Humanist

Perspective in Electro-mobility systems

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Acknowledgement

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Current situation

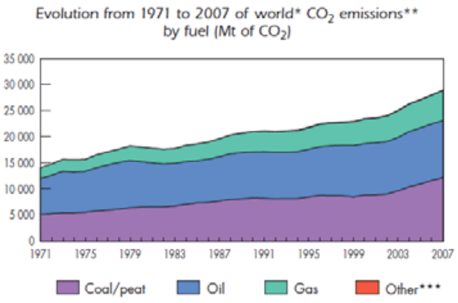
- Global CO_2-emissions from fossil fuels have almost doubled since the 1970s.

- Global warming can be definetely traced back to human behavior. Since 1985: temperatures rise 0.19 °C per decade

- Ice sheets, glaciers and ice caps melt faster than expected → until the year 2100 sea-level will rise up to 2 meters

- If global warming continues at this pace, endangered elements of the climate system (continental ice sheets, the Amazonas rainforest) could be altered **irreversibly!**

- Germany is one of the top five CO_2-emitters worldwide; **traffic causes in Germany 1/5 of the emissions**, thereof almost 70 % are due to emsissions of passenger cars .


Evolution from 1971 to 2007 of world* CO_2 emissions** by fuel (Mt of CO_2)

*World includes international aviation and international marine bunkers, which are shown together as Bunkers. **Calculated using the IEA's energy balances and the Revised 1996 IPCC Guidelines. CO_2 emissions are from fuel combustion only. ***Asia excludes China.

IEA, 2009

Sources: www.copenhagendiagnosis.com
German Federal Ministry of Economics and Technology, BP

Current situation: Scarce resources and mobility

- Germany buys almost 75 % of energy demand abroad, **import of mineral oil** even accounts for **97 %!**

- Gap increases between delivery output of petroleum and new oil discoveries → **final oil crisis**

- "If we get to the point, where there is insufficient supply, the only way to balance the market will be **through higher prices and a drop in demand."**

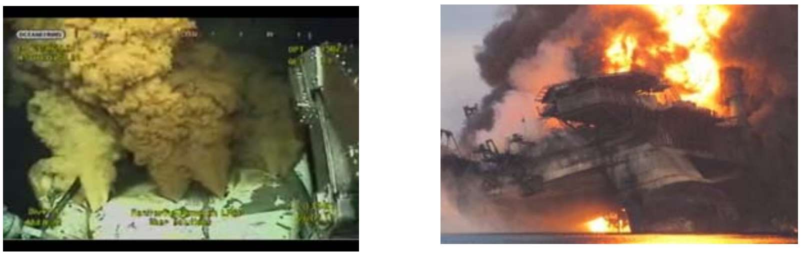
Lawrence Eagles, International Energy Agency (IEA)

- Although the availability of resources decreases, Germans have become more mobile in recent years: Increase of transport performance due to individual motor car traffic since 1991: **27 %**

Source: German Traffic Forum Report 2006/07

Risks and related tasks for the future

Environmental risks are obvious



Crucial tasks for the future:

How can we deal with increasing mobility **more ecologically compatible**?
How do we get more independent from imported fossil fuels?

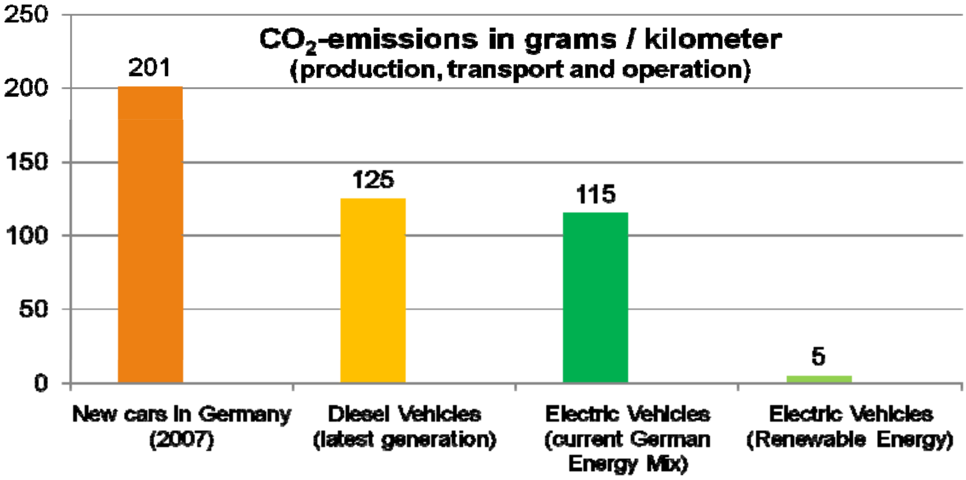
Source: AP Photo/BP PLC, The Huffington Post

The challenge

- Reduction of CO_2-emissions
- Reduction of dependency on oil
- Reduction of contaminant loads / respirable dust
- Reduction of noise

→ **emobility** ??

