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IEA ECBCS ANNEX 49

LOW EXERGY SYSTEMS FOR HIGH PERFORMANCE BUILDINGS AND COMMUNITIES

Jahresbericht 2009

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ZUSAMMENFASSUNG

This is the final year of the IEA ECBCS Annex 49 collaboration. The Swiss deliverables are all complete pending any requested revisions for the final acceptance into the Annex 49 Guidebook. The guidebook will be the final deliverable of the Annex. There will also be a final conference organized by the Annex. It will take place in Fall 2010.

This year consisted of the last two working phase meetings of the Annex. One meeting had an concurrent conference in which several Swiss projects were presented. The status of the wastewater heat recovery, the retrofit cooling decision tree, and the SEPE analysis tool were all presented at the first working phase meeting, and they were incorporated into the guidebook at the second and final meeting. Along with these promised deliverables from the Swiss participation, several other exergy-related projects from Switzerland have been incorporated into the final dissemination.

As a part of the Annex much international collaboration has continued in the sharing of research and technological advances being made in the various member countries. Along with the mentioned conference, Forrest Meggers gave a series of guest lectures in Chile on exergy and buildings, and he also presented a paper on low exergy technologies at the International Advanced Technology Conference in Malaysia. In Switzerland, Forrest Meggers also presented two papers at the CISBAT conference in Lausanne: one on a new low exergy wall system, and the other covering the expanded analysis of the wastewater heat recovery. Also in Switzerland, the collaboration with Geberit was cancelled due to limited internal financial resources at the company, which was unfortunate due to the accepted KTI grant that was cancelled along with it. But a new collaboration is being initiated between two groups at the ETH and the HSLU in Luzern to develop a new low-temperature-lift heat pump.

The Annex 49 will be finished in 2010 and the Guidebook will be compiled. A final conference focused on exergy analysis and building and community systems will be held at the end of 2010 in Munich. Presentations of project results have already been accepted for 2010 at conferences in Stuttgart, Turkey, and at a variety of conferences and meetings in Switzerland.

Projektziele

This project explores the potential of exergy analysis as applied to buildings. This is being carried out as part of the international collaboration of the IEA ECBCS Annex 49 “Low Exergy Systems for High Performance Buildings and Communities.” The use of exergy analysis for building design allows for a further optimization of the systems in the building that minimizes the total energy demand. It is especially beneficial in the reduction of fossil fuel primary energy demand, and the resulting greenhouse gas emissions. In some cases the potential reductions would be overlooked without exergy analysis. The research in this project leads to new innovations, technical solutions and analysis tools, which will lead to more sustainable building design and construction.

The Swiss participation includes the study of heat recovery from wastewater streams using exergy analysis, retrofit cooling decisions based on exergetic performance, and the extension of exergy analysis into a system-based Excel tool. Using the concept of exergy, these studies will provide both new systems for achieving better building performance as well as tools to encourage further high performance design.

The goals of the wastewater heat recovery have been to determine the potential of such a system using exergy analysis. Models have been created, and results have been presented at a variety of meetings and conferences. The final results will be presented in a full academic paper, and in the Annex 49 Guidebook. The retrofit cooling decision tree has been completed and will serve as an excellent guide for low exergy design. Finally the exergy tool, SEPE, is nearly complete and will provide an excellent system analysis tool. The proposed deliverables of the Swiss participation have nearly met all their goals, and along with these, there have been a few further developments that have resulted, such as the extension of the exergy analysis in to a better architecture-based tool, and the further motivation in the creation of higher performance, low-temperature lift heat pumps combined with decentralized pumping systems. These developments have built upon the goals being met by the original participation and will further increase the impact of the project.

Durchgeführte Arbeiten und erreichte Ergebnisse

This year is the last full year of the Annex 49. The deliverables for the international collaboration have been brought to conclusion, with a few small updates remaining. The production of the final Annex 49 Guidebook is underway, and a final conference is now being planned for the fall of 2010. During 2009 there were the final two working phase meetings, one in April in the Netherlands and one in September in Finland.

