

DTU



How Economic Incentives can Support Transport Policy

- The difficult path from Research to Policy

About the lecture

- Many years of analysis, 2000-2018
- Green transport commission, 2019-2020
- Road Pricing Experiment, 2023-2025

Many years of analysis, 2000-2018



Road pricing

Economics: "Road pricing is the most efficient way to tax car driving" Vickrey, 1955', ideas from Pigou, 1958

Has been difficult to implement in real-life

- Political arguments against
- So far, large system costs, technical and IT issues, data and legal issues, GDPR

Practical issues and concerns related to:

- Technology
- Surveillance
- Costs
- Distributional effects

Fast development recent years

– some real life experiences with road pricing



Danish, Analyses

Tolled fixed links, Denmark

2000

AKTA-experiment 2000-2004 (Alternative Kørsels og Trængselsafgifter)

IMV analysis

DØRS1



Tornings Copenhagen toll-ring

Expert-commission on congestion

S&B tests GPS precision

Ministry of Transport Expert-group on future transport

Expert-commission for green transition of cars

DØRS2

2022

Large-scale experiment for cars decided

Road-pricing for trucks decided

International, Real systems and analysis

Toll motorways and lanes, USA

Singapore Area licensing Scheme, 1976

Toll-rings (Stockholm, Oslo, Bergen, Trondheim, London, Singapore, Milan...)

MAUT for trucks, Germany first, later also in other countries

Multi-toll rings (Singapore, Oslo)

GPS-based system decided but then cancelled in the Netherlands

Orego large-scale test and use in Oregon

MOBIS eksperiment in Switzerland, 2019-2021

EETS-directive support a marked with various technical solutions (GPS-boxes, "bizzer", number plate registration, OBU car navigation systems, smartphone-based systems)

Danish analyses

Experiences and recommendations

2000	AKTA-experiment 2000-2004 with GPS and 500 cars (Alternative Driving and Congestion Charges)	Large-scale experiment, technical solution possible but expensive, (OBU and control), negative CBA
	IMV analysis	Less negative CBA, other solutions
	DØRS1	Recommend, but not technical/practical feasible
	Tornings Copenhagen toll-ring	Less negative CBA, large regional distributional effects, political protests from suburban mayors
	Expert-commission on congestion	Positive CBA, suggest the large-scale experiment
	S&B tests GPS precision	Technical development makes GPS more accurate and cheaper
	Ministry of Transport Expert commission on future transport	Recommend, positive CBA, less regional distribution, Minister of Transport positive
	Expert commission on green transition of cars	Recommend system with self-declaration using app, cheaper system, positive CBA for Copenhagen, recommend large-scale experiment
	DØRS2	Positive CBA, suggestion large reform of car taxation
2022	Large-scale experiment for cars decided	
	Road-pricing for trucks for cars decided	

Prior road pricing proposals in Cph (1)



- **Km-based systems with OBU (Onboard Units) have large costs of operations**
- **Relative small improvements of mobility**
- **Toll-rings worse than km-based systems (AKTA and subsequent optimisation of these)**

A socio-economic assessment of proposed road user charging schemes in Copenhagen

Jeppe Rich*, Otto Anker Nielsen

Centre for Traffic and Transport, Technical University of Denmark, Byngningstorvet 1, 2800 Kgs. Lyngby, Denmark

Available online 7 May 2007

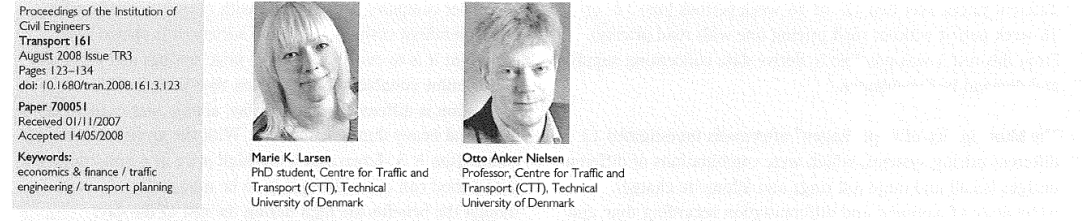
Table 9

Social costs and benefits for the four schemes, million euro per. year, 2005^{a,b}

	km charge	Cordon charge	Large toll ring	Small toll ring
Reduced climate and air pollution effects	8	8	3	-1
Reduced accidents	36	33	17	12
Reduced noise	21	21	11	1
Reduced wear damage	1	1	1	0
Improved accessibility	25	-47	0	-84
Producer surplus, public transport	20	13	7	5
Potential for reduced tax distortion	3	-11	5	5
Lost utility from changed trips	-40	-29	-35	-13
System costs ^c	-83	-83	-33	-29
Payments from motorists	-600	-320	-333	-173
Public income (charges)	600	320	333	173
Total	-11	-93	-27	-100

Further attempts to optimise charging levels in Cph. (2)

- **Optimisation of a number of variants in space and time**
- **Km-system now gave a small societal surplus**



Improving and optimising road pricing proposals for Copenhagen

M. K. Larsen MSc and O. A. Nielsen PhD

System	Chosen alternative	GC user	GC society	Traffic effects	Revenue
Small toll ring	20 DKK most expensive, not adjusted	-194	-73	-66	120
Large toll ring	50c, 50 DKK most expensive, adjusted two times, compare Table 8	-465	-104	7	470
Kilometre charge	5c2, optimised according to congestion costs, rounded to 0.10 DKK, compare Fig. 5	-378	38	45	420

Table 9. Generalised costs for users and society and traffic effects for the best price alternatives for the three systems in million € per year

Early road pricing proposals in Cph (3)

- Toll-rings results in detour driving
- Charging very far from marginal costs
 - Far to expensive for trips crossing the ring
 - No charging for trips within the ring (who have the largest externalities)
 - Detours lead to congestion outside the ring – even reduced mobility over the whole system, and large distributional effects
- Large cost for construction and operation (many links)



The control point up to [Essingeleden](#).



Toll ring in Copenhagen was a major theme in 2011 election

- Parties who were pro won the election
- Massive resistance from the socio-democratic suburban mayors
- Strongly supported by economist and researchers in the press due to negative socio-economy
- Abandoned, 20 February 2012

28-person large congestion commission 2012-2013 with researchers, sector partners, NGPs, mayors
 Despite all odds came to an agreement to recommend an large-scale experiment with GPS-based road pricing

Prime-minister; There will come a real good solution tomorrow



Thorning: Der kommer en rigtig god løsning i morgen

En smilende statsminister gentog igen og igen, at der kommer en rigtig god løsning på spørgsmålet om betalingsringen i morgen. Men hun indrømmede, at de havde lyttet til debatten.



Shift from “Build and provide solutions”...

Massive investment package only marginally reduced the forecasted growth of congestion



...to new paradigms to change behaviour to solve the societal challenges

- Pricing and nudging



- Electrification



- Transit oriented urban planning



The Green Transport Commission 2019-2020



“Climate election” where political parties gave extremely ambitious targets

- Political debate

April 2018



Mette Frederiksen sætter grønt mål: 500.000 biler skal køre på el og brint

Indfasning af en højere registreringsafgift skal udskydes, og der skal flere ladestandere op, mener partiet.



500,000 cars to drive on electricity or hydrogen

October 2018

2. oktober 2018 kl 13:17

Løkke: Om 17 år skal hver eneste nye bil i Danmark køre uden benzin eller diesel

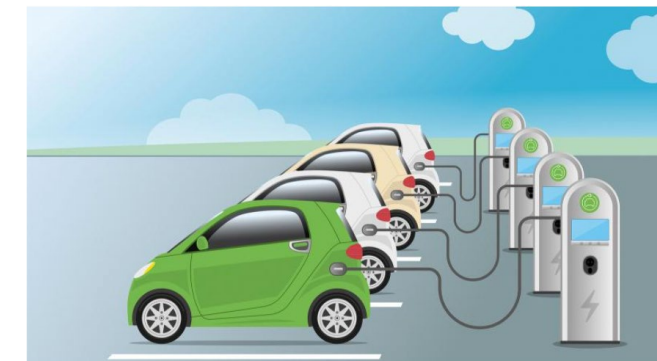
ÅBNINGSTALE: Om godt et årti skal danskerne ikke længere kunne købe almindelige benzin- og dieselbiler. Og i 2035 skal også hybridbiler være ude, så alle nye biler kører på el eller andet fossilfrit brændstof. Det sagde statsministeren ved Folketingets åbning.

