

PRT- a High-quality, Cost-efficient and Sustainable Public Transport system for Kungens Kurva

Summary of the Site Assessment Report,

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- project

Evaluation and Demonstration of Innovative City Transport (EU 5th Framework program “City of Tomorrow”)

The European Research Collaboration on PRT - EDICT

EDICT involves a consortium of 16 organisations; local authorities, consultants, industry and academia across 7 countries led by Cardiff County Council, with project management by Transport & Travel Research Ltd. The work will be evaluated by an independent assessment team led by IABG. Seven other cities are associated as “follower cities” and will help to assess transferability. The project started at the beginning of 2002 and will run until Fall 2004. It is financially supported by the European Commission Directorate-General Research through its Key Action “City of Tomorrow and Cultural Heritage”. The EDICT project is using as a model the ULTra system (www.atsltd.co.uk) an innovative PRT system developed by Advanced Transport Systems Ltd. This is currently under engineering test in Cardiff, funded by the UK Department for Transport, with support from Cardiff County Council and the National Assembly of Wales.

Personal Rapid Transit - or PRT - is a new form of transport which is both personal and public. It is a system of automatic cabs travelling on their own guideway network. In contrast to conventional public transport:

- PRT is available when you want it
- PRT takes you non stop to where you want to go
- Energy use and emissions are reduced, typically by a factor of three
- PRT is low cost, both to install and to operate
- PRT offers both greater mobility for users and a higher quality urban environment,

The Swedish part of the project has been funded to 50 % by Vinnova and is coordinated by Transek Consultants. Other partners are the Municipality of Huddinge and LogistikCentrum. The aim of the Swedish Test Site has been to study a PRT network for the Kungens Kurva the largest commercial shopping mall in Scandinavia outside downtown areas.

Local Objectives for the City of Huddinge for Kungens Kurva are:

- Improve the environment by **a more sustainable society** with less car traffic and less air pollution.
- Decrease land use demand for streets and road traffic. This would make it possible for a higher land use ratio and thereby better condition for establishing more workplaces.
- Better access to the area and therefore higher possibility for a larger amount of visitors and thereby higher real estate values and development possibilities.

The public transportation to King's Curve is not sufficient.

Why are bus and light rail not sufficiently attractive?

For a traveller the entire trip from door-to-door is important, not only from stop/station to station. This means time spent walking, waiting, riding and some times transfer times with more access/egress time. With traditional bus service the total speed will never exceed 13 km/hour. With light rail transit never seldom more than 17 km/hour for a typical urban trip.

The low average speed depends on the walking distance, infrequent service, many intermediate stops en route to the destination. Traditional surface public transport means bicycle speed. There is an urgent need for a high-quality public transport that is attractive even for car users, cost-efficient and sustainable.



Increased road congestion at Kungens Kurva

At the entrance to Kungens Kurva the peak period speed for cars and buses is around 16 km/hour. Already at a 20 % increase in car flows at peak, speed will fall below 10 km/hour. And then the buses are stuck into a real grid lock.



A substantial part of the Kungens Kurva Area is covered by surface parking lots. If the number of parked cars could be reduced, then useful land can be utilized for more valuable activities, such as working places, commercial store buildings, parks, restaurants and recreation. Kungens Kurva would be more city like and more attractive. To obtain a denser land use, the customers will demand a better accessibility to the area.

Individual trips on a common guideway, non-stop directly to the goal all seated – this is PRT!

“During the last century, not very much has happened to surface transport technology. Well, horses were replaced by the rotation electric motor, and trams were dug into tunnels together with drivers and passengers. Cars are moving around as usual, now in such a great number that it often is quicker to walk. The trains are running somewhat faster on their tracks.” ... /PA Håkansson, TMC Scandinavia/

Now, in the US and in Europe there is idle time for the next important move. With a half century of experiences, it becomes quite easy to realise what should be achieved in the field of innovative personal transport. Let us divide the goals into four separate parts::

1. Comfortable, individual trips without waiting time, always with an available seat, directly to the desired destination station without intermediate stops.
2. Traffic safety on a dedicated guideway does not interfere with other modes of transport.
3. Environmental friendly. Suitable for electric propulsion, fuel cells or other new technology.
4. Lower costs both in the short and the long run; and requires less land.



PRT - Energy end environmental friendly trips together with a chosen companion– an efficient and sustainable mode of transport!

