

User perspective on eco-driving HMIs for electric buses in local transport

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Eco-driving in Electric Buses

- **Electrification** of local public bus transport is a key measure to **reduce transport emissions**. [1]
- **Eco-driving** plays a crucial role in the optimal use of electric buses. [2]
- Electric vehicles have **specific energy dynamics** (e.g., regenerative braking) that create new challenges for eco-driving. [3]
- **HMIs** can support eco-driving. [4]
- Bus driving is a challenging context because of many **concurrent tasks** (e.g., time management, communication, passenger service).

? What are – *from users' perspective* – the **essential elements** of an action-integrated **eco-driving support system**?

Approach:

1. Develop a first **prototype** of an action-integrated eco-driving support system
2. Conduct an **interview study** with electric bus drivers to examine the user perspective and extract key features.

Interview Study



10 bus drivers (2 female)

Electric bus **experience** (driving hours): $M = 14.6$ ($SD = 8.8$)



Video-Introduction of the “Eco-Assistant” (<https://youtu.be/s7Q7YtBVJ7w>)



Interview Questions:

“...would this interface **support** you ... ?”
“...information ...well **comprehensible**?”
“...information ... **helpful**?”
“...further information **missing**?”



Recordings transcribed and **in-vivo coded**

All mentioned features listed and **clustered** as feature groups

Link to Video



Conclusion + Next Steps

1. All **indicators** generally perceived as **relevant**.
2. **Information condensation** as key requirement in this context.
3. “**Green range**”-feedback preferred over “reward/punishment”-feedback.
4. Adequate **reference route** that allows for comparability.

→ How well can different metrics/indicators actually **quantify differences** in energy efficient driving of electric buses in local transport?

→ **Challenge: Reducing information volume** vs. providing more precise and **action-oriented indicators** instead of only overall energy efficiency.

Authors at the Conference

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Markus Gödker is a PhD candidate in the field of Engineering Psychology. His current project is about user-range interaction in electric buses.



Thomas Franke

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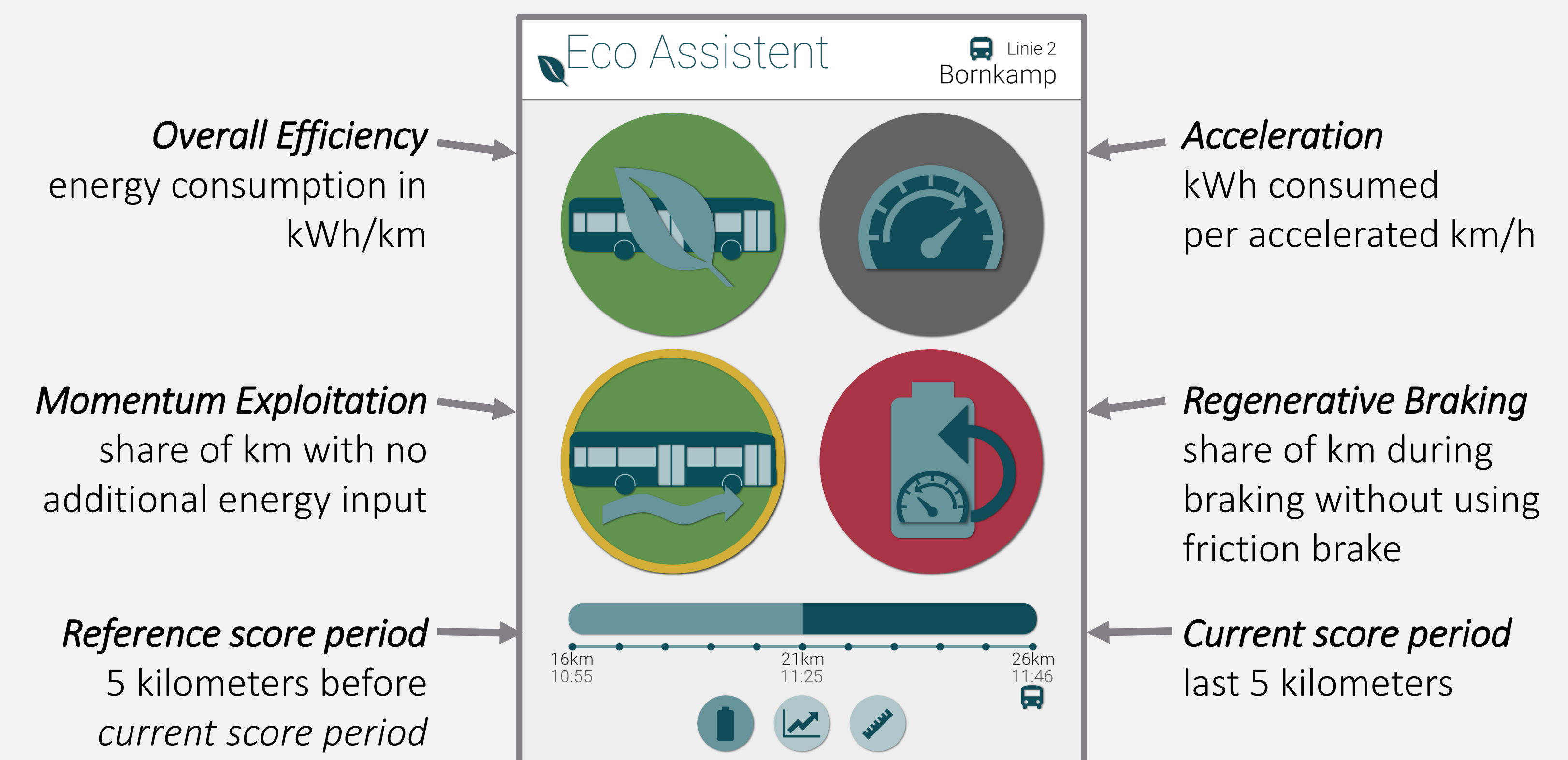


