Information and Communication Technologies for *the Environment and Sustainable Growth*

FP7 Planning Workshops
Brussels – 21 to 24 March 2006

Summary Report

European Commission
Information Society and Media
Directorate General

May 2006

Edited by the European Commission
on the basis of the synthesis provided by the workshop rapporteur, **Mr. R. Gasser**.

Table of Contents

The author gratefully acknowledges the contribution made by the specific workshop rapporteurs and Commission staff who provided comments and suggestions on the draft version of this report.

1. Executive summary

A series of four workshops was organised by the European Commission (DG INFSO & Media) as part of the planning process for the Seventh Framework Programme (FP7). The domain considered was Information and Communication Technologies (ICT) for the Environment and Sustainable Growth with four sectors:

- Environmental monitoring and sustainable management of natural resources
- Environment and health
- Risk and crisis management
- Energy efficiency

This compilation of the workshop results provides a set of recommendations from the invited experts for use by the European Commission in the process of defining the details of the work programme for FP7.

Each workshop met for one day and used a mixture of formal presentations, mind mapping and card sorting exercises to identify key research topics – in particular *breakthrough* technologies and applications. Each workshop reached clear consensus on identifying key research topics without difficulty.

This report identifies cross-cutting (horizontal) themes that are common to more than one sector
There was considerable overlap between three of the themes – with the newly introduced Energy Efficiency sector having a wider spread of themes and less overlap in both content and structure with the other sectors.

Key cross-cutting themes included:

- system interoperability,
- a single consistent user interface and service availability ("one-stop shop") to present information products,
- the provision of information products based on near-real-time data from extensive sensor networks, as well as advanced simulation and modelling,
- Systems integration of existing tools as well as the development of new tools.

Energy efficiency presents some specific issues. It is a very broad area and may require further effort to define a well focussed research programme. There appears to be considerable fragmentation in the research community with little demand at present for interoperability and standardisation within the sector. There appears to be considerable scope for close integration and synergies between all the proposed areas of research and development. Experience gained in FP4, 5 and 6 in the field of I*CT for the Environment* suggests that closer integration of energy efficiency with the other research areas may be of particular value and may help avoid repeating some the lengthy "learning curves" they have gone through.

2. Scope and purpose of this document

The European Commission is undertaking the work of detailed planning of the content of the next Framework Programme for Research – FP7 – which is due to start in 2007. Information and Communication Technology (ICT) research and development is the largest single component of the FP7 proposal made by the EC in June 2005 with 12,8 billion euros, representing 28% of this budget. This reflects the importance of ICT in delivering the Lisbon goals.

In this context, a series of four expert workshops were held in Brussels to identify key issues and requirements for the *ICT for the Environment and Sustainable Growth* domain. Focus was successively given to the four following sectors: ICT for Environmental Monitoring and Sustainable Management of Natural Resources (EM), ICT for Environment and Health (EH), ICT for Risk and Crisis Management (RCM), and ICT for Eco/Energy Efficiency (EE).

This report principally addresses the *cross-cutting* or *horizontal* themes which arose in these workshops. Areas of overlap are identified with a view to supporting the development of a single, coherent and efficient Work Programme for the whole *ICT for the Environment and Sustainable Growth* domain. Specific reports[1] from each workshop have been prepared by their respective rapporteurs and readers are referred to these for details of the issues, approaches, technologies and applications that are referred to in general terms in this report. This document is not intended to be a comprehensive account of all four workshops, but aims to highlight and draw out those issues which affected more than each single workshop and to identify the common elements that were discussed; this is an overview with "broad brush strokes" – the detail remaining available in the specific reports.

Throughout this report the different workshops will be identified by the initials as follows:

EM: ICT for Environmental Monitoring and sustainable management of natural resources
EH: ICT for Environment and Health
RCM: ICT for Risk and Crisis Management
EE: ICT for Eco/Energy Efficiency

[1] Available from: http://cordis.europa.eu.int/ist/environment/workshop-210306.htm

