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Norwegian Centre for Transport Research

Norwegian approach for assessing the costs and benefits of adaptation measures in the transport sector

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Presentation

- Cost Benefit Analyses in transportation sector
- Cost effectiveness vs. cost efficiency
  illustrative example
- Insights from 7th FP project EWENT on impacts of extreme weather events, and socio-economic costs

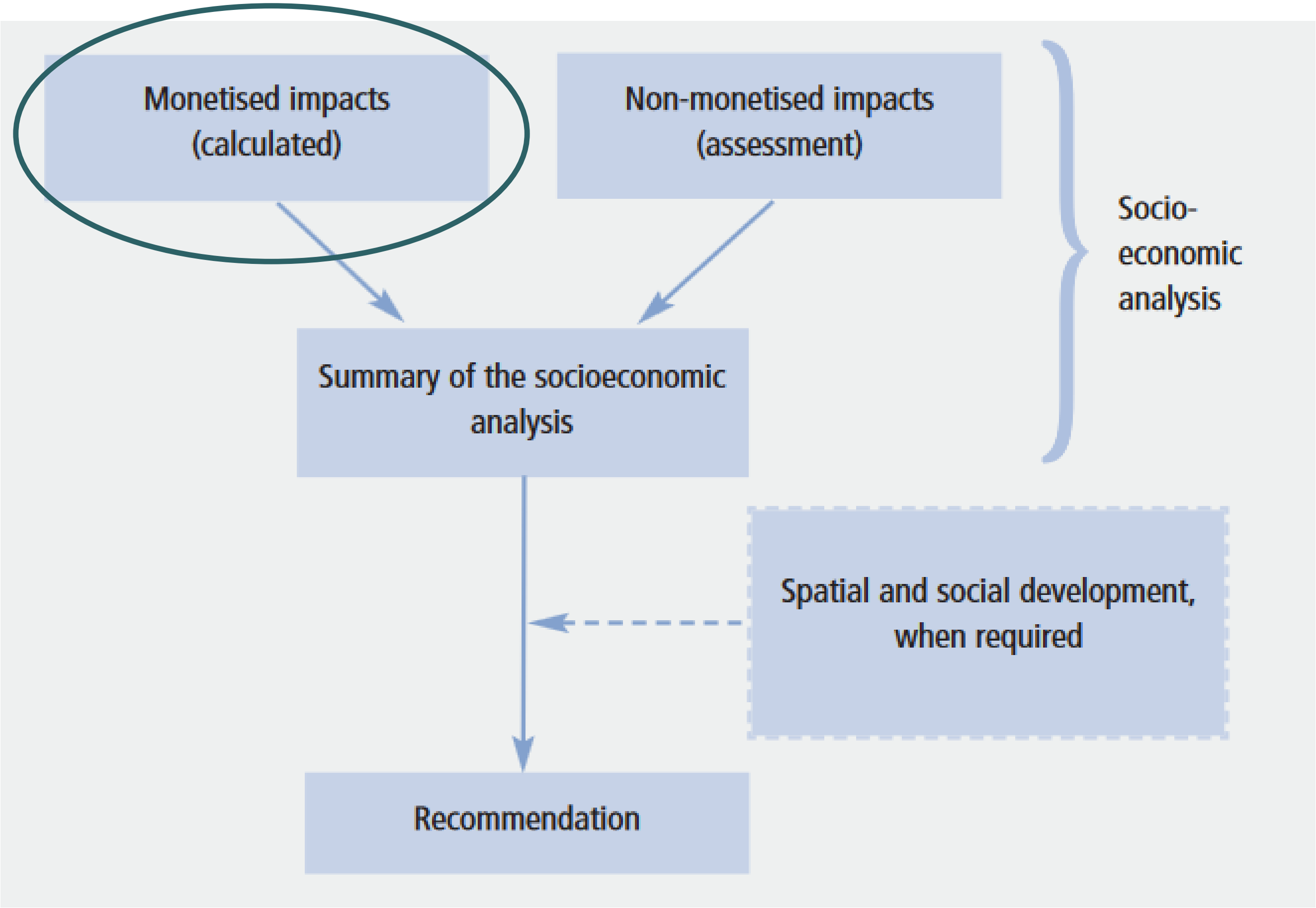
CBA is prescribed for assessing transport investments

- Norwegian Transport Plan expects transport agencies to motivate their investments based on Cost Benefit Analyses
    - *Current period 2014-2023, next 2018-2029*

- CBA is a comprehensive effort to assess and weigh together all cost and benefit components associated with public investments

- Objective is to determine whether society is better off with the measure, and whether it should be implemented or not

Impact assessments - parts



Monetised components

Participant	Main theme	Sub-theme
Transport users	Benefit for transport users	Time, distance dependent travel costs, other travel expenses, costs due to inconvenience with ferry connections, health effects due to increased physical activity (pedestrians and cyclists), unsafe conditions for pedestrians
Operators	Operator benefit	Operating company's (public transportation companies, road toll companies, ferry companies, parking companies) costs, user income and subsidy/transfers
The government	Budget effect	Investment, management, maintenance, subsidy to public transportation, tax income
Third parties	Traffic accidents	Accidents with personal injury and material damage
	Noise and air pollution	Indoor noise. Local, regional and global air pollution
	Residual value	Benefit of initiative beyond the appraisal period, calculated as the residual value of the investments
	Cost of government funds	Loss of efficiency due to tax financing, 20% of governmental costs

