Presentation P5

Refurbishment solutions for post-war housing blocks

New façades, new buildings

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• Problem statement
• Theoretical background
• Case study building
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• Energy calculations
• Old vs. New situation
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Introduction

- Post-war housing blocks (1945 – 1975)

780,000 dwellings, 11% of the housing stock
(Source: http://www.energiebesparingsverkenner.nl/p001.asp)
Introduction

• Energy consumption post-war housing blocks

• Greenhouse gas emission

• Indoor climate

• Appearance building
Introduction

How can a housing block out of the post-war period be refurbished in such a way the building can be transformed in a resource-efficient and environmentally healthy building if the focus is on the façade, the indoor climate and energy consumption?

Example of solutions

- Façade refurbishment
- Close of loggia
- Improve ventilation dwelling
- New climate system
- Solar collectors
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Problem statement

• Energy consumption post-war housing blocks

• Main goal:
Energetic refurbishment of ageing buildings focused on façade and indoor climate

• Main question:
How can a housing block out of the post-war period be refurbished in such a way the building can be transformed in a resource-efficient and environmentally healthy building if the focus is on the façade, the indoor climate and energy consumption?
Introduction

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Theoretical background

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Energy calculations

Old vs. New situation

Conclusion
Theoretical background

1. GHG emission 60.4% caused by energy use
2. Final energy consumption housing sector 26%
3. Space heating & hot water 82% of total energy consumption

(source: Eurostat, 2009)
(source: Itard and Meijer)
Theoretical background

- Energy price vs. rent

Source energieprijzen en berekening: Klimaatbureau Amsterdam,
Source huur: Amsterdamse Federatie van Woningcorporaties, Jaarboek AFW
Source: http://www.durasolar.nl/index/5
Theoretical background

• 1951 - 1974, label D or worse
Theoretical background

Source: Jellema 8

Bottlenecks

Thermal bridges

Source: Jellema 8 - woningbouw
## Theoretical background

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Torenflat, Zeist</th>
<th>Leeuw van Vlaanderen, Amsterdam</th>
<th>De Rembrandtflat, Zwolle</th>
<th>De Brandaris / the Noordwachter, Zaandam</th>
<th>De Valk, Apeldoorn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents could stay in their apartments</td>
<td>Old residents had the choice to get back in the new building</td>
<td>Residents could stay in their apartments, but also had the possibility to move out temporarily</td>
<td>Residents could stay in their apartments</td>
<td>Old residents had the choice to get back in the new building</td>
<td></td>
</tr>
</tbody>
</table>

| Façade | Placing façade in front of old structure, then removed the old façade | Stripping total building and new façade for structure | New insulation, new glazing | New façade in front of old structure, old façade remained | Stripping total building and new façade for structure |

| Floor plans | Similar | New floor plans and extra floor on top of the building | Similar | Similar | New floor plans, extra floor area per apartment |

| Climate installations | No extra installations added, only renewed | Added some mech. ventilation for the gallery | Solar collectors, heat pump, central heating and recovery system, mech. Outtake air | Solar collectors, mechanical extraction air | Mechanical extraction air, hot-fill connection to reduce water |

<table>
<thead>
<tr>
<th>Reduction total/year</th>
<th>290 tonnes</th>
<th>40% (heating costs)</th>
<th>54 tonnes</th>
<th>129 tonnes</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction CO2 (%)</td>
<td>40</td>
<td>Unknown</td>
<td>23</td>
<td>46</td>
<td>32.9</td>
</tr>
<tr>
<td>Old -&gt; new label</td>
<td>F -&gt; C</td>
<td>Unknown</td>
<td>E/F -&gt; A</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Costs/house (€)</td>
<td>85.000</td>
<td>130.000</td>
<td>100.000</td>
<td>24.700</td>
<td>100.000</td>
</tr>
<tr>
<td>Costs total (€)</td>
<td>42.000.000</td>
<td>12.500.000</td>
<td>10.700.000</td>
<td>4.150.000</td>
<td>15.000.000</td>
</tr>
<tr>
<td>Costs / m² (€)</td>
<td>1.350</td>
<td>1.250</td>
<td>820</td>
<td>275</td>
<td>1.500</td>
</tr>
<tr>
<td>Total floor area (m²)</td>
<td>30.700</td>
<td>10.033</td>
<td>13.100</td>
<td>16.000</td>
<td>10.000</td>
</tr>
</tbody>
</table>

