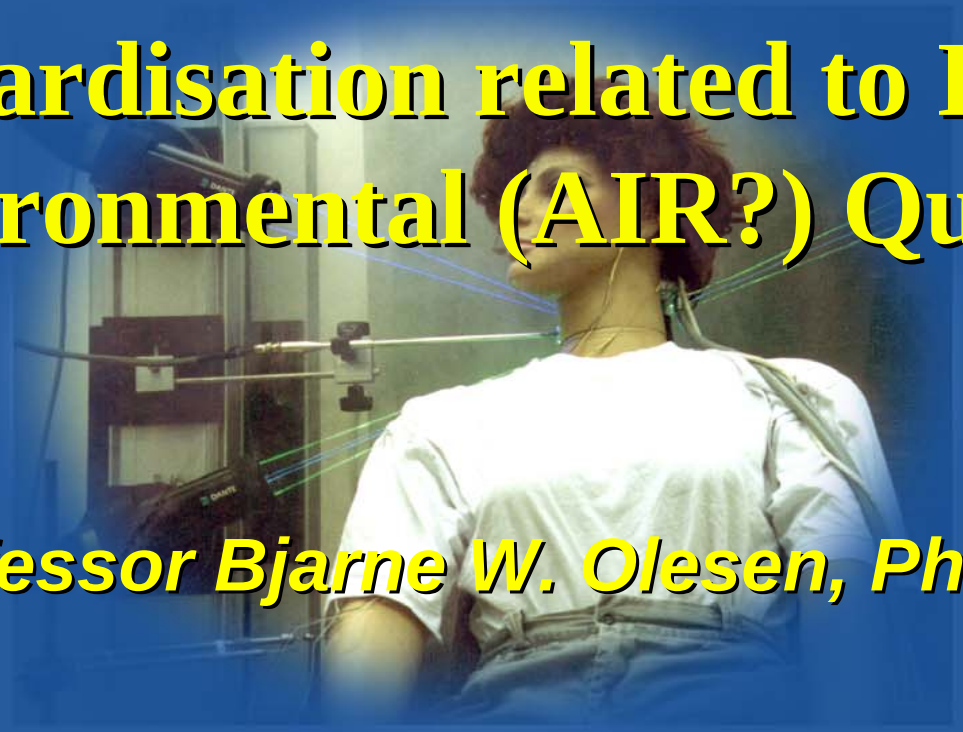
International Centre for Indoor Environment and Energy

Standardisation related to Indoor Environmental (AIR?) Quality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COMFORT-PRODUCTIVITY
Building costs

People	100
Maintenance	10
Financing	10
Energy	1

DIRECTIVE (Art.1)

The objective of the European Energy Directive for Buildings is to promote the improvement of the energy performance of buildings within the Community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness.

DIRECTIVE (Art.7)
Energy performance certificate

- Member States **shall take measures** to ensure that for buildings with a total useful floor area over 1 000 m2 occupied by public authorities and by institutions providing public services to a large number of persons and therefore frequently visited by these persons an **energy certificate, not older than 10 years, is placed in a prominent place clearly visible to the public.**

- The range of recommended and current indoor temperatures and, when appropriate, other relevant climatic factors **may also be clearly displayed**.

DIRECTIVE (Art.11)

- Moreover, the displaying of officially **recommended indoor temperatures**, together with the **actual measured temperature**, should discourage the misuse of heating, air-conditioning and ventilation systems.

- This should contribute to avoiding unnecessary use of energy and to **safeguarding comfortable indoor climatic conditions** (thermal comfort) in relation to the outside temperature.

