DELIVERABLE 3.4.2

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PROJECT N°	**FP7-233655**
ACRONYM	**CITYHUSH**
TITLE	**Acoustically Green Road Vehicles and City Areas**
Work Package 3	**Noise and vibrations control at source – Acoustically green vehicles**
3.4	**Developing quiet tyre designs for quiet road surfaces**
	Low noise DualQ tyre combined with electric vehicle
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Project Co-Ordinator Partners

Acoustic Control	ACL	SE
Accon	ACC	DE
Alfa Products & Technologies	APT	BE
Goodyear	GOOD	LU
Head Acoustics	HAC	DE
Royal Institute of Technology	KTH	SE
NCC Roads	NCC	SE
Stockholm Environmental & Health Administration	SEP	SE
Netherlands Organisation for Applied Scientific Research	TNO	NL
Trafikkontoret Göteborg	TRAF	SE
TT&E Consultants	TTE	GR
University of Cambridge	UCAM	UK
Promation of Operational Links with Integrated Services	POLIS	BE

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Duration of the project	**36 months**

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Dissemination Level

PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restrictec to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for the members of the consortium (including the Commission Services)	

Nature of Deliverable

R	Report	
P	Prototype	
D	Demonstrator	
O	Other	✓

SEVENTH FRAMEWORK PROGRAMME

This deliverable has been quality checked and approved by CityHush Coordinator
Nils-Åke Nilsson

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0 EXECUTIVE SUMMARY

0.1 OBJECTIVE OF THE DELIVERABLE

Within the CITYHUSH project, investigations with the aim to find noise reduction techniques for tyre/road noise are being performed. The objective of this study is to evaluate the reduction of emitted tyre/road noise from a new DualQ tyre design in combination with hybrid or electric cars.

0.2 DESCRIPTION OF THE WORK PERFORMED SINCE THE BEGINNING OF THE PROJECT

Calculations have been performed to attain the total traffic noise reduction when combining DualQ tyres and electrically driven road vehicles. Based on work done in previous research project QCity, it is concluded that road traffic noise is dominated by tyre/road noise for velocities above approximately 30 km/h.

The possibilities to manufacture and test the DualQ-design on hybrid or electric cars within the frame of this project have been investigated.

0.3 MAIN RESULTS ACHIEVED SO FAR

It has been shown that the total traffic noise reduction achieved by a combination of DualQ tyre design and electrically driven vehicles is approximately 10 dB(A)-units at 40 km/h.

The feasibility of manufacturing the prototype tyres and to perform tests on an electrically driven car is secured.

0.4 EXPECTED FINAL RESULTS

When testing the DualQ tyre prototypes on electrically driven cars running on smooth asphalt, a traffic noise reduction of approximately 10 dB(A)-units at 40 km/h is expected (relative to standard car with standard tyres driving on a standard asphalt pavement).

0.5 POTENTIAL IMPACT AND USE[1]

Traffic noise reduction has two major benefits. First, citizens experiencing traffic noise as a disturbance and potential health risk can be provided with a much quieter and healthier traffic environment with less residents disturbances.

Secondly, areas, which are not populated due to traffic noise pollution, may be reconsidered as an appropriate area to build residential buildings once traffic noise reduction has been achieved.

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1 *including the socio-economic impact and the wider societal implications of the project so far*

0.6 PARTNERS INVOLVED AND THEIR CONTRIBUTION

0.7 CONCLUSIONS

A combination of hybrid or electric car and the DualQ tyre design running on smooth asphalt is expected to result in approximately 10 dB(A)-units of noise reduction at 40 km/h (relative to standard car with standard car tyres driving on standard asphalt). Full-scale tests for the combination of electric car with DualQ tyres will be performed within the CityHush project.

1 BACKGROUND

Global warming and environmental issues is presently forcing the vehicle industry to produce more environmentally friendly vehicles. As a part of this work, electrically driven vehicles which have very silent drive-lines are becoming more popular. Traffic noise is mainly the combination of tyre/road noise and driveline noise. In order to significantly reduce traffic noise for the whole speed range, mitigation measures concerning both tyre/road noise and driveline noise must be considered. In this deliverable, a method of reducing traffic noise by a combination of electric vehicles and the low noise tyre design *DualQ* is presented.