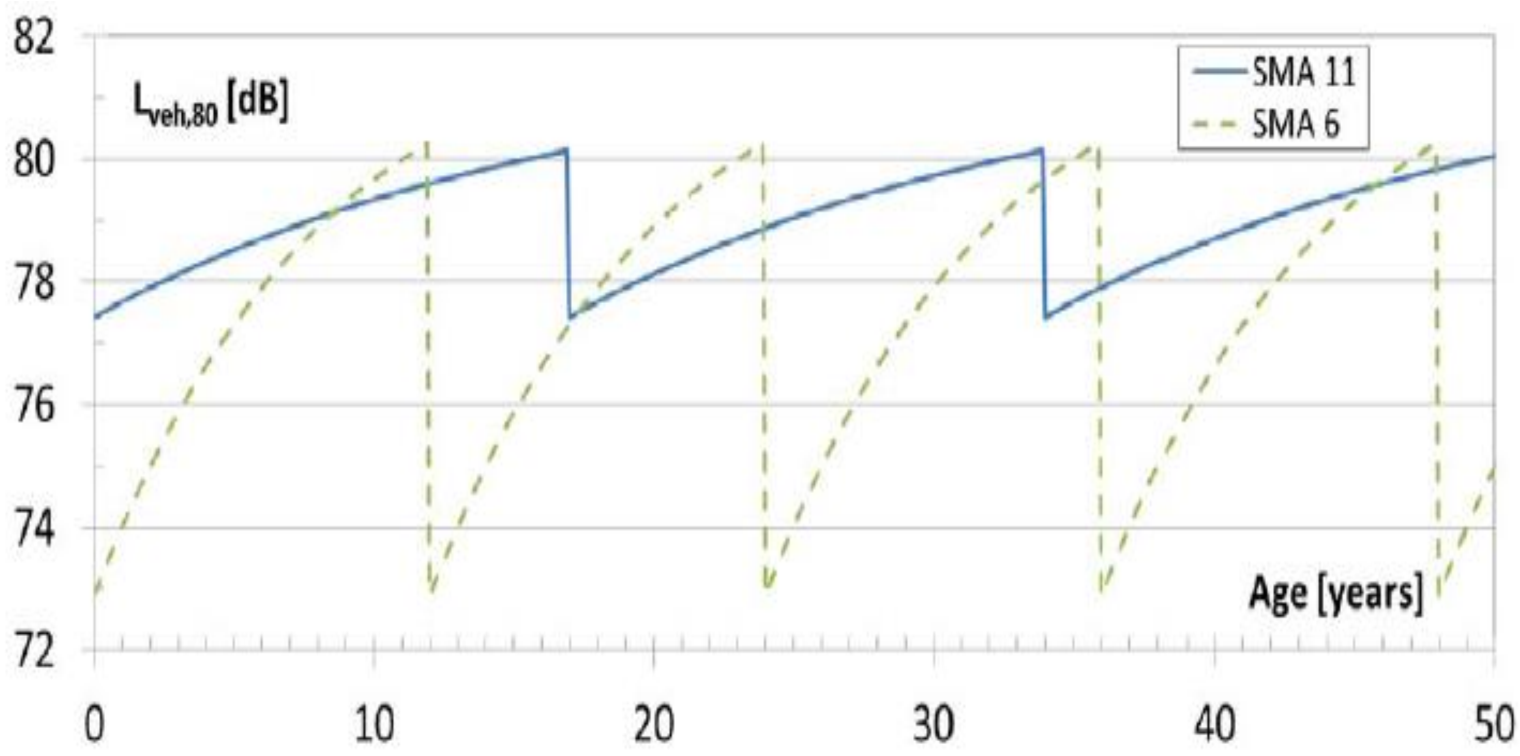
Principles of CBA-analyses

- The impacts based on the difference between without-scheme and with-scheme forecast (Focusing on net differences means that many aspects can be disregarded)
- Consequences are thus related to current situation and what would happen when doing nothing more than previously decided in the baseline «Zero» alternative
- Impacts assessed over a defined appraisal period, capturing scheme development and implementation and typically ending 25-60 years after scheme opening
- The magnitude of impacts should be interpolated and extrapolated over the appraisal period, drawing on forecasts for at least two future years

Principles …

- Values placed on impacts should be converted as appropriate from factor costs using the indirect tax correction factor
- Values should be in real prices, accounting for the effects of inflation
- Streams of costs and benefits should be given in present values, discounted to the base year
- Results should be presented in the appropriate cost-benefit analysis metrics, normally a benefit-cost ratio (BCR)
- Sensitivity testing should be undertaken to reflect uncertainty

