



## Developing Green Line Products

*based on the InnoDoors Model*

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# DEVELOPING GREEN LINE PRODUCTS



**BASED ON THE INNODOORS MODEL**



The InnoDoors project is designed around the door manufacturer JELD-WEN Door Solutions and partners from the entire value chain of this company. The project creates a collaborative approach to how to exploit potential for growth through user-driven innovation. The project is supported financially by the Danish Enterprise and Construction Authority – programme for Userdriven Innovation.

The project runs from 1 October 2009 until 31 December 2011.

The partners involved in Project InnoDoors are:  
JELD-WEN Door Solutions, Optimera, Henning Larsen Architects, INWIDO DENMARK, HP3, Abson, DI Byggematerialer, SmartCityDK, Center for Industrial Production (Aalborg University), Department of Architecture Design and Media Technology (Aalborg University) and Department of Mechanical and Manufacturing Engineering (Aalborg University).

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# Developing **green line** **products** **based on the InnoDoors model**

## PREFACE

This publication is based on the Master thesis “User-driven eco-innovation process: Towards the implementation of the Green product line at JELD-WEN” written by Ana Maria Muñoz-Marin as her Graduation Project for the MSc. Global Innovation Management degree. The company-based experiment was carried out during February 1st and May 31st 2011.

The Master thesis is developed as part of the InnoDoors research project at Aalborg University, and in close collaboration with the companies related to this project. Additionally data collected from workshops with companies and qualitative and quantitative data gained from interviews and questionnaires is used.

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# Introduction

As a reaction to global warming, destruction of limited natural resources, and other serious environmental impacts, companies are starting to consider the ecological and social consequences of their business activities, and consumers are increasingly conscious of the impact of their behavior in this matter.

The sector of Manufacturing and Construction in the European countries (EU-27) contributed to 12,4% of the greenhouse gas emissions in 2008, while deforestation contributed about a fifth of the total global emissions (Soer, 2010). JELD-WEN Europe knows that as a company belonging to this sector they contribute to these emissions and other environmental impacts and, with their vision of being a “Reliable and responsible market oriented company”, they have shown interest in being part of the solution. But how does it work? Is it possible to balance a win-win strategy that is good for the business and good for the environment?

“The movements that characterize the market today are beyond human rights and ethics, environment, and resources. The different customer segments evaluate these sub-elements very different and a company with a broad market as JELD-WEN must balance its efforts very carefully and do not appear as radical in one or more areas” (Product Manager, 2011).

As part of exploring how environmental responsibility may become part of an innovation strategy JELD-WEN, as part of the InnoDoors

project, initiated the Green Line experiment using the InnoDoors Model (Wandahl et al, 2010) as a starting point to create concepts for products considering the user, the network, and the internal activities. The original idea was to make a door using the pre-consumer recycled fibers, but it expanded into a product line idea with support from all markets. As such, the Green Line experiment focuses on the development of a full concept for an environmentally friendly inner-door.

It is said that approximately a 90% of the waste and environmental impact of a product occur before the product reaches the end-user (McAloone & Bey, 2011). Therefore, it is necessary to analyse the environmental impacts during the whole product life cycle.

The Product Life Cycle is a product designing and manufacturing analysis that divide the “life” of a product from the selection and extraction of the materials that it uses through all the processes of manufacturing, distribution to its consumers, the use that it was created for, and its disposal/reuse. Figure 1 shows the Life Cycle Diagram.

The life cycle thinking is a concept used to understand environmental problems and causes that lead to solutions, and is mainly related to the production processes, but in general are connected to all the stages from Raw Material to Disposal (or cradle to cradle in the best conception).



FIGURE 1: PRODUCT LIFE CYCLE DIAGRAM



The first step of the Green Line experiment was, therefore, to define what is environmental thinking in this context, in order to integrate environmental issues into the business operations. As such, a purpose of the experiment was to provide an overview of the processes that can be used to facilitate an environmental thinking for the development of Green products. That by gaining a general understanding of its environmental impacts during the product life cycle, identifying the customer's needs related with green products and generating ideas for possible solution by integrating stakeholders and end-users in the process. By this, the company can invest their resources more effectively detecting environmental improvement options that are feasible to achieve.

Thus, the purpose of this publication is to present how a so-called green innovation process can be initiated in a construction material network that strives to meet the ever evolving needs and expectations from their customers/end-users. This publication starts out by introducing the theoretical frameworks that will be used throughout the entire experiment and serve as the setting for the rest of this publication.





# The **green** user-driven innovation **process**

As stated in its Vision 2012, JELD-WEN recognised the importance of identifying and understanding its customers. In addition, they were aware of the fluctuating characteristics of the market today, and that in order to succeed in the changing market it was necessary to incorporate “Innovation” as part of its strategy to constantly develop and improve. There are different levels of innovation such as incremental and radical. The incremental innovation is based in the continuous implementation of improvements for existing products or services, and the radical innovation entails drastically changes usually based on new technologies. In the radical innovation the level of uncertainty, risk, and investment are usually higher.

“User-driven Innovation” (UDI) focuses on involving and integrating end-users in development and innovation activities. UDI is defined as a “systematic approach to develop new products and services, building on investigation or adoption of users’ life, identity, praxis, and needs including unrevealed needs” (Christiansson, et al., 2008). There are different methods to support UDI; those that shows what people say and think: interviews, questionnaires, focus groups, observation, and storytelling and those that focuses on what people make: collages, diaries, maps, diagrams, 3D models, etc. to get information about their feelings, dreams, fears, and aspirations (Chayutsahakij & Poggenpohl, 2002). The use of the methods will vary according to the type of product, the context where it is used, and the type of information it is needed.

Chayutsahakij & Poggenpohl (2002) state that for user-research to support incremental innovation, (known technology in known or new markets) traditional participatory research, focus group, survey, and customer interviews are all employed.

The green user-driven innovation process is split into four sections that focus on different areas:

1. Focus on selecting models for green user-driven innovation which are beneficial for the companies and the network.
2. Focus on the user and the user behaviour that are related to green-door customers. The findings are supported by the qualitative and quantitative interviews conducted on door users and costumers.
3. Focus on the activities and data collection internally in the focal company. The activities are mostly workshops and interviews with key employees regarding environmental thinking and development of green products.
4. Focus on the network activities and workshops and interviews about development of green products with the value network partners of InnoDoors.

# Designing the experiment

In this section we describe how the Green-line experiment was designed and executed.

## SELECTING THE **MODELS**

First, we present the selection of the models for the design of the process that would facilitate an environmental thinking for further development of green products at JELD-WEN.

The InnoDoors Model is a comprehensive systematic method for user driven innovation in a network perspective developed during the InnoDoors project. The InnoDoors Model is divided into three primary areas of activity:

1. **Internal activities** are the activities of each partner in the project officers within their own corporate boundaries.
2. **Network Activities** are from the network with the involvement of several partners.
3. **User-oriented activities** are the activities involving the users. This may be in the form of physically having to contact the users (e.g. in the form of interviews or co-creation) but also in terms of having to collect data about users without being in contact with them (e.g. in the form of statistics or observations) (Lassen et al, 2010).

Figure 2 shows The InnoDoors Model, which starts with the “internal clarification of Interest” followed by a series of activities and processes in the three primary areas. The processes include planned meetings, suggesting a check-list of questions that should be answered by the team to evaluate the previous stage before continuing to the next one. A more detailed description of The InnoDoors Model can be found in Lassen et al. (2011).

The InnoDoors Model can be extended and tailored to a sustainable perspective. The Design for Sustainability (D4S) is a guide made by the United Nations Environment Programme (UNEP) and DELFT University of Technology (Design for Sustainability Programme) as a result of the cooperation of international D4S experts from the Netherlands, Sweden, Italy, France, Germany, Japan and Australia, UNIDO, the Swedish EPA, and InWEnt, Germany.

