Final Project Report

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Smart Renovation Factory by INDU-ZERO

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Total Cost of Ownership calculation for INDU-ZERO

Introduction

This word document is a substantiation for the **Excel** file with the model of the Total Cost of Ownership (TCO) calculation. The main goal of this subject is to make clear what it would mean in terms of costs for the customers throughout the lifecycle of the product, when they purchase an INDU-ZERO package. In this study, the focus of the TCO calculations will be for the housing associations and private homeowners.

TCO answers the question what the bottom line benefits for the customers are, if they purchase an INDU-ZERO package. To investigate this question, an overview of all costs, cost reductions and benefits needs to be set up.

TCO is an important factor when it comes to persuading customers to buy the INDU-ZERO product. The TCO is calculated for a period of both 25 and 40 years and is compared with the following scenario's for energy savind: "traditional" NOM, BENG and INDU-ZERO NOM. Therefore, the main research question of this chapter is: *What are the total costs of ownership for the current (no renovation), BENG, NOM, INDU_ZERO NOM and during the period of 25 and 40 year?*
To answer this question, the research question is split up in the following subquestions:

1. What are the total costs of ownership for the scenario's: current (no renovation), BENG and NOM? (with the help of recognized calculation models)
   a. Which physical components are used for each scenario and how high is the investment?
   b. What are the maintenance costs over the years?
   c. What are the total costs for each scenario?

2. What are the total costs of ownership for the INDU-ZERO NOM?
   d. Which components does a INDU-ZERO package consist of?
   e. What are the costs of each component?
   f. What is the economic lifetime of a component?
   g. What are the total costs for the INDU-ZERO NOM?

Theoretical background

The TCO method is a cost calculation that describes which costs an owner should expect over a given time frame, if they purchase a product or execute a project. Total Cost of Ownership (TCO) is an approach where, in addition to the initial investment costs, also the financial consequences of other incurred choices in the design phase of buildings are taken into consideration. This is done by calculating the costs of maintenance and replacement for the expected life cycle of all underlying components. Therefore, TCO brings the total costs for the short and longer terms in the picture to an intended investment (Stern, personal communication, 2020). The context of this TCO calculation is for the Dutch housing associations, which are the intended launching customers for the INDU-ZERO product.

TCO has its limitations as well: It remains a purely economic approach. Using TCO means that potential customers also must look beyond the excepted TCO costs for making their final buying decision. It is also important to include other benefits such as growth, sustainability and risk management into the decision, which are things that a TCO calculation does not cover (Stern, personal communication, 2020). Nonetheless, a TCO analysis can be a powerful selling tool to demonstrate concrete customer value creation for alternatives that deliver comparable benefits. The execution of a TCO analysis requires experts from both the buyer and seller organizations to work closely together in mapping and modelling the target customer's application.

A TCO calculation typically consist of the following costs:

Foundation costs / Investment costs

• Land costs
• Construction costs
• Installation costs
• Additional costs
• Specific operating costs

Operating costs

• Fixed costs
• Energy costs
• Maintenance costs
• Management costs
• Specific operating costs

Other costs

• Litigation costs
• Failure costs

In this chapter the expertise and experience from the Domijn housing association in The Netherlands is used to calculate the costs that apply for this TCO model.

INDU-ZERO package costs (including materials)

This sub-chapter consists of a cost price calculation of the initial investment of an INDU-ZERO package. When buying the INDU-ZERO product, a customer will get an installed mass-customized renovation package, for a semi-detached house, a terraced house or apartment, consisting of:

- Facade panels (exact number depending on the type of dwelling)
- Roof panels (exact number depending on the type of dwelling)
- Installations for electricity and heat generation

The margin that the INDU-ZERO project organization has set for producing the renovation packages is 5% (Lub, personal communication, 2020). That means the targeted selling price for 1 complete & installed renovation package is about 40.000 euros. Besides this initial investment, it is necessary that the customer gains insight in expected further maintenance and replacement costs, as well as the expected cost benefits in terms of energy performance.

In this chapter, the expected benefits for the homeowner, the housing associations, will be calculated. There are additional benefits for the users, the renters of the housing associations, in terms of a very significant reduction of their energy bills, but these benefits are not taken into account in the calculation, as these are not directly going to influence the financial benefits of the housing associations.