Durability important for overall cost

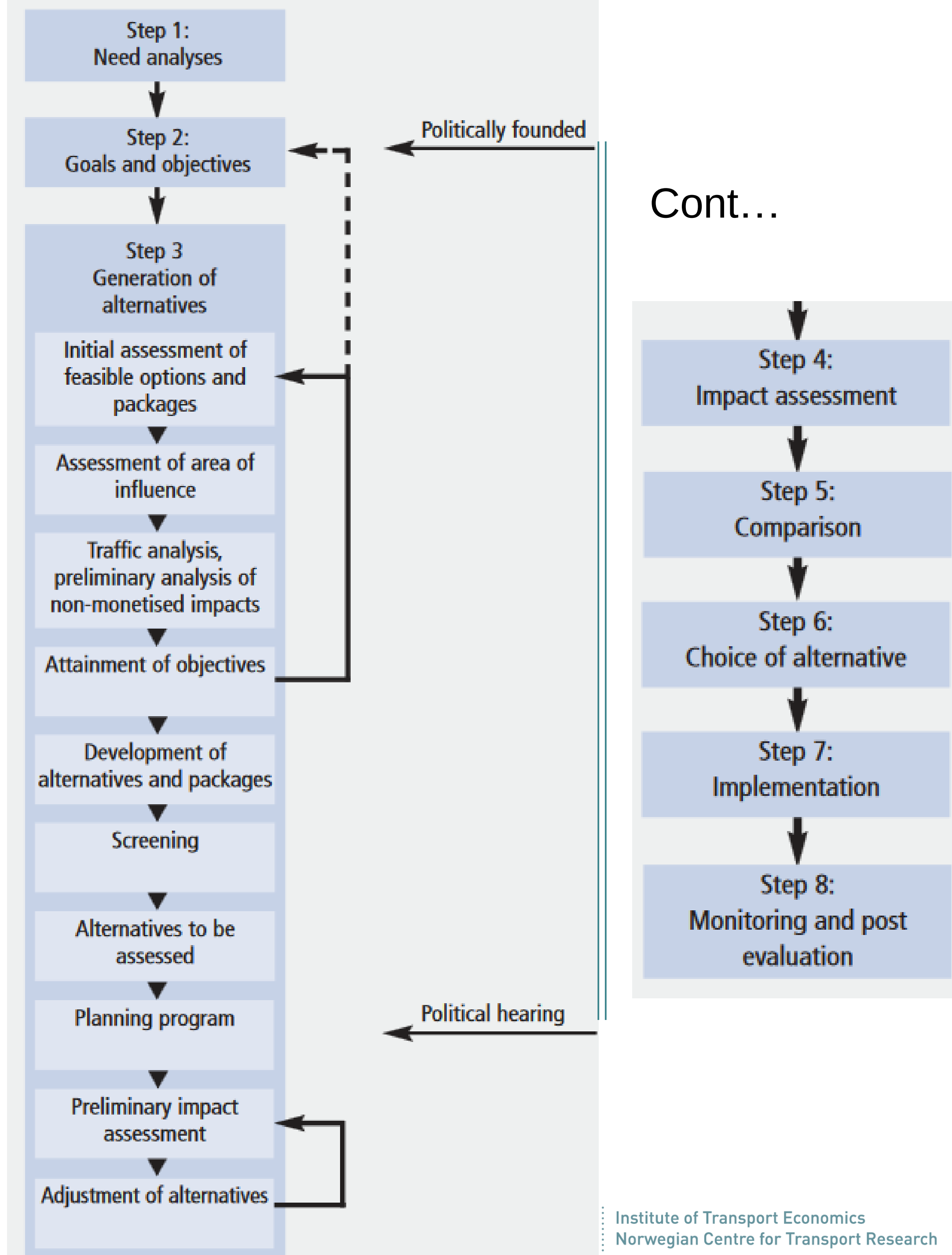


STEPS: Project impact assessment

The basis for comparison

The impacts of a project can be identified when comparison is made between the predicted state of the environment for scenarios with and without the project. In other words a reference scenario (baseline) is needed in order to to say something about the impacts of the project.

The reference scenario, which all alternatives are compared to, is called Alternative 0. A description of Alternative 0 assumes the present situation, and superimposes the expected changes which would take place without the project over the appraisal period of the project. In general it is only traffic growth and any planned/committed developments which differ between Alternative 0 and the current situation.

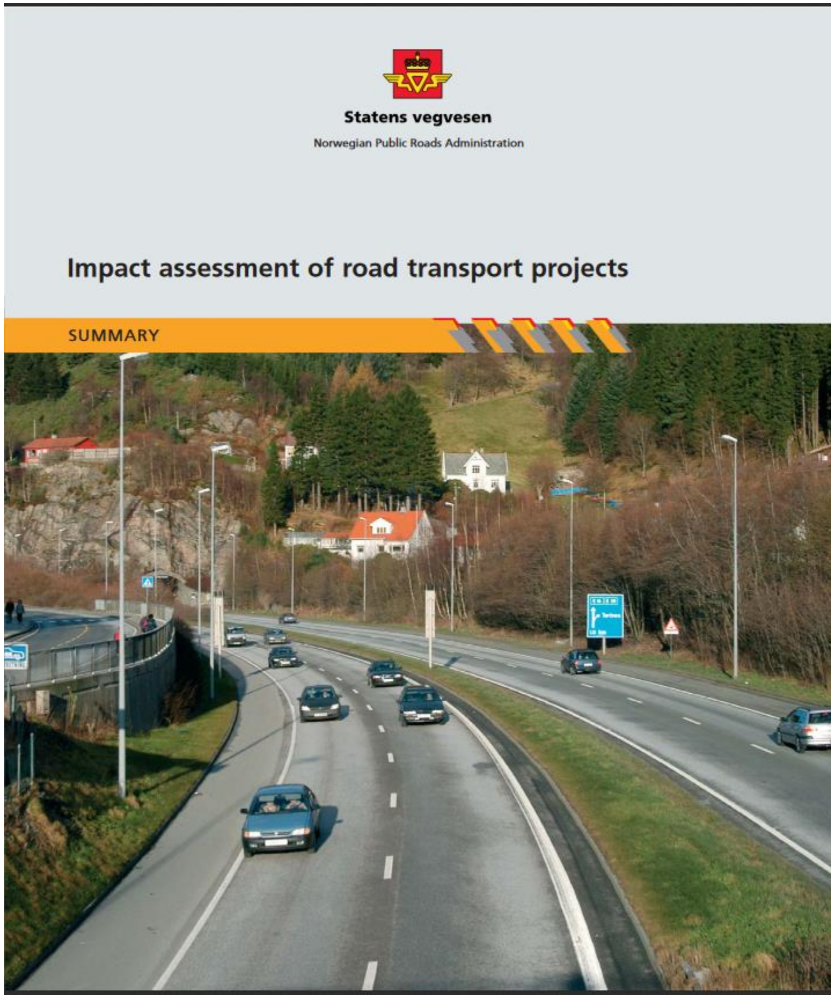


Transport models/traffic forecasts

- What is base-line growth rates (population composition, growth in income, access to car (cars owned, # licenses)
- Does the area served by the investment attract new businesses and people – or is it an area that people move away from
- Travel frequency considerations – will people refrain from travelling due to cost, or increase due to improved connectivity
- “Modal split” considerations – will people transfer from one means of transport to another
- How does effects propagate in the transport system

CBA is an artform but quite rough!

