Managing Road Traffic Noise Cost-Benefit Analysis and Cost-Effectiveness Analysis

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Background

- Road noise is a major challenge for all national road administrations.
- Demands for noise-reducing measures along existing roads, at to integrate appropriate noise mitigation measures in the planning and construction of new roads.
- Money for noise mitigation measures is in general limited and the use of measures such as noise barriers are associated with high costs.
- For decision-makers and for society as a whole, it is **important to use available means in the best possible way**.
- A key challenge in managing environmental noise from an economic perspective is to balance the costs of noise for society with the costs of controlling noise
- Cost-benefit analysis (CBAs) and cost-effectiveness analysis (CEAs) may provide answers to such questions.

Background

- END states that noise action plans must include financial information (if available): budgets, cost-effectiveness assessment, cost-benefit assessment
- CBAs and CEAs and the monetisation of the unit costs of noise is a multi-disciplinary academic discipline in the intersection of economics, acoustics and health etc.
- Limited knowledge about concepts and use of CBA and CEA techniques throughout NRAs in Europe.
- Several NRAs don´t use CBA or CEA and don´t have available data for unit costs of noise
- The CEDR Noise Group have detected a need for improving knowledge and awareness of theories and techniques to carry out CEAs and CBAs in managing noise from roads

10 ways to combat NOISE POLLUTION

Implementation: Over 3,000 km of noise barriers have been installed alongside European rail networks. They are even more widely used alongside roads, including in Austria, Denmark, France, Germany, Italy, Poland, Spain & the Netherlands.

Implementation: European freight trains are being retrofitted with low-noise brake blocks. A complete ban on 'noisy' cast iron blocks is due to take place in Germany, the Netherlands & Switzerland in 2020.

Implementation: Traffic management strategies are widely used across Europe. In Paris & Valencia there is restricted access for heavy goods vehicles, while Annecy & Parma have implemented shuttle bus services to reduce private car use.

Implementation: A Norwegian study of façade insulation found an average noise reduction of 7 dB inside buildings & a 30% reduction in annoyance.

Implementation: Electric cars have the potential to reduce noise.

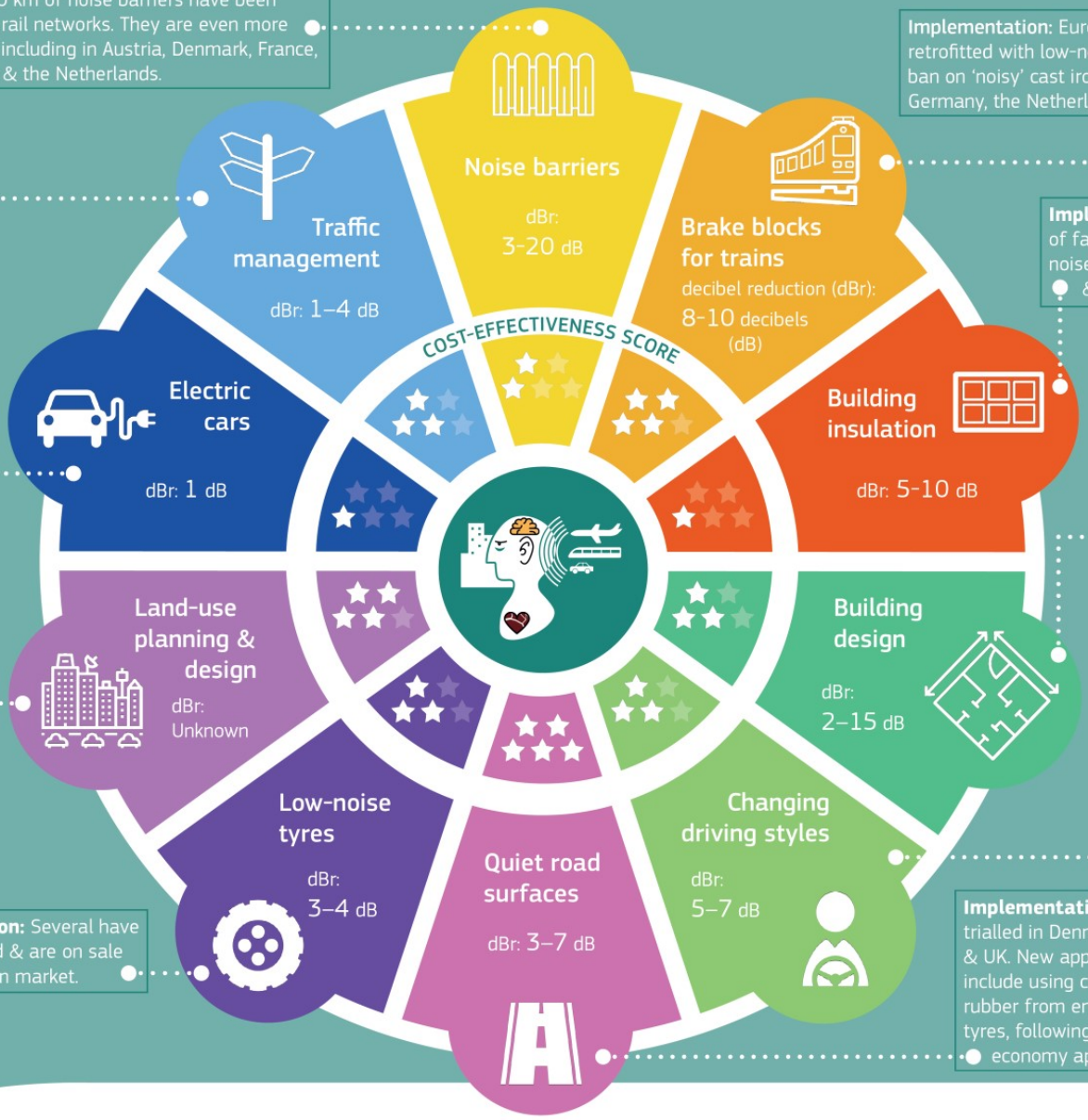
Implementation: It is unclear how widely acoustical architectural planning is used. Administrative action is needed for large-scale use.

