eFuture

„Safe and Efficient Electrical Vehicle“

Integrating the driver into the vehicle energy management

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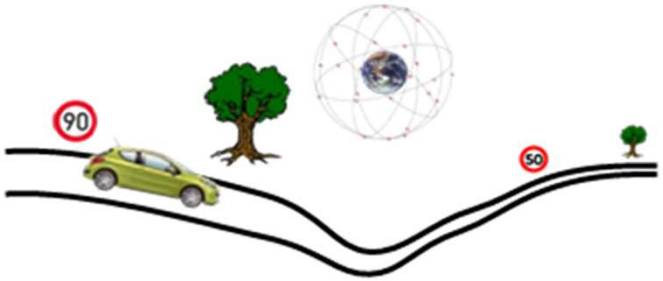
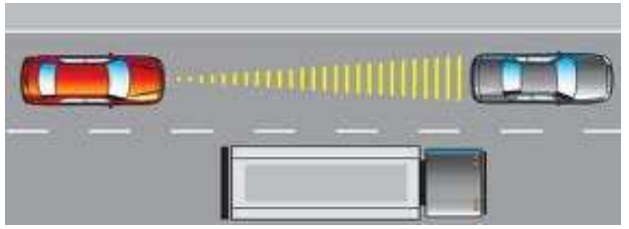
Driving style evaluation

Topography



Traffic signs/rules

Surrounding traffic



Target behaviour

Actual behaviour

Evaluation

Coaching advices

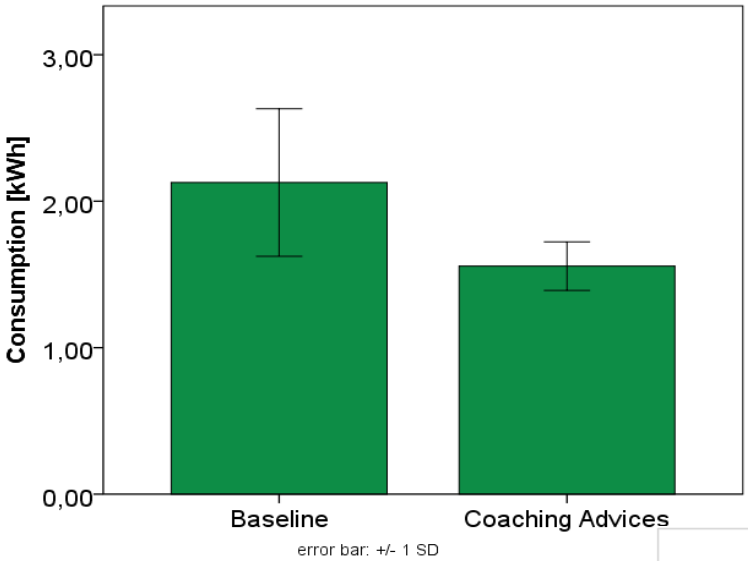
Driving style evaluation

Situation	Increasing energy efficiency
Deceleration	Earlier deceleration and longer recuperation times to compensate for more gentle deceleration
Acceleration	Lower acceleration and subsequently shorter times spent with high speed positively influence energy consumption.
Curves	More gentle and longer deceleration when approaching corners, lower speeds when cornering (but only if subsequent acceleration time is not substantially increased), more gentle acceleration when leaving the corner.
Car following	More gentle acceleration and decelerations when adapting speed.

Driver Coaching

	Omit hard accelerating
	Do not exceed the current legal speed limit
	Keep constant speed while negotiating a curve
REKUP!	Decelerate by means of the electric brake Try to omit hydraulic braking by means of anticipatory driving
SAIL!	Sail over hilltops Sail when driving downhill in order to gain speed
	Keep a sufficient distance to leading vehicles in order to omit velocity fluctuations.

