+ **Governments** should

1. educate themselves and really analyze **long-term fiscal effects** that the large scale-up of EVs would imply
2. do **commit** themselves **to E-Mobility** and communicate this clearly to manufacturers, dealers as well as utility companies
3. seize opportunities to **electrify public transportation**, government as well as commercial fleets



- + More **education** should be provided, and the levels of **public awareness** increased
- + **Utility companies** need to recognize the **potential for growth**
- + **Supporting innovation** and **start-ups locally**

The dialogue and establishment of electric mobility must happen **across sectors** and is ideally initiated by legal actions and political incentives

Source: "Electrified Islands", Viscidi et al., 2020

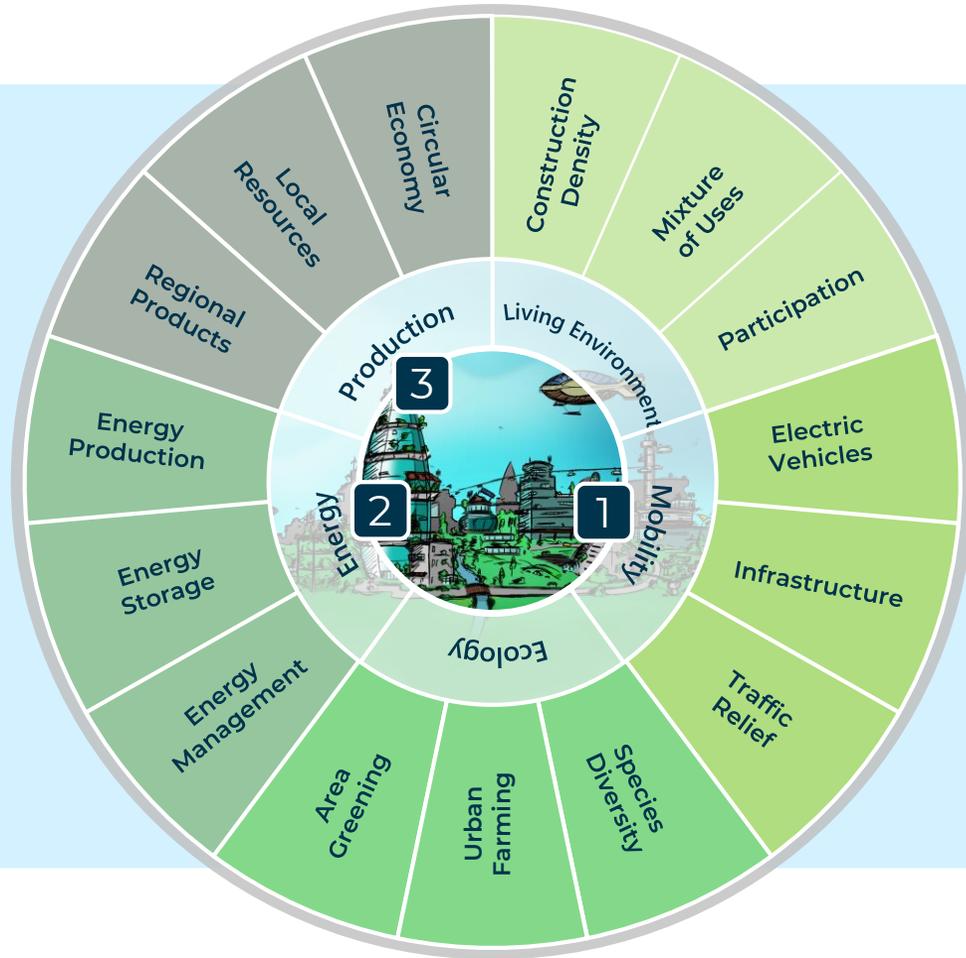
How do we create a sustainable ecosystem?



