Can Energy Efficiency Services in buildings be seen as a Cleantechnology ?

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Abstract

The debate on energy and sustainability is of main interest. Special attention and priority is continuously given to avoid CO_2 emission in view of energy production, use and/or conversion. The heating of buildings, both public and private, is a large energy end-user.

Since the beginning of 1960 environmental technologies have been developed into clean technologies with a focus on reducing environmental impacts during the whole life cycle. Moreover nowadays industrial symbiosis is setup to exchange materials in a closed loop (C2C) in combination with energy optimization.

Energy Efficiency Services in buildings focus on a lower and flexible, energy consumption in combination with renewable sources. The connected buildings (particular and industrial) are the start of urban (energy) symbiosis in smart cities and thus can be seen as an expression of clean technology (renewable energy, closed loops and decentralized). The positive impacts will be a climate friendly energy production and consumption. Due to this way of organizing, buildings are no longer the problem, but are the solution to solve the (energy) problem.

1. Introduction

In this paper the parallelism between Energy Efficiency Services (EES) in buildings and the actual clean technology is illustrated.
First, we discuss the actual energy needs for the heating of buildings, both public and private, in combination with the present greenhouse gasses (GHG) emissions. In the past one often used trias energetica principles in order to improve the energy efficiency (and thus lower the GHG) (strictly spoken this is the use of end of pipe technology). Nowadays we see across all industries a trend moving towards services, and dematerialised consumption. In this context EES and their variants can be seen as subset of Product Services System (PSS). Indeed, these project are output driven as the services (light, heat, ….) are important and the accompagnied business models are based on the cost benefits during the Total Life Cycle.
EES applied to buildings can therefore be seen as an expression of clean technology (main characteristics are renewable energy, closed loops and decentralized). Due to this way of organizing, buildings are no longer the problem, but are the solution to solve the (energy) problem.

2. Energy

Since the industrial revolution in the 18^{th} century the energy management has moved from short CO_2 cycle towards a long cycle CO_2 cycle (as the local biomass and local sustainable energy resources were no longer sufficient and men start to use fossil fuels). The rapidly increasing use of fossil fuels has led to a concentration of more than 400 ppm for CO_2 in the atmosphere. Although the IR absorption of water vapour is more efficient, the importance as greenhouse gases depends both on their concentration and on their absorption of IR radiation. As the atmospheric life time of water vapour is very short in comparison to CO_2, the increase of carbon dioxide has contributed more than 72 % of the enhanced greenhouse effect to date [1].

In 2007, European heads of state and government stressed the need to increase energy efficiency. Recently the EU has also articulated a long term goal for 2050 and the European commission [2] has decided within the 2030 Framework for Climate and Energy to increase the goals in comparison to 2020 targets namely: -40 % GHG emissions (20%), 27 renewable energy (20 %), 27 % Energy Efficiency (20) and, 15 % interconnection (10%) [2].

Belgium (together with Germany and Sweden) have somewhat ambitious (exceeding 10 %) reducing targets in both primary and final energy. Despite reduction in both primary and final energy consumption in these three countries, further efforts will be necessary until 2020 to achieve faster reduction [3].

Energy can be divided into delivered energy, useful energy and final energy services. In view of the use of energy we distinguish at least for different types: heating of buildings, energy in industrial processes, transport, and power/light.

In this paper we will focus on the energy dealing with buildings.

3. Buildings

The heating of buildings, both public and private, is a large energy end-user in addition the share of buildings in the greenhouse emissions is significant (6, 5 % direct and 12 % indirect) worldwide [4,5].

The 2010 Energy Performance of Buildings Directive and the 2012 Energy Efficiency Directive are the EU's main legislation when it comes to reducing the energy consumption of buildings. The Energy Performance of Buildings Directive requires all new buildings to be nearly zero-energy by the end of 2020. All new public buildings must be nearly zero-energy by 2018 [2].

It is clear that the transition towards a more sustainable energy supply will affect the landscape of residential and rural areas as well as industrial sites. Because of the large scale deployment and effective integration of distributed and renewable energy sources (wind energy, photo voltaic cells (small and large); the transport via power lines, the eventually CO_2 capture and storage.

The ecological footprint is very high in Flanders mainly because of the high CO_2 emissions (inefficient private and public building and too much traffic because of the rural architecture of (small) cities [6].

