Electric Vehicles - User point of view

Linda Christensen **LCH@Transport.DTU.dk**
Ole Kveiborg **OK@Transport.DTU.dk**
Stefan L. Mabit **SLM@Transport.DTU.dk**
Jørgen Jordal-Jørgensen **COWI**
Allan Olsen **AOL@Transport.DTU.dk**
Anders Nørrelund **ANN@Transport.DTU.dk**

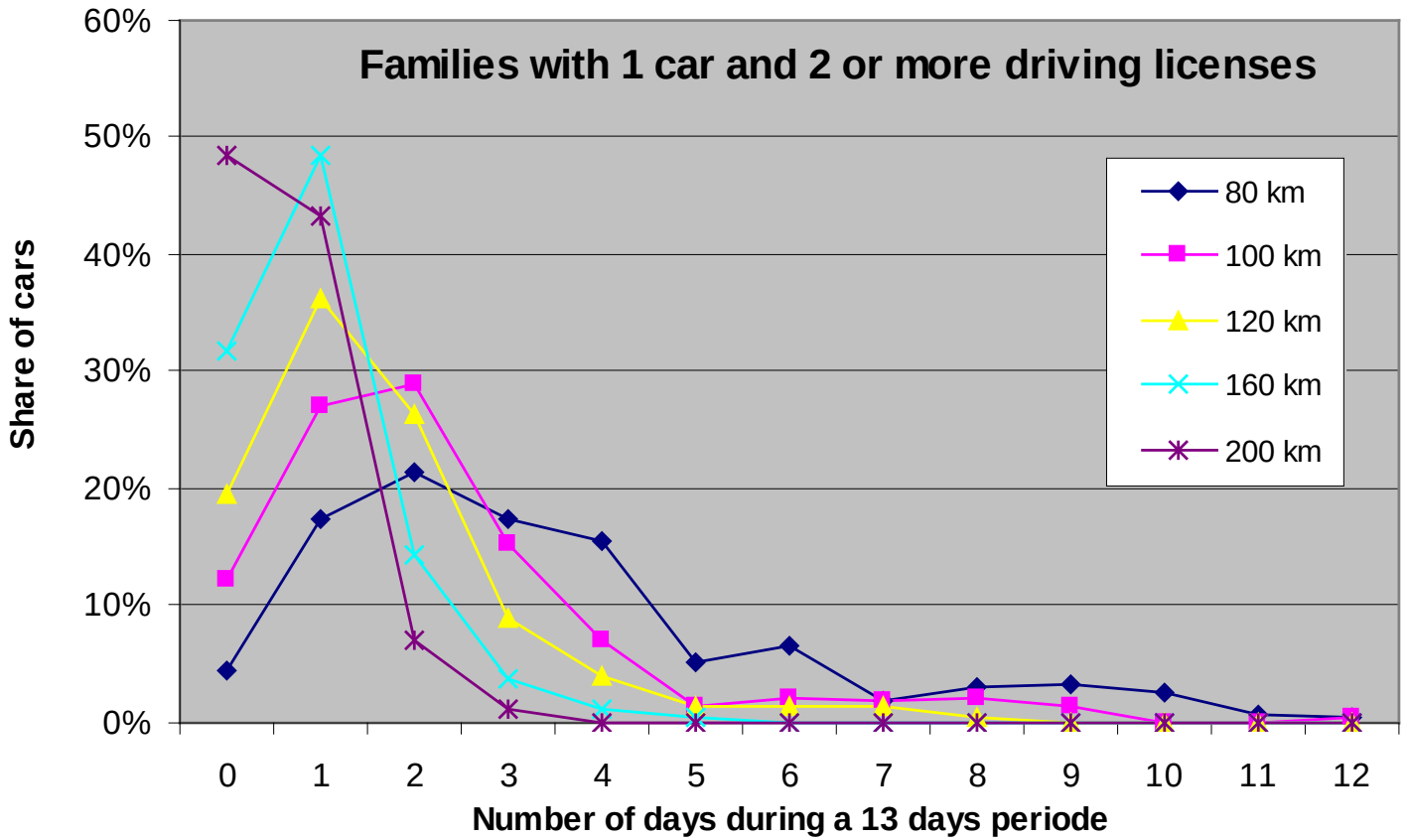
Trafikdage i Aalborg **August 23th 2010**

DTU Transport
Institut for Transport

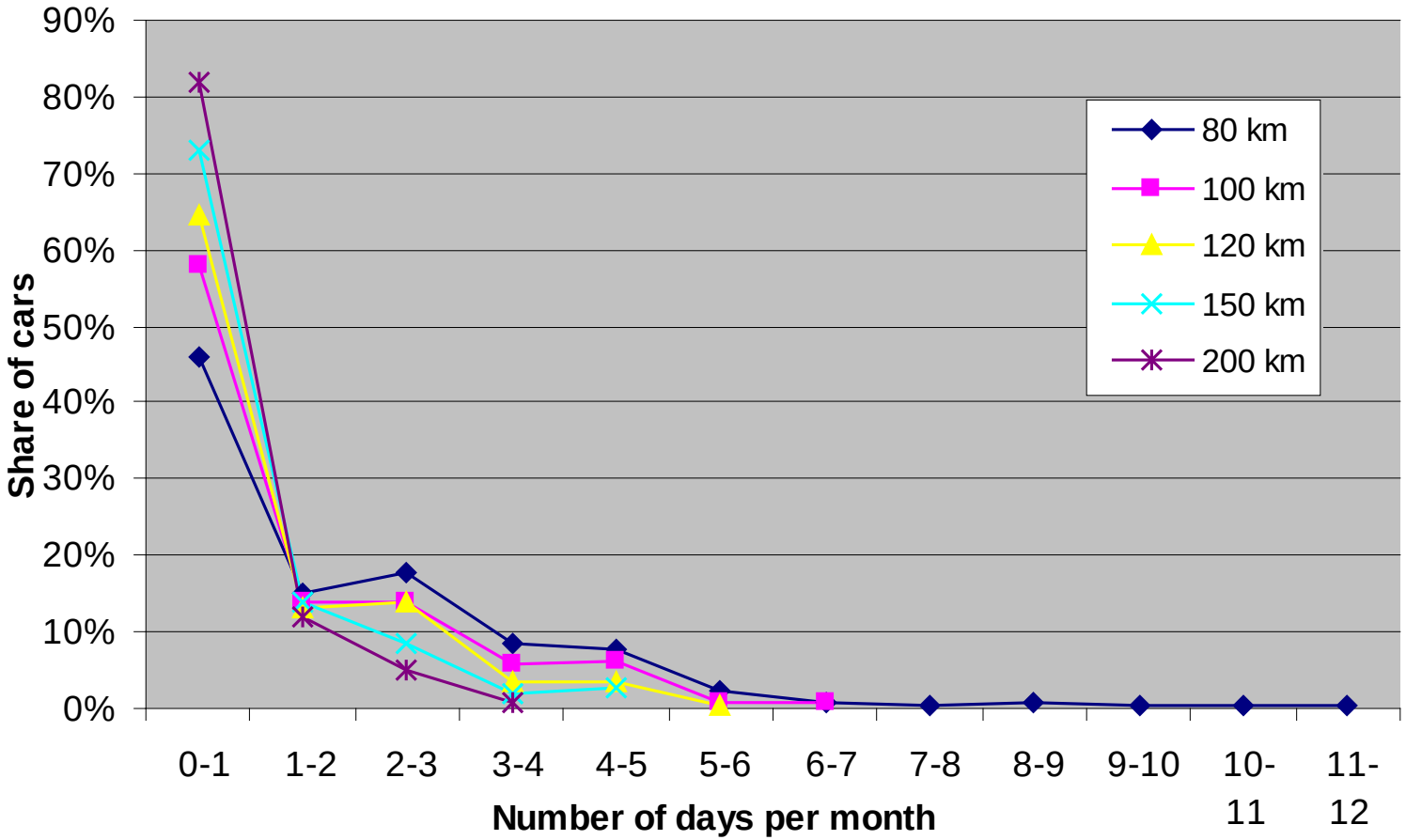
Share of cars not driving at an actual day. Share of those driving which need not to be charged. Shown dependent on the operational range

