

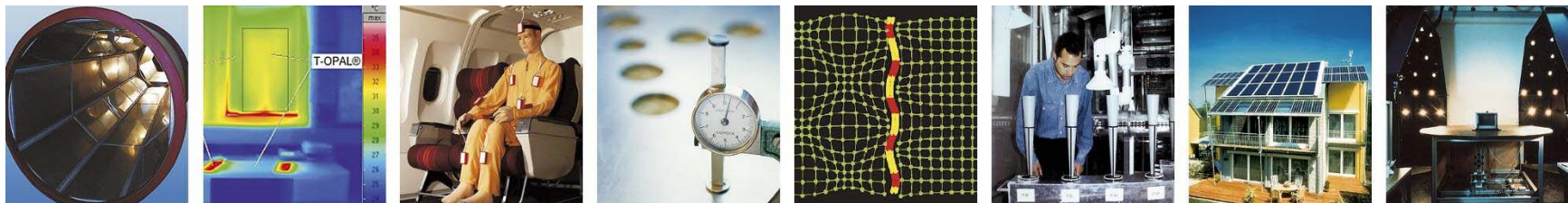
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# Feasibility study of a carbon neutral district in Munich

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Auf Wissen bauen



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# AGENDA

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- Goals of the feasibility study
- The existing district
- Plans for the extension
- The modeling process
- Validation process
- 1<sup>st</sup> goal: Retrofitting scenarios
- 1<sup>st</sup> goal: Costs for the scenarios
- 2<sup>nd</sup> goal: CO<sub>2</sub>-neutral district

# Goals of the feasibility study

- **1<sup>st</sup> goal - CO<sub>2</sub>-neutral extension of the district:**

Compensation of the additional CO<sub>2</sub>-equivalent emissions by the planned new, build-up and extension buildings (incl. underground garages) by a reduction of the CO<sub>2</sub> emissions of the existing buildings or by renewable energy production.

