Impact Assessment Study on Possible Energy Labelling of Tyres

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Revised Impact Assessment Report

To the European Commission

Directorate-General Transport and Energy

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1 INTRODUCTION

1.1 This Report

This Final Report has been prepared by GHK Consulting (one of the EPEC[1] Group members) with support from TNO, a world renowned specialist in automotive technology, to contribute to the Impact Assessment of the possible energy labelling of tyres[2]. The study has being undertaken for DG Transport and Energy (TREN) of the European Commission within the Framework Contract between EPEC and DG BUDGET (DG BUDG No BUDG06/PO/01/LOT no. 2 - ABAC 101922) on Evaluation and Evaluation-related Services.

1.2 Objectives of the Study

The overall policy aim is to shift the tyre market towards the use of low rolling resistance tyres (LRRT), taking into account the inter-relation with other tyre attributes, in particular dry and wet grip (safety), noise and tread wear.

According to the Terms of Reference, the general objective for this assignment is to:

> *'evaluate to which extent promotion of low rolling resistance tyres (LRRT) based on grading and labelling of tyres contribute to fuel savings and reduction of CO2 emissions. Both the tyre market governed by new vehicles sales and the replacement market will be covered. It should be assumed that the rolling resistance coefficient can be measured in accordance with the ISO 28580 test standard.'*

Specific objectives for the study were to:

- Analyse the current situation, including the linkage between rolling resistance (RR), safety (wet and dry grip), noise and tread wear;
- Elaborate policy options and study the interaction of policy options (such as between energy labelling of tyres with complementary legislative measures on minimum standards for RR) and consider possible synergies (such as displaying energy labelling of tyres along with fuel consumption labelling and other environment and safety measures such as grip and noise/tread wear);
- Assess, quantitatively and qualitatively, the impacts of the different policy options according to the Commission practice described in the Impact Assessment Guidelines and the cost-benefits and cost-effectiveness of the measures proposed as required in the Ex-Ante Evaluation Guidelines';
- Compare policy options, weighing strengths and weaknesses and effectiveness and efficiency;
- Identify core progress indicators for monitoring and evaluating key objectives.

1.3 Policy Context

The European Commission (EC) recognises that increasing transport emissions could seriously affect the achievement of economy-wide CO2 emission targets and the objective

[1] European Policy Evaluation Consortium (EPEC) www.epec.info

[2] DG TREN No. TREN/D3/375-2006

of sustainable transport as formulated in the mid-term review of the European transport policy (COM(2006)314). Measures to further reduce transport emissions should be considered. It is however, imperative that CO2 targets are met by the most cost-effective measures. This has been recognised by several bodies, including the CARS 21 group, the European Commission in the 2006 Energy Efficiency Action Plan (COM(2006)545) further endorsed by the European Council and Parliament[3], and the European Conference of Transport Ministers from January 2007. Balancing environmental and economic interests will keep cars affordable and safeguard jobs and production in Europe, which is key to the future health and prosperity of the EU.

The interest of the EC in promoting an expansion in the use of low rolling resistance tyres for motor vehicles (LRRTs), as one of a number of policy initiatives, is based on their potential to contribute cost-effectively towards fuel savings and CO2 emissions targets. The market take-up of LRRT through a labelling scheme has been identified as one of the measures which can contribute to achieve the 20% energy savings potential by 2020, as formulated in the 2006 Energy Efficiency Action Plan (COM(2006)545). It will complement the European new integrated strategy to reduce CO2 emissions from passenger cars and light duty vehicles, which identified the setting of minimum requirements on rolling resistance by 2012 as one of the complementary measures designed to provide an additional 10 g/km CO2 reduction from new cars and contributing to the overall target of 120 g/km for new cars (COM(2007)19). Policies to further reduce road transport emissions after 2012 are currently being discussed by Commission Services, with a Communication on 'Greening Transport' expected later in 2008.

1.4 Problem Definition and the Need for an Energy Labelling Proposal

The policy proposal for energy labelling of tyres is a response to the possible opportunity to influence customer demand from individuals and businesses as a means of achieving improved fuel consumption and emissions reduction. Rolling resistance together with aerodynamic drag are the most important resistive forces that a vehicle has to overcome while moving. The level of rolling resistance of tyres, as measured by the Rolling Resistance Coefficient (RRC)[4], varies considerably for any tyre choice of a customer. This means for passenger cars, for instance, a difference in fuel consumption between the worst and the best performing tyre of up to 10% and a reduction of 10g C02/km. This variation provides scope to influence the tyre choice of the customer in favour of more fuel efficient tyres.

The influence of rolling resistance (RR) on fuel consumption depends partly on the way the vehicle is driven, and the type of roads and speeds (the driving cycle) because of the interplay with other resistive forces acting on the vehicle[5]. For example, tyre rolling resistance has more of an effect on fuel efficiency in highway driving conditions but less of an effect in urban driving conditions. Based on the 'New European Driving Cycle' (NEDC), the rolling resistance of tyres accounts for 20% (Continental, *pers comm*) and from 20% to 30% (TNO, 2006) of total fuel consumption. Fitting lower RR tyres can lead to fuel savings. The absolute and relative fuel savings potential of lower RR tyres is discussed in more detail in Section 3.0.

[3] TTE, (Energy) Council on 23 November 2006, 15210/06; Brussels European Council 8/9 March 2007, presidency Conclusions, 7224/07; European Parliament resolution of 24 October 2007 on the Community Strategy to reduce C02 emissions from passengers cars and light-commercial vehicles (2007/2119 (INI)), point 32

[4] Rolling resistance can be expressed as a coefficient, with the units kg/t. More details in section 2.1

[5] California state fuel-efficient Tyre report: Volume II, January 2003

The potential need for a specific EC policy proposal on energy labelling responds to the current market failure to provide information that would allow customers in the replacement market from taking into account fuel efficiency and related impacts in tyre choice. This would contribute to reducing CO2 emissions and hence the scale of related externalities.

Whilst current EU legislation on fuel efficiency of vehicles already gives an incentive to car manufacturers to fit their vehicles with good performing tyres as original equipment (OE), no such incentive is provided in the tyre replacement market, which accounts for 78% of EU tyre sales. Consumers and vehicle operating companies have no access to systematic data on tyre rolling resistance performance for tyres available to them, and cannot compare tyre purchase costs with prospective fuel savings. Customers may be confronted by as many as 250 different brands with no objective information on tyre performance.

There is therefore a market failure due to the:

- *lack of market information on the rolling resistance of tyres* – the criteria for buying tyres are influenced by price, size, appearance, first fit, etc. Customers have no information on tyre rolling resistance;
- *lack of market information on the relative energy efficiency of tyres* – no tangible or transparent way for a customer to understanding a tyre's capability to increase a vehicle's fuel economy and to secure fuel cost savings;
- *lack of market information on the range of tyre attributes* – customers need to understand better the interplay between the range of tyre attributes (fuel efficiency, tyre safety, wear and noise) to make rational choices between tyres with different properties depending on customer preferences.

Energy labelling of tyres at the EU level would allow customers to make informed choices, and give an incentive/reward to tyre manufacturers to upgrade their product across the EU tyre market. Experience from the effects of energy labelling on the EU demand for household appliances (Directive 1992/75/EC) shows that energy labelling can have a significant influence on market trends and encourage a move towards more energy efficient products.

Market surveys show that after the life duration of tyres (tyre wear), tyre safety performance is the most important criterion in customers purchasing decision. Tyre energy performance is also an important criterion in purchasing decision even without harmonised information across tyres (Section 3.1).

Empirical and statistical evidence from tests carried out by magazines and academic studies have shown that tyres with low rolling resistance performance (measured as RRC) are generally associated with lower levels of wet grip. This is discussed in more detail in Section 2.3. There is therefore a risk that energy labelling would encourage a market change that at the same time as improving fuel efficiency might lead to a greater purchase of tyres with lower wet grip than would occur without energy labelling. Whether this market effect represents an increased risk of road traffic accidents is not clear from the available technical evidence. Further research is required to establish the causal relationship between levels of wet grip and safety, taking into account driver behaviour and the extent to which drivers adjust behaviour according to tyre choice.

The optimisation of tyre performance to achieve both lower RR and the maintenance or improvement of wet grip levels is possible within technical limits. The tyre industry is currently reaching the limits of tread compound development using silica and further

improvement to optimise performance across all tyre attributes will require technological change and related investment and will increase the cost of tyres.

1.5 Definition of the Policy Objectives for Policy Intervention

Given the nature of the problem, and in light of the LRRT proposal, the **General Objective** is to contribute to an increase in the fuel efficiency of vehicles to achieve CO2 savings.

The **Specific Objective:** is to *'pull the tyre market towards low rolling resistance tyres (LRRT), taking into account the interrelation with further parameters, in particular dry and wet grip (safety), noise and durability'*. The desired outcome is an increase in market share of LRRT whilst maintaining at least minimum standards for other tyre attributes.

The **Operational Objective:** given energy labelling is the preferred option, is to build an information system (i.e. a labelling scheme) providing targeted and easy to understand information to consumers, companies and retailers on tyres performance.

1.6 Market Context

The size of the road vehicle tyre market in Europe is indicated in Table (1.1) below.

Table 1.1: The EU Market for Road Vehicle Tyres Sold for Original Equipment (OE) and as Replacements (million)

Market Segment	2005	2006	2007	2007 Share (%) by Vehicle Type	2007 Share (%) of Total Tyre Sales
PC replacement – EU production	181	189	182	61%	53%
PC replacement – Imports	43	45	48	16%	14%
Total PC replacement	**224**	**235**	**231**	**78%**	**68%**
PC OE – EU production	61	64	63	21%	18%
PC OE – Imports	1	0	2	1%	1%
Total PC OE	**62**	**64**	**65**	**22%**	**19%**
TOTAL Passenger Car (PC)	**286**	**299**	**296**	**100%**	**87%**
LT replacement – EU production	15	15	16	57%	5%
LT replacement – Imports	4	4	4	14%	1%
Total LT replacement	**19**	**19**	**20**	**71%**	**6%**
LT OE – EU production	7	7	7	25%	2%
LT OE – Imports	1	1	1	4%	0%
Total LT OE	**7**	**8**	**8**	**29%**	**2%**
TOTAL Light Truck (LT)	**26**	**27**	**28**	**100%**	**8%**
TBs replacement – EU production	11	11	11	61%	3%
TBs replacement – Imports	4	5	5	28%	1%
Total TBs replacement	**15**	**16**	**16**	**89%**	**5%**
TBs OE – EU production	0	2	2	11%	1%
TBs OE – Imports	0	0	0	0%	0%
Total TBs OE	**0**	**2**	**2**	**11%**	**1%**
TOTAL Trucks & Buses (TBs)	0	**18**	**18**	**100%**	**5%**
All Vehicle Tyre Sales in EU	**312**	**344**	**342**		**100%**
Total replacement sales	258	270	267		**78%**
Total OE sales	69	74	75		**22%**

Source: Europool (courtesy ETRMA), ACEA
PC – passenger cars, LT – Light transport vehicles, TBs – Trucks and buses

In 2007 some 296 million tyres for passenger cars were sold in the EU accounting for 87% of all tyres sold. A further 46 million were sold for other vehicles such as vans, trucks and buses.

Of total sales some 78% were sold in the replacement market, the remainder being supplied to vehicle manufacturers as original equipment (OE). Tyres sold in the replacement market for passenger cars can be differentiated by price into premium, mid-range and budget segments, accounting for 54%, 25% and 21% of the total passenger car replacement market respectively.

Summer tyres and winter tyres differ in their levels of RR and need to be considered separately. Summer and winter tyres account for 70% and 30% respectively of the total replacement tyre market (Table 1.2).

Table 1.2: Replacement Market Share of Winter and Summer Tyres by Tyre Class

Market Share	C1 (PC)	C2 (CV/LT)	C3 (TB)	All Tyres
Summer	70%	69%	74%	70%
Winter	30%	31%	26%	30%

Source: Europool (courtesy ETRMA), ACEA
PC – passenger cars, LT – Light transport vehicles, TBs – Trucks and buses

The future volume of EU tyre sales for the replacement market has been projected using the market data and DG Tren growth rates from the DG Tren Pocketbook. The projections are shown in Table (1.3) below. These indicate total EU sales in 2020 of 363 million tyres.

Table 1.3: The Projected EU Market for Replacement Tyres C1, C2 and C3 (millions), including imports

Vehicle	C1-Passenger cars			C2-CV/LT			C3-TBs		
Type of Tyre	Summer	Winter	Total	Summer	Winter	Total	Summer	Winter	Total
2007	166	65	231	14	6	20	12	4	16
2008	165	71	236	14	6	20	12	4	17
2009	170	73	242	14	7	21	13	4	17
2010	174	74	248	15	7	22	13	5	18
2011	178	76	254	15	7	22	13	5	18
2012	182	78	260	16	7	23	14	5	18
2013	187	80	266	16	7	23	14	5	19
2014	191	82	273	16	7	24	14	5	19
2015	195	84	279	17	7	24	15	5	20
2016	200	86	286	17	8	25	15	5	20
2017	205	88	293	17	8	25	15	5	21
2018	210	90	300	18	8	26	16	6	21
2019	215	92	307	18	8	27	16	6	22
2020	220	94	314	19	8	27	17	6	22

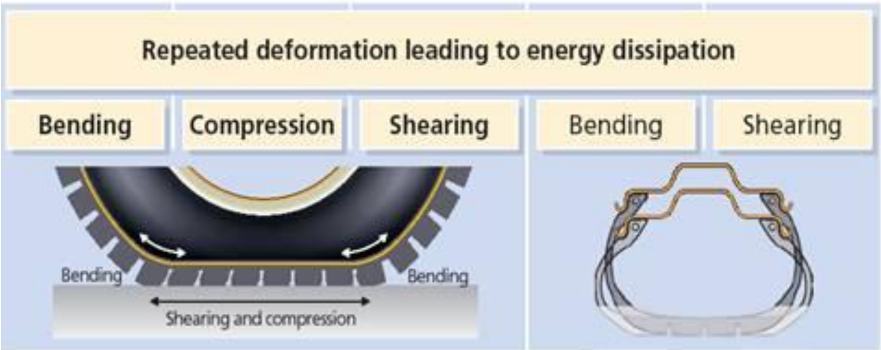
Source: *Europool (Courtesy ETRMA), ACEA and DG Tren Pocket Book*

2 THE TECHNICAL DEVELOPMENT AND COSTS OF LOWER ROLLING RESISTANCE TYRES

2.1 What is Rolling Resistance?

Rolling resistance is the resistance to motion that occurs when an object (e.g. a wheel or tyre) rolls. It is caused mainly by the deformation of the wheel or tyre or the deformation of the contact surface (e.g. the road) and thus it depends very much on the material of the wheel or tyre and the type of road surface.

A tyre's rolling resistance is defined as the energy dissipated by a tyre per unit of distance travelled (ie. rolling resistance force F_{RR}) and can be characterized by a coefficient of RR expressed in kg/t or ‰. The RRC gives the value of the rolling resistance force divided by the wheel load. RRC is by definition independent from the vehicle load. This allows for comparison across all tyres of RR properties irrespective of vehicle size. In the literature other units are used [J/m] and [N], but conceptually, rolling resistance is better understood as a loss per distance than a force. A lower coefficient means the tyres will use less energy to travel.



Source: Barand and Bokar, 2008, SAE

Rolling resistance is affected by:

- **Tyre design and construction** - diameter, width, mass, tread depth, internal components
- **Rubber compounds** – hysteretic properties, (low hysteresis material has lower RR)
- **Tyre inflation** - an under-inflated tyre is over deflected and dissipates more energy (For example, for a passenger car RRC increases by 6% when the tyres are 30kPa below recommended pressure and by 30% for 100kPa below)[6]
- **Roadway surface** - a macro rough road may mean 30% more RR than a smooth road; ground temperature also has an influence
- **Static and Dynamic Vehicle Settings** - toe, camber/steering effect
- **Vehicle usage** - torque, slip angle change due to acceleration
- **Ambient temperature** - a 10°C increase usually means 8% less RR
- **Tyre operating temperature** - a cold tyre has 30% more RR
- **Load** - RR is almost proportional to the load which is applied on the tyre

[6] *Barand and Bokar, 2008, SAE*

2.2 Current Distribution of Low Rolling Resistance Performance on the EU Tyre Market

Levels of rolling resistance vary between passenger cars (C1), commercial vehicles (C2) and trucks (C3). Data supplied by the European Tyre and Rubber Manufacturers' Association (ETRMA) (Figure 2.1, Table 2.1) indicates the approximate market distribution of RR across the different vehicle types. According to ETRMA, this data is representative of all EU sales of tyres. For summer tyres for passenger cars, the largest market segment, 88% of tyres have a RRC over 10kg/t, which indicates the existence of a market failure, as tyres below 10 kg/t are cost – effective (see section 3 for more details).

Figure 2.1: EU Tyre Market Distribution of RR for Different Vehicle Types, 2004

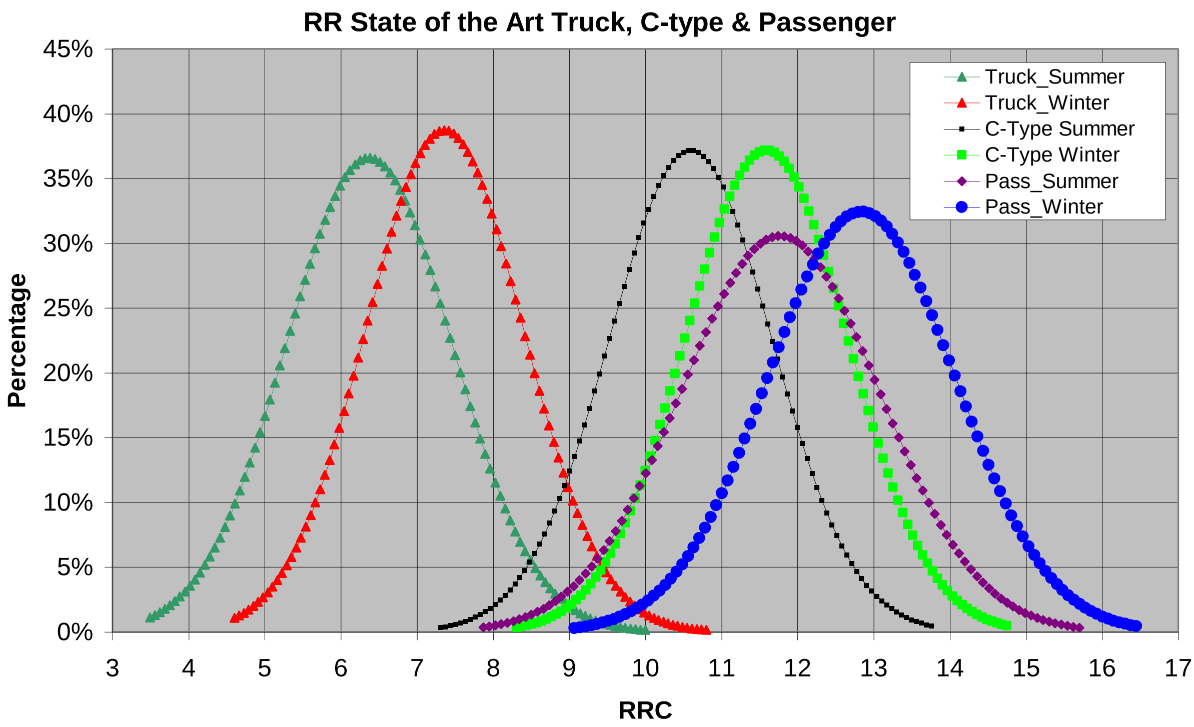


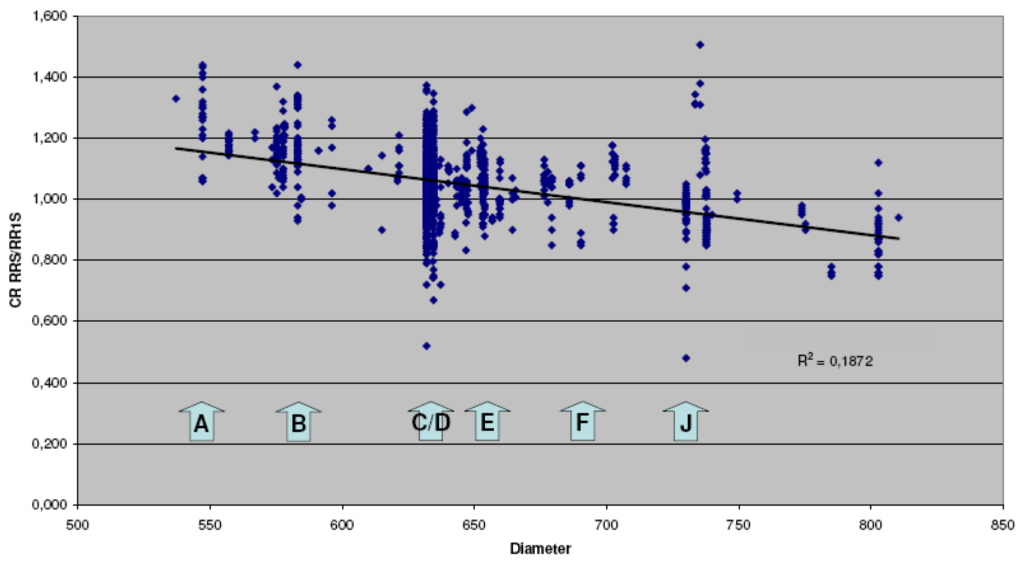
Table 2.1: Summary of Rolling Resistance (RRC, kg/t) by Vehicle Types, 2004

Vehicle Type	Average	Min	Max
Passenger Car – summer	11.8	7.9	15.7
Passenger Car – winter	12.8	9.1	16.5
All Passenger Cars (C1)	**12.1**	**8.2**	**15.9**
Light Truck – summer	10.4	7.3	13.8
Light Truck – winter	11.4	8.3	14.8
Al Light Trucks (C2)	**10.7**	**7.6**	**14.1**
Truck/Bus – summer (steer/trailer)	6.4	3.5	10.0
Truck/Bus – winter (Drive)	7.4	4.6	10.8
All Trucks & Buses (C3)	**6.6**	**3.8**	**10.2**

Source: ETRMA

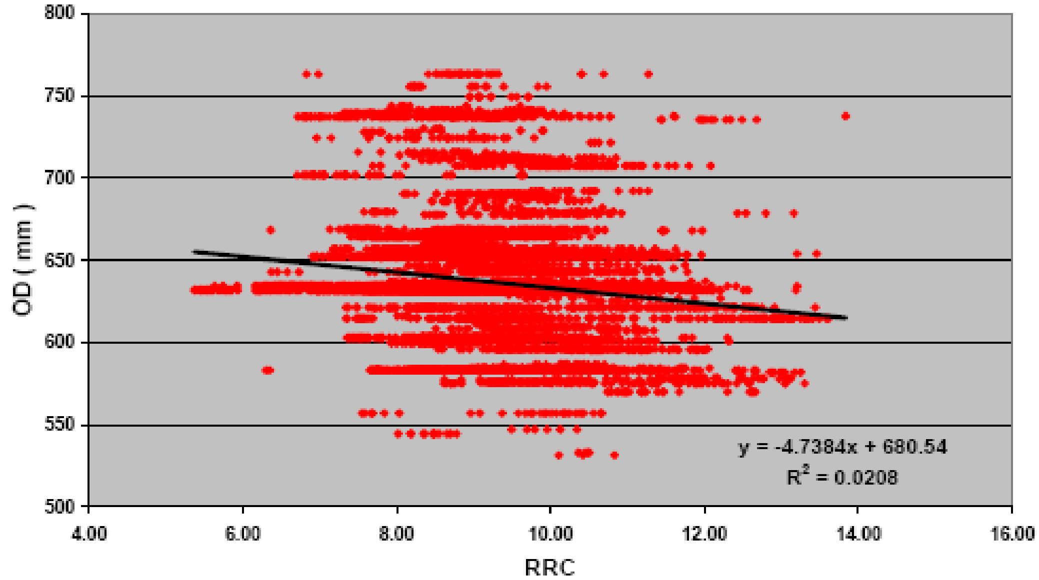
More recent data on RRC from two tyre companies (Continental and Goodyear) suggest that the minimum RRC value in 2008 is around 6.5-7 kg/t for passenger cars (Figures 2.2 and 2.3). However, according to Goodyear the lowest C1 tyre sold in the replacement and OE market is 8.4 kg/t, whilst Continental advise that the minimum value in the C1 replacement market, with an acceptable performance on wet grip, is 8kg/t. Tyres below this limit are prototypes. The maximum current C1 value is 14.4kg/t with an average of 10.5kg/t across the product range.

Figure 2.2: RRC by Outside Diameter, Continental (by EC vehicle categories)



A	MiniCars – eg. Smart, Fox,.
B	Small cars – eg. Fiat Punto
C	Medium class – eg. VW Golf
D	Upper medium class – eg. Volvo S70, 3er BMW
E	Upper class – eg. Audi A6, 5er BMW
F	Luxury class Mercedes S – eg. Audi A8, 7er BMW
J	Sport Utility Vehicle - SUV – eg. BMW X 5

Figure 2.3: RRC by Outside Diameter, Goodyear



These results (Figures 2.2 and 2.3) also suggest that RRC falls as the size of the tyre increases as measured by the outside diameter (OD). This relationship suggests energy labelling should take this into account in any adopted grading scheme otherwise incentives will tend to focus on innovation for tyres for smaller cars, rather than the whole market. To take this relationship into account and to maximise the range of grades available to all customers, a relative grading scheme should be used, where the actual RRC used to define any given grade would change between tyre sizes. We discuss this further in Annex 7.

As noted above, due to differences in tyre design for summer and winter use, there is a significant variation in RR. As tyres roll under the vehicle's weight, their shape is being deformed and their compounds, which are also designed to ensure traction and comfort, dissipate energy in the form of heat. Winter tyre deformations are greater and on average have 1kg/t greater RR than summer tyres, as shown in the ETRMA data.

However, a study by VTI (2008) in Sweden found the opposite results (winter tyres 1kg/t less RR on average than summer tyres). These contrasting results may be the consequence of different designs of winter tyres: tyres are made for Scandinavian countries to roll on ice and snow, in other countries they are made to roll on mud and wet roads with in both cases different techniques and tread patterns used. There is no quantified data based on a representative EU sample demonstrating that winter tyres have a smaller RRC than summer tyres. The impact assessment is therefore based on the market distributions of RRC (summer and winter) as suggested by ETRMA.

2.3 Trade-offs between Improvements in Rolling Resistance and Other Tyre Attributes

Tyre performance is influenced by the materials, tyre components and construction methods used. Changes in these provide a different balance of attributes. Promoting one attribute such as rolling resistance may decrease the performance of the tyre in relation to other attributes. Thus tyre design optimises performance, managing trade-offs to achieve a performance balance that best meets customer or market requirements.

The most important tyre component when designing a tyre to reduce its rolling resistance is the tread compound, with the operation of the steel belt second. Change in tread compound is however also the major influence on most of the other attributes. The key trade-offs that are likely to arise from a focus on reducing rolling resistance are a reduced level of wet grip and possibly aquaplaning (Table 2.2).

Table 2.2: Technological Options for Reducing Rolling Resistance

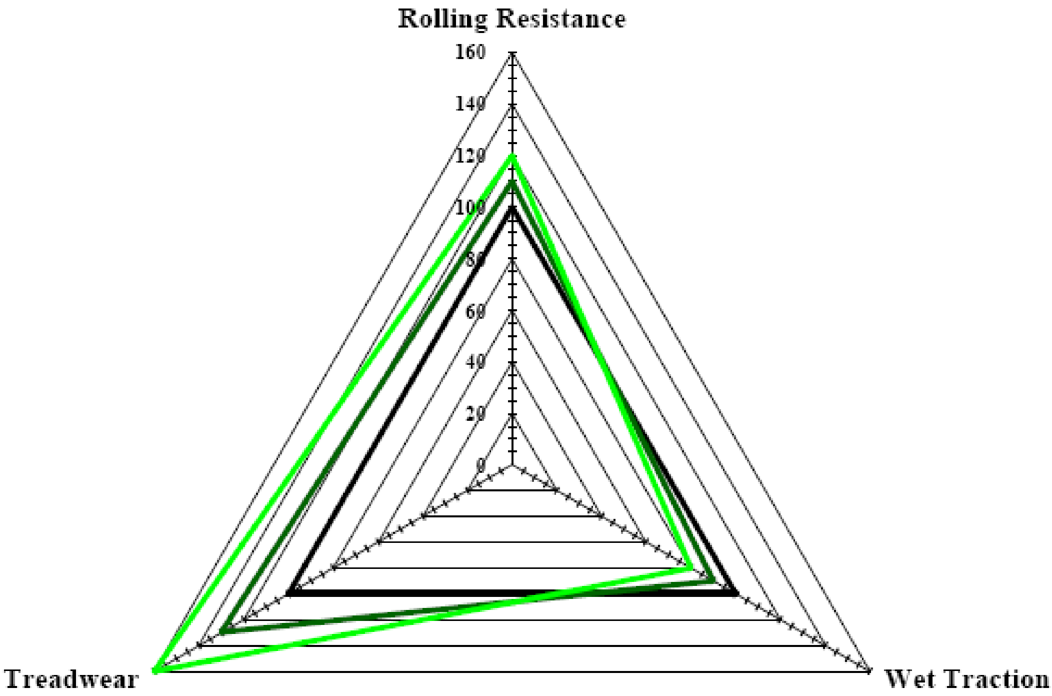
Rolling Resistance	Wet Grip	Dry Grip	Handling	Wear life	Noise	Aquaplaning	Durability	Endurance
Unit: kg/ton	Unit: Index, braking distance	Unit: ?	Unit: Lap time or points vs reference	Unit: Km	Unit: dB	Unit: If in strait line – Vmax; if in curve – various parameters	Unit: Km	Unit: Depend on the test evaluation parameter
Lowering RR by improvement/change to:								
Tread (only compound)	---	-	--	+	-	--	=	=
Side wall	=	=	-	=	=	=	--	-
Beading	=	=	=	=	=	=	=	-
Belt package	+	+	-	-	+	-	--	-

Source: GHK based on consultation with tyre producers

Note: **+++** *Strong positive correlation,* **++** *medium positive correlation,* **+** *low positive correlation,* **-** *low negative correlation,* **- -** *medium negative correlation and* **- - -** *high negative correlation,* **=** *stays the same. Durability is related to tyre body structural resistance over tyre life, until tyre is worn out, regardless the length of time life. Endurance related to resistance over tyre life to ageing, regardless the mileage accumulated.*

The interplay between rolling resistance and wet traction and treadwear for a given technology is shown in Figure 2.4 (where movement away from the centre represents an improvement), that indicates that wet traction is reduced as rolling resistance is reduced; but that reduced rolling resistance also improves treadwear.

Figure 2.4: Relationship between Rolling Resistance, Treadwear and Wet Traction for a Given Technology



Source: Goodyear

Based on a review of various studies examining the relationship between rolling resistance and other tyre attributes, mainly wet grip (WG), noise and wear (see Annex 3) a number of conclusions can be drawn:

- No correlation was found between RR and tyre noise
- Changing the tread pattern to improve wet grip is generally associated with an increase in tyre noise levels;
- Lower RR is generally associated with a lower level of wet grip across all tyre sizes;
- There is evidence that there are tyres in most sizes that can perform well on a number of tyre attributes (including wet grip) but at higher tyre costs;
- For fuel efficient tyres with low RR, there is a clear price premium for tyres which also perform well on WG compared to tyres which achieve low RR but with reduced WG performance. The price premium for the better performing tyres on RR and WG,

compared to the worst performing tyres on wet grip ranges from 20% to 40% and between 5% to 10% for tyres with an average level of performance for WG;

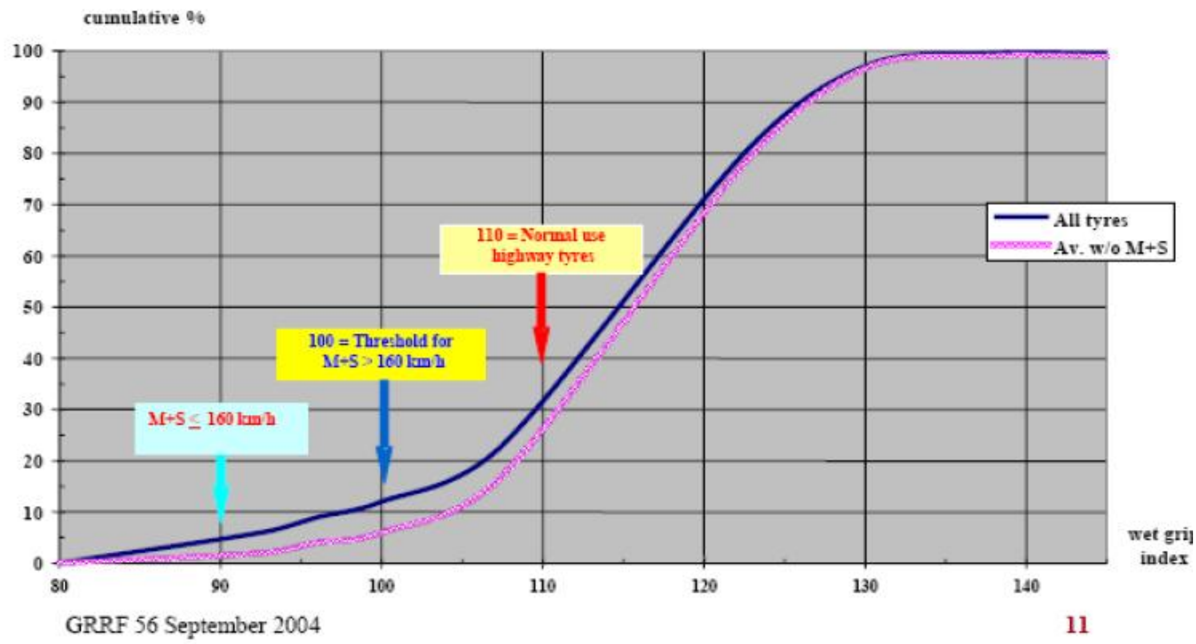
- None of the studies and tests showed that any one tyre (irrespective of cost) scored the best on all attributes. This suggests that better technology at higher cost allows some progress in reducing RR without compromising WG, but there are current technological limits to achieving the very best performance levels of RR with the very best performance standards for WG;

- Independent tests (ADAC, Which, Knall-effekt and Que Choisir) showed that imported tyres that had very low RR tended to perform very poorly on WG.

2.3.1 Accidents and wet grip

The importance of a trade-off between reduced rolling resistance and reduced level of wet grip depends on the extent to which reduced wet grip gives rise to an increase in braking distances for a given speed and road surface; and associated road traffic accidents and casualties. Wet grip is usually measured by braking distance under controlled circumstances and reported on an index with the wet grip as measured by the standard reference tyre type (SRTT) as approved by UNECE Regulation 117 providing the reference point (100%). The distribution of wet grip across the EU tyre market is presented in Figure 2.5.

Figure 2.5: Wet Grip Distribution in Europe



Note: Cumulative frequency distribution of the wet grip index (G) for a large number of tyres on the European market (GRRF 56-28, 2004). The limiting values according to the ECE R117 are indicated. The curve in lilac colour (lighter) shows data for 'normal/summer' tyres, whereas the blue curve (darker) shows data for all tyres together. Note that 'M+S' are 'mud & snow' or 'winter' tyres.

Although the SRTT provides a benchmark it does not provide a formal minimum standard which producers are required to meet. Under the UNECE regulation 117 there is a proposal to set a minimum standard at 110% of the SRTT for normal tyres and 90% to 100% for

snow tyres[7]. The proposal for a Regulation on general safety of motor vehicles (COM(2008)316) foresees the introduction of this minimum standard in EU law in 2012-2014. Currently, some 30% of tyres on the EU market would fail to meet the proposed standard. The impact assessment has assumed that this standard and related testing is approved and implemented by the end of 2012.

The introduction of the standard will limit the trade-off between WG and RR that might otherwise have occurred without it; and policy options will need to comply with the minimum standard. However, promoting RR and not other attributes, especially wet grip, introduces the risk that customers will, without knowing, purchase tyres with lower wet grip than they would otherwise have done (but not less than the minimum standard). Whether this represents a serious risk of increased accidents is unknown.

Tyre-related accident data is scarce. In most cases it is not extensive or detailed enough for conclusive insight on the relationship between accidents and relevant tyre attributes. Understandably, the industry itself, both vehicle and tyre manufacturers, is very sensitive about publishing results and statistics of their own accident research or complaint departments. However, some conclusions can be drawn regarding tyre wet grip and the risk of accidents (see Annex 4). In summary:

- Tyres vary in their level of wet grip, as do road surfaces. Braking distances depend on tyre grip, the vehicle braking system and road surface;

- Grip performance of tyres on wet roads diminishes as roads wear over time because the skid resistance reduces;

- The risk of accidents on wet roads is higher, when the grip provided by the road surface is lower; by implication the risk of accidents should intuitively also be higher when tyre grip is reduced (although there is no available data to confirm this);

- The risk of accidents is highest for a tyre with low grip performance, on a wet road below a certain level of skid resistance;

- Where road accident data on the contribution of vehicle components to accident risk is available, it suggests that tyre performance is relatively more important than other vehicle components. The total percentage of tyre-related accidents in all reported motor vehicle accidents (not just technical defects) involving personal injury in Germany and Switzerland is 0.4% and 0.1% in Italy[8].

2.4 Additional Costs of Testing and Grading for Rolling Resistance and Wet Grip

The introduction of policy options requires tyres to be tested for their performance in relation to rolling resistance and also (in the case of some options) wet grip. Depending on the required accuracy of the grading and labelling scheme, additional testing costs will be incurred by tyre producers. Information on the additional costs of tyre testing and grading for both rolling resistance and wet grip was provided by ETRMA. The costs were evaluated by: Bridgestone, Cooper, Continental, Goodyear, Michelin, Pirelli and Vredestein. These producers account for approximately 50% of the sales to the EU market.

[7] 90% for snow tyre with a speed symbol ("Q" or below minus "H") indicating a maximum permissible speed not greater than 160 km/h and 100% for snow tyre with a speed symbol ("R" and above, plus "H") indicating a maximum permissible speed greater than 160 km/h

[8] TÜV (2003) 'Survey on motor vehicle tyres and related aspects' EC DG Enterprise.

2.4.1 *Rolling Resistance*

The estimated cost per test for C1/C2 for rolling resistance (for each type approval or grading) is about 260 Euro and range between 250 and 300 Euro to allow a bandwidth of 1.5kg/t (Table 2.3a).

Table 2.3a: Costs of Rolling Resistance Testing (1.5kg bandwidth) for C1/C2/C3 Tyres

	Number of Tests per Year.	Average Cost per Test	Total Annual Cost
Reference Case - Compliance with minimum requirements set in COM(2008)316	400	€260 (250~300)	€0.1m
Grading for C1/C2	3,000	€260 (250~300)	€0.78m plus (annualised) fixed cost of €0.3m
Grading for C3	165 (@5.5% of C1/C2)	€260	€0.04m
Additional Cost			€1.04m

Source: ETRMA (C1/C2 only). C3 estimate based on share of tests for C1/C2 based on market share of C3 and assumes same average cost per test

Note: Assumes number of tests are twice the number identified to take account of market share

Note: Fixed costs include maintenance and laboratory alignment tests

The annual additional cost for rolling resistance grading is approximately €1.0m for C1/C2/C3 tyres. For the purposes of the impact assessment we have assumed that the average cost per tyre is similar to that for C1/C2 tyres and that the number of tests is in proportion to market share. This adds a small additional cost of €0.04m per year.

The cost includes the one-off start-up costs for rolling resistance grading, estimated to be approximately €2m with an annualised cost of €0.3m at 4% discount rate 2012-2020. The total annual additional cost of RR grading of €1 million represents approximately a cost per tyre sold of €0.003.

The additional costs associated with testing and grading to establish a 1.0 kg/t bandwidth could be higher given the need for more accurate testing. Based on discussions with the tyre producers the additional testing costs for a 1.0 kg/t bandwidth would be between a factor of 1 to 3 higher than the cost for the wider bandwidth (1.5kg/t). It is more likely however that the testing would be no more expensive because test equipment and test levels will already be precise enough for a 1kg/t bandwidth if they follow the future ISO 28580[9]. Assuming a factor of three, the additional RR testing and grading cost per tyre sold for a 1kg/t bandwidth would be at the most €0.01.

2.4.2 *Wet Grip*

For wet grip there is a wider range of costs per test, between €600 and €3,800, (Table 2.3b) The wet grip type approval for UN/ECE-Regulation 117.01 is based on a simple ‘pass’ or ‘no-pass’ test according to the required minimum performance.

[9] ISO28580 is a tyre rolling resistance measurement method designed to ease international cooperation and, possibly, regulation building. ISO 28580 will be an improved testing method based on ISO 18164, aiming at a better repeatability and reproducibility.

Table 2.3b: Costs of Wet Grip Testing for C1/C2/C3 Tyres

	Number of Tests per Year	Average Cost per Test	Total Annual Cost
Reference Case – Homologation – R117 / COM(2008)316	364	€2,000 (600~3,800)	€0.7m
Grading for C1	1,100	€2,311 (800~4,017)	€2.5m plus fixed cost (annualised) of €0.7m
Grading for C2/C3	170 (@15.5% of C1)	€2,311	€0.4m
Additional Cost	n/a	n/a	€2.9m

Source: ETRMA (C1 only). C2/C3 estimate based on share of tests for C1 based on market share of C2/C3 and assumes same average cost per test

Note: Assumes number of tests are twice the number identified to take account of market share (although product range is more important than sales volume in determining test costs)

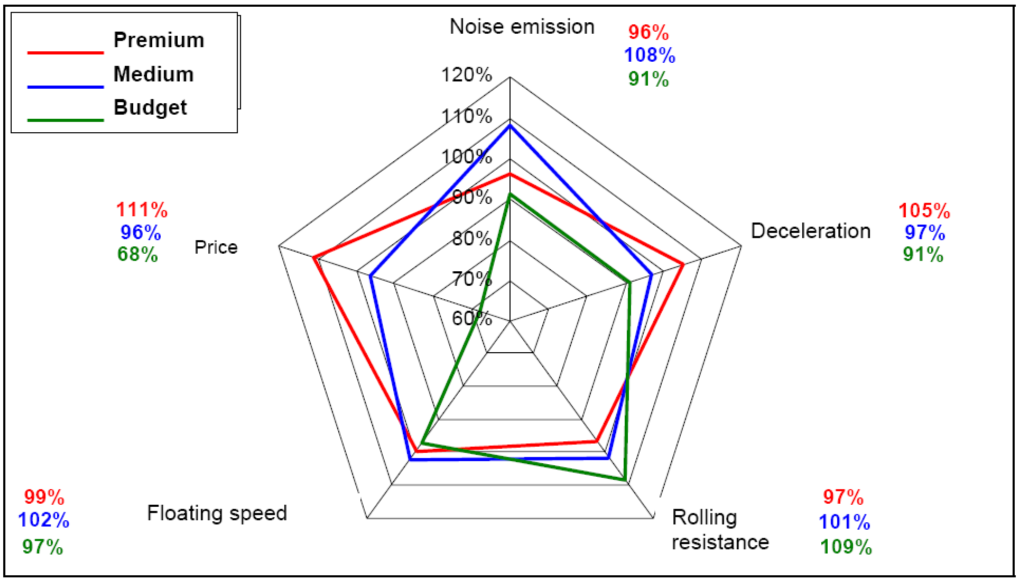
The total additional annual cost for wet grip grading per year is estimated to be approximately €2.9m for C1/C2/C3 tyres. Estimates for C2/C3 are based on number of tests for C1 and market share of C2/C3 and assuming the same average cost per test.

The cost includes an initial start up cost for wet grip grading of approximately €4.6 million in the first year to cover test facilities, or an annualised cost of €0.7m, over 8 years, 2012 - 2020, at a discount rate of 4%. The total annual additional cost of WG grading of €2.9m represents approximately a cost per tyre sold of €0.01.

2.5 Optimising RRC and Additional Costs

Technology does currently exist, given technological limits, for producing lower RR tyres without sacrificing wet grip performance, but at a higher cost. These premium tyres tend to have optimum performance on all fronts, although at higher price (Figure 2.6 below).

Figure 2.6: Spider Chart for Summer Tyres 205/55 R16 (N=8).



Source: TUV (2002)

Notes: -Relative noise emission: a higher percentage means a higher noise emission (i.e. >100% is worse)

-Relative deceleration: a higher percentage means a better braking performance (i.e. >100% is better)

-Relative rolling resistance: a higher percentage means a higher rolling resistance (i.e. >100% is worse)

-Relative floating speed: a higher percentage means a better aquaplaning behaviour (i.e. >100% is better)

-Relative sales price: a higher percentage means a higher sales price (i.e. >100% is worse)

Improving RR using the low cost option of treating only the tread compound leads to a large performance trade-off with wet grip and handling (see section 4.4.2 for an assessment of the significance of wet grip performance range). On the other hand, tyre producers and independent tests for C1/C2 indicate a 20% reduction in RR compared to the average is possible with no performance trade-off on other attributes but with 5% to 10% higher production costs (including additional R&D costs), (Table 2.4a). Annex 5 provides further details.

Table 2.4a: Production Cost of Options to Reduce RR, C1 and C2

Options	**Indicative Costs of Reducing RR from Average Levels in 2008 (11.9kg/t for C1 summer tyres)**
Zero Cost	No cost, no R&D cost, up to 20% RR reduction, but trade-off
Low Cost	**+2%** Production cost (including R&D costs), up to 10% RR reduction with partial trade-off
Medium Cost	**+3%** Production cost (including R&D costs), up to 15% RR reduction with partial trade-off
High Cost	**+5% to 10%** Production cost (including R&D costs), up to 20% RR reduction with no trade-off. Higher cost would be expected for a similar reduction in RRC in higher bands.

Source: Discussions with Tyre Producers

The main cost elements giving rise to the additional cost and change over time are as follows (in order of significance):

- Material costs – increased cost of raw material, such as silica
- Replacement cost of product lines – depending on timing of the new regulation and replacement cycle – assumed to be incurred in the reference case because of the need to meet minimum standards
- New machinery and plant costs – to allow change in tread and moulding
- R&D costs
- Personnel costs – costs of hiring additional labour
- Manufacturer's additional tyre testing and certification costs

In addition, in the case of energy labelling there would be additional costs to producers in relation to the costs of posters, stickers, communication and training (Box 2.1)

Box 2.1: Energy Labelling Costs for Producers

According to ETRMA, the estimated cost per year for the tyre industry to put a sticker based label on each tyre (C1/C2) at the factory is around €10m. The cost per tyre of stickers is thus around €0.04 for C1/C2 tyres. Costs of additional forms of communication such as leaflets, posters and marking on consumer invoices will depend on the retail and marketing structure in most member states. However, tyre producers do not expect these costs to be significant as they can be included in existing measures and communication practices. The

label can also be moulded on the sidewall of the tyre. The tyre industry does not support this idea as the RRC (and/or) WG rating would only apply when the tyre is new. Moulding would incur significant additional costs if grading were applied simultaneously to all tyres in an existing production line. If it were applied to only new production lines, costs would be low with only €13 per mould per size.

Taking the estimated range of additional costs associated with producing more fuel efficient tyres whilst maintaining or improving wet grip performance for a 20% reduction on average levels of RRC in the market in 2008 (Table 2.4a), and applying these to the average market RRC in 2012, allows an estimate of the additional cost of achieving a reduction of 1 kg/t in RRC (Table 2.4b). The estimated additional cost per 1 kg/t reduction is estimated to be between 2.3% and 4.6% of production costs for reducing RR from average levels in 2012.

Table 2.4b: Additional Production Costs per kg/t Reduction in 2008, 2012 (C1 Summer Tyres)

Year	Average Market RRC for C1 (summer) (kg/t)	Reduction on average RRC (%)	20% reduction from average levels in RRC (kg/t)	Additional production cost for a 20% reduction in RRC (%)	Additional cost (% increase per 1 kg/t)
2008	11.9	20%	2.4	5 – 10	2.1 – 4.2
2012	11.0	20%	2.2	5 – 10	2.3 – 4.6

Sources: Table 2.4a and ETRMA/TPIA (2007)

Discussion with the tyre producers indicate that the costs of improving RR by a given level would increase for tyres with lower RRC; i.e. there is a rising marginal cost of production with the move to lower levels of rolling resistance. Table 2.5a sets out an indicative range of additional costs for reducing RRC by 1 kg/t, ranging from 2.3% to 5.0% (single label) and from 4.6% to 10.0% (dual label).

Assuming higher production costs (including R&D, testing and labelling) are passed on to customers (since in a competitive market, prices reflect production costs), there is a price premium for customers for improvements in RR without compromising wet grip.

Table 2.5a: Price Premium for Reductions in RRC by 1kg/t. Moving from 1 Band to the Next Highest Band (C1 summer tyres)

	A+	**A**	**B**	**C**	**D**	**E**	**F**	**G**
RRC kg/t	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
Single Labelling	?	5.0%	3.5%	2.8%	2.5%	2.3%	0.0%	0.0%
Dual Labelling	?	10.0%	7.0%	5.6%	5.0%	4.6%	0.0%	0.0%

Dual labelling, compared to single labelling, provides an increased incentive to improve wet grip performance over the minimum limit, and as a consequence the additional costs for dual labelling are higher than single labelling. Dual labelling would thus encourage optimisation of both wet grip and RR. The higher price premium for dual labelling takes into consideration:

- higher grading and testing costs – ETRMA and TUV estimate;

- higher production cost – the costs of producing tyres in the higher bands of both RR and WG, and to maintain existing minimum standards for tyre rolling noise;
- higher manufacturer and retailer costs due the set up and maintenance of two databases.

The price premium of moving from Band F (taken as the band with the average market level of RRC (11.0kg/t in 2012) to higher bands is shown in Table 2.5b. This indicates that the price premium of purchasing tyres in the highest band compared to Band F is 16% (single label) and 32% (dual label). These additional costs are used to estimate the impact of market transformation in each of the years 2013-2020. These additional costs may decline over time with better understanding of the technology and with economies of scale as customers increase their purchase of higher performing tyres. This effect is not included in the estimated price premium and the estimate of additional costs may therefore represent an overestimate, especially in later years.

Table 2.5b: Price Premium for Reductions in RRC by RRC Bands, 1kg/t (C1 tyres), 2012, Compared to band F

	A+	A	B	C	D	E	F	G
RRC kg/t	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
Single Labelling	?	16.1%	11.1%	7.6%	4.8%	2.3%	0.0%	0.0%
Dual Labelling	?	32.2%	22.2%	15.2%	9.6%	4.6%	0.0%	0.0%

2.5.1 Price elasticity of demand for tyres

The price premium provides a disincentive to customers to purchase lower rolling resistance tyres. The purpose of the policy options is to counter this effect through revealing the financial benefits of switching to LRRTs (via labelling) or counter acting the premium through tax changes such as VAT or new taxes (such as a carbon tax)

The estimated long-run price elasticity of demand for car tyres is 1.2[10]. The price elasticity of demand is the proportionate change in demand given a change in price; a 1% reduction in the price produces a 1.2% increase in demand for the product.

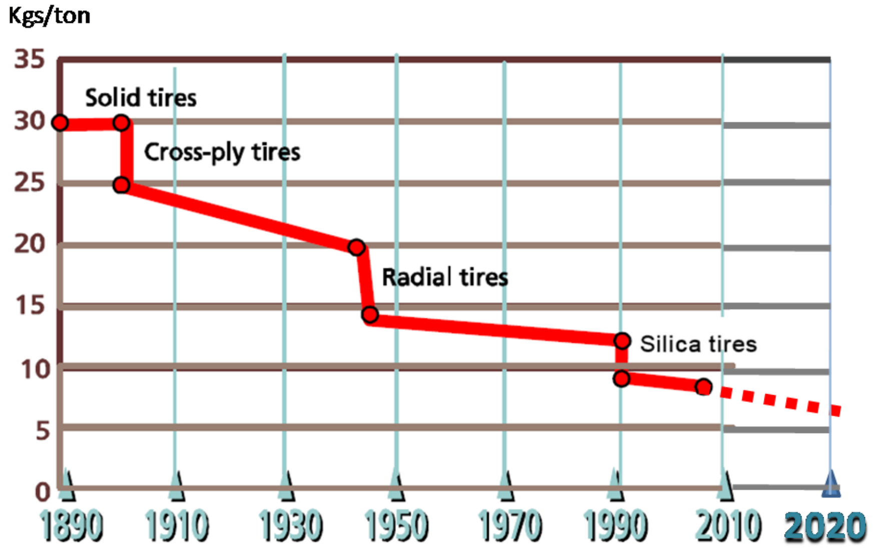
In the absence of a labelling scheme the higher costs of LRRTs will reduce their demand. An increase in price by 16.1% from Band F to A, for example, under single labelling would reduce demand by 19.3%. Labelling has to overcome the market failure and encourage customers to take account of fuel savings that offset the price premium. The extent to which labelling is able to do this is unknown. We return to this uncertainty in Section 4.

2.6 Technological Potential for Reducing Rolling Resistance

Tyre technology has been evolving over the years with a constant reduction in rolling resistance since the 1940s, with changes in tyre technology (Figure 2.7). According to the IEA/OECD (2005) there has been constant but slow improvement on rolling resistance over the past decades with a 5% decrease in rolling resistance per decade (after accounting for performance improvements). RRC of tyres in 2000 had declined by over 50% compared to the 1940s.

[10] Mackinac Center for Public Policy, "Price Elasticity of Demand," November 13 1997, www.mackinac.org/1247 No later data has been found to update this estimate.

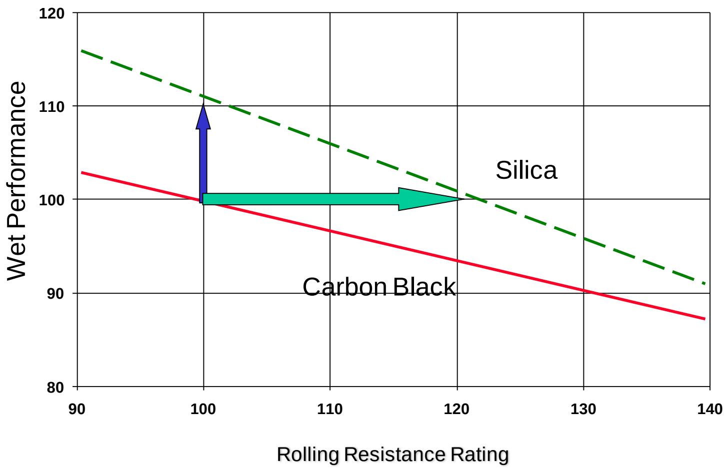
Figure 2.7: Main Tyre Technology and State-of-the-Art RRC Over Time



Source: Michelin Green-meter www.michelingreenmeter.com

In 1992, Michelin launched green energy saving tyres, which integrated silica in the tread as a partial substitute for carbon black. Silica, in decreasing the loss property of the compound, helps to lower rolling resistance without compromising performance in traction, grip (especially on wet surfaces) and tread life (Figure 2.8). This innovation enabled a reduction in fuel consumption of 1.7lt/1,000 kms.

Figure 2.8: Role of Silica in reducing RR without compromising wet grip



Source: Axel Friedrich, Umweltbundesamt (UBA), Germany, CEC Workshop 2002

Today, further advances are still possible. Researchers at Michelin, for example, believe that significant additional reductions in rolling resistance, up to 50 per cent on 2007 standards, is possible within the next 10 to 15 years – a technical challenge to which Michelin is responding with special research programmes.

As discussed in section 2.1, rolling resistance can be reduced by: a) reducing the deformation of the tyre and b) reducing the hysteretic properties of the compounds/textile fabrics. For example, the deformation of a steel wheel of a train is very low, hence an

absolute RRC limit of around 0.1 – 0.2 kg/t. However, this drastically reduces the braking performance due to the small contact footprint and friction value (μ) compared to a car tyre.

The deformation can be reduced by increasing the tyre inflation pressure. However, experiments with high pressurized passenger car tyres have failed in the past because of reduced comfort as well as loss in braking performance. Deformations can also be reduced by optimizing the tyre contour, but this has been exploited considerably with reduced scope for further improvements.

The tyre industry is thus concentrating on reducing the hysteretic properties of the tyre. This is expected to be the main area for reducing rolling resistance in the next decade. This can be done by changing the compound itself with new rubber types and filler systems or by reducing the amount of material. Another way is to reduce the non skid depth, but this would also reduce the tyre lifetime mileage.

According to two tyre producers, the lowest RRC achieved in the replacement market at the current (2008) time for C1, with acceptable levels of wet grip performance is 8.0 to 8.5 kg/t. The state of the art RRC in 2008-2009 from Figure 2.5 (Michelin Green meter) is around 8-9kg/t. Extrapolating the RRC trend in Figure 2.5 indicates a level of RRC of 6 to 6.5kg/t in 2020.

However, it should be recognised that technological evolution cannot be accurately predicted. The tyre industry has to consider a number of factors such as material cost, material technology, market demands and availability of different raw materials. In addition to this the industry also has to meet the proposed noise and wet grip limits without any trade-off on tread wear performance. According to ETRMA, tyres with a RRC of 7.5kg/t in the C1 tyre category (with the possibility of a small number of tyres being available below this level) and 6 – 7.5kg/t in the C2 tyre category could be available by 2020. VTI (2008) indicated that in 2007, the state of the art was probably around 7 kg/t and cited unpublished measurements made in 2007 by tyre technical experts at the Technical University of Gdansk, Poland.

For the purposes of the impact assessment we have assumed that the technological limit in 2020, beyond which RRC can not fall is 6 kg/t for C1 tyres, and hence the maximum incentive is achieved by setting Band A with a RRC below 7kg/t. This reflects:

- tyres currently on the market with RRC of 6.5 - 7kg/t, see Figures 2.2 and 2.3, (although WG and wear performance can be compromised at these levels) and some existing prototypes as low as 5.5kg/t;
- ETRMA views that 7.5kg/t is achievable with a possibility of some tyres in the range 7.0kg/t to 6.0 kg/t;
- a possible 50% reduction (Michelin Greenmeter) in rolling resistance on 2007 standards within the next 10 to 15 years, to around 6kg/t (if the average is assumed to be around 11.5kg/t)

Given the maximum limit of 12kg/t in 2012 from the proposal for a Regulation on general safety of motor vehicles (COM(2008)316) which should set the lowest (worst) band, a RRC range of 12kg/t to 6kg/t is used for this study. However, in consultation with tyre producers it was clear that some producers have greater technological ability to produce tyres in higher bands (low RRC). Therefore, it is possible that not all producers will supply tyres in higher band.

