

UN ECE GRRF TPMS

Draft Cost / Benefits Analysis TPMS for M1 Vehicles

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Overview

- Effect of underinflation & TPMS benefits on:
 - Fuel consumption
 - Tyre wear

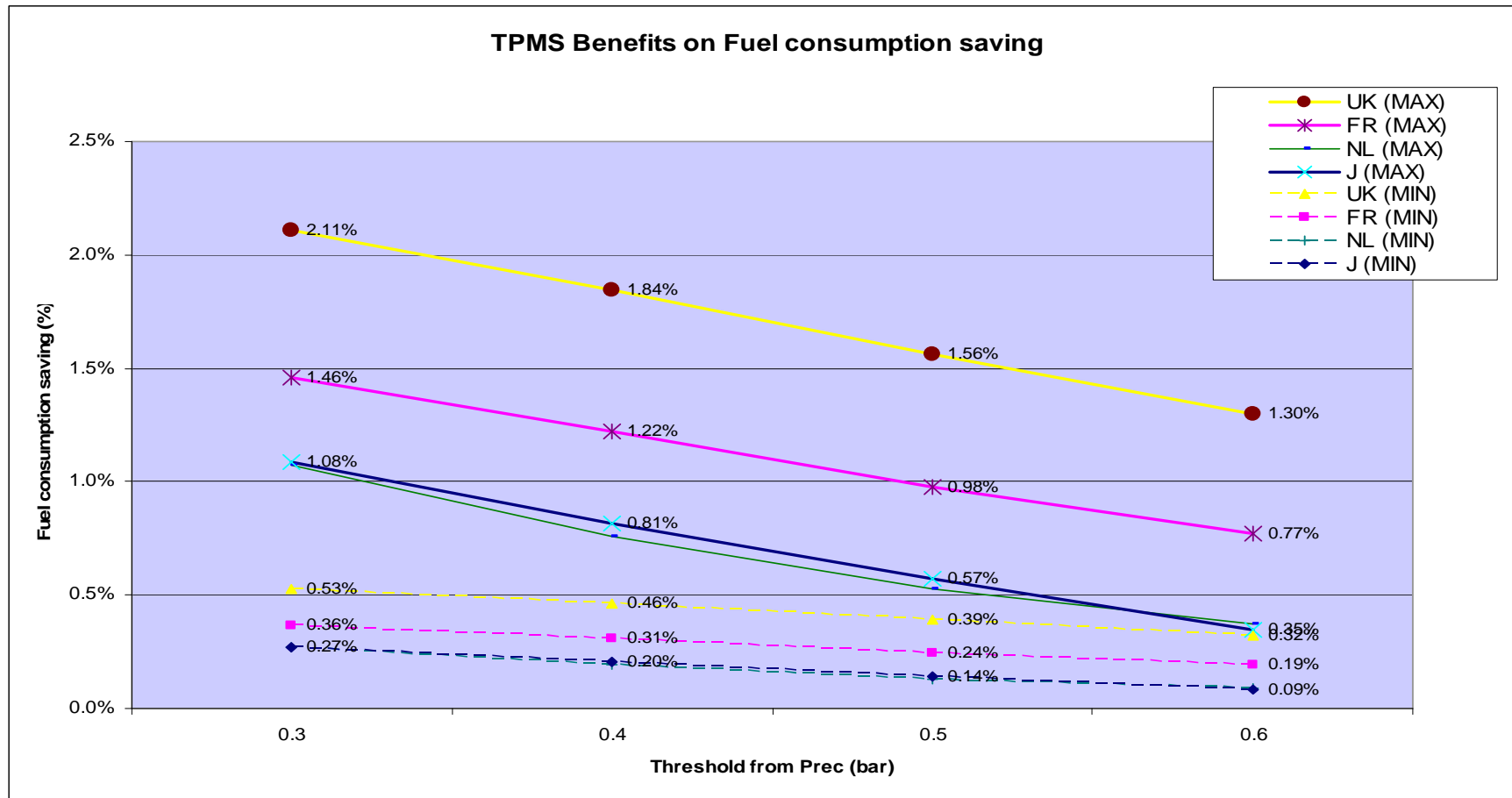
- Individual benefit impact
- Macro-economic benefit review
 - CO₂, Fuel & Tyre wear
 - Safety

