Power or Pollution?

Air pollution vs. cycling – a multidisciplinary challenge

Malte Rothhämel at Cycling & Society (2026-08-25)

Malte Rothhämel

- Associate Professor in the Vehicle Dynamics group at KTH, specializing in Vehicle System Technology.
- Research interests
  - bicycles, with a particular focus on their vehicle dynamics.
  - vertical dynamics (comfort)
  - longitudinal dynamics (energy consumption)
- Otherwise
  - human-machine interaction in vehicle steering and fail-safe chassis architectures for autonomous operation

Intro



Vienna, Austria (fully electric fleet)



Stockholm, Sweden (majority combustion engines)

Source: https://riderhub.foodora.com/at/

The legal fiction

Moped class II is a motor vehicle with two [...] wheels, designed for a maximum speed of 25 km/h and with a power output < 1 kW.

License plate: No
Periodic (roadworthiness) inspection: No
Vehicle tax: No
Traffic insurance: Yes
Speed requirement: Maximum design speed of 25 km/h.
Helmet requirement: Yes
Riding on bike paths: Yes, if available.
— Exception: signs marked 'Ej moped'

https://www.transportstyrelsen.se/sv/vagtrafik/fordon/fordonsregler/regler-for-olika-fordonsslag/moped/moped-klass-ii/

Exhausts



nature COMMUNICATIONS

ARTICLE

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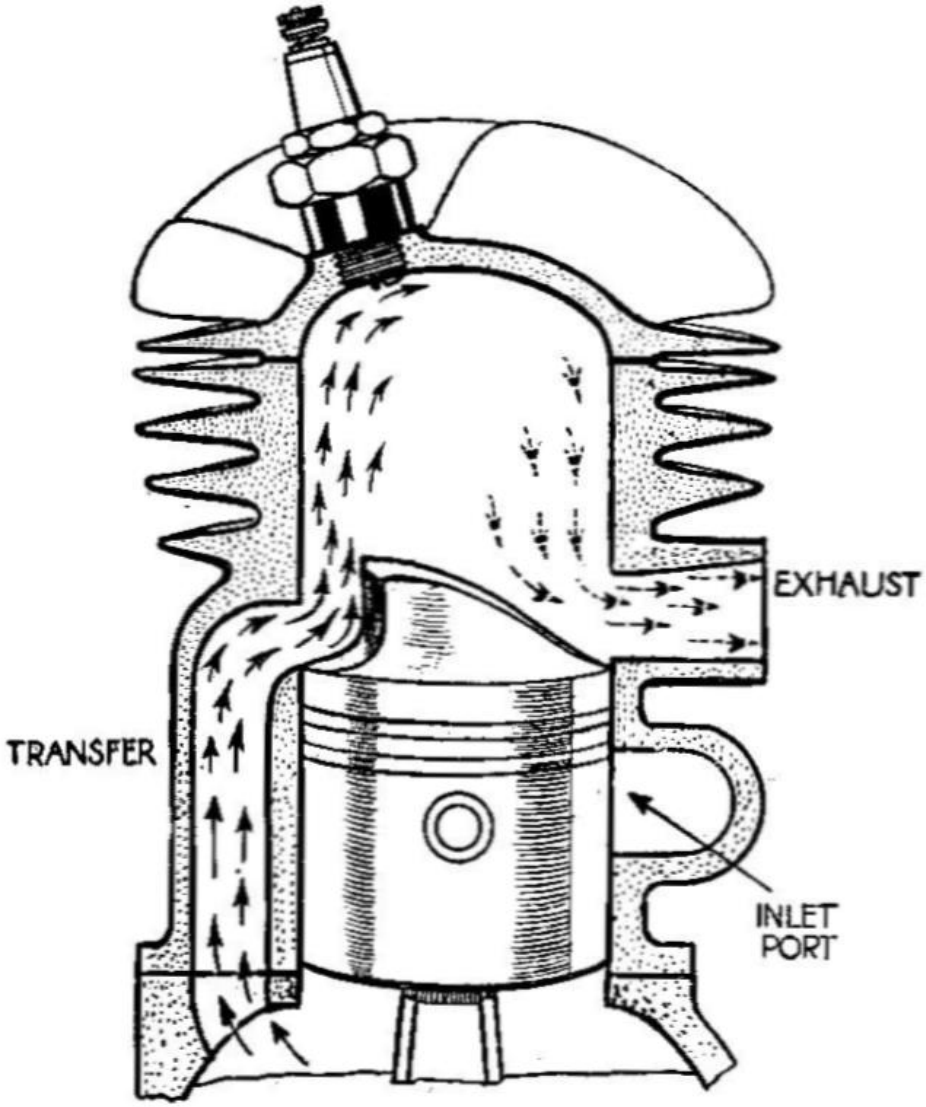
Two-stroke scooters are a dominant source of air pollution in many cities