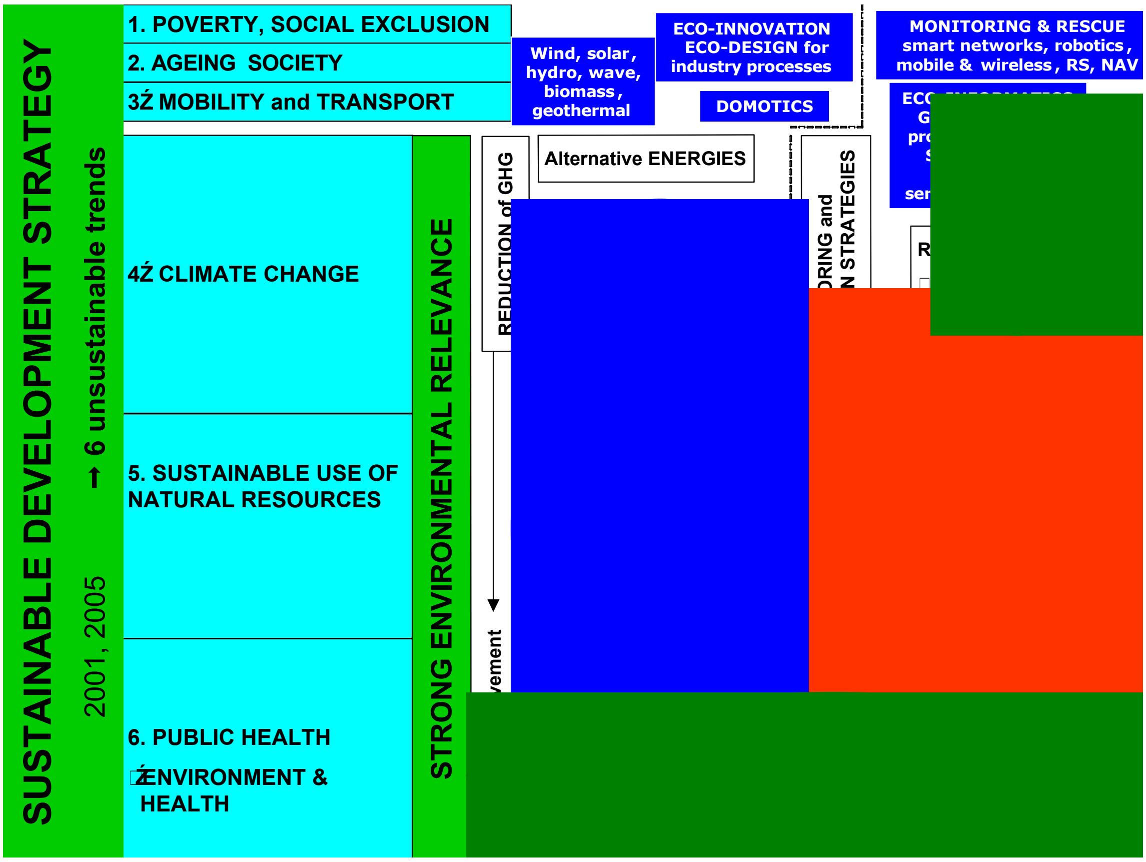


Diagram used by European Commission (DG-INFSO & Media, Unit G5) to present to workshop participants the relationship between the different areas of work and the overall programme for the relevant part of FP7. Note: Modelling and Prediction are important components of all the sectors though not explicitly mentioned in the diagram.

- EM: ICT for Environmental Monitoring and sustainable management of natural resources – red circle
- EH: ICT for Environment and Health – lower green ellipse
- EE: ICT for Eco/Energy Efficiency – blue/purple ellipse
- RCM: ICT for Risk and Crisis Management - top right green ellipse

This report was prepared by an independent consultant, Russell Gasser, HTC Ltd (UK), who was the overall rapporteur for the four workshops. The specific workshop rapporteurs were as follows:

- EM: Horst Kremers, Berlin (DE)
- EH: Jacques LeFèvre, IDEA.SIM LTD (UK) and Ecole Centrale de Lille (F)
- EE: Patrick Corsi, KINNSYS (BE)
- RCM: Ian Whitworth, Cranfield University (UK)

3. Introduction and methodology

The domain of *ICT for the Environment and Risk Management* has been addressed by the European Commission, Directorate General INFSO & Media, in the 4th, 5th and 6th Framework Programmes for Research. It is intended to continue this work under FP7 (which spans the period 2007 to 2013). For FP7, the domain currently investigated has been augmented by including the sector of *Energy Efficiency* in addition to Risk and Crisis Management, Natural Resource Management, and Environment and Health.

Anticipating the research and development effort required to produce services and products for society more than 10 years ahead is a very challenging task. The workshops had to address questions regarding technologies to be introduced up to about 2020 (according to current schedules, a large project in one the last calls of FP7 could end as late as 2018, then there might follow two years of implementation work). In all four workshops participants attempted to identify the most important areas for research; the Framework Programmes aim to fund key *breakthrough* or *rupture technologies* which will fundamentally change the domain. Distinguishing the advances that could be reasonably expected from *business as usual* research and *incremental* technological advances from those needing or triggering a breakthrough is a demanding task.

All four workshops used their time efficiently, were able to achieve consensus on content readily, and identified key challenges and technologies. Each participant brought their own knowledge, priorities and views, and these were used to build an overall vision of a future research and development effort which was, in each case, acceptable to all the experts present despite their different foci. The ability to cover a wide range of views without creating dissent was helped by the professional and participative atmosphere.

The methodology used during each workshop day started with prepared short individual presentations and later included collectively drawing a *mind-map* of the technologies and applications of the specific workshop sub-domain, and used coloured cards to identify key items and then group them into thematic areas. These less-conventional methods – recorded using digital photos – were highly effective and were well received in all four workshops with a lot of positive comments heard. Commission staff should be commended for the success of this innovative approach.

4. Overview comparison of the four workshops

There were significant similarities and overlaps in the challenges and technologies outlined by three of the four workshops, with the new sector *Energy Efficiency* standing apart from the others. This dissimilarity was not only due to the intrinsic difference in technology but, more importantly, there was a significant difference in the *preparedness and overall maturity of development* of the sector and this was reflected in the approach to both technical and strategic issues by the participants.

Due to EE being a new sector, and being somewhat different from the other three sectors, attention is given to discussion of the EE sector in both this section of the report and in the sections "Eco/Energy Efficiency – specific challenges for this new sector" on page 13 and "Further work defining Energy Efficiency goals" on page 16.

Two of the themes which were evident in the other three domain sectors, but not in Energy Efficiency, were:

- A strong emphasis (and overwhelming agreement) on needs such as *interoperability, open systems and architectures*, and *a unified user-interface (the concept of a "one-stop shop").*
- In terms of strategy, agreement on the need to have the *policies* in place if there is to be take-up of new technologies, and to address technical and non-technical barriers to take-up.

