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<b>Project</b>	CO2 reduction dwellings Obvion RMBS GREEN STORM 2016	<b>Date</b>	19 May 2016
<b>Subject</b>	Reduction CO2-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 1.263 dwellings, as selected by Obvion, was determined using the energy consumption of these dwellings. The energy use of dwellings is based on the WoOn2012 study. In this study, the real energy consumption of Dutch dwellings was determined using the energy label.

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

The CO<sub>2</sub> emission of Dutch natural gas is 1.78 kg/m<sup>3</sup>.

#### CO<sub>2</sub>-emissions - 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>1</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 label methodology<sup>2</sup>.

Table 1 Average gas consumption<sup>3</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.

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<sup>1</sup> Based on the use of non sustainable electricity, as determined by CE, Delft, jan 2015

<sup>2</sup> Based on the Isso 82

<sup>3</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>

**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 residents and their household equipment. Therefore, in this survey an average consumption of 3.500 kWh was assumed for all dwellings.

**Group composition**

In the table 2 some relevant parameters of the groups are shown. The parameters show that the pool of Obvion has slightly 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	1263	1263
Percentage condominium	28%	32%
Average building year	2002	1961

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

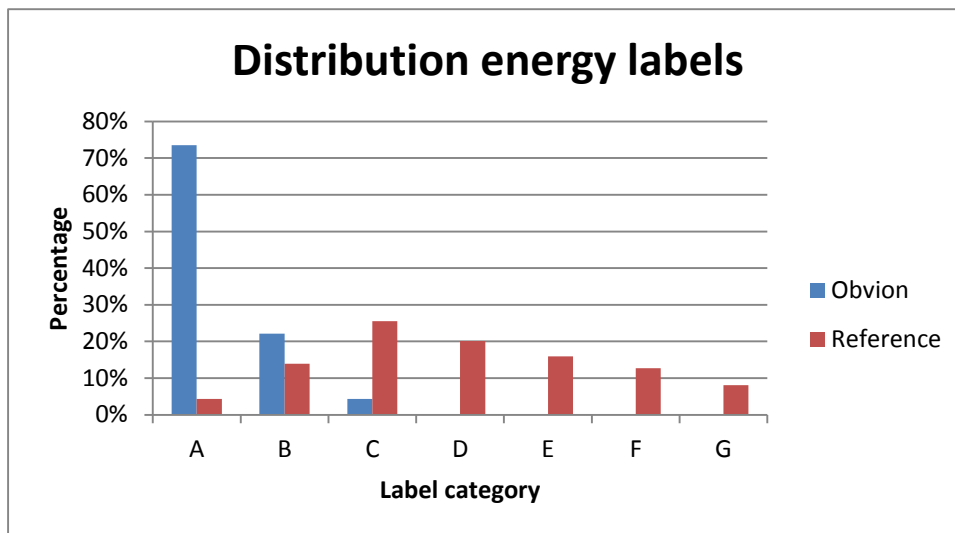


Figure 1 Distribution of energy labels for both groups

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

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>-emissions is relatively 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 house without any improvements is considerably higher.*

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

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

		Obvion	Reference
Average gas consumption	m <sup>3</sup> /year/dwelling	1.307	1.690
Average electricity consumption	kWh/year/dwelling	3.500	3.500
Average CO <sub>2</sub> -emission	kg/year/dwelling	4.093	4.775
Total CO <sub>2</sub> -emissions	ton/year	5.170	6.031
Reduction CO <sub>2</sub> -emission	ton/year	861	-
Difference in CO <sub>2</sub> -emission	%	14%	-

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 a factor three more than when they are based on the real energy consumption.

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

		Obvion	Reference
Average gas consumption	m <sup>3</sup> /year/dwelling	1.355	2.549
Average electricity consumption	kWh/year/dwelling	3.500	3.500
Average CO <sub>2</sub> -emission	kg/year/dwelling	4.179	6.305
Total CO <sub>2</sub> -emissions	ton/year	5.278	7.963
Reduction CO <sub>2</sub> -emission	ton/year	2.684	-
Difference in CO <sub>2</sub> -emission	%	34%	-

## Conclusion

From this study the following conclusions are determined:

- The amount of A-label dwellings of Obvion is much higher (over 70%) than in the reference (less than 5%).
- Based on the real energy consumption, the pool of dwellings of Obvion has 861 tons less CO<sub>2</sub> emissions per year in comparison to the reference, which is a difference of 14%. This is based on conservative assumptions.
- Based on the theoretical energy consumption, the pool of dwellings of Obvion has 2.684 tons less CO<sub>2</sub> emissions per year in comparison to the reference, which is a difference of 34%.