Intelligent Vehicle Safety Systems

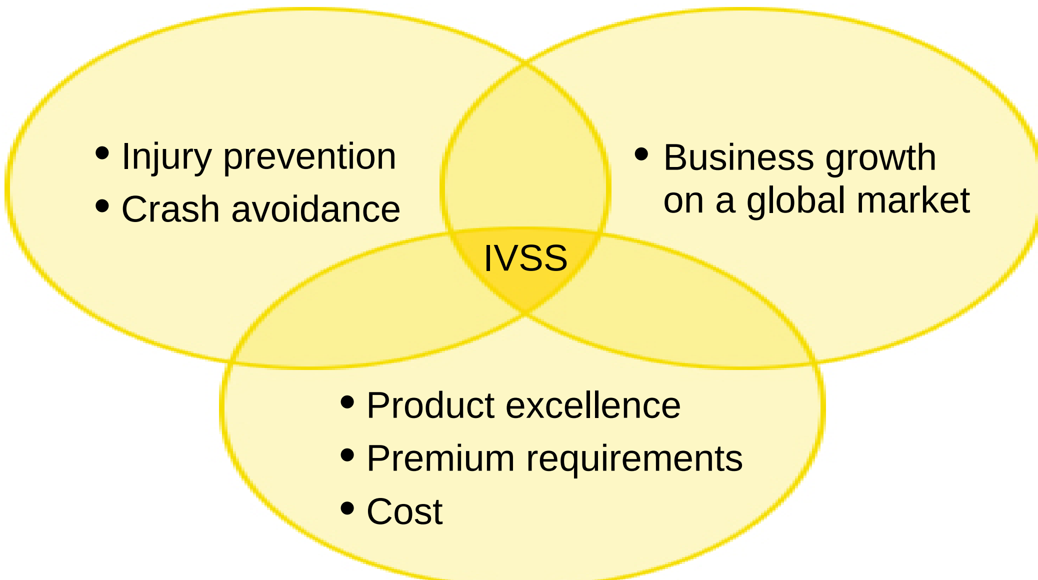
eIMPACT – Benefits and Costs of Intelligent Vehicle Safety Systems in Europe

IVSS Project Report

The IVSS Programme

The IVSS programme was set up to stimulate research and development for the road safety of the future. The end result will probably be new, smart technologies and new IT systems that will help reduce the number of traffic-related fatalities and serious injuries.

IVSS projects shall meet the following three criteria: road safety, economic growth and commercially marketable technical systems.



Three interacting components - for better safety, growth and competitiveness:

The human being

Preventive solutions based on the vehicle’s most important component.

The road

Intelligent systems designed to increase security for all road users.

The vehicle

Active safety through pro-active technology.

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1. Summary

IVSS are seen as having tremendous potential for reducing road fatalities, which were over 40,000 in 2005 in the EU. The eIMPACT project, "Socio-economic Impact Assessment of Stand-alone and Co-operative Intelligent Vehicle Safety Systems (IVSS) in Europe", assessed the socio-economic effects of Intelligent Vehicle Safety Systems (IVSS) and their impact on traffic, safety and efficiency. The project carried out impact assessments of twelve stand-alone and cooperative systems at the EU level, for 2010 and 2020. For each of these two future years, a scenario with a low penetration rate, reflecting no incentives to accelerate deployment, and a high penetration rate, including policy incentives for system deployment, was analysed.

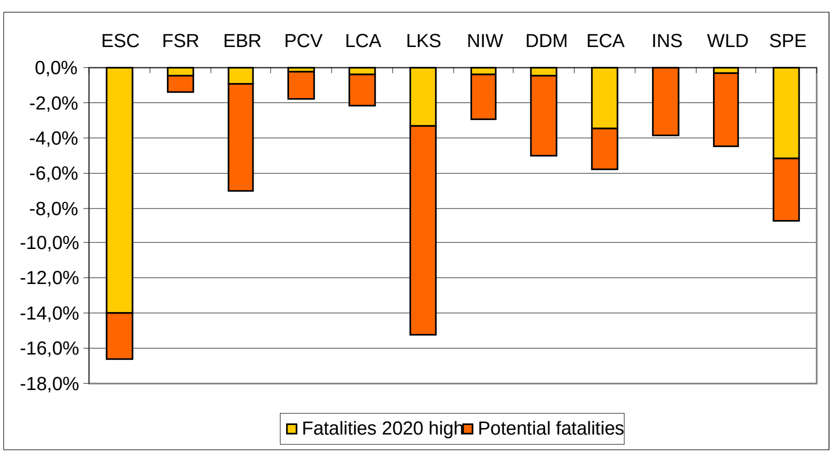
Systems Analysed in eIMPACT

Twelve promising systems were selected for analysis in eIMPACT (in brackets: the 3-letter abbreviation used in figures). Description of the systems can be found in Appendix 3 of the eIMPACT Final report.