2.7 The Proposed Grading Scheme for Rolling Resistance for the Impact Assessment

In the light of the technological review above, it is possible to consider the type of grading of RR that could provide a framework for assessing the impact of policy options. There are two main considerations: a) what accuracy of grading RRC using tests consistent with ISO 28580 can be achieved? b) what range should the grading cover, based on the likely market distribution in 2012 and the technically feasible reductions of RRC to 2020? Note the time period for the impact assessment was chosen to reflect the intended implementation of the proposed regulation COM (2008)316 in 2012 and the time required to implement agreements on testing. The end point of 2020 was chosen to comply with the objective of the Energy Efficiency Action Plan (COM (2006)545) which sets the target of achieving 20% energy saving by 2020. On the one hand sufficient time is required to elapse for policy options to take effect; on the other, impacts need to be established in a reasonable period of time. The increased benefits from accelerating implementation are examined as part of the impact assessment.

The highest level of accuracy of testing and scoring a tested tyre (in RRC) is approximately +/- 0.33 kg/t for C1/C2 and 0.3 kg/t for C3 tyres, excluding tyre to tyre variation. Based on a controlled sample (ETRTO – IEA Workshop) to assess tyre variation, including this uncertainty would suggest a testing accuracy of closer to 0.5kg/t[11].

There are some producers who suggest that to achieve this accuracy would be too expensive. The costs of testing, even with a three fold increase in costs to achieve an improvement on +/- 0.75kg/t accuracy, are €0.01 per sold tyre. With a testing accuracy of +/-0.5 kg/t it would be possible to band tyres to within at least 1.0 kg/t. It has been suggested in the VTI study that each tyre be given its own score rather than a band. This may work for say a carbon tax but for a labelling scheme where the point is to encourage comparisons bands would provide a clearer basis for customers. A banding would also be required for an instrument such as VAT rate reductions or as the basis of public procurement rules.

The technical range has to match the market range of tyres expected in 2020 to ensure there are tyres available to customers. Based on the review, an RRC range of 12 kg/t to 6 kg/t based on expected state of the art and technological limits in 2020 appears valid for C1. The RRC performance in the market should be monitored and if necessary additional bands should be added to include tyres with RRC below 6 kg/t if necessary. In the case of C2/C3 the number of measured values is smaller and makes definition of the range more difficult. However, the maximum limit should be reviewed when more data becomes available (VTI, 2008). The ranges for C2/C3 reflect the advice from the various consultations. The testing accuracy of 0.5 kg/t would allow 7 bands for C3. To the extent that C3 customers do not have a full choice of tyres across the full RRC range, because of the more specialist nature of the tyres chosen (by truck size, axle and transport use), narrower bandwidths may be required to provide sufficient choice as the basis of market transformation.

The following grading system for C1/C2/C3 has been used in the impact assessment (Table 2.6) based on the maximum limits set out in COM (2008)316 and the considerations described above. The labelling of the bands from G (highest RRC) to A (lowest RRC) is to assist with the presentation of the impact assessment; it is not intended as any specific recommendation for labelling. In the case of energy labelling being the preferred policy option the need for relative banding between C1, C2 and C3 would need to be considered with labelling of bands adjusted in each of the three tyre classes. The need for relative

[11] This assumes the same accuracy is achieved as the one required for the alignment procedure in the draft ISO 28580 and reflects the uncertainty resulting from inter lab variation (μ=0.2) and intra lab test variation (ρ=0.043 for C1/C2 tyres and 0.035 for C3 tyres). Please see Annex 7 for more details.

grading to take account of the possible influence of outside tyre diameter on RRC would also need to be examined. This is discussed in more detail in Annex 7.

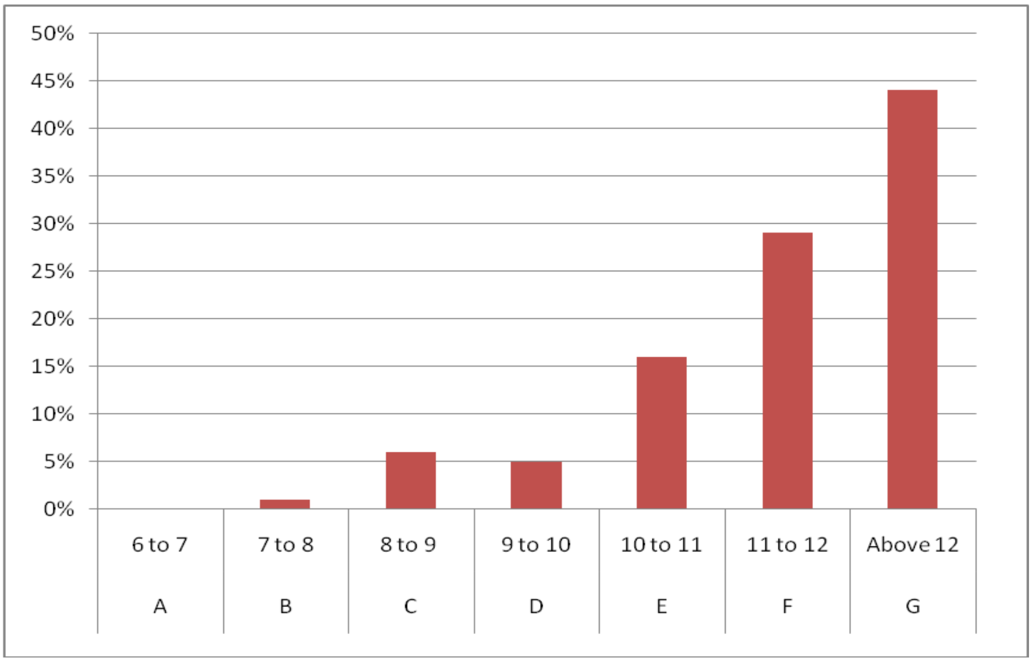
According to the available evidence, there is no requirement for any special classes for winter tyres, or to distinguish between steering and drive axle tyres for C3 tyres (ETRMA and VTI, 2008).

Table 2.6: Classification of Tyres into RRC Classes (kg/t)

	RRC Range for C1 (passenger car tyres)	**RRC Range for C2 (commercial vehicles)**	**RRC Range for C3 (trucks and buses tyres)**
G	Above 12		
F	11 to 12 (12 max limit from 2014 for all tyre types)	above 10.5	Above 8
E	10 to 11	9.5 to 10.5 (10.5 max limit from 2014 for all tyre types)	7 to 8 (8 max limit from 2016 for all tyre tyres)
D	9 to 10 (10.5 max limit from 2018 for all tyre types)	8.5 to 9.5 (9 max limit from 2018 for all tyre types)	6 to 7 (6.5 max limit from 2020 for all tyre types)
C	8 to 9	7.5 to 8.5	5 to 6
B	7 to 8	6.5 to 7.5	4 to 5
A	6 to 7	5.5 to 6.5	below 4

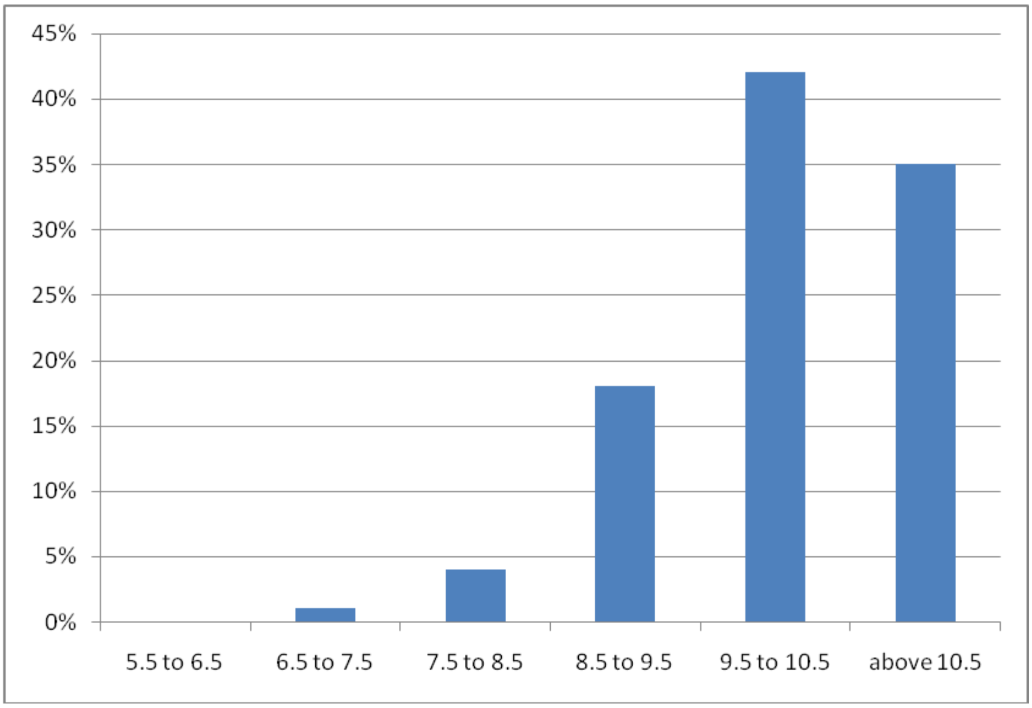
The expected market distribution in each of the three tyre classes in 2012 with respect to this grading is indicated in the following figures (Figures 2.9 to 2.11).

Figure 2.9: Expected RRC Market Distribution in 2012 Passenger Cars (C1 – summer and winter)



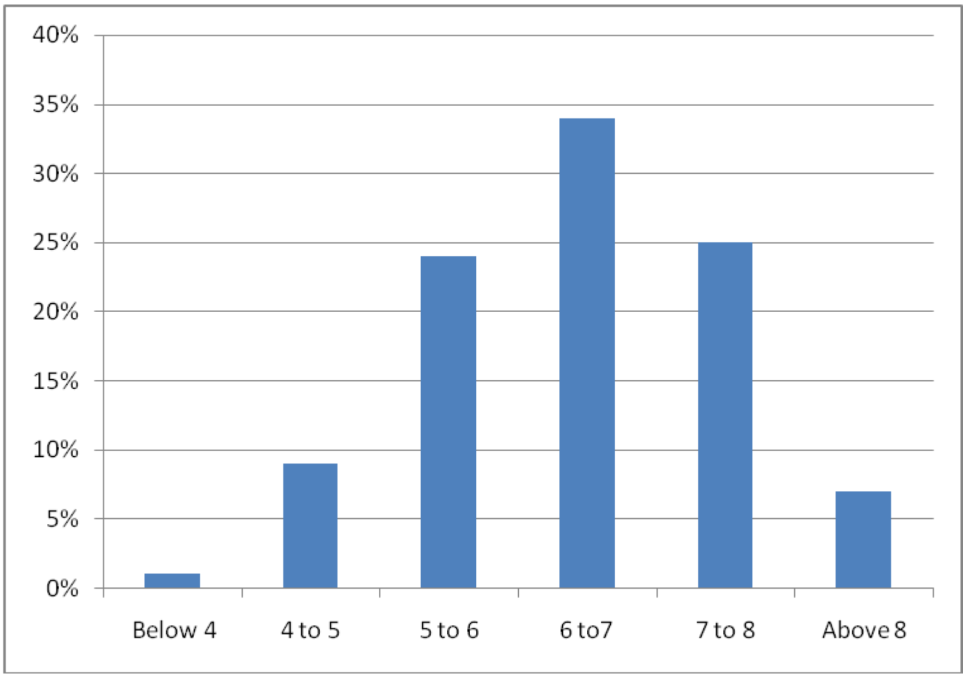
For C1 the grading scheme has approximately 75% of the market in the two lowest bands providing sufficent potential for interventions to secure market transformation (Figure 2.9). For C2 a similar share, 75%, of the market is also in the two lowest bands (Figure 2.10)

Figure 2.10: Expected RRC Market Distribution in 2012 Commercial Vehicles (C2 – summer and winter)



For C3 the market distribution is less skewed to the lowest bands, with only a third of the market in the two lowest bands (Figure 2.11). This refects the original tyre distribution advised by ERTMA, see Table 2.1.

Figure 2.11: Expected RRC Market Distribution in 2012, Trucks and Buses (C3 – summer and winter)



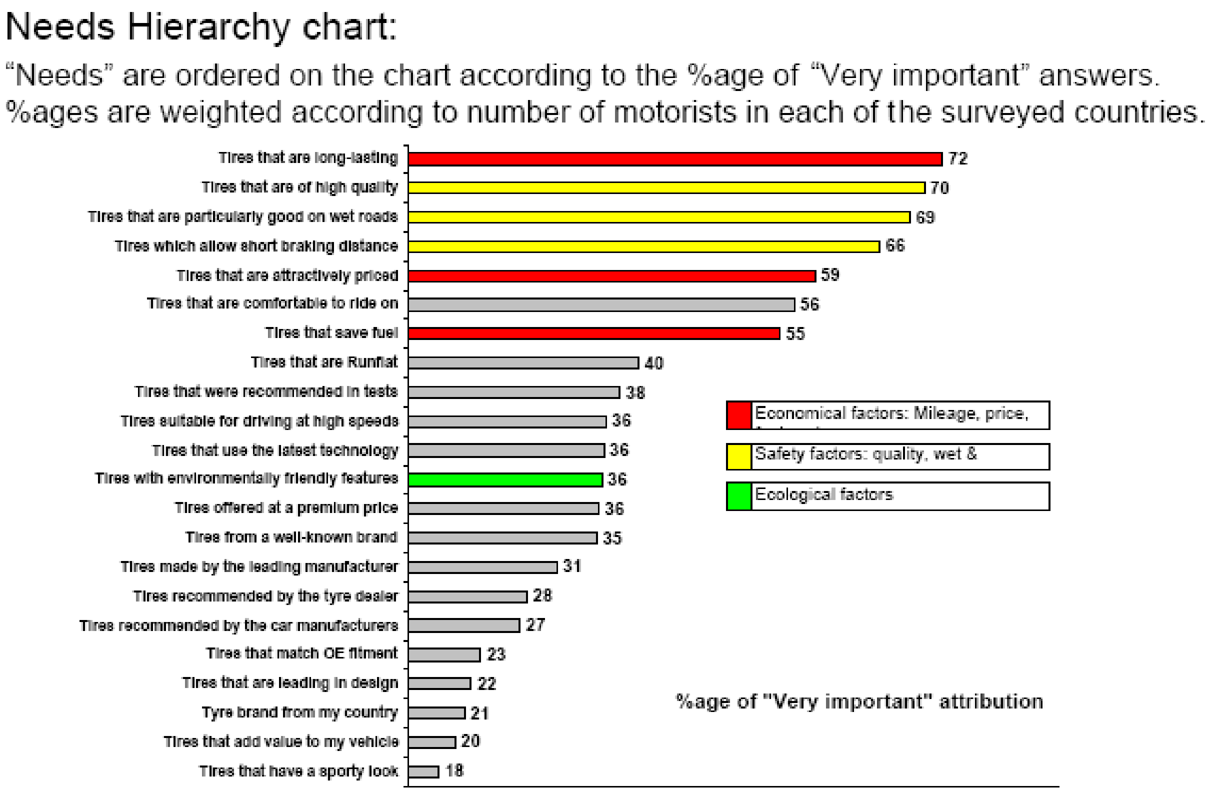
3 COSTS AND BENEFITS OF LOWER ROLLING RESISTANCE FOR TYRE CUSTOMERS

3.1 Criteria for Choosing Tyres

For new vehicles the vehicle manufacturer and in some cases the importer decides on the specifications of the set of original equipment (OE) tyres and thus decides the desired quality and costs. For the replacement tyre market the owner of a vehicle (including businesses and vehicle leasing companies) decides on the replacement fit. A share of the replacement market demand is from business rather than individual consumers. This includes the purchase by dedicated service stations for car dealers or by car dealers or service stations for car lease companies and vehicle fleet managers. Data from Benelux Member States and from the UK suggests that this demand could represent a third of the market. We define tyre customers to include both businesses and individual consumers.

Current consumer preferences are summarised in Figure 3.1 below. Tyre wear, good grip and braking properties are the most important attributes for consumers, though fuel savings are a very important attribute for 55% of consumers. Consumers may also decide beforehand to fit the same tyre as the OE (23% of respondents consider that "tyres that match the OE fitment" are 'very important' in their purchasing decision and 28% of respondents consider "tyres recommended by the retailer" to be 'very important'). Business preferences are unlikely to be very different, with perhaps greater weight on those parameters such as price, tyre wear and fuel efficiency that effect costs.

Figure 3.1: Consumer Preferences for Tyre Attributes, 2006



Source: (TAAS) Tyre Awareness and Attitude Study, Frequency & Methodology: Yearly (since 1999). Includes face-to-face (or online) interviews and 30 minutes structured questionnaire (incl. Physical tyre check). Countries & no. of respondents (2006): France, Italy, UK, Spain, Switzerland, Portugal, Belgium, Austria, Greece, Denmark: 6908 Respondents + Germany (run by IPSOS): 1038 Respondents. Total: 7946 Respondents. Contracted agency: Open-air market research www.open-air.fr

3.2 Improved Fuel Efficiency and Fuel Cost Savings

In the literature (see Annex 5), a 10% reduction in RRC is estimated to provide between a 1% and 2% improvement in fuel economy. According to ETRMA, for C1/C2, a 6% reduction in RRC leads to a 1% reduction in fuel consumption (equivalent to a 10% reduction in RRC leading to a 1.67% reduction in fuel consumption). The impact assessment for C1/C2 is based on a 1.5% reduction in fuel consumption for a 10% reduction of RRC[12]. The fuel savings potential for trucks and buses (C3) is higher than for C1/C2, for a given reduction in RRC. A 15% reduction in RRC leads to a 5% reduction in fuel consumption (equivalent to a 10% reduction in RRC leading to a 3.33% reduction in fuel consumption) (INFRAS,2006 and Barand and Bokar, 2008). See Annex 5 for details

Empirical calculations by Barand and Bokar (2008) on the impact of reducing RRC by 1kg/t on fuel consumption for a medium sized EU gasoline (petrol) and diesel car under the New European Driving Cycle (NEDC) is given in Table 3.2a and Table 3.2b below. Three sets of tyres were chosen with nearly 2kg/t variation between them. The study also showed that real fuel savings are almost independent of the driving cycle.

Table 3.2a: Fuel Savings and CO2 Reduction on NEDC for Petrol – Mid-size Car

NEDC	Fuel consumption (l/100km)	CO2 emission (g/km)	Fuel savings per 1kg/t reduction in RRC (l/100km)	CO2 reduction per 1kg/t reduction in RRC (g/km)	Reduction in fuel consumption due to 1kg/t reduction in RRC (%)	Reduction in CO2 due to 1kg/t reduction in RRC (%)
Tyre set A	7.49	176.80				
Tyre set B	7.70	181.70				
Tyre set C	7.96	187.70				
Average	**7.72**	**182.07**	**0.13**	**3.00**	**1.68%**	**1.65%**

Source: Barand and Bokar, 2008, SAE

Table 3.2b: Fuel Savings and CO2 Reduction on NEDC for Diesel – Mid-size Car

NEDC	Fuel consumption (l/100km)	CO2 emission (g/km)	Fuel savings per 1kg/t reduction in RRC (l/100km)	CO2 reduction per 1kg/t reduction in RRC (g/km)	Reduction in fuel consumption due to 1kg/t reduction in RRC (%)	Reduction in CO2 due to 1kg/t reduction in RRC (%)
Tyre set A	5.86	154.90				
Tyre set B	5.99	158.40				
Tyre set C	6.17	163.00				
Average	**6.01**	**158.77**	**0.08**	**2.20**	**1.33%**	**1.39%**

[12] Based on recent research published by Barrand J and Jason Bokar (Michelin), 2008, Reducing Tire Rolling Resistance to Save Fuel and Lower Emissions, SAE Technical Paper Series

Source: Barand and Bokar, 2008, SAE

Assuming that the EU passenger car fleet comprises of 50% gasoline and 50% diesel vehicles, a 1kg/t reduction in RRC leads to 1.5% (average of 1.68% and 1.33%) reduction in fuel consumption.

The 1.5% reduction in fuel consumption based on a 1 kg/t reduction for a mid-size passenger car is assumed to be representative of the average EU car fleet due to the absence of test data for vehicles of different sizes. The absolute impact of a 1.5% reduction in fuel consumption for a bigger car will be higher than a smaller car (Table 3.2c).

Applying the 1.5% reduction in fuel consumption from a 1kg/t reduction in RRC to the average fuel consumption (l/100km) and CO2 emissions (g/km) of the EU car fleet for years 2008 and 2012-2020 enables an estimate of the fuel and CO2 saving (Table 3.3a and 3.3b). In summary, 1.5% fuel savings (i.e. a 10% reduction of RR) is equivalent to a fuel saving of 0.12 l/100km and a CO2 saving of 3 g/km for the EU Fleet average in 2008[13]. Annex 5 provides equivalent fuel saving estimates for C2 and C3 tyres.

Table 3.2c: Fuel Consumption Performance by Car Size from 1.5% Reduction in Average Fuel Consumption

	Average CO2	Average Fuel Consumption	1.5% Fuel Consumption Reduction	Revised Average Fuel Consumption
	CO2 g/km	l/100km	(l/100km)	(l/100km)
Mini	128.5	6.19	0.09	6.09
Supermini	141.8	6.83	0.10	6.72
Lower medium	158.6	7.64	0.11	7.52
Upper medium	169.1	8.14	0.12	8.02
Executive	192.6	9.27	0.14	9.13
4x4	228.3	10.99	0.16	10.83
Luxury	273.8	13.18	0.20	12.98

Source: The Society of Motor Manufacturers and Traders, UK

Table 3.3a: Effect of a 1.5% Reduction in Fuel Consumption on the Average EU Passenger Car Fleet (l/100km)

	EU Fleet Average Fuel Consumption	1.5% of EU Fleet Average Fuel Consumption	EU Fleet Average Fuel Consumption Following Reduction
	l/100km	l/100km	l/100km
2008	8.04	0.12	7.92
2012	7.32	0.11	7.21
2020	6.18	0.09	6.08

[13] The 1.5% reduction due to a 1kg/t reduction in RRC based on a mid-size car seems to be a good approximation for the EU average fleet . The saving in 0.12 l/100 km and 3.0 CO2 g/km when based on the EU fleet average matches very closely with the saving in fuel of 0.11 l/100km and 2.6 CO2 g/km from Table 3.2a and 3.2b

Source: ETRTO and CARS 21

Table 3.3b: Effect of a 1.5% Reduction in Fuel Consumption on CO2 Emissions of the Average EU Passenger Car Fleet (CO2 g/km)

	EU Fleet Average		**1.5% of EU Fleet Average CO2**		**EU Fleet Average CO2 Following Reduction**	
	TA CO2 g/km	**RW CO2 g/km**	**TA CO2 g/km**	**RW CO2 g/km**	**TA CO2 g/km**	**RW CO2 g/km**
2008	167	199	2.5	3.0	164	196
2012	152	182	2.3	2.7	150	179
2020	128	153	1.9	2.3	126	151

Source: ETRTO and CARS 21 Note: TA - Type Approval: RW- Real World

This estimated impact of a given reduction in RRC on fuel consumption allows an estimate of fuel cost savings per tyre in money terms for an individual car owner, given a lifetime tyre use of 40,000km or 2.5 years.

The level of future fuel cost savings depends on the future level of oil prices. This is highly uncertain, although future prices are expected to rise in real terms compared to current prices. The impact assessment has used three long term oil price scenarios to 2020 (Table 3.4). The fuel cost (i.e. the fuel price excluding all taxes) heavily depends on the price of oil. A relation between oil price and fuel cost has been determined in (TNO 2006) (See Annex 5 for more details).

Table 3.4: Future EU Oil and Fuel Price Scenarios in 2020

	Oil price €/bbl	Avg Fuel price €/lt (exc. Fuel Tax and VAT)	Avg Fuel price €/lt (inc. Fuel Tax and VAT)	Diesel price €/lt (inc Fuel Tax, exc. VAT)
Scenario 1	50	0.41	1.03	0.80
Scenario 2	75	0.61	1.28	1.02
Scenario 3	100	0.80	1.53	1.23

Source: Eurostat[14], TNO Estimates

Note: Relation between oil price and fuel price (with and without tax) is based on the average EU-27 diesel and petrol price (with and without tax) provided by Eurostat

The fuel cost savings from policy options are calculated by multiplying the change in fuel consumption due to the change in RRC band due to the option, by fuel prices assuming that the EU passenger car fleet is 50% petrol and 50% diesel.

The fuel cost savings per tyre resulting from a change of 1.0 kg/t is presented in Table 3.5. Since the fleet average fuel consumption (l/100km) and CO2 g/km reduces over time, the fuel cost savings per tyre from a one band change decreases during the period 2012-2020. Fuel costs savings should be considered as savings per set of 4 tyres. This is because the

14

http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H2/H21/ebc24848

http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H2/H21/ebc25360

fuel savings from the use of low RR tyres would only apply if all four tyres are changed at the same time.

Table 3.5: Life-time Fuel Cost Savings (€) per Tyre from a 1 Band Change – 1.0kg/t bandwidth (1.5% fuel saving per 1.0 kg/t reduction)), inc. tax, for Oil Price Scenarios

	Fuel Cost Saving per Tyre (€)		
	Scenario 1	Scenario 2	Scenario 3
2012	11.3	14.0	16.8
2013	11.0	13.7	16.4
2014	10.7	13.4	16.0
2015	10.5	13.1	15.6
2016	10.3	12.8	15.3
2017	10.0	12.5	15.0
2018	9.8	12.3	14.7
2019	9.7	12.0	14.4
2020	9.5	11.8	14.2

Source: GHK estimate

3.3 Additional Costs of Lower RR Tyres per Tyre

The current weighted average price of premium, mid and budget C1 summer tyres is €87 inc VAT and €70 exc VAT. The incremental cost of moving from one band to the next highest is calculated by applying the price premium in Table 2.5a to the weighted average tyre price. Results are given in Tables 3.6 and 3.7. For example, for single labelling, the price premium of moving from Band F to Band E is 2.3% or €2 with VAT. To move from Band B to Band A the price premium is 5% or €4.3 with VAT.

Table 3.6: Price Premium for Reductions in RRC by 1kg/t, Moving from 1 Band to the Next Highest Band, RR only labelling (C1 Summer Tyres)

	A+	A	B	C	D	E	F	G
RRC kg/t	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
Price premium (%)	?	5.00%	3.50%	2.80%	2.50%	2.30%	0	0
Price premium (€) inc. VAT	?	4.3	3.0	2.4	2.2	2.0		
Price premium (€) exc. VAT	?	3.5	2.5	2.0	1.8	1.6		

Table 3.7: Price Premium for reductions in RRC by 1kg/t. Moving from 1 Band to the Next Highest Band, Dual labelling (C1 Summer Tyres)

	A+	A	B	C	D	E	F	G
RRC kg/t	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
Price premium (%)	?	10.00%	7.00%	5.60%	5.00%	4.60%	0	0
Price premium (€) inc. VAT	?	8.7	6.1	4.9	4.3	4.0		
Price premium (€) exc. VAT	?	7.0	4.9	3.9	3.5	3.2		

Applying the price premium (Table 2.5b) of purchasing a tyre in a higher band compared to band F to the weighted average price of car summer tyres (€87 inc VAT and €70 exc VAT) indicates the cost (2008 prices) of moving bands relative to band F, (Tables 3.8 and 3.9).

Table 3.8: Price Premium for Moving Bands Compared to Band F (RR only labelling, 1 kg/t), C1 Summer Tyres

	A+	A	B	C	D	E	F	G
RRC kg/t	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
Price premium (%)	?	16.10%	11.10%	7.60%	4.80%	2.30%	0	0
Price premium (€) inc. VAT	?	14.0	9.6	6.6	4.2	2.0		
Price premium (€) exc. VAT	?	11.3	7.8	5.3	3.4	1.6		

Table 3.9: Price Premium for Moving Bands Compared to Band F (Dual labelling, 1 kg/t), C1 Summer Tyres

	A+	A	B	C	D	E	F	G
RRC kg/t	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
Price premium (%)	?	32.20%	22.20%	15.20%	9.60%	4.60%	0	0
Price premium (€) inc. VAT	?	27.9	19.2	13.2	8.3	4.0		
Price premium (€) exc. VAT	?	22.6	15.6	10.7	6.7	3.2		

The additional tyre cost and fuel cost saving per tyre allows the payback period for an individual car owner to be calculated. This is shown in Table 3.10 below. For example, if a customer purchases 4 tyres from band E then this will cost them an additional €8 compared to band F (from Table 3.8). Tyres are expected to last 2.5 years on average during which a set of 4 tyres purchased in 2012 would provide (under oil price scenario 2) €56 worth of fuel cost savings (€14x4, from Table 3.5). This gives a pay-back period of around 4 months

under the RR only labelling[15]. Note that the payback period increases with moves to higher bands as a result of the rising marginal price premium in higher bands, and as a result of dual labelling compared to single labelling because of the greater price premium for dual labelling.

Table 3.10: Average Payback Period (Months) in 2013 for Moving Bands Compared to Band F (inc. Vat), RRC 1 kg/t, Oil Price Scenario 2

	A+	A	B	C	D	E	F	G
RRC kg/t	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
Single Labelling (RR only)	?	6	5	5	4	4		
Dual Labelling (RR & WG)	?	8	8	7	7	7		

3.4 Net Cost Savings per Tyre for a Vehicle Owner for a 1 Band Move (C1 summer)

The fuel cost savings per tyre for a given reduction in RRC by 1kg/t are greater than the additional costs to customers. There is a marginal reduction in net cost savings with a move to higher bands. This is summarised in Table 3.11 and 3.12.

Table 3.11: Net Cost Savings (€) per Tyre per Band for a Reduction of RRC of 1kg/t, 2020 (inc. VAT), RR only labelling

RR only		**Additional costs of LRRTs (€ per tyre)**	**Fuel saving per band (€ per tyre)**	**Net cost saving (€)**
G	Above 12			
F	12 to 11			
E	11 to 10	2.0	11.8	9.8
D	10 to 9	2.2	11.8	9.6
C	9 to 8	2.4	11.8	9.3
B	8 to 7	3.0	11.8	8.7
A	7 to 6	4.3	11.8	7.4
A+	6 to 5			

Note: Based on oil price scenario 2

Table 3.12: Net Cost Savings (€) per Tyre per Band for a Reduction of RRC of 1kg/t, 2020 (inc. VAT), Dual labelling

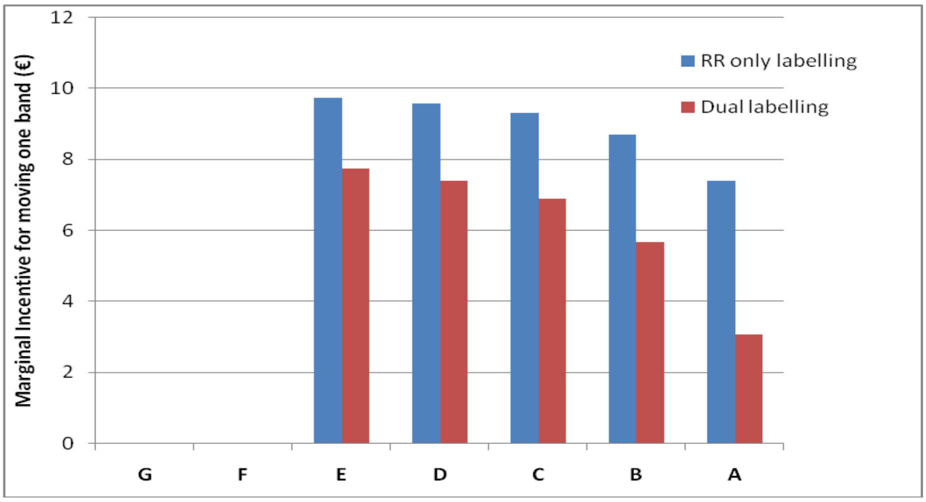
Dual labelling		**Additional costs of LRRTs (€ per tyre)**	**Fuel saving per band (€ per tyre)**	**Net cost saving (€)**
G	Above 12			
F	12 to 11			
E	11 to 10	4.0	11.8	7.8
D	10 to 9	4.3	11.8	7.4
C	9 to 8	4.9	11.8	6.9
B	8 to 7	6.1	11.8	5.7
A	7 to 6	8.7	11.8	3.1
A+	6 to 5			

Note: Based on oil price scenario 2

[15] €8 divided by €1.86 fuel savings per month (€56/30mths).

Table 3.11 and 3.12 suggest that the rate of market transformation towards lower RR tyres will be influenced by the effect of declining economic incentives at higher bands (Figure 3.2 below). Even though a shift to higher bands is cost-effective and economically rational for customers, the incentive is greater to move in the lower bands than to move in the higher bands (say band B to band A). A faster switch from say Bands F or E to say D or C would be expected compared to a switch from bands C or D to bands B or A. Because fuel savings from a change to LRRTs decline slightly in later years as overall vehicle efficiencies improve, the disincentive to switch in higher bands will be lower in earlier years.

Figure 3.2: Marginal Incentive for Moving One Band



3.5 Cumulative Net Cost Savings per Tyre for a Vehicle Owner Moving From Band F (C1 summer)

Following the introduction of a labelling scheme, under RR only labelling if a customer for example, switches tyres from an F band to a B band in 2013 then the additional cost of 4 tyres would be €38 inc. VAT (From Table 3.8 €9.6×4). The fuel cost saving over the lifetime of the 4 tyres would be €219 inc tax (From Table 3.5, €13.7x4x4[16]). This gives a net cost saving of €181 per vehicle or €45.3 per tyre. The estimated cumulative fuel cost savings and net savings of moving from F to a higher band are given in Table 3.13 below.

Table 3.13: Net Savings of a Shift from F to Higher Band (€ per tyre), in 2013, RRC 1kg/t

			RR only labelling		Dual labelling	
		Cumulative fuel savings per tyre(€)	Additional costs per tyre (€)	Net savings of a shift from F to higher band (€)	Dual labelling additional costs per tyre (€)	Net savings from a shift from F to higher band (€)
G	Above 12					
F	12 to 11					
E	11 to 10	13.7	2.0	11.7	4.0	9.7
D	10 to 9	27.4	4.2	23.2	8.3	19.1
C	9 to 8	41.1	6.6	34.5	13.2	27.9
B	8 to 7	54.8	9.6	45.2	19.2	35.6
A	7 to 6	68.5	14.0	54.5	27.9	40.6

16 €13.7 x 4 tyres x 4 band shift (F to B)

3.6 Costs of CO2 Abatement

The abatement costs of reducing CO2 emissions by reducing RR by 1 kg/t from passenger cars with LRRTs depend on the fuel savings, oil prices and additional costs of LRRTs, described above. This allows an estimate of the costs to achieve a given reduction or abatement in CO2 emissions.

The abatement costs per tyre in Table 3.14a and Table 3.14b below are based on real world fuel consumption and CO2 emissions in 2020 assuming all four tyres are changed. For an oil price of 75 €/bbl the CO2 abatement costs, under oil price scenario 2, range from -54 €/tonne to -155 €/tonne under single labelling and from 152 €/tonne to -66 €/tonne under dual labelling. Note the negative sign indicates that because fuel cost savings are greater than the price premium of LRRTs, the abatement is achieved without additional cost. In other words the abatement per tonne is associated with an economic saving to the EU economy.

Table 3.14a: CO2 Abatement Cost (€/tonne) per Tyre per Band for a Reduction of RRC of 1kg/t, 2020 (ex. VAT), RR Only Labelling (assuming all 4 tyres are changed)

	A+	**A**	**B**	**C**	**D**	**E**	**F**	**G**
RRC kg/t	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
CO2 abatement (€/tonne) sc. 1		31	-30	-58	-69	-75		
CO2 abatement (€/tonne) sc. 2		-54	-114	-140	-150	-155		
CO2 abatement (€/tonne) sc. 3		-138	-197	-222	-231	-235		

Table 3.14b: CO2 Abatement Cost (€/tonne) per Tyre per Band for a Reduction of RRC of 1kg/t, 2020 (ex. VAT), Dual Labelling (assuming all 4 tyres are changed)

	A+	**A**	**B**	**C**	**D**	**E**	**F**	**G**
RRC kg/t	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
CO2 abatement (€/tonne) sc. 1		237	112	54	30	14		
CO2 abatement (€/tonne) sc. 2		152	28	-28	-51	-66		
CO2 abatement (€/tonne) sc. 3		68	-55	-110	-132	-146		

4 MARKET IMPACT OF POLICY OPTIONS

4.1 Policy Options

The impact assessment has identified a range of policy options designed to secure a market transformation to lower rolling resistance tyres. These are summarised in Table 4.1.

Options considered, but now removed after initial research, were:

- Tyre labelling based on 'brands' such as the Nordic eco-label or the Blue Angel label in Germany – because there is no evidence that they are capable of providing a dynamic incentive, and fail to focus attention on RR. Producers are also opposed because of cost and lack of market impact

- Voluntary agreements – because although there is a high concentration of EU sales among EU producers, there would be a requirement to include other producers (especially of EU imports), of which there are too many for a feasible agreement

During the course of the impact assessment major changes have been made or are proposed, which are assumed to be part of the reference case. The first is the proposed EC regulation (COM(2008)316) on general safety of motor vehicles which includes minimum standards for rolling resistance introduced over a period starting in 2012. The second is a proposal for changes in the Type Approval test for vehicles on fuel efficiency, which requires the tyre with the worst RR for the test (or where there are more than three sizes of tyre, the second worst); and that tyres fitted to production models should reflect those used in the test.

Based on the initial assessment the following options have been agreed as the basis of the detailed impact assessment. It is assumed within the framework of this study that the implementation date for a labelling scheme is October 2012 at the same time as the supposed entry into force of the new standards on tyre defined in COM(2008)316, which will have a market impact in 2013 and in subsequent years:

- **Option A:** No new EU actions = reference case including the adoption of minimum requirements on Rolling Resistance as proposed in (COM(2008)316) and existing incentives on car producers to fit their vehicles with LRRT in order to reduce type approved (TA) emissions measurement.

- **Option B:** Single criteria labelling scheme for C1 tyres on energy efficiency (RR) with limit values on other parameters (wet grip (safety) and rolling noise)

- **Option C:** Multi-criteria labelling scheme for C1 tyres, adoption of a labelling scheme which provides a grading on both RR and wet grip and possibly noise

- **Option D:** Single criteria labelling scheme extended to C2 and C3 tyres (respectively light and heavy duty vehicles) representing respectively 8% and 5% of total tyre sales.

- **Option E:** Economic instruments and public procurement. This option does not necessarily substitute other options but could complement energy labelling.

Note: The total impact assessment only account for savings occurring on the replacement market as it is assumed that a labelling scheme will have no significant impact on the OE market. See more explanation in annex 1.

Table 4.1: Assessment of Policy Options

Assessment Criteria	Policy Options					
	Do Nothing – Reference Case (including minimum standards)	Energy Labelling	Public Procurement	Economic Instrument	Voluntary Agreement	Type Approval (part of the reference case –Do Nothing)
Problem Relevance	Market trends will be influenced by the proposed EC regulation (COM(2008)316) on general safety of motor vehicles and TA legislation on car emissions	Labelling information on RR will influence those consumers concerned about fuel economy. Market failure in tyre replacement market addressed	Public sector environmental responsibilities are reflected in standards for products including 'green' vehicles	Fiscal incentives to purchase LRRT. Incentives could be based on emissions (carbon tax) or changes in current tax rates (VAT)	Tyres with the worst fuel economy would be withdrawn to an agreed schedule	TA rules put pressure on car producers to lower vehicle emissions. As tyres impact TA measured values, TA provides incentives for car producers to fit cars with LRRT
Objective Relevance & Outputs	The proposed regulation will introduce minimum standards for rolling resistance	Market transformation to LRRT requires changes in consumer preferences, or ways in which preferences can be expressed – information will help	Public sector market share in OE and replacement markets will influence direct outputs (greater in C2 and C3). Some indirect influence on other consumers	Incentives change consumer preferences in favour of LRRT depending on relative scale compared to market price	As with standards, withdrawal of tyres with high rolling resistance would force consumers to select tyres with lower rolling resistance	TA tyre rules may influence OEM; and, because replacement of like for like is common, influence choices in the replacement market
Evolution & Context	The proposed regulation will replace the existing Type Approval for tyres (defined in Directive 92/23/CE and its amendments)	Energy efficiency labelling of household electrical appliances provides some insight to possible rates of market transformation over time	Growing use of public sector procurement to further environmental objectives	A range of economic instruments have been used to incentivise carbon savings, including carbon taxes and differential VAT rates	Voluntary agreements have been used in a wide range of contexts to secure environmental objectives	TA for tyres and vehicles are well established based on international agreement. Recent proposals for changes to TA for vehicle fuel efficiency and specification of RR tyres for test
Activities &	Proposed regulation will introduce minimum	Mandatory use of labels including the use	Addition of LRRT to tyre procurement	VAT differentials can be implemented by MS.	Producers would need to conclude a	TA rules are rigorously defined and implemented.

Assessment Criteria	Policy Options					
	Do Nothing – Reference Case (including minimum standards)	Energy Labelling	Public Procurement	Economic Instrument	Voluntary Agreement	Type Approval (part of the reference case –Do Nothing)
Implementation	standards starting in 2012, and periodically to 2018. Prior investment in testing and grading for RR will be required	of internet access to databases of tyre performance, and posters. Labelling based on grading tyres into bands to allow comparison.	standards	Carbon taxes require MS unanimity at EU level. Taxes apply to all tyres sold in EU irrespective of origin of production	common agreement. Given competition from imports, non-EU producers would need to participate	Changes require major review.
Expected Outcomes	Will ban worst performing tyre and progressively improve RR of tyres	Increase in replacement market share of LRRT, depending on pace of change. Labels of limited use in OE market	Changes in public sector procurement. Overall market impact largely limited to public share	Depending on relative scale of incentives, increases in LRRT market shares can be expected	A concluded agreement could, depending on scheduled withdrawal, lead to changes in market share	TA rules have a direct effect on OEMs and, indirectly on replacement tyres when replacing OE

4.1.1 Energy Labelling Options

Product labelling is a long established method for producers to influence consumer demand. Energy labelling has become a strong market and sales tool in the case of domestic appliances. Providing customers for tyres with information on RR and fuel efficiency would be expected to influence the demand of a share of tyre customers and to increase the share of the market taken by lower rolling resistance tyres.

The effect of energy labelling (including the provision of performance data on RRC via the Internet) is to encourage customers to buy energy efficient tyres in higher bands. Over time the market share of tyres in lower bands should decline as the market moves to higher bands. The likely pace of change is unknown but can be informed by evidence from the experience of energy labelling of domestic appliances. Experience with labelling schemes has shown that uptake of products in the higher energy efficient bands takes time to occur. To allow for the inherent uncertainty over the pace of change that a labelling scheme will have on customers, the impact assessment examines a slower and a faster pace of change. This is based on different assumptions about the share of the market in any one band moving to the next highest band within a year, over the period 2012 to 2020.

The number of bands and hence the number of tyre choices provided to the customer can be expected to influence the effectiveness of energy labelling. Use of a narrower bandwidth to grade RRC (of say 1.0 kg/t) would provide customers with more choice compared to the use of a broader bandwidth (of say 1.5 kg/t), although change from one band to the next has less effect on levels of RR in the market when moving between bands of a narrower bandwidth. The use of a narrower bandwidth requires greater accuracy in the testing and grading of tyres generating a higher cost, although this cost is marginal in comparison with the estimated level of production costs (say €0.01 per sold tyre on an average price before tax of €70 per tyre).

Providing customers with information on rolling resistance will therefore change the demand of some customers. In the absence of any information on wet grip, these customers are likely to seek to purchase tyres with lower RRC at the price normally paid, resulting, in some cases, in customers purchasing tyres with lower wet grip performance than they would otherwise have chosen. Thus it is important to test two variants of energy labelling – (1) a single grading scheme on RR only, and (2) a multi-criteria grading scheme on different tyre parameters. Stakeholder consultation has suggested that 3 parameters could be considered in the short term for a multi-criteria grading scheme including, RR, WG and rolling noise.

Due to the timeframe of the study, it has focused on a dual labelling scheme on RR and wet grip, but this does not imply the exclusion of rolling noise from a labelling scheme. The need to comply with minimum rolling noise standards in any policy option has been taken into account in the estimate of costs. The single grading scheme will ensure that future RR reductions achieve at least the minimum standards for WG and rolling noise while a dual labelling scheme will ensure simultaneous improvement in both RR and WG above the minimum requirements.

The market impact of energy labelling has been assessed against a reference case that takes into account a number of new or proposed polices that will directly or indirectly influence RR in the future, including the adoption of minimum standards for rolling resistance, wet grip and rolling noise. The introduction of a minimum standard on wet

grip to be brought in by 2012/14 is stricter than the current benchmark. The standard is expected to remove 30% of the current tyres on the market that fall below the proposed standard.

The impact of energy labelling is considered only in relation to the replacement tyre market (summer and winter tyres). The impact of energy labelling on vehicle producers who specify the original equipment (OE) tyres is considered to be negligible given that they already undertake extensive market research into the preferences of consumers (including fuel efficiency). They are also subject to incentives as a result of the Type Approval requirements for certifying vehicle fuel efficiency, which will also cause them to negotiate the optimum level of rolling resistance for OE with tyre producers. Further discussion is provided in Annex 1.

4.1.2 Economic instruments and public procurement

The first stage of the impact assessment also identified the possibility of securing market transformation to LRRTs using economic instruments. The use of market based instruments to influence demand is a well established principle and one which receives regular recommendation, especially for responding to environmental externalities. In the case of tyres, given the grading framework proposed for certifying rolling resistance and the technical evidence on the scale of externality associated with higher rolling resistance tyres, it is feasible to consider either a carbon tax based on the social cost of carbon as revealed by the EU emissions trading scheme (ETS), or a simple reduction in VAT rates for tyres achieving a given and certified level of rolling resistance. These are both examined further as individual options. They are not necessarily an alternative to energy labelling, although it would make policy design more complex to combine an economic instrument with energy labelling. The scope to use economic instruments as a complement to energy labelling is considered further in the impact assessment.

The review of options also identified the possibility of using public procurement rules as a means of encouraging take up of LRRTs. Since the share of the market taken by public bodies is likely to be small, it was considered that rather than a stand alone option, it could act to complement other policy options. This is examined below in Section 4.6.3.

4.2 Base Case – Business as Usual (BAU) Tyre Market Distribution by RRC

Before examining the policy options, the impact assessment has reviewed the possible ‘business as usual’ case in the absence of any new public intervention in terms of the market distribution of RRC. ETRMA provided an estimate of the approximate share of the replacement tyre market in 2012, based on the ‘State of the Art, 2004’ data in Figure 2.1 above. This is based on the tyre industry’s expectation of future supply and demand characteristics (Table 4.1).

Table 4.1: ETRMA ‘Business as Usual’ Estimate of the Share (%) of Replacement C1 Summer Tyre Market by 1.5 kg/t RRC Bands, 2012

	Grade A	B	C	D	Above D
RRC (kg/t)	below 9	9 to 10.5	10.5 to 12	12 to 13.5	Above 13.5
SOA 2004	2%	15%	41%	34%	9%
2012	10%	25%	35%	30%	0%

Source: ETRMA TPIA (2007)

This assessment has been translated into an approximate representation of the market profile indicated, but using the grading framework described in Section 2.7, using 1kg/t bandwidths. The resultant translation is presented in Table 4.2. This provides a benchmark for examining subsequent policy changes.

Table 4.2: 'Business as Usual' Estimate of the Share (%) of Replacement C1 Summer Tyre Market by 1.0 kg/t RRC Bands, 2012

Bands	A	B	C	D	E	F	G
RRC	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
Base SOA 2004		0%	1%	6%	19%	30%	43%
2012		1%	9%	7%	20%	33%	30%

Source: GHK estimate

Data for C2/C3 tyres for 2012 was not available. The BaU case for C2/C3 is based on the estimates for 2004.

4.3 Option A: Reference Case – Based on Minimum Standards for RR

The reference case provides an estimate of market changes projected to occur from 2012 in the absence of the policy options, but assuming implementation of current proposals, including COM(2008)316 and especially minimum standards for rolling resistance. Minimum standards according to the latest Commission proposal on the Regulation of the European Parliament and of the Council concerning type-approval requirements for the general safety of motor vehicles, COM(2008) 316 final on 23.05.2008, are summarised in Table 4.3:

Table 4.3 Proposed Minimum Standards for RRCs for Vehicle Tyres

	First Stage		Second Stage		
	Oct 2012	Oct 2014	Oct 2016	Oct 2018	Oct 2020
C1 (passenger cars)	12kg/t (new tyre types (TT))	12kg/t (existing TT)	10.5kg/t (new TT)	10.5kg/t (existing TT)	
C2 (light duty vehicles)	10.5kg/t (new TT)	10.5kg/t (existing TT)	9kg/t (new TT)	9kg/t (existing TT)	
C3 (heavy duty vehicles)	8kg/t (new TT)		8kg/t (existing TT) 6.5kg/t (new TT)		6.5kg/t (existing TT)

Source: COM(2008)316

Note: TT – tyre type

The reference case is based on the assumed market evolution in the absence of policy interventions until 2020 (calculated in projecting the observed 2004-2012 trend) and is then adjusted to reflect minimum standards. The adjustment is based on an assumption that the switch by consumers from tyres that fail to meet the minimum standard to tyres in other tyre bands is proportional to the size of the sales in each band. There is no reason to assume that customers of tyres no longer allowed have any systematic preference for tyres with higher or lower RR.

In 2012, the minimum standards are applied in the First Stage (Table 4.3) to new tyre products. On average tyre product lines change every 3-4 years and are therefore

assumed to be a third of the market in any given year. Existing tyre products are given a further 2 years to comply. This leaves a certain proportion of the tyre market above the limit in 2012, but none of the market above the limit in 2014 for PCs and CVs. Estimates for later years take account of the proposed Second Stage increase in standards.

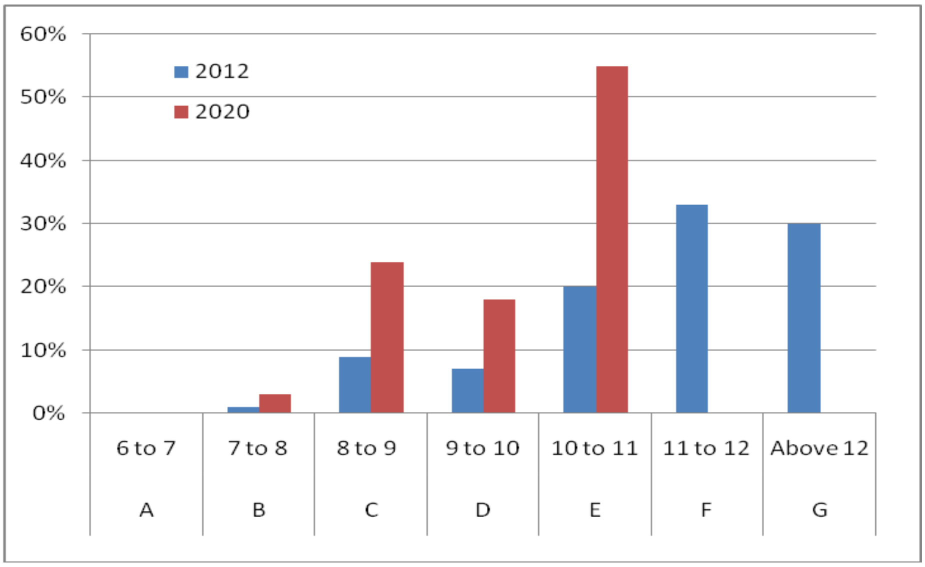
The results of the analysis, using 1 kg/t bands to grade RRC (Table 4.4) indicate that by 2020 the EU summer tyre market for C1 (passenger cars) has a maximum level of RRC of 10.5kg/t, with 27% of the tyres sold having a RRC of less than 9 kg/t. The shift in the market from 2012 is shown in Figure 4.1. Similar reference cases have been estimated for C1 winter tyres and for C2 and C3 vehicles (with separate estimates for summer and winter).

Table 4.4: EU Market Distribution of C1 Summer Replacement Tyres by RRC – Reference Case

Bands	A	B	C	D	E	F	G
RRC	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
Base SOA 2004		0%	1%	6%	19%	30%	43%
2012		1%	9%	7%	20%	33%	30%
2013		1%	10%	8%	23%	37%	20%
2014		1%	11%	8%	25%	40%	13%
2015		1%	13%	10%	29%	46%	
2016		1%	13%	10%	29%	46%	
2017		2%	16%	13%	38%	31%	
2018		2%	19%	14%	43%	21%	
2019		3%	24%	18%	55%		
2020		3%	24%	18%	55%		

Note: The Second Stage minimum standard of 10.5kg/t for C1 new tyre types comes into effect in 2016 (with impact in year 2017), we thus assume that all tyres in band E are below 10.5kg/t.

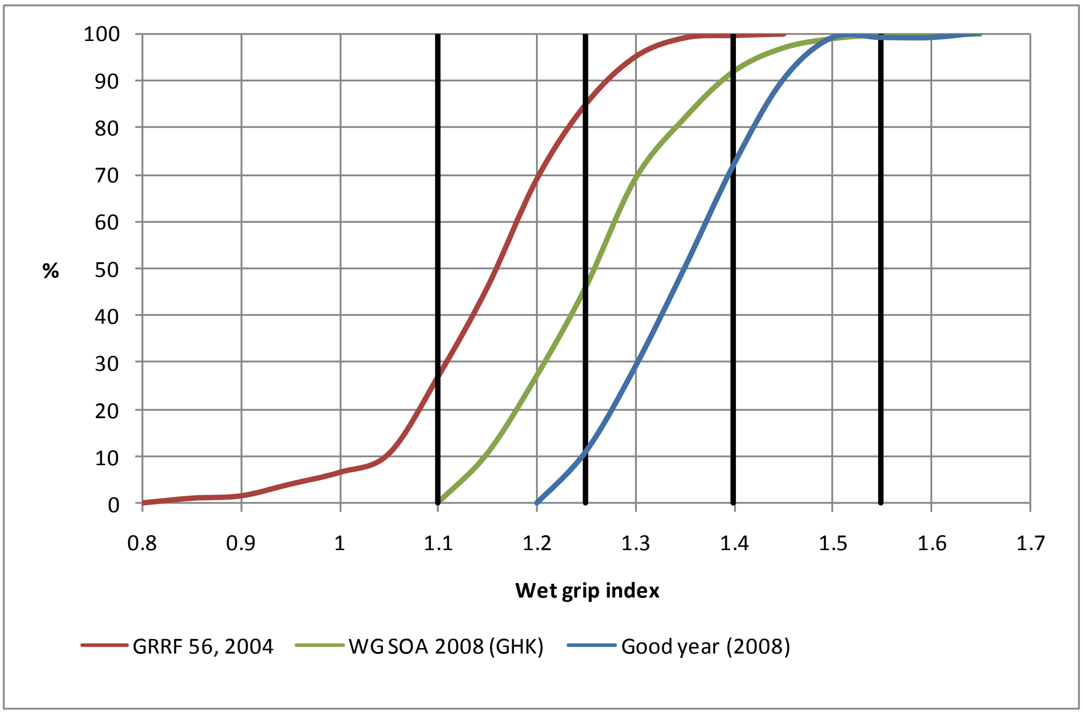
Figure 4.1: Change in C1 Summer Tyre Market Distribution by RRC from 2012 to 2020 in the Reference Case



Source: GHK based on Table 4.4

To examine the impact of a dual label for RRC and WG, a new reference case has to be estimated, that projects changes in the market distribution of RRC and WG. The market distribution of wet grip is estimated based on GRRF, 56 (2004) data. In order to estimate a realistic distribution of the market in 2008 an average of the GRRF, 56 (2004) and WG distribution from Goodyear, was calculated by GHK (Figure 4.2).

Figure 4.2: Market Distribution of Wet Grip Performance (PC summer tyres)



Note: Goodyear data is based on a very small tyre sample that does not cover the entire Goodyear/Dunlop product portfolio.

The minimum requirement on wet grip for C1 summer tyres by 2012-14 (COM (2008) 316, Annex 1 Part A) is 1.1 on the WG index (WGI) (where 1.0 is set by the SRTT). Tyre producers have advised that the wet grip state of the art has moved from the 1.4 indicated in the GRRF data to approximately 1.5 (as shown in the move from the GRFF curve to the SOA (2008) curve in Figure 4.2). In 2008, according to tyre producers, no tyres above 1.55 are available on the market. For the purpose of the impact assessment, in the absence of any further data on the projected trends in WG market distribution, the distribution of the SOA (2008) WG is assumed to remain constant over the period 2012-2020, in the reference case.

For the purposes of the impact assessment, the grading scheme for wet grip is based on the WGI using four bands to reflect the market distribution in Figure 4.2. Based on the current market limit, the highest band for wet grip is set at 1.45 or above. Based on the reference case distributions for RRC and WGI for the period 2012-2020, estimates of the market distribution have been provided for combinations of WG and RR. The 2012 and 2020 reference case for RRC and WGI is given in Tables 4.5a and 4.5b below.

Table 4.5a: EU Market Distribution of C1 Summer Replacement Tyres by RRC and WG – 2012 reference case

		Bands	A	B	C	D	E	F	G	WG only
		RRC / WGI	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
Wet Grip										
Wet Grip	A	Above 1.45		0.0%	0.4%	0.3%	0.8%	1.3%	1.2%	4%
Wet Grip	B	1.45 - 1.30		0.3%	2.4%	1.9%	5.4%	8.9%	8.1%	27%
Wet Grip	C	1.30 - 1.15		0.6%	5.3%	4.1%	11.7%	19.3%	17.6%	59%
Wet Grip	D	below 1.15		0.1%	0.9%	0.7%	2.1%	3.5%	3.2%	11%
Wet Grip										
RRC only				1%	9%	7%	20%	33%	30%	

Table 4.5b: EU Market Distribution of C1 Summer Replacement Tyres by RRC and WG – 2020 reference case

		Bands	A	B	C	D	E	F	G	WG only
		RRC / WGI	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
Wet Grip										
Wet Grip	A	Above 1.45		0.1%	1.0%	0.7%	2.2%			4%
Wet Grip	B	1.45 - 1.30		0.8%	6.5%	4.9%	14.9%			27%
Wet Grip	C	1.30 - 1.15		1.8%	14.0%	10.5%	32.2%			59%
Wet Grip	D	below 1.15		0.3%	2.5%	1.9%	5.8%			11%
Wet Grip										
RRC only				3%	24%	18%	55%			

4.4 Energy Labelling Options – Policy Options B, C and D

The estimated pace of change of market transformation to LRRTs is based on the assumption that labelling is sufficient to encourage a share of the market in any one band to move to the next highest band in a year. This share is unknown but estimates can be informed by the comparison with the effects of energy labelling on the demand for domestic appliances. Given the technological limits to ever declining levels of rolling resistance, we have assumed that for the purposes of the impact assessment, the minimum level of RRC by 2020 is 6 kg/t.