The benefits for a housing association is that this investment can result in higher rent incomes for the renovated houses. The extra income would be gotten with the so-called EPV (short for Energie

Prestatie Vergoeding), a Dutch legal instrument which housing associations can use to charge their renters for the investments done to improve the energy performance of dwellings. For the renter it usually doesn't matter to pay this extra charge on top of their rent price, because the monthly energy bill will decrease more than the legal maximum surcharge of the EPV.

Table 1: Estimated total targeted investment costs for a INDU-ZERO package

100%	**40.000**		Total targeted costs
1%	570	Engineering	measure software, configuration, data processing
50%	20.000	Materials	panels, roofs, installations
10%	4.000	Production cost	energy, workforce, inbound logistics, assembly, inbound/ outbound / production planning, quality control & tracebility
1%	360	Outbound logistics	transportation per truck
10%	4.000	Mounting	disassembly, tenant guidance, assembly
3%	1.000	Selling costs	pre-sales and marketing, after sales, input from engineering, digital configurator
10%	4.000	Fixed costs	maintenance, management, proces engineering, product developoment, insurance
10%	3.879	Capital costs	depreciation, overhead, capital costs

Costs of the different INDU-ZERO components

The INDU-ZERO product consists of a completely installed renovation package that consists of 3 main products:

- **Facade and Roof elements**

The facade and roof elements are mass customized renovation panels, produced in the INDU-ZERO smart factory and benefits from low maintenance costs. Total targeted costs for both components are approximately 12.000 euro per dwelling.

- **Installations**

For energy production, solar PV panels are used, but these not produced in the INDU-ZERO factory, but instead bought from suppliers. The average price of a solar panel (a set of 10) on a terraced house is currently approximately 3450 euros. This is based on the price paid for at terraced houses from the target group of INDU-ZERO (1970-1985) from the Domijn housing association. The VAT can be reclaimed by the customer, resulting in cost savings. The market of solar PV panels is very dynamic, and further cost reductions here can be expected in the future. Also included in the installation is the so-called inverter. An inverter is an electronic device that can convert the input voltage to another voltage or convert electrical energy into energy of another frequency. This is needed to use certain equipment. The purchase price of an inverter is around 1200 euros, also based on costs of previous renovation projects from Domijn. Finally, in terms of installations, a heat pump is needed. Based on the same previous projects mentioned above, the costs of such a heat pump are approximately 6000 euros.

Lifetime of the different components

In this subchapter, the lifetime of the different components of the INDU-ZERO package is described, so that costs for maintenance and replacement can be identified.

- **Installations;**

The advantage of solar PV panels is that there are no moving parts inside a panel. This means that solar panels are virtually free of maintenance and they don't actually break. In general, they last very long. However, what does occur is a reduction in the ability to generate energy. Independent research has shown that an average solar panel has an aging rate of 7% over 25 years. In other words, after 25 years a solar panel will still be able to achieve 93% of its maximum efficiency. Exactly how long they last often depends on the brand and the circumstances in which the solar panels have been over the years.

The heat pump has an expected lifespan of around 15 years. With the proper maintenance that the pump needs every other year, it can happen that the pump will last longer than 20 years, but this is not guaranteed by the producer.

The economic lifespan of *inverters* in domestic installations is approximately 15 years. On average, the inverter needs to be replaces once during the life of your solar panels. Depending on the circumstances and environment in which it operates, inverters could have a longer lifespan, but just like with the heat pump, this is not guaranteed by the producer.

- **Façade and roof elements**

Both the façade and roof should be able to last a very long time. Some costs for repair must be taken into consideration, for when specific things are damaged. It is also important to continue doing condition measurement to test the quality of the materials (NEN 2676). Besides a reservation for possible repairs, no further maintenance or replacement costs apply.

Possible revenue streams for housing associations

Housing associations do not directly feel the benefits of the lower energy usage of their dwellings, as the energy bills are paid by their renters. For housing associations, a possible direct revenue stream of an energetic renovation is the so-called EPV (Energie Prestatie Vergoeding). As discussed in one of the previous sections, EPV is a legal instrument in The Netherlands for housing corporations and other suppliers of social rental housing. House owners can request a fee from tenants for (almost) zero-on-the-meter homes (NOM). The housing associations will in this way receive back part of their investments to turn social rental homes into NOM homes. In practice, the EPV rules stimulates homes to be renovated in an energy-efficient manner. When there is an EPV, fewer points are awarded to the home in the WWS. If the rent is a percentage of the maximum reasonable rent, the actual (target) rent can therefore also change.

