

Energy Resilience of the Buildings in Remote Cold Regions (Annex 93)

Dr. Hassam ur Rehman
Technical Research Institute of Finland (VTT)

Dr. Alexander Zhivov
US Army Engineer Research and Development Center
(ERDC-CERL)

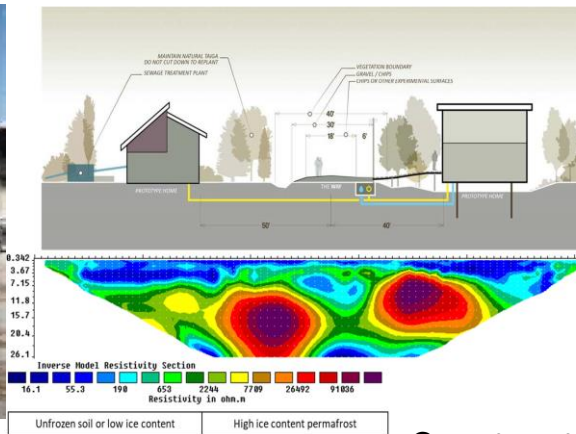
Challenges in Cold and Arctic Regions



Remoteness, shortage of resources (e.g. fuel)



Cold wave



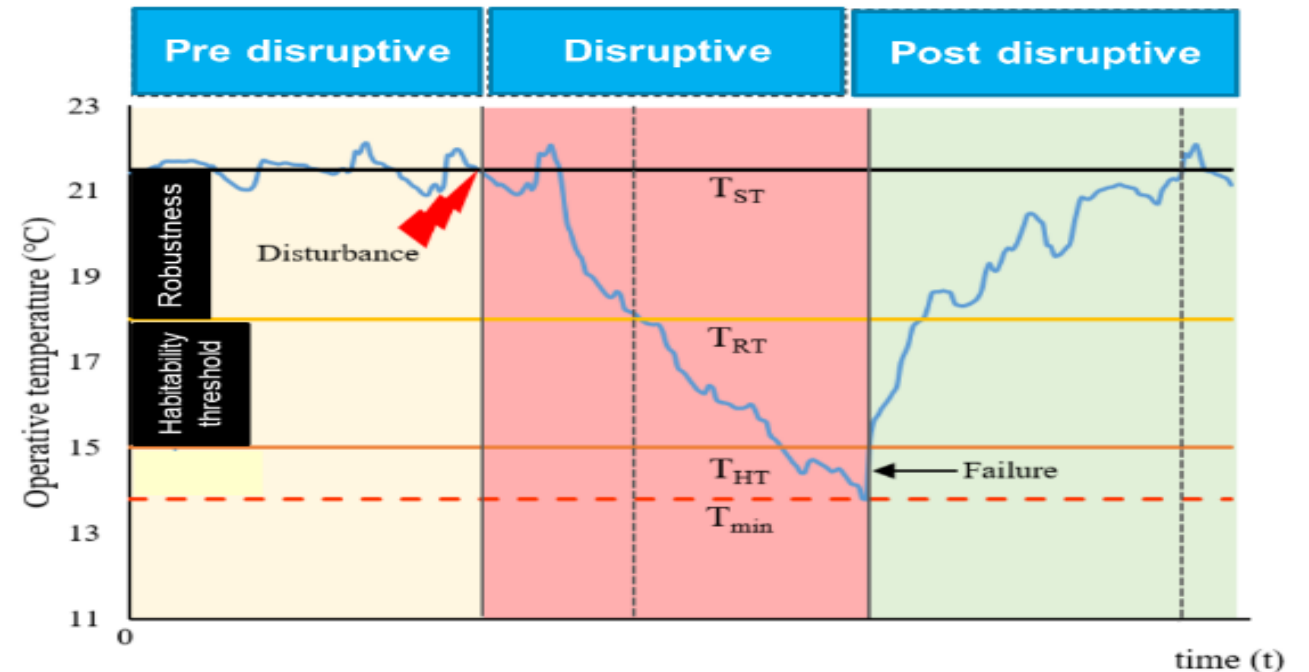
Construction challenges (permafrost)