All new cars must be non-fossil driven in 17 years

1 million electric or hybrid cars in 2030



Lars Løkke trumfer Klimarådet: 1 million el- og hybridbiler i 2030



(Illustration: koson/Bigstock)

Statsministeren lover i sin åbningstale til Folketinget at forbyde salg af biler uden en elmotor i 2030. Men allerede inden da skal elbiler i stort tal rulle ud på vejene.

- Work process in the ministries

– DTU and other universities was asked to propose members to a commission in December 2018

Commission for green transition of passenger cars

- Commission and its terms of reference was announced, February 2019
- Main task:
 - Sub-report ultimo 2019 with focus on car taxation
 - Final report ultimo 2020w with focus on charging infrastructure
 - Revisit road pricing as a funding option
- Commission with 10 members
 - 6 external, including the chairman
 - 4 head of departments from the Ministries of Finance, Taxation, Transport, and Climate & Energy
- Public announcement of results, consultation of key actors in the sector

Terms of reference

- *”.....must deliver a specific strategy for how the Government’s target in the best possible way can be realised, at the same time as the tax revenue should be maintained.,....., It is important, that the entire strategy is implementable.”*
- The target of 1 million electric cars are not explicit mentioned, but that it is *”...the Governments ambition, that all new registered passenger cars latest from 2030 are low-emission and from 2035 zero-emission”*

Focus first report

- Focus on car taxation
- Cars are generally highly taxed in Denmark
- Electric cars had no registration tax and very low annual owner tax
- Expectation of significant increase of registration tax as of January 1, 2021
- Mainly high end electric car sale => tax exemption for the rich!
- Small/cheap electric cars not yet at the market then – expectation that it will take some time
 - Problem with size, weight and cost of batteries
- Dilemma:
 - Increased taxes on expensive cars will delay the green transition
 - But lower/no taxes will result in an increasingly growing deficit in public finance and are also distributional skewed among income groups

September 2020



Fast modelling and forecasting effort on car prices, technology development and consumer choices



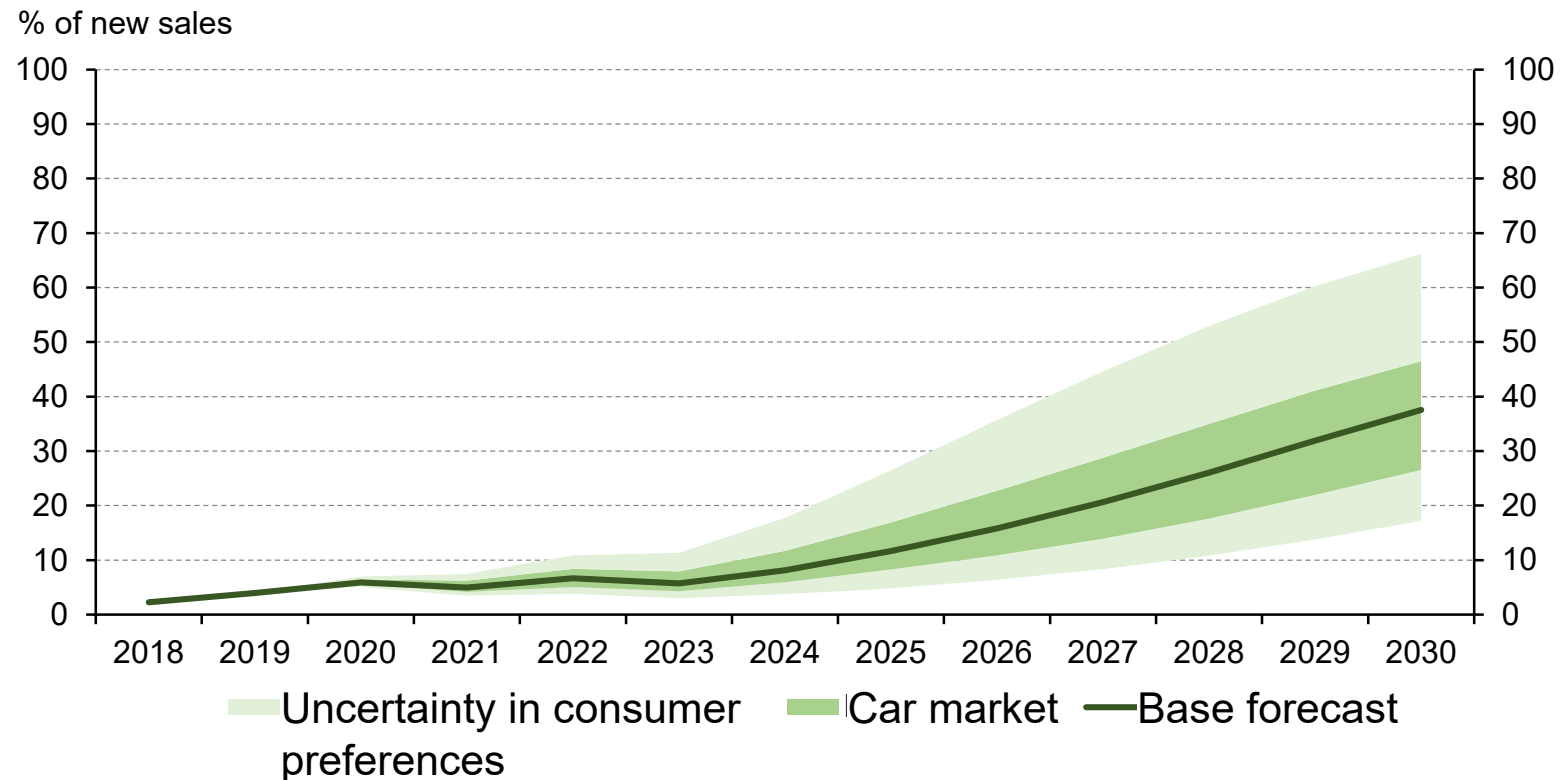
The technological development and competition will reduce production costs on green cars, but it is uncertain how fast

Uncertain market development

- EU regulation may lead to sale prices close to production cost, if global demand is lower than minimum supply
- If demand is larger than maximum supply, prices may be larger than production costs

Uncertainty of the development of range and speed of charging, and user preference on this