1. Electronic Stability Control (ESC)
2. Full Speed Range ACC (FSR)
3. Emergency Braking (EBR)
4. Pre-Crash Protection of Vulnerable Road Users (PCV)
5. Lane Change Assistant (Warning) (LCA)
6. Lane Keeping Support (LKS)
7. NightVisionWarn (NIW)
8. Driver Drowsiness Monitoring and Warning (DDM)
9. eCall (one-way communication) (ECA)
10. Intersection Safety (INS)
11. Wireless Local Danger Warning (WLD)
12. SpeedAlert (SPE)

Highlights from the results:

All the IVSS investigated in eIMPACT show a great safety potential. The figure below shows the expected reduction in fatalities in the high penetration rate scenario in 2020 (yellow), as well as the full potential (red and yellow together) if all vehicles and roads would be equipped.



The figure shows that few systems are close to achieving their full potential; most are not. As a benchmark, each percentage reduction in fatalities represents approximately 230 fatalities. In the case of ESC in the 2020 high scenario, 3,250 fatalities would be avoided at the penetration rate of about 75%.

The figure also shows that no single system reduces the number of fatalities to zero at 100% penetration rate. In order to achieve the goal of "zero fatalities", it is not a matter of choosing either one system or the other. Rather, it is a combination of systems that will lead towards the vision of zero fatalities.

Cost-Benefit Analysis
On the basis of the benefit-cost ratios (BCR), the clear majority of the IVSS investigated in eIMPACT is distinctly profitable from the society point of view. For the year 2010, all systems already introduced – except Night Vision Warn which is close to 1 – are fairly above the BC-threshold of 1 which indicates the profitability of a system from the society point of view. *Electronic Stability Control* and *Lane Change Assistant* are the two systems which achieve BCR's of more than 3. In the year 2020 all twelve systems are available on the market. Again, the clear majority of the systems proves their profitability from the society point of view. The highest scoring system in terms of BCR is *Emergency Braking* which has a benefit-cost ratio of above 3. *Lane Change Assistant* and *Electronic Stability Control* have a BCR above 2 in all scenarios.

2. Sammanfattning

IVSS anses ha en oerhörd potential att minska dödsolyckorna på vägarna, vilka uppgick till över 40,000 år 2005 inom EU. Projektet eIMPACT, "Socio-economic Impact Assessment of Stand-alone and Co-operative Intelligent Vehicle Safety Systems (IVSS) in Europe", har bedömt de samhällsekonomiska konsekenserna av intelligenta fordonssäkerhetssystem (IVSS) och deras påverkan på trafik, säkerhet och effektivitet. Projektet genomförde effektbedömningar av tolv isolerade och samverkande system på EU-nivå för åren 2010 och 2020. För vart och ett av dessa två framtida målår analyserades ett scenario med en låg införandenivå för IVSS, som avses återspegla marknadsintroduktion utan politiska incitament, och en hög införandenivå, som förutsätter politiskt stöd för att accelerera implementeringen av IVSS på systemnivå.

System som analyserats i eIMPACT
Tolv lovande system valdes ut för bedömning i eIMPACT (inom parentes anges den 3-ställiga förkortningen som används i figurer och tabeller). Beskrivning av systemen finns i Appendix 3 i slutrapporten till eIMPACT-projektet (bilaga till denna rapport).

1. Electronic Stability Control (ESC)
2. Full Speed Range ACC (FSR)
3. Emergency Braking (EBR)
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9. eCall (one-way communication) (ECA)
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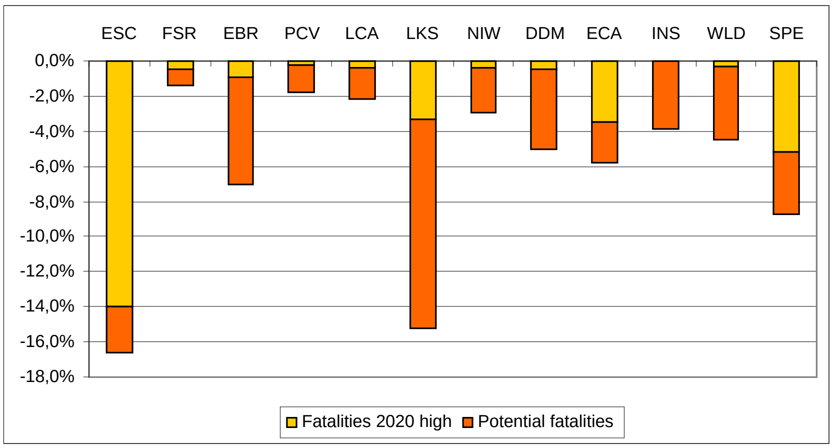
12. SpeedAlert (SPE)

Vikigare resultat
Alla fordonssäkerhetssystem som undersökts i eIMPACT uppvisar en stor säkerhets-potential. Bilden visar den förväntade minskningen i dödsfall vid hög införandenivå enligt scenariot för år 2020 (gult) jämte den potentiella reduktionen (rött och gult tillsammans) om alla fordon och vägar var fullt utrustade.



Bilden visar att bara några enstaka system är I närheten av att nå sin fulla potential; de flesta är tvärtom långtifrån. Som en tumregel gäller att varje procentenhet minskning av dödsfall motsvarar ca 230 färre dödade. När det gäller ESC (antisladdsystem) i scenariot för år 2020 är bedömningen att 3250 dödsfall skulle kunna undvikas vid en införande-grad i hela den europeiska fordonsparken på 75%.