How „green“ are EVs?
Emissions - well to wheel



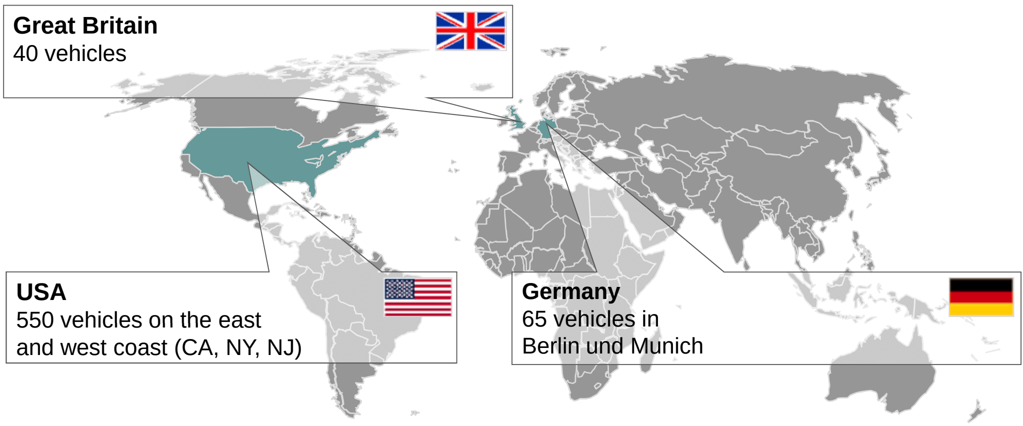
Source: German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2010

So, will it work?

- To answer this question: the largest field study (FOT) by now on behalf of BMW

Learnings MINI E Field Trial.

MINI E Pilot Projects in Germany, USA and Great Britain.



Great Britain
40 vehicles

USA
550 vehicles on the east and west coast (CA, NY, NJ)

Germany
65 vehicles in Berlin und Munich

- Experience with a test fleet in real daily usage
- Integration of renewable energy

Learnings MINI E Field Trial.

MINI E Berlin – powered by Vattenfall.

- Sponsorship and funding
- Political framework

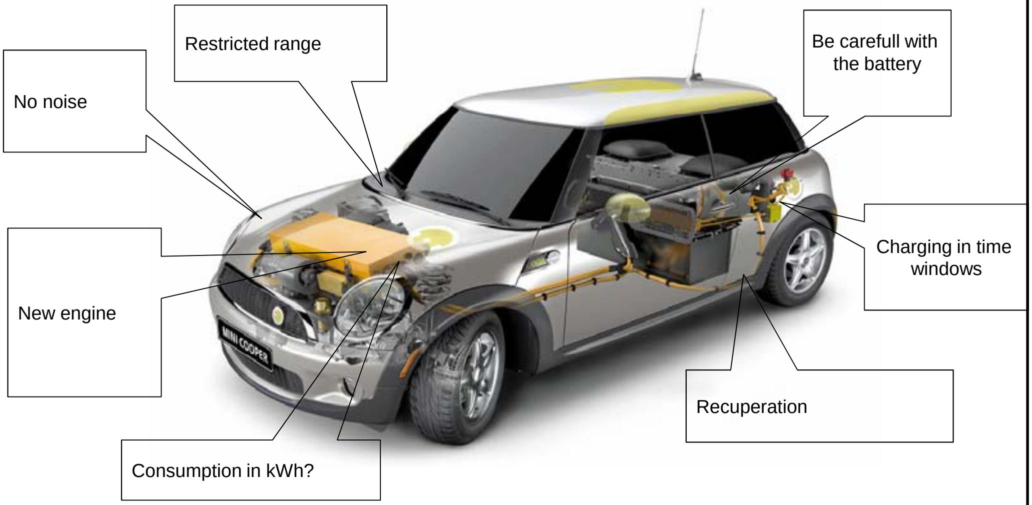
**MINI E Berlin-
powered by Vattenfall**

- Electric vehicles
- User selection
- Data logging

- E-infrastructure
- Renewable energy
- Managed charging

- TU Chemnitz, User study
- TU Ilmenau, managed charging
- TU Berlin, Vehicle-to-Grid

Driving EVs – facing new concepts & challenges



Restricted range

No noise

Be carefull with the battery

New engine

Charging in time windows

Recuperation

Consumption in kWh?

