



**European Cooperation  
in the field of Scientific  
and Technical Research  
- COST -**

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**Brussels, 15 May 2014**

**COST 060/14**

**MEMORANDUM OF UNDERSTANDING**

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Subject :           Memorandum of Understanding for the implementation of a European Concerted  
                          Research Action designated as COST Action TU1403: Adaptive Facades Network

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Delegations will find attached the Memorandum of Understanding for COST Action TU1403 as  
approved by the COST Committee of Senior Officials (CSO) at its 190th meeting on 14 May 2014.

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**MEMORANDUM OF UNDERSTANDING**  
**For the implementation of a European Concerted Research Action designated as**  
**COST Action TU1403**  
**ADAPTIVE FACADES NETWORK**

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4114/13 “COST Action Management” and document COST 4112/13 “Rules for Participation in and Implementation of COST Activities”, or in any new document amending or replacing them, the contents of which the Parties are fully aware of.
2. The main objective of the Action is to harmonise, share and disseminate technological knowledge on adaptive facades at a European level, leading to increased knowledge sharing between European research centres and between these centres and industry, the development of novel concepts, technologies and new combinations of existing technologies for adaptive facades, as well as the development of new knowledge such as effective evaluation tools / design methods for adaptive facades.
3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 80 million in 2014 prices.
4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.
5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of section 2. *Changes to a COST Action* in the document COST 4114/13.

**A. ABSTRACT AND KEYWORDS**

Multi-functional and adaptive building envelopes can provide step-change improvements in the energy efficiency and economic value of new and refurbished buildings, while improving the wellbeing of building occupants. They therefore represent a significant and viable contribution to meeting the EU 2020 targets. There is a critical mass of European knowledge, expertise, resources, and skills in the fields relevant to adaptive facades, but the research efforts across the multi-disciplinary topics and the wide range of novel technologies are scattered across several R&D centres in Europe. This Action aims to harness this knowledge and will thereby generate new ideas and concepts at a fundamental and product/system development level. This will be achieved by creating a research network with a strong multidisciplinary approach, involving academics, industrial partners from the façade supply chain, and other stakeholders. The Action will facilitate the sharing of experimental data, the development of modelling and simulation techniques, and the sharing of common evaluation methods. The work of this Action is expected to form the basis for exploiting recent technological developments in adaptive façades and energy efficient buildings, and will help to train the future generation of façade R&D professionals in Europe.

**Keywords:** responsive and adaptive facades, multi-functional facade, energy efficiency, technology transfer, new building envelope materials and technologies

**B. BACKGROUND****B.1 General background**

Reductions in building energy consumption and carbon dioxide emissions are two of the most important challenges facing the building industry. These must be addressed in a cost effective manner and without compromising occupant comfort and well-being.

Approximately one third of all end-user energy in Europe is consumed by space heating / cooling, ventilation and lighting of buildings, which is governed by the efficiency of the building envelope. Energy demand in buildings may be reduced by up to 13 % by 2020 and up to 71% by 2050 by improving existing and future building envelopes (BPIE 2011). However, the performance of the building envelope cannot be measured in terms of energy reduction alone. In fact, the envelope has a direct influence on Indoor Environmental Quality (IEQ), and safety/security of buildings and their occupants. It is therefore evident that building envelopes are of paramount importance and can play a key role in achieving the EU climate change and energy sustainability targets for 2020 whilst

enhancing the wellbeing of citizens.

## **B.2 Current state of knowledge**

Modern building envelopes are high-tech components that must meet several requirements and constraints with regards to architecture / planning, structural performance, energy efficiency, indoor environmental quality, buildability and ultimately, value. As a result, building envelope design itself has become a specialist discipline, where the building envelope engineer (aka façade engineer) collaborates with the other members of the design team to devise a façade that meets the various requirements and constraints. This is compounded further by the emergence of Adaptive Facades. This next generation of facades (or building envelopes) consists of multifunctional and highly adaptive systems, where the physical separator between the interior and exterior environment (i.e. the building envelope) is able to change its functions features or behaviour over time in response to transient performance requirements and boundary conditions with the aim of improving the overall building performance.

