



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement für
Umwelt, Verkehr, Energie und Kommunikation UVEK
Bundesamt für Energie BFE

Eracobuild

INTEGRATED STRATEGIES AND POLICY INSTRUMENTS FOR RETROFITTING BUILDINGS TO REDUCE PRIMARY ENERGY USE AND GHG EMISSIONS (INSPIRE)

Final status report and deliverables

10 February 2014, updated 12 March 2015

Prepared by

TEP Energy GmbH

Rotbuchstr. 68, CH-8037 Zürich, Switzerland, www.tep-energy.ch

econcept AG

Gerechtigkeitsgasse 20, CH-8002 Zürich, Switzerland, www.econcept.ch

**Lund University, International Institute for Industrial Environmental
Economics (IIIEE)**

P.O. 196, SE-221 00 Lund, Sweden, www.lunduniversity.lu.se

Aalborg University, Department of Development and Planning

Fredrik Bajers Vej 5, 9220 Aalborg, Denmark, www.plan.aau.dk

**Politehnica University of Timisoara, Faculty of Civil Engineering,
Department of Steel Structures and Structural Mechanics**

Str. Ioan Curea no. 1, RO-300224 Timisoara, Romania, www.upt.ro

VTT Technical Research Centre of Finland

P.O. Box 1000, FI-02044 VTT, Finland, www.vtt.fi

Funded by

SFOE – Swiss Federal Office of Energy
3003 Bern, Switzerland

FORMAS – The Swedish Research Council Formas
Kungsbron 21, Box 1206, 11182 Stockholm, Sweden

Erhvervs og Byggestyrelsen
Denmark

TEKES – The Finnish Funding Agency for Innovation
P.O. Box 69, FI-00101 Helsinki

UEFISCDI – Executive Agency for Higher Education, Research, Development and Innovation Funding
Mendeleev street 21-25 Bucharest, 010362 Romania

In the frame of the ERA-NET, «Eracobuild»

Authors

Martin Jakob, TEP Energy, Zurich (Coordinator)

Walter Ott, econcept, Zurich (Deputy Coordinator)

Roman Bolliger, econcept, Zurich

Sonja Kallio, TEP Energy, Zurich

Hristina Chobanova, TEP Energy, Zurich

Claudio Nägeli, TEP Energy, Zurich

Remo Forster, TEP Energy, Zurich

Stefan von Grünigen, econcept, Zurich

Arne Remmen, Department of Development and Planning, Aalborg University, Denmark

Davide Maneschi, Department of Development and Planning, Aalborg University, Denmark

Mette Alberg Mosgaard, Department of Development and Planning, Aalborg University, Denmark

Christoffer Kirk Strandgaard, Department of Development and Planning, University of Aalborg, Denmark

Bernadett Kiss, IIIIEE, University of Lund, Sweden

Viorel Ungureanu, Politehnica University of Timisoara, Faculty of Civil Engineering, Romania, Department of Steel Structures and Structural Mechanics

Alexandru Botici, Politehnica University of Timisoara, Faculty of Civil Engineering, Romania, Department of Steel Structures and Structural Mechanics

Adrian Ciutina, Politehnica University of Timisoara, Faculty of Civil Engineering, Romania, Department of Steel Structures and Structural Mechanics

Ludovic Fülöp, VTT Technical Research Centre of Finland, Finland

Asko Talja, VTT Technical Research Centre of Finland, Finland

The authors are carrying the full responsibility for the content and the conclusion of this report.

Download:

www.bfe.admin.ch/dokumentation/energieforschung

Content

- 1 The INSPIRE project objectives and achievements..... 5
- 2 WP 1: Techno-economic assessment of energy-efficient building retrofit strategies..... 8
- 3 WP 2: Case studies of sustainable renovation in Eastern and Northern Europe 9
- 4 WP 3: Embodied energy and embodied GHG of energy-efficient building retrofit strategies 14
- 5 WP 4: Policy instruments for innovation of energy efficient retrofit measures in existing building..... 17
- 6 WP 5: Synthesis 20
- 7 Bibliography (additional references not listed in previous sections) 21

1 The INSPIRE project objectives and achievements

This report collects to all the deliverables of the international Eracobuild project INSPIRE. Its objectives are presented below, followed by the general project achievements.

The work package of the project are presented in the subsequent chapters. Each chapter is introduced with the work package description, agreed milestones and deliverables, and concluded the final achievements and deliverables that represent the outcome of the considered work package.