Shortage of parts and limited maintenance, high costs, accessibility, delivery issues



Mold and other sustainability issues), Dry air during cold time of the year



Energy systems resilience: risks to missions, health and buildings sustainability

Aim and scope

- Develop guidelines on energy-efficient and energy resilient buildings and building communities located in cold and remote locations by using passive and active methods.
- The scope of the study is limited to the following:
 - *Climates*: cold, very cold, subarctic climate zones (U.S. DOE climate zone 6-8 classification).
 - *Scale*: buildings and building clusters (residential and/or commercial spaces).
 - *Remoteness*: variously defined, e.g., related to power supply (e.g., a facility not connected to the grid), related to physical isolation (a facility that is logistically challenging to reach), small population etc.

Objectives

- Objective 1: **Identify major threats** specific to cold regions;
 - **Develop definitions** for energy resilience in cold regions
 - **Key performance indicators** for habitability, survivability in cold regions; and establish
 - **Requirements** for energy resilient building envelope, indoor environment quality and supply system
- Objective 2: **Document and assess existing practices** through case studies across cold regions with different local conditions.
- Objective 3: **Develop guidelines** for energy resilient and efficient buildings and energy systems for different cold regions. The guidelines will address technical, social and economic aspects.
- Objective 4: **Disseminate** best practices for planning and construction of energy-resilient buildings and communities in cold regions through technical papers, conference presentations, and training.

Subtasks



Subtask 1:
Establishing energy
resilience definition,
threshold and
challenges for the
building clusters in
cold climate

Subtask 2:
Investigate specifics
of buildings and
their construction in
remote cold regions

Subtask 3: Investigate
resilient building and
building clusters'
energy systems,
renewable energy
sources, and systems
integration