Forecast on electric cars market share of new sale



CO₂ from passenger cars – expectation with the regulation in 2019

Long transition period – also with significantly increased sale of electric cars

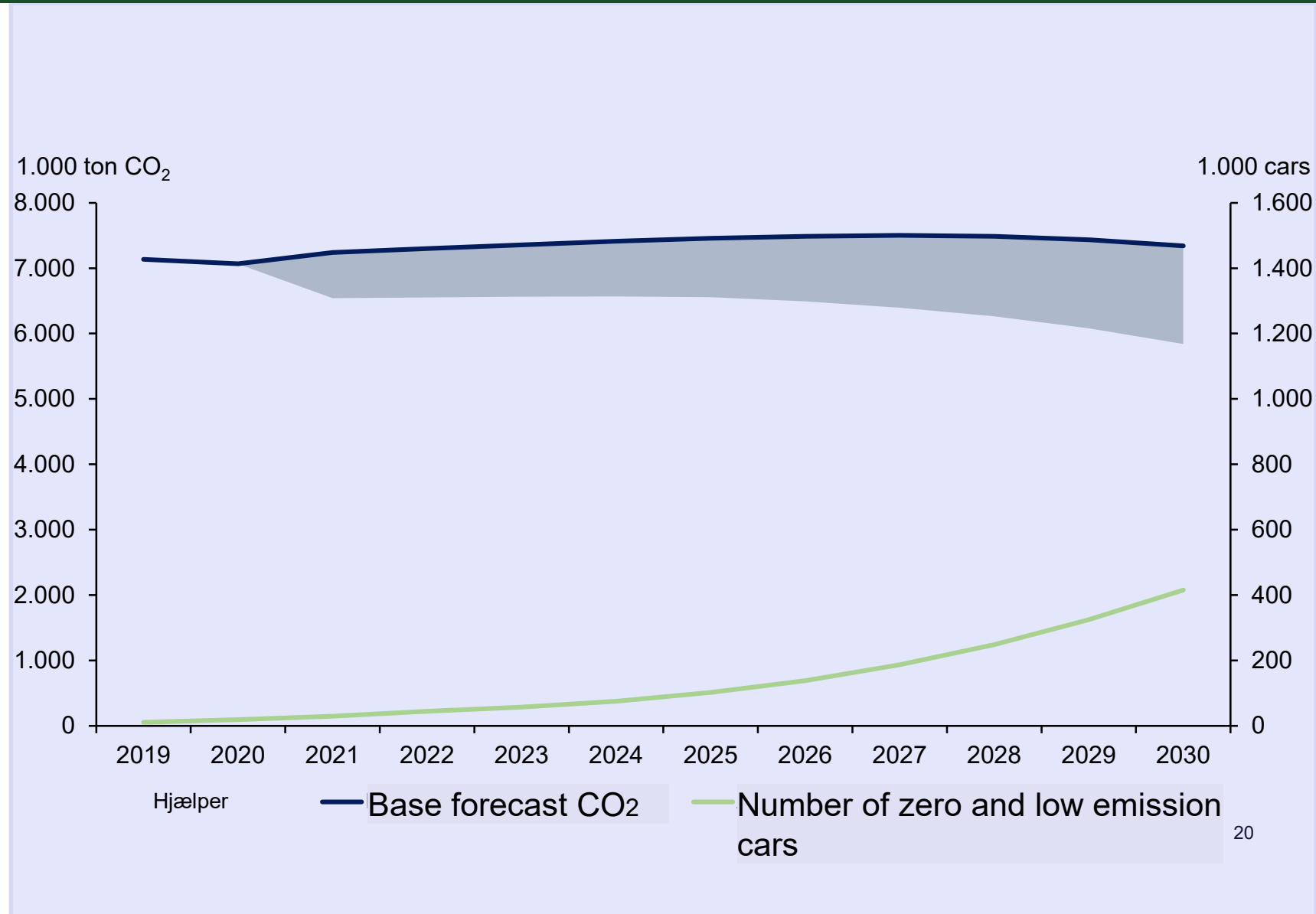
Limited 2030-effect is due to

- Slow replacement of cars, which has an average lifetime of 16.5 years in Denmark
- Forecast of increased number of cars towards 2030

CO₂-effect is dependent on how many conventional cars that leaves the market – NOT how many zero and low emission cars that enter the market

More significant CO₂-effect towards 2040-2050. This can justify early stronger policies – or it may be more cost-efficient to wait for the technological development

Because of this, we also recommended CO₂-charge on the registration tax and increased fuel tax (some models)



Main targets in the work and recommendations

We ended up with 4 different taxation models, and 3 variations of these

Number of zero and low emission cars varied between ½ to 1 million

In additional significant differences in CO₂-reduktions, revenue, socio-economy and distributional effects



Taxes should reflect the external costs of car use



Clear path for introducing and reducing tax reductions towards 2030



Technology neutral reform



Simplification of the present tax system



Subsidies that are only relevant on short term should be avoided



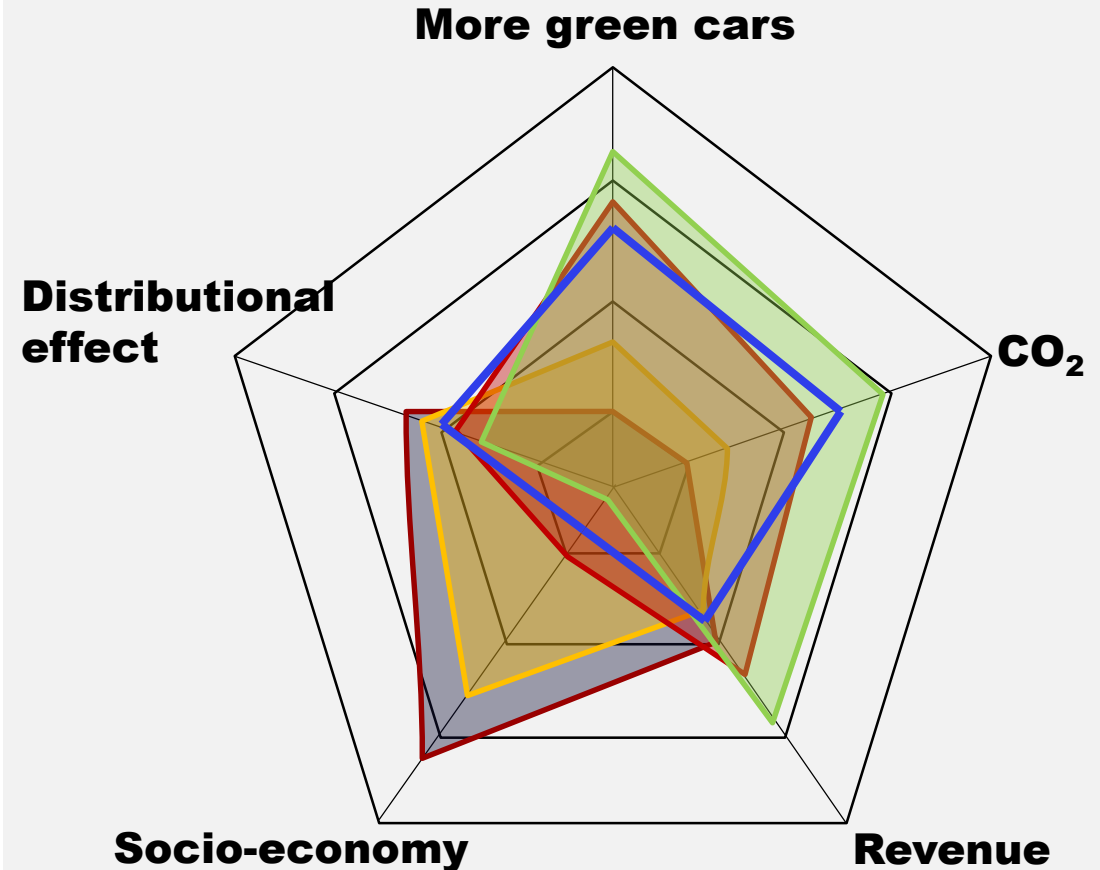
Steppingstones to an intelligent road pricing system

Change of car taxation is an act of balance

Illustration of to which degree the different taxation models balance the criteria in the terms of reference



- Model 1 (500,000 zero and low emission cars)
- Model 2 (600,000 zero and low emission cars)
- Model 3 (750,000 zero and low emission cars)
- Model 4 (1,000,000 zero and low emission cars)
- Political agreement



Steppingstones to an intelligent road pricing system



Start with a simple vignette charging



Kilometer-based charges for trucks from 2025



Other charges reflect the average external costs of driving



Kilometer-based charges based on the cars external costs will promote zero and low emission cars – but to less extent than the former as well as suggested taxation

Recommendations

- *A km-based charge should be part of a future taxation model*
- *Denmark should not take on the risk of being first-mover as the first country implementing a km-based road pricing for passenger cars*
- *A km-based road pricing should be justified from a socio-economic consideration of taxing the marginal externalities of car driving*
- *A km-based road pricing will result in significant distributional effects, that should be tried to be handled in the wider taxation system*

Main elements in the recommendations from the commission

Elements in all recommended taxation models

- Still progression by value in registration tax
- CO₂-supplement in registration tax
- Temporarily subsidy for zero- and low-emission cars
- Simple road charge (vignette)
- Still reduced taxes for zero- and low emission cars until 2025, thereafter gradually increased taxation, phased to 50 – 60% in 2030
- Base tax-deduction for all cars
- Special base-deduction zero- and low emission cars
- Increase of insurance taxation equal of external costs of accidents

