Klimagassregnskap.no - usability for the average architect

AAR4817 - Use and Operation of Zero Emission Buildings

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Abstract

Klimagassregnskap.no is a Norwegian tool for calculating greenhouse gas emissions from buildings. The tool calculates emissions from transportation, materials, energy use and the building phase, and has both early phase modules and planned/built modules. The version 3 of the tool was launched in march 2011. Calculating emissions from a building is important to be able to reach the goal on less greenhouse gas emissions in Norway. Materials have a big impact on the emissions from a building, and in the choice of materials the greenhouse gas emissions should be considered. A tool like *klimagassregnskap.no* where you can calculate the emissions both in an early phase of the design process and when the building is planned and built will help the architect to consider more environmentally friendly solutions for the building. *Klimagassregsnkap.no* is a easy accessible tool for calculations, however, the tool needs to be developed further to be a good tool for architects. Today, the incorrectnesses in the tool, the lack of consistency in the interface and the low degree of accuracy in the calculations due to difficulties in the input are making the tool not relialbe enough to be used as the only greenhouse gas emission calcualtion tool for an architect.

Preface

This essay started with a wish to look at architectural consequences of zero emission buildings. To be able to find an answer to this I wished to look at newly built building projects that are not zero emission, but complies to low energy usage or the passive house standard. By importing the data for these buildings in to a certification or calculation tool, I would like to study the factors that make this building a non-zero emission building, and through that find out which elements has had the biggest impact on the greenhouse gas emissions and thereby needs to be changed in order to make the building a zero emission building. Would there be any clear findings of building materials that influences the GHG emissions in such a way that it would be easy to say that it needs to be replaced, or is the question more related to the architectural concept or the area use, or are all these aspects more closely connected? Would there be a need for a totally different architectural mindset in order to achieve the goal of zero emission buildings, or is it sufficient just to replace the materials with better materials?

Through this I wished to test the usability of the Norwegian GHG emissions calculation tool klimagassregnskap.no, and to see if it is a useful tool to use for reducing the GHG emissions in a building. Would the results be so significant that they would be easy to use in order to change the design to the better? The usability of a certification tool is important. For an architect it would be good to have an easy tool, where the user does not need any special training to be able to understand it and use it fully and correctly.

I have chosen to focus my essay and research on the last question, as I find it very interesting how a tool like klimagassregnskap.no can be used by an architect through the whole design process in order to make the buildings more environmentally friendly and sustainable.

Contents

Introduction

The national goal in Norway for reducing the greenhouse gas emissions is that Norway shall comply with the commitments in the Kyoto protocol, in effect that emissions in the years 2008-2012 shall not be more than 1 per cent higher than in the year 1990 (Stortingsmelding nr 26 2006-2007). Through the "environment compromise" (in Norwegian: klimaforliket) made in the Norwegian parliament 17 January 2008 including all but one of the political parties, Norway commits itself to be carbon neutral within the year 2030 (Avtale om klimameldingen, 2008).

These are very ambitious goals, and there is a need for reducing the emissions in all sectors. 34 % of the total Norwegian energy consumption is used for operating buildings, about 80 % of this energy use is electricity (Civitas, 2007). About 13,5 % of the GHG emissions, 7,22 million tons, per year in Norway come from the building industry (Civitas, 2007).

To be able to reach these goals also within the building industry, there is a need for calculating the GHG emissions from the different phases of the building life cycle, from production of the materials, to the building phase, through the operating years and to the demolition and recycling of the building. There is a need for the average architect to be able to calculate GHG emissions in an easy, simple and correct way to have a larger understanding of the different building materials and solutions and their influence on the emissions and energy use in the building. Through that there is a possibility of changing behaviour and attitude towards the importance of considering GHG emissions and energy consumption from the start of the building design process.

