SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

International Energy Agency
Energy Conservation in Buildings and Community Systems Programme

SHC Task 40 ECBCS Annex 52

IEA Joint Project: Towards Net Zero Energy Solar Buildings (NZEBs)

Task/Annex Text

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Developed by: Karsten Voss, Mark Riley
Contributors: Andreas Athienitis, Chiel Boonstra, Dru Crawley, Michael Donn, François Garde, Paul Torcellini, Maria Wall

IEA SHC TASK 40 – IEA ECBCS ANNEX 52

TOWARDS NET ZERO ENERGY SOLAR BUILDINGS (NZEBs)

1. Preamble

Energy use in buildings worldwide accounts for over 40% of primary energy use and 24% of greenhouse gas emissions[1]. Energy use and emissions include both direct, on-site use of fossil fuels as well as indirect use from electricity[2], district heating/cooling systems and embodied energy in construction materials.

Given the global challenges related to climate change and resource shortages, much more is required than incremental increases in energy efficiency. Currently, a prominent vision proposes so called "net zero energy", "net zero carbon" or "EQuilibrium" buildings[3]. Although these terms have different meaning and are poorly understood, several IEA countries have adopted this vision as a long-term goal of their building energy policies[4].

To achieve market adoption, what is needed is a clear definition and agreement on the measures of building performance that could inform "zero energy" building policies, programs and industry building practices and design tools, case studies and demonstrations that would support industry adoption.

What is known about achieving "zero" in buildings?

The first strategy is to reduce energy demand through suitable architectural design and improved building envelopes. Measures for achieving this depend on climate and building type and include insulation, improved glazings and daylighting, airtight building envelopes and natural ventilation as well as active or passive shading for control of solar gains. Improving the efficiency of energy systems and services through better heating, cooling and ventilation systems, controls and lighting is the corresponding strategy for efficient use of the energy supplied. The so-called "Passive House" reflects these concepts for cold and moderate climates.

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[1] IEA *Promoting Energy Efficiency Investments – case studies in the residential sector* ISBN 978-92-64-04214-8. Paris. 2008

[2] Note: In most countries, indirect emissions are not counted as emissions from the building sector but from the industry (power plants). This means the environmental footprint of building related energy use is often underestimated.

[3] Another ambitious approach was formulated with the 2000-W-Society and the resulting energy demand limits for buildings: Zimmermann, M.*, Althaus, H.-J., Haas, A.: Benchmarks for sustainable construction – A contribution to develop a standard*, Energy and Buildings, 37, 2005

[4] CA, DE, UK, USA, NL, NZ

However, to reach “zero” use of fossil fuels or zero-carbon emissions requires intensive utilization of renewable energy concepts including solar heating, solar cooling, solar PV, biofuels or other clean energy generation sources.

The “net zero” option

Zero energy buildings (ZEBs) are not a new concept. An area of focus has been autonomous building energy options. With existing technology, this “off-grid” approach has been and still is a technical, economical and ecological challenge for most applications[5]. For example, seasonal and daily variations of demand and supply, at most locations worldwide, result in costly over-sizing of energy supply systems. As well, autonomous buildings require expensive thermal storage systems that can embody large amounts of energy relative to the small energy stored and efficient, long-term electrical storage is still not solved. Furthermore, most of these so-called ZEBs do require some “imported” energy for backup and high power density loads, such as cooking.

Addressing the limitations of autonomous buildings, while still achieving “zero”, leads to utility-connected solutions that optimize energy generation, distribution and storage. This “net zero” approach (NZEBs) still incorporates on-site renewable energy but the focus is on achieving an annual balance of energy supply and demand economically through interactions with electricity grids and other utilities such as community energy systems.

To minimize impacts to grids by reducing the mismatch of supply and demand, the NZEB approach requires a very high level of energy-efficiency, smart controls, load management and on-site solar energy utilization. This approach applies to the existing building stock as well as to new buildings, clusters of buildings and small settlements.