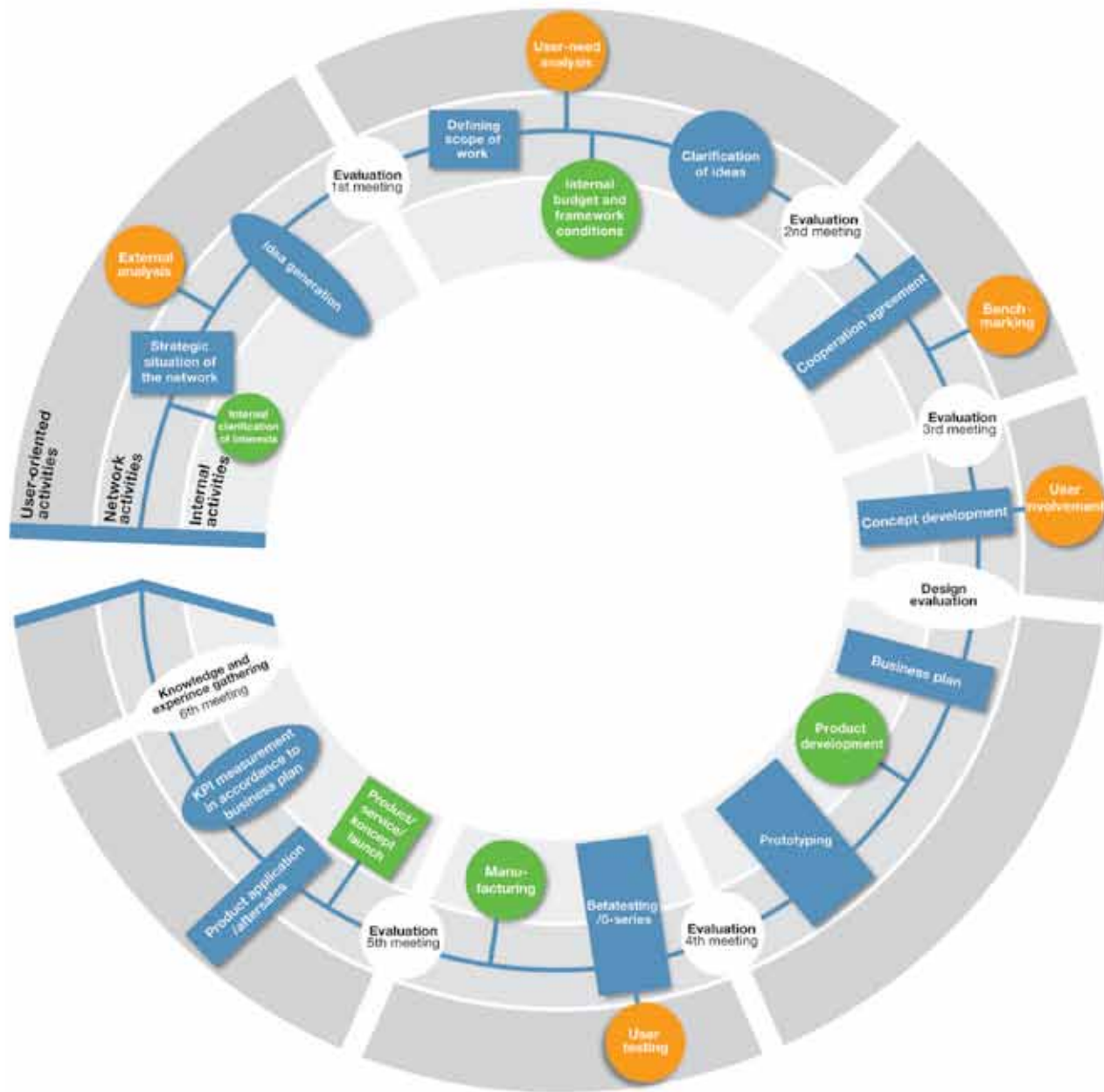


FIGURE 2: THE INNODOORS MODEL



FIGURE 3: DESIGN FOR SUSTAINABILITY APPROACH: PEOPLE, PROFIT, PLANET AND PRODUCT. SOURCE: D4S



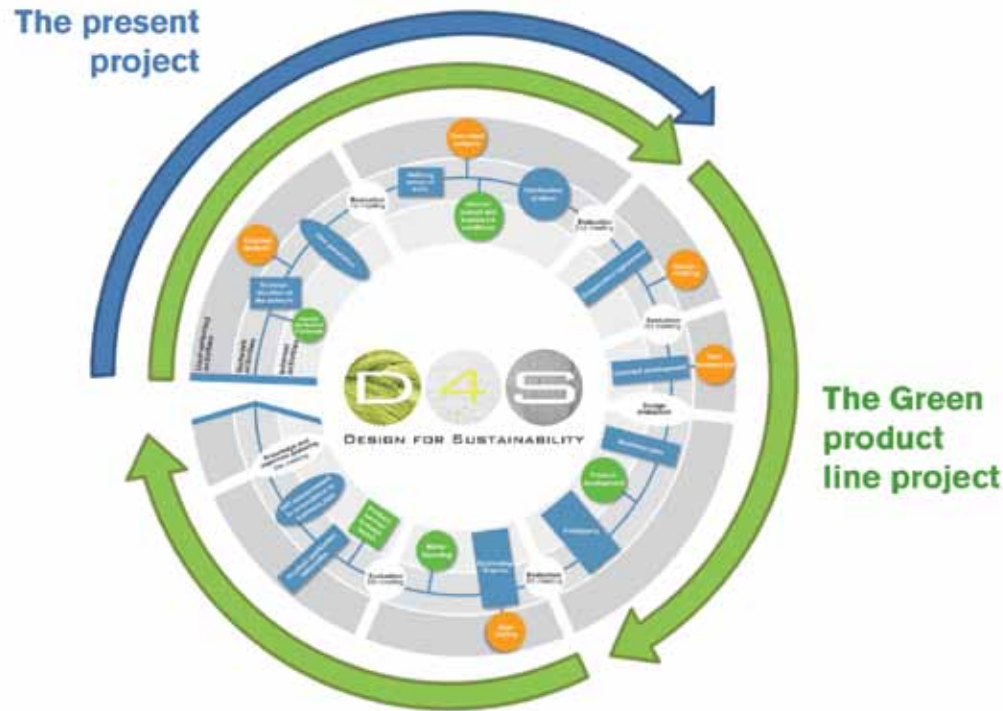
The D4S consists of three parts; the first explains the importance of design for sustainability and product innovation; the second presents how to do it in practice; and the third one presents reference information like case studies and creativity techniques. Design for sustainability, as its name implies, attempts to go beyond of making “green” products to include the social and economic aspects embraced by the Sustainable approach which are also called People, Profit, and Planet. (Crul & Diehl, n.d) Figure 3 shows the Design for Sustainability approach.

In summary, by combining both models, the Green line experiment will take advantage of using The InnoDoors Model as the base model as the experiment will integrate the users into the innovation process and will gather first-hand information about their wishes and demands. In addition, it will integrate the network into the process

in order to gain from their specific and envisioned competences by collaborating under a common goal. Using the Design for Sustainability (D4S) approach that ideally can be used by companies that are partners in a product innovation experiment in the Internal activities and the Network activities, will facilitate an environmental awareness of the selected product impacts during its life cycle and will give them the option to think in possible solutions.

It is relevant to clarify that this publication reports on the activities from the first part of the designed process in order to facilitate an environmental thinking for the development of green products at JELD-WEN (see Figure 4). The next step for the company and the Network is to continue following the model that should lead to the implementation of the Green product line experiment.

FIGURE 4: ACTIVITIES FOR THE PESENT PROJECT AND THE GREEN PRODUCT LINE PROJECT



Once the models are selected, the next step is to design the process and planning the activities that should be followed in order to facilitate an environmental thinking for the development of green products using a framework for user-driven innovation in a network.

The experiment plan was designed generally for the Green-line experiment until the “Prototyping stage” considering The InnoDoors Model and the Design for Sustainability guide. It included a summary of the background information, the initial objective, the suggested network participants, the time frame, the coordination, and the general plan with the description of the activities, the time frame and the expected outputs.

With the completion of the final network the implementation began.

In accordance with the framework, the three different activity forms, (1) user-oriented, (2) internal, and (3) network-oriented, were carried out simultaneously. However, for the sake of the reader, the three activity forms have been split in this publication to ensure better readability. As such, the following section will describe the activities conducted in the user-oriented activity form, followed by the internal activities, and rounded up by the network-oriented activities.

# SELECTING DATA

Secondly, we briefly describe the data generated and gathered throughout the experiment in order to address and unify the three different layers of the models chosen.

## USER-ORIENTED DATA

When a user-driven innovation process is used, the user inputs are of course very important. To this end, two different groups are selected for the experiment:

1. The potential end-users, who are the people potentially willing to use and buy the green doors
2. The architects who act as influencers on the buying decisions and specifiers of the green doors requirements.

Both qualitative and quantitative studies were carried out within the two groups of users.

The qualitative study selected interviewees and its aim was to understand the costumers' perception of green doors.