## Previous projects

- Every project its own approach
- Energy reduction depends on approach
- Increase comfort of the dwellings (energetic, sound or climate)
- Inform residents
- Improvement insulation and glazing
Theoretical background

- Energy consumption post-war dwellings
- Existing building stocks exceeds new buildings
- Thermal bridges (gallery and loggia are thermal bridges)
- Different refurbishment concepts
- Refurbishment means new demands for dwellings and residents
- Program of requirements for refurbishment and case study building

Conclusion
• Introduction
• Problem statement
• Theoretical background

• Case study building
  • Refurbishment concepts
  • Energy calculations
  • Old vs. New situation
• Conclusion
Case study building

Existing situation
Case study building

- Suringarflat, Zaandam (1963)
- 96 dwellings (3 types) about 70 m²
- Architect: J.M. van Dokkum
- Owned by housing company ‘Rochdale’

‘Rottinghuis’ building system

*Developed after the Second World War*
Case study building

- Concept for middle high buildings
- Prefabricated concrete elements for walls and floors

Source: Niet-traditionele woningbouwmethoden in Nederland – Priemus H.

Fig. - Typical isometric detail of balcony and window frame

Fig. - Typical detailing of the 'Rottinghuis' building method
Case study building

Energy calculations done by ‘ABC-bouwkundig’

Energy labels dwellings
- 29 dwellings label D
- 46 dwellings label E
- 21 dwellings label F
Case study building
Case study building
Case study building

Elevations

South façade

North façade
Case study building

Main problems

• Moisture
• Mold
• Draft
• Noise from the neighbours
• Energy efficiency
Case study building

Main goals:

• Energetic refurbishment post-war flats
• Energy reduction focused on façade
• Improve indoor climate
• Focus on middle dwelling (84 in total)
P5 Presentation

- Introduction
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- **Refurbishment concepts**
- Energy calculations
- Old vs. New situation
- Conclusion
Refurbishment concepts

- Façade improvement
- Façade replacement
- Close gallery / loggia
- Façade extension
- Extra floors on top
- Inside improvement
- Create greenhouse
- Second skin façade
Refurbishment concepts

Pro
• Low impact residents
• Low impact building
• Generic solution

Con
• Does not solve critical connections
• Limited façade possibilities
• Low impact indoor climate

Façade improvement

Pro
• Low impact building
• Improvement critical connections
• Façade possibilities
• Generic solution

Con
• Impact residents
• Execution

Façade replacement
Refurbishment concepts

Pro
• Low impact residents
• Improvement critical connections
• Thermal buffer (outside – inside)
• Generic solution

Con
• Fire safety
• Ventilation dwelling
• Overheating
• Regulation gallery (open/close)

Close loggia / gallery

Façade extension

Pro
• Bigger floor plans
• Improvement critical connections
• Positive impact indoor climate
• Façade possibilities

Con
• High impact residents
• Not really generic
Refurbishment concepts

Pro
• Bigger and other floor plans
• In combination with other concepts
• Exploitation building

Con
• No façade refurbishment
• Not really generic
• Does not improve the existing building

Extra floors on top

Pro
• Impact building
• Generic solution

Con
• Smaller floor area
• Impact residents
• Difficult solutions

Inside improvement
Refurbishment concepts

Pro
• Low impact residents
• Improvement critical connections
• Impact indoor climate

Con
• Ventilation dwelling
• Impact building
• Fire safety
• Overheating
• Not generic

Create greenhouse

Second skin façade

Pro
• Low impact residents
• Execution
• Improvement critical connections
• Impact indoor climate

Con
• Ventilation dwelling
• Impact building
• Fire safety
• Overheating
• Not generic
Refurbishment concepts

1. Façade improvement
2. Façade replacement

Selection

3. Façade extension

4. Close gallery / loggia
Refurbishment concepts

Design values façade

- Insulation: Design value (EPC: 0,6)
- Rc-value façade / floor: 4,0 m² • K/W
- Rc-value roof: 5,0 m² • K/W
- U-value doors/windows: 1,5 - 1,2 m² • K/W

