Towards Sustainable Travel in Stockholm’s Public Transport

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Today’s menu

- Something about Stockholm and SL
- General Swedish policies and efforts regarding renewable fuels
- Why biofuels in Public Transport?
- 3 ways to tackle CO₂
- SL’s work on renewable fuels
- Ethanol Bus Buyers’ Consortium
- Questions and Discussion
The County of Stockholm

1.6 % of Sweden’s total area

Population 1.9 million

Every fifth Swede lives here

Cars per thousand inhabitants
County of Stockholm: 402
Sweden: 459
Climate policies in EU/Sweden

- Kyoto: Industrialised countries should decrease emissions by on average 5 % until 2012 (of 1990 levels).
- EU members have agreed on an 8 % reduction until 2010.
- Division of emission burdens vary between countries – some are even allowed to increase emissions (e.g. Sweden)
- Sweden's national goal is a decrease with 4 % in 2012. (20 – 30 % 2020?)
- For transportation the EU directive (2003/30/EG) stipulates an increase in renewable fuels
  - 2 % 2005, 5.75 % in 2010, 10 % 2020.
  - Public transport specifically mentioned as an important forerunner
Tax Strategy for Alternative Fuels

CO$_2$-neutral fuels are exempt from both CO$_2$ tax and energy tax with effect from 2004 as part of a five-year programme.

According to budget bill for 2006, biofuels will continue to have tax exemptions to ensure competitiveness.
According to legislation passed in December 2005, large filling stations will be obliged to market a biofuel alternative from April 1st 2006.

The obligation will be expanded to include all filling stations selling more than 1 000 m³ of conventional fuels by 2009.

An investment support for the filling station choosing to provide biogas will be made available.
...and carrots.

Reduced vehicle tax for green cars.

Reduction of benefit attributed to green cars for tax purposes to encourage the introduction of environment friendly company cars.

The environmental policy for government vehicles states that, from 2006, at least 75 percent of the cars bought by government agencies etc should be green cars. Cars with special requirements are exempted.

Taxi priority.

Free parking.
Congestion Charging…

Reduction of traffic to and from the city center by 20 to 25 percent

Times spent in traffic queues:
Decrease by 30 to 50 percent

Emissions: Decrease by 14 percent in the city, and 2.5 percent in the county.

Green cars free of charge.

Increased travel with Public Transport

Higher fees during peak hours.
Sales of Clean vehicles in Stockholm
2001-2006

Andel (%)

City cars
Etanol
Biogas
El & hybrid

Jan-Apr 2006

2001 2002 2003 2004 2005 2006
Biofuels per type …
Share of Biofuels since 1998 ...
Stockholm Public Transport Authority (SL)

- Planning, Procurement and Follow-up of Public Transport in the County of Stockholm. Infrastructure management.
- Metro, Buses (2 000), Commuter trains, local trains, trams.
- 2.5 million trips/day, >70 % market share during peak hours.
Owner and share holder
Stockholm County Council

AB Storstockholms Lokaltrafik (SL)
(Stockholm PTA)

Contractors
- operations
- station services
Financing of public transport
(MSEK, running prices)
Not only an Environmental problem!

Oil dependency and CO$_2$ cause:

- Environmental problems!
- Problems with security of supply!
- Financial problems!
Local emissions - on the right track...

PM emissions from traffic, Sweden 1946-2020

VOC-emissions from traffic, Sweden 1946-2020

SO₂-emissions from traffic, Sweden 1946-2020

NOₓ-emissions from traffic, Sweden, 1946-2020

Källa: Vägverket och SPI
2000-03-16/UN1/BAFF
...but CO₂ is not!

Oil use in OECD

Other sectors

Transport sector

- 70%

Oil and gas supply

OIL AND GAS LIQUIDS
2004 Scenario

[Graph showing oil and gas liquids production by region and type, with data from 1930 to 2060.]
“By 2025, we need to find, develop and produce a volume of “new” Oil & Gas that equals 8 out of every 10 barrels produced today.”

ExxonMobil

“The world needs new oil fields!”