Research goals

- Elicitation of user expectations and experiences, user behaviours in dealing with electric mobility (concerning an estimation how this will affect energy provision, infrastructure, and demands for electro mobility concepts)
- Identification of strengths and weaknesses regarding the usage of electric cars as well as usage of and change to other means of transportation
- Determination and quantification of factors influencing the acceptance of electric cars related to renewable energies
- Collection of personal perceptions of and feedback to electric cars
- Identification of adjusting levers and potentials for market launch and penetration

4 core questions

1. Is range an issue?
2. Is e-mobility different?
3. Do we need public charging stations now?
4. Are customers aware of renewable energy issues?

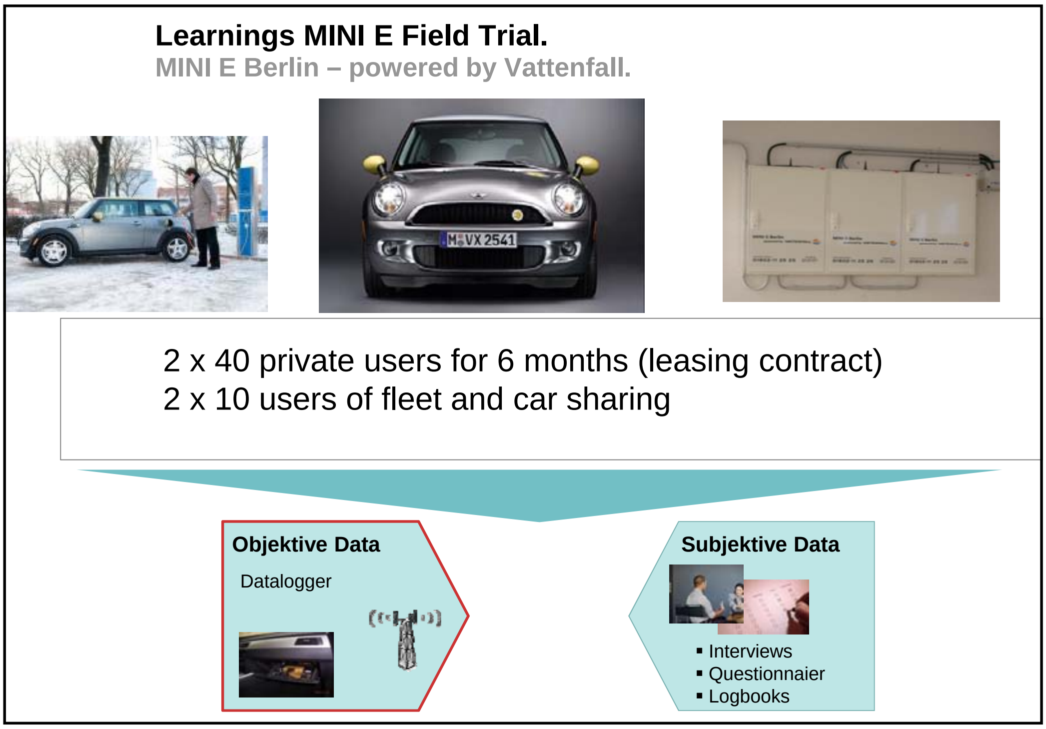
Data collection in two different usage scenarios

´Private setting´

- Framework:
  - 40 vehicles
  - Limited number of users per vehicle:household
  - Data collection: face-to-face, paper-based, computer-based (Conjoint Analysis)
- Subjective rating
  - Environmental attitudes
  - Usability
  - Mobility behavior
  - Vehicle to Grid
  - Range
  - Displays
  - Driving behavior
- Objective measurement
  - Vehicle usage (trip length, speed, acceleration) via data loggers
  - Usage of charging infrastructure (duration and location of charging cycles)

´Fleet setting´

- Framework:
  - 10 vehicles
  - Numerous users per vehicle
  - Normal fleet usage: 6 vehicles
  - Car-sharing usage: 4 vehicles
  - Data collection: web-based / paper-based
- Subjective rating
  - Environmental attitudes
  - Usability
  - Mobility behavior
  - Vehicle to Grid
  - Range
  - Displays
  - Driving behavior
- Objective measurement
  - Vehicle usage (trip length, speed, acceleration) via data loggers
  - Usage of charging infrastructure (duration and location of charging cycles)



Learnings MINI E Field Trial.

MINI E Berlin – powered by Vattenfall.