The quantitative study looked for specific information in a wider range of users through a survey. Two survey studies were used – one focusing on the perspectives of the consumers on environmental products in general, and one focusing more specifically on the aspects influencing the development of a green line door.

## INTERNALLY ORIENTED DATA

The information collected for the internal activities include analysis of the focal company, JELD-WEN, its planned strategies, interviews with selected personnel to understand the product flow, and workshop activities prepared for and with the participation of key employees.

The workshop activity was divided in two main parts consisting of:

1. Brainstorm on the doors' environmental impacts and its root cause.
2. Idea generation workshop.



## NETWORK ORIENTED DATA

In the network concept, the value creation should be analysed by investigating at how the organisation creates value within the context of a network. The network partners were selected from the perspective of JELD-WEN as the focal company and their potential contribution to the “greenness of a door”.

In relation to evaluation and a pre-analysis of interests and capabilities, it was decided to work with suppliers and architects that corresponded to Abson and Henning Larsen Architects from the InnoDoors' network

The network partners participated in several activities:

1. Involvement in the clarification of the problem and participation on similar network activities helped narrowing down the objective and expectations.
2. Network idea generation workshop





# Analysis of the experiment

In this section we turn to the analysis of the activities carried out during the experiment, and how these have added to our knowledge of how to create a successful green-line door.

## USER-ORIENTED ACTIVITIES

Every product developed under a market oriented perspective needs to identify and understand the customer's demands in order to create a product or service that fulfil their needs. In this section we insight into consumers of green products and their behaviour are presented.

Typical characteristics of green consumers are high education, high income, female, and young (Abele, Anderl, & Birkhofer, 2005). Nevertheless, Wilska (2006) cited in (Hassi, Kumpula, & Riittanen, 2007) suggest that even though the youngest are more conscious on environmental matters, it is the middle aged and elderly women who actually buy green products. Therefore, instead of demographic segmentation, psychographic characteristics like behavior are becoming more important. Life style, opinions, interest, loyalty, and occasions are part of that segmentation. One of the new segments of life style is called "Neo-greens" who do not sacrifice their comfortability for environmental friendliness and prefer to relate this concept to luxury design and energy efficient cutting edge technology (Hassi, Kumpula, & Riittanen, 2007).

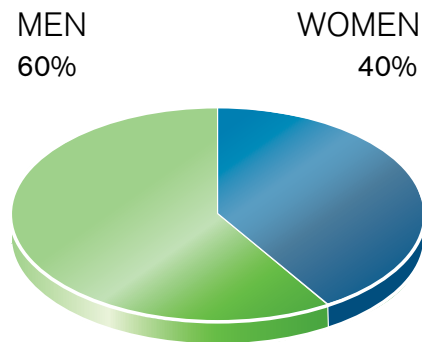
Many customers state that they would choose the environmentally friendly product alternative instead of the conventional product if both had the same price (Preisendörfer, 1996). However, as suggested in different studies, the environmental aspects of the product themselves do not necessarily provide a substantial added value (Abele, Anderl, & Birkhofer, 2005) (Hassi, Kumpula, & Riittanen, 2007) and environmental friendliness is accepted as a default value where other characteristics should predominate.

# WHO ARE THE GREEN DOOR CUSTOMERS?

The green door costumers are analyzed in terms of the end-users. The end-users represent the main clients for private homes, the main target in a costumer oriented strategy, and the main focus under the user-driven innovation process.

In order to identify the green door costumers, the survey question: "If there was a possibility to buy environmentally friendly doors, would you consider doing it?" was analyzed. The majority of affirmative answers are from men aged between 31 and 40 year old, see Figure 5.

## GENDER



This result differs from previous studies which state that women are more active than men in environmental protection (Haanpää, 2005; Suomalaiset, 2002; Torvi & Kiljunen; 2005) cited in (Hassi, Kumpula, & Riuttanen, 2007). The reason for this result could be that men in general are more involved in the purchase of doors, as it is often associated with being a construction material, rather than an interior design material.

In order to perform better analyses on the survey data and obtain more information about the green door potential customers, the answers to the same question were analyzed isolated by gender and group of age. It was found that from the women who answered the question 100%, answered affirmative comparing with 95% of men which is also a higher percentage. When the same procedure is used by group of age, the groups that showed more interest (those where 100% answered affirmative) were the youngest (20-25), the middle-aged (41-50) and the elder aged (61+) see Figure 6.

## AGE

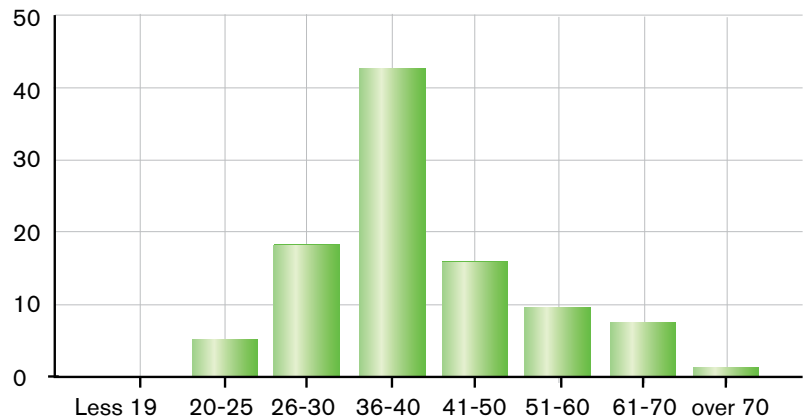
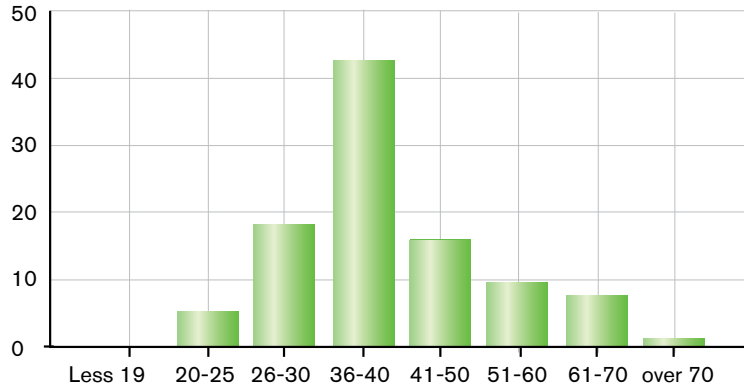
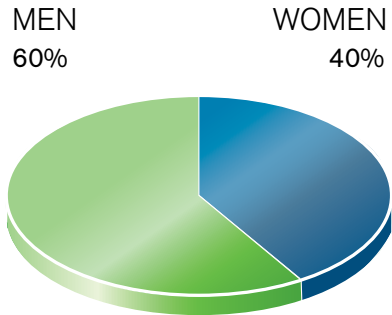
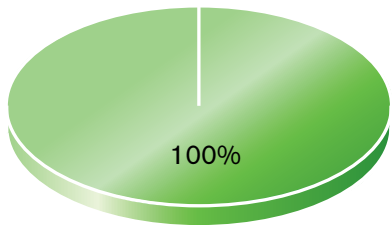