Implementation: Computer models can predict noise exposure & identify areas unsuitable for development. No houses should be allowed under landing and take-off, for instance.

Implementation: Quieter driving could be incorporated into existing campaigns promoting 'eco-driving' to save fuel & reduce air pollution (e.g. http://www.ecodriver.org).

Implementation: Several have been developed & are on sale on the European market.

Implementation: Low-noise surfaces have been trialled in Denmark, France, Italy, the Netherlands & UK. New applications include using crumb rubber from end-of-life tyres, following a circular-economy approach.



For more information, see the **SfEP Future Brief, 'Noise abatement approaches',**
or sign up for the **Science for Environment Policy News Alert** at http://ec.europa.eu/science-environment-policy

Purpose

- To improve the knowledge and awareness of theories and techniques to carry out CEAs and CBAs in the handling of noise from roads.
- To introduce the general principles for carrying out CBAs and CEAs and the methodological background of evaluation noise impacts
- To provide examples of how such methods are used in different member countries.

The type of questions the report seek answers to are as follows:

- What is CBAs and what is CEAs and what are the differences in principle?
- What can CBAs and CEAs be used for with regard to noise planning?
- Why is it important for National Road Authorities (NRAs) to use CBA/CEA?

Content of report

- Introduction to the general principles for carrying out CBAs and CEAs and the methodological background of evaluation noise impacts
- Introduction to methods to monetise social costs of noise
- Practical examples use of CBA and CEA in different European countries
- Conclusions and recommendations

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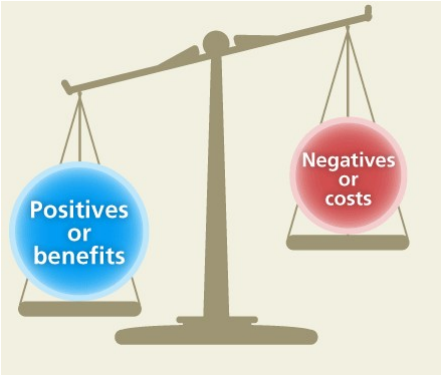
Definitions – CEA and CBA

- **Cost-effectiveness analysis (CEA)**
  Seeks to identify and place monetary value on the costs of a programme. Relates these costs to specific measures of programme effectiveness.

$$Cost\text{-}Effectiveness\ Ratio = \frac{Total\ Cost}{Units\ of\ Effectiveness}$$

- **Cost-benefit analysis (CBA)**
  A method for establishing the monetary value of all the benefits and disbenefits experienced by all parties in a (national) society as a result of a given project being implemented

