

PEBS: A Predictive Emergency Braking System Approach and Estimation of its Benefits

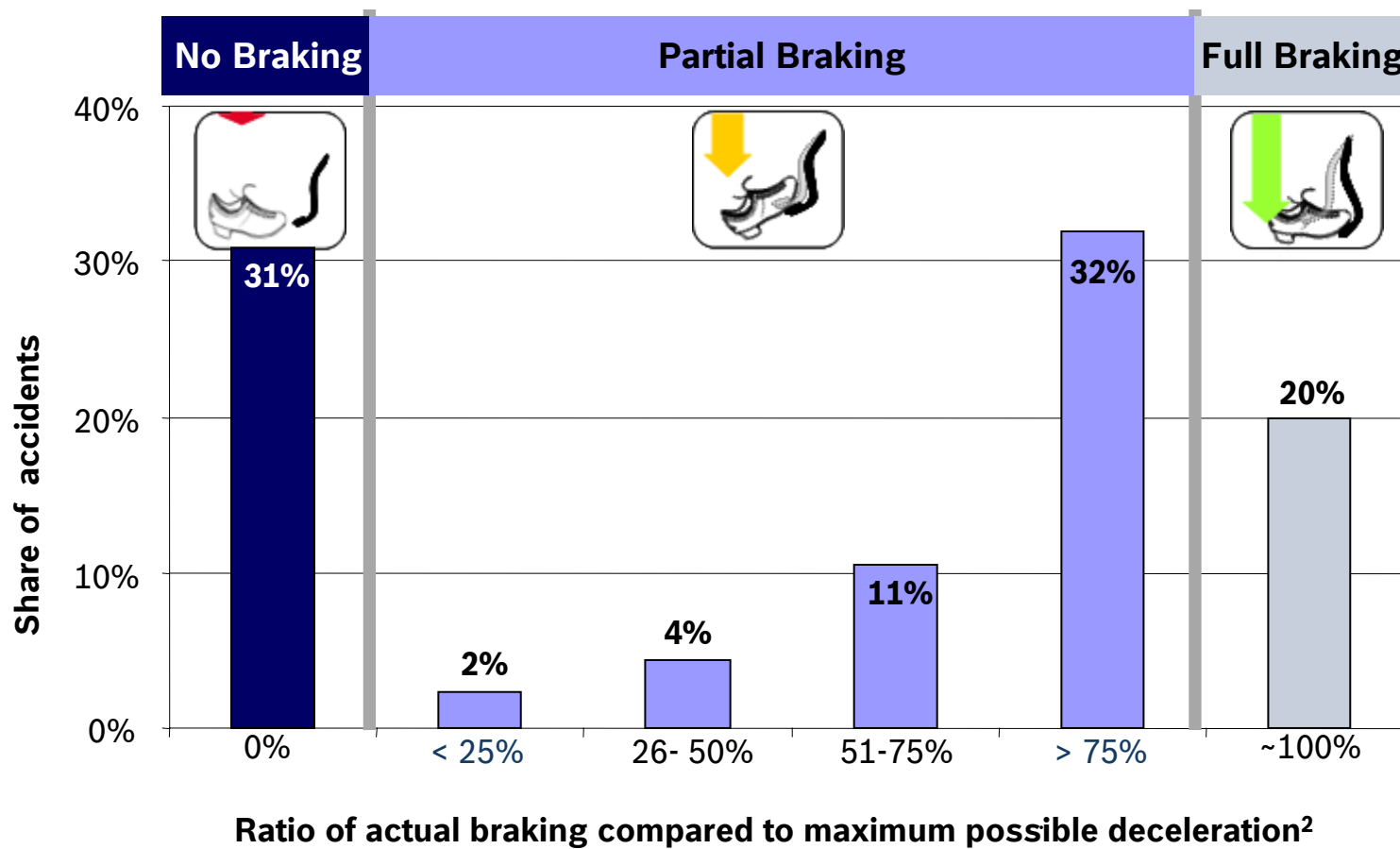
Dr. Kay Stepper
Robert Bosch LLC



Outline

- Analysis of Rear-End Crash Data based on *General Estimate Systems* (GES - NHTSA) and *German In-Depth Accident Study* (GIDAS)
- Description of Typical Crash Scenario Timeline with Various Stages of PEBS Driver/Vehicle Intervention
- Description of PEBS Intervention Stages
- PEBS Benefit Analysis Process
- Effectiveness of PEBS with Respect to Rear-End Crashes