For the architect to be able to do so, there needs to be a good tool that at least makes you able to see which parts of the building contribute most to the emissions, so you can consider it more in your next project. It would be best if it is possible to use the tool during the design and planning phase, so that GHG emission impact from choices made on architectural concept, materials, transportation and technical solutions, would be discovered in an early phase.
Together, Civitas and Statsbygg have developed a tool for calculating the GHG emissions, called klimagassregnskap.no. It is yet the only tool available in Norwegian.
My research question is to investigate if klimagassregnskap.no is usable for the average architect, when there is a wish for reducing the GHG emissions from a design project. I will do this by importing data from an already built project, the Løvåshagen dwellings, to the version 3 of the tool. Aoife Houlihan Wiberg has earlier in 2011 done the same with the version 2 of the tool. In a comparison of the results, it would be interesting to see if the results from the calculations are the same, and if the tool is being developed to the better.

Theory

Certifications systems and calculation tools

The certification systems and calculations tools shall provide a holistic assessment of a building's or building project's sustainability (Ebert, Eßig and Hauser, 2011). There is a need for evaluating green house gas emissions in a life cycle perspective, to find out which aspects of the building is

contributing most to the emissions (Selvig and Cervenka, 2008).

The aim of the certification systems and calculation tools is to make it more visible both to the society, the investors and the clients which buildings are sustainable and which are not. This is not only in order to make more sustainable buildings, but it is also related to economy and the wish for earning money (Ebert, Eßig and Hauser, 2011), both from the companies that would like to be known for being the greenest builders, and for the owners of certification systems, who will earn more money if more companies use their tool.

The certification systems provide defined criteria that can be used as guidelines for achieving a sustainable design for the building. The different assessment methods are becoming more and more complex and are constantly changed to include more aspects of the design and building (Ebert, Eßig and Hauser, 2011). The calculation tools do not have defined criteria, but as they are becoming more and more used, the results from the calculations of different buildings can be used for benchmarking. In development of sustainable buildings, it is critical to make sure that assessment methods are not getting too complicated so that they complicate the design process and the building in such a way that they are not being used. However, there is a need for the systems to be as detailed and precise as possible to be sure that all aspects of the building are counted for and considered, so that the results for different buildings are comparable. There is a scepticism on whether such tools makes the planning and design process more focused on sustainability, or just more rational, and because of that, force prefabricated and pre-made decisions on the design (Ebert, Eßig and Hauser, 2011)
It is essential that the different systems are adaptable to different regions, so that differences in regional climate, social and economic conditions can be included in the assessment (Ebert, Eßig and Hauser, 2011). This is also important regarding the emission factors used in the calculations. Nevertheless, it is fundamental that the tools and systems are comparable from country to country and region to region, in order to make it possible to compare the different buildings assessed.

The tool Klimagassregnskap.no

Klimagassregnskap.no is a calculation tool developed by the Norwegian state building council Statsbygg, with Civitas as the head of the project. The version 3 of the tool was launched 3rd March 2011 (Klimagassregnskap.no, 2011a).

With the tool, you can calculate the green house gas emissions from buildings in a life-cycle perspective. It is a free, web-based tool in Norwegian. The tool is for architects, planners, engineers, developers and builders. There is now the possibility to both calculate a building that is not yet built in a planning level, and compare the results with a reference building, and to do a detailed calculation on a building that has been built (Klimagassregnskap.no, 2011b). On the web page it is stated that you can find out which parts of your project contributes most to the greenhouse gas emissions and that you through this can study possibilities for reducing your building's impact on the environment. The results from the calculations can also be used for documenting your building's climatic footprint (Klimagassregnskap.no, 2011b).

The tool is in use by a number of Norwegian building companies. The governmental programs Cities of the Future and FutureBuilt are both requiring greenhouse gas emissions in their project,

either done with klimagassregnskap.no or a similar tool (Statsbygg, 2011).

The Norwegian University of Science and Technology is engaged in the development of a new database for materials. It will be a more thoroughly prepared and complete database, which will reduce the uncertainty in the calculations and allow for more different materials to choose from. The first updated emission factors will be implemented early in 2012 (Klimagassregnskap, 2011c; Statsbygg, 2011).

When BREEAM-NOR is fully launched in Norway, klimagassregnskap.no will be the greenhouse gas emission part of the certification system (Statsbygg, 2011).
Klimagassregnskap.no gives you a possibility for studying the relationship between the different construction parts and the influence they have on the GHG emissions (Civitas, 2007). The version 3 of the tool should better the possibility of doing greenhouse gas emission calculations with data from different sources (Statsbygg, 2011). The introduction of an early phase module which let you calculate emissions in an early state of the design process, is an important improvement of the tool. The version 3 has also made it easier to compare the different parts of the building, to see clearly which one is the one contributing most to the emissions (Statsbygg, 2011).

