Advances in Housing Renovation

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Solare Energiesysteme ISE

FINAL TASK 37 SEMINAR

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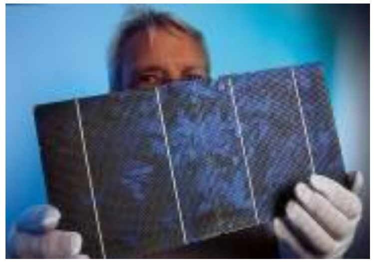



- Located in Freiburg/Germany
- Main areas of business
  - Photovoltaics
  - Energy efficiency and renewable energy use in buildings
  - Solar thermal energy use
- Total staff 950 (~100 PhD-students, ~100 master students, ~350 regular staff)
- Budget ~ € 55 million (2009)
- Financing mainly based on 3rd party contracts (industry, public)

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Subtask C: Analysis and Concepts
Objectives

- Evaluate the performance of advanced housing renovation projects, using performance characterization methods developed in SHC Task 28
- Assess the adaptability of new energy supply systems, including renewable energy systems, as part of comprehensive renovation packages
- Analyze new products and concepts for advanced housing renovations and provide manufacturers feedback to optimize products
- Develop and publicize optimized renovation concept packages

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Outline

- Technologies
- Design Concepts & Process
- Analysis of building renovation projects
- Building retrofit examples: *Rislerstraße* and *Blaue Heimat*

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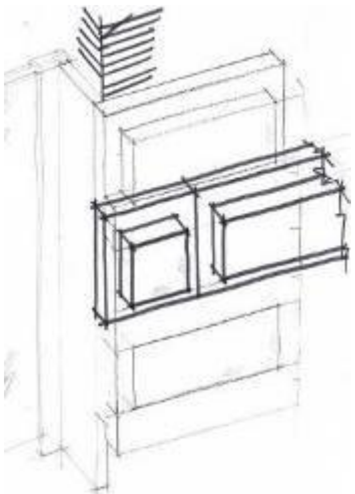
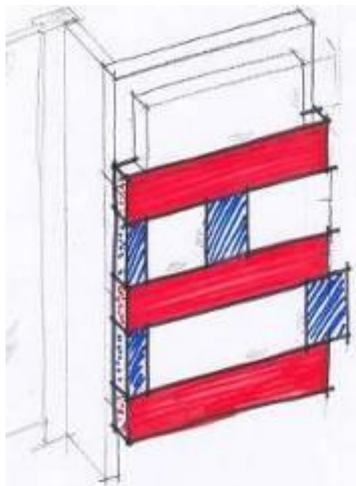
Vacuum insulation system
New Insulation technologies


source: Fraunhofer ISE, D

- New development with industrial partner (Maxit; Maxit LockPlate®)
- Required insulation thickness reduced by a factor of 3
- Recently introduced into the market

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Spray insulation system
New Insulation technologies

source: TU Graz, Austria

- Internal insulation for historic building
- Based on recycled materials
- Relatively low water vapour diffusion resistance factor (μ) of 6 [-]
- Capillary-active and open-diffusion internal insulation system

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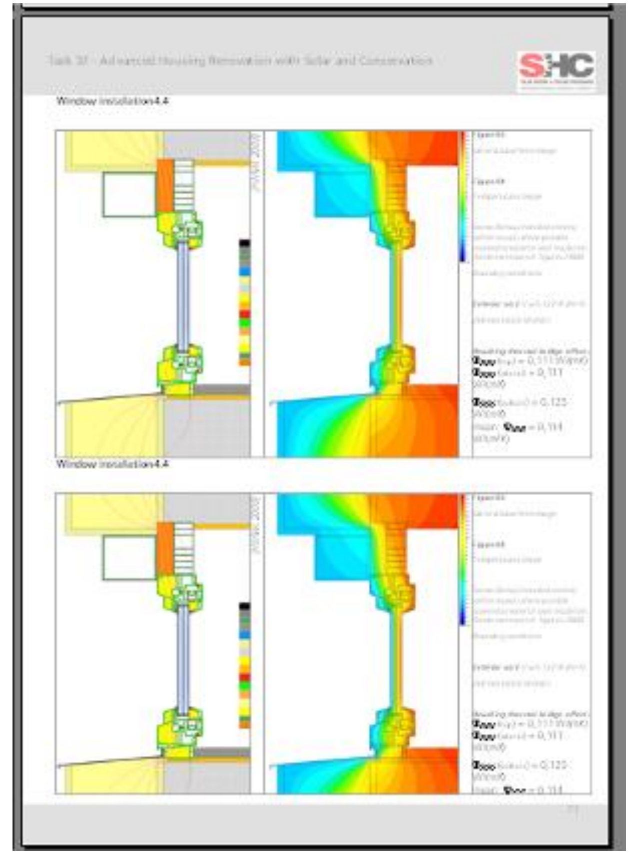
Development of a heat bridge catalogue for retrofit specific issues

- Window integration
- Balconies
- Combination of unheated basement and heated ground floor
- Published in Final Report of Subtask C

source: Gütermann, CH, PHI D



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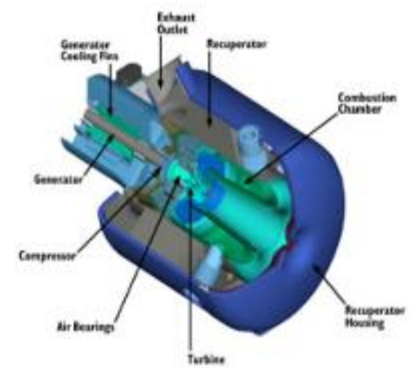
Efficient energy transformation
Trends

Use the exergy content of energy:

- Combined heat and power (CHP) for any type of fuel (fossile, biomass)
- Heat pumps for use of electricity for heating application
- Minimized temperature differences between room and heat transfer fluid (heating, cooling) ➔ low-exergy heating and cooling (LowEx)



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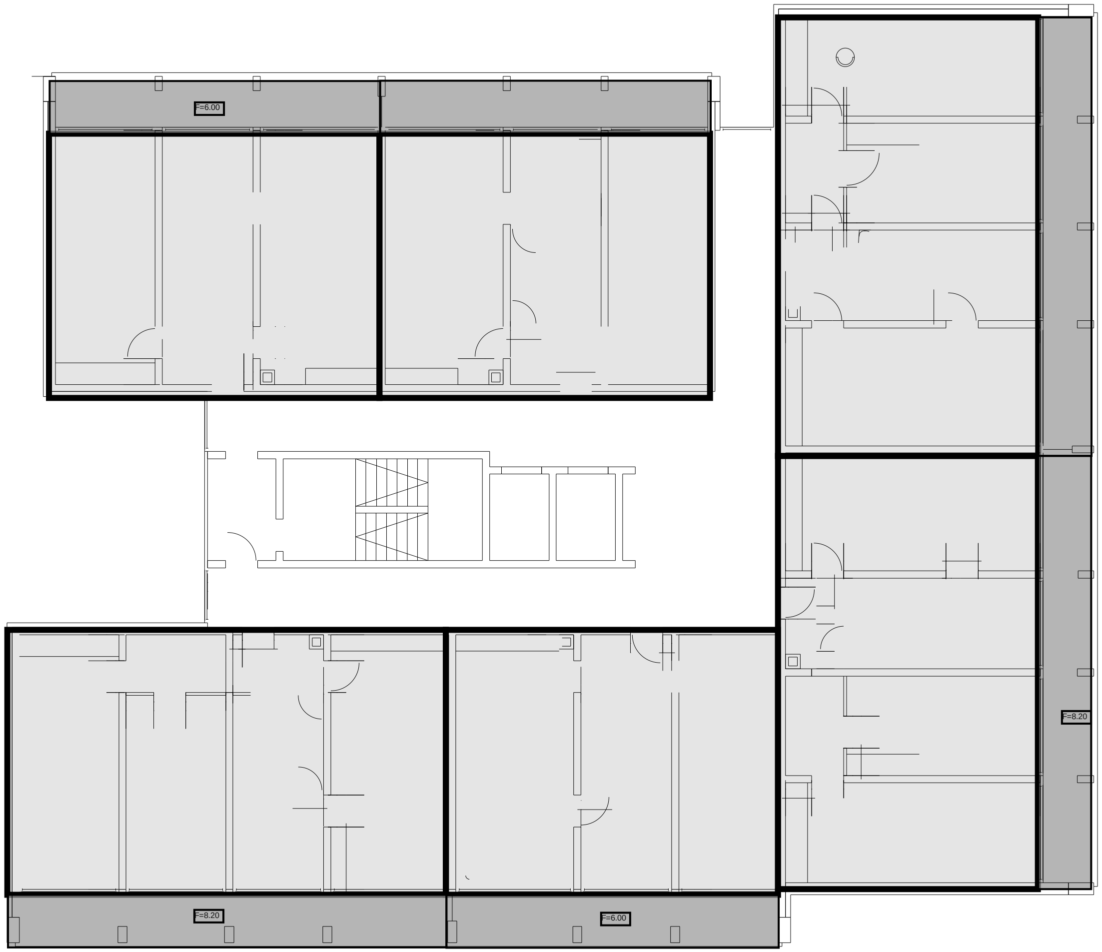
Restructuring of Floor Plans

