



**CONECT**  
2024



**RIGA TECHNICAL  
UNIVERSITY**

# **XVII International Scientific Conference of Environmental and Climate Technologies**

**BOOK OF ABSTRACTS**

**15–17 May 2024 | Riga, Latvia**

CONECT 2024  
XVII International Scientific Conference of  
Environmental and Climate Technologies

**BOOK OF ABSTRACTS**

Riga Technical University  
Institute of Energy Systems and Environment  
Address: 12-k1 Āzenes iela, Riga,  
LV-1048, Latvia  
Phone: +371 670 899 23  
E-mail address: [conect@rtu.lv](mailto:conect@rtu.lv), [ect@rtu.lv](mailto:ect@rtu.lv)  
Web page: [www.conect.rtu.lv](http://www.conect.rtu.lv)

More information: [www.conect.rtu.lv](http://www.conect.rtu.lv)

© Riga Technical University, 2024  
ISBN 978-9934-37-065-6 (pdf)

Images: Anna Marta Babre  
Design: Paula Lore  
Main managing editor: Dace Lauka  
Editor: Darja Slotina  
Organizer: Inguna Bremane

## Scientific Committee

### **Dagnija Blumberga**

Riga Technical University, Latvia

### **Ivars Veidenbergs**

Riga Technical University, Latvia

### **Gatis Bazbauers**

Riga Technical University, Latvia

### **Andra Blumberga**

Riga Technical University, Latvia

### **Karlis Valters**

Riga Technical University, Latvia

### **Silvija Nora Kalnins**

Riga Technical University, Latvia

### **Timo Laukkanen**

Aalto University, Finland

### **Adam Cenian**

Polish Academy of Sciences Institute  
of Fluid-Flow Machinery, Poland

### **Stelios Rozakis**

Technical University of Crete, Greece

### **Raimondas Grubliauskas**

Vilnius Gediminas Technical University,  
Lithuania

### **Vytautas Martinaitis**

Vilnius Gediminas Technical University,  
Lithuania

### **Uli Jakob**

Hochschule für Technik Stuttgart, Germany

### **Maris Klavins**

University of Latvia, Latvia

### **Sylvestre Njakou**

Djomo University of Hasselt, Belgium

### **Marika Rosa**

Riga Technical University, Latvia

### **Valeria Mezzanotte**

University of Milano-Bicocca, Italy

### **Francesco Romagnoli**

Riga Technical University, Latvia

### **Fosca Conti**

University of Padova, Italy

### **Zaneta Stasiskiene**

Kaunas University of Technology, Lithuania

### **Ingo Weidlich**

HafenCity Universität Hamburg, Germany

### **Anna Volkova**

Tallinn University of Technology, Estonia

### **Edmunds Teirumnieks**

Rezekne Academy of Technologies, Latvia

### **Julija Gusca**

Riga Technical University, Latvia

### **Pal Davidsen**

Riga Technical University, Latvia

ISSN 2592-9704

CONECT 2024  
XVII International Scientific Conference of  
Environmental and Climate Technologies  
15–17 May 2024 | Riga, Latvia

**BOOK OF ABSTRACTS**

**ORGANIZERS**

---



**SUPPORTERS**

---



Embassy of Italy  
Riga



# CONECT 2024

## XVII International Scientific Conference of Environmental and Climate Technologies

Welcome to CONECT 2024 – an international scientific conference that has been held since 2008 and annually brings together scientists, researchers, PhD students and professionals from all over the world.

The conference's purpose is to acquaint with achievements in the area of energy systems and environmental engineering and to give an opportunity to exchange and share experiences and publish research results.

The three-day event will feature an impressive line-up of speakers from around the world in Plenary and Panel sessions on the following topics:

- Bioresources
- Biotechnologies
- District Heating
- Energy Efficiency
- Environmental and Energy Policies and Frameworks
- Low Carbon Development and Bioeconomy
- Renewable Energy Technologies
- Sustainability and Resilience





The conference papers are published in the international scientific journal “Environmental and Climate Technologies” (ISSN: 2255-8837) indexed in SCOPUS and Web of Science.