Handbook of impact assessment



http://www.vegvesen.no/_attachment/61439/binary/14146

Cost Effectiveness

- Choose the least costly alternative satisfying the desired objective
- Compare €/unit improvement– we want this figure to be as **SMALL** as possible
- Advantages:
  - *We need less information*
  - *Can be used where no valuations are readily available*
- Disadvantages:
  - *Disregards other benefits*
  - *No time penalty*

Cost Benefit Analysis

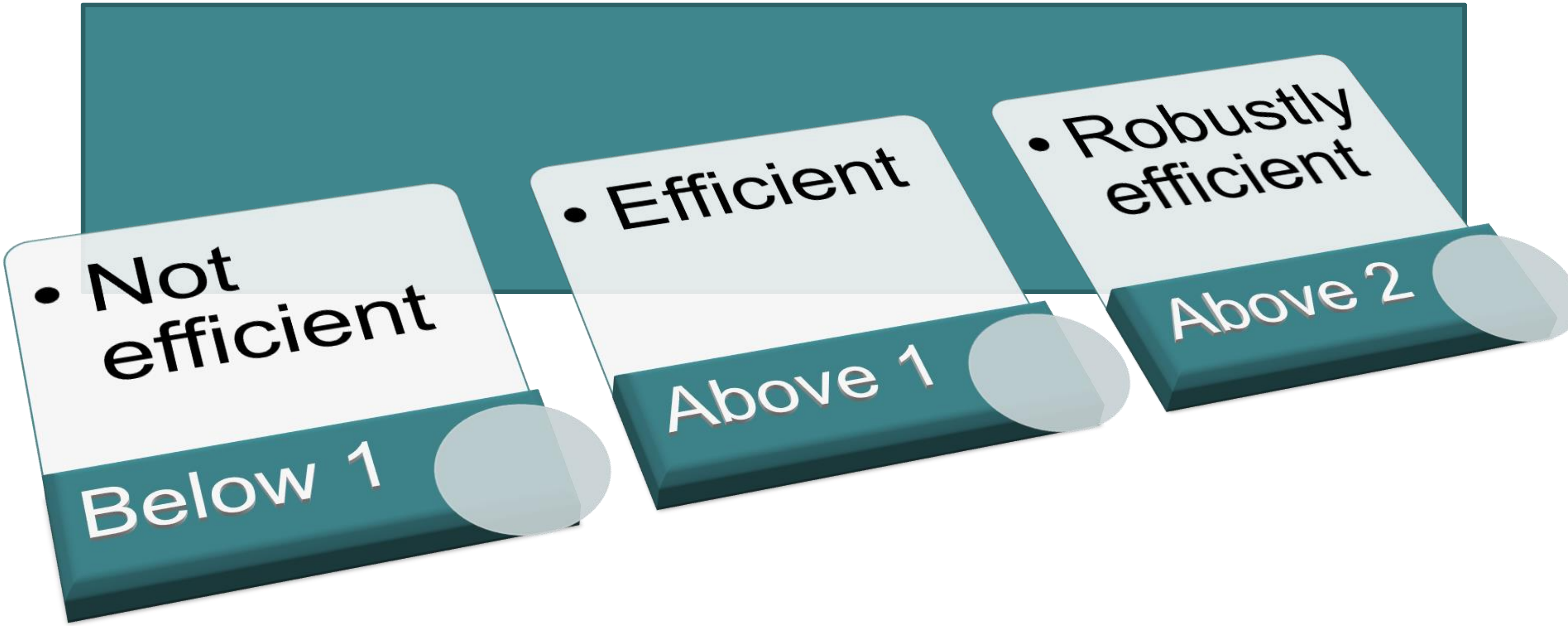
- Benefits are valued against costs
- B/C Ratio = Σ(Benefits in €)/Σ(Costs in €)
- We want this figure to be as **BIG** as possible

- HOSANNA Tool values solutions with a mix of attributes
- Friction, Noise, Local emissions, CO_2, splash, wear)

- Barriers aesthetics
- Maintenance efforts (upkeep, cleaning)

- Disadvantages:
  - *Valuation for important benefits/beneficiary groups lacking*
  - *Valuations may be based on indicators not easily available*
  - *Relevant unit costs may be difficult to obtain*
  - *Deterioration rates and performance data are not recorded*

Benefit/Cost Ratio – Three areas



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New regulation noise pollution

Transport sources became subject to pollution regulation
From 2005: Indoor noise levels must not exceed 42 dB(A)

➔ National effort from the Public Road Authorities to insulate the façades of 2,500 dwellings

➔ Since façade insulation cost € 28,125 per dwelling – what is the cost effectiveness and cost efficiency?

➔ Could a mix of façade insulation and low noise road surfaces be better – from an economic point of view?

Assumptions

At least two dwellings along same road exceeds new limit ➔ densely populated area (30% of the dwellings)

Length: 1 km
Speed: 60 km/h
Traffic: 12 000 AADT
Households: 300

Time horizon: 25 years, tax cost 20%, 4.5% annuity, 2.2 person/dwelling

Table 1- Results from the cost-effectiveness and cost-benefit analyses.

	Alternative 1	**Alternative 2**	Alternative 2 components	
		Asphalt/Façade	Façade 70%	Asphalt 30%
Dwellings affected	2,500	55,750	1,750	54,000
Noise-control benefits	12,423,693	136,026,766	8,696,585	127,330,181
Other benefits (PM_{10})	0	75,748,024	0	75,748,024
Sum benefits	**12,423,693**	**211,774,790**	8,696,585	203,078,205
Costs	**84,375,000**	**159,604,214**	59,062,500	100,541,714
Net benefits	**-71,951,307**	**52,170,577**	-50,365,915	102,536,491
Cost-effectiveness ratio/dwelling	**33,750**	**63,842**		
			Low noise asphalts	
			"Do nothing"	**Facade ins.**
Benefit-cost ratio	**0.15**	**1.33**	**2.02**	**2.65**
In percentages	**15%**	**133%**	**202%**	**265%**
40 years/3%/Adjusted PM10/no tax costs	18%	101%	149%	192%

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Conclusions – Effectiveness vs efficiency

- In the Norwegian single objective situation, façade insulation was the most cost effective solution, but not the most cost effective (BCR=0.15 << 1)