PROJECT OBJECTIVES

The goal was systematically to 1) evaluate retrofit strategies regarding their technological applicability, economic performance, impact on primary energy and CO₂-emissions, and interactions with other retrofit needs and 2) to seek for adequate and tailored policy strategies and instruments, depending on building types, actors and institutional or country contexts.

The research was meant to result in

- a) guidelines and specific advice for technically and economically favourable retrofit strategies and basics for retrofit evaluating tools.
- b) design guidelines, including intervention points, for policy approaches and institutional settings to foster energy- and CO₂-efficient retrofitting. Results may be used in building retrofit policy strategy tools.
- c) identification of business opportunities for the retrofit and renewable energy sector in EU countries (particularly EE).
- d) involvement of relevant actors, stakeholders and organizations from the industry, the demand side and the authorities.

ACHIEVEMENTS

The main achievements of the INSPIRE project are presented hereafter. The project systematically evaluated retrofit strategies within different countries regarding their technological applicability, economic performance, impact on primary energy and CO₂-emissions, and interactions with other retrofit needs. These evaluations are presented in the synthesis report (D5.2). The other goal was to seek for adequate and tailored policy strategies and instruments, depending on building types, actors and institutional or country contexts. These are presented as well in the synthesis report (D5.2).

The research resulted in

- a) Guidelines and specific inputs for technically and economically favorable retrofit strategies, presented in Chapter 2 of the international INSPIRE report which is a main part of WP 1.
- b) From the methodological point of view the design guidelines for policy approaches and institutional settings to foster energy- and CO₂-efficient retrofitting were achieved and are presented in Chapter 3 of the final INSPIRE report (WP 4).
- c) The business opportunities for energy efficiency retrofits in EU countries, mainly Eastern Europe, are presented in the deliverables of WP 2.

d) The relevant actors, stakeholders and organizations from the industry, demand side and authorities were involved successfully in the ISPIRE project. Especially, the Swiss part of the project was adjusted towards the needs of these actors from the different fields. The INSPIRE tool was developed instead of general guidelines in order to serve better the needs of different actors.¹ Additionally, the actors were involved into an advisory and council group in order to meet their needs better. The Romanian industry partners were also successfully involved into the international part of the INSPIRE project.

The seminar in D2.3 was divided into two parts in order to involve better the early practical decision makers in Romania, such as small design offices, micro-companies and SME's. Due to this the seminar was held first in Romanian language and then in English.

¹ It can be download from www.energieschweiz.ch > Gebäude > Energierechner > INSPIRE Tool

2 **WP 1: Techno-economic assessment of energy-efficient building retrofit strategies**

The objective of WP1 based on the project description:

Currently available technologies and retrofit practices should be evaluated with respect to technical performance, primary energy needs, range of application, costs and CO₂ emission reduction potential, for both broadly available and best practice technologies.

The existing building stock should be classified (country-wise) into the most common building types (BTs) with respect to appropriate energy-efficiency retrofit measures: One- and two-family houses, multi-family houses, office buildings, school buildings, etc.

For each of these BTs technology mixes to fulfil ambitious energy standards are to be determined. Focus should be on cost efficient reduction of primary energy consumption and greenhouse gases. Especially interesting is the exploration of favourable mixes of measures to reduce energy losses of buildings and measures to tap renewable energies within the building perimeter.

The WP is carried out by econcept AG (responsible) and TEP Energy GmbH, with inputs from all partners.

Agreed milestones:

M1.1: Methodology, BTs, technologies, energy standards, methodology for the evaluation of retrofit strategies and for data collection in the different countries.

M1.2: Appraisal of energy-efficiency retrofit strategies in terms of their cost-effectiveness, their primary energy use and CO₂-emissions.

Agreed deliverables:

D1.1: Report on WP1.

The work package achievements and deliverables of WP 1:

The milestones were reached successfully and the planned deliverable D1.1 is Chapter 2 of the international final report of the project (Jakob M., et al., 2015).

3 WP 2: Case studies of sustainable renovation in Eastern and Northern Europe

The objective of the WP2 based on the project description:

Scope of WP2 is the adaptation of renovation experience of prefabricated concrete residential buildings in Finland to Eastern European (EE) countries, with special focus on the technological, economic, institutional and policy setting.

Concrete residential buildings represent the largest retrofitting challenge in EE; and one of the best opportunities to substantially improve energy efficiency of residential buildings.