Number of cars in household Number of persons in household with driving license	**1 car** **1 with licence**	**1 car** **2 with licence**	**2 cars** **2 with licence**
Car not driving	38 %	21 %	29 %
Percentage that only needs to charge at home at:			
80 km	79 %	65 %	70 %
100 km	86 %	75 %	79 %
120 km	90 %	81 %	85 %
160 km	94 %	90 %	92 %
200 km	96 %	93 %	95 %
Share of license holders	17 %	45 %	16 %

Need for **charging away from home** 0, 1, 2 etc. days during a period of 13 days.
Represents a family in Greater Copenhagen (AKTA data)



Share of cars that need to **fast charge during the day in** 1, 2 etc number of days over a month.



Stated Preference survey

- **Cowi collected information about car buyers' *stated choices* from August 2007 to July 2008**
  - about their preferences for alternative fuel vehicles
- **Random sample of 2146 respondents selected among new car buyers**
  - Of these 1348 can be used in relation to the choice of EVs
- **Each respondent answers 12 binary questions**
  - Choice between two specified alternatives
  - Alternatives are specified in relation to own actual choice
  - But when considering EV we only use 4 questions per respondent
- **Total 5392 observations**

The demand of EVs is determined by several aspects

- **Characteristics of the electric vehicle**
  - The purchase price (battery, the car, recharging facilities etc.)
  - The operation costs
  - The operation range of the car/battery
  - Speed, acceleration, max speed and other driving characteristics
- **Infrastructure for charging**
  - Access to charging poles
  - Access to fast charging
- **The alternatives: conventional cars and other cars**
  - Prices, costs, driving characteristics etc
- **Travel patterns**
- **Attitudes and habits and other sociological aspects**

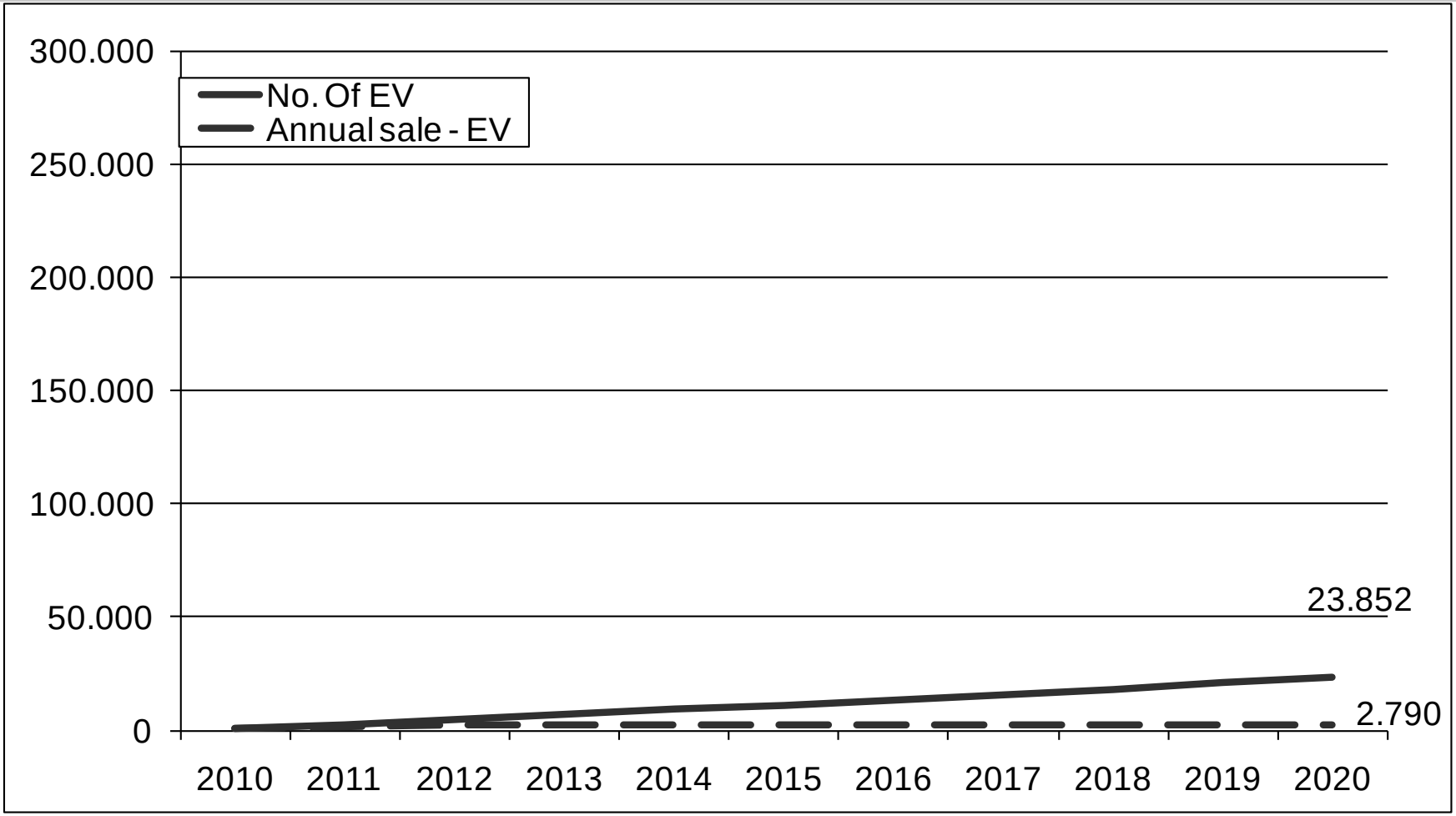
Infrastructure and accessibility

- **Above investigations**
  - Indicate a level for the demand for recharging
    - Night/home charging
    - Fast charging
    - Recharging during the day
- **To meet this demand we must**
  - Install charge facilities at home (also in dense apartment areas)
  - Install charge facilities at working places
  - Install external public facilities
- **Not enough:**
  - To install where demand is highest
  - To install along major roads and centrally in cities
  - The possibilities have to be accessibility ”everywhere”