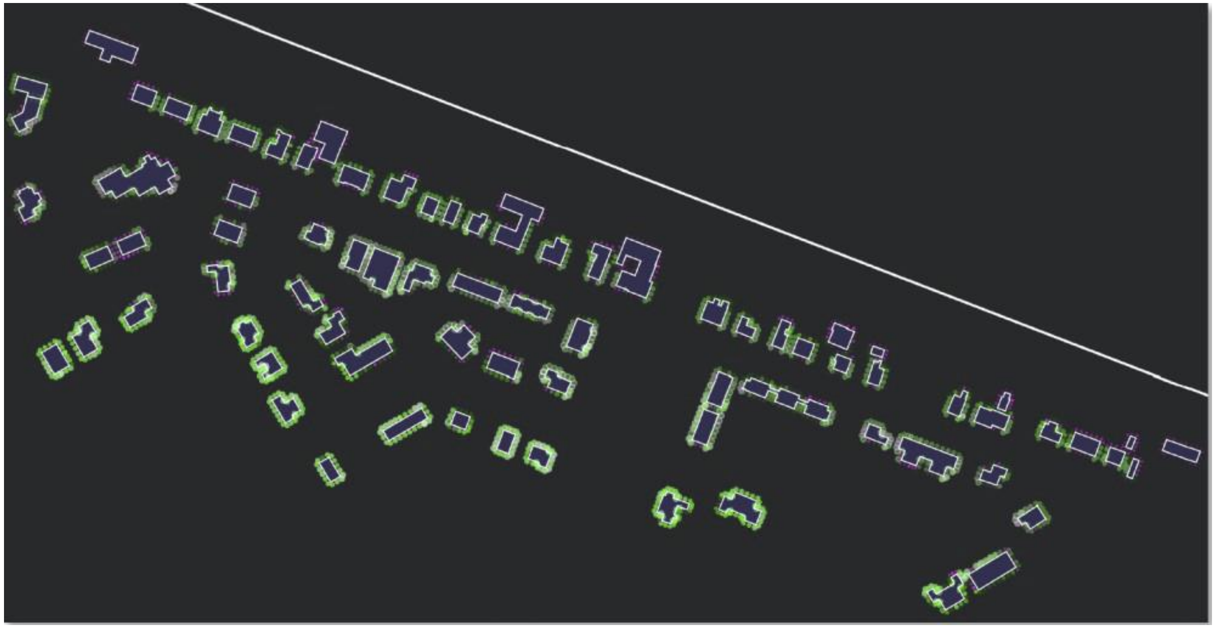
➔When the goal is to make effective use of public resources other measures should be considered.

➔A mix of 30 percent low-noise asphalts and 70 percent façade insulation gives a benefit-cost ratio of about 1.3.

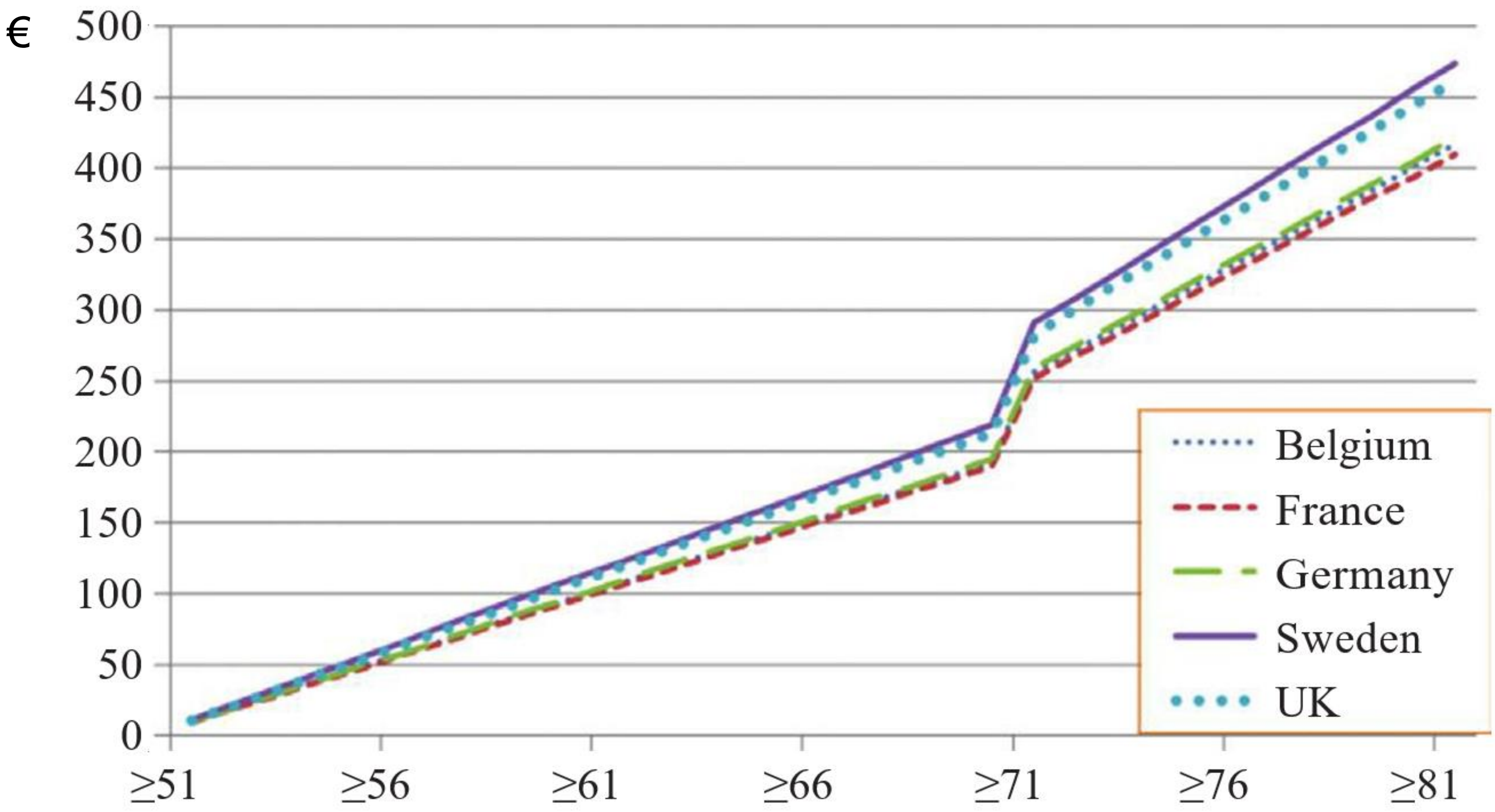
What level of effort is appropriate ?
– Example from 7th FP HOSANNA