The operative modules of the tool are 1) Transportation during operation, 2) Energy during operation, 3) Building phase and 4) Materials, both early phase and planned/built (Statsbygg, 2011). The different modules can be used independently from each other. You can get both written and graphical reports on the greenhouse gas emissions from the tool, both for each module separately and for the total.

In the different modules, it is possible to make multiple inputs. You can make different and alternative versions for your project in each module, so you can easily test the impact different

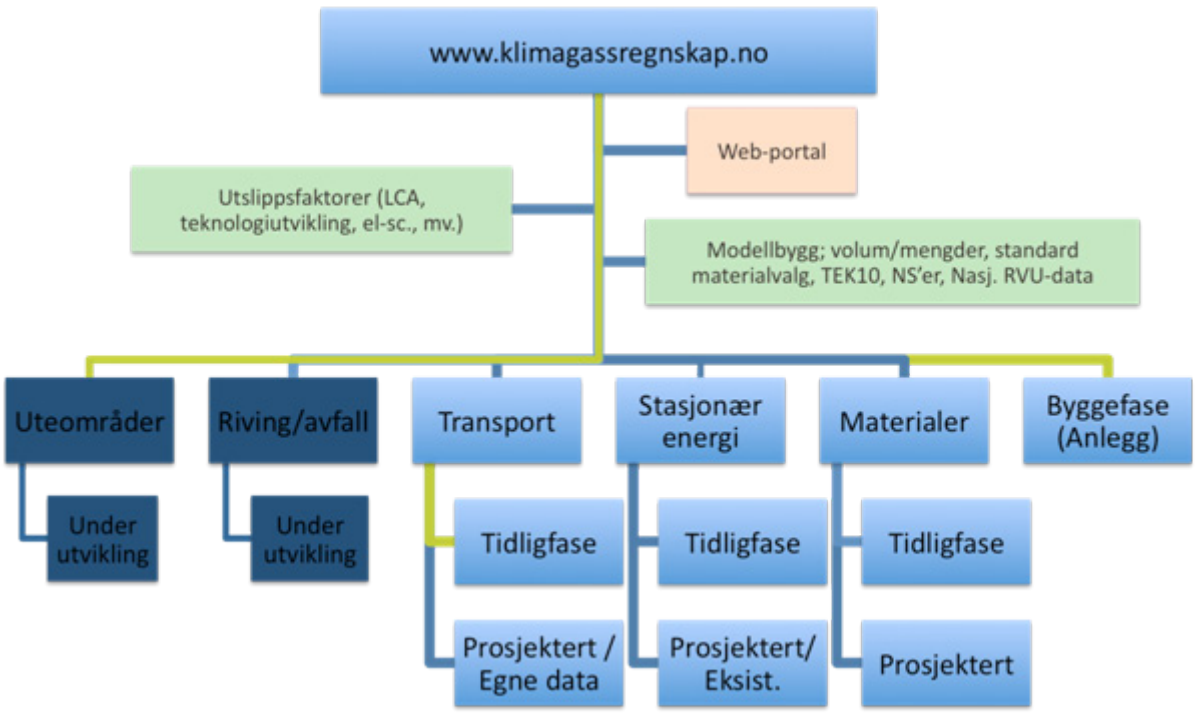

Fig 1: The structure of klimagassregnskap.no. The light blue ones are those in operation now or planned in near future.

solutions have on the emissions from the building (Statsbygg, 2011).

The materials module

In the materials module, the amount of the different basic materials are multiplied with the appropriate emission factor, and sums it up to a total emission for the current building element. The amounts for the different elements are thereafter summed up to the total emissions from the materials in the building.

There is a need for quite detailed information in the planned/built module in the materials. It is not yet possible to directly import data from BIM or from EPDs from the producers, but Statsbygg would like to develop the tool in this direction in the future (Statsbygg, 2011). The calculations you get from the tool are therefore on a more generic level (Statsbygg, 2011).

