European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

WGs Meeting, Sofia, 16 - 18 December 2015

organized by Institute of Electronics & National Institute for Meteorology and Hydrology hosted by Bulgarian Academy of Science

Review of EU Infrastructure for Environment Monitoring

Action Start date: 16/05/2012 - Action End date: 30/04/2016

Year 4: 1 July 2015 - 30 April 2016 (*Ongoing Action*)

Dr. M Foysol Chowdhury

Prof. Julian Gardner & Prof. F Udrea

CAMBRIDGE CMOS SENSORS

Function in the Action: WG Member

United Kingdom

Overview of EU Research Infrastructure

Material and Analytical
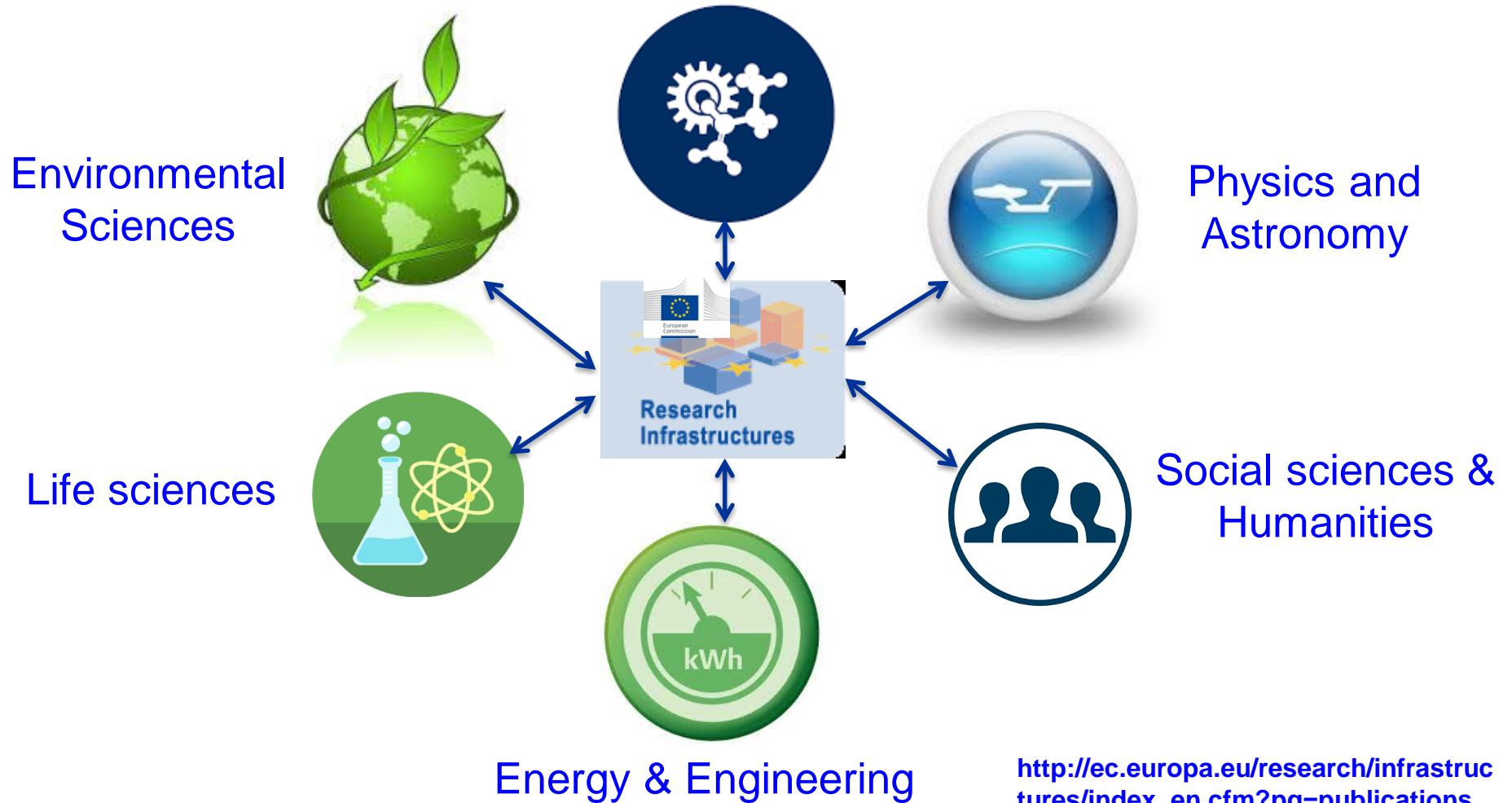
Environmental Sciences