Vehicle Deceleration prior to Rear End Crashes¹



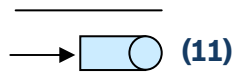
¹ Evaluation based on 1103 rear end crashes in GIDAS.
Source: Bosch Analysis of GIDAS Database (2001-2005)

² Maximum possible deceleration was determined based on weather and road condition

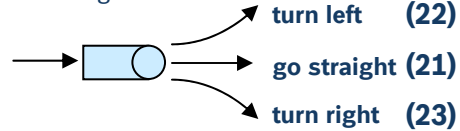
Distribution of Rear-end Collisions

Collision with ...

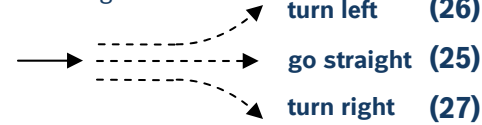
parked vehicle



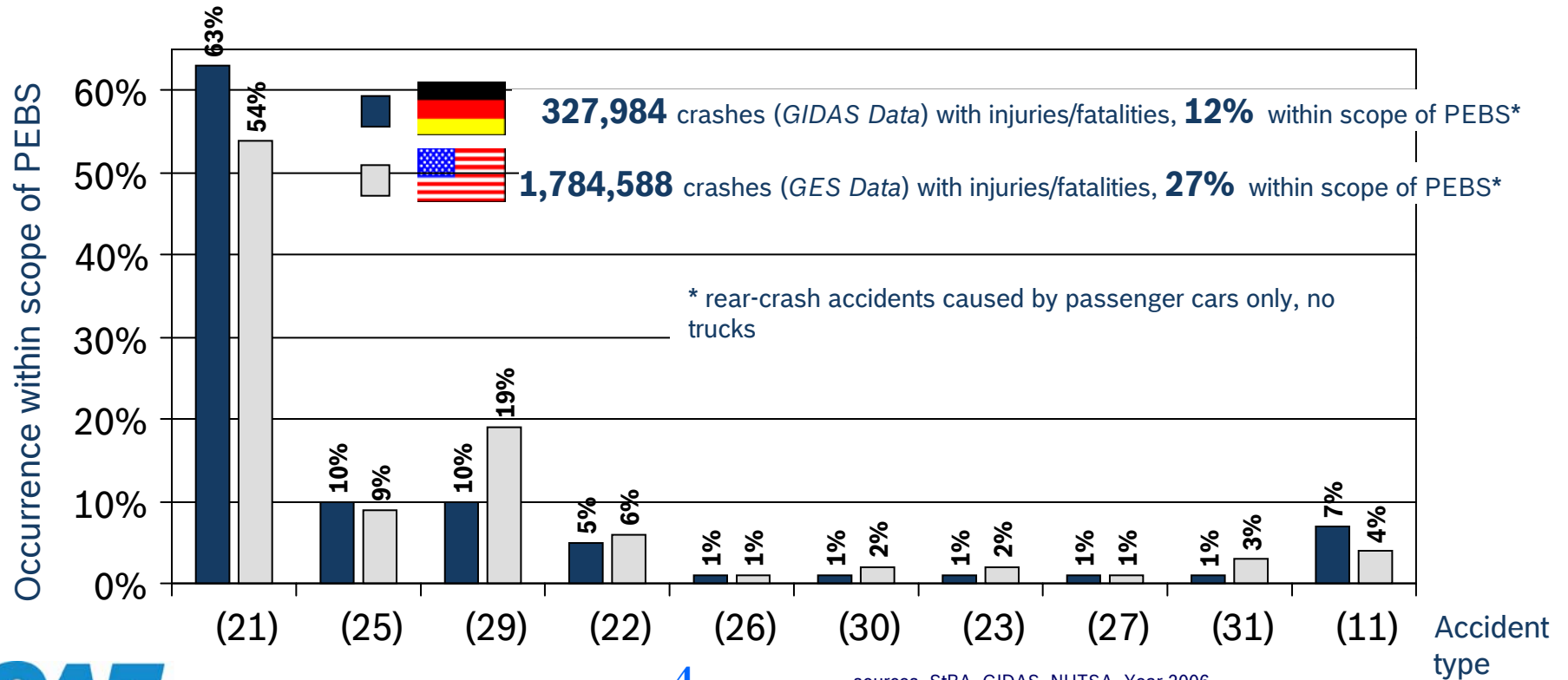
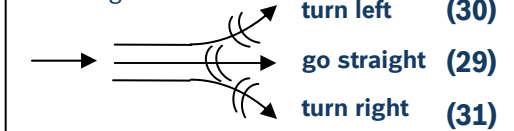
stopped vehicle
intending to...