In contrast, the Energy Efficiency workshop was more focused on technologies and applications with a strong reluctance to engage in the discussion of policy. There was no clear agreement as to whether the overall goal of Eco/Energy Efficiency was to reduce energy usage and impact, or to continue to increase energy usage while developing technologies to reduce the environmental impact – or some meaningful intermediate position. Moreover, this question was clearly considered by the participants to be out of scope for technology developers and was put aside. The absence of an energy efficiency industry standard interface and architecture (there exist at least five proprietary communications standards) was noted by participants, but was not registered as a particularly urgent issue. There was a clear and explicit consensus by the participants that they perceived their role *as helping to deliver potentially useful technologies* and not being involved in the legislative, economic or strategic decisions which dominate the later take-up of new technologies. Examples of non-technical barriers were raised (e.g. the need to change legislation in Italy to enable net energy supply from distributed generators towards the grid, and the take-up of wind power in Germany) but discussion of these were seen by the participants as inappropriate for a technical workshop.

In the other sectors technical developers have had longer experience of the impact of legislation and policy and have become more involved in *take-up* issues. The position taken by the EE workshop is perhaps similar to the historical position of the other three sectors in FP4 or FP5 when separate development of stand-alone systems with no interoperability was undertaken.

Similarly, there was discussion and agreement in the other three workshops on multi-lingual and multi-cultural constraints, and the urgent need for further work on *ontologies, semantics, meta-data representation* and similar issues related to the different national structures, cultures and languages in Europe.

By comparison the more strictly *technological* approach of participants in the Energy Efficiency workshop led to less focus on those issues while communications and standards questions were principally raised in the context of control and safety of distributed generation systems and in managing data from extensive sensor networks.

5. Policy issues

The individual workshop rapporteur on Environment and Health summarised the policy issue as "the challenge addressed is how to understand and manage the complex environments and the data characteristic of this problem: how to help policy (strategic) and decision (tactical) making, how to communicate and transfer knowledge and recommended behaviours to all the actors involved (including members of the public)."

6. Information – sensors

Accurate, timely data collection from large networks of low cost sensors was seen as important – indeed fundamental - in all four workshops. This is covered in detail in the specific reports.

There was a clear demand for "Real time, ubiquitous monitoring with widely disseminated, multi-risk, smart and adaptive (intelligent) sensors networks" (EH workshop)

The workshop on EM added "Sensor-web technologies, portable & affordable sensors, cheap environmental sensors, [which are] easy to deploy."

The EE workshop noted that modelling would be based on "Personal sensors and ubiquitous remote sensors" and on a requirement "at sensing level: intelligent environments and flexible adaptive sensors networks; collection, fusion and diffusion of reliable data, analysis/diagnostics."

The workshop on RCM also considered web-based sensor networking "the web approach can extend down to ad-hoc 'sensor web' infrastructures."

In terms of the need for RTD, the EE workshop concluded "A key technical and market bottleneck here is the drastic reduction of costs of measures points (by a factor of 10); this requires breakthrough research at both sensors and control levels."

Whether *breakthrough* research is needed in all sectors, or whether environmental sensors *will* continue down the path of miniaturisation and lower cost in any case was not so clear. However, the specific aspects of *ad-hoc deployable sensor networks,* and *intelligence in sensors* were agreed in all the workshops as needing further research in continuation of the work on these same themes already undertaken in FP6. Further work was considered necessary because development of sensor technology, as well as its massive application, will result in analysis, modelling and information generation at levels far in advance of the current basic research effort. The value of the "human as a sensor" and the need to integrate information gained from human sources with that from technical sensors and sensor nets was of particular relevance to the RCM workshop, and was mentioned in other workshops. This brings challenges in integrating information that does not have the same reliability or precision but which does add to the overall picture.

7. The mobile phone (GSM) paradigm for sensor development

Several times throughout the workshops reference was made to the way that mobile phones have reduced in size and cost in recent years. A similar decrease in the size and cost of sensors was considered necessary for the massive use of sensors proposed by the participants in the workshops. This was generally agreed as a reasonable forecast. Low cost – prices mentioned were typically a few euros to a few tens of euros – miniature sensors were seen as fundamental to environmental monitoring, modelling and the energy efficiency sector. It was noted that the integration of data from many relatively imprecise sensors by data fusion might be a way to produce high quality information.

The evident success in international inter-operability of mobile phones was little mentioned, nor the key role played by the EC in bringing about the standardization.

8. Information – data management, semantics and interoperability

Key information issues which were repeated in more than one of the workshops included:

- how to manage the substantial data volumes generated by extensive sensor networks,
- how to use data from different sources with different accuracy and reliability, and how to deal with missing data,
- how to develop and validate *models*, *simulations* and *decision support systems* (DSS) to effectively use the extensive data to generate the required information products,
- how to archive data,
- how to protect privacy.

Apart from in the Energy Efficiency workshop, participants in the workshops considered as important "Meta-information, Semantic Web Technologies and Interoperability" and "Data base systems characterised by the following keywords: population oriented, integrated, distributed, interactive, targeted to all stakeholders according to their needs, semantically aware, open access, cumulative, robust in face of modifications and new technologies." The implication is a move towards information resources based on service-oriented architectures. The Energy Efficiency workshop focused more on the physical models of communication networks and on optimising complex distributed systems at a technical level.

9. The backend system to support the user interface

The delivery of the advanced ICT *backend system* required to deliver a comprehensive information service is clearly a major challenge. It is difficult to draw together all the strands of discussion over four days; the following list covers the key points. Further details of individual topics can be found in the specific workshop reports[2] – the intention here is to list themes which were addressed in more than one workshop.