In this sense, an operable window in a façade or a manually operated curtain behind the façade constitute an adaptive façade. But the degree / range of adaptiveness in these cases is relatively low / narrow. On the other hand, a façade is considered to be fully adaptive if it can respond to all the transient conditions in such a way that it maintains occupant satisfaction without imposing additional loads on the building services. This Action will deal with façades with a high degree/range of adaptiveness that can be achieved by means of self-adaptation (smart materials), or active control (intelligent systems).

It is important to note that the timescales of the transient conditions to which an Adaptive Façade responds (i.e. the dynamic frequency) may vary from: a few minutes or hours (e.g. cloud cover or transient lighting requirements in a room); to diurnal and seasonal (e.g. air temperature and radiation cycles); through to several years (e.g. climate change and change of use of building). This Action will deal with all of these timescales.

Highly adaptive facades offer unprecedented opportunities to reduce energy demand and improve indoor environmental quality and they are therefore crucial to the 2020 Net Zero Energy/Emission Building target and beyond. They are particularly complex as they often involve novel materials / systems and they interact dynamically with the external environment, the internal environment and the occupants. At present there is a lack of standardized procedures to evaluate and test the performance of adaptive building envelope components and this is a barrier to their widespread adoption.

Therefore the three principal needs are to:

1. Map out existing and future technologies that can be deployed in adaptive façades and provide a quantitative overview of the performance of each technology.
2. Develop experimental procedures and performance metrics for assessing the dynamic performance of these facades systems.
3. Evaluate the integration of adaptive technologies into the building and their interaction with the internal and external environment and occupants during the lifecycle of the façade.

### **B.3 Reasons for the Action**

Despite the investments in many EU countries on building envelope-related research the research programs across EU states are disjointed. This together with the international nature of the supply chain leads to a relatively low transfer of knowledge transfer between academic institutions and industry. This Action aims to pool together the knowledge, technologies and research from across European countries and beyond. At the same time it will create a strong link between stakeholders such as scientists and companies who are involved in the design, development and evaluation of adaptive facades. The Action framework is the ideal platform to build up this multidisciplinary collaborative network.

The Action will foster existing and initiate new research projects, and trigger innovative solutions and technologies. This will result in a significant social and economic impact as it will strengthen Europe's scientific and industrial position on energy efficient buildings.

This Action will initiate and contribute to the development of regulations for building envelopes in the EU. A collection of existing technologies, research and evaluation methods will provide essential input for the creation of uniform and harmonized design rules and product standards. In particular, it will facilitate the adoption of adaptive and dynamic facades.

The Action will be an ideal incubator and platform for Early Stage Researchers to identify relevant research fields and to create a strong network with the relevant experienced researchers and industrial partners.

The next generation of façade engineers and the façade industry in the EU will benefit from the educational pack developed during the course of this Action. This which allow them to increase their knowledge and competitiveness on the international market.

This Action will build on the success of previous COST Actions related to this area (described in

PartII-History), namely COST Action C13 and COST Action TU0905.

## **B.4 Complementarity with other research programmes**

Other relevant COST Actions are: TUD – C16, "Improving the quality of existing urban building envelopes", TUD – C23 "Strategies for a Low Carbon Urban Built Environment" and TU0802, "Next generation of cost effective PCM". TU1205: "Building Integration of Solar Thermal Systems (BISTS)", TU1303: "Novel structural skins: Improving sustainability and efficiency through new structural textile materials and design". These Actions provide useful links and overlaps, but none of these actions treat the façade in sufficient detail or consider a wide range of adaptive façade technologies.

This Action will build on the outcomes of the above-mentioned COST Actions as well as other relevant bodies such as the International Energy Agency and the European Façade Network.

The Action will seek to engage with specific national and international research projects in this area, such as the successful recipients of the recently announced Horizon 2020 calls for funding (EeB-2-2014: Adaptable envelopes integrated in building refurbishment projects; EeB-8-2015: Integrated approach to retrofitting of residential buildings).

Please refer to section E.3 for further details.

## **C. OBJECTIVES AND BENEFITS**

### **C.1 Aim**

The main aim of the Action is to harmonise, share and disseminate technological knowledge on adaptive facades at a European level. This shall lead to: (1) increased knowledge sharing between the various European research centres and between these centres and industry; (2) the development of novel concepts and technologies and/or the new combinations of existing technologies for adaptive facades; (3) the development of new knowledge such as effective evaluation tools / design methods for adaptive facades; (4) the start of new collaborations and research projects in the area of adaptive facades technologies that will continue beyond the end of this Action.