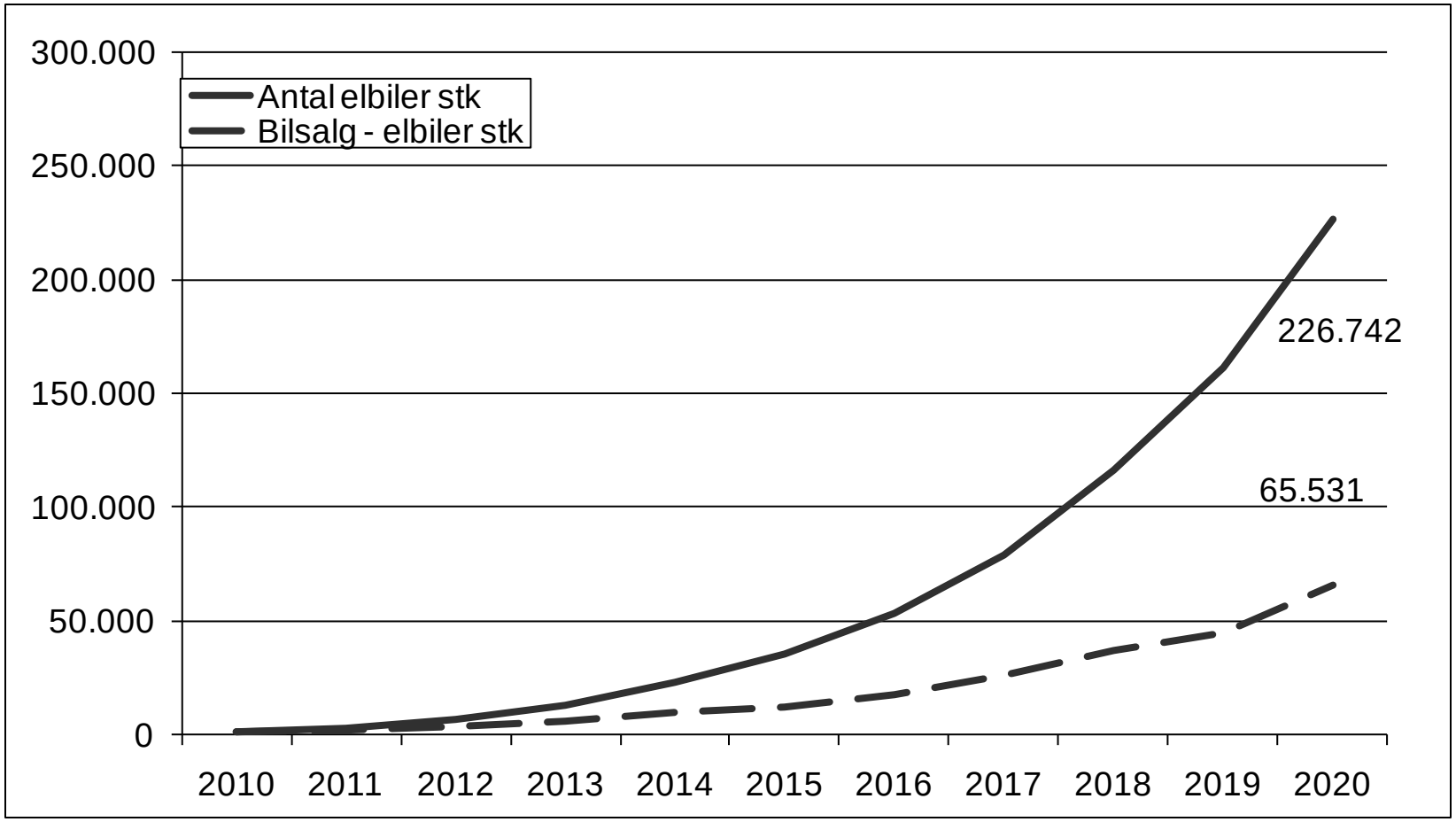
Infrastructure and accessibility

- **Due to lower operation radius recharging happens more often than normal refuelling**
  - Also as an insurance against running out of electricity
  - Under some circumstances the operations radius is even lower
  - An inconvenience to ”remember” to recharge (how many of you have experienced that your cell phone has run dry?)
- **This is interpreted by applying an inconvenience reduction in the accessibility measure**
  - Which can thus at maximum be 90%
- **The relation between infrastructure and accessibility is based on assumptions and assessments!**