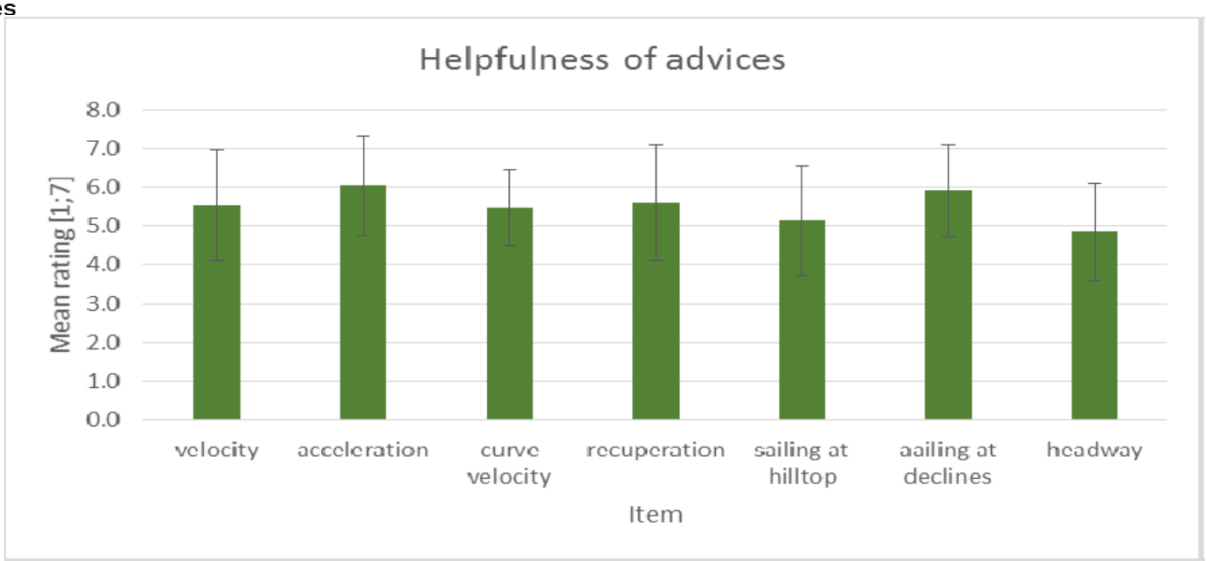
Driver Coaching



Driver coaching has a significant impact on energy consumption ($t(9)=4.76$; $p=.001$).

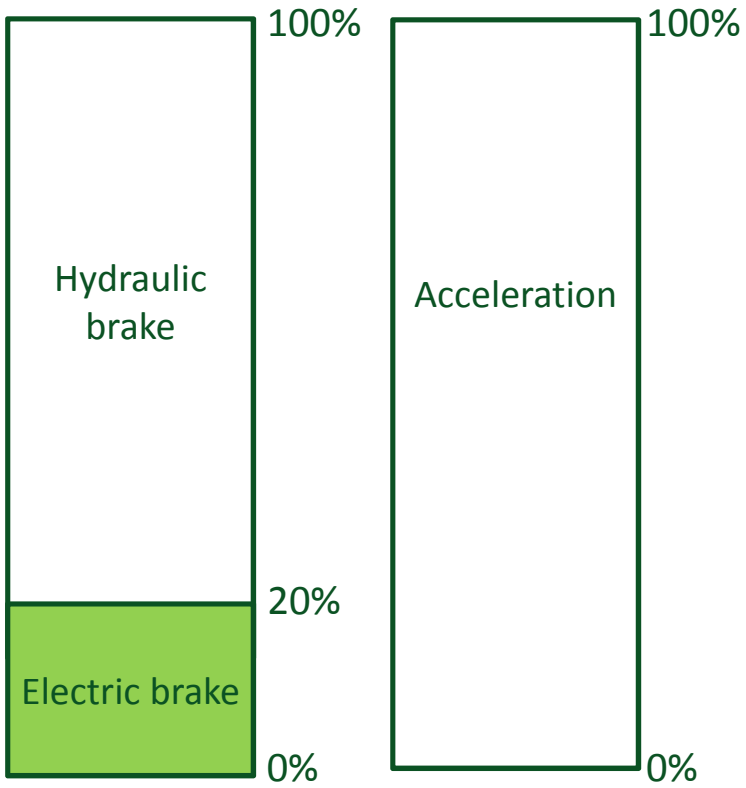
Energy consumption was reduced by 27% due to specific online coaching advices.

All coaching advices were rated to be helpful when in comes to driving energy efficiently.

