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Guidlines for Inventors "From Idea to Product"

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Abstract. The article deals with the problem facing Latvian inventors in how to develop the idea to a real product. There are often cases where innovative ideas "migrate" from original inventors to other inventors, when they turn to them to seek support for developing and supporting the idea. The main components of the guidelines are the establishment of a patent application and, in general, a description of the entire patent acquisition process and the creation of a life cycle analysis using the SimaPro software.

The article is intended primarily for the development of environmentally friendly inventions, which is why the life cycle analysis is one of the main components of the article, to make it possible to conclude whether the production and use of the new product will not result in a higher "ecological footprint" than previously used technologies, paying particular attention to the inventor stage in order to accurately develop a life-cycle analysis. The article does not only explore the necessary theoretical knowledge of the realisation of the idea to the product, but also looks at the pilot case, a practical example of an innovative "dust co-firing burner" compared to the conventional natural gas burner. The life-cycle analysis compares the following steps: manufacture of plants, transportation of plants and special emphasis on the combustion phase of fuels, three scenarios are examined: a natural gas burner burning natural gas, a dust burner in which natural gas is co-incinerated and fine wood particles − dust and a dust burner burning. biomethane and wood dust. The use of such an installation would not only reduce emissions from the replacement of natural gas by wood dust, but also allow energy companies to work more effectively, as it would be possible to regulate the proportion of different fuels depending on demand, because the fuels have different heat of combustion.

The article establishes a methodology to analyse the quality and implementation of inventions in response to the following key questions:

- how to identify original ideas and how to protect authors from the migration of ideas;
- how to collect and analyse the risks associated with migration of ideas;
- how to use life cycle analysis for the assessment of the "ecological footprint" of the invention.

Keywords: patent, life cycle assessment (LCA), co-firing, dust burner, natural gas burner, inventors, ecological footprint.

Introduction

Nowadays it is very easy to find information about almost everything and amount of information available in internet is extremely large, therefore people must be very careful about what they are publishing on the web. There have been many cases where ideas have been stolen or migrate from its author to someone else. But this paper is not about how to be safe on the internet. Much bigger issues are transition from fossil energy to green energy, integration of renewable energy resources into heating systems and use of renewable energy resources for energy production in general and many more other issues related to ensuring more environmentally friendly activities and reducing emissions. So overall the main goal of this paper is to explain to inventors how to protect their invention and how to verify if their invention is environmentally friendly, and therefore sustainable. The main goal from this paper is to give example to inventors how verify if their invention is environmentally friendly, highlight the main principles to be followed in order to safeguard the invention from its "migration", in practical part examine if the innovative wood dust burner will be environmentally friendlier than well-known natural gas burner including impact of the combustion process, explain how is working the patent acquisition process and how to prepare for it more effectively and overall create guidelines for inventors how to realise their idea to real applicable product. The innovation of this paper is that guidelines like these are not made before and this is first time life cycle assessment has been established for wood dust burner.

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Practical part of this paper includes life cycle assessment example and its analysis of three different combustion scenarios- “Natural gas”, “Natural gas + wood dust” and “Biomethane + wood dust”, using dust burner and natural gas burner to compare which burner leaves smaller ecological footprint. The following life stages of the product- heat energy- were considered:

1. Extraction of raw materials;
2. Transportation of raw materials;
3. Manufacture and transportation of burners;
4. Combustion process;
5. Emissions and impact to environment

As well as life cycle assessments, the practical part of the paper includes a patent application for an innovative wood dust burner, guidelines written as a summary of what inventors need to focus on when creating a new product, and a summary of the main risks from which inventors should be careful during the period from idea till product.