slower vehicle
intending to...



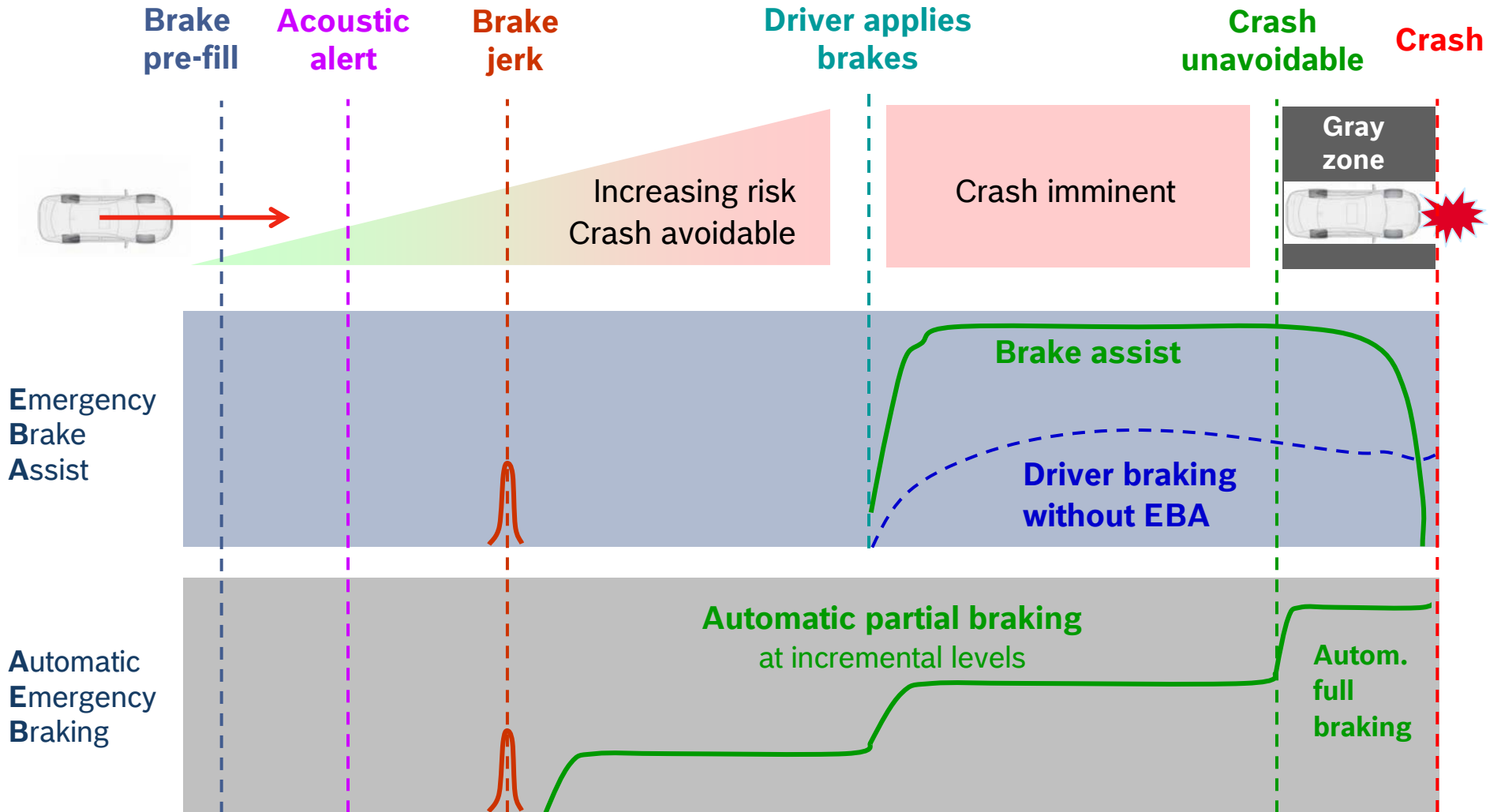
decelerating vehicle
intending to...