Bilden visar också att inget enskilt system minskar antalet dödsfall till noll vid en 100%-ig införandegrad. För att nå en lång väg mot visionen om "noll döda I trafiken", handlar det inte om att välja det ena eller det andra systemet. Snarare gäller det att utnyttja en kombination av system som tillsammans kan bidra till att uppfylla delmål på väg mot nollvisionen.

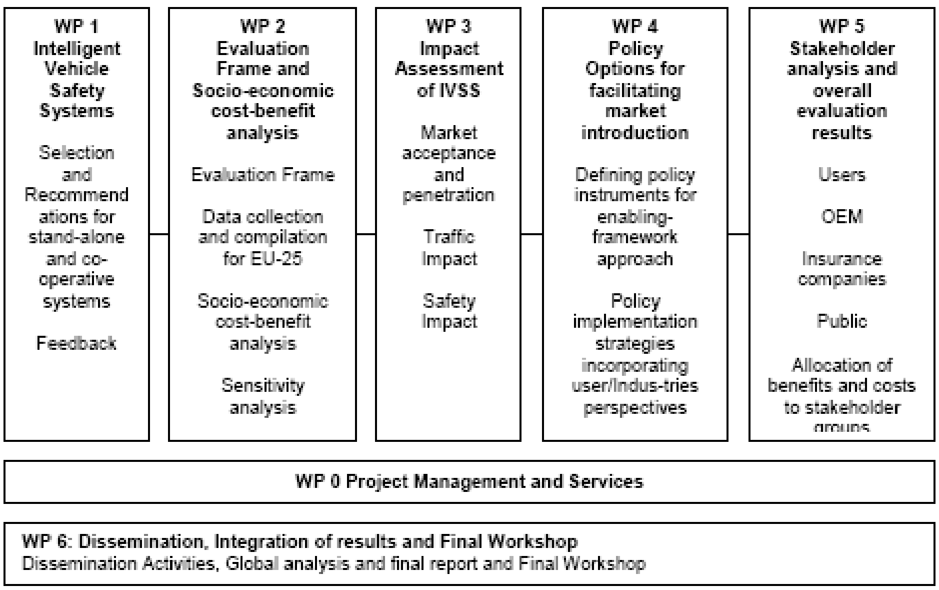
Nytto/kostnads-analys
Utifrån de beräknade nytto/kostnadskvoterna (brutto) så uppvisar de flesta av de IVSS-tillämpningar som undersökts i eIMPACT en tydlig lönsamhet ur ett samhällsperspektiv. När det gäller år 2010 så har alla system som väntas vara implementerade en nytto/-kostnadskvot som ligger ganska mycket over gränsen 1, vilket indikerar ett samhälls-ekonomiskt lönsamt system (utom Night Vision Warn som ligger strax under gränsen 1). *Electronic Stability Control* och *Lane Change Assistant* är de två system som når högst med en nytt/kostnadskvot på mer än 3. År 2020 väntas alla tolv system finnas på mark-naden. Även för detta år så är den samhällsekonomiska lönsamheten hög för de allra flesta av systemen. Högst lönsamhet har då *Emergency Braking* med en nytto/kostnads-kvot över 3. *Lane Change Assistant* och *Electronic Stability Control* har en kvot över 2 i alla scenarier.

3. The eIMPACT Project

3.1. Partners

The consortium consisted of 13 partners, representing Original Equipment Manufacturers (OEM's) and suppliers, public authorities, research institutes and universities, covering both the older and newer EU states, and bringing the required perspectives into the project.

The project started in January 2006 and finished in June 2008. It was divided into several workpackages.



The Swedish partner, Movea Trafikkonsult AB, was mainly involved in the Safety Impact Assessment (WP3) and in specifying the Evaluation Frame for the Socio-economic cost-benefit analysis (WP2).

3.2. Scope and structure

The main objectives of eIMPACT were:

- To carry out a socio-economic impact assessment of IVSS, based on a description of relevant IVSS, and their expected impacts on traffic safety and efficiency.
- To provide perspectives on the market introduction of IVSS, integrating the input from the impact analysis, policy options and stakeholder roles.

Intelligent Vehicle Safety Systems (IVSS) are seen as having tremendous potential for reducing road fatalities, which were over 40,000 in 2005 in the EU. ICT[1] systems such as ABS, cruise control, adaptive cruise control and electronic stability control (ESC) have been on the market for years, in some cases decades. The uptake of these systems varies; ESC has had a relatively quick uptake and now is present in approximately 40% of vehicles on the road. ACC on the other hand is installed on less than 1% of vehicles. To achieve safety goals, more vehicles need to be equipped. The deployment of the systems should be accelerated. To accelerate deployment, stakeholders such as road authorities, policy makers and industry want to know which systems should be chosen to be accelerated, and why? What are the benefits? Who do they benefit? Who should promote them, and how? Different stakeholders have different emphases. The eIMPACT project, "Socio-economic Impact Assessment of Stand-alone and Co-operative Intelligent Vehicle Safety Systems (IVSS) in Europe", addresses the need to quantify the effects of the systems in order to support decision-making about research, investments, deployment incentives, etc. eIMPACT is part of the EU's Sixth Framework Programme for Information Society Technologies and Media and supported by the Swedish IVSS programme.