The solutions from WP1, are to be reviewed from the points of view of: (i) technological applicability in EE, (ii) compatibility with other, non-energy focused retrofit needs of concrete residential buildings and (iii) economic feasibility in EE markets. Therefore, the solutions are to be analysed in a broader perspective, by integrating all the complex aspects of a building retrofit intervention.

Agreed milestones

M2.1: Identify common deficiencies of existing concrete building typologies and technological solutions for correcting them.

M2.2: Retrofit market conditions in Romania; propose business models for financing retrofit.

M2.3: Proposed detailed retrofit measures in case study examples and assess their impact.

Agreed deliverables

D2.1: Workshop for problem identification and search of suitable refurbishment (Romania).

D2.2: Report on the market situation and business opportunities.

D2.3: Seminar disseminating the results. Synthesis results to upgrade teaching material for the training energy auditors (Romania).

The work package achievements and deliverables of WP 2:

D2.1: Workshop for problem identification and search of suitable refurbishment strategies

The workshop "Strategies for cost-optimal energy efficient and sustainable building retrofits" – 29th March 2012 was co-organized by VTT and IIIIEE in Espoo, Finland. This workshop and the planned workshop in WP4 (D4.4) were unified. The following items represent the outputs from the workshop:

- VTT, IIIIEE (2012). *Workshop program*.
- Jakob M., Bolliger R. (2012). *Why are we INSPIREd? Introduction to the workshop and the project*. TEP Energy GmbH, econcept AG, Zürich.
- Botici A., Ungureanu V., Ciutina A., Nagy Zs., Talja A., Fülöp L. (2012). *Prefabricated buildings in East Europe - a retrofit challenge and opportunity*.

- Kiss B. Maneschi D.(2012). *Actors in building retrofits. A meso-level perspective.*
- Kiss B. Maneschi D.(2012). *Strategies for energy efficient retrofitting. The role of policy instruments and actors.*
- Nielsen P. (2012). *Perspective on sustainable retrofitting (Energy City Frederikshavn).*
- Aaltonen T. (2012). *Retrofitting strategies of housing associations.*
- Soilu J. (2012). *How Companies View Sustainable Retrofitting.*

The deliverables D2.1 and D4.4 were merged due to the similarities of the views of participants from Nordic countries. This arrangement facilitated networking between stakeholders from Sweden, Denmark and Finland; and contributed to collect a boarder point of view on the problem identification and search of suitable refurbishment strategies. The summary outcome of the joint D2.1, D4.4 "way finding" workshop were the excellent remarks written by Walter Ott "Strategies for cost-optimal energy efficient and sustainable building retrofits" (Ott W., 2012), summarizing remarks to Espoo workshop and defining the direction of research for all activities in INSPIRE.

D2.2: Report on the market situation and business opportunities

There are two deliverables within D2.2:

- Riihimäki M., Perälä A., Jaakkonen L., Grönfors T. (2012). The report: *Retrofit Market and Business Models of Romania*
- Nagy Z. Fülöp L. (2012). The report: *Business models for the renovation market in Romania and Eastern European countries*

D2.3: Seminar disseminating the results of Romania in the WP 2. Synthesis results to upgrade teaching material for the training energy auditors.

As deliverable D2.3 there is one seminar, which was held in two versions for two audiences because some of the stakeholder groups in Romania who were targeted would not join a seminar in English language. Early practical decisions on refurbishment are often in the hand of small design offices, most often micro-companies or SME's. These stakeholders were targeted with a Romanian language seminar, with information from the INSPIRE findings, tailored to their interest.

The first one was held for designers organized by PUT in Romanian language on 20th November 2012. Having the title "Strategii pentru reabilitarea structurală și termică a clădirilor realizate din panouri mari prefabricate din beton armat în vederea reducerii consumului primar de energie și reducerea emisiilor de gaze cu efect de seră – InSPIRe - 20th November 2012" the following topics were presented:

- Ungureanu V. (2012). *Prezentarea proiectului internațional: Strategii pentru reabilitarea structurală și termică a clădirilor realizate din panouri mari prefabricate din beton armat în vederea reducerii consumului primar de energie și reducerea emisiilor de gaze cu efect de seră – InSPIRe.*
- Botici A. (2012). *Aspecte arhitecturale privind reabilitarea structurilor de locuit din panouri mari prefabricate.*
- Stoian V. (2012). *Strategii pentru refuncționalizarea clădirilor de locuit multietajate alcătuite din panouri mari prefabricate.*