2. Objective and Scope

The *objective* of the Task is to study current net-zero, near net-zero and very low energy buildings and to develop a common understanding, a harmonized international definitions framework, tools, innovative solutions and industry guidelines. A primary means of achieving this objective is to document and propose practical NZEB demonstration projects, with convincing architectural quality. These exemplars and the supporting sourcebook, guidelines and tools are viewed as keys to industry adoption. These projects will aim to equalize their small annual energy needs, cost-effectively, through building integrated heating/cooling systems, power generation and interactions with utilities.

[5] Goetzberger, A., et. al., *The Self-Sufficient Solar House Freiburg*, Advances in Solar Energy, vol. 9, p.1-70, 1994

The planned outcome of the Task is to support the conversion of the NZEB concept from an idea into practical reality in the marketplace. The Task source book and the datasets will provide realistic case studies of how NZEBs can be achieved. Demonstrating and documenting real projects will also lower industry resistance to adoption of these concepts.

The Task will build upon recent industry experiences with net-zero and low energy solar buildings and the most recent developments in whole building integrated design and operation. The joint international research and demonstration activity will address concerns of comparability of performance calculations between building types and communities for different climates in participating countries. The goal is solution sets that are attractive for broad industry adoption.

The *scope* includes major building types (residential and non-residential), new and existing, for the climatic zones represented by the participating countries. The work will be linked to national activities and will focus on individual buildings, clusters of buildings and small settlements. The work will be based on analysis of existing examples that leads to the development innovative solutions to be incorporated into national demonstration buildings.

Although this Task will not research large community-scale developments, the Task will study the interaction and integration of large numbers of NZEBs with electric and natural gas utilities and community energy systems. The work will be connected to other international collaborations on net zero energy solutions at the community level.

This Task will pursue integrated architecture and optimal integrated design solutions that provide good indoor environment for both heating and cooling situations. The process recognizes the importance of optimizing the design for the functional requirement, reducing loads and designing energy systems that pave the way for seamless incorporation of renewable energy innovations as they become cost effective.

A goal of the Task is to advance the NZEB concept from an idea into practical reality in the marketplace. The Task source book and the datasets will provide realistic case studies of how NZEBs can be achieved. Demonstrating and documenting real projects will also lower industry resistance to adoption of these concepts.

3. Means

(a) The objectives shall be achieved by the Participants in the following Subtasks and activities:

1) Subtask A: Definitions & Large-Scale Implications

The objective of this Subtask (STA) is to establish an internationally agreed understanding on NZEBs based on a common methodology.

The Participants shall achieve this objective by:

- The review and analysis of existing NZEB definitions and data (site/source energy, emissions, exergy, costs, etc.) with respect to the demand and the supply side;
- A study of grid interaction (power/heating/cooling) and time dependent energy mismatch analysis.
- The development of a harmonized international definition framework for the NZEB concept considering large-scale implications, exergy and credits for grid interaction (power/heating/cooling).
- The development of a monitoring, verification and compliance guide for checking the annual balance in practice (energy, emissions and costs) harmonized with the definition.

2) Subtask B: Design Process Tools

The Subtask (STB) aims to identify and refine design approaches and tools to support industry adoption of innovative demand/supply technologies for NZEBS.

The Participants shall achieve this objective by:

- Documenting processes and tools currently being used to design NZEBs and under development by participating countries.
- Assessing gaps, needs and problems and, considering the work of STA and STC, inform simulation engine and detailed design tools developers of priorities for NZEBs.
- The development/refinement of design processes and simplified NZEB tools or interfaces (e.g. spreadsheet or web-based method), linked to STC Solution Sets to support integration of NZEB technologies and architecture at the early design stage.

3) Subtask C: Advanced Building Design, Technologies and Engineering

The objectives of this Subtask (STC) are: to develop and test innovative, whole building net-zero solution sets for cold, moderate and hot climates with exemplary architecture and technologies that would be the basis for demonstration projects and international collaboration.