The project carried out impact assessments of twelve stand-alone and cooperative systems at the EU level, for 2010 and 2020. For each of these two future years, a scenario with a low penetration rate, reflecting no incentives to accelerate deployment, and a high penetration rate, including policy incentives for system deployment, was analysed. Outputs include safety impacts in terms of reductions in fatalities, injuries and accidents, traffic effects in terms of direct (traffic flow) and indirect (reduction in congestion) effects, and the cost-benefit analysis (CBA) for the twelve systems. The CBA was extended by a stakeholder analysis, examining the costs and benefits incurred by users, industry and public authorities. Finally, policy options and strategies were explored for deployment strategies of IVSS.

eIMPACT produced an integrated set of quantitative impacts that can inform decision making on strategic orientation, innovation, investment, awareness, promotion and deployment activities by stakeholders. The exploration of possible policy options and strategies provides insight into what elements form a successful deployment strategy. Thus, eIMPACT supports the three pillars of the EC’s Intelligent Car Initiative (ICI), addressing stakeholders, research, and awareness-raising.

The guiding principles of the eIMPACT analyses reflect the information available to the partners at the time. Most of the systems analysed were not yet on the market, therefore little or no empirical information was available. The ex-ante analyses are based on the most recent empirical results, literature review and expert judgment available. The bases of findings are made as transparent as possible. Most importantly, the results can be improved when new findings from Field Operational Tests (FOTs), driving simulators and test tracks are made available.

[1] ICT = Information and Communication Technology

4. Project results

4.1. Systems analysed in eIMPACT

The twelve systems selected for analysis in eIMPACT reflect a threestep method, where all potentially beneficial systems were considered, the most promising systems were selected and a balanced choice was finally made. Firstly, eIMPACT developed an overview of the potential systems to be considered, based on the findings of EU projects. Secondly, the systems were ranked in a workshop with stakeholders, external experts and representatives of EU research projects on IVSS, using a multi-criteria assessment. The third and final step made use of the portfolio method to reduce the number of systems. In the portfolio method, eIMPACT chose a set of systems such that the set of systems:

- covers a range of time-to-market (present – 2020);
- covers both stand-alone and cooperative systems;
- covers systems addressing different types of functionality (longitudinal, lateral, etc.);
- reflects the ranking from the workshop.

The highest ranking systems were then chosen based on all of the criteria above.

The following twelve systems met the criteria above (in brackets: the 3-letter abbreviation used in tables and figures throughout this report):

1. Electronic Stability Control (ESC)
2. Full Speed Range ACC (FSR)
3. Emergency Braking (EBR)
4. Pre-Crash Protection of Vulnerable Road Users (PCV)
5. Lane Change Assistant (Warning) (LCA)
6. Lane Keeping Support (LKS)
7. NightVisionWarn (NIW)
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10. Intersection Safety (INS)
11. Wireless Local Danger Warning (WLD)
12. SpeedAlert (SPE)

The Deliverable, “Stand-alone and co-operative Intelligent Vehicle Safety Systems – Inventory and recommendations for in-depth socioeconomic impact assessment,” (D2, [Vollmer et al., 2006]) documents the selection process.

4.2. Methodologies

The integrated approach used engineering, demographical, economic, psychological and behavioral views in the analyses. With respect to the individual analytical approaches:

- The safety impact analysis made use of nine mechanisms to address all possible effects of IVSS. The mechanisms cover exposure, crash risk and consequences, including intended and unintended impacts and “positive” and “negative” impacts. After choosing a main factor out of a possible 6 from the accident data, such as collision type, junction, weather conditions, this information was combined with the frequency of road and weather conditions in the accident data, and applied to the eIMPACT accident trend data for 2010 and 2020 to produce quantified estimates of the reductions in the number of accidents, fatalities and injuries.
- The traffic impact analysis took into account both the direct effects, e.g., changes in speeds and headways, and indirect traffic effects in terms of reduced congestion due to avoided accidents with fatalities and injuries.
- The socio-economic impact assessment is a comprehensive framework which integrated the assessment framework to show the profitability of the IVSS on a societal level.
- The stakeholder analysis extended the results of the costbenefit analysis by exploring a wider socio-economic perspective on key interest groups: system users, OEMs and suppliers, the insurance industry and public authorities.
- The policy analysis identified the key elements for a successful market introduction. It also developed a methodology for support policy development for accelerated market introduction.

These methodologies were developed and applied to systems not yet on the market. The project demonstrated the usefulness of the approach itself, as well as the potential value of the systems not yet on the market.

