The COST Action TD1105: Lessons Learned and Outcome

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Abstract

This is a short overview of the COST Action TD1105 *EuNetAir - European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability* - funded in the framework *European Cooperation in the field of Scientific and Technical Research* (COST) during the period 2012-2016. The international networking has involved more than 120 teams from academia, research, agencies and industry from 31 COST Countries and 7 Non-COST Countries (November 2016).

Key words: Sensing technologies, air pollution modelling, environmental measurements, methods and protocols, air quality control, environmental sustainability

Introduction

The main objective of the Concerted Action *EuNetAir* is to develop new sensing technologies for Air Quality Control (AQC) at integrated and multidisciplinary scale by coordinated research on nanomaterials, sensor-systems, air-quality modelling and standardised methods for supporting environmental sustainability with a special focus on Small and Medium Enterprises.

The COST Action TD1105 [1,2] - *European Network on New Sensing Technologies for Air-Pollution Control and Environmental Sustainability - EuNetAir* (see Fig. 1) aims to establish a top-level Pan-European multidisciplinary R&D platform based on a new sensing paradigm for AQC contributing to sustainable development, green-economy and social welfare, and finally to create collaborative research teams in the European Research Area (ERA).

This international Networking, coordinated by ENEA (Italy), includes over 120 big institutions/organizations and over 200 international experts from 31 COST Countries (EU-zone: *Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, Luxembourg, The Former Yugoslav Republic of Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom*) and 7 Non-COST Countries (extra-Europe: *Australia, Canada, China, Morocco, Russia, Ukraine,*

USA) to create a S&T critical mass in the environmental issues.

The challenges addressed by the COST Action TD1105 are listed as follows as:
- Nanomaterials for AQC sensors
- Low-cost gas sensors
- Low-power sensor-systems
- Wireless technology (*Environmental Sensors Network*)
- Air quality modelling
- Environmental measurements
- Standards and protocols

EuNetAir includes more than 200 experts and is mainly based on 4 Working Groups (WGs) and 4 Special Interest Groups (SIGs), coordinated by a leader:

- ✓ WG1: *Sensor materials & nanotechnology*
- ✓ WG2: Sensors, devices & systems for AQC
- ✓ WG3: *Environmental measurements & air-pollution modelling*
- ✓ WG4: *Protocols & standardisation methods*
- ✓ SIG1: *Network of spin-offs*
- ✓ SIG2: *Smart sensors for urban air monitoring in cities*
- ✓ SIG3: *Guidelines for best coupling air-pollutant and transducer*
- ✓ SIG4: *Expert comments for revision of the Air Quality Directive (2008/50/EC)*

Only a multidisciplinary cooperation will ensure cleaner air in Europe and reduced negative effects on human health for future generations in smart cities, efficient management of green buildings at low CO_2 emissions, and sustainable economic development.

Fig. 1.   The logo (a) and consortium (b) of COST Action TD1105. For further information: www.cost.eunetair.it.

Short history of EuNetAir

In the period 2012-2016, the COST Action EuNetAir [3-9] organized 28 Meetings (including 6 Scientific Meetings, 14 Focus/Core Group and Dissemination Meetings, 4 Working Group Meetings, 4 Workshops); 9 Management Committee Meetings, 4 Training Schools plus 2 Short Courses, and supported 43 European Early Career Investigators to carry out challenging research in the field of the environmental sensor technologies and measurements in foreign host institutions of the COST Countries and Associated Countries signing the Memorandum of Understanding (MoU) EuNetAir. Shortly:

Scientific Meetings

- *Kick-off Meeting* at COST Association, 16 May 2012, Brussels, Belgium
- *1st Scientific Meeting* at ENEA, 4-6 December 2012, Rome, Italy
- *2nd Scientific Meeting* at Queens' College, University of Cambridge, 18-20 December 2013, Cambridge, UK
- *3rd Scientific Meeting* at Bahcesehir University, GEBZE Technical University, 3-5 December 2014, Istanbul, Turkey
- *4th Scientific Meeting* at Linkoping University, 3-5 June 2015, Linkoping, Sweden
- *5th Scientific Meeting* at Bulgarian Academy of Sciences, 16-18 December 2015, Sofia, Bulgaria
- *6th Scientific Meeting (Final Meeting)* at Czech Academy of Sciences, 5-7 October 2016, Prague, Czech Republic

