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Measuring the cost-effectiveness of noise-mitigating measures for Schiphol Airport

In the context of the Balanced Approach procedure

4th assessment report, 5 December 2024 V2

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Contents

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1. Study background

Introduction

In 2022 The Dutch government announced plans with the aim to reduce the noise impact around Schiphol airport. Such measures requires a so-called Balanced Approach procedure laid down in EU Regulation 598/2014.

The Balanced Approach procedure consists of the following subsequent steps:

1. Define the noise abatement objectives
2. Identify feasible measures to achieve the objectives
3. Assess the cost-effectiveness of each measure and combination of measures
4. Consult relevant stakeholders
5. Determine the most cost-effective combination of measures to achieve the noise objectives by taking the stakeholder inputs into account
6. Notify the European Commission on the preferred combination of measures and discuss its impacts and implementation

The study

The Ministry of Infrastructure and Water Management defined the noise abatement objectives for Schiphol in the *Environmental Noise Action Plan 2024-2029*:

Noise abatement objectives for Schiphol	
• Houses within 58 dB(A) L_{den} contour	-20%
• Highly annoyed people within 48 dB(A) L_{den} contour	-20%
• Houses within 48 dB(A) L_{night} contour	-15%
• Severely sleep disturbed people within 40 dB(A) L_{night} contour	-15%

The objectives are expressed as percentage reductions compared to a reference situation which assumes autonomous traffic and technological developments.

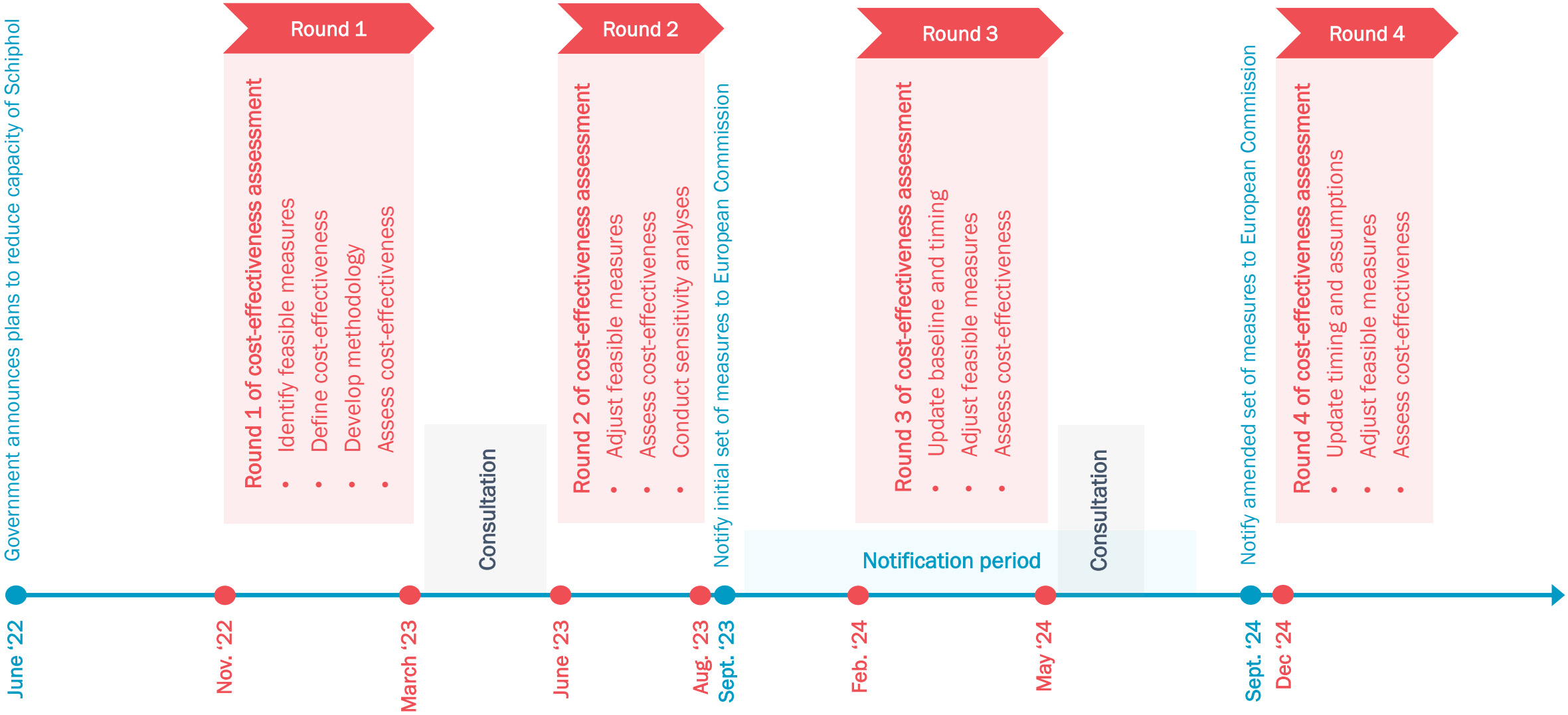
The Ministry commissioned a consortium consisting to assess the cost-effectiveness of various (combinations of) measures, whereby:

- **To70** modelled the noise impacts for the various (combinations of) measures;
- **Decisio** and **Beelining** estimated the cost-effectiveness of the (combinations of) measures.

The Ministry updated the preferred combination of measures, based on inputs from stakeholders and the European Commission. This resulted in various rounds of calculations.

This 4th assessment report describes the results from the 4th round of calculations. Appendix A provides a summary of previous assessments.

Timeline of the study



The 4th assessment

In September 2023 the Ministry of Infrastructure and Water Management notified an initial set of measures to the European Commission. The measures should reach the noise objectives by November 2024.

The European Commission raised concerns about the proportionality of the notified measures and the speed of implementation. The Commission also stressed the importance of alternative measures (other than a capacity reduction) to meet the noise objectives.

The Ministry therefore decided to take phase in the various measures over a longer period of time. The first phase should lead to a noise reduction of 15% by November 2025. The second phase should cover the remaining 5% of the noise objectives for the day.

The longer phase-in period allowed for the inclusion of measures that require more time for implementation. Including more measures means that there is less need to reduce overall capacity (which should be considered a last resort based on the noise regulation).

Stakeholders were consulted about the new set of measures in May and June 2024. Also, assumptions were checked with stakeholders. This led to some changes to the package of measures.

In September 2024 the Ministry notified an amended set of measures to the European Commission.

The 4th assessment

This 4th assessment report describes the cost-effectiveness of the following measures as well as the cost-effectiveness of three combination of measures.

The modeling and analysis of the noise impacts of the various (combination of) measures was performed by To70. We used their results to estimate the cost-effectiveness of the measures and combinations. For more detailed information on the noise impacts, we refer to the To70 report.

	Combinations		
Measures	**1**	**2**	**3**
1. Use of quieter aircraft during nighttime period by KLM	✓	✓	✓
2. Stimulate airlines to use quieter aircraft through airport charges	✓	✓	✓
3. Additional fleet renewal	✓	✓	✓
4. Ban on noisy aircraft during nighttime period	✓	✓	✓
5. Reduce night capacity to 27,000 movements	✓	✓	✓
6. Overall capacity	500k	475k	480k

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2. Definition of cost-effectiveness

What costs to include?

EU Regulation 598/2014 prescribes a comparison of the costs of the measures. A full Cost-Benefit Analysis (CBA) is not required although Member States may conduct a CBA when deemed appropriate.

The Regulation does not provide a definition of cost-effectiveness nor does it specify which costs should be taken into account. However, it does mention that operating restrictions should be assessed by taking into account:

- The anticipated noise benefit, now and in the future
- The safety of operations
- The capacity of the airport
- Impacts of the European aviation network and an assessment of cross-border impacts

In addition, competent authorities may take other impacts into account, such as: health and safety of local residents, environmental impacts and direct, indirect, catalytic economic impacts.

Broad definition

We use broad definition of costs which aligns with the approach used in Social Cost-Benefit Analyses (SCBA) in particular the guideline on aviation specific SCBA's (Werkwijzer Luchtvaartspecifieke MKBA's, SEO/Decisio 2021):

- **Passengers/Freight**: changes in consumer surplus / generalised travel costs (ticket prices and travel times). In addition, generalised travel costs are used as a proxy for welfare loss when demand can not be accomodated at Schiphol (for instance when capacity is restricted)
- **Airlines, airports & ANSPs**: changes in producer surplus / profits (scarcity rents and operational costs)
- **Economy**: changes in productivity (indirect economic impacts incl. agglomeration impacts)
- **Government**: changes in tax revenues and additional expenses, monitoring costs
- **Society**: changes in emissions (including health effects) and climate impacts (external impacts)

As impacts on the European network and cross-border impacts are also relevent, we do not apply a national scope (which is generally used in a SCBA).

Gross economic impacts

Separately, the impacts on (gross) direct and indirect (backward) employment and value added in the Schiphol area and rest of the Netherlands are estimated*. This entails a separate assessment which partly overlaps with the previous assessment. Therefore the results cannot be added and should be evaluated separately.

It should be noted that – given the fact that labour supply is tight within the Dutch economy – any change in employment within the Dutch aviation industry (direct) or at suppliers (indirect backward) will likely result in a shift in employment to other industries, not in a net change in employment. Because we assess the effect on the short-term (2025), there will be a temporary effect of friction unemployment. This means additional government costs in unemployment allowances and decreasing tax revenues.

* Effects on global supply chains, networks and related investment decisions of specific airlines are not part of this gross economic impact analysis. As this falls beyond the scope of this study.

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3. Cost-effectiveness of individual measures

1. Use of quieter aircraft during nighttime period

The operation of quieter aircraft during the night reduces noise during the nighttime period (07:00h - 23:00h).