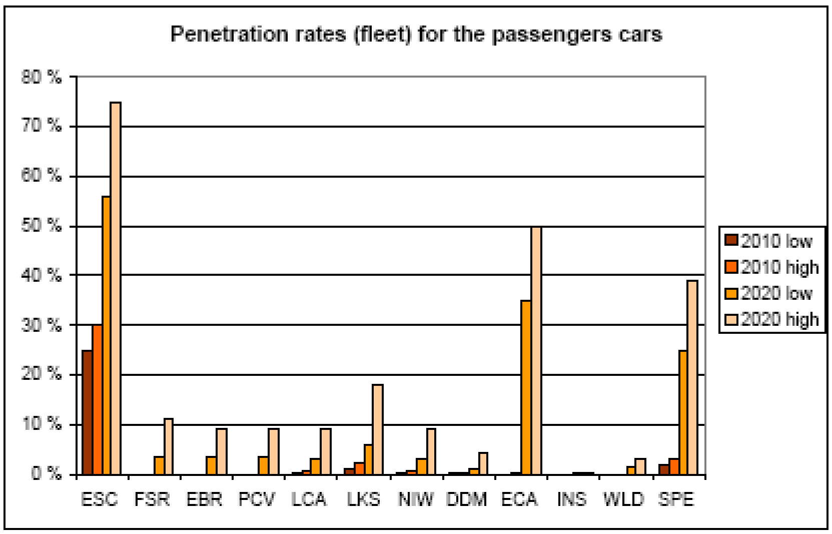
4.3. Safety impact

eIMPACT applied the methodologies to produce quantitative results for the safety and traffic impacts and costs and benefits of twelve IVSS for the EU for 2010 and 2020. For this, an estimate of the accident trend for the years 2010 and 2020, as well as the estimation of penetration rates of systems for these years had to be made.

The estimated numbers of fatalities in 2010 (33,900) and 2020 (20,800) form the “accident base”, to which the changes in the number of fatalities are applied (a similar process is followed for the injuries). In the accident base for 2010 and 2020, the effect of the ESC systems currently on the market has been accounted for. Only in the quantification of the effects of ESC itself has a larger accident base been used (to exclude the effects of ESC), in order to show the impact of ESC in a realistic way.

The safety and traffic impacts and benefit-cost ratios (BCRs) of IVSS are related to the number of kilometers driven with equipped vehicles on equipped roads. For this reason, eIMPACT undertook a three-step process to determine the number of equipped kilometers that were driven in 2010 and 2020.

In step 1, the penetration rates for each system for passenger cars and goods vehicles were estimated for 2010 and 2020. This rate reflects both vehicle equipment (and road equipment, if appropriate) and retrofits of vehicles, for systems where that was possible. The first scenario represents the "Business as usual" scenario, that is, one without incentives to promote IVSS. In contrast, a "high" scenario for each target year was developed, assuming that policies to accelerate deployment of IVSS are undertaken. This scenario reflects a higher penetration rate. The figure below shows the penetration rates for passenger cars for the 2010 and 2020 low and high scenarios. Penetration rates were also determined for goods vehicles and busses.



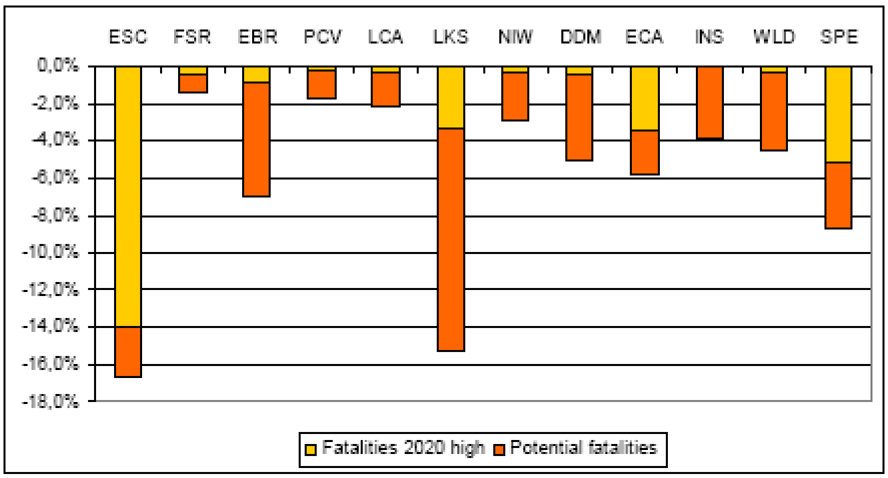
The second step translated the estimates for new vehicles to the fleet penetration rates for the whole vehicle fleet in the years 2010 and 2020, on the basis of current vehicle fleet age distributions in each member state.

The third step produced the number of kilometers driven by equipped vehicles on equipped infrastructure, an important input for impact assessments. The calculation convoluted the distribution of vehicles by age and the distribution of annual vehicle kilometers by vehicle age.

All the IVSS investigated in eIMPACT show a great safety potential. The next figure shows the expected reduction in fatalities in the high penetration rate scenario in 2020 (yellow), as well as the potential reduction (red and yellow together) if all vehicles and roads would be equipped. This figure shows that few systems are close to achieving their potential; most are not. As a benchmark, each percentage reduction in fatalities represents approximately 230 fatalities. In the case of ESC in the 2020 high scenario, 3,253 fatalities would be avoided at the penetration rate of about 75%.

The following table contains the absolute numbers of fatalities and injuries avoided for all scenarios. The 14% reduction in fatalities by Electronic Stability Control in the 2020 high scenario from the figure corresponds to the 3,253 avoided fatalities in the 2020 high scenario in the summary table.