$$Net\ Benefits = Total\ Benefits - Total\ Cost$$

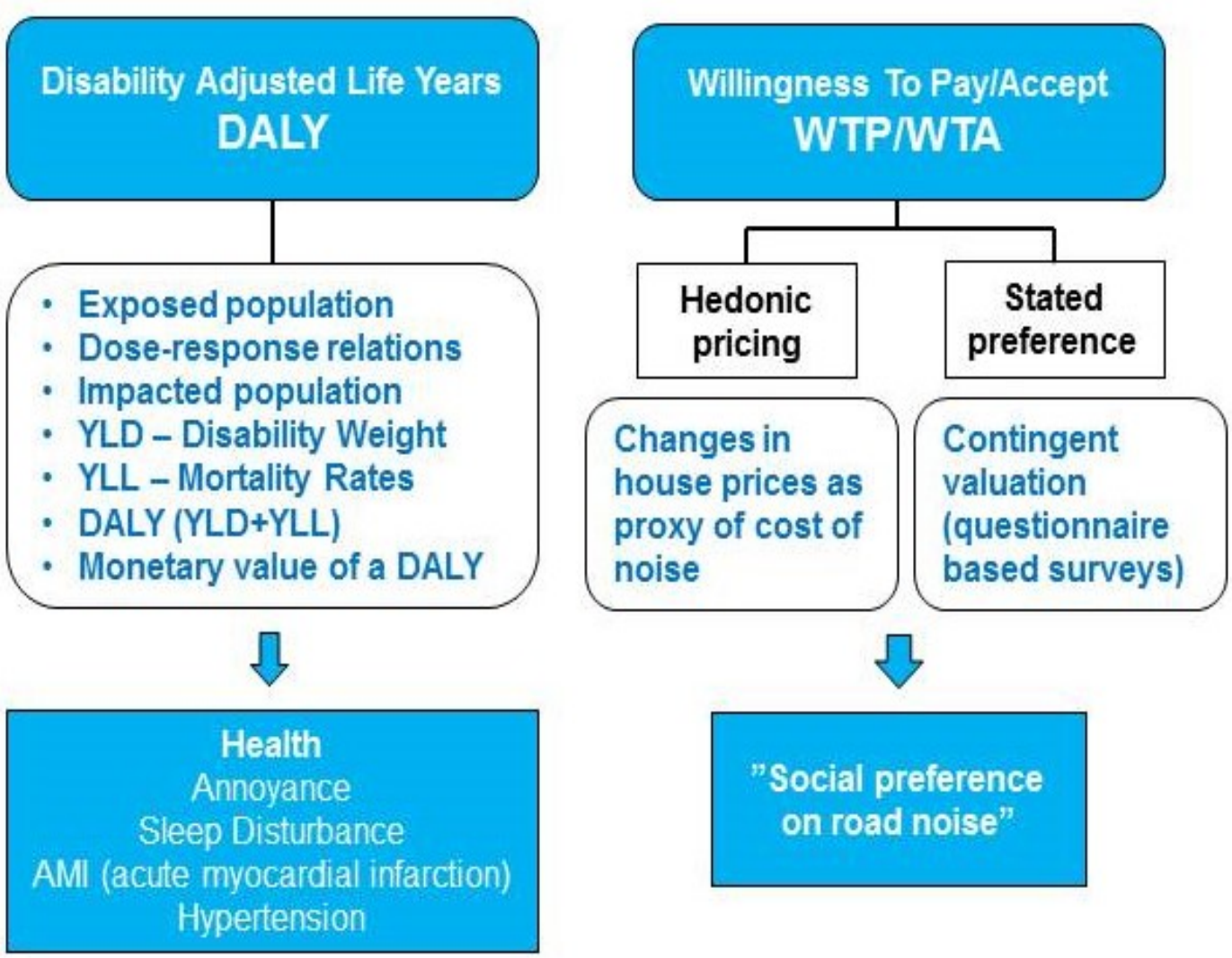


Cost-benefit components and elements in road planning

Overview of main issues per cost category (RICARDO-AEA, 2014).

Cost-benefit component	Cost-benefit elements
Construction costs	Direct costs of the project
Congestion costs (road)	Time and operating costs Additional safety and environmental costs
Accident costs	Medical costs Production losses Loss of human life
Air pollution	Health costs Years of human life lost Crop losses Building damage Costs to nature and biosphere
Noise costs	Annoyance costs Health costs Rent losses
Climate change	Prevention costs to reduce risk of climate change Damage costs of increasing temperature
Costs to nature and landscape	Costs to reduce separation effects Compensation costs to ensure biodiversity
Additional environmental costs (water, soil)	Costs to ensure soil and water quality
Additional costs in urban areas	Separation costs for pedestrians Costs of scarcity of non-motorised traffic

Different approaches for monetising the effects of road noise on health and quality of life



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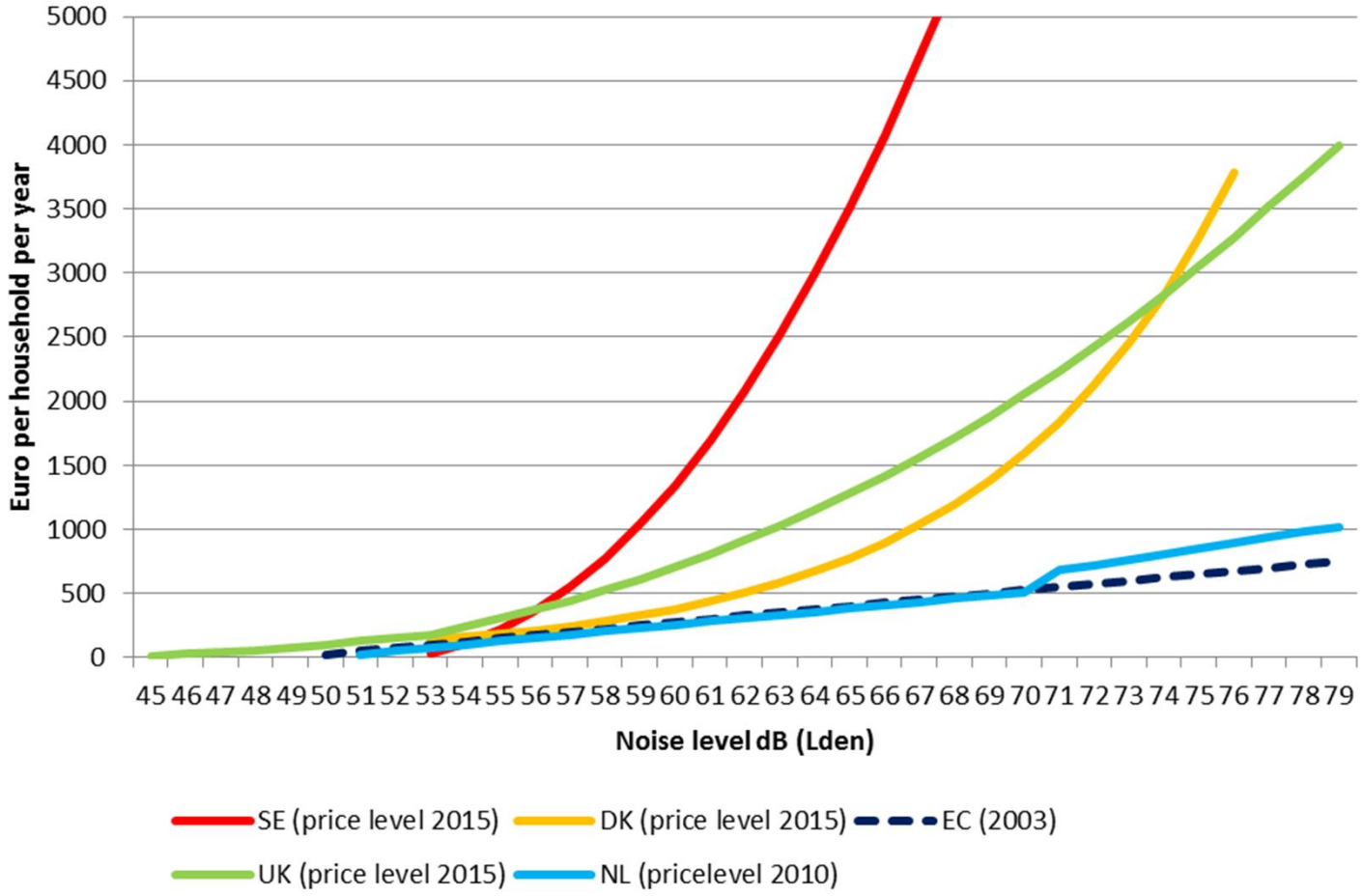
The costs of 1 dB???