The conference is organized by the Institute of Energy Systems and Environment (IESE) of Riga Technical University



**WE WISH YOU ALL  
A FRUITFUL CONFERENCE!**  
CONECT 2024 Conference  
Organising Committee

**FIND MORE INFORMATION  
ABOUT THE CONECT  
CONFERENCE HERE:**  
[www.conect.rtu.lv](http://www.conect.rtu.lv)

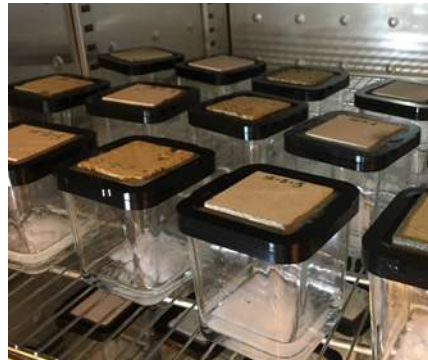
## RTU IESE

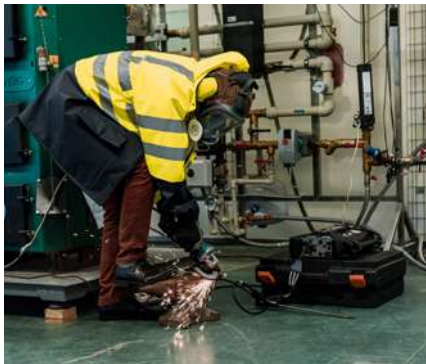
**IESE is gradually becoming a leader in Environmental Science and engineering science in Latvia.**

This is testified by our partners' unwavering interest in cooperation with us both in research sectors well-balanced in climate technologies and resilience, energy and environmental policy, environmental governance and energy management and resolution of engineering-technical issues in industrial, agricultural, energy and waste management companies.

IESE commitment to sustainability fosters innovation and subsequently supports future projects.

The balanced advancement in the IESE scientific research capacities is made sustainable through cooperation with partners in Latvia, the European Union member states, Norway, the USA, Colombia, Canada, Taiwan, India, and other countries. We participate in joint projects within the Baltic Sea Region, HORIZON and the Nordic Energy Research programmes. Our commitment to collaboration and our international focus has been the key factors in attracting investment and facilitated the resolution of several environmental and engineering issues.







# JOURNAL OF ENVIRONMENTAL AND CLIMATE TECHNOLOGIES

The Journal of Environmental and Climate Technologies, published by RTU IESE, is an international scientific journal that offers global exposure for original research and innovations.

It covers a variety of topics for all aspects of Environmental science:

- Renewable Energy Technologies,
- Cleaner Production and Industrial Symbiosis,
- Ecodesign and Life Cycle Assessment,
- Climate Technologies,
- Climate Change and Resilience,
- Circular Economy,
- Environmental Monitoring and Remediation.

The electronic version of the journal is published by De Gruyter Open (formerly Versita). The papers are indexed in Scopus and Web of Science data bases.

**Scopus** WEB OF SCIENCE

You can easily find a journal paper on your topic in Thematic Distribution of Articles section on <https://conect.rtu.lv/ect-journal/>



**FOR MORE INFORMATION  
AND REGISTRATION VISIT:  
[ect-journals.rtu.lv](https://ect-journals.rtu.lv)**

## SUPPORTERS

**We express gratitude to the sponsors  
for their support towards this year's conference.**



The French Institute in Latvia is a structural unit of the French Embassy in Latvia and, together with other services of the Embassy, is actively involved in the diplomacy of French influence. Its aim is to present French excellence in various fields (new technologies, cultural and creative industries, digital sphere, cultural heritage, climate for debate on societal issues, etc.) to a wide range of stakeholders through an innovative and interdisciplinary approach. It also offers French language courses and internationally recognised French proficiency tests. To achieve its objectives, the French Institute in Latvia works closely with the French Institute in Paris, the implementing agency for French cultural diplomacy abroad.