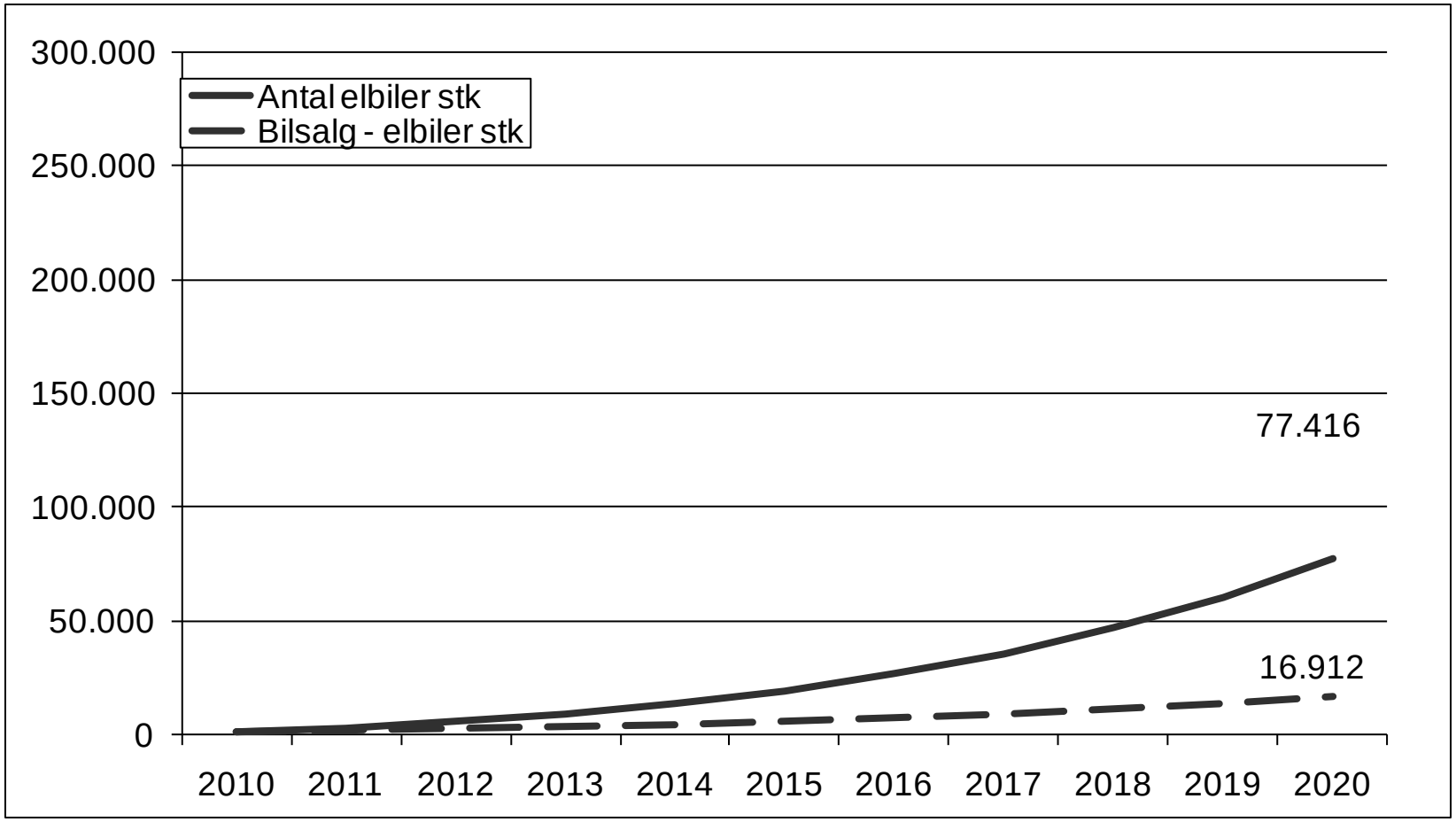
How large will the EV market be if we do not do anything?



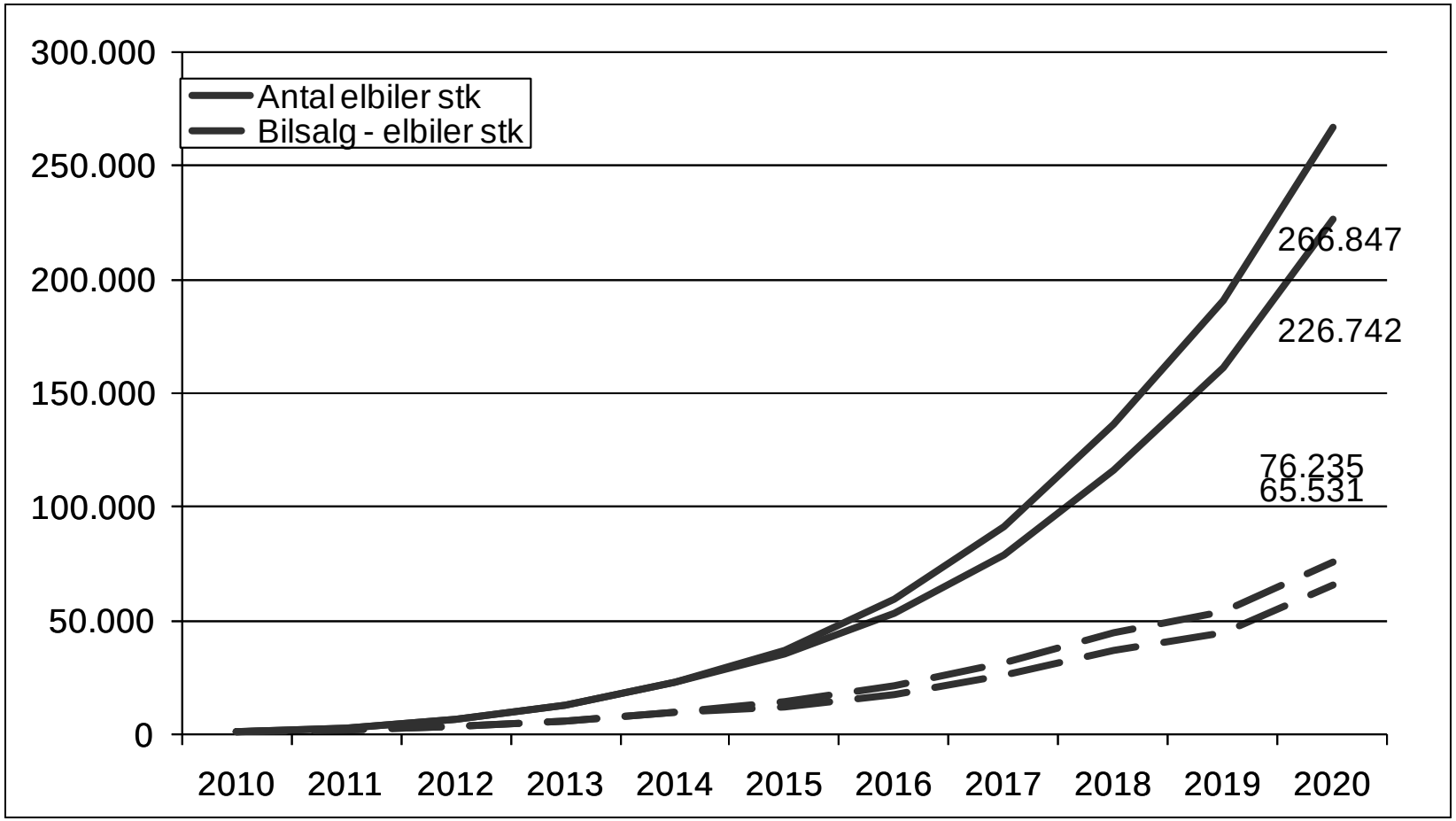
How many EVs with full accessibility in 2020



If accessibility is halved….



