

<b>Project:</b>	Green STORM 2018 CO <sub>2</sub> reduction dwellings	<b>Date:</b>	22 May 2018
<b>Subject:</b>	Reduction CO <sub>2</sub> -emission	<b>Status:</b>	Definitive
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As requested by Obvion, DWA compared the CO<sub>2</sub>-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 CO<sub>2</sub>-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 WoOn2012<sup>1</sup> study. In this study, the theoretical energy consumption of Dutch dwellings was determined using the energy index methodology.

#### CO<sub>2</sub>-emission - natural gas

The CO<sub>2</sub> emission of Dutch natural gas is 1,78 kg/m<sup>3</sup>.

#### CO<sub>2</sub>-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/kWh<sup>2</sup> 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 methodology<sup>3</sup>.

Table 1 Average gas consumption<sup>1</sup>

Energy label	Real gas consumption (m <sup>3</sup> /year)	Theoretical gas consumption (m <sup>3</sup> /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.

<sup>1</sup> 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>

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

<sup>3</sup> Based on the Iso 82

*Electricity consumption*

As proved by ECN and others<sup>4</sup> 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 3.050<sup>5</sup> 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 <sup>6</sup>

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.

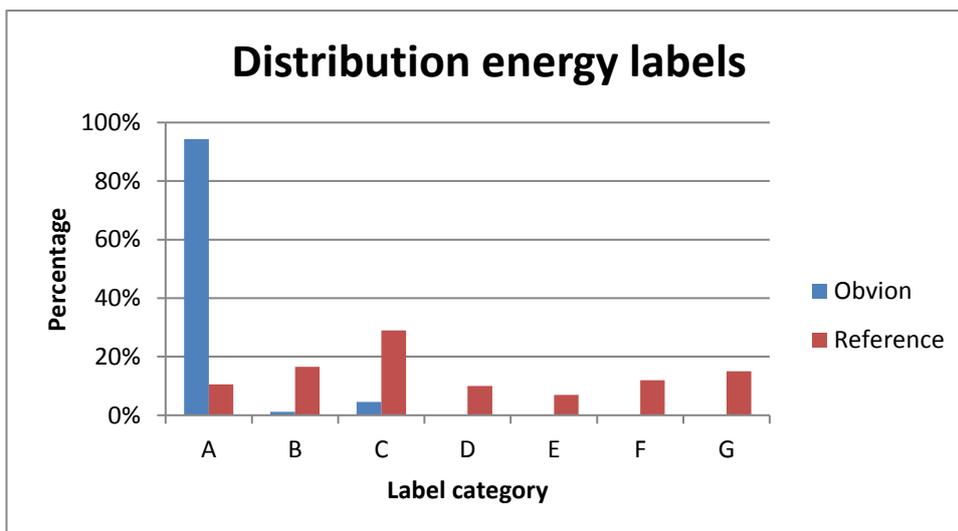


Figure 1 Distribution of energy labels for both groups

**CO<sub>2</sub>-emission**

Table 3 shows the CO<sub>2</sub>-emissions of both groups, based on the real energy consumption. It is found that the reduction of CO<sub>2</sub>-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 CO<sub>2</sub>-reduction compared to the original houses without any improvements is considerably higher.

<sup>4</sup> Energietrends in Nederland', 2014 van ECN, Energie-Nederland en Netbeheer Nederland

<sup>5</sup> Centraal Bureau voor de Statistiek (CBS), 2014.

<sup>6</sup> Compendium voor de Leefomgeving, Rijksoverheid, 2014

Table 3 CO<sub>2</sub>-emission, based on the real energy consumption

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

In table 4 the CO<sub>2</sub>-emissions of both groups are shown, based on the theoretical energy consumption. The results show that the absolute amount of CO<sub>2</sub>-emission reduction in this case is over a factor three more than when they are based on the real energy consumption.

Table 4 CO<sub>2</sub>-emission, based on the theoretical energy consumption

		Obvion	Reference
Average gas consumption	m <sup>3</sup> /year/dwelling	1.281	2.569
Average electricity consumption	kWh/year/dwelling	3.050	3.050
Average CO <sub>2</sub> -emision	kg/year/dwelling	3.821	6.112
Total CO <sub>2</sub> -emission	ton/year	9.182	14.688
Reduction CO <sub>2</sub> -emision	ton/year	5.506	-
Difference in CO <sub>2</sub> -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 CO<sub>2</sub>-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 CO<sub>2</sub>-emission that is 5.506 tons per year less in comparison to the reference, which is a difference of 37%.