Elements, that are part of some of the recommended taxation models

- Increase of the registration tax of conventional cars
- Increase of fuel tax

Elements that simplify the car taxation

- No technical safety deduction
- Minimum tax is removed
- Reduction/addition for energy efficiency is removed

Political agreement

Elements in all recommended taxation models

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Elements that simplify the car taxation

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Financial suggestions



Higher registration tax for conventional cars

Varies among models

Higher fuel taxes

Increased by 1 DKK per liter from 2021

Increased in one model (3b) with additional 1 DKK from 2026-2030

Some concerns on boarder trade

Increased insurance taxation

Increase from 42.9% to 60%

The increase replace various technical tax deductions that needs updates over time

Better targeted towards external costs

Kilometer-based pricing for trucks

Replace the present vignette

Can be implemented from 2025

Expected revenue
1 billion DKK/year

Passenger tax in air travels

A passenger charge on 100 DKK

Suggested introduced after COVID-19 normalization

Expected revenue
1¼ billion DKK/year

Road charges

A simple charge/vignette at 1,000 DKK/year from 2023

Expected revenue from foreign transit

0.7 billion DKK/year

Some models

All models



Influence the existing car fleet use directly

Not decided revenue initiatives

Was decided November, 2023
Segmented on distance



Higher registration tax for conventional cars	Higher fuel taxes	Increased insurance taxation	Kilometer-based pricing for trucks	Passenger tax in air travels	Road charges
<p>Varies among models</p>	<p>Increased by 1 DKK per liter from 2021</p> <p>Increased in one model (3b) with additional 1 DKK from 2026-2030</p> <p>Some concerns on boarder trade</p>	<p>Increase from 42.9% to 60%</p> <p>The increase replace various technical tax deductions that needs updates over time</p> <p>Better targeted towards external costs</p>	<p>Replace the present vignette</p> <p>Can be implemented from 2025</p> <p>Expected revenue 1 billion DKK/year</p>	<p>A passenger charge on 100 DKK</p> <p>Suggested introduced after COVID-19 normalization</p> <p>Expected revenue 1¼ billion DKK/year</p>	<p>A simple charge/vignette at 1,000 DKK/year from 2023</p> <p>Expected revenue from foreign transit 0.7 billion DKK/year</p>

Some models
 All models
 Influence the existing car fleet use directly

725,000 green passenger cars in the calculations became one million in the press release

en Nyheder ▾ Udgivelser Arbejdsområder ▾ Job ▾ Ministeriet ▾

Nyheder > Nyhedsarkiv > 2020 > December > Grøn vejtransportaftale: Massiv CO2-reduktion og ambition om 1 mio. grøn

Nyheder

Nyhedsbrev

Nyhedsarkiv

Pressekontakt

Grøn vejtransportaftale: Massiv CO2-reduktion og ambition om 1 mio. grønne biler i 2030

04-12-2020

Ambition om 1 million grønne biler, grønnere brændstoffer og en markant CO2-reduktion på 2,1 mio. ton, som bringer Danmark et stort skridt nærmere 2030-klimamålsætningen. Det er centrale elementer i en ny, ambitiøs aftale om grøn omstilling af vejtransporten. Aftalen er den tredje i en række aftaler om grøn genstart af Danmark, som regeringen i øjeblikket forhandler med Folketingets partier om.

Second report



- **Following the political agreement based on first report**
 - **775,000 zero- and low emission cars in 2030**



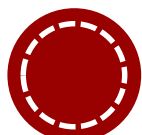
- **Expected to be electrical cars**
 - **Large requirement to charging infrastructure**



- **Long-term agreement on car taxation secure a good basis for private investments in charging infrastructure**



- **Denmark has good conditions to secure this**
 - **Large potential for home-charging (75% of car owners)**
 - **Relatively short driving distances (98% of trips <100 km)**
 - **High degree of green electricity and well-functional electricity grid**



- **Focus on challenged areas**
 - **Charging on long trips → along national roads (fast chargers)**
 - **Car owners with no access to home-charging → further responsibilities for municipalities, tenders on public roads**
 - **Areas without market interest → tenders with possibility of subsidies**

Februar 2021



Municipalities should have a central role

- **Should make plans for tenders on urban streets**
- **Wider authorities for**
 - **Tenders on public space**
 - **Better planning after charging infrastructure**
 - **Can earn and give subsidies dependent on conditions**
- **Parking**
 - **Equal parking charges independently of car-type**
 - **Changing locations should be used for charging, not parking**
- **Possibility to tender and subsidy of destination charging for employees**



Ned model for charging facilities in public space

- **Tender is the key!**
 - Both along national roads and within municipalities
 - Secure transparency and fairness
 - Increased competition
- **Tenders should be flexible**
 - Locations are given to those who pay most or require least subsidy
 - Requirements for the operators (roaming, “uptime”, public data access, transparency on prices)
- **New model for accounting (writing off)**
 - Before was everything accounted over few years (tender period)
 - In the new model can construction above ground be accounted as previous (5-15 years)
 - Construction below ground can be accounted over the expected time of living (e.g. 50 years)
- **National knowledge centre to support municipalities**

