LIFE-Respire

Radon r**E**al time monitoring **S**ystem and **P**roactive **I**ndoor **Re**mediation - LIFE16 ENV/IT/000553

Website: www.liferespire.eu, www.liferespire.it

According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), radon (Rn) is the most important source of ionizing radiation related to indoor air quality. The most important health effect of Rn exposure is the increased risk of lung cancer, second only to cigarette smoking (World Health Organization). The most recent European directive regarding human exposure to natural radiation (2013/59/EURATOM) deals primarily with indoor Rn, and encourages national action plans to identify buildings (i.e., areas) where annual Rn average is expected to exceed the national reference level defined at 300 Bq/m^3 (i.e., Radon Prone Areas, RPA) and propose remediation.

As the direct measurements of soilgas Rn, coupled with geological data, are well recognised to define the Geogenic Radon Potential (GRP) of an area (i.e., an estimate of the Rn originating from geological sources), the GRP can then be used to guide indoor surveys; as indoor Rn values are often highly variable. LIFE-RESPIRE demonstration project objectives are:

- To demonstrate in 4 significant areas, with different GRP in Italy and Belgium, a cost-effective and eco-friendly solution for Rn real-time measurement and remediation **to keep indoor Rn levels below 100 Bq/m3 level** (as indicated in European Directive 2013/59/EURATOM). RESPIRE project will implement an intelligent, adaptable and versatile hybrid Rn remediation system composed by sensors, an Air Quality Balancer (SNAP) and an external additional fan-system (eolian and/or electric) working on positive pressure method. A control model based on a IoT protocol will be implemented;

- To construct a real time LIFE-RESPIRE geodatabase of collected continuous Rn measurements, coupled with other geological, geochemical and building characteristics data, that could be integrated within the framework of the European Atlas of Natural Radiation (promoted by the Joint Research Centre-JRC of the European Commission);

- To provide local authorities with Rn hazard guidelines and real-time WebGis radon maps for land use planning and health risk assessment, helping to prepare relevant national action plans (see Articles 54, 74 and 103 in 2013/59/EURATOM).

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The LIFE-RESPIRE project will improve the use of geochemical monitoring of Rn for the assessment and the protection of human health from exposure to natural radioactivity. The visibility of the proposal and the availability of collected data are guaranteed by the WebGIS geodatabase that will be accessible to all stakeholders and several derived Web Mapping Applications to be used by the public and the authorities. Furthermore, a series of actions regarding communication and dissemination activities will be addressed to inform stakeholders and to ensure use and development of project results during and beyond the project completion. The demonstration character is shown by the use of an integrated methodology that will include modified and/or innovative rapid remediation system for the measuring of soil gas Rn activity and the monitoring of the indoor Rn for the protection of human health and the environment. This integrated methodology will be implemented on a pilot scale that allows evaluation of technical and economic viability at larger scale by stakeholders (i.e., national, regional and local authorities). By making data available and accessible through the construction of a geodatabase and a Website, LIFE-RESPIRE aims to bridge the gap between research, policy and development results and widespread implementation, and to improve innovative solutions related to land use planning and for further epidemiological research due to Rn exposure.

CONSORTIUM

CERI-Sapienza: Centre for Research of the Sapienza University of Rome, Italy

CNR-IGAG: Institute of Environmental Geology and Geoengineering of the National Research Council, Rome, Italy

INGV: National Institute of Geophysics and Volcanology, Rome, Italy

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The LIFE-RESPIRE consortium at the kick-off meeting, September 2017, Rome

PROJECT STRUCTURE

Action A. Preparatory actions

A1. Analysis of available and new collected geochemical data in the municipalities of Caprarola (VT), Celleno (VT), Ciampino (Rome) and in the Ardenne region (BE)
A2. Permissions for Demonstration cases implementation

Action B. Implementation actions

B1. Prototype assembly and tests
B2. Implementation of demonstration cases including remediation measures
B3. Monitoring and WebGis
B4. Replicability potential evaluation and demonstrative case in Belgium

Action C. Monitoring of the impact of the project actions

C1. Monitoring of project impact indicators and LCA
C2. Socio-economic impact assessment

Action D. Public awareness and dissemination of results

D1. Dissemination planning and execution
D2. Networking

E. Management

PROJECT ACTIVITIES

Action A. Preparatory actions

A1. The LIFE-RESPIRE project will benefit of the available geochemical data already collected within ongoing specific research projects in the municipalities of Celleno (VT), Ciampino (Rome) and in the Ardenne region (BE). In the fourth site (Caprarola, VT), after an inter-calibration session of field devices, Rn surveys will take place to complete the collection of the geochemical information. All permissions from buildings owners needed to implement the Demonstration cases will be collected.
In Italy the 3 sites have been selected for the implementation of the mitigation measures and monitoring activities: Caprarola, Celleno (Viterbo, Northern Lazio) and Ciampino (Roma, central Lazio). The selection of these monitoring sites has been done on the basis of the Geogenic Rn Potential map of the Lazio region (Ciotoli et al., 2016), in which these 3 sites are characterised by high, medium and low Rn potential, respectively. The objective of this action is to characterise the better location in the area of Caprarola collecting all information (already available for Ciampino and Celleno City) useful for demonstrator implementation during Action B2.
In this action, a field based inter-comparison survey will be carried out in Italy to harmonize and intercompare the monitoring techniques and calibrate the different monitoring devices used in the project, even in Belgium.
For Caprarola site, the Action A1 will provide all needed information, in particular the following laboratory and field activities will be carried out:

1. Measurement devices calibration and harmonization of field techniques and data analysis;

2. Collection of data from available databases;

3. Field activities
   - Rn activity and other gases in the soil, Rn flux from soil, soil permeability, and Rn dissolved in groundwater and in drinking water (public and / or private),
   - Radiogenic elements (U, Th, Ra) in the soil,
   - Rn in public and /or private buildings.

A2. The permissions will be applied to identify right buildings where carrying out demonstration measurements and monitoring. Owners and local administration (for public facilities) will be contacted in order to apply for all the permitting procedures. At the end of the action a shortlist with all the potential buildings will be presented.

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Action B. Implementation actions

RESPIRE remediation system prototypes consisting of the SNAP, Rn sensors and the subslab depressurization system for ventilation will be developed, tested and validated. 50 RESPIRE remediation system prototypes will be installed at demonstration sites to validate the effectiveness of the proposed remediation solution. The chemical Rn monitoring data will be made available, accessible, comparable and interoperable through the construction of a harmonised geodatabase including Rn geological information from existing geological maps and databases. The LIFE RESPIRE geodatabase will be created within a WebGIS environment and made available to all stakeholders. After the first Demonstrators in three Italian cities, replicability will be proved in Belgium in a different geological/climatic setting and environment; obtained results will be evaluated against today's regulatory framework.

B1. The aim of this Action is to design and optimise the RESPIRE remediation system prototypes for real-world use
in Demonstrators. In particular:
- Design the prototypes and produce early versions for tests (10 prototypes);
- Validate the best solution and guarantee timely and effective supply chain management;
- First installation and test of the devices in one building.

Based on preliminary design already developed and thanks to the cooperation among ELICA, as large industry experienced in remediation systems, and all the involved research centres with huge experience in
monitoring Rn concentration, the system' final design will be engineered. Also the sensors for the mitigation system will be defined, assessed and integrated. Remediation system configuration has already been shown in part B2 of the proposal. Here a detailed description of the single components is given. Main components of the prototype will be:

- Rn Sensors
- Simple air extractor (SNAP) with bidirectional airflow
- Supplementary external fan (eolic or not)

B2. The main phases of this demonstration action can be summarized as follows:
• Building selection: the selection will include public and private buildings of inhabited zones located in areas characterized by different GRP already identified in a shortlist;
• Installation of monitoring and remediation measures. 10 to 15 Remediation systems will be installed in each city;
• Monitoring of indoor Rn measurements;
• Checking and control. Periodically, soil Rn measurements will be performed at the same site with all the available instruments to verify whether the initial cross-calibration is still valid.

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Action B. Implementation actions

B3. After installation of RESPIRE remediation system prototypes in Action B2, the data collected will be monitored and stored in the WebGis portal. All the measurements will be stored on a Cloud (ELC will provide the one included with SNAP), creating the RESPIRE database. The main objective of this action is thus to develop the RESPIRE Web-GIS RadonMap to display and to query all the data stored in the LIFE RESPIRE project's database. The Web-GIS will be developed with open-source softwares and will be accessible by all major browsers, ensuring low costs and the greatest number of accesses. To maximize the use and the interoperability of data, also by other users and systems, we will use only standard geographic web services implemented by the Open Geospatial Consortium (OGC), the main organization for geographic data standards. In particular we will use WMS and WFS standards, also adopted by ISO and by the INSPIRE Directive (2007/2/EC)
The RESPIRE Web-GIS will allow:
• to display with different styles all the geographic layers, so that it is possible to get each item of information within the whole context of the data;
• to search for a specific location or a specific range of quantity of one of the dimensions within the data system;
• to investigate for a correlation within the different layers involved in the Rn hazard analysis;
• to emphasize the areas of focus, where the local authorities have to plan about health risk assessment;
• to get continuously information about the exceeding of the threshold values of Rn, emphasizing the areas where implement mitigation measures.

