City-KURT as catalyst for urban electric mobility

From Vehicles to Mobility as a Service

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City-KURT is much more than an electric vehicle. Its a vehicle concept specifically optimised for use in cities (size, weight, speed) that is very energy-efficient and can compete with traditional vehicles. It is also a concept of shared vehicles using opportunity charging that can address people's mobility as well as city logistics.

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Mobility and transport: complex issues

- Small parcels, pallets, containers, … for **goods**
- Single person, families, masses ... for **people**
- Real Maa**Service**: **point-to-point + comfort**
- **Space and time are resources**: density issue
- **(Clean) energy** is a resource
  - Energy efficiency to be measured in relationship to mass&volume moved per road surface used @ speed
- Today:
  - Multi-modal carriers, space and time inefficient
  - Connection points are bottlenecks

Mobility and transport is about moving mass (or people) from one point to another. We do that using resources such as energy, space and materials t build the means of transport. Today, often use fossil fuels along the whole chain starting with mining, production to actually driving around. When in use, we must keep in mind that what counts is the door-to-door connectivity. Time is a resource, but so is space and (clean) energy.

Today, mobility and transport is provided by a mex of vehicles and technologies. While they each have their niche, the connectivity between them is a major issue.

Is this the solution?

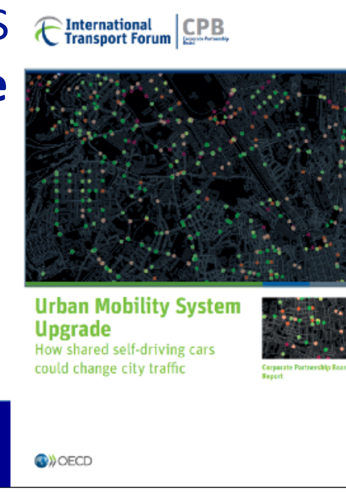
Connectivity is the issue

Resource efficiency is the other issue

Hence, to improve our mobility we must focus on connectivity and on a better use of the resources. Else, the system will not be sustainable

Or is this the solution?

- No more cars/vans in city and replaced by **TaxiBots** ?
  - http://www.internationaltransportforum.org/cpb/projects/urban-mobility.html (OECD)
  - 90 % less vehicles, 80% less parking space needed
  - Mobility increases with up to 89% (in km)
  - Less air, heat, noise pollution
  - Enormous economic consequences: MaaS
- **Shared autonomous driving = disruptive**
  - 80-90% less vehicles needed
  - Displaces public transport
  - Lifetime vehicle
  - Mobility will increase



While still in the conceptual stage, simulations have already been done to assess the impact of automated mobility. In this study the impact of banning all vehicles and replacing them with taxibots was investigated. The least one can say is that the impact will be disruptive:

- Up to 90% less vehicles in a city (because the dove all the time)
- 80% less parking space needed
- Will compete with established public transport (already the case for Uber today)
- Vehicles will be replaced after one or two years (as they drive all the time) but will have driven 1 million km.
- People will actually move more (because the marginal cost of mobility si much lower).

Conclusion:

- Mobility is clearly a fundamental need
- Must be offset by better use of resources else even using clean energy will just move the problem.

Clean energy: what to optimise for?

Physics: $E = 1/2 * m.v^2$ and $F = m.dv/dt$

- **Minimise energy use**: well to wheel or tank/battery to wheel?
- **What parameters?**
  - energy / unit of mass
  - energy / unit of surface used
  - speed
  - acceleration
  - distance

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Let's look at the physics: everything is mass, speed and acceleration related.

If we want o minimise energy use, then we have to ok on all these factors in parallel

Measures should be expressed in term of energy used per unit of mass and per unit of space

Battery and e-charging as issues

- Fuel (ICE) = **100x** Li-ion (NMC) battery in J/kg
- Efficiency ICE drivetrain 10x lower + mass + maintenance
- City:
  - Less space available, dense infrastructure
  - Shorter distances traveled, lower average speed
  - More idle time and idle space (parking)
  - Need is higher (local pollution is density related)
- Conclusion1:
  - **An e-vehicle for the road is not a e-vehicle for the city**
- How to bring clean e-energy to the vehicles?