The EPV applies to a rental property that meets the following conditions:

- The heat demand of the house is a maximum of 50 kWh / m2 year. This will be done after completion established by a certified agency.
- The actual production of sustainable energy is sufficient to heat the house plus all auxiliary energy (for pumps and fans), plus 26 kWh / m2 year for household appliances plus 15 kWh / m2 year for hot tap water.
- The production of sustainable energy and the use of energy (household and building-related) are monitored. (Energielinq stroomversnelling, 2020)

If these conditions are met, the amount of EPV for 2020 can be calculated, the actual possible EPV surcharge depends on how energy efficient the dwelling is. The numbers are displayed in table 2.

Table 2: maximum EPV income for housing associations

Heat demand in kilowatt hours/m2 yearly	Maximum EPV m2 monthly
0 - 30	€ 1,49
31 - 40	€ 1,27
41 - 50	€ 1,07

Warmtenetten (Heat networks) are also an option for NOM houses. When connected to the heat network, part of the required energy (the heat demand) comes in via an external, sustainable heat source. This means that not all required energy is generated on the home itself. The house owner buys negotiates the contract for sustainable heat for a longer period from the heat company during the renovation. This way of sustainable energy will only work in areas where are many houses that are eligible for the heat network. (Energielinq stroomversnelling, 2020)

Total costs of ownership for the INDU-ZERO NOM

To calculate the total costs of ownership for housing associations, the information from Domijn is used to make the calculations. The total value is calculated both for the current situation without any energetic renovation as well as for INDU-ZERO NOM, so that differences can be observed.

This shows that with an INDU-ZERO package, the total value of a residential unit increases by approximately 35.000 euros after 25 years. This will mean that there is room for 35.000 euros to make a possible investment without compromising on the financial situation of the housing association. For a calculation with a 40 year scope, the investment capacity rises to 45.000 euros (Oostenbroek, 2021).

The following costs have been added to the cost price calculation as well, all costs are based on figures from the Domijn housing association:

Management charges. In order to justify the overhead costs of the housing association, an intercompany charge commonly referred to as a management fee or intercompany service charge is billed to the foreign subsidiary or other foreign entity for their share of the expenses. These charges are estimated at 1.018 Euros per year.

Repair/complaint maintenance: These costs are needed to bring an asset back to an earlier condition or to keep the asset operating at its present condition (as opposed to improving the asset). These costs are of course not the same every year, but calculated at an average of 337 Euro a year.

Mutation maintenance: Mutation maintenance is the maintenance carried out by the owner of rental properties (or real estate) on a rental property (or rental object), whereby the maintenance is carried out between two rental periods, to prepare for the next renter. On average this is calculated at 237 Euro yearly.

Planned maintenance: Planned maintenance refers to any maintenance activity that is planned, documented, and scheduled. The aim of planned maintenance is to reduce downtime by having all necessary resources on hand, such as labour and parts, and a strategy to use these resources. Costs depend on different housing types. On average per residential unit (with no energetic renovation), the costs are calculated at around 950 Euro yearly.

OZB: Dutch municipal property tax (OZB) is the tax that must be paid when owning a home, another building or a piece of land. Even if a building or a piece of land is rented out. On average this costs 115 Euro a year per residential unit.

Sewage charges: Any business property that is connected to the municipal sewerage system is subject to a sewage charge (rioolheffing). Municipalities use this charge to keep the sewerage system in a good state. Price depends on location, on average this costs 143 Euro per year.

Insurances: Different types of small insurances, 20 Euro a year.

Remedation aid levy: remediation support if a housing association is no longer able to perform the necessary public task due to serious financial problems.

Owner levy: Any organization renting out more than 50 houses in the social housing sector, for rents on or below the maximum threshold for eligibility for rent allowance, a landlord levy (verhuurderheffing) must be paid to the Dutch Tax and Customs Administration. The levy consists of a percentage of the value of the rented houses.


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