

# RUF International

Investment case

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## Executive Summary and Investment Case

### The Company

RUF International has analyzed the transportation situation and defined a new transport system capable of supplying attractive mobility without using oil and with no CO<sub>2</sub> emission.

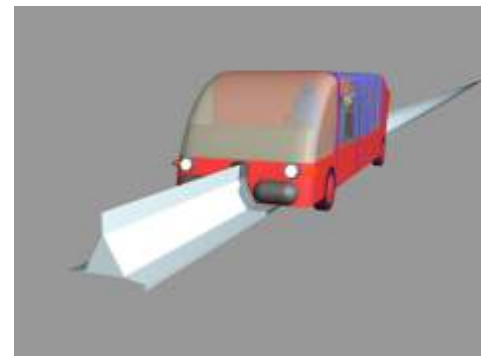
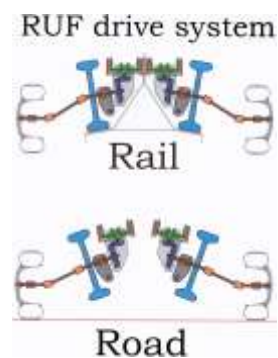
The solution is a dualmode system which uses existing Rights of Way very efficiently so that congestion problems can be avoided. See: [www.ruf.dk/ruf2006.pdf](http://www.ruf.dk/ruf2006.pdf)

RUF International has performed “Proof of Concept” and the first contract has been signed regarding RUF systems in India.

RUF International holds all rights to the RUF concept and is ready to expand.

### The Technology

The technology consists of a patented drive system which makes it possible for cars and busses to drive either on the normal roads or on a special monorail.



### The Business

The RUF concept has been under development for 32 years waiting for the timing to be right. Now the time has come to conquer the world market.

RUF has the potential to substitute for a great part of normal car traffic in large cities and almost all of Public Transport. Small goods can be delivered fast and flexibel via the RUF goods vehicles.

Public Transport using RUF will be safe in a situation where a virus is circulating. Most passengers are seated in single seats separated from the others.

RUF technology is a smart combination of well proven technologies so for an investment of 100 million EURO the first line can be put in operation.

The first customer in India is ready to pay a license of 1% of the project sum for 30 years for all RUF projects in India. A 100 km line in Kolkata has been negotiated and it will pay 120 million EURO in license.

The investment of 100 million EURO could result in ownership of more than 40% of RUF International Ltd. (to be negotiated).

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## Background

### Oil price

The transportation sector faces an enormous challenge in the near future. The oil peak is becoming reality very soon because the demand is becoming higher than the supply.

No other sources can substitute for the abundant oil supply we have had for decades.

The oil price will be finding a new level where people find other alternatives as attractive as driving cars. In Europe people can change to Public Transport or use bicycles but in USA no alternatives are realistic today. As a consequence the market mechanism will force the oil price to hit a very high level and result in major crisis in a society based mainly upon gasoline cars.

### Climate

The climate challenge makes it very difficult to continue with a transportation sector with a growing number of cars worldwide. According to the recent report by Stern, the CO2 emission needs to be reduced by a factor of 4 before 2030 in order to avoid disastrous climate effects.

This is simply not possible with current car technology and EV tech faces major problems.

### Congestion

All big cities are growing. In all cultures, car ownership is growing. It is very difficult to expand the road network because of the existing buildings leave no space for expansion.

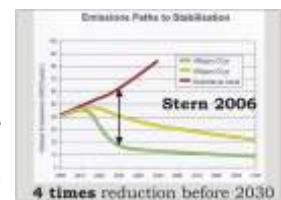
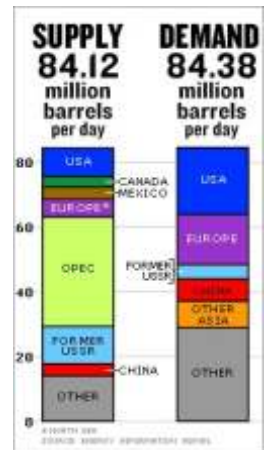
All attempts to automate highway traffic have failed so far because it is an extremely difficult task to control traffic flow in the chaotic situation that exists on the current highways.

For these reasons, congestion is a serious problem in most societies today.