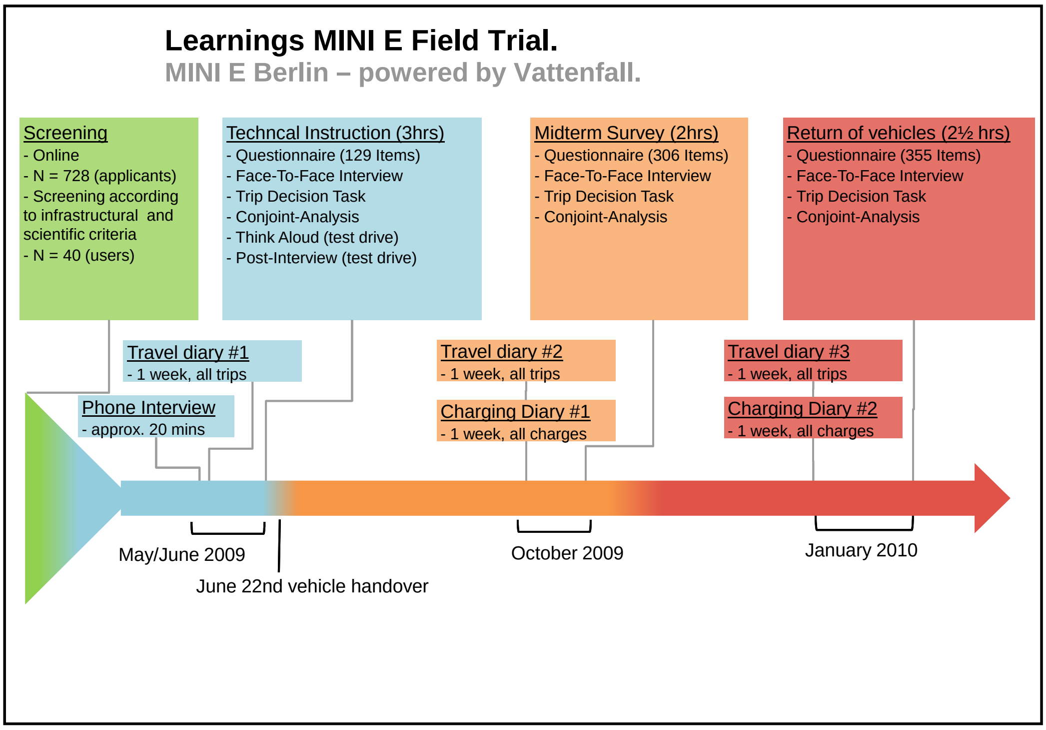
2 x 40 private users for 6 months (leasing contract)
2 x 10 users of fleet and car sharing

Objektive Data

Datalogger

Subjektive Data

- Interviews
- Questionnaier
- Logbooks



Learnings MINI E Field Trial.

MINI E Berlin – powered by Vattenfall.

Screening
- Online
- N = 728 (applicants)
- Screening according to infrastructural and scientific criteria
- N = 40 (users)

Techncal Instruction (3hrs)
- Questionnaire (129 Items)
- Face-To-Face Interview
- Trip Decision Task
- Conjoint-Analysis
- Think Aloud (test drive)
- Post-Interview (test drive)

Midterm Survey (2hrs)
- Questionnaire (306 Items)
- Face-To-Face Interview
- Trip Decision Task
- Conjoint-Analysis

Return of vehicles (2½ hrs)
- Questionnaire (355 Items)
- Face-To-Face Interview
- Trip Decision Task
- Conjoint-Analysis