FIGURE 5: MAJORITY OF USERS INTERESTED IN BUYING GREEN DOORS

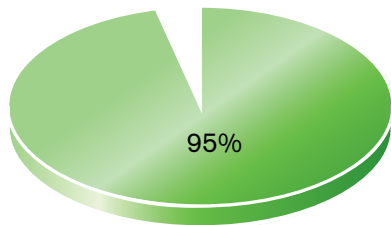
# MAJORITY OF POSITIVE ANSWERS



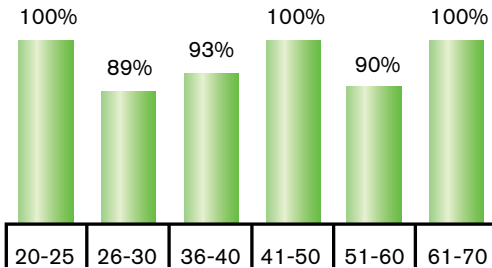
# ISOLATED RESULTS BY GENDER AND AGE



WOMEN 100%



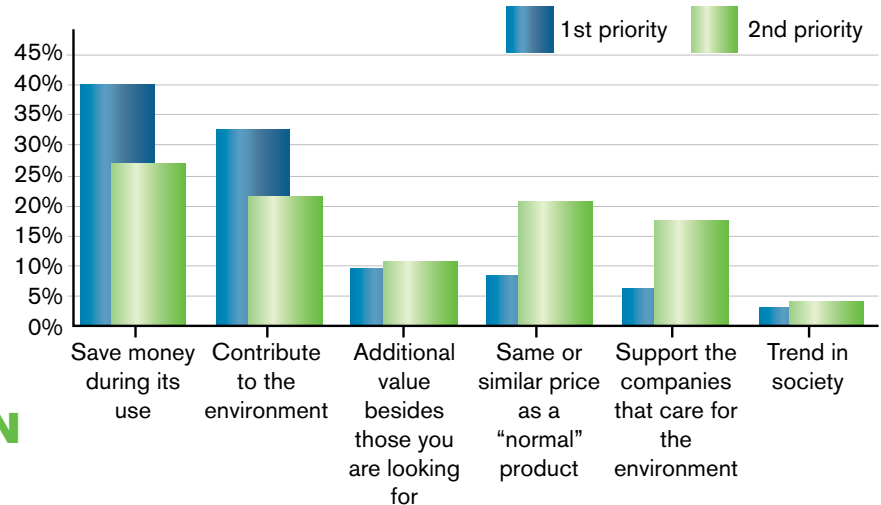
MEN 95%



These results show a wider range of customers interested in green doors than the typical green door consumers. Even though the analysis of information also includes women between 41-50 as 100% interested in buying green doors, the results demonstrate higher potential of the group of men and includes more group of ages (for both genders) that should be considered for the selection of the green door end-users target group.

FIGURE 6: GREEN DOORS CUSTOMERS ANALYSED BY MAJORITY OF ANSWRS VS. ISOLATED BY GENDER AND AGE

FIGURE 7: PRIORITIES WHEN BUYING GREEN DOOR PRODUCTS. (1<sup>ST</sup> AND 2<sup>ND</sup> PRIORITY)



## WHY DO CUSTOMERS BUY GREEN PRODUCTS?

The analysis of why customers buy green products is based on the results of both the qualitative and the quantitative studies. The survey made for this study showed that “To save money during its use” is the first priority for men and women when buying environmentally friendly non-food products. That was also the result obtained in the previous survey made by Marin-Muñoz, (2010), where the open question: “Which characteristic or product information did you consider when you bought that -ecological- product?”. The concepts of efficiency during the use, Recycled content of material, Durability and Price were the characteristics the user considered. These results also corroborate with what Abele (2005) states about the customer’s description of environmentally friendly products in terms of them thinking of only very few attributes for energy consumption and recyclability of materials.

As illustrated in fig. 7, the second criteria that was chosen as first priority for the majority of respondents was “To contribute to the environment”, which is a logical response for environmentally friendly purchasing.

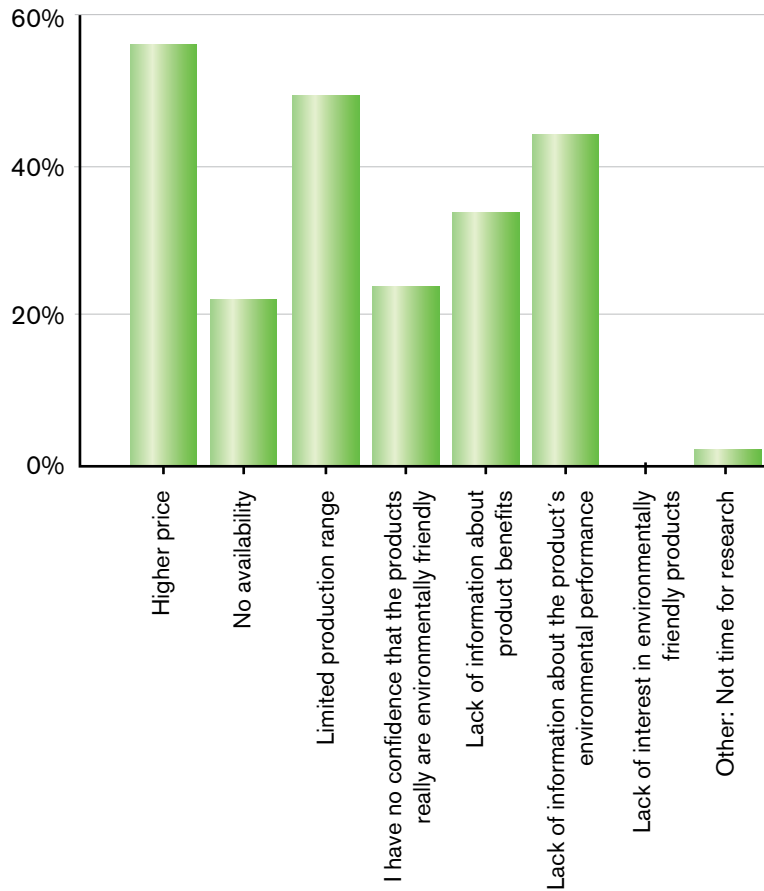
Surprisingly, the concept, “additional value besides those you are looking for”, was left behind in third position for the first priority. The importance of this concept is mentioned in user behavior for green products literature emphasizing that the concept of sustain-

ability or greenness is a default value that should be presented as an addition of other product characteristics (Abel, 2005) (Hassi, Kumpula, & Riuttanen, 2007). This is probably a consequence of a restricted answer where the respondent had to choose only one first priority, and only one second priority, and there were two more desirable concepts: “saving money during use” and “contribute with the environment”. This restriction was designed with the purpose of neutralizing the tendency of overestimation, mentioned by Abele (2005), by forcing the respondent to choose their priorities in order of importance.

For the second priority selection there are differences among genders; even though both answers focus on money. According to this result, men are more sensitive to the savings during the moment of purchase, while women tend to think more in the saving during use. The second priority criteria for men was that, “It has the same or similar price as a “normal” product”, while women were more interested in saving money during energy efficient products (first and second priority).

This finding on price is also very important, when it is combined with the survey results on the factors that limits consumers from buying more environmentally friendly products, where “higher price” was the selection number one for both men and women, see Figure 8.

## MEN



## WOMEN

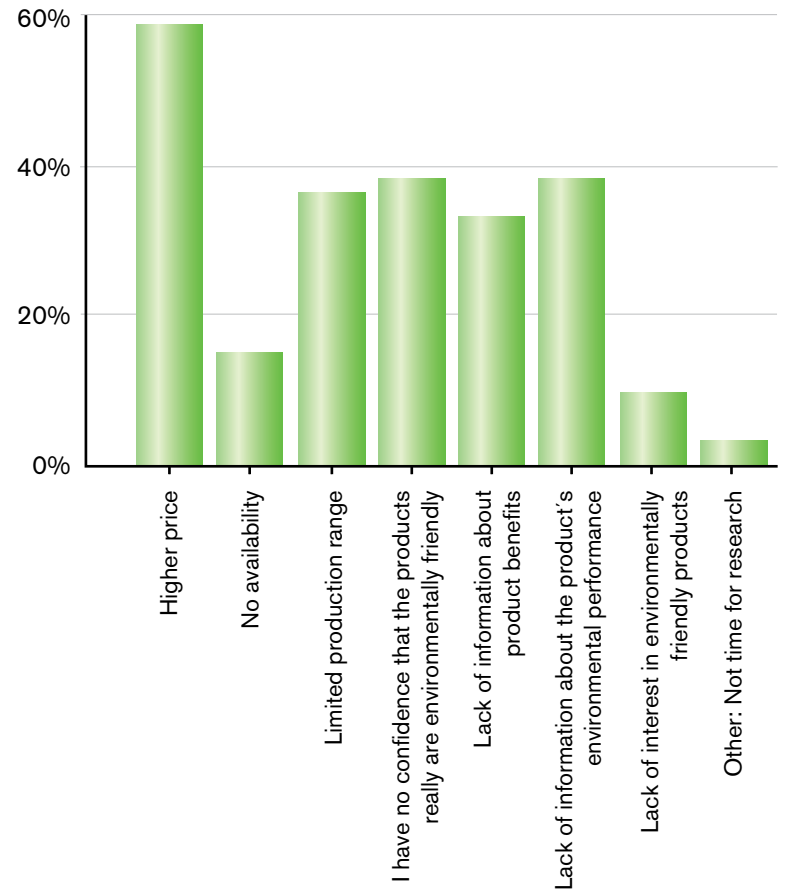


FIGURE 8: HIGHER PRICE AS THE MOST IMORTANT LIMITATION (MEN AND WOMEN) FROM PURCHASING MORE GREEN PRODUCTS.



On the one hand, price has formerly been detected as one of the most important conscious criteria for buying or recommending doors (Kunde, 2010). Furthermore, an important criterion for men, when buying green doors, and even a barrier for both genders to buy more environmentally friendly products is also the price range.