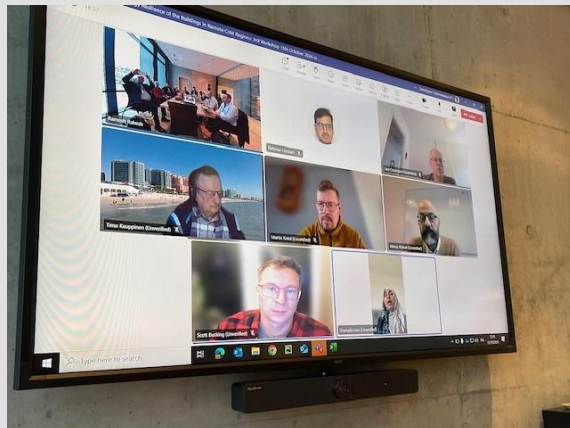
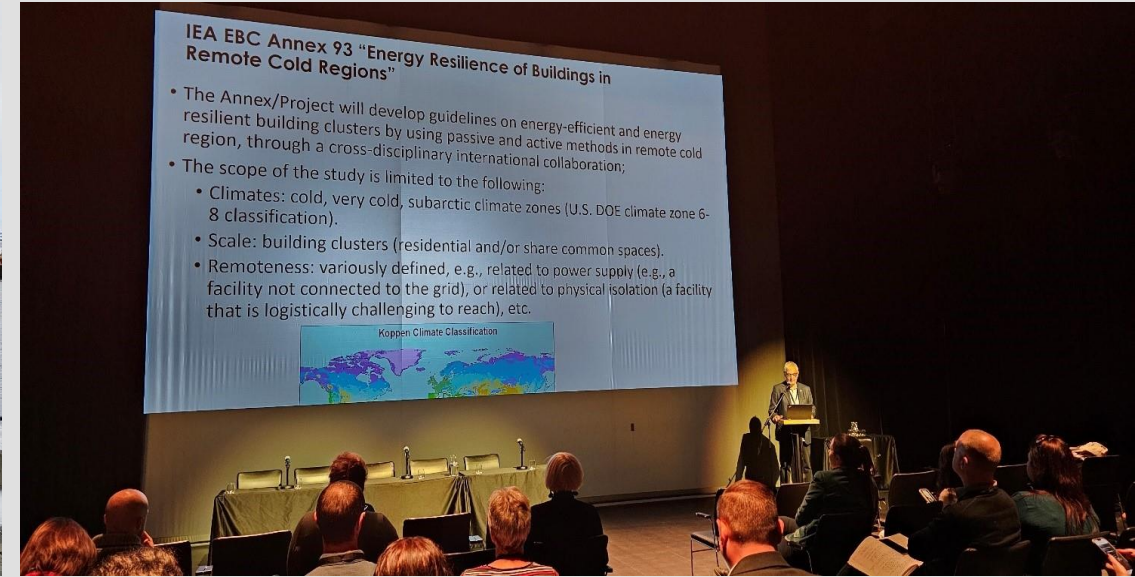
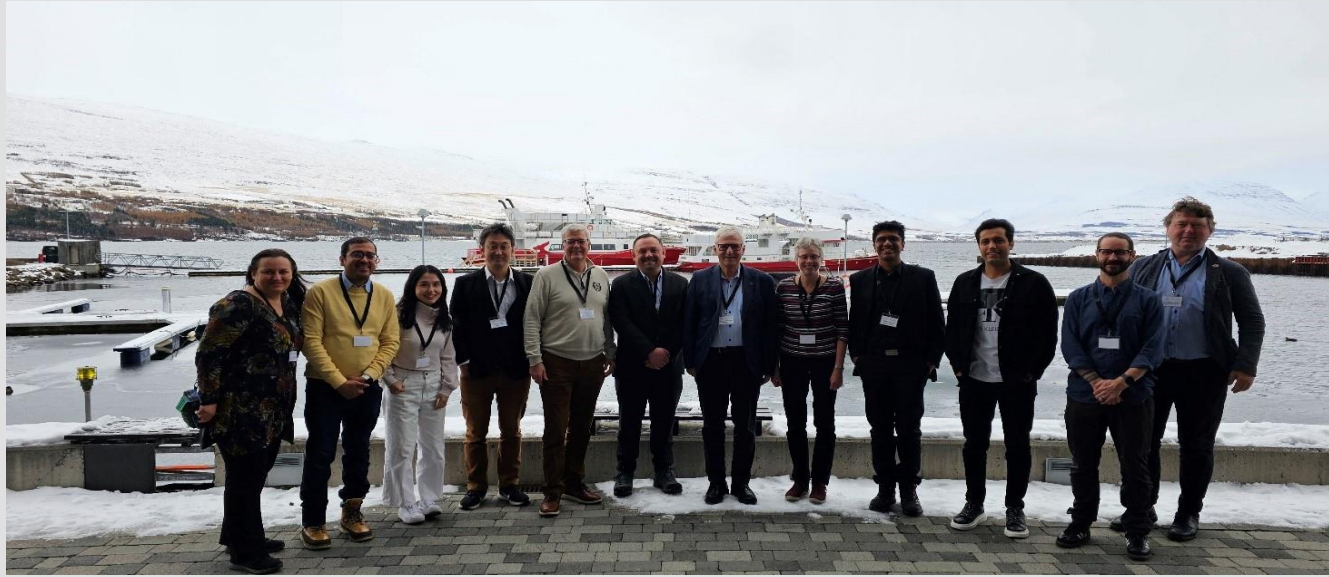
Subtask 4: Develop
guidelines and
disseminate
knowledge

Annex timeline, and progress...



Preparation meeting

- The 3rd in-person workshop was conducted on October 14th-16th, Akureyri, Iceland