1. Co-firing

Fossil energy production is currently very advanced: plants are with high efficiency, the logistics sector is developed, and the level of plant development is so high that risks are almost completely excluded (Kazulis et al., 2018). These are the main reasons why the replacement of fossil fuels with bio-energy resources is slow and gradual. Among other reasons, which are mentioned as counter-arguments for the use of bio-energy resources, are the generation of emissions through transport, the loss of natural diversity due to the cultivation of the most efficient bio-energy resources and the higher cost of production, these factors are excluded from the use of, for example, natural gas. But it is clear that the largest component that causes harmful emissions is the use of fossil fuels. Therefore, the transition to renewable energy is taking the form of the introduction of a co-firing system for energy production. Co-firing is a combustion process of several fuels for energy production. As a general rule, this system consists of one fossil fuel and one renewable energy resource, thereby reducing emissions, but at the same moment maintaining quite high efficiency. Another benefit of this system is the use of fuels with different lower combustion heat Q_{ZD}, which makes it possible to pass the fuel supply at different doses in order to adapt the produced energy to demand. For example, more heating fuels with higher combustion heat could be used to produce heat during the heating season, but when the demand for thermal energy would decrease, it would be more likely to use fuels with lower combustion heat, which could result in the facility working continuously in an optimal mode with high efficiency.

Like coal or natural gas, biomass can be burned separately, but a separate combustion of these fuels does not make the desired results: fossil fuels produce a lot of emissions, while biofuels are of lower efficiency. Co-firing of fuels creates technical, economic and environmental benefits (Demirbas, 2003).

The co-firing technologies used in the past have combined the following energy resources: coal and biomass and natural gas and biomass.

Following research into previous studies, it is possible to distinguish between a number of technological techniques (Figure 1) for the co-firing of coal and biomass (Gil & Rubiera, 2019):

1. Direct co-firing- this method is the cheapest, simplest and most common method of co-incinerating biomass with coal, usually in a pulverized coal boiler. The investment is relatively low, as a boiler already in existence needs minor changes to allow it to be used in co-firing mode (Gil & Rubiera, 2019). The amount of biomass is normally not less than 5%, calculated on the basis of the energy produced (Demirbas, 2003). The benefits of such a system are the high efficiency that can be achieved in large coal power plants, which enhances the combustion of biomass, taking into account the high rapidly volatile composition of biomass. However, there are also more risks to this system: a large amount of ash, a limited range of co-incineration fuels and a limited use of biomass types (Gil & Rubiera, 2019);
2. Indirect co-firing- co-firing system shall in addition contain a gazifier in which solid biomass is previously gazified. Solid biomass is converted into a fuel gas that is then burned along with coal in a single boiler. Such a co-firing system requires more capital investment due to gazifiator, but the main benefit of this system is that it is possible to use more biomass diversity and it is possible to use biomass in a higher proportion;
3. Parallel co-firing- in the case of parallel co-firing, the system consists of two boilers, a coal boiler and a biomass boiler. Each boiler burns its own fuels, coal and biomass separately. The heat generated at the end of the combustion system is combined and discharged in one place (Gil & Rubiera, 2019). This method makes it possible to obtain a high proportion of the combustion of biomass and may use low-quality biomass, such as bark and wood surpluses and other production processes. The use of such a system has relatively high costs but is also lower than that of a wood-fired power plant, while the efficiency of such a system is higher than that of the specialized wood power plant (Demirbas, 2003).