On the other hand, the qualitative studies show that the green products should be offered as highly desirable branding to clients because sustainability has become a luxury (Kongebro, 2011). This statement is in accordance with the new tendency in consumers, called the Neo-greens, who relate their green life style as the new luxury, and have the “tendency to receive value and satisfaction from being able to show their pro-environmental interest through money consuming purchases”, and in contrast with the traditional green consumers, “they do not want to decrease the level of their personal

consumption” (Pink, 2006; Kaarto 2006) cited in (Hassi, Kumpula, & Riuttanen, 2007). Selecting this target group has the possible benefits of higher profitability and introducing a tendency driver which is usually from a top-down social class type that in time may represent increasing in sales volume.

Thus, the result in general provides us with the understanding of the green consumers that are very sensitive to the perceived value for money. A higher price in itself is not a limitation – only when combine with a lack of additional perceived value.

These two different environmental profiles should be considered when selecting the target consumers on green products, since the design and communication of both differs completely.





## INTENSION-BEHAVIOR **GAP**

Limitations are another way of finding out why consumers buy green products by analyzing why they do not. The term “Intention-behavior gap” is when consumers have an intention to purchase but find barriers (personal or external) to do it. The question in this survey was general (not for a door in specific), since this one is not a repetitive purchase. Nevertheless, the results help understanding the door consumers’ behavior towards green products purchasing, and how to overcome their limitations.



For the general respondents the five most important limits are:

1. Higher price
2. Limited product range
3. Lack of information about the product environmental performance,
4. Lack of information about the product benefits
5. I do not trust that the products are really environmentally-friendly

These results match with the findings about limits on purchasing of sustainable clothing: Higher price, availability, limited range, and lack of information regarding what products are green (Sustainability in action sports, 2011). Similar results are also found in UK, where self-declared green consumers were interviewed to understand their behaviour when purchasing technology products: lack of time for research, the price of products, the lack of available information on the environmental and social performance of products and manufacturers (Young, Hwang, McDonald, & Oates, 2010).

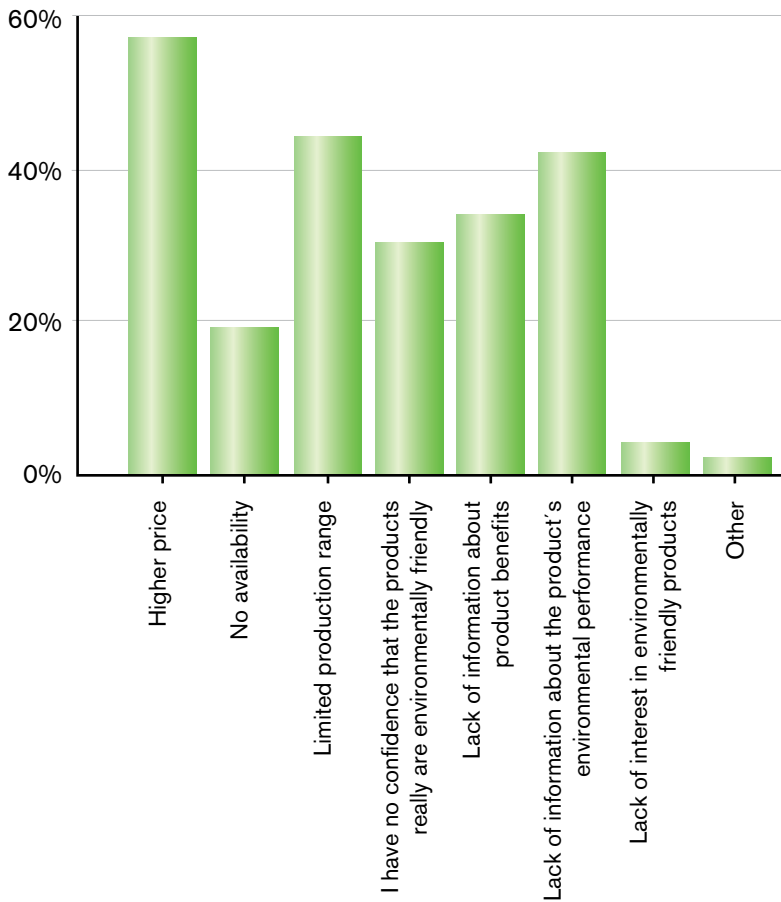
It can be noticed that the buying limitation factors are repetitive in both studies, except for “availability” in the sustainable clothing due to the specific kind of product, and “lack of time for research” in the technology products, perhaps for being these usually more expensive products where consumers spend more time and attention during the purchase.

A very important result was found (see Figure 9), when the information was analyzed for the group that corresponds to the target group of the focal company (women between 31-50). Although the five limitations are the same as the general respondents, the concept “limited product range” is considered less important than the other four, giving more importance to the concepts associated with lack of reliability: “I do not trust that the products are really environ-

mentally friendly”, and lack of information on product benefits and environmental characteristics.

JELD-WEN, as a company that wants to be recognized for reliability, should ensure that especially its target group trusts the greenness of its doors by offering environmentally friendly products, and clearly communicating the environmental properties of these products.

FIGURE 9: JELD-WEN END-USERS ACTUAL TARGET GROUP'S LIMITATIONS FROM PURCHASING MORE GREEN PRODUCTS.



## HOW DO CUSTOMERS **PERCEIVE** **GREEN** DOORS?

The analysis of this question is based on the results of the qualitative study made during the carrying out of the process in the User activities.

As analysed previously, the customer perception of green doors can differ in relation to the type of customer or user segment. Architects, for instance, tend to be more focused on the performance of the door and the consideration of many aspects during its life cycle:

*“The importance of a green door is what the product adds to the house”*

*“I think of how it is produced, from where is transported”...*

*“I think of Indoor climate: in toxics or VOC (Volatile Organic Compounds) and the reuse”*

This differs from the end-users' perceptions that tended to have more focus in sensations:

*“I think of the sensation that you can touch it, something visual, and tangible. It is important that the product is inviting, inspiring, beautiful”.*

*“Simple in appearance but stylish that shows the wood construction”,*

*“Natural colours and a texture that makes you want to touch it, that it feels warm, maybe that you can see or feel the wood rings”*



However, not all the end-users agreed that a green product should focus on its appearance but in the use of natural materials and careful use of natural resources.

*“A natural product that does not use plastic or a product that takes care of the natural resources. Green does not need to look green”.*

The perception of green doors can also vary according to cultural differences, and as mentioned by one of the architects during the interview, while in the Middle East a sustainable door should immediately be perceived as green through the aesthetics, in Europe the tendency is to make emphases on the performance. In the Middle East, when the door is green, it is not about the performance, but the aesthetic, so it is possible for the manager to say to all the visitors, “all the doors here are green”, and they can see it immediately that somehow green is visible. But there are also other clients in Europe that want to brand their ideas on the performance of the building. For instance, if it focuses on indoor climate the door should actually clean the air or improve the indoor conditions.







## WHAT DO CUSTOMERS **WANT** IN A **GREEN** DOOR?

The analysis of this question is based on the results of both studies, quantitative and qualitative, during the carrying out of the process in the user-oriented and internal activities.

### ENVIRONMENTAL CHARACTERISTICS

From the survey results it was identified that “energy efficiency during use” is the characteristic with highest priority that consumers would like to find in a green door. This result confirmed the findings on previous research made by Marin-Muñoz, (2010) on this topic where users selected: “The door increase energy efficiency” and “the process uses fewer natural resources”. This is not a surprising finding due to all the efforts that governments have done on this matter to reduce, or cut, CO<sub>2</sub> emissions and fuel consumption, and the tendency of consumers to show a clear preference for the characteristics from the Use stage in the product life cycle.

Without doubts, energy efficiency is a characteristic very significant for electronic devices or products that have high consumption of energy during its use. For exterior doors this characteristic can also be reflected, for instance, in insulation capabilities. However, when the product in consideration is an interior door, the reduction in energy consumption, although possible, is not high; therefore, other characteristics of the life cycle should be taken into consideration.

The second concept selected as first priority was “The process uses renewable sources (controlled forest, wind energy)” (see Figure 10). In the case of controlled forest JELD-WEN has already started with the FSC certification (Forest Stewardship Council), and can continue emphasizing different programs that support it, such as planting new trees or considering the option of including “clean energy” into its processes. These options have relation to the second priority selected by end-users: “uses fewer natural resources”, and “The door is made locally”, which is an alternative for reducing CO<sub>2</sub> emissions during transportation.