The path to a greener living environment

Three central pillars for a quick start in the Caribbean

1-2-3



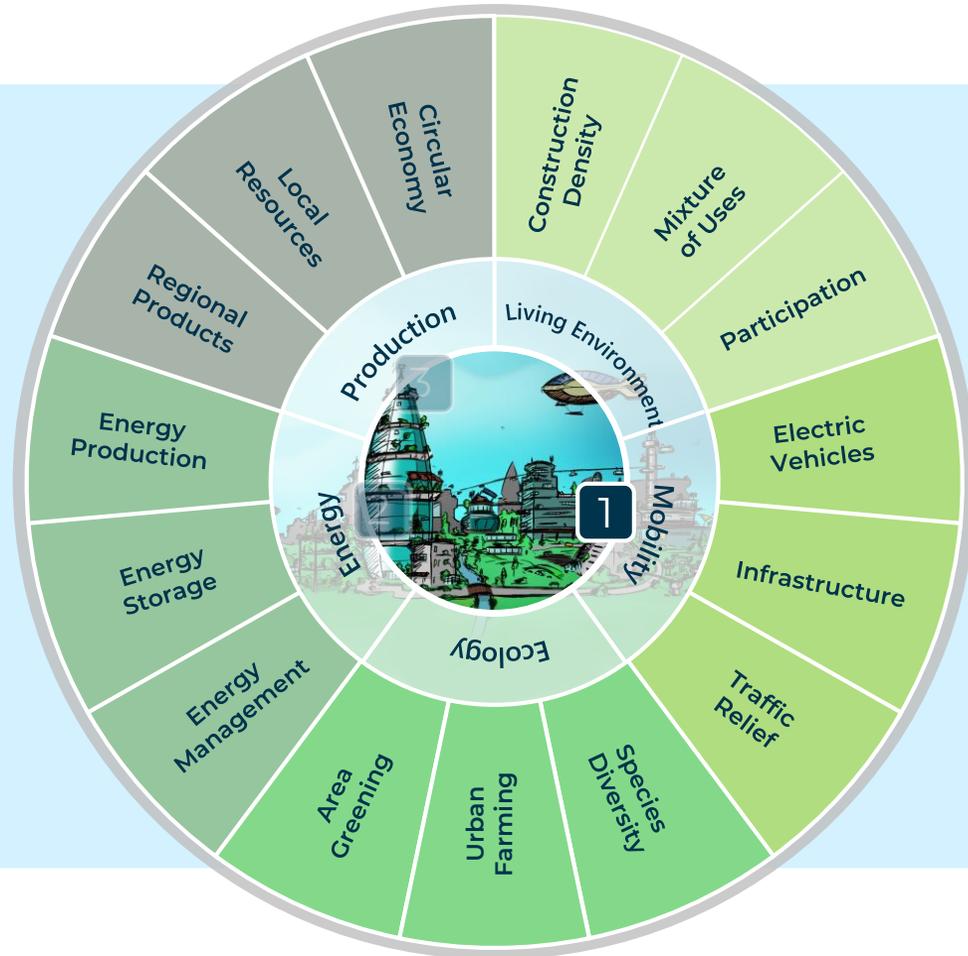
1 Mobility

1. Electric Vehicles
2. Infrastructure
3. Traffic Relief

2 Energy

1. Energy Production
2. Energy Storage

3 Local Production



1 Mobility

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2 Energy

1. Energy Production
2. Energy Storage

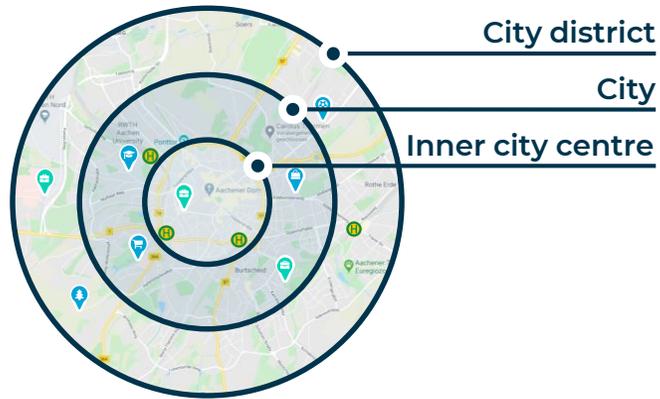
3 Local Production

Mobility solutions are selected due to their local benefit

Electric Vehicles

Assessment of urban characteristics

Identification of urban mobility needs with respect to local public transport and other relevant points of interest