Physics and Astronomy

Research Infrastructures

Life sciences

Social sciences & Humanities

Energy & Engineering

cost

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

EU Environmental Research and Development at Present

Policymakers

UNEP

Others

EUROPEAN COMMISSION
environment

Technology Development

Technology Deployment

Collaborative Research
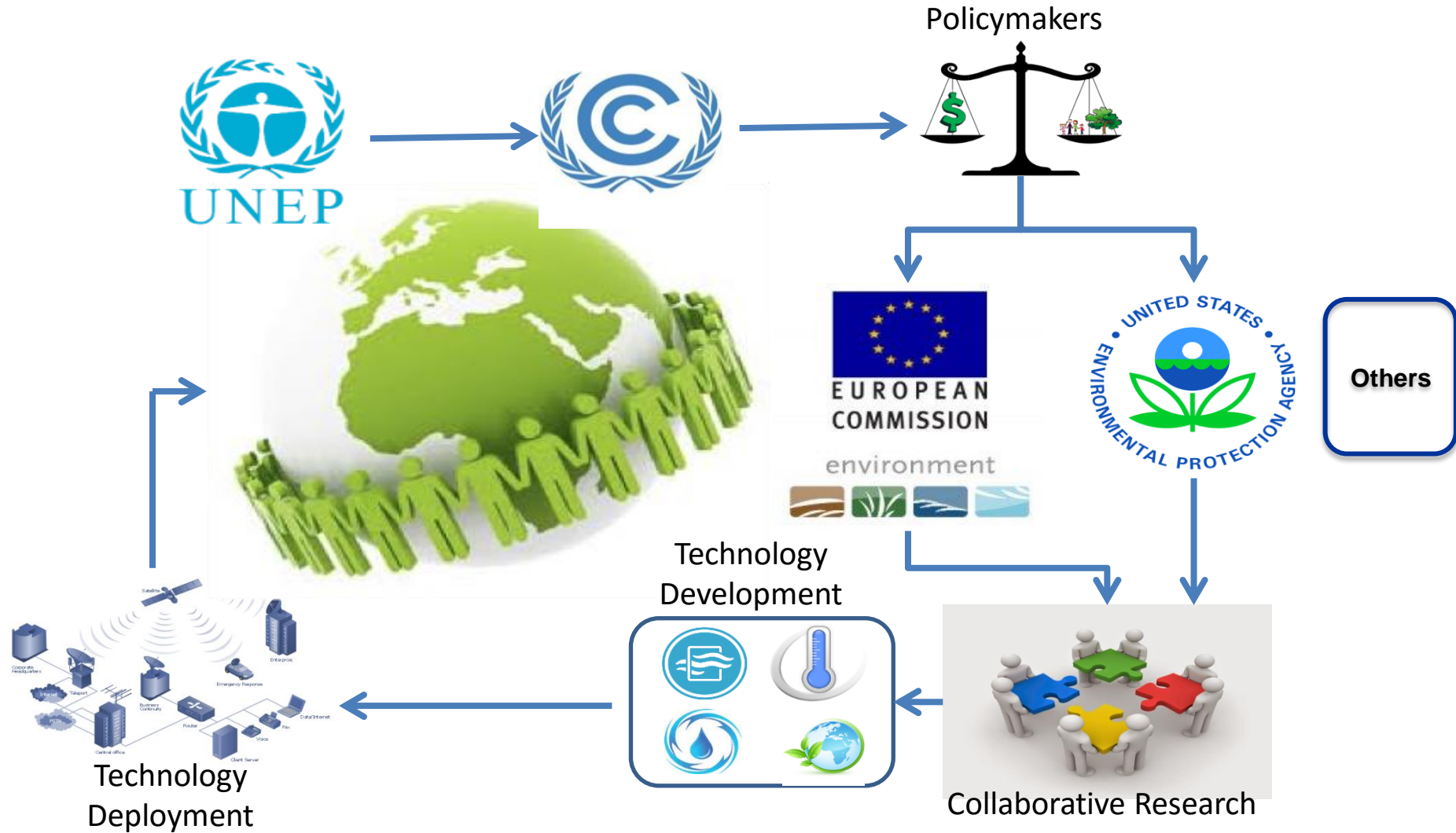
Policy: Five priorities for the UN Sustainable Development Goals

- **Devise metrics**
  - Design a set of practical indices *(Scientists, social scientists and economists)*

- **Establish monitoring mechanisms**
  - Set up systems to acquire the data *(Governments and researchers)*

- **Evaluate progress**
  - Choose criteria based on accepted principles of good practice *(Scientists)*