- Ciutina A. (2012). *Intervenții structurale și soluții pentru reabilitarea termică a blocurilor de locuințe din panouri mari prefabricate.*
- Todut C. (2012). *Reabilitarea structurală a panourilor mari prefabricate afectate de intervențiile de refuncționalizare.*
- Florut C. (2012). *Consolidarea plăcilor din beton armat ca urmare a refuncționalizării spațiilor în clădirile de locuit.*
- Bocan C. (2012). *O supraetajare ușoară din beton armat pentru reabilitarea blocurilor tipizate P+4E.*

Presentations available here: <http://virtual.vtt.fi/virtual/respire/progress.html>

The second seminar (Opportunities in sustainably retrofitting of large panel reinforced concrete building stock - 28th January 2013 – Timisoara) was held for a broader audience of stakeholders, such as city authorities, architects, companies, researchers and international participants) on 28th January 2013, co-organized by PUT and VTT, yielding in the following contributions:

- Ungureanu V. (2012). *Introduction to the seminar and the work in INSPIRE.*
- Fülöp L. (2012). *Introduction to the seminar and the work in INSPIRE.*
- Bădescu Ș., Radoslav R. (2012). *Urban sustainable strategies.*
- Ciurariu S. (2012). *Retrofit as a community revitalizing tool. Perspective of city authority.*
- CONSTRUCTIM S.A.- Retrofit as a business. Presentation of a company active in this business area in Romania.
- Botici A.A., Ciutina A., Ungureanu V., Botici A., Dubina D. (2012). *Sustainable retrofitting solutions for precast concrete residential buildings – architectural and structural aspects(part 1 and 2).*
- Stoian V., Daniel D., Nagy-Gvörgy T., Demeter I., Florut C., Todut C., Pecari S., Fofiu M., Bindean A. (2012). *Seismic performance of a precast RC wall and floor panels retrofitted using CFRP composites.*
- Ciutina A., Ungureanu V., Grecea D., Dubina D. (2012). *Sustainable thermal retrofitting solutions for multi-storey residential buildings.*
- Talja A. (2012). *Overview of retrofit practice in Finland.*
- Nagy Zs., Talja A., Fülöp L. (2012). *Business models for renovation in different market environments.*
- Popov M., Szitar M., Sămânță M. (2012). *An Integrated Approach Towards the Retrofitting of Prefabricated Panel Blocks of Flats.*
- Fülöp L., Ungureanu V., Ott W., Bolliger R., Jakob M. (2013). *Cost effectiveness of energy retrofit solutions – Results from generic calculations with a reference building in Romania.*

Presentations available here: <http://virtual.vtt.fi/virtual/respire/progress.html>

These seminars were used to disseminate the results of the WP2 in Romania.

Based on the presented work the deliverables of the second seminar have been published as a collection of papers in a book: Ungureanu V., L Fülöp (editors) (2013). Opportunities

in sustainably retrofitting the large panel reinforced concrete building stock., Editura Orizonturi Universitare, 2013, ISBN: 978-973-638-537-7.

Additional deliverables

D2.4: Additional deliverables to disseminate the results

The following articles were delivered as additional disseminations of the WP 2's results.