There are arguments for a relatively slow pace of change to reflect the situation that many customers do not buy tyres off-the shelf as with domestic appliances and may not actually see the new tyres until they are fitted to the vehicle. Customers may decide beforehand to fit the same tyre as OE or buy the one recommended by the retailer rather than refer to labelling information. Also, as discussed in Section 3, tyre consumer preference for fuel cost savings has previously ranked below tyre durability, grip and tyre cost, though a labelling scheme is intended to change customer preferences by raising awareness.

A ‘fast’ pace of change should also be considered since the evidence is that where price penalties for switching are small (say less than 5% of price) a greater share of the market will switch more quickly. Moreover, because of projected increases in the real costs of fuel, energy labelling is likely to become more important in framing customer choice.

Experience from energy labelling of household appliances (Table 4.6) shows variation in the rates of change achieved by different appliances.

Table 4.6 Share of Band A or above in Total Market (%)

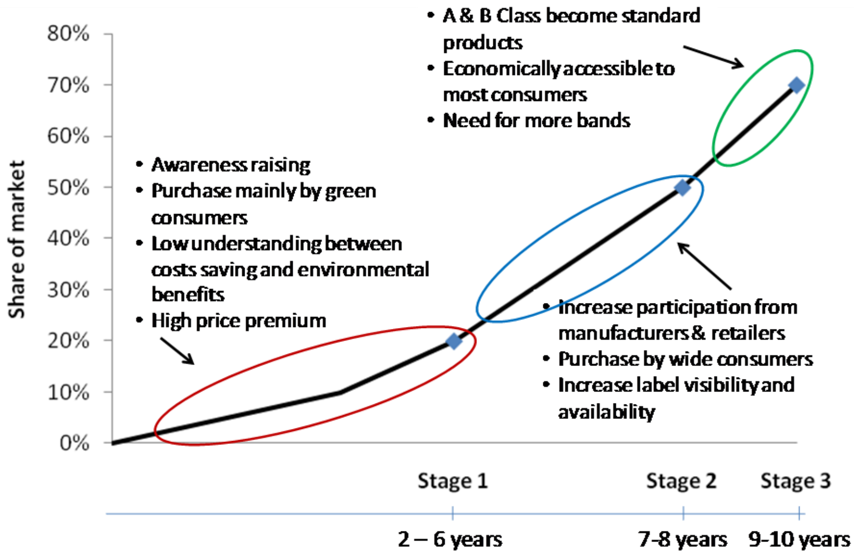
Share (%)	1995	2000	2005	First 8 years (EU-15)
Washing machines	2	34	85	50 – 60[a]
Dishwashers	na	21	82	
Refrigerators (Cooling)	2	22	70	15 - 20 [b]
Freezers	4	19	56	
Cookers/Ovens	na	2	34	

Source: Stockle, GfK (2006), [b]Europe Economics (2007)
Note: Basis: 1995 to 2005 for 8 countries West Europe, measured by GfK since 1995. Countries: AT, BE, DE, ES, FR, GB, IT and NL.
[a] Only 2004 share available for EU Centre-East countries. 50 to 60% is an estimate based on the trend for 8 western EU countries and share of band A washing machines in 2004 for centre-east EU countries.

Some appliances, such as washing machines had a faster rate of growth of 'Band A' sales compared to cookers and ovens over the ten year period. The share of fridges in Band A or above increased from 2% in 1995 to 70% in 2005 in 8 western European countries. According to Europe Economics (2007), the share of 'Band A' fridges in the EU-15 increased from 2% in 1992 to around 16% in 1999 and 45% in 2003[17].

The experience has shown that the uptake of products in higher energy efficient classes takes several years (Figure 4.3) and depends on a number of factors including initial levels of awareness, economic incentives and disincentives, and levels of manufacture and retailer participation.

Figure 4.3: Labelling Stages and Share of Market (A & B class)

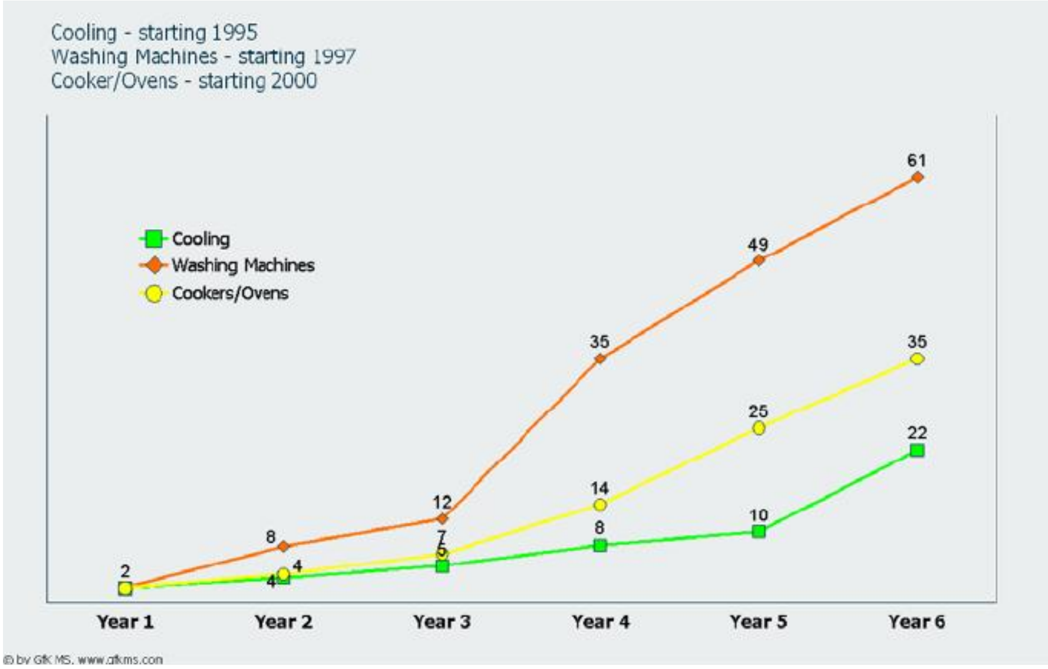


Source: GHK Estimates

[17] Please see Annex 7 and Europe Economics (2007), Appendix 1 for more on trends of domestic appliance sales by labelling bands.

The effect of these factors is to delay a greater uptake of products in higher bands usually to the 5th and 6th year (Figure 4.4).

Figure 4.4: Share of Sales in Band A or above



Source: Stockle, GfK (2006)

Note: Basis: 8 countries West Europe, measured by GfK since 1995. Countries: AT, BE, DE, ES, FR, GB, IT and NL

4.4.1 Policy Option B – RR only grading scheme for C1 tyres with minimum requirements on other parameters

The actual pace of change in market transformation cannot be known in advance. Some customers will be highly motivated and will switch immediately to tyres shown to be in the higher bands. Others will be constrained because of price constraints from any switch. The evidence from energy labelling for domestic appliances allows some idea of the possible range in the rate of market change attributable to energy labelling. Based on this evidence, but allowing for a high level of uncertainty, a range from slow to fast in the pace of market transformation has been estimated for the purposes of the impact assessment. The rate of change is based on the assumptions relating to the share of the market in one band switching to the next band in a year (Table 4.7). The resultant changes in market distribution can be considered against the evidence for domestic appliances as a rough test of 'reasonableness'.

Table 4.7: Pace of Market Change Due to Energy Labelling, RR only (1.0 kg/t bandwidth) – share of market in any one band moving to the next band in the year

	Slow	Fast
2012	0%	0%
2013	1.0%	5.0%
2014	2.0%	10.0%
2015	5.0%	15.0%
2016	7.5%	20.0%
2017	10.0%	30.0%
2018	12.5%	40.0%
2019	15.0%	50.0%
2020	20.0%	60.0%

The estimated EU market distribution by RRC, 2012-2020, as a result of energy labelling is based on the application of the assumed rates of change (Table 4.7) to the reference case (Table 4.4). The slow and fast pace of change in Table 4.7, indicate the worst and the best case scenario of the labelling effect. The results are presented in Tables 4.8a to reflect the slow pace of change and Table 4.8b for the faster rate of change. This suggests that the policy option increases the share of the market in Bands A and B from 1% in 2012 to 17% in 2020 in the slow case and 48% in 2020 under the fast pace.

Table 4.8a: EU Market Distribution of C1 Summer Replacement Tyres by RRC – Tyre Labelling (slow pace)

Bands	A	B	C	D	E	F	G	
RRC kg/t	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
2012	0%	1%	9%	7%	20%	33%	30%	100%
2013	0%	1%	10%	8%	24%	37%	20%	100%
2014	0%	2%	11%	9%	26%	40%	13%	100%
2015	0%	2%	12%	11%	30%	43%		100%
2016	0%	3%	12%	13%	31%	40%		100%
2017	1%	5%	15%	18%	37%	24%		100%
2018	1%	6%	15%	20%	35%	21%		100%
2019	3%	10%	21%	28%	38%			100%
2020	5%	12%	22%	30%	31%			100%

Source: GHK Estimates, Note: Figures may not add due to rounding

Table 4.8b: EU Market Distribution of C1 Summer Replacement Tyres by RRC – Tyre Labelling (fast pace)

Bands	A	B	C	D	E	F	G	
RRC kg/t	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
2012		1%	9%	7%	20%	33%	30%	100%
2013		2%	10%	9%	24%	36%	19%	100%
2014		3%	11%	11%	27%	37%	11%	100%
2015	0%	5%	12%	15%	32%	35%		100%
2016	1%	6%	13%	19%	33%	28%		100%
2017	4%	9%	16%	26%	32%	13%		100%
2018	7%	12%	20%	28%	24%	8%		100%
2019	14%	17%	26%	28%	13%			100%
2020	23%	25%	28%	19%	5%			100%

Source GHK Estimates, Note: Figures may not add due to rounding

Figure 4.4a below, summarises the projected sales in each band due to labelling (slow and fast) compared to the reference case in 2020. Figure 4.4b indicates the share of the market by band in 2020 due to labelling (slow and fast).

Figure 4.4a: Comparison of the EU Market Distribution of C1 Summer Replacement Tyres by RRC for RR Only labelling (with the Reference Case, 2020)

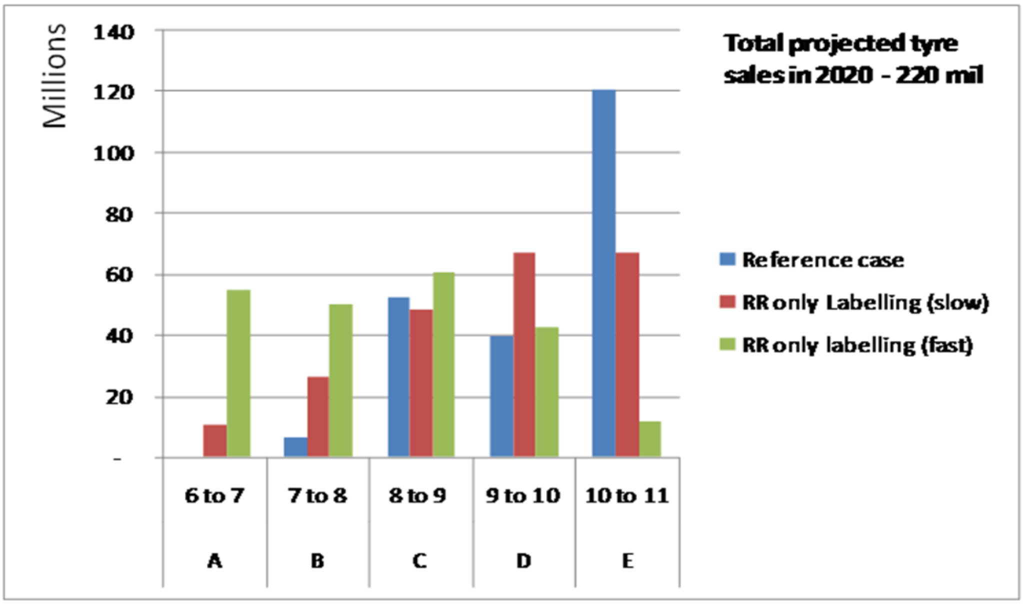
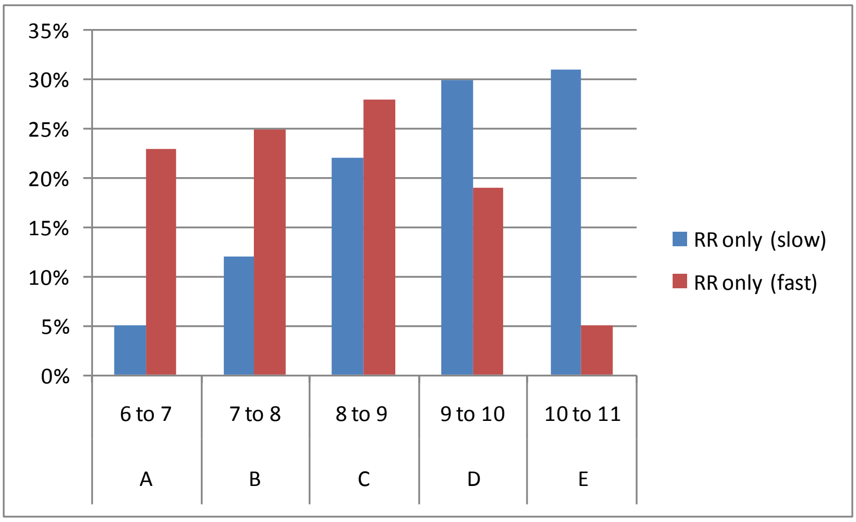


Figure 4.4b: Share (%) of C1 Summer Replacement Tyre Market by RRC for RR Only Labelling, 2020



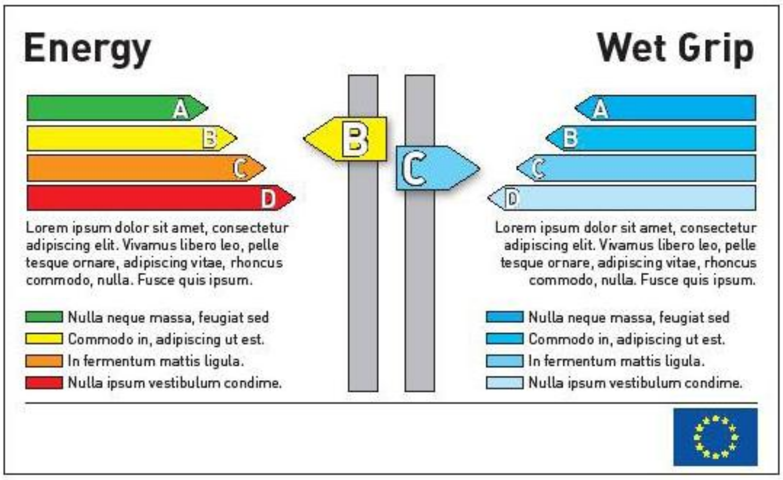
This range in market changes after 8 years can be compared with the experience of domestic appliances and the move to higher bands. The lower end of the range is consistent with that for those appliances where a combination of limited alternatives and higher costs prevented rapid change, for example in the case of fridges and freezer. For these products approximately 15-20% (for EU-15) of the market had moved to higher bands after a similar period of time. The higher end of the range is consistent with those appliances where market transformation has been much quicker such as washing machines. For these products approximately 50-60% (for EU-15) of the market had moved to higher bands after a similar period.

It should also be noted that even after a prolonged period of labelling, a part of the market will still make economically irrational purchasing decisions (as shown in Figure 4.4 and Table 4.8b); with a share of budget tyre customers unable to afford the increased purchase price even taking into account later savings in fuel.

4.4.2 Policy Option C – multiple grading scheme (with wet grip and possibly rolling noise) for C1 tyres

This option includes performance data in the labelling information on wet grip (WG) as well as RRC. Dual labelling on WG and RRC will provide a safeguard for those customers who might otherwise have purchased tyres with lower levels of wet grip than they preferred when purchasing improved rolling resistance. However, dual labelling increases the complexity of tyre choice for customers. For example, for a 4 band scheme for WG and RRC there can be 16 tyre choices for any given tyre (Figure 4.5).

Figure 4.5: Indicative Dual Tyre Label (ETRMA proposal)



Note: A more detailed design is provided in Annexe 8

The analysis of the impact of the dual labelling option requires an analysis of the effect of including wet grip in labelling information, on the likely pace of change of market transformation, generated by the energy label. As noted in the previous section, consumer preference for the safety performance of the tyre is higher than for the fuel saving performance. By making the safety aspect of the tyre more visible in the dual label it would be expected that it would encourage customers to choose tyres on the basis of the wet grip rating rather than rolling resistance, lowering the pace of change compared to that for an RR only label. This is reflected in the assumed pace of change (Table 4.9). In terms of the market transformation for wet grip, we have assumed a constant pace of change of 10%. This modest pace of change for wet grip reflects the much larger bandwidths that are used to measure the market distribution.

Table 4.9: Pace of Market Change Due to Energy Labelling, RR and WG (1.0 kg/t bandwidth) – share of market in any one band moving to the next highest band in a year

	RRC		WG
	Slow	Fast	
2012	0%	0%	0%
2013	1.0%	2.5%	10%
2014	2.0%	5.0%	10%
2015	4.0%	10.0%	10%
2016	6.0%	15.0%	10%
2017	8.0%	20.0%	10%
2018	10.0%	25.0%	10%
2019	12.0%	30.0%	10%
2020	15.0%	40.0%	10%

Using the pace of change assumptions above applied to the market distribution by RR and wet grip in the reference case the EU market distribution by RR and wet grip can be calculated for each year 2012-2020. The market transformation by 2020 is presented in Tables 4.10a (slow pace) and 4.10b (fast pace). This suggests that under dual labelling

the market share of bands A and B increases from 1% in 2012 to 14% in 2020 under the slow case and 30% in 2020 under the fast case.

Table 4.10a Market distribution for RRC and WG, passenger cars (C1) summer – 2020 – dual labelling case (slow pace)

		Bands	A+	A	B	C	D	E	F	G	WG only
		RRC / WGI	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
Wet Grip	A+										
	A	1.55		0.5%	1.4%	2.9%	4.0%	4.8%			14%
	B	1.4		1.0%	3.0%	6.1%	8.3%	9.9%			28%
	C	1.25		1.3%	4.1%	8.3%	11.3%	13.5%			39%
	D	1.1		0.7%	2.1%	4.3%	5.8%	6.9%			20%
	Above D	1.1 below		0.0%	0.0%	0.0%	0.0%	0.0%			0%
RRC only				3%	11%	22%	29%	35%			

Table 4.10b Market distribution for RRC and WG, passenger cars (C1) summer – 2020 – dual labelling case (fast pace)

		Bands	A+	A	B	C	D	E	F	G	WG only
		RRC / WGI	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
Wet Grip	A+										
	A	1.55		1.8%	2.3%	3.5%	3.9%	2.0%			14%
	B	1.4		3.7%	4.8%	7.4%	8.1%	4.2%			28%
	C	1.25		5.0%	6.6%	10.1%	11.1%	5.8%			39%
	D	1.1		2.6%	3.4%	5.2%	5.7%	3.0%			20%
	Above D	1.1 below		0.0%	0.0%	0.0%	0.0%	0.0%			0%
RRC only				13%	17%	26%	29%	15%			

Figure 4.6a below, summarises the projected sales in each band due to dual labelling (slow and fast) compared to the reference case in 2020. Figure 4.5b indicates the share of the market by band in 2020 due to dual labelling (slow and fast).

Figure 4.6a: Comparison of the EU Market Distribution of C1 Summer Replacement Tyres by RRC for Dual Labelling with the Reference Case, 2020

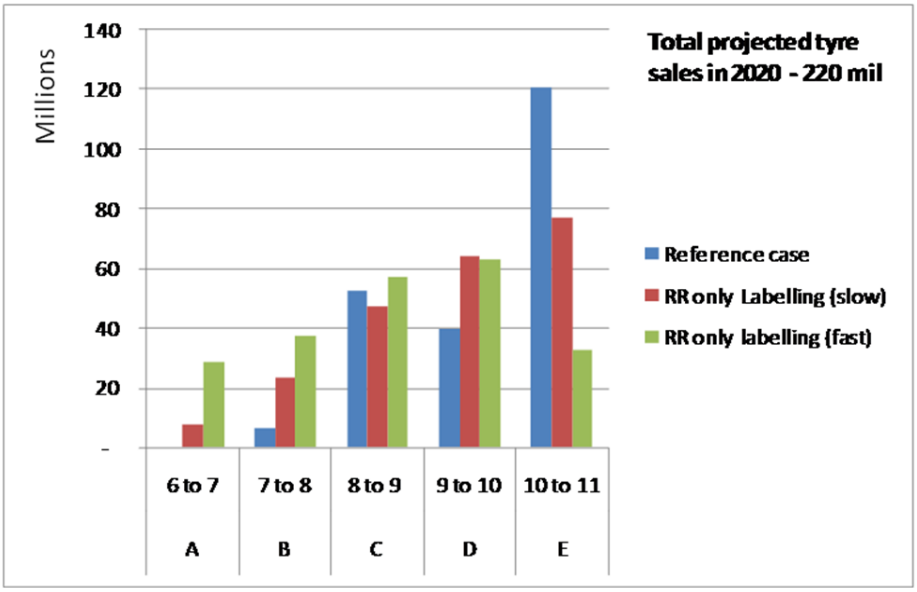
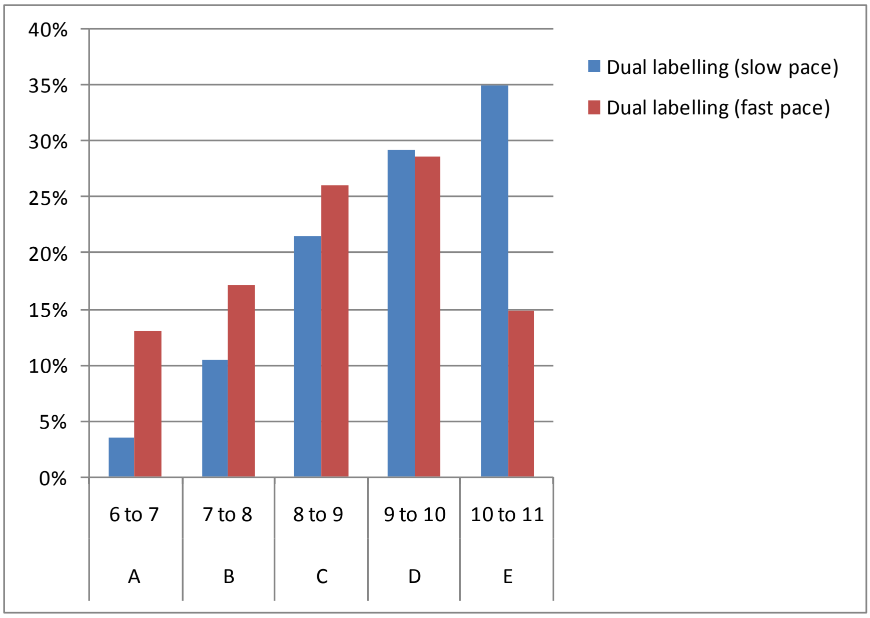


Figure 4.6b: Share (%) of C1 Summer Replacement Tyre Market by RRC for Dual Labelling, 2020



4.4.3 Policy Option B and C for C1 tyres (summer and winter)

The reference case market distribution for C1 tyres combining summer and winter based on their respective market shares is given in the table below. This indicates that only 2% of replacement tyres in 2020 are expected to have a rolling resistance of less than 8 kg/t and 19% to have a rolling resistance of less than 9 kg/t in the reference case (Table 4.11). Changes in market share by band due to energy labelling on RR only are shown in Tables 4.12a (slow pace) and 4.12b (fast pace). Tables 4.13a and 4.13b provide comparable estimates for a dual labelling on RR and WG.

Table 4.11: Market Distribution of C1 Replacement Tyres (summer and winter), Reference Case

Bands	**A**	**B**	**C**	**D**	**E**	**F**	**G**
RRC	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
2012		1%	6%	5%	16%	29%	44%
2013		1%	7%	6%	19%	37%	29%
2014		1%	8%	7%	22%	43%	19%
2015		1%	9%	8%	27%	54%	
2016		1%	9%	8%	27%	54%	
2017		1%	11%	12%	39%	36%	
2018		1%	13%	13%	47%	25%	
2019		2%	17%	17%	63%		
2020		2%	17%	17%	63%		

Note: The Second Stage minimum standard of 10.5kg/t for C1 new tyre types comes into effect in 2016 (with impact in year 2017), we thus assume that all tyres in band E are below 10.5kg/t.

Table 4.12a: EU Market Distribution of C1 Replacement Tyres (summer and winter) by RRC – Single RR Only Labelling (slow pace)

Bands	A	B	C	D	E	F	G
RRC	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
2012	0%	1%	6%	5%	16%	28%	44%
2013	0%	1%	7%	6%	20%	37%	28%
2014	0%	1%	8%	7%	22%	42%	19%
2015	0%	2%	9%	9%	28%	51%	
2016	0%	2%	9%	11%	30%	47%	
2017	1%	3%	11%	17%	39%	28%	
2018	1%	4%	12%	21%	40%	21%	
2019	2%	7%	17%	30%	43%		
2020	3%	9%	20%	33%	35%		

Table 4.12b: EU Market Distribution of C1 Replacement Tyres (summer and winter) by RRC – Single RR Only Labelling (fast pace)

Bands	A	B	C	D	E	F	G
RRC	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
2012	0%	1%	6%	5%	16%	28%	44%
2013	0%	1%	7%	7%	20%	37%	27%
2014	0%	2%	7%	9%	25%	40%	16%
2015	0%	3%	9%	13%	32%	41%	
2016	1%	4%	10%	17%	34%	33%	
2017	3%	7%	14%	26%	35%	16%	
2018	5%	10%	19%	30%	27%	8%	
2019	11%	16%	27%	31%	15%		
2020	20%	22%	29%	21%	6%		

Table 4.13a: EU Market Distribution of C1 Replacement Tyres (summer and winter) by RRC – Dual Labelling (slow pace)

Bands	A	B	C	D	E	F	G
RRC	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
2012	0%	1%	6%	5%	16%	29%	44%
2013	0%	1%	7%	6%	20%	37%	28%
2014	0%	1%	8%	7%	22%	42%	19%
2015	0%	2%	9%	9%	28%	51%	
2016	0%	2%	9%	10%	30%	48%	
2017	0%	3%	11%	16%	39%	30%	
2018	1%	4%	12%	19%	41%	23%	
2019	2%	6%	16%	28%	46%		
2020	2%	8%	18%	31%	40%		

Table 4.13b: EU Market Distribution of C1 Replacement Tyres (summer and winter) by RRC – Dual Labelling (fast pace)

Bands	A	B	C	D	E	F	G
RRC	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
2012	0%	1%	6%	5%	16%	29%	44%
2013	0%	1%	7%	6%	20%	37%	28%
2014	0%	1%	8%	8%	23%	41%	18%
2015	0%	2%	9%	11%	30%	47%	
2016	1%	3%	9%	14%	33%	39%	
2017	1%	5%	12%	22%	38%	21%	
2018	3%	7%	15%	27%	34%	14%	
2019	6%	11%	22%	34%	28%		
2020	10%	15%	26%	31%	17%		

4.5 Policy Option D – Single labelling of RR Applied to C2 and C3 Tyres

This option examines the impact of single labelling of RR on the market for C2 and C3 tyres, using the pace of change assumptions as for C1, but applied to the different market distribution of RR for C2 and C3 in the reference cases. The assessment is based on the same grading framework as set out in Section 2.7 and using the same methodology as for C1 tyres (market distribution in 2012, technological state of the art and target by 2020, minimum requirements setting the worst band), to estimate changes from energy labelling on production costs and fuel and CO2 savings.

4.5.1 Market Transformation of C2 Tyres

The reference case and the estimated single labelling (slow and fast pace) market distribution for C2 tyres is given below. In the absence of any available data, the reference case is based on the assumption that the RRC distribution of C2 tyres in 2012 is the same as the SOA RRC distribution in 2004 (Table 4.14). The effect of energy labelling on C2 tyres is to increase the market share of C2 tyres with a rolling resistance below 7.5kg/t from 1% in 2020 to 31% (slow pace) or to 68% (fast pace), Table 4.15a,b..

Table 4.14: Market Distribution of C2 Tyres (summer and winter), Reference Case

Bands							
RRC	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5	
Base SOA 2004		0%	5%	18%	36%	41%	100%
2013	0%	1%	4%	18%	42%	35%	100%
2014	0%	1%	4%	21%	50%	23%	100%
2015	0%	1%	6%	27%	66%	0%	100%
2016	0%	1%	6%	27%	66%	0%	100%
2017	0%	1%	8%	46%	45%	0%	100%
2018	0%	1%	10%	58%	30%	0%	100%
2019	0%	1%	14%	84%	0%	0%	100%
2020	0%	1%	14%	84%	0%	0%	100%

Note: The 2nd stage min. std. of 9kg/t for C2 new tyre types comes into effect in 2016 (year 2017), we thus assume that all tyres in band 8.5 to 9.5 are below 9kg/t.

Table 4.15a: EU Market Distribution of C2 Replacement Tyres by RRC (winter and summer) – Energy Labelling (slow pace)

Bands							
RRC	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5	
2013	0%	1%	4%	19%	42%	34%	100%
2014	0%	1%	5%	22%	50%	22%	100%
2015	0%	1%	7%	30%	61%	0%	100%
2016	0%	1%	9%	32%	57%	0%	100%
2017	1%	8%	33%	23%	34%	0%	100%
2018	2%	13%	38%	27%	20%	0%	100%
2019	4%	21%	40%	34%	0%	0%	100%
2020	7%	24%	39%	27%	0%	0%	100%

Table 4.15b: EU Market Distribution of C2 Replacement Tyres (summer and winter) by RRC – Energy Labelling (fast pace)

Bands							
RRC	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5	
2013	0%	1%	4%	19%	41%	33%	100%
2014	0%	1%	7%	25%	46%	20%	100%
2015	0%	2%	12%	35%	50%	0%	100%
2016	0%	5%	17%	38%	40%	0%	100%
2017	3%	18%	34%	26%	19%	0%	100%
2018	11%	26%	32%	22%	8%	0%	100%
2019	26%	32%	21%	21%	0%	0%	100%
2020	45%	23%	21%	10%	0%	0%	100%

4.5.2 Market Transformation of C3 Tyres

The reference case and the estimated single labelling (slow and fast pace) market distribution for C3 tyres is given below. In the absence of available data, the reference case is based on the assumption that the RRC distribution of C3 tyres in 2012 is the same as the SOA RRC distribution in 2004 (Table 4.16). The effect of energy labelling on C3 tyres is to increase the market share of C3 tyres with a rolling resistance below 4kg/t from 3% in 2020 to 11% (slow pace) or to 39% (fast pace), Tables 4.17a,b.

Table 4.16: Market Distribution of C3 Tyres (summer and winter), Reference Case

RRC kg/t	Below 4	4 to 5	5 to 6	6 to 7	7 to 8	Above 8	
Base SOA 2004/2008	1%	8%	23%	33%	23%	10%	100%
2013	1%	9%	24%	34%	25%	7%	100%
2014	1%	9%	24%	35%	26%	4%	100%
2015	1%	9%	25%	36%	26%	3%	100%
2016	1%	9%	25%	36%	26%	2%	100%
2017	2%	13%	36%	30%	19%	0%	100%
2018	2%	16%	43%	26%	12%	0	100%
2019	3%	17%	48%	24%	8%	0	100%
2020	3%	19%	51%	22%	6%	0	100%

Note: The 2nd stage min. std. of 6.5kg/t for C3 new tyre types comes into effect in 2016 (year 2017), we thus assume that all tyres in band 6 to 7 are below 6.5kg/t.

Table 4.17a: EU Market Distribution of C3 Replacement Tyres (summer and winter) by RRC – Energy Labelling (slow pace)

RRC kg/t	Below 4	4 to 5	5 to 6	6 to7	7 to 8	Above 8	
2013	1%	9%	24%	34%	25%	7%	100%
2014	1%	9%	25%	35%	25%	4%	100%
2015	1%	10%	26%	35%	25%	3%	100%
2016	2%	11%	26%	35%	23%	2%	100%
2017	3%	16%	36%	29%	15%	0%	100%
2018	6%	21%	41%	23%	9%	0	100%
2019	7%	23%	45%	19%	6%	0	100%
2020	11%	28%	43%	14%	3%	0	100%

Table 4.17b: EU Market Distribution of C3 Replacement Tyres (summer and winter) by RRC – Energy Labelling (fast pace)

RRC kg/t	Below 4	4 to 5	5 to 6	6 to7	7 to 8	Above 8	
2013	1%	9%	25%	33%	24%	7%	100%
2014	2%	11%	26%	34%	23%	4%	100%
2015	4%	13%	27%	33%	21%	2%	100%
2016	6%	17%	29%	31%	17%	2%	100%
2017	8%	21%	36%	23%	10%	0%	100%
2018	17%	29%	34%	15%	5%	0	100%
2019	21%	32%	35%	9%	3%	0	100%
2020	39%	35%	21%	4%	1%	0	100%

4.6 Policy Option E: Use of Market Based Instruments and Public Procurement

4.6.1 Reduction of VAT Rates in Highest Band

The average full rate of VAT in the EU-27 is 19% and the reduced rate (used for various items because they are deemed to represent basic necessities or to encourage some form of market change) is on average 7%. Based on these averages it is possible to estimate the change in demand for low RR tyres if the price is reduced by a VAT reduction from 19% to 7%. This is based on the market transformation in the reference case already estimated, using the bands to indicate the distribution and the price premium already calculated for improved RR whilst maintaining minimum standards on other tyre attributes. The VAT reduction only provides an incentive to switch to tyres with lower RR, there is no incentive in relation to wet grip.

It is assumed that the reduction would only take place for tyres with a rolling resistance below a given level (adjusted for outside diameter). This would lead to a reduction in price of around 12% for tyres that meet the required level. In the reference case the highest band is for tyres which have a RR of between 7kg/t and 8kg/t (Band B). Applying the VAT discount to tyres in Band B reduces the price premium for moving to band B from tyres with a RR of 11kg/t or more (band F) from €9.6 to €8.4 (Table 4.18). The incremental cost of moving from the next lowest band (band C) to band B is reduced from €3.0 to €1.8.

Table 4.18: Price Premium under VAT Option Compared to Reference Case, C1 Summer Tyres

Move from Band C to B		Move from Band F to B	
Reference Case	**VAT Case**	**Reference Case**	**VAT Case**
3.5% (€3.0)	2.2% (€1.8)	11.1% (€9.6)	9.8% (€8.4)

As previously noted, (Section 2.5.1), the estimated long-run price elasticity of demand for automobile tyres is 1.2. Thus a price reduction of 12% in band B would increase the demand for band B tyres by almost 14% (price elasticity of 12x1.2). The change in market distribution by RRC due to this VAT discount is shown in Table 4.18 below based on a pro-rate reduction in demand in other bands. The VAT discount would increase the market share of tyres less than 9kg/t from 27% in the reference case to 34% in 2020 (Table 4.19).

Table 4.19: EU Market Distribution of C1 Summer Replacement Tyres by RRC – VAT Policy Option

Bands	A	B	C	D	E	F	G
RRC	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12
2012		1%	9%	7%	20%	33%	30%
2013		1%	10%	8%	23%	37%	20%
2014		2%	11%	8%	25%	40%	13%
2015		2%	13%	10%	29%	46%	
2016		3%	13%	10%	29%	46%	
2017		4%	16%	12%	37%	30%	
2018		5%	19%	14%	42%	20%	
2019		7%	23%	18%	52%		
2020		9%	25%	16%	50%		

4.6.2 Carbon tax

A tax based on C02 emissions and the EU ETS price of €25/tonne of CO_2 (or €0.025/kg) would increase the costs of all tyres but would provide no incentive for market transformation, given the small absolute difference between bands and the total level of emissions. An alternative is this option which examines a tax based on the relative CO_2 emission of tyres in lower bands compared to band A, as a complement to energy labelling. Tyres in the highest band would be zero rated, with the tax increasing in lower bands based on the increased level of emissions compared to band A. The tax internalises the CO_2 cost of tyres in lower bands relative to tyres in the highest band.

A 1kg/t reduction (a 1 band move to the next highest band) in RRC leads to a reduction of 10 kg CO_2 per tyre per year (Table 4.20). A carbon tax based on the EU ETS price can be levied on the increased emissions relative to band A, i.e €0.25 for each band move from band A. Thus the tax per tyre increases from zero for band A to €1.0 for tyres in band E. This halves the difference in the price premium of Band A over Band E. As a result there is a greater likelihood of a faster switch to LRRTs.

Table 4.20: Carbon Tax on CO2 Emissions per Tyre (C1 Summer) by Band and Relative to Band A

RR only 1kg/t	A+	A	B	C	D	E
	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11
RW CO2 g/km		154	156	159	161	164
CO2 kgs per annum per tyre		615	625	635	645	655
CO2 tax (@€0.025/kg)		15.4	15.6	15.9	16.1	16.4
Increase in CO2 emissions (from band A) kg/tyre/pa		0	10	20	30	40
CO2 tax (€) relative to Band A (@€0.025/kg)		0.00	0.25	0.50	0.75	1.00
Previous Price Premium		4.3	3.0	2.4	2.2	2.0
Revised Price Premium		4.3	3.3	2.9	3.0	3.0

4.6.3 Public Procurement

A study by Pricewaterhouse Coopers (2007) estimated the annual number of vehicles procured by public bodies in EU-25 (Table 4.21).

Table 4.21: Annual Pubic Procurement of Road Vehicles, (2005)

Base case – annual procurement	Passenger cars	Light Duty Vehicles	Heavy Duty Vehicles	Buses	TOTAL
Conventional DIESEL	22.615	88.227	34.734	15.922	**161.497**
Conventional PETROL	85.714	20.189	216	733	**106.854**
Natural Gas – CNG	167	245	43	203	**657**
LPG	1.144	1.070	7	31	**2.252**
BIOFUEL	-	-	-	46	**46**
ELECTRIC	287	269	-	36	**591**
HYBRID	73	-	-	29	**102**
TOTAL	**110.000**	**110.000**	**35.000**	**17.000**	**272.000**

Source: Impact Assessment On A New Approach For The Cleaner And More Energy Efficient Vehicles Directive Proposal (2007), PWC

It was assumed in the PWC study that the procurement level does not vary during the time period of the analysis (2007 – 2017). It was also assumed that scrapped conventional vehicles are replaced with new ones complying with the current emissions Euro standard. As for the alternative technologies already included in the public fleets, it is assumed that they are replaced with the same technology.

Assuming that the procurement level provides an approximation to the size of the vehicle fleet operated by public bodies in the EU, the approximate number of tyres procured can be calculated, based on the number of replacement tyres per vehicle per annum. The estimated number purchased, and as a share of the replacement market is given in Table 4.22. Public procurement of energy efficient tyres can only affect a very small part of the replacement market and is unlikely to have any significant effect on market transformation except as a complement to energy labelling. In absolute terms however, the cumulated net savings may be significant.

Table 4.22: Total Number of Public Procured Replacement Tyres (2005)

	Passenger Cars (C1)	Light Duty Vehicles (C2)	Trucks and Buses (C3)	Total
Total Replacement Tyres	173,000	241,000	281,000	695,000
Share of Total Replacement Market	0.1%	1%	2%	0.3%

Source: GHK Estimates

Assuming that currently the RRC distribution of all publically procured tyres (C1, C2 and C3) is the same as the reference case replacement market distribution, the aggregate and average annual savings if all public procurement tyres were in Band B and C is shown in Table 4.23a and 4.23b below. The total aggregated social benefits including economic value of CO2 savings would be around €226 million (NPV) from 2012-2020. The average annual benefit would be around €34 million. For PCs, the cumulative CO2 savings is 0.08 mt and average annual CO2 savings is 0.01 mt. For CVs/LTs, the cumulative CO2 savings is 0.27 mt and average annual CO2 savings is 0.03 mt. For TBs, the cumulative CO2 savings is 1.3 mt and average annual CO2 savings is 0.2 mt.

Table 4.23a: Impact of Public Procurement of Tyres in Band B or C on the EU Economy, NPV of Costs and Savings, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Costs of LRRTs	Fuel Cost Saving	Net Consumer Savings	Cumulative CO2 Savings	Total Social Benefit
	(€m, NPV)	(€m, NPV)	(€m, NPV)	(€m, NPV)	(€m, NPV)
Passenger Cars (C1)	7	16	9	2	11
Light Duty Vehicles (C2)	12	69	57	6	63
Trucks and Buses (C3)	124	250	125	27	152
Total	143	335	191	35	226

Note: Numbers may not add up due to rounding

Table 4.23b: Public Procurement of Tyres in Band B or C on the EU Economy, Average Annual Benefit, 2012-2020, (sensitivity analysis to oil price scenario)

	Additional Costs of LRRTs	Fuel Cost Saving	Net Consumer Savings	CO2 Savings	Total Social Benefit
	(€m)	(€m)	(€m)	(€m)	(€m)
Passenger Cars (C1)	1.1	2.5	1.4	0.2	1.6
Light Duty Vehicles (C2)	1.8	10.5	8.7	0.9	9.5
Trucks and Buses (C3)	19.0	38.0	19.0	4.0	23.0
Total	21.9	51.0	29.1	5.1	34.1

Note: Numbers may not add up due to rounding

5 TOTAL IMPACT ASSESSMENT

5.1 Assessment Criteria

The impact assessment of policy options for energy labelling and VAT reduction builds on the market analysis in the previous section to estimate changes in the economy, and for safety and the environment for the different labelling options. The specific assessment criteria examined are:

1) Economy – impact on customers

2) Environment – overall savings in CO2 emissions and abatement costs

3) Economy – impact on the EU economy

4) Safety – effects of changes in wet grip performance (only considered in the framework of this study in the labelling for passenger cars though it may be necessary as well for light and heavy duty vehicles)

5) Administrative costs

The impact assessment separately considers policy options for tyres for each of the three vehicle markets (passenger cars (C1), light trucks and vans (C2), and heavy trucks and buses (C3). In each case the analysis is based on the detailed analysis for each of summer and winter tyres. The impact assessment is defined in terms of the cumulative costs and benefits of the policy options, compared to the reference case, over the period 2012 to 2020 reported as the net present value (NPV) (using a discount rate of 4%), or as the average annual costs and benefits over this 8 years period. Note that implementation of policy options is assumed to take place late in 2012, with no effects on the tyre market until 2013.

5.2 Impact Assessment of Energy Labelling for Tyres for Passenger Cars (C1)

Tyre sales to replace original equipment (OE) for passenger cars represents 78% of all tyres sold for passenger cars and 68% of all tyres sold for all vehicles in the EU. The impact of energy labelling depends on the labelling option (single labelling of RR only, or dual labelling of RR and WG). The impact also depends on the assumed pace of change (slow/fast) in market transformation. Given the uncertainty over the market impact the respective impacts under the slow and fast pace of change provide an approximate range to the scale of impact.

5.2.1 Impact on Customers

The economic impact of energy labelling on customers including both retail customers and business customers is determined by the extent of market transformation and by the consequent effect of energy labelling on the cost of new replacement tyres and the savings in fuel costs as a result of the improved fuel efficiency. The higher price of more fuel efficient tyres (the price premium) reflects the higher costs to producers of improving fuel efficiency by reducing rolling resistance without any reduced loss of performance on any other tyre attributes, especially wet grip. The additional costs are higher in the case of dual labelling because of the need not only to improve RR whilst

maintaining minimum standards for wet grip, but because of the incentive to improve both RR and wet grip simultaneously.

On a per tyre basis (Section 3.4 above) the additional costs to customers of purchasing lower rolling resistance tyres is more than offset by the fuel savings achieved over the life of the tyre (assuming oil price scenario 2). These savings, when calculated on the basis of the share of the sales of EU passenger car tyres in different bands of RR when compared with the reference case, in each of the years 2012-2020 provide an estimate of the aggregate financial saving to customers, on average each year and in total over the period (Table 5.1a) as a result of energy labelling.

The impact assessment indicates that customers collectively achieve an average annual saving of between €139m and €983m as a result of energy labelling (assuming oil price scenario 2) and depending on the pace of market transformation. The fuel cost saving in Table 5.1a is equivalent to 2 Mtoe to 11 Mtoe (or 2,700m litres to 11,430m litres of fuel)[18]. This is equivalent to the load carried by between 13 to 54 crude oil super tankers[19].

Table 5.1a: Impact of Energy Labelling of Passenger Car Tyres on EU Customers, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Tyre Costs (inc VAT) (€m, NPV)		Fuel Cost Savings (inc VAT) (€m, NPV)		Net Cost Savings (inc VAT) (€m, NPV)		Net Average Annual Cost Savings (€m)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	1,240	4,392	4,291	14,611	3,052	10,219	295	983
Dual Labelling	1,967	5,373	3,441	9,128	1,474	3,754	139	358
Net Benefits of Single Labelling compared to Dual Labelling	-728	-982	850	5,483	1,578	6,465	156	625

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

The impact assessment indicates that the single label option provides a greater cost saving than dual labelling because of the higher costs associated with tyres purchased under a dual labelling scheme to achieve the same level of improved fuel efficiency. The cost penalty to end users (including foregone fuel savings) per year on average of dual labelling is between €156m and €625m. This cost penalty is offset by an improved level of wet grip compared to that achieved under a single labelling option. It is not possible to

[18] On average 1000lt of fuel=0.92 toe, 1000 lt of diesel = 0.98 toe and 1000 lt of petrol = 0.86 toe

[19] 1.5 gallons of crude oil is required to make 1 gallon of gasoline (www.eia.doe.gov). A super tanker on average carries around 2 million barrels of crude oil (Source: Wikipedia)

quantify the value of this benefit except by an inferred improvement in safety. This is discussed in Section 5.2.4 below.

These savings depend critically on the assumed level of oil price in the period to 2020. Table 5.1b illustrates the sensitivity of the estimated impact on customers of changes in the oil price. Compared to the savings for RR only under scenario 2, the average annual savings range from –28% lower (scenario 1) to +28% higher (scenario 3). The range for dual labelling is -47% to +49%.

Table 5.1b: Impact of Energy Labelling of Passenger Car Tyres on EU Customers, 2012-2020, 2008 prices (sensitivity analysis to oil price scenario)

	Net Average Annual Savings – Scenario 1 (€m)		Net Average Annual Savings – Scenario 2 (€m)		Net Average Annual Savings – Scenario 3 (€m)		Range in Net Average Annual Savings Compared to Scenario 2 (%)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	213	704	295	983	377	1,261	-28%	28%
Dual Labelling	74	183	139	358	205	532	-47%	49%
Net Benefits of Single Labelling compared to Dual Labelling	139	522	156	625	172	729		

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

5.2.2 Impact on the Environment

The intended purpose of energy labelling is to switch the demand for tyres to more fuel efficient tyres, away from tyres that are less fuel efficient, and hence secure a reduction in fuel use and the related CO2 emissions per vehicle kilometre.

The market transformation from 2012 to 2020 gives rise to an aggregated reduction in CO2 emissions of between 9mt (slow pace) and 38mt (fast pace) depending on the labelling option (Table 5.2a). Multiplying this reduction by the social cost of carbon revealed by the EU emission trading scheme of €25/t indicates a social benefit of between €167m and €709m (NPV) from 2012 to 2020. The average annual CO2 saving ranges from 0.6 million tonne to 2.7 million tonne depending on the labelling option. This is equivalent to having 215,000 to 914,000 fewer cars on EU roads per year[20]. Assuming a set of 4 tyres is sold per car translates into an average annual CO2 saving of 15 to 62 kgs per car depending on the labelling option.

[20] Assuming an average car emits 3 tonne of CO2 per year (GHK/TNO estimate).

Table 5.2a: Impact of Energy Labelling of Passenger Car Tyres on EU Vehicle CO2 Emissions, 2012-2020, 2008 prices (oil price scenario 2)

	Cumulative CO2 Savings (mil tonnes)		Average Annual CO2 Savings (mil tonnes)		Cumulative CO2 Savings (€m, NPV)		Average Annual CO2 Savings (€m)		Average Annual CO2 Savings per car (kgs)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	11	38	0.8	2.7	208	709	20	69	18	62
Dual Labelling	9	23	0.6	1.7	167	443	16	43	15	29
Net Benefits of Single Labelling	2	14	0.2	1	41	266	4	26	3	33

Source: GHK estimates based on unit fuel savings of EU vehicle fleet per kg/t RRC reduction and estimates of market transformation

From the average annual CO2 savings for cars and the projected tyres sold the CO2 g/km saved per vehicle (assuming projected tyres are fitted as set of 4 tyres) can be calculated. On average the replacement market for C1 tyres would fit around 72 million cars a year. Assuming that the average annual distance covered by a car is around 16,000 km a year would generate a 1.2 to 4.1 CO2g/km reduction under single labelling and 1.0 CO2g/km to 2.6 CO2g/km under dual labelling.

Table 5.2b CO2 Abatement Cost (€/tonne) (average annual), by Oil Price Scenario

	Scenario 1		Scenario 2		Scenario 3	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	-59	-55	-138	-135	-211	-207
Dual Labelling	47	50	-33	-29	-112	-109

Note: Excludes the economic value of the environmental benefits of C02 emissions reduction

CO2 abatement costs for low RR tyres are sensitive to fuel prices and additional costs of low RR tyres. LRRTs are most cost effective under single labelling compared to dual labelling because of the lower costs compared with tyres purchased under a dual labelling scheme, to achieve the same level of improved fuel efficiency. With dual labelling for oil price scenario 1(€50/bbl) the CO2 abatement cost is positive as the additional cost of LRRTs is higher than the fuel cost saving but remains cost-effective compared to other technological options (e.g. low viscosity lubricants, biofuels and CNG) to

reduce CO2 from passenger cars (see for example INFRAS 2006 report p.111) since it is still below or equal to €50/tonne.

The impact assessment has examined the evidence of possible trade-offs of tread wear and tyre noise with reduced levels of rolling resistance which could give rise to environmental costs. In both cases the evidence for substantial trade-offs does not exist. In the case of tyre wear, its primary importance in customer choice means that it is considered unlikely that customers would choose tyres, or retailers would recommend tyres, that had significantly reduced life with no incentives for tyre producers to compromise on tread wear. In the case of noise, the new standards for tyre noise currently proposed will reduce current impacts. The supply of tyres with energy labelling will need to comply with these standards.

However, there is an identified trade-off between increased performance on wet grip and tyre noise (see Section 2.3 above), such that dual labelling might give rise to increased tyre noise levels (although not above adopted standards). This increased challenge for tyre producers to optimise not just rolling resistance and wet grip but also to ensure tyre noise does not exceed the standards set is reflected in the higher tyre production costs estimated for dual labelling. The rationale for including wet grip on a labelling scheme together with RR, to give incentives for the simultaneous optimization of both attributes above minimum standards, may well apply to rolling noise. This was however not analysed in this study for time constrains.

In relation to the life-cycle of tyres, a tyre's greatest environmental impact, as high as 86%, occurs during its use phase compared to the manufacture or disposal phase. Figure 5.1 below shows the environmental impact of a tyre throughout its life. LRRTs have integrated silica in the tread as a partial substitute for carbon black. Silica helps to lower rolling resistance without compromising performance in traction, grip (especially on wet surfaces) and tread life. The CO2 footprint of carbon black[21] is higher than silica as it is sourced from fossil fuels. The introduction of energy labelling and market transformation is not considered to have a negative impact on the life-cycle impacts of a tyre.

Figure 5.1: Life Cycle Assessment of an Average European Passenger Car Tyre

Source: Michelin Green-meters (Originally from study conducted by Préc Consultant B.V, 2001)

[21] Carbon black is a material produced by the incomplete combustion of heavy petroleum products such as FCC tar, coal tar, ethylene cracking tar, and a small amount from vegetable oil (Source: Wikipedia)

5.2.3 Impact on the EU Economy

The impact of energy labelling on the EU economy is calculated in a similar way as for the impacts on customers. The main differences are that the estimates of costs and savings exclude VAT because changes in VAT do not represent any economic gain or loss at the level of the EU economy and represent transfer payments; and the value of reduced CO2 emissions is included.

The average annual economic benefit to the EU of the energy labelling of tyres over the period to 2020, including CO2 savings, range from €115m (slow pace of market transformation) to €376m (fast pace of market transformation) for the single label and €11m to €18m for the dual label. The respective sum of cumulative economic benefits derived over the period 2012-2020 (calculated as Net Present Value (NPV)), range from €142 m (slow pace for dual label) to €3,933m (fast pace from single label), (Tables 5.3a and 5.3b). The benefits from the fast pace single label are equivalent to 4% of the EU-27 value added in the motor vehicles sector (€134 billion in 2004)[22].

Table 5.3a: Impact of Energy Labelling of Passenger Car Tyres on the EU Economy, Average Annual Cost and Savings, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Tyre Costs (€m)		Fuel Cost Savings (€m)		Net Cost Savings (€m)		CO2 Savings (€m)		Total EU Benefit (€m)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	103	362	198	669	95	307	20	69	115	376
Dual Labelling	163	446	158	420	-5	-26	16	43	11	18
Net Benefits of Single Labelling	-60	-84	40	249	100	332	4	26	104	358

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

Notes: Values exclude VAT

[22] Source: Eurostat
http://epp.eurostat.ec.europa.eu/portal/page?_pageid=2293,59872848,2293_68195486&_dad=portal&_schema=PORTAL

Table 5.3b: Impact of Energy Labelling of Passenger Car Tyres on the EU Economy, Net Present Value (NPV) of Costs and Savings, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Tyre Costs (€m, NPV)		Fuel Cost Savings (€m, NPV)		Net Cost Savings (€m, NPV)		CO2 Savings (€m NPV)		Total EU Benefit (€m NPV)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	1,042	3,690	2,031	6,915	989	3,224	208	709	1,198	3,933
Dual Labelling	1,653	4,516	1,628	4,320	-25	-196	167	443	142	247
Net Benefits of Single Labelling	-612	-825	402	2,595	1,014	3,420	41	266	1,055	3,686

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

Notes: Values exclude VAT. Discount rate of 4%

As in the case of cost savings to customers, the benefits to the EU economy depend on the future price of oil. The sensitivity of the estimate of EU economic benefit to changes in oil price are shown in Table 5.3c. This indicates that the benefits, compared to those estimated under scenario 2, range from -463% (scenario 1) to +761% (scenario 3).

Table 5.3c: Impact of Energy Labelling of Passenger Car Tyres on the EU Economy, Average Annual Benefit, 2012-2020, 2008 prices (sensitivity analysis to oil price scenario)

	Total EU Benefit – Scenario 1 (€m)		Total EU Benefit – Scenario 2 (€m)		Total EU Benefit – Scenario 3 (€m)		Range in Total EU Benefit Compared to Scenario 2 (%)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	50	157	115	376	179	594	-56%	+58%
Dual Labelling	-40	-120	11	18	62	155	-463%	+761%
Net Benefits of Single Labelling	91	277	104	358	117	439		

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

The minimum proposed standards for RRC and WG in 2012 (COM(2008)316) will affect imports as well as EU production. Imports account for around 21% of the C1 replacement market (Table 5.3d). A significant share of the imported tyres in the replacement market, are sold in the budget segment. Findings from the independent tests (Annex 3) showed that tyres in the budget segment in general had low rolling resistance but tended to perform very poorly on wet grip. Thus, single or dual labelling of tyres would be expected to reduce imports due to increased costs of complying with EU proposed standards or encourage importers to shift into higher value products to protect market share. Either way it is unlikely that the option will have a significant impact on imports. The impact on exports is uncertain, but given the high levels of customisation of tyres to the demands of regional markets the changes in the EU market may have only modest influence over export activity.

Table 5.3d: Share of Tyre Imports for C1 – summer and winter, Replacement Market (millions)

	2005	2006	2007
C1 import replacements	43	45	48
Total EU C1 replacement	224	235	231
Share of imports (%)	19%	19%	21%

Source: Table 1.1

5.2.4 Impact on Safety

The lack of a quantitative relationship between changes in wet grip performance and the number and severity of road accidents and related injuries and fatalities prevents a direct assessment of the effects of including wet grip in the tyre labelling.

We note that:

- The market transformation to LRRTs can be achieved by compromising wet grip performance above minimum standards if low cost methods are used (although the adoption of minimum standards for wet grip will limit the scale of this compromise and guarantee a satisfactory level of safety)
- A reduction in wet grip performance increases braking distances
- Longer braking distances increase the risk of accidents, other factors being the same.

Dual labelling has a reduced effect on market transformation compared to a single label based on RR. This is because customers are likely to rank safety as a more important attribute than fuel efficiency when purchasing a tyre (although this may change because of increases in the real cost of fuel). But, the dual labelling ensures customers do not inadvertently trade-off levels of wet grip performance when switching to a tyre with lower rolling resistance. Dual labelling therefore may have a positive effect on road safety in giving incentives to tyre producers to continuously improve wet grip above minimum standards and hence possibly reduce the risk of a road accident. This benefit is not included in the total benefit estimated for dual labelling because it is not possible to calculate the size of the improved safety and possible reduction in road accidents. It is also important to underline that tyre grip on wet roads also greatly depends on driver

behaviour, braking systems and road surface. However, the benefit from the improved braking distance would have to be greater than the difference in economic benefits between the two labelling options for the dual label option to have the larger economic benefit.

Using estimates of the social cost of a road traffic accident casualty of €0.96m per casualty (UNECE, 2007 and Trawn et. al, 2003), the minimum number of casualties that dual labelling would need to prevent before it provided the greater benefit can be calculated (Table 5.4). This estimate then provides some indication of how effective the dual label needs to be, and whether it is likely that the dual label would have a greater economic benefit than a single label.