### Public Transport

Every society needs public transport but almost no innovation has taken place in this field for decades. Public transport still relies on buses and trains following fixed routes and trying to follow fixed time tables. Since buses are using normal roads where traffic flow is unpredictable, it is impossible to match train and bus. The result is that people will have to wait for transfer and travel times will be long and unpredictable. The comfort level in public transport is far below the comfort of using a car even when highways are congested. Also virus spread has shown to be a major problem. People only use public transport if they have no other option.

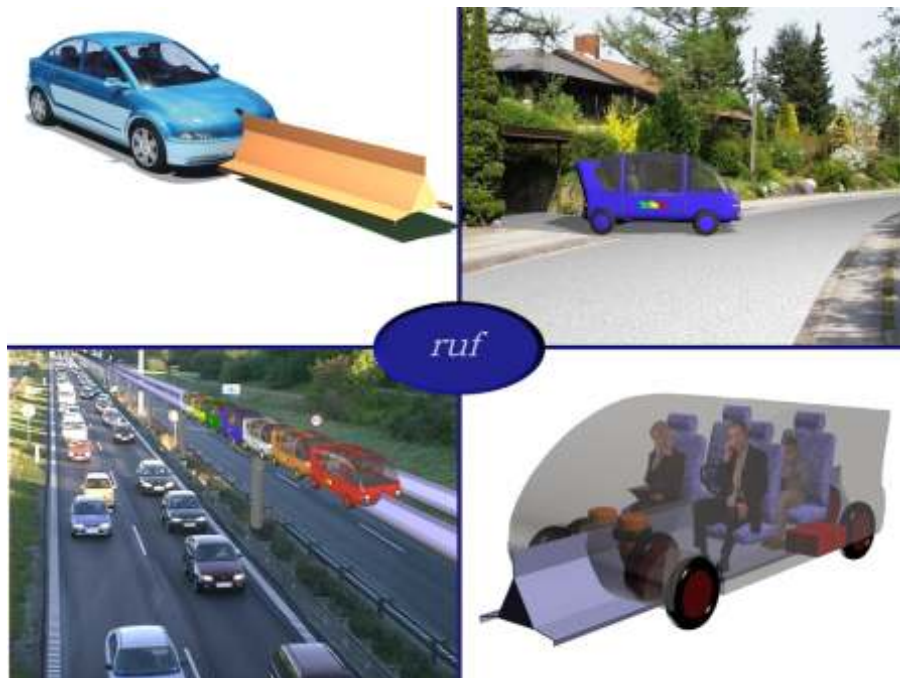
All this can be changed using RUF dualmode.





RUF Concept

Rapid Urban Flexible



The RUF Car (ruf)

Top speed on monorail = 150 km/h powered by the monorail

Range when powered by onboard batteries > 50 km

Range extender (hybrid unit) can be used when not on the monorail.



The RUF Bus (maxi-ruf)

Electric bus with 10 single seats and no standing.

Every seat has its own door. Extremely easy access.

No risk of virus spread.

Dimensions: 7 m long and 2 m by 2 m cross section.

## RUF Drive System

The RUF Drive System is a synthesis of different important technical aspects:

### Very stable vehicle guidance

The drive system has two sets of wheels: the support wheels and the drive wheels. When the support wheels carry the vehicle rolling on smooth surfaces and the drive wheels press against the top of the monorail, the vehicle is “locked” to the monorail and cannot possibly derail.