Unit cost for road noise for four different countries and the recommended EC value from WGHSEA (2003) Valuation of noise. Position paper[1)]



[1)]The Swedish cost factors, determined in LAaeq,24h and euros per person, are adjusted by assuming that Lden-values are 3 dB higher than LAeq,24h-values and by presuming that there are two persons per household. The values from the Netherlands are also based on the assumption that there are two persons per household. The UK values use the UK noise indicator LAeq,18h instead of Lden (LAeq,18h may differ approx. 0.5 dB from Lden).

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Figure 30 Total costs for noise for two alternatives.

Valuing costs of noise in road projects in DK, NO and NL

- Same methodology BUT different unit costs of noise
- Calculating noise costs before and after intervention
- Calculating noise levels at each dwelling in the area of study
- Calculating noise level at each dwelling multiplied by unit cost per dB

Figure 30 Total costs for noise for two alternatives.

noise band (in dB Lden)	final price € per noise band per person per year	shift in number noise annoyed people alternative 1	costs or benefits for noise (in € per year)	shift in number noise annoyed people alternative 3	costs or benefits for noise (in € per year)
40 - 45	76	-39	2.976	51	-3.891
45 - 50	229	1	-229	-66	15.107
50 - 55	382	-201	76.682	-50	19.075
55 - 60	534	75	-40.058	-13	6.943
60 - 65	687	-244	167.555	-123	84.464
65 - 70	839	-197	165.342	-84	70.501
70 - 75	992	-53	52.571	0	0
> 75	1145	7	-8.012	0	0
total costs for noise			416.827		192.200
present value (in M€)			6,78		3,13