For the cooperative systems using infrastructure, eCall and Intersection Safety, the potential case only is shown. Among the group of the twelve selected IVSS, Electronic Stability Control, Lane Keeping Support and SpeedAlert show the highest absolute numbers in avoiding fatalities and injuries at the estimated penetration rates. The potential of eCall (implying 100% penetration for a fair distribution of infrastructure equipment costs) represents also a significant reduction of fatalities and severe injuries. The difference in penetration rate explains the large differences between the 2020 high scenario and the potential scenario for some systems, such as the Lane Keeping System.



This figure also shows that no single system reduces the number of fatalities to zero at 100% penetration rate. In order to achieve the goal of "zero fatalities", it is not a matter of choosing either this system or that one. Rather, it is a combination of systems together with traditional safety measures that will lead towards the vision of zero fatalities.

	Fatalities				Injuries			
	2010		2020		2010		2020	
	low	high	low	high	low	high	low	high
ESC	1,914	2,240	2,577	3,253	32,792	38,265	41,549	52,182
FSR	n.a.	n.a.	49	101	n.a.	n.a.	3,668	9,774
EBR	n.a.	n.a.	72	193	n.a.	n.a.	4,241	10,925
PCV	n.a.	n.a.	14	39	n.a.	n.a.	718	1,918
LCA	2	11	33	86	264	1,189	3,449	8,596
LKS	56	149	197	678	1,420	3,784	5,109	17,296
NIW	2	10	30	73	87	367	1,046	2,542
DDM	4	13	20	94	153	367	682	2,715
ECA	*1,955*		*1,199*		*severe: 13,691* *slight: -15,647*		*severe: 8,398* *slight: -9,598*	
INS	*n.a.*		*803*		*n.a.*		*63,700*	
WLD	n.a.	n.a.	29	66	n.a.	n.a.	989	1,906
SPE	77	119	753	1,076	2,405	3,463	24,643	34,887
Base	33,895		20,791		1,409,415		873,695	

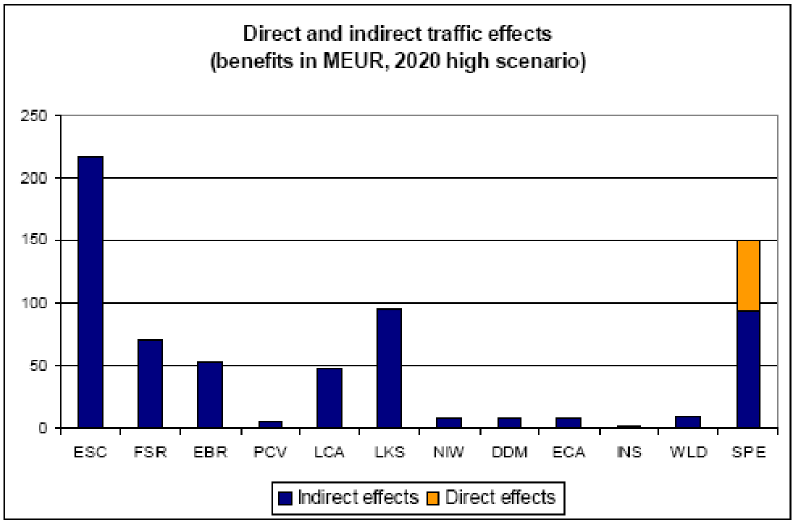
4.4. Traffic impact

With eIMPACT's focus on safety systems, only five of the twelve systems were expected to produce direct traffic effects. All twelve systems produced indirect traffic effects, due to the reduction in the number of accidents. Traffic impacts were modest compared to safety impacts at the estimated penetration rate. This is logical because the systems are primarily designed to improve traffic safety.

In general, the analyses showed that safety systems have no negative effect on traffic flow (direct effects) at the penetration rates examined in eIMPACT.

All systems produce effects locally (on a cross-section), due to change in speed, earlier braking, increased headways, and change in gap acceptance. The effects on the network level are very small to negligible, primarily due to the low penetration rates and the fact that the local effects of IVSS are cancelled out by other traffic flow characteristics (e.g. delays at traffic lights). Only SpeedAlert showed a slight increase in overall travel times on rural roads due to the speed reduction.

The indirect traffic effects (at estimated penetration rates) were more substantial. Positive benefits were found for all systems. The greatest effects were found for systems that are effective on all road types (especially motorways) and in high density traffic (when accidents are most likely to cause congestion).



The figure above shows the value of the direct (yellow) and indirect (blue) traffic effects for the 2020 high scenario, expressed in millions of euros. All systems had positive indirect effects, as a result of the reduced accidents resulting in reduced congestion. The chart also shows that only SpeedAlert had direct traffic effect. The negative effect of slightly longer travel times was offset by positive environmental effects due to lower speeds. In monetary terms, it was a relatively small effect.

4.5. Costs and benefits

On the basis of the benefit-cost ratios, the clear majority of the IVSS investigated in eIMPACT is distinctly profitable from the society point of view.

The next table provides an overview of the benefit-cost ratios for all scenarios at the estimated penetration rates and share of driven kilometres with the systems. For eCall and Intersection Safety – which both require infrastructure investment – the benefit-cost ratio is displayed only for the potential case (equipment of the total vehicle fleet, 100% penetration) for reasons of a fair allocation of infrastructure investment costs.