2 ELECTRIC CAR NOISE REDUCTION

As a part of the QCity project, the driveline noise for a hybrid electric vehicle operated by electric motor only and a standard gasoline car (Volvo V70) was studied and compared by ACL [1]. The hybrid electric vehicle used was a Toyota Prius manufactured in 2006.

In the study mentioned above it was possible to separate the driveline noise and the tyre/road noise from the total emitted noise level. The driveline noise is reduced by 12 dB(A) in the whole speed range, see Figure 2.1 below. However, the velocity exponent for tyre/road noise was higher compared to the driveline noise velocity exponent. This means that the impact from the electric driveline on the total noise reduction becomes less important, while the impact from the tyre/road noise on the total noise reduction becomes increasingly important as the vehicle speed increases.

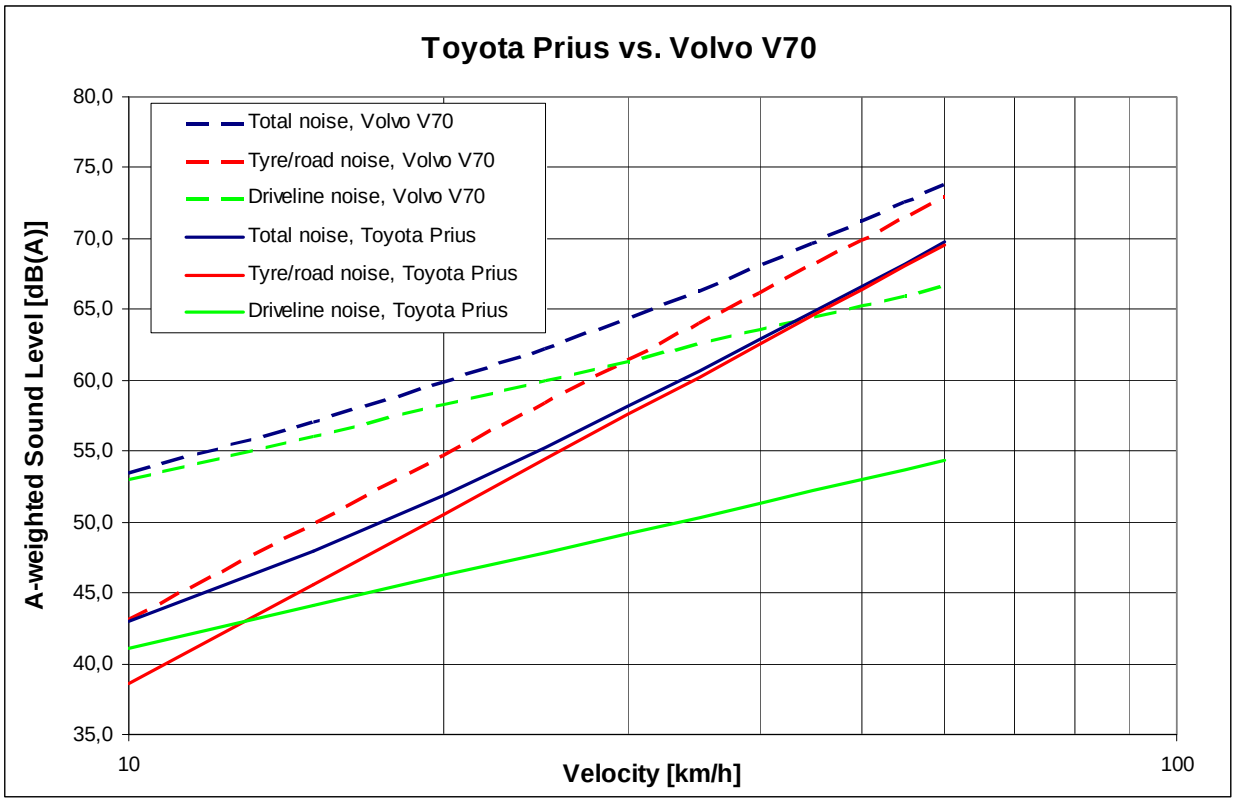

Figure 2.1 Comparison of noise emission levels for the hybrid and the gasoline car [1].