Travel diary #1
- 1 week, all trips

Phone Interview
- approx. 20 mins

Travel diary #2
- 1 week, all trips

Charging Diary #1
- 1 week, all charges

Travel diary #3
- 1 week, all trips

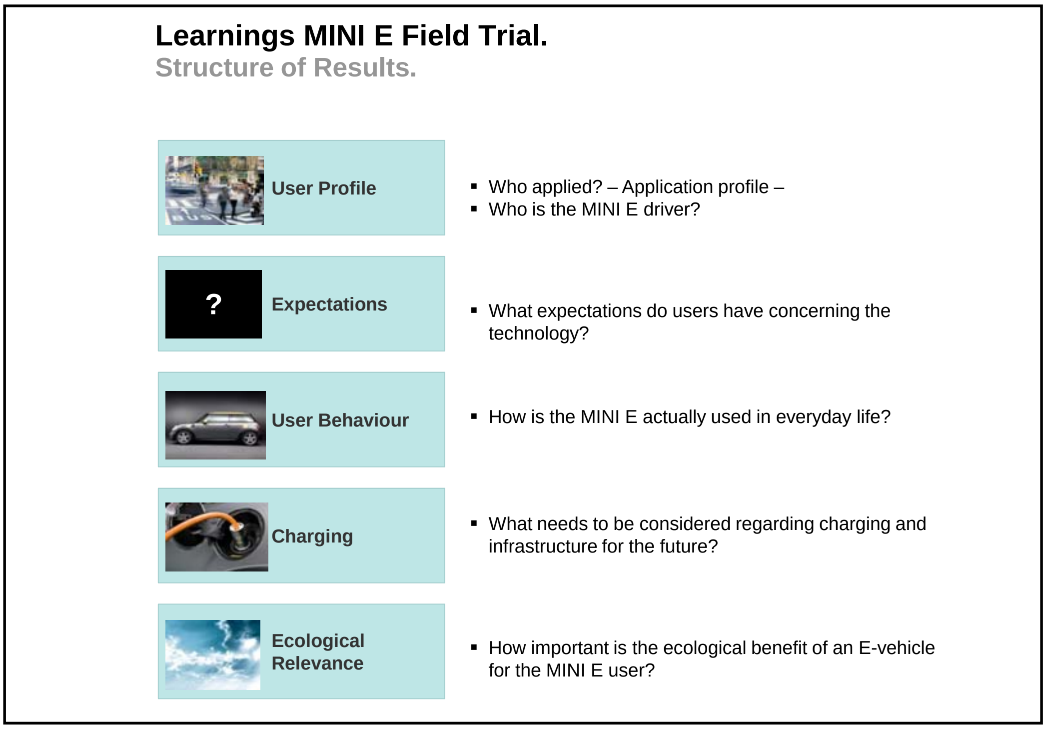
Charging Diary #2
- 1 week, all charges

May/June 2009

June 22nd vehicle handover

October 2009

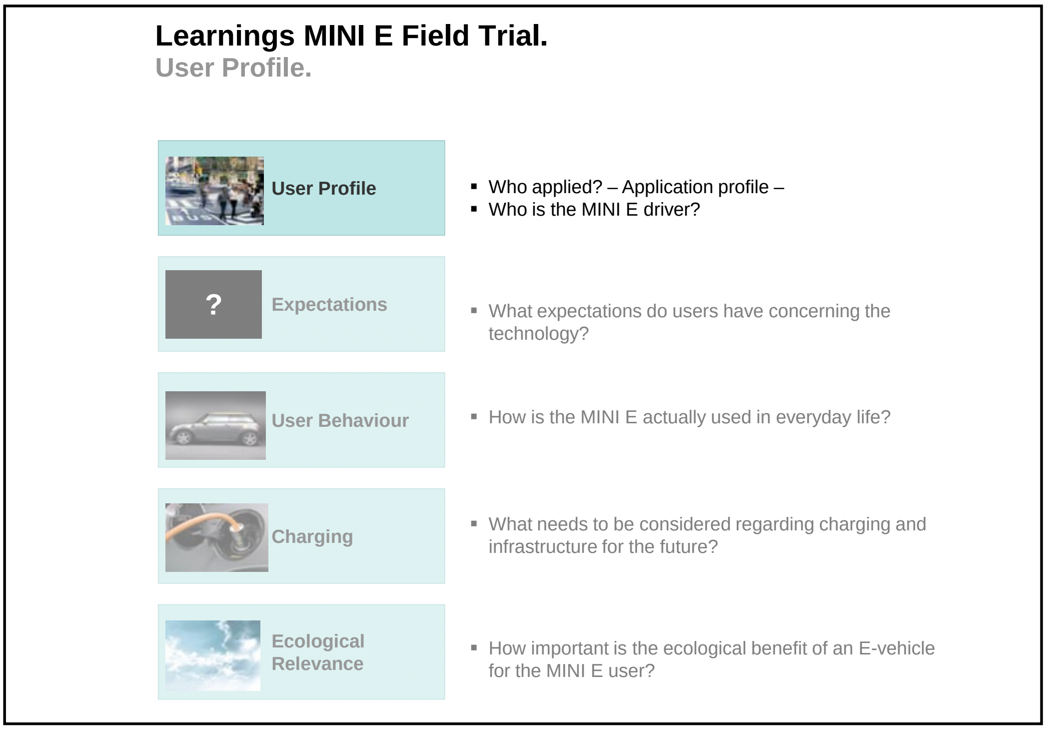
January 2010



Learnings MINI E Field Trial.

Structure of Results.

User Profile	▪ Who applied? – Application profile – ▪ Who is the MINI E driver?
Expectations	▪ What expectations do users have concerning the technology?
User Behaviour	▪ How is the MINI E actually used in everyday life?
Charging	▪ What needs to be considered regarding charging and infrastructure for the future?
Ecological Relevance	▪ How important is the ecological benefit of an E-vehicle for the MINI E user?



Learnings MINI E Field Trial.

User Profile.