PRT – is like a cab for up to 4 persons, runs on a dedicated guideway and separated from other modes. PRT has been developed to offer some of the advantages of the private car:

- + departs whenever without timetables
- + direct to destination without any stop or transfer
- + private trip/with a chosen companion of your own

At the same time, one wants to avoid some of the disadvantages of the private car:

- noise and exhausts
- congestion and accidents
- parking demand

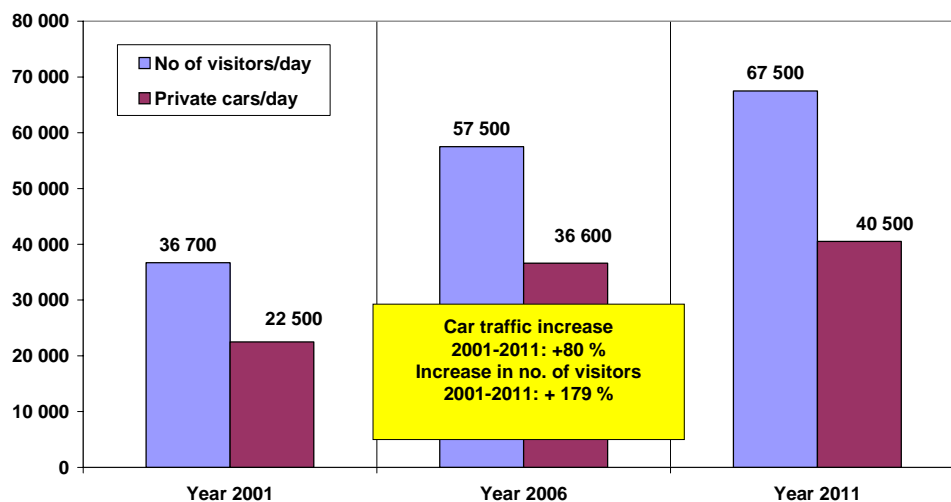
PRT consists of small driverless vehicles on a dedicated guideway dispatched on demand without intermediate stops en route. The driverless cab waits for you, instead of you waiting for the vehicle!



The Land-use Development at Kungens Kurva

In 2002 Kungens Kurva had 42 000 daily visitors. A survey among the 18 largest stores at Kungens Kurva yields an estimate of 63 500 daily visitors, an increase of over 50 %.

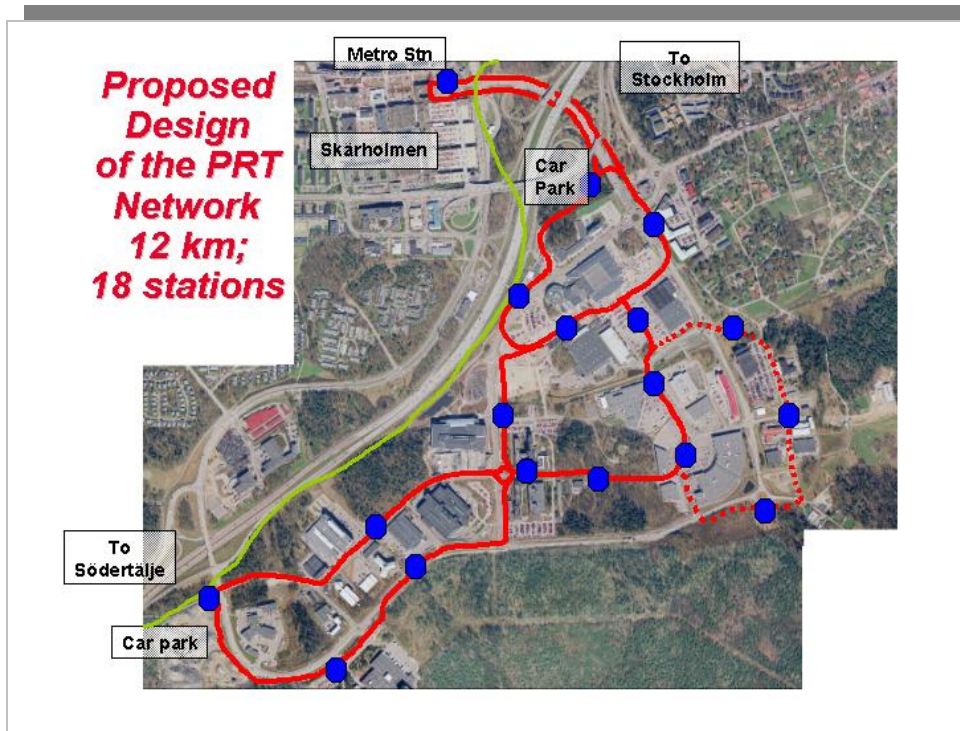
No of visitors per day to Kungens Kurva



A addition in commercial floor space of 260 000 sq.m. is foreseen for the period to