Definition of the suiting mobility mix

Selection of mobility solutions depending on identified urban characteristics



E-Scooter | L1e-B



E-Bike Passenger | L1e-A



Cargo EV | StreetScooter

Infrastructure

Sustainable Modular Mobility Stations including

- + Packing Station
- + Battery Compartments
- + Photovoltaics to power the station and batteries



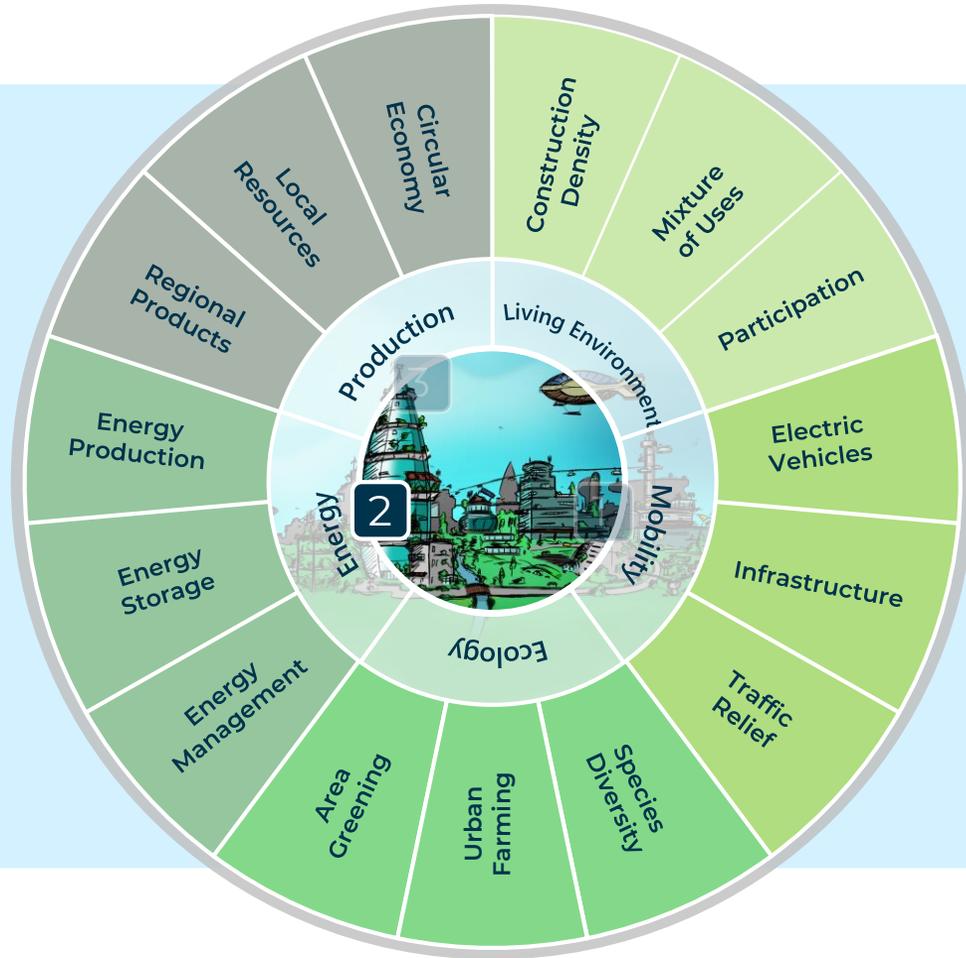
Traffic Relief

Improve actual
What causes traffic at the moment?