### **C.2 Objectives**

The aim of this Action translates into the following measurable objectives.

(1) Harmonize the European research and knowledge in the area of adaptive façades between

industry and academia and foster their collaboration.

The European research effort on multi-functional and adaptive façade is very dispersed among different academic institutions manufactures, researchers, designers, and other stakeholders. This Action will serve to establish pockets of expertise (Working Groups) with common objectives and complementary skills / knowledge. These will be tasked with harmonising and disseminating the recent research in their areas of competence.

(2) Share and disseminate technological knowledge at a European level between the different stakeholders in the façade industry and the academia.

There is a vast amount of multi-disciplinary technological knowledge on adaptive facades at a European level, but this has to be organized in order to facilitate the development of new optimal adaptive facades. The state-of-the-art and emerging technologies / concepts will first be identified and a database of relevant technologies will be created. This will serve as a basis for proposing and pursuing novel concepts / technologies for adaptive facades.

(3) Share and develop more holistic approaches, metrics and tools to evaluate the performance of adaptive facades with the purpose of standardisation and feasibility assessment of novel concepts; There are different scales and variants of evaluation methods: numerical (component and whole building) and experimental (laboratory and post-occupancy). These will be collated and reviewed in this Action. This will include a database of available experimental facilities that will be shared among the members and with the European institutions, with the aim to provide a framework to support research and standardise procedures and results. The Action will also address some of the current gaps in existing evaluation methods for example: (a) the lack of key parameters to assess adaptive facades; (b) the lack of holistic methods and simulation tools that account for the different domains of interaction of the adaptive façade with the building and users (i.e. energy performance, physiological and psychological impact on building users, safety and structural performance); (c) the lack of a robust whole-life-cycle assessment approach for adaptive facades.

(4) Develop an effective means of disseminating the work of the Action on adaptive facades with an emphasis on engaging with early-stage researchers, industrial partners and the wider public.

Effective communication will feature prominently in this Action. This will be achieved through the development of a web-based knowledge portal. The portal will host the results and the resources of the Action, namely: (a) the database of adaptive technologies; (b) the experimental procedures and the evaluation methodologies; (c) the multi-disciplinary educational pack aimed at the development of façade engineers and researchers. The Action will also include Training Schools and stakeholder workshops.

(5) Align and organize the efforts between the stakeholders and academia and initiate new research

projects in the area of adaptive facades.

The mapped resources, interests and objectives of the different stakeholders, as well as the main outcomes from the different Working Groups (WGs) will be communicated systematically to stimulate future research and product development for new and refurbished buildings;

### **C.3 How networking within the Action will yield the objectives?**

Façade Engineering is inherently multi-disciplinary and has a wide and dispersed supply chain. The objectives of this Action can only be achieved if networking through physical and virtual meetings between all involved researchers is facilitated and guaranteed. The Action will provide the essential networking activities such as: Workshops at Working Group and task group levels; round table discussions between academic institutions, research centres and industry; Short Term Scientific Missions (STSMs) among different institutions and the industrial partners involved; round robin exercises; common case studies; peer reviews within the network; Training Schools for early stage researchers and professionals. Moreover there will be a coordination activity for the existing and future research in the Working Groups.

In the short term, this network will stimulate new research ideas and significantly increase the collaboration between researchers in Europe. In the long term, this network will be the basis for the creation of unified design rules, new test requirements, facilities and future product standards in European Union.

Special attention will be given to the involvement of stakeholders (material producers, fabricators, architects, engineers etc.) for specifying research questions, methodologies and when presenting research output.

The Milestones are specified in E.1. The common objectives - to work together, to produce valuable research output through the Action and to create a perspective for long term cooperation - are beneficial for all the participants and will ensure positive engagement.

### **C.4 Potential impact of the Action**

Façade-related research and industry across Europe would greatly benefit from the network initiated by this Action. This would in turn generate the following individual benefits:

*Economics* - The high-tech façade industry is in its infancy and there is significant room for development and growth. The results of this Action will therefore strengthen Europe's position and align technical expertise in the EU with future global market needs. The collaboration between

academia and industry in this Action will accelerate knowledge transfer and will establish quick routes to market. Moreover, high performance building envelopes can reduce energy demand, increase the amount of usable interior space in a building, and lead to improved productivity in the workplace, thereby increasing the value of buildings.