- Cost/Benefit ratio

TPMS benefits on CO2 emissions and fuel consumption

TPMS benefits on fuel consumption in Europe & Japan

- The following graph calculated using Clepa theoretical method (which has been recognized as providing results more conservative than the Oical method comparing actual TPMS/No TPMS populations), shows the TPMS benefits in terms of fuel saving for different thresholds and across the population studied:



- Note: Straight lines represent max value (factor 2)
Dashed lines represent min value (factor 0.5)

TPMS benefits on fuel consumption in Europe & Japan

– Summary table:

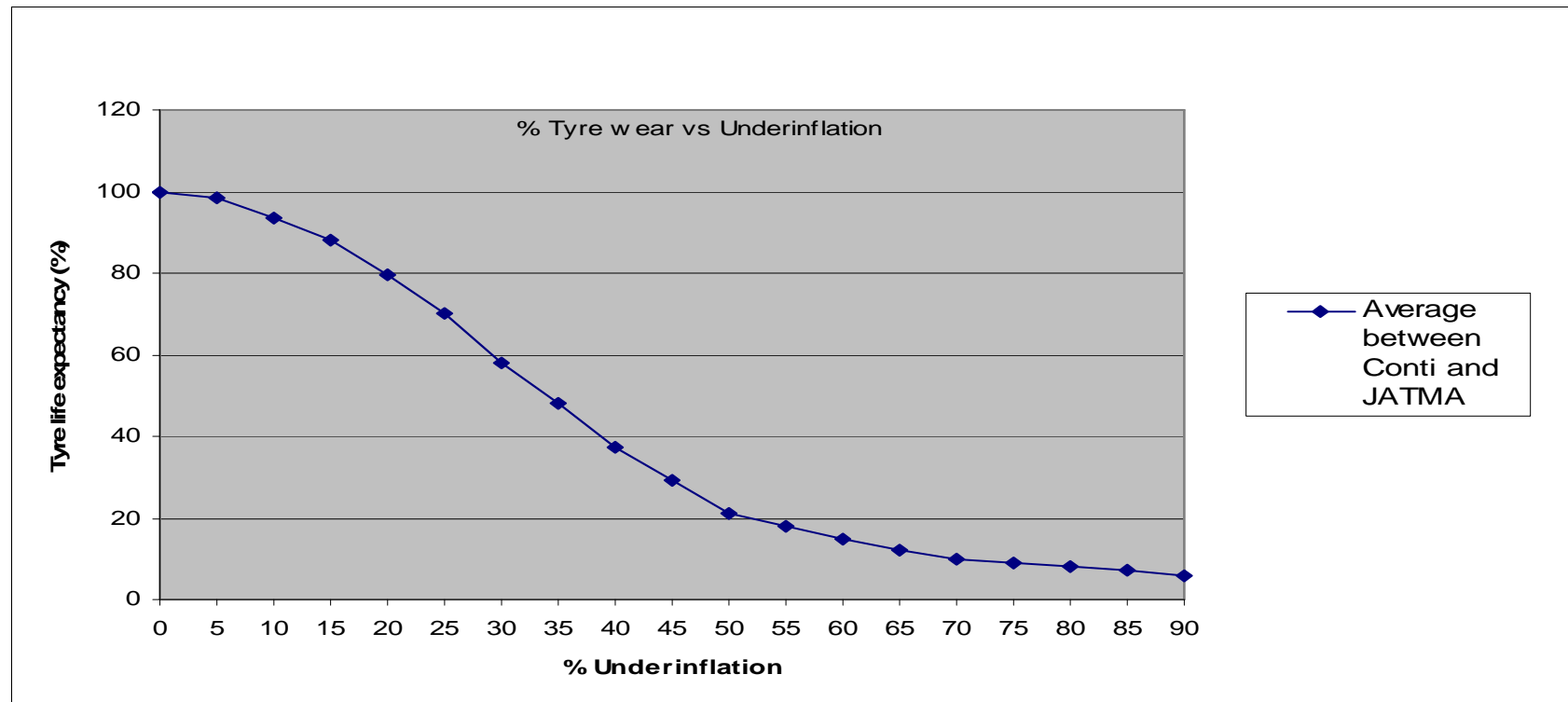
Japan	Threshold 0.3 bar from Prec	Threshold 0.4 bar from Prec	Threshold 0.5 bar from Prec	Threshold 0.6 bar from Prec
MIN (factor 0.5)	0.27%	0.20%	0.14%	0.09%
MAX (factor 2)	1.08%	0.81%	0.57%	0.35%
NL	Threshold 0.3 bar from Prec	Threshold 0.4 bar from Prec	Threshold 0.5 bar from Prec	Threshold 0.6 bar from Prec
MIN (factor 0.5)	0.27%	0.19%	0.13%	0.09%
MAX (factor 2)	1.07%	0.76%	0.53%	0.37%
FRANCE	Threshold 0.3 bar from Prec	Threshold 0.4 bar from Prec	Threshold 0.5 bar from Prec	Threshold 0.6 bar from Prec
MIN (factor 0.5)	0.36%	0.31%	0.24%	0.19%
MAX (factor 2)	1.46%	1.22%	0.98%	0.77%
UK	Threshold 0.3 bar from Prec	Threshold 0.4 bar from Prec	Threshold 0.5 bar from Prec	Threshold 0.6 bar from Prec
MIN (factor 0.5)	0.53%	0.46%	0.39%	0.32%
MAX (factor 2)	2.11%	1.84%	1.56%	1.30%