In Flanders the CO_2 emissions in buildings has increased between 1990 and 2009 with 17 % [6] This is caused by increase of habitants together with the decrease of the numbers of persons in one family (from an average of 2,98 in 1970 into 2,3 in 2009). The EEA [3] stated in her recent report that Belgium is not on track in view energy consumption neither on achieving the GHG emissions targets. The target on the share of renewable in final energy consumption is achieved. In the province of Limburg (Flemish part of Flanders), the aim has been set at 2050, with a 30% reduction in greenhouse gas (GHG) emissions by 2020. It was estimated that over 20% of the yearly regional GHG emissions were related to domestic heating and cooling and another 5-7% to that of public and (semi)commercial buildings. But we notice also positive trends. A lot of habitants and companies make efforts in view of energy savings and sustainable energy, but a lot of progress is still possible.

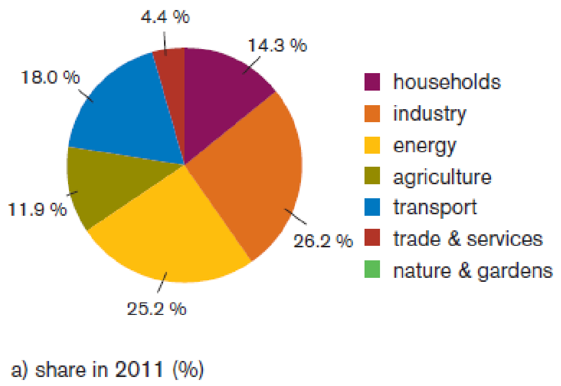

Figure 1 CO_2 emission in Flanders [6]

4. Technology

The environmental technology has already modified strongly since the first development in the early 60's of the previous century.
The first environmental technologies, designed as "end of pipe" technologies, moved towards clean technologies with a focus on reducing environmental impacts during the whole life cycle [7].

Clean technology is often defined as "Clean technologies are any product, service or process that delivers value using limited or zero non-renewable resources and/or creates significantly less waste than conventional offerings" [8].

At this moment Clean technologies are divided into six subcategories: environmentally-friendly energy and energy storage, circular economy, sustainable water management, sustainable mobility, resource and material efficiency and energy efficiency [9].

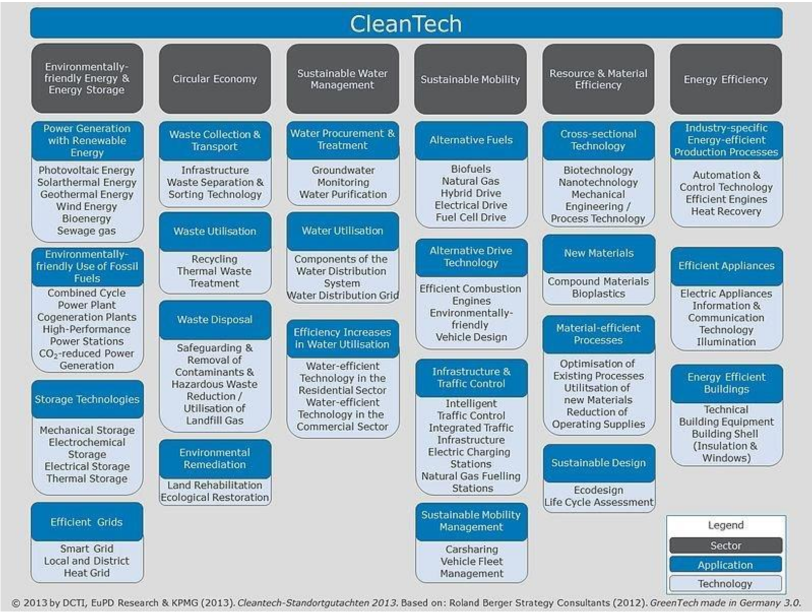

Figure 2 CleanTech categories [9]

The most recent evolution in environmental technologies is directed towards interaction between different industrial processes namely the industrial symbiosis: the waste from one industrial plant might be the input for another process [10].

Besides industrial symbiosis there is also a trend to develop urban symbiosis projects [11]. This can be a strategy to create a more efficient metabolism of the cities. In addition new urban areas will/must be created. These areas provide scope for experimentation regarding novel infrastructures as well as new products/services. Many cities have started their metamorphosis into a new city model. These cities will not only connect services, utilities and road to internet, but the smart cities will manage their energy, material flows (including waste and urban mining), logistics and traffic. One of the positive impacts will be a decentralized, climate friendly energy production and consumption.

Due to this way of organizing, buildings are no longer the problem but are the solution to solve the (energy) problem. As they fit with the main characteristics namely

- Renewable energy
- Closed loops (as much and as many as possible) products
- Decentralised

they can be seen as an application of clean technology.

Energy Efficiency for buildings and his variants (see further) can thus be seen as an implementation of the principle of Clean Technology. Special attention must be given so that all instruments and approaches applied to promote building energy efficiency should be coordinated to ensure that they are pulling in the same direction.