Existing floor plan



Example: Buggingerstr. 50, Freiburg, D

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Restructuring of Floor Plans

Increased areas, smaller flats

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Prepared **I**n all **A**spects for **F**uture

The PIAF Methodology

(developed by ECN, the Netherlands)

The developments that are considered in this methodology are:

- Developments with implications on security of supply of energy
- Price developments of energy
- Technological developments (either resulting in new technologies and/or improved existing technologies) and cost development

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Prepared **I**n all **A**spects for **F**uture

The PIAF Methodology

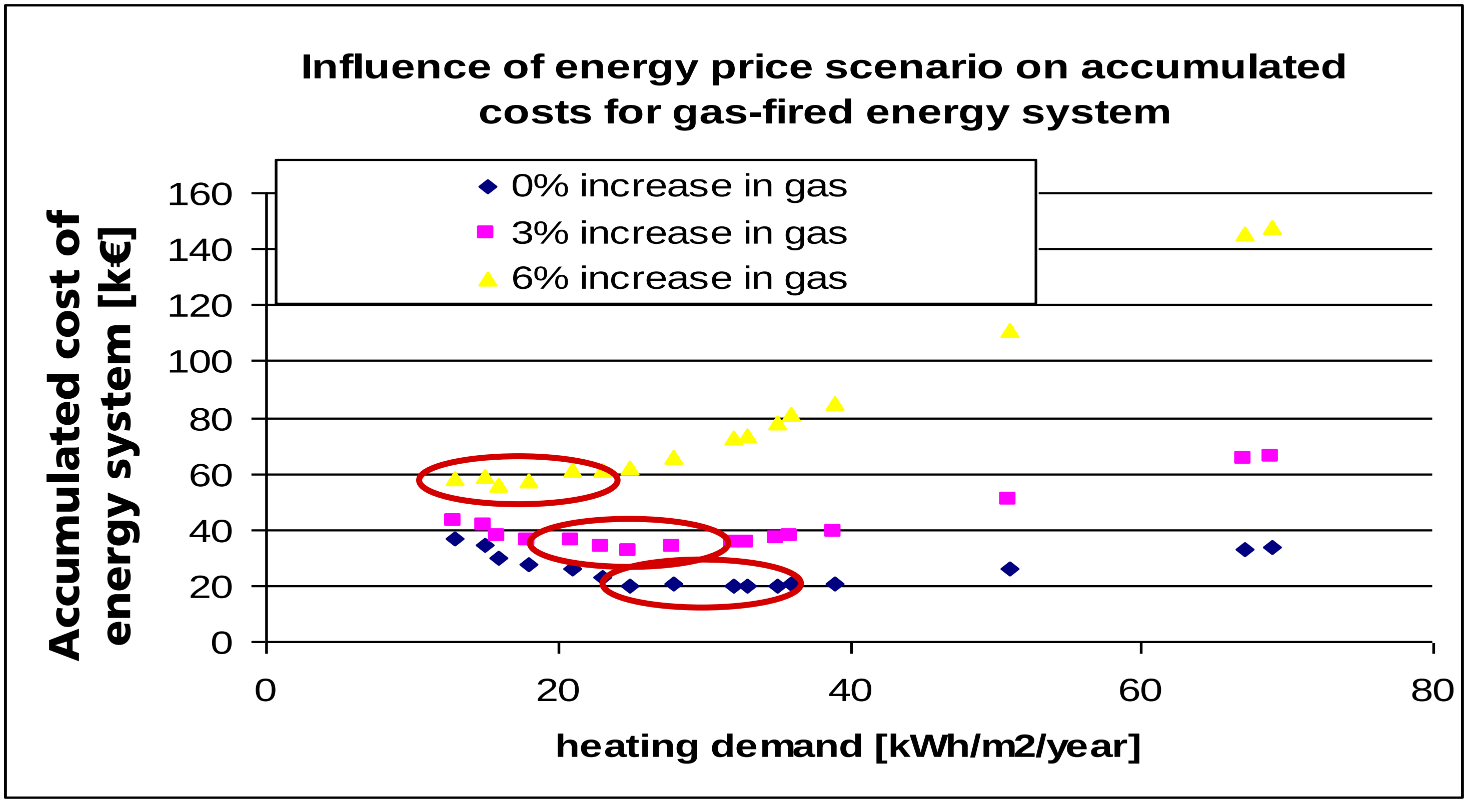
(developed by ECN, the Netherlands)

- Four step procedure:
- Set an energy target for the building, to be reached at the next natural renovation cycle, i.e. the replacement of the HVAC system.
- Determine the optimal HVAC system to put in place at that moment in time, composed from the best available technology (in terms of cost-performance ratio, taking into account the effect of energy price developments).
- Determine the optimal building skin (in terms of cost-performance ratio, taking into account the effect of energy price developments) associated with the HVAC system resulting from 2.
- Determine the optimal HVAC system (in terms of cost-performance ratio, **taking into account the effect of energy price developments and impact of necessary alterations to the system of step 2** in the future) for the time until the next natural renovation cycle

Prepared In all Aspects for Future
The PIAF Methodology

(developed by ECN, the Netherlands)

Example: Energy supply for a single family house



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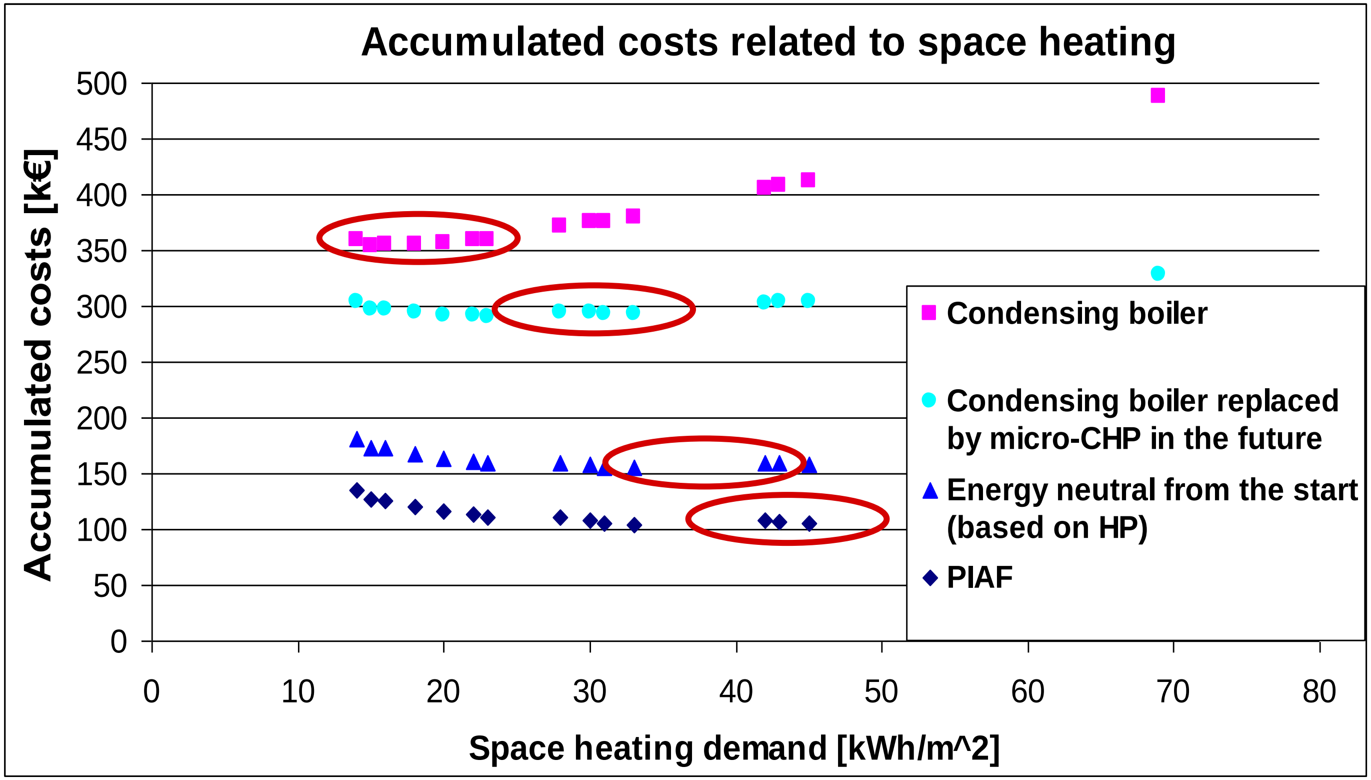

