"Monitoring results nearly and net energy dwellings"

Monitoring of Platform31," EnergySprong" projects

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Can we renovate towards comfortable Net Zero Energy dwellings at a reasonable price, and of good quality which perform as promised?
111.000 homes for rent to be refurbished to zero-energy

Four constructors and six housing corporations signed a deal called “De Stroomversnelling” (or "The Rapids") on the 20th of June 2013. The goal of this collaboration: to refurbish 111.000 homes to zero-energy, starting with 11.000 homes and ten organisations.
111.000 homes for rent to be refurbished to zero-energy

All these homes will be refurbished with no negative consequences in the total cost of living (rent and energy bill) for the tenants, leading to a positive business case for the housing corporation and constructors, without external financing.

- Tenants will pay an Energy Performance Reimbursement fee (which will not be higher than the guaranteed reduction of the energy bill) directly to the housing corporation;
- The corporation invests this money in refurbishing the homes;
- Constructors will refurbish the homes to a zero-energy level.
New deal renovation of private residences starting with 100 dwellings

- Result after renovation: Net zero energy dwellings
- Consortium >150 organisations: bank, municipalities, contractors
- Stimulate demand: municipalities, energy companies, local ambassadors
- Supply: Cooperation of contractor and manufacturers (co-developers)
- Enable: Set up Energy-neutral Renovation Mortgage
## Typical concepts of Net Zero Energy Concepts

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Location</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trebbe</td>
<td>Maurik</td>
<td><strong>Condensing boiler</strong>, Demand contr. Vent., Rc = 5</td>
</tr>
<tr>
<td>Klimaatgarant</td>
<td>Rijswijk</td>
<td><strong>Ground source HP</strong>, Vent, heat recov., Rc = 3,5 – 5</td>
</tr>
<tr>
<td>Heijmans</td>
<td>Grijpskerke</td>
<td><strong>Ground source HP</strong>, Vent, heat recov., Rc = 10-14</td>
</tr>
<tr>
<td>Klaassen</td>
<td>Oosterhout</td>
<td><strong>Air/Water HP</strong>, Air heating system. Rc=8</td>
</tr>
<tr>
<td>Novitijd</td>
<td>Nieuwleusden</td>
<td><strong>HP</strong>, natural supply vent.. Rc = 6 – 9</td>
</tr>
<tr>
<td>Bam</td>
<td>Arnhem</td>
<td><strong>Air/Water Heat pump</strong>, demand control vent. Rc = 5,3</td>
</tr>
</tbody>
</table>
Energy leap program

Innovation-implementation program “Energiesprong” (Energy leap in English) focuses on the development of marketable propositions for energy neutral (on the meter) buildings which are affordable, profitable for the building industry, provide good living conditions and realize the promised performance characteristics.
Monitoring program Energy leap

Integral monitoring of demonstration projects is an important part of this program. 200 dwellings including Net Zero Energy will be monitored by:

› Smart meters gas
› Smart meters electricity
› Temperatures living room, sleeping room
› Outdoor climate (through weather stations)
› Questionnaires
› Blowerdoor, infrared, inspections
Comfort: Simulation shows possible overheating in many concepts

- Kerkrade Passive house renovation + night ventilation + overhang
- Air tight + heat recovery
- Air tight and heat recovery
Example 1: no passive cooling measures

Montferland

Floor, Roof, Façade insulation of Rc=6

Heating: Combination of gas boiler and air/water heat pump

No passive cooling, some houses have active cooling (heat pump)

Survey: 58 % satisfying temperatures in the bed rooms during the summer, 8% too hot, 17 % sometimes to hot and 17% fluctuating temperatures.
Example 2: passive cooling measures

- Kerkrade
- Floor Rc=5, Roof Rc=10, Façade Rc=7
- Heating: gas boiler, ventilation with heat recovery
- Passive cooling: overhang + night ventilation
- Survey: 95% of tenants stated temperature improved after renovation
Example 3 Active cooling measures

- Montferland
- Floor Rc=3.5, Roof Rc=5, Façade Rc=4
- Heating and Cooling: Ground source heat pump
- No passive cooling measures
- Cooling is used to balance ground source

![Cooling load / ground source regeneration during data collection](image)
Summer comfort is possible in NZEB dwellings

A good strategy has to be chosen:
- Passive measures to prevent cooling load or
- In case of ground source heat pump cooling can be used to balance the ground source.
Reasonable price

Energy cost in Dutch houses is about 45.000 Euro in 20 years (6,4 Million Japanese Yen)
Development in retrofitting