Thermal comfort

- Minimum temperature: 18,0 °C
- Lower/upper comfort limit: 20,0 °C (Winter) / 25,5 °C (Summer) PMV = 0,5
- Maximum temperature: 28,0 °C
- Amount of overheating (> 25,5 °C): < 300 hours (best if < 200 hours)

Ventilation

Each function has got its own ventilation demand

- Living room/ bedroom: 0,7 – 0,9 dm³/s per m²
- Bathroom: 14 dm³/s
- Kitchen: 21 dm³/s
- Toilet: 7 dm³/s
• Introduction
• Problem statement
• Theoretical background
• Case study building
• Refurbishment concepts

**Energy calculations**

• Old vs. New situation
• Conclusion
Energy calculations

Energy calculations in CAPSOL

- Walls
- Zones
- Ventilation
- Functions
- Temperatures
- Power (internal)
- External references
- Controls
- Sensor points
- Sun obstacles

Demands according Dutch building regulations
Energy calculations

Energy use per application

Difference = 10.9%

Comparison

Energy use per application

Calculation existing situation (ABC-bouwkundig)

Calculation ‘ABC-bouwkundig’
- Heating 651 m³ gas 22,888 MJ Primary energy
- Water 277 m³ gas 9,745 MJ “
- Extra energy 237 kWh 2,184 MJ “
- Lighting 420 kWh 3,877 MJ “ + 38,694 MJ Primary energy use

[CO2 emission 2023 kg]

Simulation existing situation (Capsol)

Simulation existing situation Capsol
- Heating 585 m³ gas 18,670 MJ Primary energy
- Water 277 m³ gas 9,745 MJ “
- Extra energy 237 kWh 2,184 MJ “
- Lighting 420 kWh 3,877 MJ “ + 34,476 MJ Primary energy use

[CO2 emission 1804 kg]
Energy calculations

- Energy consumption for space heating
- 14 calculations
- North – South orientation
- East – West orientation
- Energy reduction in %
- Energy use in kWh/m²
- Amount of overheating in hour

Calculations N – S

Energy use middle dwelling North - South orientation

Energy calculations

- Energy consumption for space heating
- 14 calculations
- North – South orientation
- East – West orientation
- Energy reduction in %
- Energy use in kWh/m²
- Amount of overheating in hour
Energy calculations

- 75.8 kWh/m² existing
- 23.1 kWh/m² new
- 23.1 kWh/m² new

Comparison N - S

Energy use middle dwelling North - South orientation

- 69% reduction
**Energy calculations**

- 83,3 kWh/m² existing
- 28,6 kWh/m² new
- 25,5 kWh/m² new

**Comparison E-W**

Energy use middle dwelling East - West orientation

**Energy calculations**

- 83,3 kWh/m² existing
- 28,6 kWh/m² new
- 25,5 kWh/m² new

**65,7% reduction**
Energy calculations

- N-S 69.6% reduction
- E-W 65.7% reduction

Comparison

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Reduction in % N-S orientation</th>
<th>Reduction in % E-W orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing situation</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Façade improvement</td>
<td>59.9%</td>
<td>55.8%</td>
</tr>
<tr>
<td>Close gallery &amp; FLR side</td>
<td>56.0%</td>
<td>53.7%</td>
</tr>
<tr>
<td>Close loggia</td>
<td>32.3%</td>
<td>27.9%</td>
</tr>
<tr>
<td>Close loggia &amp; FLR side</td>
<td>50.5%</td>
<td>48.9%</td>
</tr>
<tr>
<td>Close gallery &amp; FLR side</td>
<td>65.7%</td>
<td>67.9%</td>
</tr>
<tr>
<td>Close gallery &amp; FLR side &amp; FLR side</td>
<td>67.6%</td>
<td>67.6%</td>
</tr>
<tr>
<td>Close loggia &amp; facade repl.</td>
<td>59.5%</td>
<td>63.9%</td>
</tr>
<tr>
<td>Close loggia &amp; facade repl.</td>
<td>62.3%</td>
<td>63.9%</td>
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<tr>
<td>Close loggia &amp; facade repl. &amp; facade repl.</td>
<td>58.3%</td>
<td>62.3%</td>
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<tr>
<td>Close loggia &amp; facade repl. &amp; facade repl.</td>
<td>69.6%</td>
<td>69.6%</td>
</tr>
<tr>
<td>Close loggia &amp; facade repl. &amp; facade repl. &amp;</td>
<td>67.6%</td>
<td>69.4%</td>
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<tr>
<td>Close gallery &amp; FLR side &amp; FLR side</td>
<td>66.7%</td>
<td>69.6%</td>
</tr>
<tr>
<td>Close gallery &amp; FLR side &amp; FLR side</td>
<td>66.7%</td>
<td>69.6%</td>
</tr>
<tr>
<td>Glass replacement</td>
<td>39.9%</td>
<td>35.7%</td>
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</tbody>
</table>
Energy calculations