5. Business models.

Across all industries, there is large evidence that these new clean technologies are having a major impact on business models. In addition changes also occur at the consumption level, by moving the demand for products and services for more dematerialised consumption. Consequently there are calls for a new sustainable business models. Bocken[12] developed eight sustainable business models archetypes. One group with particular attention are known as Product Services Systems (PSS) [13]. These PSS business strive to present value propositions that simultaneously meet economic, ecological and social needs economy (see fig. 3). They have been recognized as a concept that can help from a classical linear economy (product) towards circular economy (service, function).

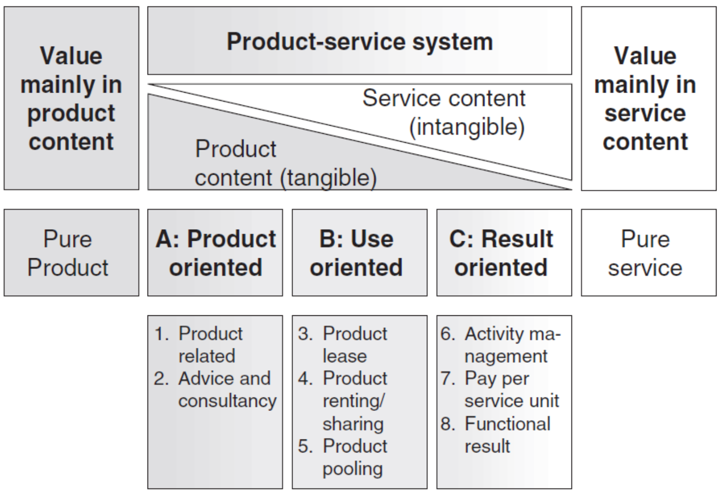

Figure 3 PSS subcategories [13]

Community is an important topic in this evolution. We need to evaluate from good projects into integrated cluster of smart activities.

The energy efficiency for buildings can be improved by replacing existing installation with actual technologies and accurate control systems. But often the use of the trias energetica [14] is not sufficient in order to get the (climate, environmental) goals.

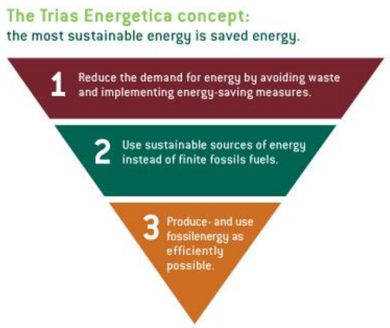

Figure 4 Trias energetica [14]

Our society is technocratic and innovation driven. The technique is often seen as the cause of the pollution. On the other hand there is also hope that the technology can be the solution for a sustainable society. So EES and his variants (solar ESC, ESC, EPC, Smart EPC, CR-EPC, ….) [15,16] (See fig. 5) can be seen as an implementation of the principles of clean technology and as a sub-set of the PSS family focussed on energy services provision [17]. In this PSS context, the service provider is often stimulated to use and maintain any related products properly, increasing both efficiency and effectiveness, which leads to several potential sustainability such as

- Lower materials and energy consumption during production and use
- Extensions of the manufacturers responsibility for the product in the use and the end-of-live phase
- Development of more durable and use-intensive products
- Easier upgrading to more eco-efficient technologies

The PSS accelerate transition towards a post fossil society.

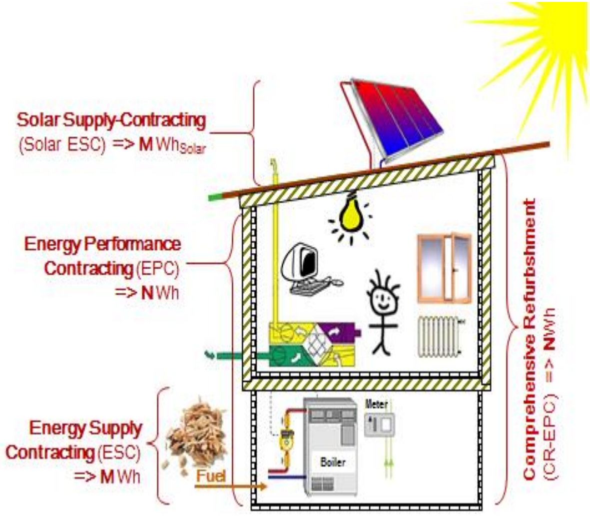

Figure 5 Different possibilities for EES [15]

6. Case

6.1. Introduction

At this moment in Flanders the hospital OPZ in Rekem has realised the first ESCO project to reduce their energy bill, maintain their technical installations, and guarantee comfort. Indeed although sustainable building has evolved to a more mainstream concept, it soon became apparent that even building professionals often lacked specific knowledge and insights. Therefor the PXL University Colleges has customized a postgraduate with the strong interaction of several dedicated stakeholders. The collaboration between early adapters and the steering committee is important and helps to develop the “ESCo” market. The PXL has recently started an EES project for its own buildings and the students of the PG EES, having a public or private professional background, taking different initiatives, several projects (private and public) are in the pipeline. The PG EES is definitely a catalyst for more EES projects in our region. The Energy Quick Scans, as a first step in our EES for PXL, is illustrated in this case.