3 DUAL TYRE NOISE REDUCTION

As a part of the QCity project, two DualQ prototype tyres were developed and evaluated regarding its reduction of external tyre/road noise. The DualQ tyre consists of two narrow tyres with small crown radius mounted on the same rim with a spatial separation between them. This spatial separation is preventing the two tyres to interact acoustically, which ensure that the horn amplification is not re-established. The horn amplification effect was significantly reduced and this effect was found to be responsible for a major part of the total noise reduction [2].

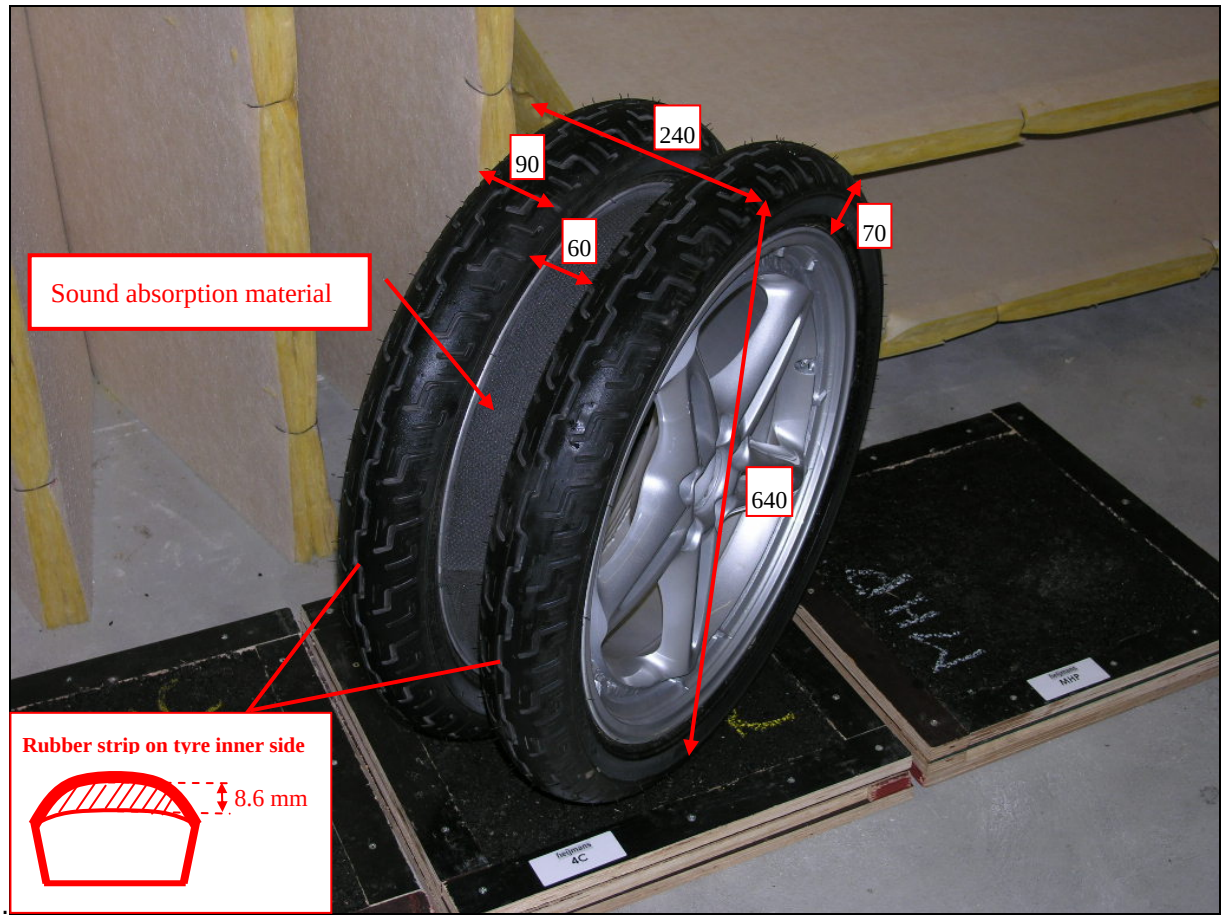

Figure 3.1 *DualQ prototype. Dimensions in mm [2].*

Measurements with the aim to evaluate the reduction potential from the DualQ tyre were partly performed by Acoustic Control (ACL) with the CPX method using a single wheel trailer for tyre/road noise measurements. Further evaluation measurements of the DualQ concept were performed in the acoustical laboratory at Goodyear (GOOD) in cooperation with ACL staff. The CPX measurement results reveal that the DualQ prototype reduces tyre/road noise by 6.3 – 8 dB(A) compared to standard car tyres with similar dimensions. The reference tyres selected were Goodyear Hydragrip with dimensions 205/65R15 and 215/65R15. The measurements performed in acoustic

laboratory on rough road replica resulted in noise reduction of 3 – 6 dB(A) compared to one of the best newly developed tyre designs by Goodyear (Eagle F1 Asymmetric).
The DualQ concept was proved successful and has the potential to give a substantial reduction of emitted sound levels, especially when combined with electrically driven vehicles.