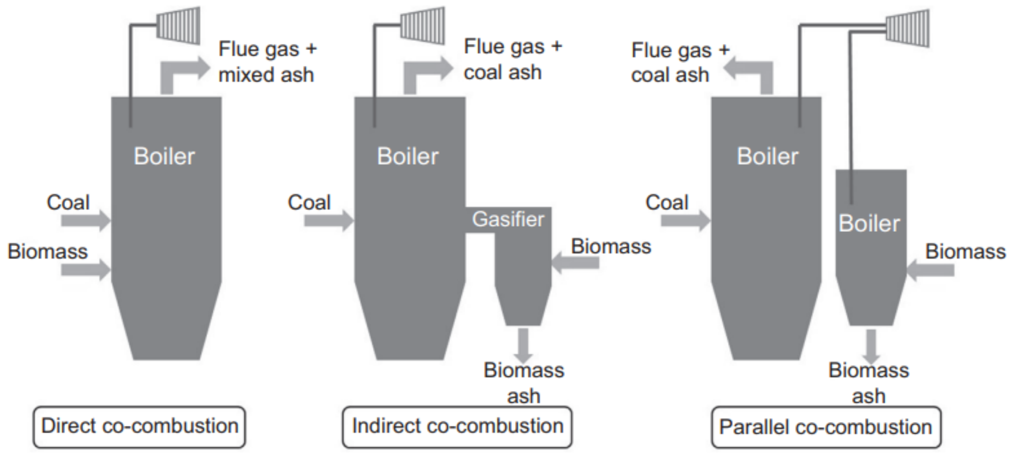

Figure 1. Schematic presentation of coal and biomass co-firing technology options (Gil & Rubiera, 2019)

Like the "Coal + Biomass" system, "Natural gas + Biomass" system is designed to reduce emissions from fossil fuels, in this case natural gases, and to improve the efficiency of the combustion of biomass. It is more than clear that replacing natural gas with biomass during the combustion phase will lead to a reduction in emissions, but at the same time it should be taken into account that biomass is delivered and prepared to such a phase that it can be used by fossil energy sources, both for transportation and for the production of electricity and heat for biomass processing. In Latvian conditions, the estimated amount of CO_2 needed to prepare and transport biomass, which ultimately results in a size approximately equal to d = 6 mm, is 26.84 kg CO_2/t (Table 1) (Kazulis et al., 2018).

Table 1. Fossil GHG emissions from wood acquisition to pellet raw material production (Kazulis et al., 2018)

Process	Description	Electricity consumption, kWh/t	Fossil GHG emissions, kg CO_2/t
Tree cuting	At forest	–	14
Transportation	Lorry, 40 km	–	4.68
Chipping	To 30 mm pieces	10	1.09
Pre-milling	To 10 mm pieces	17.07	1.86
Second milling	To sizes around 6 mm	7.79	0.85
Drying	W = 50% to W = 8%	40	4.36
Total			26.84

In several laboratories around the world, the natural gas and biomass co-firing furnaces has been experimentally installed to experiment with the combustion process. If in the case of "Coal + Biomass" the biomass was more in the form of wood chips, then in the "Natural Gas + Biomass" scenario the wood is more finely ground as it is burned in the burner (Casaca & Costa, 2003). Therefore, the data presented in Table 1 is also so important, since most of the procedures for the preparation of wood for co-incineration with natural gas are not carried out by co-firing with coal. In the case of "Coal + Biomass", only the first three headings of Table 1 are implemented.

2. Patenting

To define what is a patent from the beginning, it is certainly necessary to define what is an invention. An invention is a result of technical innovation which has a practical application, a technical solution to a technical problem. An invention may be a device, technique, substance or biological material (Latvijas Republikas Patentu Valde, n.d.).

Today, the term "patent" is commonly used to refer to the rights conferred on someone who invented a new and useful process, a combination of devices, materials or substances. A patent is a type of intellectual property that protects products of technical innovation (Latvijas Republikas Patentu Valde, n.d.).

A patent is a set of exceptional rights granted by any sovereign State to the inventor or his successor for a specified period of time, in exchange for the obligation to publish the invention. The patent gives its owner the right to prohibit others from producing, using or selling an invention in the territory of that country (Latvijas Republikas Patentu Valde, n.d.).

Anyone else who wants to use an invention for commercial purposes while protected by a patent must require a permit (licence) to the owner of the patent and potentially pay it a license fee. As a general rule, if a patent is maintained by the regular payment of maintenance fees, the exclusive right of the patent holder, commercial exploitation of the invention, lasts for up to 20 years from the date of filing of the application (Latvijas Republikas Patentu Valde, n.d.).

The patent application, in accordance with Section 27 of the Patent Law of the Republic of Latvia, shall include:

1. An application for the granting of a patent;
2. A description of the invention;
3. One or more claims;
4. Drawings where the description or claims refer to them;
5. Summary.