B4. The evaluation of the potential replicability of the remediation system will be demonstrated in Belgium in the Rn prone areas of the Ardenne Massif in Belgium, where about 13% of the buildings (corresponding to about 17000 buildings) exceed 400 Bq/m³ and about 4% (5500 buildings) exceeds 800 Bq/m³. Detailed information on the local geology, soil-gas, soil permeability and soil composition is available too. This makes the region suited for comparing the mapping and remediation and to demonstrate its effectiveness. Buildings will be selected based on existing measurement and during new measurement campaigns. Several design settings will be installed, using hybrid wind-electric fans driven by the prototype controlling detector system. The results will be effective if they allow the average long-term Rn concentration to be reduced below 150 Bq/m³, the target level when doing Rn mitigation. Several continuous monitoring systems will be used to monitor the effectiveness and to compare the data-driven solution to static (continuous) systems in terms of energy consumption and Rn concentration reduction. For this, it will be necessary to compare similar buildings during the same period and individual buildings with different systems during different periods.

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Action C. Monitoring of the impact of the project actions

C1. A detailed analysis shall be made to identify the performance of the prototypes in terms of resource and energy consumption, considering environmental impacts and safety. A preliminary Life Cycle Analysis (LCA) of the system (and related products) will be undertaken in the eighteen months of the project and the "Radon Hazard Guidelines" will be prepared, based also on the comparison of the four demonstration case scenarios started during action B.4, in view of future transfer of project results to other localities.
An LCA will be then deployed in the second half of the project. This task is of outmost importance for the success of the concept brought about by the present project. The main environmental parameters and indicators, starting from Key Project indicators, need to be defined in the first stage of the project, at two levels: process and product. In particular, a list of main parameters to be monitored (and the rationale for their monitoring) will be prepared, including the following (non-exhaustive list):
- The percentage of indoor radon concentration reduced in comparison to current measured values;
- The difference in GHG emissions between standard remediation systems and RESPIRE solution;
- The reduced indoor radon concentration by using active or passive systems;
- The time needed to change the air in the building volume.

C2. A Social-Economic Impact Analysis will assess the potential for the LIFE RESPIRE to change the lives of current and future residents in the European Community. The analysis will be based on quantitative parameters. Some (non-exhaustive) quantitative parameters to be considered in the analysis will be:
- Analysis of people risk perception
- Employment and labor markets: for example the creation of green jobs;
- Social inclusion and gender equality;
- Social impacts, for example health related to radon and indoor air pollution;
- Competitiveness of the solution, for example end price;
- Replication potential of the innovative REMEDIATION system;

The perceptions of the community about how the process may change their lives will also be taken into account. In fact, understanding community values and concerns is an important step in conducting a socioeconomic impact assessment. The Socio-economic Impact Analysis will constitute an aid to decision-making. It will generate an important input by informing decision-makers and the European Commission of the consequences of RESPIRE solution. Furthermore, the project shall constitute a blueprint for both a monitoring and remediation technology to consolidate current efforts at European level towards a sustainable and environment-friendly economy and society. In this view, this action will contribute to the AfterLife Plan, ensuring that the project outcomes can create further impact through the assessment of the real potential of RESPIRE innovative system.

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Action D. Public awareness and dissemination of results

D1. The general objective of this action is to disseminate the activity and results of LIFE RESPIRE to selected stakeholders' groups including policy and decision makers, all levels of administration, end-users and operational personnel involved in disaster management (at the building and urban level), relevant scientific communities and general public using a variety of channels and means. A consistent, appealing as well as appropriate look and feel for all public material produced by the project (including reports) will be decided and maintained.
The method employed will be to invite stakeholders and RESG (RESPIRE EXTERNAL STAKEHOLDERS GROUP) members to showcase and disseminate their best results. The LIFE RESPIRE project will only be a starting point to collect as many successful experiences as possible. CERI shall be in charge of the design, development and online launch of a dedicated website for the promotion of the project and as the key source for all LIFE RESPIRE information and documentation. The website will be online early in the project (by M3) and until 5 years after the project. Over time, the Web site will host site information, news and progress, deliverables, working reports, links and key results aimed at a wide international audience. Project partners led by CERI will promote the project through the following activities:

- Develop a Dissemination Plan
- Publishing a website comprising
- Participation to international events and workshops
- Organisation of Workshops
- Preparation of dissemination materials
- Layman Report
- Publication of articles

D2. The objective of this action is twofold:
• **Planning and implementing networking activities.** Such activities will include visits and meetings, as well as interaction with international European technology platforms. This will contribute to enhance the transfer of knowledge and experience among the network partners, thus promoting further innovation in the overall project lifecycle and beyond. The External Stakeholders Group will support the networking and take part in events.
• **Create and managing the RESPIRE External Stakeholders Group (RESG). The RESG will be** important to widely spread RESPIRE innovative results and sustain AfterLife project activities and market introduction.

The presence of an Advisory Board will oversee the quality of project deliverables (internal evaluation in a form of peer-reviews), and to advise and assist on the dissemination, international discussion and promotion of project results. It will be composed by Gutierrez Villanueva, Jose Luis (RADONOVA); Peter Bossew (German Federal Office for Radiation Protection); Valeria Gruber (Responsible for implementing the EU-BSS in the field of Radon in Austria) and Tommaso Aureli (ARPA, Agenzia Regionale di Protezione Ambientale del Lazio).