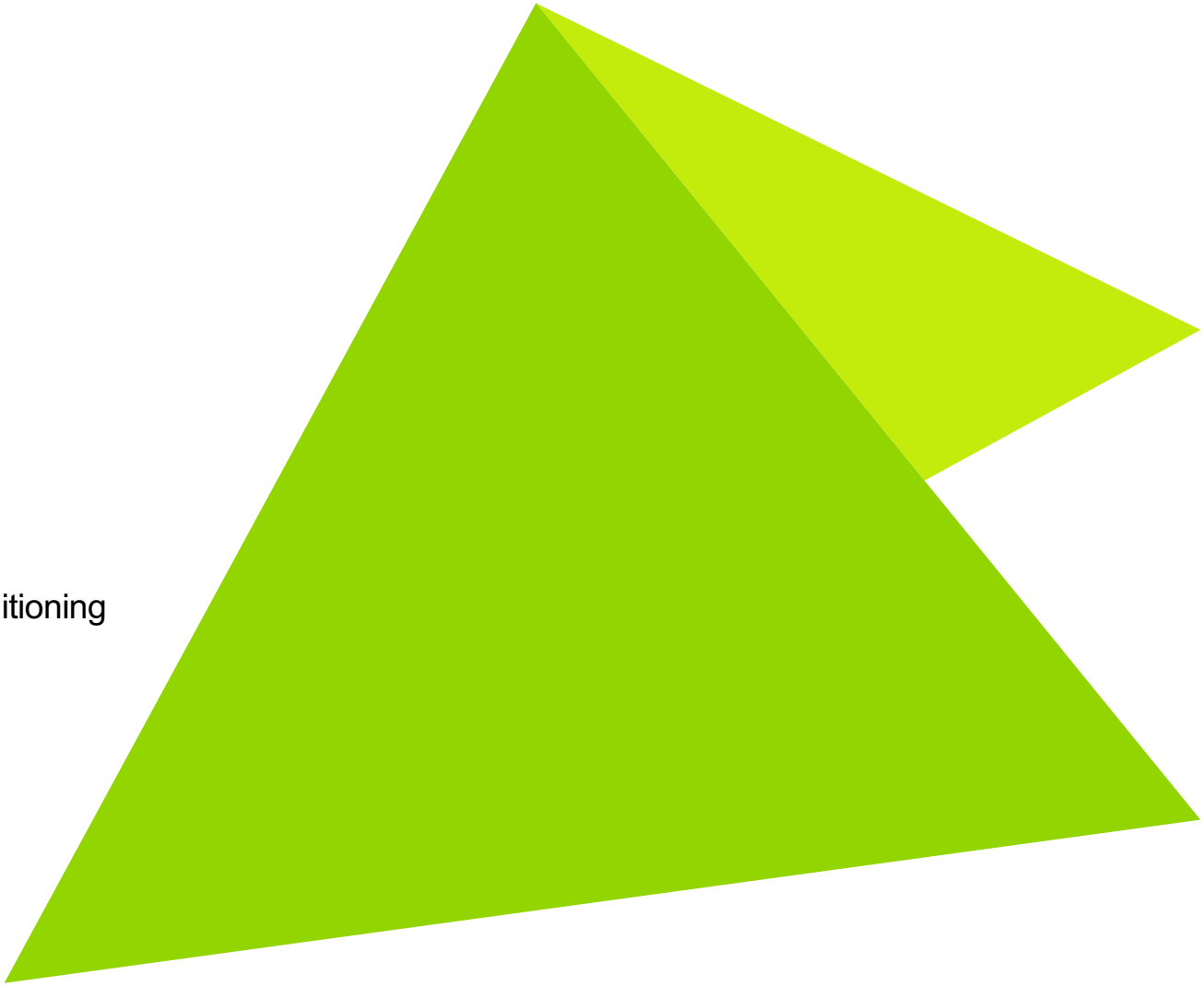
Guidehouse
Outwit *Complexity*

Solar shading

A cost-effective means to stop rising air-conditioning needs in Europe

Dr. Andreas H. Hermelink



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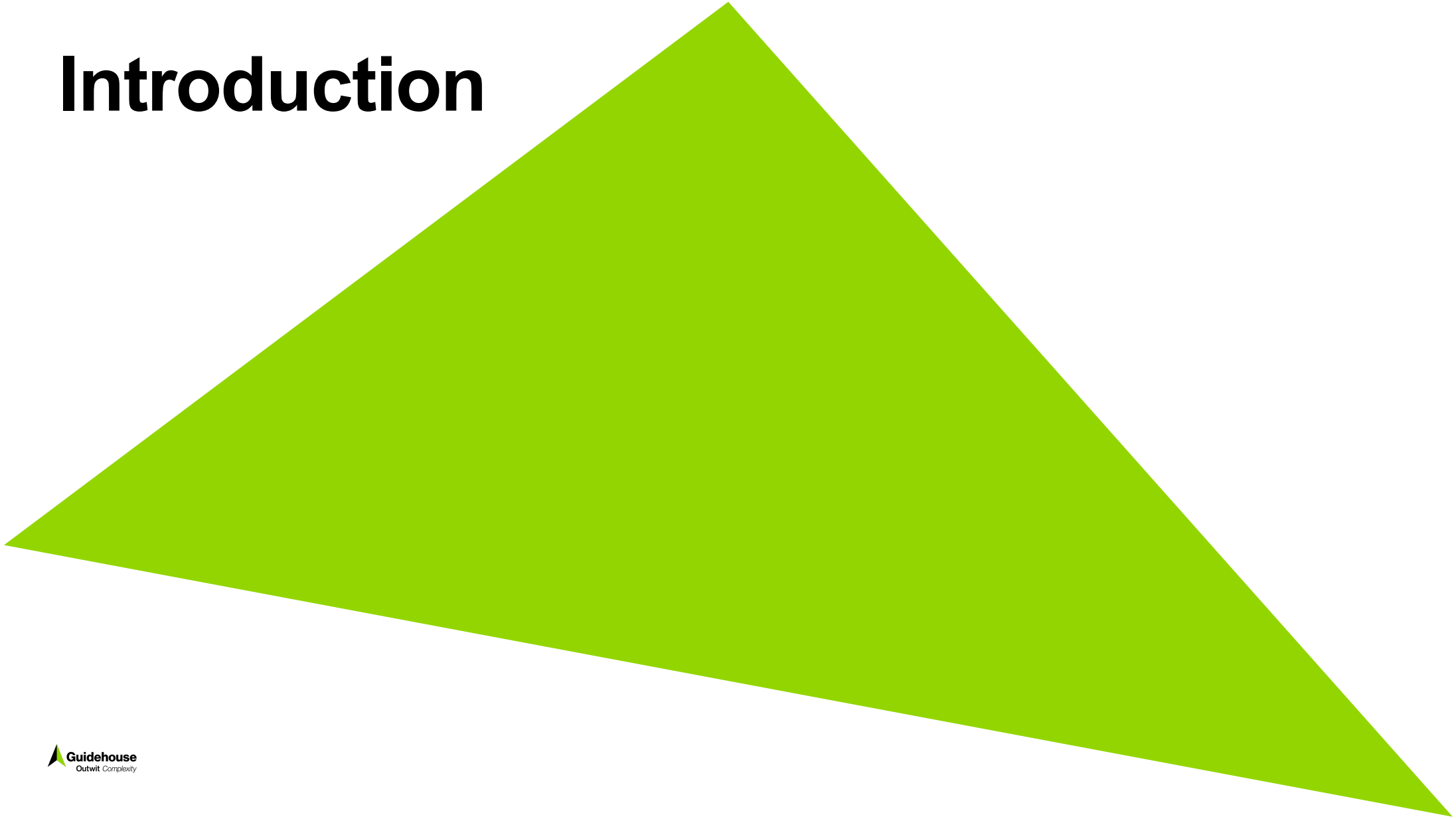

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What‘s the problem?

Soaring need for Air-Conditioning (AC)

The International Energy Agency (IEA) estimates air conditioners (AC) in Europe to soar from 115 million units in 2020 to 275 million units in 2050.

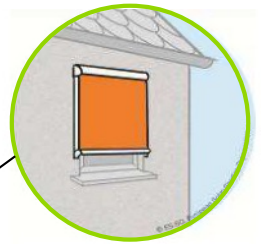
Impact

- More AC units need more electricity
- More electricity leads to higher GHG emissions
- Higher GHG emissions from AC increase the risk to miss the climate neutrality by 2050 target

What‘s the solution?

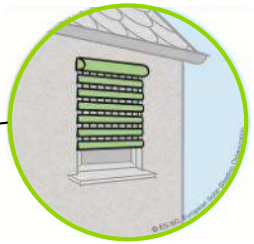
Hypothesis

Dynamic/Smart solar shading devices on windows are a key technology to limit additional electricity use and associated GHG emissions for space cooling.