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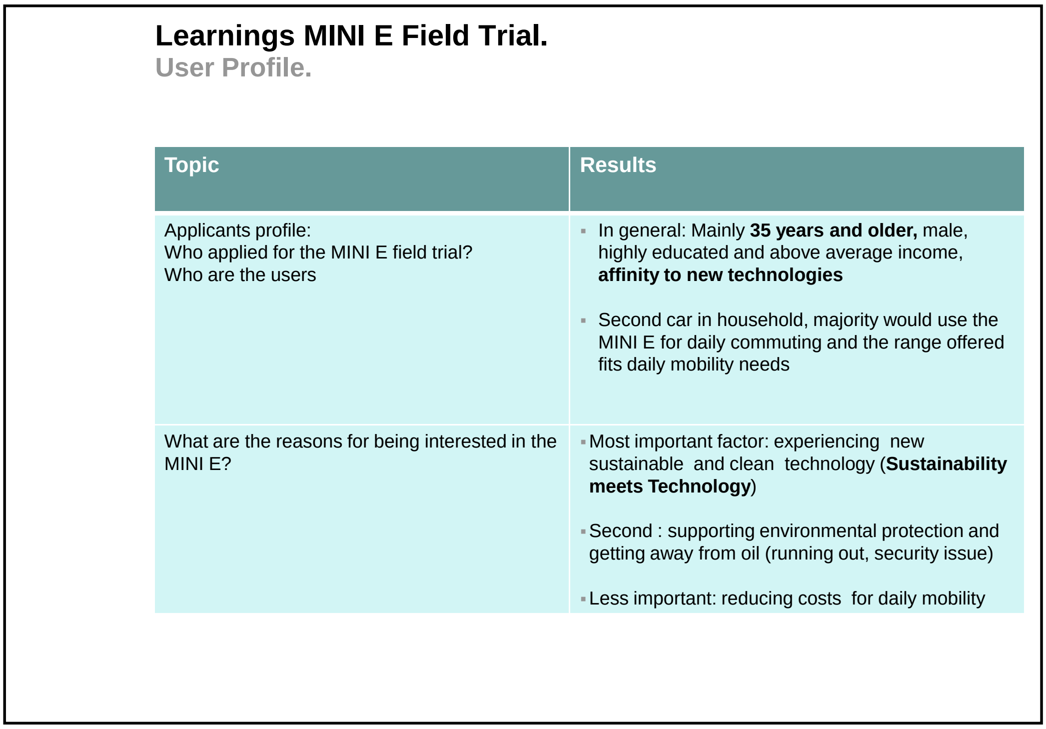
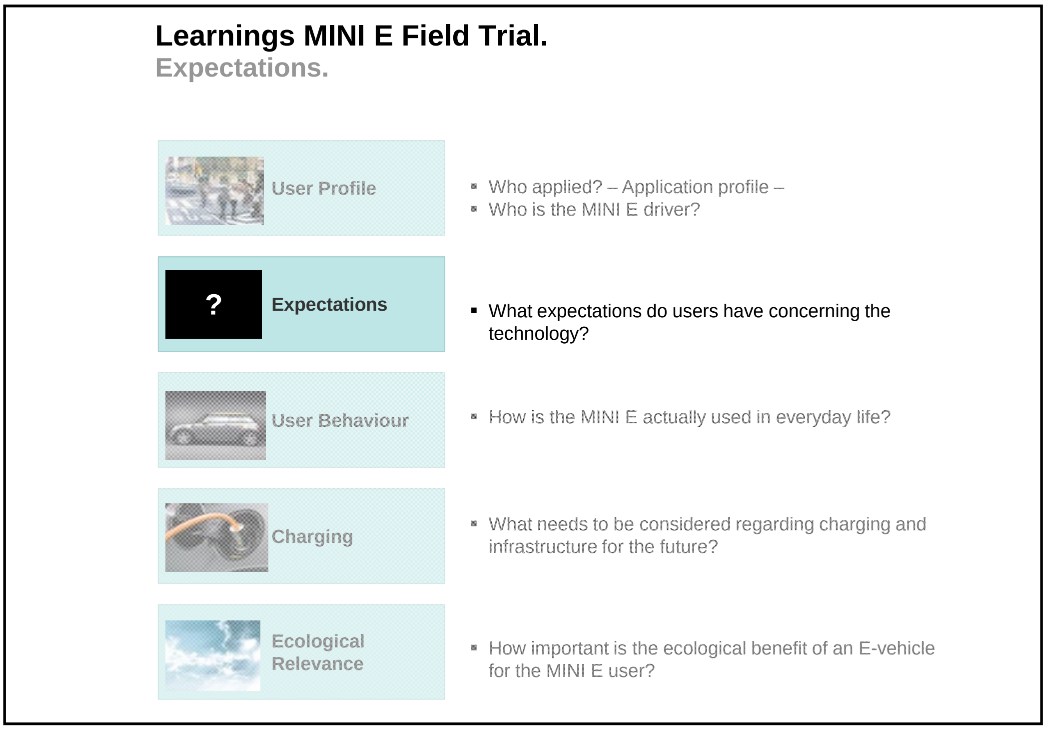


Learnings MINI E Field Trial.

User Profile.

Topic	Results
Applicants profile: Who applied for the MINI E field trial? Who are the users	- In general: Mainly **35 years and older,** male, highly educated and above average income, **affinity to new technologies** - Second car in household, majority would use the MINI E for daily commuting and the range offered fits daily mobility needs
What are the reasons for being interested in the MINI E?	- Most important factor: experiencing new sustainable and clean technology (**Sustainability meets Technology**) - Second : supporting environmental protection and getting away from oil (running out, security issue) - Less important: reducing costs for daily mobility



Learnings MINI E Field Trial.