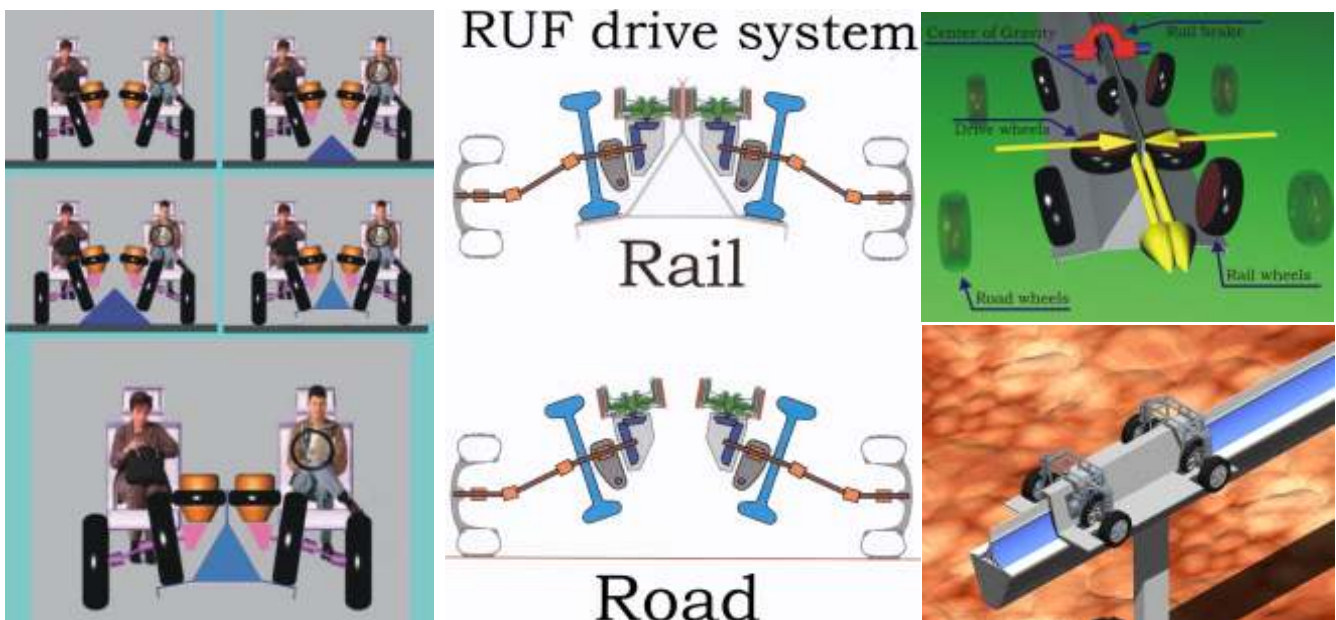
Unlike in a train there is very little sideways jerk and the ride will be very smooth. The surfaces used by the support wheels are tilted 10 degrees in order to stabilize the vehicle at high speed (up to 200 km/h).

### Adjustable friction

The pressure from the drive wheels to the monorail can be adjusted dynamically. This means that the friction can be minimized. Only when high friction is needed for acceleration and deceleration, do the drive wheels press hard. This effect is not possible in a transport system (cars and trains) where friction is defined by gravity which cannot be changed.

### Slender inexpensive monorail

A triangular monorail is a very good construction because it represent high torsional stiffness combined with high load carrying capability. Produced in modules at a factory it will be possible to keep the production price down.



### Low noise

Electric motors make very little noise. The wheel noise on the monorail is also very low because the wheels are smooth wheels rolling on a smooth surface. Half of the already low wheel noise is absorbed in the slot between vehicle and monorail.

## RUF Qualities

### Dualmode

RUF represent a new way of moving a vehicle which has the advantages of road driving combined with the qualities of rail driving.

The patented drive system makes it possible to change from road to rail and back at 30 km/h.

This means that a network of RUF monorails can complement the highway system in a city and add new capacity to the transport system.



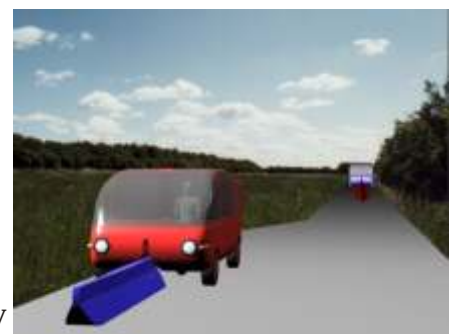
### Electric Propulsion

All RUF vehicles use electric motors. They can be pure electric or hybrid.

Only small batteries are needed for the road part of the trips since they are powered from the monorail during most of the trip. The small batteries will be recharged with power from the monorail.

A hybrid unit can be mounted in the empty slot under the vehicle when it needs to drive more than 50 km away from the network.

This hybrid unit can use hydrogen/ethanol/gasoline and will run at constant speed producing electricity to the vehicle.



### Automation

The RUF vehicles can drive manually using the street network and automated using the monorail network.

This means that the users can use the time on the monorail for work or pleasure.



### Magnetic Guidance

The RUF network uses magnetic guidance to guide the vehicles through the RUF switch at 30 km/h.

This kind of switch is very reliable and extremely flexible. There is no delay as in a traditional rail switching system.



### Rail Brake

The RUF vehicles can brake very efficiently using a special rail brake. The top of the triangular monorail can be used by a caliper to press hard from both sides against the rail. This way it will always be possible to obtain enough braking power. The pressure is not limited by gravity as in a car or a train.





## RUF History

RUF is a very unusual project.