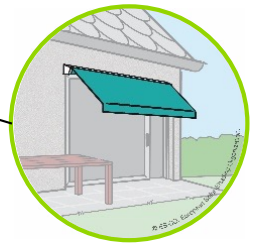


External
roller blinds

External
venetian blinds



Roller shutters



Window awnings

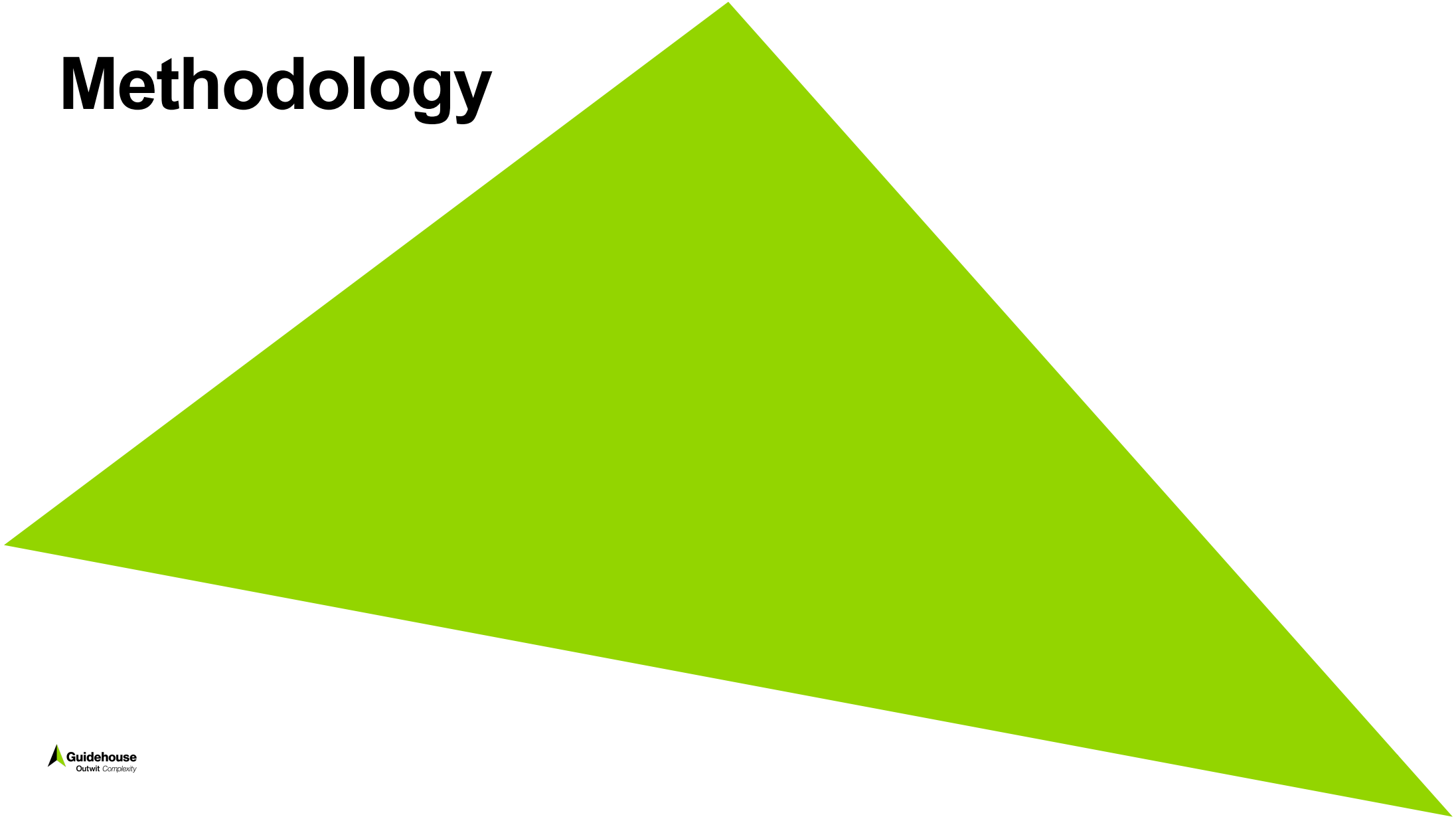
Questions to be addressed

How would the need for air-conditioning likely develop without any improvement in solar shading?

To what extent can dynamic solar shading mitigate this development?

What is the best possible estimated impact dynamic solar shading could have?

Methodology



General methodological approach

Stage 1

Determinants of overheating in buildings?

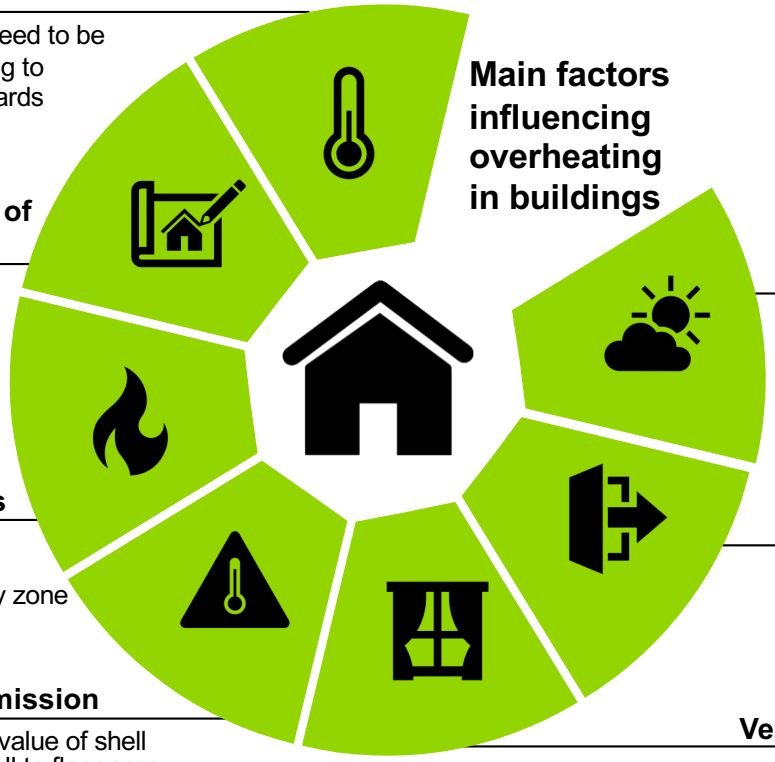
Stage 2

Simulation of overheating risk in typical buildings incl. different types of shading and smartness

Stage 3

Aggregation into three shading **scenarios** with different assumptions on shading uptake

What determines overheating?



Thermal comfort perception & affordability

- assumptions need to be made according to relevant standards

Thermal mass of the building

- façade
- floor
- roof
- internal
- walls

Internal heat loads

- persons
- appliances
- daily load profiles by zone

Heat transmission

- average U-value of shell
- specific shell to floor area

Climate

- location
- change over time (climate change, urban heat island effect)