The 5th working phase meeting was in April in Maastricht in conjunction with the one-day conference in nearby Heerlen, organized by the Annex 49 group. The conference was titled, “The Future For Sustainable Built Environments – Integrating the Low Exergy Approach.” Forrest Meggers attended along with three colleagues from the ETH. There were six posters on Exergy from this group, including one on the wastewater heat recovery exergy analysis [1]. Two others by Meggers showed first the newest developments in the energy and exergy analysis 3D software extension: the Design Performance Viewer [2], and second a new proposed low exergy active insulation system [3]. The other three were explaining the potential of decentralized pumps [4], two community scale Swiss low exergy projects [5], and finally the potential influence of low exergy design on architecture [6]. At the working phase meeting of the Annex 49 in Maastricht Forrest Meggers also gave a presentation providing updates on the status of the wastewater heat recovery analyses, as well as an overview of the other new developments from the ETH that were displayed on the posters from the conference described above. Also at the meeting in Maastricht, Petra Benz-Karlström gave two presenations: one on energy efficient cooling for building retrofit, and one on cooling system performance analysis using the SEPE software tool.

The 6th working phase meeting took place outside of Helsinki, Finland. This was the final planned working phase meeting of the Annex 49. Therefore the focus here was the dissemination of the final deliverables, and primarily the organization of all the deliverables into the Annex 49 Guidebook. Forrest Meggers was put in charge of gathering and compiling all the inputs on the various Exergy software tools into one chapter for the guidebook. He would also provide input into the technologies chapter on the wastewater heat recovery analysis and the new wall insulation system. Also the case studies presented at the conference in Heerlen on community scale exergy projects in Switzerland will be included in the guidebook. These are the potential use of tunnel-water from the Furka tunnel for a resort in Andermatt, and the exploitation of lake water as a heat source or heat sink by sending it into the river further downstream where the temperature difference between the river and the lake can be

captured from the stream, avoiding any harmful impact on the temperature of either lake or river. The guidebook will also include a section describing the SEPE tool, one of the promised contributions of the Swiss participation. This is also true for the retrofit cooling decision tree, which will also be displayed in its own section in the guidebook. After the guidebook had been organized at the meeting, there was some discussion on the final conference and the potential expansion of the present work in another IEA ECBCS Annex.

There were several publications relating to the work being done in Switzerand. The final published version of the Annex 49 Midterm Report was completed and is available on the web [7]. The final three Annex newsletters were published. Two of these newsletters contained articles by Forrest Meggers explaining work being done in Switzerland on low exergy systems: one on wastewater heat recovery [8] and one on the Design Performance Viewer Software [9].

As mentioned, the wastewater heat recovery system analysis has been continued through 2009, with some further developments. This includes the extended analysis for a range of different sized buildings. This provides a better basis for the potential extension of the system concept into the market, where it would have to be applicable to a variety of building sizes. The exergy analysis for the different sizes of buildings gives again optimal operating points for the heat recovery tank as shown in Figure 1. These new results were presented at the Swiss CISBAT conference in Lausanne in September [10].

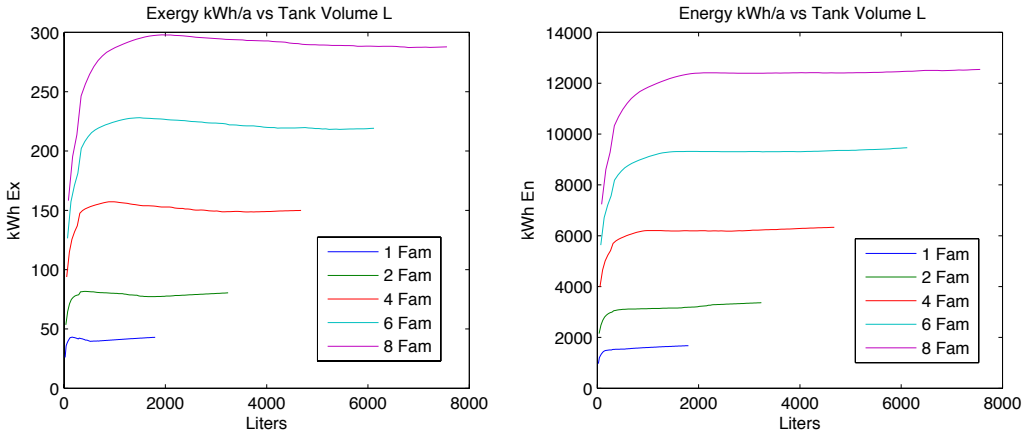

FIGURE 1: EXERGY ANALYSIS (LEFT) OF TANK SIZE SHOWING THE MAXIMUM RECOVERY VALUE FOR A YEAR OF HOT WATER USAGE, A MAXIMUM WHICH IS NOT PROVIDED BY THE ENERGY ANALYSIS ALONE (RIGHT) [10]