Measure

The measure was suggested by KLM during the first consultation in 2023. It proved highly cost-effective in the 2nd round of cost calculations and was therefore included in the initial notification to the European Commission.

Assumptions

The measure only applies to the operation of KLM. Other airlines at Schiphol have indicated that they cannot optimize their night operations in a similar way.

KLM outlined that it will:

- Replace 832 flights with noisy widebody aircraft during the nighttime (Boeing 777-200) by less noisy aircraft types (Boeing 787-9/10)
- Move 1,404 flights with noisy widebody aircraft from the nighttime to the daytime (Airbus A330-200/300 and Boeing 777-300) and using the freed-up night slots for the operation of less noisy regional aircraft (Embraer E195-E2)

This means that more noisy widebody aircraft (Airbus A330-200/300 and Boeing 777-200/300) are operated during the daytime.

1. Use of quieter aircraft during nighttime period

Cost estimation

- **Passengers/Freight:**
  - Increase in generalised travel costs as travel times increase for some tranfers passengers: travel time increase x time valuation for air passengers in Netherlands.

- **Airlines:**
  - Cost of reallocation of aircraft across fleet → less efficient operation. Increase in operational costs due to lower utilisation of assets: increase in fixed costs (based on operational costs per block hour).

- **Airports:**
  - No overall impact on profitability. Less aeronautical revenues due to more efficient fleet at night, but this will be compensated in the charges, as charges need to remain cost-based.

- **Indirect economic impacts (agglomeration effects)**
  - Less efficient operation and increase in generalised travel costs have negative economic effects on the agglomeration of Schiphol.

- **Government:**
  - Additional costs to monitor the use of quieter aircraft during the nighttime (not estimated +PM).

- **Society (net external effects):**
  - No overall impact on CO_2 and non-CO_2 as the noisy (and probably less-efficient aircraft) are operated at other times of the day.

- **Employment and value added (local effect):**
  - No gross impact as total number of flight movements does not change

1. Use of quieter aircraft during nighttime period

Cost effectiveness of reduction per house/annoyed person:

- The measure in itself does not reach any noise objective
- The measure contributes relatively much to the noise objectives during the night, but less for the objectives during the entire day
- The measure is highly cost-effective both for the night (L_{night}) and the entire day (L_{den})

Annual costs in million euro's with respect to baseline (500k)

	1. Quieter aircraft during the night
Net costs	
Operational costs airlines	-€ 3,8+/- PM
Generalised travel cost passengers/freight	-€ 3,5+/- PM
Government costs	+PM
Direct costs	**-€ 7,3+/- PM**
Net External effects (less flights)	
Climate effects - CO_2 and non-CO_2	
Air quality - NO_x	
Air quality - PM_{10}	
Additional economic impact Schiphol (agglomeration)	-€ 1,1+/- PM
Total costs (including indirect and external costs):	**-€ 8,4+/- PM**

Costs in euro's per house/annoyed persons with respect to baseline (500k)

With respect to baseline 500k:	Change in number of houses/persons:	Change in % of houses/persons:	*Net operational costs per reduction of:*	*Direct costs per reduction of:*	*Total costs per reduction of:*
Houses in 58 dB Lden Contour	-91	-1,3%	-€ 41.422	-€ 80.175	-€ 92.201
Houses in 48 dB Lnight Contour	-552	-9,6%	-€ 6.844	-€ 13.248	-€ 15.235
Highly annoyed persons in 48 Lden Contour	-1.584	-1,4%	-€ 2.387	-€ 4.620	-€ 5.313
Highly annoyed persons in 40 Lnight Contour	-1.816	-7,4%	-€ 2.081	-€ 4.028	-€ 4.632

= Noise abatement objective not achieved

= Noise abatement objective achieved

2. Stimulate airlines to use quieter aircraft

Stimulating airlines to use quieter aircraft, through a stronger differentiation of airport charges, may reduce noise around the airport.

Current situation

- Airport charges at Schiphol are currently differentiated based on the noise category of the aircraft (and time of day)
- Schiphol distinguishes 7 noise categories ranging from S1 (most noisy category) to S7 (least noisy)
- During the daytime category S3 connected aircraft for instance pay the base tariff (see table). S1 aircraft pay twice that amount, S6 aircraft pay half

- The following table illustrates which aircraft types fall into each category. In practice, different versions of one type may fall into two categories

Current LTO-charge factors at Schiphol

Aircraft noise category		Current charge factors		
		Day	Night (landing)	Night (take-off)
S1	ΔEPNdB > -11	200%	500%	600%
S2	-11 >= ΔEPNdB > -15	145%	225%	250%
S3	-15 >= ΔEPNdB > -18	100%	140%	165%
S4	-18 >= ΔEPNdB > -21	80%	120%	145%
S5	-21 >= ΔEPNdB > -24	65%	100%	120%
S6	-24 >= ΔEPNdB > -27	50%	80%	95%
S7	-27 >= ΔEPNdB	40%	65%	75%

Note: LTO-Landing charges are levied per MTOW. EPNdB = Effective Perceived Noise in Decibels and is an international measure for aircraft movements

2. Stimulate airlines to use quieter aircraft

The airport charges at Schiphol are set for a period of three years. The next three-year cycle starts in April 2025. The airport is currently consulting airlines on the charges for the upcoming cycle.

Measure

The new charging scheme includes a significant increase in the base tariff and a stronger differentiation by aircraft noise category and time of day, especially for aircraft in the S1 and S2 noise categories.

The measure was not included in the initial notification to the European Commission as it could only contribute to the noise objectives as of April 2025. The decision to phase-in the various measures over a longer period of time made this measure feasible.

The EU Directive 2009/12/EC on airport charges stipulates that airport charges should be cost-based. A stronger differentiation of the charges by aircraft category and time of day should therefore be a zero-sum game. This means that higher charges for noisy aircraft should be compensated by lower charges for quieter aircraft.

2. Stimulate airlines to use quieter aircraft

The new charging scheme incentivices airlines to:

- Replace aircraft by quieter types
- Shift noisy aircraft from the night to the day
- Reduce flight activity at Schiphol

How each airline will respond to the new charging scheme depends on the:

- **Ability to change the operation: In the short-term a**irlines can only replace aircraft by quieter types, when they such types in their fleet. Also, night flights can only be moved to the day, when slots are available at daytime hours. In case airlines choose to reduce flight activity at Schiphol, their slots will be allocated to other airlines that most likely operate quieter aircraft.
- **Associated costs and benefits:** The greater the benefits are compared to the costs, the more attractive it is to adjust the operation.

Predicting how each airline will respond to the measure is difficult due to the various (airline-specific) factors that are at play.

2. Stimulate airlines to use quieter aircraft

Assumptions

The Ministry provided replacement rates for the various aircraft noise categories and for various airlines segments. These were determined based on the new charging scheme and expert judgement.

The Ministry assumes that airlines replace aircraft in the S1-S4 categories by the rates in the table when they have quieter aircraft available in their fleet. In total around 12,500 flight movement by aircraft in the S1-S4 categories are replaced by quieter types.

Replacement rates by aircraft category and segment

	Legacy	Low cost	Freight	easyJet
S1	100%	100%	100%	NA
S2	25%	12.50%	12.50%	25%
S3	12.50%	6.25%	6.25%	12.50%
S4	6.25%	3.125%	3.125%	6.25%
S5	0%	0%	0%	0%

Source: Ministry of Infrastructure and Water Management

Other airline responses, such as shifting noisy aircraft from the night to the day and/or reducing flight activity, were not taken into account. As a result, the noise impact and cost-effectiveness should be considered as a lower bound.

2. Stimulate airlines to use quieter aircraft

Cost estimation

- **Passengers/Freight:**
  - Cargo carriers with S1 aircraft move to other airports, this means an increase in the generalised travel cost for freight.
- **Airlines:**
  - Cost of reallocation of aircraft across fleet → less efficient operation. Costs for airlines that switch to quieter aircraft (S6-S7) are lower than the increase in airport charges. If switching costs are higher there is no economic reasoning for an airline to switch. If an airline does not switch to quieter aircraft it will incur the full increase of the airport charges.
- **Airports:**
  - No overall impact on profitability. Less aeronautical revenues due to more efficient fleet, but this will be compensated in the charges, as charges need to remain cost-based.
- **Indirect economic impacts (agglomeration effects):**
  - Less efficient operation and increase in generalised travel costs have negative economic effects on the agglomeration of Schiphol.
- **Government:**
  - Additional costs to monitor the use of quieter aircraft during the nighttime.
  - Some (S1) cargo flights will be replaced by passenger flights. The latter is less labour-intensive which means in short-term unemployment allowances increases and tax revenue decreases.
- **Society (net external effects):**
  - No overall impact on CO_2 and non-CO_2 as noisy (and probably less-efficient aircraft) are deployed elsewhere
- **Employment and value added:**
  - S1 cargo flights are replaced by passenger flights. Passenger flights are less labour-intensive than cargo flights. This means an increase in (short-term) frictional unemployment. In the long-term the labour market is competitive as stated in the CBA guidelines of the Central Planning Bureau.