Entry transmission of shortwave radiation

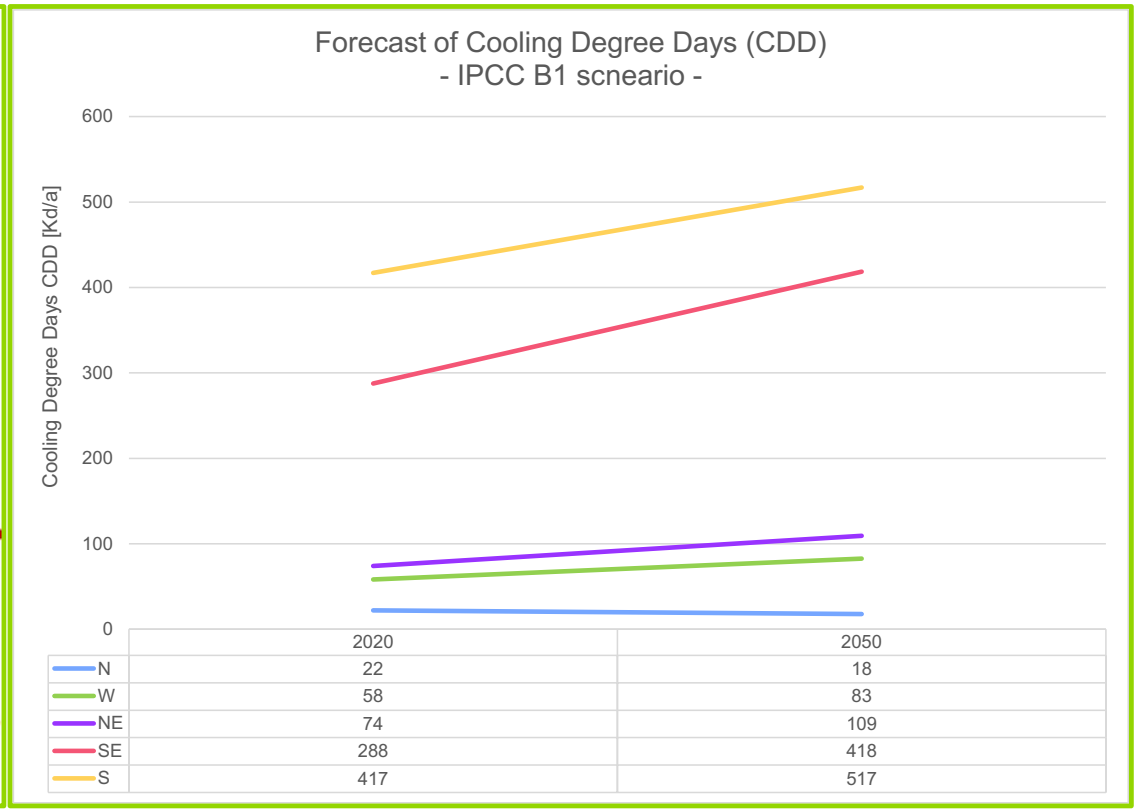
- solar shading: total shading factor (g*Fc) and operation parameters
- specific window to floor area
- orientation
- external shading by surroundings

Ventilation

- infiltration
- mechanical ventilation
- window opening by user

Climate change as main driver for increasing overheating

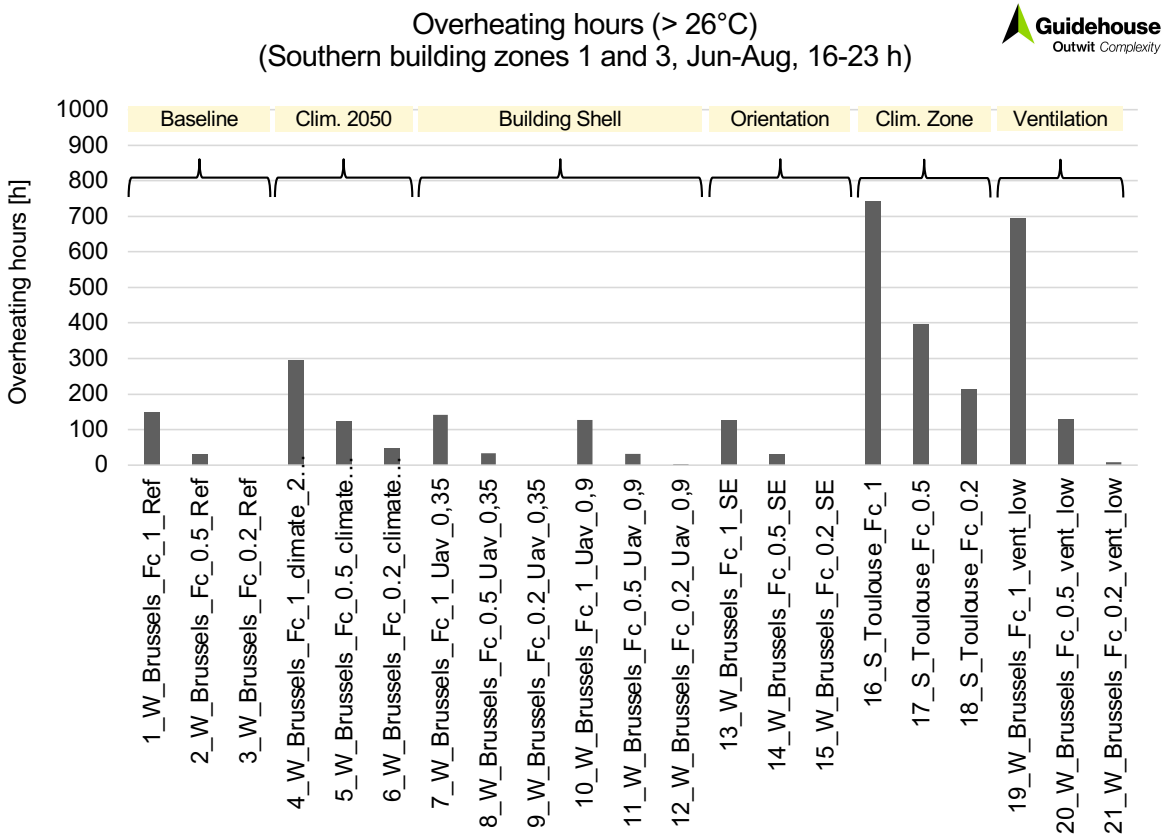
Climate zones and cooling degree days forecast



	2020	2050
N	22	18
W	58	83
NE	74	109
SE	288	418
S	417	517

Simulation of overheating risk in typical buildings (SFH)

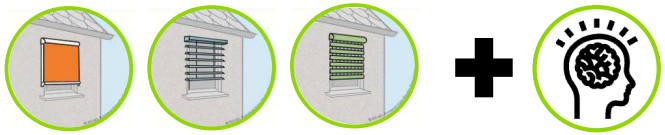
Results overview of sensitivity analysis (Overheating: > 26°C)



1. **“no shading”**

2. **“mod. shading”**
   moderate shading (50% reduction solar gains, no automation)

3. **“opt. shading”** / dynamic shading
   optimised shading (85% reduction solar gains, best practice automated)