A PRT network connects Skärholmen (metro) with Kungens Kurva

A dense PRT network is proposed to connect Skärholmen residential and shopping area (and metro station) with Kungens Kurva with 12 km guideway and 12 stations, of which two inside a Parking house:



A Local Travel Survey shows a great concern for PRT

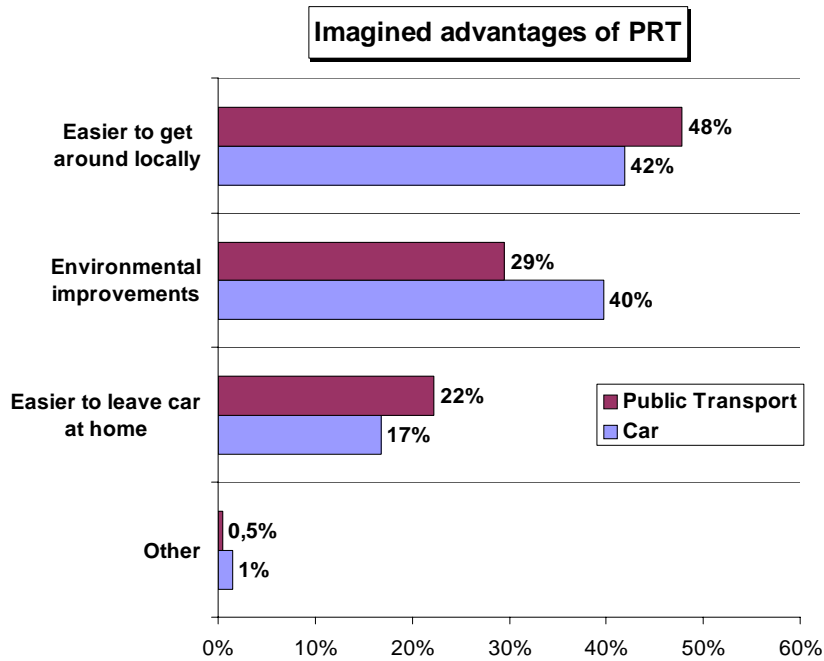
A Local Travel Survey carried out by Transek Consultants and the Municipality of Huddinge in May-June 2002 shows:

- 2 of 3 visits IKEA and/or a major grocery store (ICA Kvantum)
- 3 of 4 visits at least 2 shops or activities when they visit Kungens Kurva
- A vast majority of the visitors is very satisfied with the supply of shops
- Half of the car users and 70 per cent of the bus users are dissatisfied with the traffic conditions to and inside the Kungens Kurva area.
- Among the negative views, the long intervals between bus arrivals and the long distance between the shops were noticed. Also the difficulties to find a free parking lot in peak periods was mentioned.

Positive Attitudes to PRT at Kungens Kurva

With a PRT system at Kungens Kurva the traffic conditions is expected by the visitors to be substantially improved:

- 41 % of the car users and 83 % of the bus users have a positive view about PRT
- In all, 57 % of all interviewed persons are in favour of PRT system to be built
- 1 out of 5 believes it would be easier to travel without a car to the Kungens Kurva
- > 1 of 3 believes it would lead to fewer cars, less exhausts and fewer accidents.
- Movements between the stores at Kungens Kurva would be easier;
- 86 % believe more shops and stores could be established in the area.