2. Stimulate airlines to use quieter aircraft

Cost effectiveness of reduction per house/annoyed person:

- The measure in itself does not reach any noise objective
- The measure has limited potential
- The measure is not very cost-effective, except with respect to reducing the number of highly annoyed persons during the entire day
- The noise impacts and the cost-effectiveness might be underestimated as the increase in the base fare of the LTO-charge and the charges increase during the night have not been taken into account

Annual costs in million euro's with respect to baseline (500k)

	2. Stimulate airlines through airport charges
Net costs	
Operational costs airlines	-€ 18,1+/- PM
Generalised travel cost passengers/freight	-€ 2,9+/- PM
Government costs	-€ 0,4+/-PM
Direct costs	**-€ 21,4+/- PM**
Net External effects (less flights)	
Climate effects - CO_2 and non-CO_2	
Air quality - NO_x	
Air quality - PM_{10}	
Additional economic impact Schiphol (agglomeration)	-€ 3,2+/- PM
Total costs (including indirect and external costs):	**-€ 24,6+/- PM**

Costs in euro's per house/annoyed persons with respect to baseline (500k)

With respect to baseline 500k:	Change in number of houses/persons:	Change in % of houses/persons:	*Net operational costs per reduction of:*	*Direct costs per reduction of:*	*Total costs per reduction of:*
Houses in 58 dB Lden Contour	-104	-1,5%	-€ 173.753	-€ 205.432	-€ 235.737
Houses in 48 dB Lnight Contour	-145	-2,5%	-€ 125.330	-€ 148.180	-€ 170.039
Highly annoyed persons in 48 Lden Contour	-1.803	-1,6%	-€ 10.051	-€ 11.884	-€ 13.637
Highly annoyed persons in 40 Lnight Contour	-197	-0,8%	-€ 92.023	-€ 108.801	-€ 124.851

= Noise abatement objective not achieved

= Noise abatement objective achieved

3. Additional fleet renewal

New generation aircraft are quieter and more efficient than previous generations. Fleet renewal therefore contributes to less noise.

Fleet renewal is a continuous process driven by operational costs. A trend-based development of airline fleets is therefore assumed in the reference scenario. As the noise objectives are defined against the reference, the objectives also implicitly assume a trend-based development of airline fleets.

Measure

During the first consultation in 2023 and in subsequent discussions various airlines noted that they were planning to renew their fleets at a faster pace than assumed in the reference scenario.

The contribution of this additional fleet renewal to the noise objectives is therefore taken into account in the study.

Assumptions

It should be noted however, that fleet renewal decisions have been made prior to the government's decision to reduce Schiphol's capacity. The decision therefore did not lead to accelerated fleet renewal nor extra costs for airlines above and beyond what was already planned. As there are no extra costs, the cost-effectiveness cannot be calculated.

Also, the pace of fleet renewal may decline after 2025 and return to the long-term trend.

4. Ban on noisy aircraft during nighttime period

Banning noisy aircraft from the nighttime period (07:00h - 23:00h) contributes to the noise objectives for the night.

Current situation

Only aircraft with a cumulative margin of at least -10 EPNdB are allowed at Schiphol

Measure

During the first consultation in 2023 Schiphol suggested a stricter ban on noisy aircraft both for the day (at least -12 EPNdB) and the night (at least -13 EPNdB). However, a legal analysis showed that banning aircraft with a cumulative margin of at least -12 EPNdB during the entire day is not possible.

Therefore, the measure only consists of a stricter ban on noisy aircraft with a cumulative margin of at least -13 EPNdB during the nighttime. Other European airports already apply such a ban.

The stricter ban on noisy aircraft during the night forces airlines to:

- Replace aircraft by quieter types
- Move flights from the night to the day

4. Ban on noisy aircraft during nighttime period

Assumptions

KLM provided input on how this measure would affect their operation:

- Replace part of Boeing 737-900 flights during nighttime by Boeing 737-800 flights
- Move part of Boeing 747-400 flights to daytime and part of Boeing 737-800 flights to nighttime

Furthermore, KLM indicated that it would reduce the Maximum Take-off Weight (MTOW) of its Airbus A330-200/300 and Boeing 747-400 aircraft by 3 and 8 tons respectively. This would improve the cumulative margins of the respective aircraft to at least -13 EPNdB. In practice this will only have a beneficial impact on noise when it leads to a lower take-off weight.

For other airlines it was assumed that they would:

- Replace part of their Boeing 747-400 flights during the nighttime by Boeing 747-8 flights
- Replace part of their Boeing 737-400 flights during the nighttime by Boeing 737-800 flights
- Replace part of their Airbus A300 flights during the nighttime by Airbus A330-200 flights

In total this measure leads to around 470 flights during the night that will be replaced by quieter aircraft types.

The measure leads to similar types of costs (although of a different magnitude) as the type of costs associated with a stronger differentiation of airport charges.

4. Ban on noisy aircraft during nighttime period

Cost estimation

- **Passengers/Freight:**
  - Cargo carriers with noisy aircraft move to other airports, this means an increase in the generalised travel cost for freight.
- **Airlines:**
  - Cost of reallocation of aircraft across fleet → less efficient operation. Increase in operational costs due to lower utilisation of assets: increase in fixed costs (based on operational costs per block hour).
  - Airlines will fully absorb increase in operational costs because of competitive market.
- **Airports:**
  - No overall impact on profitability. Less aeronautical revenues due to more efficient fleet, but this will be compensated in the charges, as charges need to remain cost-based.
- **Indirect economic impacts (agglomeration effects)**
  - Negative impact on business climate around Schiphol due to less attractive network and higher travel costs may lead to lower overall productivity.
- **Government:**
  - In short-term unemployment allowances increases and tax revenue decreases (employment effect is small because of small switch of cargo flights with pax flights).
- **Society (net external effects):**
  - No global impact on CO_2 and non-CO_2 as older aircraft are deployed elsewhere.
- **Employment and value added (local effect):**
  - Banned noisy cargo flights are replaced by passenger flights. Passenger flights are less labour-intensive than cargo flights. This means an increase in (short-term) frictional unemployment. In the long-term the labour market is competitive as stated in the CBA guidelines of the Central Planing Bureau

4. Ban on noisy aircraft during nighttime period

Cost effectiveness of reduction per house/annoyed person:

- The measure in itself does not reach any noise objective
- The measure has limited potential to reduce noise during the night (as only during that period the most noisy aircraft are banned)
- The measure is cost-effective during the night as a limited number of flights is affected

Annual costs in million euro's with respect to baseline (500k)

	4. Ban on noise aircraft at night
Net costs	
Operational costs airlines	-€ 4,4+/- PM
Generalised travel cost passengers/freight	-€ 1,9+/- PM
Government costs	-€ 0,2+/-PM
Direct costs	**-€ 6,5+/- PM**
Net External effects (less flights)	
Climate effects - CO_2 and non-CO_2	
Air quality - NO_x	
Air quality - PM_{10}	
Additional economic impact Schiphol (agglomeration)	-€ 0,9+/- PM
Total costs (including indirect and external costs):	**-€ 7,5+/- PM**

Costs in euro's per house/annoyed persons with respect to baseline (500k)

With respect to baseline 500k:	Change in number of houses/persons:	Change in % of houses/persons:	*Net operational costs per reduction of:*	*Direct costs per reduction of:*	*Total costs per reduction of:*
Houses in 58 dB Lden Contour	-45	-0,6%	-€ 98.506	-€ 144.557	-€ 165.520
Houses in 48 dB Lnight Contour	-136	-2,4%	-€ 32.550	-€ 47.767	-€ 54.694
Highly annoyed persons in 48 Lden Contour	-1.173	-1,0%	-€ 3.781	-€ 5.549	-€ 6.353
Highly annoyed persons in 40 Lnight Contour	-969	-4,0%	-€ 4.579	-€ 6.720	-€ 7.695

= Noise abatement objective not achieved

= Noise abatement objective achieved

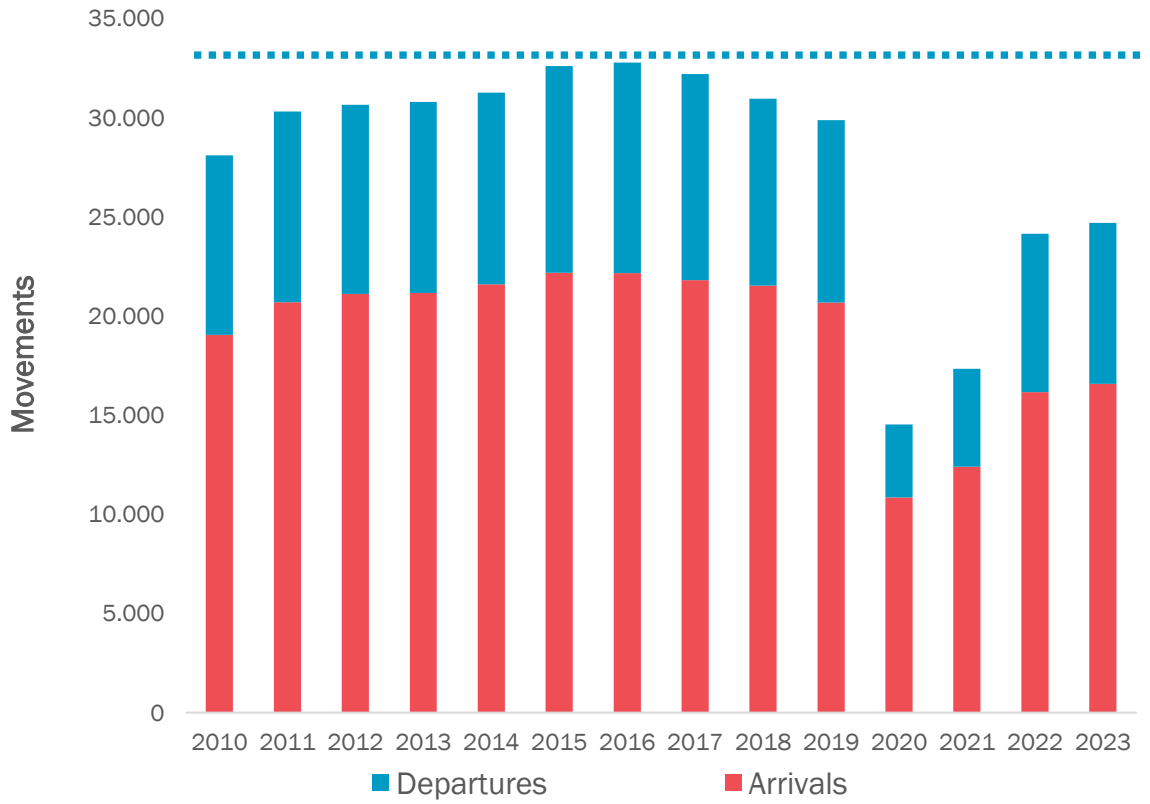
5. Reduce night capacity to 27,000 movements

Reducing the night capacity might be an effective measure to reduce sleep disturbance and associated health impacts.