Key criteria are that the operation of this complex, and probably distributed, system must be both seamless and also normally invisible to the user (for a range of users from professional researchers, policy makers and strategists to members of the public seeking local information).

The backend system may include (or may require):

- Sensors (see also the section in this report on sensors).
- Decision support systems; including actor and situation specific DSS. Decision processes which can function with poor and/or missing or inaccurate or hard to reach information must be supported.
- Modelling – including developing standard models and modelling of multi-risk events, widespread events (such as a pandemic which overloads all available resources) and complex interactions. Modelling linked to agents and GIS.
- GIS analysis tools; map algebra, interpolation, spatial analysis.
- Information mining – with validated data accessibility for privacy.
- Validation - especially large scale validation of models and of entire systems.
- *Open architectures* and *open systems.* Work on a single architecture for all risks, for use in all phases of risk and crisis was successfully started in FP6. An ambitious goal would be to extend these principles across a wider domain to generate *a unified multi-role and multi-use architecture,* so that the alert and crisis response system is fully compatible with the environmental health and environmental management information. This not only reduces artificial barriers but, as noted, lets users build familiarity and confidence before they have to rely on the system in an emergency. *User confidence* was noted by several speakers as a key element of a warning

[2] Available from: http://cordis.europa.eu.int/ist/environment/workshop-210306.htm

system.
- Data management, including quality management, and data interoperability at all levels from data, metadata and semantic web through to services and context mapping.
- Advanced human factors research so that the psychological elements of the interface and the information are properly addressed.
- Access, privacy and data security issues must be comprehensively addressed (see also the section in this report on privacy and ethical issues). Legitimate users will require unimpeded, transparent access to data which might be enabled through their identity, job function, location, the urgency of the required response – or a combination of all of these and perhaps further factors as well.
- There may be a need to identify how the initial investment in information can be resourced.

Some of the most significant challenges reside in *system integration* rather than in the development of entirely new tools.

10. The advanced user interface

A clear desire for improved user interfaces to present complex data and information products to both professional and general public system users emerged in the first two workshops, EM and EH – where the needs showed considerable similarity – and also in the final workshop RCM. The Energy Efficiency workshop also discussed user interfaces but the preferred option for energy system control and optimisation was much simpler and aimed at reducing the need for user interaction (see below). The workshops struggled to articulate what was clearly a widely shared idea. "Google everything about the environment" was considered an insufficient model as it does not reflect the powerful analytical, situation aware and DSS capabilities needed, including modelling and simulation. The dynamics and complexity of the underlying system (ecosystem, pollution model, crisis or energy network for example) need to be both perceived and understood.

What emerged was clear consensus on a User Interface using what could be described as *advanced simplicity* to present extremely large and complex information sets in a clear and user friendly manner and facilitate collaborative working by researchers, policy makers or legislators. Wiki interfaces were repeatedly mentioned in the workshops, but it was clear that Wiki, which is a multi-user editing facility, offers no data processing and hence is not the key.

In discussion it was clear that participants were referring to an *advanced, intelligent, interactive interface*. It can perhaps be better described with a scenario than a formal technical description – the lack of ways found in the workshops to formally express the concept reflects the "ahead of the state of the art" position:

ADVANCED USER INTERFACE

The interface should be able to address the following, or similar, end user needs for the public. Similar user needs descriptions can be developed for the research community, strategic planners and others, and the overall vision is that these interfaces for public, professionals and researchers will be closely related. The following scenario is intended as an example to communicate the vision of one role of ICT in the future:-

> An end user states: "I need to make a decision now in this location about risk/exposure/pollution or other environmentally related issues. I want the system to bring me the relevant up-to-date information and make some forecasts (using modelling and simulation as required – but invisibly to the end user) and let me choose. I don't want to be overwhelmed with too much or irrelevant information, and I want everything presented in a way that I can understand – especially if I am in a hurry. The same information should be available on my mobile phone and PDA (or professional-user hand-held terminal) as well as fixed terminals, though the degree of detail will be different of course.
>
> The same look and feel and layout should be used for all information to help navigation through the options and to make the system feel familiar when I am using it for new purposes. It should "feel" the same today as when I used the system yesterday or last week for a different purpose. (e.g. last week I was worried about airborne particulates and whether I should drive or take the train to work, today I am worried about flood risk. A month ago I was trying to find out how I could save energy, next month I want to plan my environmentally friendly vacation and check the impact of avian flu.)
>
> As I have used the system often, and found it works well, I have confidence in the information I receive, so when the alert functions warn me that I may have to evacuate my home quickly I am prepared to trust the information. Even in an emergency, information and advice will be updated in near real time.
>
> Availability of real-time and near real time information will depend on networks of very low cost sensors - perhaps sensors worn by people. I may be prepared to carry such a sensor to help the system to build up its data resources.
>
> The system will provide regular information that I have signed up for, send important and urgent information even if not requested, and will also allow me to browse and research. Early warning messages will be generated, and when I get an advance alert that I have requested (e.g. concentration of particulates in the air) I will easily be able to find out enough further information to make the right decision.
>
> The information should depend not only on where I am, but who I am. I may need different information from my neighbour who has different family and work situations - but we should be able to discuss what to do in an emergency even though we may want access to information in a different language and we may live across a national border so are under different civil protection systems (e.g. neighbours across a river which is a border and that is flooding).
>
> Suggestions for action (for example to help improve the environment or save energy) would be good but should be clearly different from alerts and alarms.
>
> When a crisis happens the system will still be able to give me essential information about what to do and where to go without information overload leading to collapse (both in the sense that the technology fails and in the sense that I am unable to act because I have no single clear advice).
>
> Granularity will be small - highly localised information will be available, but the

coverage will be extensive. Seamless interpolation will assist in coverage where data is missing and information about the reliability and probable confidence of the information, and its provenance, will be available within a few clicks on the interface.