Sketch of fast-chargers

- In a scenario with 1 million electric cars in 2030



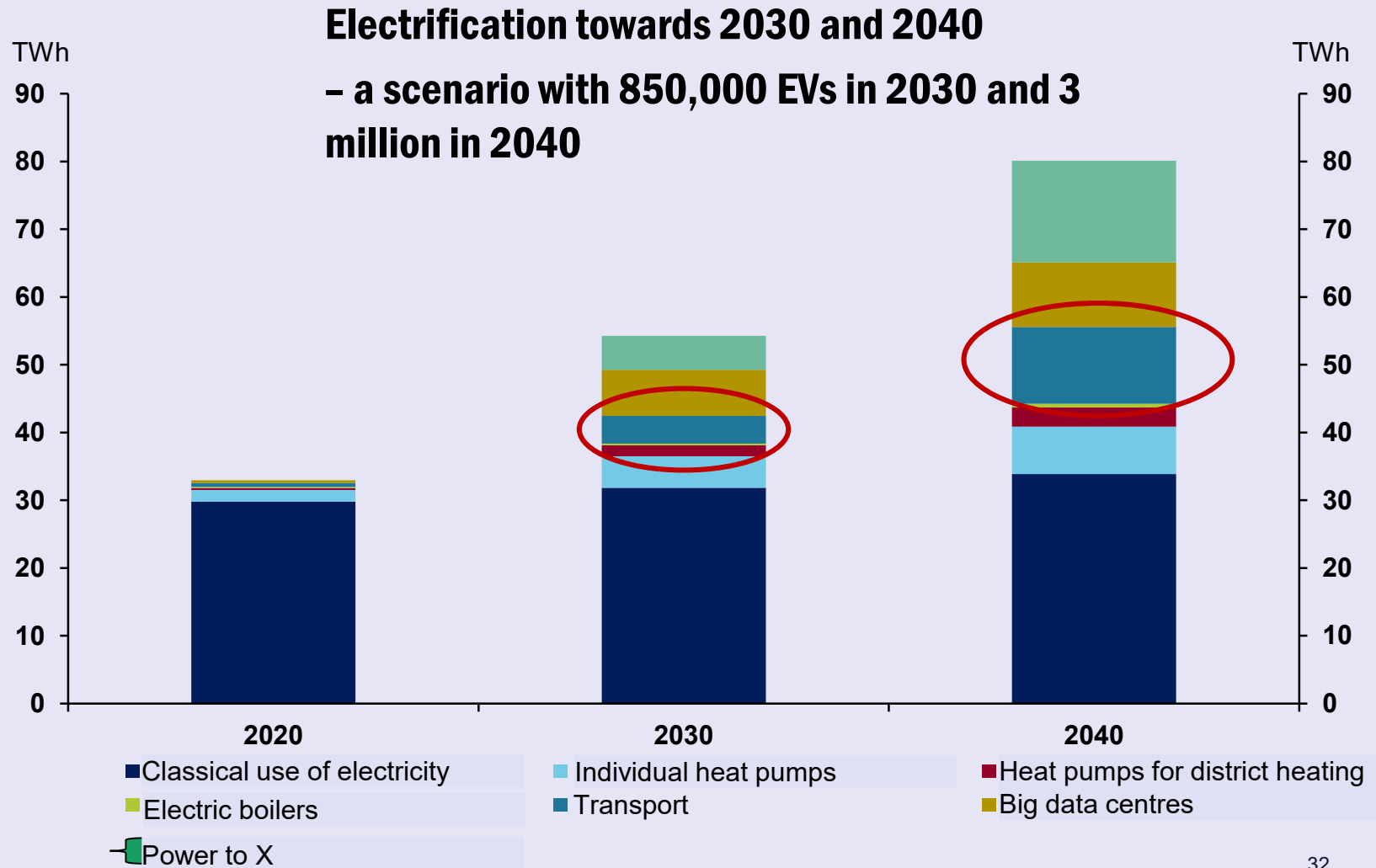
Grid not really an issue

▪ Electric cars

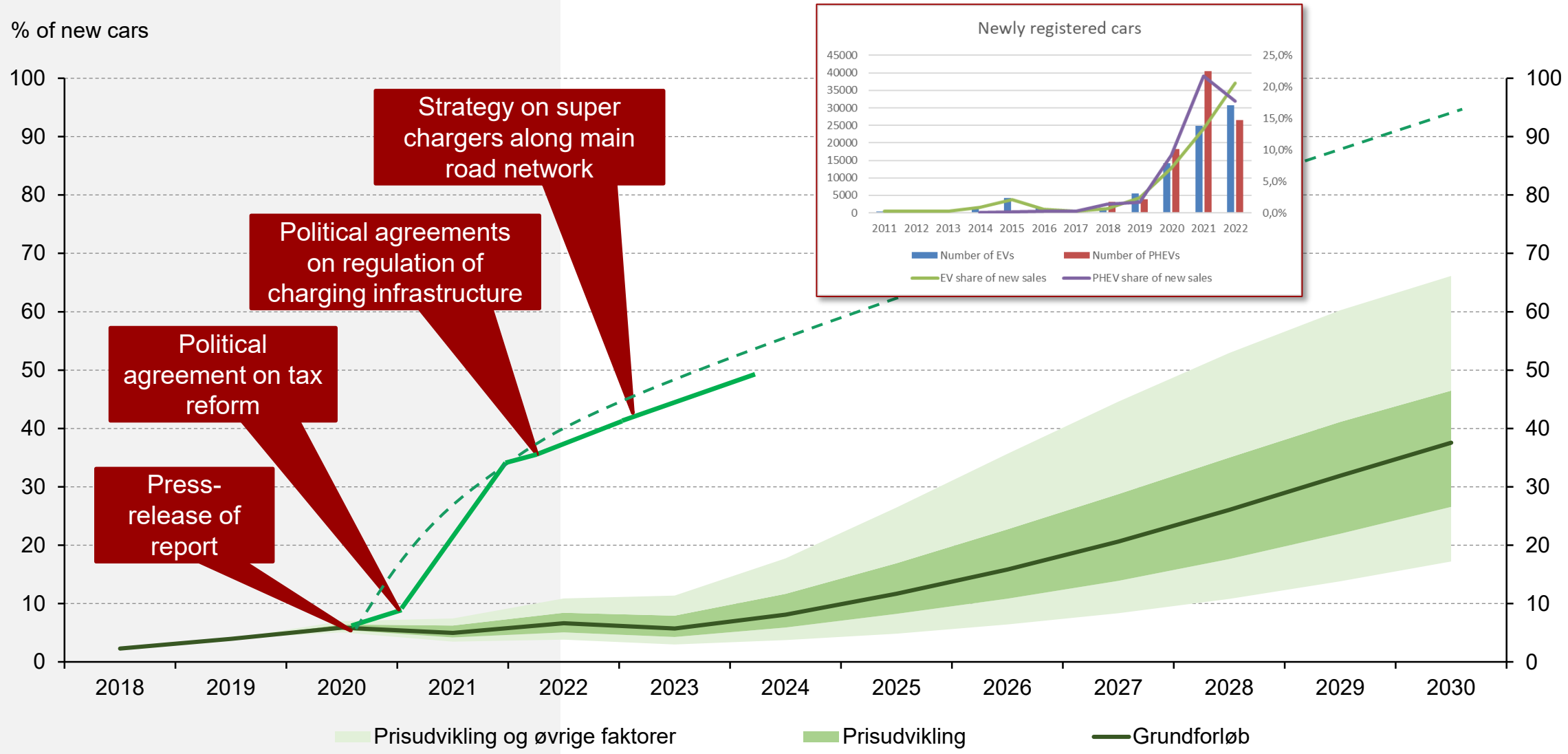
- Limited share of the entire electrification in 2030

▪ Regulation should be seen in cross-sectoral perspective

- Many components in the electrification of the society towards 2030 and 2040



Impact of the reform

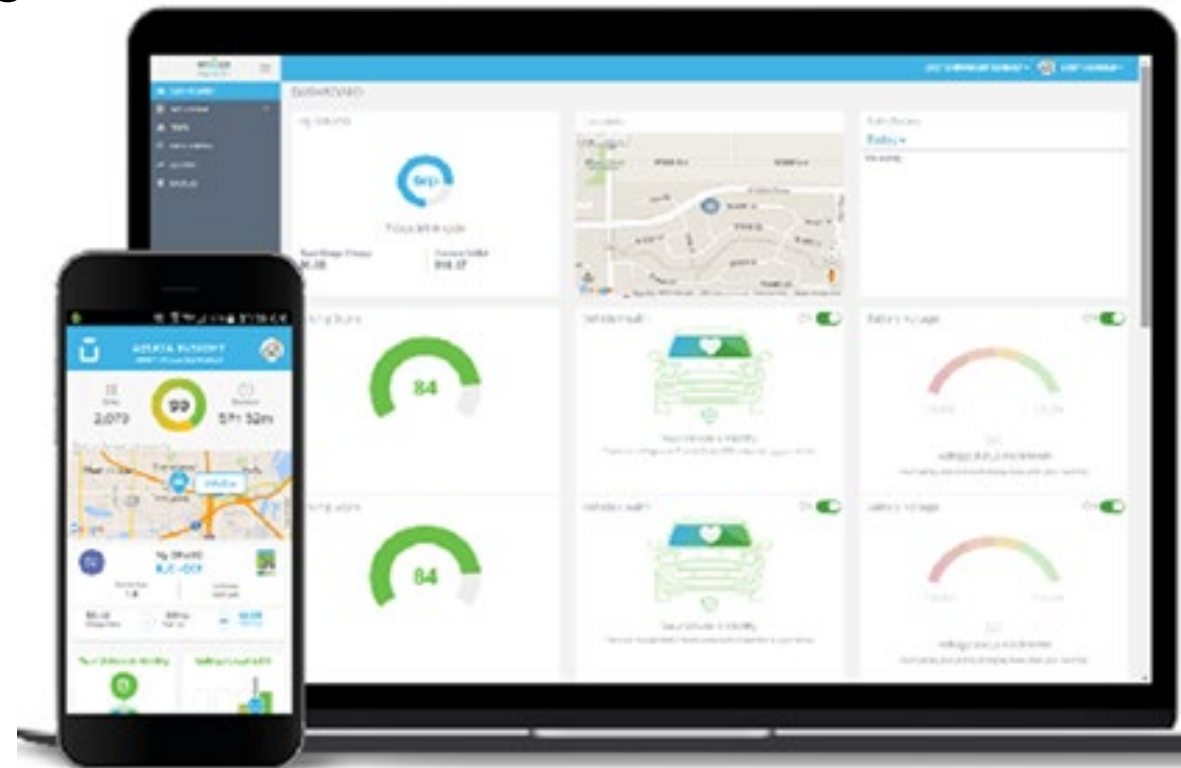


Working group on road pricing



Can there be more efficient technological solutions?