Going electric in cities cannot done by supplying the energy with overhead wires of conductors in the track. Such solutions are however not very flexible and result in energy loss as well.

Using batteries, we can regain the flexibility but batteries still have hard time to compete with classical fossil fuels. the same volume in full has 100 times more energy than a top of the range Li-ion battery.

How can we bridge this gap?

First of all, burning fuel is not that efficient. An internal combustion engine is complex and looses about 90% of its energy before the wheel hist the road. On the other hand, electric motors convert about 80% in traction to the wheel. Secondly, we don't need very big vehicles in a city. Space is limited, range is limited an the speed is limited. Hence it makes little sense to drove around with Tesla like vehicles in the city (of which the battery weights one ton).

City-KURT solution approach

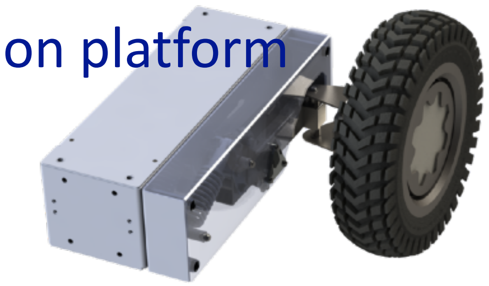
1. **Cost-efficient e-vehicle for urban environments**
   - **KURT** concept: one platform, multiple vehicles
   - No need for another Tesla
2. **City-KURT Cost/vehicle/ride sharing** scheme:
   - Reuse idle/empty capacity in time and space
   - For people and goods
   - City-KURT micro-depot for city-logistics
   - Later: (semi)-autonomous driving
3. **Distribute the charging** infrastructure:
   - City-KURT station

Traditional vehicle concepts are designed for high speed driving on open roads. These conditions are vey different in cities, where space is at a premium and speeds must be limited. The other issue is cost as e-vehicles have to compete with established classical vehicles that benefit from cost reductions due to volume production. The KURT address these issues with a dedicated modular and scalable propulsion platform, allowing to offer many different vehicle types for different applications at a much lower cost. In addition, as the platform has a low empty weight and can transport more weight, the energy consumption is much lower, addressing the issue of energy density of batteries.

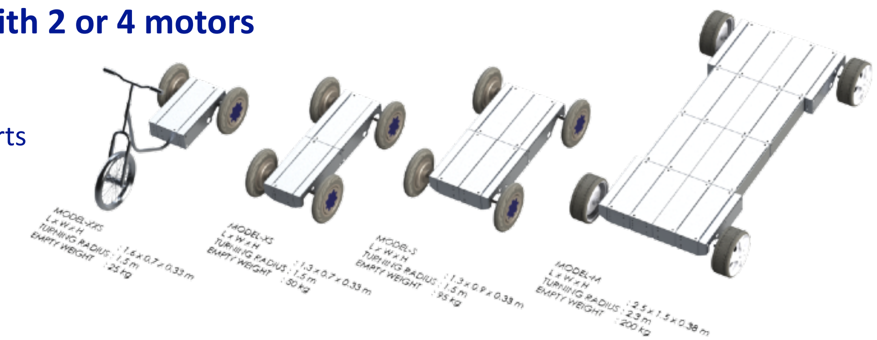
The same platform has been developed into vehicles for moving people and for transporting goods. Combined with a movable Kurt-Station or micro-depot used for charging a netwrok can be created across a city that operates like a virtual public network. The vehicle platform is also largely controlled by software and ready for additional frontons like autonomous driving.

1. KURT modular light electric vehicle

» Modular & scalable propulsion platform



- **Base is 1/4 vehicle:**
  - motor integrated in wheel
  - battery + electronics in main box
  - flexible suspension in suspension box
  - additional modules when needed
  - lower production cost
- Typical: **4 wheels with 2 or 4 motors**
- **Drive by wire**:
  - less mechanical parts
  - flexible



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The basis of the KURT platform is one wheel (one forth of a vehicle). It is composed of a wheel with motors, motor controller, battery, vehicle controller and a suspension unit. As this is a self-contained unit, it lowers the production cost. Mad out of aluminum, it provides robustness, fully shielded and is 100% recyclable.