After a disaster the insurance company will be able to use the information to assess damage and I will be able to see their decision and check that I agree."

This fictitious scenario is based on elements gathered from all the workshops. Behind the apparently simple user interface will be an advanced "back-end" system, probably using distributed computing, and relying on high bandwidth communications.

To turn such a concept into reality will require a strongly *multidisciplinary approach.*

11. Situational awareness – both more detail and larger scale

The specific rapporteur for the workshop on Risk and Crisis Management noted: "Appropriate situational awareness is critical in crisis response, and demands real-time information and widespread information sharing. It depends on availability of geospatial information, sensor information and dependable communications, and will inform decision support systems."

Situational awareness was also discussed in the first two workshops (Environmental Management and Environmental Health). The combination of local and general sensor information as inputs to a DSS with a contextual and situational dependent output for either professional or general public users was addressed in these three workshops.

All the workshops considered that there will be a substantial demand for spatially localised data which forms part of a large overall map, model, database or GIS. The ability to produce locally mapped, context aware, fine-grain, interchangeable and interoperable information anywhere in Europe is indeed a major challenge. Some of this data will have critical time elements and dependencies.

This fine-grain detail for large areas is also a very significant challenge in modelling. Workshop EH articulated the general need for improved "relevance driven spatio-temporal modelling including environment and population data and based on statistical data obtained by personal (human carried) sensors and ubiquitous remote sensors." (The use of personal sensors may be less relevant in other sectors).

There was agreement on the need for improvements – perhaps breakthroughs – in the way that real-time sensor data can be linked to geographic information systems (GIS). Risk and crisis management participants also emphasised the utility of (and challenges for) developing three dimensional geospatial solutions (3D GIS) with application both inside and outside buildings, and also underground.

Heterogeneous data has to be combined to provide some of the required information. For example in environmental health it is the combination of the environment (e.g. pollution levels) with personal exposure which produces the health effects, in disaster management it is the impact of the disaster (e.g. flood) combined with the infrastructure (e.g. road network, housing, etc) that produces the impact.

12. Energy efficiency – specific challenges for this new sector

See also the comparison between the workshops in "Overview comparison of the four workshops" on page six.

The Energy Efficiency workshop had to address a very broad field of action and noted some different user requirements from the other workshops. Whilst the participants were able to bring considerable experience in many technical areas, a key participant on renewable energy technologies was unable to attend at the last minute and this left the renewable energy sector under-represented.

Energy efficiency is a broad topic. The workshop discussed:

- efficient, safe and reliable production, conservation and distribution of energy
- control and monitoring of industrial processes and living environments
- optimising energy consumption and reducing environmental impact, including the overall energy cost through the life cycle of a building including materials and construction costs.

The topics discussed ranged from individual sensor development to managing and optimising the overall energy used in constructing and using a large building.

Some of the key needs that were elicited substantially overlapped with other sectors, including:

- Data collection from large numbers of sensors
- Modelling (including the development of standard models to be used across different systems)
- Prediction and strategy decision support systems
- Real time optimisation (for energy production and use)
- Real-time decision support based on highly reliable networks and heterogeneous information in a complex event environment.

These are elements that are shared – to a lesser or greater degree – with the Environmental Resource Management, Environmental Health and Risk and Crisis Management sectors.

For large-building management the requirements were closer to those set out in the other workshops, but requirements appeared to be substantially different in two important areas: domotics and distributed power generation and co-generation.

(1) DOMOTICS – the application of ICT to the home – makes some very specific demands for a maximally simple user interface for everyday energy management, behind which lies *intelligence, predictive ability* and perhaps *advanced modelling, security* and other features. At an everyday level, domestic energy system controllers must be very simple and intuitive to operate. It was noted that spending

even five minutes a day to optimize energy use is probably unacceptable to many people for both home and also small business applications. (It is unusual for people to re-programme existing domestic heating controllers from one day to the next in order to save energy, hence a *fit and forget* technology appears necessary). Simple, intuitive and ergonomically optimised *user interfaces* are one key to this.

Two specific issues of importance to domotics were considered in the workshop: the lack of standards and the limited incremental options.

Incremental options for domotics

Domotics represents one of the relatively few areas in environmental and energy ICT where there is a consumer market, it is widely acknowledged that many aspects of environmental and energy ICT are dependent on legislative impetus or public funding (or both).

However, it was noted in the workshop, that few consumers may be willing to pay a substantial premium, perhaps 30% on the initial price, for *intelligent appliances* until they have a domestic infrastructure installed which can take advantage of this to provide savings in energy use and costs, and to get some advantage in convenience from the appliance intelligence. Conversely, installing the domestic energy efficiency ICT infrastructure may seem a poor investment if the consumer has no appliances able to take advantage of it. A multiple approach of *standards (interoperability), legislation* and possibly *economic incentives* may be required to overcome this barrier to take-up.