Conclusion :
 Using Clepa theoretical method, maximum fuel saving achieved with a threshold at 0.3b :
 ranging from 0.3 % to 2.1 %
 across the populations

Effect of Under-inflation & TPMS benefits on Tyre wear

Effect of Underinflation on tyre wear – Calculation Method

- In order to calculate the effect of underinflation on tyre wear, the TF agreed to use the following graph as base of calculation.
- The graph is referenced on approved data received from Tyre Industry and JATMA.



Effect of Underinflation on tyre wear – Calculation Method

- Using the raw data of the 4 populations studied (UK, NL, France & Japan), the contribution of underinflated tyres to excessive tyre wear could be estimated.
- Since the graph on previous slide is based on relative Pressure delta, it was adjusted for different placard in order to take into account Prec for each population.
- The figures in terms of tyre wear savings can then be given for each underinflation degree, starting at 0.3b.

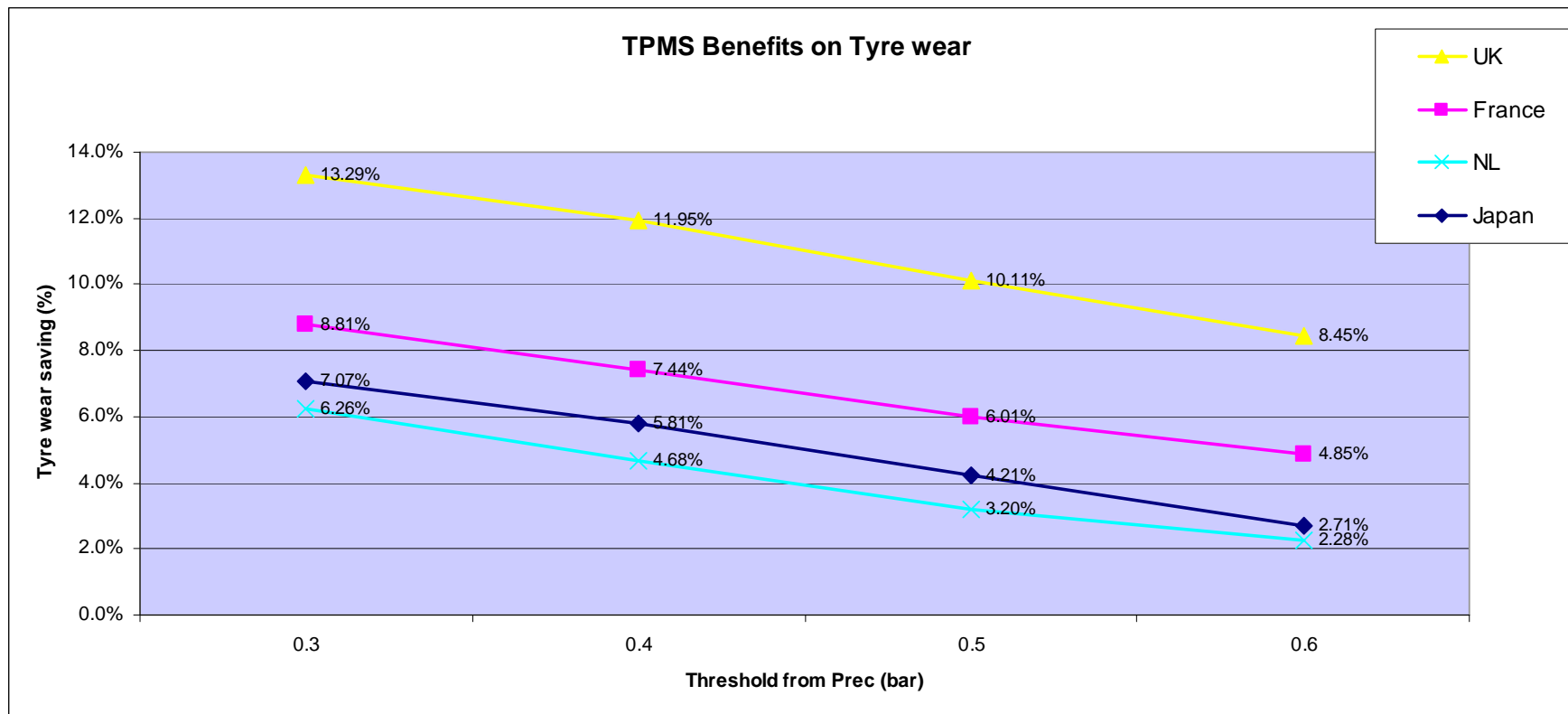
	Threshold 0.3 bar from Prec	Threshold 0.4 bar from Prec	Threshold 0.5 bar from Prec	Threshold 0.6 bar from Prec
Japan	7.07%	5.81%	4.21%	2.71%
NL	6.26%	4.68%	3.20%	2.28%
FRANCE	8.81%	7.44%	6.01%	4.85%
UK	13.29%	11.95%	10.11%	8.45%