Simulation of overheating risk in typical buildings

Observations for overheating hours > 26°C

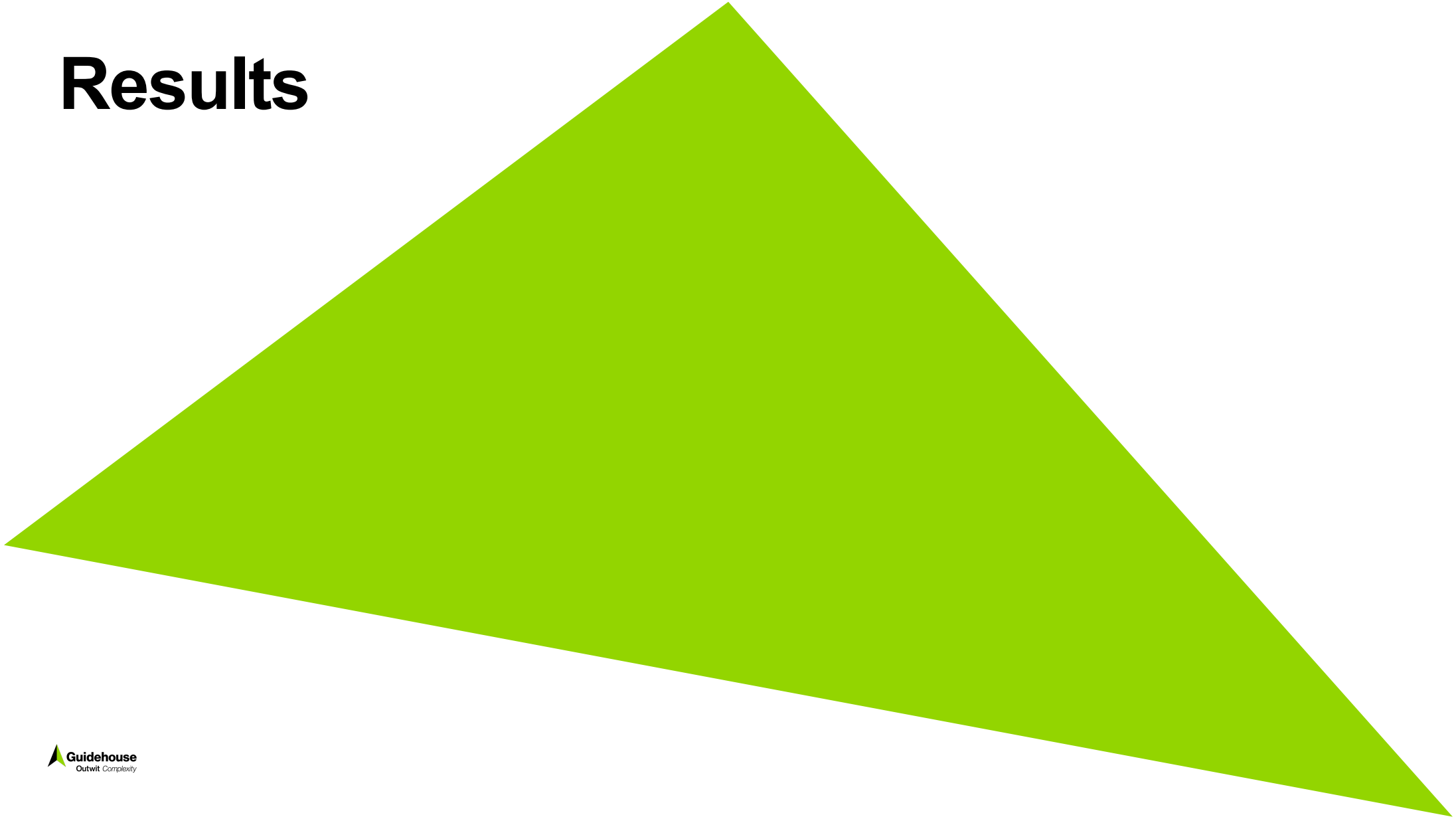
High Impact

- **Optimised dynamic shading** can significantly reduce overheating hours > 26 °C (close to „0“ for **Fc**=0.2)
- **Climate data year (2020 vs. 2050)**
- **Climate zone / location**
- **Ventilation**