- Botici A.A., Ungureanu V., Ciutina A., Botici A., Dubina D. (2014). *Structural interventions for rehabilitation of precast large concrete panels for residential buildings*. Proceedings of the 2nd International Conference on Protection of Historical Constructions. 7-9 May 2014, Antalya, Turkey, Bogazici University Publishing, Istanbul, ISBN 978-975-518-361-9, 133-139.
- Botici A.A., Ungureanu V., Ciutina A., Botici A., Dubina D. (2013). *Steel Retrofitting Solutions for Collective Buildings by Interior Repartitioning*. Design, Fabrication and Economy of Metal Structures, Proceedings of the International Conference, Miskolc, Hungary, 24-26.04.2013, 601-606, Springer-Verlag, ISBN 978-3-642-36690-1.
- Botici A.A., Ungureanu V., Ciutina A., Botici A., Dubina D. (2013). *Sustainable retrofitting of large panel prefabricated concrete residential buildings*. Central Europe Towards Sustainable Building 2013-Sustainable Building and Refurbishment for Next Generations. 39-42 (+CD), Praga, Czech Republic, 26-28.06.2013, ISBN 978-80-247-5015-6.
- Ungureanu V., Botici A.A., Bolliger R., Ott W., Fulop L., Jakob M., Stoycheva Chobanova H., Kiss B., Manenschi D., Mosgaard M., Remmen A (2013). *Integrated strategies for retrofitting buildings to reduce primary energy use, GHG emissions and costs*. Central Europe Towards Sustainable Building 2013-Sustainable Building and Refurbishment for Next Generations. 183-186 (+CD), Praga, Czech Republic, 26-28.06.2013, ISBN 978-80-247-5015-6.
- Ciutina A., Ungureanu V., Dubina D., Grecea D. (2013). *Integrated design applied in thermal retrofitting solutions for residential buildings*. Proc. of the 2nd International Conference on Structures and Architecture: Concepts, Applications and Challenges – Cruz (ed), 187-188 (615-622 on CD), 24-26.07.2013, Guimaraes, Portugal, CRC Press, Taylor & Francis Group, London, ISBN 978-0-415-66195-9.
- Botici A., Ciutina A., Ungureanu V., Dubină D. (2013). *Soluții structurale metalice pentru reabilitarea funcțională a clădirilor de locuit din panouri mari prefabricate din beton armat*. A XIII-a Conferință Națională de Construcții Metalice: Tendințe actuale în Ingineria Structurilor Metalice, București, 21-23.11.2013, Ed. Conspress București, ISBN: 978-973-100-306-1, pp. 255-264.
- Botici A., Ungureanu V., Ciutina A., Botici A., Dubina D., Nagy Zs., Riihimäki M., A. Talja, Fülöp L. (2014). Sustainably challenges of residential reinforced - concrete panel buildings. *Urbanism. Arhitectură. Construcții*. Vol. 5, Nr. 2, 2014, ISSN 2069-0509 (print) / 2069-6469 (on-line).
- Botici A.A., Ungureanu V., Ciutina A., Botici A., Dubina D. (2012). *Architectural and structural retrofitting solutions for large precast concrete residential buildings*. Proceedings of iNDiS 2012 - Planning, Design, Construction and Renewal in The Civil Engineering. Novi Sad, Serbia 28-30, November. ISBN 978-86-7892-453-8, pp. 530-539.

- Botici A.A., Ungureanu V., Ciutina A., Botici A., Dubina D (2012). *Sustainable retrofitting solutions for precast concrete residential buildings*. Proceedings of the Third International Symposium on Life-cycle Civil Engineering: Life-Cycle and Sustainability of Civil Infrastructures, IALCCE 2012, Vienna, Austria, 3-6.10.2012, CRC Press, Taylor & Francis Group, ISBN: 978-0-415-62126-7, pp. 357 + CD (1722-1729).
- Ungureanu V., Ciutina A., Dubina D. (2012). *Sustainable thermal retrofitting solutions for multi-storey residential buildings*. Proceedings of the Third International Symposium on Life-cycle Civil Engineering: Life-Cycle and Sustainability of Civil Infrastructures, IALCCE 2012, Vienna, Austria, 3-6.10.2012, CRC Press, Taylor & Francis Group, ISBN: 978-0-415-62126-7, pp. 361 + CD (1753-1760).
- Botici A.A., Ungureanu V., Botici A., Dubina D. (2011). Interventii structurale pentru reabilitarea functională a blocurilor de locuinte din panouri mari prefabricate. Revista AICPS Review 3/2011 (ISSN: 2067-4546, acreditata CNCSIS – cod 316), pp. 53-67. PhD Final Defence - Alexandru Botici: Studies on rehabilitation systems of residential collective buildings built with large precast concrete panels. UPT PhD Thesis, Seria X, Nr. YY, Editura Politehnica, 2014, 371 pp. ISSN: 1842-581X, ISBN: 978-606-554-801-5.951-38-7820-7.
- Nagy-György T., Fülöp L., Demeter I. (2012): Panelépületek felújítása – Miért? Miként? (Rehabilitation of Panel Buildings – Why? How?), Conference on Civil Engineering and Architecture – EPKO, June 2012 (in Hungarian).
- Nagy Zs., Fülöp L., Talja A., Reconversion of Flat Buildings Administration: New Romanian Business Opportunities, Advanced Engineering Forum 8, 621-630
- Nagy Zs., Fülöp L., Talja A., Are we too capitalists for a comfortable life? business models for future and existing flat building administration, Quality - Access to Success (S5), pp. 205-210.

4 WP 3: Embodied energy and embodied GHG of energy-efficient building retrofit strategies

The objective of the WP3 based on the project description:

In WP 3, the impact of embodied energy and embodied GHG on the performance of building retrofit strategies is explored and integrated into the evaluation framework of WP 1. More precisely it is investigated to which extent primary energy efficiency and GHG mitigation performance and thus, cost-effectiveness is undermined if embodied energy and embodied GHG is included in the considerations.