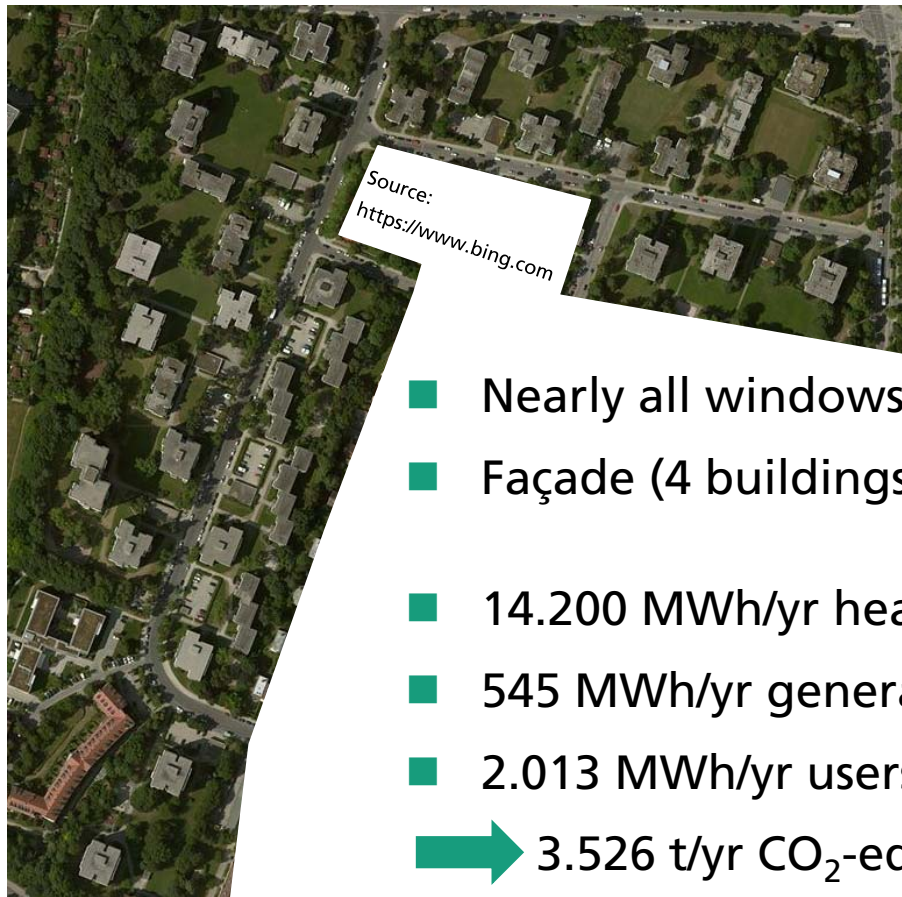
**Main focus**

- **2<sup>nd</sup> goal - CO<sub>2</sub>-neutral district:**

Compensation of CO<sub>2</sub>-equivalent emissions of the whole district through renewable energy production.

Consumers considered are heating, domestic hot water, ventilation, lighting, general and user electricity.

# The existing district



- 36 buildings
- Built between 1963 and 1973
- 97.400 m<sup>2</sup> living area
- 1.486 residential units
- Nearly all windows installed between 2000 and 2010
- Façade (4 buildings) and roof (6 buildings) insulation
- 14.200 MWh/yr heat consumption (district heating)
- 545 MWh/yr general-purpose power consumption
- 2.013 MWh/yr users power demand (21 kWh/m<sup>2</sup>yr)
- ➔ 3.526 t/yr CO<sub>2</sub>-equivalent-emissions

# Plans for the extension



Buildings (living area):

■ Existing (97.400 m<sup>2</sup>)

■ Build-ups (9.200 m<sup>2</sup>)

■ Extension (3.100 m<sup>2</sup>)

■ Newly build ( )

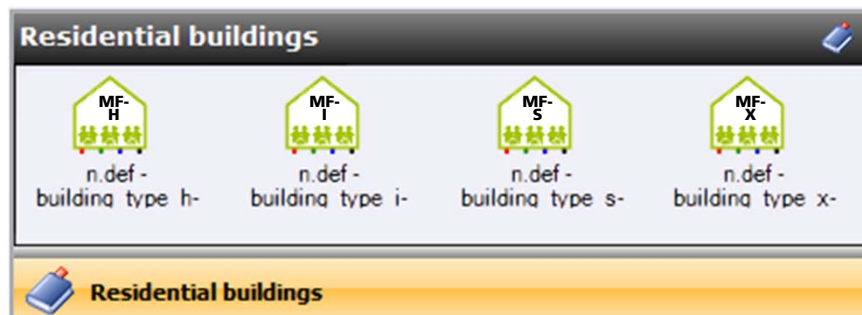
- 28.000 m<sup>2</sup> living area
- 3.900 m<sup>2</sup> net floor area (day care centre)
- 26.000 m<sup>2</sup> underground garage

