PROJECTAANVRAAG

Datum	: 14 November 2016
Project naam	: Guidebook towards nZEB Hospitals Buildings
Project nr.	:
Project aanvrager	: W.H. Maassen
Projectleider	: H. Besselink
Versie	: Concept 1.1

Project description & Motivation:

Towards nZEB Hospital Buildings
powered by TVVL/Rehva and Royal HaskoningDHV in co-operation with Eindhoven University of Technology

Introduction
EU legislation (Energy Performance Directive for Buildings) demands all EU member states to set maximum energy usage requirements for new buildings by 2020. Also hospitals have to comply. The so-called nearly Zero Energy Building (nZEB) requirements set by the Dutch Government d.d. July 2015 now imply for new buildings a significant energy reduction of building en building services related energy by 2020 compared to the current requirement. These NL nZEB requirements were set preliminary and are still under consideration.

nZEB Requirements for existing buildings will follow in 2050. Furthermore besides nZEB requirements for new buildings hospitals also have to reduce the energy consumption in the existing Buildings by 2020. The Academic Hospitals have to realize together a reduction of energy consumption of 30% in 2020 compared to the energy consumption in 2005. In 2015 they achieved a reduction of 14% and consequently they are facing the challenge of reducing a further 16% in less than 5 years. To achieve their target they have to reduce instead of 1.4% energy reduction per year in the last 10 years now > 3% energy reduction per year each year from 2015 to 2020.

For hospitals this will be a greater challenge than for example offices. This because of the special focus on the primary process, relatively low energy tariffs which negatively effect sound business cases for energy saving measures and consequently the way energy management is organized in hospitals. Although specific attention is given to energy reduction compared to other organizations the successful implementation of energy saving measures stayed behind.

Hospitals consume circa 1 % of the primary energy in the Built Environment. Studies show that only 25% - 40% of the energy use by Academic Hospitals is for appliances and medical equipment. The rest is building and building services related to realize the required indoor conditions.

To achieve the energy reduction and nZEB goals hospitals are now focusing on the 3 pillars: organization, behavior (awareness) and technology. Wherein future scenarios of required building performances, functions/usage of the buildings, technological innovations and business case parameters, e.g. energy tariffs and rates, are part of the technology pillar.

TVVL/ Rehva and RHDHV-TU/e want to:

- Give information and insight in nZEB developments that will occur in the near future and what the consequences of these developments are for Hospital Buildings and in particular for Building Services.

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- Contribute to the road to nZEB for Hospital Buildings and help our society to make the right choices.

To this end in 2016 the project nZEB Hospital Buildings has been executed. Results of the project have been presented and discussed during REHVA and TVVL workshops and led to the following conclusions and directions for future work:
''Hospitals are conservative systems with a high hierarchy in decision-making (medical staff take responsibility of crucial decisions). The suggested solutions have to be reliable and based on documented research and testing to gain users' trust. The development of guidebooks by REHVA and ASHRAE would stimulate the realisation of nZEB Hospital Buildings. Participants from Switzerland, United Kingdom, Turkey and Morocco expressed their will to join the REHVA project on nZEB Hospital Buildings.''

Scope
Hospital Buildings and HVAC systems within the scope of the EU nZEB definition.

Target Group
Hospital Building Designers, especially HVAC consultants, hospital owners, developers and users. To communicate, inspire, seduce/convince (evidence based) and enable them to search for, find, select, apply, use and maintain/optimize safe evidence based nZEB Hospital Building design solution .

Main Content
- Overview of future Hospital Building requirements
- Method how to fulfill these requirements
- Overview design solutions
- Overview future innovations
- Best practice case providing evidence of safe and effective solutions
- Indication of financial feasibility of nZEB Hospital Building solutions using LCC (EU cost optimality method) and LCPD (EU method including benefits and scenario's) calculations.

Inivited Authors
- Prof. Jarek Kurnitski Professor Tallinn University of Technology
- Frank Mills BSc(Hons) FCIBSE MIMechE MASHRAE MASHE MIE - Low Carbon Design Consultants (UK)
- Souad LALAMI Institut de Recherche en Energie Solaire et Energies Nouvelles (Morocco)
- Marco Waldhauser - CEO / Owner Waldhauser+Hermann AG
- Prof. Dr. Birol Kilkis, Fellow ASHRAE - Baskent University and Chair of Energy Engineering Graduate Program
- Wim Maassen – Royal HaskoningDHV, TU/e
- …..