Workshops

- *1st Workshop EuNetAir* at IREC, joined to Transducers 2013 - Eurosensors 2013, 20 June 2013, Barcelona, Spain
- *2nd Workshop EuNetAir* at ENEA, 25-26 March 2014, Brindisi, Italy
- *3rd Workshop EuNetAir* at University of Latvia, 26-27 March 2015, Riga, Latvia
- *4th Workshop EuNetAir* at FFG, 25-26 February 2016, Vienna, Austria

WG Meetings

- *1st WG Meeting EuNetAir* at Fraunhofer Inhaus, 4-6 March 2013, Duisburg, Germany
- *2nd WG Meeting EuNetAir* at European Environment Agency, 3-5 October 2013, Copenhagen, Denmark
- *3rd WG Meeting EuNetAir* at IDAD, 13-15 October 2014, Aveiro, Portugal
- *4th WG Meeting EuNetAir* at VINCA Institute - University of Belgrade, 14-15 October 2015, Belgrade, Serbia

Training Schools

- *1st Training School EuNetAir* at University of Barcelona, Green Week 2013 Satellite Event, 13-15 June 2013, Barcelona, Spain
- *2nd Training School EuNetAir* at Saarland University, 31 March - 2 April 2014, Saarbrucken, Germany
- *3rd Training School EuNetAir* at University of Helsinki, 2-8 May 2015, Hyytiala (Helsinki), Finland

- *4th Training School EuNetAir* at Aarhus University, 19-22 April 2016, Copenhagen, Denmark
- *EuNetAir joined to Short Course ISOCS 2014* by Universitè Joseph Fourier, 9-14 February 2014, Les Houches, France
- *EuNetAir joined to Short Course ISOCS 2015* by University of Brescia, 8-13 March 2015, Tonale (Brescia), Italy

Focus/Core Group and Dissemination Meetings

- *EuNetAir* at SGS-2012, 13 September 2012, Cracow, Poland
- *EuNetAir* at ISQL-2012, 29 September 2012, Halkidiki, Greece
- *EuNetAir* at TCM-2012, 21 October 2012, Hersonissos, Greece
- *EuNetAir* at EUROSENSORS-2014, 10 September 2014, Brescia, Italy
- *EuNetAir* at IEEE SENSORS 2014, 3 November 2014, Valencia, Spain
- Focus Group *EuNetAir* at Federal Environmental Agency - WHO Collaborating Centre, 17 April 2015, Berlin, Germany
- Focus Group *EuNetAir* at Siemens AG, 29 April 2015, Munich, Germany
- *EuNetAir* at ISOEN-2015, 28 June 2015, Dijon, France
- *EuNetAir* at EUROSENSORS-2015, 9 September 2015, Freiburg, Germany
- *EuNetAir* at AMA SENSOR+TEST-2016, 12 May 2016, Nuremberg, Germany

International Symposia and Conferences

- *EuNetAir* at European Materials Research Society (EMRS) Spring Meeting 2014, Symposium B: *Advanced Functional Materials for Environmental Monitoring Applications*, 26-30 May 2014, Lille, France
- *EuNetAir* at European Materials Research Society (EMRS) Spring Meeting 2016, Symposium X: *Functional Materials for Environmental Sensors and Energy Systems*, 2-6 May 2016, Lille, France
- *EuNetAir* at International Society of Exposure Science (ISES 2016), *Advancing Exposure Science through Technology: Focus on Sensors*, 9-13 October 2016, Utrecht, The Netherlands
- *EuNetAir* at Materials Research Society (MRS) Fall Meeting 2016, Symposium PM4: *Novel Materials, Fabrication Routes and Devices for Environmental Monitoring*, 27 November - 2 December 2016, Boston, USA