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Users participation
Examples from Austria

- Participation of users in various phases of the design process is an important success factor for advanced housing renovation

- Technologies
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Retrofit Projects I
IEA SHC Task 37

protected façade

Roter Block, Freiburg
Owner: Freiburger Stadtbau GmbH
Architecture: Huller, Banzhaf + Partner
BT / Energy Concept: Fischer / Stahl + Weiß

passivhouse renovation

Tevesstrasse, Frankfurt
Owner: AGB Frankfurt
Architecture: Grenz / Rasch
BT / Energy Concept: Baumgartner / PHI

passivhouse renovation

Hoheloogstrasse, Ludwigshafen
Owner: GAG Ludwigshafen
BT / Energy Concept : PHI

Vacuum-insulation

Guter Hirte, Ulm
Owner: Kath. Gemeinde Bofingen
Energy Concept : IBP

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Retrofit Projects II
IEA SHC Task 37

„KfW40“
„KfW60“

Rislerstrasse, Freiburg
Owner : Freiburger Stadtbau GmbH
Architecture: B. Thoma – G. Henninger-Thoma
BT / Energy Concept : Lenz / Stahl + Weiß

„Zero“-House

Blaue Heimat, Heidelberg
Owner : GGH- Heidelberg
Architecture: J. Gerstner, Heidelberg
BT / Energy Concept : solares bauen GmbH

3L- House

Freyastrasse, Mannheim
Owner : GBG – Mannheimer Wohnungsbaugesellschaft mbH
Energy Concept: IBP / IGE

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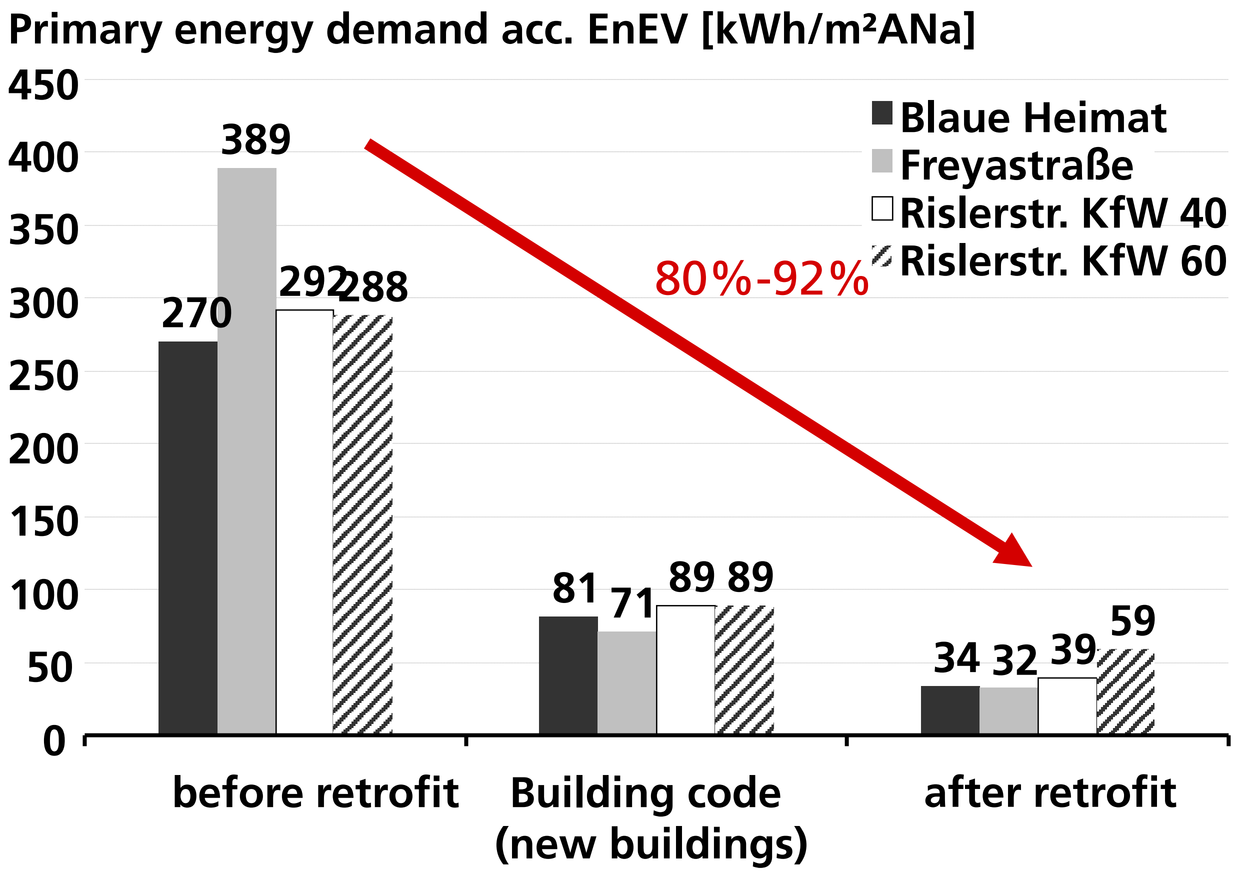
Key Data - Energy Design

- Blaue Heimat: Reduction 84% (KfW 40/ „Zero“)
- Freyastrasse: Reduction 92%
- Rislerstrasse 1-5: Reduction 87% (KfW 40)
- Rislerstrasse 7-13: Reduction 80% (KfW 60)