- Compromise between
 - Costs of establishing and operating the system
 - How close it is possible to charge driving relative to the marginal externalities of driving



**Ban for trucks and vans
without particle filters**

Large fines

12,500 DKK for trucks and
busses, 1,500 kr. for vans

**Control by cameras and
number plate recognition**

Cleaner air for the citizens is the aim by environmental zones in the country's largest and most dense populated cities



Possible administrative model



- **Road pricing for all trips in the environmental zone**
- **Self-declaration; The user declare his/her driving e.g. via an app or the systems home-page**
- **Control by camera technology – re-use of stationary and mobile cameras which are used in the existing environmental zone**
- **Data from cameras and payment details are compared after 48 hours, and fines/control fees are sent, where there miss payment**

Very small cost for establishing and operating the system in Copenhagen

0.1% of Denmark's area, relative large share of congestion and local environmental externalities

Small control effort

Level of needed control and hence cost of operations depend on size of fines

Tabel 5.1

Periodebaseret trængselsafgift i miljøzoner – investering og årlige driftsomkostninger

Mio. kr. (2020-priser)

Investeringsomkostninger

Website og webportal til registrering/betaling	3,0
Køretøjsgenkendelsesudstyr, strøm, netværk, installation	0,6
Etablering/udvidelse af billedbehandling og back office systemer	10,5
Projektledelse, kommunikation og markedsføring	9,0
Øvrige omkostninger (usikkerhed)	1,5
Samlede investeringsomkostninger	24,6

Driftsomkostninger (pr. år)

Administration, kommunikation og billedhåndtering	11,7
Kortgebyrer	15,0
Håndtering af kundehenvendelser	10,0
Inddrivelse nettoomkostning (baseret på kontrolafgift)	0,0
Vedligehold af systemer	8,0
Øvrige omkostninger (usikkerhed)	3,5
Samlede driftsomkostninger (pr. år)	48,2

Omkostninger pr. år inkl. afskrivninger	53,6
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Kilde: Sund & Bælt for Bilkommissionen.

Three principles for pricing

- 1. The entire day (possible with higher rush hour charge)**
- 2. Per minute**
- 3. Per kilometer**

Extend of data and surveillance

- **Principle 1 (The entire day)**
 - **The need for documentation is minimal (number plate + date)**
- **Principle 2 (minute)**
 - **Moderate need documentation (number plate + date + time interval(s) in the zone)**
- **Principle 3 (km)**
 - **Large need for data (number plate + date + time interval(s) + GPS-coordinates + potential need to map-match or filling gaps between GPS signal fall outs), complex control**

CBA – (rough calculation)

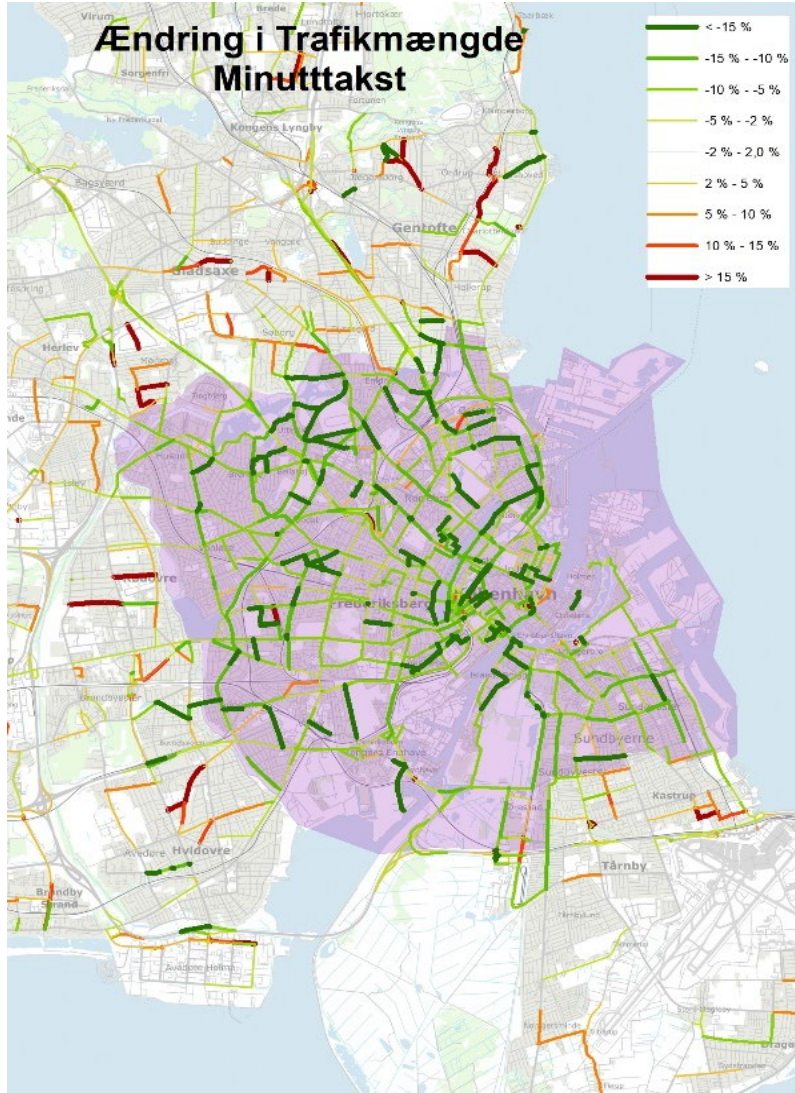
- **Surplus in the minute system (240 million DKK/year, 2025)**
- **160 million congestion**
- **10 million CO2, (40 with the climate council, 20,000 less CO2, negative shadow price)**
- **590 million in tax revenue**
- **Distributional effects**
 - **Car users pay**
 - **Surroundings and the general society wins**
 - **Business transport win, private transport looses (mostly)**

Tabel 5.2

Periodebaseret trængselsafgift i miljøzoner – samfundsøkonomisk resultat 2025 og 2030

	2025 - Minutmodel	2030 - Minutmodel	2025 - Dagsmodel	2030- Dagsmodel
Mio. kr. (2020 priser)				
Effekter for brugerne	-630	-630	-910	-900
Vejafgift	-670	-670	-930	-930
Andre omkostninger ved kørsel	60	60	100	110
Ændret turvalg ¹⁾	-30	-20	-80	-80
Effekter for staten	590	600	750	750
Afgifter ²⁾	650	650	800	810
Administration ³⁾	-50	-50	-60	-60
Eksternaliteter	240	250	140	150
Drift, vej	-10	-10	-10	-10
Trængsel ⁴⁾	160	160	40	50
Uheld	40	40	50	50
Støj	50	50	30	40
Lufforurening	10	10	10	10
Klima (CO2)	10	10	10	10
Arbejdsudbud	30	30	20	20
Arbejdsudbudsforvridning	60	60	70	70
Arbejdsudbudsgevinst	-30	-30	-50	-50
Effekter i alt	240	250	0	10

Why were the results now positive?



- A minute-based system turned out to be a smart way to price congestions
 - Time-use reflects congestions
 - Time gains are experience most places
- Detour driving is limited, because it seldom saves time
 - Good for congestions and CO2
- Payment is larger on local roads and smaller on large roads
 - Generally good for safety and local emissions to move traffic from small to big roads
 - May require more speed-control enforcement outside rush hours

DTU Political decision on experiment with road pricing for passenger cars

Nyhed

Forsøg med vejafgifter for personbiler kan sættes i gang

Et udviklingsforsøg med vejafgifter for personbiler skal give indblik i, hvilken effekt afgifter vil have på trængsel og CO₂-udledningen fra trafikken. DTU skal stå bag forsøget.