*Environmental and wellbeing* - This Action will directly contribute to the development and evaluation of new energy efficient building envelopes that will make a significant contribution to energy and carbon reduction targets for 2020 and 2050. Adaptive building envelopes contribute to the reduction of material consumption, embodied energy, the energy consumption of buildings and the use of renewable energy. In addition to energy reduction and optimal whole-life-cost, the adaptive / high performance building envelopes investigated in this Action are intended to enhance safety, security and occupant comfort.

*Society* - Dissemination activities such as conferences, workshops, Training Schools and seminars, will aim to involve all relevant stakeholders, including architects, construction professionals, building services engineers, policy makers and building component and façade manufacturers. This will ensure that all the stakeholders gain an insight into the design of adaptive facades and will lead to energy efficient and comfortable buildings. Moreover the Action may become an important step in a series of actions promoting the energy consciousness and effectiveness in the EU construction industry.

*Building regulations and standardization* –This Action, will initiate and contribute to the development of unified regulations, experimental procedures and design rules for building envelopes in the EU. In particular it will facilitate the adoption of adaptive and dynamic facades.

### **C.5 Target groups/end users**

The Action will provide a strong contribution to the on-going development of European standards in this field, as well as to the development of innovative products and more holistic evaluation methods. Consequently, the scientific research reports and outcomes from the seminars, workshops and round tables will provide researchers, academics, architects, engineers, fabricators, construction firms, building owners and policy makers with up-to-date overviews of research results on materials, advanced methods for the design and evaluation of adaptive facades. In addition, a guidance/educational pack will be developed to support university curricula and professional development programmes across Europe.

The following target groups are expected to be involved in the Action: researchers, academics, engineers, fabricators, construction firms and standardisation committees.

## **D. SCIENTIFIC PROGRAMME**

### **D.1 Scientific focus**

This Action will focus on the coordination of current research undertaken through national programmes in three scientific areas (1) Development of new technologies and concepts for adaptive facades; (2) Multi-disciplinary characterization methods of novel adaptive façade technologies and concepts at a component level; (3) Whole-life evaluation methods of novel adaptive façade at the building level and building/user integration. Three Working Groups (WG) will be set up to coordinate research within each theme and a fourth one is dedicated to dissemination activities.

The Action will create new partnerships and collaborations for the exchange of scientific knowledge and data. In doing so, it will improve the outcomes of the national research activities and it will lead to the technological advancement of adaptive facades. In particular, it will accelerate the development of components and evaluation techniques, and their adoption and application in buildings.

Dissemination of the research between the partners within the Action will be achieved by means of MC/WG meetings, STSMs and Training Schools. Dissemination to end users and the wider public will be accomplished via workshops, mid-term and final International Conferences and the Action website.

### **D.2 Scientific work plan methods and means**

There is a critical mass of European knowledge, expertise, resources, skills and R&D in the area of high performance and adaptive facades. If harnessed, it has the potential to generate innovative ideas and concepts at a fundamental scientific level as well as to produce novel adaptive façade products and systems. This Action will facilitate: sharing of experimental data; development of modelling and simulation techniques; sharing of common evaluation methods; thereby leading to real and significant advances in adaptive facades and their use in energy efficient buildings. This network will provide the immediate sharing of nationally-based research and enable the establishment of common platforms to accelerate trans-national research projects in the area of adaptive facades.

The immediate outcome is a large shared knowledge-base in adaptive facades technologies and evaluation methods. This will lead to: novel adaptive components and technologies; capital cost and

operational cost efficiencies in buildings; and reductions in building energy consumption. The activities will broaden the scope of the Energy Performance of Buildings Directive, whilst facilitating the introduction of new technologies into building sector. This Action will also have a significant impact on building-related regulations and systems standards such as the experimental characterization and numerical simulation, in-situ performance testing of adaptive facades. The Action will also contribute to the development of whole-life cycle methods in the building industry. **Three main** scientific tasks have been identified, which will be undertaken through the above-mentioned 3 Working Groups (WG). A fourth WG (WG4) will be set up to co-ordinate the dissemination activities and the future research at a European level. The Action will be flexible enough to accommodate newly emerging fields and topics in scientific tasks and if needed will create new strategic scientific task groups that can operate within or between the Working Groups.