Expectations.

User Profile	- Who applied? – Application profile – - Who is the MINI E driver?
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Learnings MINI E Field Trial.

Expectations.

Topic	Results
Expectations in terms of restrictions prior to actual vehicle usage	▪ **Range** is the most important restriction users expect ▪ Users, however, **expect to be able to cope** with restrictions e.g. using second car ▪ Although aware of range restrictions, nearly all users expect the vehicle will **fulfill their daily mobility needs**
Expectations in terms of security issues	▪ Almost all users feels as safe as with a conventional car ▪ No substantial fears in terms of safety concerning the battery ▪ Users do have a need for more information on electric-vehicle specific topic such as batteries (car washing)

Learnings MINI E Field Trial.

User Behaviour.

User Profile

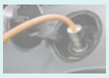
- Who applied? – Application profile –
- Who is the MINI E driver?

? Expectations

- What expectations do users have concerning the technology?

User Behaviour

- How is the MINI E actually used in everyday life?



Charging

- What needs to be considered regarding charging and infrastructure for the future?

Ecological Relevance

- How important is the ecological benefit of an E-vehicle for the MINI E user?

Learnings MINI E Field Trial.

Evaluation of range in terms of daily mobility.

- For more than **90 % of the users range is sufficient for everyday needs**, especially within the city.
- About 66% of the users rate the flexibility with MINI E as high as with a conventional vehicle.
- Mobility behavior has changed among 35 % of the users. Due to MINI E users **feel less guilty** and have **more fun** while driving.
- The mean maximum range tested by the users is 150 km. For users a target value for range of…
  - less than 100 km would be insufficient
  - **200 km would be sufficient**
  - approx. 250 km would be the optimum

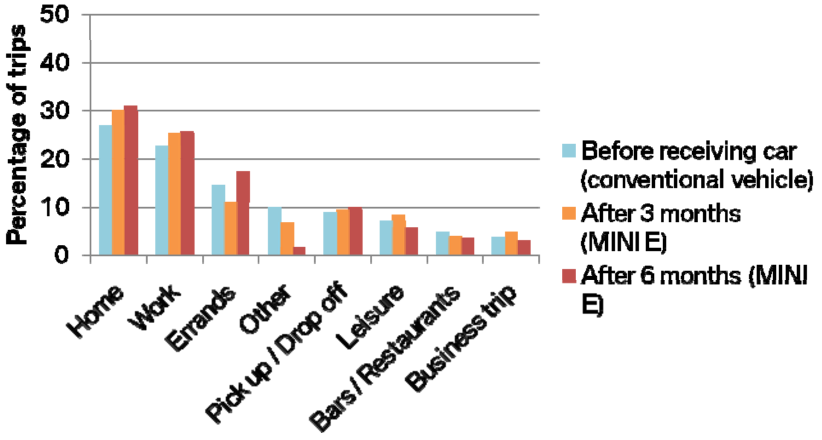
Source:
Berlin User
>Interviews

MINI E User Behavior.

How do the users behave with the MINI E compared to a combustion engine?

Source:
User feedback

What purpose are the vehicles used for?



Travel diary
N=40 (before receiving car)
N=31 (after 3 months)
N=32 (after 6 months)

Learnings MINI E Field Trial.
Charging.

User Profile

- Who applied? – Application profile –
- Who is the MINI E driver?

? **Expectations**

- What expectations do users have concerning the technology?

User Behaviour

- How is the MINI E actually used in everyday life?

Charging

- What needs to be considered regarding charging and infrastructure for the future?

Ecological Relevance

- How important is the ecological benefit of an E-vehicle for the MINI E user?

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1) Public charging station

2) Private wallbox

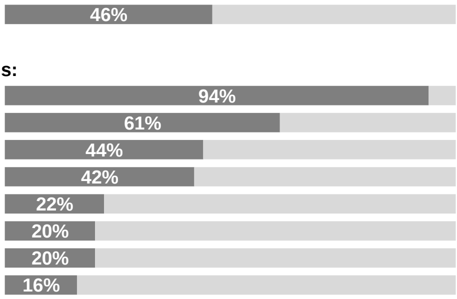
MINI E Charging.

Charging – where do users charge the vehicle?

Source:
User feedback

46 % of users have never used a public charging station.They mainly use private Autostrom boxes.

Reasons for non-use of public charging stations:
Autostrom Box is sufficient.
Unfavourable location.
Not enough stations.
Parking period too long.
Charging sessions might be interrupted.
Dirty cable.
Cable not in car.
Station in use.



Possible ways of increasing use:
- Increase density of network and select appropriate locations for charging stations.
- Information on locations,
- e.g. in navigation system.
- Information on availability.
- Users obtain parking privileges.

duced charge duration.