It is a concept connecting two major industries: the car industry and the train industry.

Almost nothing has been developed in the field between car and train. The big industries have been dominating the development activities. Lobby activities from these industries have been successful with regard to prevent new concepts to become mature. The politicians have always been advised to not consider unproven technology.

The inventor of RUF, Mr. Palle R Jensen (MScEE), has been working full time for 32 years in order to develop this new concept using the best from train technology and the best from car technology.

These efforts have been successful and the concept has gained support from many sources:

Private sponsors:

Mogens Balslev A/S, Siemens Danmark A/S, NCC A/S, .....

Danish Government sources:

Ministries for Energy, Environment, Commerce, Education and Culture.

EU

5th Framework program: EESD and IST, CyberMove and CyberCar projects

USA

The Lounsbery Foundation

All these activities have resulted in the opening of a short test track in Ballerup outside Copenhagen, Denmark in year 2000. It has been proven that the basic technology works.



## Industrial Investors

All development activities have resulted in a “RUF-package” containing all patent rights and all know-how regarding RUF technology.

The plan is to sell this package to a major industrial investor and to make the RUF concept develop into maturity this way.

For this to happen, an investment in the order of magnitude of €100 million is needed.

Next step

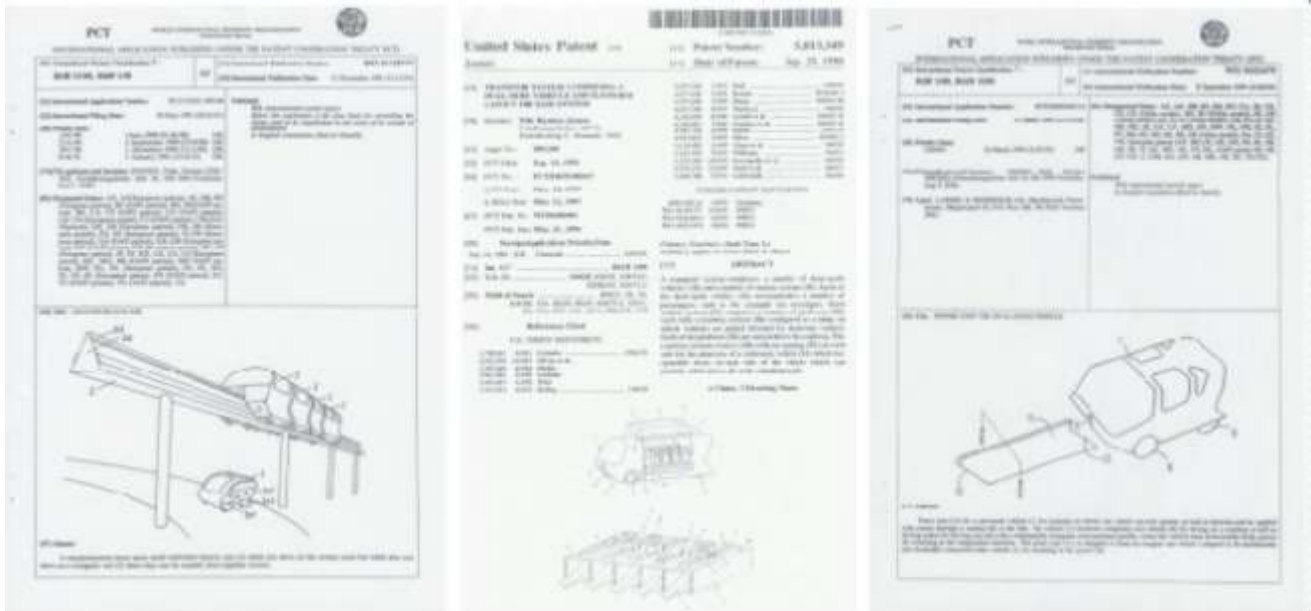
Next step in the development has been prepared. An abandoned railroad has been identified as the site for a 2 km test track for RUF. The local political level will support these activities and they hope to be host for a certification center for RUF technology in the future.

## RUF Patents

4 patents have been granted since 1990, but they have all expired.

Patent no. 4 was granted in year 2003: US Pat. No. 6,523,480

The development has resulted in a number of new patentable ideas which will be part of the RUF package.