A typical vehicle will have 4 of these units (it can be two). More units can be used to assemble larger vehicles.

The vehicle is also fully controlled in software, providing flexibility and reducing the number of mechanical parts.

The design is patented.

Reuse at all levels for cost and flexibility

City-Logistics 110 cm

Persons mover 110 cm

Mail & small parcels 80 cm

- Adapted to urban constraints
- Cost-efficient
- Compact
- Quiet
- Low platform facilitates getting in and out
- Speed: 25/45 kph
- Low empty weight => > 200 kg cargo
- Equivalent energy use: 0.5 l/100 km
- Autonomy: one day
- Standard charging point + opportunity charging
- Very manoeuvrable
- Safe by design (towards autonomous driving)
- Remote monitoring & fleet management
- Semi-autonomous: manoeuvring using smartphone
- Or remotely over internet/3G/4G

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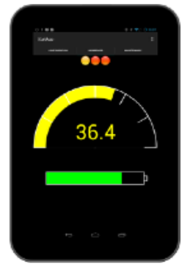
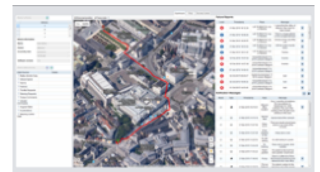
An example are the City-KURT vehicles. using the same platform, multiple vehicles are provided. The modular architecture allows to fine-tune te vehicle to meet specific needs, e.g. by using larger or smaller batteries, different cargo options, etc. The equivalent fuel consumption is 0.5 l/100 km.

All vehicles can also be remotely monitored and manoeuvred using a smart phone. We even demonstrated steering one internet using a browser whereby the drivers located 3000 km away.

Software controlled towards autonomous driving

KURT remote monitoring app





Monitors
- battery, temperature, motor, …
- alarm conditions
- position (GPS, transponders)
- routes

To and from dispatching
- text messages
- pictures

KURT remote steering app

Remote manoeuvring
- authentication
- speed and acceleration limited

Optional
- drive by smartphone/tablet
- drive by web
  - camera input from KURT
  - operator steers via web client

Each KURT vehicle (even when it has no steering wheel) can be monitored and manoeuvred using a smart phone. A central dataserver can hence supervise multiple vehicles in a fleet. battery status, technical issues can hence be automatically reported to a dispatching centre. Messages and pictures can be exchanged.

In some scenarios, the KURT vehicle will have no driver or it can be a KURT with a cargo box. These can also be connected like a train. In such cases, an individual vehicle can be locally maneuvred. We have this also tested over an internet browser using a camera feed from the smartphone.

Cost of ownership KURT-Post vs. ICE-scooter

	KURT-Post	ICE-Scooter	
Market price (€)	12.000	5.000	-
Total fuel/energy cost	731	4.300	+ + +
Consumables (tires,…)	588	419	-
Maintenance	100	3.544	- -
Total	13.419	13.262	=
Payload capacity	100	27	X 3
Cost per kg	**134**	**491**	**X 3,6**
Other benefits			
Health problems	no	knees, falling	+ +
Weather protection	yes	no	+ +
Productivity	All cargo at start	3 to 4 extra pick-up points	x 3
Environment	no emission	euro 3	+ + +
Oil changes	no oil	every 1600 km	+ +

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This comparison shows a KURT vehicle developed for Postal services in comparison with a typical 2-tact engine scooter, often used by postal organisations.

While the initial purchase cost is higher, the Cost oF Ownership over the lifetime of the vehicle is comparable. However the KURT e-vehicle poses a lot less health and safety risks, is 3 times more effective nut of cargo that it can transport, requires almost no maintenance and greatly increases the productivity. So, it wins overall.