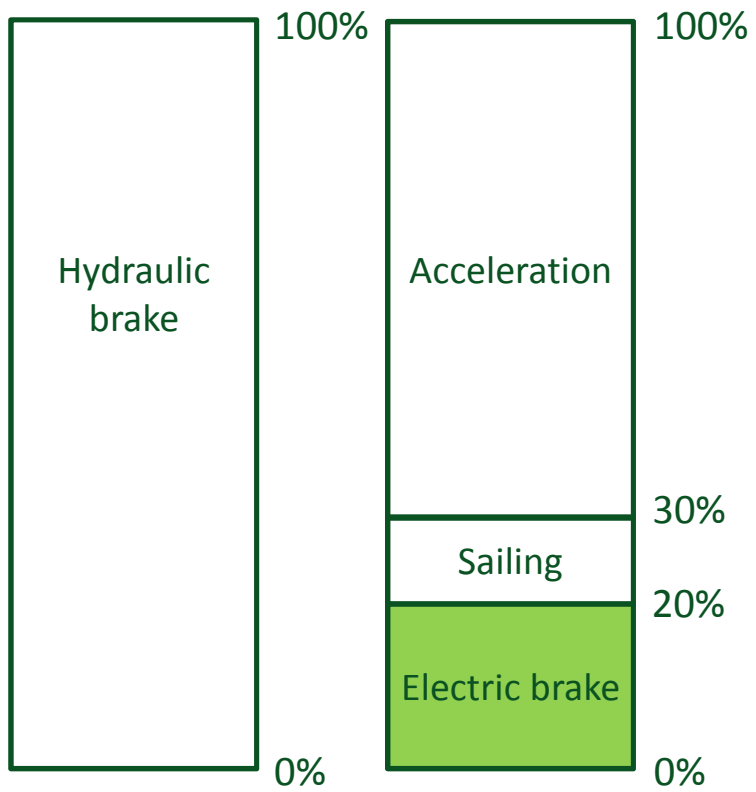


Driver feedback

Split pedal solution



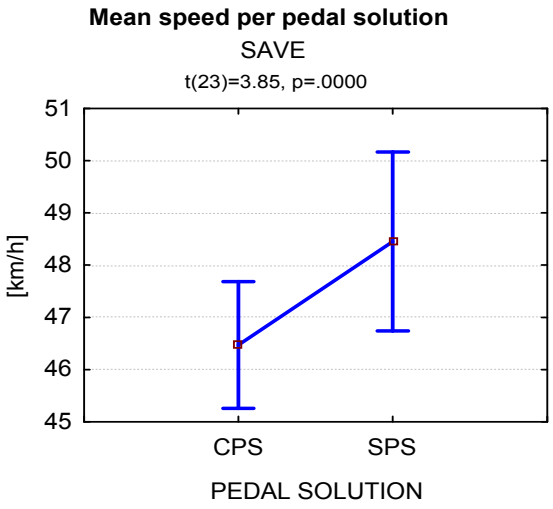
Combined pedal solution

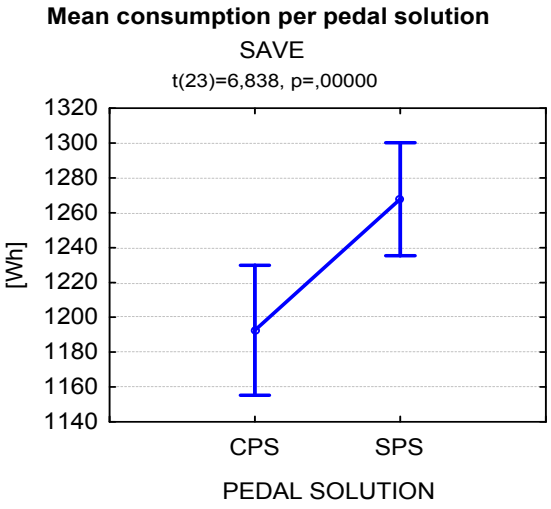


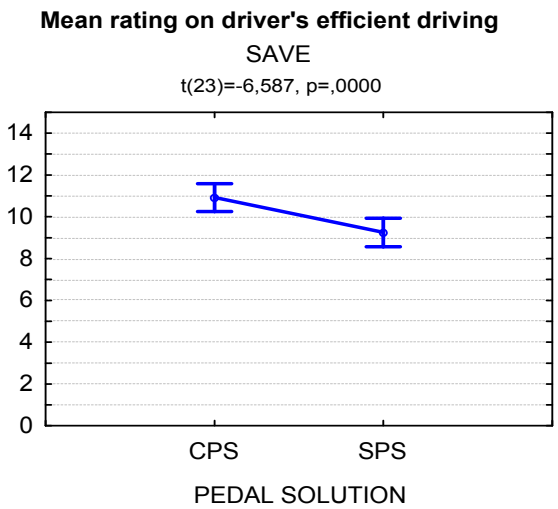
Driver feedback

- **Pedal solution**
  - CPS results in less hydraulic brake usage / more electric braking
  - CPS results in less sailing time compared to the SPS
  - Subjects drove slower with CPS
  - Accelerated slighter with CPS

  -> **6% less energy**







Energy modes

» How do drivers accept the limitations in maximum torque and maximum power?