Low Impact

- **Building envelope** quality
- **Orientation**

Results



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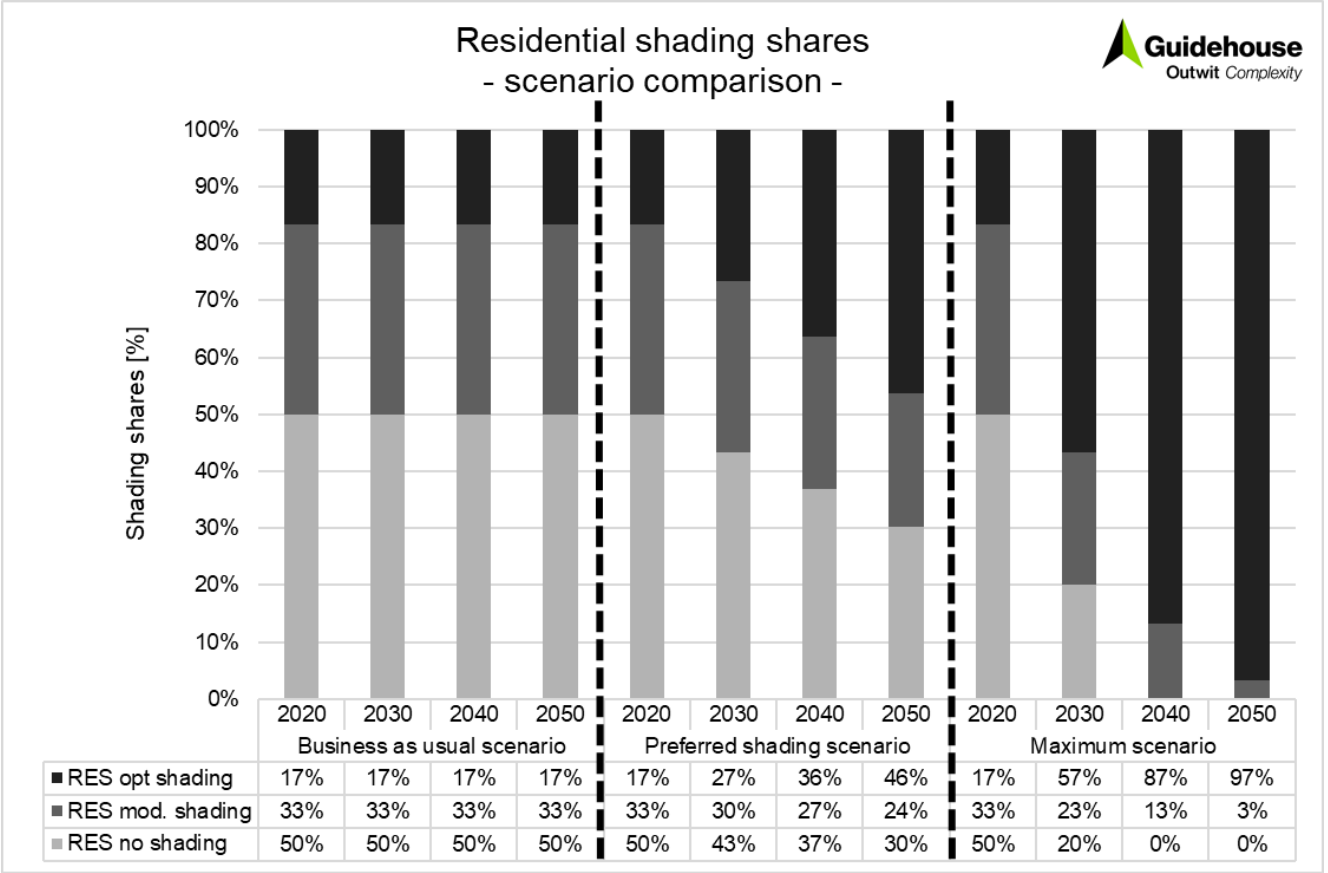
Aggregation into three shading scenarios

Scenarios having different assumptions on shading uptake

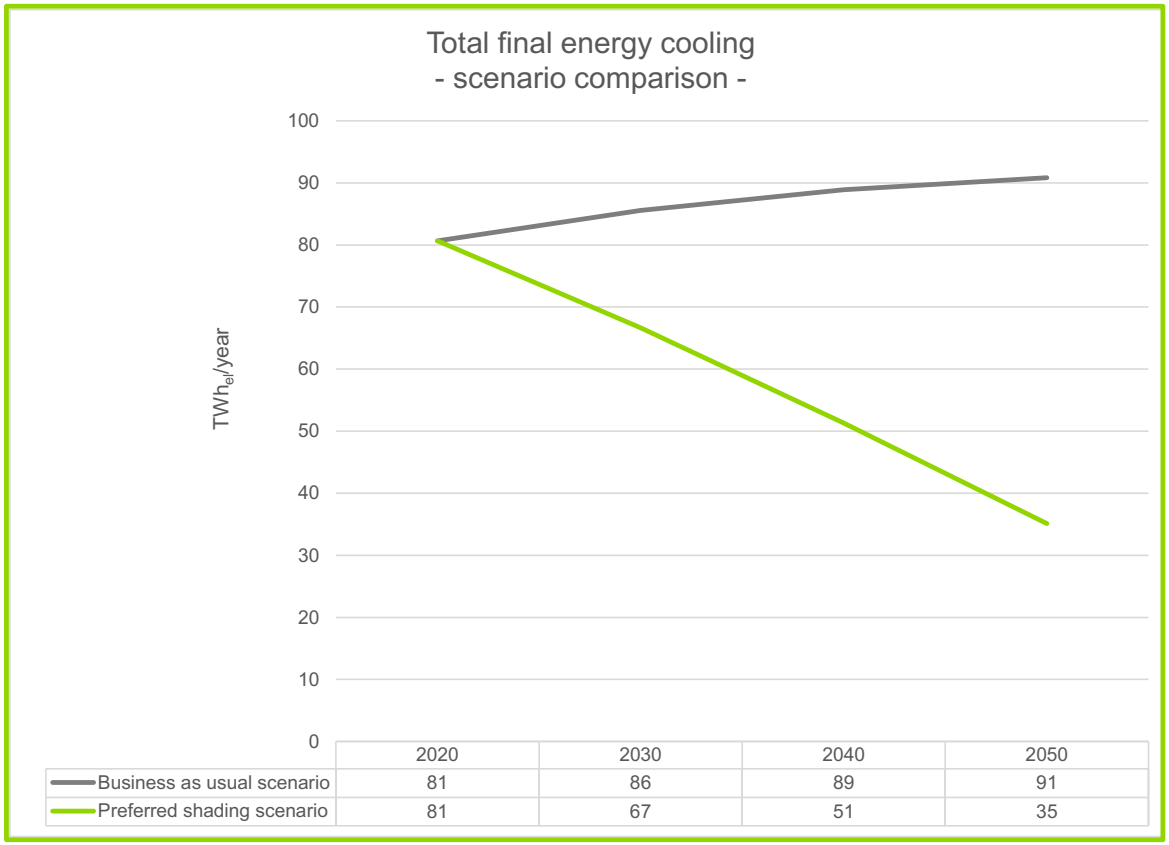
- Business as usual scenario (BAU)
  - Current distribution of shading devices across Europe remains unchanged until 2050
- Maximum scenario
  - Analysis of theoretical potential for optimal, dynamic shading in all European buildings until 2050
- **Preferred scenario**
  - Economically **optimised** scenario
  - Optimal, dynamic shading is installed only, but in all cases where otherwise air-conditioning would be installed by 2050 in BAU scenario