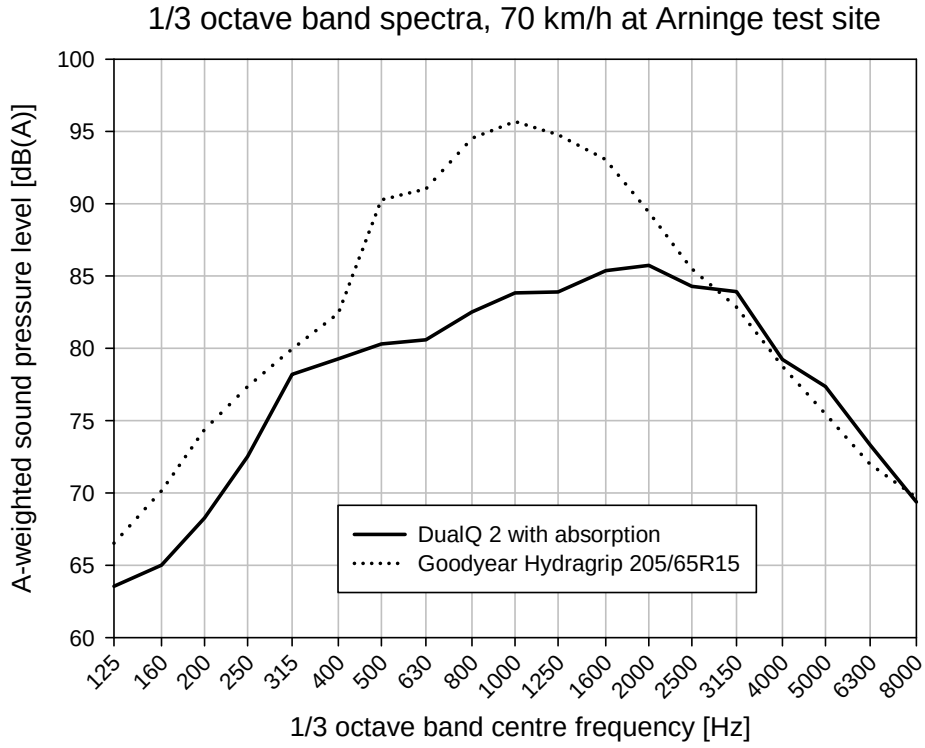

Figure 3.2 *A-weighted sound pressure level in 1/3 octave band for the DualQ 2 (with absorption) and the reference car tyre at speed 70 km/h, Arninge test site [2].*

4 DUAL TYRE MOUNTED ON ELECTRIC CAR – EXPECTED NOISE REDUCTION

The total noise reduction which could be achieved by a combination of reduced tyre/road noise and reduced driveline noise was studied in [1]. In figure 4.1 below it is seen that if tyre/road noise can be reduced with approximately 8 dB, the total noise reduction could be as high as 9-12 dB-units for typical urban traffic vehicle speeds.