What is the future of urban mobility?
Create new

Energy – Energy storage



Mobility

1. Electric Vehicles
2. Infrastructure
3. Traffic Relief

2 Energy

1. Energy Production
2. Energy Storage

3 Local Production

Energy Production and Storage

Energy Production

Assessing and using of existing technologies correctly

- + Identifying potential technologies best suited for predominant conditions
- + Technologies for wind and solar energy are already well developed but not used to their full potential
- + Challenge: limited possibilities to store energy



Solar energy



Wind energy



Hydro energy



Geothermal energy



Bio energy

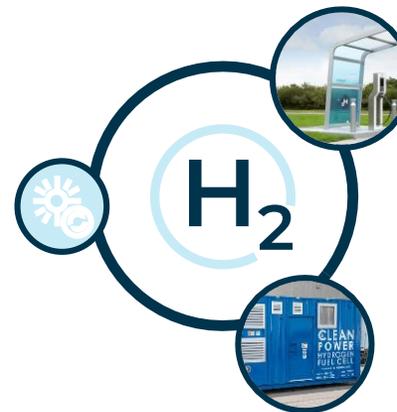
Energy Storage

Using existing resources instead of new ones



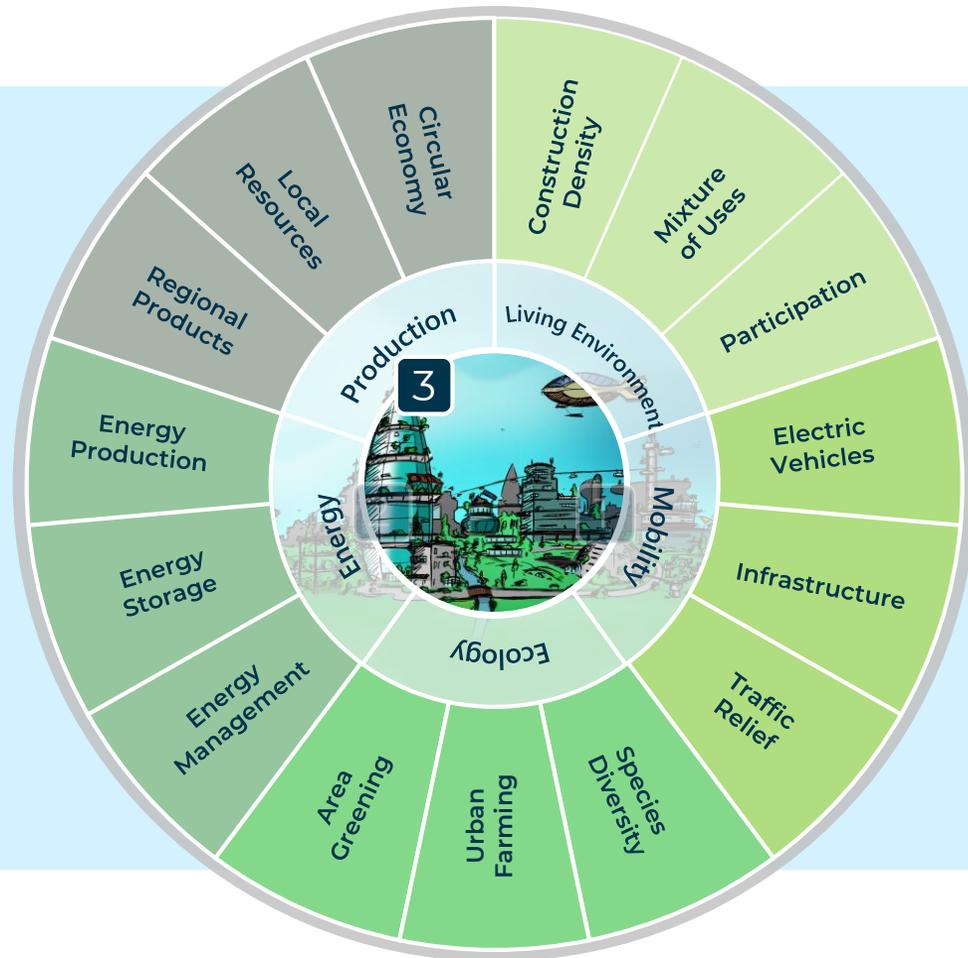
- + Old batteries (i.e. from vehicles) can be reused for a second life purpose
- + After collection, battery packs are assembled to stationary storage systems to provide various services
- + Start of second life as an energy storage unit