The object of the invention may be a device, technique, substance, substance composition or biological material (see Section 10 of the Patent Law of the Republic of Latvia).

An invention can be protected by a patent if it is a new technical solution to a technical problem, it can be industrially used and has an inventive level.

Inventions, if patent protection for the same objects is requested, shall not be considered (see Section 9 of the Patent Law):

- discoveries, scientific theories and mathematical methods;
- aesthetic solutions;
- plans, intellectual activities, commercial or game rules and techniques, as well as computer programs;
- methods of providing information.

Patents shall not be granted for inventions whose disclosure or use is contrary to public policy or to the principles of morality accepted by the public. Treatment and diagnostic methods are also not considered to be patentable, since it is assumed that the prevention of human and animal health problems is a more socially important task for patent rights, by legally excluding them from patentable sites, claiming that such inventions are not industrial.

When the inventor has decided that a new invention has been produced or even before the work begins on the new invention, it is worth a search to see if such an invention has already been invented somewhere in the world and already protected by a patent. Thus, the inventor can avoid an alien patent infringement, save his time without spending on creating an invention and preparing documents, and resources without paying for a patent that can be challenged in court, and avoiding punishment for another patent infringement. Patenting can give impetus to finding new solutions.

Life cycle assessment

Life cycle assessment is a method that evaluates the impact of a product throughout its life. It includes stages such as: the extraction, transport, processing, use, processing, recycling and other phases depending on the type of product, use, materials, etc. It calculates emissions occurring at each particular stage and then using built-in algorithms assess the overall environmental impacts (IMPACT 2002+: User Guide, n.d.). In this paper, the life cycle assessment has been developed using the SimaPro software.

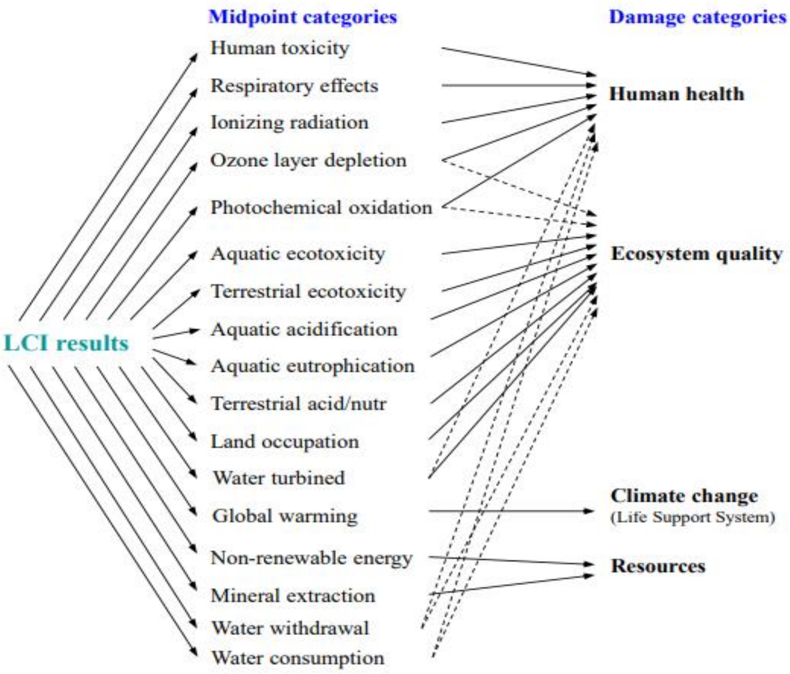

Figure 2. Overall scheme of the "IMPACT 2002+" (IMPACT 2002+: User Guide, n.d.)

One of the proposed built-in evaluation methods of SimaPro is "IMPACT 2002 +", consisting of 4 endpoints, which are categories where total impacts are collected and represented from all phases of the product life cycle that affect the specific impacts, of course it would not be correct and would be difficult to analyse afterwards if the whole impact of the product were divided into 4 endpoints, so they are divided 17 smallest and most specific midpoints (Figure 2) (IMPACT 2002+: User Guide, n.d.).