Conclusion :

Maximum tyre wear saving
achieved with threshold at
0.3b ranging
from 6.3 % to 13.3 %
across the populations

TPMS Benefits on Tyre wear in Europe & Japan

- By applying the same methodology we can see how tyre wear increase evolves with the degree of underinflation and the following graph presents TPMS benefits on tyre wear (for different thresholds).



TPMS Benefits impact

Individual benefit impact – Assumption summary

- The previous calculation of fuel consumption and tyre wear increase linked to underinflation have allowed to determine the TPMS benefits for different thresholds, across several European countries and Japan.
- ⇒ The maximum benefits are achieved with a threshold of 0.3 bar from Prec.

- For our benefit impact assessment we will therefore use the percentage of fuel and tyre wear savings at this threshold :
 - Fuel : Min = 0.3% ; Max = 2.1%
 - Tyre wear: Min = 6.3% ; Max = 13.3%

- Assumptions considered in the benefit impact assessment:
 - Average annual car mileage: 15,000km (source : ACEA Key figures 2005).
 - Tyre life : 40,000 km (source Tyre industry : Conti / Bridgestone)
 - Tyre price : €75 (including mounting cost)
(Source Conti – survey Top 15 tyre sizes in Europe)

 - Fuel Price : 1.4 € / litre
 - Fuel consumption average ; 7.6 L/100km.