In the early phase module there is a need for data on the building's function, the heated area, geometry and the area over and under earth. The amounts of materials in the building are calculated from data from approximately 50 reference buildings (Statsbygg, 2011). In this module you can adjust the reference building so it better fits the building you are designing. The calculations will then be more relevant to compare your building with.

Method

The methodology used in this essay is review of literature about klimagassregnskap.no, and importing of data from the Bills of Quantities (BOQ) from the Løvåshagen dwelling blocks into the version 3 of klimagassregnskap.no.

The results from the inputs are compared with the ones that Houilhan Wiberg found in her performance analysis of the version 2.

Not all the data from the BOQ from Løvåshagen are imported to klimagassregnskap.no. The aim of the task has not been to get at full calculation of the buildings, but to test the usability and user friendliness of the tool. For an architect that plans and designs a building, the emissions from the materials would be the most interesting ones, as the energy use in operation and the transportation emissions in operational phase are less interesting in the planning and one does not have the information on energy use before long after the building is finished. The material module in klimagassregnskap.no is the one that requires most work and has the most challenges (Statsbygg, 2011). Therefore, I have chosen to use only the material module of the tool.

I would like to include a overview of my inputs at the end of the essay, but as there is now opportunity for exporting the table of inputs to excel or in another way, this was not possible.

Results

Klimagassregnskap.no is easy to access and it is easy to get started. It is a huge advantage that the tool is accessible for everyone and that it is web-based and not paper based, which contributes to the

sustainability thinking, and it makes it easier to use for more people. Rambøll (in Statsbygg, 2011) also lists this as one of the main advantages of the tool, although they note that this is still a whole new program that one needs to learn and know to be able to use correctly. That it is accessible on the Internet for free, does not mean that it is an easy tool (Rambøll, in Statsbygg, 2011). The need for specifications and detailed knowledge of materials, energy use and transportation in the topical project is very detailed, although the interface looks very simple.

A good thing about the tool is that it saves your inputs automatically and there is no need to check that your inputs have been saved to your project.

It is not yet developed a proper user manual for the tool. It is stated on the web page that there are some explanations under the different modules and alternatives, but the real user manual will be launched later. There is a list of persons with email addresses you can contact if you have any further questions (Klimagassregnskap.no, 2011d). There is a small user manual that describes the different modules of the tool, and helps you to get started (Klimagassregnskap.no, 2011e). It is more like an explanation of the tool structure, and no real user manual that can help you or answer your questions about the input. The tool would have been much more usable if the user manual was launched together with the tool itself, as it is crucial for the correct use of the tool. The explanations under each module are in most cases insufficient and do not explain what you should do, they only describe the module.

Problems with the input

There is a lot of possible sources of error in the input process and in the results from the calculations. Even if the material module should be organised according to building components in the Norwegian standard NS 3451, in order to make it easy to gather input data from existing building documentation, as well as making the system recognisable (Selvig and Cervenka, 2008), there are many building components that are difficult to include in the model. One example, which both could not be included in the version 3 and in the version 2 (Houlihan Wiberg, 2011) is the windows Nordan N-tech 0,7 passive which has a wooden frame with aluminium coating. There is no alternative that includes both

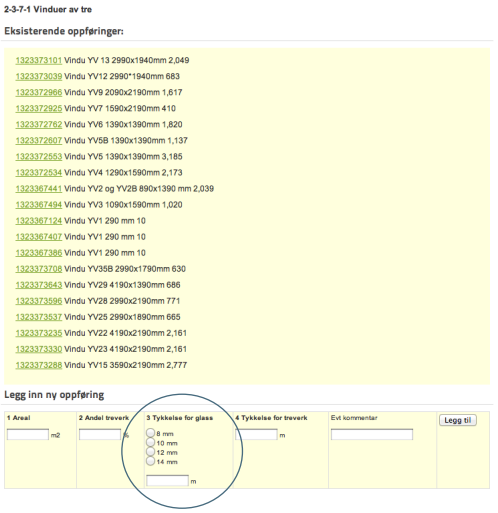

Fig 2 and 3: Input for doors and windows. For the doors, you can input the amount of doors of the specific type and dimensions. The same possibility does not exist for the windows. In my input of the windows, I have summarized the area for the specific window type with the number of windows of this type, to make the input less time consuming.
Under "tykkelse for glass" it is also not clear which thickness that should by inputted. The same counts for "tykkelse for treverk!, as a window frame is not uniformly thick the whole way around, and it does not say where the thickness should be measured.