- **Enhance infrastructure**
  - To expand to give better global coverage to allow direct comparisons of data by using similar instruments *(Earth observation, ground-based monitoring - industry)*

- **Standardize and verify data**
  - To design monitoring and sampling approaches with robustness in mind, and to verify data *(Scientists and governments)*
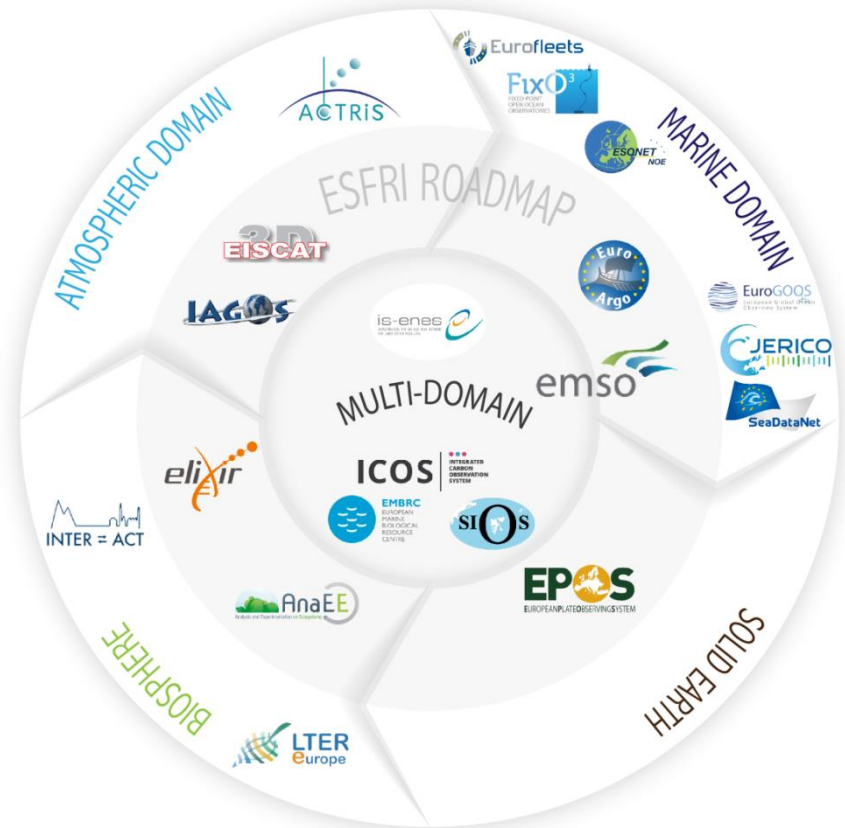
http://www.nature.com/news/policy-five-priorities-for-the-un-sustainable-development-goals-1.17352

cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Snapshot of EU Environmental Research Infrastructure

Motivations

Projects

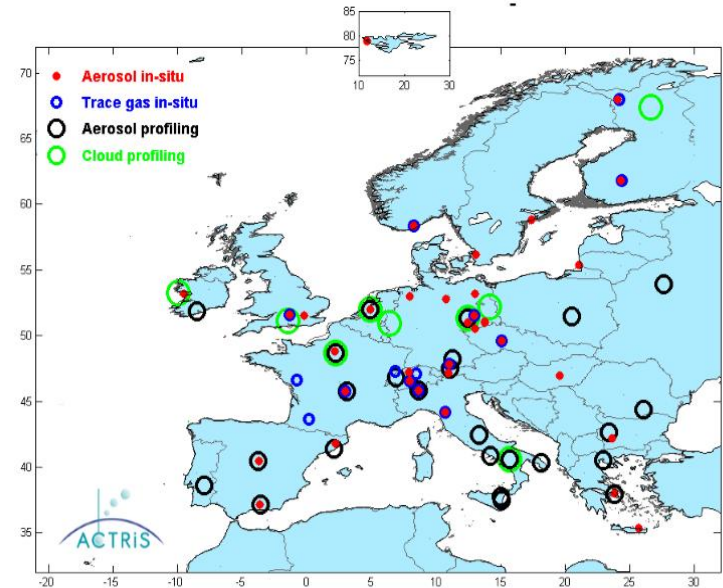http://ec.europa.eu/environment/action-programme/objectives.htm

Environment and Earth Sciences Infrastructure: Atmospheric

ACTRIS - Aerosols, Clouds, and Trace gases Research Infrastructure network

Mounting, implementing and monitoring an effective response of atmospheric components — aerosols, clouds and short-lived gas species.