Participation is seen as pre-requisite for achieving sustainable development. It is one of the buzzwords that has entered the sustainability discourse (SD), but lacks a more differentiated use and application.

Higher educations (HEI), seen as a key player in the promotion of SD are making advancements in SD implementation (e.g. in terms of campus greening, curriculum renewal and research orientations). Stakeholder groups of HEI can be classified by internal/external, individual/collective, academic/non-academic, but as well the government or other substantial supporters the main stakeholders [18]. The University College PXL has taken the initiative to organise a customized postgraduate. It is developed with the strong interaction of several dedicated stakeholders: BELESCO (association Belgium), Infrax (a public ESCo), Encon (a private ESCo), Dubolim (sustainable building) and the (local) government the province Limburg [19].

6.2 Curriculum Postgraduate Energy efficiency services.

Although sustainable building has evolved to a more mainstream concept, it soon became apparent that even building professionals often lacked specific knowledge and insights [19].

There are three obliged modules in this course

1) Energy efficiency services dealing with buildings (with special attention towards the iterative project cycles including the topics audits, measurements and verification and the role for facilitator). Also the link between building and mobility is a subject, as well as attention for monuments.

2) In the second module the life cycle costing is the main subject. In addition the aspects of circular economy as well as the green value/added value are explained.

3) Communication.
Special attention towards in- and external communication in combination with change management strategy.

6.3 (present) Output

The University College PXL recently decided to start a preliminary EPC study for their own existing buildings. The goals of the preliminary EPC study are

- The potential of the energy savings in the main technical domain
  - HVAC (heating, ventilation, cooling)
  - Lighting
  - Isolation of the outher shell (roof, wall, window and door).
- The determination of the perimeter of the investment. Different scenarios can be considered
- Determination of the duration of the EPC contract (including maintance as wel), in view of the financial scheme versus the total investment
- The development of a financial plan and the evaluation of the financial profitability of the EPC project

The energy quickscans performed in view of this preliminary study, will clarify the potential in the mentioned technical domains. Production, distribution, emission en regulation will be considered in view of HVAC optimization. For relighting both relamping and automation will be calculated. In case of isolation of the outer shell, there will be a focus on the several construction components. Special attention will be given for these measurements with a reasonable payback time (typical max. 15 years). The energy efficiency options will be analyzed and put into an investment matrix.

In addition participation of academic and non-academic staff is foreseen in view of present knowledge but also in order to improve the support and to communicate the non-energy benefits. This PG is also a catalyst for other (public) project in the neighborhood. The City of Hasselt Hasselt signed the covenant of majors 2020 and made the commitment to reduce the CO_2-emissions with 20 % in 2020 and to achieve the target on the share of renewables in final energy consumption (13 %). But as a consequence of this PG and the debate, sustainability is strongly incorporated in the procurement for their new city office. Geothermal heating pumps, PV installations, green roofs and low energy lighting will be incorporated. The excellent isolation and energy values meet and even surpass the nearly zero-energy criteria for buildings of The Energy Performance of Buildings Directive of the EU, even though the criteria has only to be met in 2018.

7. Conclusion

Progressing towards several climate and energy targets at the same time presents a number of co-benefits. For example, the significant deployment of renewable energy between 2005 and 2012 resulted in GHG emissions savings and to a certain extent, a reduction in primary energy consumption, through the replacement of less efficient fossil fuels plants. Additional efforts will be necessary on implementing and enforcing existing policies and in overcoming common barriers associated with EES (high investment capital costs, lack of information,…). EES can help to decarbonize the energy sector and make the energy transition successful. (trends and in the EU)
In combination with the integrated environmental assessment [20] of the use of materials in buildings (based on monetised indicators), we can counter the strong demand for energy and material resources if combined with new sustainable business models.

In addition connected houses have the potential to be vastly more energy efficient, reducing direct cost for consumers as well as mitigating economically damaging environmental degradation [21].

This specific approach of the postgraduate EES deals with a “built on” (extra sustainability courses) as well as with a built-in approach (an integration of sustainability in research and campus development).

This PG EES is a catalyst for more projects in our region: in other words, it can contribute to develop the “ESCo-market” and to overcome the several barriers. Therefore governments need to be responsive to the rapid changes and challenges. They need to adapt and continuously evolve in order to co-create public value with private and public sectors.

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