Current situation

Schiphol has a night capacity of 32,000 movements per year. Around one third of all night flights consists of departures and two thirds of landings

Night movements at Schiphol (2010-2023)



5. Reduce night capacity to 27,000 movements

Measure

Reducing the night capacity proved highly cost-effective in the 1st round of cost calculations. A reduction to 28,700 night flights was therefore included in the initial notification to the European Commission. This was further reduced to 27,000 in the amended notification.

Reducing capacity during the night has a negative impact on aircraft utilisation. This means that airlines need more aircraft to operate the same amount of flights. Airlines may shift night flights to the late evening and/or early morning. For the hub carrier this may lead to longer transfer times and therefore a less attractive transfer product.

However, shifting flights from the night to the daytime may lead to more convenient departure and arrival times for passengers. Some cargo flights during the night are replaced by passenger flights during the day.

Assumptions

Airlines have to give up night slots pro rata*, but slots can be shifted to other moments of the day.

How airlines shall use their remaining slots depends on the contribution of each flight to overall profitability. As such information is not publicly available we assume that airlines reduce their night flights pro rata over routes.

* This is in line with the recent advice given by the Airport Coordination Netherlands (ACNL), see also the document Advies Reductie Vluchten Schiphol (ACNL, 13 februari 2023).

5. Reduce night capacity to 27,000 movements

Cost estimation

Gray items not quantified; these items are a redistribution of a cost of one stakeholder which comes in as an additional revenue to another stakeholder. This redistribution is a zero-sum game and has no net effect on total costs.

- Passengers:
  - Increase in generalised travel costs: average increase in transfer times x value of time, higher ticket prices
  - More convenient departure/arrival times
  - Reduction in non-aeronautical spending
- Airlines:
  - Increase in operational costs due to lower utilisation of assets: increase in fixed costs (based on annual reports)
  - Higher ticket prices
  - Lower labour costs: increased labour productivity and reduction in hours worked during the night x wage premium
- Airports:
  - Lower labour costs: increased labour productivity and reduction in hours worked during the night x wage premium
  - Reduction of non-aeronautical revenues
- Society:
  - Lower income for workers: increased labour productivity and reduction in hours worked during the night x wage premium
  - Fewer night shifts and more predictable work schedules (not quantified, PM)
- Government:
  - Some cargo flights will be replaced by passenger flights during the day. In short-term unemployment allowances increases and tax revenue decreases (employment effect is small and not quantified (-PM) because of small switch of cargo flights with pax flights).
- Employment and value added
  - Cargo flights might decrease as they will be replaced by passenger flights during the day. Passenger flights are less labour-intensive than cargo flights. This means an increase in (short-term) frictional unemployment. In the long-term the labour market is competitive as stated in the CBA guidelines of the Central Planing Bureau

5. Reduce night capacity to 27,000 movements

Cost effectiveness of reduction per house/annoyed person:

- The measure in itself is able to achieve the noise abatement objectives for the night
- The measure also contributes to the noise objectives for the entire day
- The measure is highly cost-effective especially during the night

Annual costs in million euro's with respect to baseline (500k)

	5. Reduce night capacity to 27k
Net costs	
Operational costs airlines	-€ 16,0+/- PM
Generalised travel cost passengers/freight	-€ 11,5+/- PM
Government costs	- PM
Direct costs	**-€ 27,4+/- PM**
Net External effects (less flights)	
Climate effects - CO_2 and non-CO_2	
Air quality - NO_x	
Air quality - PM_{10}	
Additional economic impact Schiphol (agglomeration)	-€ 4,1+/- PM
Total costs (including indirect and external costs):	**-€ 31,6+/- PM**

Costs in euro's per house/annoyed persons with respect to baseline (500k)

With respect to baseline 500k:	Change in number of houses/persons:	Change in % of houses/persons:	***Net operational costs*** *per reduction of:*	***Direct costs*** *per reduction of:*	***Total costs*** *per reduction of:*
Houses in 58 dB Lden Contour	-294	-4,2%	-€ 54.307	-€ 93.317	-€ 107.314
Houses in 48 dB Lnight Contour	-1.289	-22,4%	-€ 12.387	-€ 21.284	-€ 24.477
Highly annoyed persons in 48 Lden Contour	-5.547	-5,0%	-€ 2.878	-€ 4.946	-€ 5.688
Highly annoyed persons in 40 Lnight Contour	-4.592	-18,7%	-€ 3.477	-€ 5.974	-€ 6.871
		= Noise abatement objective not achieved			
		= Noise abatement objective achieved			

6. Reduce overall capacity to 475-480k movements

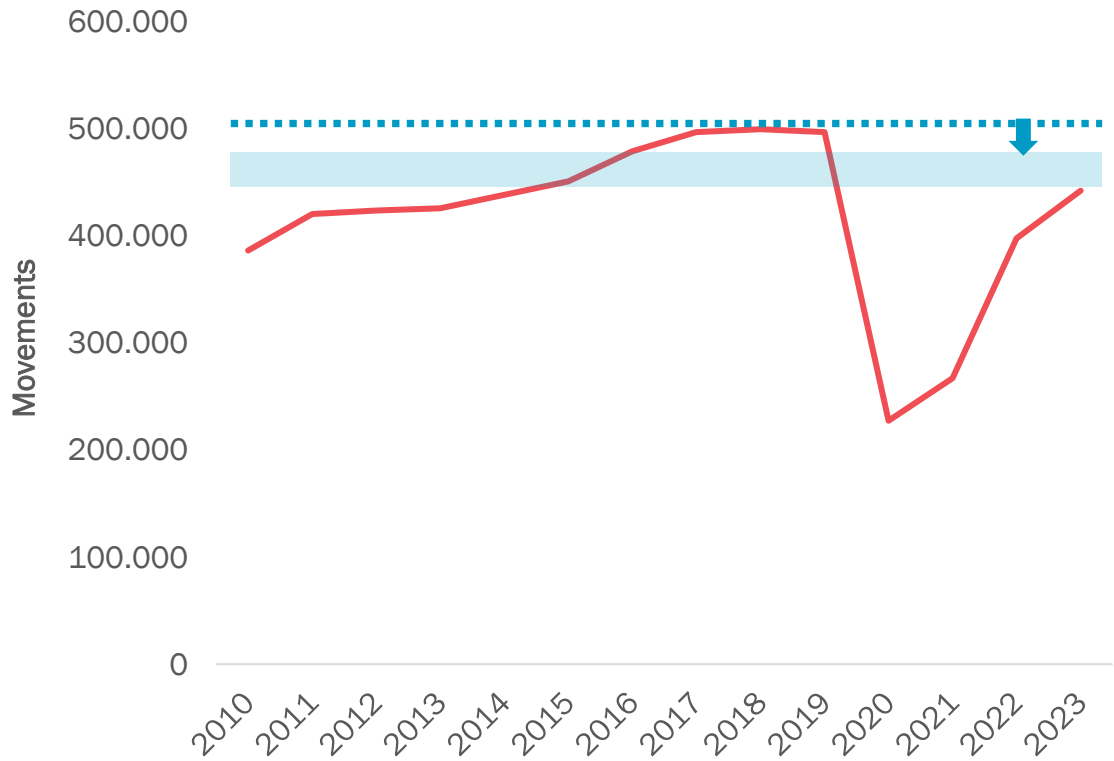
Reducing overall airport capacity may have a relatively large noise impact as a larger share of traffic can be handled at noise preferential runways.

However, according to EU Regulation 598/2014, operating restrictions (including reductions in overall airport capacity), should only be implemented after other measures have been considered.

Current situation

Before the COVID-19 pandemic Schiphol was operating at its maximum capacity of 500,000 flight movements per year.

Total flight movements at Schiphol (2010-2023)



6. Reduce overall capacity to 475-480k movements

Measure

When combined, the aforementioned measures are still insufficient to reach the noise objectives. This means that an overall reduction in capacity is required.

Initial calculations suggest that capacity should be reduced to 475,000 - 480,000 movements in order to reach the noise objectives set for November 2025.

The capacity reduction is smaller than initially communicated by the government (440,000 movements) and initially notified to the European Commission (452,500 movements).

This is the result of the longer phase-in period, which allowed for the inclusion of more measures as well as changes in various assumptions (see Appendix A).

Reducing capacity in a market where supply is already constrained will lead to more scarcity. This means that a larger share of demand cannot be accommodated. Enhanced scarcity allows airlines to increase fares and capture scarcity rents which are paid for by the users of air transport (zero sum)

Consequently, price sensitive segments (leisure, transfer & cargo) are the first to substitute to other modalities and airports or choose not to travel anymore.

6. Reduce overall capacity to 475-480k movements

Airlines shall use their scarce slots for those flights that contribute most to overall profitability. This could lead to a less diverse network.

However, hub carrier KLM shall remain dependent on transfer traffic for operating its long-haul flights.

Home-based carriers and the airport will be faced with additional costs in terms of:

- Redundancy payments for layed off workers
- Higher depreciation of redundant assets (fleet, infrastructure)

As most of the airport's costs are fixed, the costs per aircraft movement shall increase. This will lead to higher airport charges paid for by the airlines.

Finally, there is a risk that other countries introduce retaliative measures, such as reducing the number of landing rights for Dutch carriers

Assumptions

The total number of flights is reduced from 500.000 to 475,000 - 480,000 movements. Airlines have to give up slots pro rata*.