25. feb. 2022



- 20 Februar 2012



Thorning: Der kommer en rigtig god løsning i morgen

En smilende statsminister gentog igen og igen, at der kommer en rigtig god løsning på spørgsmålet om betalingsringen i morgen. Men hun indrømmede, at de havde lyttet til debatten.



- Experiment with road pricing from 2022-2024 with final reporting 2025

Retrospective:

We might decide upon a good solution in 13 years

And we might obtain a good solution in 16 years

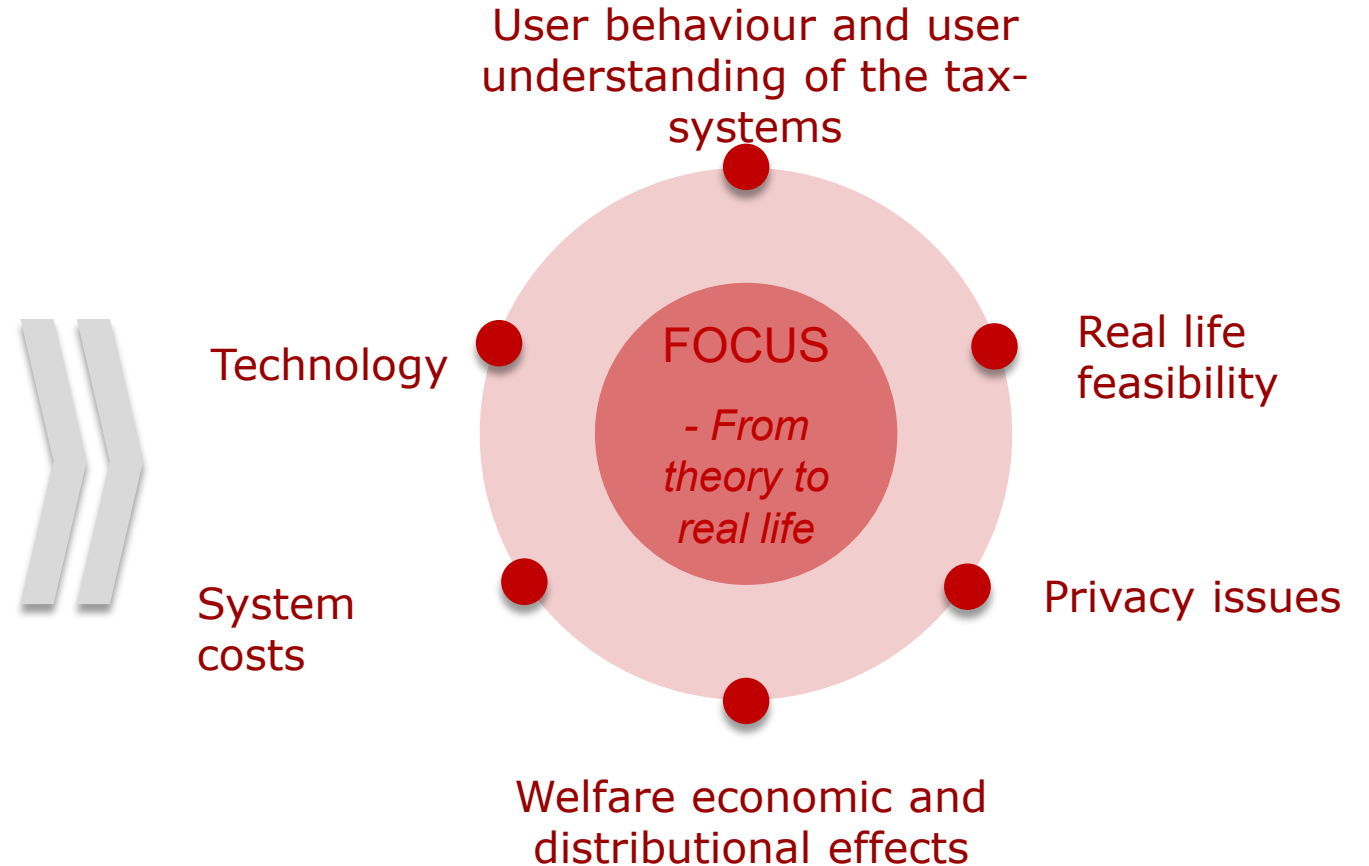
Road pricing experiment, 2023-2025



We examine effects of road pricing and how it can potentially be implemented

We consider some specific road pricing systems and evaluate the system (360°)

Effect on traffic and transport, externalities, and other effects

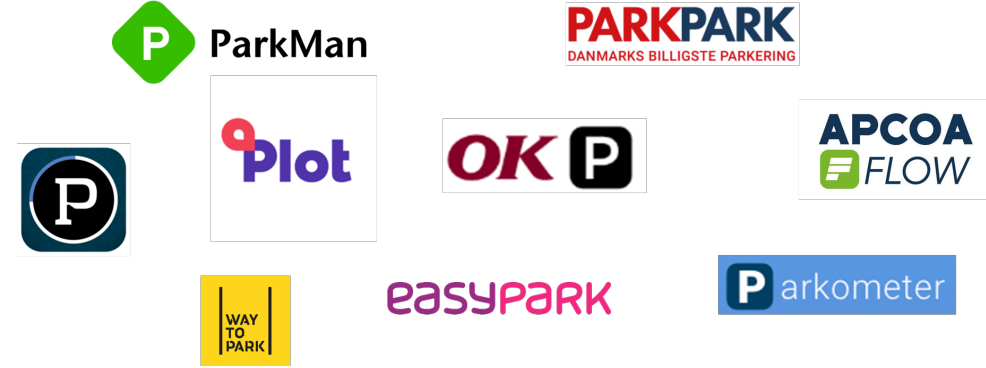


Technology exist and works – it should therefore not (only) be a technology test



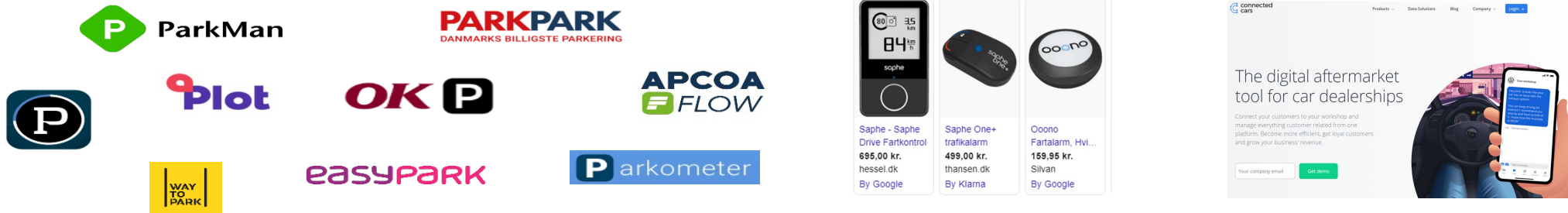
Different types of technical solutions

- Parking apps and other apps
- On-board Units (OBU), eg. speed control alarm devices
- Cars built in navigation equipment or other built in tracing



<p>Saphe - Saphe Drive Fartkontrol 695,00 kr. hessel.dk By Google</p>	<p>Saphe One+ trafikalarm 499,00 kr. thansen.dk By Klarna</p>	<p>Oono Fartalarm, Hvi... 159,95 kr. Silvan By Google</p>

Benefit with external provider model



- **Secure competition on solutions and costs**
- **Countrywide (international) instead of local solutions**
- **Solutions for private and business**
- **Provider responsible for GDPR**

Example from OReGO



WHY IT MATTERS

HOW IT WORKS

GET STARTED

CONNECT

Directly compare account managers:



- Pay: Pay as you go
- Method: credit or debit card
- GPS: GPS and non-GPS options
- Out-of-state miles credited
- Value-added services
- EV compatible

[LEARN MORE](#)



- Pay: post-pay quarterly
- Method: credit or debit card
- GPS: yes
- Out-of-state miles credited
- Value-added services
- EV compatible

[LEARN MORE](#)

