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| Project: | Green STORM 2018 CO ₂ reduction dwellings | Date: | 22 May 2018 |
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As requested by Obvion, DWA compared the CO₂-emission of a specific, energy-efficient group of dwellings (in this document indicated as Obvion) to that of a comparable group of dwellings with an average energy-efficiency (indicated as Reference). In this document the results are shown.

Methodology

Within this study the CO₂-emission of 2.403 dwellings, as selected by Obvion, was determined using the energy consumption of these dwellings. The energy use of dwellings is based on the WoOn2012¹ study. In this study, the theoretical energy consumption of Dutch dwellings was determined using the energy index methodology.

CO₂-emission - natural gas

The CO₂ emission of Dutch natural gas is 1,78 kg/m³.

CO₂-emission - electricity

Values for carbon intensity, in kg per produced kWh of electricity, vary depending on assumptions made in the calculation method. In this assessment, an emission of 505 g/kWh² was used.

Gas consumption

The gas consumption strongly depends on the energy label of dwellings. In table 1 the average gas consumption is shown. The real gas consumption is based on the WoOn2012 survey; the theoretical gas consumption is based on the energy-index methodology³.

Table 1 Average gas consumption¹

| Energy label | Real gas consumption (m ³ /year) | Theoretical gas consumption (m ³ /year) |
|--------------|---|--|
| A | 1.259 | 1.251 |
| B | 1.424 | 1.606 |
| C | 1.512 | 1.820 |
| D | 1.706 | 2.271 |
| E | 1.818 | 2.925 |
| F | 2.004 | 3.719 |
| G | 2.043 | 5.108 |

From table 1 was found that the theoretical gas consumption is not a good indication of the real gas consumption. Therefore, the real gas consumption was primary used in this survey.

¹ WoOn2012, results presented in "Benchmarkonderzoek duurzaamheid rijksmonumentale woonhuizen", 2015. This document can be found at

<https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2015/06/09/benchmarkonderzoek-duurzaamheid-rijksmonumentale-woonhuizen/benchmarkonderzoek-duurzaamheid-rijksmonumentale-woonhuizen.pdf>

² Based on the use of non sustainable electricity, as determined by CE, Delft, jan 2015

³ Based on the Iso 82

Electricity consumption

As proved by ECN and others⁴ there is hardly any correlation between the consumption of electricity and the energy label. At most 19% of the electricity consumption is attributed to the building; over 80% is attributed to the number and behaviour of the residents and their household equipment. Therefore, in this survey an average consumption of 3.050⁵ kWh was assumed for all dwellings.

Group composition

In table 2 some relevant parameters of the groups are shown. The parameters show that the pool of Obvion has less condominiums than the reference. Furthermore, the pool of dwellings of Obvion has significantly younger buildings.

Table 2 Composition of the groups

| | Obvion | Reference |
|------------------------|--------|-------------------|
| Number of dwellings | 2.403 | 2.403 |
| Percentage condominium | 20% | 35% |
| Average building year | 2004 | 1965 ⁶ |

Figure 1 shows the distribution of the energy labels of Obvion and the reference group. The label distribution of the reference group is based on the WoOn2012 survey. It is clear that the percentage of A-labels is much higher in the pool of Obvion.