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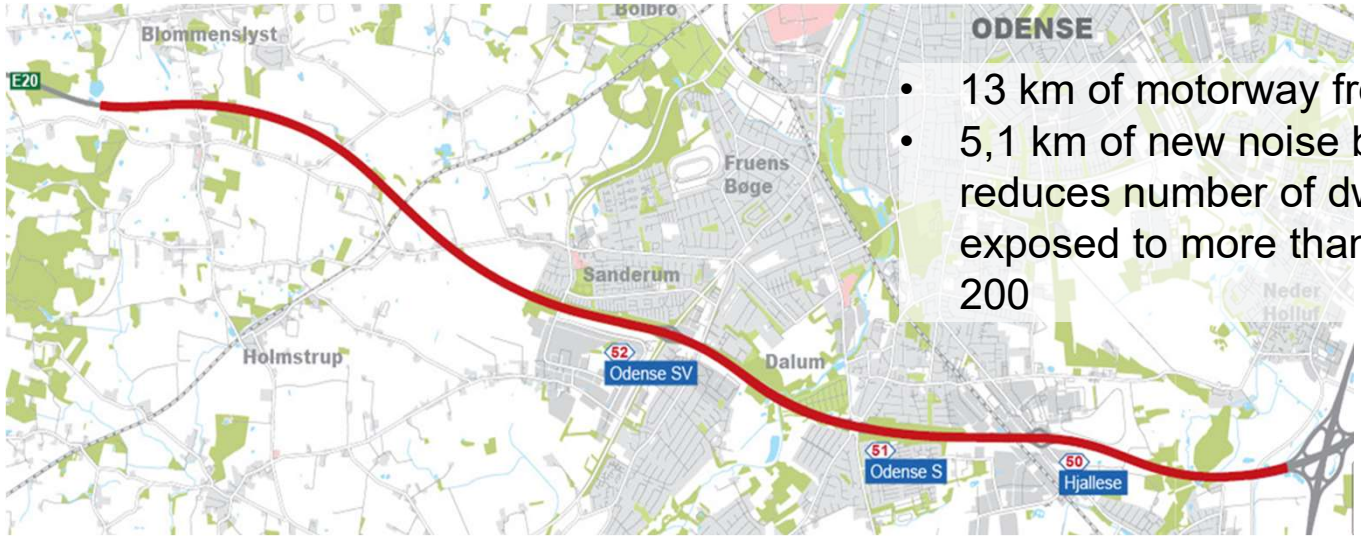
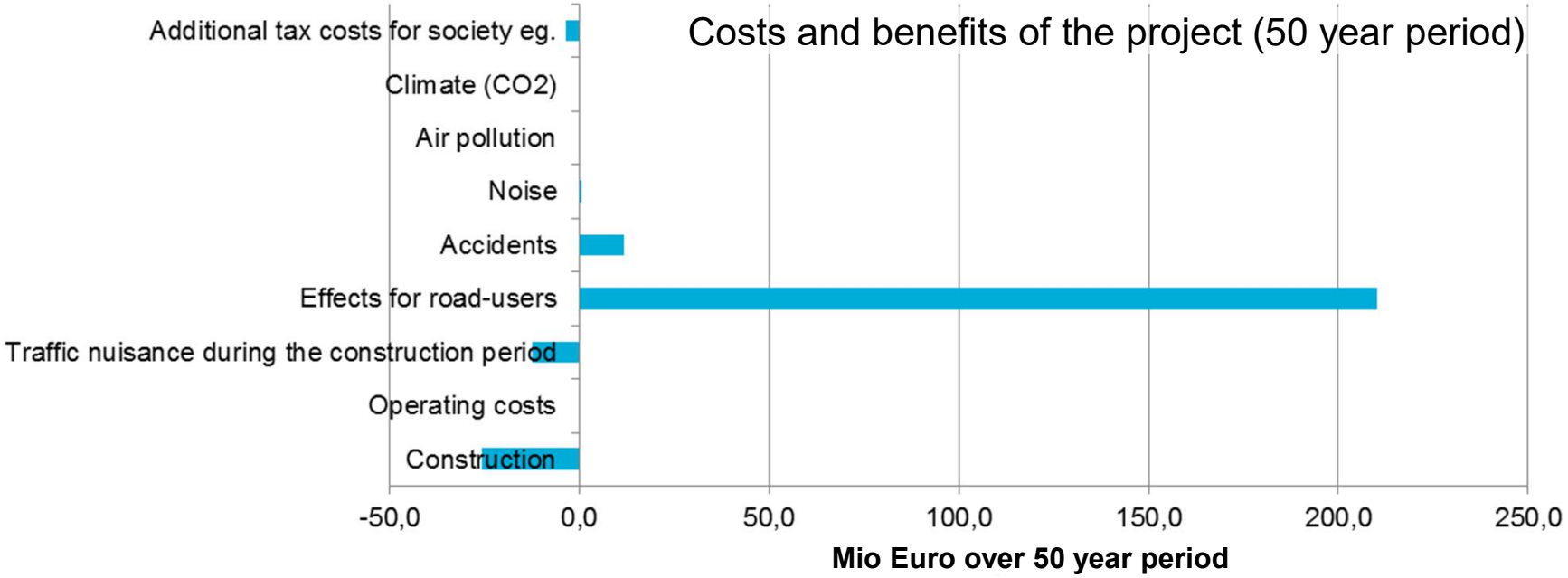
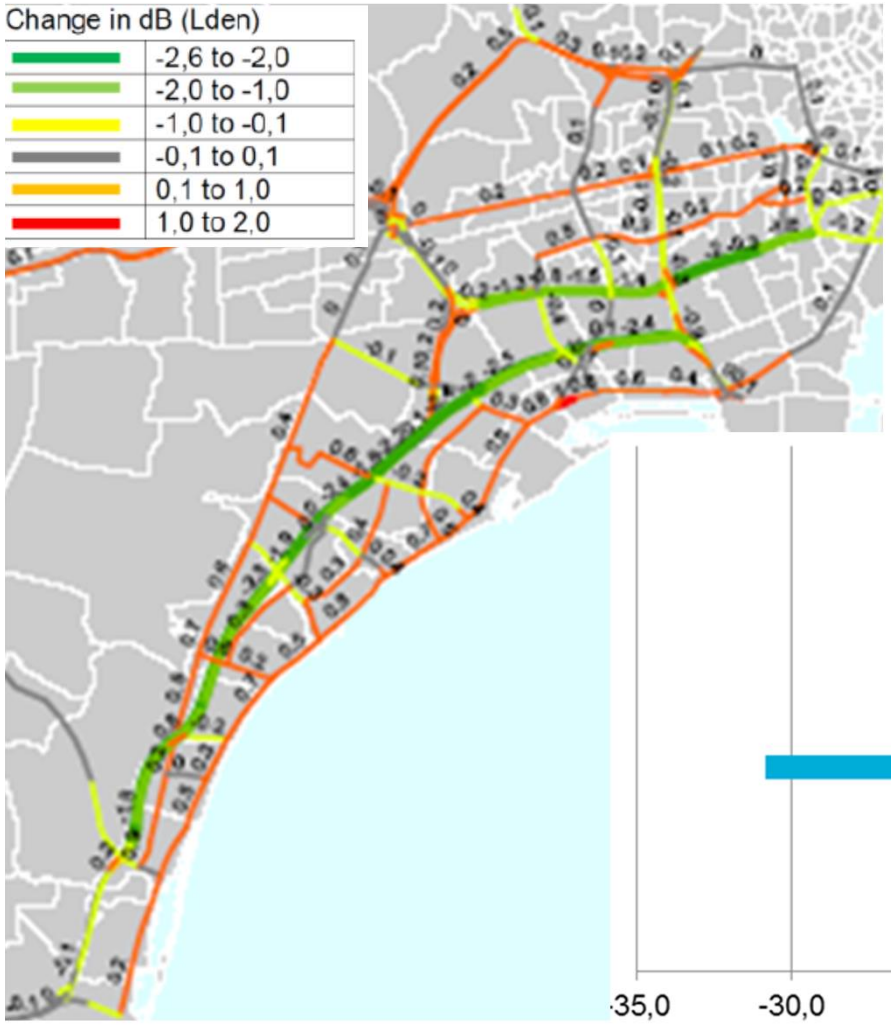
Example 1 – Enlargement of a motorway
Main purpose: To counteract traffic congestion



- 13 km of motorway from 4 to 6 lanes
- 5,1 km of new noise barriers => reduces number of dwellings exposed to more than 58 (Lden) by 200