The Embassy of Italy in Riga primarily facilitates diplomatic relations between Latvia and Italy by promoting trade and investment, stimulating the exchange and cooperation of research Institutes and Universities, and providing assistance to home country citizens living or travelling abroad. The Embassy of Italy in Riga actively promotes economic ties between Latvia and Italy by organizing trade missions, business and scientific conferences, and other events to connect businesses, entrepreneurs, and scientists from both countries. At the same time, the Embassy promotes cultural and educational exchanges between the two countries by facilitating study-abroad programs, hosting exhibitions, and encouraging other cultural and educational events.



Latvian-Italian Cooperation Centre of Riga Technical University (RTU) promotes EU common values, inclusive education, the European dimension of teaching, as well as provides a sense of community for the Italian students and scientists at RTU. The Centre fosters the cultural and scientific relations between Italy and Latvia, with particular regard to the teaching of the Italian language and the coordination of RTU activities with Italian higher education institutions, research centres, institutions and business companies.



The accommodation of CONECT 2024 participants is taken care of by the Mogotel hotel group.

# TABLE OF CONTENTS

## 01

<b>ENERGY EFFICIENCY, ENERGY SYSTEMS (DISTRICT HEATING)</b>	<b>15</b>
ELECTRIC VEHICLE CHARGING INFRASTRUCTURE STUDY FOR APARTMENT BUILDINGS	16
ROBUST DESIGN OF 5 <sup>TH</sup> GENERATION DISTRICT HEATING AND COOLING (5GDHC) SYSTEMS WITH SEASONAL THERMAL ENERGY STORAGE VIA GIS ASSESSMENT	17
MAIN PRINCIPLES AND SOLUTIONS FOR ACCELERATION OF ENERGY EFFICIENT RENOVATION IN LATVIA	18
NUMERICAL ANALYSIS OF HARMFUL ENVIRONMENTAL IMPACT OF ACCIDENTAL EXPLOSION AT A HYDROGEN FILLING STATION	19
COMPARING NUMERICAL AND ANALYTICAL METHODS FOR HEAT LOSS DETERMINATION OF DISTRICT HEATING SYSTEMS	20
FUTURE OF DISTRICT HEATING SYSTEMS – INVESTIGATION OF VARIOUS TECHNOLOGIES IN THE DANISH CONTEXT	21
DESIGN AND PERFORMANCE ASSESSMENT OF DISTRICT HEATING SYSTEMS IN THE LATVIAN REGION	22
USE OF AN ABSORPTION HEAT PUMP TO LIFT THE DISTRICT COOLING WASTE HEAT TEMPERATURE FOR THE DISTRICT HEATING SUPPLY IN TALLINN: A TECHNICAL AND ECONOMIC ANALYSIS	23
A SHOWCASE FOR RESILIENT AND SUSTAINABLE DISTRICT HEATING IN DENMARK	24
ATTRACTING CUSTOMERS TO DISTRICT HEAT SUPPLY: THE CASE OF RIGA	25
ASSESSMENT OF THE POTENTIAL FOR INCREASING THE ENERGY EFFICIENCY IN THE COOLING SECTOR	26
ARE BSR MUNICIPALITIES ON TRACK FOR ENERGY TRANSITION?	27
ENERGY EFFICIENCY IMPROVEMENT FOR MANUFACTURING COMPANIES IN LATVIA	28
INTEGRATING SUSTAINABLE ENERGY TECHNOLOGIES INTO DISTRICT COOLING SYSTEMS: A REVIEW OF MODELLING AND OPTIMISATION APPROACHES	29
MEASURING THE DECARBONISATION PROGRESS OF BUILDINGS BASED ON EUROPEAN OPEN BIG DATA	30
EXPLORING THE EFFICACY OF RANDOM LINEAR PARAMETER MODELS FOR FORECASTING HEATING DEMAND IN DISTRICT HEATING NETWORKS	31
TECHNO-ECONOMIC MODEL OF DISTRICT HEATING ENERGY HUB: THE CASE OF LATVIA	32
INTEGRATING LOW TEMPERATURE WASTE HEAT IN DISTRICT HEATING SYSTEMS. LEGAL FRAMEWORK AND PRICING	33
ENHANCING THE EVALUATION OF DISTRICT HEATING SYSTEM RESILIENCE: A LITERATURE REVIEW	34
ADAPTIVE BUILDING ENVELOPE STRUCTURES	35
AIR FLOW ANALYSIS FOR TRIPLY PERIODIC MINIMAL SURFACE HEAT EXCHANGERS	36
SAFE INSULATION FROM THE INSIDE AS A SOLUTION TO THE ENERGY AND CLIMATE CRISIS	37