WP 3 is carried out by TEP Energy GmbH (responsible) and econcept AG, with inputs from all partners. The contribution of each country typically includes a description of the state-of-the-art of embodied energy and embodied CO₂ in the building sector:

- Definition and methods used in each country
- Description of data availability and list of literature (including provision of copies)
- Compilation of some key figures (e.g. kWh and kgCO₂ per m²) of construction elements and building technologies (e.g. wall, window, heating system) and energy-efficiency measures (e.g. wall insulation).

Agreed milestones

M3.1: Methodology on how to include embodied energy and embodied GHG emissions into the evaluation framework of WP1.

M3.2: Literature review of the significance of embodied energy and embodied GHG of the most relevant retrofit measures such as envelope insulation, window replacement and heating systems such as heat pumps, by BT and country.

Agreed deliverables

D3.1: Final report on the performance of efficient retrofit strategies and portfolios with and without including embodied energy and embodied GHG emissions. Consortium workshop to disseminate the findings, country-specific workshops with interested actors.

The work package achievements and deliverables of WP 3:

D3.1: Final report on the performance of efficient retrofit strategies and portfolios with and without including embodied energy and embodied GHG emissions. Consortium workshop to disseminate the findings, country-specific workshops with interested actors.

- The methodology on how to include embodied energy and embodied GHG emissions into the evaluation framework of WP 1 was developed and included into the INSPIRE tool (Jakob M., von Grünigen S., Kallio S., Bolliger R., & Ott W., 2013). The tool is equipped with an opportunity to investigate retrofit strategies with and without embodied energy and GHG emissions. Additionally, the influence of different retrofit measure selections to the increase or reduction of embodied energy and GHG emissions can be investigated with the tool because embodied energy and GHG emissions are included in the tool (see Footnote1 on page 6 for download link).

- The Swiss report on the generic strategy calculations includes an investigation of reducing embodied energy and GHG emissions by choosing less embodied energy and GHG emissions intensive retrofit measures. Jakob M., Ott W., Kallio S., Bolliger R., & von Grünigen S. (2014). Integrate
- d strategies and policy instruments for retrofitting buildings to reduce primary energy use and GHG emissions (INSPIRE) - Final synthesis report regarding generic strategies for buildings in Switzerland. TEP Energy, econcept AG, Zürich.
- Conference paper about the INSPIRE tool, which considers the embodied energy use and was presented in the CISBAT 2013 conference in Lausanne, Switzerland. Jakob M., Ott W., Bolliger R., von Grünigen S., Kallio S., & Nägeli C. (2014). A comprehensive instrument to assess the cost-effectiveness of strategies to increase energy efficiency and mitigate greenhouse gas emissions in buildings. TEP Energy GmbH, econcept AG, Zürich.
- The literature review of the significance of embodied energy and embodied GHG of the most relevant retrofit measures by country was written as a separated document. (Jakob M., et al., 2013).
- A lean version of the INSPIRE tool, including embodied energy use was applied for parametric calculations of cost effective energy and GHG optimized building renovation measures in 8 European countries within IEA EBC Annex 56.

5 **WP 4: Policy instruments for innovation of energy efficient retrofit measures in existing building**

The objectives of WP4 based on the project description:

WP 4 is focusing on analysing the role of learning and networking in energy efficient (EE) renovations considering the following four aspects: (1) The challenges of (current) policy strategies with regards to the implementation of EE retrofit technologies are identified. EE strategies and policy instruments for more EE and cost effective retrofitting in Europe are reviewed. (2) Building projects, incl. broadly applied and best practice retrofit measures are assessed, focusing on the role of knowledge development, learning, networking, actors and institutions. (3) Based on the assessments, key success factors are identified for the development and implementation of different EE retrofit measures. (4) It will be crucial for future design of different policy instruments addressing more efficient energy use in existing buildings. It also helps to identify points of intervention in the technology development and implementation phase (in terms of both new and currently applied solutions) for policy design. Innovative policy instruments are discussed with the focus on network support.

WP 4 is carried out by IIIIEE of Lund University (responsible) and Aalborg University.

Agreed milestones:

M4.1 Policy strategies for retrofit measures.

M4.2 The assessment of retrofit building projects in different national contexts. Identification of success/failure factors.

M4.3 Comparative analysis of building projects. Identification of points of intervention.

M4.4 Future policy design for retrofit strategies.

M4.5 Synthesis and reporting on WP4.

Agreed deliverables:

D4.1: Workshop on retrofit strategies and supporting policy instruments.