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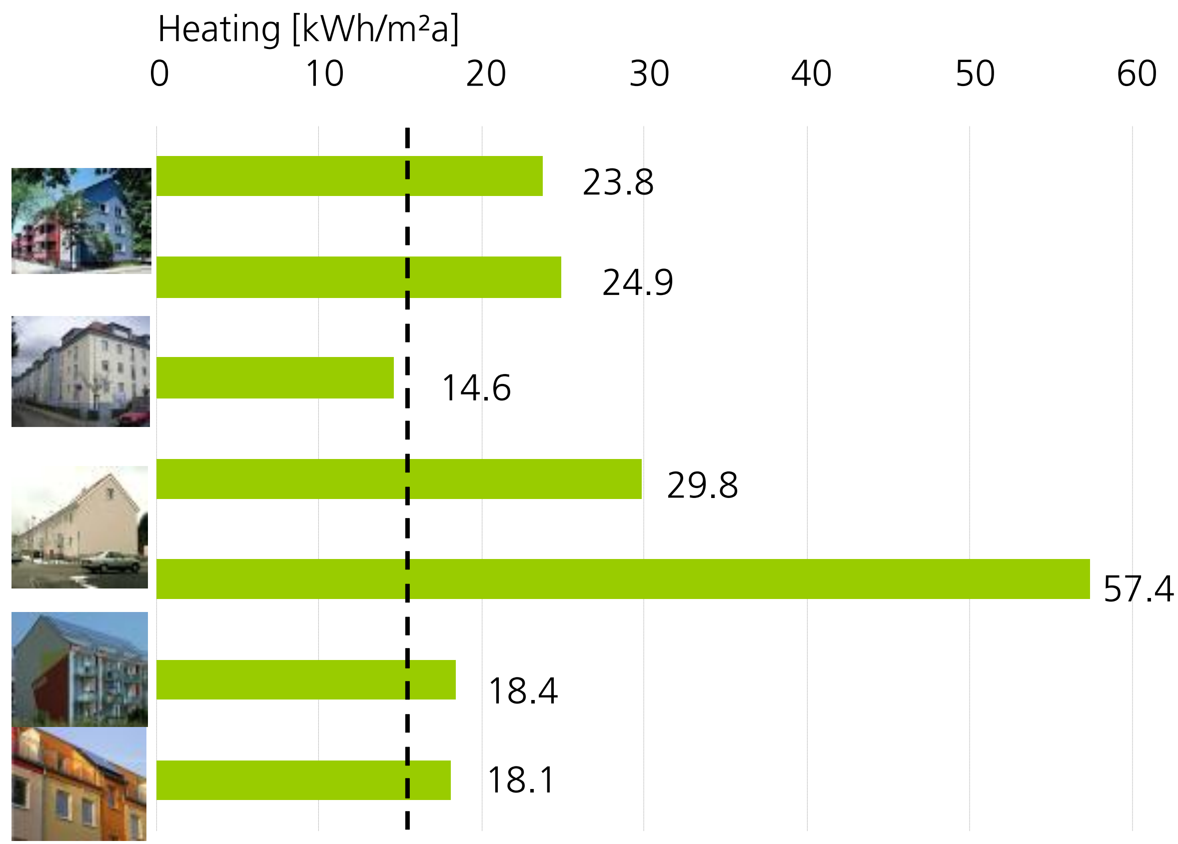
Cross Analysis: measured heating energy [kWh/m²year]

- Heating energy below 30 kWh/m²a for "KfW –Houses"
- Blaue Heimat < 15 kWh/m²a
- Large variations in attached houses Freyastrasse 11 – 60 kWh/m²a
- Passivhouse in renovation (Ludwigshafen, Frankfurt) 18 kWh



Data: ISE, IBP, IGE, PHI

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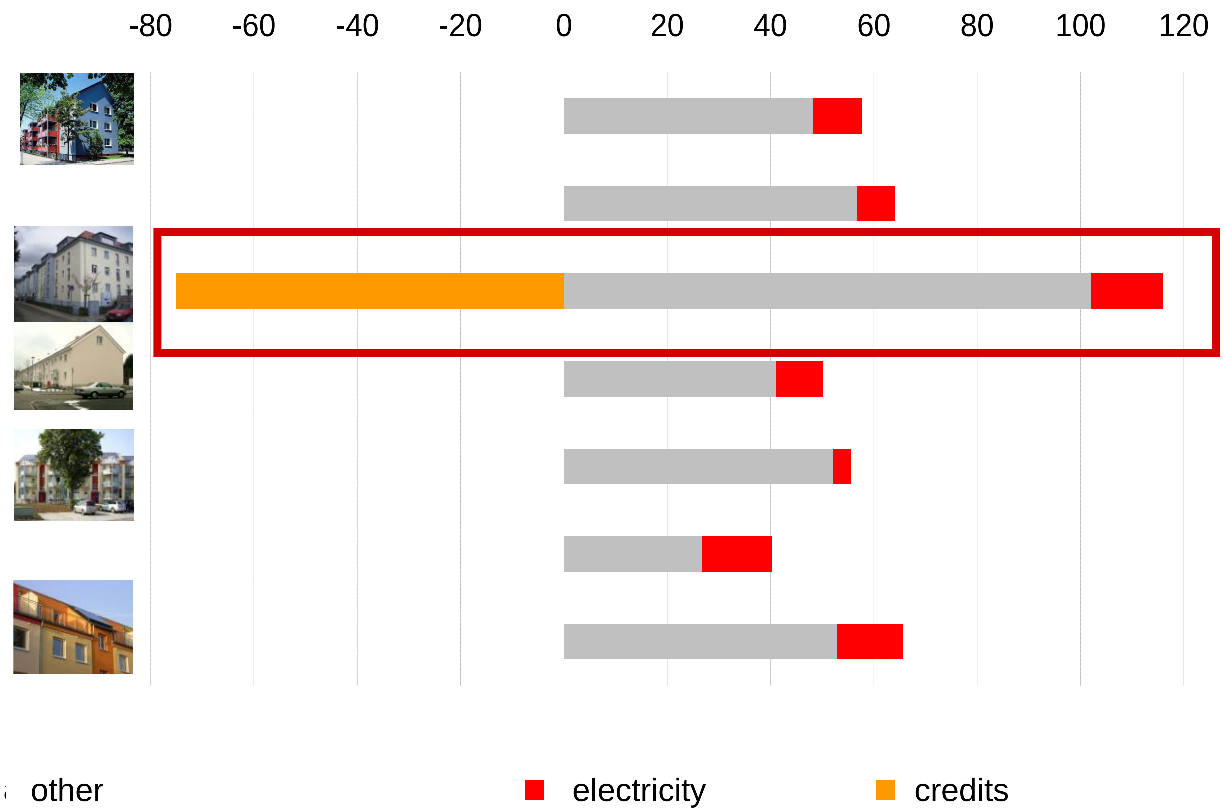
Measured primary Energy Consumption [kWh/m²a]

- Rislerstrasse KfW 40: 57.7 kWh/m²a
- Rislerstrasse KfW 60: 64.0 kWh/m²a
- Blaue Heimat (incl. CHP credits): 39.9 kWh/m²a
- Freyastrasse: 50.2 kWh/m²a
- Hoheloogstr: 40.2 kWh/m²a
- Tevesstr.: 65.6 kWh/m²a



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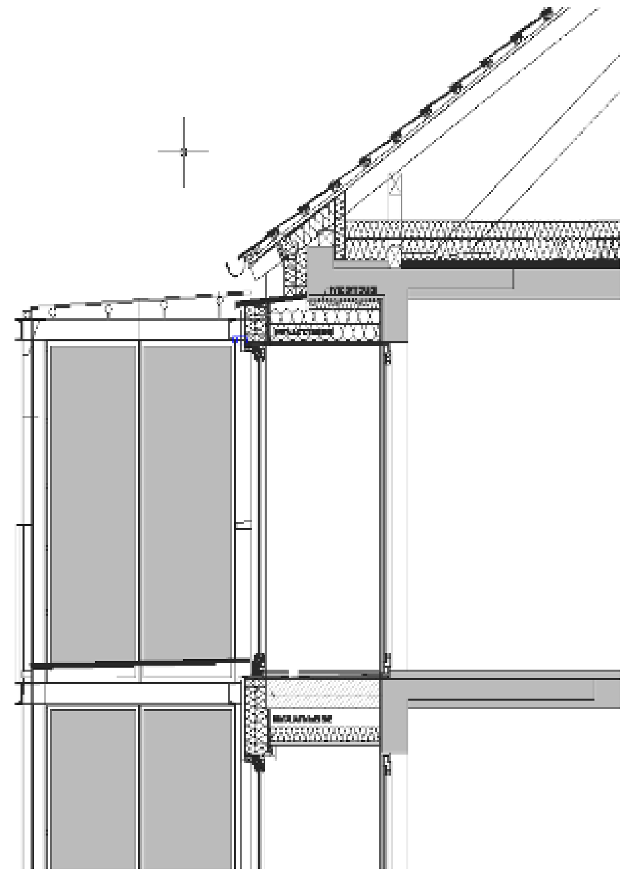
Risslerstrasse, Freiburg

- Built in 1961
- Retrofit 2005
- Two energy standards: KfW40 resp. KfW60
- Net Heated Floor Area: 1230m² resp. 1640m²
- No. of flats: 18 resp. 24

Concept – building envelope

- Insulation of external wall, roof and floor to basement
- Windows:
  KfW40: triple - glazing
  KfW60: double - glazing
- Transmission losses
  KfW40: HT'=0,27 W/m²K
  KfW60: HT'=0,35 W/m²K
- Distribution in ceiling's insulation



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Concept – supply

- Gas condensing boiler 60kW each
- Heating system low temperature radiators
- Solar thermal collector for DHW
  KfW 40: 24 m²
  KfW 60: 29 m²
- Buffer storage 750 l, DHW storage 500 l
- Ventilation
  KfW 40: balanced vent., heat recovery 85%
  KfW 60: Exhaust ventilation