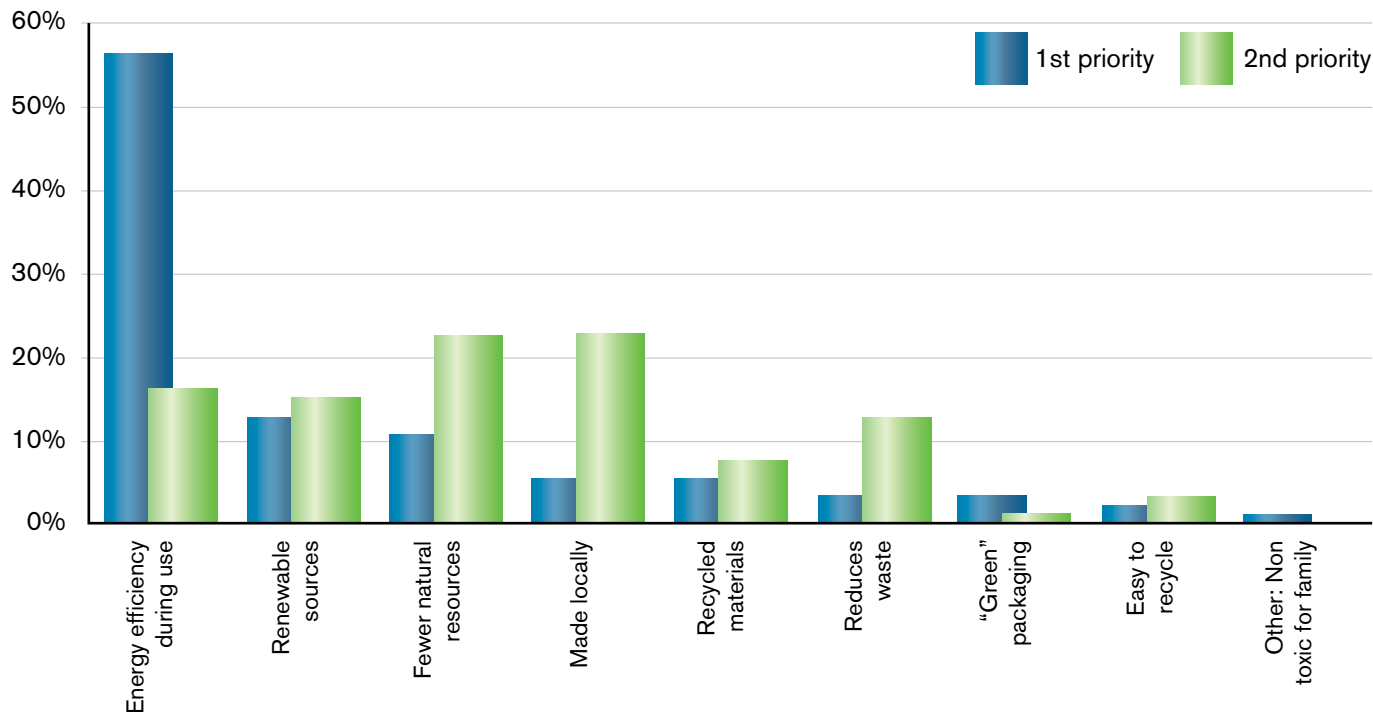


FIGURE 10: MOST IMPORTANT CHARACTERISTICS FOR GREEN DOORS (1<sup>ST</sup> AND 2<sup>ND</sup> PRIORITY)

## REGULATIONS AND CERTIFICATIONS

Governmental regulation plays a main role when costumers, both end-users and projects (contractors influenced by architects), select their requirements for green doors. In Denmark, for example, by 2015 all new buildings should use 50% less energy than used in 2006, and 75% less by 2020; which made the state not only a regulator of law, but also a follower of law, when it is in charge of building schools, hospitals or other governmental institutions. Other countries with high sustainability policies are Germany, where in order to sell or rent a property the building's energy consumption should be provided; moreover, their plan by 2020 is that all buildings should be operating without fossil fuel; in United Kingdom there should be 50% reduction by 2015, and all new homes should be carbon zero by 2016; and the French plan for 2020 is that all new buildings should be energy-positive (Danish Building Institute, 2008; European Strategies to move towards very low energy build-

ings, 2008; European Copper Institute. 2008). Moreover, according to InnoDoors partner Henning Larsen Architects, more than half of their company clients have higher ambitions than what is required in their local regulations with a very strong tendency on being able to measure, document and prove the performance of the product (Andresen, 2011)

According to the Sustainable Manager at Henning Larsen Architects, "what the Project costumers want in a green door is that it fulfills certain certifications" (Kongebro, 2011). The most internationally recognized and used certifications are LEED (originally from USA) and BREEAM (originally from UK), which work with a system of points. The new benchmark in Denmark is DGNB (German Sustainable Building Council), which is a certificate for environmentally friendly building based on a holistic and performance-oriented view of the entire building cycle (e.g. Considering a Life Cycle Analysis in materials).





## HOW TO **COMMUNICATE** THE **GREEN** DOOR ENVIRONMENTAL INFORMATION TO CUSTOMERS?

Understanding how costumers prefer the communication of the door environmental values, gives input not only for the communication itself, but also from additional wishes or requirements the costumers are expecting from a green door.

From the survey results it was detected that three of the limitations to buy more green products were related with the communication of the environmental information to the consumers:

- Lack of information about the product environmental performance
- Lack of information about the product benefits
- Lack of trust of the environmentally friendliness of the product

When the costumers were asked about how they would prefer to find the environmental information of the green door, the majority (men and women) answered by “green certifications they trust”. These results are concordant with Abele’s (2005) statement “the ecological Labels facilitate the understanding of environmental characteristics of the product”. A trustable green certification act as a third part that is in charge of analysing the detailed environmental information and gives approval of it, facilitating the selection process for the costumer. It is also important to consider that 20 % of the respondents selected that they would like “detailed explanation”, which implies the need of offering the possibility to find detail information for those who are interested (through a website for example).



## PRICE AND LUXURY

This characteristic was also noticed in the previous study made by Marin-Muñoz (2010), where the environmental information of leading companies in green product development such as Phillips, Siemens, BASF, and Herman Miller was analyzed. These companies in general show very clear environmental information, and at the same time the possibility to access to a more complete and detailed data for those who are interested.

In relation with the labels they recognize and trust the most, the first selection was the Nordic Swan, which is one of the most marketable labels in Denmark, followed by FSC and the Ecolabel. Considering that JELD-WEN has recently acquired a FSC certification, this one could be considered part of the green product line.

From the analysis of “why do costumers buy green products?” the importance of price and luxury in green products were discussed. The neo-greens are described as a new tendency of consumers, who related the environmental friendly tendency with luxury. For this type of consumers the environmental product should be communicated through green luxury design, meaning that the green should be presented as a characteristic among others that are more important, thus, “there is no trace of lower quality appearance, compromises in style, or visible eco-labels” (Hassi, Kumpula, & Riuttanen, 2007) for this trend, and meeting the environmental requirements is expected in all products.

During the discussion of the use context of the product, the option of offering the green doors as part of another product line was considered, due to the possibility offering it as a product with extra value, which can be charged with higher price. Even during the Internal workshop, comments like, “if is not with higher price, then people will not believe in it”, give the general idea that green should be more expensive, which contrast to the results found in this study, and with affirmations like, “many customers stated that they would choose the environmentally friendly product alternative instead of the conventional product, if both had the same price (Preisendörfer, 1996)”, are repetitive.





# Internal Activities

The information collected for the internal activities include analysis of the focal company, its planned strategies, interviews with selected personnel to understand the product flow, and the workshop activities prepared for and with the participation of key employees.

## USE OF THE PRODUCT

The first part included, among others, an activity on the doors' environmental impacts and its root cause. That activity helped the participants to gain an overview of the environmental impacts that occur during each of the stages in the life cycle of a door. The findings were the following:

- Raw materials: not controlled (sustainable) wood, cutting waste to make the chipboard, energy and waste generated in the saw-mill and the process.
- Component material: MDF (Medium Density Fiberboard): energy use and waste, packaging and the NH<sub>3</sub> emissions from the production of the components.
- In house Manufacture: glue, lacquering (oil-based or UV), formaldehyde, VOC (Volatil Organic compounds), waste of wood when cutting edges, waste of materials during the production set-up; and the energy for each of the processes.
- Distribution: CO<sub>2</sub> emissions, no energy efficient, fuel consumption, long distances in transportation, use of plastic, packaging, transport material (pallets),
- Retail: light consumption in the exhibitions, make to stock (heating, CO<sub>2</sub>), print brochures, extra packaging.
- Use: Cleaning products, difficulty to find spare products, waste during installation.
- Disposal: Difficult to separate into components to be recycled, difficult to re-use the material, Not information to the user about what to do with it after.