Large-scale, coordinated initiative facilitating long-term observations and simplifying the access to these infrastructures and their data is lacking.
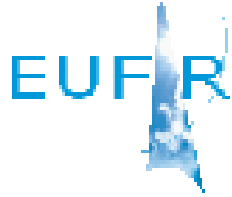
ACTRIS intends to fill the gap by integrating **world-class ground-based stations** equipped with advanced probing instrumentation.

FP7 project – till 2015

http://ec.europa.eu/research/infrastructures/pdf/thematic/KI0414648ENE-environment.pdf#view=fit&pagemode=none

Environment and Earth Sciences Infrastructure: Atmospheric

EUFAR2 - European Facility for Airborne Research in Environmental and Geo-sciences:

- Supports the subsidised airborne research community in Europe with open access across national boundaries for measuring:

- Trace gases in the atmosphere. Study the surface of the Earth using remote sensing equipment.

- Counting polar bears...

http://ec.europa.eu/research/infrastructures/pdf/thematic/KI0414648ENE-environment.pdf#view=fit&pagemode=none

Environment and Earth Sciences Infrastructure: Oceanic/Marine

FixO^3 - Fixed-point Open Ocean Observatories Network

The project is creating the world's largest network of observatories to carry out multidisciplinary measurements in the open ocean covering:

- Arctic Ocean
- Southern polar ice cap
- In the middle of the Atlantic
- And off the shores of Crete

Europe has established permanent observatories in these and several other locations to carry out ocean research.

FixO^3 project aims to combine them into a coherent, interoperable infrastructure and making them more accessible.

http://ec.europa.eu/research/infrastructures/pdf/thematic/KI0414648ENE-environment.pdf#view=fit&pagemode=none

Environment and Earth Sciences Infrastructure: Oceanic/Marine

EUROFLEETS2 encourages cooperation among Europe's research fleets to:

- Facilitate the access to these rare floating labs.
- Maximise their contribution to the advancement of science.

The aim is to allows European research fleets have to continue to play important role in scientific discovery - this includes polar ones.

http://ec.europa.eu/research/infrastructures/pdf/thematic/KI0414648ENE-environment.pdf#view=fit&pagemode=none

Environment and Earth Sciences Infrastructure: Oceanic/Marine

JERICO
Towards a Joint European Research Infrastructure network for Coastal Observatories

MESOAQUA
Network of leading MESOcosm facilities to advance the studies of future AQUAtic ecosystems from the Arctic to the Mediterranean

UP-GRADE BS-SCENE
Up-Grade Black Sea Scientific Network

http://ec.europa.eu/research/infrastructures/pdf/thematic/KI0414648ENE-environment.pdf#view=fit&pagemode=none

Environment and Earth Sciences Infrastructure: Bio-diversity

Trees4Future is an Integrative European Research Infrastructure project that aims to:

Integrate, develop and improve major forest genetics and forestry research infrastructures.

SYNTHESYS3, a network of prominent institutions across Europe, strives to ensure that **natural history collections** to realise their full potential to support outstanding research.

It offers funded opportunities to study specimens on site and supports the creation of new types of digital collections.

The project is also exploring innovative ways to make the partners' material available online through the development of digitisation tools and services.

Environment and Earth Sciences Infrastructure: Bio-diversity

EXPEER
Distributed infrastructure for EXPErimentation in Ecosystem Research

INCREASE
An Integrated Network on Climate Research Activities on Shrubland Ecosystems

ASSOCIATION OF EUROPEAN MARINE BIOLOGICAL LABORATORIES
ASSEMBLE
Association of European Marine Biological Laboratories

Arctic Research

INTERACT - International Network for Terrestrial Research and Monitoring in the Arctic

Integrating research infrastructures run by different organisations, in different countries and from different funding streams is always an ambitious task.

Where these infrastructures are located in a harsh environment, difficult to access and often unmanned for months, the challenge takes on a whole new layer of complexity.

In the Arctic, for example. Sparsely populated and particularly fragile, this is also the area of the world undergoing the fastest rate of climate-related change.

An international alliance of researchers is taking field research and monitoring activities in this region to new heights.

Arctic Research

IS-ENES2 - Infrastructure for the European Network for Earth System modelling — Phase 2

Melting ice caps, rising sea levels, shifting landscapes... as the climate changes, so will the face of the Earth.

Understanding the mechanisms that shape the climate and predicting how it is likely to evolve has, therefore, become a crucial challenge.

Scientists use sophisticated numerical models to generate information that helps the world's policymakers to develop mitigation and adaptation strategies.