3. LCA results

In Table 2 and Table 3 is shown input data, which was used for further modulation in SimaPro software. Natural gas nowadays is one of the main energy sources which is commonly used to produce heat-energy. To get 1 MWh Heat (heat was assumed as product of this process) and 0.57 MWh electricity (in Table 1 shown in green colour) to get that amount of energy there is needed to burn 102 m^3 natural gas. During this burning process in air is emitted 0.0181 kg CO_2; 0.062 kg CO; 0.142 kg NO_x; 0.002 kg SO_2. When the natural gas is burned emitted PM emission is not considered as they are not relevant. Calculations for natural gas were based on sources 7 and 8 from source list.

Table 2. Inventory of scenario "Natural gas"

Inventory			
Input		Output	
Natural gas	102 m^3	Electricity	0,570 MWh
		Heat	1 MWh
		CO_2	0.181 kg
		CO	0.062 kg
		NO_x	0.142 kg
		SO_2	0.002 kg

As natural gas is non-renewable energy source, therefore society need to look for more sustainable resource which could replace natural gas. At this point we suggest to use biomethane instead of natural gas since biomethane is considerate as renewable source. To increase efficiency of the system we also suggest to add wood powder during the burning process. Also, as in previous system during burning process the oxygen is supplied to biomethane. To get 1 MWh Heat and 0.57 MWh electricity (in Table 3 shown in green color) we need to burn 48 m^3 biomethane with 106 kg wood powder. During this burning process in air is emitted 0.085 kg CO_2; 0.602 kg CO; 0.191 kg NO_x; 0.020 kg SO_2; 0.062 kg PM; 3.18 kg ash.

Table 3. Inventory of scenario "Biomethane + wood powder"

Inventory			
Input		Output	
Biomethane	48 m^3	Electricity	0.570 MWh
		Heat	1 MWh
		PM	0.062 kg
Wood powder	106 kg	CO_2	0.085 kg
		CO	0.602 kg
		NO_x	0.191 kg
		SO_x	0.020 kg
		Ash	3.18 kg

The main difference between alternatives based on end-points is the use of resources, which is significantly higher in natural gas burning process scenario, on the other hand biomethan + wood powder burning process scenario wood powder is considered as a waste and thus it helps to avoid its deposition in landfills. The biggest focus was on combustion process, because the constructions of the burners are very similar, transportation impact is also very similar, but the biggest difference is in combustion process. End points like ecosystem quality, climate change have similar assessment, as seen in Figure 3. the difference is just 1−2 mPt (miliPoints unit given from SimaPro). In both processes the impact on human health is high, however difference between alternatives are relatively small (5 mPt).