Achieving Excellence in Indoor Environmental Quality

- **Physical factors**
  - Thermal Comfort
  - Air quality (ventilation)
  - Noise-Acoustic
  - Illumination
- **Personal factors**
  - Activity
  - Clothing
  - Adaptation
  - Expectation
  - Exposure time

STANDARDS

- **ISO EN 7730-2005**
  - Ergonomics of the thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort effects.
- **ASHRAE 55-2004**
  - Thermal environment conditions for human occupancy
- **ASHRAE 62.1 and 62.2 -2004**
  - Ventilation and indoor air quality
- **CR 1752**
  - Ventilation of buildings-Design criteria for the indoor environment
- **EN 13779**
  - Ventilation for non-residential buildings - performance requirements for ventilation and room-conditioning systems

EN15251
(CEN TC156 WG12)

Indoor environmental input parameters for design and assessment of energy performance of buildings- addressing indoor air quality, thermal environment, lighting and acoustics

ENEN 15251-INDOOR ENVIRONMENT

- DESIGN CRITERIA FOR DIMENSIONING OF BUILDINGS AND HVAC SYSTEMS
- INDOOR ENVIRONMENT PARAMETERS FOR ENERGY CALCULATION
- EVALUATION OF THE INDOOR ENVIRONMENT AND LONG TERM INDICATORS
- INSPECTION AND MEASUREMENTS OF THE INDOOR ENVIRONMENT IN EXISTING BUILDINGS
- CLASSIFICATION AND CERTIFICATION OF THE INDOOR ENVIRONMENT

Categories

Category	Explanation
I	High level of expectation and is recommended for spaces occupied by very sensitive and fragile persons with special requirements like handicapped, sick, very young children and elderly persons
II	Normal level of expectation and should be used for new buildings and renovations
III	An acceptable, moderate level of expectation and may be used for existing buildings
IV	Values outside the criteria for the above categories. This category should only be accepted for a limited part of the year

Indoor Environmental Criteria

- Thermal
- AIQ (Ventilation)
- Acoustic
- Illumination

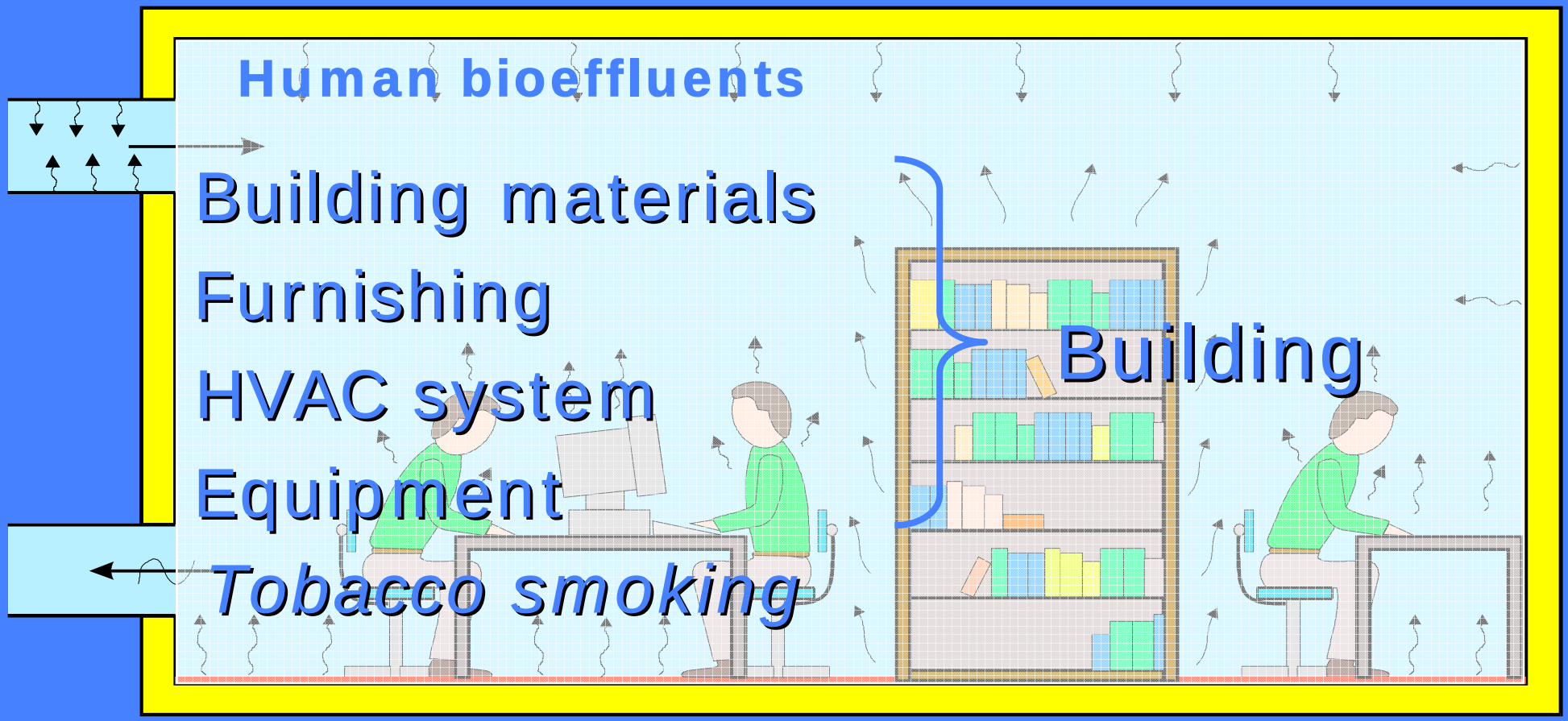
Recommended categories for design of mechanical heated and cooled buildings

Category	Thermal state of the body as a whole		Local thermal discomfort			
	PPD %	Predicted Mean Vote	Draught Rate, DR %	Vertical air tempe-rature difference %	Warm or cool floor %	Radiant Tempe-rature Asymmetry %
I	< 6	-0.2 < PMV < + 0.2	<10	< 3	< 10	< 5
II	< 10	-0.5 < PMV < + 0.5	<20	< 5	< 10	< 5
III	< 15	-0.7 < PMV < + 0.7	<30	< 10	< 15	< 10
IV	> 15	PMV<-0.7; or 0,7<PMV	>30			

Temperature ranges for hourly calculation of cooling and heating energy in three categories of indoor environment

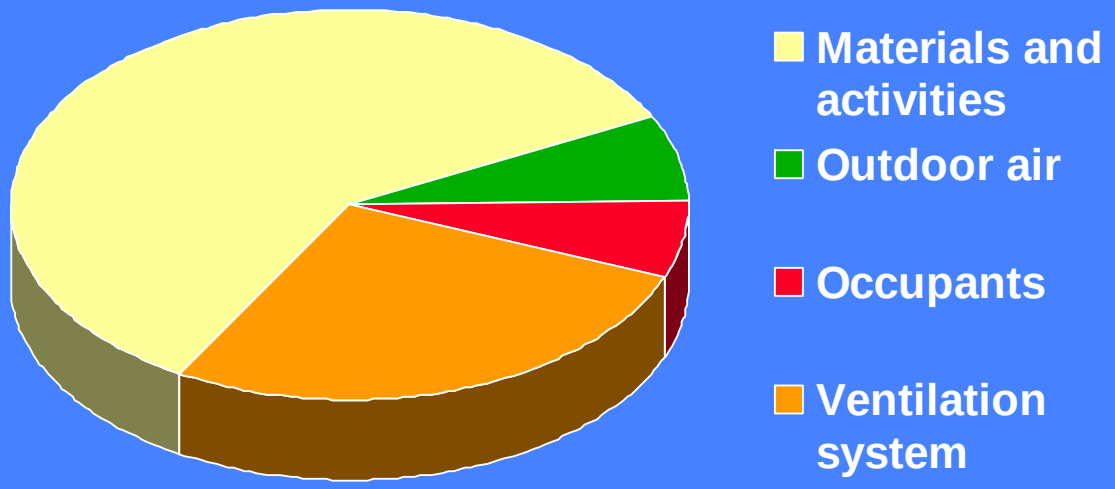
Type of building/ space	**Category**	**Operative Temperature for Energy Calculations** °C	
Offices and spaces with similar activity (single offices, open plan offices, conference rooms, auditorium, cafeteria, restaurants, class rooms, Sedentary activity ~1,2 met		**Heating (winter season), ~ 1,0 clo**	**Cooling (summer season), ~ 0,5 clo**
	I	**21,0 – 23,0**	**23,5 - 25,5**
	II	**20,0 – 24,0**	**23,0 - 26,0**
	III	**19,0 – 25,0**	**22,0 - 27,0**

Indoor pollution sources



European Audit Project to Optimise Indoor Air Quality and Energy consumption in Office Buildings

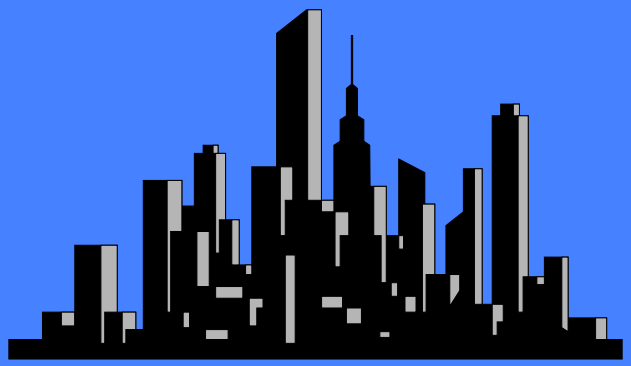
Sensory pollution load- perceived air quality



Concept for calculation of design ventilation rate

People Component

Building Component



Breathing Zone Outdoor Airflow

$$V_{bz} = R_p P_z + R_s S_d + R_a A_z$$

- R_p: Minimum l/s/Person
- P_z: Number of People
- R_s: Ventilation per Smoker
- S_d: Number of Smokers
- R_a: Building Area
- A_z: Minimum l/s/m²

Existing standards prescribe mediocrity.

CEN CR 1752
ASHRAE 62

The Princess on the Pea

DISSATISFIED

20%

< 1

7

140 L/s • p

VENTILATION

Basic required ventilation rates for diluting emissions (bio effluents) from people for different categories

Category	Expected Percentage Dissatisfied	Airflow per person l/s/pers
I	15	1O
II	20	7
III	30	**4**
IV	> 30	< 4

Adapted persons 2,5 l/s person (Cat. II)

7 independent studies have measured sensory pollution loads in 120 buildings (olf/m^2floor)

97 office buildings & assembly halls (previous ETS)	**0.23±0.06**
6 office buildings (no ETS)	**0.11±0.09**
10 kindergartens	**0.06±0.04**
6 schools	**0.06±0.06**
1 department store	**0.15**

European standard (EN15251):

Very Low-polluting building	**0.05**
Low-polluting building	**0.1**
Non-low-polluting building	**0.2**

Basic Ventilation

		Airflow for building emissions pollutions (l/s/m²)		
Category	Airflow per person l/s/pers.	Very low polluting building	Low polluting building	Non low polluting building
I	1O	0,5	1	2
II	7	0,35	0,7	1,4
III	4	0,2	0,4	0,8

Low Polluting Building

- **The majority of the materials are low polluting. Low polluting materials are natural traditional materials, such as stone and glass, which are known to be safe with respect to emissions, and materials which fulfil the following requirements:**
  - **The emission of total volatile organic compounds (TVOC) is below 0.2 mg/m²h.**
  - **The emission of formaldehyde is below 0.05 mg/m²h.**
  - **The emission of ammonia is below 0.03 mg/m²h.**
  - **The emission of carcinogenic compounds (IARC) is below 0.005 mg/m²h.**
  - **The material is not odorous (dissatisfaction with the odour is below 15 %).**

Very Low Polluting Building

- **All of the materials are very low polluting and smoking has never occurred and is not allowed. Very low polluting materials are natural traditional materials, such as stone, glass and metals, which are known to be safe with respect to emissions, and materials which fulfil the following requirements**
  - **The emission of total volatile organic compounds (TVOC) is below 0.1 mg/m²h.**
  - **The emission of formaldehyde is below 0.02 mg/m²h.**
  - **The emission of ammonia is below 0.01 mg/m²h.**
  - **The emission of carcinogenic compounds (IARC) is below 0.002 mg/m²h.**
  - **The material is not odorous (dissatisfaction with the odour is below 10 %).**

Recommended ventilation rates for non-residential buildings for three categories

Type of building or space	Cate-gory	*Per person* l/s,person	*Per floor area* l/s,m²	*Per person* l/s,person	*Per floor area* l/s,m²	*Per person* l/s,person	*Per floor area* l/s,m²
		Very low polluted building, revision		Low polluted building, revision		Non-low polluted building, revision	
Single office	I	5,0	1,5	10,0	2,0	20,0	3,0
	II	**3,0**	**1,0**	**7,0**	**1,4**	**14,0**	**2,1**
	III	2,0	0,6	4,0	0,8	8,0	1,2
Landscaped office	I	7,5	1,5	15,0	1,7	30,0	2,7
	II	**4,5**	**1,0**	**10,5**	**1,2**	**21,0**	**1,9**
	III	3,0	0,6	6,0	0,7	12,0	1,1
Conference room	I	1,0	1,5	2,0	6,0	4,0	7,0
	II	**0,6**	**1,0**	**1,4**	**4,2**	**2,8**	**4,9**
	III	0,4	0,6	0,8	2,4	1,6	2,8

Analytical calculation of required ventilation

- Comparable to analytical calculation of cooling loads.
- No table with cooling loads (W/m^2) depending on room type.

Comfort model

$$Q = 10 \cdot \frac{G}{C_i - C_o}$$

Ventilation rate – Cooling load

Parameter	Ventilation rate	Cooling load
Comfort requirement	% dissatisfied-odor(PAQ) Health-"*TLV*"	% dissatisfied Max. t_o, 26 ^oC
Analytical	Mass balance	Heat balance
Outside environment	Particles, odors, gases	Temperature, solar load, humidity
	Air cleaning	Heat recovery
Building materials	Emissions/adsorption	Heat resistance/heat capacity
People	Bioeffluents	Heat emission Evaporation
Internal sources	Emissions	Heat emission
Computers	Odors, gases	Watts
HVAC system	Outside air, emissions from components	Outside air, Cooled air, heat exchange

Examples of recommended CO2 concentrations above outdoor concentration for energy calculations and demand control

Category	Corresponding CO2 above outdoors in PPM for energy calculations
I	350
II	500
III	800
IV	< 800

Residential buildings

Category	Air change rate [1]		Living room and bedrooms, mainly outdoor air flow		Exhaust air flow, l/s		
	l/s,m² (1)	ach	l/s, pers [2] (2)	l/s/m² (3)	Kitchen (4a)	Bathrooms (4b)	Toilets (4)
I	0,49	0,7	10	1,4	28	20	14
II	0,42	0,6	7	1,0	20	15	10
III	0,35	0,5	4	0,6	14	10	7

Indicators for the indoor environment

1. Design indicators
2. Measured indicators
3. Calculated indicators

Classification

Classification based on criteria for energy calculations

Criteria of indoor environment	Category of this building	Design criteria
Thermal conditions in winter	II	20–24 °C
Thermal conditions in summer	III	22–27 °C
Air quality indicator, CO_2	II	500 ppm above outdoor
Ventilation rate	II	1 l/s m^2
Lighting		$E_m > 500$ lx; UGR < 19; $80 < R_a$
Acoustic environment		Indoor noise <35 dB(A), noise from outdoors <55 dB(A)

Classification based on occupants responses

	Percentage						
People finding the thermal environment acceptable	85						
People finding the indoor air quality acceptable	80						
Distribution of thermal sensation votes	-3	-2	-1	0	+1	+2	+3
	0	5	10	53	20	10	2
Distribution of temperature preference	Colder			Unchanged		Warmer	
	20			75		5	

Quality of indoor environment in % of time in four categories				
Percentage	5	7	68	20
Thermal Environment	IV	III	II	I
Percentage	7	7	76	10
Indoor Air Quality	IV	III	II	I

RECOMMENDATIONS

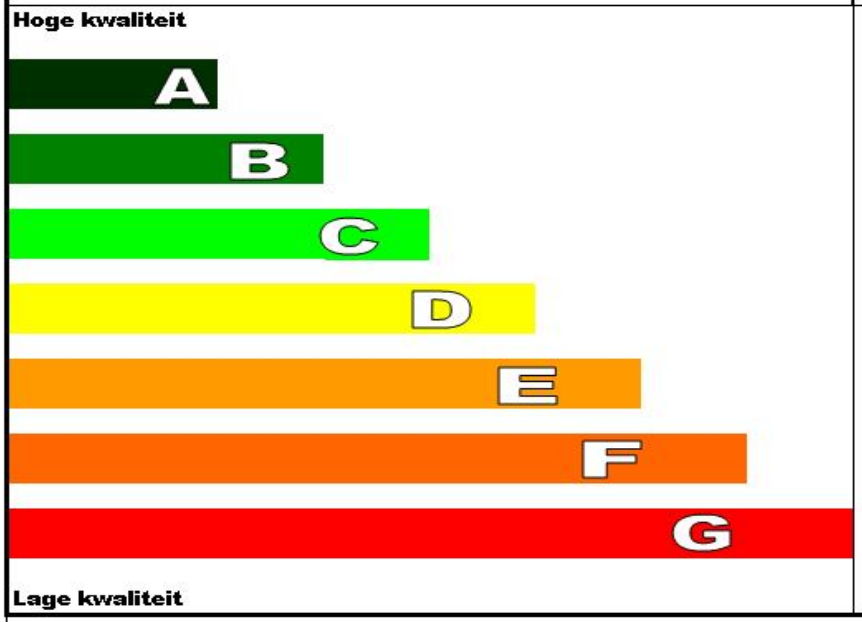
- **Indoor Environmental Quality Directive**
- **Labelling of building materials related to required ventilation rates**
- **Indoor Environmental Quality Certificate for buildings**
- ***”TLV”* values for health in non-industrial environments**
- **Full analytical calculation of required ventilation rate (material emissions, air cleaning, etc)**

Indoor Environmental Certificate

- A simple & quick survey will already be a step forward
- Combine the EP-certificate survey with a simple indoor environment survey
- Use the same communication, a similar Label as the EP-label
- Until now there is no overview if member states consider this except Portugal and Netherlands
- Difficult to express the quality of the indoor environment with one factor
- More knowledge needed on the relative importance of thermal environment, indoor air quality, noise and light for peoples comfort and performance

Kwaliteitslabel woningen

kwaliteitslabel woningen



	energie			CO_2 emissie	comfort aspecten			gezond heid
	bestaande woning	renovatie	nieuwbouw		winter	zomer	geluid	
			A	C	A	D	B	B

Buitengevel			A	A	A	A	B	
Dak			A	A	A	A	A	
Begane grond vloer			A	A	A	A	A	
Verdiepingsvloer			A	A	A	A	B	
Ramen en zonwering			A	A	A	E	A	
Verwarming- en ventilatiesysteem			B	B	B	C	nvt	
Koelsysteem			N/A	N/A	N/A	N/A	N/A	
Warm tapwatersysteem			C	C	nvt	nvt	nvt	
Kwaliteit bouwkundige detaillering			A	A	A	A	A	

Energie Prestatie/ Index		primair energiegebruik:		CO_2 emissie	
0,8	EPC	57	kWh/ m^2 /jaar	11	kg CO_2 eq. jaar/ m^2

Adres:	Veldedreef 14
Postcode en plaats:	2602 DF Delft
Woningtype:	Tussenwoning
Bouwjaar:	2006
Renovatie:	nvt

logo ontwikkelaar/ adviseur bouwproject

MINIMIZE

$$\frac{\text{Primary Energy Use}}{\text{Indoor Environmental Quality}}$$