the materials wood and aluminium, you have to choose either aluminium framed window or wood framed window. There is also no place to include the amount of insulation in the input, although that can not be the same in every window. It is also difficult to input the thickness of the glass, as it is not specified whether you should enter the total thickness of the glass layers in the window, the thickness of one of the glass layers, or even the total thickness from the end of one glass to the end of the last one.

An irritating shortage in the model is the lack of consistency in the different alternatives. For example, for the windows you can not input how many windows you have of one type, but that is possible to do for the doors. For the timber beams the tool ask for the cross section area, but as the cross section area is not included in the bill of quantities, it would be much easier to input the dimensions yourself and have the tool calculate the area. In that case, it is only a need for one blank for the length and one for the width, and not some predefined ones and the possibility of writing in the area.

Many of the problems related to the tool are not related to the results you get from the calculations, but to the tool itself and its composition and user friendliness. This makes the tool less interesting to use, because it makes you irritated on the tool in itself, and through that people can become less interested in using the tool.

The lack of consistency in where the different building parts are placed in the system could be frustrating, as for the "gipsplater i himling" which is not an alternative under "yttertak", even if it is listed in the "yttertak"-part in the BOQ. To input these, you have to go to the "dekker"-part for importing this. This means that if you would like to compare the different building parts when you are done with

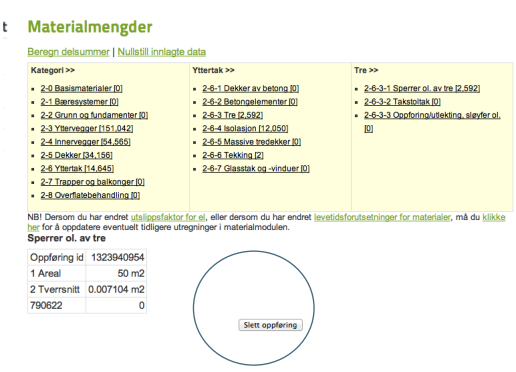

Fig 4 and 5: The figure to the right shows the entries listed under one of the categories, with your own comments as a sort of title on the entry. When you click on the green number by the entry, you get to see the numbers that were inputted. There is here only the possiblity to delete the entry and not change it. There is also no showing of calculated emissions on a specific entry. There should have been an explantion on the last blank with the number on the left and a zero on the right, which is not a part of the input.

the calculations, things that count in the different parts actually belongs to other parts of the building, and the calculations could then be misleading.

An unnecessary irritating thing about the inputs you already have done is that you have only the possibility of deleting them and not changing them. It is always good to have the possibility to change the inputs you have made, as you may have typed the wrong number, or sometimes you can get better information later in the input process and thereby have a need to correct an earlier input. If you open one of your inputs, the comment information that you have inputted to be able to identify

the different inputs is also not visible, only the reference numbers that the program makes, which is not that explanatory.

If you know from the start of a design process that using klimagassregnskap.no is required from the builder, the data from the building contractor should be adapted to the information needed when inputting data in klimagassregnskap.no. This way it will be less time consuming to import the data and there will be a standardized way of listing all the building materials. For example, if klimagassregnskap.no requires the percentiage of wood in the windows, this should be listed in the bills of quantities. Most preferably it should be listed in the specifications from the producer of the windows, and these data should automatically be imported in the klimagassregnskap.no.

To get accurate and correct calculations of the greenhouse gas emissions from a building, the tool also need to be correct and precise. A low degree of accuracy in the input possibilities in the tool leads to a low degree of accuracy in the calculation results.

Are the mistakes related to the BOQ or the tool?