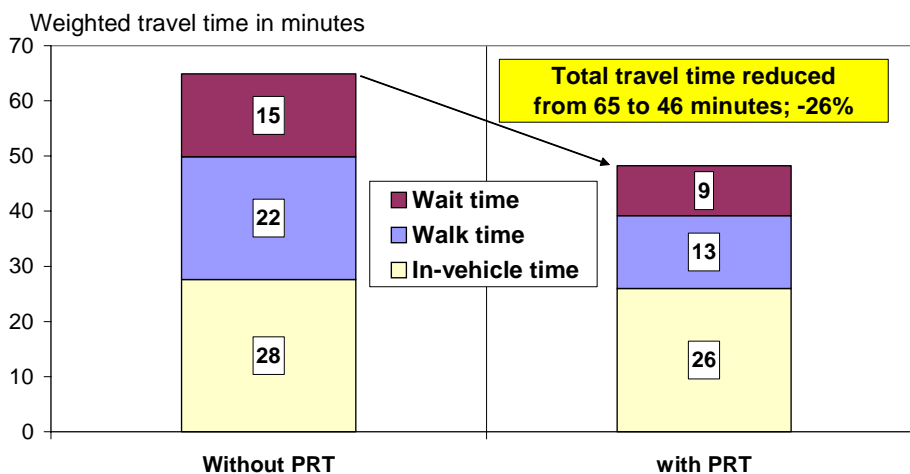


Many visitors are very positive to PRT at Kungens Kurva.

Door-to-door trips faster with PRT

- The total travel time between Skärholmen and Kungens Kurva will be reduced from 14 to 8 minutes incl. walk time with PRT, i.e. a 41 % reduction.
- The total travel time from Stockholm city to Kungens Kurva can be reduced by 26 % from 65 to 46 minutes (incl. walk and wait time).
- In off-peak, the travel time gain will be 20 minutes between Stockholm City and Kungens Kurva with PRT.

Generalized (weighted) travel time from Stockholm City to Kungens Kurva without and with PRT in 2002

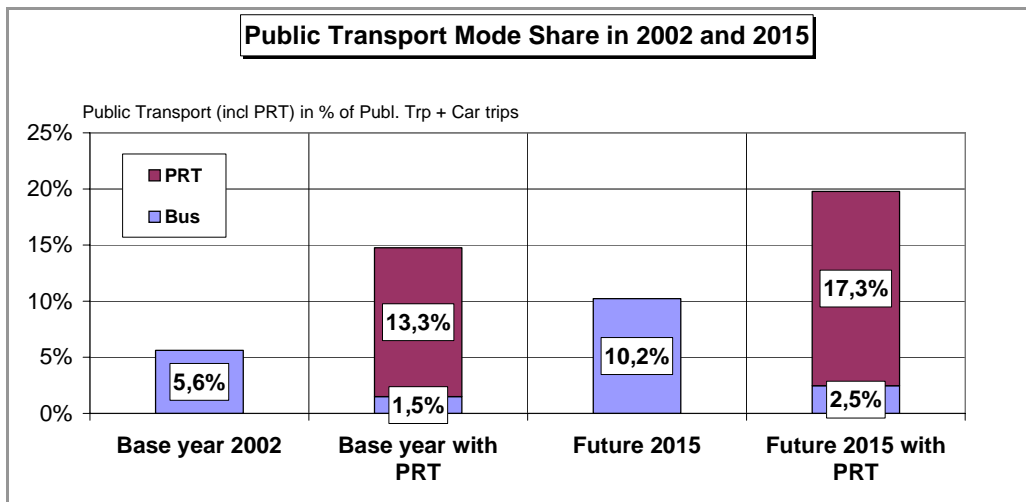


PRT – available twenty-fours a day even for disabled

IKEA personnel needs a proper public transport supply even during the night. This is because they need to unpack the stream of goods before the store opens up in the morning. However, at present, no such established public transport service is available. With a driverless PRT system in operation, it will be much easier to provide a 24 hour service at affordable costs. PRT is also available for all kinds of travelers, even for disabled, as wheel-chairs can be taken on-board.