### **WG1. Adaptive technologies and products**

The main aims of this Working Group are:

1. To provide the Action with a database of different technological solutions and application of adaptive facades, constituting a the state-of-the-art literature review of either new market technologies and possible developments of adaptive facades. This supporting database is a first stage to evaluate the current and future trends of adaptive facades.
2. To pursue and support the development of novel adaptive technologies. These may consist of novel adaptive technologies that are new to the façade research community and/or new combinations of existing adaptive technologies.

The objectives of WG1 are: to map out the different technologies (available either on the market, or as prototypes or concept) allowing a façade to be adaptive and responsive, in terms of materials and systems (including control systems); to provide an overview of the performance of each technology compared to the state-of-the-art high performance facades; to identify and pursue new concepts and new products for adaptive façades; to provide a selection of applications of technologies already adopted in existing projects identifying the strongest and weakest points.

The headline tasks of WG1 can be identified as:

*Task 1.1 Definition of state-of-the-art materials for responsive and adaptive facades*

*Task 1.2 Definition of state-of-the-art systems for responsive and adaptive facades*

*Task 1.3 List of case studies and available applications of adaptive facades*

*Task 1.4 Future adaptive facades*

The deliverables of WG1 are:

D.1.1. Report and database with current state-of-the-art adaptive façade materials, systems and new concepts.

D.1.2. Report real world case studies of adaptive façade applications.

D.1.3. Report on progress made in new adaptive technologies over the course of the Action.

D.1.4. Input and contributions to relevant parts of educational pack

D.1.5. Contribution to Industry Workshop

D.1.6. Contribution to Annual Training School for dissemination of expertise to Early Stage Researchers

D.1.7. Annual STSMs for Early Stage Researchers on novel adaptive facade technologies

## **WG2. Component performance and characterization methods**

The main aim of this WG is to provide a unified approach for characterizing and evaluating the performance of an adaptive and multi-functional façade, at the component level. This will include the various physical characteristics that affect the wide range of transient performance requirements of a façade.

The objectives of WG2 are: to identify for each aspect of façade performance (energy efficiency, structural, safety, fire, weather protection, durability, aesthetics) where the adaptive technologies would be most beneficial; to establish and standardise numerical and experimental ways of characterizing their performance (with an emphasis on performance related to energy efficiency); to evaluate the suitability of conventional performance parameters to fully address the behaviour of adaptive facades; to develop new metrics that are able to capture the transient and multi-parameter performance of adaptive façades and thereby enable quantitative comparisons between different facades, where the adoption of conventional metrics is not satisfactory; to develop new numerical tools for evaluating the most promising adaptive technologies.

The headline tasks of WG2 can be identified as:

*Task 2.1 Map out performance metrics and requirements for adaptive facades*

*Task 2.2 Evaluate current simulation tools for adaptive facades performance assessment.*

*Task 2.3 Analysis of current experimental procedures for the evaluation of adaptive facades.*

*Task 2.5 Develop standardised experimental procedures and metrics for evaluating the performance of novel and existing adaptive façade concepts.*

*Task 2.4 Develop new simulation tools for the evaluation of the performance of novel and existing adaptive façade concepts.*

*Task 2.5 Identify sources of European and national funding and apply for funding for new research projects in the field of adaptive facades*

The deliverables of WG2 are:

- D 2.1. Report on current adaptive facades modelling techniques.
- D.2.2. Annual STSMs for Early Stage Researchers on theoretical modelling and numerical simulation of multi-functional and adaptive facade components and systems
- D.2.3. Annual STSMs for Early Stage Researchers on experimental procedures and measurements for the evaluation of multi-functional and adaptive facades components and systems
- D 2.4. Report on the validation of developed simulation tools and models
- D 2.5. Report on the developed experimental procedures.
- D.2.6. Contribution to Annual Training School for dissemination of expertise to Early Stage Researchers (Month 18, 30, 42). This will include topics on theoretical modelling, numerical simulation, experimental characterization and building integration of adaptive and multifunctional facades.
- D.2.7 Contribution to Education pack
- D.2.8. Contribution to Industry Workshop
- D.2.9. Report / presentation on funding available for new European research projects

### **WG3. Whole building integration and whole-life evaluation methods of adaptive facades**

The main aim of this WG is to evaluate the integration and interaction of an adaptive façade with the building (aesthetics, structure etc.), the building services, the building users and the environment, thereby providing an account of the whole-life performance of an adaptive façade. The quality of future energy efficient buildings depends on the performance of each component (established in WG2) but also on the interaction between these components in the entire façade system and how the façade interacts with the internal / external environment and users. The objective of WG3 is thus the evaluation of the pros/cons of adaptive façades when these technologies are analysed with a wider perspective, i.e. the impact of the adaptive façade when: 1) integrated into a building; 2) under realistic boundary conditions and users' interaction; 3) in a multidisciplinary, holistic perspective.