Table 5.4: Estimated Required Safety Benefits of Dual Labelling (oil price scenario 2)

	Single Label (A)	**Dual Label** (B)	**Difference in Impact of Single vs Dual Label (C) = (A-B)**
Average annual economic benefit of label option (excluding safety benefits) (Table 5.3a)	€115m (slow) to €376m (fast)	€11m (slow) to €18m (fast)	€104m (slow) to €358m (fast)
Estimated minimum prevention of road traffic accident casualties from dual labelling required to equal the benefits of a single label, per year		€104m / €0.96m = 108 casualties (slow) €358m / €0.96m = 373 casualties (fast)	
Estimated minimum prevention of road traffic accident casualties required, as share of total EU road accident casualties, per year		108 casualties / 2.1m = 0.01% (slow) 373 casualties / 2.1m = 0.02% (fast)	

The calculation indicates that the minimum number of casualties to be prevented by dual labelling before it is the preferred labelling option ranges from 108 to 373. To put this effect in context, there are an estimated 2.1m road traffic casualties in the EU each year. The required dual label effect would need to account for a reduction in casualties amounting to between 0.01% to 0.02%. This suggests that the dual label has only to achieve a modest reduction in risk before it would be preferred to the single label.

5.2.5 Administrative Costs

The introduction of energy labelling would require a stand alone legislative proposal. The same costs can be assumed as those found in the background study for the impact assessment for the revision of the Energy Labelling Framework Directive 92/75/EEC (Europe Economics, 2007), which calculated the administrative costs of developing a new Implementing Directive of about €720,000 per new Directive[23]. The transposition

[23] The amount includes all considered technical changes.

cost by national administrations of the Directive is estimated to be about € 4 million[24]. We have also assumed a multiplier of 1.5 for calculating the administrative costs of implementing a dual labelling scheme compared to single RR label.

In summary, the one-off administration costs assumed for the impact assessment and borne by Member States are:

- Labelling on RR only: €4.76 million
- Labelling on RR and WG: €7.14 million

Producers will be mainly responsible for the running and maintenance of the labelling scheme but Member States would have to monitor and enforce the scheme. We do not have estimates for monitoring and enforcement costs, this information is confidential to the EC available from national authority budgets[25].

5.2.6 Overall Assessment

The impact assessment indicates that the introduction of the energy labelling of C1 tyres, compared to a reference case based on the introduction of minimum standards for rolling resistance but no energy labelling, would have a net economic benefit to the EU, irrespective of the specific choice of a labelling option, excluding safety benefits but including administrative costs. Under oil price scenario 2 the option generates both economic and environmental benefits; a real case of a 'win-win' intervention.

The impact assessment suggests that because of the risk associated with generating additional road traffic accidents from a single label on RR compared to a dual label, and the very limited requirement of a dual label in terms of risk avoidance, the dual labelling scheme, despite generating lower economic and environmental benefits and having a higher administrative cost, is the preferred option. The dual label option, even though it generates fewer economic and environmental benefits is likely to have a positive social net benefit.

5.2.7 Intensity of the Measure (for C1 only)

Assuming that the benefits as estimated over the 8 year period 2013-2020, can be secured two years earlier, the benefit of early implementation is simply the effect of avoiding the discounting of annual benefits. With a 4% annual discount rate the benefit of early implementation (by two years) is 8% of the annual average benefits (Table 5.5). Under oil price scenario 2, the benefits range from €1m with a dual label and a slow pace of change, to €30m with a single label and a fast pace of change.

[24] 27 Member States x €150.000 = €4.040.000.

[25] Europe Economics, et. al: 'Impact assessment study on a possible extension, tightening or simplification of the framework directive 92/75 EEC on energy labelling of household appliances'

Table 5.5: Intensity of the Measure of Energy Labelling of Passenger Car Tyres on the EU Economy, Economic Benefit from Early (2 Year) Implementation, 2008 prices

	Total EU Benefit – Scenario 1 (€m)		Total EU Benefit – Scenario 2 (€m)		Total EU Benefit – Scenario 3 (€m)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast
Average Annual Benefits of Single Labelling	50	157	115	376	179	594
Average Annual Benefits of Dual Labelling	-40	-120	11	18	62	155
Average Annual Benefits from early Implementation: Single Labelling	4	13	9	30	14	48
Average Annual Benefits from early Implementation: Dual Labelling	-3	-10	1	1	5	12

5.3 Impact Assessment of Energy Labelling for Tyres for Light Trucks and Van (C2)

Commercial vehicles such as light trucks and vans can also benefit from a labelling scheme. The impact assessment has only examined a labelling option on RR only. It maybe desirable to use a dual label, but data on wet grip distribution for C2 tyres is not available to test.

Generally, light commercial vehicles use the same type of tyres as passenger cars. The impact of reducing 1kg/t of RRC leads to a 1.5% reduction in fuel consumption but it is assumed that the EU fleet comprises of 100% diesel vehicles. A labelling scheme for commercial vehicles would also help in making cost-effective decisions regarding tyre choice. We have assumed the same pace of change (slow and fast) as estimated for C1. The nature of the market for C2 tyres is different to C1 tyres and would not necessitate a sticker based labelling scheme. Annex 6 provides more details.

5.3.1 Impact on Customers – C2

The impact assessment indicates that C2 customers collectively achieve an average annual saving of between €78m and €144m as a result of energy labelling (assuming oil price scenario 2). The fuel cost saving in Table 5.6a is equivalent to 1 Mtoe to 2 Mtoe (or 1,050m to 1,981 litres of fuel), which is equivalent to the load carried by 5 to 9 crude oil super tankers[26].

[26] 1.5 gallons of crude oil is required to make 1 gallon of gasoline (www.eia.doe.gov). A super tanker on average carries around 2 million barrels of crude oil (Source: Wikipedia)

Table 5.6a: Impact of Energy Labelling of C2 Tyres on EU Customers, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Tyre Costs (ex VAT) (€m, NPV)		Fuel Cost Savings (inc fuel tax, ex VAT) (€m, NPV)		Net Cost Savings (€m, NPV)		Net Average Annual Cost Savings (€m)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	159	314	1,068	2,020	909	1,706	78	144

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

These savings depend critically on the assumed level of oil price in the period to 2020. Table 5.6b illustrates the sensitivity of the estimated impact on customers of changes in the oil price. Compared to the savings under scenario 2, the average annual savings range from –27% lower (scenario 1) to +27% higher (scenario 3).

Table 5.6b: Impact of Energy Labelling of C2 Tyres on EU Customers, 2012-2020, 2008 prices (sensitivity analysis to oil price scenario)

	Net Average Annual Cost Savings – Scenario 1 (€m)		Net Average Annual Cost Savings – Scenario 2 (€m)		Net Average Annual Cost Savings – Scenario 3 (€m)		Range in Net Average Annual Savings Compared to Scenario 2 (%)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	57	105	78	144	96	183	-27%	27%

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

5.3.2 Impact on the Environment – C2

The market transformation from 2012 to 2020 gives rise to a aggregated reduction in CO2 emissions of between 4mt (slow pace) and 7mt (fast pace) (Table 5.7a). Multiplying this reduction by the social cost of carbon of €25/t indicates a social benefit of between €69m and €130m (NPV) from 2012 to 2020. The average annual CO2 saving ranges from 0.3 million tonne to 0.5 million tonne depending on the labelling option. This is equivalent to having 86,000 to 160,000 fewer cars on EU roads per year[27].

[27] Assuming an average car emits 3 tonne of CO2 per year (GHK/TNO estimate)

Table 5.7a: Impact of Energy Labelling of C2 Tyres on EU Vehicle CO2 Emissions, 2012-2020, 2008 prices

	Cumulative CO2 Savings (mil tonnes)		Average Annual CO2 Savings (mil tonnes)		Cumulative CO2 Savings (€m, NPV)		Average Annual CO2 Savings (€m)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	4	7	0.3	0.5	69	130	6	12

Source: GHK estimates based on unit fuel savings per kg/t RRC reduction and estimates of market transformation

Table 5.7b CO2 Abatement Cost (€/tonne) (average annual), Energy Labelling for C2 Replacement Tyres

	Scenario 1		Scenario 2		Scenario 3	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	-107	-105	-183	-181	-259	-257

5.3.3 Impact on EU Economy – C2

The average annual economic benefit to the EU of the energy labelling of tyres over the period to 2020, including CO2 savings, range from €52m (slow pace of market transformation) to €93m (fast pace of market transformation) for the single label. The respective sum of cumulative economic benefits derived over the period 2012-2020 (NPV), range from €545m to €1,018m (Tables 5.8a and 5.8b).

Table 5.8a: Impact of Energy Labelling of C2 Tyres on the EU Economy, Average Annual Cost and Savings, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Tyre Costs (€m)		Fuel Cost Savings (€m)		Net Cost Savings (€m)		CO2 Savings (€m)		Total EU Benefit (€m)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	15	29	60	110	45	81	6	12	52	93

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

Table 5.8b: Impact of Energy Labelling of C2 Tyres on the EU Economy, NPV of Costs and Savings, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Tyre Costs (€m, NPV)		Fuel Cost Savings (€m, NPV)		Net Cost Savings (€m, NPV)		CO2 Savings (€m NPV)		Total EU Benefit (€m NPV)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	159	314	636	1,202	476	888	69	130	545	1,018

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

Notes: Values exclude VAT. Discount rate of 4%

The sensitivity of total benefits to oil price scenario is shown in Table 5.8c below.

Table 5.8c: Impact of Energy Labelling of C2 Tyres on the EU Economy, Average Annual Benefit, 2012-2020, 2008 prices (sensitivity analysis to oil price)

	Total EU Benefit – Scenario 1 (€m)		Total EU Benefit – Scenario 2 (€m)		Total EU Benefit – Scenario 3 (€m)		Range in Total EU Benefit Compared to Scenario 2 (%)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	32	57	52	93	71	129	-38%	+39%

Imports account for 20% of the EU tyre replacement market for C2 (Table 5.8d). As with C1 tyres a significant share of the imported tyres in the replacement market, are sold in the budget segment. Energy labelling of tyres would be expected to reduce imports due to increased costs of complying with EU proposed standards or encourage importers to shift into higher value products to protect market share. There is unlikely to be a significant impact on imports.

Table 5.8d: Share of Tyre Imports for C2 – summer and winter, Replacement Market (millions)

	2005	2006	2007
C2 import replacements	4	4	4
Total EU C2 replacement	19	19	20
Share of imports (%)	21%	21%	20%

Source: Table 1.1

5.4 Impact Assessment of Energy Labelling for Tyres for Heavy Trucks and Buses (C3)

According to the PHEM[28] model, the potential to reduce fuel consumption and CO2 emission using LRRTs is relatively higher for trucks and buses (C3) compared to passenger cars (C1). A 15% reduction in rolling resistance would provide reductions in fuel consumption by between 4% and 7% depending on the amount of urban compared to motorway driving. The additional cost is expected to be in the range of €50 per tyre (INFRAS, 2006). Additionally, Michelin have recently reported that their new 2nd generation of LRRTs, depending on operational circumstances, can save up to 6% in fuel consumption compared to the previous generation tyre[29] and around 9% in fuel consumption compared to non-Michelin tyres (Faber Maunsell, 2008). This report has also acknowledged that a labelling scheme could be adopted for Heavy Duty Vehicles, though the form of communication due to the nature of the market would be different to one based on a sticker based scheme. Annex 5 and 6 provide details on the costs of benefits of low RR tyres for Trucks and Buses.

We present a brief summary of the main results. As with C2 tyres, the impact assessment has only examined a single label on RR, although a dual label including wet grip may be desirable. No data on C3 wet grip performance for the market is available. Since a C3 tyre customer will not have a choice of tyres across the entire RRC range, we have calculated the market transformation and related impact based on a shift from the average level of RRC for C3 tyres (Band 6 to 7), rather the highest level of RRC, to higher bands.

5.4.1 Impact on Customers – C3

The impact assessment indicates that C3 customers collectively achieve an average annual saving of between €163m and €498m as a result of energy labelling (assuming oil price scenario 2). The fuel cost saving in Table 5.9a is equivalent to 2.6 Mtoe to 8 Mtoe (or 2,615m to 8,105m litres of fuel), which is equivalent to the load carried by 12 to 38 crude oil super tankers[30].

Table 5.9a: Impact of Energy Labelling of C3 Tyres on EU Customers, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Tyre Costs (ex VAT) (€m, NPV)		Fuel Cost Savings (inc fuel tax, ex VAT) (€m, NPV)		Net Cost Savings (€m, NPV)		Net Average Annual Cost Savings (€m)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	704	2,308	2,667	8,267	1,963	5,959	163	498

[28] Passenger car and Heavy duty vehicle Emission Model (PHEM). The model has been developed in several international and national projects including the EU 5th research framework program ARTEMIS, the COST 346 initiative and the benefitted from German-Austrian-Swiss cooperation on the Handbook of Emission Factors.

[29] http://www.michelintransport.com/ple/front/affich.jsp?codeRubrique=42&codePage=PLOE_ENERGY&lang=EN

[30] 1.5 gallons of crude oil is required to make 1 gallon of gasoline (www.eia.doe.gov). A super tanker on average carries around 2 million barrels of crude oil (Source: Wikipedia)

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

These savings depend on the assumed level of oil price in the period to 2020. Table 5.9b illustrates the sensitivity of the estimated impact on customers of changes in the oil price. Compared to the savings under scenario 2, the average annual savings range from –30% lower (scenario 1) to +30% higher (scenario 3).

Table 5.9b: Impact of Energy Labelling of C3 Tyres on EU Customers, 2012-2020, 2008 prices (sensitivity analysis to oil price scenario)

	Net Average Annual Cost Savings – Scenario 1 (€m)		Net Average Annual Cost Savings – Scenario 2 (€m)		Net Average Annual Cost Savings – Scenario 3 (€m)		Range in Net Average Annual Savings Compared to Scenario 2 (%)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	115	347	163	498	212	649	-30%	30%

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

5.4.2 Impact on Environment – C3

The market transformation from 2012 to 2020 gives rise to a aggregated reduction in CO2 emissions of between 9mt (slow pace) and 28mt (fast pace) (Table 5.10a). Multiplying this reduction by the social cost of carbon of €25/t indicates a social benefit of between €171m and €530m (NPV) from 2012 to 2020. The average annual CO2 saving ranges from 0.6 million tonne to 1.8 million tonne depending on the labelling option. This is equivalent to having 15,000 to 46,000 fewer trucks on EU roads per year[31].

Table 5.10a: Impact of Energy Labelling of C3 Tyres on EU Vehicle CO2 Emissions, 2012-2020, 2008 prices

	Cumulative CO2 Savings (mil tonnes)		Average Annual CO2 Savings (mil tonnes)		Cumulative CO2 Savings (€m, NPV)		Average Annual CO2 Savings (€m)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	9	28	0.6	1.8	171	530	15	46

Source: GHK estimates based on unit fuel savings per kg/t RRC reduction and estimates of market transformation

[31] Assuming an average truck emits 40 tonnes of CO2 per year (GHK/TNO estimate).

Table 5.10b: CO2 Abatement Cost (€/tonne) (average annual), Energy Labelling for C3 Replacement Tyres

	Scenario 1		Scenario 2		Scenario 3	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	-44	-39	-120	-115	-196	-191

5.4.3 Impact on EU Economy – C3

The average annual economic benefit to the EU of the energy labelling of tyres over the period to 2020, including CO2 savings, range from €85m (slow pace of market transformation) to €254m (fast pace of market transformation) for the single label. The respective sum of cumulative economic benefits derived over the period 2012-2020 (NPV), range from €1,054m to €3,142m (Tables 5.11a and 5.11b).

Table 5.11a: Impact of Energy Labelling of C3 Tyres on the EU Economy, Average Annual Cost and Savings, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Tyre Costs (€m)		Fuel Cost Savings (€m)		Net Cost Savings (€m)		CO2 Savings (€m)		Total EU Benefit (€m)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	67	217	137	426	70	208	15	46	85	254

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

Table 5.11b: Impact of Energy Labelling of C3 Tyres on the EU Economy, NPV of Costs and Savings, 2012-2020, 2008 prices (oil price scenario 2)

	Additional Tyre Costs (€m, NPV)		Fuel Cost Savings (€m, NPV)		Net Cost Savings (€m, NPV)		CO2 Savings (€m NPV)		Total EU Benefit (€m NPV)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	704	2,308	1,587	4,920	883	2,611	171	530	1,054	3,142

Source: GHK estimates based on unit cost and cost savings and estimates of market transformation

Notes: Values exclude VAT and tax. Discount rate of 4%

Table 5.11c: Impact of Energy Labelling of C3 Tyres on the EU Economy, Average Annual Benefit, 2012-2020, 2008 prices (sensitivity analysis to oil price

	Total EU Benefit – Scenario 1 (€m)		Total EU Benefit – Scenario 2 (€m)		Total EU Benefit – Scenario 3 (€m)		Range in Total EU Benefit Compared to Scenario 2 (%)	
Pace of Change	Slow	Fast	Slow	Fast	Slow	Fast	Slow	Fast
Single Labelling	40	115	85	254	130	393	-53%	55%

Imports account for a larger share of the tyre replacement market for C3 than for the other tyre classes, accounting for 31% in 2007. As in the case of C1 and C2, it is not expected that there would be major impact on import penetration.

Table 5.11d: **Share of Imports, C3 – summer and winter, Replacement Market (millions)**

	2005	**2006**	**2007**
C3 Imports	4	5	5
Total EU C3 replacement	15	16	16
Share of imports (%)	27%	31%	31%

Source: Table 1.1

5.5 Total Impact Assessment (C1, C2 and C3) of Energy Labelling

5.5.1 Impact on the EU Economy

The average annual benefit of energy labelling (RR only) for all vehicle types is given in Table 5.12 below. Energy labelling, if applied to all vehicle types, has the potential to generate between €252m and €723m economic benefit per year.

Table 5.12: Impact of Energy Labelling (RR only) on C1, C2 and C3 on the EU Economy, Average Annual Benefit, 2012-2020, 2008 prices (oil price scenario 2)

Vehicle Type	Total Annual Average EU Benefit (€m)	
	Slow	Fast
Passenger cars (C1)	115	376
Commercial vehicles (C2)	52	93
Trucks & Buses (C3)	85	254
All Vehicles	**252**	**723**

The total economic benefits by vehicle type depends on the combination of a number of factors (Table 5.13a) that determine total fuel cost savings from a given market transformation. A market distribution of RRC that is more concentrated around the average (small standard deviation) will mean that a 1 kg/t reduction will have a slightly bigger effect than where the distribution is less concentrated (Figure 5.13b).

5.5.2 Impact on Fuel Savings

The impact of the three options on fuel savings compared to the reference case is shown in Table 5.13, in physical units. Financial savings are presented below.

Table 5.13: Average Annual Fuel Savings

	Annual Average Fuel Savings (Mil litres)		Average Annual Fuel Savings (Mtoe)	
Tyre class	Slow	Fast	Slow	Fast
C1 (labelling RR)	326	1,104	0.30	1.02
C1 (multi-criteria label)	260	694	0.24	0.64
C2 (labelling RR)	99	181	0.10	0.18
C3 (labelling RR)	226	701	0.22	0.69

Note: Assumption for C1 tyres (passenger car fleet): 50% fuel, 50% diesel, Assumption for C2 and C3 tyres (vans, trucks and buses): 100% diesel

The fuel savings from energy labelling when introduced into all three tyre classes is greatest from Option B, the use of energy labelling in the C1 market (Figures 5.14a and 5.14b).

Figure 5.14a: Fuel Cost Savings (€m) for the EU Economy for Energy Labelling Options in C1/C2/C3 Replacement Market (Slow pace)

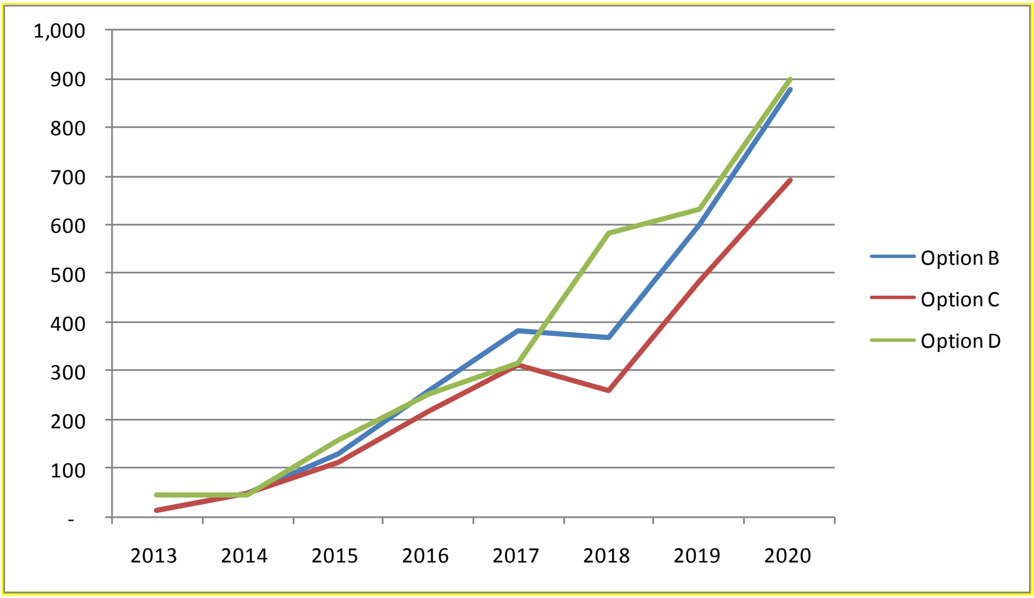
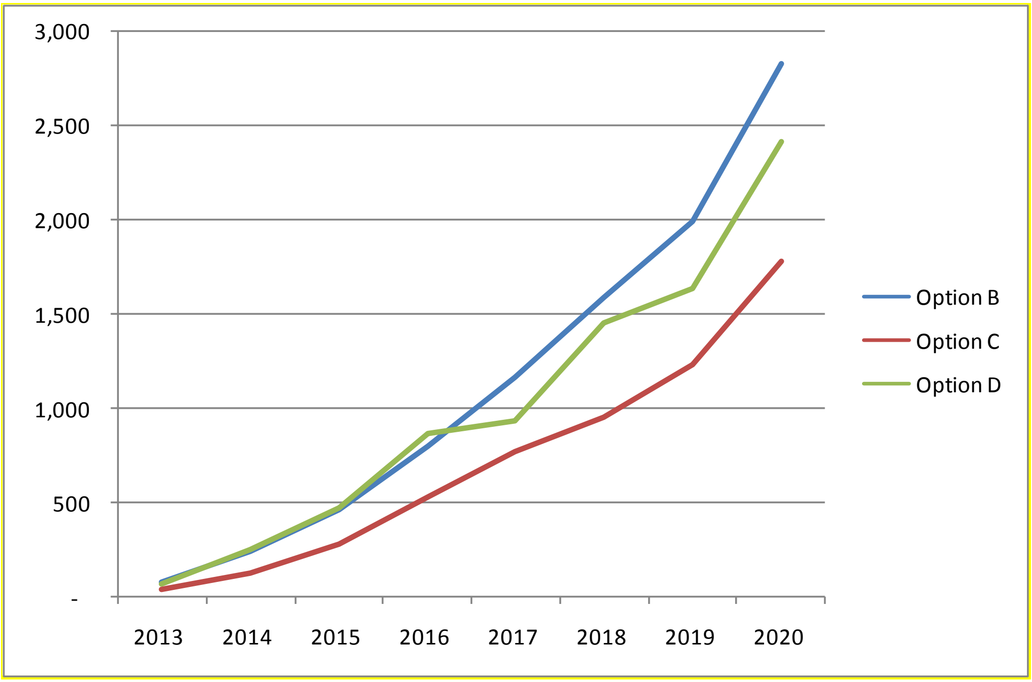


Figure 5.14b: Fuel Cost Savings (€m) for the EU Economy for Energy Labelling Options in C1/C2/C3 Replacement Market (Fast Pace)



5.5.3 Impact on the Environment

The total CO_2 savings from all vehicle types per year ranges from 1.7m tonnes to 5m tonnes, equivalent to removing 0.6m to 1.6m cars from EU roads (Table 5.14). This in turn approximates to between 3% to 10% of new EU passenger car registrations per year.

Table 5.14: Impact of Energy Labelling (RR only) on C1, C2 and C3 on the EU Environment, Average Annual CO2 Savings, 2012-2020, 2008 prices (oil price scenario 2)

Vehicle Type	Average Annual CO2 Savings (million tonnes)		Average Annual CO2 Savings (€m)	
	Slow	Fast	Slow	Fast
Passenger cars (C1)	0.8	2.7	20	69
Commercial vehicles (C2)	0.3	0.5	6	12
Trucks & Buses (C3)	0.6	1.8	15	46
All Vehicles	**1.7**	**5**	**41**	**127**

5.6 Impact Assessment of VAT Reduction on Highest Band for Passenger Cars (C1 – summer tyres)

5.6.1 Impact on Customers

The impact assessment indicates that for C1-summer tyres, the market transformation results in customers securing an average annual saving of €139m as a result of a VAT discount of 12% on the highest band (assuming oil price scenario 2).

Table 5.15a: Impact of VAT Reduction on Highest Band on Passenger Car Tyres (summer) on EU Customers, 2012-2020, 2008 prices (oil price scenario 2)

Additional Tyre Costs (inc VAT)	Fuel Cost Savings	Net Cost Savings	Net Average Annual Cost Savings
(€m, NPV)	(€m, NPV)	(€m, NPV)	(€m)
229	1,082	853	139

Source: GHK estimates based on price elasticity, unit cost and cost savings and estimates of market transformation

5.6.2 Impact on Environment

The market transformation from 2012 to 2020 due to the VAT discount gives rise to a cumulative reduction in CO2 emissions of 3mt (Table 5.16a). Multiplying this reduction by the social cost of carbon of €25/t indicates a social benefit of €53m (NPV) from 2012 to 2020. The average annual CO2 savings is around 0.3mt. The abatement cost (Table 16b) indicates that the reduction is achieved at no net cost to the economy.

Table 16a: Impact of VAT Reduction on Highest Band of Passenger Car Tyres (summer) on EU Vehicle CO2 Emissions, 2012-2020, 2008 prices (Oil price scenario 2)

Cumulative CO2 Savings	Average Annual CO2 Savings	Cumulative CO2 Savings	Average Annual CO2 Savings
(mil tonnes)	(mil tonnes)	(€m, NPV)	(€m)
3	0.3	53	9

Source: GHK estimates based on price elasticity, unit fuel savings of EU vehicle fleet per kg/t RRC reduction and estimates of market transformation

Table 5.16b: CO2 Abatement Cost (€/tonne) (average annual), for Reduced Rate of VAT on Highest Band

Scenario 1	Scenario 2	Scenario 3
-84	-164	-243

5.6.3 Impact on EU Economy

The average annual economic benefit to the EU of a VAT reduction on the highest band over the period to 2020, including CO2 savings, is around €60m. The cumulative economic benefits derived over the period 2012-2020 (NPV), is around €372m.

Table 5.17a: Impact of VAT Reduction on Highest Band for Passenger Car Tyres (summer) on the EU Economy, Average Annual Cost and Savings, 2012-2020, 2008 prices (oil price scenario 2)

Additional Tyre Costs	Fuel Cost Savings	Net Cost Savings	CO2 Savings	Total EU Benefit
(€m)	(€m)	(€m)	(€m)	(€m)
38	84	52	9	60

Table 5.17b: Impact of VAT Reduction on Highest Band for Passenger Car Tyres (summer) on the EU Economy, NPV of Costs and Savings, 2012-2020, 2008 prices (oil price scenario 2)

Additional Tyre Costs	Fuel Cost Savings	Net Cost Savings	CO2 Savings	Total EU Benefit
(€m, NPV)	(€m, NPV)	(€m, NPV)	(€m NPV)	(€m NPV)
227	512	320	53	372

Source: GHK estimates based on price elasticity, unit cost and cost savings and estimates of market transformation

Note: *Values exclude VAT. Discount rate of 4%*

5.6.4 Comparison with Energy Labelling (C1 summer, tyres)

The option of introducing a VAT reduction of 12% on tyres with the lowest levels of rolling resistance has a smaller effect, of approximately half, on the economy and the environment than RR only labelling when based on the slow pace of change (Table 5.18).

Table 5.18: Comparison of Energy Labelling and VAT Reduction on the EU Economy, Average Annual Benefit, 2012-2020, 2008 prices (C1 summer tyres, oil price scenario 2)

Assessment Criteria	Policy Options			Benefit of Label (Slow) cf VAT Reduction
	Label – Slow	Label - Fast	VAT Reduction	
Total Annual EU Benefit (€m) p.a.	115	376	60	55
CO2 Savings (mt)	0.8	2.7	0.3	0.5
CO2 Savings (€m)	20	69	9	11

6 CONCLUSIONS OF THE IMPACT ASSESSMENT

6.1 The Nature of the Problem

Rising emissions of greenhouse gases from road transport seriously affect the achievement of economy-wide CO2 emission targets. Measures to further reduce transport emissions should be considered if they can be shown to be relatively cost-effective. The interest of the EC in promoting an expansion in the use of low rolling resistance tyres for motor vehicles (LRRTs), as one of a number of policy initiatives, is based on their potential to contribute towards fuel savings and CO2 emissions targets proposed by the Commission in a cost-effective manner.

The case for intervention in the tyre market is made not just on the potential for environmental benefits. The market for tyres is characterised by market failure arising from the lack of information on tyre performance, preventing customers from making rational choices concerning the most cost-effective tyre choice for a given set of customer preferences. It is therefore likely that if the intervention could address these market failures then a relatively cost-effective way to reduce CO2 emissions should exist.

However, improving market information on tyre performance, if only focused on fuel efficiency, could have a perverse effect on tyre choice with regard to other tyre attributes. Tyre design seeks to optimise a range of tyre attributes. Improving the fuel efficiency of tyres can be achieved by reducing the wet grip performance of tyres. Optimising both rolling resistance and wet grip performance (and maintaining compliance with tyre noise standards) will increase costs. Although there are proposals for a minimum standard for wet grip, increasing tyre costs could, without information on wet grip, lead customers to choose tyres with a lower wet grip than they would otherwise have done. To avoid this risk, dual labelling, containing information on both rolling resistance and wet grip, may provide a solution, recognising the shortcomings of wet grip measurement. These include the limited coverage of wet grip testing in relation to other safety aspects such as aquaplaning or handling in a curve. Using wet grip as a proxy measure for safety is also uncertain when safety performance is dependent on a range of influences such as driver behaviour and road conditions.

6.2 Policy Options

The impact assessment has examined a range of options to encourage customers to choose lower rolling resistance tyres. Two options appear to have the greatest potential to secure this change. The first is energy labelling using either a single label providing information on rolling resistance / fuel efficiency or a dual label that also includes information on wet grip. The second is a reduction in VAT on tyres with the lowest rolling resistance.

The first option has the advantage that it addresses market failure and allows the possible risk of trade-offs with other attributes to be addressed. The second option provides a direct financial incentive to customers to choose the tyres with the lowest rolling resistance. The scope to address possible trade-offs with this option does not exist, unless some form of adjustment was made for wet grip, but this would undo the purpose of the option to provide a clear price incentive. This option would also require as a fully alternative option unanimity at the EU level to the change in VAT. It is more likely that individual MS would consider a change in VAT as a complementary measure to the energy label. The option of a CO2 tax, designed as a complement to energy labelling, was also examined and found capable of compensating in large part for the relative price premium of tyres in higher bands compared with tyres in lower bands. As such the tax has a significant potential to encourage a faster

pace of market transformation. However, even as a complement to energy labelling it would require MS unanimity to implement.

6.3 Qualitative Assessment of Selected Policy Options

The impact assessment allows a qualitative assessment of the selected policy options (A to E), compared against the reference case, (Table 6.1). All options have positive or negligible impacts on end-users, the economy and the environment. Energy labelling for tyre types C2 and C3 (Option D) has the largest positive impacts on these three criteria, followed by single labelling of RR for C1 (Option B). Multiple criteria labelling (Option C) and VAT reductions (Option E) also have positive impacts. Public procurement is judged to have a negligible impact.

Table 6.1: Qualitative Assessment of Selected Policy Options to Increase the Demand for Lower Rolling Resistance Tyres

	Assessment Criteria				
Policy Option	End-User	Economy	Environment	Safety	Administrative
A – Reference Case – Do Nothing	+	+	+	+	0
B – RR Only Energy Label – C1	+++	+++	+++	0	-
C – Multiple Criteria Energy Label – C1	+	+	+	++	- -
D – RR Only Energy Label – C2 & C3	+++	+++	+++	0	-
E – Market Based Instruments	+	+	+	0	- - -

Key to Scale of Impacts

Very Strongly Positive	+++
Strongly Positive	++
Weakly Positive	+
Negligible or No Impact	0
Weakly Negative	-
Strongly Negative	- -
Very Strongly Negative	- - -

All the options, compared to the reference case, with the exception of the multiple criteria labelling, are assessed to have a negative impact on safety as a consequence of a possible risk that interventions focused exclusively on rolling resistance may incentivise customers

to purchase tyres with a lower wet grip than they would have done. Whether this market effect represents an increased risk of road traffic accidents is not clear from the available technical evidence. Further research is required to establish the causal relationship between levels of wet grip and safety, taking into account driver behaviour and the extent to which drivers adjust behaviour according to tyre choice. Conversely, by providing information on wet grip, the multiple criteria label option improves safety compared to the reference case.

The public sector cost of implementation was estimated for energy labelling and found to be modest in comparison with the financial benefits. The feasibility of implementing the policy options in terms of the scope to introduce new policies is probably lowest in relation to the introduction of market based instruments and especially the carbon tax, which would require the unanimous adoption by Member States. The introduction of a VAT reduction across the EU, with MS free to determine the level of reduction would also raise a significant challenge. In the case of public procurement, proposals would be required for tyre performance standards including levels of rolling resistance above which public entities would not be allowed to or would be strongly encouraged not to buy tyres in public procurement. In the case of the multiple criteria label this is likely to have higher costs than the single label.

The administrative costs, relative to the financial benefits are small. The identification of the preferred option depends on the weight attached to the safety benefits of multiple criteria labelling. The high social costs of road accident casualties, even if the probability of contributing to a higher number of road traffic accidents is very low, suggests that it would be prudent, at least for C1 to favour multiple criteria labelling.

6.4 Quantitative Assessment of Selected Policy Options

The impact assessment has examined:

- The costs and benefits of single labelling compared to dual labelling for passenger car (C1) tyres
- The costs and benefits of applying single labelling to light and heavy truck (C2 and C3) tyres
- The costs and benefits of VAT reduction

in terms of the impacts on customers, the environment and the EU economy. Issues of safety have also been examined in the context of dual labelling for C1.

6.4.1 Impacts on Customers

The impact of both labelling options and VAT reduction is to provide net cost savings to customers. The additional costs of higher performing tyres are more than offset by the fuel savings that they provide. The additional costs of tyre purchase are, on average, paid back within 6 months of purchase. These net savings are however dependent on projections on the future price of oil. Three scenarios describing future oil prices have been used. In the case of the lowest price ($50 bbl) customers still secure net savings, which increase if higher oil price are assumed.

6.4.2 Impacts on Safety (C1 only)

The lack of detailed technical data on the relationship between wet grip performance and the risk of road accidents prevents any formal estimate of the potential safety costs associated with single labelling. Dual labelling is associated with a higher cost of switching to tyres with lower rolling resistance because of the optimisation with wet grip. Dual

labelling, because it also provides incentive to select tyres with improved wet grip rather than fuel efficiency, also has less effect on the market switch to LRRTS. It is also more expensive to implement. The cost penalty of dual labelling provides a basis for estimating the minimum numbers of accident casualties that it would need to prevent for it to have a greater social benefit. Given the high social cost of road accident casualties the numbers are not large and represent at most 0.02% of total annual casualty numbers.

6.4.3 Impacts on the Environment

The policy options, by securing fuel savings, generate reductions in CO2 emissions. Because of the net savings these emissions reductions are achieved at no net cost to the economy. The policy options represent a win-win policy, generating economic and environmental benefits. The total CO2 savings from energy labelling applied to all vehicle types per year ranges from 2.5m tonnes to 7.8m tonnes, equivalent to removing 0.8m to 2.5m cars from EU roads. This in turn is equivalent to reducing, by between 5% to 16%, the number of new EU vehicle registrations per year. The VAT reduction option has only one third of the environmental benefit than is derived from energy labelling, with a relatively poorer abatement cost. In terms of the vehicle emissions from new cars expressed in g/km of CO2, energy labelling generates between 1and 4 g/km reduction. A CO2 tax, as a complement to energy labelling, would be efficient by accelerating the pace of change from slow to fast by reducing substantially the price premium of tyres in higher bands relative to tyres in lower bands.

6.4.4 Impacts on the EU Economy

The annual average savings to the EU economy after taking into account both the additional tyre production costs and the economic value of CO2 reductions based on the social cost of carbon, is positive for all energy labelling options and for VAT reduction, under oil price scenario 2 ($75 per bbl). Again the main factor influencing the scale of impact is future oil price. However, only dual labelling for passenger cars has a net cost under low oil prices, with an annual net cost of between €40m and €120m. Under oil price scenario 2, energy labelling for all vehicle types has the potential to generate between €0.5bn and €1.4bn economic benefit per year.

6.5 Final Conclusions

In the light of the impact assessment:

1. interventions to move the replacement tyre market to LRRTs generate both economic and environment benefits and represent win-win policies;

2. energy labelling has a greater benefit than VAT reduction even with a slow pace of change; however, the use of market based instruments as a complement to energy labelling should be seriously encouraged;

3. the dual energy label has an average annual net cost to the EU economy of between €104m and €358m compared to single labelling. However, the limited effect required from dual labelling to reduce any possible risk from a relative reduction in wet grip performance under single labelling suggests that dual labelling should be considered as the preferred option taking the shortcomings of wet grip as a measure of safety into account;

4. the extension of energy labelling to C2 and C3 should be seriously considered, with or without multiple criteria labelling.

7 MONITORING AND EVALUATION FRAMEWORK

7.1 Monitoring the Policy Objectives

The preferred policy intervention of energy labelling should be monitored periodically for its effectiveness and efficiency. We suggest the following objectives and indicators as the basis of this activity.

The **General Objective** (the overall policy goal, expressed in terms of its ultimate impact): is to contribute to an increase in the fuel efficiency of vehicles. Fuel efficiency and related CO2 savings need to be achieved.

Key monitoring indicators:

- Vehicle fuel efficiency and related CO2 emissions
- Real changes in oil and fuel prices

The **Specific Objective** (the immediate objectives of a policy, expressed in terms of direct and short term effects or outcomes of the policy) is to *'pull the tyre market towards low rolling resistance tyres (LRRT), taking into account the interrelation with further parameters, in particular dry and wet grip (safety), noise and durability'*. The desired outcome is an increase in market share of LRRT whilst maintaining minimum standards for other parameters where trade-offs are identified.

Key monitoring indicators:

- Market share of tyres (by tyre class (C1, C2, C3) by RRC and wet grip
- Levels of (non-)compliance with minimum standards for tyre performance (rolling resistance, wet grip and rolling noise)
- Evidence of technological progress, by tyre class, enabling the achievement of lower RRC whilst maintaining performance on other attributes.

Operational Objectives (normally expressed in terms of outputs, i.e. the direct results of the intervention). The operational objective is to implement energy labelling for all three tyre classes (C1, C2, C3) using a range of advertising, labelling and web-based information sites on tyre performance.

Key monitoring indicators:

- Energy labelling costs to producers and public administration costs
- Take-up and use of labelling information (eg through counts of web-site hits and public awareness surveys)
- Real changes in replacement tyre price, by tyre class and market segment (premium, mid-range, budget)

7.2 Review of the Policy Option

The proposed regulation COM(2008)316 proposes the introduction of minimum standards periodically through to 2018 as part of the reference case. It would therefore by timely to

review the performance of both minimum standards and policy options in 2020 or just after. In the case of the energy label option, market transformation and technological development will be subject to regular (say annual) monitoring. There may be an argument for a review of the scheme before 2020 if the market share in the highest bands is very high (say over 75%) because further incentives would be required. A review may also be justified if producers are able to supply tyres with an RRC below 6.0 kg/t whilst maintaining minimum standards, enabling a higher band to be specified and strengthening the incentive provided by the label. Experience from energy labelling of domestic appliances showed that new higher bands had to be introduced around the 8th year for most appliances as the top two bands accounted for the majority of sales and the label ceased to provide an incentive.

Impact Assessment Study on Possible Energy Labelling of Tyres

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Annexes to the Impact Assessment

To the European Commission

Directorate-General Transport and Energy

Specific Contract:

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1 ANNEX 1: POLICY OPTIONS

This Annex summarises some of the early discussion in the impact assessment concerning the identification and review of policy options.

1.1 Initial Ideas for Policy Options

The following policy options were set out in the Terms of Reference:

Option 1: Business as Usual (no energy labelling of tyres) - The "do nothing" option provides the baseline for the impact assessment study. Note that since we are looking at potential impacts in 2012 (the date for the achieving the target reductions in CO2 emissions from passenger cars), account should be taken of trends in rolling resistance over this period without any of the policy interventions described below. This option includes measures brought forward by DG Enterprise for type approval legislation for passenger and goods vehicles for advanced safety features and tyres[1], which includes proposed minimum standards for rolling resistance, as well as new tyre noise standards.

Option 2: Use existing policy measures and/or voluntary agreements to promote energy efficient tyres – This policy option should take into account the existing strategy to reduce CO2 emissions from passenger cars and light-commercial vehicles. Furthermore, other relevant legislation and voluntary agreements for promoting energy efficient tyres should be identified and evaluated. This should for example, include an evaluation of extending the scope of Directive 92/75/EEC[2] on energy efficiency labelling beyond household appliances to cover tyres, or the setting of compulsory minimum standards for rolling resistance (beyond those set out as part of type approval legislation).

Option 3: Create new legislation for labelling of tyres – This policy option implies an evaluation of developing specific Community legislation on energy labelling of tyres. This will include an evaluation of the costs and benefits of this policy option, also identifying possible solutions for a feasible implementation.

Option 4: Create new voluntary agreements with tyre manufacturers and/or self regulation to promote energy efficient tyres – This policy option implies an evaluation of establishing voluntary agreements with tyre manufactures in order to achieve the policy objective.

These options were further developed and informed by the need to consider:

- The possible need for alternative or complementary measures to labelling recognising the need to influence vehicle producers in the choice of OE; and the limited exposure of customers to labelling information when purchasing tyres
- In some cases the policy instrument might be implemented through regulation or as a voluntary measure.

In the light of discussion during the Inception phase the following options were suggested for examination in the replacement tyre market for categories C1, C2, C3 (considering where appropriate and relevant retreading):

- use of labelling, and assessment of its effectiveness depending on options for the detailed design of the scheme (such as combination with vehicle labelling)
- public procurement rules and legislation,
- more stringent minimum standards (maximum RR)

[1] The future proposal for a Regulation on general safety of motor vehicles (COM(2008)316)

[2] European Legislation relating to Domestic Appliances

- economic instruments including a bonus for LRRT when assessing the CO2 emissions of a certain vehicle

The implementation method (existing legislation, new legislation or voluntary agreements) were considered as part of the feasibility and administrative cost of each of the options.

Options were developed further, see below.

1.2 Labelling of Tyres

Several countries in the world and member states in the EU have adopted labelling schemes for appliances or products fulfilling certain criteria. These schemes are designed to encourage manufacturers to design environmentally sound products and to inform and motivate consumers to purchase these products. Existing labelling schemes include:

Eco-label	Coverage
EU ecol-label	EU + Norway, Liechtenstein, Iceland
Nordic Swan	Norway, Sweden, Iceland, Finland
Good environmental choice	Sweden
Blue Angel	Germany
NF Environment	France
Stichting Mileukeur	Netherlands
Umweltzeichen Baume	Austria
AENOR Medio Ambiente	Spain
Green Seal programme	USA
Environmental Choice	Canada
Eco-Mark	Japan

Labelling of tyres would potentially give vehicle producers and vehicle owners additional information when choosing a tyre. Given the various performance characteristics of a tyre in addition to rolling resistance (safety / grip, noise, durability) a label could include a range of information. As a minimum the label would contain information on rolling resistance and minimum requirements on grip, The effectiveness will depend on the clarity of the information, the reach to target audiences and the associated costs of selecting LRRT when more expensive than the preferred tyre, and availability. Reach of a scheme will depend on the target actor. In the case of OE it is clearly the vehicle manufacturer. In the case of replacements, the target comprises a wide range of wholesale and retail distributors as well as individual consumers. Given the importance of the distribution chain and the fact that some vehicle owners never see the tyres before they are fitted, the ability to influence the distributors / retailers will be critical. In this context it is important to recognise that the labelling scheme includes the provision of comparable data across the tyre market in the form of accessible databases as well as the official labels on tyres and associated advertising and promotional materials.

The option is designed to promote LRRT as a means to improve vehicle fuel efficiency; in which case the label might indicate the fuel savings rather than more technical information on rolling resistance. This in turn raises the question of whether the information on the OE tyre might be contained within the new vehicle fuel efficiency label. The question of whether a label covering a range of parameters such as the Nordic eco-label[3] for tyres, that provides information on environmental properties including RR, safety, durability and the use and care of the tyre, should be a model or one more directly focused on RR, also needs to be considered.

The label must also address the purchase of van (C2) and truck (C3) tyres where the choice is made more by vehicle fleet managers and businesses and public organisations than by individual consumers. Again the complexity of vehicle leasing and lease company decisions will need to be taken into account.

[3] Nordic Ecolabelling of Vehicle Tyres (version 2.3, 6 June 2001 – 30 June 2009).

1.3 Public Procurement

Public procurement provides the opportunity to stimulate the market in alternative more fuel efficient vehicle technologies and fuels by creating economies of scale for manufacturers and thereby reducing the costs of production.

In the case of LRRT the option might be to ensure that existing ‘green’ public procurement initiatives in support of more fuel efficient vehicles include LRRT tyres as part of the specification. Since the public sector purchase of tyres is likely to be a small share of the market, public procurement is likely to be an option used in support of other options.

1.4 (Increased) Minimum Standards

The market would be altered in favour of LRRT were minimum standards on RR to be introduced. The impact would obviously depend on the standard used; and whether a single minimum standard applied to all tyres or by tyre class. The latter would seem preferable to ensure a closer fit to market choice. Issues include the level of the standard, the time allowed for producers to comply and the availability of alternatives. Of course the standard would guarantee a market shift, depending on the level chosen; although it may result in consumer choice that inadvertently selected tyres with lower grip, unless there was a companion standard for the levels of grip allowed. However, since minimum standards are proposed as part of the DG Enterprise type approval proposals, including a more stringent set of proposals, we have not included this option in the impact assessment, but rather incorporated it explicitly in the reference case.

The minimum standard in the reference case is assumed to complement the other options. For example a minimum standard could support the use of labelling by ensuring that the average level of RR in the market was lower than it would otherwise be (the lower the RR level, the more fuel efficient). A minimum standard used with labelling would also overcome the problems of potentially encouraging the choice of lower grip tyres.

1.5 Economic Instruments

The use of economic instruments has the advantage of a direct and guaranteed incentive on consumers to favour LRRT; either by increasing the cost of tyres with higher RR or providing a rebate for tyres with lower RR. On the basis of the polluter pays principle, the externality cost from the use of high compared to low RR tyres could be used as the basis for a tax on higher RR tyres. The tax might be set to be revenue neutral such that rebates offset tax revenue but would be administratively complex.

As with a minimum standard one effect of an economic instrument might be to encourage the choice of tyres with a lower grip. Tax revenues could be used to finance a labelling scheme designed to explain and support the tax whilst providing information on grip. The option might also be used to complement a labelling scheme by providing a tax incentive (e.g. through reduced VAT rates) for tyres in bands with the lowest RR.

1.6 Voluntary Agreement

All the previous options would require some form of legislation (unless the labelling was only voluntary, in which case there would be concerns over its effectiveness). An alternative option is to agree with tyre producers the gradual withdrawal of higher RR tyres from the EU market in a selective way to minimise the risk that consumers would switch to lower grip tyres. The agreement could be underpinned by the threat of a tax or a minimum standard were progress not to be made.

The high level of industrial concentration in the EU market together with the high brand choice available suggests that the option could be feasible; although a failure of one of the larger producers to participate would jeopardise the scheme. Conversely, the increasing share of the EU tyre market taken by imports suggests that non-EU producers would need to be a part increasing the cost, complexity and political sensitivity of the option. The effectiveness would obviously depend on the scale and speed of withdrawal.

1.7 IEA Workshop on Energy Efficient Tyres

Finally, we briefly review the options against the main points arising from the IEA Workshop held in Paris in 2005. The meeting discussed the technical issues and policy responses. Key points made in relation to policies are summarised in Table 5.1. No reference was made to economic instruments or voluntary agreements.

Table 5.1: Comments on Policy Options from the IEA Workshop, 2005

Policy Option	Comment from IEA Workshop
Labelling	Several different labelling schemes for tyres were proposed, explored and demonstrated to be technically feasible. A labelling scheme is attractive because it addresses the market failure arising from lack of information to the consumer. Manufacturers noted that individual efforts to label rolling resistance had been ineffective, perhaps because consumers preferred a third party labelling system or perhaps because consumers considered fuel efficiency a low priority. For maximum effect, a label needs to take into account other features of the tyres and be linked to new or existing regulations
Public Procurement	Savings from low rolling resistance tyres may justify a procurement specification by government agencies. Government procurement specifications can have an enormous impact on the market because the government is typically the largest customer in a country. Furthermore, the impact may be amplified because the national specifications are often adopted by local governments The Federal Energy Management Program (inside the U.S. Department of Energy) plans to work with the General Services Administration and the Defence Logistics Agency -- the U.S. Federal government's two major supply agencies -- to evaluate current specifications and consider new ones
Minimum Standards	Some manufacturers supported establishing mandatory efficiency levels (that is, maximum rolling resistance) for tyres. A mandatory programme would create a level playing field for all manufacturers. California will soon require tyre manufacturers to report rolling resistances of replacement tyres sold in that state. Based on a review of these and other data, California may establish minimum efficiencies for replacement tyres. Other states in the United States are likely to follow California's example. The European Union and Canada are also investigating policy options

Source: Summary of IEA Workshop Proceedings, 2005

1.8 Assessment of Policy Options

Before undertaking a more detailed impact analysis, we have broadly examined each policy option to understand its rationality and key attributes. The following set of questions has been addressed for each policy option:

- **The problem** - Does the option address the problem? Does it address the other issues which also need to be considered?

- **The objectives -** How does the option meet the policy objectives? Do the options cover the main measures to provide the anticipated effects? Are the anticipated effects measurable?
- **The evolution and context -** What is the context (national and EU level; policy and practice) within which the option will operate? Has it been tested before? (e.g. pilot projects, other labelling initiatives, in other countries).
- **The activities –** Are the appropriate institutional arrangements in place for the option to be delivered (legislation, technical and administrative capacity, etc.)
- **The outcomes -** What results and outcomes are expected from the option? Why would these be expected to follow from the activities and outputs?

The assessment was based on detailed interviews with trade associations and tyre producers as well as detailed examination of the relevant commercial and technical literature and discussion with members of the steering committee to help articulate the underlying assumptions for each of the policy options above. The results are reported in the main report (Section 4.0). The process suggested useful combinations of different options as well as suggesting the deletion of certain options

Based on the initial assessment the following options and combination of options were proposed for detailed impact assessment, based on their introduction in 2012:

1. **Option A – Reference case:** No new EU actions after the proposed regulation – tyre evolution and market take-up under existing drivers (including the Proposal for a Regulation on general safety of motor vehicles (COM (2008)316) which includes minimum standards for rolling resistance introduced over a period starting in 2012. This option will take into account current type approval (TA) legislation setting mandatory standards for a given car and its component to be sold on the EU market[4].
2. **Labelling**: Based on a relative or equivalent grading scheme such that consumers may objectively compare tyres performances. . The possibility of a seven band grading, in the same format as the labelling scheme used for households appliances (Directive 1992/75/EC), based on a 1kg/t bandwidth is apparently feasible under the current draft ISO 28580 guidelines for RR testing. The precision of the testing methods is discussed in section 7. By 2012 the limit on wet grip will be at 110 wet grip index. For C2/C3 tyres no wet grip labelling is assumed because of the lack of available standard reference tyre testing (more in section 7). There is no SRTT available for commercial vehicles and trucks and buses. The labelling variants being considered are:
    - **Option B:** Single criteria labelling scheme for C1 tyres (replacement tyre fitted on passenger cars, representing 68% of all tyre sales) on energy efficiency (RR) with limit values on other parameters (wet grip (safety) and rolling noise)
    - **Option C:** Multi-criteria labelling scheme for C1 replacement tyres, adoption of a labelling scheme which provides a grading on both RR and wet grip and possibly noise
    - **Option D:** Single criteria labelling scheme extended to C2 and C3 replacement tyres (respectively light and heavy duty vehicles) representing respectively 6% and 5% of tyre sales.
3. **Option E:** Economic instruments and public procurement. This option does not necessarily substitute other options but could complement energy labelling.
    a. **Economic Instruments**: Use of VAT Discounts in the Highest Band for rolling resistance with minimum standards for wet grip. This based on the market

[4] See Directive 2004/17/EC which provides a framework for all requirements car producers have to comply with, including mandatory limits on pollutant emissions and tyres (Directive 92/23/EC)

transformation in the reference case already estimated, using the bands to indicate the distribution, not as the basis of energy labelling, and the price premium already calculated for single labelling (the VAT reduction option provides only an incentive to switch to tyres with lower RR, there is no incentive in relation to wet grip).

b. **Public Procurement**: Use existing 'green' public procurement initiatives to favour more fuel efficient vehicles and include LRRT as part of the specification. Public procurement provides the opportunity to accelerate market transformation towards LRRT by creating economies of scale for manufacturers and thereby reducing the costs of production. This option will look at the economic and environmental impact of the replacement tyres for the annual publically purchased fleet in Europe.

1.9 Energy Labelling and Application to the OE and Replacement Market

The review of policy options has considered their suitability for application to the choices made by vehicle producers when fitting tyres as original equipment (OE). ACEA have suggested that vehicle producers have detailed and extensive discussion with selected tyre producers (five tyre producers supply 95% of all OE tyres to vehicle producers) in the design of tyres as OE, and the specification of the tyre family for a given vehicle. Major influences on these discussions are the target market for the vehicles and hence the costs and vehicle design (including tyres), and the type approval (TA) process[5] that vehicle manufactures are required to comply with which establishes standards for vehicle performance including vehicle fuel efficiency and related CO2 emissions.

In the case of the vehicle design, this is guided by the market research conducted by the vehicle producers as to customer preferences. In some cases vehicles are marketed according to their environmental performance, and customers are offered choices including the fitting of more fuel efficient tyres. The option of sourcing such tyres would have been discussed with the tyre producers at the time of vehicle design. Customer preferences for fuel efficiency as identified by OEMs provide an incentive on OEMs to negotiate a lowering of rolling resistance.

In the case of the Type Approval requirements for vehicles that address the fitting of tyres in the context of certified fuel efficiency (litres/kilometre), this is subject to a new proposal[6]. In summary, vehicle producers will be required, for the purposes of the TA testing, to fit the tyre with the worst (highest) level of rolling resistance of the family of tyres designed for the vehicle (or the second worst if there are more than three sizes of tyre in the family). To the extent that customers are influenced by the certified fuel efficiency of the vehicle, this will provide an incentive on OEMs to negotiate a lowering of rolling resistance with tyre producers.

[5] TA legislation establishes mandatory standards / minimum requirements for vehicles and their components (including tyres) to be sold on the EU market. Specific TA legislation on tyres is defined in Directive 92/23/CE and its amendments. The EC proposal for a regulation (COM (2008)316) on general safety of motor vehicles is intended to replace this Directive.

[6] Under consideration for Euro 5 and 6 Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information.

'The choice of tyres shall be based on the expected coast down power or rolling resistance. Either the tyres expected to produce the highest coastdown power at 50km/h or the tyres with the highest rolling resistance shall be chosen... Rolling resistance shall be measured according to ISO 28580. If there are more than three sizes of tyre, the tyre with the second highest expected coastdown power at 50 km/h or second highest rolling resistance shall be chosen. The power absorption or rolling resistance characteristics of the tyres fitted to production vehicles shall reflect those of the tyres used for type-approval' Paragraph 4.1.2. of Appendix 3 to Annex 4

The market failure resulting from the absence of information that exists in the replacement tyre market is therefore less significant in the OE market. Energy labelling options will have a far less significant influence on OE market change given these other influences on vehicle producers although it is likely that use of energy labelling will be made by vehicle producers especially to support current sales offers around eco-friendly fittings. It is possible that policies which address market failure in the replacement market result in greater numbers of customers aware of fuel efficiency benefits, which is then reflected in the market research and weight given by customers to vehicle fuel efficiency and hence the design of OE tyres.

In the light of the smaller market failure in the OE market, the impact assessment examines the effect of energy labelling options only on the replacement market. To the extent that there is an indirect influence on the OE market from greater customer awareness, this would be an argument for judging that a faster rather than slower pace of change in market transformation would be realised in due course. In the timescale of the impact assessment (2012-2020), given the time lags between changes in consumer preference and the design of new vehicles including tyre design, we have assumed that the energy labelling options will have no measureable effect on the OE market within this timescale. To the extent that there are OE market impacts, the impact assessment will provide an underestimate of the benefits of the energy labelling options.

A standardised grading could thus have the following communication methods: stickers, posters, websites, catalogues and CD-ROMs. Even in the replacement market, a sticker would not be of significant use for the B2B market compared to the private car market (B2C). Fleet managers would just as well benefit from a central or publically available information for making purchasing decisions.

2 ANNEX 2: MARKET CONTEXT

This Annex provides further background information on the nature of the EU tyre market and the distribution of tyre products. The intention is to supplement the data provided in the main report.

2.1 Vehicle and Tyre Classes

The tyre market is differentiated by vehicle class, C1, C2, C3 as well as by OE and replacement and winter/summer.

The market for tyres needs to be differentiated by vehicle type since the tyre choices for any given vehicle producer / owner is set by the vehicle type. Tyre classes defined in Directive 92/23/EEC can be adopted. In general terms as defined in the proposal for a Regulation on general safety of motor vehicles (COM(2008)316), C1 tyres are used for passenger cars, C2 tyres are used for light commercial vehicles, and C3 tyres are used for heavy commercial vehicles (See Box 2.1).

Box 2.1: Classification of Tyres

C1, C2 and C3 tyres from the ‘Regulation Of The European Parliament and of The Council, concerning type-approval requirements for the general safety of motor vehicles, **COM (2008) 316’** refers to types of tyres classified according to the following classes:

(a) Class C1 tyres - tyres intended for vehicles of category M1, O1 and O2;

(b) Class C2 tyres - tyres intended for vehicles above 3.5t of category M2, M3, N, O3 and O4 with load capacity index in single formation ≤ 121 and speed category symbol ≥ ‘ N’;

(c) Class C3 tyres - tyres intended for vehicles above 3.5t of category M1, M2, M3, N2, N3, O3 and O4 with one of the following load capacity indices:

(i) load capacity index in single formation ≤ 121 and speed category symbol ≤ ‘M’;

(ii) load capacity index in single formation ≥ 122.