GEOSPATIAL ANALYSIS OF ENERGY POVERTY AND ACCESSIBILITY TO DISTRICT HEATING SYSTEMS	38
THE CREATION OF A NEW MODEL OF A GAS-TURBINE ELECTRIC POWER-GENERATING DEVICE	39
VALIDATING ANSYS HEAT TRANSFER MODELS USING EXPERIMENTAL DATA ANALYSIS OF TWO PHASE CHANGE MATERIALS WITH DIFFERING MELTING TEMPERATURES	40

## 02

<b>ENERGY AND ENVIRONMENTAL MODELLING</b>	<b>41</b>
LIFE CYCLE ASSESSMENT FRAMEWORK FOR DIAGNOSTIC IMAGING	42
SURGICAL PROCEDURES FOR A GREENER FUTURE: AN APPROACH TO ASSESS THE ENVIRONMENTAL IMPACT	43
CHALLENGES IN STANDARDIZING GLOBAL EMISSION FACTORS FOR PEATLANDS	44
VERTICAL HALOPONICS: SUSTAINABLE AND RESILIENT PRODUCTIONS USING BRACKISH WATER	46
PROPORTIONING OF OIL SHALE ASH FOR SUSTAINABLE 3D PRINTABLE MORTARS	47
ASSESSING ENVIRONMENTAL IMPACT: ORGANOSOLV EXTRACTION OF CELLULOSE PULP FROM WOOD WASTE	48
CLIMATE CONSCIOUS COMMUNITIES: NAVIGATING TRANSFORMATION THROUGH SIMULATION GAMES AND CREATIVE ENGAGEMENT	50
INCORPORATING LIFE CYCLE ASSESSMENT IN THE GREEN METRIC RANKING: A CONCEPTUAL APPROACH	51
WILL CHANGING HABITS ENSURE SUSTAINABLE MOBILITY: SYSTEM DYNAMICS MODELLING EXAMPLES FROM MUNICIPALITIES IN FOUR COUNTRIES	52
SUSTAINABLE FISH FEED: A COMPREHENSIVE LIFE CYCLE ANALYSIS	53
REPLACING TRADITIONAL MATERIALS WITH MORE SUSTAINABLE ONES: THE USE OF PHRAGMITES AUSTRALIS (CAV.) TRIN. EX STEUD. AS BIO-BUILDING MATERIAL AND PELLET	54
LIFE CYCLE ANALYSIS OF A BATTERY ENERGY STORAGE SYSTEM	56
CARBON FOOTPRINT OF A NEARLY ZERO ENERGY BUILDING IN ACCRA (GHANA): AN LCA-BASED MODEL	57

## 03

<b>BIOTECHNOLOGIES, BIORESOURCES</b>	<b>58</b>
CREATION OF SINGLE CELL PROTEIN-PRODUCING MUTANTS OF <i>PHAFFIA RHODOZYMA</i>	59

## 04

<b>RENEWABLE ENERGY TECHNOLOGIES</b>	<b>60</b>
A HYBRID EXPERIMENTAL MODELLING APPROACH TO SOLAR PHOTOVOLTAIC CELL TEMPERATURE PREDICTION	61