# The modeling process part 1

- **1<sup>st</sup> step** – definition of type buildings



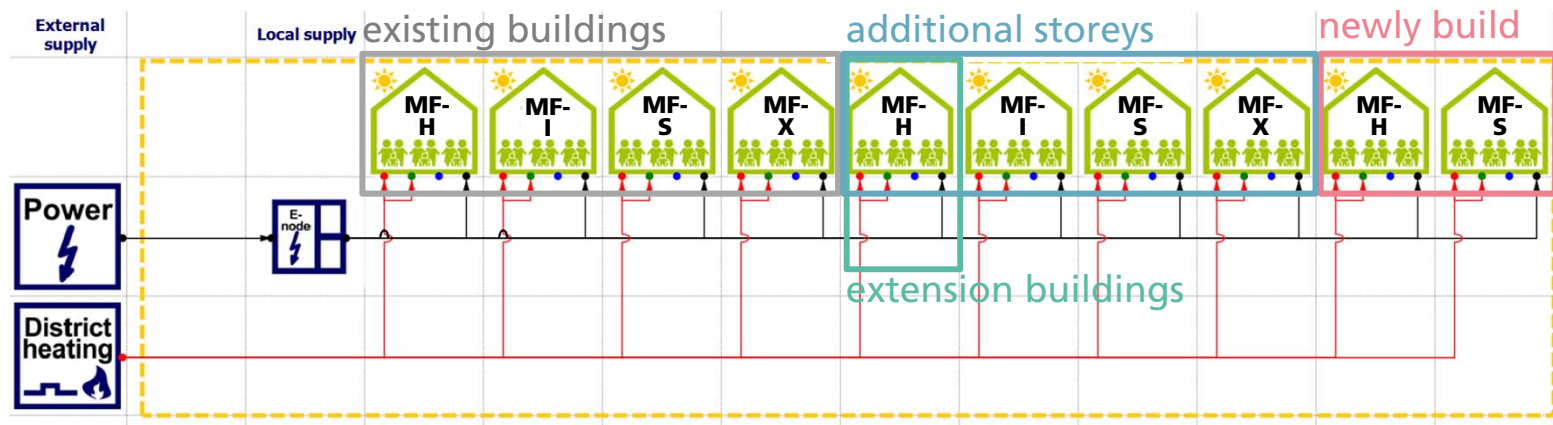
- **2<sup>nd</sup> step** – integration of the type buildings into MODER



# The modeling process

## part 2

- **3<sup>rd</sup> step** – Allocation of the existing buildings and new, additional storeys and extension buildings to the type buildings
- **4<sup>th</sup> step** – Illustration of the district in MODER



# Validation process

## Calculation of the existing district with MODER

- **1<sup>st</sup> step** – Input of the type buildings in different age groups
- **2<sup>nd</sup> step** - Input of technical equipment and the specific U-values, taking into account the renovations carried out
- **3<sup>rd</sup> step** – Calculation of demand for heating and DHW

Final energy	Heating	Hot water	
	MWh/yr	MWh/yr	
Type H - Age 69-72	4.958	1.622	
Type H - Age 68	2.214	610	
Type I - Age 63-68	210	44	
Type I - Age 69-73	689	193	
Type S - Age 69-73	1.416	317	
Type S - Age 63-68	310	51	
Type X - Age 69-73	805	188	
Type X - Age 63-68	1.025	176	
<b>Summe</b>	<b>11.626</b>	<b>3.201</b>	<b>14.827</b>

- **4<sup>th</sup> step** – Comparison with measured consumption – 14.208 MWh/yr



# Retrofitting scenarios

- Four different retrofitting scenarios for the existing buildings

U-value [W/m <sup>2</sup> K]	S1 - GEG overall retrofit	S2 - GEG retrofit of envelope	S3 – Passiv-house overall retrofit	S4 - GEG retrofit of envelope (not windows)
Opaque wall $U_f$	0,23	0,23	0,11	0,23
Window $U_w$	0,9	0,9	0,8	1,4 - 1,7
Roof $U_R$	0,16	0,16	0,07	0,16
Cellar ceiling $U_c$	0,22	0,22	0,12	0,22
Ventilation system	Supply and exhaust air system with HR 85 %	Supply and exhaust air system with HR 85 %	Supply and exhaust air system with HR 85 %	Supply and exhaust air system with HR 85 %
Heat distribution U	0,2 – 0,26	0,4	0,2 – 0,26	0,4

- Two different building standards for all newly built buildings
- 2 different extends of retrofit
  - whole district (SX.1)
  - just buildings which get additional storeys or extension buildings (SX.2)