How airlines shall use their remaining slots depends on the contribution of each flight to overall profitability. As such information is not publicly available we made assumptions on which flights are likely most profitable for various categories of airlines.

* This is in line with the advice given by the Airport Coordination Netherlands (ACNL), see also the document Advies Reductie Vluchten Schiphol (ACNL, 13 februari 2023).

6. Reduce overall capacity to 475-480k movements

- **Hub carrier:**
  - Short-haul: reduce frequencies on high-frequent routes (> 1500 flights per year; large share of transfer)
  - Long-haul: protect as much as possible (taking into account reduction in feeder traffic), but scrap low-frequent routes (<= 3 per week)
- **Other network carriers:**
  - Protect routes to/from hub(s); reduce flights to non-hub destinations (if any)
- **Low-cost carriers**
  - Scrap routes with low frequencies (probably low profitability)
- **Charters**
  - Reduce flight frequencies pro rata over all routes (frequency is less relevant than a large supply of destinations)

- **Cargo carriers:**
  - Scrap routes with low frequencies; protect routes to primary airport(s)

- For **mixed-carriers** with both a passenger and cargo operation it is furthermore assumed that part of the cargo flights will be replaced by passenger flights
  - Mixed-carriers bound to Schiphol the reduction in slots is spread 2/3 and 1/3 over passenger and cargo flights
  - Mixed-carriers which also operate cargo flights from other airports nearby the reduction in slots is spread 1/3 and 2/3 over passenger and cargo flights

- We also control for an upgauging effect for certain narrowbody aircraft as larger narrowbody aircraft will replace smaller ones on certain routes

6. Reduce overall capacity to 475-480k movements

Cost estimation

Gray items not quantified; these items are a redistribution of a cost of one stakeholder which comes in as an additional revenue to another stakeholder. This redistribution is a zero-sum game and has no net effect on total costs.

- **Passengers:**
  - Remaining at Schiphol: increase in generalised travel costs: ticket price increase due to scarcity rents
  - Substituting to other modalities, airports or not travelling anymore: increase in generalised travel costs x 0.5 (so-called rule of half), see appendix B
- **Airlines:**
  - Increase in revenues per remaining passenger: ticket price increase due to scarcity rents (distribution from passengers, zero-sum, therefore not modelled)
  - Increase in operational costs due to lower utilisation of assets: increase in fixed costs (based on annual reports)
  - Higher costs of infrastructure due to less efficient use: increase in airport charges
- **Airports:**
  - Higher costs of infrastructure due to less efficient use: increase in airport charges (distribution from airlines, zero-sum, therefore not modelled)
- **Employment and value added**
  - Gross impact due to reduced airport activity: % reduction in passenger and cargo volumes x gross employment and value added at Schiphol
- **Government:**
  - In short-term unemployment allowances increase and tax revenue decrease
- **Society:**
  - Effect on climate and environmental effects because of net reduction of flights on global scale (also see appendix A)
  - Retaliation of other countries; hard to predict and quantify

6. Reduce overall capacity to 475-480k movements

Total costs:

- Operational costs increase significantly due to the lower and less efficient utilitisation of assets (aircraft). Operations of all airlines are affected to some extent.
- Generalised travel costs also increase significantly as the demand of pax and freight flights is not accommodated at Schiphol with respect to baseline. This means welfare loss for around 1,5 to 2 million O/D pax and around 800 full freight flights as they have to go to other airports or choose other modalities, see appendix B.
- Cap on total flights reduces gross employment and value added (second table, bottom right). The net effect on employment leads to an increase in government expenses because of increasing costs in allowances and a reduction in tax income.
- The external effects decrease due to a net reduction in emissions.

Total costs in million euro's with respect to baseline (500k)

	6. Reduce to 475k	6. Reduce to 480k
Net costs		
Operational costs airlines	-€ 94,0+/- PM	-€ 75,2+/- PM
Generalised travel cost passengers/freight	-€ 219,4+/- PM	-€ 175,5+/- PM
Government costs	-€ 6,8+/-PM	-€ 5,5+/-PM
Direct costs	**-€ 320,3+/- PM**	**-€ 256,2+/- PM**
Net External effects (less flights)		
Climate effects - CO2 and non CO2	€ 36,4	€ 29,1
Air quality - NoX	€ 1,8	€ 1,4
Air quality - PM10	€ 0,2	€ 0,1
Additional economic impact Schiphol (agglomeration)	-€ 47,0+/- PM	-€ 37,6+/- PM
Total costs (including indirect and external costs):	**-€ 328,9+/- PM**	**-€ 263,1+/- PM**

Direct and indirect economic impact (gross and net effect)

	Reduce cap to 475k		Reduce cap to 480k	
	Gross effect (direct+indirect)	Net effect (short-term friction)	Gross effect (direct+indirect)	Net effect (short-term friction)
Employed Persons	-6.290	-314	-5.032	-252
FTE	-5.146	-257	-4.117	-206
Value added (mln. euro's)	-€ 665,7	-€ 33,3	-€ 532,6	-€ 26,6

6. Reduce overall capacity to 475-480k movements

Cost effectiveness of reduction per house/annoyed person:

- The measure contributes to the noise objectives for the entire day, but not for the night.
- The measure is not cost-effective due to the high costs to users and airlines.

Costs in euro's per house/annoyed persons with respect to baseline (500k)

With respect to baseline 500k:	Change in number of houses/persons:	Change in % of houses/persons:	*Net operational costs per reduction of:*	*Direct costs per reduction of:*	*Total costs per reduction of:*
Reduce capacity to 475k					
Houses in 58 dB Lden Contour	-298	-4,3%	-€ 315.598	-€ 1.074.727	-€ 1.103.790
Houses in 48 dB Lnight Contour	-	0,0%			
Highly annoyed persons in 48 Lden Contour	-4.997	-4,5%	-€ 18.821	-€ 64.092	-€ 65.825
Highly annoyed persons in 40 Lnight Contour	-	0,0%			
Reduce capacity to 480k					
Houses in 58 dB Lden Contour	-231	-3,3%	-€ 325.708	-€ 1.109.156	-€ 1.139.150
Houses in 48 dB Lnight Contour	-	0,0%			
Highly annoyed persons in 48 Lden Contour	-4.020	-3,6%	-€ 18.716	-€ 63.735	-€ 65.459
Highly annoyed persons in 40 Lnight Contour	-	0,0%			

= Noise abatement objective not achieved

= Noise abatement objective achieved

Overview of results of individual measures

In the table below the total costs (in 2025) of the individual measures are compared:

Total costs in million euro's with respect to baseline (500k)

in mln. Euro's	1. Quieter aircraft during the night	2. Stimulate airlines through airport charges	3. Additional fleet renewal*	4. Ban on noise aircraft at night	5. Reduce night capacity to 27k	6. Reduce to 475k	6. Reduce to 480k
Net costs							
Operational costs airlines	-€ 3,8+/- PM	-€ 18,1+/- PM	-	-€ 4,4+/- PM	-€ 16,0+/- PM	-€ 94,0+/- PM	-€ 75,2+/- PM
Generalised travel cost passengers/freight	-€ 3,5+/- PM	-€ 2,9+/- PM	-	-€ 1,9+/- PM	-€ 11,5+/- PM	-€ 219,4+/- PM	-€ 175,5+/- PM
Government costs	+PM	-€ 0,4+/-PM	-	-€ 0,2+/-PM	+/-PM	-€ 6,8+/-PM	-€ 5,5+/-PM
Direct costs	**-€ 7,3+/- PM**	**-€ 21,4+/- PM**	**-**	**-€ 6,5+/- PM**	**-€ 27,4+/- PM**	**-€ 320,3+/- PM**	**-€ 256,2+/- PM**
Net External effects (less flights)							
Climate effects - CO2 and non CO2						€ 36,4	€ 29,1
Air quality - NoX						€ 1,8	€ 1,4
Air quality - PM10						€ 0,2	€ 0,1
Additional economic impact Schiphol (agglomeration)	-€ 1,1+/- PM	-€ 3,2+/- PM	-	-€ 0,9+/- PM	-€ 4,1+/- PM	-€ 47,0+/- PM	-€ 37,6+/- PM
Total costs (including indirect and external costs):	**-€ 8,4+/- PM**	**-€ 24,6+/- PM**	**-**	**-€ 7,5+/- PM**	**-€ 31,6+/- PM**	**-€ 328,9+/- PM**	**-€ 263,1+/- PM**

** Investment decisions and associated costs of fleet renewal for 2025 are also incurred in the baseline (years ago). Therefore, we see no changes in costs in 2025.*

Overview of results of individual measures

In the table below the cost-effectiveness (in 2025) of the individual measures are compared:

Costs in euro's per house/annoyed persons with respect to baseline (500k)