The Participants shall achieve these objectives by:

- Documenting and analyzing current NZEBs designs and technologies, benchmarking with near NZEBs and other very low energy buildings (new and

existing), for cold, moderate and hot climates considering sustainability, economy and future prospects using a projects database, literature review and practitioner input (workshops).

- Developing and assessing case studies and demonstration projects in close cooperation with practitioners.
- Investigating advanced integrated design concepts and technologies in support of the case studies, demonstration projects and solution sets
- Developing NZEB solution sets and guidelines with respect to building types and climate and to document design options in terms of market application and CO2 implications.

4) Subtask D: Dissemination

The objective of the dissemination activity is to support knowledge transfer and market adoption of NZEBs on a national and international level.

This Subtask integrates the activities of Subtasks A, B, and C. Each Subtask will be responsible for the production of designated parts of the overall information dissemination activity. Subtask leaders will be responsible for the coordination of the individual contributions of Subtask participants and for coordination with the other Subtasks where a combined output is planned. Individual participants will be selected to take over responsibility for each of the proposed dissemination activities. These dissemination activities will be coordinated through the Subtask Leaders Committee.

The Participants shall achieve the objectives by:

- Establishing an NZEB web page, within the IEA SHC/ECBCS Programmes framework, and a database that can be expanded and updated with the latest projects and experiences.
- Producing a NZEB source book including example buildings for investigated building types and climates.
- Transferring the Task outputs to national policy groups, industry associations, utilities, academia and funding programmes.
- Establishing an education network, summer school and contributions to the Solar Decathlon and similar student activities.
- Workshops, articles and features in magazines to stimulate market adoption.

4. Results

The products of work performed in this Task are targeted to and designed for the building industry (building manufacturers, manufacturers of components and systems), housing companies and building developers, architects, building engineers and utilities.

Results of the activity specific for the three Subtasks will consist of:

Subtask A:

(a) Harmonized international definitions framework and a monitoring, verification and compliance guide.

(b) A report on the technical potential including impacts on grids.

Subtask B

(a) Identification of a suite of NZEB tools to support the design process and user manuals.

(b) With STC, worked examples and case studies to support industry adoption.

Subtask C:

(a) Case studies, demonstration projects and knowledge for the task sourcebook and database and other dissemination materials.

(b) Solution sets for different climates and building types incorporating market available and near market technologies and systems and integrated concepts for industry adoption.

Subtask D: Dissemination results in addition to the work of STA, STB and STC are:

(a) A NZEB web page and database.

(b) An NZEB source book covering the methodology, technologies, tools, case studies and demonstration projects.

(c) Education network for students, summer school and contributions to the Solar Decathlon and similar student activities.

(d) Technical papers, special issues of industry magazines, brochures and booklets.

5. Time schedule

This Task shall start on October 1, 2008 and remain in force until September 30, 2013.

Building upon a successful task definition workshop that resulted in this draft Task proposal, a“start-up“ phase will be conducted from October 1st, 2008 to April 30th, 2009. This “start-up“ phase will focus on preparation of the detailed workplans for

each Subtask and provide time to establish national teams and secure funding for participation in the work. As well, work will begin on NZEB definitions under Subtask A and background information will be gathered. The “start-up“ phase shall be followed by a 4-year "work" phase to May 31st, 2013 and then a 4 month “wrap-up“ phase ending September 30th, 2013.

6. Specific Obligations and Responsibilities of the Participants

(a) A Participant must undertake and complete all agreed activities and contribute to all or to a specific of the tasks outlined in Section 3 in a timely manner.

(b) Each Participant in must actively participate in working meetings and other activities such as workshops.

(c) Attendance at Experts meetings of the Task will be mandatory. Experts meetings of the Task will be carried out at intervals of approximately six months. Experts meetings may be accompanied by national workshops dedicated to target audiences of the Task, mainly from the national industry of the host country of the Experts meeting.