## RUF Technology

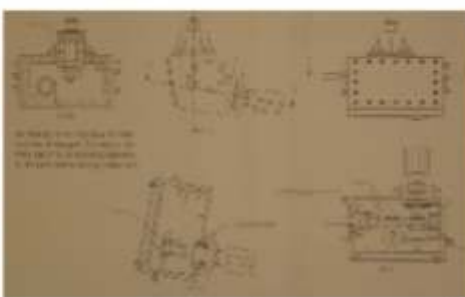
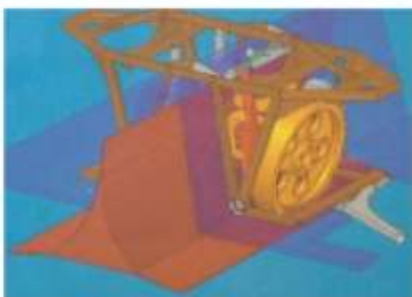
The RUF testcenter at the Copenhagen University-College of Engineering has defined a long range of projects for engineering students. More than 50 projects have been delivered. Many detailed problems have been analyzed and solved.

The result of all these projects are part of the RUF package.

Other universities have also contributed to the collection of RUF projects.

The companies Siemens and Balslev have been sponsors for RUF and made important contributions to the technology.

Prof. Ortwin Ohtmer from California State University, Long Beach has declared that "... such a technology is feasible and that it is mechanically and technically possible"



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## RUF Scientific Papers

Since 1990, RUF has been presented at numerous conferences:

- Jensen, Palle R. : RUF traffic system, THERMIE seminar on Public Transport in medium sized cities, June 18th 1992 in Vejle, Denmark
- Jensen, Palle R. : Clean transport with the RUF system, OECD conference: Towards Clean Transport, Mexico City, March 28-30 1994, Proceedings p. 503-510
- Jensen, Palle R. : The RUF system  
Traffic-days at Aalborg University, August 29-30 1994, Proceedings p.227-234
- Jensen, Palle R. : The RUF Dual-Mode Intelligent Electric Vehicle Concept, Special seminar at University of Washington, May 22nd 1995
- Jensen, Palle R. : Bæredygtig mobilitet ved hjælp af RUF systemet (Sustainable mobility using the RUF system), Traffic-days at Aalborg University, August 21-22, 1995, Proceedings p. 587-596
- Jensen, Palle R. : The RUF Auto/Transit Dual-Mode system  
ISATA, 28th International Symposium on Automotive Technology and Automation, Stuttgart, Sept. 18-22 1995, Proceedings p. 95-102
- Jensen, Palle R. : The RUF system - A dual-mode Auto/Transit concept, ITS 95, The second World Congress on Intelligent Transport Systems, Yokohama, Nov. 9-11 1995, Proceedings p. 2213-2215
- Jensen, Palle R. : The RUF system, A Dual-Mode Auto/Transit Electric Vehicle System  
OECD conference: Towards Sustainable Transportation, Vancouver March 24-27 1996
- Jensen, Palle R. : The RUF system, Special seminar at University of Southern California, School of Urban Planning & Development, April 1st 1996
- Jensen, Palle R. :The RUF (Rapid Urban Flexible) Dual-Mode Concept, Special seminar at Institute of Transportation Studies, cosponsored by the Department of Economics and Department of Civil and Environmental Engineering, April 2nd 1996
- Jensen, Palle R. : The RUF concept, a dual-mode car- and APM-System, APM 96, 5th International Conference on Automated People Movers, Paris June 10-14 1996, Proceedings p. 641-650
- Jensen, Palle R. : The RUF System, a Dual-Mode Auto/Transit Electric Vehicle System, International Conference on PRT & Other Emerging Transportation Systems, Minneapolis November 18-20, 1996
- Jensen, Palle R.: The RUF System, a Dual-Mode Electric Vehicle System, Sixth International Conference on Automated People Movers, Las Vegas, April 9-12, 1997
- Jensen, Palle R. : The RUF Concept, a Dual-Mode electric/hybrid vehicle riding on top of a very slender guideway. 1997 SAE Future Transportation Technology Conference, San Diego, August 6-8, 1997
- Jensen, Palle R. : RUF Dual-Mode Transport - A Quantum Leap in Mobility? European Urban Mass Transit conference. **Invited Speaker.** Berlin, Febr. 3-4, 1999
- Jensen, Palle R. : Basic Qualities of a RUF System, APM 99, 7th International Conference on Automated People Movers, Copenhagen, May 5-7, 1999
- Jensen, Palle R. : The RUF System, New Visions in Transportation, NVT2000. **Invited Speaker.** Aspen, Colorado, Oct. 18-20, 2000
- Jensen, Palle R.: RUF special seminar, Aalborg University, "Traffic Days", August 2006
- Jensen, Palle R.: RUF, "The Podcar City", International PRT conference, Uppsala, Oct. 2007



## RUF Media Exposure

RUF has been featured by all the major news media as well as a lot of local and global media.