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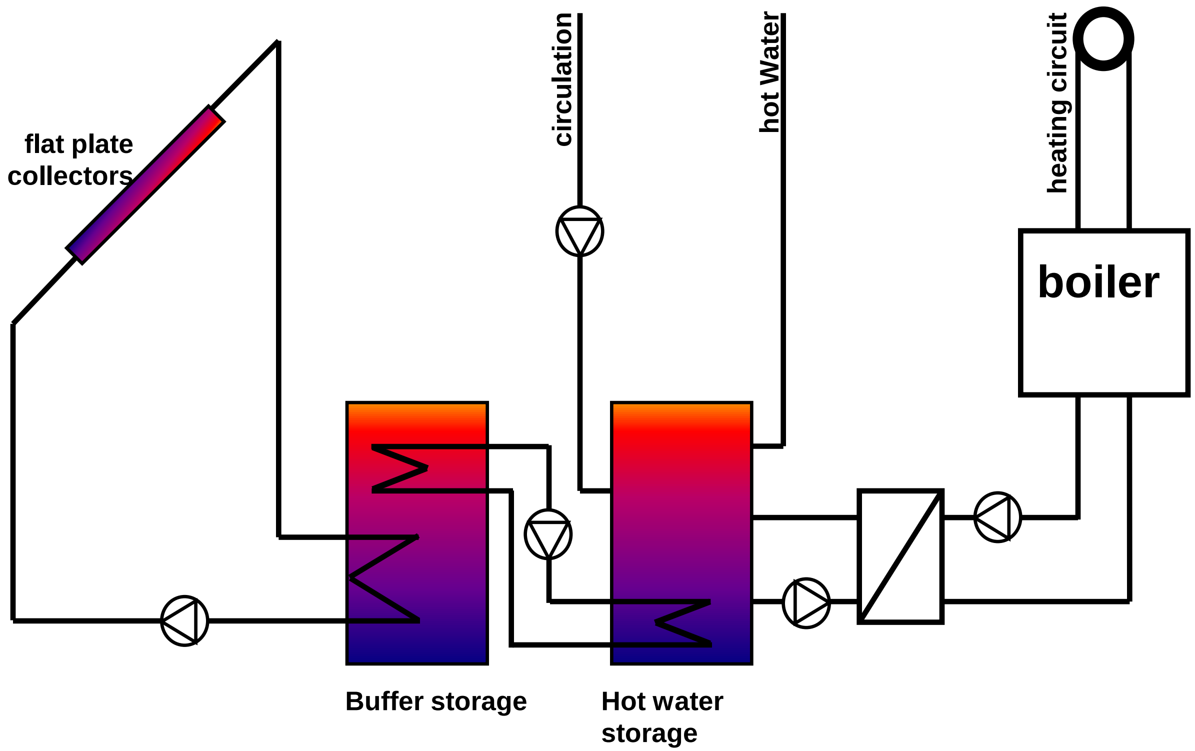
Supply scheme
Rieslerstrasse



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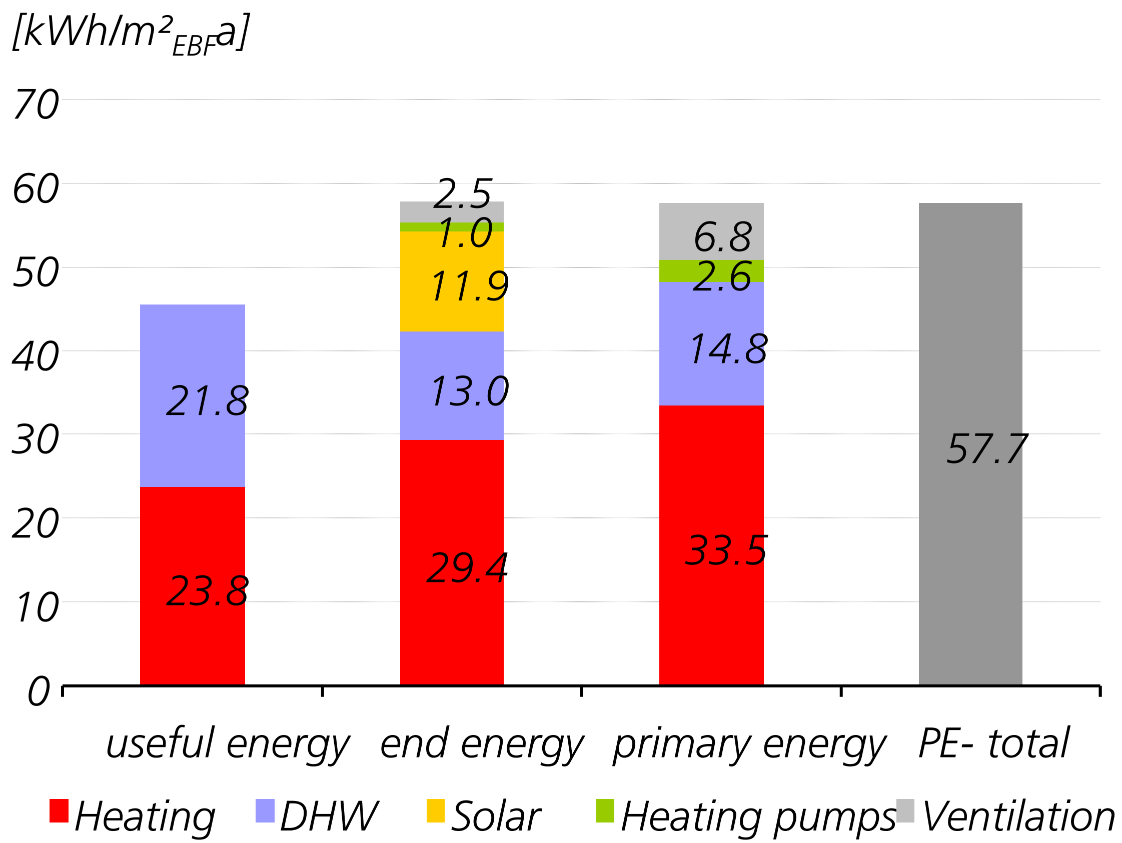
Energy consumption KfW 40

- 01/07 – 12/07
- PE- consumption (NFA) 58 kWh/m²a (planned: 54 kWh/m²a)
- end energy / primary energy

  electricity 2.7 kWh_{PE}/kWh_{EE}

  natural gas 1.1 kWh_{PE}/kWh_{EE}

  solar thermal 0 kWh_{PE}/kWh_{EE}



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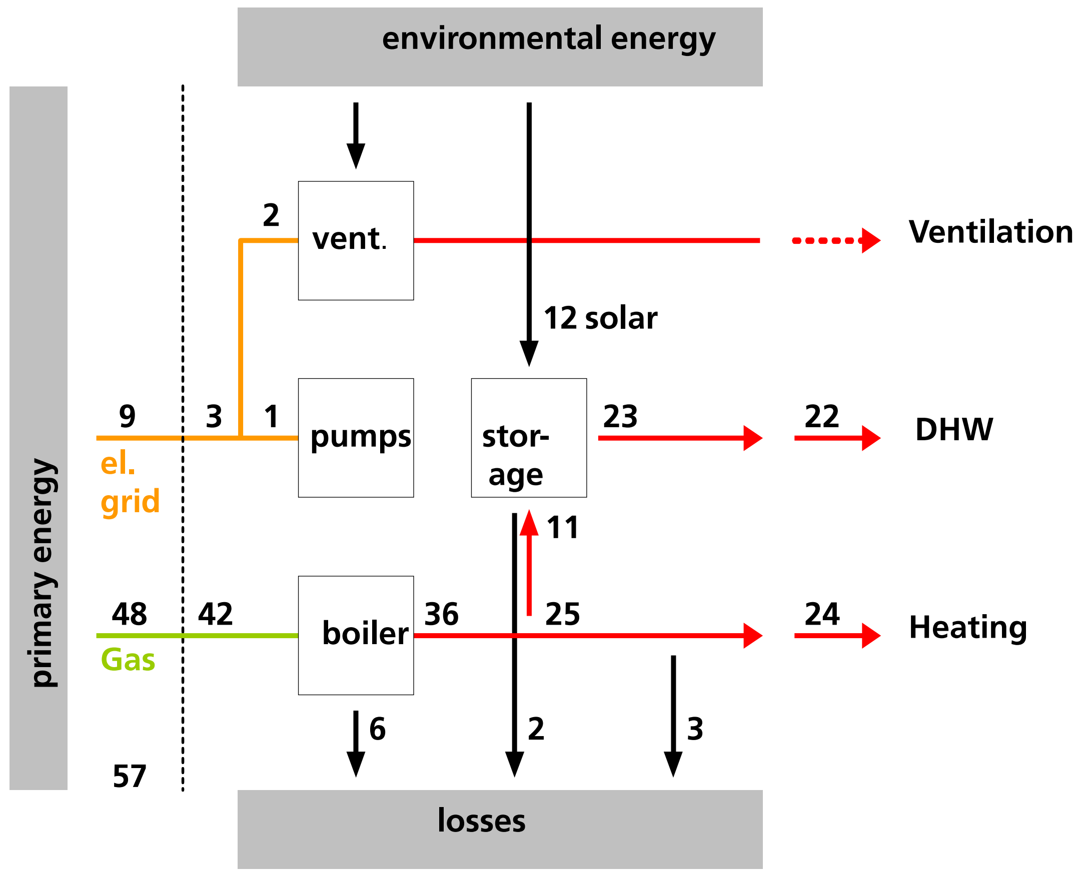
Energy flow - KfW 40