IS-ENES2 is boosting Europe's contribution to this global research effort

eStation
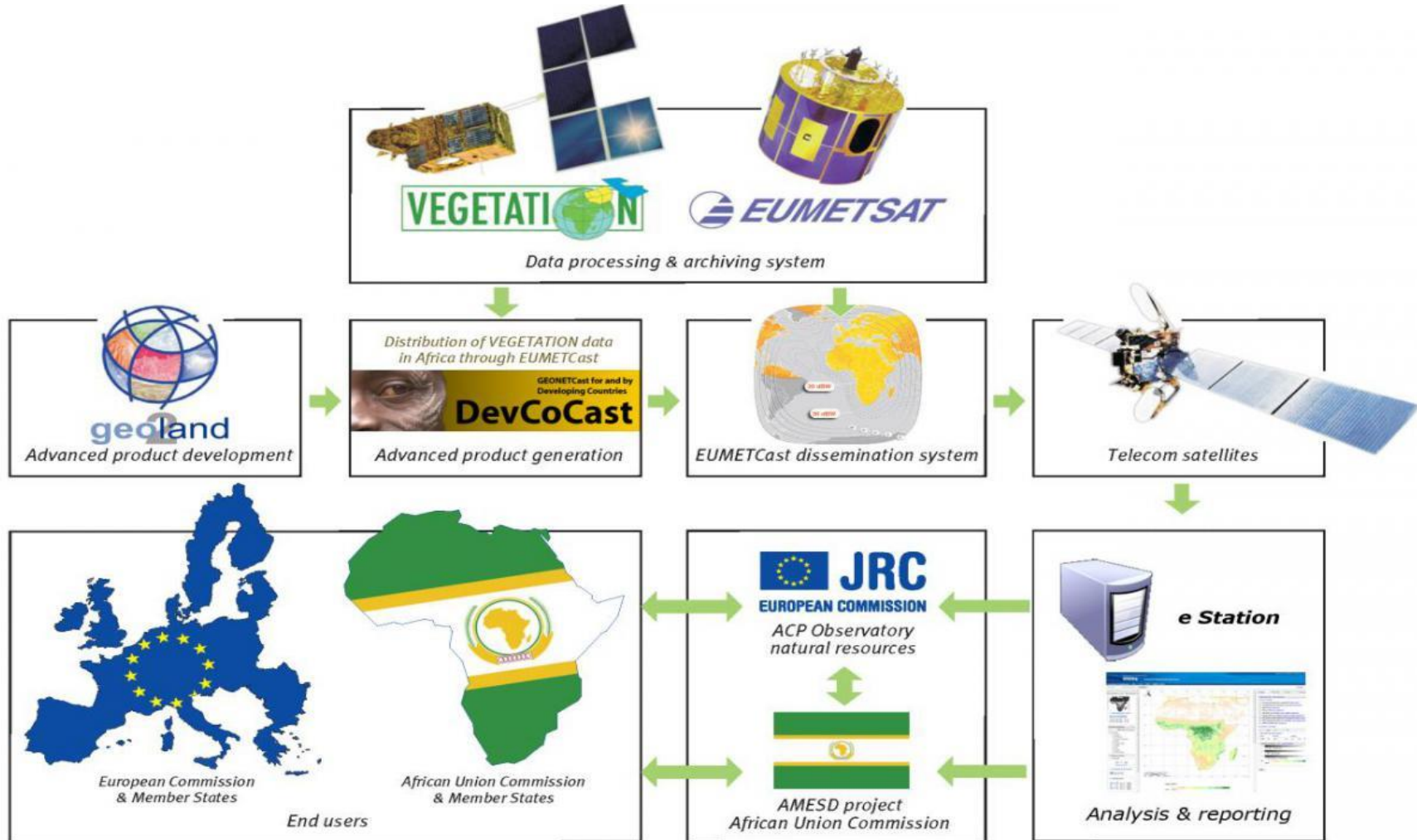
http://estation.jrc.ec.europa.eu/index_en.htm

Existing Environmental Monitoring Toolsets

http://www.uneplive.org/

Existing Environmental Monitoring Toolsets: Global

European Environment Agency

Five key problems are:

- The lack of structured architecture for air quality system
- Disparity of the datasets formats
- Lack of or inconsistent metadata
- Lack of sensor
- Cost – monitoring stations are too expensive

http://www.eea.europa.eu/data-and-maps

Fundamental Challenges to Overcome

Volume – too much data from sensors

Variety – many types of sensors

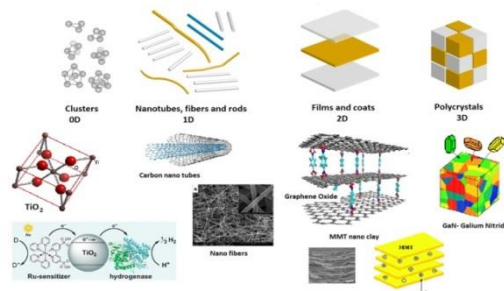**Velocity – real time measurements**

Veracity – reliability of sensors

Emerging Technology and Infrastructure

Maps of city air.
Streets of people aware.