Source: Uppsala University 2004-06-16
The Oil Triangle

Within the Oil Triangle you can find roughly 60 percent of the remaining oil reserves. The 2001 Cheney report says that in year 2020 around 54 to 67 percent of the world production of oil needs to come from the Oil Triangle. USA has moved their military head quarter from Riyadh to Qatar.
Interrelation of Atmospheric CO₂ - Temperature

Temperature change from present, °C

Temperature and CO₂ concentration in the atmosphere over the past 400,000 years (from the Yostok ice core)

- 700 ppm (2100)
- 375 ppm (now)
Financial CO$_2$ problems

- Cost of emissions rights in industrial/energy sector is booming;
- Emission trading for transportation soon a fact.
- CO$_2$ taxes, km-taxes, etc;
- Scientists and oil industry agree that there will be a physical shortage of oil in the near future;
- Oil price likely to be sluggish and high;
- It will cost you to be oil addicted and to cause fossil CO$_2$ emissions!
Strategically and financially very important for everyone dependent on fuels to secure the supply of renewable fuel!
Only 3 ways to reduce oil dependency and fossil CO$_2$ from transportation!

→ Curb the uncontrolled growth of transport
→ Increase energy efficiency
→ Increase the use of biofuels
SL’s goals

Rail Traffic
SL only uses electricity made from renewable sources (wind, water, biomass)

Bus Traffic
- 25% 2006
- 50% 2011
- 100% 2025
I. Apply today’s environmentally friendly standard solutions on a large scale! (Ethanol and biogas, etc.)

How to get there - Sustainability Philosophy

II. Support what you believe to be future solutions for a sustainable transport system! (Fuel Cells, Intermodality, etc.)
How to get there
SL - World Leadership on Renewable Fuels

→ The future has always been just around the corner – at least since the 1970s…?
How to get there
SL - World Leadership on Renewable Fuels

➔ CUTE - Test of 3 hydrogen Fuel Cell buses 2004-2005

- 27 buses in 9 EU cities
- Only water as exhaust
- FCs not commercial yet
- 2 years in standard traffic with very high availability
- FCs + renewable fuels + hybridisation = An “optimal” vehicle in the future??
Availability / Technical problems

- Very high availability!
- Bus problems few and not related to FC but to auxiliary systems, e.g. sensors, valves, electric components (inverter), pressure regulator, water tanks.
- Lack of spare parts
- High fuel consumption; 2.2-2.5 kg H₂/10 km (equals approx 7.5-8.5 l diesel/10 km)
- A proper "FC-design" could increase energy efficiency dramatically
- Driving style important
Sankey diagram
Energy flow in the buses, average from test

Water route, July 2004

→ Flat route in downtown traffic

→ Low average speed: 10 km/h

→ The fuel cell is regulated to not operate below a certain voltage. In times when this voltage is not needed for keeping the engine running, the electricity produced is dumped.
Possible improvements

- Optimize control systems to avoid “power dumps” (14 %)
- Adapt auxiliary systems to Electric driveline (heating, gearbox, AC, generators, door openers…) (5 %)
- Regenerative breaking (20 %)
- Hybridization (20 %)

- Not cumulative, but a proper FC-design would save approximately 40 % of energy.
- "Heavy-duty” quality and lifetime for components
- H2 infrastructure!
- Price – mass production
- Administration of hydrogen issues
One of Europe's largest Biogas Bus Fleets to be built up from 2004 and onwards

- 51 buses 2006 - 130 buses in 2009
- Secure, clean and long term (20-year contract with Stockholm Water Ltd Waste water/Sewage)
- Volumes only enough for small part of the bus fleet
- Very suitable for fleets of heavy vehicles
The World’s largest fleet of ethanol buses.

- Since 1989
- 256 buses 2005
- 390 buses 2006
- Most cost efficient way to reduce both local and global emissions
- Liquid fuel simplifies infrastructure
- Only way to reach 50 % goal
Co-op SL – Scania

Tax exemption granted for "pilot projects"

30 buses tested in city traffic 1990

Minor technical problems were solved

Continuous introduction

Inner city first (250 buses in 2000)

Suburban traffic next (390 buses 2006)

25 % of all bus traffic runs on renewable fuel (2006)

Goal is 50 % 2011
Net gain in Stockholm with ethanol and biogas buses

- 390 ethanol buses and 51 biogas buses (2006):
- Reduce diesel use with 16 million litres of diesel/year
- Reduce fossil CO₂ by approx. 41 000 tonnes/year
- Reduce particulates by approx. 4 tonnes/year
Few “neutral” views and reports on fuels around…

OECD & International Energy Agency (IEA)

www.iea.org/books
Fuels of the future…?

- Ethanol from Sugar Cane
- Ethanol from Cellulosic Raw Materials
- Biogas
- Hybrids (any fuel)
- Fischer-Tropsch Biofuels
- DME – DimethylEther
- Methanol, Hydrogen,
- …
Must a product be perfect from every aspect to sell?