Approach
This REHVA Guidebook will be realized following the steps:
1. Define outline Guidebook
2. Invite authors
3. Set structure and content
4. Define Workpackages
5. Deliver concept chapters
6. Optimize
7. Deliver final chapters

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8. Edit final version
9. Review by authors
10. Review by REHVA

Meetings will be held in combination with REHVA meetings and using skype.
The Guidebook will also be discussed with ASHRAE TC 9.6.

Time Schedule
The project will be executed in a period of 2 years.
Preferably starting January 2017 and ending February 2019.
This includes review by REHVA (max 3 months) and making some adjustments (2 months) based on possible comments for revision.

Reference group
The study will be conducted under the supervision of a reference group, the members are:

- Jarek Kurnitski Professor Tallinn University of Technology
- Hans Besselink Consultant RHDHV, TVVL –Impuls
- Rob van Bergen, Managing Director ISSO, Scientific Institute of Dutch Building Services Organizations
- Sytze de Boer, Managing Director Estee bv
- Johan de Feijter, Stichting Zorgsaam
- Roel Braeken, VieCuri
- Wobbe van den Kieboom, KWA

Results:
This results in a REHVA Guidebook Design of nZEB Hospital Buildings (ca. 50 pages)

Prioriteit: hoog~~/ midden/ laag~~

(intended) start date: January 2017

end date: February 2019

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Letter of NL Minister Blok d.d. July 2nd 2015, see http://www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/wetten-en-regels-gebouwen/energieprestatie-epc/regelgeving/beleid

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http://www.ashraeasa.org/pdf/TVVL-study--Roadmap-to-nZEB--2014.pdf

MJA-Sectorrapport 2014 Universitair Medische Centra
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http://www.rvo.nl/sites/default/files/Routekaart%20UMC%20-%2022-08-2012.pdf

EUT master thesis Ilse Schoenmakers: A systematic approach to obtain energy reduction in the complex HVAC systems of UMCs. *A case Study in isolation rooms of Erasmus MC Sophia.* January 29th 2015.

EUT master project report Riccardo Caparucci Roadmap to Nearly Zero Energy Hospitals. Case Study : Policlinic – VU Medical Center Amsterdam, May 5th 2015

EUT master thesis Dave Baas, Design method to narrow the Energy Performance Gap of energy saving measures for hospitals, in progress (Apr 2016)

EUT master report Pamela Greveling, Feasibility of nZEB Hospital requirements, in progress (Feb 2016)

EUT master report Mike van Osta, Transformation of multi- to one-patient rooms, in progress (Jan 2017)

There is a Dutch plan on nZEB already, are there any alternatives possible?
http://www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2012/10/23/aanbiedingsbrief-bij-nationaal-plan-bijna-energieneutrale-gebouwen.html

Smart grids for smart buildings
http://www.rehva.eu/?download=_/629/smart-buildings-for-smart-grids-en.pdf

Sustainable energy storage
http://www.rehva.eu/?download=_/631/the-storage-of-sustainable-energy-in-the-built-environment-exploratory-research-on-increasing-sustainability-using-smart-grids.pdf

nZEB rehva definition
http://www.rehva.eu/?download=_/bruconf18102012/kurnitski_rehva-seminar_bru.18.10.2012.pdf

rehva seminar zero energy buildings

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http://www.rehva.eu/en/rehva-seminar-towards-net-zero-energy-buildings-and-building-labelling

EU FP7 research program STREAMER (2013-2017): http://www.streamer-project.eu/

ASHRAE TC 9.6 Healthcare Facilities**:** http://tc96.ashraetcs.org/

CEN TC 156 WG 18 Hospital Ventilation

STW Perspective research project: Smart Energy Systems in the Built Environment (SES-BE);
Smart Energy Management and Services in Buildings and Grids, see

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Appendix – Building and HVAC system performance in practice, REHVA Workshops at CLIMA 2016, Aalborg, Denmark, 22-25 May 2016