With respect to baseline 500k:	1. Quieter aircraft during the night	2. Stimulate airlines through airport charges	3. Additional fleet renewal*	4.. Ban on noise aircraft at night	5. Reduce night capacity to 27k	6. Reduce to 475k	6. Reduce to 480k
Change in % of houses/persons:							
Houses in 58 dB Lden Contour	-1,3%	-1,5%	-4,3%	-0,6%	-4,2%	-4,3%	-3,3%
Houses in 48 dB Lnight Contour	-9,6%	-2,5%	-9,8%	-2,4%	-22%	0,0%	0,0%
Highly annoyed persons in 48 Lden Contour	-1,4%	-1,6%	-5,9%	-1,0%	-5,0%	-4,5%	-3,6%
Highly annoyed persons in 40 Lnight Contour	-7,4%	-0,8%	-8,5%	-4,0%	-18,7%	0,0%	0,0%
t operational costs *per reduction of (wrt baseline 500k in euro's):*							
Houses in 58 dB Lden Contour	-€ 41.422	-€ 173.753		-€ 98.506	-€ 54.307	-€ 315.598	-€ 325.708
Houses in 48 dB Lnight Contour	-€ 6.844	-€ 125.330		-€ 32.550	-€ 12.387		
Highly annoyed persons in 48 Lden Contour	-€ 2.387	-€ 10.051		-€ 3.781	-€ 2.878	-€ 18.821	-€ 18.716
Highly annoyed persons in 40 Lnight Contour	-€ 2.081	-€ 92.023		-€ 4.579	-€ 3.477		
ect costs *per reduction of (wrt baseline 500k in euro's) :*							
Houses in 58 dB Lden Contour	-€ 80.175	-€ 205.432		-€ 144.557	-€ 93.317	-€ 1.074.727	-€ 1.109.156
Houses in 48 dB Lnight Contour	-€ 13.248	-€ 148.180		-€ 47.767	-€ 21.284		
Highly annoyed persons in 48 Lden Contour	-€ 4.620	-€ 11.884		-€ 5.549	-€ 4.946	-€ 64.092	-€ 63.735
Highly annoyed persons in 40 Lnight Contour	-€ 4.028	-€ 108.801		-€ 6.720	-€ 5.974		
:al costs *per reduction of (wrt baseline 500k) :*							
Houses in 58 dB Lden Contour	-€ 92.201	-€ 235.737		-€ 165.520	-€ 107.314	-€ 1.103.790	-€ 1.139.150
Houses in 48 dB Lnight Contour	-€ 15.235	-€ 170.039		-€ 54.694	-€ 24.477		
Highly annoyed persons in 48 Lden Contour	-€ 5.313	-€ 13.637		-€ 6.353	-€ 5.688	-€ 65.825	-€ 65.459
Highly annoyed persons in 40 Lnight Contour	-€ 4.632	-€ 124.851		-€ 7.695	-€ 6.871		

= Noise abatement objective not achieved

= Noise abatement objective achieved

* Investment decisions and associated costs of fleet renewal for 2025 are also incurred in the baseline (years ago). Therefore, we see no changes in costs in 2025.

Overview of results of individual measures

Overall conclusions:

- The use of quieter aircraft during the night and a reduction of the night capacity are measures that are most cost-effective. Reducing night capacity has more potential and is able to reach the noise objectives for the night in isolation.
- A ban on noisy aircraft during the night is also rather cost-effective, but has more limited potential.
- A reduction of overall capacity is least cost-effective, but seems necessary to reach the noise objectives for the entire day.

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4. Cost-effectiveness of combination of measures

Combination of measures is required

Analysis of the individual measures showed that none of the measures is able to reach all noise objectives in isolation. Therefore, a combination of measures is required. This section shows to what extent a combination of measures contributes to the noise objectives. Also, the costs and cost-effectiveness of each combination is assessed.

Three combinations of measures are assessed. Combination 1 in which overall capacity stays at 500k. Combination 2 and 3 differ in terms of the reduction in overall capacity in order to fully reach the noise objectives (see table below).

	Combinations		
Measures	**1**	**2**	**3**
1. Use of quieter aircraft during nighttime period by KLM	✓	✓	✓
2. Stimulate airlines to use quieter aircraft through airport charges	✓	✓	✓
3. Additional fleet renewal	✓	✓	✓
4. Ban on noisy aircraft during nighttime period	✓	✓	✓
5. Reduce night capacity to 27,000 movements	✓	✓	✓
6. Overall capacity:	500k	475k	480k

Combination of measures is required

Combining measures may weaken or strengthen the impact of the individual measures. Stimulating airlines to use quieter aircraft (through a stronger differentiation of airport charges), for instance, weakens the impact of a ban on noisy aircraft as the charge differentiation already leads to a lower number of noisy aircraft. This will also affect costs.

Interactions between measures have been taken into account when assessing the noise impacts, costs and cost-effectiveness of the combinations.

Combination of measures - results

Total costs

- Combination 1 (without a reduction in overall capacity) leads to significantly smaller costs for users and airlines, but is unable to achieve the noise objectives for the entire day (see next slide)
- Combinations 2 and 3 (with capacity reduction to 475k and 480k respectively), lead to higher costs, but contribute significantly more to the noise objectives for the entire day (see next slide)

Total costs in million euro's with respect to baseline (500k)

in mln. Euro's	Combination of measures: 1-5 - 500k	Combination of measures: 1-6 - 475k	Combination of measures: 1-6 - 480k
Net costs			
Operational costs airlines	-€ 35,0+/- PM	-€ 127,3+/- PM	-€ 108,8+/- PM
Generalised travel cost passengers/freight	-€ 14,3+/- PM	-€ 232,9+/- PM	-€ 189,2+/- PM
Government costs	-€ 0,6+PM	-€ 7,4+/-PM	-€ 6,0+/-PM
Direct costs	**-€ 49,9+/- PM**	**-€ 367,6+/- PM**	**-€ 304,0+/- PM**
Net External effects (less flights)			
Climate effects - CO2 and non CO2		€ 36,4	€ 29,1
Air quality - NoX		€ 1,8	€ 1,4
Air quality - PM10		€ 0,2	€ 0,1
Additional economic impact Schiphol (agglomeration)	-€ 7,4+/- PM	-€ 54,0+/- PM	-€ 44,7+/- PM
Total costs (including indirect and external costs):	**-€ 57,3+/- PM**	**-€ 383,2+/- PM**	**-€ 318,1+/- PM**

Combination of measures - results

Cost effectiveness of reduction per house/annoyed person:

- Combination 1 (without a reduction in overall capacity) is most cost-effective, but is unable to achieve all noise objectives.
- Combinations 2 and 3 (with capacity reductions to 475k and 480k respectively) are less cost-effective. However, combination 2 is able to reach all the noise objectives. Combination 3 does not reach the noise objective for houses during the entire day.
- All combinations overshoot the noise objectives during the night.

Costs in euro's per house/annoyed persons with respect to baseline (500k)

With respect to baseline 500k:	Change in number of houses/persons:	Change in % of houses/persons:	***Net operational costs*** *per reduction of:*	***Direct costs*** *per reduction of:*	***Total costs*** *per reduction of:*
1. Combination of measures: 1-5 - 500k					
Houses in 58 dB Lden Contour	-784	-11,3%	-€ 44.693	-€ 63.666	-€ 73.107
Houses in 48 dB Lnight Contour	-2.394	-41,6%	-€ 14.636	-€ 20.850	-€ 23.941
Highly annoyed persons in 48 Lden Contour	-15.339	-13,7%	-€ 2.284	-€ 3.254	-€ 3.737
Highly annoyed persons in 40 Lnight Contour	-9.090	-37,1%	-€ 3.855	-€ 5.491	-€ 6.305
2. Combination of measures: 1-6 - 475k					
Houses in 58 dB Lden Contour	-1.082	-15,5%	-€ 117.654	-€ 339.710	-€ 354.196
Houses in 48 dB Lnight Contour	-2.394	-41,6%	-€ 53.175	-€ 153.536	-€ 160.084
Highly annoyed persons in 48 Lden Contour	-20.336	-18,2%	-€ 6.260	-€ 18.074	-€ 18.845
Highly annoyed persons in 40 Lnight Contour	-9.090	-37,1%	-€ 14.004	-€ 40.436	-€ 42.160
3. Combination of measures: 1-6 - 480k					
Houses in 58 dB Lden Contour	-1.015	-14,6%	-€ 107.241	-€ 299.543	-€ 313.355
Houses in 48 dB Lnight Contour	-2.394	-41,6%	-€ 45.467	-€ 126.999	-€ 132.855
Highly annoyed persons in 48 Lden Contour	-19.359	-17,3%	-€ 5.623	-€ 15.705	-€ 16.429
Highly annoyed persons in 40 Lnight Contour	-9.090	-37,1%	-€ 11.975	-€ 33.447	-€ 34.989

= Noise abatement objective not achieved

= Noise abatement objective achieved

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Appendix A: Overview of previous estimations

Round 1 (November 2022 – March 2023)

1. Identify feasible measures

The project first identified which measures could feasibly contribute to the noise objectives by November 2024. This resulted in the following six measures:

Measures shortlisted in round 1

1. Stimulate airlines to use quieter aircraft (through tariff differentiation)
2. Extend night regime
3. Reduce use of Buitenveldert runway
4. Reduce use of secondary runways
5. Reduce overall capacity to 440,000 movements
6. Reduce night capacity

2. Define cost-effectiveness and develop methodology

Next, cost-effectiveness was defined and a method was developed to measure cost-effectiveness.

3. Assess cost-effectiveness of measures

The cost-effectiveness assessment of the six measured showed that:

- Reducing the use of secondary runways proved most cost-effective, but contributes little to the noise objective
- Reducing night capacity also proved relatively cost-effective, both during the night and for the entire day
- Reducing the use of the Buitenveldert runway is cost-effective for reducing noise during the day
- Reducing the overall capacity to 440,000 proved least cost-effective, but contributes significantly to the noise objective
- The noise objectives can only be achieved by a combination of measures

Round 1 (November 2022 – March 2023)

4. Define & assess cost-effectiveness of combinations

Based on these findings, five different combinations of measures were composed. Combining measures may weaken or strengthen the impact of the individual measures. This was taken into account when assessing the cost-effectiveness of the combinations.

Three combinations (B, C and D) were able to reach the noise objectives. Combination C appeared most cost-effective, despite overshooting the objectives.

The complete results of round 1 can be found here.

Stakeholders were invited by the Ministry to share their views on the combinations between March and June 2023. The consultation document can be found here.

Combinations of measures	A	B	C	D	E
1. Stimulate airlines to use quieter aircraft (through tariff differentiation)	✓	✓	✓	✓	
2. Extend night regime	✓	✓	✓	✓	✓
3. Reduce use of Buitenveldert runway	✓	✓	✓		
4. Reduce use of secondary runways	✓	✓	✓		
5. Reduce overall capacity to 440,000 movements		✓		✓	
6. Reduce night capacity*	✓		✓		✓

* The number of night movements differs between combinations A (29.000 movements) and C (25.000 movements)

Round 2 (June – August 2023)

1. Adjust feasible measures

The consultation yielded 224 responses from local governments, local communities, environmental organization, airlines and the airport.