WATER-ENERGY-FOOD NEXUS FOR CLIMATE CHANGE MITIGATION IN JORDAN	62
WASTE-HEAT RENEWABLE GASIFIER DESIGN THROUGH TAGUCHI'S METHOD AND MANFIS	63
THE IMPACT OF RED III DIRECTIVE ON THE USE OF RENEWABLE FUELS IN TRANSPORT ON THE EXAMPLE OF ESTONIA	64
ANALYTIC HIERARCHY PROCESS ASSESSMENT FRAMEWORK FOR BLOCKCHAIN IN RENEWABLE ENERGY	65
UNVEILING FUTURE OFFSHORE WIND POTENTIAL: A MULTICRITERIA FRAMEWORK FOR SUSTAINABLE DEVELOPMENT	66
REMOTE SOLAR PARKS FOR BUILDING DECARBONISATION: A LITHUANIAN CASE STUDY ON VIRTUAL PROSUMERS	67
ENZYMATIC ACTIVITY OF FUNGI FOR HYDROLYSIS OF WHEAT BRAN AND CULTIVATION OF OLEAGINOUS YEASTS	68
ASSESSING THE FEASIBILITY OF CLIMATE POLICIES OF JAPAN, LATVIA AND LITHUANIA TO REACH THE TARGETS OF THE PARIS AGREEMENT	70
USE OF SOLAR ENERGY TO INCREASE THE SUSTAINABILITY OF SHARED MICROMOBILITY	71
A PRELIMINARY EVALUATION OF ALTERNATIVE RAW MATERIALS FOR PELLET PRODUCTION	72
NATURE-INSPIRED WIND FARM LAYOUT OPTIMIZATION: HARNESSING SMART PATTERNS FOR SUSTAINABLE ENERGY	74
EXPLORING THE POTENTIAL OF RENEWABLE ENERGY TO ENABLE GREEN HYDROGEN PRODUCTION FOR A SUSTAINABLE FUTURE	75
CURRENT TRENDS AND SOLUTIONS FOR PORT DECARBONISATION: A SYSTEMATIC LITERATURE REVIEW	76
CHALLENGES OF UNDULAR JUMP MODELLING	77
ELUCIDATING STAKEHOLDER PRIORITIZATION FOR SUSTAINABLE OFF-GRID RENEWABLE ELECTRIFICATION USING THE FUZZY AHP-GPESTLE FRAMEWORK: A COMPREHENSIVE ANALYSIS	78
PH-OPTIMIZED BIOMETHANE PRODUCTION: EVALUATING CARRIER MATERIALS FOR EX-SITU BIOMETHANATION	80
SUITABLE SOFTWARE FOR THE STUDY OF COMBUSTION PROCESSES IN BOILERS	81
ASSESSING THE APPLICABILITY OF SOLAR THERMAL TECHNOLOGIES FOR INDUSTRIAL TEA DRYING	82

## 05

<b>LOW CARBON DEVELOPMENT AND BIOECONOMY</b>	<b>83</b>
A NOVEL GE-MACKINSEY MARKET APPROACH: INVESTMENT OPPORTUNITY FOR THE BIOPOLYMER PACKAGING MATERIALS	84
CURRENT CHALLENGES AND FUTURE OUTLOOK: TRENDS AND FORECASTS IN THE MARICULTURE SECTOR	85
GREEN WHEELS, GREENER WALLETS: ECONOMIC VIABILITY OF LAST-MILE DELIVERY FLEET ELECTRIFICATION IN CASE OF LATVIA	86

ENVIRONMENTALLY FRIENDLY PROCESSING OF FORESTRY BIOMASS SIDE STREAMS – CONIFEROUS NEEDLES AND GREENERY	88
CARBON FARMING: A SYSTEMATIC LITERATURE REVIEW ON SUSTAINABLE PRACTICES	89
IMPACT OF EU FUNDING ON LATVIAN AQUACULTURE: PRODUCTIVITY, COMPETITIVENESS AND PERSPECTIVES	90
ORGANIC OR NON-ORGANIC AGRICULTURE: COMPARISON OF ORGANIC AND CONVENTIONAL FARMING SUSTAINABILITY	91

## 06

### ENVIRONMENTAL AND ENERGY POLICIES AND FRAMEWORKS 92

USE OF THE NATIONAL CLIMATE AND ENERGY POLICY SIMULATION TOOL IN THE POLICY MAKING PROCESS	93
WHAT TO DO WITH CROSS-BORDER ENVIRONMENTAL POLLUTION: LEGISLATIVE ASPECTS	94