Another objective of this WG is to initiate and harmonize European and national research projects in order to further develop these methods and create a basis for future European standards, design rules and testing procedures.

The tasks of WG3 can be identified as:

*Task 3.1 Requirements for building integration and user interaction for adaptive and multifunctional facades*

*Task 3.2 Evaluation methods for in-situ assessment of adaptive and multifunctional facades*

*Task 3.3 Experimental post-occupancy evaluation methods*

*Task 3.4. Develop new whole-life evaluation methods for adaptive facades as an integral part of a*

*building*

The deliverables of WG3 are:

D.3.1. Annual STSMs for PhD students and Early Stage Researchers on integration requirements and current and post-occupancy evaluation methods

D 3.2. Report on the requirements for building and user integration

D 3.3. Report on current and post-occupancy evaluation methods.

D.3.4. Input for the annual Training School for dissemination of expertise to Early Stage Researchers (Month 18, 30, 42).

D.3.5 Contribution to Education pack

D.3.6. Contribution to Industry Workshop

D.3.7. Report / presentation on funding opportunities for new European research projects

#### **WG4. Dissemination and future research**

Responsibilities of this WG is to organize and manage the Action website, the workshops, the Short Term Scientific Missions (STSM), Training Schools and Symposium (each Early Stage Researcher will present his/her work published as papers in a booklet) and co-ordinate the International conference, publication of journal papers and guidelines, and finally coordinate the application for future research projects. These responsibilities of WG4 will be achieved through the following headline tasks:

*Task 4.1 - Organisation and coordination of Action events (MC/WG meetings, stakeholder/industry meetings; Mid-term and final conferences).*

*Task 4.2 - Educational Pack and Training School (see also H2.).*

*Task 4.3 - Coordination of Short Term Scientific Missions (STSMs)*

*Task 4.4.- Database of research project and experimental facilities in the domain of the Action.*

*Task 4.5 – Creation and management of Action website. (see also H2.).*

*Task 4.6 – Dissemination through journal, conference, trade publications and website. (see also H2.)*

The deliverables of WG4 are:

D.4.1 Creation and maintenance of the Action specific website

D.4.2. Organisation of all meetings and related minutes reports

D.4.3. Educational pack content definitions and development

D.4.3. Organisation of 3 Training Schools (1 per year except the first year) and related material published

D.4.4. Completion of at least 20 STSMs by the end of the Action.

D.4.5. Organisation of Action Mid-term Conference (beginning of 3rd year)

D.4.6. Organisation of Action Conference (end of the 4th year) and production of proceedings

D.4.7. 16 peer reviewed scientific journal papers and conference publications

D.4.8. Submission of at least two research proposals at the end of the Action

## E. ORGANISATION

### E.1 Coordination and organisation

The work of the Action will be headed by a Management Committee (MC), constituted by representatives of the participating countries. At the Kick-off Meeting the MC nominates the Chair, the Vice Chair, the grant holder, an executive secretary and the Chairs of the four WGs. These eight individuals will also form the Steering Committee (SC), which will directly report to the MC (who will have the final say on any decisions), monitor the activities of the Action and review the progress of the WGs. MC and SC will be responsible for the progress of the action and ensure that the objectives set out in section C are met. The SC will be responsible for the coordination of the work programme, the coordination of events such as STSMs, Training Schools and Conferences. Additionally the SC will manage the relationship with the COST office and other administrative aspects of the Action.

WG meetings will be held twice a year. In order to reduce travel expenses MC and SC will meet the day before. Video conferencing facilities and email will be used in the intervening periods (i.e. between official meetings) for communication within WGs, MC and SC.