The final work on the wastewater heat recovery system will include a better integration with low-temperature-lift heat pumps in the model. This will allow for better analysis of other indirect performance enhancements. A final paper on the overall system potential considering various building sizes and the potential exergy minimization via new heat pump integration will be produced at the beginning of 2010.

Along with the thermodynamic research, there has been much progress made in the development of tools for the application of exergy analysis in building systems. A new version of the Design Performance Viewer software from the ETH has a new and more streamlined version of the software that allows architects to have a quick and easy display of the energy and exergy performance. Here the improvements to the exergy analysis are a direct result of the work being done for the Annex 49. The SEPE tool being developed with help from Petra Benz-Karlström is also nearly complete, and it will allow better connection of individual building systems for comparative exergy analysis at the component level. Finally Petra Benz-Karlström has also completed the decision tree tool to help in the selection of low exergy retrofit systems for cooling. This excellent graphical aid guides a user that may be unfamiliar with the benefits of low exergy systems to select the most high performance system for a retrofit.

Nationale Zusammenarbeit

Forrest Meggers of the ETH and Petra Benz-Karlström of Basler and Hofmann compiled the deliverables offered by the Swiss participation in the Annex 49. This involves the collaboration with various

colleagues and co-workers along with each other to test and review the completion of these aspects. There was also discussion of the work being done with colleagues at the CISBAT conference as well as at the AGS meeting in Zurich during 2009.

One of the main national collaboration was the organization of a KTI project with Geberit International AG for the development of a wastewater heat recovery system. This would build on the theoretical results of the Annex 49 to develop a prototype and eventually a product for the market. The KTI project was accepted at the end of 2008. Unfortunately due to economic strains within Geberit causing limited internal resources for development, they had to cancel their participation. This was unfortunate due to the year of work that had been invested in setting up the project in order to have it accepted by KTI. Nevertheless, the interest in such a system remains. Perhaps it will be brought to market when more financial resources become available to fully develop it.

Another new development in 2009 was the initiation of a potential collaboration to develop a new type of low-temperature-lift heat pump. This would be done between the Building Systems Group at the ETH, The Power Electronics Systems Laboratory at the ETH, and the Thermal Energy and Process Engineering Group at the HSLU (HTA) in Luzern. This would provide the important step needed in heat pump technology to realize the full potential of the high temperature source of warm wastewater heat recovery.

Internationale Zusammenarbeit

The principal international collaboration was a part of the working meetings and the conference in for the Annex 49 that have been previously described. At the conference in Heerlen there was also paricipation by the IEA ECBCS Annex 51 on District Heating. This was important as some of the new concepts that were presented from Switzerland were related to district heating.

There was also a further development that resulted from the PLEA conference in 2008 in Dublin Ireland where Forrest Meggers presented research on wastewater heat recovery. A house that is being showcased on an Irish national television program as an example of a new high performance design incorporated a prototype wastewater heat recovery system into its design. The design was based on the presentation by Meggers in Dublin, as well as a few followup emails describing the potential setup over the past year. It was completed this year and is now in operation pending some optimization.

Along with the Annex-related international events during 2009, Forrest Meggers also was an invited lecturer for a series of presentations to university students in Santiago and in Valparaiso Chile on the potential of new building technology in September [11]. He also presented a paper covering low exergy technology at the International Advanced Technology Conference in Kuala Lumpur, Malaysia in November [12]. At both of these events, not only were the main projects described, but interesting contacts were made and the potential impact of these systems was expanded.

Bewertung 2009 und Ausblick 2010

Much progress was made toward the completion of the deliverables promised in the Swiss participation in the IEA ECBCS Annex 49. The contributions to the final Guidebook are complete pending some internal review. There was also additional contributions and extensions of the work that arose from collaboration with colleagues within Switzerland.