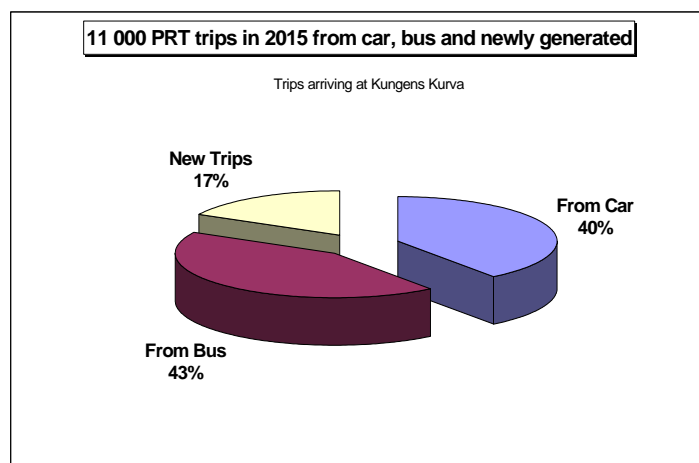
3 times more Transit Trips with PRT compared to today's Bus

Of today's 42 000 daily visitors, the bus mode carries some 2 350 or 5,5%. In 2015 – with the Kungens Kurva area fully developed – almost 1 out of 5 visitors is expected to go by public transport, of which 17.3 % or 11 000 by the PRT mode. This modal split is almost four times higher than today. PRT will provide an environmental-friendly and attractive complement to the private car, and it also draws more passengers to metro and bus.



PRT attracts 17 % more visitors to Kungens Kurva

Of the 11 000 riders on the PRT system in 2015, no less than 40 % comes from the car mode, 43 % from the bus mode, while 17% are newly generated trips, not done before.

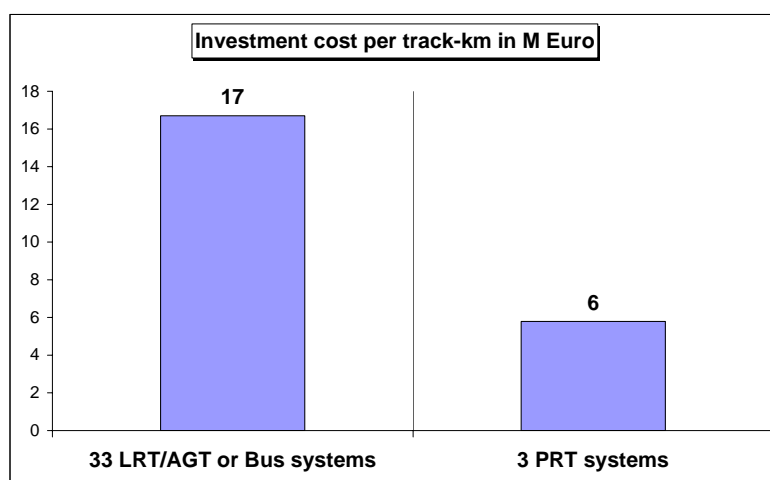


Dedicated Guideway in favour of Traffic Safety

A substantial part of today's road traffic accidents is caused by collision between unprotected pedestrians/cyclists and cars/trucks. PRT with its separated and elevated guideway 5 meters above the ground, helps to avoid conflicts with other traffic modes. In Morgantown, West Virginia a Group Rapid Transit has been in operations since the middle of the 1970's. During its over 25 years of operation, not one single fatal accident has occurred.

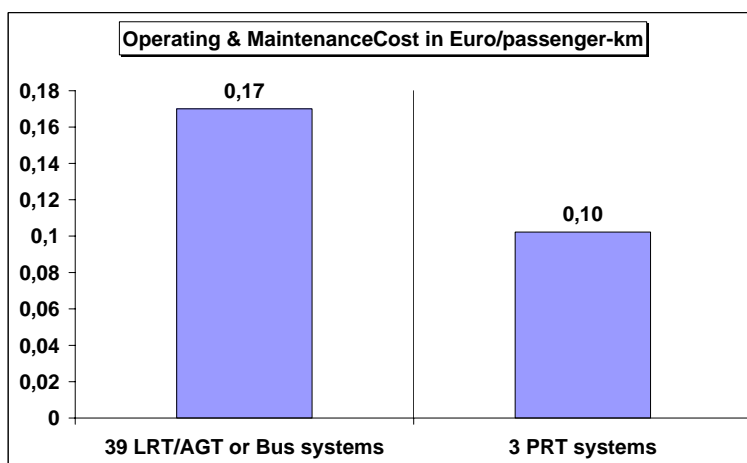
PRT Investment Costs one third of a LRT system

Cost estimates from three independent PRT suppliers (ULTRa, Taxi 2000 and Austrans) (including guideway, vehicles and stations) indicates an investment cost of 6 M€ per track-km, compared to 17 M€ for 33 other LRT/AGT or "guided" bus systems. The PRT cost is one third of the cost of the new Light Rail Transit "Tvärbanan" in Stockholm. PRT would yield a gain of 111 M€ per a 10 km track compared to a LRT system.