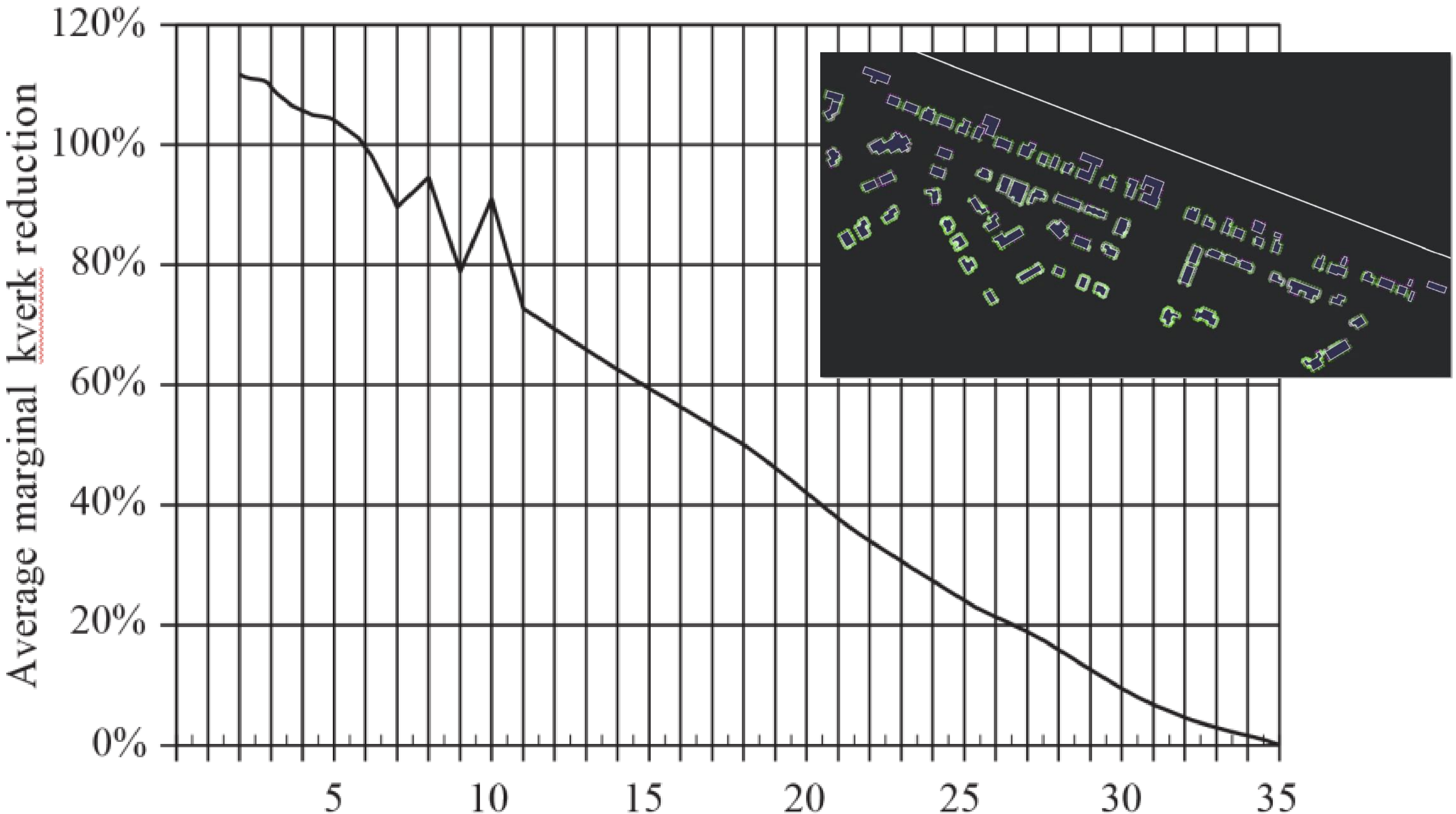
Brick lattices (generates noise interference)

See: Environmental methods for transport noise reduction. Taylor and Francis. CRC Press.