Subsequently, each participant individually selected the three priority areas where they consider JELD-WEN should put its efforts. Those mentioned were:

- Raw Material: Reduction of cost, use of controlled wood (sustainable), Use recycled materials (The end-users need a good story)
- Manufacturing: Reduction of energy in the process to save money, Reduce emissions in the process (lacquer, paint, glue)
- Distribution: Energy use during distribution (make good distribution concepts)
- Retail: Reduce material (make online marketing and sales)
- Use: Reduction of energy and emissions due to stronger environmental legislation
- Disposal: Solid waste (will be easy to break down or re-use in the process)

The environmental impacts that obtained the majority of answers in the prioritization stage corresponded to:

- Material Use in Raw material
- Reduce emissions in Manufacture
- Reduce energy in Distribution

From the results in the first part of the Internal workshop, it was clear that there is a difference between how the product is perceived

by the user - basic function - and how the team would like the user to perceive it -added value. This corresponds to the company's effort in their brand strategy of changing the conception that, "a door is just a door", increasing the perception of its use options with the new campaign concept: "Door of possibilities".

Following this concept, and as it was presented in the internal activities, the green product line could be part of the Consumer division due to its emphasis on the end-users, and the possibility to offer them an extra value (e.g. the offered through Advance line) in a product that is ready to use.

At the same time, the green products under the Consumer division has the possibility to be used in the Project division for some Consumer oriented projects where there is an environmental focus, like eco-hotels or institutions. The use of the green doors in buildings projects, as the architects in Henning Larsen addressed, also gives the opportunity to show the brand identity of a company when they want to include sustainability into their values.

Continuing with this analysis, this concept is applicable at JELD-WEN, but in this case it is not merely through the use of the green door, but through the production of it, which can be used to position the company as market leaders and innovators as well as supporting their efforts on brand differentiation.

## SUMMARY OF IDEA GENERATION AT JELD-WEN

### LIFE TIME

The summary from the second part of the Internal activity, an idea generation workshop, is presented in table 1.

The life-time of the product can have a significant impact on the sustainability assessment, and in the decisions that need to be taken during the design and material selection. This was also experienced during the idea generation in both workshops (Internal and Network), where the decision of materials was dependent of this variable. During the Internal workshop, it was stated that an interior door can last at least 25 years, and during that time it has been painted or treated. In the users' survey it was found that the users would like to renovate or change their doors every 21 years or more. However, there is also a considerable respond from the options from six years, which matches the possibility of implementing the "Renovation as a Service" idea, which arose during both workshops. This idea should be tested with end-users in order to prove their willingness of using this service.

As such, the green door with an environmental added value can be targeted to both end-users and sustainable buildings projects (with the architects as influencers), without geographical limitations and a product life-time of 21 years or more including renovation from every six years could seem of high interest and relevance.

#### RAW MATERIAL

- Use of recycled material (fibers)
- Use of alternative (eco) materials (like Eucalyptus, Bamboo, Coconut fiber, etc)
- Use clean energy to transport it
- Reduce glass (uses a lot of energy to process)

#### COMPONENT MATERIAL

- Substitute metal for eco-plastic from hinges and locks (quantify impact)
- Use carbon fibers
- Use eco-laminate
- Reuse components packaging

#### MANUFACTURE

- Use secondary material (process) with less environmental impact (glue, lacquering)
- Use clean energy (wind) for production and for heating
- Reduction of specific waste (from 30 to 10% is possible)
- Recycle pre-consumer material (instead of selling it)

#### DISTRIBUTION & RETAIL

- Send directly from the terminal (factory) to the end-consumer
- Increase internet for promotion and sell instead of retailers (digital showrooms, ordering on-line)
- Standardization of packaging/help materials (like Europallets), reduce volume, packaging with recycled materials

#### USE

- Self-cleaning doors, easy to install and repair, "living products" materials that evoke green story, reduce of paper (online, barcode), green insulation materials

#### DISPOSAL

- Use a take back system (reuse them without down-cycling: easy to disassemble)
- Use biodegradable materials
- Renovation as a service (Skin to renew allowing the user to design it online)

TABLE 1: SUMMARY OF THE IDEA GENERATION AT JELD-WEN

## THE DOOR ENVIRONMENTAL IMPACTS RELATED WITH ROOT CAUSES

	RAW MATERIAL	COMPONENT MATERIAL	IN HOUSE MANUFACTURE	DISTRIBUTION	RETAIL	USE	DISPOSAL
<b>MATERIAL USE</b>	Not controlled sustainable wood		Formaldehyde, glue, water-based paint, lacquering	Plastic, packaging, transport material (pallets)			Not separate materials
<b>ENERGY USE</b>	Saw-mill	Making MDF	Processes	Fuel consumption (oil, gas)	Exhibition (light), make-to-stock (heating)		
<b>SOLID WASTE</b>	Saw-mill	Packaging	Production set-up (paint, wood), cuts	Wrapping	Packaging / Wrapping		No information to the user
<b>OTHER EMISSIONS</b>		NH <sub>3</sub> (ammonia)	VOC (Volatil Organic Compounds)	CO <sub>2</sub>		VOC (Volatil Organic Compounds)	NO <sub>x</sub> gasses, CO <sub>2</sub>

TABLE 2: THE DOOR ENVIRONMENTAL IMPACTS RELATED WITH ROOT CAUSES.

## ENVIRONMENTAL IMPACTS FROM THE LIFE CYCLE OF A DOOR

The environmental impacts of a door can be analyzed under the perspective of its life cycle. The Environmental impact workshop activity during the implementation of the Internal phase at JELD-WEN consisted of company representatives from almost every stage in the product life cycle and environmental specialists who gave support during the environmental impacts' identification. Table 2 shows an analysis of the workshop results using a qualitative method called Impact Matrix, which relates the environmental impacts in each stage of the product life cycle (columns), and its root causes (rows).

With this matrix, the environmental impacts are easier to analyze from two different perspectives: from the Product life cycle stages (what are the most relevant impacts and how they are generated); and the Root cause (collecting them in main problems).

The areas where most of the environmental impacts were detected are: Material use in Manufacture, Material use in Distribution, and Energy use in Distribution.

Since the purpose of this activity was to have an overview of the environmental impacts during the whole life cycle to facilitate an environmental thinking, no quantification of impacts was carried out.

Therefore, the prioritization process was performed in accordance to the knowledge of each participant within his/her own field, and the discussion with the environmental specialist. Prior to making any decision on the matter, it would be necessary to use tools such as Life Cycle Assessment (LCA) or similar to help quantifying them.

The output of the following Idea generation workshops was the following:

## RAW MATERIAL

- Wood substitution for more ecofriendly materials or faster growing wood. For this idea, transportation and processing impacts should be analysed.
- Light doors: Reduce quantity of material, reduce transportation impacts.

The emotional sensations of protection and feeling vs. solid door should be carefully analysed.

- Reused material in hinges and locks. According to the supplier it is cheaper to use recycled materials, but the quality would be reduced.
- To stamp all the components with the material information. This will facilitate the recycling process to reuse those materials, and therefore use less raw materials

## MANUFACTURING

- Material like glue and lacquer need to be replaced by products with fewer emissions that use less energy and are easy to recycle.

## DISTRIBUTION AND RETAILER

- Use of Internet and virtual platforms for promoting and selling lead to several ideas to reduce transportation, and at the same time be closer to the end-user.
- Standardization of transportation aids to enable its reuse

## USE

- Cleans the air (for odours, air flows), no toxics materials, no chemical emissions (paint, VOC)
- Display the energy consumption (of the room)
- Users design their product online and select the level of green they want.
- Take back system: It is possible if the design facilitates disassembly. Calculations must be made on energy and cost used in transportation and reprocessing. End-users did not show interest on this type of solutions, probably due to the long time that a door is expected to last.

## DISPOSAL

- Renovation as a service: Combining the idea of long lasting doors, the market consumerism on fashion, and the idea of refurbishing as green concept; this idea was explored and combined with previous ideas on the use of internet to design their own product. As the previous alternatives, the process should be quantified to avoid false environmentally friendly characteristics.