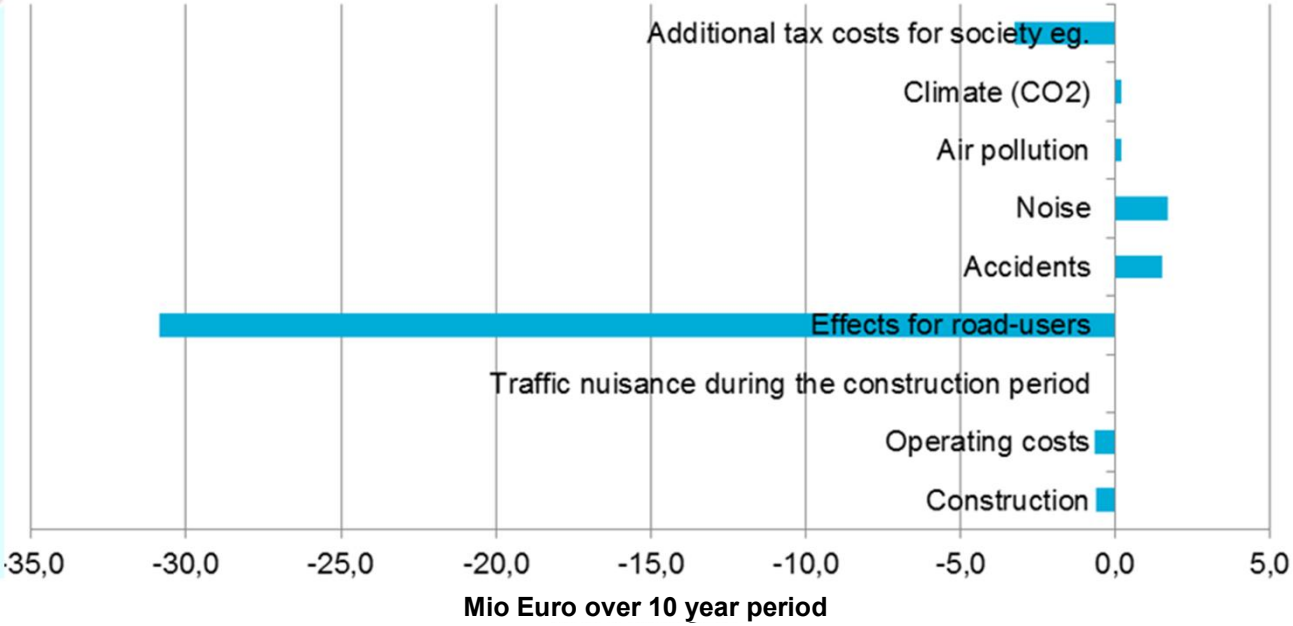
Example 2 – Speed reduction on motorway to CPH
Main purpose: To reduce noise



Reduction of noise emission due to reduced speed limit from 110 to 80 km/h in the evening and night time periods on weekdays and all day at weekends.

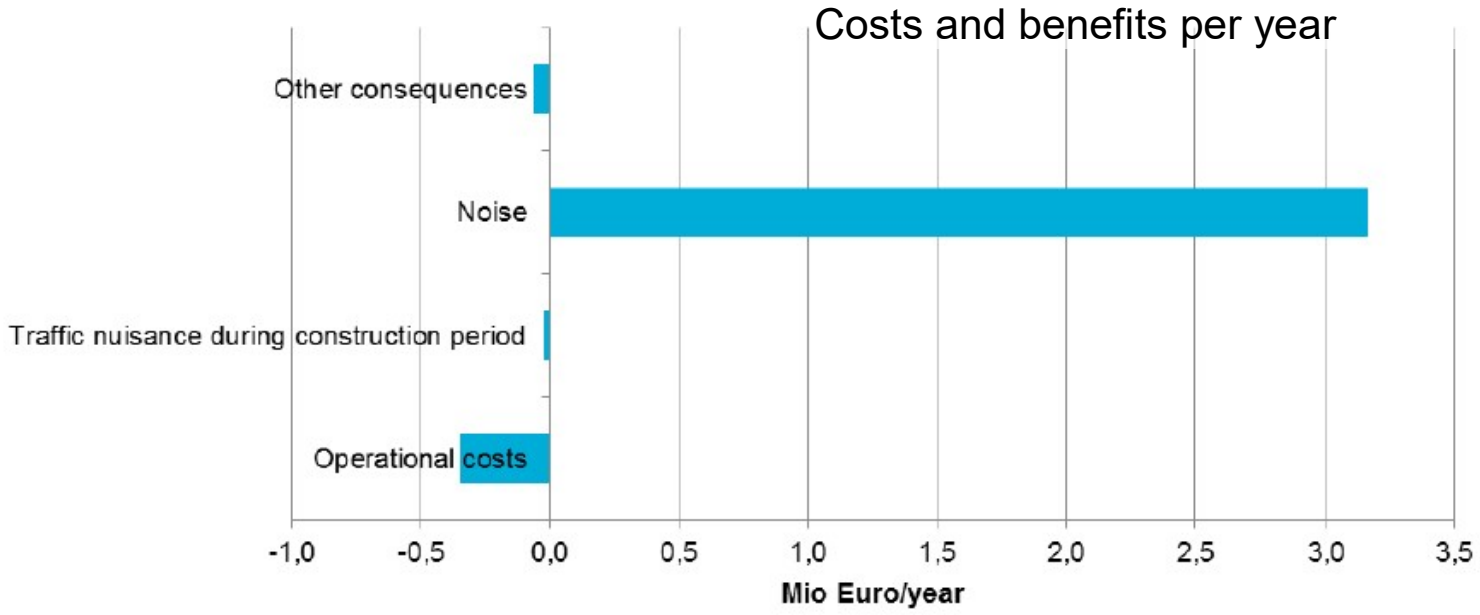
Approx 40 km of motorways
Approx 100-150,000 vehicles a day
Approx 40,000 dwellings exposed to noise > 58 dB (Lden)

Costs and benefits of the project (10 year period)



Example 3 – Noise reducing asphalt
Main purpose: To reduce noise

- Increased operational cost due to more frequent maintenance
- (les extent) delays for road users because of more frequent roadworks
- Noise-reducing asphalt leads to economic gains in the form of less noise in the surroundings



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Cost-Benefit Analyses – when to use, advanges/disadvantages