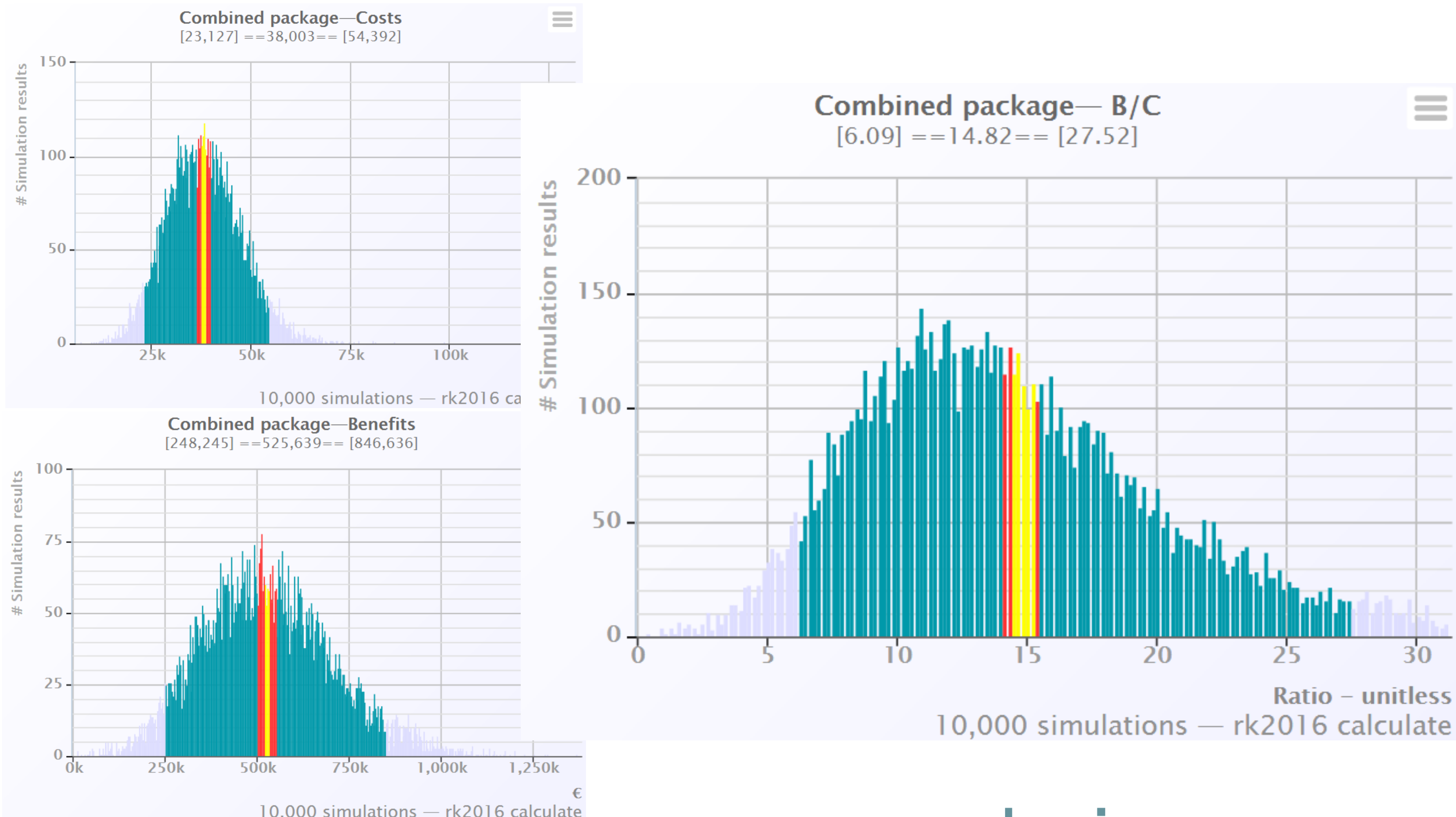


Heatco valuation of noise




120%
100%
80%
60%
40%
20%
0%
Average marginal kverk reduction
5
10
15
20
25
30
35

Taking uncertainty into account



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Advantages of economic analyses

- Considers the whole project period
- Balances efforts vs gains – (easier said than done)
- What are time savings worth? How do we value fewer accidents and lives saved? What are the noise costs?
- Difficult for practitioners to determine when enough is enough (when to stop)
- What is appropriate maintenance efforts?
- What is the best allocation of resources?
- How should one prioritise efforts?
- How to rank measures according to economic benefits

Adaptation measures – often focus on immediate consequences

- Removal of vegetation:
  - *Avoid falling trees damaging catenaries (overhead power lines)*
  - *Avoid short circuits and operation disturbances*
  - *Improve visibility and predictability*

►Speedier transports (time savings), improved punctuality, improved comfort, avoided accidents

- Drainage – water pipes
  - *Avoid washing out/*
  - *Avoid slippage (Sideways movement)*

►Avoid serious disruptions, forced down-speeding and delays

Bad Weather Impacts on Road and Rail Freight Transport

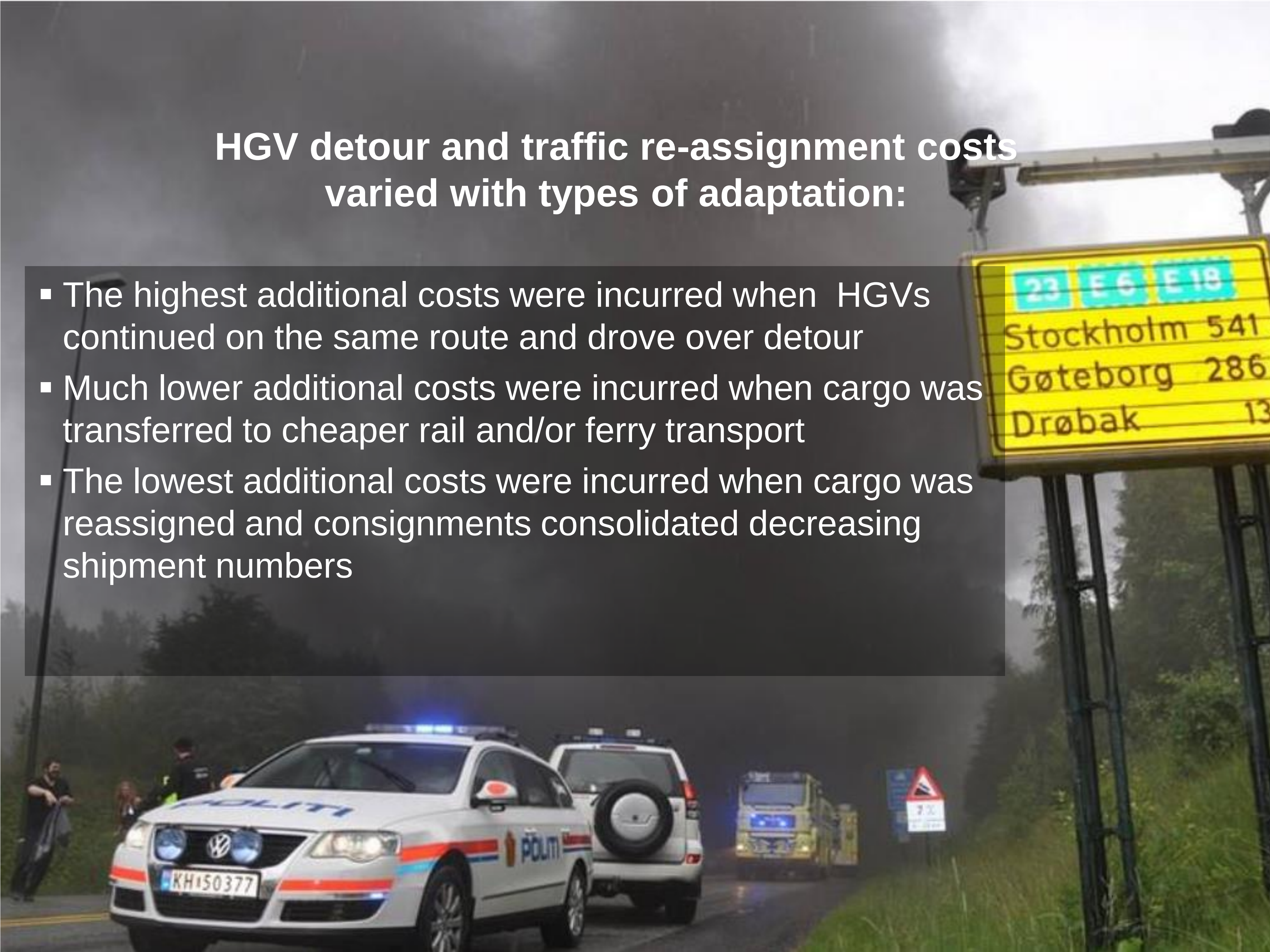
Breakdown of rail and road transport operations
Shutdown of road and rail infrastructure
Ad hoc damage containment