Google Earth Outreach   aclima.

EPA — What does this all mean?

	Current Approach	Sensor Technology →	New Paradigm
Who Collects the data?	Limited Mostly to Governments, Industry, and Researchers		Expanded Use by Communities and Individuals
Why data is collected?	Compliance Monitoring, Enforcement, Trends, Research		New Applications and Enhancement of Existing Applications
How data is accessed?	Government Websites, Permit Records, Research Databases		Increased Data Availability and Access

Snyder et al., 2013

Sensors

Gyroscope, Magnetometer, Accelerometer, Pressure, Humidity, Ambient Light, Proximity, Gesture, Heart Rate, Temperature, UV, Gas

Nanomaterial

Clusters 0D, Nanotubes, fibers and rods 1D, Films and coats 2D, Polycrystals 3D, TiO2, Carbon nano tubes, Graphene Oxide, GaN- Gallium Nitride, Nano fibers, MMT nano clay, Ru-sensitizer, hydrogenase
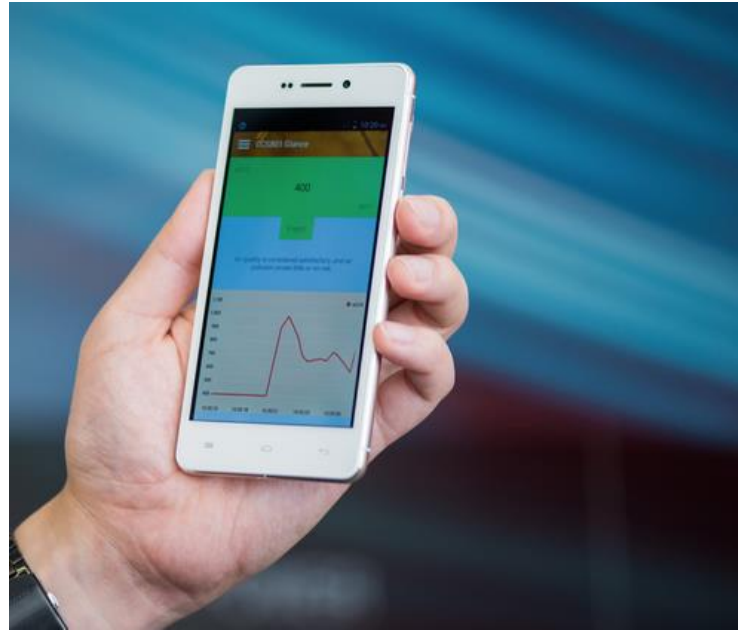