DIRECTIVE 2007/46/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles

A. DEFINITION OF VEHICLE CATEGORY

Vehicle categories are defined according to the following classification: (Where reference is made to ‘maximum mass’ in the following definitions, this means ‘technically permissible maximum laden mass’ as specified in item 2.8 of Annex I.)

1. Category M: Motor vehicles with at least four wheels designed and constructed for the carriage of passengers.

- Category M1: Vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver’s seat.
- Category M2: Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver’s seat, and having a maximum mass not exceeding 5 tonnes.
- Category M3: Vehicles designed and constructed for the carriage of passengers, comprising more than eight seats in addition to the driver’s seat, and having a maximum mass exceeding 5 tonnes.

The types of bodywork and codifications pertinent to the vehicles of category M are defined in Part C of this

Annex paragraph 1 (vehicles of category M1) and paragraph 2 (vehicles of categories M2 and M3) to be used for the purpose specified in that Part.

2. Category N: Motor vehicles with at least four wheels designed and constructed for the carriage of goods.

- Category N1: Vehicles designed and constructed for the carriage of goods and having a maximum mass not exceeding 3,5 tonnes.
- Category N2: Vehicles designed and constructed for the carriage of goods and having a maximum mass exceeding 3,5 tonnes but not exceeding 12 tonnes.

- Category N3: Vehicles designed and constructed for the carriage of goods and having a maximum mass exceeding 12 tonnes.

In the case of a towing vehicle designed to be coupled to a semi-trailer or centre-axle trailer, the mass to be considered for classifying the vehicle is the mass of the tractor vehicle in running order, increased by the mass corresponding to the maximum static vertical load transferred to the tractor vehicle by the semi-trailer or centre-axle trailer and, where applicable, by the maximum mass of the tractor vehicles own load.

The types of bodywork and codifications pertinent to the vehicles of category N are defined in Part C of this Annex paragraph 3 to be used for the purpose specified in that Part.

3. Category O: Trailers (including semi-trailers).

1. Category O1: Trailers with a maximum mass not exceeding 0,75 tonnes

2. Category O2: Trailers with a maximum mass exceeding 0,75 tonnes but not exceeding 3,5 tonnes.

3. Category O3: Trailers with a maximum mass exceeding 3,5 tonnes but not exceeding 10 tonnes.

4. Category O4: Trailers with a maximum mass exceeding 10 tonnes.

In the case of a semi-trailer or centre-axle trailer, the maximum mass to be considered for classifying the trailer corresponds to the static vertical load transmitted to the ground by the axle or axles of the semi-trailer or centreaxle trailer when coupled to the towing vehicle and carrying its maximum load.

2.2 Choosing a Tyre

For a newly sold vehicle the manufacturer and in some cases the importer decides on the specifications of the set of tyres and thus decides over quality and costs. Most tyre manufacturers put substantial effort in reaching the OE market as they believe that a substantial group of consumers will replace like for like and stick to the same brand and type and so OE market share dictates replacement market share. Please see section 2.2.3 for more discussion on criterion for choosing tyres for the replacement market.

For the replacement market the owner of a vehicle (including vehicle leasing companies) is the one to decide on the replacement fit.

A range of typical groups can be identified which all have a certain degree of interest in tyre purchase and hence one or more of the technical parameters of tyres. The groups are:

- End-users (consumers, vehicle fleet managers etc.)
- vehicle manufacturers,
- tyre manufacturers,
- vehicle importers, dealerships, service stations

2.2.1 Technical description of relevant parameters.

The choice of tyre depends on a range of parameters describing its cost and performance. The tyre industry has already made clear that from all relevant parameters safety has the highest priority. From a consumer point of view one can easily imagine that this could also be true. Other parameters influence choice. The most important are:

- Handling: steering force, steering precision, directional stability, straight line/cornering, vehicle stability, steering character,
- Safety: grip (dry and wet),
- Comfort: noise, smoothness, suspension,
- Durability: structural, high speed performance, bursting pressure, puncture, resistance, resistance against solar radiation/chemicals,
- Economy: expected life, wear, retreadability, rolling resistance, mass,
- Image/Look: some tyres are also designed to look good,

- Costs (manufacture/purchase)

Some of these tyre characteristics are subjective. The handling or feel of a tyre/vehicle combination for example may well depend on someone's taste, but a great deal of the important characteristics can be determined objectively by measuring them, so long as well defined measuring procedures result in discriminative, representative figures.

For the replacement market there is only limited information directly available to the consumer[7]. Besides the costs of a set of tyres, most other parameters can be judged only after careful examination and experience after the purchase of more than one set of tyres or after reading consumer oriented test reports. Even with this information in hand a good comparison is often very hard to make for consumers.

Some of the tyre specifications are related. For a consumer, 'costs' are either a direct stimulant, i.e. purchase the cheapest (and assume all available tyres are the same in all other respects) or costs can also be associated indirectly to other parameters like safety and tread wear, i.e. life duration of tyres (and rolling resistance) and often these effects are hard to determine.

2.2.2 How do OEM's choose tyres for new vehicles?

Vehicle manufacturers mainly set the criteria for physical parameters and subjective parameters of tyres and the tyre manufacturers follow up those criteria (TNO 2006). Next to the specifications of the tyre itself, the combination of tyre and vehicle characteristics is found to be important for handling, comfort and durability related issues.

In most EU countries cars are certified together with a limited range of tyres based on size. Such a mandatory range of tyres prescribed per vehicle reduces the choice for a consumer.

The passenger car manufactures choice is influenced by the rules for the Type Approval (TA) test according 80/1268/EC and amendments. The actual influence of this mandatory test on the manufacturer's choice of tyre is not clear, but is potentially significant (see section 1.9).

2.2.3 Choosing Replacement Tyres

For replacement tyres the method of distribution to the consumer may have a high impact on the choice or on the availability itself. A short inquiry has revealed that tyres are distributed through:

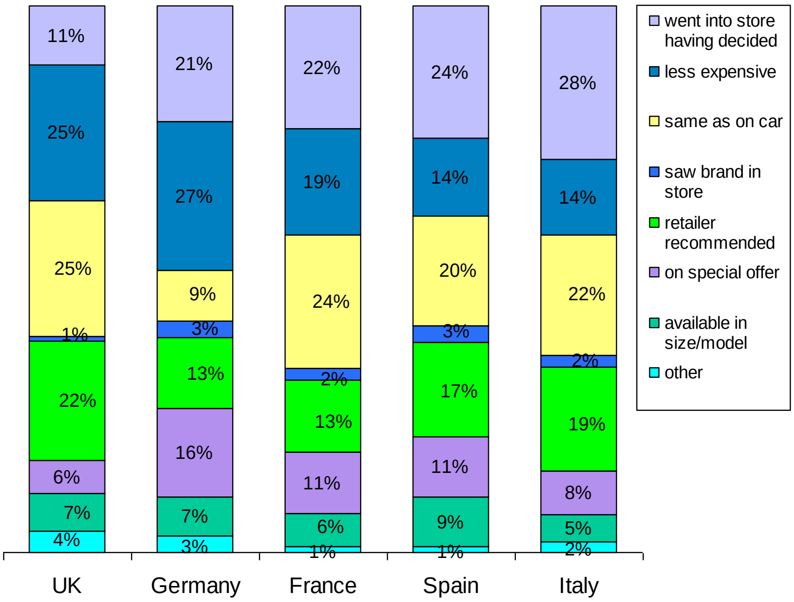
- service/maintenance chains
- local service stations
- dedicated tyre service stations
- vehicle dealerships

A large share of the distribution concerns business to business and only a small share is business to consumer distribution. This means that tyres are fitted by e.g. dedicated service stations for car dealers or by car dealers or service stations for car lease companies and vehicle fleet managers. For both the end consumer is not involved. For the matter of car lease companies a labelling scheme may be influential as cost reduction through the reduction of fuel consumption probably will be a good driver. Thus the effectiveness of a labelling scheme will depend on how it reaches the end-users**,** be it a consumer or a company.

For the consumer, preferences are revealed through the survey work by tyre producers (Figure 2.1).

[7] See VTI study 2008 for detailed analysis

Figure 2.1: Consumer Research, 2003



Source: Bridgestone

Tyre price and OE fitted tyre are the main factors which affects consumer choice (Figure 2.1). The figure also suggests that it is possible to influence tyre choice in the replacement market as only 20% of consumers on average replace tyres like for like. Tyre tests from independent magazines such as ADAC and 'Which' also weight their test according to the importance of the above factors. The 'Which' study also commented on the low availability of LRRTs, especially in small and independent tyre retailers. The results of these tests are discussed in more detail in Annex 3.

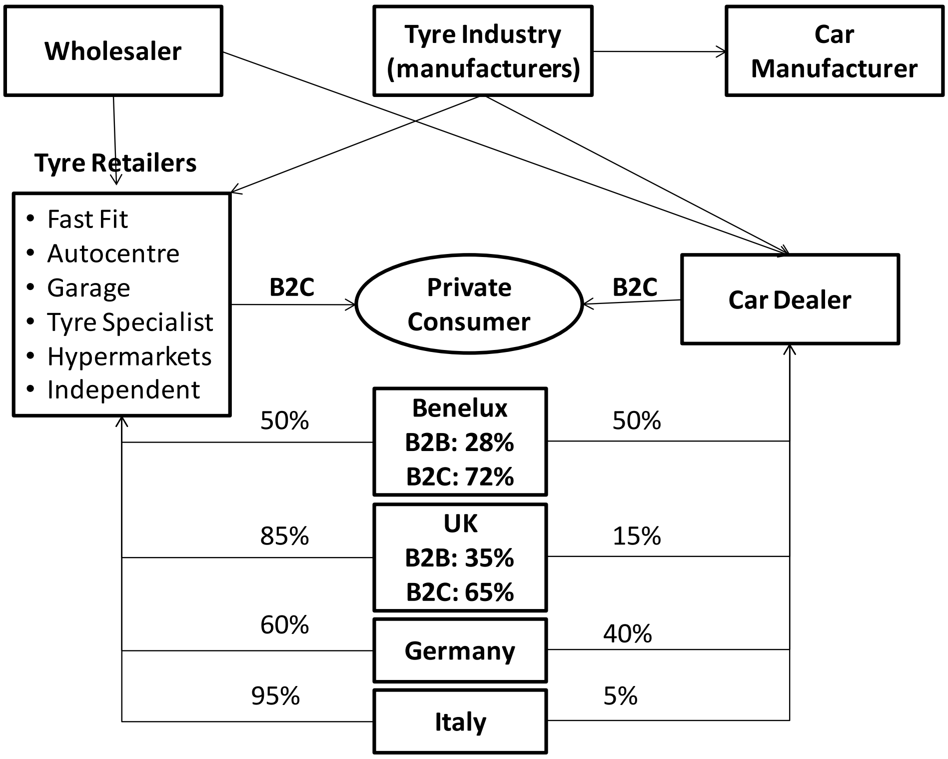
2.3 Retail Structure and Distribution Channels

Customers for replacement tyres range from the ordinary motorist purchasing replacement car tyres occasionally, for example once every two and a half years (after 40,000 km in average for European roads), to very large fleet owners (both for passenger car and commercial vehicles) who spend significant sums of money each year on replacement tyres. For the purposes of this study sales of fleet vehicles include sales of cars owned by companies and cars and vans owned by rental companies, leasing and contract hire firms. In the UK, the sales of fleet vehicles now account for over 50 per cent of new car sales.

The average time before a fleet car is sold ranges from 2-3 years during which time it would travel, on average, approximately 88,514kms. During that period a fleet car would be expected to require five new replacement tyres. Fleet car tyres are replaced more frequently compared to passenger cars due to safety reasons, variety of driving conditions, damages due to potholes and driving over kerbs. Thus, fleet car tyres are generally replaced before their full tyre wear life. Therefore, fleet vehicles can account for a significant proportion of replacement tyres. They account for around 28% in the Benelux countries and 35% in the UK.

Figure 2.2 below outlines the tyre market retail and distribution channels.

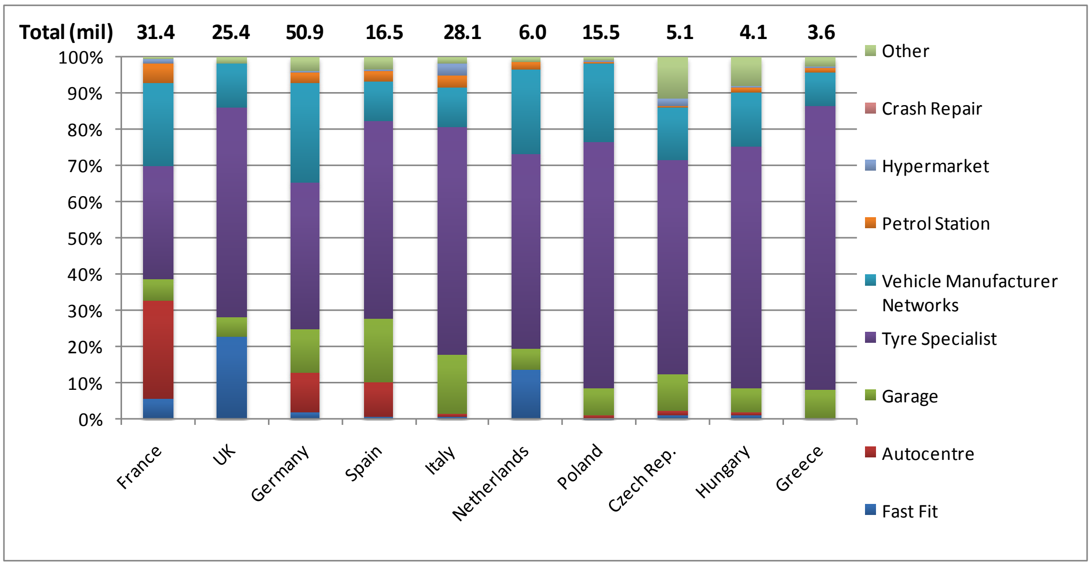
Figure 2.2 : EU Tyre Retail and Distribution Channels



Source: CETRO

The share of tyres sold by the different retail units differs widely across Europe. The Western European MS have a variety of retail units compared to the four eastern European member states (Figure 2.3). Historically the supply of replacement car tyres was dominated by garages (both independent and franchised) but their share of the market has fallen dramatically and now most tyres are supplied through specialist fitting centres. This new trend is likely to increase the impact of a labelling scheme if it were to be introduced.

Figure 2.3: Share of Tyre Replacement Market by Point of Sales (2007)



Source: Tyre producers and ETRMA

2.4 Tyre Branding

In the past, the decision of which brand of tyre to choose was relatively simple. There was a solid core of household brand names- Goodyear, Dunlop, Michelin etc. plus a few budget alternatives. However, in recent years, the tyre market has become much more sophisticated and EU consumers have a plethora of brands to choose from. For example there were a total of 254 different brands available in the UK (source: Tyre Industry Federation 2007).

There are a number of reasons why the number of tyre brands has grown. Firstly the tyre industry in other parts of the world, particularly Asia, has grown rapidly and all these manufacturers are now looking to export their goods to Western Europe. Also important has been the growth of the tyre wholesale trade, wholesalers being constantly on the lookout for new brands to represent. This, together with the growing importance of national retail chains has led to an increase in demand for private brands, exclusive to one particular wholesaler or retailer.

The most important reason for the increase in the number of tyre brands, however, is the fact that the average consumer has become more sophisticated with their choice of tyre. Faced with increased competition, the tyre manufacturers have realised that they can no longer expect to rely on their premium brands. The high technology-premium price leading brands are no longer capable of maintaining sales amongst the proportion of end users where price is one of the main priorities (Figure 2.2a and 2.2b). With the realisation that the majority of the economy priced tyres being imported from Eastern Europe and the Far East are of good quality, consumers who are not looking specifically for a premium household brand have been switching to alternative brands. The leading manufacturers, aware of the need to avoid a collapse in the price of their leading brands, have realised that they need to adopt increasingly complex multi-brand marketing strategies if they are to maintain their market share across all sectors of the market.

Currently all major tyre manufacturers have a multi-brand marketing strategy offering tyres in premium, mid-range and budget brands as well as private and exclusive brands aimed at specific distribution channels.

2.5 The Market for Cold Weather or Winter Tyres

The market for winter tyres is around 28% of the EU replacement tyre market in 2007. However, it is an area, which is currently experiencing significant growth due to the renewed efforts of the tyre industry to raise awareness and to highlight the safety benefits of switching to cold weather tyres in the winter months.

Estimates based on Europool figures and published by the tyre industry specialist magazine Tyre & Accessories suggest that winter tyre sales increased despite mild winter weather in recent years. The share of winter tyres has increased from 23% in 2000 to 28% in 2007.

Although the market is still small, some industry experts are predicting that the market for cold weather tyres could eventually rise to as much as 3 million units per year in the UK. This is based, to a degree on growth achieved in the Netherlands by the trade association, VACO[8], which managed to work together with the tyre industry to create a market for cold weather tyres by running an active campaign together with tyre dealers to promote the safety benefits of changing over to cold weather tyres in the winter. The result was to achieve a market share of around 15% from almost nothing within only a few years.

The main barrier to the growth of the winter tyre market in the Member States such as the UK has been the assumption on the part of both consumers and tyre dealers, that winter tyres are only necessary in snow and, because most of the UK receives only a minimal snow covering, they are not necessary in the UK. The tyre industry has therefore changed

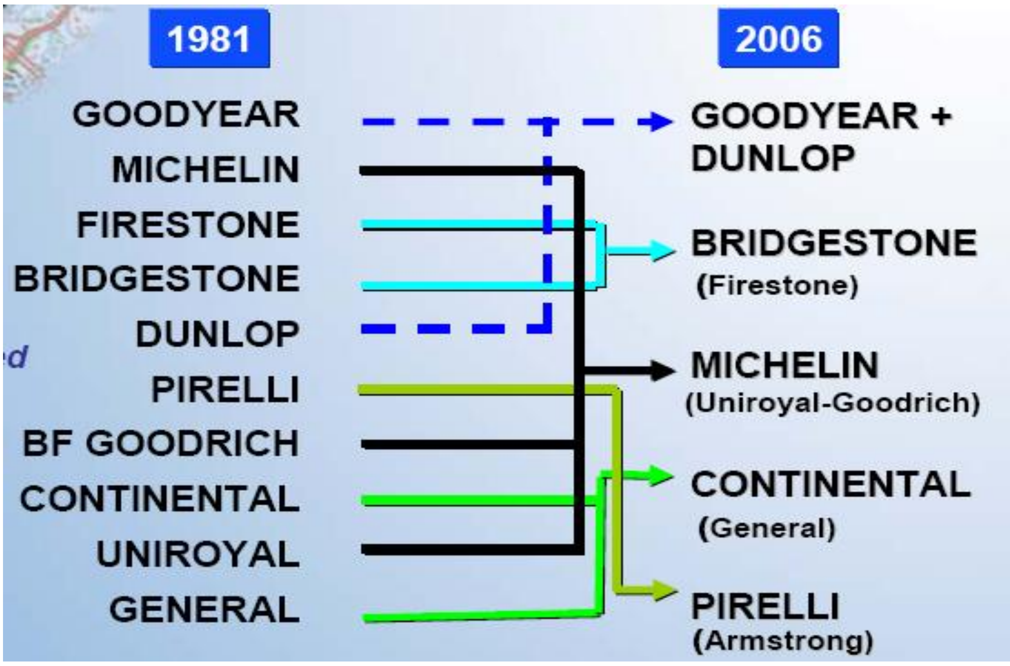
[8] VACO is the representative for the tyre and wheel business in The Netherlands,

the emphasis from "winter tyres" to "cold weather tyres", emphasising the performance improvements that such tyres can provide at temperatures below 7 degree centigrade.

2.6 Changing Industry Players and Industrial Concentration

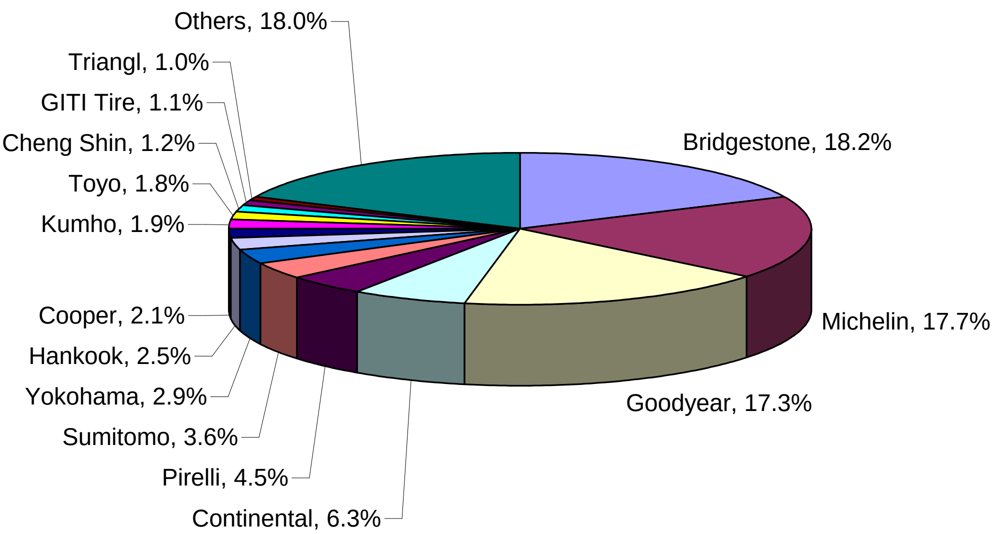
The tyre industry has consolidated in recent years (Figure 2.4). Over 64% of the world market is supplied by the five largest producers (Figure 2.5).

Figure 2.4: Changes in Industry Ownership



Source: Michelin Factbook 2007

Figure 2.5: Industrial Concentration in the Tyre World Market

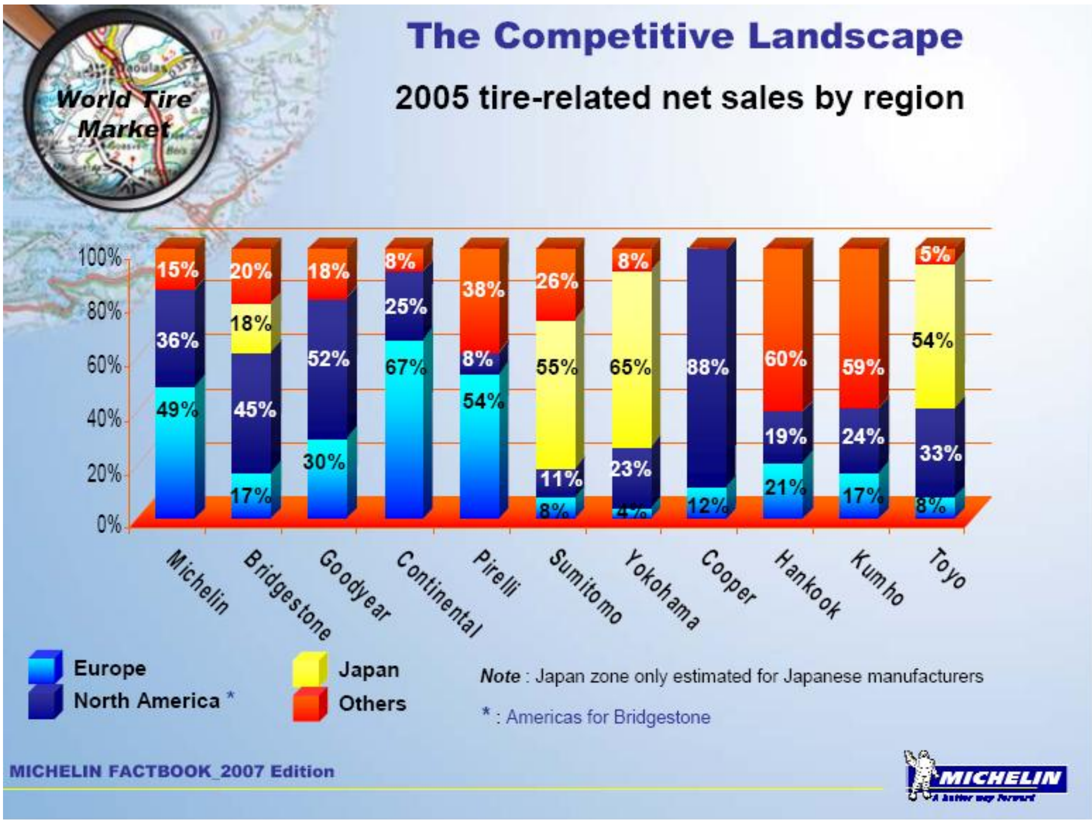


Source: Michelin Factbook 2007

In terms of the significance of the EU market for tyre produces for the five largest producers, Continental and Pirelli are most reliant with over half of sales from the EU. EU sales are also very significant for Michelin and Goodyear. Only Bridgestone has a limited interest in the EU (Figure 2.6). Also noteworthy is the significance of the Japanese market

for the next tier of producers (Sumitomo and Yokohama) where fuel efficiency is accorded greater significance.

Figure 2.6: Market Presence of Major Tyre Producers



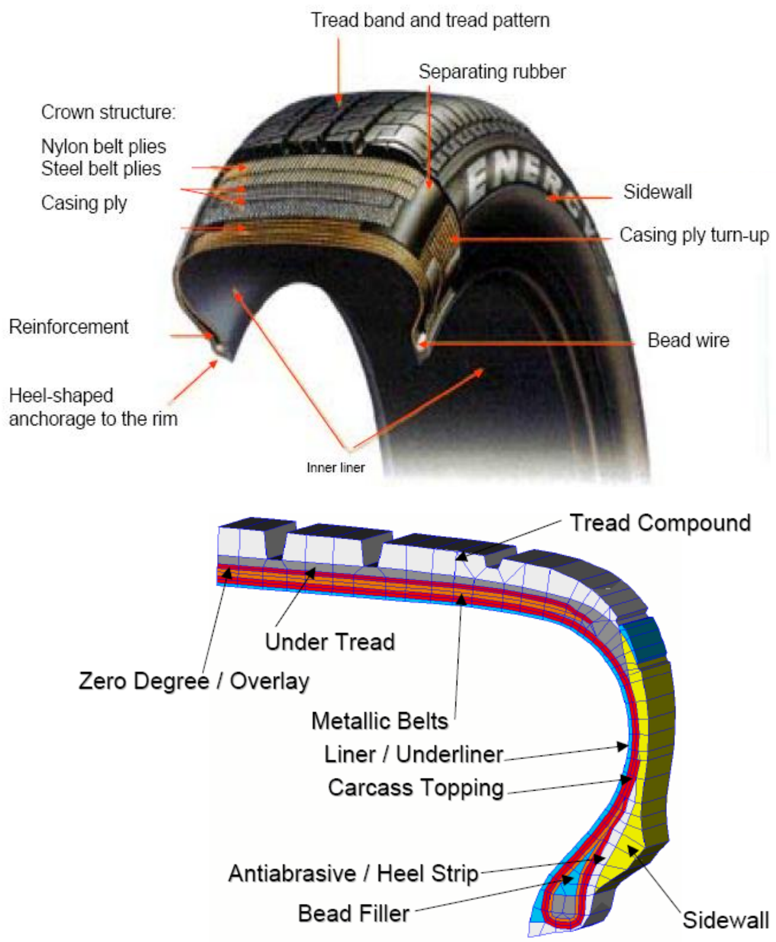
Source: Michelin factbook 2007

3 ANNEX 3: POTENTIAL TRADE-OFFS OF RR WITH WET GRIP, WEAR AND NOISE

This Annex summarises the available technical evidence on the relationships between different tyre attributes

3.1 Main Tyre Components Contributing to Rolling Resistance

The four main components that affect rolling resistance are: Tread (53%), Belts (18%), Bead (17%) and Sidewall (12%).



However, these components affect other tyre attributes as well such as wet grip and wear life. See Table 3.1 below for more details.

3.2 Potential Trade-Offs of RR with Wet Grip, Wear and Noise

Combinations of tyre parameters like material, construction, looks, dimension, design and construction all cause tyres to differ in rolling resistance. Promoting one attribute such as rolling resistance may decrease the performance of the tyre in relation to other attributes. The tyre industry when producing a tyre for the OEM under a set of requirements always try to optimise performance in all attributes, such as wear wet grip and noise.

3.2.1 Main tyre components that effect tyre performance

A tyre is a multi-laminate pneumatic structure of different materials and components bonded together, to perform a range of functional requirements. Extending any one of tyre's performance characteristics affects others, sometimes negatively. Thus tyre design is a trade-off process to achieve a performance balance that best meets customer or market requirements. Table 3.1 indicates the relative significance of effect of different tyre components on tyre attributes.

Table 3.1: Relationship between Tyre Components and Tyre Attributes

	Casing ply	Bead	Sidewall	Steel Belts	Tread compound	Tread pattern	Mold shape
RR	1	1	1	2	3	1	1
Wet grip	1	1	-	1	3	3	1
Dry grip	1	1	-	2	3	3	2
Wear life	1	-	-	2	3	3	3
Mass	2	1	2	2	3	1	2
Resistivity	-	-	1	-	3	-	-
Cut resistance	-	-	1	-	3	2	1
Handling	3	3	-	3	3	3	3
Spring Rate	3	3	2	3	-	-	2
Noise	2	3	1	2	1	3	2

Effect:
1- small
2- Medium
3- Large

Source: RMA Presentation to the California Energy Commission, August 2007

Note: The table shows the effect of each tyre component on tyre performance. For example, the tread compound has a large effect on RR and Wet grip. Any changes in the tread compound to maximise RR could compromise Wet grip. This is discussed below.

The most important tyre component when designing a tyre to reduce its rolling resistance is the tread compound, with the operation of the steel belt second. Change in tread compound is however also the major influence on most of the other attributes. Since hysteresis is a volumetric effect reducing the volume of hysteretic rubber will reduce RR. Since the tread band is the largest volume component it is the greatest contributor to tyre RR. Reducing tread band volume gives the greatest payback in terms of RR gain. However, this will affect, in the absence of technical change, other attributes of the tyre. The influence of designing for RR on other attributes is summarised in Table 3.2.

Table 3.2: Effects of Rolling Resistance Design on Other Tyre Attributes

Tyre Attribute	Interaction level	Description
Mass	3 ↑	Hysteretic effects directly related to volume
Dry Traction	3 ↓	Tread compound properties for dry traction inversely correlate with those for low RR. Difficult to identify counter measures.
Resistivity	3 ↓	Low RR compounds achieved by low carbon black compared to silica are poor for conductivity.
Wear	2 ↓	Wear loss increases with low RR compounds. Counter measures constrained by other performance requirements.
Cut Resistance	2 ↓	Very low RR compounds are poorer for cut resistance.
Wet Traction	2 ↓	Loss of wet traction can be offset to some degree by silica reinforcement.
Handling	2 ↓	Lower RR compounds lower stiffness.
Spring Rate	1 ↓	Greater deflection is worse for RR.
Noise	1 ↑	Low RR compounds improve noise absorption.

Interaction level	**Direction**
1 - Small	↓ - Deteriorates
2 - Medium	↑ - Improves
3 - Large	

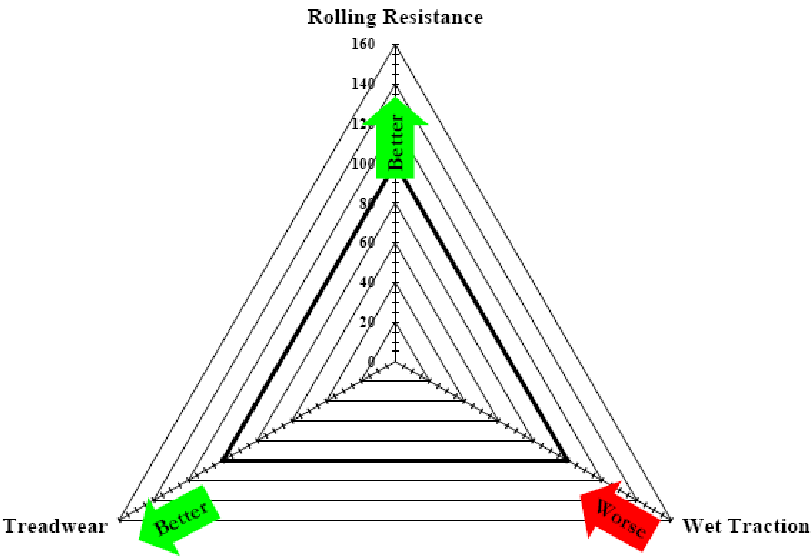
Source: RMA Presentation to the California Energy Commission, August 2007

Based on this analysis the key trade-offs that are likely to arise from a focus on reducing rolling resistance are dry and wet traction, resistivity, tyre wear, cut resistance and handling. Of these the most important trade-offs for economic, social and environmental impacts are dry and wet traction and tyre wear.

- Traction/Dry/Wet Grip – Traction helps the vehicle to stop quicker / in a shorter braking distance. On wet surfaces, wet traction impacts on how quickly a vehicle can stop on slippery roads. Note that measures of traction are most developed for wet surfaces (Wet Grip).
- Treadwear – Treadwear is a measure of how long the tread rubber on the tyre will last and perform its necessary functions. Improved treadwear means the tyre tread is more durable and lasts longer (number of kilometres of life).

In addition, changing the tread pattern to improve wet grip is generally associated with an increase in tyre noise levels.

The interplay between these attributes and rolling resistance are shown in the figures below.



Improvement in Rolling Resistance and Treadwear may cause a corresponding loss in Wet Traction (figure below).

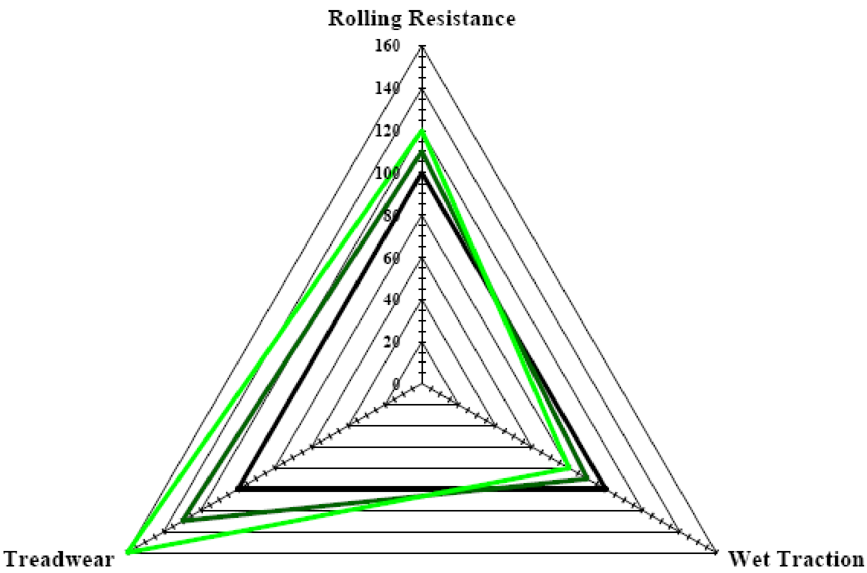
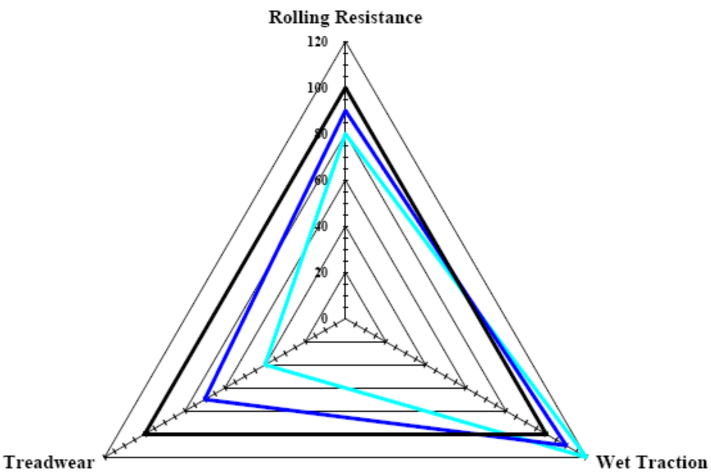


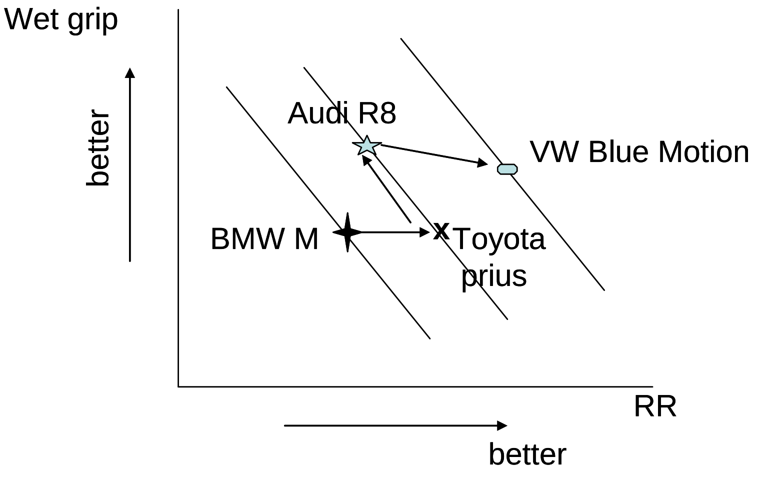
Table 3.2 considers improvement in RR only, the figure above is considering improvement in RR and Treadwear which is achieved using better compounds.

Similarly, Improvement in Wet Traction may cause a corresponding loss in Treadwear and Rolling Resistance (Fuel Economy) (Figure below).



Currently, the evolution of tyre technology is based on specific requirements by OEMs for tyres for different types of vehicles and market segment. Even for OEMs safety related tyre attributes are paramount. Under pressure from OEMs, that have multiple tyre requirements, tyre companies compete to offer improvements in all attributes, which drives innovation, illustrated in Figure 3.1.

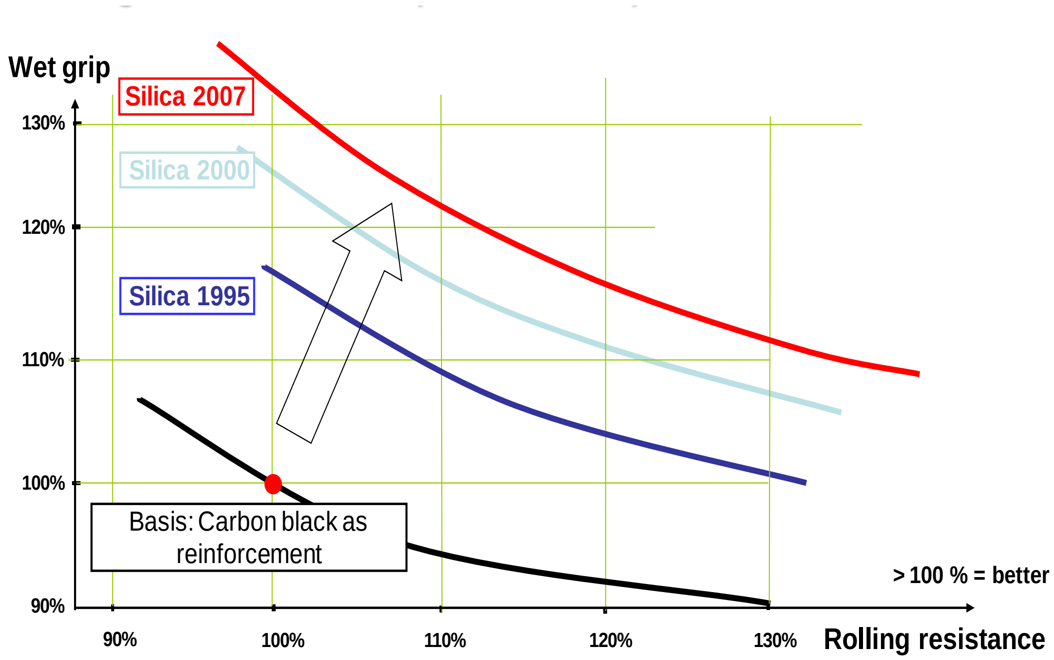
Figure 3.1 Improvement in tyre performance on wet grip and RR



Simultaneous improvement in all of the key attributes requires innovation and step changes in technology. The issues are the time and costs associated with innovation and the resultant scale of improvements. The tyre industry, along with car producers, aims to optimise tyre performance on all fronts.

Technological progress and new compounds (mainly silica mixed with rubber) have allowed tyre manufacturers to maximise performance on wet grip and RR simultaneously (Figure 3.2 below). The industry is currently reaching the limits of tread compound development using silica and further improvement to optimise all tyre attributes comes at a price premium.

Figure 3.2: Progress in Tread Compound Development



Source: Continental

3.3 Statistical and Empirical Evidence on Relationship between RR, Wet Grip, Wear and Noise

In this section we summarise the findings of a number of studies examining the relationship between rolling resistance and other tyre attributes, mainly wet grip, noise and wear. Some of the studies have also looked at the variation in price for a given level of RRC. These

studies provide a range for the price premium of LRRTs with above or above average performance on wet grip.

Rolling resistance is measured in kg/t and expressed as a coefficient, RRC. Some of the studies and tests below (Table 3.3) explicitly compare RRC with tyre attributes and some have translated their test findings into RR scores or indicators.

Table 3.3: Summary of Studies

Source	No. of tyres	No. of tyre size	Other tyre segments	Tested for	Year
TÜV SÜD Automotive	14	2		Wet braking & RR	2008
Which, UK	97	8	Premium & economy	RR, WG, wear & noise	2007-2008
Que Choisir Study	37	2	-	WG, RR and wear	Mar-08
ADAC auto reifentest	37	2	-	RR, WG, wear & noise	Mar-08
Knall- effect	*7*	1	Comparison with Imported tyres	RR, WG & noise	2008
VROM, Netherlands	*198 (consumer tests)*	Various (165-225 mm width)	50% winter and 50% summer	Noise, RR and WG	2005-2007
RMA, US	162	7	Rep. mkt & OE, speed rating	Traction, RR and wear	2005
TUV Europe Study	183	12	Summer/winter, Sport, 4x4, Light truck, etc	RR, WG & wear	2004-2005
California Energy Commission(CEC)	43	4	7	Traction, RR and wear	2003
TUV UBA	81	4	Summer/Winter, premium, mid, budget	RR, WG, wear & noise	2002

It should be pointed out that the research described below is not directly comparable. The testing methods used are not standardised. There were some variations in scores/results even when the same tyre size and brands were tested. However, the tests did provide information to allow the overall trend and direction of the relationships of the main tyre attributes.

Summary of findings from studies

- Lower RR is generally associated with lower level of wet grip across all tyre sizes;
- Changing the tread pattern to improve wet grip is generally associated with an increase in tyre noise levels;
- There is evidence that there are tyres in most sizes that can perform well on a number of tyre attributes (including wet grip) but at higher tyre costs;
- For fuel efficient tyres with low RR, there is a clear price premium for tyres which perform well on WG compared to tyres which achieve low RR but with reduced WG performance. The price premium for the better performing tyres on RR and WG, compared to the worst performing tyres on wet grip ranges from 20% to 40% and between 5% to 10% for tyres with an average level of performance for WG;

- None of the studies and tests showed that any one tyre (irrespective of cost) scored the best on all attributes. This suggests that better technology at higher cost allows some progress in reducing RR without compromising WG, but there are current technological limits to achieving the very best performance levels of RR with the very best performance standards for WG;
- Independent tests (ADAC, Which, Knall-effekt and Que Choisir) showed that imported tyres that had very low RR tended to perform very poorly on WG.

3.3.1 TÜV SÜD Automotive (2008)

TÜV SÜD Automotive conducted tests in April and May 2008 on two different tire sizes (195/65 R15 H and 195/65 R15 V) among those most widely sold in Europe, which it purchased in tire outlets.

In the tyre size 195/65 R15 H, Michelin Energy saver had the lowest RRC and shortest braking distance. In the tyre size 195/65 R15 V, the Michelin Energy saver had the lowest RRC and the third shortest braking distance but by only 0.5m. According to the tests conducted by TÜV SÜD Automotive, the Michelin Energy Saver reduces fuel consumption by 0.2 l/100 km3, due to lower rolling resistance, which is nearly 20% lower than that of its direct competitors. This greater fuel efficiency translates into a fuel cost saving of around €125 over the average lifespan of the tyre.

Tyre size - 195/65 R15 91H				Tyre size - 195/65 R15 91 V			
Tyre brand	Braking Distance (m)	Deceleration (m/s2)	RRC (kg/t)	Tyre brand	Braking Distance (m)	Deceleration (m/s2)	RRC (kg/t)
Michelin energy saver	31.3	7.4	8.58	Michelin energy saver	30.8	7.53	8.6
Conti Premiumcontact 2	31.6	7.32	9.82	Bridgestone Turanza ER300	32.2	7.18	9.9
Goodyear excellence	32	7.24	10.2	Conti Premiumcontact 2	30.3	7.64	11.1
Pirelli P6	32.4	7.15	10.42	Dunlop SP sport Fastresponse	32.3	7.17	11.2
Bridgestone B 250	31.9	7.25	9.84	Goodyear excellence	30.7	7.55	10.6
Dunlop Fastresponse	33.5	6.92	11.58	Pirelli P6 Cinturato	32	7.23	10.1
Nokian H	32.6	7.09	10.07	Vredestein Sportrac 3	32.7	7.08	10.3

Source: TUV SUD Automotive

3.3.2 Knall- effect

This German test magazine looked at the wet grip and braking performance of imported Chinese tyres compared to a European brand – Pirelli. The tests showed that most imported Chinese tyres performed poorly on wet braking. The worst tyres had a braking difference of 25 metres compared to the Pirelli tyre.

	Brand	Pirelli	Wanli	Linglong	Chengshan	Triangle	Sunny	Sonar
	Size	195/65R15 H	195/65R15 H	195/65R15 H	195/65R15 H	195/65R15 H	195/65R15 H	195/65R15 H
	Pattern	P6	S-1093	Radial 600	CSR 60	Talon Sport TR918	Power Touring 3300	SX-608 N
	Price (Euros)	80	43	41	33	42	44	41
Wet	Handling (20)	20	14	15	10	10	13	10
	Braking (40)	40	14	24	0	0	0	4
	Aquaplaning (20)	20	18	7	10	5	0	0
	TOTAL (80)	80	46	46	20	15	13	14
Dry	Handling (20)	20	18	18	18	17	18	17
	Braking (30)	30	21	25	21	18	21	22
	Comfort (10)	10	7	6	6	8	6	8
	Noise (10)	8	9	8	9	10	9	10
	Rolling resistence (10)	2	7	3	7	8	6	10
	Speed test (20)	20	20	0	20	20	20	5
	TOTAL (100)	90	82	60	81	81	80	72
	GRAND TOTAL (180)	170	128	106	101	96	93	86

Note: The tyres were scored on wet and dry performance. The maximum scores are given in brackets in the first column. The maximum score a tyre could achieve was 180.

3.3.3 'Which' study (UK) (2007-2008)

'Which' is UK's largest consumer body and undertakes independent tests on a range of household products. Which road tested 97 premium and economy tyres, spanning eight different sizes in February 2008[9].

Tyres were tested for: Dry braking - Braking on dry roads, Dry handling - assessment of handling on a dry road, Wet braking - braking on wet roads, Wet grip straight - resistance to aquaplaning in a straight line, Wet grip bend - resistance to aquaplaning in a bend, Wet handling - assessment of handling on a wet road, Noise is assessed inside and outside the car, Rolling resistance - compared rolling resistance, by measuring fuel consumption on a fixed route at three different speeds and Wear - How quickly the tyre wears.

Exact measurement values were not available and tyres were rated as – Excellent, Good, Acceptable, Poor and Very Poor.

Main findings

- For each tyre size there were a number of tyres with 'good' and 'excellent' score on RR. Of these only a few scored 'good' or 'excellent' on WG but at a price premium.
- The prices in tyre size 175/65 R14T and 185/60 R14H were very competitive with no price premium for tyre performing well on WG and RR compared to the worst and average performing tyre on WG in that tyre size.

Size	No. of tyres	Price range		Price premium (worst)	Price premium (average)
155/70R13T	11	£30 - £47	RR - 7 scored 'good' and 4 'excellent'. Of the 4, 1 was 'very poor' on WG and 3 'acceptable'.	43%	10%
165/70 R14T	10	£38 - £59	RR – 1 Excellent, 8 Acceptable, 1 poor. Of the 8, 5 scored Good on WG	35%	6.2%
175/65 R14T	17	£33 - £50	RR – 1 scored acceptable and 16 scored 'Good'. Of the 16, 3 scored very poor, 2 poor, 3 acceptable, 8 good & 1 excellent on WG	16%	No
185/60 R14H	10	£44 - £61	RR – all acceptable, of that 2 scored acceptable on WG, 7 good and 1 excellent.	No	No
195/65 R15H	25	£40 - £72	RR – 1 scored poor, 8 acceptable & 16 Good. Of the 16, 1 scored excellent on WG, 7 scored good, 4 acceptable, 3 poor & 1 very poor.	22%	11%
205/55 R16 V	14	£55 - £86	RR – 4 scored acceptable and 10 good. Of the 10, 4 scored good on WG, 4 good, 1 poor and 1 very poor.	20%	7.3%
225/45 R17 W	10	£75 - £120	RR – All acceptable WG – 9 scored good & 1 acceptable	No	No

9 http://www.which.co.uk/reports_and_campaigns/cars/reports/running_a_car/accessories/Tyres/Tyres_essential_product_574_70980.jsp

Note: Price premium (worst) shows the price premium of tyres that scored as ‘Good’ or ‘Excellent’ on RR and ‘Good’ or ‘Excellent’ on WG compared to tyres that scored ‘Good’ or ‘Excellent’ on RR but ‘Poor’ or ‘Very poor’ on WG. Price premium (average) shows the price premium of tyres that scored as ‘Good’ or ‘Excellent’ on RR and ‘Good’ or ‘Excellent’ on WG compared to tyres that scored ‘Good’ or ‘Acceptable’ on RR and WG.

3.3.4 Que Choisir Study (2008)

For the purpose of the study 16 tyres were assembled on a Ford fiesta (dimension 175/65) and 21 tyres on a Volkswagen golf (195/65). The vehicles, equipped with ABS, were driven on a circuit (asphalt and concrete coating) by experienced drivers. Tyres’ performances have been compared with reference tyres’ performances. Before starting the tests, the tyres were broken in on a distance of 400 to 500km so as to get rid of the light layer of ‘parafine’ that covers the rolling strip during the transportation phase. No measurement values were available but classification/score, (1 = very bad, 2=below average/bad, 3 is average, 4=good, 5 = very good).

Main findings

Tyre Size 175/65 R 14 T

	Tyre Size 175/65 R 14 T	Price			Braking	Rolling resistance	Avearage Life
		From	To	Average			
1	Pirelli Cinturato P4	59	73	66	5	4	5
2	Continental EcoContact 3	52	80	66	4	3	4
3	Fulda Eco Control	45	60	52.5	4	4	4
4	Maloya Cron 465t			42.1	4	4	3
5	Goodyear DuraGrip	50	73	61.5	3	4	4
6	Firestone Multihawk	45	94	69.5	4	4	3
7	Dunlop SP 30	52	79	65.5	3	4	4
8	Kumho Solus KH17	49	57	53	4	4	4
9	Semperit Comfort Life	51	57	54	4	4	3
10	Hankook Optimo K715	48	77	62.5	4	4	3
11	Bridgestone B250	51	77	64	3	4	3
12	Vredstein T-Trac Si	46	53	49.5	3	4	2
13	Barum Brillantis	49	71	60	2	4	4
14	Sava Perfecta	42	51	46.5	2	4	4
15	Tigar TG 621	38	46	42	1	4	5
16	Trayal T400			37.6	1	4	4

- All tyres had a ‘good’ level (score 4) of rolling resistance except for one with an ‘average’ score. However, the wet braking scores differed significantly
- Only one tyre had scored a ‘very good’ for wet braking with a ‘good’ score for RR. However, the price premium for this tyre was 66% compared to two tyres with the ‘very bad’ scores and 10% compared to 4 tyres with ‘average’ scores.
- Higher prices do not always reflect better tyre performances
- 7 tyres were classified with a ‘good’ score for wet braking with a 43% price premium compared to the two worst two tyres for wet braking. However, there was no price premium for these 7 tyres when compared to 4 tyres that scored ‘average’ on wet braking. Moreover, 4 of these 7 tyres undercut the price of the 4 tyres that scored ‘average’ on wet braking.
- Thus, there were 8 tyres with low RR had ‘good’ to ‘very good’ levels of wet braking performance although at higher price. On the other hand there were 4 tyres with low RR but ‘bad’ to ‘very bad’ wet braking scores.
- Of the 16 tyres, 10 tyres scored ‘good’ and ‘very good’ on tyre life.

Tyre Size 195/65 R 14 T

- 5 tyres scored ‘good’ on braking and rolling resistance and 5 tyres scored ‘average’ on braking and ‘good’ on rolling resistance.
- On average the 5 tyres scoring ‘good’ on braking and RR had a 4% price premium on tyres scoring ‘average’ on braking and ‘good’ on rolling resistance.
- 3 tyres scored ‘good’ on RR with ‘below average’ or ‘bad’ scores on wet grip. The price premium of tyres scoring ‘good’ on braking and RR compared to these 3 tyres was around 24%.

Tyre Size 195/65 R 14 T	Price			Braking	Rolling resistance	Avearage Life
	From	To	Average			
Bridgestone Turanza ER300	70	113	91.5	4	4	3
Pirelli P6	68	113	90.5	4	4	3
Continental Premium Contact2	69	126	97.5	4	3	3
Vredestien Sporttrac 3	59	76	67.5	3	3	3
Maloya Futura Sport V	60.1		60.1	4	4	3
Dunlop Sp Sport Fastresponse	68	97	82.5	3	3	3
Yokohamm C.drive	73	117	95	4	4	3
Michelin Energy Saver	83	102	92.5	3	4	5
Uniroyal Rallye	60	96	78	3	4	3
Firestone Firehawk TX200 FS	61	115	88	3	4	3
Barum Bravuris 2	70	99	84.5	3	4	3
Hankook Ventus Prime K105	72	97	84.5	3	4	3
Ceat Tornado	77	86	81.5	4	4	5
Nokian V	81.8		81.8	2	3	3
Fulhda Carat Progresso	62	91	76.5	4	4	4
Toyo Proxes CF1	63	93	78	2	4	3
Goodyear Excellence	64	113	88.5	3	3	4
BFGoodrich Profiler 2	62	96	79	2	4	5
Wanli S1095	48	59	53.5	1	4	4

3.3.5 ADAC auto reifentest (2008)

The ADAC (Allgemeiner Deutscher Automobil-Club e.V.) is Germany's and Europe's largest automobile club, with 15,290,614 members in August 2005. ADAC is respected by motorists and tyre companies for the severity of the tests carried out. The findings for two tyre sizes – Summer tyres 175/65 R 14 T and Summer 195/65 R 15 V is given below. Again no measurement values were available but each attributed was given a particular score. Low scores indicate better performance of each attribute.

Tyre Size 175/65 R 14 T (Corr. Coeff RR and WG=-0.3)

	Tyre make and Brand	Price			Dry Grip	Wet Grip	Noise	Rolling Resistance	Durability
		From €	To €	Average €					
1	Barum Brillantis	43	63	53	2.7	3.2	3.5	1.6	1.8
2	Semperit Comfort Life	43	62	52.5	2.5	2.5	3.5	1.7	3.2
3	Tigar TG 621	37	47	42	3.2	4.8	4.6	1.7	1.3
4	Yokohama C.drive	49	60	54.5	1.6	2.3	3.6	2	3.2
5	Goodyear Duragrip	48	71	59.5	2.5	2.8	3.6	2	2
6	Dunlop SP 30	47	70	58.5	2.1	2.9	3.5	2	2.4
7	Hankook Optimo K715	43	60	51.5	2.3	2.4	3.9	2	3.2
8	Sava Perfecta	34	47	40.5	2.8	3.8	4.1	2	2.4
9	Traya T 400	31	41	36	4.3	5	4.3	2	2.2
10	Fulda Eco Control	39	58	48.5	2.2	2.4	3.6	2.1	1.7
11	Firestone Multihawk	41	72	56.5	2.2	2.6	3.5	2.1	2.7
12	Pirelli Cinturato P4	53	72	62.5	2.3	2.2	3.8	2.2	0.8
13	Kumho Solus KH17	37	49	42.1	2.3	2.4	3.5	2.2	2.4
14	Bridgestone B250	49	70	59.5	2.1	2.9	3.5	2.2	2.8
15	Maloya Crono 465t	36	51	43.5	2.1	2.2	3.6	2.4	3.1
16	Vredestein T-Trac Si	39	62	50.5	2.2	2.4	4.4	2.4	4.3
17	Avon CR322 Enviro	40	49	44.5	2.8	4.6	3.8	2.5	3.3
18	Continental EcoContact 3	49	70	59.5	2.2	2	3	2.7	2.2

Tyre Size 195/65 R 15 V (Corr. Coeff RR and WG=-0.2)

		Price			Dry Grip	Wet Grip	Noise	Rolling Resistance	Durability
		From	To	Average					
1	Michelin Energy Saver	80	108	94	1.6	3.0	2.4	1.7	0.8
2	BF Goodrich Profiler 2	59	75	67	2.0	3.2	6.5	1.9	1.3
3	Barum Bravuris 2	59	79	69	2.5	2.8	2.9	2	2.8
4	Maloya Furutra Sport V	55	70	62.5	2.2	2.1	3.1	2.1	3.1
5	Pirelli P6	66	99	82.5	1.9	2.1	3.1	2.3	2.6
6	Ceat Tornado	65	80	72.5	2.0	2.7	2.9	2.3	1.3
7	Fulda Carat Progresso	55	80	67.5	2.1	2.6	3.1	2.3	2.5
8	Hankook Ventus Prime K105	63	88	75.5	2.4	2.9	3.3	2.3	3.1
9	Toyo Proxes CF1	57	73	65	2.1	3.6	3.4	2.3	3.1
10	Firestone Firehawk TZ200 FS	54	91	72.5	2.0	2.7	2.5	2.4	2.7
11	Wanli S 1095	41	59	50	2.9	5.5	3.5	2.4	1.6
12	Bridgestone Turanza ER300	69	106	87.5	1.5	2.3	2.8	2.5	2.7
13	Yokohama C.drive	68	87	77.5	2.0	2.2	2.7	2.5	3.3
14	Uniroyal rallye 550	57	94	75.5	2.2	2.4	2.4	2.5	3.2
15	Continental Premium Contact 2	65	98	81.5	1.7	2.1	2.8	2.6	3.2
16	Goodyear Excellence	59	91	75	2.4	2.8	2.9	2.6	1.9
17	Vredstein Sportrac 3	53	81	67	1.9	2.0	3.8	2.7	2.7
18	Dunlop Sp Sport Fastresponse	63	97	80	1.9	2.4	2.4	2.7	3.0
19	Nokian V	75	86	80.5	2.2	2.8	2.7	2.8	2.9

Note: Low scores are more desirable. Scores range from 0.6 to 5.5. Weights for overall score: Dry Grip 20%, Wet Grip 40%, Noise 10%, Rolling Resistance 10% and Wear 20%.