PEBS Functions - Video



PEBS – Concept Timeline



Benefit Analysis: Assessed Functions



PCW Predictive Collision Warning

- warning strategy including brake jerk
- driver monitoring to optimize warning strategy
- adapted system reaction for stationary objects

EBA Emergency Braking Assist

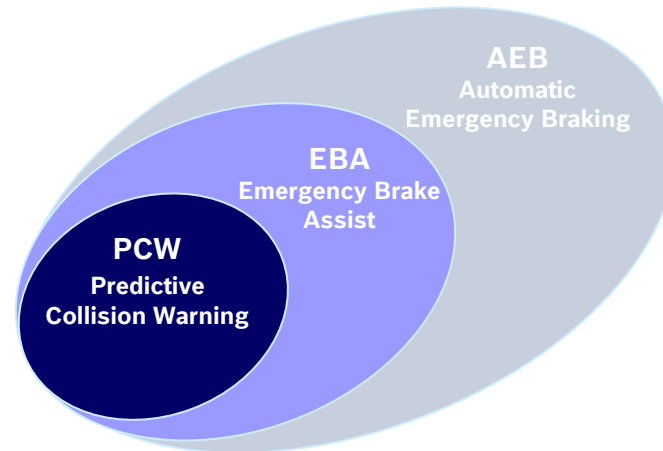
- includes PCW
- target braking for optimized brake support to avoid collision

AEB Automatic Emergency Braking

- includes EBA
- automatic partial braking
- automatic full braking when collision unavoidable