The BOQ for the Løvåshagen dwelling blocks does have some mistakes, and this is also a source of error when one is using such a tool. In the BOQ the description of insulation in the outer walls does not correspond with the building that is listed in the description. For example for the 02.230.13 Insulation of mineral wool thickness 100 mm it is written that this is for the passive houses, although the numbers are put on the lines for the low energy houses. Such mistakes can also lead to unreliable and wrong calculations, especially if one does not have the drawings to compare with or the mistakes in the BOQ are not discovered by the person importing the data.

Usability

There is a strong need for integrating the tool with BIM, so that importing data can be done easier and quicker. As it is now, it takes way too much time to import all the data. Since BIM is getting more and more used, and large developers, like Statsbygg, requires it for their projects, it is important that the calculation tool keeps up with the technological development. This is all about integration between different programmes and tools, and making the paper work more efficient for the users.

The improvements in the version 3 were among others that the tool now should be easier to use when comparing for example the impacts from use of different materials. You have the possibility of making alternative calculations, so there is a possibility for looking at the differences in the emissions when you have the load bearing system in wood and when it is in concrete. This is a very useful improvement of the tool. It is important that there is a possibility for you to look at the emissions from the different alternatives you have for the materials in the building, to be able to consider them in an early phase of the design process. However, the inputting of data is still very time consuming, and I doubt that anyone would really use the tool in this way other than when they are required to do so, as you need to know so much and detailed information about the building in order to input the data and get useful results from the calculations. Information on this detailed level is often not available until the building is built. If an integration with BIM comes that makes it very easy to import the data and the data do not need to be inputted manually, there is of course much more

Fig 6: Input of balcony doors. No emissions are calculated, althought there are entries in the category. There is also no possiblity for importing data for the amount or thickness of glass in the doors.

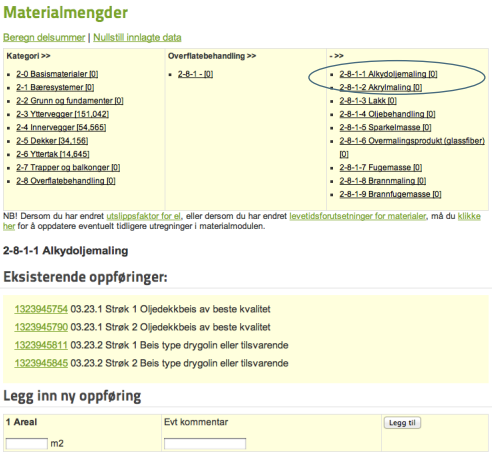

Fig 7: Input of paint. The tool does not calculate any emissions from paint. There is also no clear alternative for "oljedekkbeis".

likely that this improvement of the tool will be used.

Comparing the results with the results from a test of version 2

Houlihan Wiberg has had a lot of the same difficulties as I have had in importing the data. Both the windows, the different baseboards and other building materials that are not possible to import or where it is difficult to find an alternative that considers all the different parts of for example a window, a railing or a door. It is disappointing to see that some aspects that really influences the calculations, for example the input of material quantities, are not improved from version 2 to version 3. Hopefully there will be a full upgrade of the input categories in version 4 when the new materials database is launched.

Another example of results that are not reliable because of the lack of input possibilities applies to the balcony doors, where both in version 2 (Houlihan Wiberg, 2011) and in version 3, there is no possibility for writing the amount or thickness of glass, although that surely influences the greenhouse gas emissions from the production of the doors.

Houlihan Wiberg has also calculated emissions by hand in order to check if the results are the same as those in klimagassregnskap.no. The results were discouraging, as they were not the same as the results from the tool.

In the input of paint, it looks like the tool does not calculate any emissions at all. This is a problem both in the version 3 and in the version 2 (Houlihan Wiberg, 2011).

Houlihan Wiberg also questions the usefulness for the practitioner, as it is very time consuming to input the data, and the results are not reliable enough for use in the project.

In the summary of emissions it is not easy to discover which materials are contributing most to the emissions. It is possible to track the emissions back to the different components, but there is no summary of the different materials and how they contribute to the emissions. This was also a lack in the version 2 (Houlihan Wiberg, 2011), and it would have been great to have a breakdown of emissions in the different material components. On the bottom of each input category it is a heading named

Detaljer for: Modul 5349 - Materialbruk - Prosjektert - Uten tittel

(under utvikling...)