(d) Each Participant shall provide timely, detailed reports on the results of their work carried out to the Subtask Leader and Operating Agent.

(e) Each Participant must contribute to one or more Task deliverables and shall participate in the editing and reviewing of draft reports and other outputs of the Task and Subtasks.

7. Specific Obligations and Responsibilities of the Operating Agent and Subtask Leaders

7.1 Operating Agent

(a) In addition to the obligations enumerated in Articles 5 and 6 of this Agreement, the Operating Agent shall:

(1) Be responsible for the overall management of the Task, including overall co-ordination and communications with the Executive Committee.

(2) Prepare the detailed Programme of Work for the Task in consultation with the Subtask Leaders and the Participants and submit the Programme of Work for approval to the Executive Committee.

(3) Provide semi-annually, periodic reports to the Executive Committee on the progress and the results of the work performed under the Programme of Work.

(4) Manage the preparation and distribution of the results described in Article 4 above.

(5) At the request of the Executive Committee organise workshops, seminars, conferences and other meetings.

(6) Provide to the Executive Committee, within six months after completion of all work under the Task, a final report for its approval and transmittal to the Agency.

(7) In co-ordination with the Participants, use its best efforts to avoid duplication with activities of other related programmes and projects implemented by or under the auspices of the Agency or by other competent bodies.

(8) Provide the Participants with the necessary guidelines for the work they carry out and report with minimum duplication.

(9) Perform such additional services and actions as may be decided by the Executive Committee, acting by unanimity.

7.2 Subtask Leaders:

(a) A Subtask Leader shall be a Participant that provides to the Subtask a high level of expertise and undertakes substantial research related to the Subtask.

(b) In addition to the obligations enumerated in Articles 6 of this Agreement, the Subtask Leaders shall:

(1) Assist the Operating Agent in preparing the detailed Programme of Work.

(2) Actively participate in the Task Steering Committee and dissemination activities.

(3) Co-ordinate the work performed under that Subtask.

(4) Subtask leaders may arrange, direct and provide summarizes of Subtask meetings and workshops in between or in association with Task meeting.

(5) Provide the Operating Agent with timely written summaries of Subtask work and results.

(6) Edit technical reports resulting from the Subtask and organize their publication.

(7) Collaborate with the Operating Agent and other Subtasks and contribute to the preparation, production and distribution of the results described in Article 4 above within the framework of the Task dissemination plan.

(c) The Subtask Leaders shall be proposed by the Operating Agent and designated by the Executive Committee, acting by unanimity of the Participants. Changes in the Subtask Leaders may be agreed to by the SHC Executive Committee upon the recommendation of the Operating Agent.

8. *Funding*

(a) Each participant will bear the *costs* of their participation in the Task, including travel costs. Task meetings will be held twice annually and hosted in turn by Participants. The cost of organising meetings will be borne by the host country.

(b) Participation in the Task requires active participation in at least one of the Subtasks A, B or C.

(c) Level of effort

The Participants agree on the following commitment:

(1) Each Participant (country) will contribute to this Task a minimum of 4 person months per year for the duration of the Task.

(2) Subtask Leaders will contribute a minimum of 5 person months per year for the duration of the Subtask.

(3) The Operating Agent will contribute a minimum of 6 person months per year to the Task.

(d) Participation may partly involve *funding already allocated* to a national (or international) activity which is substantially in agreement with the scope of work outlined in this Task. Aside from providing the resources required for performing the work of the Subtasks in which they are participating, all Participants are required to commit the resources necessary for activities which are specifically collaborative in nature and which would not be part of activities funded by national or international sources. Examples include the preparation for and participation in Task meetings, co-ordination with Subtask Participants, contribution to the documentation and dissemination work and Task related R&D work which exceeds the R&D work carried out in the framework of the national (or international) activity.