	2020	2030	2040	2050	2020	2030	2040	2050	2020	2030	2040	2050
	Business as usual scenario				Preferred shading scenario				Maximum scenario			
RES opt shading	17%	17%	17%	17%	17%	27%	36%	46%	17%	57%	87%	97%
RES mod. shading	33%	33%	33%	33%	33%	30%	27%	24%	33%	23%	13%	3%
RES no shading	50%	50%	50%	50%	50%	43%	37%	30%	50%	20%	0%	0%

Final energy savings

Business as usual scenario vs. preferred scenario



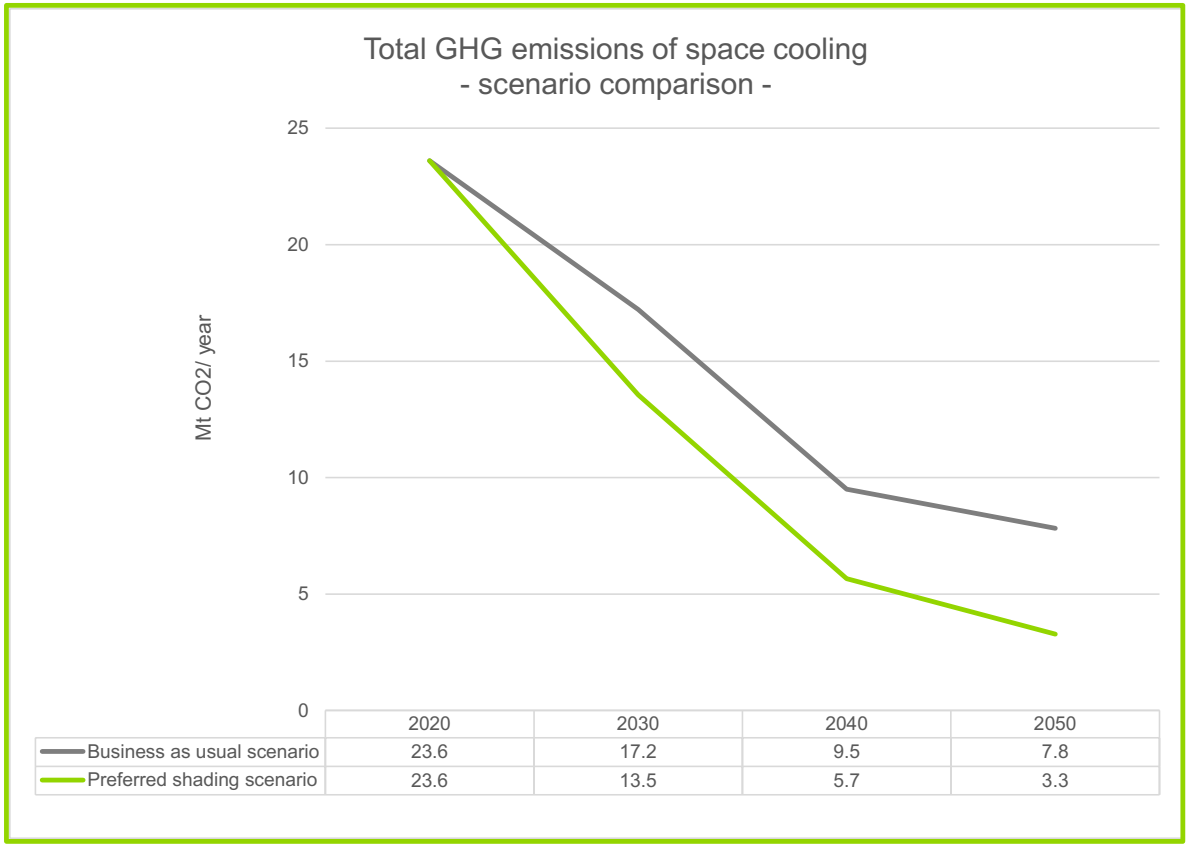
	2020	2030	2040	2050
Business as usual scenario	81	86	89	91
Preferred shading scenario	81	67	51	35

- **Very significant final energy savings in preferred scenario of up to ≈ 60% (2050)**