The shortlisted set of measures was adjusted based on inputs received during the consultation and the safety and feasibility assessments conducted by the competent authorities (LVNL and ILT).

Measures shortlisted in round 2

1. Reduce use of secondary runway
2. Reduce overall capacity
3. Reduce night capacity
4. Additional fleet renewal
5. Use of quieter aircraft during nighttime period

Two new measures were added:

+ Additional fleet renewal;
+ Use of quieter aircraft during nighttime period.

Three measures were removed:

– Stimulate airlines to use quieter aircraft, as this cannot be implemented before November 2024;
– Extend night regime, as this would increase peaks and complexity in the shoulder-periods;
– Reduce use of Buitenveldert runway, as the use of this runway is already minimized.

Round 2 (June – August 2023)

Several other measures were proposed during the consultation such as a night curfew or a ban on noisy aircraft. Though promising, these would require more analysis or a longer implementation phase and therefore were unable to contribute to the noise objectives by November 2024.

In order to provide room for such measures, the Ministry allowed more time for reaching the full noise objectives:

- **Step 1: until November 2024.** A 15% reduction for all noise objectives;
- **Step 2: after November 2024.** The remaining 5% reduction for the entire day would be realized after November 2024.

2. Assess cost-effectiveness of measures

The cost-effectiveness assessment of the adjusted set of measured showed that:

- The use of quieter aircraft during the nighttime appeared most cost-effective, but contributes little to the noise-objectives for the day
- Reducing the use of secondary runways and night capacity again proved cost-effective
- Additional fleet renewal appeared relatively ineffective and contributes little to the objectives
- Reducing the overall capacity to 440,000 still proved least cost-effective, but contributes significantly to the noise objective
- The noise objectives can only be achieved by a combination of measures

Round 2 (June – August 2023)

3. Assess cost-effectiveness of combinations

Based on these findings two new combinations of measures were defined. The combinations consisted of the same measures, but differed with respect to the number of total movements and night movements.

The number movements was chosen in such a way that the (adjusted) noise objectives for November 2024 could be reached:

Combinations of measures	A	B
1. Use of quieter aircraft during nighttime period	✓	✓
2. Reduce use of secondary runways	✓	✓
3. Reduce overall capacity	452,500	462,500
4. Reduce night capacity	28,700	27,000

The cost-effectiveness assessment showed that:

- Combination A led to higher costs, but contributed more to the noise objective for the entire day;
- Combination B overshoots the noise objective for the night.

The complete results of round 2 can be found here.

Combination A was preferred by the Ministry and notified to the European Commission on 1 September 2023. The notification document can be found here.

Round 3 (February – May 2024)

The European Commission raised concerns about the proportionality of the notified measures and the speed of implementation. The Commission also stressed the importance of alternative measures (other than a capacity reduction) to meet the noise objectives.

The topics have been actively discussed with the Commission. This has delayed the process, which meant that implementation of the measures by November 2024 had become largely infeasible.

The Ministry therefore decided to phase in the various measures over a three-year period (November 2024 – November 2025). The longer implementation period allowed for the inclusion of three additional measures:

+ Stimulate airlines to use quieter aircraft (through tariff differentiation);*
+ Ban on noisy aircraft;
+ Additional fleet renewal.

* This measure had already been assessed in round 1, but was later rejected (in round 2) as it could not be implemented before November 2024. Due to longer phase-in period, the measure became feasible.

The cost-effectiveness of the new measures was assessed in round 3 as follows:

1. Update baseline and timing of measures

The delayed and phased approach necessitated an update to the baseline (2025) and the assumed implementation of the various measures

Round 3 (February – May 2024)

Also, the measure 'Reduce the use of secondary runways' was redefined and reassessed. The measure was limited to one period during the day (13:00-15:00h) as doubts were raised about the feasibility of implementing the measure in the morning period (07:00-08:00h).

Measures shortlisted in round 3

1. Stimulate airlines to use quieter aircraft
2. Reduce use of secondary runways
3. Ban on noisy aircraft
4. Additional fleet renewal*

* The reference situation assumes autonomous developments including autonomous fleet renewal. The projected fleet renewal at Schiphol is expected to outpace this autonomous development. The noise impact resulting from this additional fleet renewal – on top of the autonomous development - is taken into account. However, aircraft that enter airline fleets until November 2025 have been ordered prior to the government's decision to reduce Schiphol's capacity. The decision therefore did not lead to accelerated fleet renewal nor extra costs for airlines above and beyond what was already planned. As there are no extra costs, the cost-effectiveness cannot be calculated.

3. Assess cost-effectiveness of measures

The cost-effectiveness assessment of these measured showed that:

- Reducing the use of secondary runways again proved cost-effective;
- Stimulating airlines to use quieter aircraft is not cost-effective and hardly contributes to the noise objectives;
- Banning noisy aircraft leads to significant cost increases for airlines and contributes – to a limited extend – to the noise objectives;
- The noise objectives can only be achieved by a combination of measures.

Round 3 (February – May 2024)

In May 2024 the Ministry proposed a new combination of measures to be implemented in 3 phases:

Phase 1: November 2024

- Use of quieter aircraft during nighttime period by KLM. Other airlines announced that they could not contribute to this measure.

Phase 2: November 2025

- Reduce use of secondary runways;
- Additional fleet renewal;
- Stimulate airlines to use quieter aircraft;
- Ban on noisy aircraft during nighttime period;
- Reduce night capacity to 27,000 movements;
- Reduce overall capacity to 460,000 – 470,000 movements;

Phase 3: November 2026

- The government considers a (partial) night curfew. However, this requires more research and a separate Balanced Approach procedure which takes additional time.

Phase 1 and 2 should contribute around 17% of the noise objectives. Phase 3 should cover the remaining 3% of the noise objectives for the entire day.

Stakeholders were invited by the Ministry to share their views on the new combination of measures in an additional consultation. The consultation was open between 24 May and 21 June 2024. The consultation document can be found here.

Round 3 (February – May 2024)

The additional consultation yielded 218 responses. Based on these responses and a court ruling (the RBV case), the Ministry decided to change the combination of measures as follows:

- Use of quieter aircraft during nighttime period by KLM (delayed to November 2025 due to timing of slot allocation process);
- Reduce use of secondary runways (removed due to opposition from local residents and operational difficulties).

Furthermore, it appeared that the noise calculations differed from those of stakeholders. The underlying assumptions and data were compared. This led to various changes in the assumptions and data used. Also, the Ministry decided to use a less conservative uncertainty range for the influx of new aircraft.

With these changes the 17% noise reduction - anticipated for November 2025 - could be achieved with a smaller reduction in overall capacity (475,000 movements).

Later it appeared that the noise calculations might underestimate the actual noise impacts of the various measures. Therefore, the government decided to assume a bandwidth of 475,000 to 485,000 movements for the overall capacity.

Round 3 (February – May 2024)

The following (amended) combination of measures was therefore notified to the European Commission in September 2024:

- Use of quieter aircraft during nighttime period by KLM;
- Additional fleet renewal;
- Stimulate airlines to use quieter aircraft;
- Ban on noisy aircraft during nighttime period;
- Reduce night capacity to 27,000 movements;
- Reduce overall capacity to 475,000 – 485,000 movements.

The combination of measures was expected to reach the anticipated 17% noise reduction for the entire day in November 2025. The amended notification document can be found here.

The (new) government decided to monitor the results of this combination for one year. Additional measures required to reach the full noise objectives for the entire day are therefore not expected before 2027. Possible future measures are not part of the notification.

Later, new noise calculations showed that overall capacity might need to be reduced to 465,000 – 470,000 movements to achieve the noise objectives. In response, the Ministry reduced the noise target for November 2025 from 17% to 15% (for the entire day) in order to keep the overall capacity within the notified bandwidth. A bandwidth of 475,000 – 480,000 has been assumed in this 4th assessment.

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Appendix B: Key figures and methods

Key figures – operational costs

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Operational costs per block hour airlines:

The operating costs per block hour depend on the size of the aircraft, the age of the aircraft, type of airline (network carrier or low-cost/charter) and region of the world (due to differences in wages / social premiums etc). For estimating the impacts of longer flight times at Schiphol we use operating costs that best resemble the local situation.

For KLM the operating costs per block hour were estimated based on their annual reports. For European network carriers we use the same values as their cost structure likely resembles that of KLM. For non-European network carriers the operational costs per block hour for US carriers are used (as published by the FAA). Cargo flights are often operated by non-European carriers. Therefore, we also use the FAA values for cargo carriers. For low-cost carriers and charters we use the operating costs per block hour for easyJet. Some ultra low-cost carriers as Ryanair and Wizz Air may operate at even lower costs, but others might have higher costs. This results in the following (right table in prices 2018):

- KLM & European network carriers: use the estimated values per aircraft category for KLM;
- Non-European network carriers: use the values estimated by the FAA;
- Cargo flights: use the values estimated by the FAA, except for KLM;
- Low-cost carriers & charters: use the easyJet values for 2018.