Main Findings

- There was a small negative correlation between WG and RR for both tyre sizes.
- For tyre size 175/65, there was an 18% price premium for tyres ‘highly recommended’ (low scores) for WG and RR compared to tyres with low scores on RR but high scores on WG.
- For tyre size 195/65, there was a 7% price premium for tyres with low scores on RR and WG compared to tyres with low scores on RR but high scores on WG.
- The Chinese imported tyre Wanli S1095 scored worst on WG with average score for RR and had 20m braking distance difference compared to the best in the class.

- The Michelin Energy 195/65 R15V saver provides half a litre fuel saving against the tyre with the worst RR score but had a 7m more braking distance compared to the best tyre for WG. However, the ADAC test shows a far greater breaking distance difference between the Michelin Energy saver and the best performing tyre than the TÜV SÜD Automotive results (Section 3.3.1). The TÜV SÜD tests found that the Michelin Energy 195/65 R15V had the lowest RRC and the third shortest braking distance of 0.5m. The other main tyres tested were more or less the same in both tests.

3.3.6 VROM, Netherlands Ministry of Housing, Spatial Planning and the Environment (2005-2007)

The Netherlands have compiled additional data, both on noise and on the potential interaction with rolling resistance and wet grip. The data has been obtained from consumer tests over the last three years and evaluated if these data can be made useful for the evaluation of the tyre noise directive. Rolling resistance is expressed as scores of 1-10, with 10 being excellent instead of actual measurement values. This new data set contains in total 198 tyres in various popular sizes (165-225 mm width) with 50% winter and 50% summer tyres.

Main Findings

- Tyres with both good wet grip and good rolling resistance were scarce in this data set
- Tyres with both low noise and good rolling resistance are ample available in this data set
- According to this study, availability of tyres which perform very well on all three categories depends on the stringency of the criteria;
    - especially on the stringency of RR and WG, because the data shows a trade off between RR and WG
    - not so much on the stringency of Noise; because the data shows no trade off between Noise and RR

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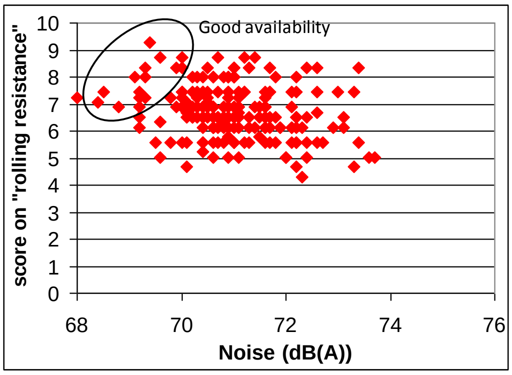
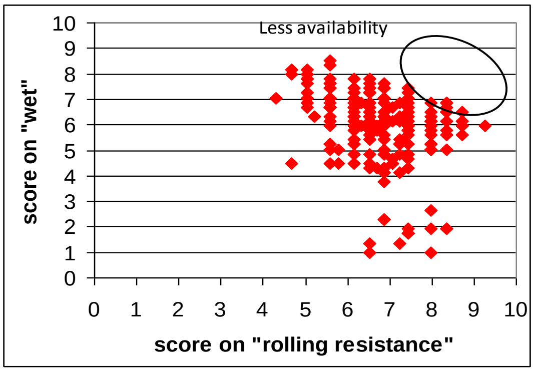
<tr><td>
</td><td>
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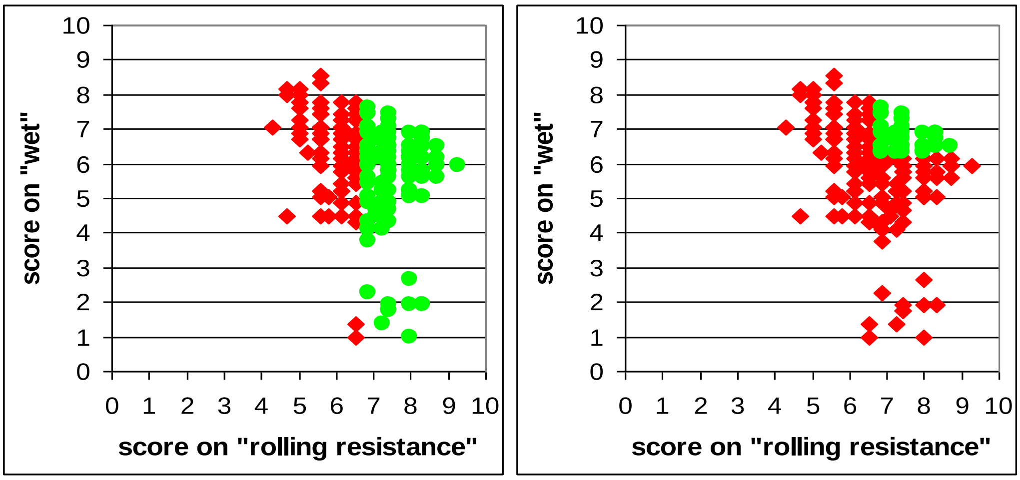


50% best for rolling resistance, leaves 50% of tyres   50% best for rolling resistance AND 50% best for wet grip Leaves only 18% of tyres instead of 0,5*0,5 = 25%

Note: Rolling resistance: No measurement value but classification/score, (1 = inadequate, 10 = excellent). Wet grip: No measurement value but classification/score, (1 = inadequate, 10 = excellent)

3.3.7 Transport Research Board, US based on Rubber Manufacturers Association (RMA) and Ecos Consulting Data (2005)

The RMA dataset contained 162 tyres – 154 replacement market and 8 OE tyres, 3 tyre manufacturers – Michelin, Bridgestone and Goodyear and 7 tyre sizes. The Ecos dataset contained 34 tyres, by four sizes including performance and standard tyres.

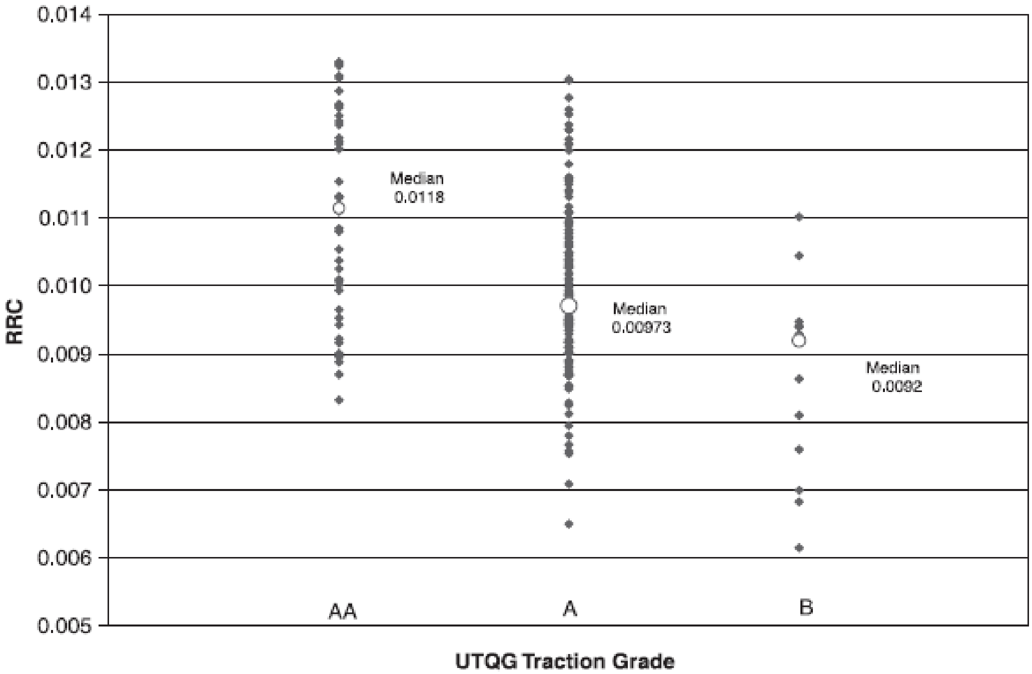
The analyses of sampled replacement tyres suggest that most tyres having high (AAA) UTQG[10] wet traction grades are rated for high speeds and that few such tyres attain low levels of rolling resistance. These results may reflect the technical difficulty of designing tyres that can achieve high levels of wet traction and low rolling resistance. They may also reflect a lack of interest in energy performance among users and makers of high-performance tyres or a general lack of consumer information on this characteristic (the UTQG system does not provide information on RR, it is therefore impossible for consumers to assess this parameter in their purchasing decision). Among the majority of tyres that have an 'A' grade for wet traction, the spread in RRCs is much wider. Indeed, the existence of numerous tyres having both low RRCs and an A grade for wet traction suggests the potential to reduce rolling resistance in some tyres while maintaining the most common traction capability as measured by UTQG. RRC differentials of 20 percent or more can be found among tyres of the same size, speed rating, and UTQG traction grade.

Figure below shows that tires with higher wet traction grades[11] tend to have higher RRCs. At the same time, the graph reveals a wide spread in RRCs within all three grades. More than one-quarter of the AA-graded tires have RRCs below 0.010, and one-quarter have values above 0.012 The absence of very low RRCs among AA-graded tires may indicate a lack of consumer demand for energy performance in high-traction tires, or it may be indicative of a technical or cost difficulty in achieving both qualities. The RRCs for A-graded tires cover a wider spectrum, from a low of 0.0065 to a high of 0.013.

[10] Uniform Tire Quality Grading (UTQG)

[11] UTQG traction grades are based on a tire's measured coefficient of friction when it is tested on wet asphalt and concrete surfaces. The subject tire is placed on an instrumented axle of a skid trailer, which is pulled behind a truck at 50 mph on wet asphalt and concrete surfaces. The trailer's brakes are momentarily locked, and sensors on the axle measure the longitudinal braking forces as it slides in a straight line. The coefficient of friction is then determined as the ratio of this sliding forced to the tire load.

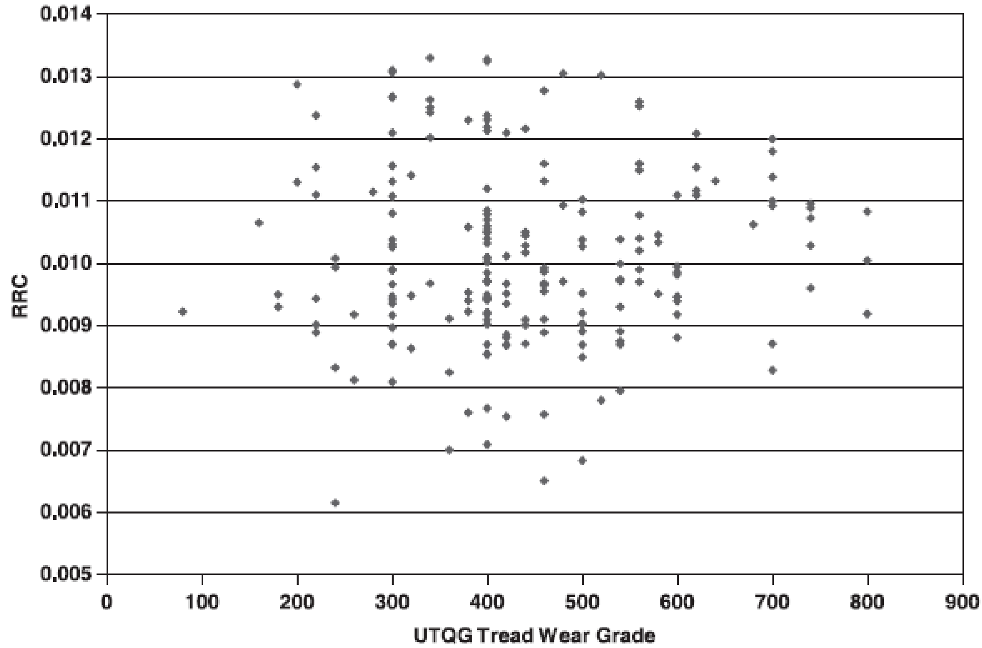
RRCs by UTQG wet traction grade, combined Ecos and RMA data.



A scatter graph of all 196 tyres (Figure below) in the combined data set does not exhibit any noticeable association between RRC and tread wear rating[12]. In other words, it is not possible to conclude whether there is any trade-off between RRC and treadwear.

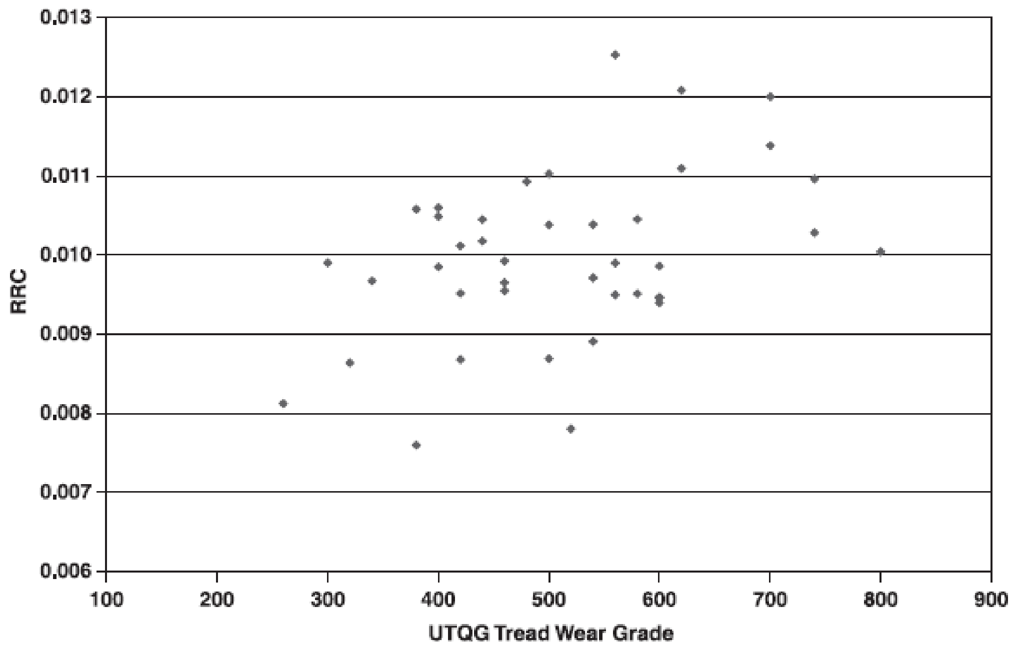
[12] The UTQG tread wear grade is a comparative rating generated from the results of an outdoor highway test course in which the subject tire is run in a convoy with several standardized “course-monitoring” tires. After 7,200 miles, the subject tire’s wear rate is compared with that of the monitoring tires. Tires are rated for tread wear as part of UTQG. These grades are numerical, and most assigned values range from 100 to 800. The scale is an index intended to reflect relative wear life. In general, tires graded 400 should outwear tires graded 200.The relative performance of tires, however, depends on the conditions of use, and therefore it may depart significantly from the norm because of variations in operating conditions and maintenance.

RRC and UTQG Tread Wear Grade (combined dataset)



Further disaggregation by graphing (Figure below) only those S or T[13] tires with 15-inch rim diameters suggests the possibility of a relationship between rolling resistance and UTQG tread wear grade, which warrants more data for thorough statistical analysis involving more explanatory variables. Figure below shows that tyres with higher wear life tend to have higher RRC.

Scatter graphs of RRC and UTQG tread wear ratings, combined data set but tires with speed rating of S or T and 15-inch rim diameter.



[13] Speed rating 180-190 km/t, for family cars or vans

Research TRB which investigated trade-offs stated that:

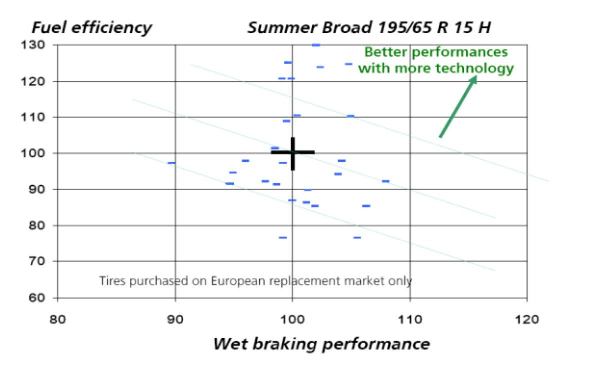
- The effects of reductions in rolling resistance on tire wear life and scrap tires are difficult to estimate because of the various ways by which rolling resistance can be reduced.
- Changing tyre tread to reduce rolling resistance may affect traction, but the consequences would be 'undetectable'.

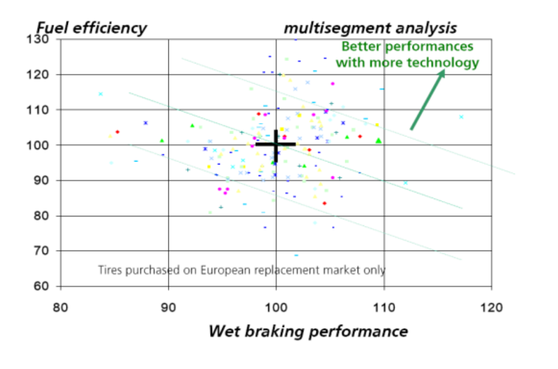
3.3.8 TUV Europe Study (2004 – 2005)

A study by TUV in Europe in 2004 & 2005, based on 183 tyre lines based on 12 tyre segments[14], purchased directly on the European replacement market, examined the relationship between rolling resistance and wet grip and with treadwear. In this study the test findings on rolling resistance has been converted into fuel efficiency indices. An index of greater 100 indicates better performance. The results are summarised in the Figures below.

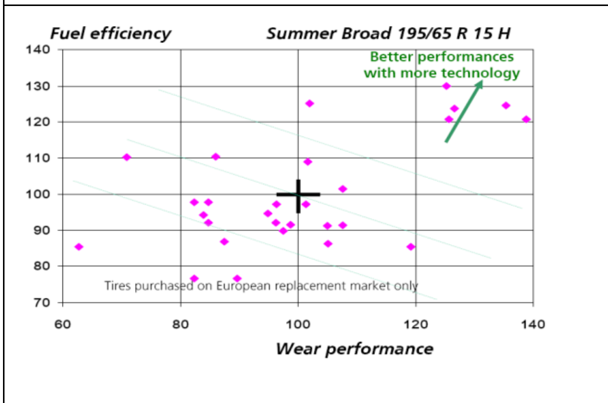
- No clear pattern exists, though some tyres have good performance in both dimensions below.
- For some tyres wet braking performance is achieved at the cost of fuel efficiency.
- Safety and long wear life along with fuel efficiency is possible with high cost technology.

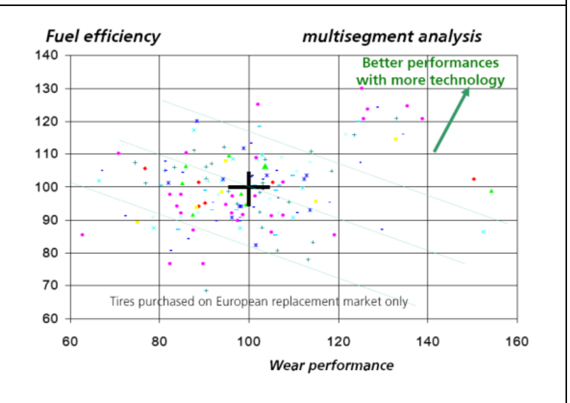
Fuel Efficiency and Wet Braking





Fuel Efficiency and Wear Performance





Note: Each type of marker shows a tyre segment.

[14] Summer, Winter, Sport, 4x4, Light truck, etc. Please see Annex for more details.

3.3.9 California Energy Commission's (CEC) Fuel Efficient Tire Programme (2003)

The CEC in consultation with the California Integrated Waste Management Board (CIWMB) has adopted and implementing a tyre energy efficiency programme of statewide applicability for replacement tires for passenger cars and light-duty trucks. A workshop in 2007 was conducted to discuss with and receive input from members of the public and interested parties about the Energy Commission efforts to develop and implement a comprehensive fuel efficient tyre programme.

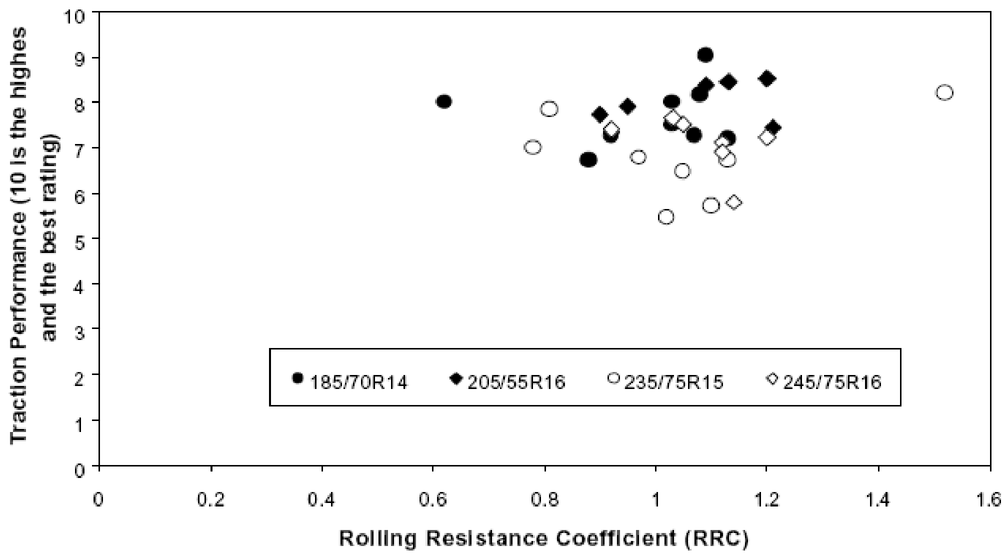
CEC study15 examined traction, tread wear, tyre prices, and overall customer satisfaction in the context of rolling resistance. 43 tyre models were tested for rolling resistance testing under SAE J1269 testing guidelines.

Main findings

No clear trend that would indicate a strong correlation between rolling resistance (RRC) and traction. The most fuel-efficient tyre tested had a rolling resistance coefficient of 0.62 – about 60% less than the least fuel-efficient tyre tested. The majority of the tyres achieved a rolling resistance coefficient between 0.9 and 1.2.

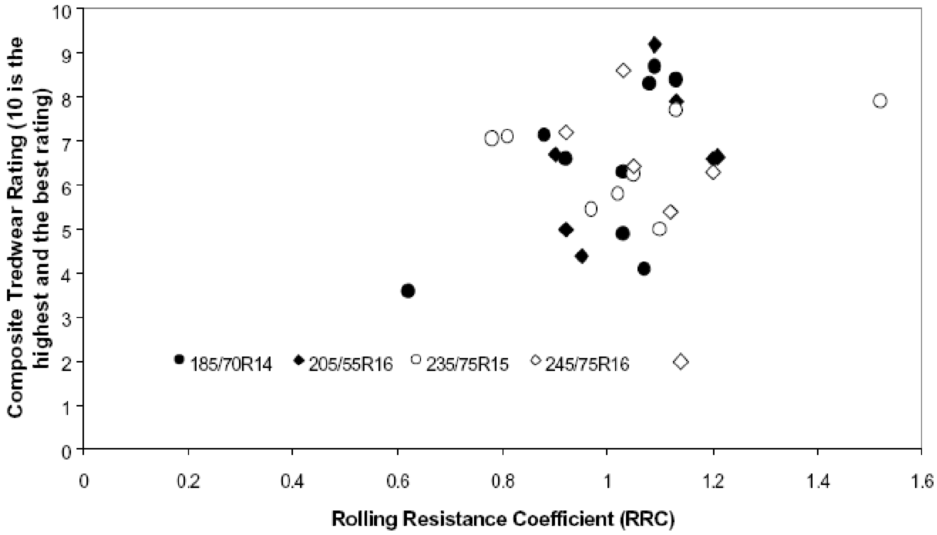
The findings showed a wide range of tread wear ratings both by tire size and by RRC. The tire that has been highly optimized for low rolling resistance exhibits a low tread wear rating, but the next three highest scoring tires all deliver above average tread wear performance. This comparison shows that there is no significant relationships between tyre tread wear rating and its rolling resistance characteristics.

RRC and traction performance

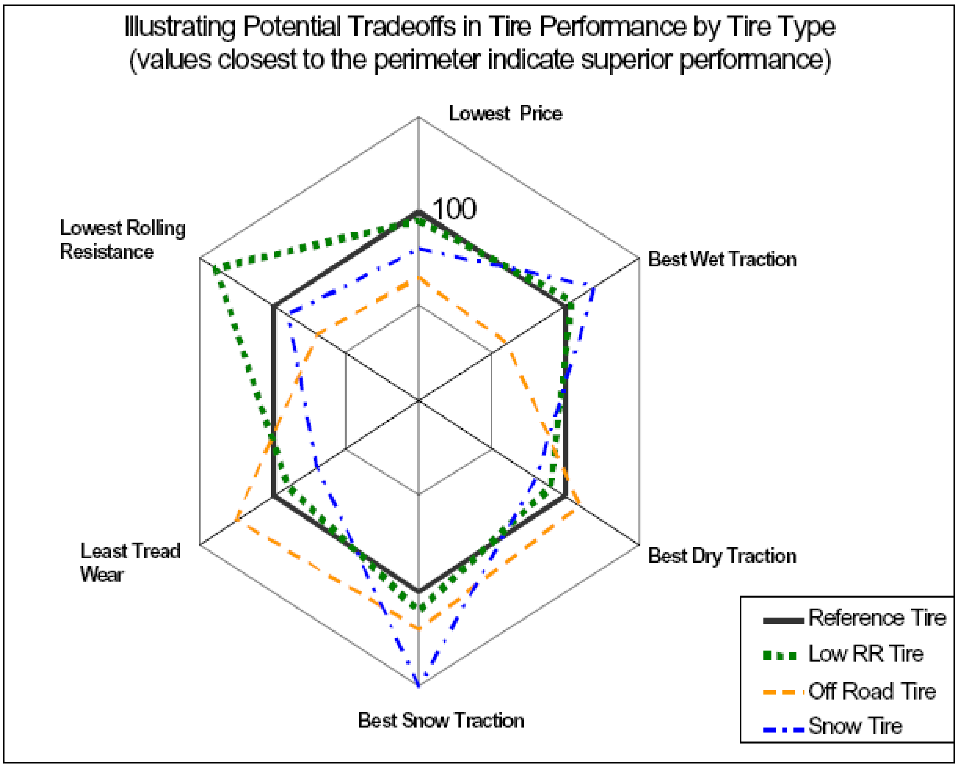


[15] http://www.energy.ca.gov/reports/2003-01-31_600-03-001CRVOL2.PDF

RRC and treadwear



Spider chart showing potential trade-offs



In the spider chart above, the reference tire achieves nominal performance of 100 on all design aspects, while the hypothetical low rolling resistance tire achieves major improvements in rolling resistance and minor improvements in wet traction and snow traction at the cost of a slightly higher price and slight reductions in dry traction and longevity.

3.3.10 TUV study for German Federal Environment Agency (2002)

Study investigated rolling noise, rolling-resistance (RRC), aquaplaning and wet-braking characteristics of various tyres in the dimensions155/60 R14, 165/70 R14, 185/60 R14, 195/65 R15, 205/55 R16 und 225/45 R17. Each tyre population comprised between 3 and

11 tyre brands selected according to market relevance, covering a broad range from outstanding to poor performance in the single criteria.

Main Findings

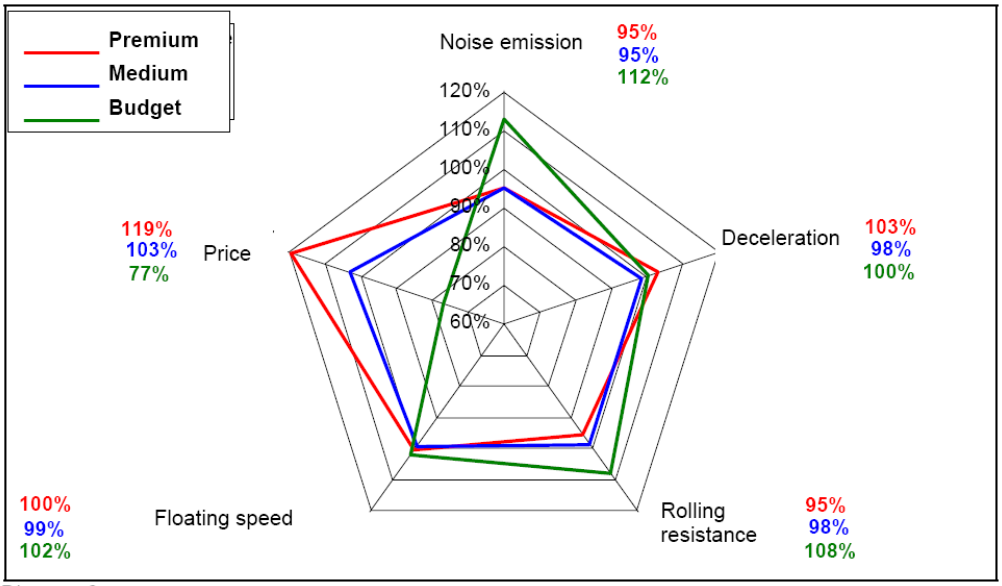
	Tyre size	Weather	No. of tyres in each group	Correlation (coeff.) between RRC & wet braking	Correlation (coeff.) between RRC & noise
1	155/60R14	Summer tyres	3	0.94	0.99
2	165/70R14	Summer tyres	10	-0.53	0.47
3	165/70R14	Winter and all-season tyres	11	0.51	0.12
4	185/60R14	Summer tyres	7	-0.46	0.62
5	185/60R14	Winter tyres	7	0.39	-0.76
6	195/65R15	Summer tyres	10	-0.29	-0.06
7	195/65R15	Winter tyres	10	0.23	0.27
8	205/55R16	Summer tyres	8	-0.72	0.03
9	205/55R16	Winter tyres	8	0.56	-0.55
10	225/45R17	Summer tyres	7	-0.49	-0.53

Note: Wet Braking - tyres were tested for deceleration (m/s^2). The greater the deceleration the better is wet braking performance.
Source: http://www.umweltdaten.de/publikationen/fpdf-l/3163.pdf

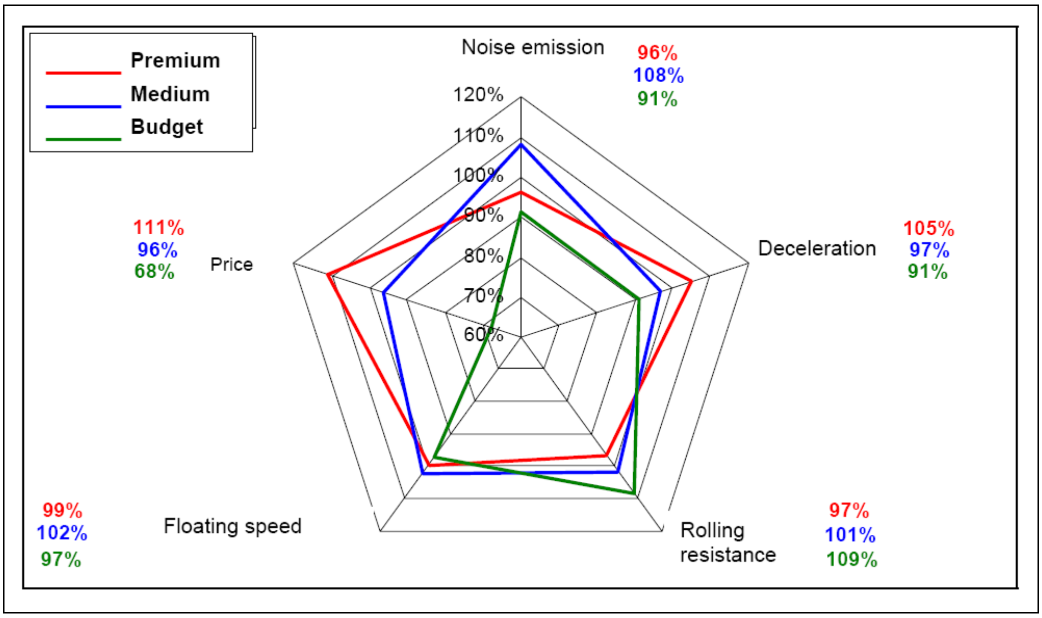
- Of the ten tyre groups 5 had a negative correlation between RRC and WB.
- Smaller tyres tend to have positive correlation between RRC and noise.
- Winter tyres tend to have positive correlation between RRC and WG i.e. WG is better with higher RRCs.
- Winter tyres tend to have negative correlation between RRC and noise i.e. winter tyres with low RRC tend to be noisier.

The study also classified tyres by – premium, mid and budget category. The performance of the main tyre attribute for two of the tyre sizes is shown below. The premium tyres mainly tend to have optimum performance on all fronts, although at higher price.

Summer Tyres 185/60 R14 (N=7)



Summer Tyres 205/55 R16 (N=8)



Note: -Relative noise emission: a higher percentage means a higher noise emission (i.e. >100% is worse)
-Relative deceleration: a higher percentage means a better braking performance (i.e. >100% is better)
-Relative rolling resistance: a higher percentage means a higher the rolling resistance (i.e. >100% is worse)
-Relative floating speed: a higher percentage means a better aquaplaning behaviour (i.e. >100% is better)
-Relative sales price: a higher percentage means a higher sales price (i.e. >100% is worse)

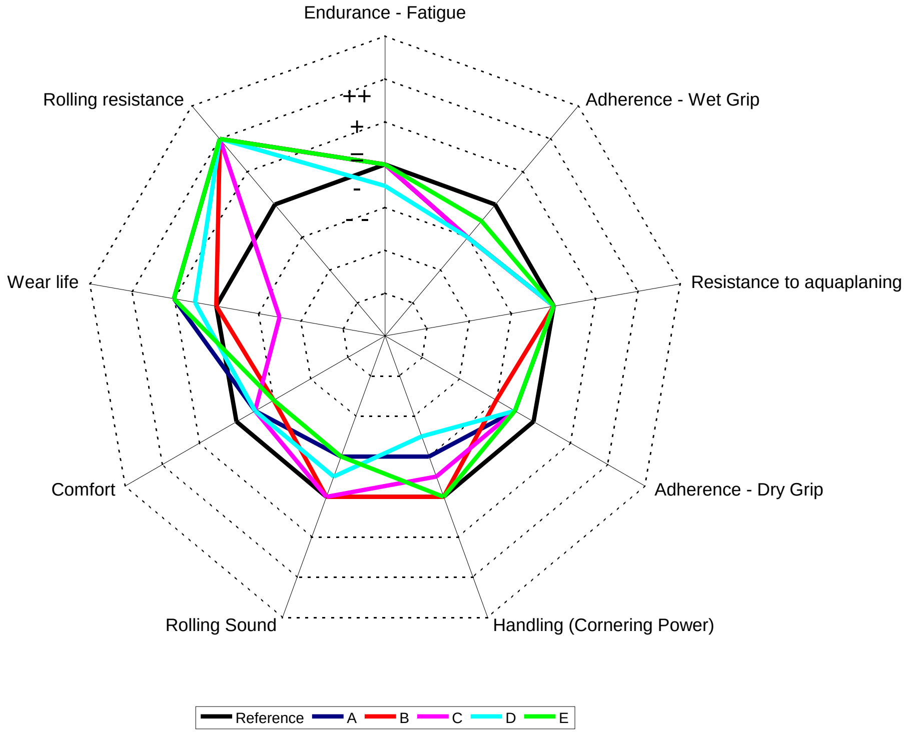
3.4 ETRMA Spider Charts for Optimising RRCs

ETRMA presented a Tyre Performances Integrated Approach to the European Commission (DG Enterprise) in July 2007. They provided evidence on potential trade-off of tyre performance when maximising RR for 5 tyres (passenger cars and light transport) from different manufacturers. The black line shows the reference performance. The measurement values are not given but each interval can be considered as a 10% improvement or deterioration[16].

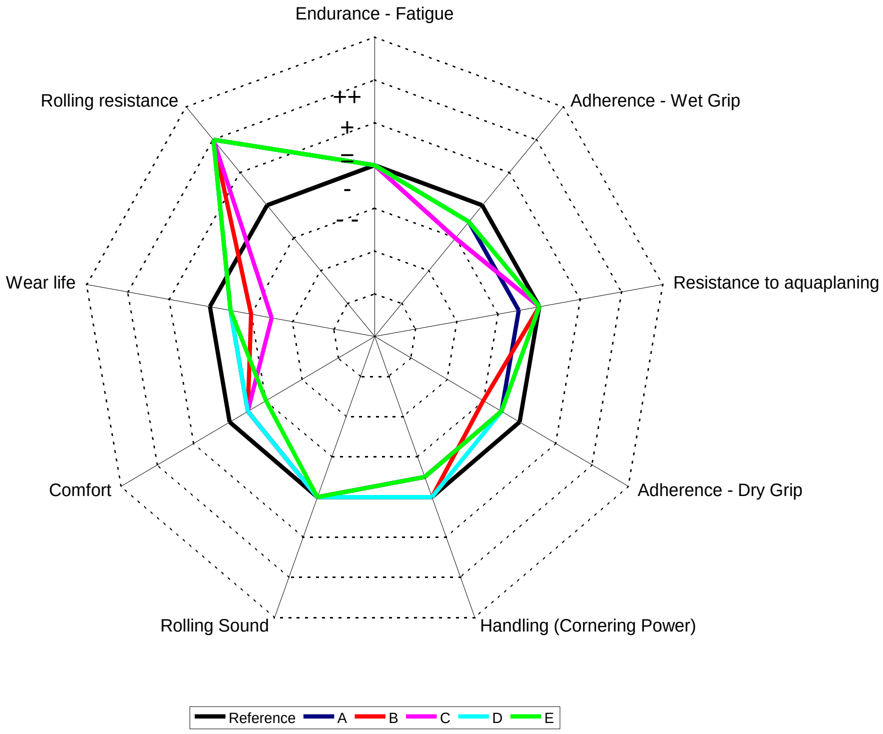
This showed that maximising RR can reduce wet and dry grip.

[16] Verbal communication from ETRMA

PC Maximized Rolling Resistance



LT Maximized Rolling Resistance



4 ANNEX 4: RELATIONSHIP BETWEEN WET GRIP AND RATE OF ACCIDENTS

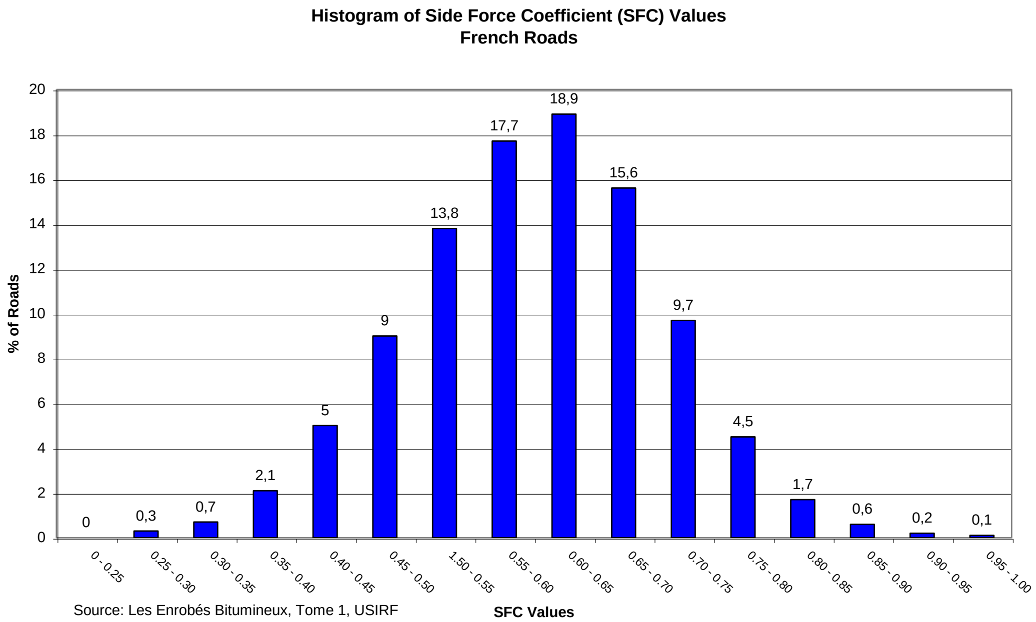
This Annex summarises the available technical evidence between wet grip measurement and the risk of accidents Wet grip is only one safety parameter measured under specific conditions as set out in ISO 23671. Other important tyre related safety parameters are: road holding ability, directional control, deceleration ability on wet and dry surfaces at higher speed and aquaplaning behaviours. In this Annex, the implications on risk of accidents is only focused on wet grip grading as there are no agreed methods for other safety parameters. There is evidence and unanimous agreement from the tyre producers that there is a good correlation between wet grip performance and other tyre safety performances.

4.1 The Relationship between Wet Grip and the Risk of Accidents

The relationship between wet grip and rate or probability of accidents depends on the interplay of numerous factors. The condition, age, tread depth of the tyre, level of grip of the road, weather, visibility, speed of vehicle and human factors are the main factors.

Wet grip performance of tyres is an important safety criteria as not all road surfaced provide the same level of grip under wet conditions. The variation in road friction for French roads is given in Figure 4.1 below.

Figure 4.1: Variations in Road Friction



Source: Les Enrobés Bitumineux, Tome 1, USIRF

Grip performance on wet road surface diminishes over time with constant use (while the tyre wears). The difference in brake force coefficient (BFC) for smooth and rough asphalt by tread depth is given below.

	Smooth road (low texture)	Rough road (high texture)

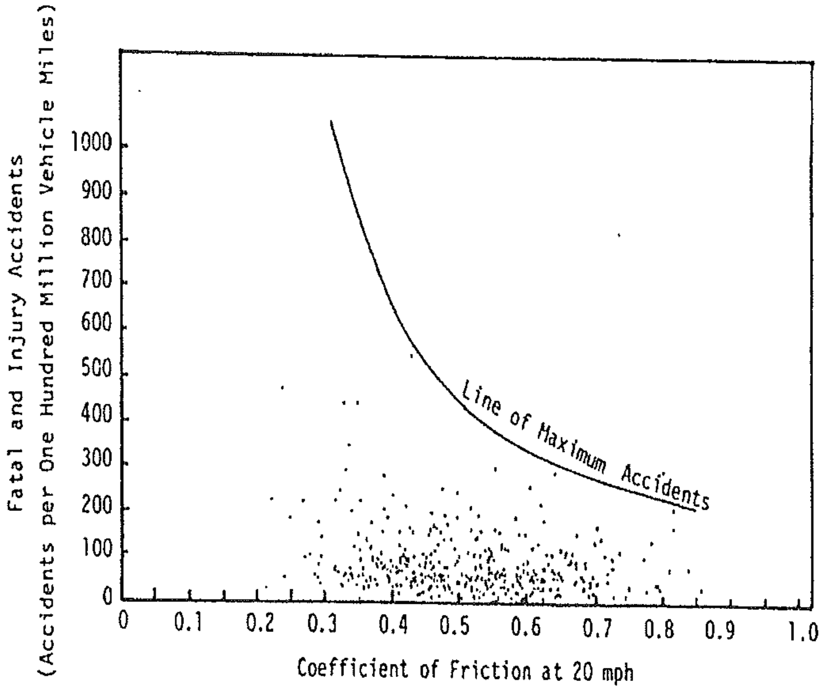
Tread depth (mm)	2	7	2	7
BFC	0.4	0.58	0.7	0.8
Difference	45%		14%	

Note: At 80 km/hr

Source: Staughton and Williams TRL (UK), 1970, cited in Tyres, Road surfaces and reducing accidents. AA Foundation for Road Safety Research. J.C. Bullas May 2004.)

Research by Michelin based on a literature review of 35 independent papers and journals concluded that wet road accident risk is significantly higher than accident risk on dry road. The study found that on average twice as many accidents happen on a wet road than on a dry one. Also there was an inverse relationship between skid number (affected by road surface and tyre wet grip properties) and wet road traffic accidents. Roads with low skidding resistance resulted in higher road risk. Wet road accident rate and skid number had a non-linear relationship (see figure 4.2 below). Skidding resistance is a function of tyre and road forces.

Figure 4.2: Comparison of Accidents and Road Friction

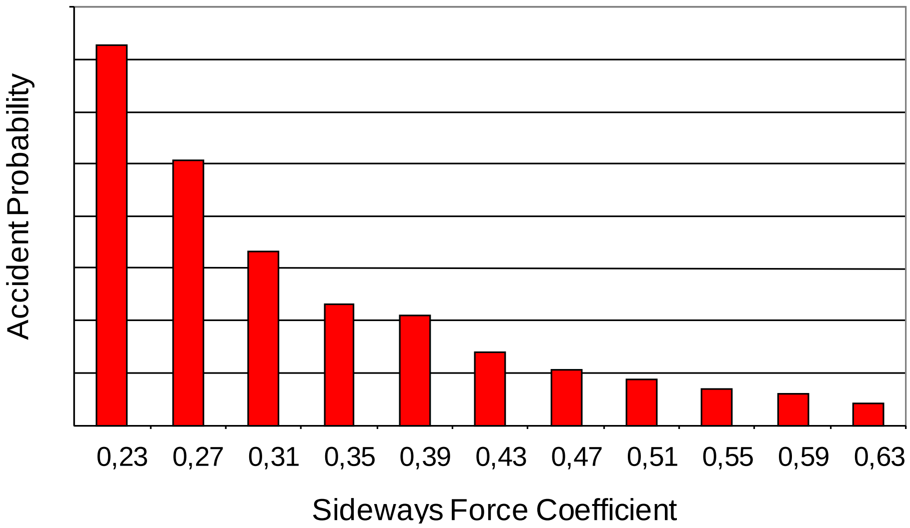


The main reasons from the study as to why wet road accident risk is significantly higher than accident risk on dry road is explained by the following reasons related to wet weather:

- Influence on physiological and psychological characteristics of people
- Reduction in the driving visibility
- Water on roads causes glare
- Water on roads reduces the visibility of road markings
- Reduction of the tyre/road forces (skidding resistance)

A study from the University of Aachen in Germany also shows that accident probability increases for lower 'µ' friction values (grip factor). Braking distance is directly correlated to road friction value (Figure 4.3).

Figure 4.3: Accident Probability and SFC



A study by TÜV (2003)[17] analysed the main car components responsible for accidents. Among accidents due to technical failures resulting in personal injury or fatalities which represent 25% of all accidents, the share of tyre failures amounted to 45% within the past 10 years in Germany (Table 4.1). Similar ratios for Switzerland, Finland and the US are given in Table 4.2. However, the total percentage of tyre-related accidents in all reported motor vehicle accidents (not just technical defects) involving personal injury in Germany and Switzerland is 0.4% and 0.1% in Italy (see Table 4.2). According to TÜV (2003), the national differences in reporting, recording and researching accidents do not allow a completely valid comparison to be drawn between the various countries.

Table 4.1: Technical Defects by Main Car Components in Germany

	Technically defective assembly group							**Ratio: Tyre defect/accident leading to injury or death total**
	Total	Lights	**Tyres**	Brakes	Steering	Towing Unit	Others	
Year	Counts	Counts	Counts	Counts	Counts	Counts	Counts	%
1993	4,390	378	2,032	750	221	87	922	46.3
1994	4,334	411	1,925	762	208	88	940	44.4
1995	3,878	359	1,740	682	202	74	821	44.9
1996	3,521	367	1,543	591	187	76	757	43.8
1997	3,513	364	1,578	562	163	79	767	44.9
1998	3,327	363	1,486	491	120	61	806	44.7
1999	3,367	358	1,542	503	149	64	751	45.8
2000	3,288	331	1,477	519	124	83	754	44.9
2001	3,059	316	1,351	428	136	52	776	44.2
2002	3,017	278	1,374	412	115	57	781	45.5

[17] TÜV (2003) 'Survey on motor vehicle tyres and related aspects' http://ec.europa.eu/enterprise/automotive/projects/report_motor_vehicle_tyres.pdf

Table 4.2: Country Findings – Share of Tyre Related Accidents among Accidents Involving Technical Failures

Country	Tyre defect/ accident leading to injury or death	Year	Source	Notes
Germany	44.20%	2001	SBD	• 1993-2002 the total incidence of tyre defects has been decreasing at nearly regular levels.
				• 51.5% of casualty accidents due solely tyre failure [1] & rising rate of vehicles with faulty tyres linked to driving behaviour
	36.50%	1996-2000	DEKRA	• Tyre failure most frequent technical failure to be a direct cause of an accident
				• majority of tyre failures causing accidents due to poor maintenance
Switzerland	9.10%	2001	S.B.U.	• High proportion of drivers switching between summer and snow tyres possible reason for low percentage
Italy	0.10%	2001	Instituo Nazionale di Statistica	• Only blowouts or excessive wear considered as defects
				• 12% of vehicles inspected during tyre campaign were damaged
Finland	19%	1998-2000	VALT	• Most tyre failures caused by the use of inappropriate tyres for weather condition and poorly maintained tyres
Northern Ireland	0.17%	2002	PNI	• Only blow outs considered as a tyre failure
USA	11%	2001	NCSA & FARS	• Tyre failure 2nd most frequent vehicle related factor in fatal crashes
				• 1.1% of all vehicles involved in fatal crash had tyre problems
				• Light trucks had higher rates of tyre failures than did passenger cars
Japan	66%[a]	1996-2000	ITARDA	• the use of summer tyres in snow and excessive tread wear were the 2 most common defects
[a] % of total accidents due to "inadequate maintenance" rather than total accident leading to injury or death				

Source: TÜV (2003)

Note: [a] % of total accidents due to "inadequate maintenance" rather than total accident leading to injury or death

SBD =Federal Statistics Office Germany (Statistisches Bundesamt Deutschland)
SBU =Schweizerische Beratungsstelle Fur Unfallverhutung
GUT = Gesellschaft fur Technische Uberwachung mbH
INS = Instituo Nazionale di Statistica
VALT= Finish Motor Insuers' Centre/Traffic Safety Committee of Insurance Companies
VIT = Swedish National Road and Traffic Research Institute
NCSA = National Centre for Statistics and Analysis
FARS = Fatality Analysis Reporting System
ITARDA = Institute for Traffic Accident Research and Data Analysis (Japan)
PNI = Police Services Northern Ireland

Table 4.3: Sources of Tyre Failures

Sources of and responsibilities for tyre failures reported in passenger car accident investigations	%
Insufficient/wrong maintenance (by owner / user, e.g. inflation pressure, tread wear, over-aged tyres)	36.8
Failures related to tyre mounting / repair	6.9
Production-related failure (e.g. retreaded tyres)	14.6
Damage during operation (e.g. puncture)	14.6
Not exactly identifiable	27.1

37% of all tyre defects identified were due to insufficient or wrong maintenance (Table 4.3). This implies that the driver or mechanic can play an important role if tyres are inspected regularly and maintained properly.

Tyres have the highest or second highest share of all accidents involving technical failures, in nearly all considered areas in Europe, Japan, and the US. Across all of these areas the majority of tyre failures were caused by poor maintenance, or the use of improper tyres for the weather conditions.

Main conclusions

- Not all tyres have same level of grip and this varies significantly across Europe.
- Grip performance of tyres on wet road diminishes as roads wear over time.
- The risk of accidents on wet road is higher, as the grip of road surface is lower. Therefore, the wet grip performance of the tyre becomes critical.
- A tyre with low grip performance implies higher risks of accidents on wet road below a certain level for skid resistance.
- The total percentage of tyre-related accidents in all reported motor vehicle accidents (not just technical defects) involving personal injury in Germany and Switzerland is 0.4% and 0.1% in Italy[18].
- The main responsibility for tyre failures from the statistics is attributed to the drivers/vehicle owners, resulting predominantly from failure to perform proper maintenance.

This and previous studies have found that tyre-related accident data is very scarce. In most cases it is not extensive or detailed enough for conclusive insight on the relationship between accidents and relevant tyre attributes. Understandably, the industry itself, both vehicle and tyre manufacturers, is very sensitive about publishing results and statistics of their own accident research or complaint departments.

The complexity of car accidents means that tyre often given second consideration (unless a failure or defect such as a burst tyre is responsible) as human errors are by far the main cause. Most accident reports lack the required details on tyre condition. This makes it extremely difficult to determine the actual influence of tyres – correct fit, were they mounted properly, load/speed index, tread depth and wet grip index.

[18] TÜV (2003) ‘Survey on motor vehicle tyres and related aspects’

4.2 Road Safety and the Social Costs of Road Traffic Accidents

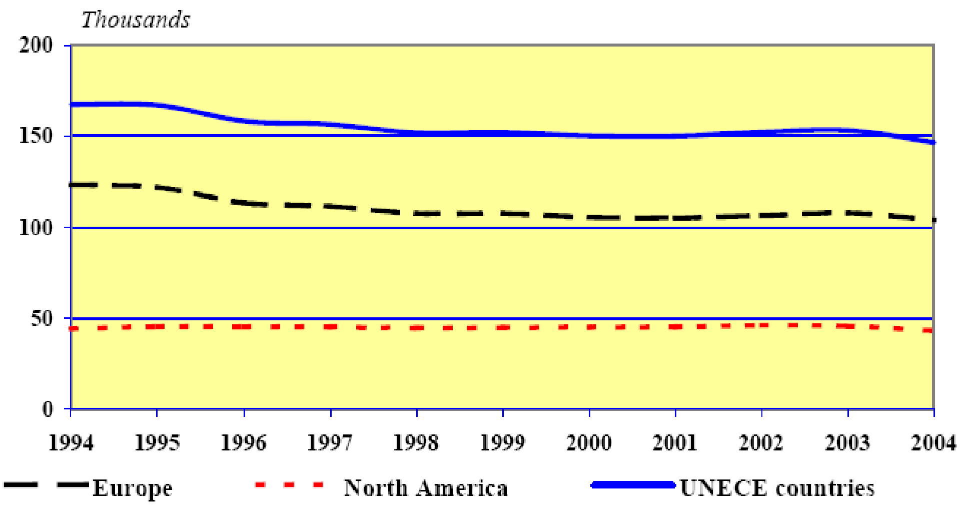
The lack of a quantitative relationship between changes in wet grip performance and the number and severity of road accidents and related injuries and fatalities prevents a direct assessment of the effects of including wet grip in the tyre labelling.

We note that:

- The market transformation to LRRTs can be achieved by compromising wet grip performance if low cost methods are used
- Reductions in wet grip performance increase braking distances
- Longer braking distances increase the risk of accidents.

From the literature, road traffic accidents in 13 EU countries[19] led to about 45,000 deaths and more than 1.5 million people injured in 1993, representing an estimated cost of €150 million[20]. These costs were based on lost productive capacity, human costs, medical/non-medical rehabilitation, damage to property, administration costs and other costs. According, to a report from the UNECE[21], the number of people killed and injured in Europe in 2004 was 100,000 and 2 million respectively (Figure 4.4 and 4.5).

Figure 4.4 Killed in Road Accidents



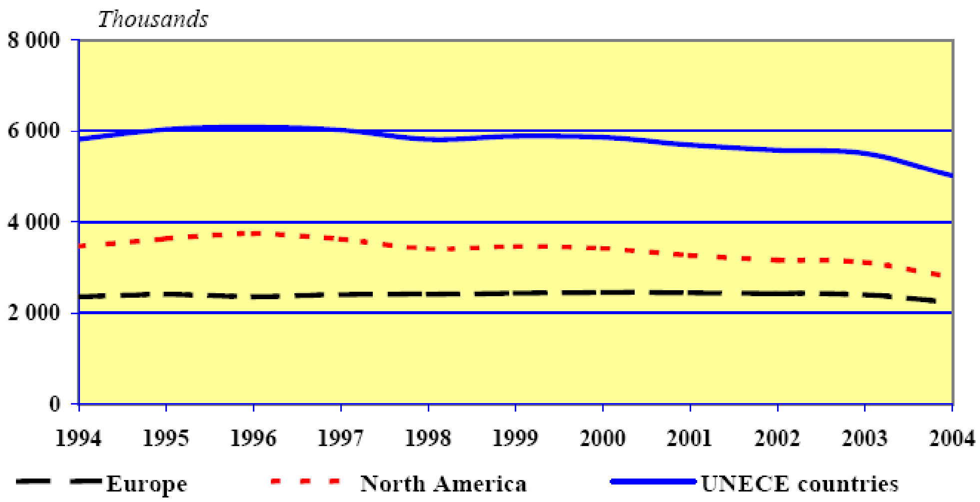
Source: UNECE (2007)

[19] Countries: Austria, Denmark, Finland, France, Germany, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and Yugoslavia

[20] CORDIS - COST 313 Socio-economic Cost of Road Accidents (http://cordis.europa.eu/cost-transport/src/cost-313.htm)

[21] Statistics Of Road Traffic Accidents In Europe And North America, Economic Commission For Europe, Geneva (2007). http://www.unece.org/trans/main/wp6/transstatpub.html

Figure 4.5 Injured in Road Accidents



Source: UNECE (2007)

Road accidents have many negative consequences which from the viewpoint of society are regarded as socio-economic costs. The main purpose of calculating the socio-economic costs of accidents is to evaluate accident consequences that might be avoided by road and vehicle safety measures.

In a recent international comparison of the social costs of road accidents, Trawn et al. (2003) valued the costs per casualty type and per accident in Belgium. Empirical data are provided on human and economic production losses as well as on direct accident costs such as medical costs, hospital visiting costs, accelerated funeral costs, property damage, administrative costs of insurance companies, litigation costs, police and fire department costs, and congestion costs. In Belgium the unit cost of a road casualty is estimated at €2.36m per fatal casualty, €850,000 per seriously injured casualty and €35,000 per slightly injured victim. These results are consistent with valuations reported in other high-income countries. The total costs of road accidents in 2002 in Belgium was estimated to be around €7.2 billion (2004 prices), or 2.6% of gross domestic product.