Source: Berlin user survey.

Learnings MINI E Field Trial.

Ecological Relevance.

User Profile

- Who applied? – Application profile –
- Who is the MINI E driver?

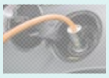
?

Expectations

- What expectations do users have concerning the technology?

User Behaviour

- How is the MINI E actually used in everyday life?



Charging

- What needs to be considered regarding charging and infrastructure for the future?

Ecological Relevance

- How important is the ecological benefit of an E-vehicle for the MINI E user?

MINI E Ecological relevance.

User perception.

Source:
User feedback

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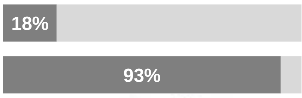
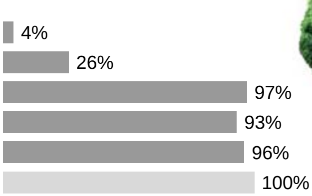
Only 18 % of users rate energy from the German "energy mix" as environmentally compatible.

93 % of users rate electrical energy from renewable sources as environmentally compatible. (nur NZ 1 gefragt)



How should energy for electric cars be generated?

Coal-fired power station.
Nuclear power station.
Wind energy.
Hydroelectric power station.
Solar energy.



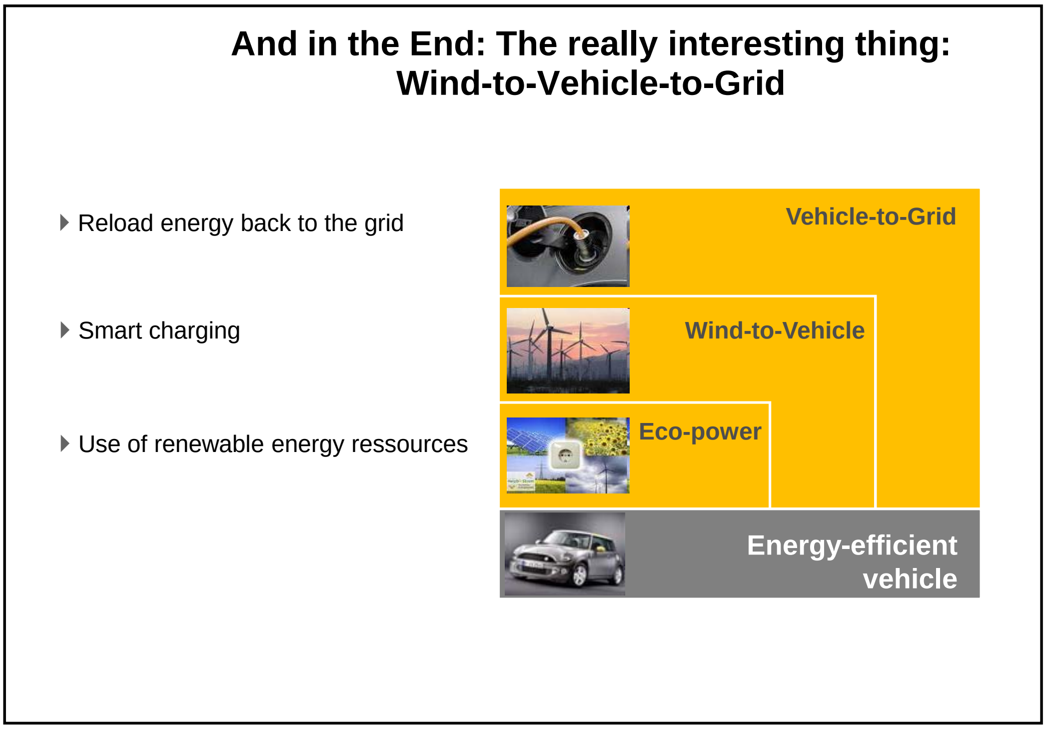
To sum up: answers to the 4 questions

1. Is range an issue?	no
2. Is e-mobility different?	no
3. Do we need public charging stations now?	no/yes
4. Are customers aware of the engergy mix?	yes

Learnings MINI E Field Trial.

Overall Learnings.

1. User **behaviour** of MINI E users **differs only marginally** to comparable MINI Cooper and BMW 116i drivers.
2. Prior to the field trial, users **expected restrictions** regarding range and charging time. However, those restrictions were only perceived in a **minority of cases** during the field trial.
3. Collected data indicate that a Megacity Vehicle with **slightly increased range** and **expanded passenger and cargo space** would fulfill almost **100% all urban mobility needs**.



And in the End: The really interesting thing: Wind-to-Vehicle-to-Grid

- Reload energy back to the grid
- Smart charging
- Use of renewable energy ressources

Vehicle-to-Grid

Wind-to-Vehicle

Eco-power

Energy-efficient vehicle