## 07

### ENVIRONMENT, HEALTH, POLLUTION PREVENTION 95

DESIGN OF A FERTILIZING ROBOT APPLICATION WITH REGARD TO ENERGY CONSUMPTION	96
OPTIMIZING THE BATTERY MANAGEMENT ALGORITHM OF THE AGRICULTURAL ROBOT BASED ON THE WORKLOAD	97
ENVIRONMENTAL PERFORMANCE OF A POLYAMIDE-BASED THERMOPLASTIC COMPOUND WITH BROMINATED FLAME RETARDANTS	98
METHODS FOR MEASURING THE IMPACT OF SUSTAINABLE TOURISM DEVELOPMENT ON CLIMATE AND ENVIRONMENT	99
VULNERABILITY OF THE INFRASTRUCTURE: RISK MANAGEMENT AND IMPLEMENTATION OF THE INFORMATION SYSTEMS	100
JUSTIFICATION OF THE USE OF CONTAINER TECHNOLOGY IN DUMPING	101
STEPLESS TRANSMISSION OPTIMIZATION FOR GREEN MICROMOBILITY	102
ANALYZING VNO AIRPORT TRAFFIC DATA OF 2023: SPECIFIC AIRCRAFT NOISE MEASUREMENT AND MITIGATION RECOMMENDATIONS	104

## 08

### WASTE. WASTE TO PRODUCT, VALUE ADDED PRODUCTS 105

INTEGRATION OF ACOUSTIC METAMATERIALS MADE OF PLASTIC TO IMPROVE BUILDING ACOUSTICS	106
INVESTIGATION ON PFAS SOURCES AND REMOVAL IN A MUNICIPAL WASTEWATER TREATMENT PLANT	107
CHITOSAN/GRAPHENE OXIDE/SIO <sub>2</sub> NANOADSORBENTS FOR THE REMOVAL OF CR(VI) FROM WASTEWATERS	108

ANALYSIS AND ASSESSMENT OF H <sub>2</sub> S SORPTION CAPACITY OF THE SELECTED BIOFILTRATION MATERIALS	110
SUSTAINABLE END-OF-LIFE TYRE MANAGEMENT: A COMPREHENSIVE ANALYSIS OF ENVIRONMENTAL IMPACTS AND CRUMB RUBBER INTEGRATION IN COMPOSITE CONCRETES	111
DEVELOPMENT OF GREEN ALKALI-ACTIVATED MORTAR BASED ON BIOMASS WOOD AS	112
ANALYSIS OF INTRODUCING PLASTIC WASTE ENZYMATIC RECYCLING FOR SUSTAINABLE WASTE MANAGEMENT IN LATVIA	114
HOW DOES A DECISION-MAKING TOOL ENHANCE SPENT MUSHROOM SUBSTRATE VALORIZATION INTO POLYSACCHARIDES?	115
DEVELOPMENT OF SUSTAINABLE 3D PRINTABLE TERNARY COMPOSITE	116
SUSTAINABILITY OF BLENDED TEXTILE. LIFE CYCLE ANALYSIS	118
END-OF-LIFE MANAGEMENT OF PHOTOVOLTAIC PANELS: A MODEL FOR FORECASTING AND ECONOMIC EVALUATION	119
SOUND ABSORPTION EVALUATION AND ANALYSIS OF DIFFERENT HEMP FIBER TYPES	120
WET EXTRACTION OF BY-PRODUCT SAMPLES AND FRACTIONATION OF VALUABLE COMPOUNDS USING SUPERCRITICAL CO <sub>2</sub> EXTRACTION: AN INNOVATIVE APPROACH FOR SUSTAINABLE RESOURCE UTILIZATION	121
OPTIMISATION OF THE PRODUCTION OF BIO-BASED BASIC CHEMICALS FROM BIOGENIC SECONDARY WASTE THROUGH DISPERSION	122
BIODEGRADABLE WASTE MANAGEMENT IN GEORGIA: PROBLEMS OF THE COMPOSTING SYSTEM INTRODUCTION	124
STEARATE FROM STEEL WIRE DRAWING PROCESSES AS A RESOURCE	126
FACTORS AFFECTING WASTE RECYCLING HABITS IN LATVIA – RESULTS FROM AN ONLINE SURVEY	127
UNDERSTANDING MUNICIPAL GREEN INITIATIVES AND CITIZEN HABITS IN FOUR BALTIC SEA REGION COUNTRIES: SURVEY RESULTS	128
HOW TO NOT WASTE GLASS WASTE	129
RECYCLING POSSIBILITIES OF WOOD-CEMENT PARTICLE BOARD MANUFACTURING WASTE	130
ADVANCING SUSTAINABLE ACOUSTIC SOLUTION: EXPLORING THE SOUND ABSORPTION CHARACTERISTICS OF BIODEGRADABLE AGRICULTURAL WASTES, COCONUT FIBER, GROUNDNUT SHELL, AND SUGARCANE FIBER	131
BRINE VALORISATION USING MECHANICAL VAPOR COMPRESSION DESALINATION: APPROACHES TO CONSIDER	132
QUANTIFICATION OF LOST RESOURCE POTENTIAL OF UNSORTED TEXTILE WASTE	134
WHAT HAVE WE LEARNT SO FAR ABOUT THE EXTENDED PRODUCER RESPONSIBILITY – RESULTS OF BIBLIOGRAPHIC REVIEW	135
MOVING WASTE SECTOR TOWARDS CLIMATE NEUTRALITY. SCENARIO ANALYSIS	136
EFFICIENT LOW-TEMPERATURE NUTRIENT REMOVAL FROM AGRICULTURAL DIGESTATE USING MICROALGAE	138