Creating new storage mediums



- + New storage mediums favor a sustainable mobility
- + Combination battery and fuel cell
 - + Long range and payload similar to conventional combustion engine
 - + Short refueling times, high dynamics, TCO-compatible costs

Local Production



Mobility

Energy

Local Production

Local production by establishing the Ramp-up factory

1-2-3

Our Solution

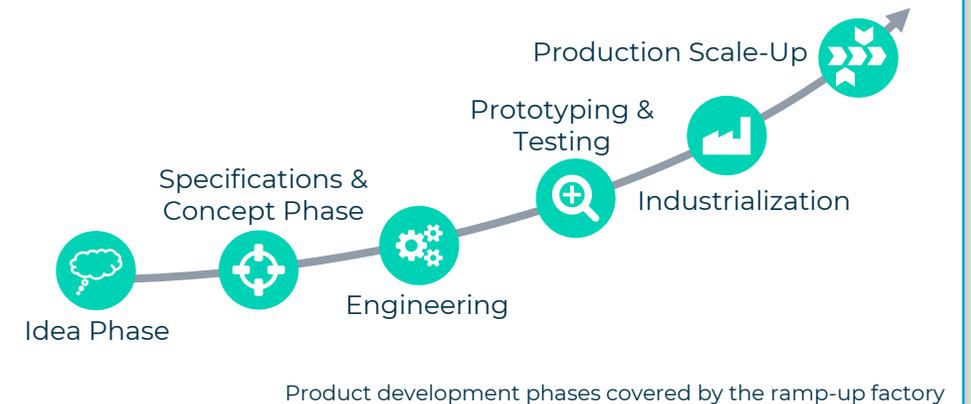
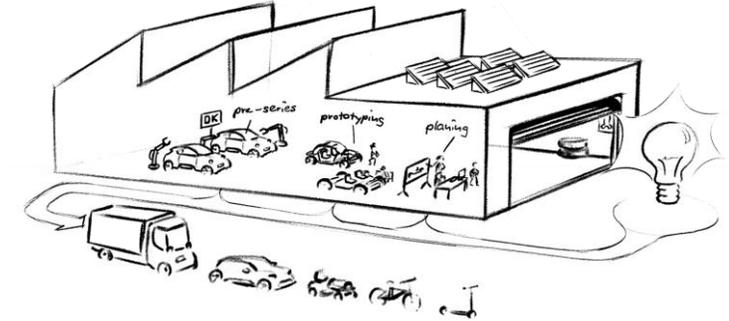
Targets:

- + Reduction of emissions
 - + Securement of local supply chains and innovation
 - + Creation of jobs and prosperity
- Introduction and establishment of **Ramp-Up Factories**

Concept

- + From ideation to production in one facility
- + Addressing **start-ups, SMEs, OEMs and research institutions** alike
- + **Flexible prototyping and manufacturing infrastructure**
- + **Cost effective industrialization and accelerated time to market**
- + In cooperation with **leading partners** we provide **state-of-the-art knowledge**

Ramp-Up Factory



PEMs initiatives in the Caribbean and Central America

México



- + Electrification of cargo vehicles
- + Ramp-up Factory Monterrey
- + Sustainability Dialogue German Embassy
- + Education and university courses
- + Training center
- + Innovation projects
- + Mobility Focus