CNN has made a very positive report from the RUF test track.

See: [www.ruf.dk/cnn.doc](http://www.ruf.dk/cnn.doc)

CNN has also invited Palle R Jensen to appear on a show called Principal Voices to discuss the transport problems globally. The time for the program has not yet been decided. This program is sponsored by SHELL in association with TIME magazine and FORTUNE.

Discovery Channel has made a very positive report about RUF. It can be viewed from: [www.ruf.dk/disc.rm](http://www.ruf.dk/disc.rm)

A large number of articles has been written about RUF both in local newspapers and in international magazines.





## RUF Hardware

During the development period from 1990 to 2007, many prototypes have been developed.

A long list of sponsors have contributed to the creation of the hardware.



## RUF Software

With funding from the Danish Ministry for Energy and Environment and from EU programmes CyberCars and CyberMove, some important software components have been developed.

Large scale RUF systems are networks. In order to show what can be done with networks, two network programs have been made. One for a network covering Greater Copenhagen ([www.ruf.dk/rufcph.exe](http://www.ruf.dk/rufcph.exe)) and one for a network covering Los Angeles ([www.ruf.dk/ruf-la.exe](http://www.ruf.dk/ruf-la.exe)).

The capacity of a network is large when the flow is controlled by the system operator. The consequence has been demonstrated using a program ([www.ruf.dk/rufcom.exe](http://www.ruf.dk/rufcom.exe)) which shows the flow in the network when all commuters are given the shortest route. The capacity can be increased by rerouting some of the vehicles through the network to take alternative and slightly longer routes.

Two flow simulators have been developed:

One program ([www.ruf.dk/rufsim.exe](http://www.ruf.dk/rufsim.exe)) shows how the flow of vehicles through a simple junction can be controlled locally.

Another program ([www.ruf.dk/ruftrain.exe](http://www.ruf.dk/ruftrain.exe)) demonstrate the strategy recommended for train creation between the junction



With funding from the EU program: CyberMove, a cost benefit analysis has been performed using the network in Copenhagen as an example. The result, which can be seen at [www.ruf.dk/rufcba.doc](http://www.ruf.dk/rufcba.doc) and [www.ruf.dk/rufcba.xls](http://www.ruf.dk/rufcba.xls) demonstrates the very powerful traffic solutions which can be created using RUF technology.

Using standard calculation methods, the network covering Greater Copenhagen has a very large benefit for the society compared to the costs.

Internal Rate of Return (IRR30) is shown to be 29%

## Conclusion

### The technology

RUF dualmode technology is the most powerful technology to deal with the future challenges in the transportation sector.

The RUF system's patented drive system makes it possible to run in Dual Mode. Dual Mode systems have very attractive qualities both as system for individual vehicles and as a system for public vehicles.

The RUF technology is a smart combination of well proven technologies, so no further research is needed.

### The timing

The timing for RUF is right.

1) The climate crisis has resulted in political promises regarding CO2 emission reductions without any solutions which can match the promises.

RUF can deliver the solution without limiting the mobility.

A convincing demonstration will start an avalanche of interest regarding RUF solutions.

2) The oil price will increase further in the future and it will force the transportation sector to move towards electricity.

The best way to use electricity efficiently in moving vehicles is by means of power supply from a guideway as used by the RUF system.

3) Innovation in the transportation sector has been suppressed for a long time and the car and train concepts have been dominating.

Now, new concepts are beginning to appear.

The ULTra PRT (Personal Rapid Transit) system is used in Heathrow Airport.

### The implementation

RUF can be started incrementally, starting with small projects and ending with connected networks covering whole continents.

1) Demonstration of RUF technology in a RUF show room in Copenhagen 2022

2) RUF test track in Køge (south of Copenhagen) 2024

3) RUF used as a connector system to the MetroCityring in Copenhagen

4) RUF used to connect the two largest cities in Denmark via Kattegat

5) RUF used as public transport in Kolkata, India (100 km)

Finally a global RUF standard is defined and all major cities will create networks which will then be connected to a very efficient transportation web for both Public Transport and special RUF cars.