When to use?	• Useful in analysing a programme, project or policy to determine whether the total benefits exceed the costs, • To compare alternatives to see which one achieves the greatest monetary benefit.
Advantages	• The analysis can predict whether a given action gives a reasonable use of financial resources.
Disadvantages	• Often difficult to place monetary values on all costs and benefits. • In particular – appears to be considerable uncertainty on the unit costs used in the monetisation of noise • Doesn´t capture whether the advantages and disadvantages of a project are socially desirable (eg noise barriers rarely provide a socio-economic benefits – still it seems reasonable to invest in noise barriers)

Cost-effectiveness analysis

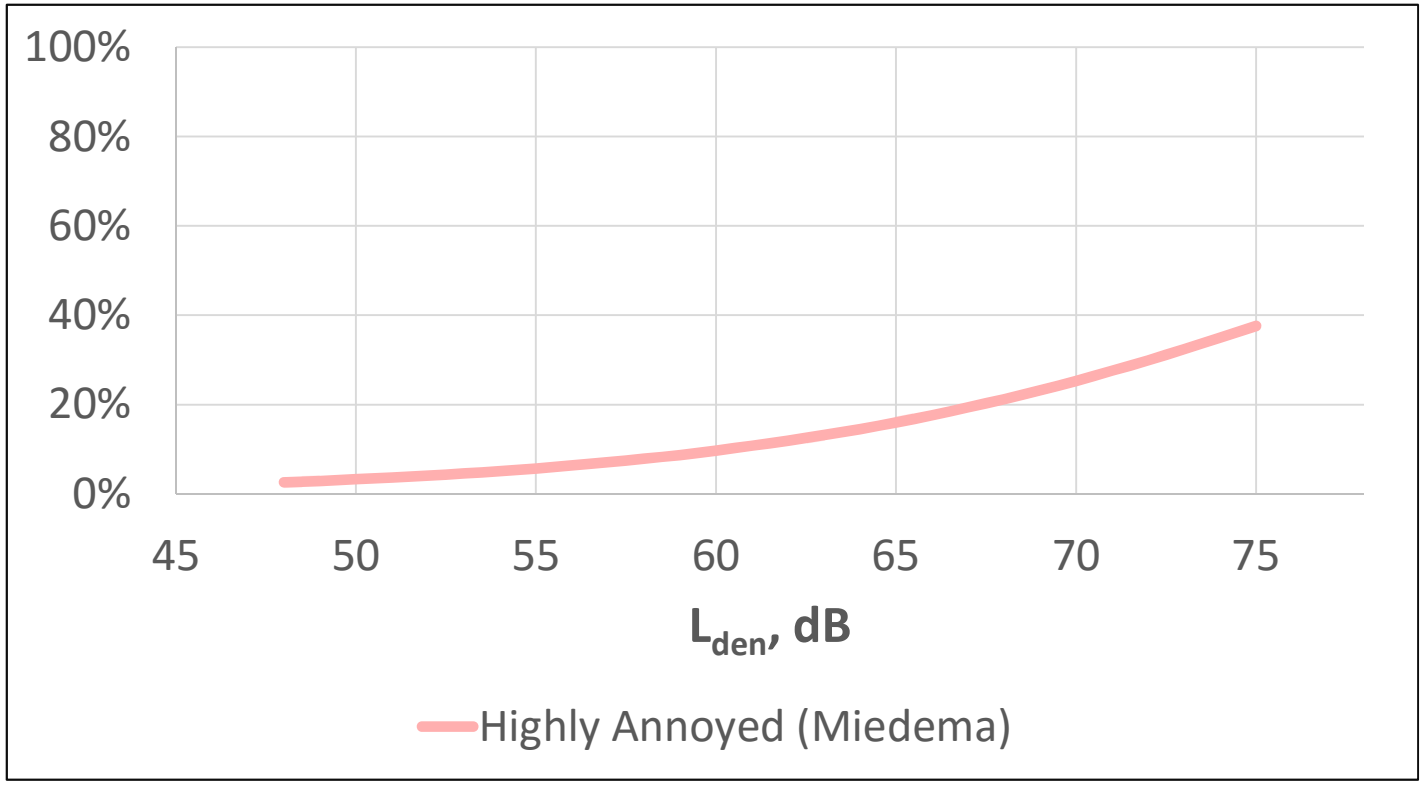
- Useful to determining which of a set of alternative programs or projects achieves the greatest outcome for the cost. For example, if the objective is reduction of noise nuisance compared to direct costs of noise reduction measure, then CEA can be a helpful tool.
- Beneficial in comparing interventions, eg
    - To compare the effects and costs of a specific noise mitigation measure in different noise exposed areas (hot spots)
    - To compare different interventions in order to reduce noise in a specific noise-exposed area.
- In case a CEDR member country has no CEA, it is recommended to use the following simple method based on comparing the total costs of noise reducing measures with shift in the total noise annoyance in an area before and after an intervention.

Recommended procedure

1. **Calculate** for each alternative the **total costs** of the noise reducing measure(s).
2. **Calculate** for each alternative the **number of people exposed** to noise levels at their dwellings **before** and **after** the **intervention**
3. **Calculate** for each alternative the **number of highly annoyed people** by multiplying the percentage of highly annoyed at different Lden levels **before** and **afte**r the **intervention**
4. **Calculate** for each alternative **the shift** in the total number **of highly annoyed people** before and after intervention = Δ total highly annoyed people
5. **Calculate** for each alternative **the cost-effectiveness ratio**: total costs / Δ total highly annoyed people

Dose-respons relationship

- The percentage of highly annoyed (% HA) people at a certain Lden noise level is given in this formula:
- % HA = 9.868 * 10–4 * (Lden – 42)3 – 1.436 * 10–2 * (Lden – 42)2 + 0.5118 * (Lden – 42)