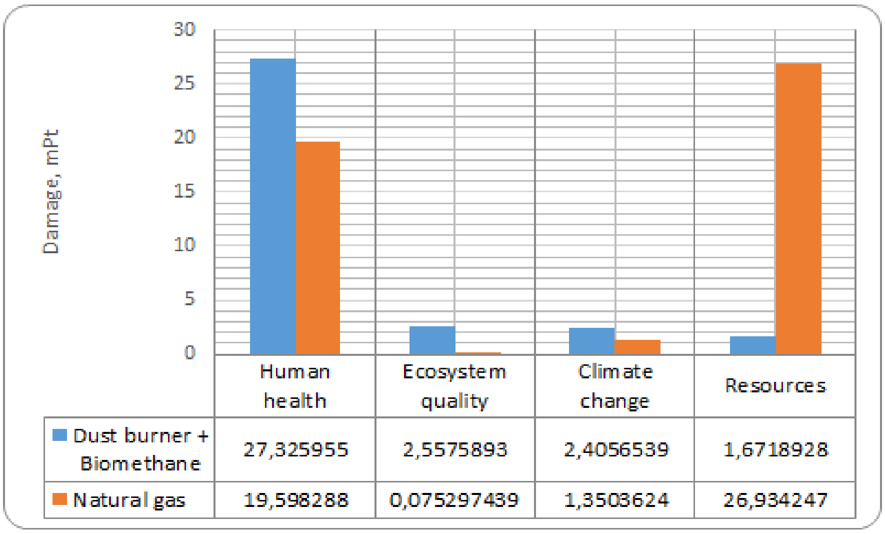

Figure 3. Impact to endpoint categories

From Figure 4 we can see total impact of booth scenarios. We can conclude that dust burner is more sustainable than natural gas burner, the difference is significant to assume that. Moreover, in dust burner system is included transportation and production of the dust burner, which in SimaPro was define as Industrial furnace and yet by including said features the dust burner + biomethane is more sustainable.

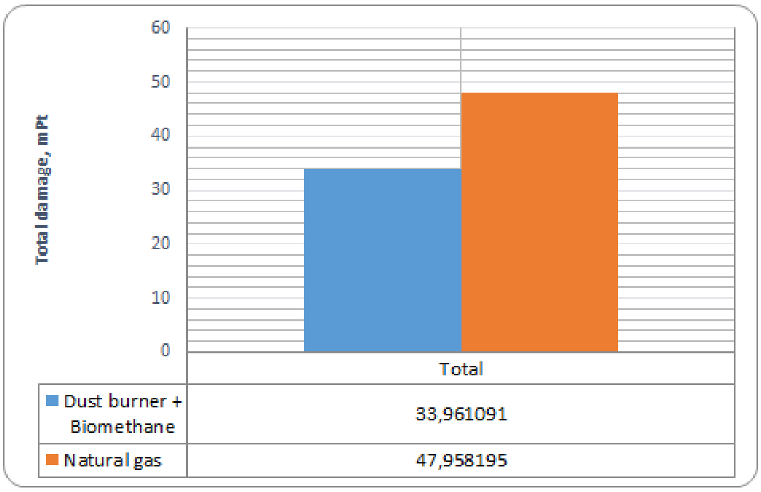

Figure 4. Total impact to environment

The most important conclusion of this LCA is shown in Figure 4, which is "Natural gas" scenario leaves larger impact to environment than "Biomethane + dust burner" scenario, what was also predicted at the beginning of this work. The next conclusions that is important to notice is endpoints and midpoints that are most affected in scenario "Biomethane + dust burner" because only way to conclude how to improve further this system or what preventive measures is needed to adapt to this system, because consequences of these two scenarios are different (from the perspective of around living people, nature, prominent objects etc.).

Asked questions before LCA was made and answers to them:

- Which solution, natural gas burning system or biomethane with wood powder/dust burning system, is more sustainable? − Regarding this LCA biomethane with wood powder/dust burning system is more sustainable according to SimaPro results (end points).
- Which method is more effective regarding usage of raw materials? − more effective regarding usage of raw material is biomethane with wood powder/dust burning system, because biomethane is renewable energy source and wood powder is considerate as a waste. On the other hand, natural gas is fossil energy source thus the impact is higher.
- Either the dust powder can be considered as a waste or rather valuable material? − dust powder is considerate as a waste and using this material in a burning process is better than depose to landfill. It would be a waste of wood dust particles were produced as a primary product, there are many products that could be produced from wood with higher added value.

Conclusions

1. The patenting process is an important stage in the marketing of an innovative product, the release of this stage may result in consequences that the author and developer of the idea will not be entitled to pursue their own ideas if the idea has been noticed by others and donated before the original authors. It is therefore very important to patent it before presenting the product to a wider range of people.
2. A life-cycle analysis gives a view of product sustainability, environmental friendliness, and allows for a preliminary assessment of the major cost sources of product creation.
3. Partial replacement of natural gas with particles of wood dust significantly reduces environmental impacts and reduces CO_2 emissions.
4. The transformation of a natural gas burner into a dust burner does not require major investments and requirements for the storage of large areas of dust.
5. Since such a co-firing method is innovative, it still takes time to complete and modernise it, but this method is certainly potential because it is a way of using wood waste.

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