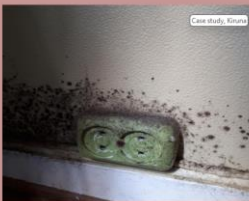
1st Working meeting, Norway 2025

- The working meeting was conducted in March 2025



Case study, Narvik

INDOOR CLIMATE AND MOLD PROBLEMS IN BUILDINGS



- Living quality
- Tenant
- Sustainable
- Maintenance
- Long term



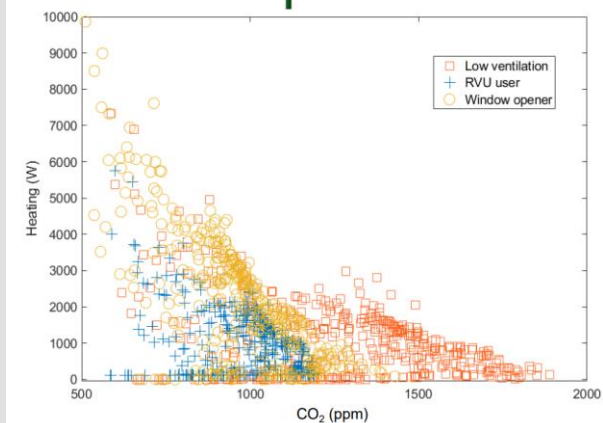
Case buildings and the renovation measures

- Constructed in 1968 and 1973
- Renovation in 2015



Results

Air Quality and Ventilation Performance with Different Ventilation Practices



- 3650 occupied hours (22:00-08:00)
- 48 bedrooms across 12 floors

Fig. Distribution of CO₂ concentration and heating load in master bedrooms with three ventilation operations.

Case study, Kiruna

Our task

- ✓ Create space for 3000–4000 housing
- ✓ Plan for new commercial centre, offices and healthcare.
- ✓ Plan and build new infrastructure in the new city center.
- ✓ Plan and build new public buildings like cultural centre, swimming hall, upper secondary school, sportshall.



KIRUNA KOMMUN

A fantastic new city, a good example
The model city 2.0

VINNOVA



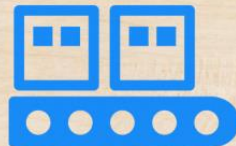
Teknisk plattform och monteringskoncept



The Architect



Technical platform



Production and assembling on site



Deliverables

#	Official Deliverable	Timing
D1	Biannual Annex Status Report according to Annex Status Report template including material to be used in the EBC Annual Report; progress, main results, and events organized and completion of final report	Every 6 months
D2	Newsletters for Annex	Monthly
D3	Summary on the project outcome, guideline and best practices dedicated for target audience	At the end of the project
D4	Project final report and guideline book	At the end of the project
D5	A collection of scientific publications in high-level journals.	Throughout the project when individual results are available

Other outreach activities

- **Website**
- **Workshops/webinar with relevant stakeholders and TCPs**
- **International conferences/workshops**
- **Blogs, book publishing etc**
- **Summer school**
- **Social media**

List of chapters for guidebook

Chapter title (tentative)	Subtask
1) Introduction	1
2) Requirements for indoor climate under normal and emergency operations in cold regions	1,2
3) Building envelope	2
4) Parameters for thermal energy system	3
5) Consideration for foundation construction	3
6) Best practices for HVAC system	2,3
7) Resilience of energy system system in cold region a) Energy system design and operation b) Heating and cooling demand in building cluster c) Electric supply and resilience in remote cold locations d) District heating systems e) District cooling solutions f) Combined heat and power production as a resilient energy solution g) Emergency generation h) Alternative fuels for more resilient energy systems i) Boosting energy resilience with energy storage solutions j) Resilience enhancing operation k) Resilient energy system control/management l) Case studies and best practice	3

List of Participation countries

- Canada
- Denmark
- Finland
- Norway
- Sweden
- USA
- China
- UK
- Japan
- Iceland

Publication, website and outreach

- Follow the website :
<https://annex93.iea-ebc.org/>
- Publications : 8
- Special Issue edited: Advanced Energy Systems in Energy Resilient, Zero/Positive Energy Buildings, Communities and Districts
 - ISBN 978-3-7258-4187-5 (Hardback)
 - ISBN 978-3-7258-4188-2 (PDF)
 - <https://doi.org/10.3390/books978-3-7258-4188-2>
- Case studies, presentations, news meetings

Annex 93 Publications  

Q Keyword.. Sort By Publication Date ▾



Energy Resilience of the Buildings in Remote Cold Regions (PDF 0.71MB) 