	2010		2020	
	low	high	low	high
ESC	4.4	4.3	3.0	2.8
FSR	n.a.	n.a.	1.6	1.8
EBR	n.a.	n.a.	3.6	4.1
PCV	n.a.	n.a.	0.5	0.6
LCA	3.1	3.7	2.9	2.6
LKS	2.7	2.7	1.9	1.9
NIW	0.8	0.9	0.7	0.6
DDM	2.5	2.9	1.7	2.1
ECA	2.7		1.9	
INS	n.a.		0.2	
WLD	n.a.	n.a.	1.8	1.6
SPE	2.2	2.0	1.9	1.7

n.a. not available

Looking at the results for the year 2010, all introduced systems – except NightVisionWarn which is close to 1 – are fairly above the BC threshold of 1 which indicates the profitability of a system from the society point of view. Electronic Stability Control and Lane Change Assistant are the two systems which achieve BCR's of more than 3. The result of 4.4 for Electronic Stability Control implies that every spent Euro leads to societal benefit of 4.40 Euro. Four systems are above 2: Lane Keeping Support, Driver Drowsiness Monitoring and Warning, eCall and SpeedAlert. NightVisionWarn is around 1. The other systems are not available on the market or have no significant market penetration in the year 2010.

In the year 2020 all twelve systems are available on the market. Again, the clear majority of the systems prove their profitability from the society point of view. The best system is Emergency Braking which has a benefit-cost ratio of above 3. Lane Change Assistant and Electronic Stability Control are in both scenarios above 2. Six systems have a BCR of between 1.5 and 1.9: eCall, Lane Keeping Support, Driver Drowsiness Monitoring and Warning, Full Speed Range ACC, Wireless Local Danger Warning and SpeedAlert. The remaining systems are below 1 under the estimated conditions: NightVisionWarn, Pre-Crash Protection of Vulnerable Road Users and Intersection Safety. However, no premature conclusions should be drawn about the profitability of those systems. The result only indicates that from the society point of view they are less efficient than other systems and they are not efficient under the current estimated conditions. However, as the functionality of the system may be enriched or system costs will decline in the future, the benefit-cost ratio may be significantly higher.

Sensitivity analyses can provide some indication on this effect. Moreover, it might also be the case that parts of the benefit (i.e. higher driving comfort) are not properly reflected in the framework of the cost-benefit analysis because the CBA focus is limited to savings of productive resources, whereas comfort effects represent a subjective benefit. Hence, it is necessary to carry out stakeholder analyses from the user perspective in order to explore benefits beyond CBA.

4.6. Stakeholder analysis

Break-even analyses and the assessment of wider economic effects were used in the stakeholder analysis.

The break-even analyses for system users reveal that the pay-off period of investing in IVSS depends largely on the kilometers driven per year. Since frequent drivers are more exposed to safety risks, systems which avoid driving conflicts or mitigate the consequences are more attractive to them. At least for the 2020 high scenario, all systems reach the break-even point within the average vehicle lifetime which is assumed to 12 years throughout the eIMPACT project.

The comparison between IVSS shows that mature systems and systems with rather low market prices (e.g. Electronic Stability Control, eCall) perform better in the break-even analysis than other systems.

4.7. Policy options

In the eIMPACT project, a list of policy options for accelerated deployment was compiled; also, different stakeholders ranked the policy options (use, perceived effectiveness, and feasibility). The analysis of the policy options showed that there is no single ideal strategy to promote all selected IVSS. This is because there are different stakeholders involved per IVSS, mainly depending on whether the system is stand alone or cooperative, available on the market or near market introduction, factory-fitted or after market. In addition to these factors, whether there is an attractive business case for the stakeholder that bears the main financial load of a strategy is also crucial. It is more important to find a combination of instruments that all relevant stakeholders can agree on than merely selecting a number of instruments that are perceived to be the most effective ones.

Recommendations to progress towards a strategy to promote IVSS from the key elements that have been identified are:

- Do not try to create a uniform strategy to promote IVSS.
- Focus on a jointly agreed upon bundle of instruments to be used by all relevant stakeholders for a specific system.
- Round table discussions for stakeholders should take place on a regular basis.
- The methodology described and applied in eIMPACT can serve as a basis, to acquire empirical data regarding evaluation parameters from a stakeholder specific perspective, for the round table discussions.
- One organization or stakeholder should take the lead in organizing this process. A possible organization could be eSAFETY.

4.8. Conclusions and recommendations

eIMPACT has contributed valuable knowledge about the types and magnitude of the benefits for twelve IVSS. eMPACT developed complete, exhaustive and integrated methodologies for socio-economic impact assessment, exploration of policy options, and extension of the CBA to stakeholder analysis. There were applied successfully in the project to produce an integrated impact assessment of twelve IVSS. The approach can be used in the future to assess other stand-alone and cooperative IVSS as well as other ICT systems. The methodologies can be applied to safety systems as well as systems that may have other primary effects.

New information available in the future can be used to improve the estimates provided by eIMPACT. For example, Field Operational Tests in Europe, Japan and the US can provide valuable empirical data about driver behavior, attitudes, risk, exposure willingness to pay and cost data needed for evidence, improved assessments and systems. Such information can be used to improve the impact assessments of systems such as those addressed by eIMPACT.