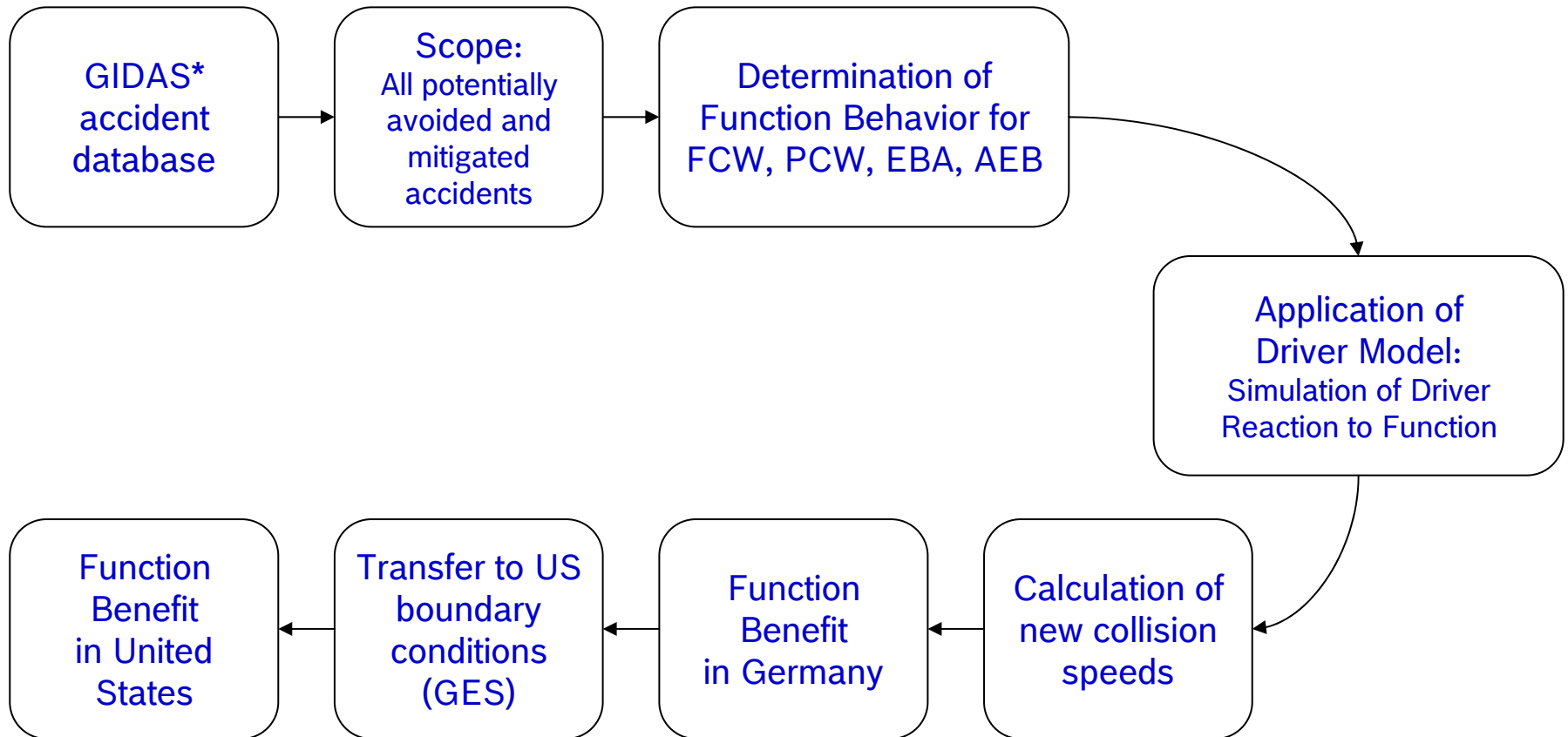
FCW Forward Collision Warning*

- acoustic/optical warning only at fixed point in time
- limited to good weather and to minimum vehicle speed



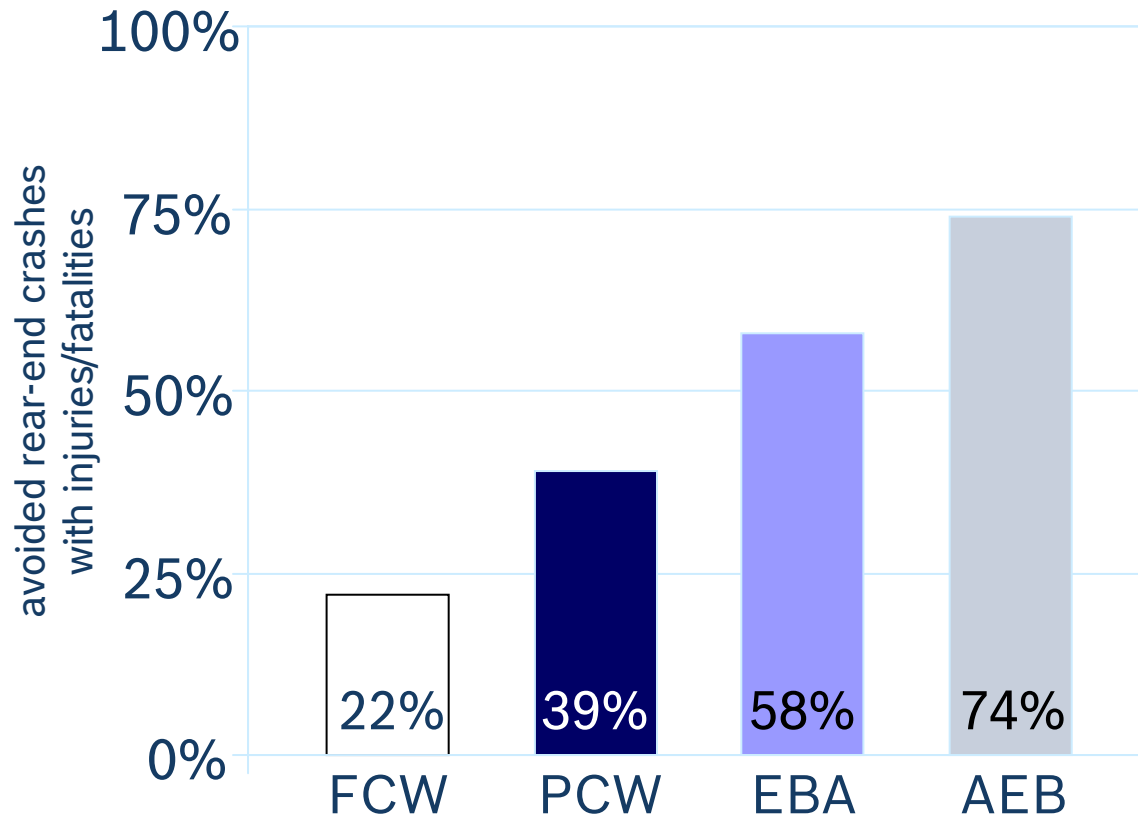
*Remark: For the following investigation an FCW realization is used that would just fulfill the requirements of the NHTSA FCW Confirmation Test.