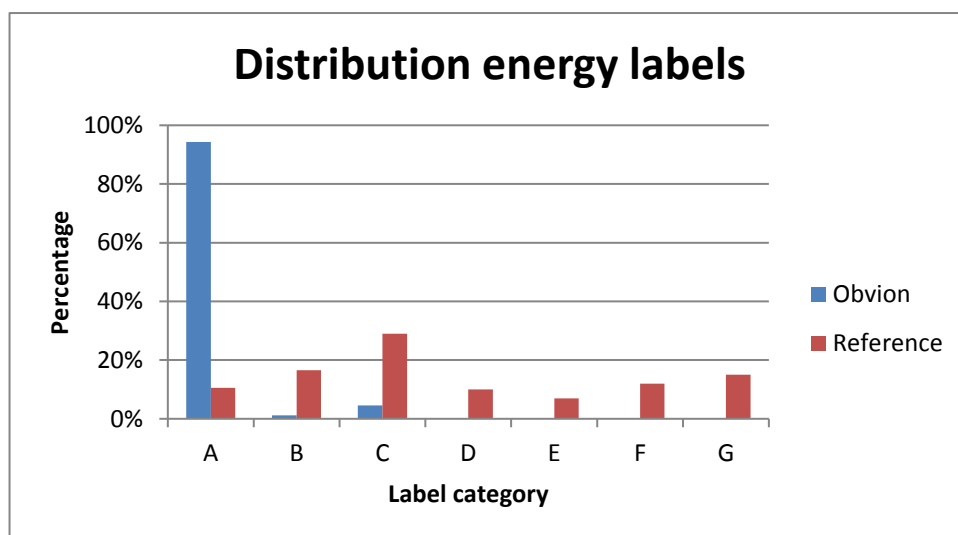


Figure 1 Distribution of energy labels for both groups

CO₂-emission

Table 3 shows the CO₂-emissions of both groups, based on the real energy consumption. It is found that the reduction of CO₂-emission is relative small. This is caused by the fact that the real gas consumption depends less on the energy label than the theoretical gas consumption. Simultaneously we want to state that the baseline for selection of refurbished properties is conservative. The energy label of these dwellings has improved with at least two classes. The baseline for these buildings is also the Dutch average; the real baseline is worse. This means that the CO₂-reduction compared to the original houses without any improvements is considerably higher.

⁴ Energietrends in Nederland', 2014 van ECN, Energie-Nederland en Netbeheer Nederland

⁵ Centraal Bureau voor de Statistiek (CBS), 2014.

⁶ Compendium voor de Leefomgeving, Rijksoverheid, 2014

Table 3 CO₂-emission, based on the real energy consumption

| | | Obvion | Reference |
|--|-------------------------------|--------|-----------|
| Average gas consumption | m ³ /year/dwelling | 1.272 | 1.650 |
| Average electricity consumption | kWh/year/dwelling | 3.050 | 3.050 |
| Average CO ₂ -emision | kg/year/dwelling | 3.805 | 4.478 |
| Total CO ₂ -emission | ton/year | 9.144 | 10.761 |
| Reduction CO ₂ -emision | ton/year | 1.617 | - |
| Difference in CO ₂ -emision | % | 15% | - |

In table 4 the CO₂-emissions of both groups are shown, based on the theoretical energy consumption. The results show that the absolute amount of CO₂-emission reduction in this case is over a factor three more than when they are based on the real energy consumption.

Table 4 CO₂-emission, based on the theoretical energy consumption

| | | Obvion | Reference |
|--|-------------------------------|--------|-----------|
| Average gas consumption | m ³ /year/dwelling | 1.281 | 2.569 |
| Average electricity consumption | kWh/year/dwelling | 3.050 | 3.050 |
| Average CO ₂ -emision | kg/year/dwelling | 3.821 | 6.112 |
| Total CO ₂ -emission | ton/year | 9.182 | 14.688 |
| Reduction CO ₂ -emision | ton/year | 5.506 | - |
| Difference in CO ₂ -emision | % | 37% | - |

Conclusion

From this study the following conclusions are determined.

- The amount of A-label dwellings of Obvion is much higher (over 90%) than in the reference (about 11%).
- Based on the real energy consumption, the pool of dwellings of Obvion has a CO₂-emission that is 1.617 tons per year less in comparison to the reference, which is a difference of 15%. This is based on conservative assumptions.
- Based on the theoretical energy consumption, the pool of dwellings of Obvion has a CO₂-emission that is 5.506 tons per year less in comparison to the reference, which is a difference of 37%.