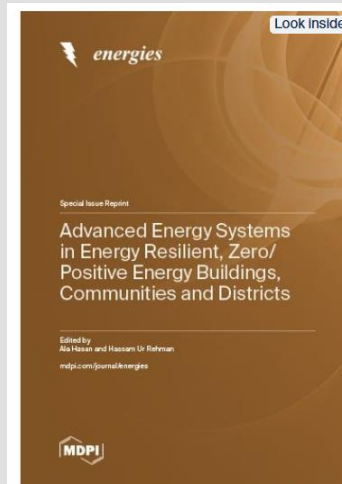
Factsheet
November 2024



EPCDescriptor: A Multi-Attribute Visual Network Modeling of Housing Energy Performance (PDF 1.53MB) 

August 2025
Author(s): Hafiz Muhammad Shakeel, Shamaila Iram, Hafiz Muhammad Athar Farid, Richard Hill, Hassam ur Rehman
Publisher: MDPI buildings

Conventional methods of studying houses' Energy Performance Certificates (EPCs) typically fail to investigate the impact of interrelated contextual elements instead fixating exclusively on the specific attributes of individual houses. This study presents a new method that combines network graph analytics (NGA) with interactive visual analytics to investigate hidden linkages at the individual house level. Our proposed platform collects and analyses data related to housing attributes, creates a network based on the links between these attributes, and employs sophisticated graph algorithms to provide visual representations. Users have the ability to dynamically choose postcodes, metrics, and attributes, which, in turn, generate layouts of networks that provide valuable insights. The visualisation utilises colour gradients and node metrics to improve the comprehensibility of energy performance areas. The platform enables homeowners and stakeholders to comprehend the interrelationships between aspects such as neighbouring housing features, and house infrastructure. The results prove the efficacy of the strategy by giving a collection of case studies that encompass various Energy Performance Certificates (EPCs) ranging from A to G. Each case study demonstrates the evolution of network architectures and visual assessments, showcasing the energy performance linked to certain EPC ratings. The platform offers a user-friendly interface for stakeholders to investigate and understand attribute relationships.



March 2025

Main discussion and outcomes

1. Kiruna, Sweden city plan 1
2. Kiruna, Sweden city plan 2
3. Tiny village concept
4. Indoor environment in the Arctic zone
5. Narvik building renovation use case
6. Narvik housing company use case

Outreach

- LinkedIn: <https://www.linkedin.com/company/iea-ebc-annex-93/?viewAsMember=true>

Follower highlights ?

85

Total followers

 IEA EBC Annex 93 - Energy Resilience of the Buildings in...
85 followers
1d •

Join Us in for the IEA EBC Annex93 Meeting, Workshop

We are excited to invite you to the upcoming IEA EBC Annex 93 - Energy Resilience of the Buildings in Remote Cold Regions event from October 7-8, 2025 Online. This event offers insightful discussions and technical workshops.

Event Details:
Dates: October 7-8, 2025
Location: Online (TEAMS)

Don't miss this opportunity to connect with experts, share knowledge, and deep dive in energy resilience topic. Please contact Hassam ur Rehman (hassam.rehman@vtt.fi), Alexander Zhivov, or [Rakesh Ramesh](#) for any questions.

Looking forward to seeing you!

[#IEA_EBC](#)
[#Annex93](#)
[#EnergyResilience](#)
VTT, Research Council of Finland | Suomen Akatemia ([#REBUIDFin](#)), International Energy Agency (IEA), [RESPED](#)

Education · 26 (30.6%)

Research · 19 (22.4%)

Engineering · 5 (5.9%)

Business Development · 4 (4.7%)

Operations · 4 (4.7%)

Administrative · 2 (2.4%)

Consulting · 2 (2.4%)

Community and Social Services · 1 (1.2%)

Entrepreneurship · 1 (1.2%)

 M

Thank you

Hassam ur Rehman, Ph.D.

Senior Scientist and PostDoc fellow, VTT Technical Research Centre of Finland, hassam.rehman@vtt.fi

Dr. Alexander Zhivov, Ph.D.

Senior Research Engineer, US Army Engineer Research and Development Center (ERDC-CERL)

Alexander.M.Zhivov@usace.army.mil