And if the purchage charge tax excemption is prolonged to 2020…



So the main conclusions are…

- **The price has an impact on the market penetration of EV**
  - But there are limits on how much this can be used
- **Without physical infrastructures we find that the number of EV will be limited**
  - Despite a relatively reduced demand for recharging
- **The faster the installation the faster the penetration**
  - An accumulated effect

But the magnitudes of changes are quite different

- A tax of 20,000 DKK corresponds to 10% of purchase price
- Accessibility varies from 5 to 90%, which corresponds to much larger changes
- BUT accessibility is perhaps also the most realistic variable to do something about (fast)

Some further reservations are …

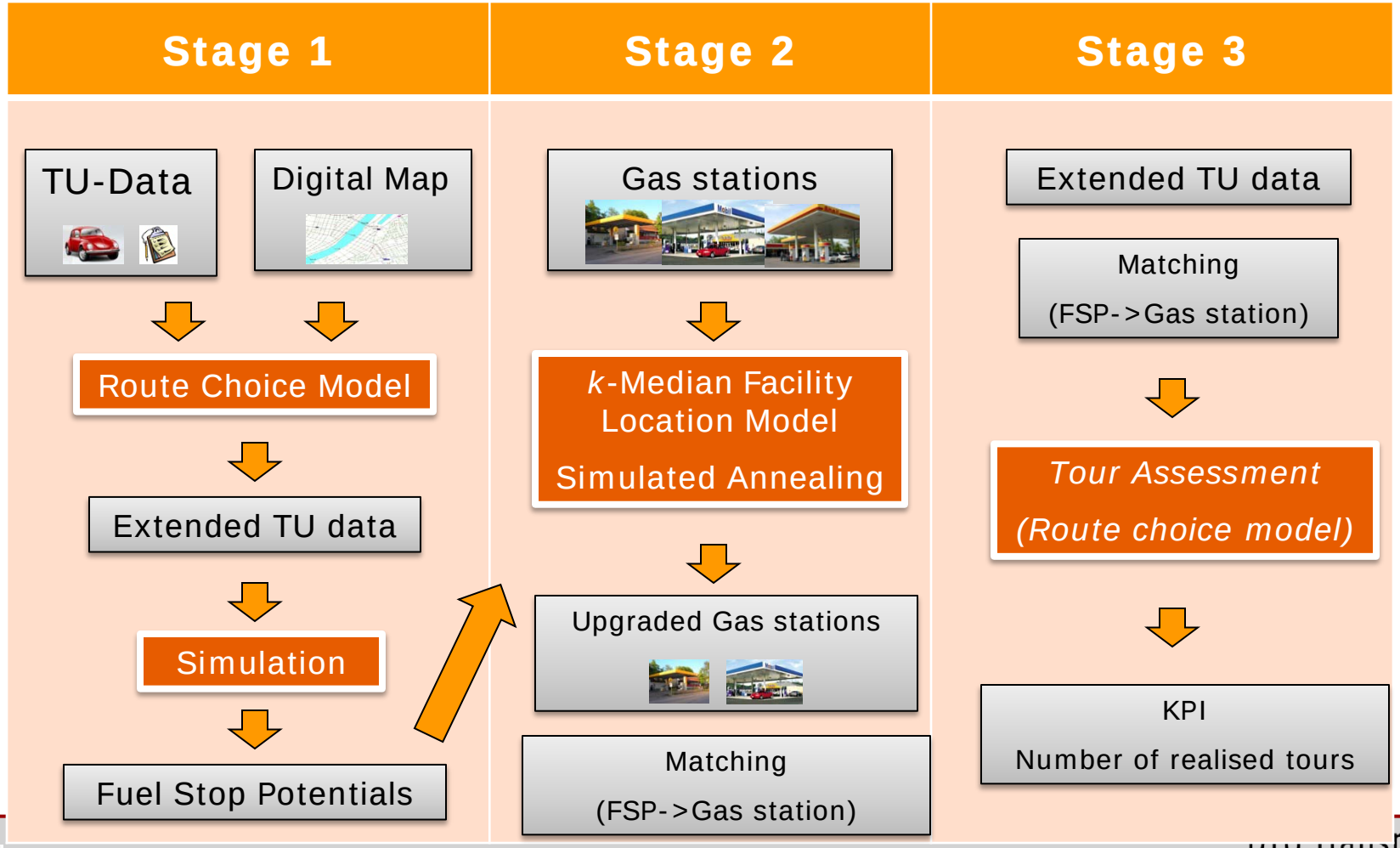
- **Our calculations are**
  - Based on a supply of EVs corresponding to the supply of conventional cars
    - Models, makes, equipment, variations etc.
  - Does not consider who is supplying the infrastructure (effect of different business models)
  - Not separate analysis of fast charging vs. Battery swap
  - The price on conventional cars assumed constant

- **We are perhaps somewhat optimistic with respect to**
  - The development in operation range (3% annual increase)
    - Starting on 160 km!
  - The price of batteries reduces by 5% annually

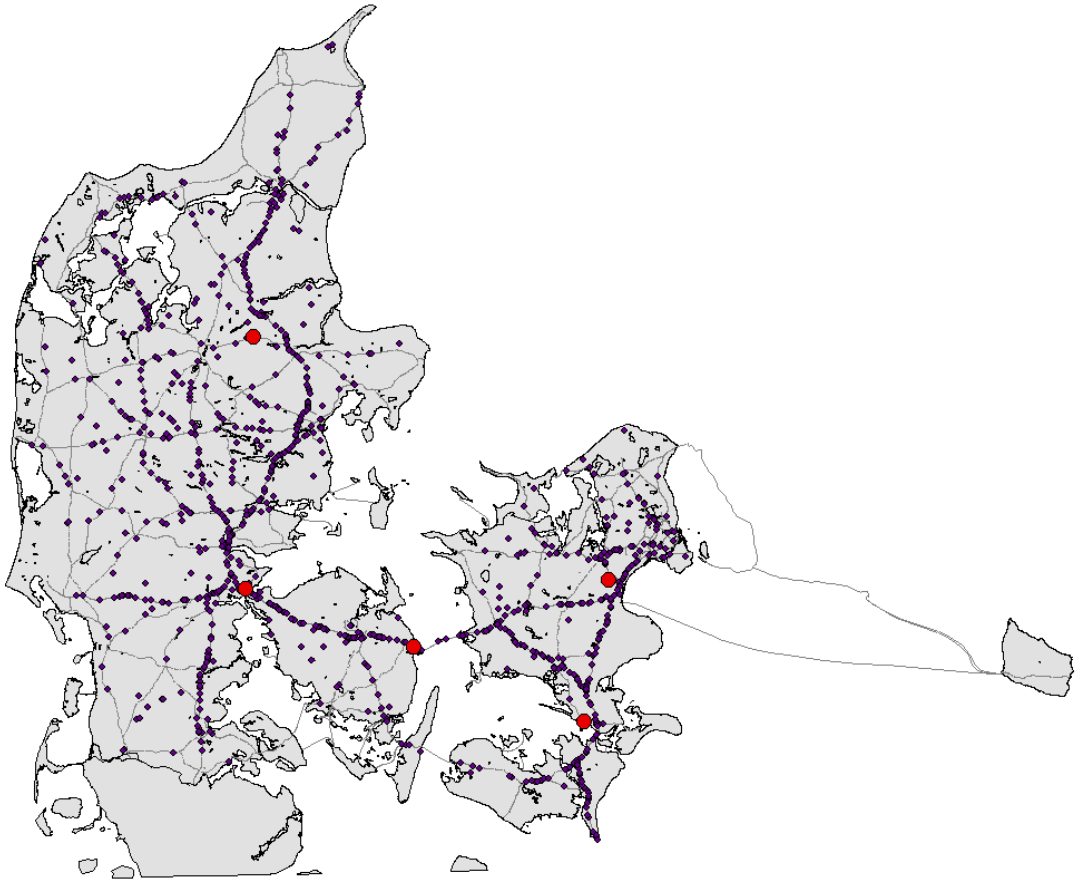
Demand for charging poles at public and semi public space.
shown as a percent of the EV stock