Low Operating Costs with PRT saves scarce Resources

As PRT means much lighter vehicle and guideway constructions than Light Rail Transit, the investment cost will be much lower. Besides, being driverless, the operating costs also becomes lower than LRT and bus. Three PRT systems are calculated to cost 0.10 € per passenger-kometer, while 33 other rail systems (or



guided buses) cost on average 0.17 € per passenger.km. Thus, a PRT system will in most cases, be cheaper to build and to operate than the established light and heavy rails systems. PRT may have the same capacity as other systems with bigger vehicles. One PRT vehicle with 2 passengers/vehicle every 3 seconds gives the same capacity as one LRT-vehicle every 15 min.

PRT reduces Car Traffic by 8 % and facilitates Land-use for Commercial Activities

One of the most important local objectives of the municipality of Huddinge, is to reduce the need for parking space; to improve the traffic environment and to enhance the property values in the area. The reason for this is to create a more attractive area for more visitors, entrepreneurs, employers and employees.

Our forecasts show a reduction in car traffic by the year 2015 by 8 % with a PRT system installed. Still, the number of cars might increase up to 2015 by as much as 28 %, due to the estimated rapid growth in activities in the area.. But without PRT the growth in car traffic might be 40 %. We propose to build two parking-houses at each entrance to the area and to integrate a PRT station in each parking house, for a convenient transfer between car and PRT.

PRT yields a positive Social Net Surplus to the Benefits of the Society

The social benefit-cost analysis is carried out for the full PRT network at Kungens Kurva. The following **benefits** have been considered and analyzed:

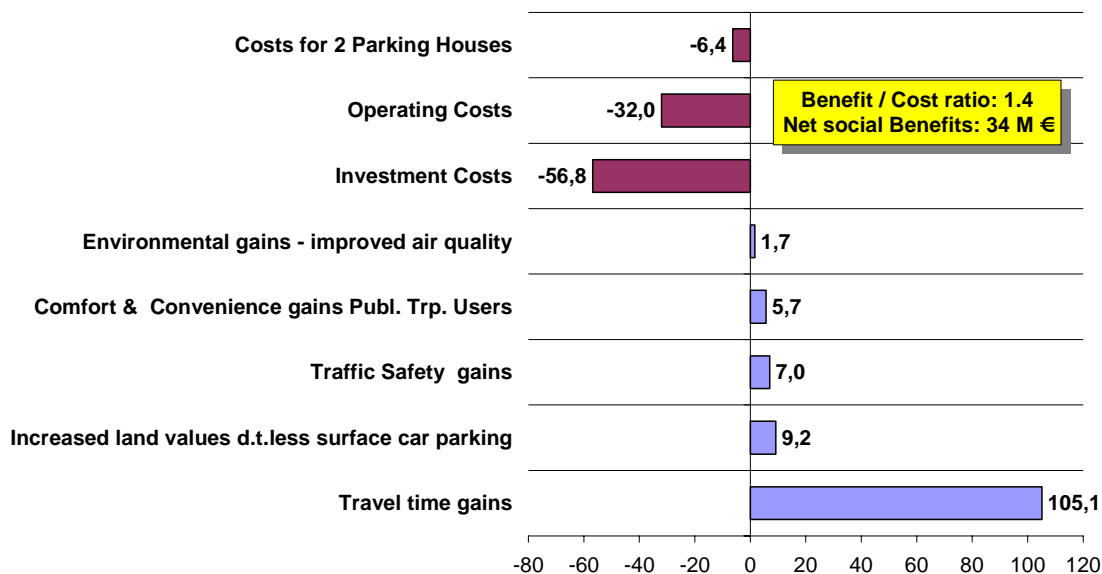
- Travel Time Savings for car users and for public transport users
- Reduced Road Congestion, both on urban roads and inside Kungens Kurva
- PRT vehicle & station comfort & convenience gains
- Environmental Impacts in terms of reduced air pollution exhausts
- Traffic Safety Gains
- Increased land values due to reduced surface car parking

As **costs** we have identified:

- Capital costs for PRT guideway, stations and vehicles; also for 2 Parking -houses
- Operating and maintenance costs.