After-shock contagion

- infrastructure to transport operations
- transport to logistics operations
- logistics to manufacturing and wholesale/retailing stock-outs and/or production breakdowns

HGV detour and traffic re-assignment costs varied with types of adaptation:

- The highest additional costs were incurred when HGVs continued on the same route and drove over detour
- Much lower additional costs were incurred when cargo was transferred to cheaper rail and/or ferry transport
- The lowest additional costs were incurred when cargo was reassigned and consignments consolidated decreasing shipment numbers



Bad Weather Impacts on Rail Freight Transport

- Higher tonnage of goods delayed per train due to bad weather disruptions leads to higher value of time lost

- Cargo volumes and values of time lost increased during autumn and winter, when weather became harsher

- 60 % of all freight train delays over 2008-2010 were attributed to bad-weather disruptions and/or weather-induced technical damages

- Combined effect of temperatures below 7 centigrade and 10-20 cm increase in snow depth from the month before explained 65% of variation in the log odds for freight train delays

Bad Weather Impacts on Rail Freight Transport in Finland 2008-2010

Changes in number of days with 10-20 cm snow depth explained 65% variation in train lateness contributing to 10 ½ delay hours

Change in number of days with snow falls over 5 mm accounted for 77% of variation in arrival lateness. Each additional day with this snow fall contributed tp19 ½ hours delay

Increase in number of days with 5 mm snowfalls and temperature below 20’C explained 80% of variation in train arrival tardiness contributing to 3h 15’ delay

Mismatch between: Meteo data, usability and operator requirements

- Poor quality of meteo-data makes it difficult/impossible to establish meaningful causal links between bad weather, technical problems with rail infrastructure and freight train delays

- A set of mechanisms through which weather events feed into operations of rail freight industry is required

- In response thereto, a five–step proposal for how the outputs from meteo-models could be integrated with operations routines of rail operators is presented to improve the precision of delay forecasting and heighten the preparedness level

- Weather-induced disruptions pose considerable threats to supply reliability and competitiveness of environmentally friendly rail freight transport in Europe
- Establishing causal links between harsh weather and transport operations requires much better spatial and temporal resolution and meteo indicators tailored to user needs
- To effectively combat weather-induced disruptions, better understanding of the interactions between transport operations and weather conditions is needed
- Tight collaboration between meteo-professionals, transportation managers and behavioral scientists is recommended to enhance our understanding of the potential utility of disaster preparedness programs and risk management skills at transportation, logistics and manufacturing companies

Organizational preparedness and reactions to adverse events

- Low willingness to improve organizational/channel robustness though
  - *Physical preparedness*
  - *Disaster risk management skills*
- Poor understanding of weather-hazard probability: Exacerbated by
  - *Intra-organizational differences in risk definition*
  - *Underestimating risk consequences stemming from lean operations models*
- Failure to commit resources to risk management and preparedness due to uncertainty of operational and financial consequences
- Inadequate managerial/operational preparedness at infrastructure and transport providers during harsh winters 2010 and 2011

CBA climate adaptation

Should handle:

- Increasing likelihood of adverse events over time
- The likelihood (when possible to calculate) of event of different severity for each year within project period
- Population increases, increases in elements at risk and their value over time
- Accumulated multi hazard consequences
- Incorporate larger impact areas from more seldom, but more extreme events
- Should be able to take into account upstream and downstream consequences and factor inn value of improved resilience in first, second, and third line «defenses»

Should be able to assess and visualize uncertainties in economic indicators

Some of our works

- 2014 Ludvigsen, J. & Klæboe, R. 2014. Extreme weather impacts on freight railways in Europe. Natural Hazards, 70 (1): 767-787.

- 2014 Klæboe, R. & Veisten, K. 2014. Economic analyses of surface treatments, tree belts, green façades, barriers and roofs. I: Nilsson, M., Bengtsson, J. & Klæboe, R. (red.) Environmental Methods for Transport Noise Reduction: CRC Press.

- 2014 Thune-Larsen, H., Veisten, K., Rødseth, K. L. & Klæboe, R. (2014). Marginal external costs from transport (In Norwegian), 1307/2014. Oslo: Transportøkonomisk institutt

- 2013 Dyrrdal, A. V., Frauenfelder, R., Gangstø, R., Harbitz, A., Harbitz, C. B., Haugen, J. E., Hygen, H. O., Haakenstad, H., Isaksen, K., Jaedicke, C., et al. (2013). Impacts of extreme weather events on infrastructure in Norway (InfraRisk). Oslo: NGI.

- 2012 Klæboe, R. 2012. Economic Analyses. I: Nilsson, M., Bengtsson, J. & Klæboe, R. (red.) Novel Solutions for Quieter and Greener Cities, s. 42-45. Stockholm: Hosanna 7th Framework Project.

- 2011 Klaeboe, R., Veisten, K., Amundsen, A. H. & Akhtar, J. 2011. Selecting road-noise abatement measures: Economic analysis of different policy objectives. Open Transportation Journal, 4: 87-92.

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