The introduction of e-Meters (electronic electricity meters with communications capability and limited intelligence) for the forthcoming EU-wide electricity market deregulation in 2007 may prove to be an important driver in changing public perceptions, but it is only a first step and not a systems level solution. Application is also varied; in the workshop it was stated that Italy has 27 million e-meters installed and France some 10 million, but other member states have lower numbers.

(2) DISTRIBUTED POWER GENERATION (DPG) emerged as the power generation technology considered most likely to produce a breakthrough. This was not obvious until late in the day when the card exercise (see the section in this report on the workshop methodology, page six) revealed it to be by far the most popular technology for research, and the group discussion led to it being regarded as a *breakthrough technology.*

DPG requires very extensive ICT for control and safety reasons as well as for optimisation. As one participant stated “we must ensure that DPG does not become distributed *pollution* generation”. There are some potential synergies with communications and control technologies for RCM, including “Crisis anticipation using advanced models, methods and tools.”

Standards

The energy efficiency industry is apparently still at a relatively early stage and has many proprietary standards at an equipment interface level. Standards have been developed as a consequence of commercial results, in other areas of the ICT for the Environment domain it was stated that “standards are driving developments and become more and more an integral part of the research.”

Whilst there is some interoperability in large building control systems (and a healthy market for intelligent devices to interface between incompatible systems), at a domestic level this need for broad interoperability appeared to have little recognition in the workshop. Broad interoperability probably implies significant work on the range of supporting activities such as semantics, ontologies, metadata standards, etc that have been identified in other sectors in the ICT for the Environment domain. The view in the EE workshop appeared to be that a dominant standard would eventually emerge commercially, rather than from any strategic international effort to develop industry wide *architectures, standards and interfaces.* So called “stovepipe” (vertically integrated) applications appeared to be a common paradigm. This can perhaps be compared to the position of Environmental Monitoring and Risk and Crisis Management in earlier Framework Programmes where separate projects addressed single risks such as forest fires or floods in incompatible ways, and the lack of interoperability between different national civil protection services was notorious - both at a basic equipment level like radio frequencies and transmission protocols, and also at an organisational and linguistic level.

As the specific workshop rapporteur noted in the workshop’s vision for 2020, “objects, devices and documents will most likely be able to interact and together perform collective tasks. There will be intelligent buildings with intelligent furniture and appliances that will operate functions intelligently.” This is to be based on “Advanced Intelligent Infrastructure as a founding aspect”. Concerted action at non-technical as well as technical levels will be required to realise this vision.

Defining and enabling a Europe-wide *advanced intelligent infrastructure for energy efficiency in buildings* may be a key challenge. Using the experience of the domain ICT for the Environment and Risk Management domain in FP5 and FP6 strongly suggests that *interoperability, open architectures, semantics and linguistics, ontologies, metadata* and similar “high level” strategic issues may prove crucial – this view has taken some time to evolve in the EM, EH and RCM sectors, and slowly re-evolving it for energy efficiency could be a significantly less-than-optimal approach.

Scalability was also noted as a key requirement in the Energy Efficiency sector.

13. Further work on defining Energy Efficiency goals

Given the fragmentation and early state of energy efficiency ICT research, and the significant impact of legislation and policy decisions in this sector, there may be added value in bringing together *technology actors* with *key policy makers, experts in energy legislation* (both current and future legislation) and *economic analysts* for further workshops or meetings before planning the FP7 work programme in detail.

Addressing fragmentation (i.e. actions to support the development of the European Research Area) may be of interest. Key high-level concepts and goals would seem to require further definition (e.g. the issue of whether the focus is to do more with less energy, or to use more energy but with less environmental impact, the discussion arose on the foreseen scarcity of energies not on the objective to lower drastically energies consumption in the workshop I attended) if a coherent approach to Europe-wide technology research is to be achieved.

There appears to be some risk of an interaction that just answers one question with another if policy makers and technologists are not brought together to define the program: technologists might ask the question “what technologies should we develop for energy efficiency? – what are the priorities that will be supported economically and legislatively?” and the policy makers respond by asking “what technologies can you offer us to improve energy efficiency, as we cannot plan which ones to support until we know what is the best available?” A coherent vision from strategies through to technologies may be needed if rapid progress towards the Lisbon goals is to be achieved.

14. Privacy and ethical issues across all four sectors

Any information collection, analysis and distribution service must address issues of privacy and the ethical use of information. Location based services, miniature sensors worn by individuals and the use of massive distributed data storage and processing give rise to quite proper concerns which must be fully addressed, starting at the most fundamental level of system design. The linkage between environment and health requires very careful handling if personal health data are to be generated or accessed. On the commercial side, information for insurance claims and compliance with environmental legislation is also very sensitive.

Similar issues were noted in all four workshops. There was widespread agreement that these are serious concerns which must be included from the outset in FP7. However, the prevailing opinion was that adequate strategies, methods, and technologies have been, and continue to be, developed to ensure information security, and the ethical issues are part of a larger debate. The main task for ICT and the Environment is to *implement* existing and future security systems, protocols and technologies and not to research this area at a technical level. The implementation will require a multidisciplinary approach and need to address social, behavioural, legal, assessment and lifestyle issues.

This is not an *add-on* task: development, or adoption, of suitable standards and protocols, at a legal, a systems architecture and an equipment interface level is necessary from the outset if both *data security* and *privacy* are to be ensured in addition to *interoperability.*

15. The position of Europe compared with the USA

The general current position of Europe compared to the USA (perceived as the main competitor) in ICT for the Environment was discussed in all the workshops. Other developed regions/countries such as Japan may also be competitors but were not specifically considered.