Technology

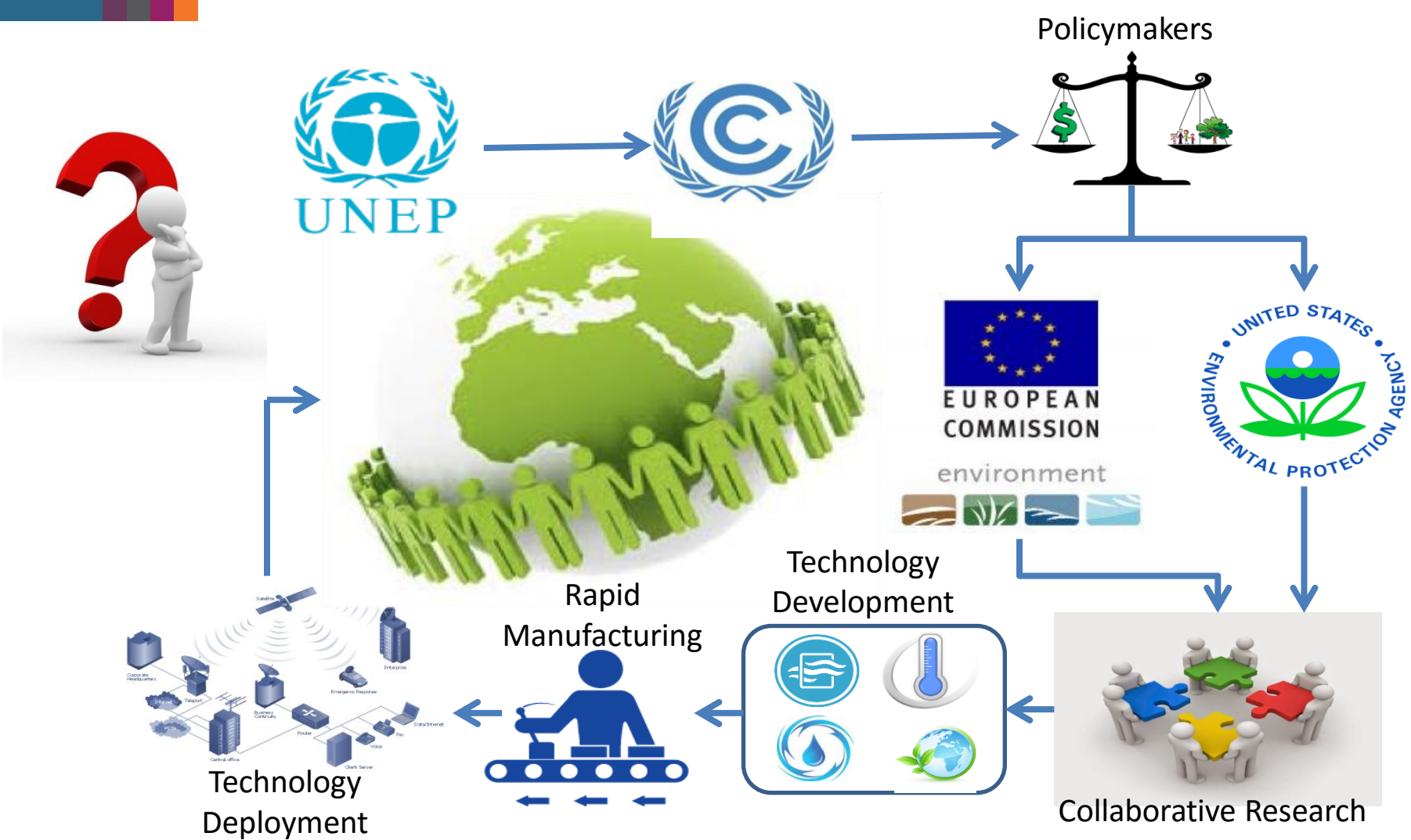# Emerging Technology and Infrastructure

Smartphones get gas sensor

Cambridge CMOS Sensors announced its MEMS-CMOS design-wins with K-Phone and K-Free white-box smartphone that will be branded by Chinese carriers for their home markets where sensing dangerous chemicals in the air is critical to one's health as they move about the incredibly polluted cities, homes and businesses.
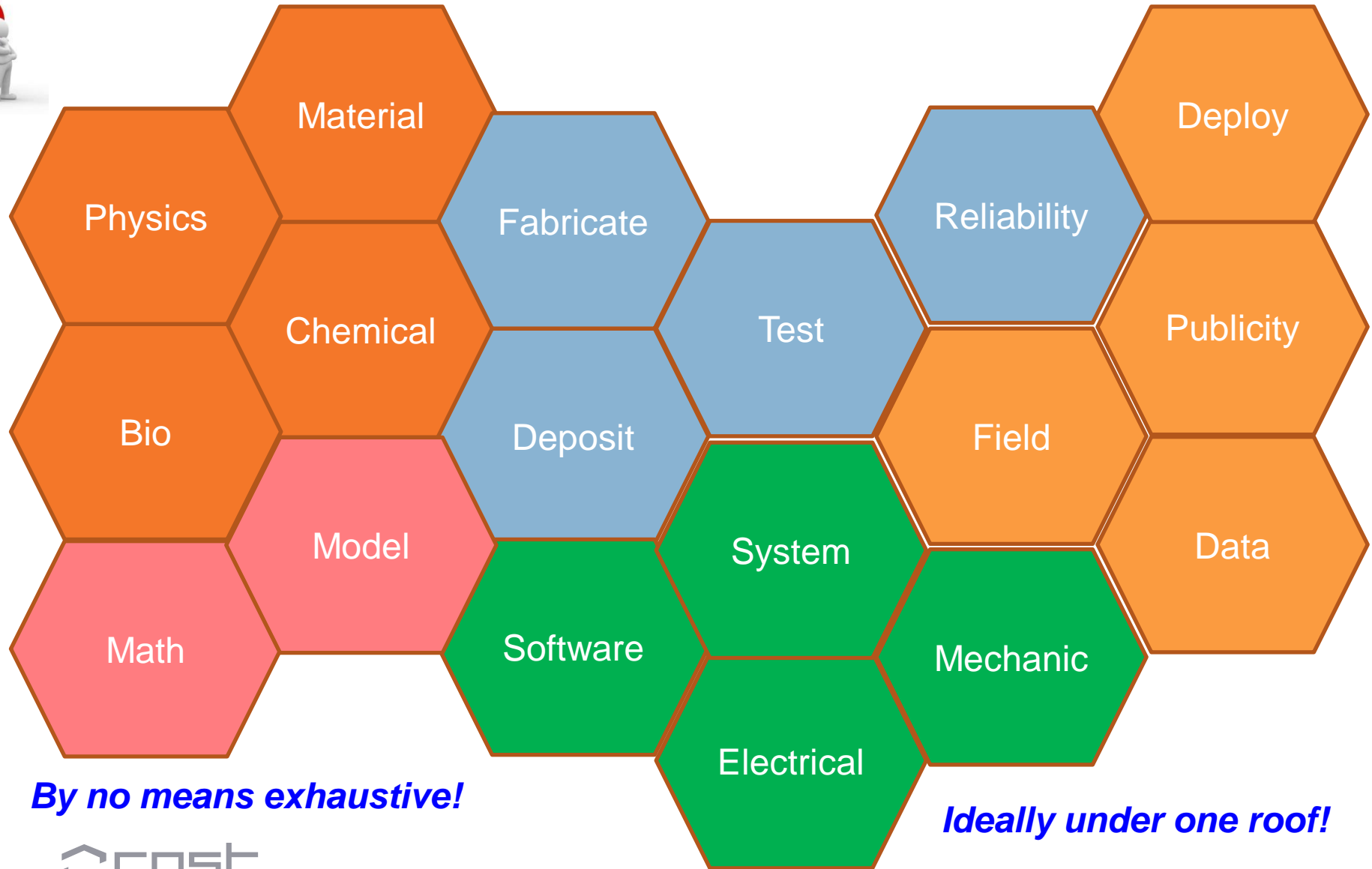
http://www.embedded.com/electronics-news/4440779/Smartphones-get-gas-sensor