Gruppe	Tonn CO_2-ekv/livsløp	Tonn CO_2-ekv/år	Kg CO_2-ekv/m^2/livsløp	Kg CO_2-ekv/m^2/år
2-0 Basismaterialer	0	0	0	0
2-1 Bæresystemer	0	0	0	0
2-2 Grunn og fundamenter	0	0	0	0
2-3 Yttervegger	151.0	2.5	108.820	1.814
2-4 Innervegger	54.6	0.9	39.312	0.655
2-5 Dekker	34.2	0.6	24.608	0.410
2-6 Yttertak	14.6	0.2	10.551	0.176
2-7 Trapper og balkonger	0	0	0	0
2-8 Overflatebehandling	0	0	0	0

Andeler

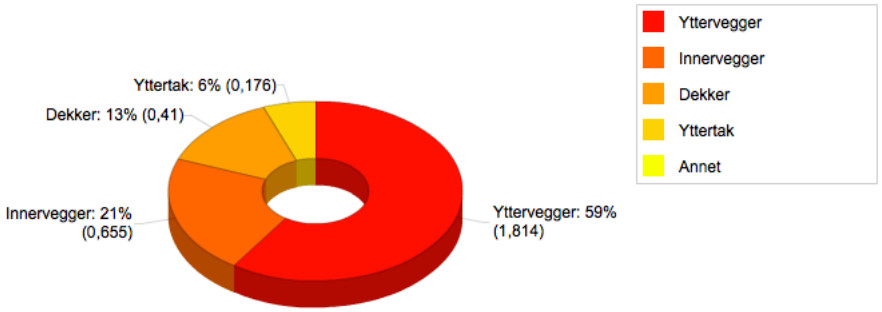

Figure 8: The emissions from the materials in the building. There is no possbility to show the emissions breaked down to materials like glass, wood, insulation, concrete etc, only for the different parts of the building, although you have to specify the material when inputting the numbers for the different building parts. It would have been interesting to see for example which building material in the 'yttervegg' (outer walls) are contributing most to the emissions. But as it say on top of the table, this part is under development, and hopefully an improvement is soon to come.
Please note that this figure does not show a complete picture of the emissions from the building, as not all materials and building components from the BOQ are included.

'regnskap' (accounts), but there are no information there. Hopefully this will be deveolped to show the emissions breaked down on materials under each category.

Conclusion

The tool is easy to access and use. The fact that it is in Norwegian and adapted to Norwegian standards of buildings, makes klimagassregnskap.no easier to use. The threshold for users is therefore low.

Weaknesses and limitations in the tool

The tool is difficult to use when there is such a need for detailed information to be able to use the tool in a proper way. Even in the early phase module, you need a lot of information. In this module there is also a lack of explanation on the different input categories and what the different numbers mean.

This makes it more difficult than necessary when you need the drawings to be able to input a lot of the data, as the parameters in the tool are different from the ones in the BOQ.

There is a need for developing an information system for the different categories and different parameters in the input categories. There should have been an information icon with every input possibility that you could click on to see where the measurements should be taken or how it is meant to measured, or which area the tool means when it asks for the area of a beam. There are no easy found explanations within the tool, which makes the sources of errors much larger than they should be.

The overall layout of the tool is also difficult to read, it is not clear which menus are relevant for which functions and there is a lot of text. On some occasions the text is in green color while the background is yellow, which does not make a good contrast and visibility for the user.

Recommendations and further work

Through the use of the tool, I have added some improvement suggestions into these main recommendations:

A good improvement of klimagassregnskap.no would be to include product data from the most used building part producers, such as the Nordan N-tech passive windows, directly into the model, so the different building parts are calculated accurately and correctly.

With an overview in a tree-diagram, it would be nice to look at and compare the different categories at the same time, instead of needing to click around in the tool and look for the alternative you are searching for under every possible category.

A possibility to move an input to another category if you have listed it wrong.

An overview on the right side of the page of the inputs you have already made, with a summary of the emissions so far, making it easy to see what you have inputted and what you have not, making it easy to go back to earlier inputs and change them or look at what you wrote.