Result

• Energy reduction of about 69% can be accomplished for space heating

• More than 1 solution for energetic façade refurbishment

• Refurbishment case study combination of 3 different refurbishment concepts
  (*Improvement, replacement and extension*)

• Close of loggia combined with façade replacement or façade improvement

• Façade extension to gain extra floor area
  (*External balcony*)

• Energy use dwelling (north – south) from 75,8 kWh/m² → 23,1 kWh/m²
• Energy use dwelling (east – west) from 83,3 kWh/m² → 25,5 kWh/m²

\[\text{69}\% \text{ reduction}\]
Energy calculations

• Close loggia with façade improvement and replacement best overall solution

• Overheating without balcony :  >25,5°C  211 hours
• Overheating with balcony :  >25,5°C  178 hours

• Energy use heating without balcony :  24 kWh/m²
• Energy use heating with balcony :  30 kWh/m²
• Introduction

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• Old vs. New situation

• Conclusion
Old vs. new situation

• Improvement insulation values façade
• Replacement of existing façade elements
• Improvement of prefabricated elements
• Close of loggia to get rid of thermal bridges
• Extension floor plan with external balcony
• New ventilation concept to improve indoor climate
• Solar collectors to reduce energy demand hot water
Old vs. new situation

Floor plans

New
Old vs. new situation

Elevations
Old vs. new situation

Sections

Gallery
Living room
Loggia
Old vs. new situation

Details

Project: Suringarflat
Zaandam

Master Thesis
24
Detail 2 new
Scale 1:10

Designer: Edwin Tensen (1547275)

TYU Delft
Delft University of Technology

Building technology
June 22nd 2011

Edwin Tensen (1547275)
Old vs. new situation

New situation

Building sequence
Gallery side
Old vs. new situation

Building sequence
Living room side
Old vs. new situation
Old vs. new situation
Old vs. new situation

Simulation existing situation
- Heating 585 m³ gas 18.670 MJ Primary energy
- Water 277 m³ gas 9.745 MJ
- Extra energy 237 kWh 2.184 MJ
- Lighting 420 kWh 3.877 MJ

[CO2 emission 1804 kg]

Simulation façade refurbishment
- Heating 203 m³ gas 7.140 MJ Primary energy
- Water 277 m³ gas 9.745 MJ
- Extra energy 237 kWh 2.184 MJ
- Lighting 420 kWh 3.877 MJ

[CO2 emission 1201 kg]

Simulation façade refurbishment and solar collectors
- Heating 203 m³ gas 7.140 MJ Primary energy
- Water 168 m³ gas 5.900 MJ
- Extra energy 237 kWh 2.184 MJ
- Lighting 420 kWh 3.877 MJ

[CO2 emission 1000 kg]
Final result

Energy label
2233 – 1047 = 1186 kg CO2 reduction / dwelling
1186 kg x 96 = 113,856 kg CO2 reduction

EPC
1874 – 1119 = 755 kg CO2 reduction / dwelling
755 kg x 96 = 72,500 kg CO2 reduction

Capsol
Reduction 800 kg CO2 / dwelling
800 kg x 96 dwellings = 76,800 kg CO2 reduction

12,5 x around the world by car

http://www.energy-aware.org
P5 Presentation

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Conclusion

- Concept for post-war gallery flats
- Also applicable to porch flats
- With façade refurbishment 34% energy reduction
- In combination with solar collectors 45% energy reduction
- More energy reduction can be reached with more interventions
- Overall improvement of the building in appearance and safety
- Improvement ventilation of the building by mechanical ventilation
- Improvement floor area / accessibility of the building and dwelling

780,000 dwellings, 11% of the housing stock (1945 – 1975)  
(Source: http://www.energiebesparingsverkenner.nl/p001.asp)
Thanks for your attention!