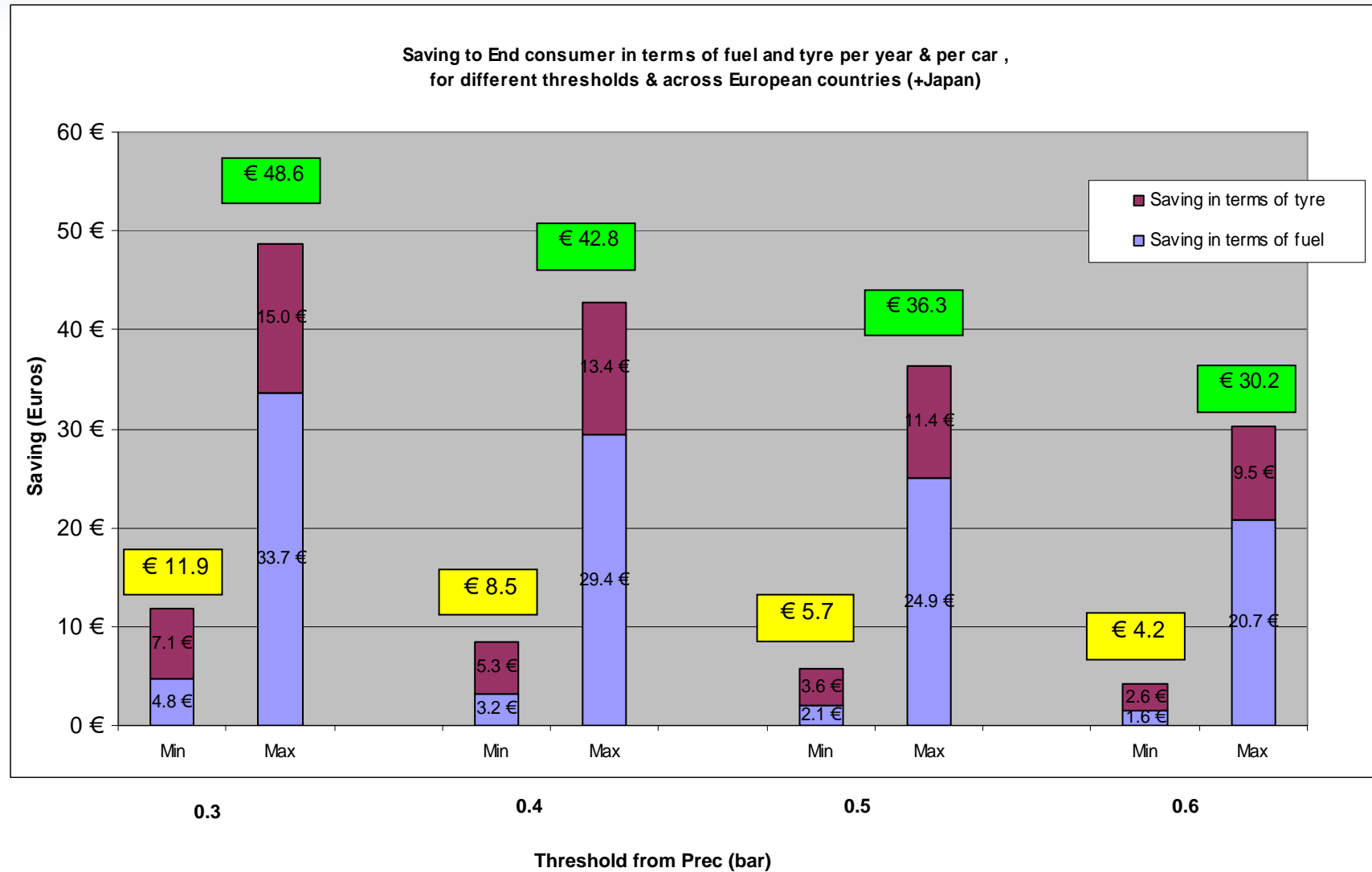
Individual benefit impact – Maximum achieved with Threshold of 0.3b from Prec

Basis Of Model		
Distance travelled per annum	15,000 Kms	
Fuel consumption average	7.6 L/100kms	
Fuel Price	1.4 Euros/litre	
Annual Fuel Costs	1,596 €	
Tire Life	40,000 Kms	
Tire Cost	75 €	
Total Underinflated population	Min across populations	Max across populations
Saving in fuel consumption	0.3 %	2.1 %
Saving in tire wear (this varies with tire type and driving style)	6.3 %	13.3 %
Saving per car (per annum)		
Fuel	4.8 €	33.7 €
Tires	7.1 €	15.0 €
Total	11.9 €	48.6 €

Conclusion :

With a system threshold at 0.3 b, the individual saving ranges from 12 € to 49 € per year across the populations

Individual Benefit impact – At different thresholds



Macro economic benefits on CO2 Emissions

- CO2 Emissions due to passengers cars are estimated to be 12% of the total EU CO2 emissions (Source : EEA - TERM 2007 Indicators tracking transport and environment in the EU).
- The total CO2 emissions for EU27 is around 4555 Mt CO2 (EEA figure 2005).
- ⇒ 12% of 4555Mt = 547 Mt CO2 are due to passengers cars.