- There is always a better solution “just around the corner”…
- Optimal technology is not necessary…
- …it will sell anyway - if it is good enough and the timing is right!
- Transportation does not need another test project…
- …we need a functional, cost- and CO2-efficient product.
Local emissions (PM, NOx)

Biodiesel

Petrol (electric hybrid)

CNG

LPG

Petrol

H2, electricity (water power)

E95

E85

Biogas

Summary of swedish studies on renewable fuels 2006, Inregia
An International Consortium for procurement of ethanol buses

Kick-start the market for ethanol buses

Transfer of 20 years of ethanol knowledge

A test period with a small number of buses (5-30) for 1-2 years in pilot cities.

If the test period is satisfactory, an introduction in a larger scale and in other cities, by the means of an International Buyers Consortium;

www.ETHANOLBUS.com
The BEST Proposal
EU-call on "Biofuels in Cities"

BEST
Bioethanol for Sustainable Transport

- Ethanol cars
- Ethanol buses
- Low blends in petrol and diesel
- Distribution
- Incentives
- Transfer of knowledge
- Dissemination and Communication
- Evaluation
- Coordination

Partners participating with buses:
- Stockholm
- Madrid
- Rotterdam
- Nanyang
- Sao Paolo
- Luxembourg
- La Spezia
- Slupsk
- BioFuel Region
BEST

- Transfer of knowledge
  - Infrastructure
  - Political incentives
  - Campaigns, media work etc
- European marketing
  - Web sites, work shops, seminars, study tours, site visits
- BEST friends = close followers who can take advantage of the transfer of knowledge, etc.

BEST BioEthanol for Sustainable Transport

The ethanol buses

The ethanol buses are standard Scania Omni buses with a 9 litres Scania diesel compression-ignition engine, slightly modified to operate on bioethanol bus fuel (E95).
The ethanol fuel is developed for heavy-duty, ethanol compression-ignition engines.
- 95% ethanol, 5% ignition improver
- It fulfills the ethanol fuel standard given by Scania.
- Originates from renewable sources only.
- The fuel is produced and delivered by SEKAB located in Sweden.
Refuelling bioethanol

- The bus driver will not observe any considerable differences. Refuelling ethanol is not different from refuelling diesel.
- For safety reason the fuel tank installation must be a dedicated tank for ethanol use.
- The fuel tank can be rented, leased or purchased from a number of companies that manufacture such installations.
Fulfils EURO 5 standard

- Ethanol bus with Euro 3 engine
- Ethanol engine with today’s technology
Energy use worldwide

- Global Energy Demand: ~ 420 Exajoule
- Transports: ~ 120 Exajoule
Volumes of sustainable fuels

Bioenergy production potential in 2050 for different scenario’s

Source: Smeets, Faaij 2004
Ethanol from sugar cane


Fig. 2. Ethanol and gasoline prices.
Ethanol markets develops rapidly
Car industry has decided...

- E85 is the fuel that will be used to reach environmental goals
- 2000 pumps in 2008
- All major brands sell ethanol cars in South America
- Ethanol is the biggest fuel worldwide
SL’s conclusions

- Necessary to secure the supply of (renewable) fuel.
- Biogas and ethanol only functional and renewable fuels in the near future.
- Ethanol is the only renewable fuel with a large volume potential in the near future.
- Ethanol is the financially most viable way to handle both global and local emissions.
"It’s hard to be green!" *

(*Kermit the Frog)

Buses
- Biogas and ethanol buses = available standard buses.
- Dramatically reduces both global and local emissions.
- Economy/km now equal (ethanol) or close (biogas) to diesel

Infrastructure
- Biogas and ethanol has a standard infrastructure.
- Leasing of a fuelling station possible.

Fuel
- All cities can produce biogas.
- Ethanol is the World’s biggest renewable fuel.
- Available in large volumes in many countries.
- Fully taxed ethanol in Brazil is cheaper than petrol.
- The future potential of sustainable fuel from biomass is higher than today’s consumption.
End of Presentation

Thank You!

www.SL.se (om SL - Miljö)
www.ETHANOLBUS.com
www.fuel-cell-bus-club.com
### Service compared to a diesel bus

- Articulated bus 60 000 km/year in city traffic;
- For the next generation of Ethanol buses, service level is expected to be the same as for diesel buses.

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