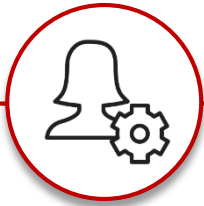


- Pay: post-pay quarterly
- Method: credit or debit card
- GPS: No
- No out-of-state miles credited
- Not EV compatible

[LEARN MORE](#)

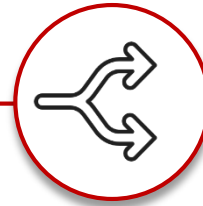
The core of the experiment is to mimic a real-life implementation as good as possible

2.200 PARTICIPANTS



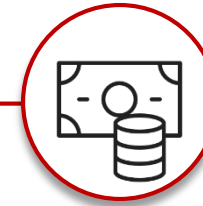
Four groups starting over a year. First group start November 2023

2 TEST TRIALS



Each group driving (almost) a year, two trials and to controls

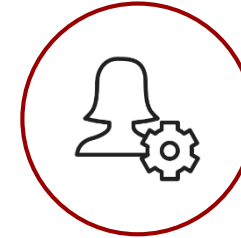
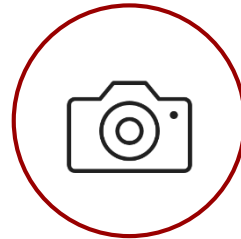
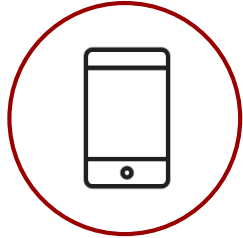
REAL MONEY



Participants receive a driving budget, unused funds will be paid out

A small pilot group ran in September-October

... technical and operational part of the experiment



**MODIFIED
TECNICAL
SOLUTION**

**EXISTING
TECHNOLOGY**

ORGANISATION

- Modified App
- Central system for handling of users, driving data and control data

- Reuse of existing cameras
- Both stationary and floating cars in the environmental zones
- Possible a few more cars

- Home page
- Customer support
- Technical surveillance
- Communication with test users
- Manual picture valuation

We test a variety of pricing-systems – and study user experiences and driving

GAINS VS COMPLEXITY

DIFFERENTIATE



TIME TAX PER MINUTE



DISTANCE TAX PER KILOMETER

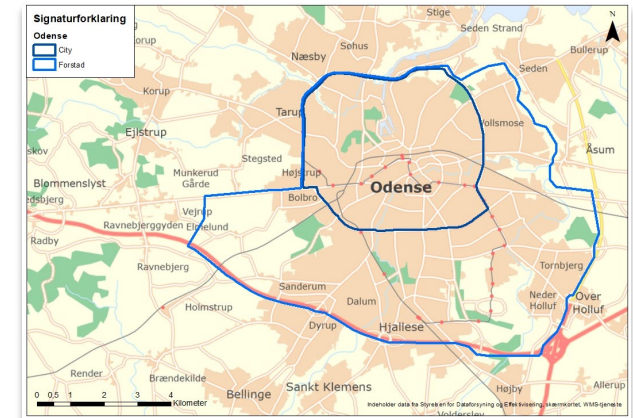
RUSH-HOUR

CITY

SUBURBS

NATIONAL

Experiment covers all of Denmark, but with a focus on the areas where congestion is most severe

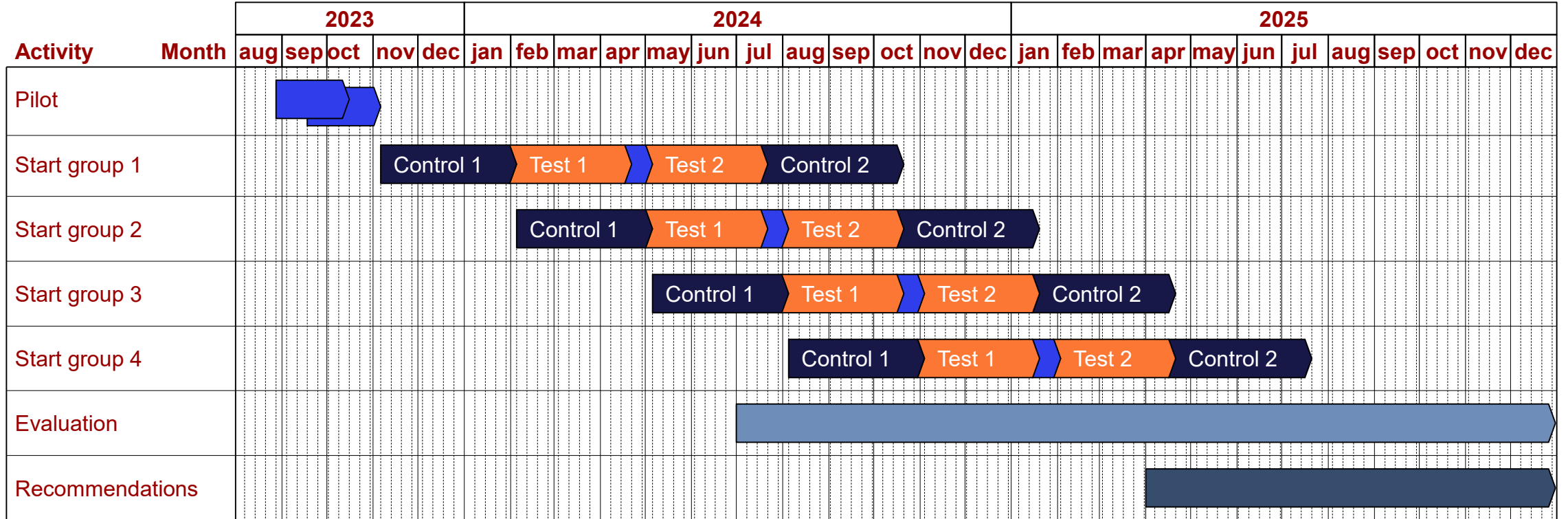




Experiences from development of design

- Experimental design and the technical solution is closely linked
 - Zonal-approach is easier
 - The more differentiations => the more complex is the technical solution as well as data demands
 - Is there a need for a definition of a trip?
 - Some unexpected issues with a time-based system
- Household based vs individual based solutions

Timeline



Following group

Small external pilot

Needed experiences on

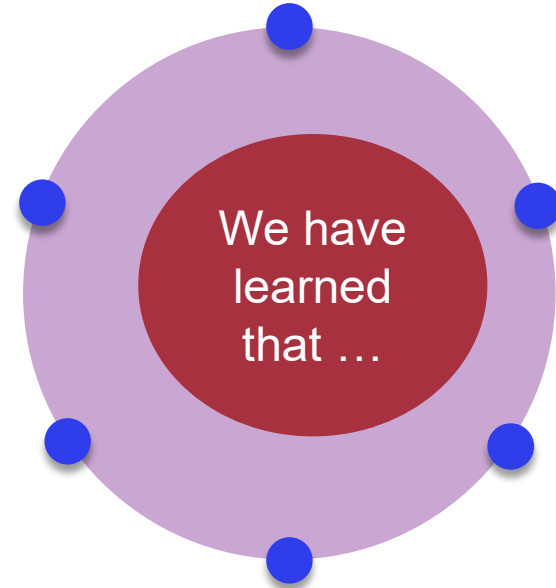
- Recruitment process
- Technical solution
- Driving behavior
- Experimental design
- Driving budget



Onboarding in app works

Back office works

Recruitment process works



Low participation rate (5-3%)
6% in first real experiment

Majority of men,
majority of 30-60 years

Participants with both one or more cars

Game-changers for introducing road pricing

- The technology works, and is an order of magnitude cheaper than a few years ago
- Road pricing can now target congestion very efficiently compared to other taxes
- Geographical different taxes reduce distributional effects
- More congestion and lack of land for increasing road capacity makes it more peeling
- Electrification of cars leads to loss of fuel taxes

Some reflections on process

- Steady communication of research findings and dialogue with politicians may influence policies on the longer run
- Expert commissions is a way of politicians to let external give advises on (obvious) needed but sometime unpopular policies with conflicting targets
- Political opposition trust apolitical external experts more than ministries

DTU



Questions?