D4.2. Academic paper on EE retrofit strategies and the role of learning and networking in a broader policy context.

D4.3. Academic article on the success/failure factors of innovation of retrofit approaches and intervention points for future policy mix.

D4.4 Seminar with the aim of triangulating the results of M4.3-M4.4.

D4.5 Report on WP4.

Work package achievements and deliverables of WP 4:

D4.1: Workshop on retrofit strategies and supporting policy instruments

The workshop on Sustainable Buildings Aalborg was carried out by Aalborg University. In addition to the workshop agenda and invitation two presentations were delivered as deliverables of the workshop.

- Seminar program (Aalborg University, 2012).

- The presentation: Promoting energy efficiency renovations: the role of banks (Maneschi D., 2012).
- The presentation: Policy instruments for energy efficient buildings (Kiss B., 2012).

D4.2: Academic paper on EE retrofit strategies and the role of learning and networking in a broader policy context.

The academic paper "Emerging actors in sustainable renovations of single-family houses" (Maneschi D., 2012) was presented in the ERSCP2012 conference in Bregenz, Austria, May 2012. The following contribution was done for the conference as well:

- The academic paper for the oral presentation in the ERSCP2012 conference: Emerging actors in sustainable renovations of single-family houses (Maneschi D., 2012).
- The oral presentation in the ERSCP2012 conference: Banks and energy renovations of buildings (Maneschi D., 2012).
- The abstract presented as a poster in the ERSCP2012 conference: Changing practices of built environment professionals to face sustainability challenges. Analysis of two Scandinavian case studies. (Montrucchio V. & Maneschi D., 2012)
- Building Energy Efficiency – Policy, learning and technology change. PhD thesis. Online available: <http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=3738662&fileOId=3738663> (Kiss B., 2013)

D4.3: Academic article on the success/failure factors of innovation of retrofit approaches and intervention points for future policy mix.

The journal articles for this deliverable D4.3 are still under work. However, two conference papers were presented in the IST2012 and ECEE2013 and delivered within D4.3:

- Widening the scope? How intermediary actors can change energy consumption patterns? (Maneschi D., 2012).
- Energy retrofitting in existing buildings – an interactive construction of change? (Kerndrup S., Moesgaard M., & Maneschi D., 2012).
- Exploring Transaction Costs in Passive-house oriented retrofitting. In Building Energy Efficiency – Policy, learning and technology change. Online available: <http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=3738662&fileOId=3738663> (Kiss B., 2012)

D4.4: Seminar with the aim of triangulating the results of M4.3-M4.4

This deliverable was met with a common workshop in WP 2. See WP 2 and D2.1 for the references.

D4.5: Report on WP4

The report on the WP 4 is the Chapter 3 in the final international report (Jakob M., et al., 2015) and is successfully delivered.

6 WP 5: Synthesis

In WP 5, a synthesis is performed to generate guidelines of energy- and CO₂-efficient retrofit strategies and tailored policy instruments to foster their diffusion, by country.

The work package achievements and deliverables of WP 5:

D5.1: General dissemination activities

- Annual report to the Swiss Federal Office of Energy with focus on WP 1. Jakob M., Ott W., Gross N., & Bolliger R. (2011). Integrated strategies and policy instruments for retrofitting buildings to reduce primary energy use and GHG emissions (INSPIRE). Zürich: TEP Energy GmbH, econcept AG.
- The poster presented in the ERSCP2012 conference in Bregenz, Austria: Jakob M. , Ott W., Gross N., Bolliger R., & Unterhollenberg S. (2012). Searching for energy-efficient building retrofit strategies leading to cost-optimality. TEP Energy GmbH, econcept AG, Zürich.
- Presentation of PhD research: The role of banks in energy efficient renovation of buildings. (Maneschi D., 2011).
- Presentation of PhD research: The role of intermediaries in energy efficient renovation of buildings. (Maneschi D., 2011).
- Annual report to Ehrverv- och Bolygstyrelsen (Maneschi D., Mosgaard M., & Remmen A., INSPIRE 2011 project Status Report , 2011) and (Maneschi D., Mosgaard M., Strandgaard C. , & Remmen A. , 2012).
- Participation in Building Green conference in Copenhagen, October 2012, (no written output).

D5.2: Synthesis Report.