All impacts are calculated over a 30 year period and calculated as a discounted present value at a 6 % real 'time preference rate', with the following result:

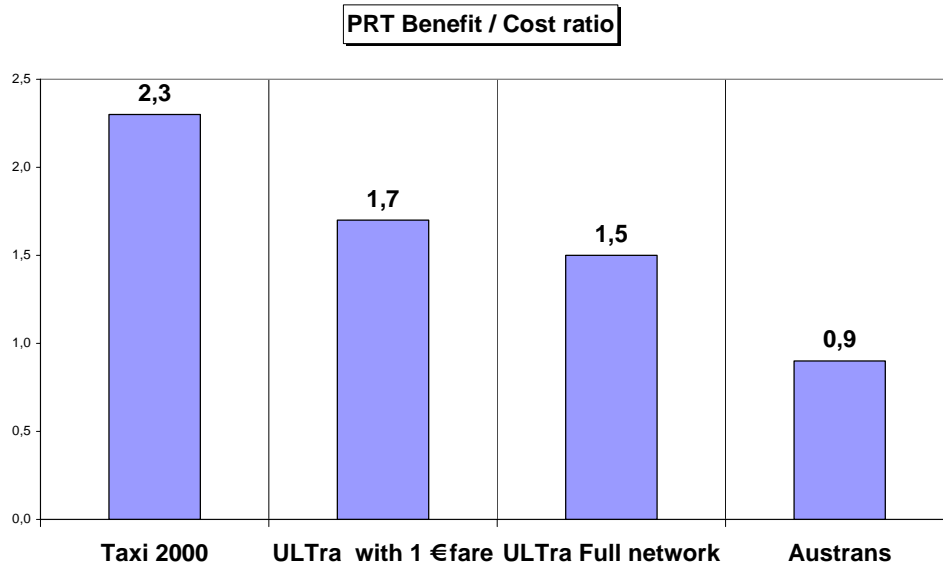
Benefits and Costs for PRT at Kungens Kurva. Net present Values in M €



Social **Benefits** (129 M€) exceeds costs (95 M€) based on the ULTra concept. Travel time gains dominate the benefits (80 %). Increased land values is the second largest benefit (7 %). The two parking houses give rise to a net benefit as they play a major role for the positive outcome. PRT Comfort, Traffic Safety gains and Environmental Improvements together make up 14 M€ of benefits, or 10 % of the total benefits. Direct **costs** (capital and operating) make up 89 M€, or 69 % of all benefits.

The benefit/Cost ratio for the Ultra PRT full network system at Kungens Kurva then becomes 1.5. If an extra fare of 1 € is levied, then the B/C ratio augments to 1.7 with ULTra. The Austrans system is rather close to but not quite at “break-even”; it is a little more costly for the Kungens Kurva area, but it might play a role as a regional GRT system as a low cost alternative instead of a LRT. Taxi 2000 has the most favourable benefit/cost ratio with its low costs.





To Sum up: The benefit-cost analysis clearly reveals that PRT is an economic viable, sustainable and environmental friendly transport system for the “cities of tomorrow”.

Several PRT systems to choose from

We have analysed three PRT systems suitable for use in Kungens Kurva. All three are based on small vehicles running on an elevated guideway.



The ULTra vehicle is similar to a 4-passenger car with rubber wheels driven by battery and an electric rotary motor. Vehicles steer autonomously on a guideway of concrete and steel. Batteries are shifted in a depot after a few trips. Possible snow or ice on the guideway would be melted with chemicals. Already two vehicle prototypes run on a 1 km partly elevated test track.

SkyWeb Express is being developed in Minnesota, USA. Vehicles take 3 passengers side by side. Propulsion and braking is by linear motors in the vehicle powered from contact rails in the guideway. The chassis with wheels and motors run inside a U-shaped guideway. One vehicle and a short guideway section are being demonstrated indoors with passengers.





The Flyby PRT system is being developed by a Scandinavian-Korean industry consortium aiming to serve the former airport area Fornebu in Oslo Norway. 4-passenger vehicles run on plastic wheels on rails. Vehicles are pushed/braked by magnetic fields generated by linear motors in the guideway. Power, positioning and distance

control are all in the guideway.