	Street parking	Shopping centre parking	Residential stocks	Company employees parking	Total	Private houses
Residence	8 %		17 %		25 %	75 %
Maximum need						
Working places	7 %			36 %		15 %
Shopping, recreation	5 %	10 %				
Maximum needs, total	20 %	10 %	17 %	36 %	83 %	
Minimum need						
Work, shopping	4 %	1 %		12 %		
Minimum need, total	12 %	1 %	17 %	12 %	42 %	

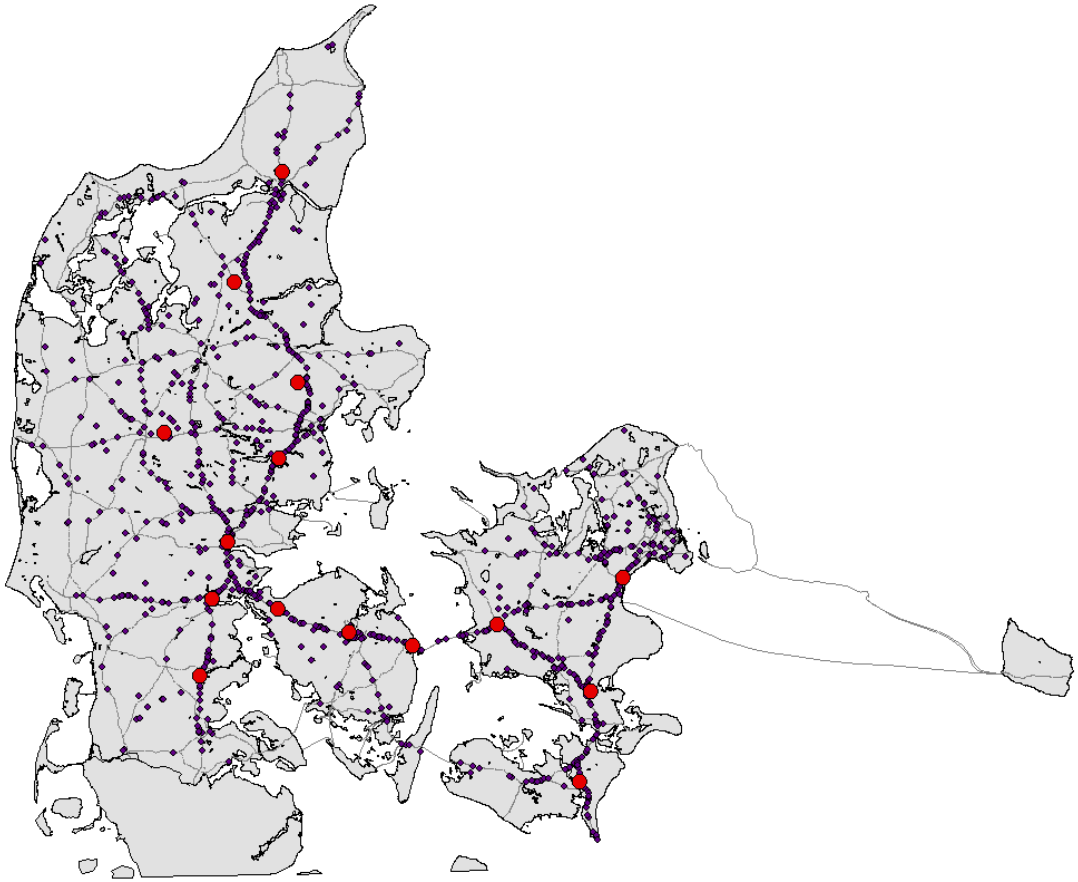