- Almost same demand for DHW and heating
- Solar contribution ~ 12 kWh/m²a
- Overall losses ~ 11 kWh/m²a
- Hot water con-sumption under-estimated following ENEV



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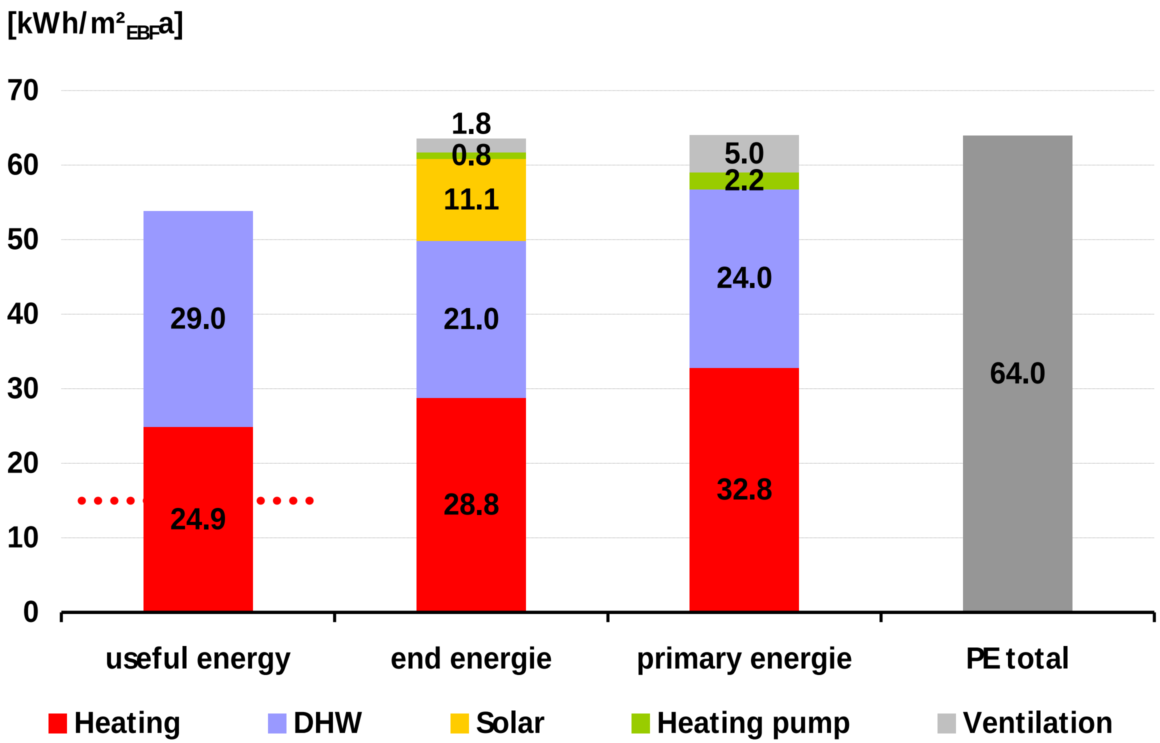
Energy consumption KfW 60

Measurement period 01/07 – 12/07

Specific PE-consumption:

- 64 kWh/m²y
- (planned: 80 kWh/m²y)



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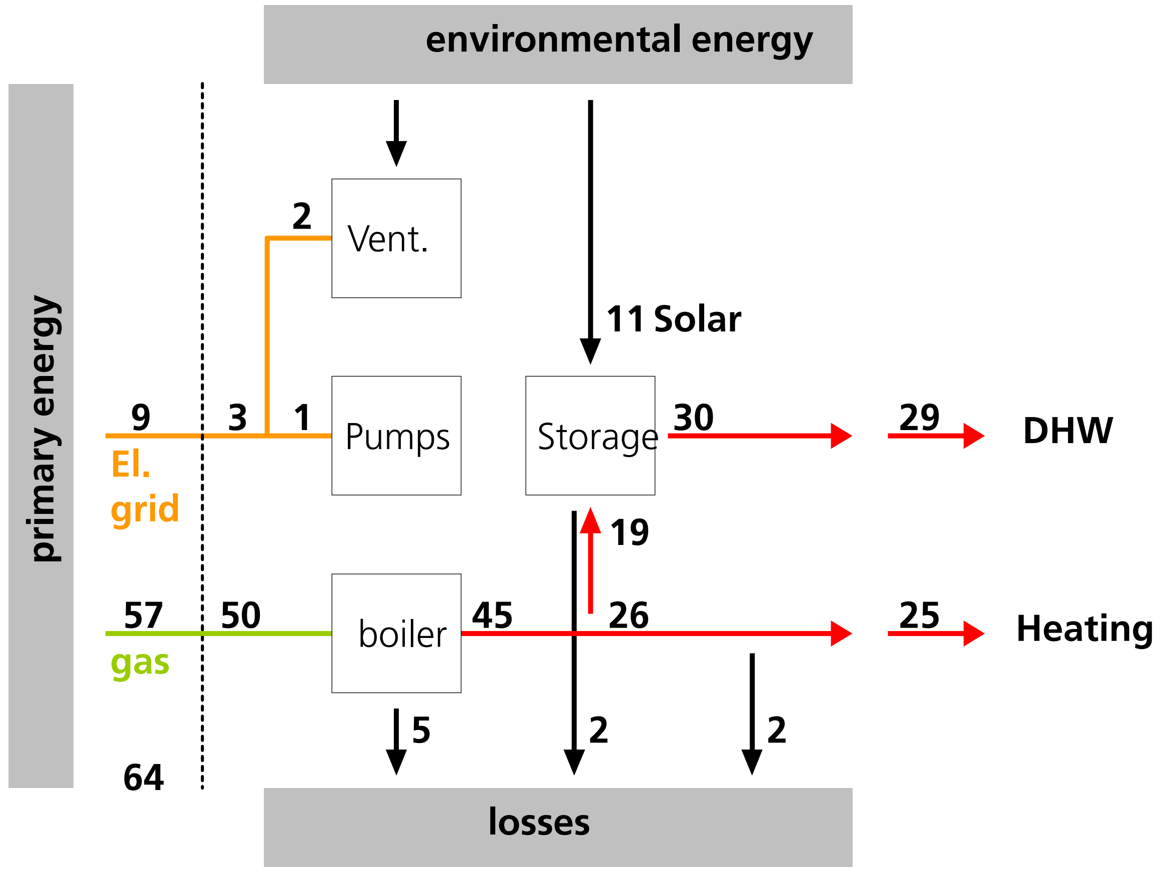
Energy flow – KfW 60

- Appr. same part DHW and Heating
- Solar contribution ~ 11 kWh/m²a
- Overall losses ~ 10 kWh/m²a
- Hot water con-sumption under-estimated following ENEV