# 1<sup>st</sup> goal - Results of the retrofitting scenarios

	Scenario	CO <sub>2</sub> -Equivalent-Emissions [t <sub>CO2-Equi</sub> /yr]	Necessary renewable electricity production [MWh/yr]
<b>S1 – GEG overall retrofit. Raised floors, extension and newly built also GEG-Standard</b>	S1.1	3.301	-
	S1.2	4.166	1.140
<b>S2 – GEG retrofit of the envelope. Raised floors, extension and newly built also GEG-Standard</b>	S2.1	3.447	-
	S2.2	4.214	1.228
<b>S3 – Passiv-house overall retrofit. Raised floors, extension and newly built also Passiv-house</b>	S3.1	3.065	-
	S3.2	4.028	880
<b>S4 – GEG retrofit of the envelope (not windows). Raised floors, extension and newly built in GEG-Standard</b>	S4.1	3.603	84
	S4.2	4.267	1.328

- Necessary renewable electricity production depends on quality and extend of retrofit
- Additional CO<sub>2</sub>-equivalent emissions due to the extension of the district can not be compensated without retrofitting parts of the existing buildings

# 1<sup>st</sup> goal - Costs for the retrofiting

- Investment necessary to achieve a CO<sub>2</sub>-equivalent-neutral extension of the district

		KG 300 [Mio €]	KG 400 [Mio €]	Sum [Mio €]
<b>S1 – GEG overall retrofit. Raised floors, extension and newly built also GEG-Standard</b>	S1.1	48,7	7,0	55,7
	S1.2	18,0	3,9	21,9
<b>S2 – GEG retrofit of the envelope. Raised floors, extension and newly built also GEG-Standard</b>	S2.1	48,7	7,0	55,7
	S2.2	18,5	4,0	22,5
<b>S3 – Passiv-house overall retrofit. Raised floors, extension and newly built also Passiv-house</b>	S3.1	55,2	7,0	62,2
	S3.2	18,7	3,5	22,2
<b>S4 – GEG retrofit of the envelope (not windows). Raised floors, extension and newly built in GEG-Standard</b>	S4.1	28,0	7,2	35,2
	S4.2	12,3	4,1	16,4

- Not included: demolition costs and costs for work inside of the buildings

## 2<sup>nd</sup> goal – CO<sub>2</sub>-neutral district

- Final energy demand of district: 6.674 MWh/yr heat and 4.272 MWh/yr electricity
- Maximum PV production potential of the district: 1.550 MWh/yr

➔ Solution: Combined heat and power with wood chips

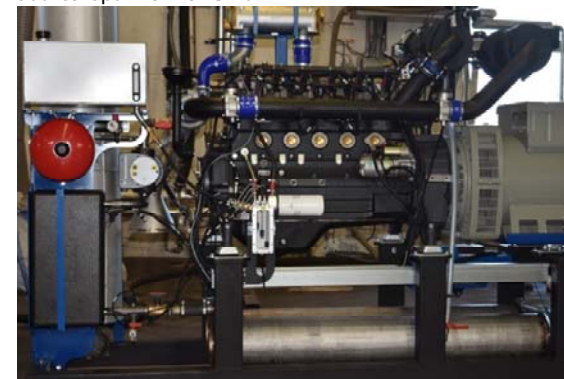


wood gasifier

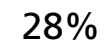
90%



Source: Spanner Re<sup>2</sup> GmbH



28%



49%



wood gas cogeneration unit

## 2<sup>nd</sup> goal – CO<sub>2</sub>-neutral district

- District grids for heat and power
- Supply of 90% of heat demand with CHP, 10% wood chip combustion
- Demand for wood chips: 13.850 MWh/a – 381 t<sub>CO2-Equi</sub>/yr




4.100 MWh/yr      7.300 MWh/yr

- With the PV systems the power demand and CO<sub>2</sub> emissions can be covered

net investment costs	KG 300 and KG 400 [Mio €]
GEG-Standard overall retrofit of all existing buildings	55,7
Wood gasifier and wood gas CHP	10,3
Wood chip combustion unit	0,3
Local heating grid (including insertion)	1,2
Local power grid (including insertion)	0,5
Cogeneration plant	1,3
PV systems	2,2
<b>Sum</b>	<b>71,5</b>