Suggested **R&I Needs** for future research

Policymakers

UNEP

EUROPEAN COMMISSION
environment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Technology Development

Rapid Manufacturing

Technology Deployment

Collaborative Research

Benefits: accelerate new technology deployment; encourage spin-offs; reduce cost; manufacture

Suggested **R&I Needs** for future research

Physics · Material · Fabricate · Reliability · Deploy · Chemical · Test · Publicity · Bio · Deposit · Field · Model · System · Data · Math · Software · Mechanic · Electrical
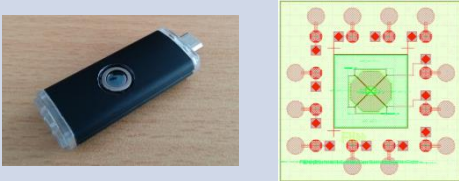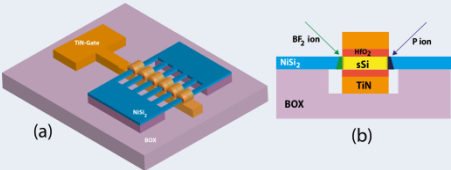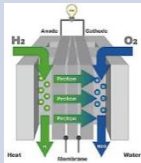
By no means exhaustive!

Ideally under one roof!

SUMMARY & CONCLUSIONS

- To tackle climate change according to Multilateral Development Banks, some trillions and not billions dollars is required!

- Realistically, world can afford some $100 billion a year by 2020.

- EC's Programme for the Environment and Climate Action (LIFE), some €3.5 billion budget has been allocated for 2014-2020 .

- Infrastructure for environmental monitoring is making good progress and this is enabled by improved data communication capabilities.

- What is lacking is the infrastructure to accelerate technology transfer for sensors development.

- This acceleration process will lead to affordable solutions.

- Currently environmental systems are too expensive for developing countries.

- By establishing an EU centre for Environmental Monitoring Technology development will encourage practical contributions from industrial and academic partners to help protect our planet! …

Some of Current research activities

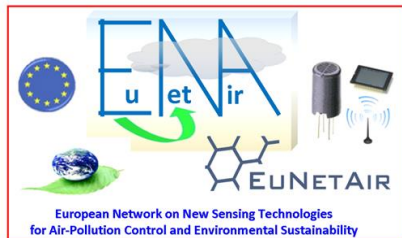## WG2: CMOS Sensors, Devices and System for Air Quality Control

Project	Sensor Type	Application	Picture
MSP	TPD + TPD array	IR Sensor for People presence	
E2SWITCH	Low voltage Circuit & MHP	TFET Low voltage Gas sensor	
EPSRC (HFC)	CO, H_2S, NH_3	Hydrogen Fuel Cell	
TSB (GGP)	CO, H_2S, SO_2, NH_3	Poultry environment	

Acknowledgements

Team at Cambridge CMOS Sensors.

Thank you for listening!