- Knowing the potential fuel saving at different thresholds we can calculate how much CO2 would be saved per year if TPMS was fitted, and how many Euros this would be equivalent.

- Assumptions:
 - 229 million passenger cars in use in EU-27 (2006 - Source - ANFAC)
 - Cost of CO2/t :
 - Current market approx €28 / t
(Source Point Carbon: www.pointcarbon.com)

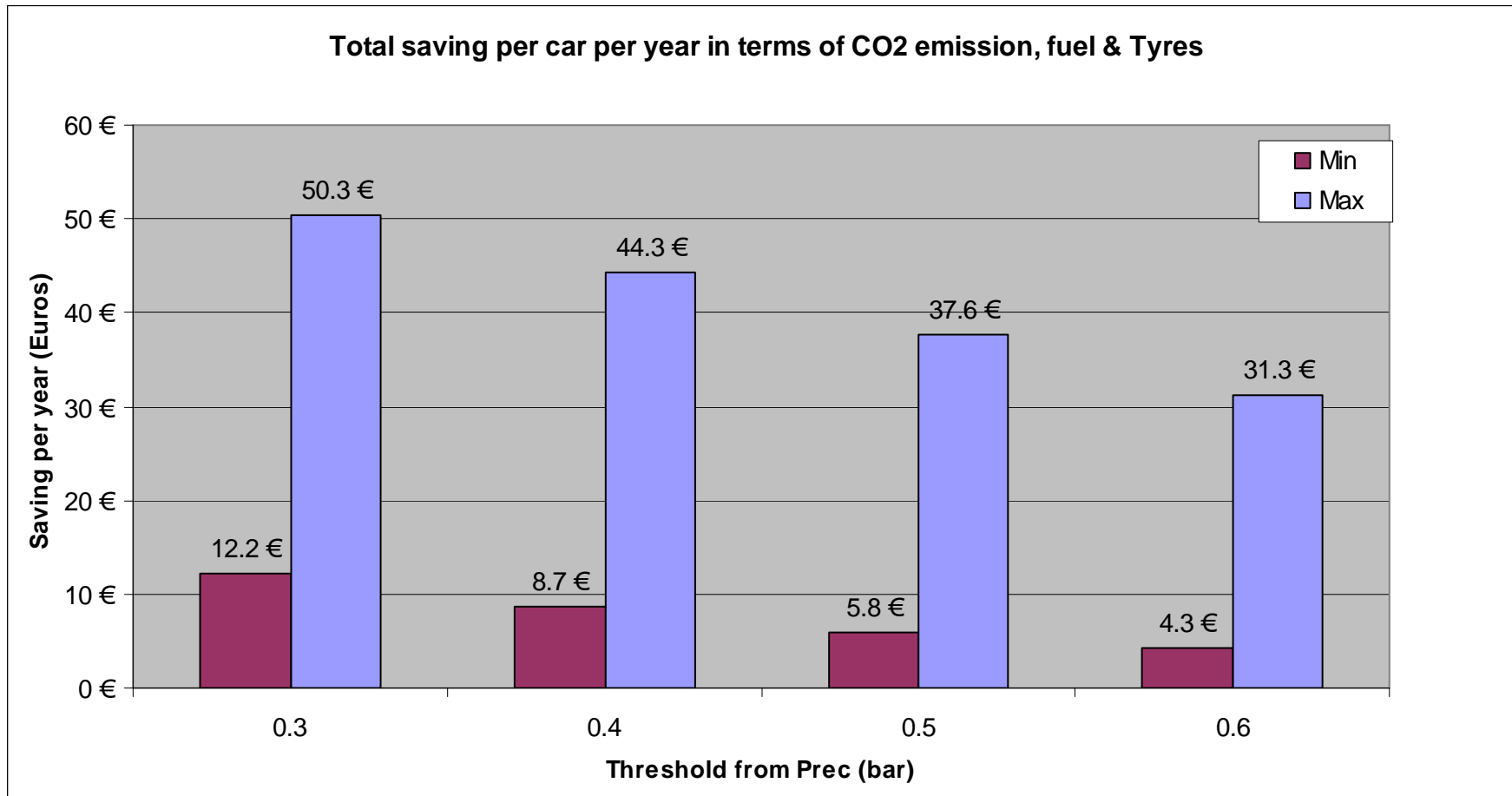
- Let us take an example: if TPMS contribution to fuel saving is 1 %, an additional saving of 5.5 Mt CO2 emissions per year would be achieved, equivalent to an additional 154 Million Euros per year (at 28 €/t).