Project Overview



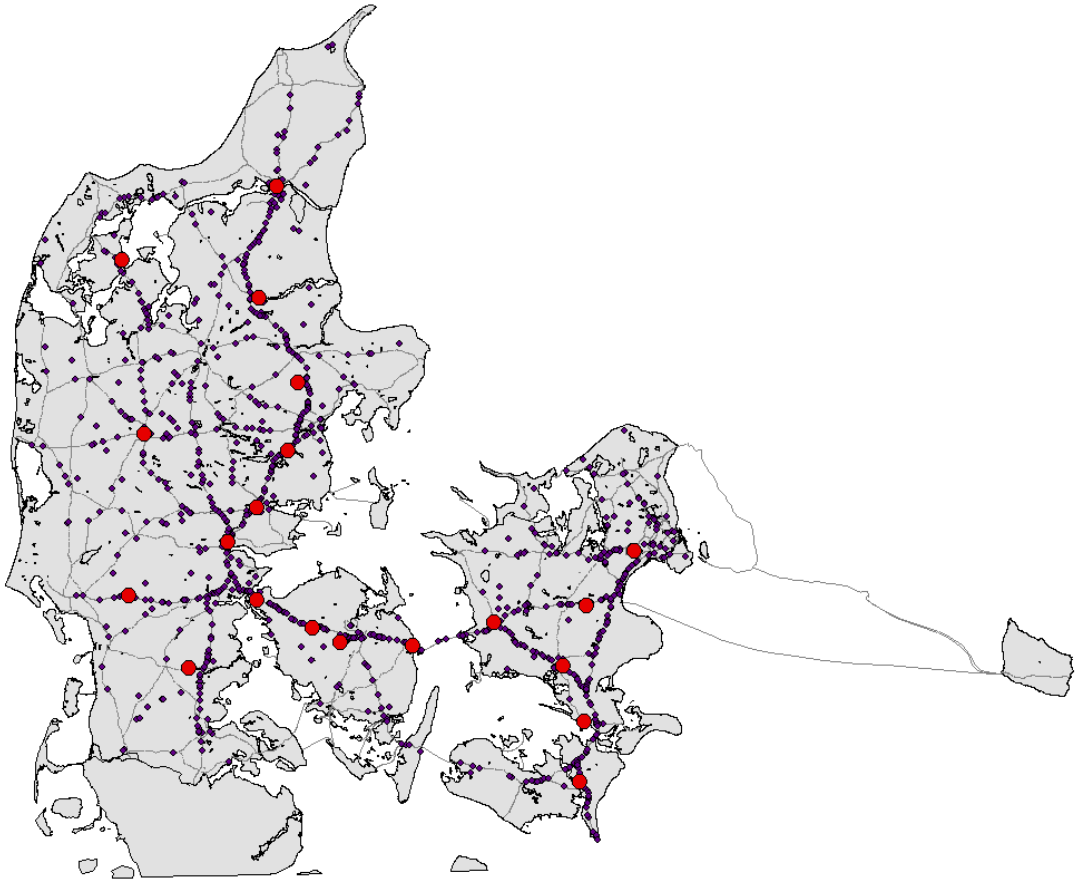
Results – 5 stations



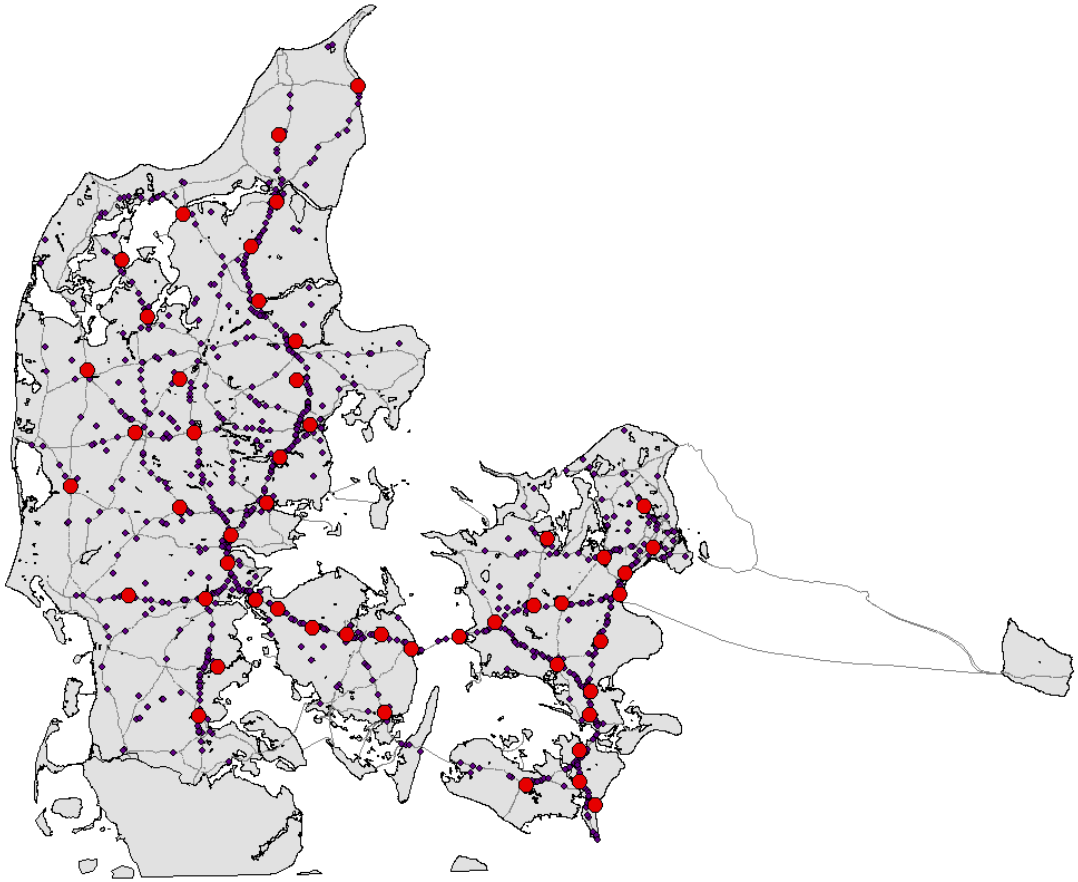
Results – 15 stations



Results – 20 stations

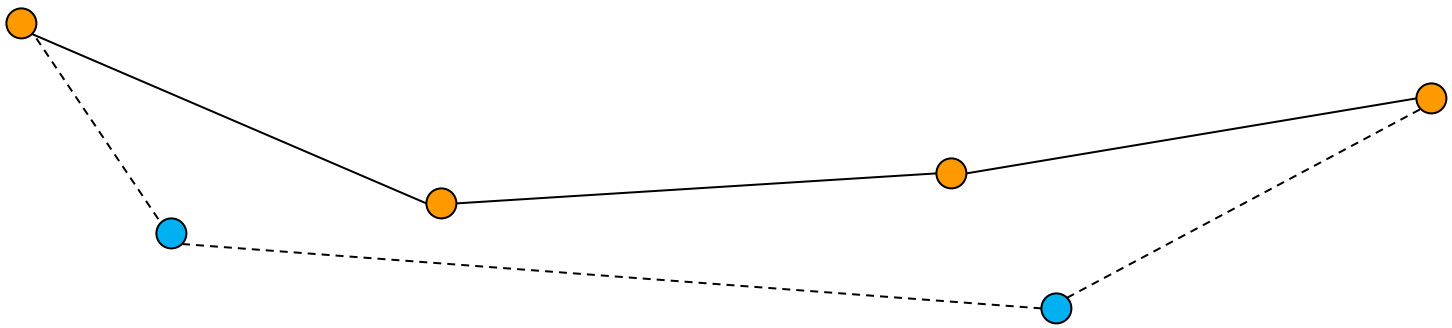


Results – 50 stations

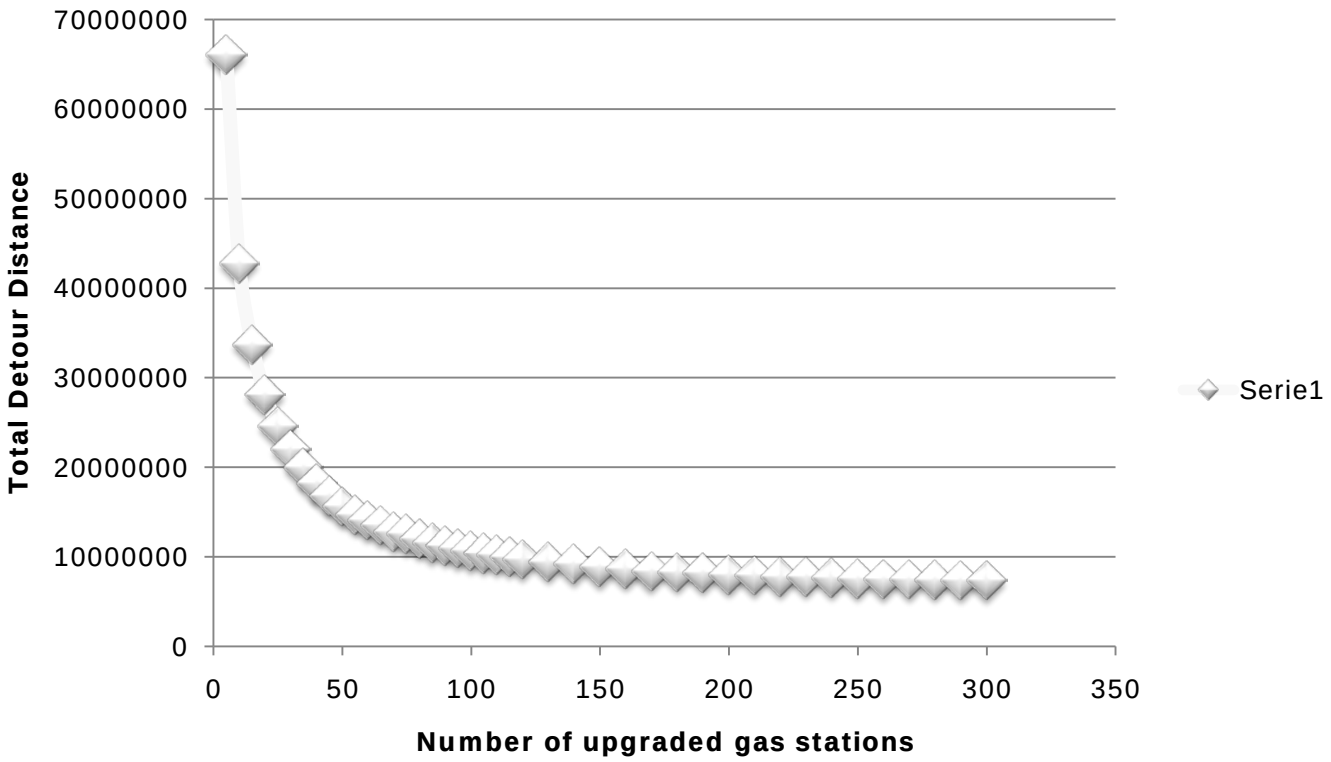


Stage 3: Post processing

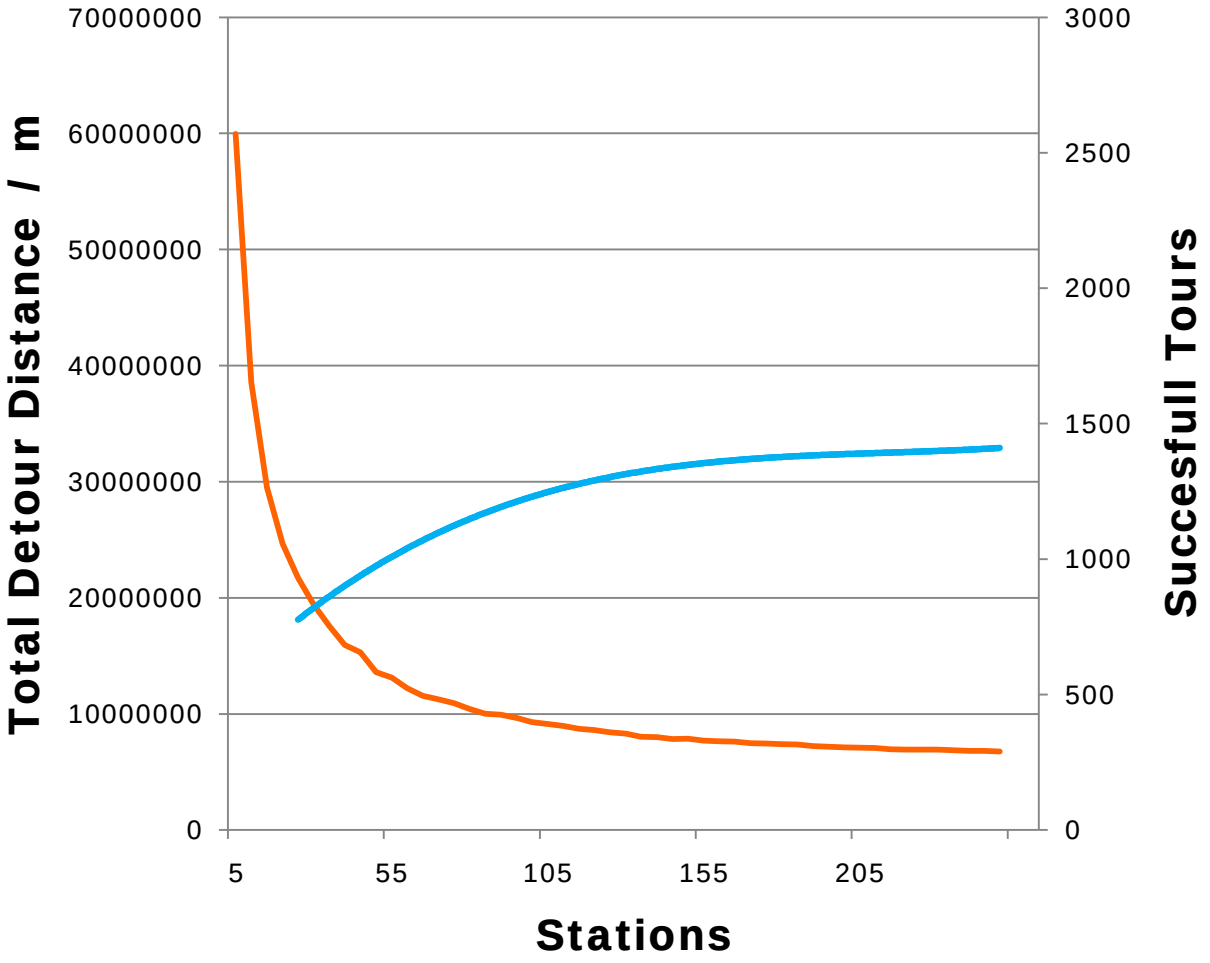
- Original tour – startcapacity /endcapacity
- Check if car can reach first fast charge stop
- 2. Check: can car reach destination / or next fast charge stop?



Results


70000000
60000000
50000000
40000000
30000000
20000000
10000000
0
Total Detour Distance
0
50
100
150
200
250
300
350
Number of upgraded gas stations
Serie1

Results



1448 Extended trips

With all 1288 open stations – succesfull tours = 1441

bad matchings = 7

With 1288 open stations – detour dist = 6321672 m