- Improving AC efficiency until 2050 is already considered

Reduction of greenhouse gas emissions

Business as usual scenario vs. preferred scenario



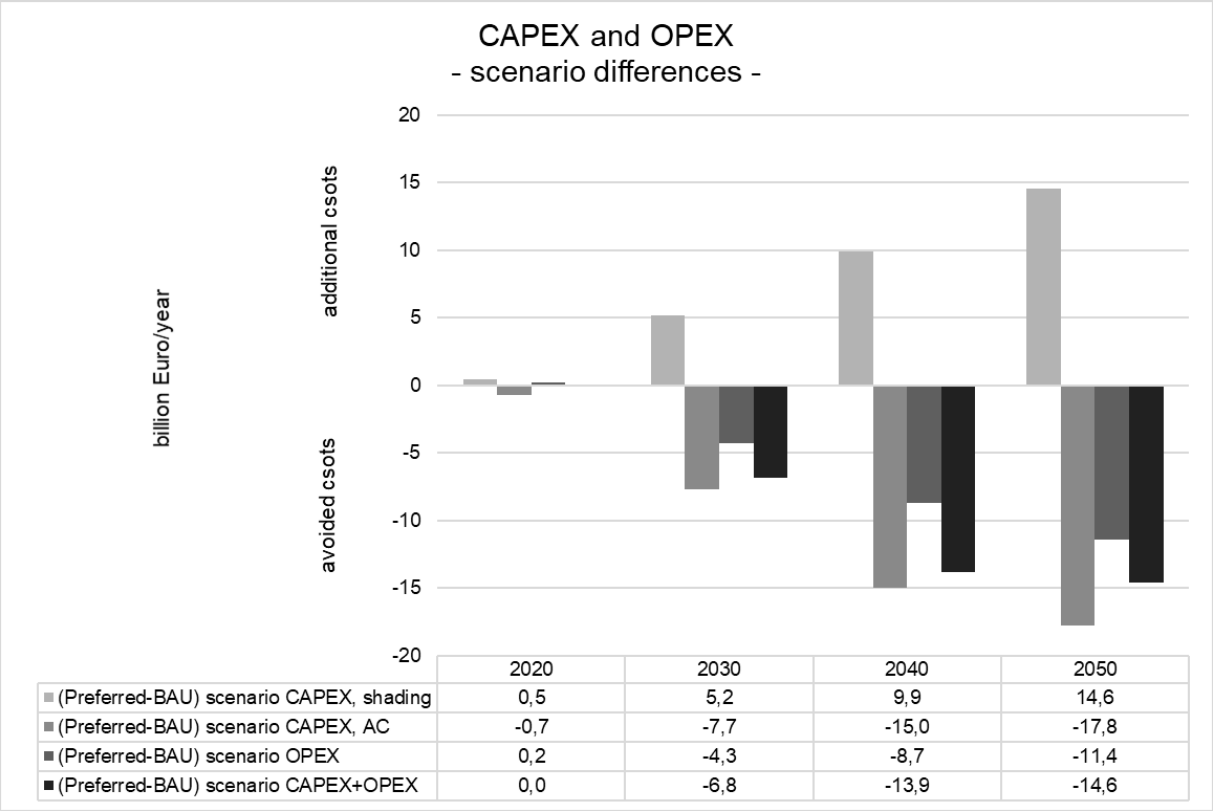
	2020	2030	2040	2050
Business as usual scenario	23.6	17.2	9.5	7.8
Preferred shading scenario	23.6	13.5	5.7	3.3

- **Very significant GHG savings in preferred scenario of up to 58% (2050)**

- Decarbonisation of electricity until 2050 is already considered and in line with the EPBD Impact Assessment 2021.

Cost savings: Annual CAPEX & OPEX

Difference between preferred and BAU scenario



	2020	2030	2040	2050
(Preferred-BAU) scenario CAPEX, shading	0,5	5,2	9,9	14,6
(Preferred-BAU) scenario CAPEX, AC	-0,7	-7,7	-15,0	-17,8
(Preferred-BAU) scenario OPEX	0,2	-4,3	-8,7	-11,4
(Preferred-BAU) scenario CAPEX+OPEX	0,0	-6,8	-13,9	-14,6

Columns show (left to right)

- CAPEX for additional dynamic shading (annuity)
- CAPEX for avoided AC units (annuity)
- OPEX for energy and maintenance savings
- Net savings

➢ **Optimised uptake of dynamic shading is highly cost-effective**

- CAPEX for additional dynamic solar shading is (over-) compensated by avoided CAPEX in AC
- Significant savings on electricity costs

Conclusions and EPBD recommendations

New recommendations for EPBD

The EPBD should **enable** dynamic solar shading (= energy efficiency measure) being considered on an **equal footing** with air-conditioning (cf. EC's EE1st recommendation).

- **Require the EE1st principle** for setting up minimum energy performance requirements

  by 'improving first the performance of the building envelope before other measures are applied' (cf. EC's EE1st guidelines)

- **Introduce mandatory due diligence for overheating** in new buildings & retrofits, applying EE1st principle

  stipulate to first apply solar shading as far as this is technically, functionally and economically feasible and only then consider active air-conditioning if still needed

- **Link building envelope and technical building systems** via building automation and control (BACS)

  Dynamic solar shading is a bivalent building element, uniting building envelope and technical building systems (TBS) through its smart control and automation. This unification has already taken place in standards (EN 15232) and in the Smart Readiness Indicator (SRI). EPBD articles currently lag behind by linking BACS only to TBS, but not to elements of a dynamic building envelope.

Suggestions for updates of EPBD articles (1/2)

- **Art. 3a (building automation and control systems)**
  'building automation and control systems … support … technical building systems or elements of the building envelope … '

- **Art. 4 (setting of minimum energy performance requirements)**
  add EE1st principle: e.g. 'Minimum energy performance requirements need to be set with a view to the EE1st principle: first energy **needs** for space heating, space cooling, domestic hot water, ventilation and lighting need to be reduced in so far as this is technically, functionally and economically feasible, and then need to be provided by optimised TBS according to Art. 8.'

Suggestions for updates of EPBD articles (2/2)

- **Art. 5 (Calculation of cost-optimal levels of minimum energy performance requirements)**
  indirect update applying Art. 22, requiring to update Annex I (points 3 and 4) to technical progress, with a focus on existing delegated regulations, e.g. the one on cost-optimality, where so far dynamic solar shading lacks 'equal footing'
  - Update Annex I, point 3 (g): '... solar protection including their controls and integration into BACS'
  - Update cost-optimality delegated regulation and/or guideline with EE1st principle

- **Art. 11 (energy performance certificates)**
  - Currently further harmonisation is discussed
  - This could also include the '**recommendations** for the cost-optimal or cost-effective improvement of the energy performance of a building or building unit' (both for major renovation and building elements)'
  - Harmonisation could be facilitated by a **template**, including recommendations for **standard measures**
  - Standard measures could **include installation or upgrade of solar shading**, based on previous due diligence of overheating
  - Alternatively, this could be included in a tempate for building renovation passports (BRP)

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