Benefit Analysis - Procedure



* To date no US database available that contains all necessary accident related information for this examination.

Fraction of Avoided Rear-End Crashes with Injuries/Fatalities



Source: Bosch Analysis of GIDAS Database (2001-2005), modeled under idealized conditions

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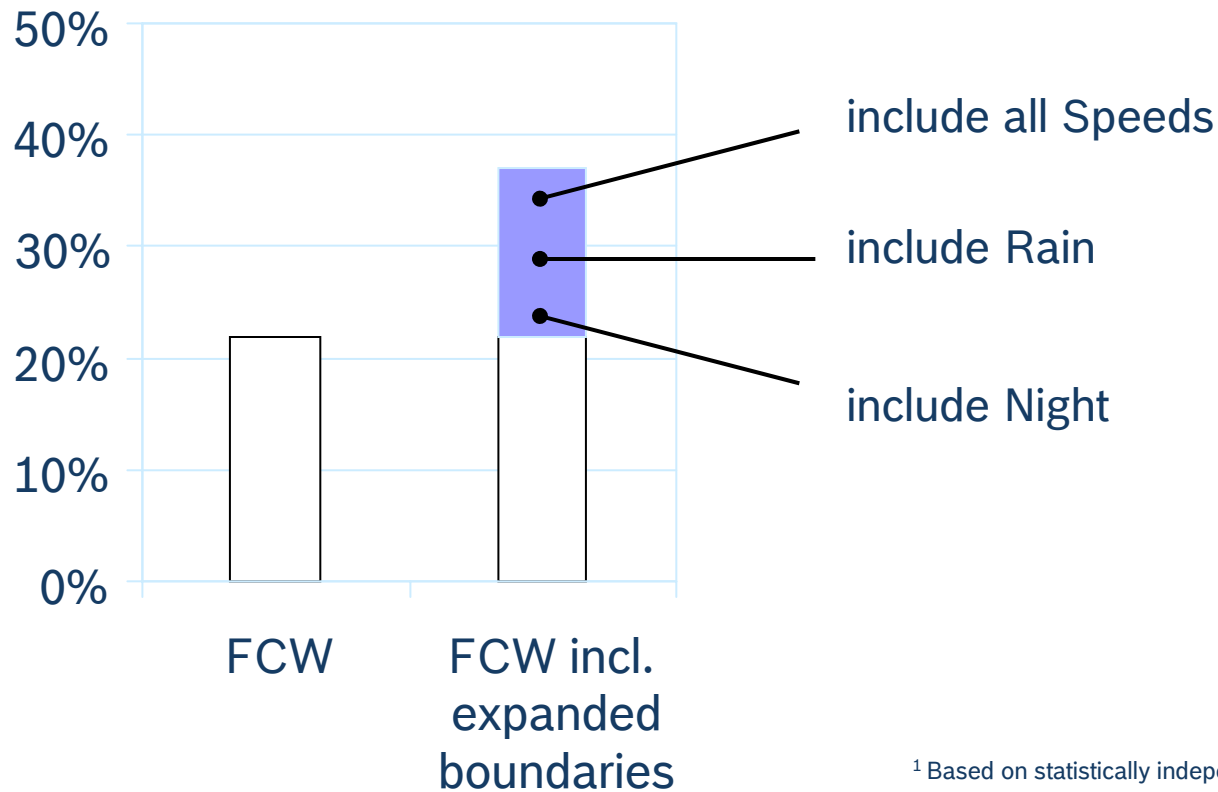
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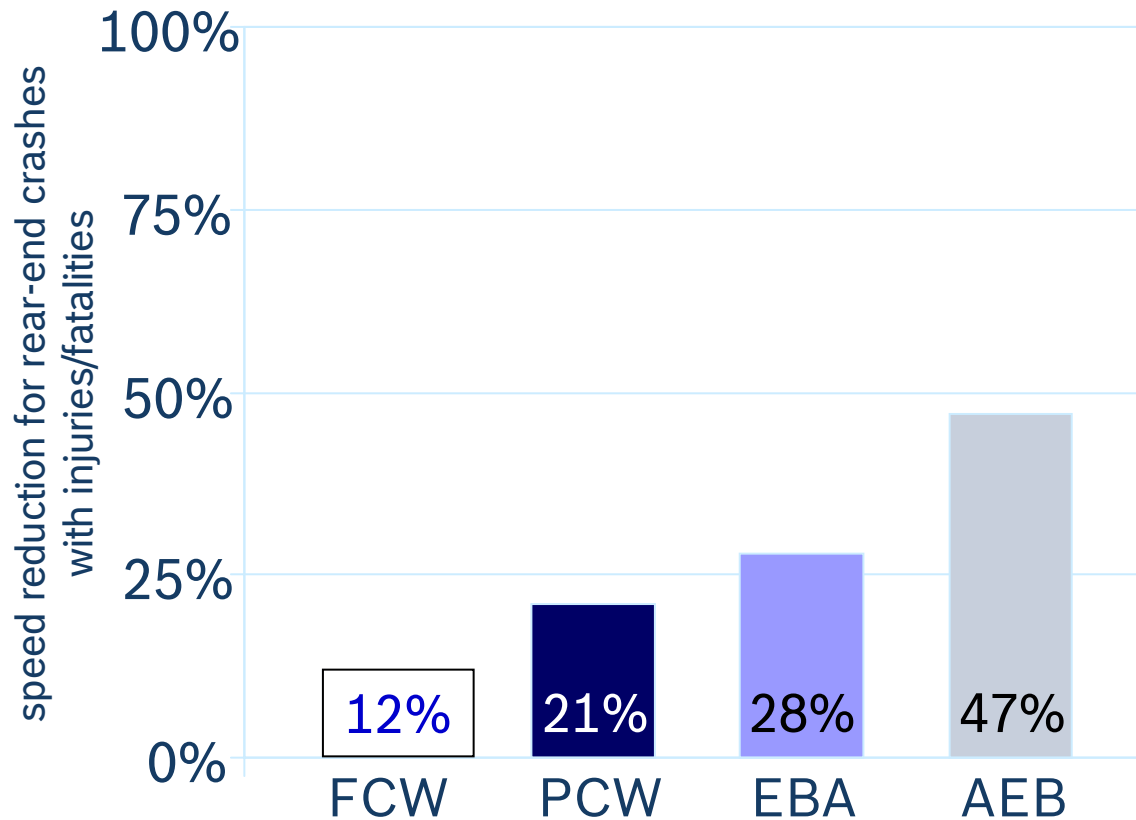
Detailed Comparison of FCW with Expanded Boundaries

Fraction of Avoided Rear-End Crashes with Injuries/Fatalities



¹ Based on statistically independent analysis

Average collision speed reduction (for unavoided accidents)



Source: Bosch Analysis of GIDAS Database (2001-2005), modeled under idealized conditions

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Summary

- Most Rear-End Collisions are due to inadequate driver braking and driver inattention.
- PEBS intervenes with driver warnings along with additional braking support, up to and including automatic partial & full braking.
- Driver warnings have the potential to reduce rear-end collisions. PEBS supported automatic braking will have additional benefit in mitigating/avoiding collisions
- Predictive Emergency Braking Systems have a high potential to prevent crashes & reduce road fatalities & injuries.
- In order to realize these benefits a high market penetration will be needed.