In our judgement:

- SkyWeb Express looks to be the least costly but has not yet raised the necessary financing for a full-sized test track.
- FlyBy makes the least visual intrusion, offers reliable propulsion and a full-size test track is being planned.
- ULTra is the most market-ready system with satisfied passengers, but without a good solution for snow and ice.

A PRT system for Kungens Kurva can be installed in stages

In the first phase the Skaerholmen subway station is connected to Ikea and a new parking-house. The guideway connects to the second floor at the Skaerholmen bus turn-around and runs under the motorway on the wayside slopes.



The first phase has 5 stations and 3 kms guideway. 8 vehicles offers less than one minute waiting at the present level of demand.

In phase two a loop is added south of Ikea serving ICA Maxi, Smart Club, Emerson and Heron City. That requires 11 stations, 5 kms guideway and 45 vehicles.

The third phase would connect to a second parking house at the south entrance serving Asko Finn Center and Apotekbolaget. The system would be 7 kms guideway, 15 stations and 85 vehicles would cover the estimated demand for year 2015.



All stations except Skaerholmen are off-line so that traffic can pass on the main track. A typical station has place for 2 vehicles at a platform where passengers load and unload. There is space for three vehicles waiting before the platform and one vehicle after the platform waiting to exit.

We recommend and have assumed that ride-sharing is encouraged by lower fares at least from major stations during peak demand. All passengers in one vehicle share the same destination so there will be no stopping on the way. No passenger has to wait more than one minute to depart.

Strong User Acceptance for PRT at Kungens Kurva

In October 2003 three focus group interviews were carried out at Kungens Kurva, in order to study the users' acceptance and willingness to pay for a PRT system there. In all 28 persons participated in these in-depth interviews. The attendants were chosen among those who are frequent visitors to the area and who travels by various means of transport to Kungens Kurva.

Difficult to get to Kungens Kurva

It could be difficult to get to Kungens Kurva and to move around within the area. Those who get to the area by public transport often complains over the long distances between shops; and they think that the area is not very pedestrian-friendly.

More visits and more shops visited by PRT

Most of the public transport users (80 %) admit they would pay more visits to Kungens Kurva if it was substantially easier to get around with a high-quality system such as PRT.



While, on the other hand, very few car users who say so. However, about 50 per cent of the car users would visit many more shops, once they are in the area, it would be more accessible to get around by PRT.

A great curiosity about PRT among everybody, except from those with bulky luggage

Everybody was very curious about PRT. They would absolutely try the PRT, if installed. Very few car users would leave their car at home when going to Kungens Kurva, but they can imagine to park and ride PRT between the shops. Car user with very bulky luggage will not use PRT.

A positive willingness to pay for PRT among public transport users

The most positive attitudes were found among public transport users. 39 % of the transit users are willing to pay about 0.5 € extra per PRT trip. Few of the car users are willing to pay for a PRT trip; instead their view is to have a PRT system financed by the shop owners, as the real winners of such a system; commercial suppliers should pay the operating and maintenance costs of a PRT system.

Visual intrusion is no problem – PRT it is rather a positive adventure

”It will be funny to go by PRT ’up-stairs’”. ”The vehicles really look great and smart, just like science fiction. The kids would love it, I believe”.

Technical reliability is very important; less concern about personal safety and security

The PRT must always work properly and be fresh-looking, to have a future. If it fails and gets into trouble, it gets a bad reputation and nobody will use it. Security is no problem, because many people are moving around during shopping hours at Kungens Kurva. Fine with cameras and possibilities to choose companions for the ride. The short travel time and short distance between stops brings a sense of security to you. A break-down of the PRT-system would be most unpleasant.

What happens outside Sweden?

In Cardiff the ULTra-light driverless cabs are already running on the 1 km test track with passenger trials. The willingness to pay for this high-quality service is 80 % higher than for the established bus service. This is due to the perceived higher comfort and convenience with PRT compared to ordinary buses: In Minnesota a new test track was inaugurated on April 10th 2003 with the SkyWeb express from Taxi 2000. In Australia a slightly bigger vehicle (for 9 passengers) is being tested on a test track outside Sydney. In Norway, there are plans to look into more detail for a PRT system at Fornebu, Oslo. To date, there exists over 110 AGT - Automated Guided Transit systems all over the globe. One late example is the mini-metro in Copenhagen, Denmark, the first AGT system in Scandinavia. These AGT systems carries together well over 4 million trips per day.

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