Main objective:

The emergency family shelter used in cold climate conditions should stay on an appropriate/constant temperature at night by solely using the body heat of the inhabitants.
Introduction – Northern idyllic regions of Pakistan
Introduction – fleeing because of natural disaster and/or armed conflicts
Introduction – emergency sheltering, in anticipation of a permanent solution
Introduction - shelters

- Immediate Cause
- Problem Definition
- Research
- Conclusions
Introduction

- Immediate Cause
- Relevance of the research
- Problem definition
- Research
- Sections
- Conclusions and Results
Immediate Cause

- Background
Immediate Cause

- Winter 2010: 2.5 to 3 million refugees
- About 500,000 emergency shelters needed in Pakistan
Immediate Cause

- Past Winter: 2.5 to 3 million refugees
- About 500,000 emergency shelters needed in Pakistan
- Currently: 4 million new homeless people (floods)
- About 800,000 emergency shelters needed in Pakistan
- Normally 250,000 - 1 million homeless with a large scale disaster
- In comparison: about 75,000 building licenses per annum in the Netherlands for new buildings and renovation
The Netherlands Red Cross

Sheltering

Warm Climates
- Frame + Sail cloth

Cold Climates
- ????
  - Winterized tents?
Sheltering

Winterized tents

Zero energy winterized shelter
Problem Definition
Some requirements

- Production - CO₂ emissions, costs
- Environment - natural resources, use
- Costs - Final price
- Material efficiency - refuge and reduction of volume
- Life expectancy - re-use
- Transport - volume, weight, costs
- Local economy - introduction new materials

3 layers:
- Protection of victims
- Protection of the environment
- Reduction of costs
SlimBouwen regarding emergency sheltering
Research approach

Insulation:
- Problem definition
- Approach
- Solution
Insulation – current situation
Insulation – points of departure

5 inhabitants - dormant 360W
Desired temperature difference with the outdoors: 20°
Necessary warmth resistance: 2.22 m²K/W
## Insulation - Conventional insulation materials

<table>
<thead>
<tr>
<th>Category</th>
<th>Products</th>
<th>$\lambda$ [W/mK]</th>
<th>Thickness with 2.22 m²K/W</th>
</tr>
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<tbody>
<tr>
<td>Synthetic</td>
<td>EPS, XPS, PUR, PIR, Aerogel</td>
<td>0.011 – 0.035</td>
<td>24 – 78 mm</td>
</tr>
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### Disadvantages:
- Re-use possible?
- Damage local economy
- High costs: from 6.8,- €/m²
- Voluminous: 3.2 m³
## Insulation - Conventionel insulation materials

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### Disadvantages:
- Re-use?
- Damages local economy
- High costs from 6-8,- €/m²
- Voluminous: 3,2m³
Dry air is one of the best insulators: and comes free of charge!
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1/3. Insulation - physics

Dry air is one of the best insulators: and it comes free of charge!
1/3. Insulation - Solution!

Existing products:

Insulation based on reflection – SOLUTION!

a great variety of material qualities were found during testing in the lab.
Insulation - Calculations

Different performance for different qualities of foils
1/3. Insulation - solution!
Insulation - tests
Insulation - tests

Intro - Immediate Cause - Problem Definition - Research - Conclusions
Insulation – test results

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<tr>
<th>Material</th>
<th>$R_c$, expected</th>
<th>$R_c$, measured</th>
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<td>“Reflecting card board”</td>
<td>1,10 m²K/W</td>
<td>1,39 m²K/W</td>
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<tr>
<td>EPS</td>
<td>1,50 m²K/W</td>
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Insulation based on reflection as solution
- Warmth resistance of 1,10 m²K/W for 2 cavities
- Demanded: 2,20 m²K/W → 4 cavities is sufficient
Insulation – preliminary elaboration

- Foldable
- Light
- Very cheap
- Modular