EXERGY RATIONALE IN NET-ZERO ENERGY BUILDINGS (NZEB)

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Biography

Dr. Kilkis received his Ph.D. degree in Mechanical Engineering with high honors from Middle East Technical University. He graduated in 1972 with an honors degree from von Karman Institute for Fluid Dynamics in Belgium- a NATO Research Center. Dr. Kilkis has been working on heat transfer, unified heat transfer theory, high-performance buildings, quantum mechanics, fluid dynamics, heat pumps, energy strategies, aerodynamics, exergy analysis, combined heat and power, tri-generation, ORC, integrated solar PV systems, simulation, and computer aided design of green buildings. He has been very active in wind and solar energy, heat pumps, small hydro-turbines, green energy, sustainable buildings, innovative HVAC systems, geothermal energy, environmental issues, low-exergy and waste heat utilization, district energy systems, energy strategies, innovation in sustainable systems of the future, and green habitat optimization. He is a founder member of the Turkish Wind Energy Association, Turkish Solar Energy Association, and the past Country Coordinator of Wind Energy for CENTO. He has developed seven standards on Heat Pumps, three standards on Radiant Panel Heating and Cooling, and authored the revised Chapter 6 in ASHRAE Handbook on Radiant Panel Heating and Cooling and four other chapters at a capacity of principal reviewer. He is the co-author of a most recent book on Cogeneration with renewables. He taught graduate and undergraduate courses at several universities like Gannon University (full time), University of Missouri Rolla (adjunct) and Middle East Technical University (full time) since 1972. Currently, he is the head of Energy Engineering Graduate Program and a full-time professor at Baskent University. In total, he has published more than 400 papers in several journals and proceedings on a large variety of topics, and has several patents pending on green buildings, solar trigeneration, heat pump coupled cogeneration, and low-exergy HVAC systems. He had also contributed articles to IEA Heat Pump Letter, observer to IEA Heat Pump Center. Currently, Dr. Kilkis is the member of ASHRAE Building Performance Metrics Steering Committee and has been elevated to Fellow Grade in 2003 due to his outstanding services and has been named distinguished lecturer. Recently, he has established a co-operation with TU Delft University in the Netherlands on Green Initiative Sustainable Campus Project and has authored the Ten-Year Green Campus Project and the Roadmap for Baskent University in

collaboration with OSTİM and TU Delft (2012). Dr. Kilkis has been appointed to the Executive Committee membership of the European Union Solar Thermal Platform is 2015.

Summary:

NZEXB or NZEB?

"We are paying for energy but using exergy"
Peter Novak, ASHRAE, TC 7.4, 1996

This panel topic will introduce the exergy dimension to zero-energy building concept and will discuss its importance. Several European countries are in the process of developing and implementing their road maps for near-zero energy buildings (nZEB) according to the relevant EU Directive for High Performing Buildings. There are several definitions like the ones mentioned in the previous section, for nZEB concept and all models, definitions, and implementations are based on the First Law of thermo dynamics, which only deal with the quality of the energy exchange between the building, grid, and the district [3]. Current practice is primarily focused on electric power exchange. Currently, Denmark is the only EU country that factors-in the thermal energy exchange. Thermal energy at different states and temperatures mean a wide variation of the thermal energy quality (exergy). A building may be receiving a certain amount of thermal energy but may be feeding back the same amount of thermal energy at a lower temperature (thus lower exergy). In this case although the first law balance is satisfied, the second-law balance has a deficit. Therefore, the second law of thermodynamics becomes the only viable tool to define an nZEB building, which is exchanging both thermal energy and electric power. This is the most important flaw of the current nZEB definitions, rules, practices, and definitions. With further development and the sector penetration of the district energy systems (steam, hot water, service water, cold water, and fresh water) the need for factoring in the thermal exchange into the definitions of nZEB is becoming a dominant factor.

NZEXB Net-zero Exergy Building. It is a building, which is connected to a district energy system and on an annual basis provides the same total exergy of heat and power to the district as the total exergy of heat and power received from the district. Exergy of power and different thermal energies like heat or cold or at different temperatures are calculated separately on the ideal Carnot Cycle and then summed.

nZEXB Near- zero Exergy Building. It is a building, which is connected to a district energy system and on an annual basis provides at least 80 % of the total exergy of heat and power to the district as the total exergy of heat and power received from the district. Exergy of power and different thermal energies like heat or cold or at different temperatures are calculated separately on the ideal Carnot Cycle and then summed.

LoWEXB Low-Exergy Building is a building, which can satisfy its thermal loads with low exergy sources at about 40^{o}C.