For all sectors there was broad agreement that research in the USA has developed some specific technologies and applications that are ahead of Europe – most notably in GIS - yet it was stated that, in general, there was no significant dominance across a whole sector and Europe was in fact ahead in many aspects (e.g. digital voice radio communications and certain forms of messaging).

In the Energy Efficiency sector it was felt that Europe was well ahead as the dominant paradigm in the USA has been to guarantee plentiful energy rather than to increase efficiency. There were no areas identified where the panels felt that the USA was so far ahead that a European RTD effort would be misplaced; rather there were areas (e.g. novel hypothesis generation for multi-causal environmental health analysis) where Europe could benefit from work already done in the USA.

It was also noted that there are important requirements in Europe which the USA is unlikely to address. Although there is considerable cultural variety in the USA there is a fairly uniform public administration and legal structure with Federal, State, County, City and District levels. European systems have to cope with a large range of political and administrative structures, and considerable linguistic and ontological variety. This leads to a substantial research effort being expended on regional interoperability whereas the USA can, for government contracts at least, mandate single systems for the whole nation. Despite this it was noted by the rapporteur for the EM workshop that the USA is at the forefront of semantic technologies.

16. Technology Transfer to Mitigate the Digital Divide

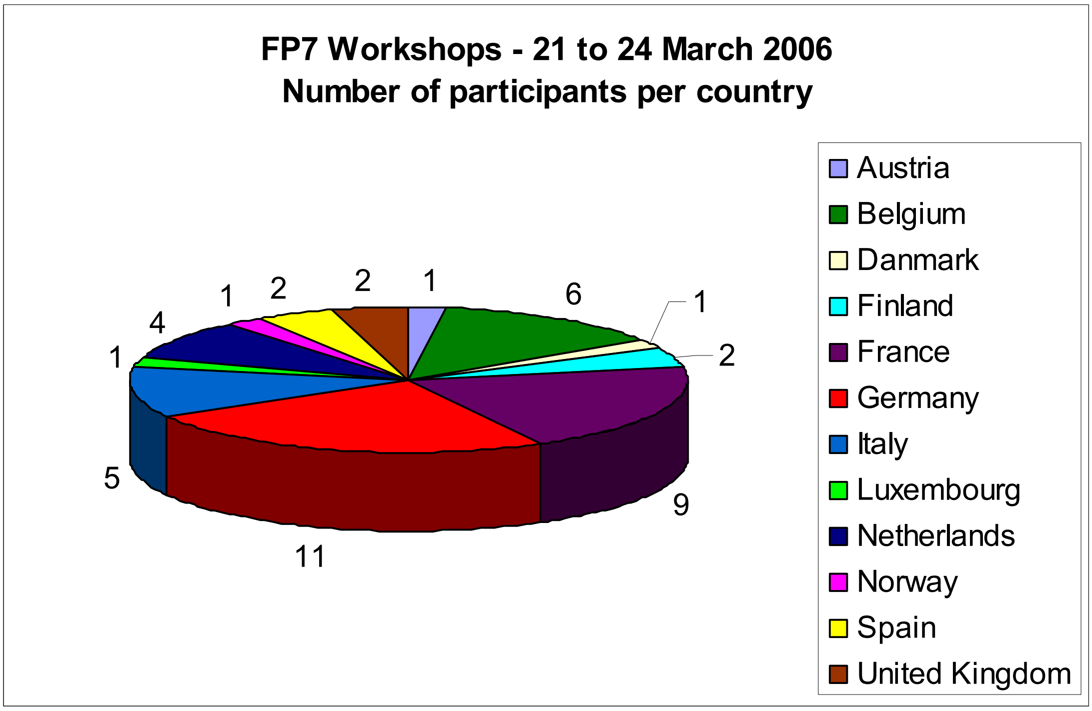
The Digital Divide (the gap between developed countries with extensive ICT and less developed countries with limited ICT access and infrastructure) was discussed briefly in all the workshops. It was noted that the cultural and linguistic diversity in Europe (see above) leads to the implementation of more flexible models for systems and this may be of advantage in bridging the digital divide. The choice of distributed power generation as a key breakthrough technology in energy efficiency may also have a positive impact as this technology is highly suitable for countries with limited and unreliable energy infrastructure.