The final international report is delivered. (Jakob M., et al., 2015)

7 Bibliography (additional references not listed in previous sections)

- Aalborg University. (2012). *Sustainable Buildings: strategies and policies for energy efficient renovations*. Aalborg: Aalborg University, Department of Development and Planning.
- Aaltonen T. (2012). *Retrofitting strategies of housing associations*. Omataloyhtiö.fi, Sanoma Digital.
- Botici A., Ungureanu V., Ciutina A., Nagy Zs., Talja A., & Fülöp L. (2012). Prefabricated buildings in East Europe - a retrofit challenge and opportunity. Politehnica University of Timisoara, Technical University of Cluj, VTT Technical Research Centre of Finland.
- Jakob M. (2010). *INSPIRE - Integrated strategies and policy instruments for retrofitting buildings to reduce primary energy use and GHG emissions*. Zürich: TEP Energy GmbH.
- Jakob M., Bolliger R., Kallio S., Chobanova H., Nägeli C., von Grünigen S., . . . Fülöp L. (2013). *The consideration of Embodied Energy in the context of the building envelope performance - Research in the context of project INSPIRE*. TEP Energy, econcept, Lund University Sweden, Aalborg University, University of Timisoara, VTT.
- Jakob M., Ott W., Kiss B., Fülöp L., Maneschi D., Bolliger R., . . . Talja A. (2015). *Integrated strategies and policy instruments for retrofitting buildings to reduce primary energy use and GHG emissions (INSPIRE)*. Zürich: TEP Energy GmbH, econcept AG.
- Jakob M., von Grünigen S., Kallio S., Bolliger R., & Ott W. (2013). *Dokumentation zum INSPIRE Tool*. Zürich: TEP Energy GmbH, econcept AG.
- Kerndrup S., Moesgaard M., & Maneschi D. (2012). *Energy retrofitting in existing buildings - an interactive construction of change?* Aalborg: Aalborg University.
- Kiss B. (2012). *Policy instruments for energy efficient buildings*. Aalborg: International Institute for Industrial Environmental Economics, Lund University.
- Kiss B., & Maneschi D. (2012). *Strategies for energy efficientretrofitting - The role of policy instruments and actors*. Lund University, Aalborg University.
- Kiss B., & Maneschi D. (2012). *Actors in building retrofits - A meso-level perspective*. Lund University, Aalborg University.
- Maneschi D. (2011). *The role of banks in energy efficient renovation of buildings*. Aalborg: Stockholm School of Economics.
- Maneschi D. (2011). *The role of intermediaries in energy efficient renovation of buildings*. Aalborg: Aalborg University.
- Maneschi D. (2012). *Promoting energy efficiency renovations: the role of banks* . Aalborg: Aalborg University, Department of Development and Planning .
- Maneschi D. (2012). *Emerging actors in sustainable renovations of single-family houses*. Aalborg: Department of Development and Planning, Vestre Havnepromenade 9, Aalborg, 9000 Denmark.
- Maneschi D. (2012). *Banks and energy renovations of buildings*. Aalborg: Department of Development and Planning.

- Maneschi D. (2012). *Widening the scope? How intermediary actors can shape energy consumption*. Aalborg: Aalborg University.
- Maneschi D., Mosgaard M., & Remmen A. (2011). *INSPIRE 2011 project Status Report*. Aalborg: Aalborg University.
- Maneschi D., Mosgaard M., Strandgaard C., & Remmen A. (2012). *INSPIRE project Status Report 2012*. Aalborg: Aalborg University.
- Montrucchio V., & Maneschi D. (2012). *Changing practices of built environment professionals to face sustainability challenges. Analysis of two Scandinavian case studies*. Bregenz: Department of Architecture and Design, Polytechnic of Turin; Department of Development and Planning, Aalborg University.
- Nagy Z., & Fülöp L. (2012). *Business models for the renovation market in Romania and Eastern European countries*. Tampere: VTT Technical Research Centre of Finland.
- Ott W. (2012). *Strategies for cost-optimal energy efficient and sustainable building retrofits - Summarizing remarks to Espoo workshop*. Zürich: econcept AG.
- Riihimäki M., Perälä A., Jaakkonen L., & Grönfors T. (2012). *Retrofit Market and Business Models of Romania*. Tampere: VTT Technical Research Centre of Finland.
- Ungureanu V., & Fülöp L. (editors). ((2013)). *Opportunities in sustainably retrofitting the large panel reinforced concrete building stock*. Timisoara: Editura Orizonturi Universitare.
- VTT, IIIIEE. (2012). *WORKSHOP: Strategies for cost-optimal energy efficient and sustainable building retrofits*. Retrieved from <http://virtual.vtt.fi/virtual/respire/progress.html>