Macro economic benefits on CO2 Emissions

- CO2 emissions related to tyre wastage are estimated to be 37.5kg CO2/ tyre (raw material, transport, confection, curing).
 - Knowing the potential tyre wear saving at different thresholds we can calculate the reduction of tyre wastage, hence the reduction in CO2 emissions.
 - Assumptions:
 - Tyre life : 40,000km
 - Cost of CO2/t :
 - Current market approx €28 / t
 - (Source Point Carbon: www.pointcarbon.com)
 - Let us take an example: if TPMS contribution to tyre wear saving is 10%, an additional 1.28Mt CO2 emissions per year would be saved, equivalent to an additional 36 Million Euros per year.

Overall Benefit Impact Summary :

Benefits at individual level: CO2 Emissions, fuel & tyre wear



Benefits at Macro level: Safety

- The underinflation study has shown that between 18% & 42% of Europeans drive with tyres underinflated by 0.5bar and more.
- ⇒ Between 41 and 96 million cars affected in Europe.
- In the UK alone, this represents 12.5 million cars driving with potentially dangerously underinflated tyres.

Benefits at Macro level: Safety

- The 1st TF data collection has concluded that:
(refer to TPMS TF conclusion V03)
 - Between 0.1% and 1% of fatal accidents are caused by underinflation.
 - Between 0.1% and 1% of accidents having generated injuries are caused by underinflation.

- Social cost per year associated with accidents in Europe is estimated to be 160 Billion Euros (Source EU: 20,000 lives. A shared responsibility, 2003).

- We consider that 0.5% of these accidents are caused by underinflated tyres
⇒ The social cost becomes 800 Million Euros.

- Note : when accidents occur, police very rarely report tyre condition, hence only very limited statistical data is available for this type of root cause (meanwhile when loss of control of the vehicle occurs, these accidents are concluded to be at the driver fault).

Benefits at individual level: Safety

⇒ In summary, TPMS would contribute to the following:

⇒ **0.5 % of accidents reduced**

⇒ **800 Million Euros in terms of social cost saved, in Europe.**

⇒ **Assuming 229 Million vehicles in Europe, safety benefit at individual level would be 3.5 € per car per year.**

TPMS Cost/Benefit

TPMS Technology & Cost

- The maximum benefits in terms of CO2 emissions reduction, fuel saved, tyre wear saved are achieved when TPMS threshold is set at 0.3bar from Prec.
- A TPMS system capable to operate at this threshold is already fitted on vehicles sold on the market today : Direct TPMS technology.
- Cost for such system is summarised in the table below :

	Content:	Cost/ System 2008 (Euros) (based on today's US volume)	Cost/ system 2014 (Euros) (European legislation in place)
Integrated TPMS System	4 TPMS sensors Software/warning strategy & Receiver integrated into e.g. Body controler	25 €	23 €
Stand alone TPMS System	1 RF receiver 4 TPMS sensors Software/warning strategy in TPMS ECU	33 €	30 €

- Note : Sensor life = 13 years
- Only the cost for the industry is considered.

Cost / Benefit Ratio

- To estimate the cost/benefit ratio of TPMS, we consider the following assumptions:
 - Lifetime of a vehicle: 13 years
 - TPMS cost to the car manufacturer: 30 Euros (within the range of previous slide)
 - TPMS cost per vehicle : 30 Euros + 35 % (= estimated Manufacturing cost for OEM)

	Min	Max
Cost of technology per vehicle	40 €	40 €
Total Saving per car per year : CO2, fuel, tyre wear	12.2 €	50.3 €
Social cost saving per car per year	3.5 €	3.5 €
Total benefits over vehicle lifetime	204.1 €	699.4 €
Cost / Benefit Ratio	0.2	0.06

Cost / Benefit Ratio - Conclusion

- Both Min and Max results are significantly below 1, which means that the benefits of accurately monitoring tyre pressure not only cover the cost of implementing the regulation but also generate significant savings to the driver and to society as a whole.