- References
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 - [2] Barkenbus, J. N. (2010). Eco-driving: An overlooked climate change initiative. *Energy Policy*, 38(2), 762-769.
 - [3] Strömberg, H., Andersson, P., Almgren, S., Ericsson, J., Karlsson, M., & Näbo, A. (2011). Driver interfaces for electric vehicles. In *Proceedings of the 3rd International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (pp. 177-184). ACM.
 - [4] Dahlinger, A., Wortmann, F., Ryder, B., & Gahr, B. (2018). The Impact of Abstract vs. Concrete Feedback Design on Behavior Insights from a Large Eco-Driving Field Experiment. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (p. 379). ACM.
- [Photo] Adobe Stock.



Prototype Design – “Eco-Assistant”

- Design goal: action-integrated indicator-based eco-driving information interface.
- Basis: literature review and translation to electric bus context.



Indicator scores of **current** and **reference route** are compared and the icon changes its color respectively:



Results

Key features (no. of participants mentioning this feature in parentheses):

► Scoring of performance feedback

Rather indicate that the eco-driving is within an **acceptable range** (6) than a reward/punishment

“Well, I like the coloring [...], because you can identify it faster than looking at some sort of an index pointer. When I have green, I know: ‘Ok, everything done right’, when red: ‘Ok, you should do something’, when gray: ‘Ok, I am in a normal range’.”

► Information volume

Even less volume by reducing the amount of indicator (2) or the workload demand (2)

“It would be enough if all of them form one result. [...] Either positive or not. That’s enough. Everyone actually knows where his strengths and weaknesses are.”

► Meaningful referencing

Long enough (2) and comparable (2) **reference routes**

“Well, I like the momentum exploitation [...] like for example when approaching a bus stop, there’s no point in accelerating again to arrive less than a second earlier but lose a kilometer of range.”

► Indicator definition

All indicators relevant (4); **Momentum Exploitation** indicator in particular relevant (4); **Regenerative braking** indicator rather irrelevant (3)

The “NuR.E” Project

Objective: Development of a system that optimally supports electric bus drivers and dispatchers in their range management.

Theories & Concepts: Framework of psychological range levels – range stress – action regulation – situation awareness – trust in automation.

Approach: Support of range assessment and range extension via enhanced range information and action-integrated feedback to reduce uncertainties in user-range interaction.

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Poster as PDF