Electric vehicle	Maximum torque [Nm]	Maximum power [kW]	Maximum acceleration[m/s²]	Maximum speed [km/h]
1	1550	50	3,445	149
2	1000	50	2,319	149
3	700	50	1,526	149
4	1550	35	3,529	130
5	1550	20	3,524	104

Energy modes

» Course and traffic situations

› Four modules

Module	Environment	Dynamic	ΔSpeed	Slope	Curvature	Length
1	Extra urban	High	High	High in-/decline	High	5480 m
2	Urban	Low	Low	Low in-/decline	Low	2683 m
3	Extra urban	Low	Low	Low in-/decline	Low	3703 m
4	Urban	High	High	-	High	2698 m

› Different speed limits

› Different in- and declines

› Sharp and broad curves

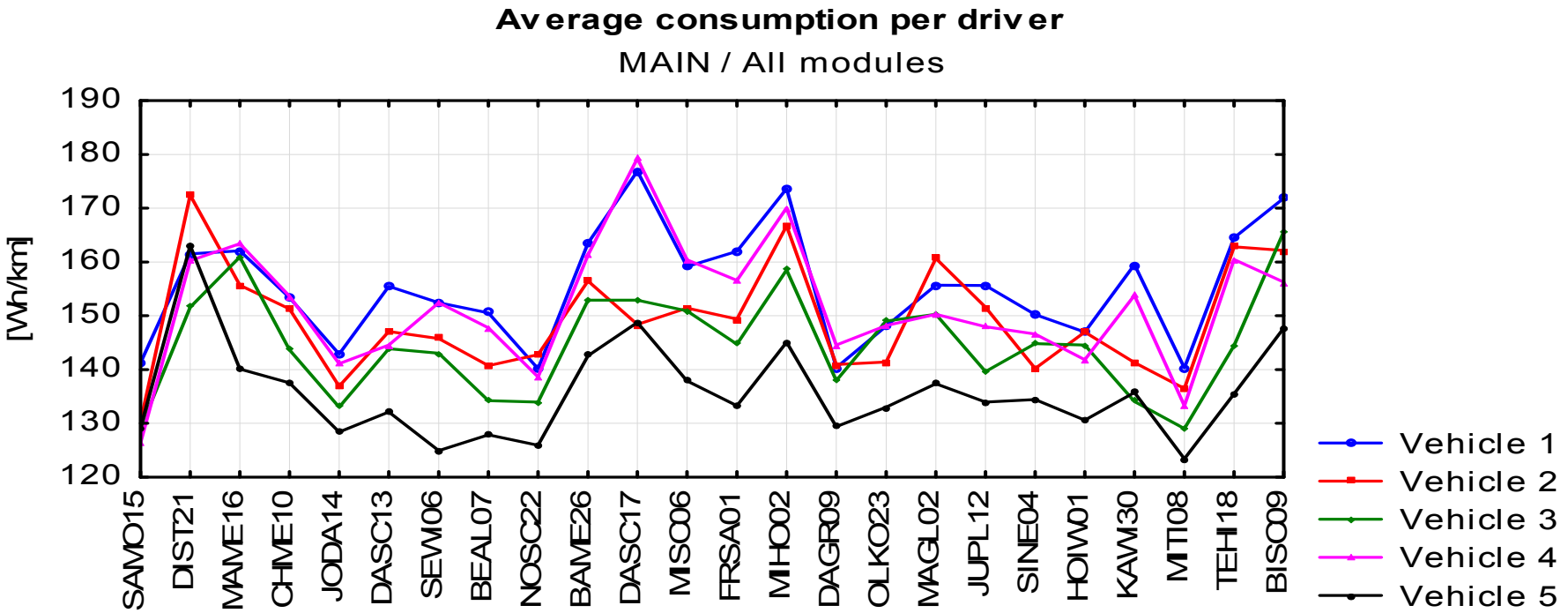
› Five intersections with crossing traffic

› Four overtaking manoeuvres

› Duration 15-20 min

Energy modes

- Limiting the maximum power led to a reduced consumption of **12.6 %**
- Limiting the maximum torque led to a reduced consumption of **6.8 %**
- The drivers accepted limitations in most traffic situations



Energy modes

Impact of individual driving styles on energy consumption