The major misfortune was the failure of the KTI project with Geberit after it had been accepted. Nevertheless the research will be presented and disseminated through academic work, and in the end a prototype based on the theoretical research has actually been built and installed in a house in Ireland. Both the SEPE tool and the Decision Tree for retrofit cooling are completed pending some final review and translation.

The project will officially end in February 2010. By then the final drafts for the Guidebook will be complete and a draft of the final paper on wastewater heat recovery will be submitted. There will be a conference put together by the Annex 49 group in the fall of 2010 where the research will again be presented. Also the REHVA Clima 2010 conference will have a special Low Exergy section where topics from Annex 49 will be presented. There will also be a presentation of the final results from the Swiss project at the Status Seminar in 2010 as well as a presentation by Petra Benz-Karlström on the LowEx tools at the conference in Stuttgart. The 2010 dissemination events are summarized in Table 1.

TABLE 1: 2010 PROJECT DISSEMINATION EVENTS

Date	Event	Participant
Spring 2010	Presentation of Annex 49 Guidebook at ETH	Forrest Meggers and Petra Benz-Karlström
2-3 Sept, 2010	16. Schweizerisches Status-Seminar, Zürich	Forrest Meggers
12 May, 2010	Clima 2010, REHVA Conference, Turkey	Forrest Meggers
Fall 2010	Annex 49 Final Conference, Munich	Forrest Meggers and Petra Karlström
Fall 2010	ETH Zurich Exergy Forum	Forrest Meggers
Fall 2010	Conference, Stuttgart	Petra Benz-Karlström
April 2010	Holcim Forum, Mexico	Forrest Meggers

Referenzen

[1] Meggers, F. The Value of Waste: Exergetic Optimization of Heat Recovery from Wastewater. Poster Presenationa at The Future for Sustainable Built Environments: Integrating the LowEx Approach. Heerlen, The Netherlands, April 21st 2009.

[2] Meggers F. and Schlueter A. Design Performance Viewer (DPV): A BIM Application Including Exergy Analysis. Poster Presenationa at The Future for Sustainable Built Environments: Integrating the LowEx Approach. Heerlen, The Netherlands, April 21st 2009.

[3] Meggers F. Low Exergy Active Insulation Heat Barrier. Poster Presenationa at The Future for Sustainable Built Environments: Integrating the LowEx Approach. Heerlen, The Netherlands, April 21st 2009.

[4] Mast, M. Local Distributed Heat Pumping Minimizing ΔT - Maximizing Exergy. Poster Presenationa at The Future for Sustainable Built Environments: Integrating the LowEx Approach. Heerlen, The Netherlands, April 21st 2009.

[5] Bruelisauer, M. Transport of Anergy Playground for Small ΔT's Mining Exergy. Poster Presenationa at The Future for Sustainable Built Environments: Integrating the LowEx Approach. Heerlen, The Netherlands, April 21st 2009.

[6] Ritter, V. Decentralized Systems Integrated Into Facades of LowEx Architecture. Poster Presenationa at The Future for Sustainable Built Environments: Integrating the LowEx Approach. Heerlen, The Netherlands, April 21st 2009.

[7] IEA ECBCS Annex 49. Midterm Report: A framework for exergy anaysis at the building and community level. Nov. 2009.

[8] IEA ECBCS Annex49. Newsletter No. 4. Sept. 2008. http://www.annex49.com/materials.html

[9] IEA ECBCS Annex49. Newsletter No. 5. Mar. 2009. http://www.annex49.com/materials.html

[10] Meggers, F. Exergy and Building Systems: The Full Potential of Heat Recovery. Proceedings of CISBAT. Lausanne, Switzerland. Sept, 2009.

[11] Meggers, F. Buildings: The Silver Bullet without a Gun. Presentation at GreenLife Conference Santiago, Chile. Sept 2009

[12] Meggers, F. New Building Technology Based on Low Exergy Design. Proceedings of International Advanced Technology Conference, Kuala Lumpur, Malaysia. Nov. 2009.

Anhang

The Newsletters and Midterm Report can be found online at http://www.annex49.com/materials.html

Any other papers, proceedings, or agendas can be provided on request.