Furthermore, the eIMPACT accident trend forms an important input to the safety impact assessment and the CBA. Improved accident forecasts can also produce more accurate safety impact estimates and CBA. Future accident trend forecasts can be improved by continued efforts toward a unified EU general accident database in which definitions (e.g. injuries, road types, etc) are harmonized across the EU. These continued efforts should begin to take into account the potentials of new safety systems in the road safety prognoses.

5. Contribution to IVSS objectives

5.1. Traffic safety

The information about the safety impacts can be used as an indicator to compare IVSS and define the sequence of introduction of IVSS. Outputs of eIMPACT project provide the opportunity to help the EU national governments to improve the traffic safety also by deploying intelligent systems. Safety analysis also supports the attitude that is needed to spur innovation in the area of constructing vehicles and using them on roads. Knowledge of intelligent systems in the area of traffic safety gives us also the opportunity to inform the users in EU countries about advantages of these systems.

5.2. Global business growth

The results will influence the research and development strategies of OEMs and suppliers. The tools developed in eIMPACT will help to improve the evaluation of further IVSS. There is no dedicated time horizon, because eIMPACT experience, results and evaluation tools will influence the current development of IVSS and components.

The results will be applied to make strategies to develop and deploy future advanced driver assistance systems, cooperative systems for safety and related marketing concepts. The exploitation patterns of industry have to consider the maturation of the used technologies and the options to bundle systems for the deployment of future IVSS.

5.3. Competitiveness

Industry will exploit the methodology of impact assessment and the methodology to calculate benefit-cost ratios. The break-even analyses will be adapted to support the a priori evaluation of future safety systems and the estimation of the impact of the related business cases. In particular these methodologies are expected to be applied both to ADAS systems and to cooperative systems for road safety that will be based on the communication among vehicles and the infrastructure.

Some of eIMPACT results will form a knowledge base which can help in other projects focussing on IVSS and their role in driving habits, drivers behaviour, traffic safety and new trends in this area. Experience concerning the traffic and safety impacts of IVSS can be used to enhance and focus European and national R&D programs. Experience concerning the costs and benefits of IVSS can be used to improve decision-making concerning IVSS (policies, strategies and funding) in the Public sector.

6. List of deliverables

eIMPACT deliverables and internal reports:

Alkim, T., H. Baum, J.A Bühne, T. Geißler, K. Roßrucker, A. Schirokoff, C. Vitale, and V. Zehnalova (2008), *Policy Option Framework for promotion of Intelligent Vehicle Safety Systems,* Deliverable D5 of the eIMPACT project, contract no. 027421, 2008.

Alkim, T., H. Baum, J.A Bühne, T. Geißler, K. Roßrucker, E. Aittoniemi, A. Schirokoff, C. Vitale, and V. Hamernikova (2008), *Policy recommendations to promote selected Intelligent Vehicle Safety Systems,* Deliverable D7 of the eIMPACT project.

Assing, K., H. Baum, J.A. Bühne, T. Geißler, S. Grawenhoff, H. Peters, W. Schulz, U. Westerkamp (2006), *Methodological framework and database for socio-economic evaluation of Intelligent Vehicle Safety Systems,* Deliverable D3 of the eIMPACT project.

Baum, H., T. Geißler, U. Westerkamp and C. Vitale (2008), *Cost-Benefit Analysis for stand-alone and co-operative Intelligent Vehicle Safety Systems*, Deliverable D6 of the eIMPACT project.

Kulmala, R., A. Schirokoff, P. Rämä,, Niina Sihvola (2008), *Safety Impacts of Stand-alone and Cooperative IVSS,* WP3300 internal report of the eIMPACT project.

Malone, K., I. Wilmink, G. Noecker, K. Roßrucker, R. Galbas and T. Alkim, *Final Report and Integration of Results and Perspectives for market introduction of IVSS,* Deliverable D10 (incl. D9) of the eIMPACT project.

Schirokoff, A., P. Rämä, N. Sihvola, R. Kulmala (2008), *Scenarios for market acceptance and penetration*, WP3100 internal report of the eIMPACT project.

Vollmer, D., H. Baum, M. Fausten, T. Geißler, K. Malone, W. Schulz (2006), *Stand alone and co-operative Intelligent Vehicle Safety Systems - Inventory and recommendations for in-depth socioeconomic impact assessment*, Deliverable D2 of the eIMPACT project.

Vollmer, D., H. Grezlikowski & G. Noecker (2007), *TCD/ TEDS Proband-Experiment – Analyses*, working document, Daimler, January 2007.

Wilmink, I., E. Jonkers, K. Malone, M van Noort, G. Klunder, R. Landman, D. Vollmer, T. Benz, (2008), *Traffic impacts of stand-alone and cooperative Intelligent Vehicle Safety Systems (IVSS),* WP3200 internal report of the eIMPACT project.

Wilmink, I., W. Janssen, E. Jonkers, K. Malone, M van Noort, G. Klunder, P, Rämä, N. Sihvola, R. Kulmala, A. Schirokoff, G. Lind, T. Benz, H. Peters and S. Schönebeck, (2008), *Impact Assessment of Intelligent Vehicle Safety Systems*, Deliverable D4 of the eIMPACT project.

IVSS partners: