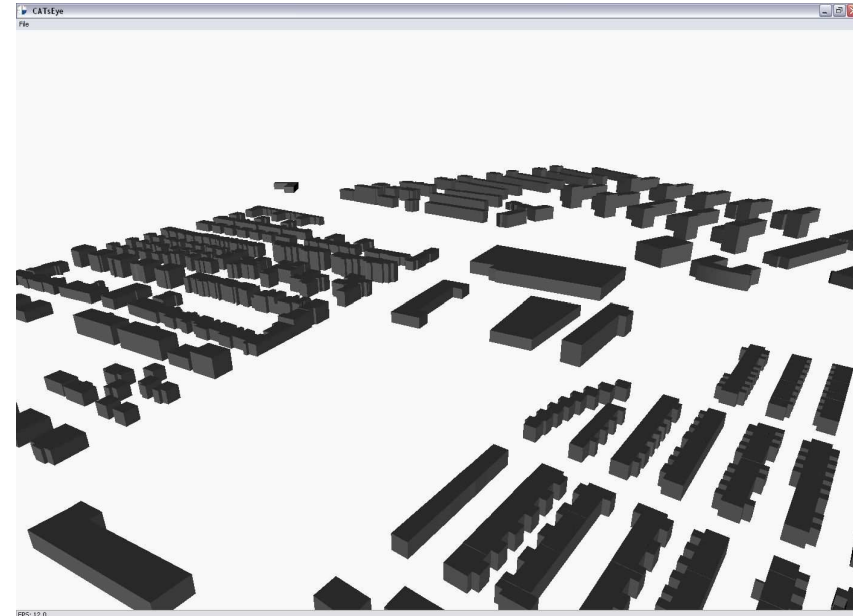


## Energy Visualization and 3D city modelling using GIS

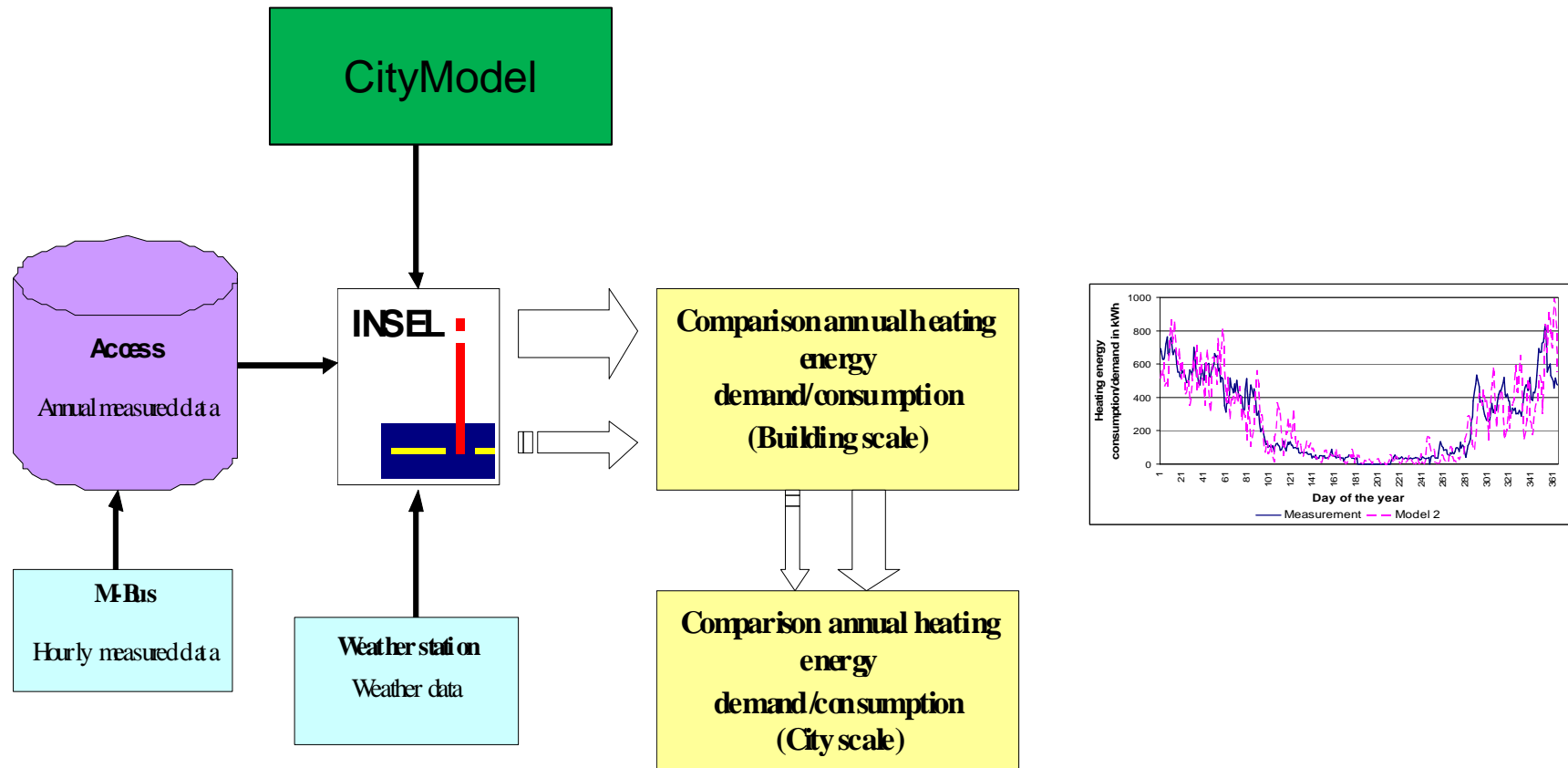
Polycity conference, 17.9.2010

## Szenario Scharnhäuser Park



**MODELING ENERGY DEMAND FOR HEATING AT CITY SCALE**  
Aneta Strzalka<sup>1</sup>, Ursula Eicker<sup>1</sup>, Volker Coors<sup>2</sup> and Jürgen Schumacher<sup>1</sup>

## Szenario Scharnhäuser Park



**MODELING ENERGY DEMAND FOR HEATING AT CITY SCALE**  
Aneta Strzalka<sup>1</sup>, Ursula Eicker<sup>1</sup>, Volker Coors<sup>2</sup> and Jürgen Schumacher<sup>1</sup>

**DO THIS FOR AN ENTIRE CITY**

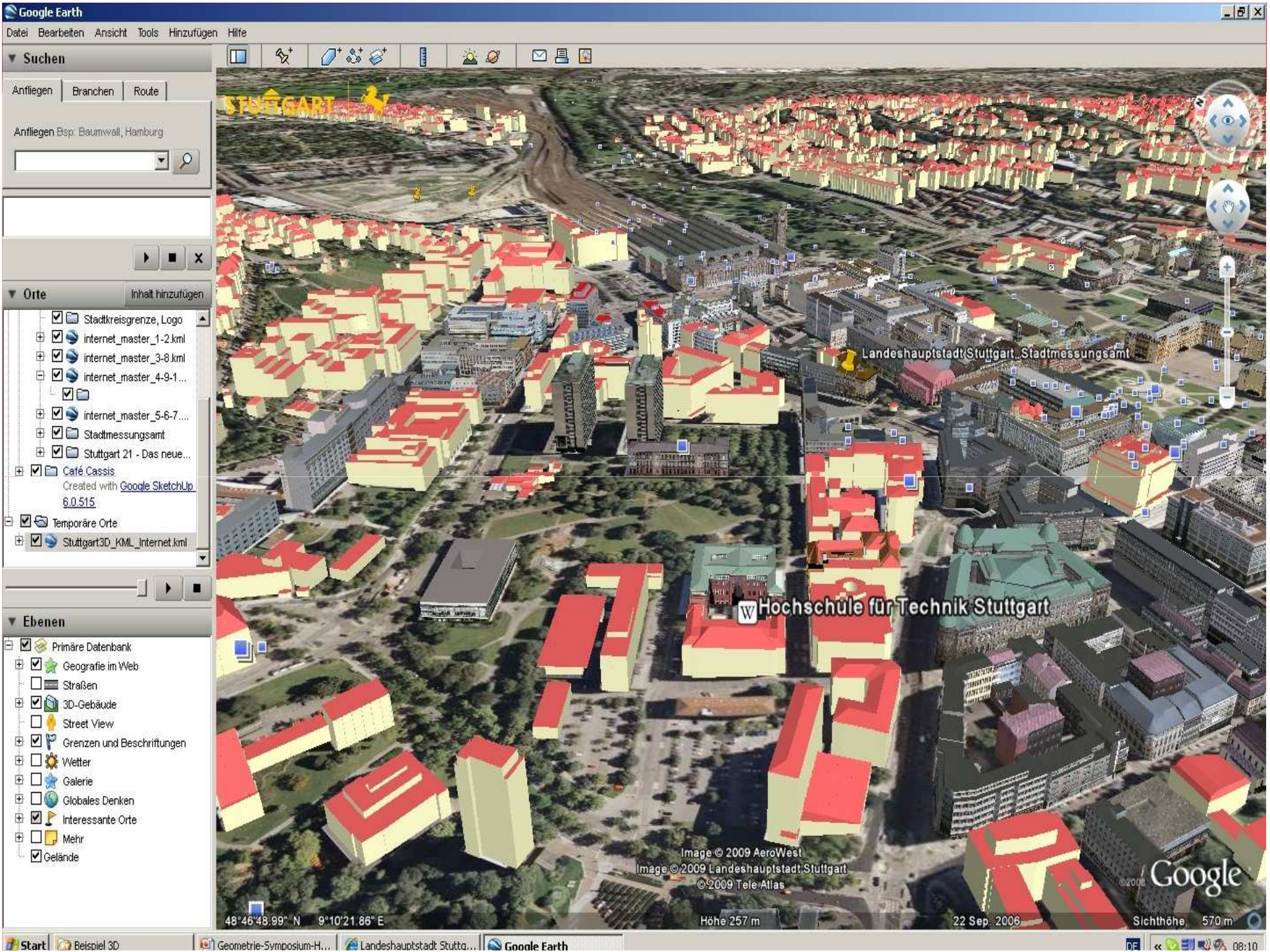
## Data Requirements

- Per Building / per Building facade
  - Volume
  - Roof area
  - Height (with roof, without roof)
  - Sun exposed facades
  - Orientation of facades and roofs
  - Percentage of windows per facades
  - u-values for facades (used material)

## What we have: CityGML LoD2

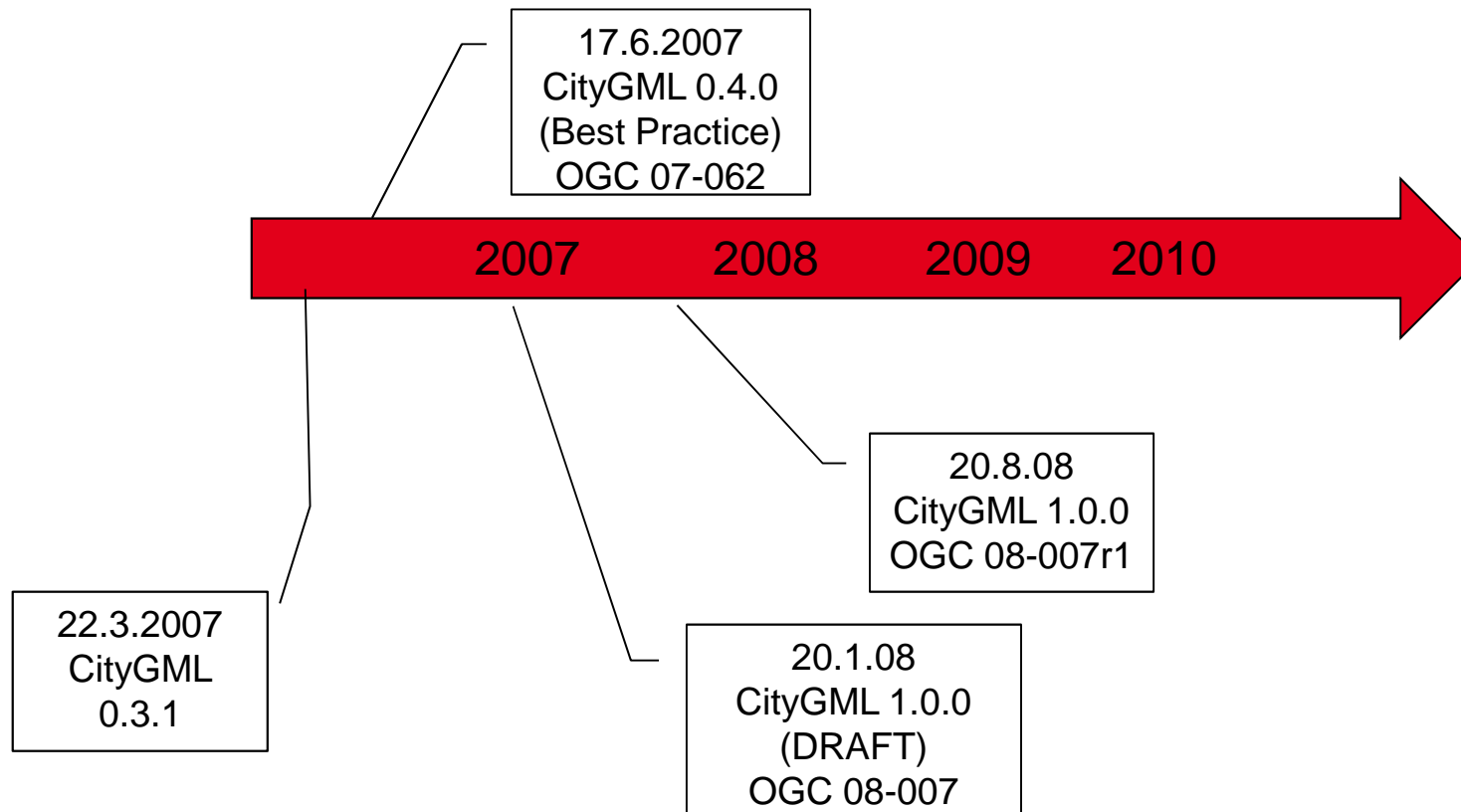
- 190.000 buildings in Stuttgart
- „BoundedBy“ WallSurface, RoofSurface, GroundSurface
- Building attributes:
  - year of construction
- Some textured models

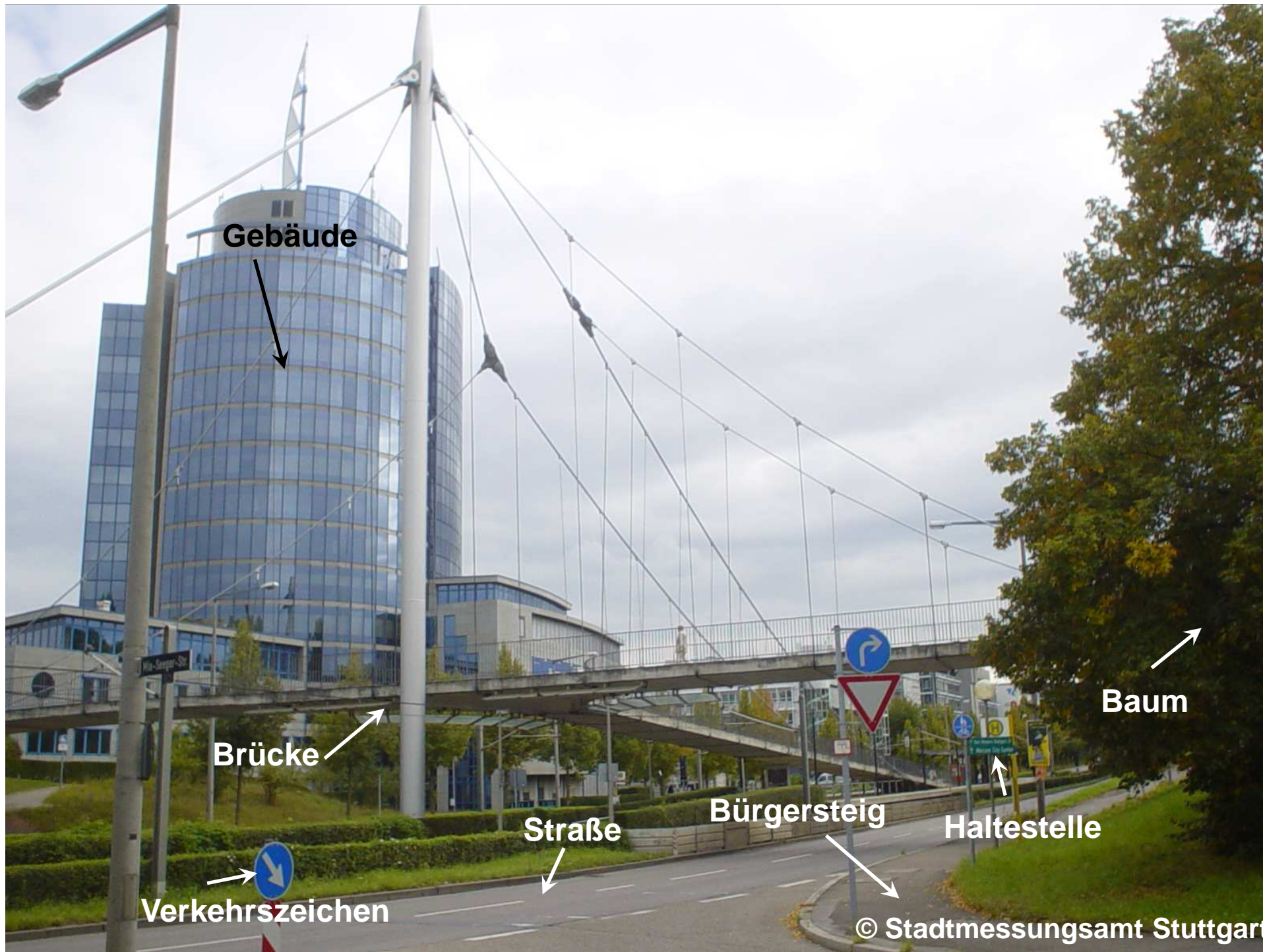






## CityGML: History





Gebäude



Brücke



Straße



Bürgersteig



Haltestelle



Baum



Verkehrszeichen



**bldg:building**



**veg:vegetation**

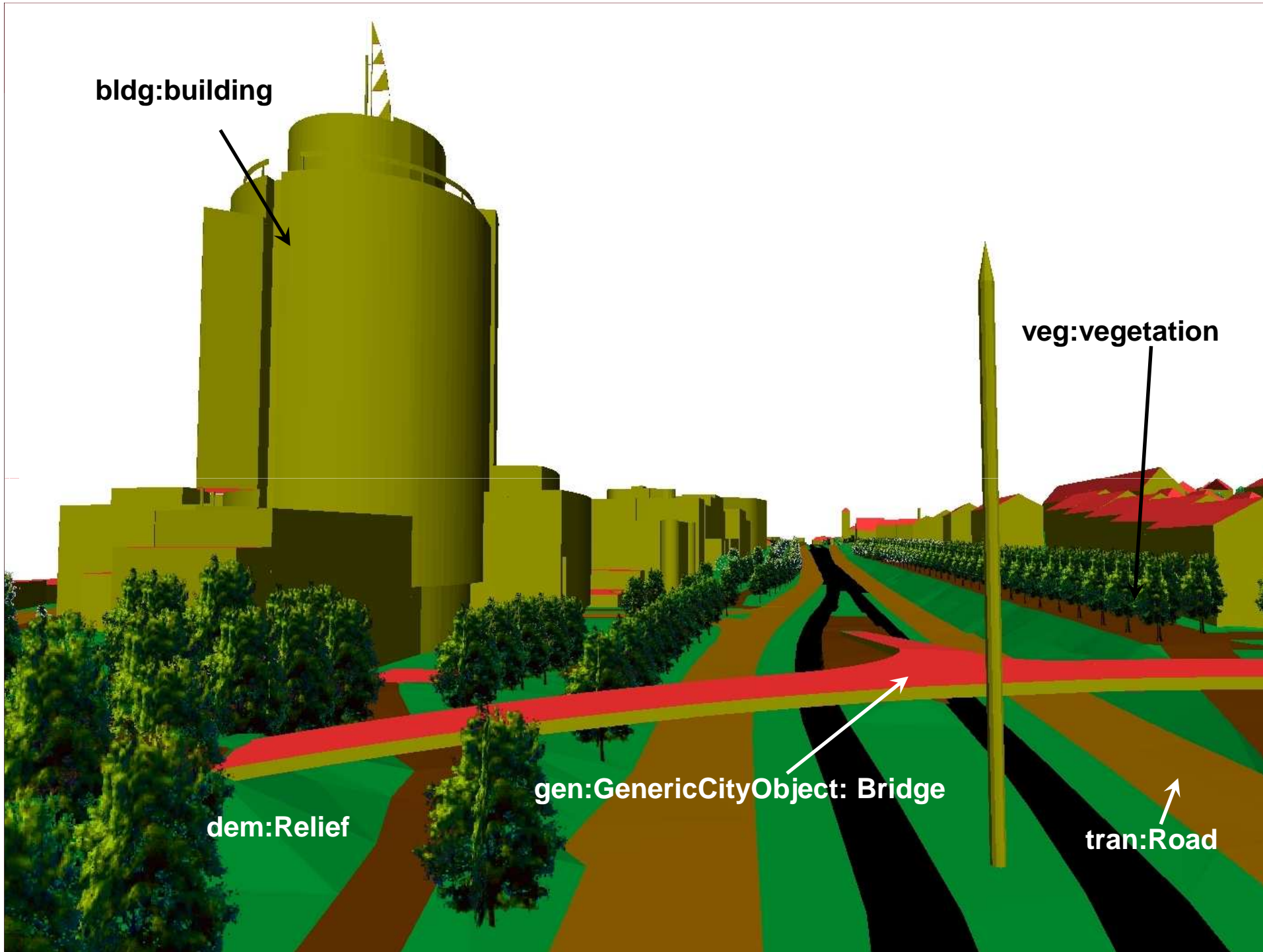


**gen:GenericCityObject: Bridge**

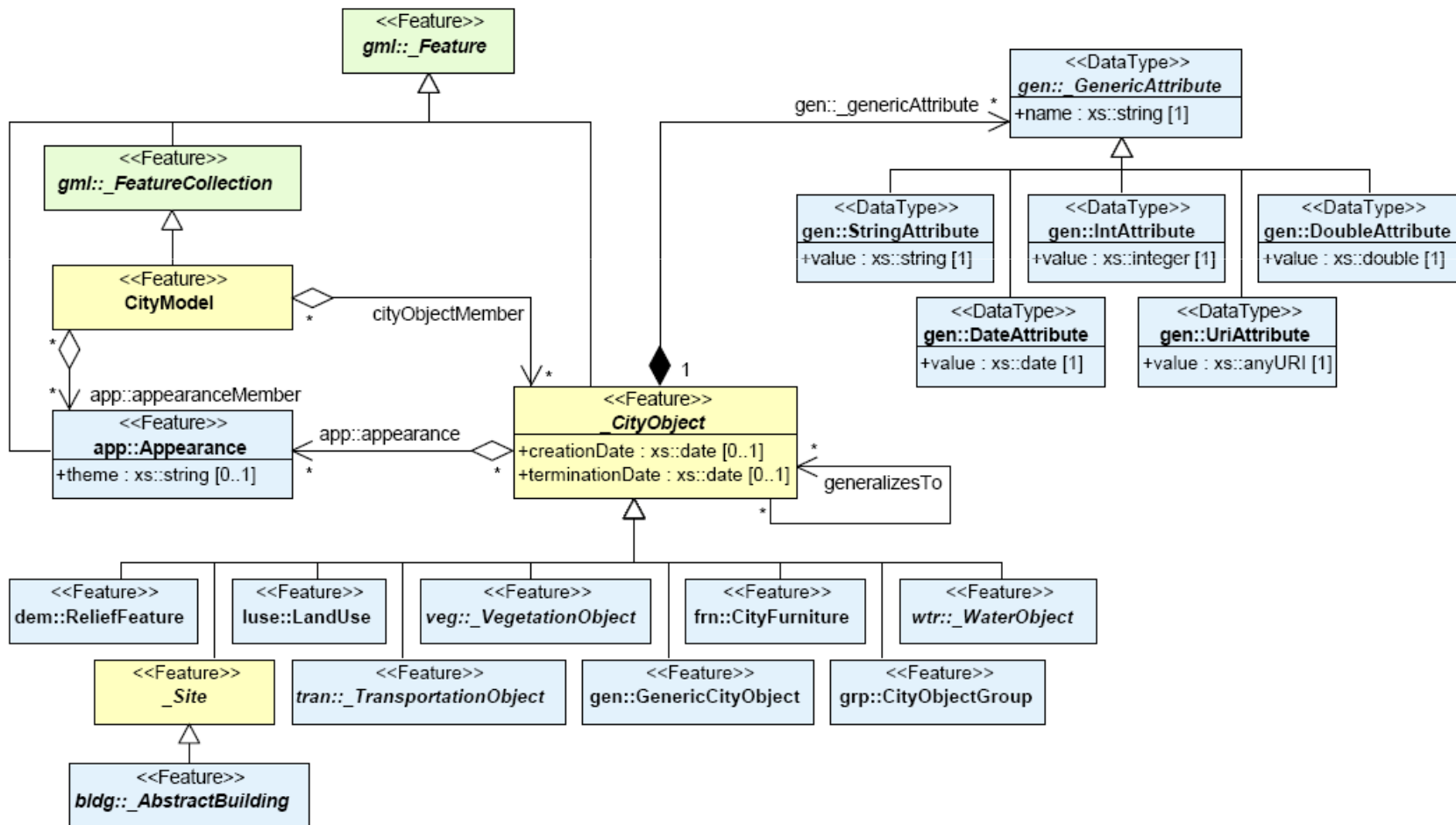


**dem:Relief**

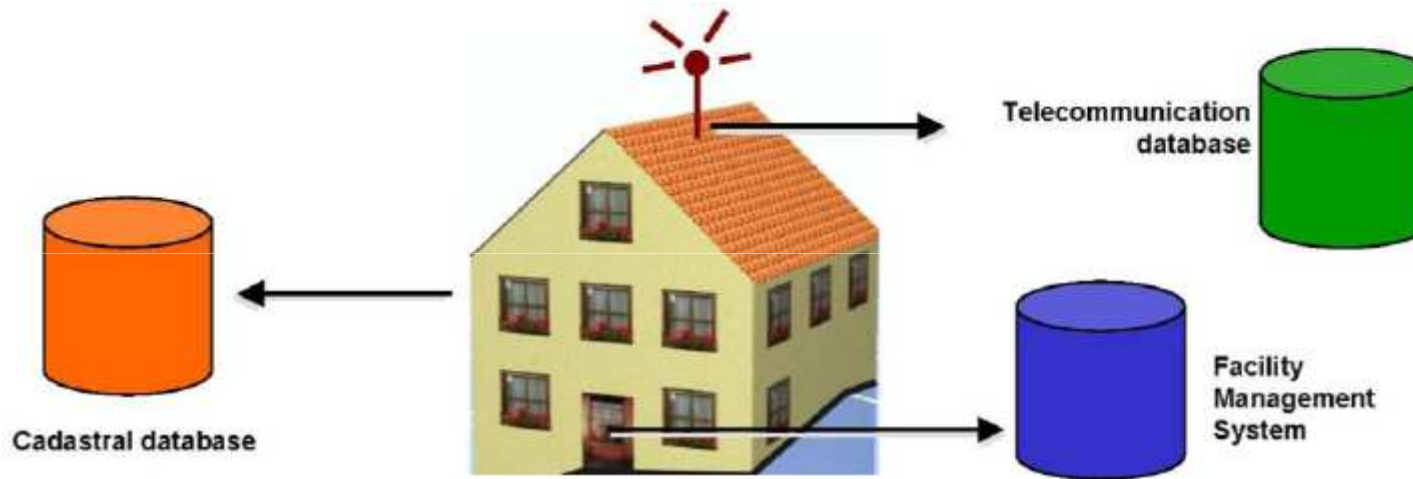
**tran:Road**



## CityGML structure

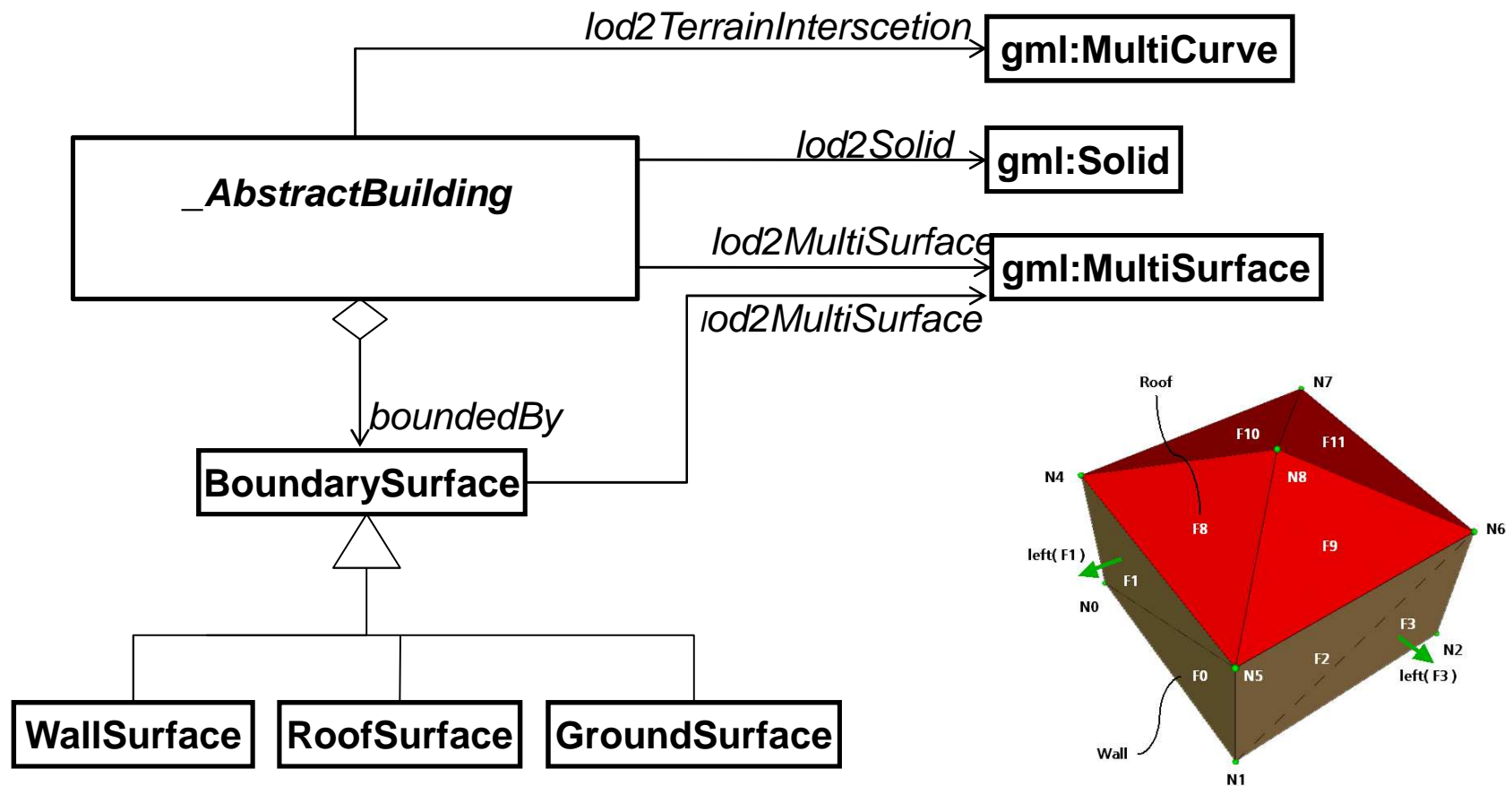


## External Reference



Quelle: OGC CityGML Implementation Specification 1.0, 20.08.2008

## LOD2 Geometry

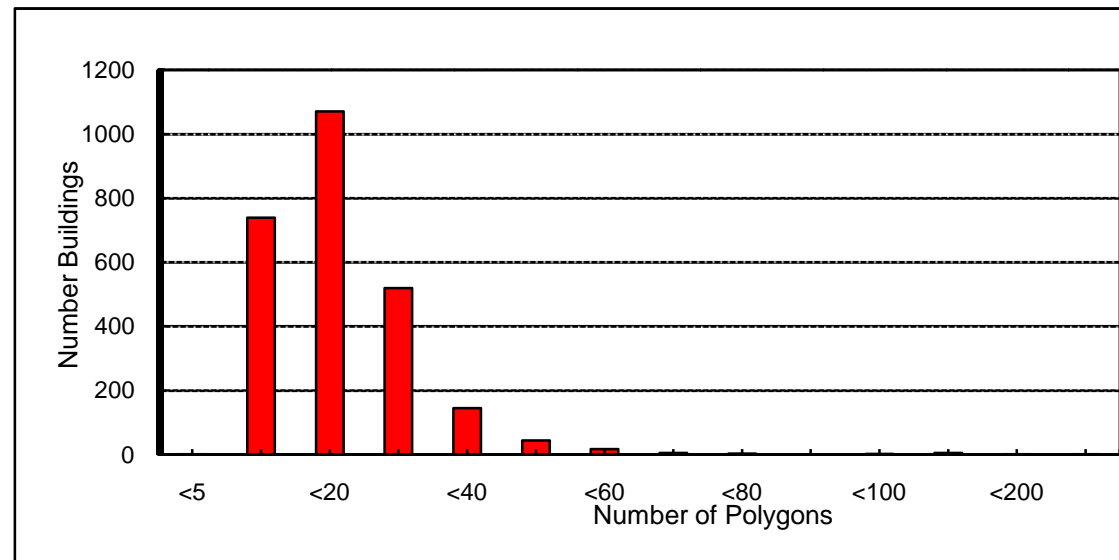


# Hochschule für Technik Stuttgart



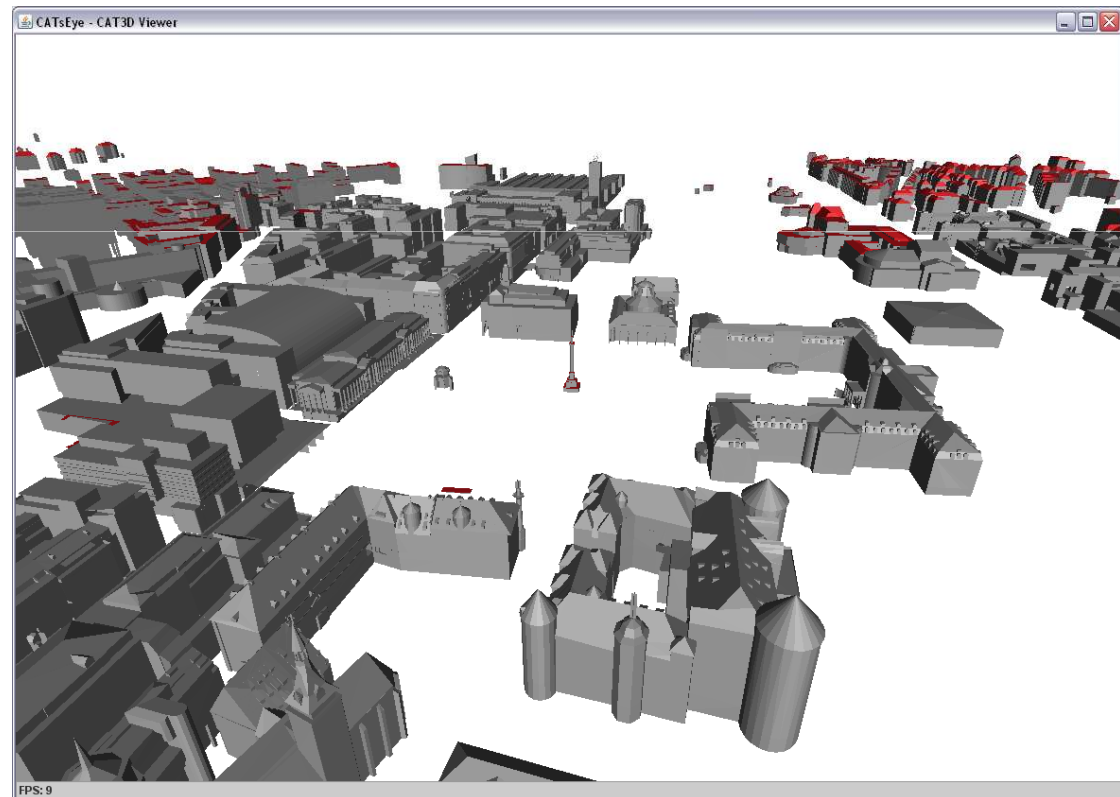
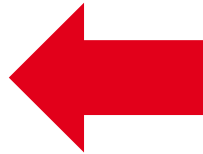
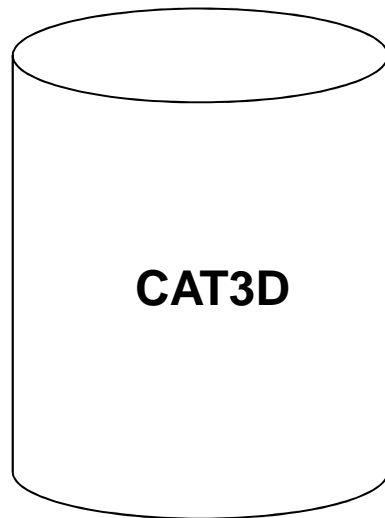
## Some details on data

<b>Buildings</b>	2553
<b>Polygons LOD1</b>	0
<b>Polygons LOD2</b>	42084
<b>Unclassified LOD2</b>	0
<b>Ground LOD2</b>	0
<b>Wall LOD2</b>	34527
<b>Roof LOD2</b>	7557
<b>unconnected comp</b>	2553



**Calculation failed for 445 buildings**

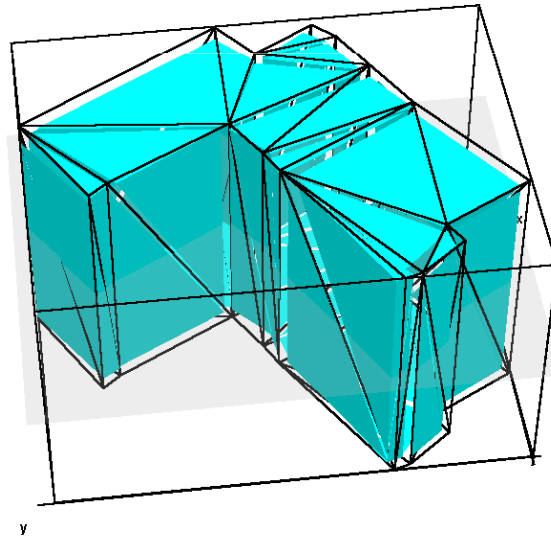
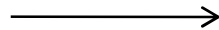
## CAT3D database



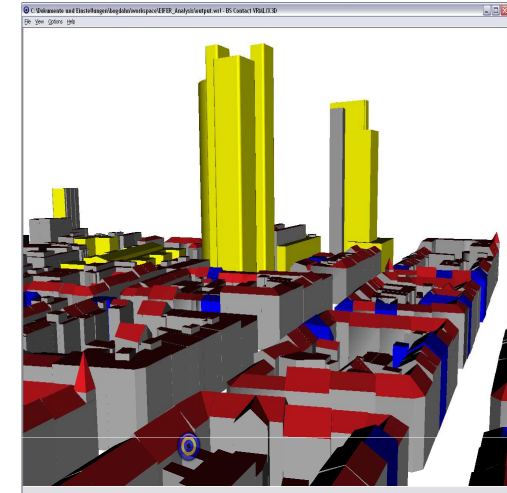
## Data Requirements

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  - Volume
  - Roof area
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  - Sun exposed facades
  - Orientation of facades and roofs
  - Percentage of windows per facades
  - u-values for facades (used material)

## Volume calculation

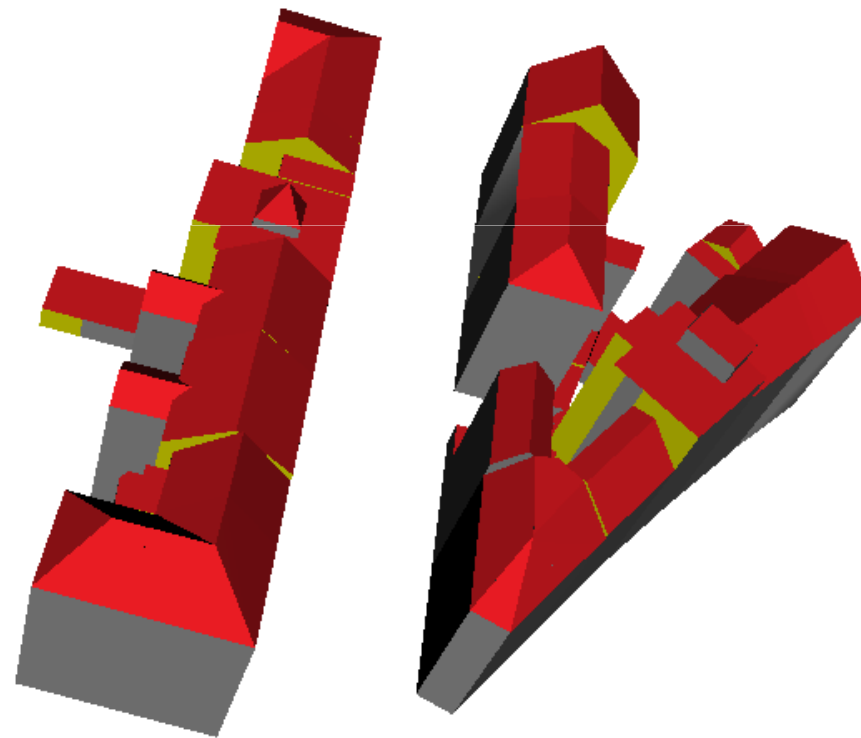


Triangulation: 45 Tetraeder

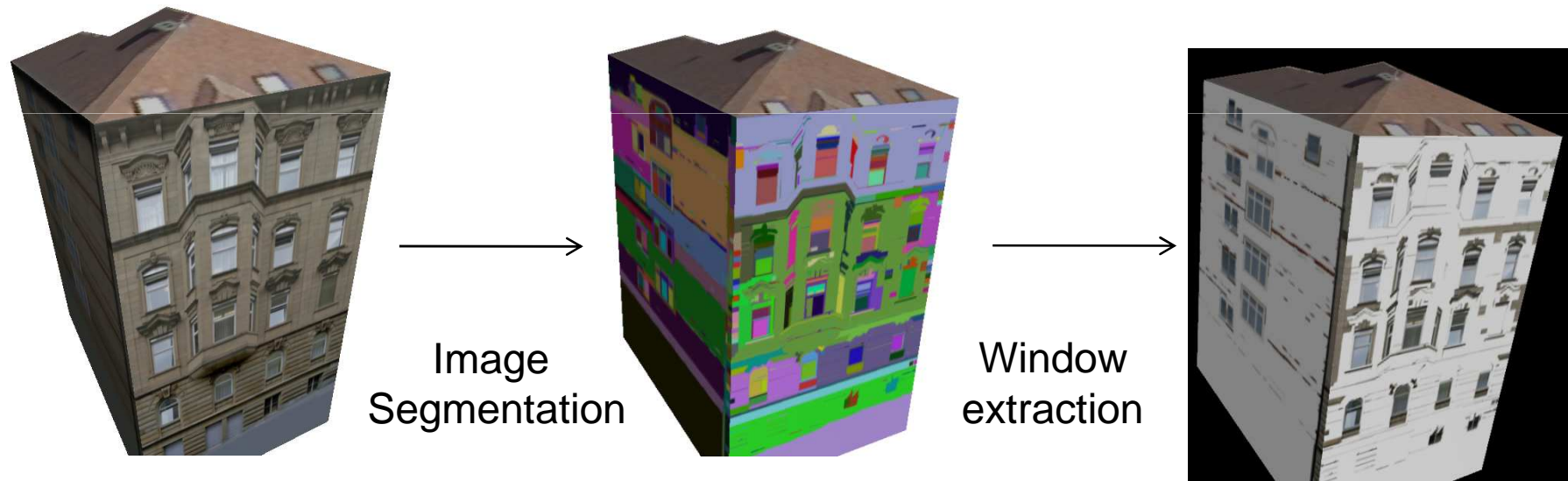


$$V = \sum_{i=1}^n \frac{|\det(a_i - b_i, b_i - c_i, c_i - d_i)|}{6}$$

## Sun exposed facades



## Window Area per Facade




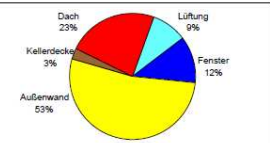
## Window Area per Facade

Textur	Auflösung	Fensterfläche (Pixel), manuell ermittelt	Fensterfläche prozentual	Fensterfläche Algorithmus (Pixel)	Fensterfläche Algorithmus (%)
k_front	1565 x 2402	744000	<b>20 %</b>		<b>22,2 %</b>
k_hinten	1021 x 2535	467300	<b>18 %</b>	363789	<b>14 %</b>
k_hinten_Treppe	595 x 2535	300000	<b>20 %</b>	179866	<b>12 %</b>
k_hinten_wand	304 x 2535	0	<b>0 %</b>	47810	<b>6 %</b>
k_knick	44 x 2535	0	<b>0 %</b>	(83990)	<b>0 %</b>
k_links	1368 x 2535	513800	<b>15 %</b>	614172	<b>17,7 %</b>
k_rechts	1368 x 2535	474800	<b>14 %</b>	630260	<b>19 %</b>

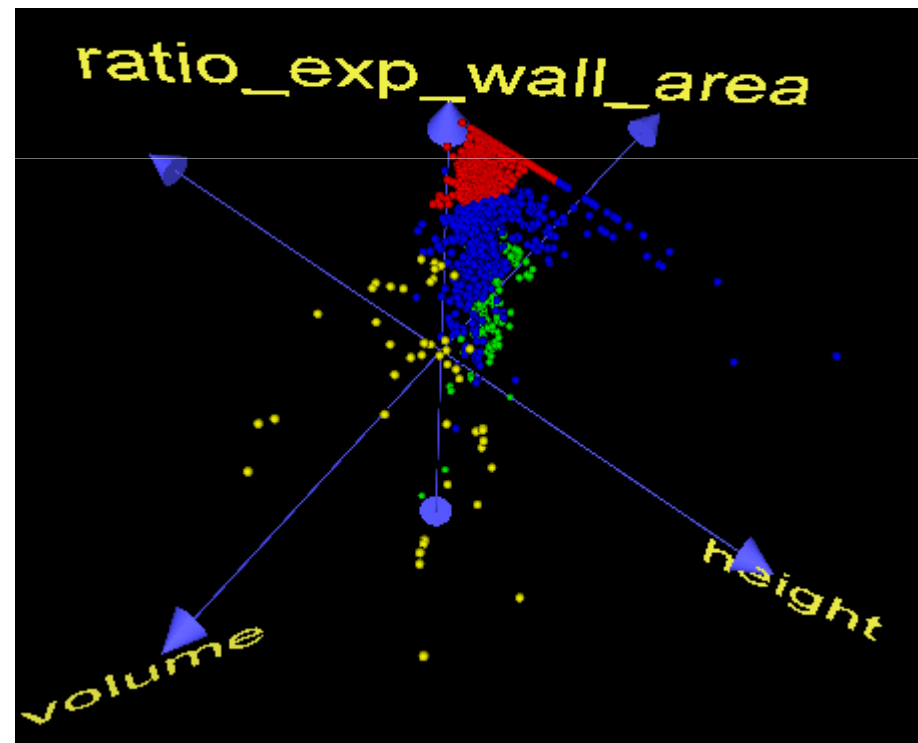
## U-value

### - Building Typology & Year of construction

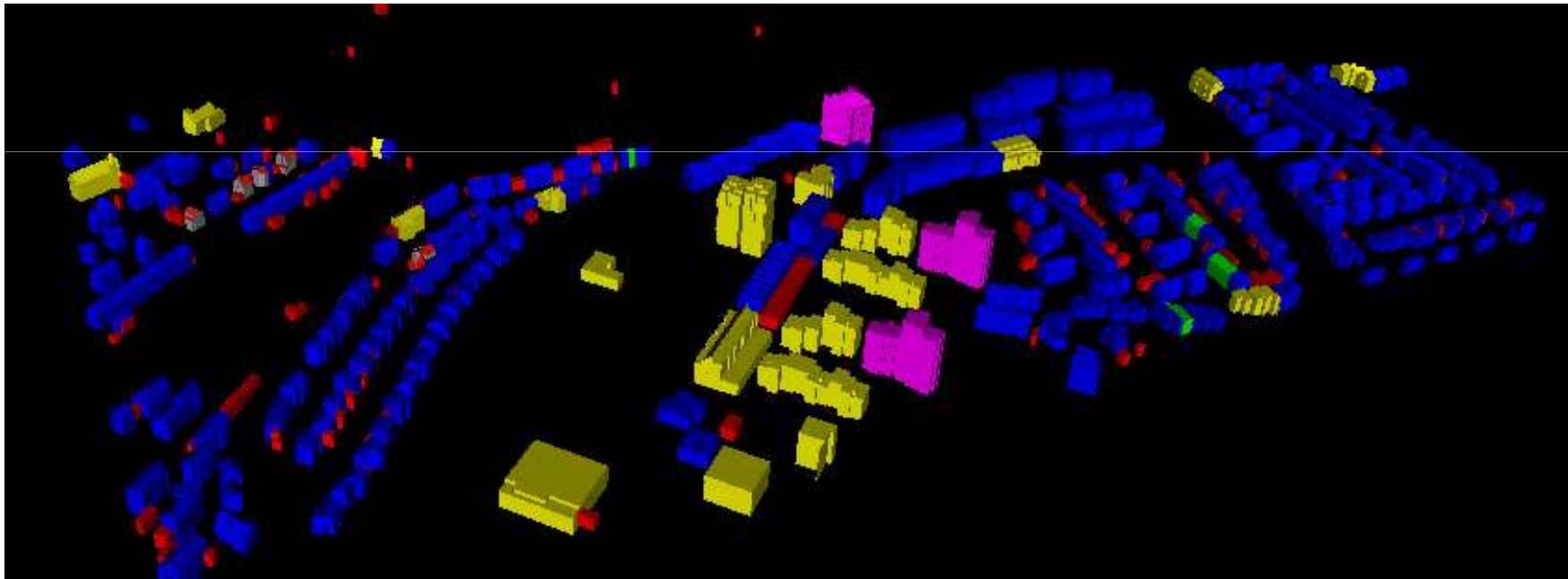
Baualtersklasse			EFH	RH	MFH	GMH	HH
A	vor 1918	Fachwerk	EFH_A		MFH_A		
B	vor 1918		EFH_B	RH_B	MFH_B	GMH_B	
C	1919-1948		EFH_C	RH_C	MFH_C	GMH_C	
D	1949-1957		EFH_D	RH_D	MFH_D	GMH_D	
E	1958-1968		EFH_E	RH_E	MFH_E	GMH_E	HH_E
F	1969-1978		EFH_F	RH_F	MFH_F	GMH_F	HH_F
G	1979-1983		EFH_G	RH_G	MFH_G		
H	1984-1994		EFH_H	RH_H	MFH_H		
I	1995-2001		EFH_I	RH_I	MFH_I		
J	nach 2002		EFH_J	RH_J	MFH_J		

HAUSTYPOLOGIE STADT DÜSSELDORF		HAUSDATENBLATT I - BESTAND	
Haustyp	A-EFH		
Baualter	bis 1918		
EKW* in kWh/(m²a)	375		
Wohnfläche	141	m²	
Umbautes Volumen	384,24375	m³	
A/V-Verhältnis	0,91	1/m	
			
BAUTEIL	BESCHREIBUNG	U-WERT W/(m²K)	ANMERKUNGEN
Außenwand	12 bis 16 cm Fachwerkkonstruktion als Sichtfachwerk, Gefache aus Mauerziegel, zum großen Teil verputzt**	2,28 bis 2,61	überwiegend

## Classification



## Building Typology



## Conclusions

- 3D City Model is a valuable data source

- Data quality is an issue

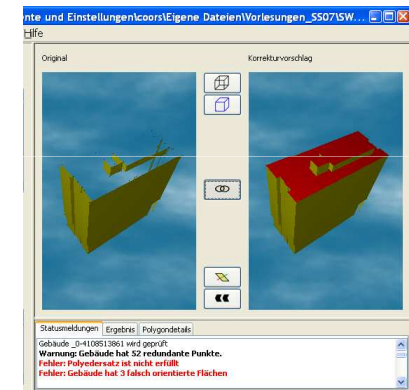
- Availability of 3D City Models?

in BW: Stuttgart, Karlsruhe, Heidelberg

- ADV:

LoD 1 Modell for all German Cities in 2013

LoD 2 Modell „in progress“





# Hochschule für Technik Stuttgart