Dominican Republic



- + Establishment of local EV production
- + Sustainable urban Infrastructure

Costa Rica



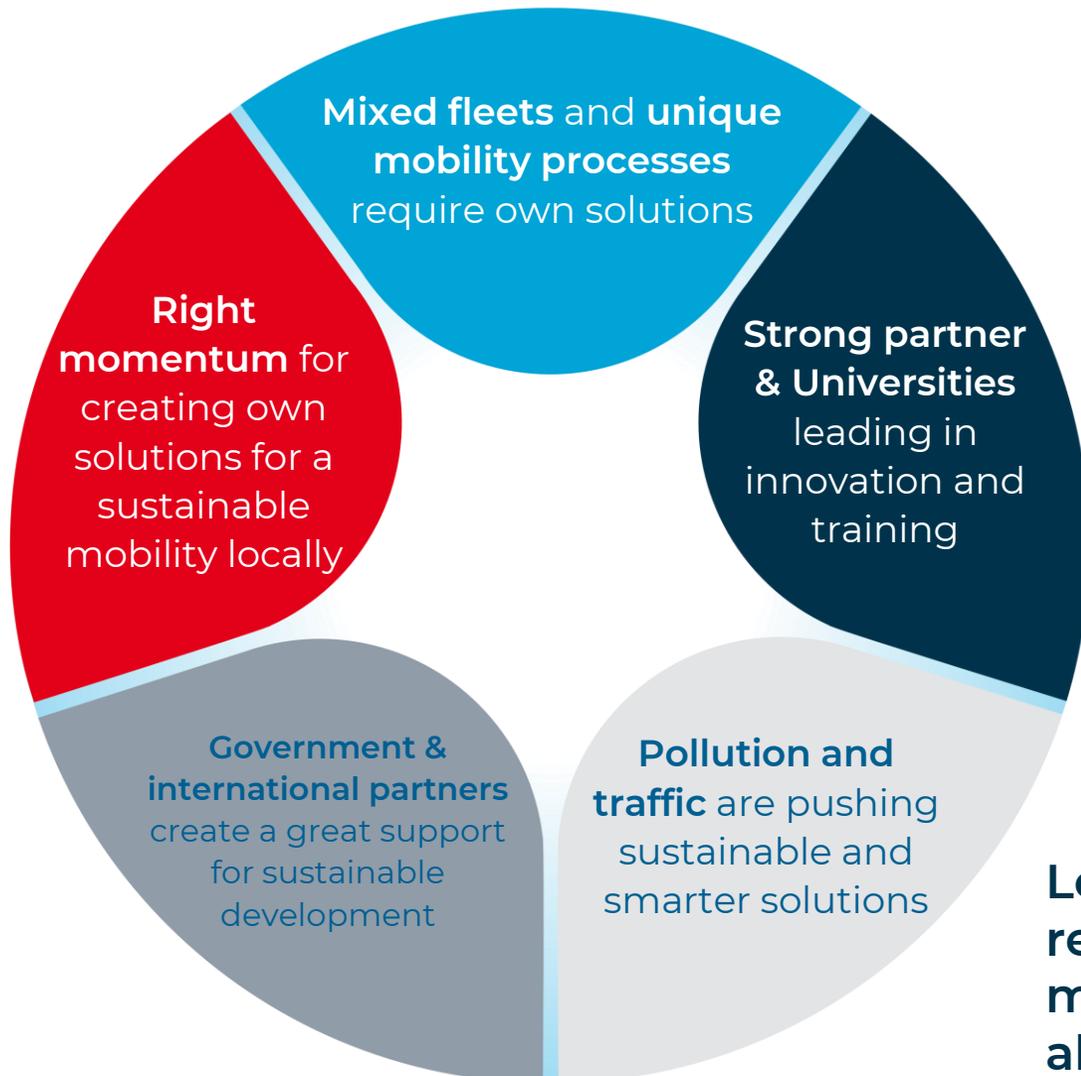
- + Ramp-up Factory
- + E-Cargo Hub
- + Remanufacturing of Batteries
- + Business Development for shared mobility

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Central America and the Caribbean as a pioneer and new value chain partner for sustainable development



Join us and let's fuel the future together – now!



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Thank you for your attention!