Main results

International Networking

This Action has successfully created a strong and qualified international networking devoted to the sensor technologies and environmental measurements/modelling including standards and protocols. In particular, the Action participants from COST Countries are *55 universities (44%)*, *39 research centres (32%)*, *4 environmental agencies* (*3%*) and *25 SMEs* (*21%*) including *9 spin-offs (8%)*. Additional 8 top-level institutions from **7** Non-COST Countries such as 3 Near Neighbour Countries (NNC) - Morocco, Russia, Ukraine - and 4 International Partner Countries (IPC) - Australia, Canada, China, USA - were involved in the Action as well.

This has created high impact with the establishing of an international network including about 15 SMEs and spin-offs. Several world-class experts from International Organizations such as European Environment Agency (EEA), World Health Organization (WHO) Europe, United Nations Economic Commission for Europe (UNECE) with group devoted to Long-Range Trans-Boundary Air Pollution - European Monitoring and Evaluation Programme (EMEP), Joint Research Center (JRC) - Institute for Environment and Sustainability, US Environmental Protection Agency (EPA), NASA Ames Research Center, MIT, CSIRO and Queensland University of Technology, have been involved with fruitful discussions and long-term cooperation.

Significant Outcome

This Action has produced significant results and deliverables as follows:

- Joint-exercise *sensors-vs-analyzers* in real city environment and related joint-publication
- Report on *Innovation in sensor technology for air quality control*
- Funded international (>2) and national (>10) research projects in air quality control

Low-cost gas and particulate sensors and low-power consumption sensor-systems for air quality monitoring need repeated calibration. To improve accuracy and investigate long-term stability of their performance in real conditions, a joint-exercise was setup in Aveiro (Portugal), 13-27 October 2014 using an IDAD Air Quality Mobile Laboratory, equipped by reference analyzers, and parked in the city centre. The intercomparison was participated by 15 teams from 15 COST Countries make available 130 advanced low-cost sensors and sensor-systems. A joint-publication in a peer-review

journal [10] at high impact factor has been co-authored by 29 EuNetAir members.

The Action will finalize a strategic report devoted to *Innovation on environmental sensor technologies*, expected on the 2016 end.

Furthermore, EuNetAir has been the networking platform to spin-out at least 5 international FP7 and H2020 projects such as SENSIndoor [11], MSP [12], IAQSense [13], CITI-SENSE [14] and iSCAPE [15] devoted to sensor-systems and their applications for air quality control. Moreover, EuNetAir affected the environmental research of the gas sensor-systems at national level in the Member States achieving funding for at least 10 national projects.

Editorial Activities and Outreach

The Action has produced 5 Special Issues to publish the most significant results, achieved by EuNetAir teams, in the *Journal of Sensors and Sensor Systems* (JSSS, Copernicus, 2014), *Urban Climate* (Elsevier, 2015), *AMA Science Proceedings* 2015, *AMA Science Proceedings* 2016, *Beilstein Journal of Nanotechnology* (Beilstein Institute, 2016).

The section VIDEO of the Action webpages [2] offers the interviews to 9 outstanding scientists and researchers from academia, research, agencies, international organizations and industry to outreach the EuNetAir topics for technical and non-technical target audience.

Conclusions and Outlook

EuNetAir is proposed to solve problems in the area of:

- Air Quality Control
- Environmental Sustainability
- Indoor/Outdoor Energy Efficiency
- Climate Change Monitoring
- Health Effects of Air-Pollution

EuNetAir is expected to impact as follows as:

- European Leadership on AQC Science & Technology
- Development of Green-Economy
- Support to Sustainable Development
- Support to Monitoring System of Clean Air for Europe
- Fostering Research & Innovation on New Sensing Technologies for Environmental Monitoring

Finally, some MC Members of the EuNetAir provided technical advising to the European Commission [16] in the field of sensor-systems at industrial relevance for H2020 inputs. This was compiled in the European Sensor Systems Cluster (ESSC) roadmap.

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