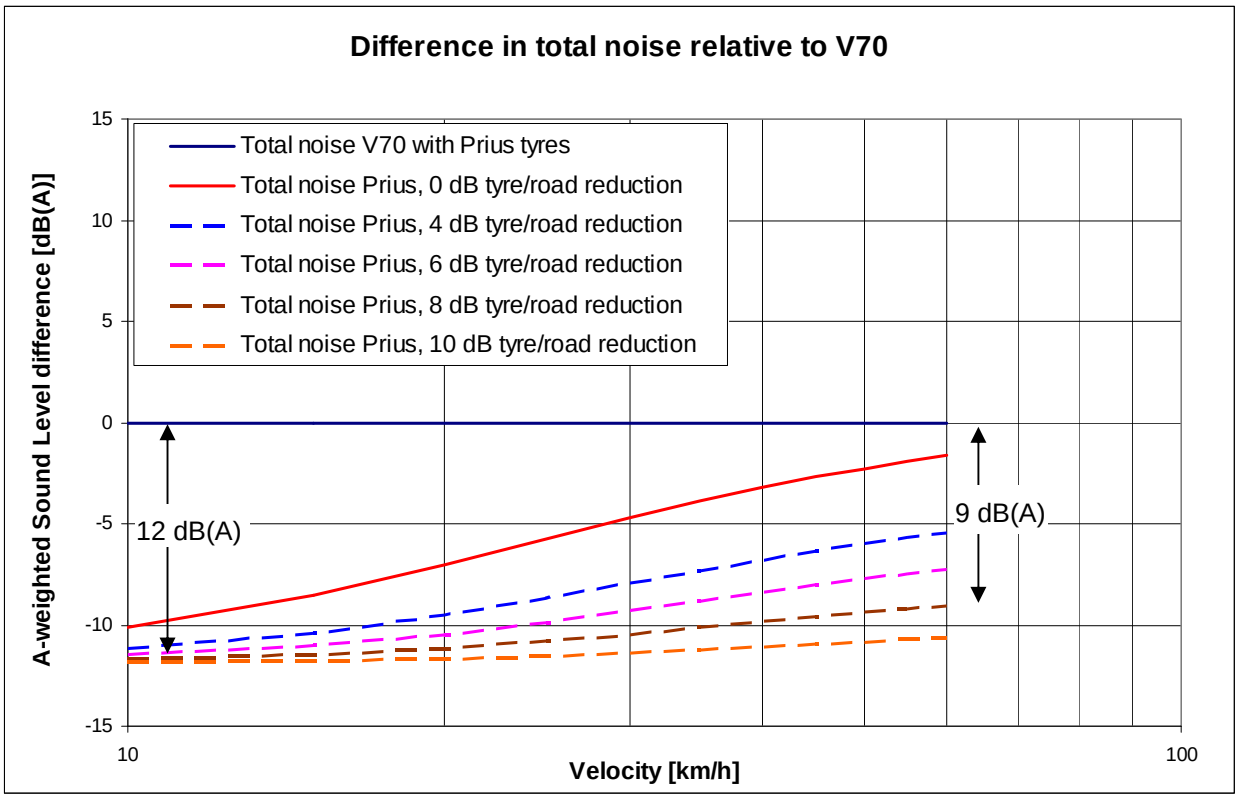

Figure 4.1 Total noise difference relative to V70 with Prius tyres [1].

4.1 FULL-SCALE PROTOTYPE TESTING

Within the Cityhush project, four prototype DualQ tyres will be manufactured and tested on an electric vehicle. The tests will be performed with various vehicle speeds and different road surfaces in order to fully investigate the potential in noise reduction for the concept.

Since vehicle interior noise is a key purchase factor for the buyer, it is a highly prioritized aspect for the vehicle industry. Therefore, besides exterior noise, which is the main interest in this project, interior noise will also be briefly investigated.

4.2 TRAFFIC NOISE REDUCTION - IMPACT AND USE

Traffic noise reduction is a very important issue in urban areas experiencing high noise levels. The potential traffic noise reduction when using DualQ tyres combined with electric cars is very high. Traffic noise reduction has two major benefits.

1) First, citizens experiencing traffic noise as a disturbance factor and potential health risks could, by the introduction of noise reduction, be provided with a much quieter and more healthy traffic environment with less annoyance for the residents.
2) Secondly, areas with dense traffic flows, which are presently not populated due to noise pollution, may be reconsidered as an appropriate area to build residential buildings once traffic noise reduction has been achieved.

For urban areas with high population but limited space, traffic noise reduction therefore has a positive socio-economic effect as well as a positive effect on the population health.

Figure 4.2 Example of urban area south of Stockholm with dense population and high traffic noise

5 REFERENCES

[1] Stenlund, F., Nilsson, N-Å., QCITY Deliverable 5.8-Part 2: *Quantification of driveline and tyre/road noise from a hybrid electric passenger car (Toyota Prius), 2008-11-26*

[2] Lundberg, O., Nilsson, N-Å., QCITY Deliverable 5.11 Part 2: Evaluation of the low noise DualQ tyre prototype, 2008-12-17