(e) The level of effort to be contributed by each country will be specified in a "Letter of National Participation" which is signed by both the Participant and their Executive Committee representative within 7 months from the start date of the Task.

9. Operating Agent, Subtask Leaders, Task Steering Committee

(a) The Operating Agent for the Task will be the Building and Communities Group of the CANMET Energy Technology Centre of Natural Resources Canada, represented by Mark Riley.

(b) Given the complexity of the Task in terms of building types, construction practices and climatic zones of countries involved in the Task, the recommendaton is to have Co-Leaders for some Subtasks. Subject to securing

funding for their participation, the Subtask Leaders and Co-Leads for the Task are:

1) The Subtask A Leader will be the University Wuppertal, Germany, represented by Karsten Voss.
2) The Subtask B Leader will be the National Renewable Energy Laboratory, U.S.A., represented by Paul Torcellini with a Co-Leader from the Solar Buildngs Network, Canada, represented by Andreas Athienitis.
3) The Subtask C Leader will be the Victoria University of Wellington, New Zealand, represented by Michael Donn with a Co-Leader from Université de la Réunion, France, represented by François Garde.
4) Subtask D will be coordinated through a Subtask Leaders Steering Committee.

(c) A Subtask Leaders Steering Committee shall be established and consist of the Operating Agent and Subtask Leaders or their respective designees. The Subtask Leaders Steering Committee shall assist the Operating Agent in the co-ordination of the Task, coordinate dissemination activities and advise the Operating Agent on the performance of the Task.

10. Information and Intellectual Property

(a) Executive Committee's Powers

The publication, distribution, handling, protection and ownership of information and intellectual property arising from this Task shall be determined by the Executive Committee, acting by unanimity, in conformity with the Agreement.

(b) Right to Publish

Subject only to copyright restrictions, the Participants shall have the right to publish all information provided to or arising from this Task, except proprietary information.

(c) Proprietary Information

The Participants and the Operating Agent shall take all necessary measures in accordance with this paragraph, the laws of their respective countries and international law to protect proprietary information provided to or arising from this Task. For the purposes of this Task, proprietary information shall mean information of a confidential nature such as trade secrets and know-how (for example computer programs, design procedures and techniques, chemical composition of materials, or manufacturing methods, processes, or treatments) which is appropriately marked, provided such information:

(1) Is not generally known or publicly available from other sources.
(2) Has not previously been made available by the owner to others without obligation concerning its confidentiality.
(3) Is not already in the possession of the recipient Participant without obligation concerning its confidentiality.

It shall be the responsibility of each Participant supplying proprietary information and of the Operating Agent for appraising proprietary information, to identify the information as such and to ensure that it is appropriately marked.

(d) Arising Information

All information developed in connection with and during activities carried out under this Task (arising information) shall be provided to each Participant by the Operating Agent, subject only to the need to retain information concerning patentable inventions in confidence until appropriate action can be taken to protect such inventions.

For arising information regarding inventions the following rules shall apply:

(1) Arising information regarding inventions shall be owned in all countries by the inventing Participant. The inventing Participant shall promptly identify and report to the Executive Committee any such information along with an indication whether and in which countries the inventing Participant intends to file patent applications.

(2) Information regarding inventions on which the inventing Participant intends to obtain a patent protection shall not be published or publicly disclosed by the Operating Agent or the other Participants until a patent has been filed, provided, however, that this restriction on publication or disclosure shall not extend beyond twelve months from the date of reporting of the invention. It shall be the responsibility of the inventing Participants to appropriately mark Task reports which disclose inventions that have not been appropriately protected by filing a patent application.

(3) The inventing Participant shall license proprietary information arising from the Task for non-exclusive use to participants in the Task:

(a) On the most favourable terms and conditions for use by the Participants in their own country.

(b) On favourable terms and conditions for the purpose of sub-licensing others for use in their own country.