Prices 2018 euro's and total with CPI correction 2023

Airline category	Variable costs				Fixed costs					Total	
	Fuel	Maintenance	Crew	*Subtotal*	Depreciation	Rentals	Insurance	Other	*Subtotal*	Prices (2018)	CPI correction (2023)
KLM & European network carriers											
Wide-body more than 300 seats	6.406	2.080	3.098	*11.583*	1.215	316	33	-	*1.564*	**13.147**	**-16.026**
Wide-body 300 seats and below	4.830	2.014	2.442	*9.286*	985	285	33	-	*1.303*	**10.588**	**-12.906**
Narrow-body more than 160 seats	2.432	1.122	1.515	*5.068*	510	169	25	-	*704*	**5.772**	**-7.036**
Narrow-body 160 seats and below	2.061	1.152	1.360	*4.572*	440	167	41	-	*648*	**5.221**	**-6.364**
RJ more than 60 seats	136	673	584	*1.393*	188	196	8	-	*393*	**1.786**	**-2.177**
Non-European network carriers											
Wide-body more than 300 seats	4.582	1.127	1.995	*7.703*	715	344	3	1	*1.062*	**8.765**	**-10.684**
Wide-body 300 seats and below	3.455	1.091	1.572	*6.119*	580	310	3	3	*896*	**7.015**	**-8.551**
Narrow-body more than 160 seats	1.739	608	975	*3.323*	301	184	3	6	*493*	**3.815**	**-4.650**
Narrow-body 160 seats and below	1.474	624	876	*2.974*	259	182	4	6	*451*	**3.425**	**-4.175**
Cargo flights											
Four-engine wide-body (KLM)	6.693	3.667	2.639	*12.999*	976	2.668	197	-	*3.842*	**16.841**	**-20.529**
Four-engine wide-body (other)	4.787	1.987	1.699	*8.473*	575	2.903	20	19	*3.517*	**11.992**	**-14.618**
Three-engine wide-body	4.134	4.025	1.949	*10.108*	964	216	18	174	*1.371*	**11.478**	**-13.991**
Two-engine wide-body	2.570	1.682	1.782	*6.033*	719	379	24	111	*1.233*	**7.266**	**-8.857**
Narrow-body more than 160 seats	1.981	2.412	1.879	*6.272*	1.183	150	26	93	*1.451*	**7.723**	**-9.414**
Narrow-body 160 seats and below	1.119	479	1.327	*2.925*	244	-	39	147	*430*	**3.356**	**-4.091**
Low-cost carriers & charters											
Narrow-body	1.230	325	699	*2.255*	207	158			*365*	**2.619**	**-3.192**

Key figures – Aircraft utlization and VOT

Aircraft utilization costs:

Measures that limit airport opening hours may reduce the number of flights an aircraft can make. This means that aircraft utilization is affected, and airlines need more aircraft to operate the same amount of flights. This leads to higher fixed costs. When aircraft utilization (block hours per aircraft) decreases by x percent, the number of aircraft required increases by 1/(1-x%)-1 percent. Its fixed operating costs increase by the same percentage.

Box. Illustration

Suppose an airline operates 40 return flights per day, each requiring 2.5 block hours. This amounts to 100 block hours per day. It has a fleet of 10 aircraft which each operate 4 return flights per day requiring 10 block hours. Due to limited opening times at an airport, its aircraft utilization reduces from 4 to 3 return flights per day and each aircraft only operates for 7.5 hours per day (-25%). This means that with its fleet of 10 aircraft it can only operate 75 block hours per day. To operate its full schedule with 100 block hours it needs 1/(1-25%)-1 = 33% or 3.3 additional aircraft.

We can use the fixed operating cost per block hour in the table of the previous slide to estimate the additional costs as a result of reduced aircraft utilization. So, when the average number of block hours decrease by x percent, the fixed costs in table 7 increase by 1/(1-x%)-1 percent.

Time travel costs (VOT) passengers and freight

The generalized time travel costs are based on the value of time studies coming from the Dutch Kennisinstuut voor Mobiliteitsstudies (KiM) in 2023 (Nieuwe waarderingskengetallen voor reistijd, betrouwbaarheid en comfort, KiM December 2023). In these studies value of time (VOT) per hour are derived from stated preference surveys conducted among business and non-business travellers.

Travel Motive air passenger	VOT per hour (2022)	VOT per hour (2023)**
Business	€ 110	€ 114
Non-business (leisure, VFR)	€ 54	€ 56
Average*	**€ 62**	**€ 64**

** Weights are based on the distribution of motives in traveled minutes from the Schiphol survey (Schiphol Enquete) 2022 (Business: 14,2%; Non-Business: 85,8%)*

*** CPI of 2023*

Freight	VOT per hour (2022)	VOT per hour (2023)*
Average per flight	€ 5.545	€ 5.758

** CPI of 2023*

Key figures – external effects

External effects are the effects caused by the aviation industry that impact climate change and the living environment (f.i. air quality, noise pollution, external safety, nature). In this study we quantify the effects of climate change and air quality when a meaure reduces flights on a global level. The effects of noise pollution are already assessed in the cost effectiveness per reduction of annoyed household and persons.

Climate effects

CO_2 emissions of aircraft contribute to climate change on a global level. When the number of flights stays the same we do not assume a change in CO_2 emissions with respect to the baseline scenario. However, there may be small impacts due to the use of different runways. These changes fall in the so-called margin of error.

When the total number of flights changes there will be an impact on CO2 emissions. This is only the case in the 465-470k scenario. Some passengers that cannot be accomodated at Schiphol deviate to other airports, which will increase the number of flights at those airports. For a correct calculation of the global CO2 impacts it is therefore relevant to estimate the number of passengers that no longer use air transport. The reduction in total passenger demand is estimated based on price elasticities summarized in various studies (PriceWaterhouseCoopers, 2005; Intervistas, 2007; Morlotti et al., 2017).

To calculate the reduction in fuel consumption and CO_2 emissions of these flights we use the ICAO Eurocontrol emission calculator (Version 5.11 7 december 2021). In this tool we can differentiate between aircraft type and distance to destination flown. To estimate the effect in euro's we use the CO_2 effective price (used in the models and scenario's build by Central Planning Bureau) in 2025 of 97 euro per tonne.

Next to CO_2 emissions also other substances have an impact on climate change such as nitrogen oxides, water vapor, sulphur dioxide and soot (Werkwijzer luchtvaartspecifieke MKBA's, SEO, Decisio, 2021). The climate effects of these non CO_2 components are not easy to determine as they depend on different factors like flight altitude, location, timing and atmospheric composition. Therefore, to estimate these non CO_2-emissions we use a factor of 1 on the estimated CO_2-effect recommended in the guidline of aviation SCBA's (SEO, Decisio, 2021).

Air quality

To estimate the net effects on air quality we look at the emissions of nitrogen oxide (NO_x) and particle matter (PM_{10}) in the LTO-cycle. See table below for the key figures and prices.

	Narrowbody	Widebody	Price per kg
NOx KG per cycle	4,0	7,5	€ 50,2
PM10 kg per cycle	0,3	0,3	€ 65,1

Source: ICAO Aircraft engine Emissions Databank, Feb 2023 and emission prices WLO-Hoog, PBL/CPB

Key figures – economic impact and agglomeration effects

Economic impact Schiphol

Calculation of the economic impact of measures are based on the economic impact studies of Decisio in 2018 considering an update of the total economic impact of Schiphol and the economic impact of the air cargo and freight sector at Schiphol. In 2024 these overall figures of total economic impact Schiphol were updated with new CBS data for the year 2023. For reference, in 2018 there were a total of 500.000 flights at Schipholand in 2023 around 442.000 flights.

In these studies a thorough analysis of the amount of people employed directly at Schiphol and outside Schiphol including the value added was conducted. In addition also the indirect economic impacts were assessed with the backward linkages of the supplying sectors to the aviation industry currently active at Schiphol.

The amount of employed persons are used to calculate the government costs of unemployment allowances (approx. 17.000 euro's per employed person) yearly and decrease in tax revenues (approx. 5.000 euro's per FTE) because of frictional unemployment of 5 percent the total number of employed persons decreases in the short-term.

Total economic impact Schiphol 2018 and 2023 (updated 2024)

	Value added		Jobs	
	2018	2023	2018	2023
Direct	€ 7.300	€ 8.280	68.400	66.800
Indirect	€ 3.080	€ 3.490	45.500	44.400
Totaal	**€ 10.380**	**€ 11.770**	**113.900**	**111.200**

Source: CBS (2024) en Decisio (2019); Decisio 2024

Economic impact air cargo/freight Schiphol (2018)

	Employed persons	FTE	Valued added	Valued added (2021)
Direct	**16.000**	**14.200**	**€ 1.840**	**€ 1.892**
Air freight at Schiphol	11.700	10.400	€ 1.360	€ 1.398
Air freight outside Schiphol	4.300	3.800	€ 480	€ 494
Indirect backwards	**14.600**	**11.200**	**€ 880**	**€ 905**
Inside Greater Amsterdam Area	10.400	7.800	€ 610	€ 627
Rest of the Netherlands	4.200	3.400	€ 270	€ 278
Totaal (direct + indirect)	**30.600**	**25.400**	**€ 2.720**	**€ 2.797**

Source: Economic impact of Air Freight at Schiphol Airport, Decisio 2018

Additional agglomeration effects

The direct impacts on connectivity, accesibility and travelling costs for passengers, freight and airlines have impacts on the attractivity of the Schiphol area as a business location and in terms of productivity, knowledge spillovers and innovation. These additional agglomeration effects are estimated by Elhorst et. al (2004) between zero to thirty percent of the direct effects on connectivity and (generalized) travel costs. In this study we use the mean value of fifteen percent.

Deviation costs for passengers

To70 has canceled flights according to the method described earlier. We merged this list of canceled flights with a dataset of Schiphol in 2019 containing the average number of OD travelers on a flight of a specific airline/destination combination.. By multiplying these averages per flight by the number of these types of canceled flights, we arrive at a decrease of more than four and a half million OD passengers. These passengers can divert to other airports. We use six** (larger) airports for this, because it is not realistic that one (nearby) airport can accommodate all diverting passengers. We multiply the average travel time to these airports by the value of time of airline passengers. We apply the rule-of-half to the part of travelers we expect not to divert.

*Brussels, Düsseldorf, Eindhoven, Frankfurt, London (Heathrow) & Paris.