WS 3: Realizing (nearly) Zero Energy Hospital Buildings together

Royal HaskoningDHV Enhancing Society Together | TU/e Technische Universiteit Eindhoven University of Technology | TVVL

Workshop organizers

TVVL/REHVA and Royal HaskoningDHV, www.royalhaskoningdhv.com

Presenters

W.H. Maassen, Leading Professional - Royal HaskoningDHV, TU/e Fellow - Eindhoven University of Technology
H. Besselink, Senior Consultant - Royal HaskoningDHV, REHVA Fellow, TVVL-Delegate
T.J. Baas, Graduate Master Student Building Services - Eindhoven University of Technology

Introduction and Background

In the Energy Performance of Buildings Directive (EPBD), the EU requires all new buildings to be nearly Zero Energy Building (nZEB) by 31 December 2020 (2018 in case of public buildings) which also applies to hospitals. Within hospitals, it is essential to guarantee appropriate and sometimes live saving functionality while saving energy. Therefore, achieving these requirements in hospitals is even a greater challenge than, for example in office buildings. Worldwide, about 6% of the total energy consumption in the buildings sector is represented by energy usage in medical centres. In the Netherlands, the healthcare sector consumes approximately 1.6% of the energy consumption, of which 64% is consumed by academic medical centres (AMCs). The approaching EPBD requirements and the expected increase of energy costs have driven AMCs to review their energy policies. In light of these concerns, a multi-year energy-efficiency covenant 2005–2020 (MJA3), organized by the Dutch Enterprise Agency (RVO), was signed by each Dutch AMC. The most relevant commitment of MJA3 for each hospital is achieving 2% additional energy efficiency every year, resulting in a minimum of 30% energy savings in 2020 compared to the total energy consumption of the AMCs in 2005.

Summary of the Presentations

The workshop started with presentations with targets that covered the following four key issues:

1. How can hospital buildings achieve nZEB?
2. What are the most promising technical solutions?
3. What is necessary to implement these solutions in practice?
4. How can REHVA stimulate the above?

The target buildings were both new (thus involving optimization in the design phase) and existing hospitals (where energy saving potential and measures could be identified). After a short summary of some projects undertaken by Royal HaskoningDHV (e.g. project management, design and energy master planning of hospitals), the presenters illustrated, in detail, the definitions and approaches used for nZEB hospitals and considered how they differed from the Energy Performance Coefficient (EPC) currently established by the Dutch government (that will be amended prior to 2020).

Statistical data from hospitals in the Netherlands was also presented and reference energy targets and benchmarks were highlighted to the audience to provide examples of technically feasible nZEB solutions for hospital buildings. Energy demand of hospital buildings related to use (and also to number of rooms) was analysed, and the need to maintain a high quality indoor environment was emphasized. The presenters provided a detailed explanation of the methodology used in the projects that covers five steps: addressing user demand and behaviour; reducing energy demand of the building; applying sustainable energy sources; adopting energy exchange and storage systems and using fossil energy efficiently. The presenters proposed typical measures for this five tier approach and explained two innovative systems under development, "Human in the Loop" and Self-Regulating (SR) ventilation systems for hospitals. The presentation session ended with a description of a case study of the VU University Medical Centre in Amsterdam.

Discussion and main results

The participants worked together in groups to consider the case study. With the feedback from the groups four key questions were answered as follows.

1. How can hospital buildings achieve nZEB? It is a difficult task because of all the specific health and safety requirements. However great improvements in energy consumption can be achieved. The proposed methods form this workshop were considered as being very useful in creating nZEB conceptual design variants for hospital buildings.