# External Network Activity

A value chain can be described as the activities within and around an organisation that interacts with other organizations to create products or services (Lambert, 2006). The focal of the value chain is the end product/service and the chain is designed around the activities required to produce it. JELD-WEN's value chain, consisting of suppliers, dealers, architects, contractors, and end-users, is known for its traditional structure where the communication is limited to its immediate link in the value chain. In contrast, firms in a network reach common objectives by working together sharing resources, capabilities and expertise, and co-creating value by combining players (Peppard & Rylander, 2006).

Since the final goal of this network is to develop green products, the selection of the network partners was based on those members of the network who could influence the product's value proposition: in addition to the manufacturing company which is the focal company, the suppliers that influence the value by definition of materials and the architects who are the value influencer by definition of product specifications were selected to join the experiment.

# SUMMARY OF IDEA GENERATION WITH THE NETWORK

MATERIAL	<ul style="list-style-type: none"><li>▪ Reused material to use in hinges and locks (It is cheaper)</li><li>▪ Stamp all the components with the material information</li><li>▪ Rigid frame and light panel (e.g. changing the skin of the surface with textile)</li><li>▪ Use faster growing wood</li><li>▪ Reduce components (locks) if they are not needed</li><li>▪ Skin door that can be changed keeping the core.</li></ul>
USE	<ul style="list-style-type: none"><li>▪ Insulation with other products (paper used in UK and Sweden)</li><li>▪ Cleans the air (for odors, air flows)</li><li>▪ No toxics materials</li><li>▪ No chemical emissions (paint, VOC)</li><li>▪ Display the energy consumption (of the room)</li><li>▪ Users design their product online</li><li>▪ People can choose the level of green they want.</li></ul>
DISPOSAL	<ul style="list-style-type: none"><li>▪ Maintaining without painting (self-healing paint)</li><li>▪ Service of "green" maintenance (e.g. JELD-WEN will refurbish your door for a minor cost)</li><li>▪ The changeable skin door</li><li>▪ Same platform (standardization of components)</li></ul>

TABLE 3: SUMMARY OF IDEA GENERATION WITH THE NETWORK

## SELECTING NETWORK PARTNERS AND FORM OF COLLABORATION

As mentioned previously, in the network concept, the value creation should be analysed by investigating at how the organisation creates value within the context of a network. In this case, the network partners were selected looking from the perspective of JELD-WEN as the focal company and analysing the network participants that influence the value wanted to provide to the costumers: in this case the "greenness of a door". In relation to evaluation and a pre-analysis of interests and capabilities, it was decided to work with suppliers and architects that corresponded to Abson and Henning Larsen Architects from the InnoDoors' network, and further analysis of their interest and capabilities as part of the network, served to define the network's strategic situation.

Their collaboration as a network started during the first meeting, when the methodology and project plan was presented. Their involvement in the clarification of the problem and participation on similar network activities helped narrowing down the objective and expectations. Their main contribution for this part of the experiment was obtained during the Network idea generation workshop, where

it was possible to cover more areas of the Product life cycle from different perspectives simultaneously, while considering the relationship and effects that one action of the network partner could have to the others, or how an action proposed by one partner may require further actions by other partners in order to be effective.

Having Abson participating in the workshop improved the quality of the ideas since there were more accurate information on component materials and transportation, and faster feedback on the possibility of those ideas, transforming one suggestion from the architects in one idea solution for the components. At the same time, the workshop was a way of involving them in the process to ensure commitment in later stages of the experiment. Having the architects as part of the network, with international sustainability experience, and a global vision of investors providing inputs on regulations on the green market that influences the specifications of the selected value, and from their experience on being close to end-users and their design process capabilities, a link between the product environmental impacts and ideas for products or services during the idea generation workshop could be established.

The output from the network workshop activity is summarized in Table 3.

# Outcome of the InnoDoors Green line experiment

## THE **USER**-ORIENTED FINDINGS

The purpose of this publication was to initiate a so-called 'green-innovation-experiment' in a construction material industry. In order to do so, three types of activities were initiated:

1. User-oriented activities: defining the true needs, desires, expectations, and necessities for them to become interested in buying a green product.
2. Internal activities: defining the internal capabilities of the focal company needed to manufacture a green product.
3. Network activities: defining the necessary network partners and how to collaborate in innovating together for a green product.

In order to carry out the different activities, the InnoDoors Model and a Design for Sustainability approach was chosen to ensure a greater overview, better planning, documentation, and flexibility of the innovation process for the construction material network.

The user-oriented data revealed that the interest of the end-users in green products mainly lies in the values of price and luxury.

The most important reason for the environmental characteristic of price is saving money during use, where it was found that men are more sensitive to the savings during the purchase while women tend to think more in the saving during use, and the second reason was contributing to the environment. The customer's limitations to buy more green products are in order: Higher price, limited product range, lack of information about product environmental performance, lack of information about the product benefits, and lack of trust on the environmentally friendliness of the products. The last limitation was selected in the second position for the actual JELD-WEN end-users target group survey.

Hence, price must be a careful decision according to the target group, and should not interfere with green door purchasing, offering variety in green alternatives, providing clear information about the product environmental performance and the product benefits, and last but not least: ensuring reliability.

The value of luxury was mainly targeted towards the 'new' end-users, also known as neo-greens, where being green is a means of not only showing interest for the environment, but also a way of showing that they have high taste and can afford such products. However, luxury should not be mistaken with the same level as higher price, and selecting this focus means being prepared to offer high tech solutions, and thorough studies on luxury perception for the target group in different countries where JELD-WEN wants to sell the green door.

## THE **INTERNAL**-ORIENTED FINDINGS

The internal oriented findings revealed a number of green values that the focal company could translate into specific goals and strategies for producing a green door. The main findings were the following:

1. Fewer natural resources: The process uses fewer natural resources
2. Energy saving: The door helps to save energy during use.
3. Renewable resources: The process uses renewable energy wind power.

For this concept, strategic alliances with Siemens or Vestas could be made to gain renewable energy, or JELD-WEN could consider buying a small wind turbine for each factory. If that was realized, the percentage of wind energy could be calculated to see how many doors can be produced with that energy (similar to FSC system).

4. Recycled material content: Use of pre or post-consumer percentage of recycled materials in the door.
5. Cleaner production: Implement the Cleaner Production concept in the Manufacturing process to reduce risk to humans and the environment.
6. VOC volatile Organic Compounds free: The door does not emit VOC.
7. Zero waste production: The manufacturing process has implemented a Zero Waste concept in order to avoid or reuse all the raw materials.
8. CO<sub>2</sub> reduction process: The process has implemented strategies to reduce CO<sub>2</sub> emissions, by for example using hybrid cars to distribute the products, or reducing distances from it, or changing processes for more efficient ones.
9. Easy to disassemble: The door is designed with the concepts Design for Disassembly which facilitates its recyclability, and therefore the use of fewer natural resources for the next door.
10. Light door: The door uses fewer natural resources. This Green value can go together with the CO<sub>2</sub> reduction process since reduction in weight has also a reduction in fuels and therefore in CO<sub>2</sub> emissions.
11. Renovation as a service: The door has the possibility to interchange skins. This Green value can be used in combination with the existent feature that resemble Durability "5 years guarantee" since it is a requirement that the door last to be able to be useful to be renovated. (HH% will renovate doors from every 6 years).

## THE **NETWORK**-ORIENTED FINDINGS

During the generation of ideas, it could be perceived that, in general, it is feasible to find or design components satisfying general environmentally friendly characteristics without increasing cost. It was also noticed that even though there was an environmental initiator of ideas, the concept of selling a “green story” that is cheaper for the company and at the same time it can be sold more expensive still remains.

There were formulated both realistic and imaginative ideas to reduce environmental impacts in the different stages explored, which need specific requirements in order to go further in its development. As a general conclusion of the team, the economic investment and payback are not the only aspects that need to be considered, when evaluate new ideas. Offering value to the costumers and being prepared for stronger regulations need to be considered as well. E.g. it is also important to consider that the European vision for 2020 states that the emphasis should be in the products, rather than the process, “since each product standard has a large impact on: the use of natural resources, waste/end of life, closed loops of materials; and Emissions over the lifetime from the product – energy use, chemical or nanoparticle content.” (Standardization for a competitive and innovative Europe: a vision for 2020, 2010)

The network-oriented findings mainly stem from an Idea Generation workshop, with a purpose of finding different manners becoming green for the entire network, rather than only focusing on the manufacturing company alone.

The workshop revealed that there are indeed many ways that the network can increase its greenness and, thus, ensure that the end-users trust them when the network claims that they are in fact green.







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