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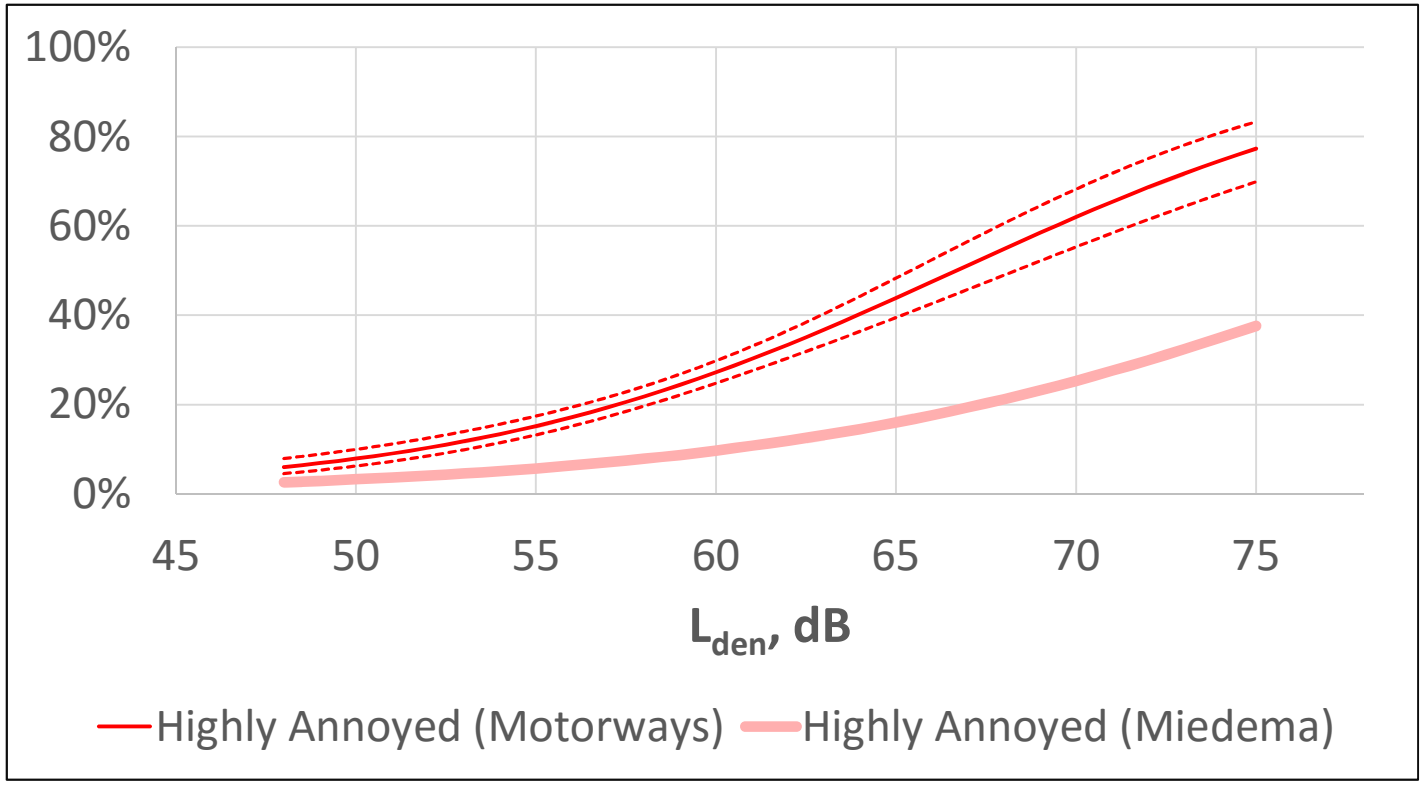
Dose-respons relationship

- Several studies show that people living along motorways are more annoyed than indicated by Miedema
- New Danish dose-response curves for motorways compared with Miedema curves for Highly Annoyed people at different Lden levels



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Policy for prioritising noise barrier projects along the national road network in DK

- Priority to residential areas where noise exposure is highest and the invested funds give the most noise reduction for money.
- ´hot spot´ area: at least one dwelling > 65 dB
- At least a 3 dB noise reduction (Lden)
- The total noise annoyance reduction for each ´hot spot´ area is calculated
- $\Delta Annoyance = A_{present} - A_{after}$
- Estimation of construction costs for each noise barrier project (EUR)
- $$Cost\text{-}Effectiveness\ Ratio = \frac{Total\ Cost}{\Delta Annoyance}$$
- Noise barrier projects where cost efficiency is the highest is given the highest priority

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Cost-Effectiveness Analysis – when to use, advanges/disadvantages

When to use?

- CEA is useful in determining which set of alternative programs or projects achieves the greatest outcome for the costs.
- Use CEAs to ensure that valuable resources are being allocated in the best possible way.

Advantages

- CEA can be beneficial in comparing interventions, in particular when policy makers e.g. want to:
  - compare the effect and costs of a certain noise mitigation measure in different noise exposed areas (hot spots)
  - To prioritise efforts where the most noise reduction for money is possible;
  - compare different interventions in order to reduce noise in a specific noise exposed area

Disadvantages

- The major difficulty with CEA is that it provides no value for the output, leaving that to the subjective judgment of the policy maker

Recommendations for CEDR

- Focus areas for future improvements are:
- Achieving better knowledge of the costs factors for road traffic noise by adding this issue to future CEDR research topics;
- Investing in the dissemination of knowledge of using cost-benefit analysis and cost-effectiveness analysis for more effective noise abatement
- If a CEDR member country has no methology for CBAs or CEAs the technical report provides examples of CBA and CEA, that can be used after some adjustments to the national context

THANK YOU FOR LISTENING

Download the report:
http://www.cedr.eu/download/Publications/2017/CEDR-TR2017-03-Noise-CBA-CEA.pdf

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