The above information was used to work out the social costs of road traffic accidents in Europe (Table 4.4). The unit cost per casualty, calculated as a weighted average, based on the total number of fatal accidents and accidents resulting in injury was around € 0.96 million. The total cost of road accidents using unit cost per casualty from Belgium as indicative for the whole of Europe was around €2 billion in 2004.

Table 4.4: Estimated EU Social Costs of Road Traffic Accidents, 2002 (2004 prices)

	Unit Cost per Casualty (€mil.)	No of Casualties (2004)	Total Cost (€mil.)
Fatal casualty	2.36	100,000	235,576
Seriously injured	0.85	2,000,000	1,769,954
Slight injury	0.03		
Total	0.96[a]	2,100,000	2,005,530

Source: UNECE (2007) and Trawn et. al.(2003)

Note: [a]Weighted average sing the total number of casualties in Europe

5 ANNEX 5: UNIT COSTS AND BENEFITS OF LOW RR TYRE FOR C1, C2 AND C3 TYRES

This Annex provides the results of detailed analysis of the costs and benefits of changes in rolling resistance on fuel and related CO2 emissions savings and on tyre production costs. The information is intended to complement the data already provided in the main report.

5.1 Improved Fuel Efficiency and Fuel Cost Savings

5.1.1 RR and fuel consumption

A summary of RR contribution to fuel consumption is given in Table 5.1a and 5.1b below. This shows the contribution of tyres to total fuel consumption. The tyre contribution to fuel consumption depends on use characteristics, vehicle specifications and the tyre's energy efficiency.

Table 5.1a Rolling resistance contribution to fuel consumption for a passenger car

Passenger Car (1.5t)	Rolling Resistance contribution to Fuel Consumption (CRR=10kg/t)
American FTP 75	15-20%
American HWFET	25-30%
European NEDC	20-25%
Japanese 10-15 Mode	15-20%
City Actual Use	5-20%
Regional Actual Use	10-25%
Motorway Actual Use	15-30%

Source: Barand and Boker, 2008, SAE

Table 5.1b Rolling resistance contribution to fuel consumption for a heavy truck

Heavy Duty truck (40t)	Rolling Resistance contribution to Fuel Consumption (CRR=5.5kg/t)
Sub Urban Use	15-25%
Regional Use	20-30%
Long Haul Use	30-40%

Source: Barand and Boker, 2008, SAE

The CEC study[22] on cost-effectiveness of LRRTs conducted a number of tests. The results from these simulations confirmed that tyre rolling resistance has different effects under different driving conditions and vehicle speeds. For example, tyre rolling resistance has more of an effect in highway driving conditions than at a constant speed of 50 mph, but less of an effect in urban driving conditions. The highway fuel economy test yielded a return ratio of 1:5.3, or more than a 2% fuel economy change for every 10% change in rolling resistance. The urban fuel economy test yielded a return ratio of 1:9.6, or about a 1% fuel economy change for every 10% change in rolling resistance.

A short review of relevant literature, presented in the TNO study, has revealed the range of the CO2 reduction potential of LRRTs. Table 5.2 summarises the reduction potential retrieved from various bibliographic sources. The first remark that can be made on these data is that there is an evident inconsistency on what is considered low friction tyre. This was expected due to the lack of specific definition of low rolling resistance tyres (LLRT). Two major approaches are distinguished; reduction potential expressed with regard to a

[22] California state fuel-efficient Tyre report: Volume II, January 2003

certain rolling resistance decrease (usually 10%) or expressed in relation to the generalised idea of a low rolling resistance tyre. It is estimated that the second equals approximately a 20% reduction of the resistance factor compared to average. Additionally, a clear difference is observed between older estimates [IEA 1993] and newer ones. This difference reveals the aforementioned technological improvements that were achieved during the last decade.

Table 5.2 Impact of reducing RRC on fuel consumption/CO2 emissions

	LAT	IEEP 2004	CARB 2004	NRDC 2004		Penant 2005	IEA 1993	
RRC decrease	10%	LRRT	10%	20%	LRRT	10%	10%	10%
Increase in fuel consumption / CO2 emission	1.70%	2%	2%	3-4%	2-6%	3-4%	1%	0.5-1%
Notes	Real world estimates			Based on tyre measurements	best case		IEA estimates	Manufacturers estimates

Source: TNO (2006)

Calculations by Barand and Boker (2008) on the impact of reducing RRC by 1kg/ton for a medium sized EU gasoline (petrol) and diesel car under NEDC indicates that, assuming that the EU passenger car fleet comprises of 50% gasoline and 50% diesel vehicles, a 1kg/t reduction in RRC leads to 1.5% reduction in fuel consumption. The 1.5% reduction is equivalent to a fuel saving of 0.12 l/100km and a CO2 saving of 3 g/km for the EU Fleet average in 2008. The effect of a 1.5% reduction in fuel consumption on average EU Passenger Car fleet from 2012 to 2020 is shown in Table 5.3.

Table 5.3: Effect of a 1.5% Reduction in Fuel Consumption on the Average EU Passenger Car Fleet / C1 tyres (l/100km), 2012-2020

	EU Fleet Average Fuel Consumption	1.5% of EU Fleet Average Fuel Consumption	EU Fleet Average Fuel Consumption Following Reduction
	l/100km	l/100km	l/100km
2012	7.3	0.11	7.2
2013	7.2	0.11	7.0
2014	7.0	0.10	6.9
2015	6.8	0.10	6.7
2016	6.7	0.10	6.6
2017	6.5	0.10	6.4
2018	6.4	0.10	6.3
2019	6.3	0.09	6.2
2020	6.2	0.09	6.1

Source: ETRTO and CARS 21

For C2 tyres fitted on commercial vehicles, we assume the same relation (1kg/t reduction in RRC leads to 1.5% reduction in fuel consumption) as passenger cars. However, for commercial vehicles (CVs), we assume that the EU fleet comprises of 100% diesel vehicles. The fuel saving estimates of a 1.5% reduction in fuel consumption for EU average CV/LT fleet from 2012 to 2020 is given in Table 5.4.

Table 5.4: Effect of a 1.5% Reduction in Fuel Consumption on the Average EU CV/LT Fleet / C2 tyres (l/100km), 2012-2020

	EU Fleet Average Fuel Consumption	1.5% of EU Fleet Average Fuel Consumption	EU Fleet Average Fuel Consumption Following Reduction
	l/100km	l/100km	l/100km
2012	12.0	0.18	11.8
2013	11.9	0.18	11.7
2014	11.8	0.18	11.6
2015	11.7	0.17	11.5
2016	11.5	0.17	11.4
2017	11.4	0.17	11.3
2018	11.3	0.17	11.1
2019	11.2	0.17	11.0
2020	11.1	0.17	10.9

Source: ETRTO and CARS 21

For C3 tyres fitted on heavy duty vehicles (HDVs), on average 1.0kg/t reduction in RRC leads to a 5%[23] lower fuel consumption (from Table 5.5 and INFRAS, 2007). According to the INFRAS (2007) report, a 15% reduction in the rolling resistance value from the PHEM[24] model leads to a reduction in fuel consumption by approximately 4% (urban driving) to 7% (highway driving). In total a 5% to 6% reduction in the specific fuel consumption can be achieved by tyre optimisation. This is equivalent to an average saving in fuel of 1.54 l/100km[25] for a heavy duty truck, assuming a specific fuel consumption of 28 l/100km (INFRAS, 2007). For heavy trucks the impact of low RR tyres depends on use, load and in the case of a trailer where the load is situated (front, middle or rear). The 5% reduction in fuel consumption based on a 1 kg/t reduction for a heavy truck is assumed to be representative of the average EU trucks and buses fleet due to the absence of test data for heavy duty vehicles of different sizes. The absolute impact of a 5% reduction in fuel consumption for a smaller truck will be lower than a bigger truck.

Table 5.5: Fuel Savings for 1kg/t reduction in RR, Heavy Duty Vehicles / C3 tyres

Heavy Truck (40t)	Fuel Consumption		Fuel Savings
12.0l Diesel engine	CRR=5.5kg/t	CRR=4.5kg/t	
Sub Urban Use – half loaded	38.9 l/100km	37.6 l/100km	1.3 l/100km / 3.3%
Regional Use – half loaded	35.6 l/100km	34.2 l/100km	1.4 l/100km / 3.9%
Long Haul Use – half loaded	29.7 l/100km	28.1 l/100km	1.6 l/100km / 5.4%
Sub Urban Use – full loaded	50.1 l/100km	48.4 l/100km	1.7 l/100km / 3.4%
Regional Use – full loaded	46.5 l/100km	44.8 l/100km	1.7 l/100km / 3.7%
Long Haul Use – full loaded	35.1 l/100km	33.0 l/100km	2.1 l/100km / 6.0%

Source: Barand and Boker (2008), Note: Average fuel saving reduction is 4.25%

[23] Average of 4.25% from Table 5.4 and 5.5% from INFRAS (2007)

[24] Passenger car and Heavy duty vehicle Emission Model. The PHEM model has been developed in several international and national projects, namely the EU 5th research framework program ARTEMIS, the COST 346 initiative and the German-Austrian-Swiss cooperation on the Handbook of Emission Factors.

[25] 5.5% of 28l/100km

The fuel saving estimates of a 5% reduction in fuel consumption for EU Average TBs fleet from 2012 to 2020 is given in Table 5.6. As for C2 tyres, we assume that the EU fleet comprises of 100% diesel vehicles

Table 5.6: Effect of a 5% Reduction in Fuel Consumption on the Average EU TBs Fleet / C3 tyres (l/100km), 2012-2020

	EU Fleet Average Fuel Consumption	5% of EU Fleet Average Fuel Consumption	EU Fleet Average Fuel Consumption Following Reduction
	l/100km	l/100km	l/100km
2012	25.7	1.29	24.5
2013	25.6	1.28	24.4
2014	25.5	1.28	24.2
2015	25.4	1.27	24.1
2016	25.4	1.27	24.1
2017	25.3	1.27	24.1
2018	25.3	1.26	24.0
2019	25.3	1.26	24.0
2020	25.2	1.26	24.0

Source: TREMOVE, TNO Estimates

5.2 CO2 emissions

The fuel consumption and CO2 emissions will change over time with improvements in vehicle technology. The impact of 1.5% reduction in fuel consumption on the average passenger car type approval (TA) CO2 g/km and 'real world' (RW) CO2 g/km from 2012 to 2020 is shown in Table 5.7 below.

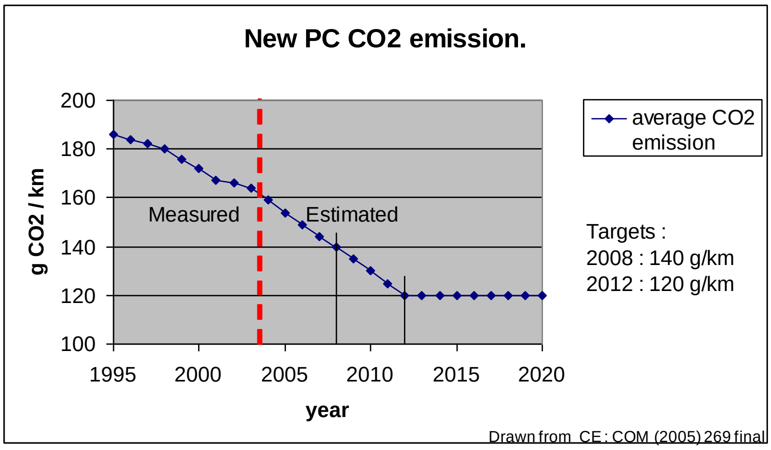
Table 5.7: Effect of a 1.5% Reduction in Fuel Consumption on CO2 Emissions of the Average EU PC Fleet / C1 tyres (CO2 g/km), 2012-2020

	EU Fleet Average		1.5% of EU Fleet Average CO2		EU Fleet Average CO2 Following Reduction	
	TA CO2 g/km	RW CO2 g/km	TA CO2 g/km	RW CO2 g/km	TA CO2 g/km	RW CO2 g/km
2012	152	182	2.3	2.7	150	179
2013	149	177	2.2	2.7	147	174
2014	145	173	2.2	2.6	143	170
2015	141	169	2.1	2.5	139	166
2016	138	165	2.1	2.5	136	163
2017	135	162	2.0	2.4	133	160
2018	133	159	2.0	2.4	131	157
2019	130	156	2.0	2.3	128	154
2020	128	153	1.9	2.3	126	151

Source: ETRTO and CARS 21

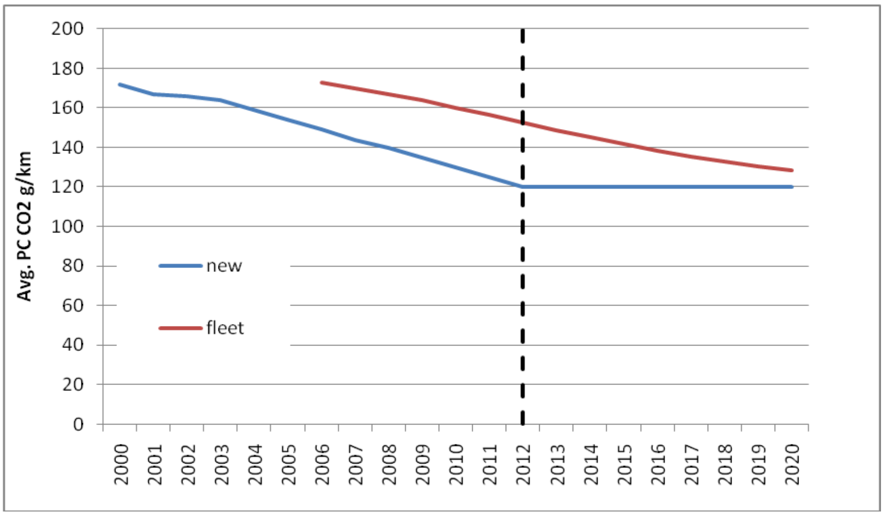
The TA CO2 g/km projections are based on average passenger car fleet estimates adjusted by the CO2 g/km for new cars from the CARS 21 project (Figure 5.1).

Figure 5.1: Actual and Projected Passenger Car CO2 Emissions (g/km)



ETRTO has calculated the average CO2 emission (g/km) for the annual passenger car fleet (new and existing) based on the proportion of remaining vehicles for a given model in use by age (which decreases with time) and the annual km by age (Figure 5.2).

Figure 5.2: Average Passenger Car CO2 Emission (g/km)



Source: ETRTO

The average commercial vehicle and trucks and buses 'real world' (RW) CO2 g/km from 2012 to 2020 is shown in Table 5.8 and Table 5.9 below. A standardised driving cycle for CVs and TBs does not exist.

Table 5.8: Effect of a 1.5% Reduction in Fuel Consumption on CO2 Emissions of the Average EU CVs/LTs Fleet / C2 tyres (CO2 g/km), 2012-2020

	EU Fleet Average	1.5% of EU Fleet Average CO2	EU Fleet Average CO2 Following Reduction
	RW CO2 g/km	RW CO2 g/km	RW CO2 g/km
2012	314	4.7	309
2013	310	4.7	306
2014	307	4.6	303
2015	304	4.6	300
2016	301	4.5	297
2017	298	4.5	294
2018	295	4.4	291
2019	292	4.4	288
2020	289	4.3	285

Source: CV/LT – ETRTO and CARS 21,

Table 5.9: Effect of a 5% Reduction in Fuel Consumption on CO2 Emissions of the Average EU TBs Fleet / C3 tyres (CO2 g/km), 2012-2020

	EU Fleet Average	5% of EU Fleet Average CO2	EU Fleet Average CO2 Following Reduction
	RW CO2 g/km	RW CO2 g/km	RW CO2 g/km
2012	672	33.6	638
2013	669	33.4	635
2014	666	33.3	633
2015	663	33.1	630
2016	662	33.1	629
2017	661	33.0	628
2018	660	33.0	627
2019	659	32.9	626
2020	658	32.9	625

Source: TREMOVE Model, TNO Estimate

5.2.1 Fuel cost savings

The estimated impact of a given reduction in RRC on fuel consumption allows an estimate of fuel cost savings per tyre for each vehicle given a lifetime tyre use.

	Annual mileage (km)	Tyre Life (Years)	Total Tyre mileage (km)
C1 – Passenger cars	16,000	2.5	40,000
C2 – Light transport	22,000	1.8	39,600
C3 – Trucks and Buses	60,000	1.6	96,000

Source: TNO (2006), INFRAS (2006)

The level of future fuel cost savings depend on the future level of oil prices. This is highly uncertain, although future prices are expected to rise in real terms compared to current prices. The impact assessment has used three long term oil price scenarios to 2020 (Table 5.10). The fuel cost (i.e. the fuel price excluding all taxes) heavily depends on the price of oil. A relation between oil price and fuel cost has been determined in (TNO 2006) (See Box 5.1 for the methodology).

Table 5.10: Future EU Oil and Fuel Price Scenarios in 2020

	Oil price €/bbl	Avg Fuel price €/lt (exc. Fuel Tax and VAT)	Avg Fuel price €/lt (inc. Fuel Tax and VAT)	Diesel price €/lt (inc Fuel Tax, exc. VAT)
Scenario 1	50	0.41	1.03	0.80
Scenario 2	75	0.61	1.28	1.02
Scenario 3	100	0.80	1.53	1.23

Source: Eurostat, TNO Estimates

Note: Relation between oil price and fuel price (with and without tax) is based on the average EU-27 diesel and petrol price (with and without tax) provided by Eurostat

Box 5.1 Methodology for determining fuel prices as function of the oil price

Assessment of societal costs is based on costs / prices exclusive of taxes. Assessment of costs at the user level are based on prices incl. all applicable taxes. In case the user is a consumer this includes VAT.

The price of automotive fuel at the pump is the sum of:

- the fuel cost exclusive of taxes
    - cost for production and distribution of the fuel
- taxes
    - excise duties (often fixed in €/litre)
    - VAT (a percentage of fuel price before VAT)

Relation between fuel price with and without tax

Based on an analysis of fuel price data on EU-27 from Eurostat with and without tax[26] the following approximate linear relations between fuel price with and without tax have been derived for the EU:

fuel price incl. taxes = a * fuel price excl. taxes + b

coefficients for relation between fuel price incl. all taxes and fuel price excl. taxes

	petrol	diesel	average (50%-50%)
a =	1,2554	1,2943	1,27485
b =	0,5874	0,4269	0,50715

Fuel price without tax as function of oil price

The fuel cost (i.e. the fuel price excluding all taxes) heavily depends on the price of oil. A relation between oil price and fuel cost has been determined in [TNO 2006]. This linear relation is given by:

fuel cost = c * oil price + d

26

http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H2/H21/ebc24848

http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=Yearlies_new_environment_energy&root=Yearlies_new_environment_energy/H/H2/H21/ebc25360

with fuel cost in €/litre and oil price in €/bbl, and the coefficients:

c = 0,0079

d = 0,0126

In [TNO 2006] fuel costs are assumed roughly equal for petrol and diesel.

Fuel price with tax as function of oil price

Combination of the above leads to the following approximate relation between fuel price incl. tax and oil price:

fuel price incl. tax = e * oil price + f

with fuel price in €/litre and oil price in €/bbl, and the coefficients:

e = a * c

f = a * d + b

and:

coefficients for relation between fuel price incl. all taxes and oil price

	petrol	diesel	average (50%-50%)
e =	0,0099	0,0102	0,0101
f =	0,6032	0,4432	0,5232

For assessments of costs to commercial users (companies) the fuel price excl. of VAT is the relevant parameter. As an EU average VAT level we have taken 19%. Prices excl. VAT are 1/(1+VAT) times the prices including VAT, leading to alternative coefficients for the relation between fuel price (excl. VAT) and oil price:

coefficients for relation between fuel price excl. VAT and oil price

	petrol	diesel	average (50%-50%)
e =	0,0083	0,0086	0,0085
f =	0,6032	0,4432	0,5232

The fuel cost savings for passenger cars / C1 tyres is calculated by multiplying the change in fuel consumption due to the change in RRC of 1kg/t per band by fuel prices assuming that the EU passenger car fleet is 50% petrol and 50% diesel. For commercial vehicles and trucks and buses it is assumed that the fleet is 100% diesel.

The fuel cost savings per tyre for passenger cars resulting from a change of 1.0 kg/t is presented in Table 5.11. Since the fleet average fuel consumption (l/100km) and CO2 g/km reduces over time, the fuel cost savings per tyre from a one band change decreases during the period 2012-2020. Fuel costs savings should be considered as savings per set of 4 tyres. This is because the fuel savings from the use of low RR tyres would only apply if all four tyres are changed at the same time.

Table 5.11: PCs Life-time Fuel Cost Savings (€) per C1 Tyre from a 1 Band Change – 1.0kg/t bandwidth (1.5% fuel saving per 1.0 kg/t reduction)), inc. tax and VAT, for all Oil Price Scenarios

	Fuel Cost Saving per Tyre (€)		
	Scenario 1	Scenario 2	Scenario 3
2012	11.3	14.0	16.8
2013	11.0	13.7	16.4
2014	10.7	13.4	16.0
2015	10.5	13.1	15.6
2016	10.3	12.8	15.3
2017	10.0	12.5	15.0
2018	9.8	12.3	14.7
2019	9.7	12.0	14.4
2020	9.5	11.8	14.2

Source: GHK estimate
Note: Takes into consideration tyre lifetime

Since the CVs/LTs fleet average fuel consumption (l/100km) and CO2 g/km reduces over time, the fuel cost savings per tyre from a one band change decreases during the period 2012-2020. Fuel costs savings for CVs/LTs should be considered as savings per a set of 4 C2 tyres[27]. This is because the fuel savings from the use of low RR tyres would only apply if all four tyres are changed at the same time. Vat is excluded for TB and CV/LT as commercial vehicle operators can recover all the VAT on their business purchases including fuel and tyres.

Table 5.12: CVs/LTs Life-time Fuel Cost Savings (€) per C2 Tyre from a 1 Band Change – 1.0kg/t bandwidth (1.5% fuel saving per 1.0 kg/t reduction)), inc. tax and exc. VAT, for all Oil Price Scenarios

	Fuel Cost Saving per Tyre (€)		
	Scenario 1	Scenario 2	Scenario 3
2012	14.5	18.3	22.2
2013	14.3	18.1	22.0
2014	14.2	18.0	21.8
2015	14.0	17.8	21.5
2016	13.9	17.6	21.3
2017	13.7	17.4	21.1
2018	13.6	17.3	20.9
2019	13.5	17.1	20.7

[27] Please not that some light transport vehicles have 6 tyres but on average we have assumed a set of 4 tyres for CVs/LTs.

2020	13.3	16.9	20.5

Source: GHK estimate
Note: Takes into consideration tyre lifetime

Since the TBs fleet average fuel consumption (l/100km) and CO2 g/km also reduces over time, the fuel cost savings per tyre from a one band change decreases during the period 2012-2020. Fuel costs savings for TBs should be considered as savings per a given set of tyres. This is because the fuel savings from the use of low RR tyres would only apply if all tyres are changed at the same time. The exact set of tyres for TBs differs by type of truck or bus. The number of tyres can range from 6 to 18 depending on whether it is a rigid truck or a long haul trailer. Some heavy hauler trucks may even have more than 18 tyres. We have assumed a set of 10 tyres as a representative average. However, this value is an expert judgement of GHK/TNO.

Table 5.13: TBs Life-time Fuel Cost Savings (€) per Tyre from a 1 Band Change – 1.0kg/t bandwidth (5% fuel saving per 1.0 kg/t reduction)), inc. tax and exc. VAT, for Oil Price Scenarios

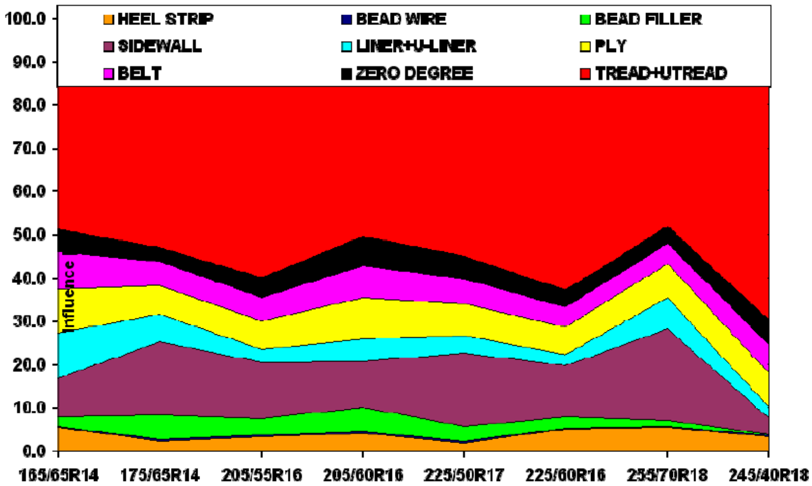
	Fuel Cost Saving per Tyre (€)		
	Scenario 1	Scenario 2	Scenario 3
2012	99	126	152
2013	99	125	152
2014	98	125	151
2015	98	124	150
2016	98	124	150
2017	98	124	150
2018	97	123	150
2019	97	123	149
2020	97	123	149

Source: GHK estimate: Note: Takes into consideration tyre lifetime

5.3 Additional Costs of Low RR Tyres

In addition to the discussion on additional cost of LRRTs in the main report, it should also be pointed out that the contribution of the four main tyre components towards lower RR differs by size of tyre for different vehicle segment (Figure 5.4 below). For example, the sidewall of a SUV tyre contributes nearly 20% to RR compared to tyres for A/B type vehicles. This means that the technology used for reducing RR based on the low, medium and high cost option above would be different for different tyre sizes. This adds another cost dimension to the tyre manufacturer but cannot be quantified explicitly.

Figure 5.4: Finite Element Analysis Estimation of Tyre Component Contribution to RR



Overall Tyre Diameter [mm]	570	584	632	652	658	676	815	653
Rim Diameter [inch/mm]	14/354.8	14/354.8	16/405.6	16/405.6	17/436.6	16/405.6	18/462	18/462
Vehicle segment	A	A	B/C	B/C	C/D	C/D	SUV	D/E

Source: from tyre companies

5.4 Additional Cost per Tyre for Trucks and Buses – C3 Tyres

The weighted average price (based on the stock of truck and bus from TREMOVE[28]) inclusive of VAT was around €253 and €205 excluding VAT (at 19%).

Tyre Size	Tyre Type	Price (€) inc of VAT
Tyre size 315/80	Steering and Drive axle tyre, truck (long distance) eg. 16-32 tonne or >32 tonne	350
Tyre size 275/70	Steering and Drive axle tyre, bus	250
Tyre size 215/75	Steering and Drive axle tyre, truck (local transport) eg. 3.5 to 7.7tonne	150
Weighted Average[a]		**253**

Source: Average price estimates from tyre producers and Tyre size categories from TUV (2000), [a] GHK estimate

The additional cost of a freight carrying HDV tyre is in the range of €50 per tyre (INFRAS, 2007). We assume that this additional cost only applies to bigger heavy duty vehicle tyres (Tyre size 315/80)[29]. It is expected that the price premium for smaller TBs tyres will be lower but there is not sufficient information to support this. The price premium for the impact assessment is thus assumed to be around 14% (€50 divided by €350, price of tyre size 315/80) for a heavy duty vehicle tyre for a 15% reduction in RRC. We assume the 14% price premium to be representative of C3 tyres as buses only accounted for 7% of the total trucks and buses vehicle stock in 2005 (from TREMOVE).

[28] Buses only accounted for 7% of the total trucks and buses vehicle stock in 2005 from TREMOVE (http://www.tremove.org). TREMOVE is a transport and emissions simulation model developed for the European Commission. The model has been developed by the Catholic University of Leuven and Transport & Mobility Leuven.

[29] Expert judgement of GHK/TNO.

Table 5.14: Additional Production Costs per 1 kg/t Reduction in RRC, TBs – C3 tyres

	Average Market RRC for C3 (summer) (kg/t), 2004 SOA	Reduction on average RRC (%)	15% reduction from average levels in RRC (kg/t)	Additional production cost for a 15% reduction in RRC (%)	Additional cost (% increase per 1 kg/t)
Truck/Bus – summer (steer/trailer)	6.37	15%	0.96	14%	15%
Truck/Bus – winter (Drive)	7.36	15%	1.10	14%	13%

Source: INFRAS (2007), ETRMA 2004 SOA

Thus, the average % increase in additional cost for a 1kg/t reduction in RRC is estimated to be approximately 15% (Table 5.14, rounding 14.5%, weighted average of 15% and 13%). As with passenger cars, the impact assessment assumes that the price premium increases in the higher bands. The 15% price premium applied to the weighted average price of a TB tyre, €205 (exc. VAT), leads to a price premium, excluding VAT, of around €31 (15% of €205) to €43 (21% of €205) for moving from one band to the next highest band (Table 5.16a). The price premium of moving from one band to the next highest and from RRC Band 6 to 7 to higher bands is shown in Table 5.16a and 5.16b below.

Price premium for C3 tyres is provided per 1kg/t change in RR for clarity and simplicity sake. However, it is obvious that a grading scheme should provide fleet managers with a sufficient discrimination among tyres and reflect real fuel savings. For C3 tyres, the fact that 1 kg/t savings imply significantly higher fuel savings than for C1 tyres (1.29 l/100km compared to 0.11 l/100km), a smaller bandwidth would appear to be recommended taking precision of testing methods into account.

We are only considering moving from Band 6 to 7 (average RRC for C3 tyres) to higher bands as a C3 tyre customer is not able to purchase tyres within the full range of RRC (4kg/t to 8kg/t) because of the specialist nature of tyre requirements. The RRC range depends on the transport use, type of axle and size of truck as shown in Table 5.15 below. According to one of the tyre manufacturers, in general, highway tyres (long haul) tend to have 5% to 10% lower RRC than regional tyres. They also suggested that on average drive tyres have roughly 1 kg/ton higher RRC than steer/trailer tyres. Since, a C3 tyre customer will not have a choice of tyres across the entire RRC range, we have therefore calculated the market transformation and related impact from a shift from the average RRC (Band 6 to 7), rather than from the lowest bands, to higher bands.

Table 5.15 C3 Tyres - RRC (kg/t) by Use and Type of Heavy Duty Vehicle

	Large Trucks		
	Highway	Regional	On and Off roads
Drive	5.6 to 9.6	5.8 to 8.9	na
Steer	4.7 to 6.4	4.7 to 6.7	na
Trailer	4.3 to 5.9	5.2 to 6.8	na
Share	30%	50%	15%

Note: Figures above are from one Tyre Company used for internal use and are not average market estimates. Estimates for small trucks were not available. The remaining 5% of the market consists of city use and severe winter use.

Source: Tyre producer

Even though there are no C3 tyres below 4 kg/t in Table 5.15, the state of market figure from ETRMA showed that in 2004 around 4% of C3 tyres were below 4 kg/t. Thus, it is expected that the share of tyres below 4kg/t would increase under the slow and fast pace of change assumption as given in Table 6.13 and 6.14 till 2020.

Table 5.16a: Price Premium for Moving from One Band to the Next Highest (RR only labelling, 1 kg/t), TBs – C3 tyres

price premium	**below 4**	**4 to 5**	**5 to 6**	**6 to 7**	**7 to 8**	**Above 8**
price premium	21%	17%	15%	0%		
RR labelling (inc. of VAT)	52	42	38	0		
RR labelling (exc. of VAT)	43	35	31	0		

Table 5.16b: Price Premium for Moving to Higher Bands Compared to Band 6 to 7 (RR only labelling, 1 kg/t), TBs – C3 tyres

price premium	**below 4**	**4 to 5**	**5 to 6**	**6 to 7**	**7 to 8**	**Above 8**
price premium	53%	32%	15%	0%		
RR labelling (inc. of VAT)	132	80	38	0		
RR labelling (exc. of VAT)	108	65	31	0		

Note: Numbers may not add up due to rounding

The additional cost and fuel cost saving per tyre allows the payback period for a Truck or a Bus customer (Table 5.17) to be calculated. For example, if a customer purchases 10 tyres from Band 5 to 6 then this will cost them an additional €310 (exc. VAT) compared to band 6 to 7 (from Table 5.16a). C3-Tyres are expected to last 1.6 years on average (and average mileage of 100,000km) during which a set of 10 tyres purchased in 2012 would provide (under oil price scenario 2) €1,260 worth of fuel cost savings (€126x10, from Table 5.13). This gives a pay-back period of around 5 months under the RR only labelling[30].

Table 5.17: Average payback period in 2013 for TBs (C3 – Tyres), for Moving to Higher Bands Compared to band 6 to 7 to higher bands, months (RR only labelling, 1 kg/t)

	3 to 4	**4 to 5**	**5 to 6**	**6 to 7**	**7 to 8**	**Above 8**
Pay back (months) inc. VAT	7	6	6	0	0	
Pay back (months) exc. VAT	5	5	5	0	0	

Source: GHK estimate, Based on oil price scenario 2 inc. fuel tax and exc. VAT

5.5 Summary Tables for Net Cost Savings for C2 and C3

Table 5.18a and 5.18b below shows net cost savings for incremental change to higher bands and move from the lowest to higher bands for C2 tyres. The additional cost of LRRTs for C2 tyres is assumed to be the same as C1 tyres.

30 €310 divided by €66.3 fuel savings per month (€1,260/19mths).

Table 5.18a: Net Cost Savings (€) per Tyre per Band, from One Band to the Next Highest, for a Reduction of RRC of 1kg/t, 2020 (exc. VAT), RR only labelling, CVs – C2 Tyres

RRC (kg/t)	Fuel saving per band (€ per tyre)	Additional costs of LRRTs (€ per tyre)	Net cost saving (€)
above 10.5			
9.5 to 10.5	16.9	1.6	15.3
8.5 to 9.5	16.9	1.8	15.1
7.5 to 8.5	16.9	2.0	14.9
6.5 to 7.5	16.9	2.5	14.4
5.5 to 6.5	16.9	3.5	13.4

Note: Based on oil price scenario 2, inclusive of fuel tax but excluding VAT

Table 5.18b: Net Cost Savings of a Shift from Lowest to Higher Band (€ per tyre), in 2020, CVs – C2 Tyres (exc. VAT), (RR only labelling, 1 kg/t)

RRC (kg/t)	Cumulative fuel savings per tyre (€)	Additional costs per tyre (€)	Net savings of a shift from lowest band to higher band (€)
above 10.5			
9.5 to 10.5	16.9	1.6	15.3
8.5 to 9.5	33.8	3.4	30.4
7.5 to 8.5	50.7	5.3	45.4
6.5 to 7.5	67.6	7.8	59.8
5.5 to 6.5	84.5	11.3	73.2

Note: Based on oil price scenario 2, inclusive of fuel tax but excluding VAT

The additional tyre cost and fuel cost saving per tyre allows the payback period for an individual car owner to be calculated. This is shown in Table 5.19 below. For example, if a customer purchases 4 tyres from Band 9.5 to 10.5 then this will cost them an additional €6.4 (exc. VAT) compared to Band above 10.5 (from Table 5.18b). C2-Tyres are expected to last 1.8 years on average during which a set of 4 tyres purchased in 2012 would provide (under oil price scenario 2) €73 worth of fuel cost savings (€18.3x4, from Table 5.12). This gives a pay-back period of around 2 months under the RR only labelling[31].

Table 5.19: Average Payback Period in 2013 for CVs (C2 – tyres), for Moving to Higher Bands Compared to Lowest Band, months, (RR only labelling, 1 kg/t)

	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5
Pay back (months) inc. VAT	3	3	3	3	2	
Pay back (months) exc. VAT	3	2	2	2	2	

[31] €6.4 divided by €3.5 fuel savings per month (€73/22mths).

Table 5.20a and 5.20b below shows the net cost savings for incremental change to higher bands and move from Band 6 to 7 to higher bands for C3 tyres.

Table 5.20a Net Cost Savings (€) per Tyre per Band, from One Band to the Next Highest, for a Reduction of RRC of 1kg/t, 2020 (exc. VAT), RR only labelling, TBs – C3 Tyres

RRC (kg/t)	Fuel saving per band (€ per tyre)	Additional costs of LRRTs (€ per tyre)	Net cost saving (€)
Above 8			
7 to 8	123		
6 to 7	123		
5 to 6	123	31	92
4 to 5	123	35	88
below 4	123	43	80

Note: Based on oil price scenario 2, inclusive of fuel tax but excluding VAT

Table 5.20b: Net Cost Savings of a Shift from 6 to 7 Band to Higher Band (€ per tyre), in 2020, RR only labelling RRC 1kg/t, TBs – C3 Tyres (exc. VAT)

RRC (kg/t)	Cumulative fuel savings per tyre (€)	Additional costs per tyre (€)	Net savings of a shift from lowest band to higher band (€)
Above 8			
7 to 8			
6 to 7			
5 to 6	123	31	92
4 to 5	246	65	181
below 4	369	108	261

Note: Based on oil price scenario 2, inclusive of fuel tax but excluding VAT

5.6 CO2 Abatement costs

Table 5.21a: CO2 Abatement Cost (€/tonne) per Tyre per Band for a Reduction of RRC of 1kg/t, for CVs 2020 (ex. VAT), RR Only Labelling (assuming a set of 4 tyres are changed)

	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5
CO2 abatement (€/tonne) sc. 1	-58	-89	-103	-108	-110
CO2 abatement (€/tonne) sc. 2	-139	-169	-182	-185	-187
CO2 abatement (€/tonne) sc. 3	-220	-250	-261	-263	-263

Note: Fuel prices is excluding fuel tax and VAT

Table 5.22b: CO_2 Abatement Cost (€/tonne) per Tyre per Band for a Reduction of RRC of 1kg/t, for TBs 2020 (ex. VAT), RR Only Labelling (assuming a set of 10 tyres are changed)

	below 3	3 to 4	4 to 5	5 to 6
CO2 abatement (€/tonne) sc. 1		-24	-49	-60
CO2 abatement (€/tonne) sc. 2		-107	-129	-135
CO2 abatement (€/tonne) sc. 3		-191	-209	-211

Note: Fuel prices is excluding fuel tax and VAT

6 ANNEX 6: MARKET SCENARIOS OF ENERGY LABELLING FOR C1-WINTER, C2 AND C3

This Annex complements the data provided in the main report for C1 summer tyres with market analyses of the impacts of energy labelling on the remaining tyre classes. The reference case has been created using the ETRMA state of the market data for 2004 for all tyre classes. The reference case takes into consideration the proposed minimum standards applied in each stage till 2020 for each tyre class.

6.1 C1 – Winter Tyres

The reference is summarised in Table 6.1, using the ETRMA data for 2004, as the best available approximation to the total (OE and replacement) market tyre distribution by RRC in the absence of policy interventions. The reference case takes into consideration the proposed minimum standards applied in each stage till 2020. The wet grip reference case for C1-Winter Tyres is the same as for C1-summer tyres.

Table 6.1 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C1/winter – reference case)

Bands	A	B	C	D	E	F	Above F	
RRC	below 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
Base SOA 2004	0%	0%	0%	1%	5%	18%	76%	100%
2013	0%	0%	0%	2%	10%	37%	50%	100%
2014	0%	0%	0%	3%	14%	49%	33%	100%
2015	0%	0%	0%	4%	21%	74%	0%	100%
2016	0%	0%	0%	4%	21%	74%	0%	100%
2017	0%	0%	0%	8%	41%	49%		100%
2018	0%	0%	0%	10%	55%	33%		100%
2019	0%	0%	0%	16%	83%	0%		100%
2020	0%	0%	0%	16%	83%	0%		100%

Note: The 2nd stage min. std. of 10.5kg/t for C1 new tyre types comes into effect in October 2016 (year 2017), we thus assume that all tyres in band E are below 10.5kg/t. The Base SOA 2004 is based on actual market data on the distribution of RR for all tyres. Numbers may not add up due to rounding

6.1.1 Labelling policy option – RR only

Table 6.2 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C1/winter) – Tyre Labelling RR only (slow pace)

Bands	A	B	C	D	E	F	Above F	
RRC	below 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
2013	0%	0%	0%	2%	11%	37%	49%	100%
2014	0%	0%	0%	3%	15%	49%	32%	100%
2015	0%	0%	0%	5%	24%	69%	0%	100%
2016	0%	0%	1%	7%	28%	63%	0%	100%
2017	0%	0%	2%	14%	44%	38%	0%	100%
2018	0%	0%	4%	22%	50%	22%	0%	100%

2019	0%	1%	9%	33%	55%	0%	0%	100%
2020	0%	3%	14%	38%	44%	0%	0%	100%

Table 6.3 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C1/winter) – Tyre Labelling RR only (fast pace)

Bands	A	B	C	D	E	F	Above F	
RRC	below 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
2013	0%	0%	0%	2%	12%	37%	47%	100%
2014	0%	0%	0%	4%	19%	47%	28%	100%
2015	0%	0%	1%	9%	32%	56%	0%	100%
2016	0%	0%	3%	14%	37%	45%	0%	100%
2017	0%	1%	8%	26%	42%	21%	0%	100%
2018	1%	4%	17%	35%	33%	8%	0%	100%
2019	4%	12%	29%	37%	18%	0%	0%	100%
2020	10%	22%	34%	26%	7%	0%	0%	100%

6.1.2 Labelling policy option – Dual

Table 6.4 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C1/winter) – Tyre, Dual Labelling (slow pace)

Bands	A	B	C	D	E	F	Above F	
RRC	below 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
2013	0%	0%	0%	2%	11%	37%	49%	100%
2014	0%	0%	0%	3%	15%	49%	32%	100%
2015	0%	0%	0%	5%	24%	69%	0%	100%
2016	0%	0%	1%	6%	27%	65%	0%	100%
2017	0%	0%	2%	13%	44%	40%	0%	100%
2018	0%	0%	3%	20%	51%	24%	0%	100%
2019	0%	1%	7%	31%	59%	0%	0%	100%
2020	0%	2%	11%	35%	51%	0%	0%	100%

Table 6.5 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C1/winter) – Tyre, Dual Labelling (fast pace)

Bands	A	B	C	D	E	F	Above F	
RRC	below 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Above 12	
2013	0%	0%	0%	2%	11%	37%	49%	100%
2014	0%	0%	0%	4%	16%	48%	31%	100%
2015	0%	0%	1%	7%	28%	63%	0%	100%
2016	0%	0%	2%	10%	33%	53%	0%	100%
2017	0%	0%	5%	21%	44%	29%	0%	100%
2018	0%	2%	10%	30%	42%	14%	0%	100%
2019	1%	5%	19%	39%	35%	0%	0%	100%

2020	2%	10%	27%	38%	21%	0%	0%	100%

6.2 C2 – Summer Tyres

The reference case for C2 tyres has been created using the ETRMA state of the market data for 2004. The reference case takes into consideration the proposed minimum standards applied in each stage till 2020. The reference case for Commercial Vehicles is shown in Table 6.6 below.

Table 6.6 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C2/summer) – Reference Case

Bands							
RRC	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5	
Base SOA 2004		0%	5%	18%	36%	41%	100%
2013		1%	6%	22%	44%	27%	100%
2014		1%	6%	25%	50%	18%	100%
2015		1%	8%	30%	60%	0%	100%
2016		1%	8%	30%	60%	0%	100%
2017		1%	12%	46%	41%	0%	100%
2018		1%	14%	56%	27%	0%	100%
2019		2%	20%	78%	0%	0%	100%
2020		2%	20%	78%	0%	0%	100%

Note: Numbers may not add up due to rounding. The 2^{nd} stage min. std. of 9kg/t for C2 new tyre types comes into effect in October 2016 (year 2017), we thus assume that all tyres in band 8.5 to 9.5 are below 9kg/t.

Energy labelling of tyres would help fleet managers of commercial vehicles to calculate the net annual fuel cost saving based on the annual mileage. The criteria for selecting tyres for commercial vehicles are similar to passenger cars. The major influences on tyre fitment / replacement are:

1. Like-for-like exchange (claimed to provide consistent handling and seen as a "safety" choice);
2. Cost;
3. Tyre wear – fleet managers consider wear to be an important factor due to higher annual mileage and variety of driving conditions. It is common for CV tyres to be replaced before 50% of tyre wear life due to damage from kerbs and potholes. A more frequent replacement rate would discourage companies to pay a higher price premium for LRRTs. The actual market data on replacement rates used in the impact assessment would be expected to reflect this level of wear and replacement.

In the EU, on average, around 50% of commercial fleets outsource their maintenance to leasing/ fleet management companies. Some of these have "exclusive" deals with tyre fitting specialists such as Kwik-Fit Fleet / ATS Euromaster.

Discussion with the association of fleet operators in the UK suggested that most fleets are owned by small businesses, (around 80% in the UK). Their demand for tyres would be very price sensitive. It was also acknowledged that larger fleets would take into account fuel efficiency savings over the tyre lifetime in their purchase decisions. Currently, fleet managers do not have access to the RRC values of the tyres they buy. According to the UK association of fleet operators, most fleet managers currently do not purchase tyres on the basis of their contribution to fuel economy.

CVs/LT vehicles can be classified by a number of sub categories (table below). The share of tyres in total running costs differs according to these categories:

	Small / Medium. Vans (car derived)				Bigger Vans / Light Trucks			
	1.8 tonne				2.8 - 3.5 tonne			
	Urban		Highway		Urban		Highway	
	Low payload	High payload	Low payload	High payload	Low payload	High payload	Low payload	High payload
Service & maintenance	£1,300	£1,375	£1,300	£1,325	£1,675	£1,800	£1,700	£1,950
Tyres	£850	£1,020	£765	£1,105	£1,400	£1,680	£1,260	£1,820
Repairs	£1,300	£1,280	£1,310	£845	£2,050	£1,870	£2,040	£1,880
Fuel (all diesel)	£15,750	£17,200	£11,000	£12,200	£20,000	£22,100	£14,700	£16,450
Total running costs £	£19,200	£20,875	£14,375	£15,475	£25,125	£27,450	£19,700	£22,100
Share of fuel %	82%	82%	77%	79%	80%	81%	75%	74%
Share of tyres %	4%	5%	5%	7%	6%	6%	6%	8%

Source: Association of fleet operators in the UK
Note: This data is considered as approximate and used for estimation purposes only, and is based on a number of different sources of cost data. Estimates are based on use of Normal Summer tyres, and all diesel, Diesel £1.30 VAT inclusive, Based on a broad mix of vehicle makes, models, detailed configurations and engine sizes, "Normal" use patterns within the broad definitions of size and descriptions of use, Averaged terms across whole UK, 100% VAT recovery, Mix of dealer / independent garage for work

The above table shows that tyres on average account for 6% of total running and maintenance costs compared to 80% for fuel. Interviews with fleet operators pointed out that with increasing costs of fuel most managers would first look at improving the service and maintenance of their vehicle. Better maintenance (eg. optimum tyre pressure, wheel alignment and servicing can significantly improve fuel efficiency. Increasing the efficiency of the route management would also reduce fuel costs). It is difficult to accurately predict the impact of labelling on demand for C2 tyres. However, the table above shows that tyres are a very small proportion of total running costs and labelling could influence the replacement market. Increase in tyre costs due to LRRTs would still be a small proportion of total running costs but could provide substantial savings in fuel costs.

The labelling pace of change is assumed to be the same as passenger cars and the market distribution for C2-summer tyres is shown in Table 6.7 and 6.8 below. This is likely however to be a conservative assumption since fleet managers are professionals and will have therefore the know-how as well as stronger incentives to reduce fuel expenditure in their total running costs.

Table 6.7 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C2/summer) – Tyre Labelling RR only (slow pace)

Bands							
RRC	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5	
2013	0%	1%	6%	23%	44%	26%	100%

2014	0%	1%	7%	26%	49%	17%	100%
2015	0%	1%	9%	32%	56%	0%	100%
2016	0%	2%	11%	34%	52%	0%	100%
2017	1%	9%	34%	24%	31%	0%	100%
2018	2%	14%	38%	27%	18%	0%	100%
2019	5%	22%	39%	33%	0%	0%	100%
2020	8%	25%	38%	26%	0%	0%	100%

Note: Numbers may not add up due to rounding. The 2nd stage min. std. of 9kg/t for C2 new tyre types comes into effect in 2016 (year 2017), we thus assume that all tyres in band 8.5 to 9.5 are below 9kg/t.

Table 6.8 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C2/summer) – Tyre Labelling RR only (fast pace)

Bands							
RRC	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5	
2013	0%	1%	6%	23%	43%	25%	100%
2014	0%	2%	9%	28%	45%	15%	100%
2015	0%	3%	14%	36%	45%	0%	100%
2016	0%	6%	19%	38%	36%	0%	100%
2017	4%	19%	34%	25%	17%	0%	100%
2018	12%	27%	32%	21%	7%	0%	100%
2019	27%	32%	22%	19%	0%	0%	100%
2020	48%	23%	20%	9%	0%	0%	100%

Note: Numbers may not add up due to rounding. The 2nd stage min. std. of 9kg/t for C2 new tyre types comes into effect in 2016 (year 2017), we thus assume that all tyres in band 8.5 to 9.5 are below 9kg/t.

6.3 C2 – Winter Tyres

Table 6.9 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C2/winter) – Reference Case

Bands							
RRC	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5	
Base SOA 2004			0%	4%	16%	80%	100%
2013			0%	9%	37%	53%	100%
2014			0%	13%	51%	35%	100%
2015			0%	20%	79%	0%	100%
2016			0%	20%	79%	0%	100%
2017			0%	46%	53%	0%	100%
2018			0%	63%	35%	0%	100%
2019			0%	99%	0%	0%	100%
2020			0%	99%	0%	0%	100%

Note: Numbers may not add up due to rounding. The 2nd stage min. std. of 9kg/t for C2 new tyre types comes into effect in 2016 (year 2017), we thus assume that all tyres in band 8.5 to 9.5 are below 9kg/t.

Table 6.10 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C2/winter) – Tyre Labelling RR only (slow pace)

Bands							
RRC	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5	
2013	0%	0%	0%	9%	37%	52%	100%
2014	0%	0%	0%	14%	51%	34%	100%
2015	0%	0%	2%	24%	73%	0%	100%
2016	0%	0%	3%	27%	68%	0%	100%
2017	0%	5%	32%	21%	41%	0%	100%
2018	1%	10%	38%	26%	24%	0%	100%
2019	3%	19%	42%	35%	0%	0%	100%
2020	6%	23%	41%	28%	0%	0%	100%

Note: Numbers may not add up due to rounding. The 2nd stage min. std. of 9kg/t for C2 new tyre types comes into effect in 2016 (year 2017), we thus assume that all tyres in band 8.5 to 9.5 are below 9kg/t.

Table 6.11 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C2/winter) – Tyre Labelling RR only (fast pace)

Bands							
RRC	5.5 to 6.5	6.5 to 7.5	7.5 to 8.5	8.5 to 9.5	9.5 to 10.5	above 10.5	
2013	0%	0%	0%	11%	38%	50%	100%
2014	0%	0%	2%	18%	49%	30%	100%
2015	0%	1%	6%	32%	60%	0%	100%
2016	0%	2%	11%	38%	48%	0%	100%
2017	2%	15%	33%	27%	22%	0%	100%
2018	8%	24%	33%	24%	9%	0%	100%
2019	24%	32%	18%	26%	0%	0%	100%
2020	43%	24%	23%	11%	0%	0%	100%

Note: Numbers may not add up due to rounding. The 2nd stage min. std. of 9kg/t for C2 new tyre types comes into effect in 2016 (year 2017), we thus assume that all tyres in band 8.5 to 9.5 are below 9kg/t.

6.4 C3 – Summer Tyres

The reference case for C3 tyres has been created using the ETRMA state of the market data for 2004. The reference case takes into consideration the proposed minimum standards applied in each stage till 2020.The reference case for C3 – summer tyres for trucks and buses is given in Table 6.12 below.

Table 6.12 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C3/summer) – Reference Case

RRC kg/t	Below 4	4 to 5	5 to 6	6 to7	7 to 8	Above 8	
Base SOA 2004	2%	11%	28%	34%	19%	6%	100%
2013	2%	11%	29%	35%	20%	4%	100%
2014	2%	11%	29%	35%	20%	2%	100%
2015	2%	11%	29%	36%	20%	2%	100%
2016	2%	11%	29%	36%	20%	1%	100%
2017	3%	17%	43%	24%	14%	0%	100%
2018	3%	20%	51%	16%	9%		100%
2019	4%	22%	57%	11%	6%		100%
2020	4%	24%	61%	7%	4%		100%

Note: The 2nd stage min. std. of 6.5kg/t for C3 new tyre types comes into effect in 2016 (year 2017), existing tyre types will have to be below 6.5 only by Oct. 2020

Energy labelling of tyres would allow fleet managers for trucks and buses (TBs) to calculate the net annual fuel cost saving based on the annual mileage. Reductions in RR have the largest impact on fuel saving for TBs compared to other vehicles, as discussed in Annex 5.

The criterion for selecting tyres for TBs is very different to passenger cars. The main running costs for a heavy goods vehicle fleet is first the driver, then fuel and lastly tyres. Tyres can account for 20 to 25% of the total maintenance and running costs[32]. The main criterion for selecting tyres for HGVs is the trade-off between 'Life cycle costs (km driven/price of tyre) versus millimetre of tyre tread wear'. In other words, fleet managers prefer tyres which provide greater mileage for a given level of tread wear taking into account the tyre cost.

As with CVs, fleet managers for TBs also outsource their maintenance to leasing / fleet management companies. Fleet companies have contracts with tyre suppliers or with tyre manufacturers which limits their ability to compare tyres from other brands. The supply chain for C3 tyres is different from C1/C2 tyres. The information on mileage, retreading capability, and rolling resistance is already provided to C3 tyre customers on an individual company basis, although exact RRC values are not provided and comparisons between brands are difficult to make.

It is thus difficult to estimate the labelling pace of change as on the one hand LRRTs for TBs have the greatest potential to reduce fuel costs and CO2 emissions but on the other the importance of tyre wear and use of retreaded tyres means that its effectiveness could be limited, although there is no evidence that shows that LRRTs for trucks and buses have reduced wear performance or vice versa.

A report by Faber Maunsell (2008) on 'Reducing Greenhouse Gas Emissions from Heavy-Duty Vehicles' stated that there has been a gradual reduction in rolling resistance over the years and that the development and use of LRRT needs to be encouraged and accelerated if they are to make a significant contribution to the CO2 reduction strategy. This could be achieved by a combination of mandatory requirements and consumer information (i.e. tyre labelling). The report also acknowledges that there is no logical reason why a labelling scheme as proposed by the EC for passenger cars should not also encompass HDV tyres.

In the absence of any more detailed data to the contrary we have assumed the same pace of change for the RR only labelling option for C3-tyres as for C1 tyres as the basis of calculating the potential range in market transformation. As for C2 tyres, this is likely to be a

[32] Personal Communication, GE Capital services

conservative assumption, since costs per km is one of the main factors fleet manager would want to optimize with recent fuel price increase. In reality, market transformation is likely to be faster in the C3-tyre market.

Table 6.13 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C3/summer) – Tyre Labelling RR only (slow pace)

RRC kg/t	Below 4	4 to 5	5 to 6	6 to7	7 to 8	Above 8	
2013	2%	11%	29%	35%	20%	4%	100%
2014	2%	12%	29%	35%	20%	2%	100%
2015	2%	13%	30%	35%	19%	2%	100%
2016	3%	14%	30%	34%	18%	1%	100%
2017	4%	19%	41%	23%	12%	0%	100%
2018	8%	25%	45%	15%	7%	0%	100%
2019	9%	27%	49%	10%	5%	0%	100%
2020	13%	32%	45%	6%	3%	0%	100%

Note: The 2nd stage min. std. of 6.5kg/t for C3 new tyre types comes into effect in 2016 (year 2017), we thus assume that the new product line tyres in band 6 to 7 are below 6.5kg/t.

Table 6.14 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C3/summer) – Tyre Labelling RR only (fast pace)

RRC kg/t	Below 4	4 to 5	5 to 6	6 to7	7 to 8	Above 8	
2013	2%	12%	29%	34%	19%	4%	100%
2014	3%	13%	30%	34%	18%	2%	100%
2015	5%	16%	30%	32%	16%	1%	100%
2016	8%	19%	31%	29%	13%	1%	100%
2017	10%	23%	38%	19%	9%	0%	100%
2018	19%	31%	34%	11%	4%	0%	100%
2019	20%	33%	36%	7%	3%	0%	100%
2020	38%	36%	21%	3%	1%	0%	100%

6.5 C3 – Winter Tyres

Table 6.15 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C3/winter) – reference case

RRC kg/t	Below 4	4 to 5	5 to 6	6 to7	7 to 8	Above 8	
Base SOA 2004/2008	0%	1%	10%	29%	36%	23%	100%
2013	0%	2%	11%	32%	40%	15%	100%
2014	0%	2%	11%	34%	42%	10%	100%
2015	0%	2%	12%	35%	44%	7%	100%
2016	0%	2%	12%	36%	45%	4%	100%
2017	0%	2%	16%	48%	32%	0%	100%
2018	0%	3%	19%	56%	22%	0%	100%
2019	0%	3%	21%	61%	14%	0%	100%
2020	0%	3%	22%	65%	10%	0%	100%

Note: The 2nd stage min. std. of 6.5kg/t for C3 new tyre types comes into effect in 2016 (year 2017), only new tyre type will have to comply with the 6.5 kg/t limit, all tyres will have to be below 6.5 only by Oct. 2020

Table 6.16 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C3/winter) – Tyre Labelling RR only (slow pace)

RRC kg/t	Below 4	4 to 5	5 to 6	6 to7	7 to 8	Above 8	
2013	0%	2%	11%	32%	40%	15%	100%
2014	0%	2%	12%	34%	41%	10%	100%
2015	0%	3%	14%	36%	41%	6%	100%
2016	0%	4%	16%	37%	39%	4%	100%
2017	0%	6%	23%	45%	25%	0%	100%
2018	1%	9%	28%	46%	15%	0%	100%
2019	3%	13%	33%	43%	8%	0%	100%
2020	6%	17%	36%	36%	4%	0%	100%

Table 6.17 Market Distribution of Replacement Tyres Sold in the EU p.a. by RRC (C3/winter) – Tyre Labelling RR only (fast pace)

RRC kg/t	Below 4	4 to 5	5 to 6	6 to7	7 to 8	Above 8	
2013	0%	2%	12%	32%	39%	15%	100%
2014	0%	4%	15%	35%	38%	9%	100%
2015	0%	6%	18%	36%	34%	5%	100%
2016	0%	10%	22%	37%	28%	3%	100%
2017	3%	16%	31%	36%	14%	0%	100%
2018	10%	23%	35%	26%	6%	0%	100%
2019	22%	29%	31%	15%	2%	0%	100%
2020	40%	31%	22%	7%	0%	0%	100%

7 ANNEX 7: STANDARDS AND PRECISION OF TESTING METHODS

This Annex provides a review of the current approach and quality of tyre performance testing

7.1 Proposal for a Regulation on General Safety of Motor Vehicles

In COM(2008)316 (23/5/2008) a proposal is made for a Regulation concerning Type Approval for the general safety of motor vehicles. The objective of the proposal is to lay down harmonised rules on the construction of motor vehicles with a view to ensuring the functioning of the internal market while at the same time providing for a high level of safety and environmental protection. The proposal also aims at enhancing the environmental performance of vehicles by reducing the amount of road noise and vehicle CO2 emissions from tyres. Finally, the proposal contributes to the competitiveness of the automotive industry by simplifying the existing vehicle safety type-approval legislation, improving transparency and easing administrative burden.