If there are some predefined dimensions under one of the material alternatives, it should always be possible to write your own dimensions.

Usability for average architect

The developing of an early phase model is very important for the architect, as this makes it possible to calculate the emissions from a very early state in the design process. The possibility for the architect to compare his/hers design with a reference building is essential if there is a wish for taking sustainability and green house gas emissions in consideration in the whole design project. This is important if the sustainable solutions in the building should be fully integrated in the architecture, making good architecture.

The calculation model in itself is not contributing to creative and innovative architecture as the input system is not flexible enough. There is a lack of alternatives for many of the materials and components in the building, which makes you more interested in using pre-made and prefabricated building parts, and the tool will drag you in the direction of standardisation.

The lack of categories and alternatives for inputs leads to unnecessary deliberately wrong

listings that make the calculations incorrect and less reliable.

Klimagassregnskap.no will be a very useful tool for the architect, when it is more integrated with BIM and other planning software, and is included or is possible to include in certification systems like BREEAM. The development of the tool continues and improvements are being launched continuously. When the tool is made less time consuming and incorrectnesses in the software are corrected, the tool will be very useful for an architect who wants to have a control with the greenhouse gas emissions when planning and designing a sustainable and environmentally friendly building.

References

Avtale om klimameldingen, Stortinget (2008), Oslo.

Civitas, 2007. Klimagassregnskap for utbyggingsprosjekter. Utvikling av et beregningsverktøy og eksempel på et klimagassregnskap for en del av Fornebu. Et FoU-prosjekt finansiert av Statsbygg. [online] Statsbygg. Available at: <http://www.statsbygg.no/FilSystem/files/prosjekter/fouprosj/miljo/11273_KlimagassregnskapSluttrappJuni07.pdf> [Accessed 9 December 2011]

Houlihan Wiberg, A., 2011. A Performance Analysis of Klimagassregnskap, Case Study Løvåshagen. Trondheim: The Research Centre on Zero Emission Buildings.

Klimagassregnskap.no, 2011. Velkommen til klimagassregnskap.no. [online] Available at: <http://www.klimagassregnskap.no/versjon3/portal16/index.php/2-generelt/6-velkommen-til-klimagassregnskapno> [Accessed 9 December 2011]

Klimagassregnskap.no, 2011. Hva er klimagassregnskap.no?. [online] Available at: <http://www.klimagassregnskap.no/versjon3/portal16/index.php/2-generelt-generelt/8-hva-er-klimagassregnskapno> [Accessed 9 December 2011]

Klimagassregnskap.no, 2011. Forsiden, Siste nytt. [online] Available at: <http://www.klimagassregnskap.no/versjon3/portal16/#> [Accessed 10.12.11]

Klimagassregnskap.no, 2011. Brukermanual. [online] Available at: <http://www.klimagassregnskap.no/versjon3/portal16/index.php/2-generelt-generelt/16-brukermanual> [Accessed 10.12.11]

Klimagassregnskap.no, 2011. Brukerveiledning - komme i gang. [online] Available at: <http://www.klimagassregnskap.no/versjon3/portal16/index.php/kgr3/?upage=regnskap&rview=introduksjon_bruk> [Accessed 16 December 2011]

Regjeringens miljøpolitikk og rikets miljøtilstand, Stortingsmelding nr 26 (2006-2007), (c. 9), Oslo.

Selvig, E. and Cervenka, Z., 2008. Holistic Life-Cycle Emissions Associated With Buildings. In: SB08, Melbourne, Australia, 19th to 25th September 2008.

Statsbygg/Civitas, 2011. Klimagassregnskap.no Version 3. Online GHG accounting tool. Statsbygg/Civitas. December 2011.

Statsbygg, 2011. Klimagassregnskap.no/versjon 3 - en modell for livsløsberegning av klimagassutslipp fra bygg. Karbonfotavtrykks- og livssyklusvurderinger. Oslo: Statsbygg.

Illustrations

Figure 1: Klimagassregnskap.no, 2011. [online] Available at: http://www.klimagassregnskap.no/versjon3/portal16/index.php/kgr3 [Accessed: 19 December 2011]
Figure 2-7: Screenshots from klimagassregnskap.no