(c) Subject to sub-paragraph (1) above, to each Participant in the Task for use in all countries, on reasonable terms and conditions.

(d) To the government of any Agency Member country and nationals designated by it, for use in such country in order to meet its energy needs.

Royalties, if any, under licenses pursuant to this paragraph shall be the property of the inventing Participant.

(e) Production of Relevant Information by Governments

The Operating Agent should encourage the governments of all Agency Participating Countries to make available or to identify to the Operating Agent all published or otherwise freely available information known to them that is relevant to the Task.

(f) Production of Available Information by Participants

Each Participant agrees to provide to a Subtask Leader or to the Operating Agent all previously existing information, and information developed independently of the Task, which is needed by a Subtask Leader or by the Operating Agent to carry out its functions under this Task and which is freely at the disposal of the Participant and the transmission of which is not subject to any contractual and/or legal limitations:

(1) If no substantial cost is incurred by the Participant in making such information available, at no charge to the Task.

(2) If substantial costs must be incurred by the Participant to make such information available, at such charges to the Task as shall be agreed between the Operating Agent and the Participant with the approval of the Executive Committee.

(g) Use of Confidential Information

If a Participant has access to confidential information which would be useful to a Subtask Leader or to the Operating Agent in conducting studies, assessments, analyses, or evaluations, such information may be communicated to a Subtask Leader or to the Operating Agent but shall not become part of the reports, handbooks, or other documentation, nor be communicated to the other Participants, except as may be agreed, between the Subtask Leader or the Operating Agent and the Participant.

(h) Reports on Work Performed under the Task

The Operating Agent shall, in accordance with paragraph 7 above, provide reports of all work performed under the Task and the results thereof, including studies, assessments, analyses, evaluations and other documentation, but excluding proprietary information.

(i) Copyright

The Operating Agent may take appropriate measures to protect copyrightable material generated under this Task. Copyrights obtained shall be the property of the IEA for the benefit of the Participants provided, however, that the Participants may reproduce and distribute such material, but if it shall be published with a view to profit, permission should be obtained from the Executive Committee.

(j) Authors

Each Participant will, without prejudice to any rights of authors under its national laws, take necessary steps to provide the co-operation from its authors required to carry out the provisions of this paragraph. Each Participant will assume the responsibility to pay awards or compensation required to be paid to its employees according to the laws of its country.

11. Participants in this Task/Annex

Participants are expected from 20 countries. Contracting Parties in this project are indicated in the following table. Others may still join and Information on participants will be provided in the detailed workplan.

Country	SHC/ECBCS Contracting Parties
Australia	Standards Australia International (SHC or ECBCS) or Sustainable Energy Authority Victoria (SHC)
Austria	Republic of Austria, AEE-Intec (ECBCS)
Belgium	TBD (SHC or ECBCS)
Brazil	Observer
Canada	Natural Resources Canada (SHC)
Denmark	The Danish Energy Agency (SHC or ECBCS)
Finland	TEKES, Finnish Funding Agency for Technology and Innovation (SHC or ECBCS)
France	Agence de l'Environnement et de la Maitrise de l'Energie (ADEME) (ECBCS)
Germany	Forschungszentrum Jülich GmbH (SHC)
Italy	ENEA (SHC or ECBCS)
New Zealand	Ministry of Commerce, Energy and Resources Division

Country	SHC/ECBCS Contracting Parties
Netherlands	SenterNovem (SHC)
Norway	Royal Norwegian Ministry of Petroleum and Energy (SHC)
Poland	Silesian University of Technology (ECBCS)
Portugal	I.N.E.T.I., Departamento de Energias Renovaveis (SHC)
South Korea	Korea Institute of Construction Technology (ECBCS)
Spain	CIEMAT (SHC)
Sweden	Swedish Energy Agency (SHC)
Switzerland	Swiss Federal Office of Energy (SHC or ECBCS)
U.S.A	The Government of the United States of America (ECBCS)