2. What are the most promising technical solutions? The five-step nZEB approach used in the projects was discussed and the attendees provided additional inputs to the proposed measures:

- User demand and behaviour.
  Lower internal heat loads (more use of standby mode), smart zoning of the building, smart positioning of building functions, smart and individual control systems (human in the loop, SR ventilation), low flow fume hoods, low energy consumption Magnetic Resonance Imaging (MRI) systems, education of users and combining process, equipment and test set-ups;

- Reduce energy demand.
  Insulation, envelope airtightness, heat recovery systems for ventilation and hot water services, use of daylight, thermal mass, integrating design with occupant functions to make the application of technologies possible (e.g. natural or hybrid ventilation of wards), better

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air handling units, larger ducts to lower pressure resistance and consequently reduce the energy consumption for ventilation, variable air volume systems (air flow management), LED lighting, reduced heating and cooling (application of different standards), energy efficient appliances, passive solutions for dehumidification (e.g. clay-based products for dehumidification in ceilings), building management systems (to guarantee and evidence system performances), reduction of tap water outlets with a hot water supply;

- Apply sustainable and renewable energy sources
  For example, photovoltaic solar cells, biomass, wind energy, adiabatic coolers;

- Energy exchange and storage.
  Long Term Energy Storage (LTES) (e.g. aquifer storage or ground storage), Short-Term Energy Storage (e.g. thermal buffers or Phase Change Materials);
  Thermo-active building systems (e.g. concrete core activation), Exchange energy between internal and external functions;

- Efficient use of fossil energy.
  High efficiency boilers, chillers, heat pumps and combined heat and power.

Step		Measures
1.	User Demand & Behaviour	Lower internal heat loads (more use of standby mode), smart zoning of the building, smart positioning of building functions, smart and individual control systems (human in the loop, SR ventilation), low flow fume hoods, low energy consuming MRI, combining processes/equipment/test set ups, education of users
2.	Reduce Energy Demand	Insulation, envelope airtightness, heat recovery ventilation/hot water services, use daylight, thermal mass, positioning of functions and integral design to make application of technologies possible, e.g. natural/hybrid ventilation of wards, better air handling units, larger ducts to reduce ventilation energy, variable air flow systems (airflow management), LED lighting, Less heating and cooling (change standards), energy efficient appliances, less or no humidification (clay products for dehumidification in ceilings), use BMS and monitoring to reduce energy consumption and to show and guarantee that systems perform as they should, less tap water stations with hot water supply.
3.	Apply Sustainable Energy Sources	Photovoltaic solar cells, biomass, wind energy, adiabatic cooling.
4.	Energy Exchange & Storage	Long term energy storage in the soil/aquifer (LTES), short term energy storage (buffers, Phase Change Materials), Concrete core activation (TABS), Exchange energy between internal/external functions.
5.	Efficient use of fossil energy	High efficiency boilers, chillers, heat pumps, combined heat and power.

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3. What is necessary to implement these solutions in practice? While the reliability of energy supply should be guaranteed in hospitals, it should not be designed and operated as a stand-alone system. Energy and CO_2 emission reduction should be realized on a local (or district) scale with a holistic approach using energy exchange and energy storage. Research shows that health risks (risks to patient safety) will not increase when implementing energy-efficient solutions. Different standard-based design solutions may provide the required level of safety and comfort, and it is important to gather and produce evidence from best practices. Knowledge sharing and user engagement (e.g. meeting with stakeholders) may also make the difference since medical staff are used to reading and relying on research studies and evidence.

4. How can REHVA stimulate the above? Speakers suggested that REHVA could assist in the following activities:

- Organizing communication activities targeting hospital users (e.g. brochures, presentations, workshops and guidebooks);
- Organizing and attending meetings with stakeholders in medical centres in diffrent countries (e.g. a first meeting in London was suggested), including ASHRAE Technical Committee 9.6 on healthcare facilities;
- Gathering and producing evidence of best practice (e.g. research studies, project case studies and guidebooks);
- Developing a dedicated REHVA Guidebook (together with ASHRAE).

Conclusion and future work directions in the field

Hospitals are conservative systems with hierarchical decision-making (with medical staff having ultimate responsibility). The suggested solutions have to be reliable and based on documented research and testing to gain users' trust. The development of guidebooks by REHVA and ASHRAE would stimulate the realization of nZEB hospitals. Participants from Switzerland, UK and Morocco expressed their will to join the REHVA project on nZEB hospital buildings.

Acknowledgement

This workshop is part of the project "nZEB Hospital Buildings" that Royal HaskoningDHV is executing in cooperation with the Eindhoven University of Technology. This project is supported by TVVL and REHVA.

References

Workshop presentations are available at
http://www.rehva.eu/events/clima2016/clima-2016-workshops.html

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