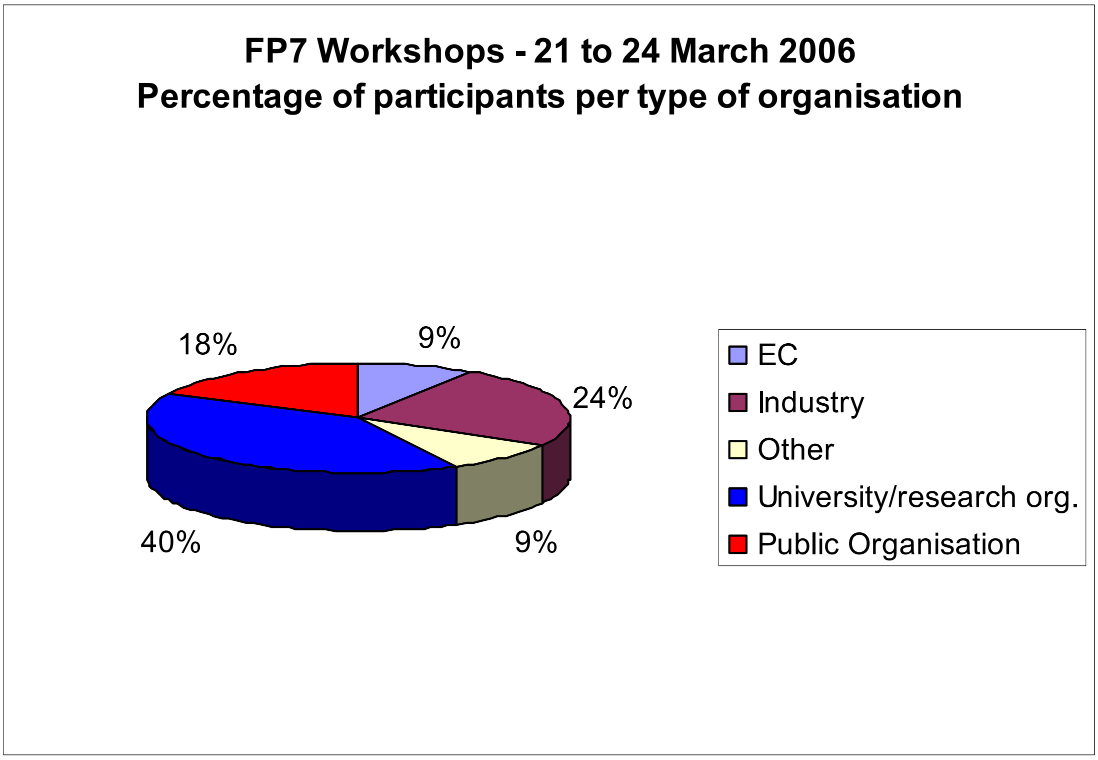
It was noted that the digital divide is not just between advanced nations and the so-called *third world* but also exists to a lesser degree between the EU member states and the non-EU states in Eastern Europe. Overcoming the digital divide should be also a matter of supporting technology transfer in Europe between EU and non-EU partners and this may prove a useful intermediate step in bridging the wider divide between the most and the least advanced nations worldwide.

Contact:
EC DG INFSO:
Michel Schouppe, E-mail: Michel.Schouppe@ec.europa.eu Tel: +32 (2) 29 60618

Rapporteur:
Russell Gasser, E-mail: RG@htc.eu.com Tel: +49 (30) 788 98 048

Annex A – Statistics on Workshops Participants





Annex B - List of participating experts

Name	Surname	Company	Country	Workshop attended
ANNONI	Alessandro	JRC	Italy	1
BARTONOVA	Alena	Norwegian Institute for Air Research	Norway	2
BENDIG	Thomas	Fraunhofer	Germany	3
BOURDEAU	Marc	CSTB	France	3
BOUTIN	Véronique	Schneider	France	3
BROCKETT	Scott	DG ENV	Belgium	2
CABALLERO	David	TECNOMA	Spain	1
CONDETTE	Nathalie	EADS	France	4
CORSI	Patrick	Rapporteur	Belgium	3
DALBOKAVA	Dafina	World Healthe Organisation	Germany	2
DEGROOF	Hugo	DG-ENV	Belgium	1
DENZER	Ralf	EIG	Germany	1
DOUGLAS	John	BRGM	France	1
ENGEL	Thomas	Université de Luxembourg	Luxembourg	4
ERLICH	Marc	SOGREAH	France	1
FERRARINI	Luca	Université	Italy	3
GASSER	Russel	Rapporteur	United Kingdom	1, 2, 3, 4
GEIGER	Werner	Karlsruhe Research Centre	Germany	1
GONTIER	Eric	TAP	Belgium	4
JANTUNEN	Matti	KTL-KUOPIO	Finland	2
JAROSINSKA	Dorota	European Environmental Agency	Danmark	2
JENSEN	Stefan	EEA	Germany	1
KARAKOS	Wassili	Disy	Germany	1
KARJALAINEN	Tuomo	DG TREN	Belgium	2
KOLBE	Thomas	University Bonn	Germany	4
KREMERS	Horst	Rapporteur	Germany	1
KWADIJK	Jaap	Technical University Delft	Netherlands	1
LEFEVRE	Jacques	Rapporteur	France	2
MARTY	Agnès	Thales	France	4
MAURI	Giuseppe	CESI Ricerca	Italy	3
PLANCHON	Dominique	DG RTD	Belgium	3
RAVAZZANI	Paolo	Institute of Biomedical Engineering	Italy	2
SAINT-DONAT	Magali	EDF	France	3
SALVI	Olivier	INERIS	France	1
SCHARL	Arno	Graz University of Technology	Germany	1
SKOULOUDIS	Andreas	JRC	Italy	2
SORIA-RODRIGUI	Pedro	ATOS Origin	Spain	3
STAATSEN	Brigitt	RIVM - Bilthoven	Netherlands	2
TUOMISTO	Jouni	APHEIS project	Finland	2
USLANDER	Thomas	Fraunhofer	Germany	4
VAN DE WALLE	Bartel	University Tilburg	Netherlands	4
VOGELE	Thomas	Environmental Ministry of Lower Saxo	Germany	1
WHITWORTH	Ian	University Cranfield	United Kingdom	4
ZEIL	Peter	University Salzburg	Austria	1
ZLATANOVA	Syska	Delft University of Technology	Netherlands	4

Where
1 - Workshop: ICT for Environmental Monitoring and Sustainable Management of Natural Resources (21 March 2006)
2 - Workshop: ICT for Environment and Health (22 March 2006)
3 - Workshop: ICT for Eco/Energy Efficiency (23 March 2006)
4 - Workshop: ICT for Risk and Crisis Management (24 March 2006)