<https://doi.org/10.7250/CONNECT.2024.007>

# DESIGN AND PERFORMANCE ASSESSMENT OF DISTRICT HEATING SYSTEMS IN THE LATVIAN REGION

Giovanni BRUMANA<sup>1\*</sup>, Gatis BAZBAUERS<sup>2</sup>, Giuseppe FRANCHINI<sup>3</sup>,  
Elisa GHIRARDI<sup>4</sup>, Madara RIEKSTA<sup>5</sup>

<sup>1,3,4</sup> *Department of Engineering and Applied Sciences, University of Bergamo, 5 Marconi Street, Dalmine 24044, Italy*

<sup>2,5</sup> *Institute of Energy Systems and Environment, Riga Technical University, Āzenes iela 12/1, Riga, LV-1048, Latvia*

<sup>5</sup> *JSC Rigas Siltums, Cēsu iela 3A, LV-1012, Latvia*

\* **Corresponding author.** Email address: [giovanni.brumana@unibg.it](mailto:giovanni.brumana@unibg.it)

**Abstract** – The energy consumed by buildings for air conditioning accounts for a large percentage of global energy consumption. To promote efficiency and sustainability, the scientific community is making great effort to develop renewable technologies. A well-known but unfortunately underestimated solution is the development of centralized heating and cooling systems that consistently reduce energy consumption. The work proposes a comparison between three heating configurations covering the demand of a settlement in the Latvian region: 1) centralized district heating (DH) system; 2) 5<sup>th</sup> generation district heating & cooling (5GDHC) system and 3) individual home heating (HH) systems. Thermal and electrical loads are evaluated by transient simulations of a residential area with 80 buildings for the Riga climate and compared with the same settlement in a Mediterranean region (Milan, IT). The energy plants are based on different technologies: combined heat and power (CHP) plants, gas-fired boilers, and domestic heat pumps. The analysis includes the option of power exchange with the national grid. A transient numerical model has been developed for each solution. Every component is modelled according to performance maps provided by the manufacturers, allowing an accurate simulation in both design and off-design operating conditions. The study covers energy, economic and environmental aspects. The result of the simulation highlights the large difference between the two locations, not only in terms of annual load but also in terms of load distribution. On an annual basis, the Latvian residential complex requires almost twice as much energy as the Italian one. The thermal losses in the district systems are 4.21 % in Milan solution and 5.65 % in Riga. The district heating system coupled with heat pump represents the best layout in terms of primary energy consumption in both locations, with energy savings of 50 % compared to other solutions. The use of 5GDHC is a good compromise that could increase the use of renewable energy. The adoption of cogeneration plant is a good choice in case of centralized district system that allows the installation of high efficiency genset. On the contrary, for small application as residential, the installation of cogeneration system results expensive and the conversion efficiency does not justify the installation.

**Keywords** – *District heating; energy efficiency; transient simulation*