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Summary Rislerstrasse

- Technologies applied (high level insulation, gas condensing boiler in combination with solar thermal) can be stated as "state of the art"
- Energy demand for DHW and heating in same level
- Efficiency of boiler as expected
- Significant contribution of solar thermal to energy demand
  - Although solar thermal system was designed for DHW only
  - Potential for enhanced solar contribution visible
- Open questions regarding user behaviour with respect to ventilation: small advantage of ventilation with heat exchanger compared to exhaust ventilation

Blaue Heimat, Heidelberg

Built in 1951

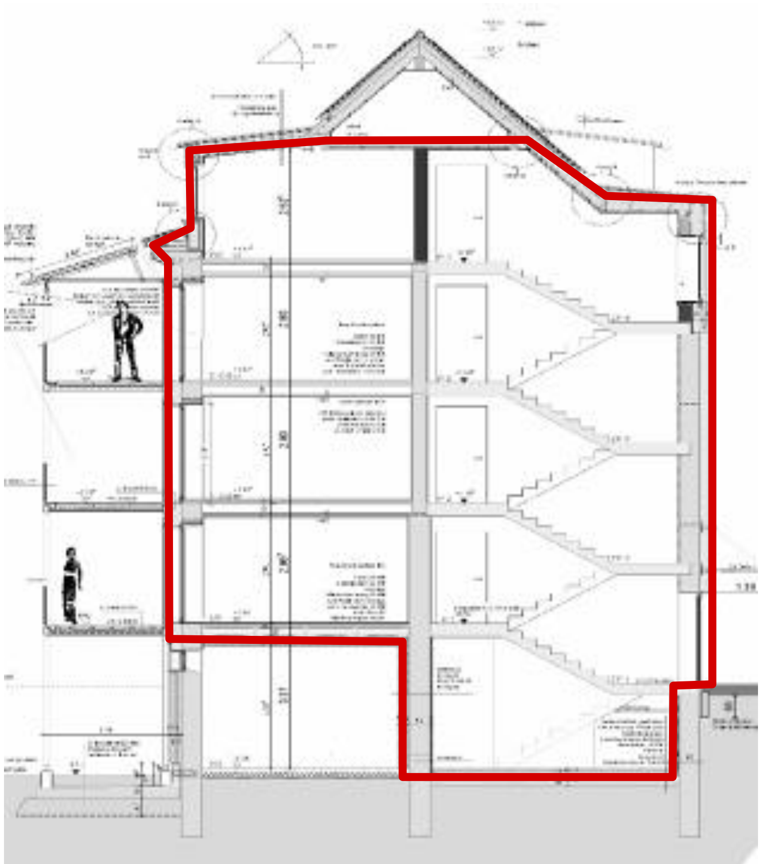
Retrofit in 2005

NHFA: 3375m²

No. of flats : 40

Concept – building envelope
Blaue Heimat

- Insulation of external wall, roof and floor to basement
- Windows: triple - glazing
- Transmission losses HT'=0,31 W/m²K
- 200% insulation of distribution pipes: reduced losses compared to building code



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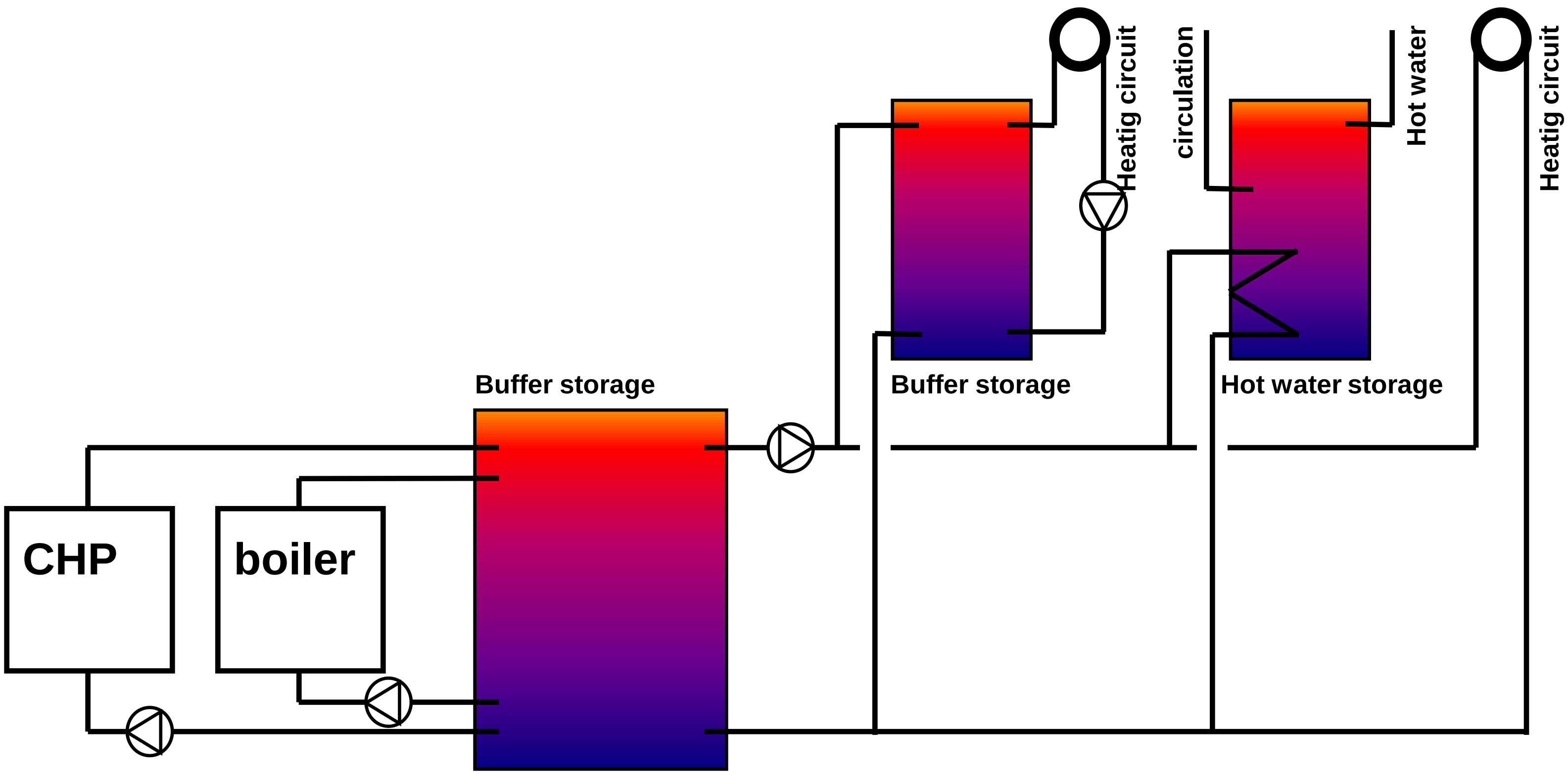
Concept – energy supply
Blaue Heimat

- Natural gas-based CHP 50 kW_{el} / 80 kW_{th}
- 3 x 1.000 l buffer storage
- 2 peak load boilers 184 kW
- Balanced ventilation with heat recovery (>85 %), 3-level control in the flats
- „Zero“- Concept: Net Zero Energy house