Regarding tyres the following requirements were set out in the proposal;

- All C1 tyres shall meet the wet grip requirements.
- All tyres shall meet the rolling resistance requirements.
- All tyres shall meet the rolling noise requirements.
- Mandatory fitting of TPMS on passenger cars

7.2 Overview of Current Standards and Testing Methods for Tyre Performance

The overview is provided in Table 7.1.

Table 7.1 Current standards and testing methods in EU

	RR	Wet grip	Noise
Current standard	n.a.	ECE R117 limiting values according to the ECE R117: 110 = Normal use highway tyres, 100 = Threshold for M+S >160 km/h and M+S≤ 160 km/h + US UTQG traction rating	ECE R117 and Directive 2001/43/EC Minimum standards per class in dB(A) depending on section width and category of use
Current testing method	Test drum; Force, torque, power or deceleration method to determine RR Force and RRC from load and force	1) BPN: British Pendulum Number 2) SRTT: Tyre mounted on a rim attached to a vehicle or trailer	Rolling sound emission Coast by of a vehicle on defined test surface
Main factors affecting accuracy of the testing method	Drum surface, temperature, accuracy of equipment, requirements for conditions equipment, quality system etc.	Surface definition Test conditions	Tolerances on the definition of the ISO test surface

Unit of measurement	Rolling resistance coefficient dimensionless	Wet grip Index (G) Relative performance compared to standard reference test tyre on - the peak braking force (pbfc) index and - the mean fully developed deceleration (mfdd) index	dB(A)
ISO standards	ISO 18164: 2005 Passenger car, truck, bus and motorcycle tyres Soon: ISO 28580 same scope as preceding ISO except motorcycle tyres	ISO 23671: 2006 Passenger car tyres -- loaded new tyres	ISO 13325:2003 Coast-by methods for measurement of tyre-to-road sound emission
ISO working group	ISO TC31/WG6		
Main EC directive	n.a.		2001/43/EC
Main ECE regulation		ECE R117	ECE R117
Critique of existing standards	n.a.	SRTT standard low compared to big 5	not demanding, especially for C1 tyres clear improvement can be achieved
Critique of existing testing methods	Reproducibility and repeatability (intra and inter lab correlation) Too many methods Drum surface not representative Conditioning variation allowed Different drum sizes; correction required No drag (relevancy questionable)	Limited proof of safety/grip (no dry grip and aquaplaning for example) Test surface definition Limitation to one surface Tolerances and definitions: (e.g. water depth)	There is a strong variation in results among test tracks. Lacking of representativity is mentioned. But at the same time ranking seems good.
Costs of testing (equipment, etc.)	€800/test[1] €1000/tyre (1tyre) €500/tyre (5-10tyres) €250 - 300/test (ETRMA)	€700/test[2] €2000/test (homologation) (wide range) €2300/test (grading) (wide range) The lowest cost figure is	€1500/test[3]

		for a single test, the higher costs figures include more tests and administrative work.	

[1] SenterNovem (NL), TÜV SÜD Automotive, ETRMA.

[2] SenterNovem (NL), ETRMA

[3] SenterNovem (NL)

Note: Treadwear standards do not exist except in the US: US UTQG Tread Wear rating

7.3 Rolling Resistance

7.3.1 Description of RR testing method

ISO 18164: 2005 Passenger car, truck, bus and motorcycle tyres – Methods of measuring rolling resistance.

- dynamometer test with a smooth steel or textured drum
- several methods to determine absorbed energy (deceleration, toque, power, force)
- steady-state conditions at fixed speed and load
- straight ahead
- optional tests possible to better reflect tyre use

ISO 28580: Tyre Rolling Resistance measurement method designed to ease international cooperation and, possibly, regulation building. ISO 28580 will be an improved testing method compared to ISO 18164, aiming at a better repeatability and reproducibility. Important details like the amount of tyres for inter-laboratories alignment to be are in the process of approval by the participating countries.

SAE J1269: A recommended practice of Society of Automobiles Engineers (SAE) that defines a standardized method for testing tyre rolling resistance under steady-state conditions at 80 km/h (50 mph).

SAE J2452: A recommended practice of SAE that defines a standardized method for testing tyre rolling resistance in simulation of a coastdown from 120 to 15 km/h.

7.3.2 Accuracy and precision of testing for RR

Currently, only limited information is publicly available on the actual accuracy of the ISO 28580 procedure. This comprises: the ETRMA / ETRTO's statement on the 1,5kg/t bandwidth, ETRMA's note on the size of the intra lab test variation (ρ=0.043) and an ETRTO presentation in 2005 (named Rolling Resistance Reference Measurement Method for PC and CV tyres from the IEA workshop in Paris).

The ETRTO input suggests the following uncertainty range and calculation formula for the RR testing procedure.

1. inter lab variation (μ) – The uncertainty arising from the fact that the RR will be measured by several RR machine worldwide, many of them substantially different from each other. In other words, the same tyre measured by two different machines will lead to different results not because of the tyre itself but because of the many technical differences among testing machines;
2. intra lab test variation (ρ) – The uncertainty coming from the fact that if we repeat N measurements of the same tyre on the same machine, over a period of time, we will have a group of different results, close to some mean values but not identical. This uncertainty is connected with variation in the machine itself over time and during several measurements;

3. tyre variation / manufacturing variability (φ) - The uncertainty arising from the fact that tyres, being a mass industrial product, even if produced under the same identical design, are not identically the same due to tolerances in building, rubber mixing, raw materials provided by external suppliers and so on.

The uncertainty is calculated as:

Uncertainty = $\mu + 3\rho + 3\varphi$; where the multiplicative factor of 3 stems from 3 times the standard deviation, which with the assumption that the population is normally distributed, would end up in a reliability of 99.7%.

Considering the ISO 28580 Round Robin test, some representative values are

$\mu = 0.2$

$\rho = 0.043$; average repeatability standard deviation for RR according to ISO 28580 independent of the precision of the machine (which can vary between 0.04 and 0.18 according to preceding round robin tests) is equal to 0.043 for C1 tyres (this is because of the number of tests, the less precise the machine, the more tests are needed to get to 0.043 average standard deviation)

$\varphi = 0.05$: average manufacturing variability from ETRTO IEA workshop (of a controlled sample which has a small variation in RRC).

Considering the optimal conditions of the sample and the optimisation of the sample size this gives a best case uncertainty of the bandwidth of 0.2 + (3 × 0.043) + (3 × 0.05) = **0.48 kg/t**.

This uncertainty range seem to be confirmed by the ETRTO's presentation from 2005, which shows a maximum deviation of about 5% which comes down to around **0.50** kg/t for a 10 kg/t tyre, for one single, but aligned test. This value was found in a total sample of C1, C2 and C3 tyres of 15 different tyre types, each tested in 5 different laboratories, the value therefore covering for both inter laboratory variation and test variation.

An addition of the maximum uncertainties however almost always overestimates the real spread resulting from the three uncertainties; only few tyres would end up in the tails of the distribution of the combined uncertainties. An overall analysis of the complete chain of uncertainties could therefore shed light on this situation, meaning statistics should be applied to the overall results of a set of tyres tested in different laboratories. Furthermore, as mentioned above the overall accuracy can be greatly increased by taking more samples (performing more tests) and additional to that one may consider if a reliability of 99.7 and using a factor of 3 is required.

An example with a lower required reliability of 95 instead of 99.7 and a root sum square addition of the errors results in the following:

Uncertainty = $0.2 + 2 \times \sqrt{(0.043^2 + 0.05^2)}$ = **0.33**

Concern manufacturing variability, the tyre to tyre variation was *minimized* for this programme by selecting tyres with a comparable RRC produced within the same day, with a maximum variation of 0.12 kg/t and an average at 0.05 kg/t. This means that a certain amount of additional tyre to tyre variation still should be included in the uncertainty margin to arrive at an overall picture of the uncertainty of the RRC test. The fact that a certain tyre to tyre variation exists implies the possibility to make an optimized selection of tyres for the RRC test. For the tyre to tyre variation very little information is currently available and the actual overall uncertainty margin is not completely clear. It is thus important to get a good insight in tyre to tyre variation from different manufacturers to judge implications for the test procedure and for a labelling scheme.

In the most conservative scenario, taking the maximum product variation as a basis (φ = 0.12), the uncertainty however remains still low. Uncertainty = $0.2 + 2 \times \sqrt{(0.043^2 + 0.12^2)}$ = **0.45**

Finally, taking into account the available information the overall uncertainty depends on the amount of tests and the actual production variation. Increasing the amount of tests per tyre can decrease the uncertainty margin. In addition, increasing the tyre sample of the same tyre type, and testing tyres *randomly* selected from the production line can also further decrease the uncertainty margin.

The following points can be considered as critical for the accuracy of the current RRC testing method as described in ISO 18164;

- The reproducibility of the test, including inter lab correlation. Inter lab alignment can rule out all sorts of systematic inter lab variations not taken care of by means of corrections or tightening of the procedure. ISO 28580 will introduce a measurement machines alignment procedure to solve this issue.
- The number of methods for the measurement of the friction force. Different methods are currently allowed. It is not fully clear, however, if systematic differences are introduced and how large they are. If they are substantial, they should be minimized by a correction or by allowance of well correlating methods only.
- The drum surface representativity. The VTI (2008) study concluded that the current drum surface texture is not representative of real road texture. However, the report also stated that the ranking of different tyres in not influenced by the surface.
- Thermal conditioning. A good procedure is required to condition the tyres at equal thermal conditions before a test.
- The variation in drum size. The drum size influences the RR in the same way RR is influenced by the outside diameter of a tyre. A smaller drum causes more deformation of a tyre than a large drum. A correction is provided in ISO 18164 and the draft ISO 28580.
- Tyre selection. It could be considered important, if a labelling scheme would be considered, to exclude possibilities to test optimised samples so that the tyres tested reflect the real world situation on RRC.

7.3.3 Discussion on absolute versus relative grading for RR

In Figure 7.1 and Figure 7.2 below data on the relationship between RRC and outside diameter (OD) is presented. The size of the relationship between RRC and OD will determine the choice between an absolute or relative grading. A relative grading scheme would make sense only if there is a proven correlation between rolling resistance coefficient (RRC) and other parameters such as OD and/or load index (LI).

Figure 7.1 RRC (by outside diameter), Continental (by EC vehicle categories)

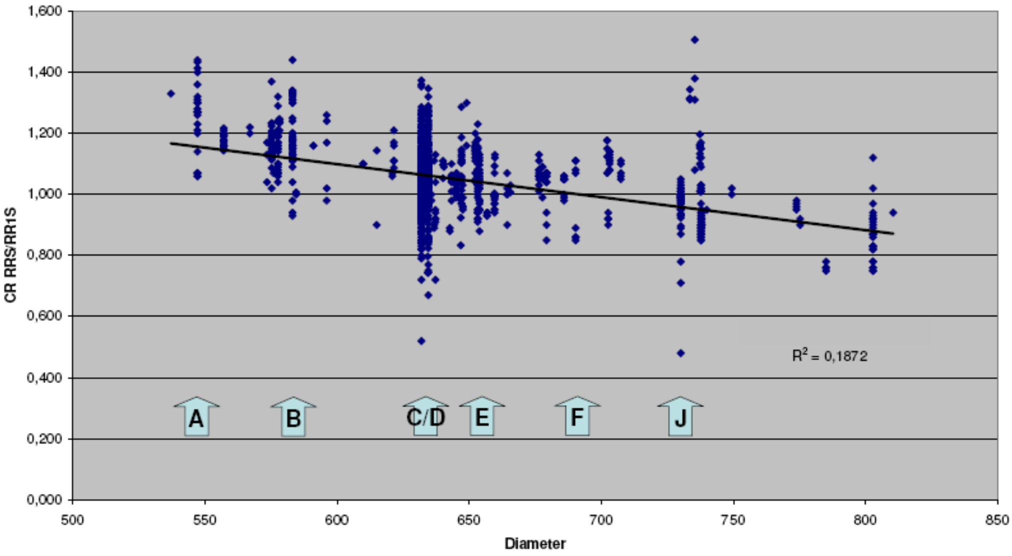
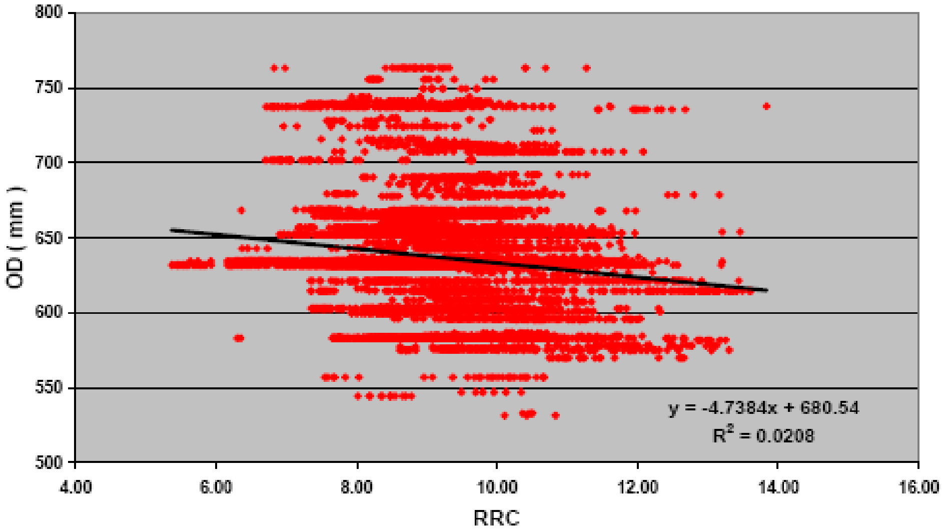


Figure 7.2 RRC (by OD), Goodyear



A relative grading scheme would have advantages:

- It would give equal incentives on all tyres dimensions to improve RRC. As the figures show that RRC decreases when tyre external diameter or load index increases. An absolute grading scheme would make it relatively easier for bigger tyres to have a lower RRC grading and less incentive for further improvement. It would also mean a relatively higher burden on smaller tyres for improvement in RRC.
- The absolute fuel and CO2 savings of LRRTs from cars using larger tyres is relatively higher. Hence, a relative grading scheme will provide the right incentive for larger vehicles to shift to LRRTs.
- It would guarantee that consumers will find band 'A' tyres in all tyres dimensions.

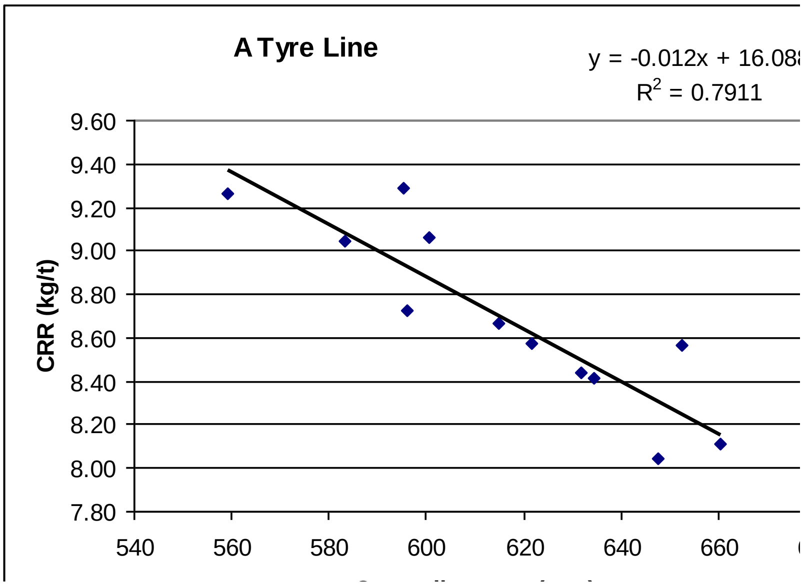
The advantage of an absolute grading scheme is the simplicity of the scheme from the legislator point of view. For a consumer there will probably be no difference as they will have the choice between tyres in a given dimension (the one necessary to fit on their vehicle) with information on ranking (eg. A to G scale). It is likely that information on the

actual measured value would not be given on a labelling scheme. In case it is decided to display the measured value on a labelling scheme, then there may be confusion in the minds of consumers.

The position of many tyre industry representatives is that there is indeed a correlation for C1 and C2 tyres but that it is too weak to justify a relative grading scheme. The R^2 in Figures 7.1 and 7.2 are very low implying that OD is not the main parameter to explain variability of RR. .

The weak correlation shown in Figures 7.1 and 7.2 is probably caused by the interference of other tyre parameters, test variation and the inclusion of several tyre families in the data set. Physical design parameters like tyre compound, tread design, casing etc all influence RRC. For example, premium tyres in a given size category generally show a lower RRC. A clearer relation would emerge from the dataset if all design parameters could be ruled out. Figure 7.3 shows the relation between RRC and OD for a single tyre line with most of other design parameters being constant in the model. This indicates a substantially higher correlation.

Figure 7.3 Example of the Relation between RRC and OD of One Tyre Line with Most Other Tyre Design Parameters Being Constant



Source: Tyre producer

In this case R² is much higher than in figures 7.1 and 7.2, which shows that OD becomes the main geometrical parameter to explain the RR variability of the different tyre sizes within a given tyre line, i.e. with the same design. Since the introduction of a RR grading would be intended to give consumers information precisely on the quality of the design parameters across tyre families, it could be better to rule out the OD influence by the mean of a relative grading scheme.

In summary, the technical relationship between RRC and outside diameter should be considered because when a tyre has a smaller outer diameter than another one built with the same rubber compounds, the stresses and strains generated when it is loaded on a flat ground are higher, due to the geometric difference in curvature variation. The higher curvature variation for tyres with a smaller OD induces a higher level of stored elastic energy and, with the same rubber compounds, higher hysteretic energy losses, hence a higher tyre Rolling Resistance Coefficient.

Even though the graphs 7.1 and 7.2 show a weak correlation between RRC and OD, we can conclude that a relation exists. However, a reliable statistical estimate of the correlation between RRC and OD can only be calculated once all other attributes influencing RRC have been ruled out. Figure 7.3 gives a good insight of the relation between RRC and OD when most tyre design parameters are ruled out (within a tyre line, most design parameters remain the same across tyre sizes). This outcome would need to be further confirmed by a multiple variable regression analyses, using data from all manufacturers.

It should also be pointed out that the Figures 7.1 and 7.2 are for passenger car tyres only. The RRC for truck tyres are generally lower than passenger car tyres due to fundamental difference in tyre design and not only due to the difference in OD.

7.4 Wet Grip

7.4.1 Description of WG testing method

The WG testing method is described in;

ISO 23671: 2006 Passenger car tyres -- Method for measuring relative wet grip performance using loaded new tyres.

and in;

UNECE R117 - Uniform provisions concerning the approval of tyres with regard to rolling sound emissions and to adhesion on wet surfaces.

The methods in the ISO standard and the UN regulation are essentially the same.

"Adhesion on wet surfaces" means the relative braking performance, on a wet surface, of a test vehicle or trailer equipped with the candidate tyre in comparison to that of the same test vehicle equipped with a reference tyre (SRTT). The total index is derived from a combination of two indices;

1. the peak braking force (pbfc) index G1 and
2. the mean fully developed deceleration (mfdd) index G2

The total wet grip index is a multiplication of two indices mentioned above;

G= G1xG2

G1= pbfc candidate / pbfc SRTT

G2 = mfdd candidate / mfdd SRTT

Comments regarding the grip test:

- not representative for braking on a dry surface
- not representative for cornering (side forces and grip), only for straight line
- not representative for aquaplaning
- the definition of the test surface specified in ASTM E965 allows a wide range of asphalt and the surface friction test allows different surface types.
- the water depth tolerance and definition allows test variations

Not much information is available on the uncertainty and variability of the test method. A Round Robin test made in 2001 on test tracks which were not all ISO certified, however, shows a Reproducibility standard deviation between 6 to 8% which already takes into account the 3% uncertainty due to test repeatability. Since wet grip mostly depend on the design of the tread depth which is more or less constant as it is impregnated by moulds, there is little variation between tyres wet grip performances at the end of the production

line. Variation in product manufacturing can therefore be considered marginal. We know therefore with certainty that current standard deviation must be lower than this range (6 to 8%). The industry is also working on a professional agreement to reduce further the uncertainty of the wet grip method.

7.5 Proposed Standards and Testing Methods in EU by 2012

The most recent standards are given in the proposal for Regulation concerning type-approval requirements for the general safety of motor vehicles (COM (2008)316). This proposal sets out requirements for Tyres with regard to Wet Grip, Rolling Resistance and Rolling Noise and is given below:

Part A- Wet Grip Requirements (mandatory by 2012/14)

Class C1 tyres shall meet the following requirements:

Category of use	Wet grip index (G)
snow tyre with a speed symbol ("Q" or below minus "H") indicating a maximum permissible speed not greater than 160 km/h	≥ 0.9
snow tyre with a speed symbol ("R" and above, plus "H") indicating a maximum permissible speed greater than 160 km/h	≥ 1.0
normal (road type) tyre	≥ 1.1

Part B- Rolling Resistance

The maximum values for the rolling resistance coefficient for each tyre type, measured in accordance with ISO 28580, shall not exceed the following:

	First Stage		Second Stage		
	Oct 2012	Oct 2014	Oct 2016	Oct 2018	Oct 2020
C1 (passenger cars)	12kg/t (new tyre types (TT))	12kg/t (existing TT)	10.5kg/t (new TT)	10.5kg/t (existing TT)	
C2 (light duty vehicles)	10.5kg/t (new TT)	10.5kg/t (existing TT)	9kg/t (new TT)	9kg/t (existing TT)	
C3 (heavy duty vehicles)	8kg/t (new TT)		8kg/t (existing TT) 6.5kg/t (new TT)		6.5kg/t (existing TT)

Note: 'New tyre' types refer to a new tyre brand or product which enters the market with a new design and on a new production line. These tyres will have to comply with the new requirement if they want to get the certification in the type approval procedure.

"Existing tyre types" refer to tyres inside an older type, i.e. an older brand which has already been type approved before the entry into force of the new requirements. These tyres will also have to comply with the new requirements but after a two year period to allow tyre producers to complete their replacement cycle.

Part C – Rolling Noise

1. The noise levels determined in accordance with the procedure specified in the implementing measures to this Regulation shall not exceed the limits designated in points 1.1 or 1.2. The tables in points 1.1 and 1.2 represent the measured values corrected for temperature, except in the case of C3 tyres, and instrument tolerance and rounded down to the nearest whole value.

    a. Class C1 tyres, with reference to the nominal section width of the tyre that has been tested:

Tyre class	Nominal section width (mm)	Limit values in dB(A)
C1A	≤ 185	70
C1B	> 185 ≤ 215	71
C1C	> 215 ≤ 245	71
C1D	> 245 ≤ 275	72
C1E	> 275	74

b. Class C2 and C3 tyres, with reference to the category of use of the range of tyres:

Tyre class	Nominal section width (mm)	Limit values in dB(A)
C2	Normal	72
	Snow (M+S)	73
C3	Normal	73
	Snow (M+S)	75

8 ANNEX 8: REVIEW OF EVIDENCE ON ENERGY LABELLING OF PRODUCTS

This Annex summarises the evidence, mainly from the experience of the application of energy labelling to domestic appliances, on the potential effectiveness of energy labelling.

8.1 Relevance of Energy Labelling of Domestic Appliances

It is clear that tyres are not comparable to domestic appliances. Tyres are a part of a vehicle and their efficiency is determined by their performance response to external factors (such as vehicle efficiency, load, speed, driving style, road surface, road conditions, driver behaviour). The choice is determined by price and expected wear, but very importantly by considerations of safety and reliability. As a result, consumer choice is more heavily influenced by tyre dealers and retailers, than is the case for domestic appliances. Over ten years of experience with energy labelling of domestic appliances has shown that providing information on energy savings has led to an increase in uptake. Experience from energy labelling of domestic appliances though insightful, should not be considered for direct comparison. However, the use of energy labelling with clear signalling of energy savings for a consumer product can provide some valuable lessons.

8.2 Main Findings on Effectiveness of Labelling

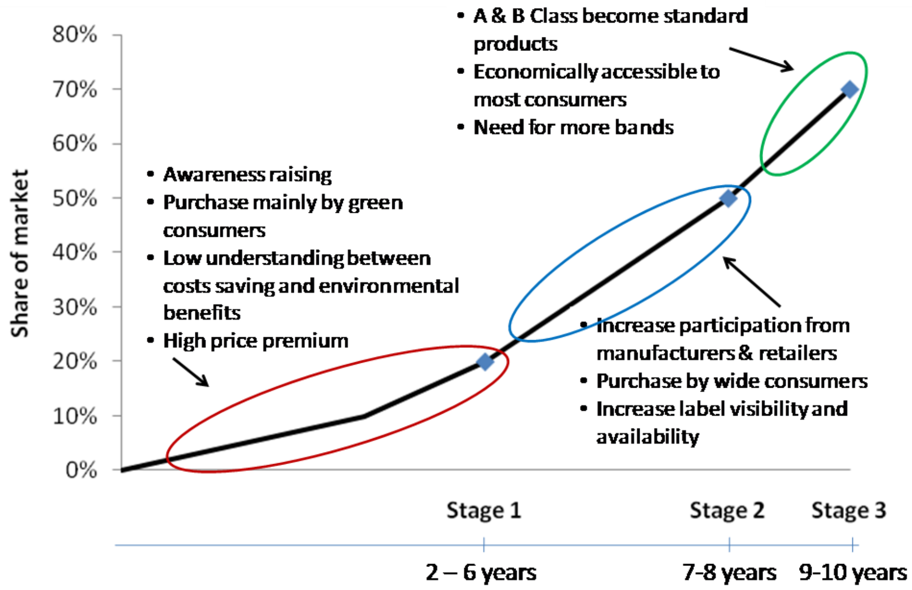
Key lessons include:

- Labelling schemes were most effective in encouraging switching to higher bands when technical progress made these higher band products economically available, such as in the case of washing machines and fridges;
- In general manufacturers and retailers have been willing to comply with the labelling schemes but lack of training for retailers and difficulties with the design of the labels were quoted as barriers for increasing their effectiveness;
- The costs of implementing the CO2 labelling scheme on cars and domestic appliances have predominantly been borne by manufacturers and retailers;
- The highest levels of compliance with labelling requirements and the most effective labelling programs were in MS with high levels of public awareness of the programme; compliance with the labelling requirement is also quoted as one of the main factor determining the success of a labelling scheme
- Coordination of testing facilities across MS would reduce the costs of product testing and in turn increase levels of compliance.

Labelling stages

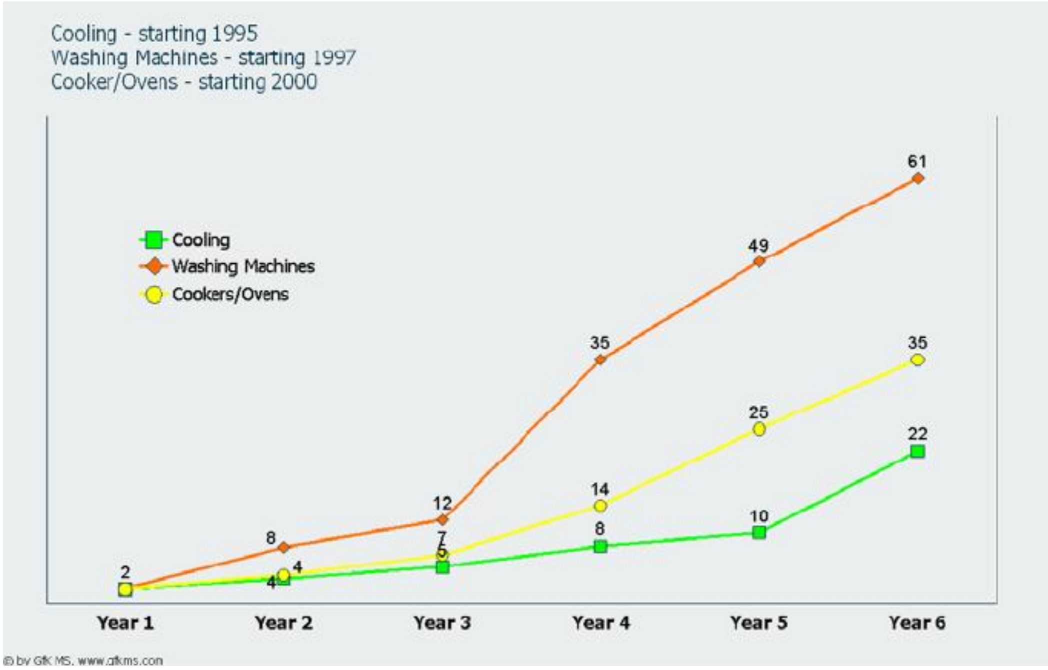
Experience with labelling schemes has shown that uptake of higher energy efficient classes initially take more time. The impact of a labelling scheme can be explained by 3 main stages as shown in Figure 8.1 below. The main factors which affect the stages are also described in Figure 8.1. The experience has also shown that the uptake of products in higher energy efficient classes takes several years (Figure 8.1) and depends on a number of factors including initial levels of awareness, economic incentives and disincentives, and levels of manufacturer and retailer participation. The share of higher energy efficient classes in each stage thus depends on the level of these factors. For example, member states such as Austria and Netherlands in general have a higher share of ‘A’ class sales due to higher levels of public awareness and consumer preferences (Cool labels, 1998).

Figure 8.1 Labelling stages and share of market (A & B class)



The effect of these factors is to delay a greater uptake of products in higher bands usually to the 5th and 6th year (Figure 8.2).

Figure 8.2: Share of Sales in Band A or above



Source: Stockle, GfK (2006)

Note: Basis: 8 countries West Europe, measured by GfK since 1995. Countries: AT, BE, DE, ES, FR, GB, IT and NL

Council Directives 92/75/EC and 1999/94/EC provide the most relevant benchmarks for a possible labelling of tyres. Both of these EU-wide directives aimed to shift consumer demand towards more environmentally friendly products by categorizing products based on the energy they consumed or the CO2 emissions they produced (Table 8.1).

Table 8.1: Overview of Relevant EU Directives on Energy Labelling

Council directive 92/75/EC. **Energy Consumption Labelling Ordinance**	**Council directive 1999/94/EC** **CO2 Vehicle Labelling Ordinance**
Label must be attached to the outside of all household appliances for sale, hire, or hire purchase. Labels must be provided for free by the manufacturer It must include a coloured background	Label must be attached to, or displayed near, the car in a clearly visible manner at the point of sale. It must include: • fuel consumption (in litres per 100 kilometres) • specific emissions of CO2 (in grams per kilometre) • reference to the fact that a free fuel economy guide is available

8.2.1 Ability of labelling to shift market towards more energy efficient products

Labelling schemes have proven to be highly effective tools to shift markets towards more efficient and environmentally friendly products, particularly in Canada, Switzerland and the United States[33,34].

The change in consumer buying preferences for LRRTs would depend on two main motivations:

- To save money (function of fuel prices)
- To act for the environment Experience with existing labelling schemes can provide some idea on the uptake of products. A survey of first three years of the European Energy label classified 11 EU countries into three main groups in terms of importance of energy in choosing an appliance:

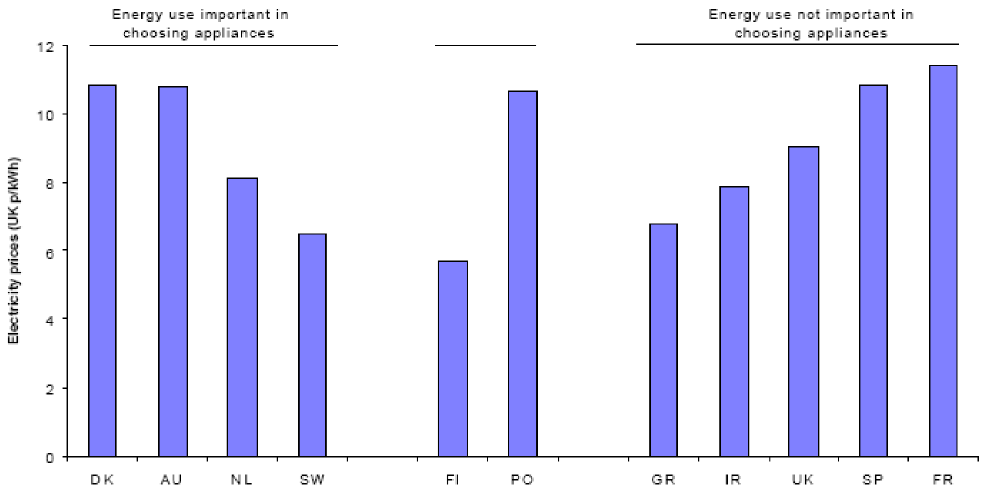
1. Very important - Austria, Denmark, the Netherlands and Sweden
2. Fairly important - Portugal and Finland
3. Not important - France, Greece, Ireland, Spain and the UK

The survey looked at the relationship between energy use and electricity prices and found no relationship between the two factors (Figure 8.3). Within each group, there are countries with a range of electricity prices, from among the highest in Europe to among the lowest. It is certainly not the case that consumers in countries with high electricity prices were more likely to mention energy use as a factor in choosing appliances. The differences in the significance consumers in different countries place on the energy use of appliances when making purchases are not explained by variations in local electricity prices.

[33] Energy labels and Standards, 2000, IEA, pp. 87-90

[34] COOL APPLIANCES Policy Strategies for Energy Efficient Homes, 2003, IEA.

Figure 8.3 Importance of energy use for respondents in relation to average electricity prices



Source: Cool labels (1998)

The importance of energy use as a selection criterion was also compared with environmental attitude of the consumers. Two measures of this can be tracked from the survey. Firstly, people spontaneously mentioning environmental factors as a criterion in choosing an appliance were recorded (separately from those mentioning energy use). Secondly, those who said (prompted or unprompted) that energy had been a factor in their choice were probed as to the main reason: was it to save money, for environmental reasons, or both? In Austria and Denmark 57% and 59% respectively of respondents cited both whereas in Portugal and Spain 49% and 65% of respondents cited saving money as an important factor.

Table 8.2 Reasons given for rating energy use as an important factor (%)

	AU	DK	FI	FR	GR	IR	NL	PO	SP	SW	UK
To save money	31	30	55	78	59	38	30	49	65	28	37
Environmental reasons	12	10	14	3	0	1	23	5	8	25	25
Both	57	59	27	12	41	7	46	36	21	42	21

Base: those mentioning energy as a selection factor
Those saying 'don't know / can't remember' have been omitted.

Consumers in the four countries (DK, AU, NL, SW) where energy use is important in choosing an appliance are more likely to mention environmental factors spontaneously as a purchase criterion, and are relatively less likely to say that energy efficiency was only important as a means of saving money. At the other end of the spectrum, in Greece, France and Spain, environmental factors were rarely mentioned as an aspect of appliance choice, while respondents in France, Spain and Ireland were particularly likely to attribute their interest in energy use only to money saving.

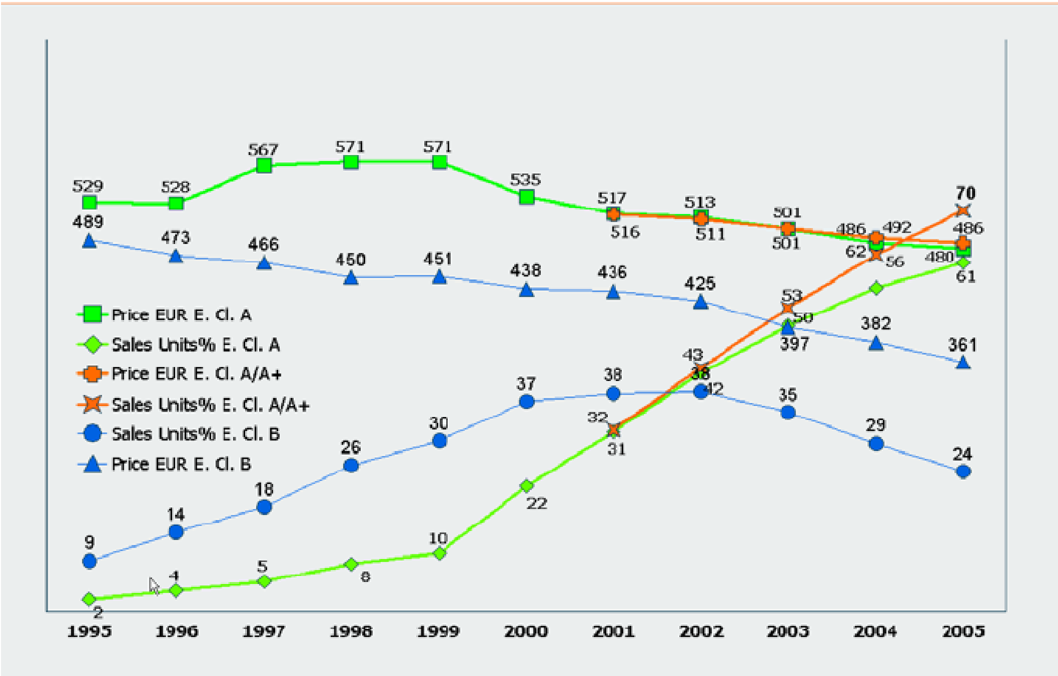
The ADAC (2005) report undertook an assessment of the CO2 labelling scheme for cars in five member states and found that labelling had an influence on the reduction of CO2 emissions. While the studies revealed that CO2 emissions have declined since the label was introduced, it was not possible to separate out the effect of the label from the broader impact of the reductions in emissions resulting from the parallel voluntary agreements.

The ADAC study also concluded that fuel consumption ranked first, when taking the "environmental friendliness" and the "running cost" into account separately. Fuel consumption is the most important factor in terms of "environmental friendliness" of a passenger car. Low CO2 emissions are less important. This shows that most consumers do not make the link

between fuel consumption and CO2 emissions of passenger cars and their environmental impact.

The first ten years of the energy labelling of domestic appliances showed that the energy class A took nearly 5 years to account for 20% of overall sales. Together class A and B accounted for over 50% of sales in year 5 (2000). In 2002, A+ products started entering the market in Western Europe[35]. By 2005, A+ and A class accounted for over 70% of the market (Figure 8.4). Figure 8.4 also shows that the price of A+/A class declines overtime.

Figure 8.4 Market for cool appliances (8 Western EU countries)



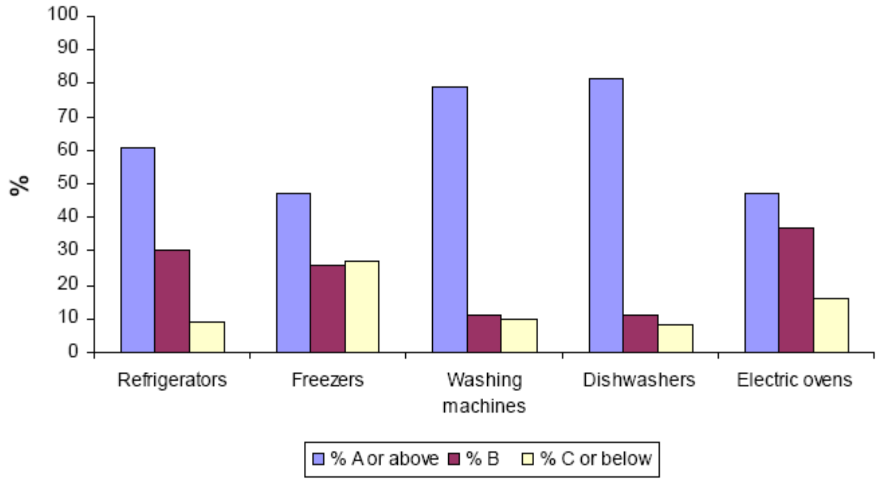
Source: Stockle, GfK (2006)

Specifically, after the introduction of Council Directive 92/75/EC, the proportion of band A and B appliances sold in the EU increased from less than 10% prior to 1992 to 50% in 1999[36]. The take up of higher energy efficient appliances has been greater in the EU-15 (Figure 8.5) than in the Centre-East European Member States (Figure 8.5).

[35] Basis: 8 countries West Europe, measured by GfK since 1995. Countries: AT, BE, DE, ES, FR, GB, IT, NL

[36] COOL APPLIANCES Policy Strategies for Energy Efficient Homes, 2003, IEA.

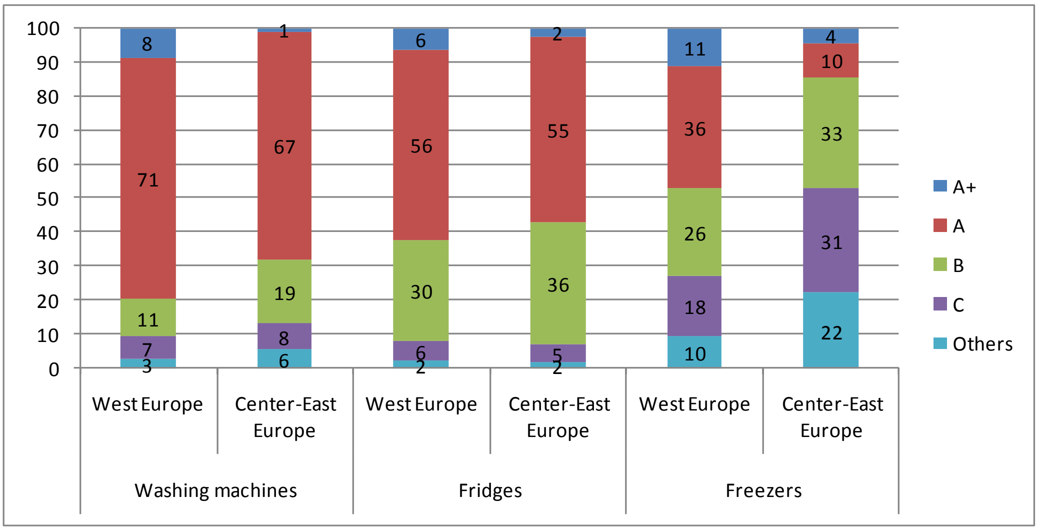
Figure 8.5 Energy rating of household appliance - percentage of sales – EU 15, 2004-05



Source: EC Status Report 2006

The share of A+ and A was lower in Centre-East European countries (Figure 8.6) in 2004. The share of band A+ and A freezer sales in western Europe was 47% compared to 14% for centre-east Europe in 2004.

Figure 8.6 Share of sales in Western Europe and Centre-East European countries (%)



Source: GfK (2005) Overview of sales and trends for main appliances

Note: 8 Country East: PL, CZ, SK, BG, SI, RO, HU, HR

10 Country West: AT, BE, DE, ES, FR, GB, IT, NL, PT, SE

8.3 Factors Affecting the Implementation of a Labelling Scheme

The assessment studies undertaken for the labelling schemes found that, while there was a high level of compliance among manufacturers providing the labelling material, the material was not always adequately available to consumers[37].

[37] GfK Evaluating the Implementation of the Energy Consumption Labelling Ordinance, 2001,

Willingness to comply

The costs of implementing the domestic appliance labelling directive have generally been low for governments and energy authorities. The level of support and enforcement of the program has varied between MS, as has its influence on energy consumption.

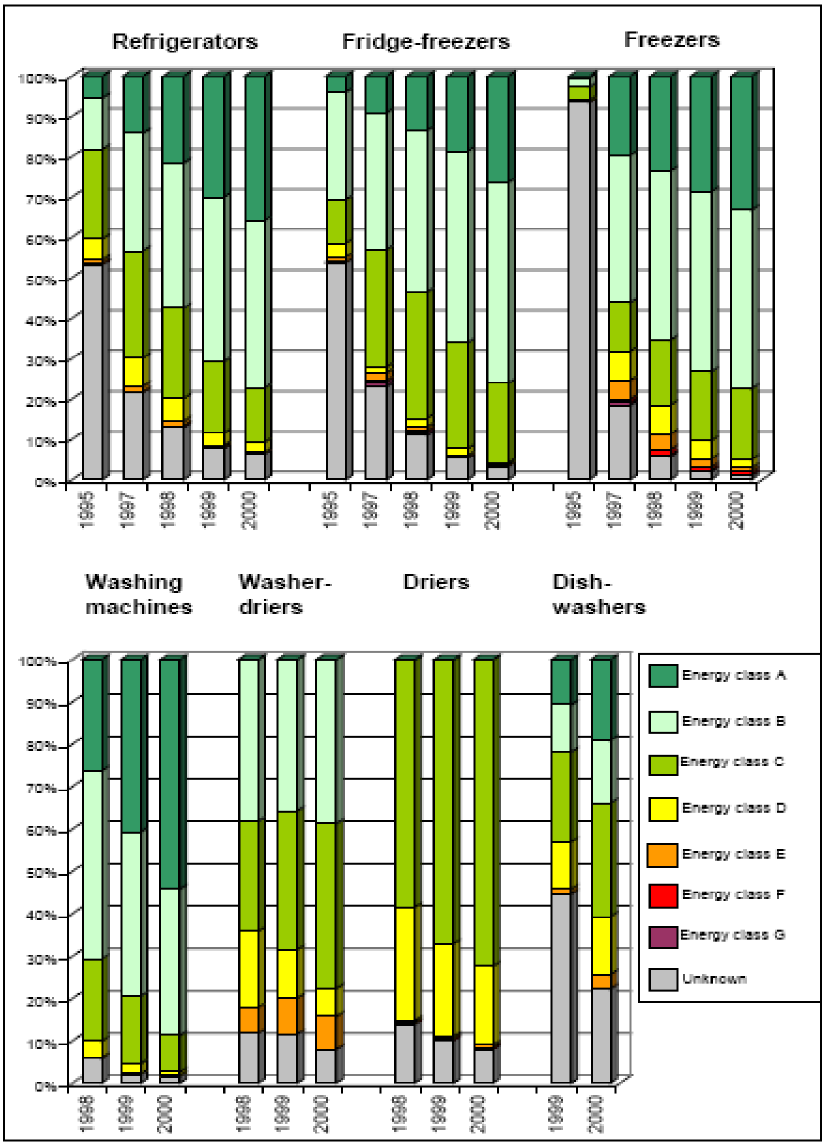
The costs of implementing the CO2 labelling scheme on cars have been borne by manufacturers (same for domestic appliance labelling). The majority of these costs are passed on to consumers.

Technical progress

It was also shown[38] that where technical progress has allowed for the development of economies of scale in the production of higher band appliances, the market shares of those products have increased at a greater rate than other labelled products. In the case of washing machines, refrigerators and freezers, technological progress allowed the improvement in design and increase in production at an acceptable cost. For example, today a typical refrigerator consumes 40% less energy, on average, than an equivalent model sold ten years ago. This progress did not occur for dryers, and the cost of band A appliances has proved prohibitive. This is reflected in the share of energy appliances by classes in Germany (Figure 8.7) where dryers had no sales in Class A.

[38] GFK and Fraunhofer ISI, 2001, Evaluating the Implementation of the Energy Consumption Labelling Ordinance: http://www.isi.fraunhofer.de/e/publikation/EnVKV/EnVKV-kurz-en.pdf

Figure 8.7 Development of the share of energy efficiency classes in total sales of large electrical household appliances in Germany 1995 to 2000



Source: GFK and Fraunhofer ISI, 2001

Lack of capacity to comply

Finally, problems inherent in the practical implementation of the directive have a direct effect on compliance. The generally high costs of testing for appliances, lack of coordination between MS and other technical problems, have affected the levels of compliance.

The effectiveness of implementation for both the energy efficiency and CO2 labelling schemes, was strongly influenced by the level of training for retailers and by use of public awareness raising campaigns. Promotion and awareness-raising campaigns included energy utilities publishing information brochures, indicating the significance of the labels, and the provision of equipment free of charge to measure consumption. However, the literature noted low coordination or information sharing between and within MS that would allow an efficient and EU-wide unified promotion of the labelling scheme.

8.4 Distribution of Labelled Products

Impact on manufacturers

Studies on energy efficient and CO2 emission labelling schemes rated the degree of compliance from manufacturers as being high. It was seen as a good way of advertising a product, because it was a credible and simplified way of communicating the environmental quality of the product.[39]

Impact on retailers

The type of retailing structure has been found to have a strong influence on the level of compliance to labelling schemes. The behaviour of retailers as regards labelling can be divided into the following categories:

- Retailer understands the labelling to be a marketing aid and takes the labelling obligation seriously;
- Retailer accepts and uses the labelling but is not adequately informed and requires support and help with its implementation;
- Retailer generally rejects the labelling as not necessary or a nuisance.

However, retailer participation towards a labelling scheme increases over time as it becomes an important marketing tool.

8.5 Impact on Consumers

Studies have found conflicting evidence on the extent to which labelling on environmental criteria affects consumer behaviour[40]. The influence of labelling on consumer choice depends in part on the homogeneity of the product. When it is quite high (e.g. refrigerators) labelling is more useful, whereas for products with extra features the label becomes less efficient[41]. More generally, consumer behaviour was classified by Environics International as follows:

Type	Features	1999 %	2000 %
Green Consumers	• Highly willing to pay for environmental attributes • Demographically they have high levels of education and income • Are car owners	27	33
Green Activist	• Low willingness to pay for green products • They express their green concerns through their lifestyle rather than “voting with their dollars” • Are car owners	10	11
Latent Greens	• Have significant environmental concerns but are focussed very locally • Not yet car owners	40	34
Inactives	• Lowest level of environmental concern • Demographically are over 65 and or with lower levels of	23	22

[39] The European energy label: an energy efficiency success story with an impact beyond EU borders- UNDP – 2007

[40] Experts Workshop on Information and Consumer Decision-Making for Sustainable Consumption, 2001, OECD.

[41] Impact assessment study on a possible extension, tightening or simplification of the framework directive 92/75 EEC on energy labelling of household appliances, 2008, Europe Economics.

	income • Around half of the people in this segment do not drive		

Source: Environics International, International Environmental Monitor, 2000. http://www.oecd.org/dataoecd/46/19/1895757.pdf

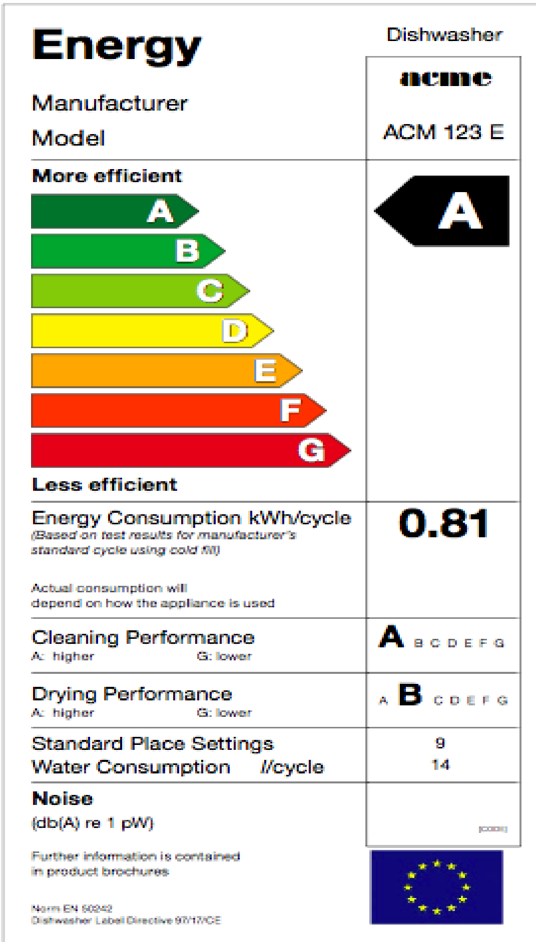
The possible link of 'green' interests with higher levels of income / car ownership suggests that choice of tyres may depend on energy labelling for this group of consumers.

Selling to consumers

Customer satisfaction has also risen in most cases with the introduction of labelling. It has facilitated direct comparisons of products by providing uniform information about the aspects of competing products e.g. relative and absolute energy efficiency. In addition, the advice consumers receive from retailers has become more objective in recent times[42].

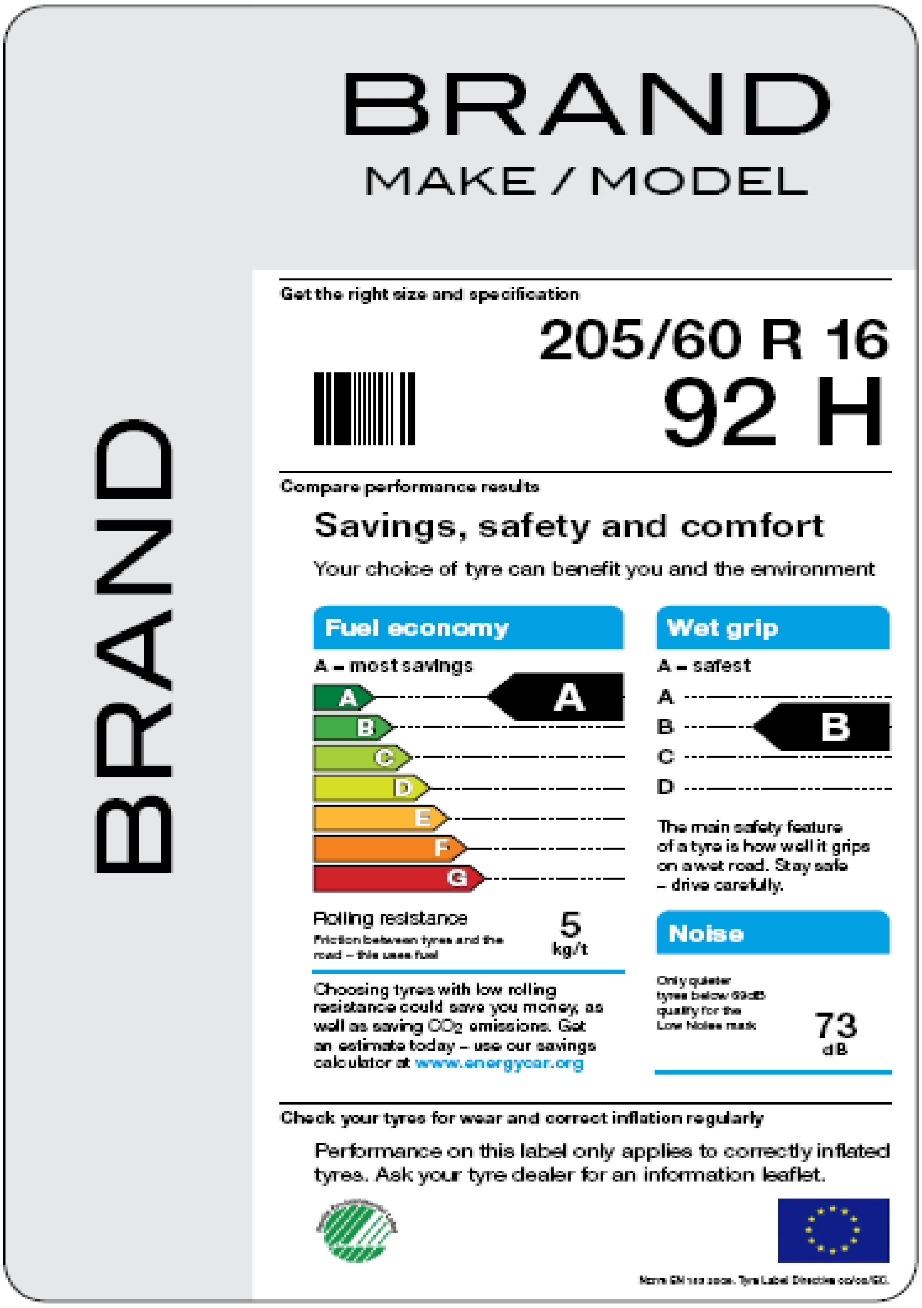
8.6 Examples of Energy Labelling

For household appliances

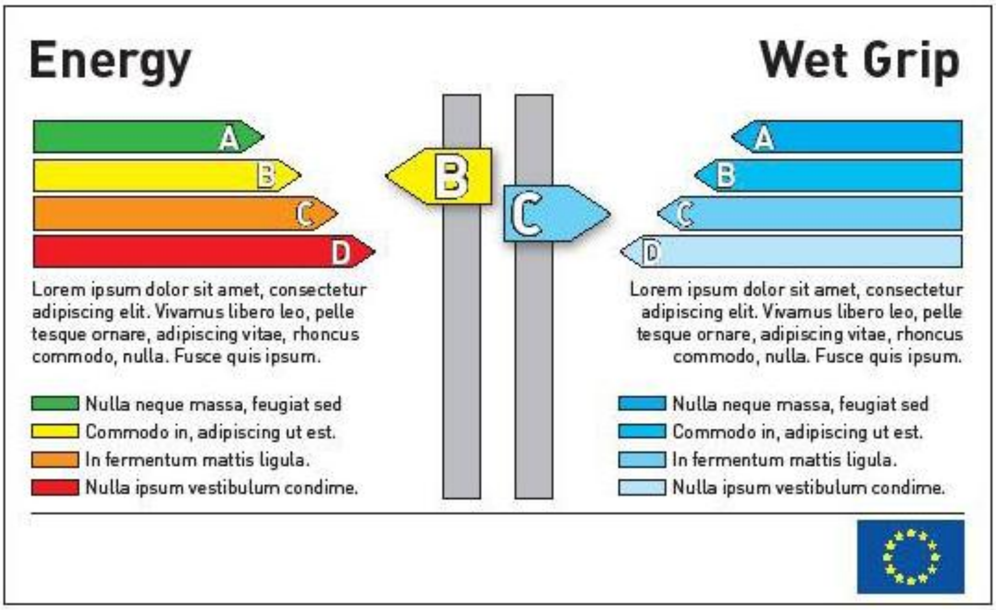


[42] Effectiveness of CO2 labelling of cars relating to availability of consumer information, Council Directive 1999/94/EC

European Federation for Transport and Environment (T&E) proposal



ETRMA Proposal



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