Roosendaal 2010
Kerkrade 2011
Apeldoorn 2012

Integral renovation costs incl. VAT

Time

Zero on the meter

130,000
100,000
80,000
60,000
Energy related costs renovation Energy leap projects

![Graph showing energy related costs vs. primary energy use (GJ/m²).]
First Results Rijswijk Buiten (NOM)

PV + Ground source heat pump + energy efficient appliances

Energy use and supply in kWh after about 11 months:

<table>
<thead>
<tr>
<th>Dwelling</th>
<th>Use (meter)</th>
<th>Supply (meter)</th>
<th>Difference</th>
<th>Yield PV</th>
<th>Actual use</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2342</td>
<td>-3122</td>
<td>-780</td>
<td>3200</td>
<td>2420</td>
</tr>
<tr>
<td>B</td>
<td>2328</td>
<td>-3079</td>
<td>-751</td>
<td>3600</td>
<td>2849</td>
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<tr>
<td>C</td>
<td>1639</td>
<td>-3333</td>
<td>-1694</td>
<td>3500</td>
<td>1806</td>
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<tr>
<td>D</td>
<td>2087</td>
<td>-3141</td>
<td>-1054</td>
<td>3400</td>
<td>2346</td>
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<tr>
<td>E</td>
<td>3135</td>
<td>-3011</td>
<td>+124</td>
<td>3400</td>
<td>3524</td>
</tr>
</tbody>
</table>

Dwelling E: High set point temperature of 23,5 °C

Net zero energy seems possible in the current year. Homeowner pays Klimaatgarant about 100 Euro/month for 25 years of proper functioning of the installations.
There is a clear need for quality control

- Higher infiltration can not only lead to more energy use but also a need for more installed power for heating or cooling.

- There are also other reasons for quality control: proper functioning of the building and installation and prevention of cold spots which can lead to moisture and mould (mold) grow.
## Performance guarantee, how to check?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Requirement</th>
<th>Method example</th>
<th>when</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Max. 300 hour PMV &gt; 0,5 (+/- 26,5 °C)</td>
<td>calculation</td>
<td>Design phase</td>
</tr>
<tr>
<td>Airtightness</td>
<td>$q_{v,10} &lt; 0,4 \text{dm}^3/(\text{s m}^2)$</td>
<td>Blowerdoor test</td>
<td>completion</td>
</tr>
<tr>
<td>Sound</td>
<td>&lt; 30 dB</td>
<td>measurement</td>
<td>completion</td>
</tr>
<tr>
<td>Electricity ventil.</td>
<td>Energy calculation</td>
<td>measurement</td>
<td>completion</td>
</tr>
<tr>
<td>Elektr. Heat pump</td>
<td>&lt; … kWh/year</td>
<td>Separate meter</td>
<td>use</td>
</tr>
<tr>
<td>Elektra User</td>
<td>&lt; … kWh/year</td>
<td>(smart) meter data</td>
<td>use</td>
</tr>
<tr>
<td>PV yeald</td>
<td>&gt; … kWh/year</td>
<td>Separate product. meter</td>
<td>use</td>
</tr>
<tr>
<td>Heat loss coef.</td>
<td>&lt; … W/K</td>
<td>Smart meter data</td>
<td>use</td>
</tr>
<tr>
<td>Dom. Hot water</td>
<td>&lt; … GJ/year</td>
<td>Smart meter data</td>
<td>use</td>
</tr>
</tbody>
</table>
Performance guarantee: need for cost effective monitoring technology

Monitoring of Rijswijk Buiten

• **Independent**
  – Smart meters

• **Manufacturer monitoring systems of heat pumps and ventilation (Itho):**
  – Indoor temperature
  – Thermostat Set point
  – Heat pump efficiency (COP)
  – Power consumption by heat pump

• **Manufacturing monitoring system of PV panels**
  – KWh Output

Need for inexpensive ways to monitor/validate the performance systems: Huge challenge for industry and research institutes
Heating demand and COP based on manufacturer performance monitoring “Rijswijk Buiten”

Outside temperature above 0 °C

COP during data collection
Automated assessment of performance

**Example:** heat loss coefficient, built in MATLAB
- Based on outsides temperatures in relation to daily average energy use
- Coefficient independent of temperature outside and setpoint

**New challenges:** fitting of performance parameters
We can built satisfying NZEB dwellings at a reasonable price, with comfort and of good quality which are reliable in the near future. But we have to learn by doing.

Thanks for your attention