Supply scheme
Blaue Heimat



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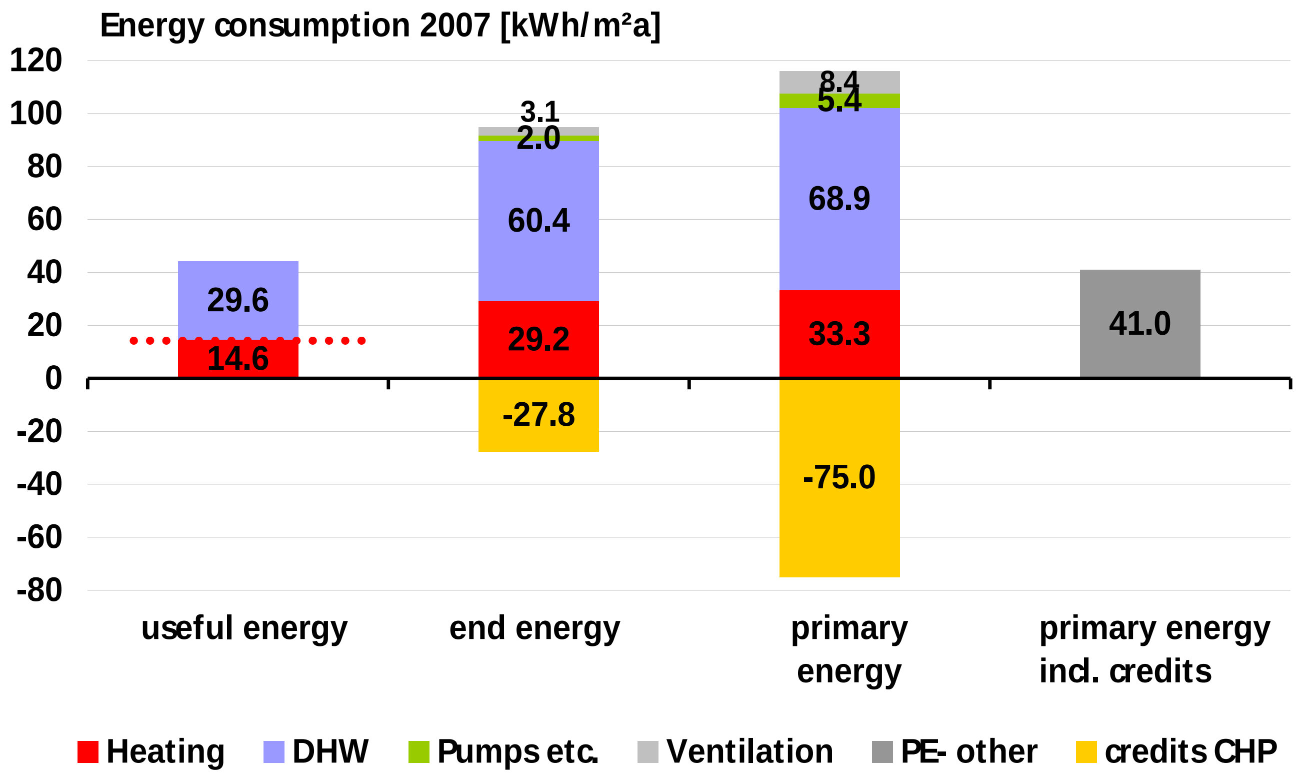
Energy consumption Blaue Heimat

- 1/07 – 12/07
- Heating energy consumption achieves almost passive house standard
- CHP- credits: 75 kWh/m²a
- Net zero energy house not completely achieved



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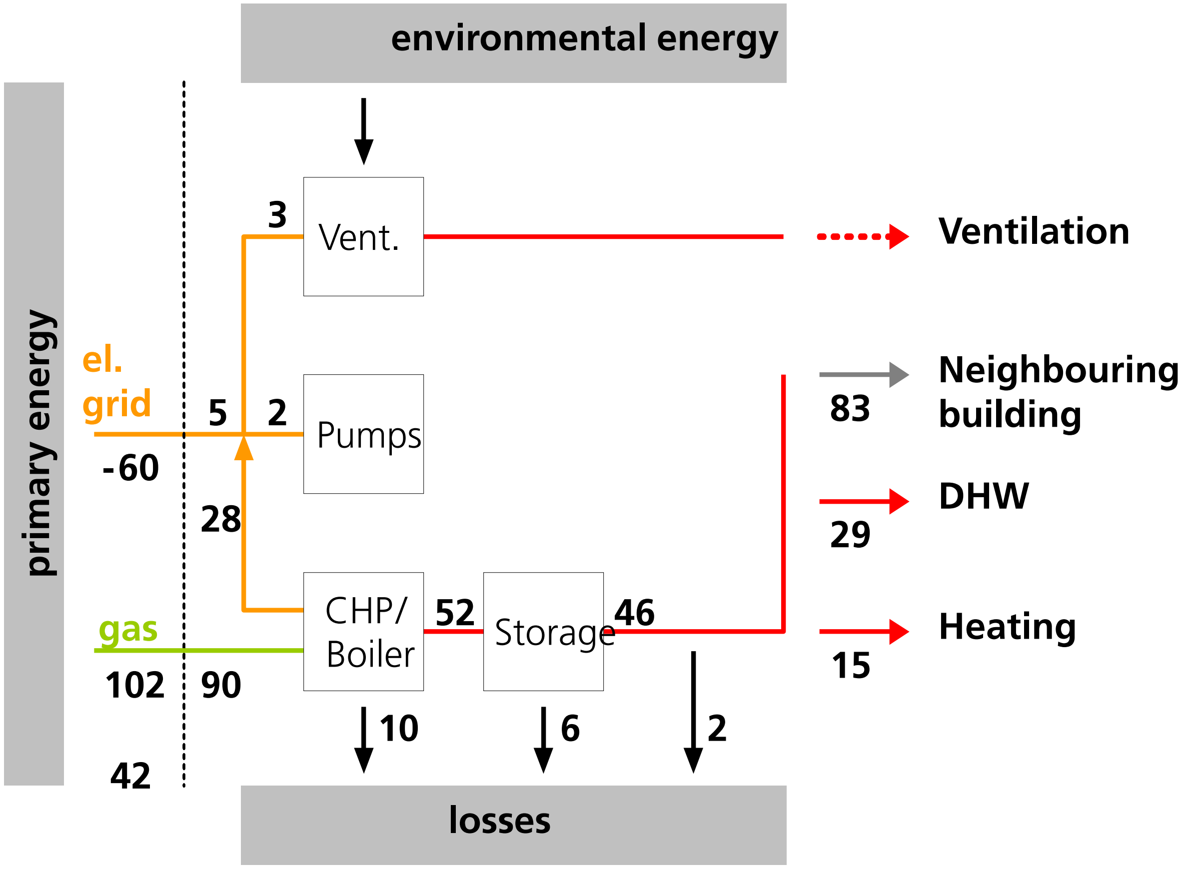
Energy flow

- Dominated by DHW demand
- Storage and distribution losses in same order of magnitude as heating demand



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Summary – Blaue Heimat

- Advanced housing retrofit possible
- DHW becomes most important
- Increased influence of user behaviour (Ventilation, DHW)
- Distribution losses and energy for ventilation and heating pumps become more important
- CHP could play a role in net zero multi-family houses
- Solution where high level insulation becomes difficult

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Conclusion

- Advanced housing retrofit even to the level of passive houses becomes state of the art
- Energy standards like the net zero energy balance possible even with specific issues in retrofit (ventilation, heat bridges, air tightness)
- DHW becomes as important as heating
- Increasing influence of user behaviour (desired room temperature, ventilation, hot water demand)
- Specific solutions have to be adapted to particular conditions (e.g. centralized vs. de-centralized, direct supply vs. storage, separated supply for DHW and heating)

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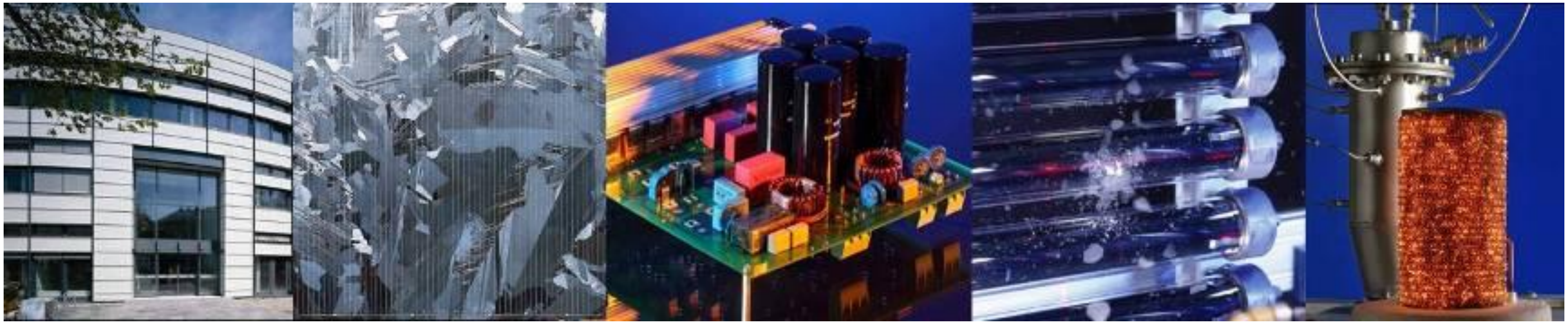

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