S.M. Platt[1], I. El Haddad[1], S.M. Pieber[1], R.-J. Huang[1], A.A. Zardini[2], M. Clairotte[2,†], R. Suarez-Bertoa[2], P. Barmet[1], L. Pfaffenberger[1], R. Wolf[1], J.G. Slowik[1], S.J. Fuller[3], M. Kalberer[3], R. Chirico[1,†], J. Dommen[1], C. Astorga[2], R. Zimmermann[4,5], N. Marchand[6], S. Hellebust[6], B. Temime-Roussel[6], U. Baltensperger[1] & A.S.H. Prévôt[1]

Main result:
10 … 1000 times more carcinogenic compounds than the average passenger car (in 2014)

Source: https://www.psi.ch/en/news/media-releases/unassuming-rampant-polluters-on-two-wheels

Why is the technology so dirty?



Source: https://commons.wikimedia.org/w/index.php?curid=15710195

Emission standards

Emission standards (EU)				
Year	Cars (Otto)	HC mg/km	Moped	HC mg/km
1993	Euro 1	970		
1997	Euro 2	500		
1998				
1999			Euro 1	1200
2001	Euro 3	200		
2002			Euro 2	630
2004				
2006	Euro 4	100		
2007				
2011	Euro 5a	100		
2015	Euro 6b	100		
2017			Euro 4	100

Source: https://www.umweltbundesamt.de/themen/verkehr/emissionsstandards/motorisierte-zweiraeder
https://www.umweltbundesamt.de/themen/verkehr/emissionsstandards/pkw-leichte-nutzfahrzeuge

Three EU countries

- Sweden
  - No registration, no statistics
- Germany
  - Insurance plate only, limited statistics
- Austria
  - Full registration, mixed traffic avoided, fully electric fleet of food delivery services



http://www.europaeische-juristenausbildung.de/_derived/laendertext.htm_txt_eurokarte2.gif

Another population







146ppm Benzene

- Benzene may cause heritable genetic defects. Repeated or prolonged exposure to very small amounts can cause temporary or permanent damage, or lead to death.
  Benzene is carcinogenic, and chronic exposure to benzene can lead to leukaemia.
- The US National Institute for Occupational Safety and Health recommends wearing respiratory protection if you work for longer than 15 minutes in an environment containing more than 1 ppm (parts per million) of benzene.
- The German Federal Institute for Occupational Safety and Health (BAUA) specifies an acceptable limit of 0.06 ppm and a tolerance limit of 0.6 ppm for benzene.

https://utslappisiffror.naturvardsverket.se/Amnen/Ovriga-organiska-amnen/Bensen/
https://www.psi.ch/en/media/our-research/unassuming-rampant-polluters-on-two-wheels
https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/pdf/TRGS-910.pdf?__blob=publicationFile&v=4

Cycleway = clean and human-powered?





Final questions

- Should cycling research and infrastructure statistics even continue to count combustion-engines-powered mopeds within the "cycling" category — or does that categorisation itself need to be challenged? (not only in Sweden!)
- Germany and Austria show two very different ways of getting from "nothing registered" to "something registered." Is Austria's full-registration model realistic for Sweden without also introducing the tax and insurance obligations that mopeds currently avoid — and is that political trade-off actually the sticking point?

Final questions

- Do commercial and hobby drivers need entirely different policy levers — commercial fleet standards for one, something closer to classic-car-style restrictions or emissions testing for the other? And more straight-forward: is it fair to describe the second group as bearing more of the actual air-quality burden along cycle paths than the delivery riders we tend to assume are the problem?

References

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Questions / Comments?

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En övervägande majoritet av Foodoras matleveranser sker med hjälp av bensindrivna mopeder, något företaget självt tvivlar på. Foto: Daniel Costantini

Matbudsföretaget Foodora har tidigare sagt att alla deras leveranser ska bli fossilfria. När DN gör stickprov visar det sig dock att en övervägande majoritet fortfarande sker med bensindrivna mopeder, något Foodora inte vill kännas vid.

– Det kan vara svårt att se skillnad på en eldriven och fossildriven moped, säger Daniel Gustafsson Raba på Foodora.

https://www.dn.se/sverige/foodora-om-de-bensindrivna-mopederna-ni-maste-ha-sett-fel/









Exhaust pipes are a characteristic feature of combustion engines and allow them to be distinguished from electric scooters.