Comparison with other e-vehicles




	City-KURT cargo assist	4-wheel scooter	Street scooter	Trike
Payload capacity (kg)	100/200	200	710	90
Empty weight (kg)	180/200	335	1370	86
Autonomy (km)	> 40	70	80	30
Length (mm)	2300	2320	4710	2311
Width (mm)	800/1100	1180	2080	910
Height (mm)	2000	1730	2039	- -
Battery capacity (kWh)	2,96	6,7	20,4	0,84
Energy efficiency (kj/km/kg)	0,14	0,64	1,41	0,57
Payload vs. empty weight	2.00 - 3.00	0,60	0,43	1,05
List price (€)	12.000	16.000	?	?

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In this comparison we took existing electric vehicles. The comparison first of all makes clear that the energy efficiency is much higher. This is due to the compact and light architecture allowing to transport more. In addition, the user is protected from the elements and rides in comfort.

2. Cost/ride/vehicle sharing

- Incentives: **cost sharing, flexibility**
- Ride sharing = better use of capacity
- Vehicle sharing = better use of resources
  - energy, space, materials
- Results:
  – Saves money!
  – Low investment: App + marcom
  – Reduces traffic, congestion, pollution, …
  – Improves Quality of Life

Another important step to reach environmentally friendly mobility and transport is to make better use of the resources. Today, most vehicles spend most of their time parked yet they take space. Most vehicle driving around carry only one person. Even many trucks are empty of only partly loaded.

By sharing vehicles as a resource, we make better use of resources, and that includes space on the road and space in a city. It will improve quality of life but last but not least, t will save money that then can be used for better things.

City-KURT - sharing vehicles

» A new form of public transport
- Vehicle sharing system (pioneered in 1970's as **witkar** in A'Dam)
- Transport grid between connected node (parking/charging/…)
- Pay by the minute
- Many stakeholders
- High impact

The City-KURT is more than a vehicle. Inspired by the successful Witkar project in the 1070's in Amsterdam, City-KURT creates an eco-system entering the world of Mobility as a Service.

The concept puts a virtual grid or mesh over a city, whereby at each node vehicles can be shared, charged or temporally parked at a multi-functional KURT-Station. The Station is mobile, so it can be moved when needed as in a living city, events happen all the time. The KURT Station als has a social function where people van meet or connect to internet using a 4G wifi hotspot. Sharing the vehicles is time based to maxime their use and to minimise their idling time. hen parked, the battery can be recharged for a few minutes, enough to drive a few km. As a result, smaller batteries are needed, yet the vehicles can drive the whole day.

This picture shows the KURT-Station as well as a City-KURT for moving people, a City-Logistics KURT ad well as one for light parcels or mail.
This is a project for the Province of Vlaams Brabant to promote the use of clean energy.

KURT-Station as micro-depot

Flexible and mobile
Less trips reduce energy
and time consumption

The KURT-Station can also be replaced by a dedicated and mobile KURT micro-depot. City-logistics and e-commerce can use it as temporary storage for their parcels or end-customers can use it to pick up their deliveries when not a home during the day.

3. Distributed charging

- Each KURT vehicle has:
  - Batteries to **last a full day** in city or opportunity charging
  - A few KWh is enough (“Ceci n’est pas une Tesla”)
- Charging **infrastructure already exists**:
  - Each building has spare e-capacity
  - Grid connections for events in city
  - Often parking space in front or in garage
  - Slow charging during the night is OK
  - Fee for using the charging connector
- Complement with carports and solar panels?

The KURT vehicles doesn’t need very heavy battery packs as the vehicles is relatively light by construction. Different wheels with motors and different batteries can be installed depending on the needs. As such, also smaller battery packs will be sufficient if the battery can be charged for a few minutes (e.g. when parked at a KURT-Station).

A KURT vehicles also doesn’t need special fast chargers, but can use any standard power outlet. As every building has enough spare capacity, no extra network is needed. This also means that it is much easier to supply the energy from alternative sources like carports with solar panels. In this case, direct DC charging is possible.

Multifunctional charging/waiting KURT-station

Social function:
- Meeting place
- Wifi-hotspot
- Charging phone
- Information kiosk

Opportunity charging
- keeps battery full
- for next trip

This side illustrates how the KURT-Station is multi-functional and mobile. It clearly demonstrates that what's count is not the vehicles but the services offered.

For more information, contact us