Milestones of the Action are:

Lead	Milestone-number	Milestone	Month	Deliverables and progress indicators
SC/MC	M-1a	Launch of Action	3	- Kick-off Meeting (KM) - Election of SC and WG Chairs - Establishment of website
SC/MC/WG1-4	M-1b	Presentation of the Action to the Industry community and state of the art database (1)	12	- Industry workshop - No of participants - First version of state of the art booklet
SC/MC/WG1-4	M-2a	Training, Dissemination (1)	18	- First version of educational pack - min. 6 STSMs initiated - First Training school - No of attendees at first Training school - 4 peer reviewed journal papers

WG1-4	M-2b	WG Progress report (1) and state of the art database (2)	24	- Reviewed state of the art database booklet - WG progress report - Review of webpage
SC/MC/WG1-4	M-3a	Mid-term Conference and Training, Dissemination (2)	30	- Reviewed version of educational pack - min. 10 STSMs completed - Mid-term conference proceedings - Second Training School - No of attendees at first training school - 8 peer reviewed journal papers
WG1-4	M-3b	WG Progress (2) report and Industry Workshop (2)	36	- WG progress report (2) - Second industry workshop - No of participants
SC/MC/WG1-4	M-4a	Training, Dissemination (3)	42	- Reviewed version of educational pack - min. 16 STSMs completed - Third Training School
ALL	M-4b	Final Conference and End of Action	48	- all 20 STSMs completed - Final conference - Conference proceeding - Final report - min. 16 peer reviewed papers

## E.2 Working Groups

A total of four WGs will be established to coordinate the research and dissemination activities of this Action:

- WG1. Adaptive technologies and products
- WG2. Component performance and characterization methods
- WG3. Whole building integration and whole life evaluation methods of adaptive facades
- WG4. Dissemination and future research

The main tasks of each WG are described in Section D. WG1 through WG 3 are scientific Working Groups focussing on the coordination of research in the three areas identified in Section D. WG4 will be responsible for the organization of all dissemination activities of the Action and the identification and initiation of future research projects. These activities comprise the Action website, workshops, STSMs, Training Schools, the international conferences, publications of journal papers and guidelines.

Each WG will be led by a Chair and a deputy Chair. They will coordinate the work within the WG and avoid any unnecessary overlaps between WG. The four WG Chairs are members of the SC who

will ultimately report to the MC. The Chair of WG4 will also have the function as a Communication and Dissemination Manager within the SC and will be responsible for the flow of information between participants and the timely and successful dissemination of results.

The WGs will be sufficiently flexible to invite additional external experts from science and industry to boost the progress and the dissemination of the Action.

### **E.3 Liaison and interaction with other research programmes**

Generally, interaction with existing and future COST Actions will be encouraged and joint activities will be supported, whenever possible. For the first scientific objective, the harmonization of existing European research and knowledge, all completed and running research projects and programs in the area of adaptive building envelopes have to be identified. Some of them have already been identified and reported here: IEA ECBCS Annex 32, Integral Building Envelope Performance Assessment; IEA ECBCS Annex 43 and SHC Task 34, Double Skin Facades; IEA ECBCS Annex 44, Responsive Building Concepts and Responsive Building Elements; TUD - C13, Glass and Interactive building envelopes. The outcomes of two currently running COST Actions: TU1205: “Building Integration of Solar Thermal Systems (BISTS)”, TU1303: “Novel structural skins: Improving sustainability and efficiency through new structural textile materials and design” and TU0802: Next generation of cost effective Phase Change Materials will be closely monitored and where relevant will feed into the work of this Action.

### **E.4 Gender balance and involvement of early-stage researchers**

Although there has been an increase of female researchers in façade engineering in the recent years, it has yet to achieve the gender balance attained in domains like architecture. The importance of adaptive facades in architecture will increase in future, as technical solutions need to be fully integrated into the architectural intent. One of the strategies of this Action will therefore be to attract architects and further improve the gender balance.

Early-stage researchers are the basis of a highly innovative and sustainable network that will continue beyond the completion of this Action. Therefore, early stage researchers will be encouraged to actively contribute and take advantage of the Action network. Early-stage researchers will be invited to coordinate sub-topics within the Working Groups and workshops. In addition, Short Term Scientific Missions and Training Schools will be specifically addressed to early-stage researchers.

## F. TIMETABLE

The duration of this Action is four years. The official launch of the Action will be the Kick-off Meeting (KM) where the Management Committee (MC) and the Steering Committee (SC) will be set up and the four Working Groups (WGs) will be established. MC and SC will meet at least twice a year. The final meeting (FM) will be held at the end of the Action. The scientific and dissemination activities are shown in the time table below.

Activity/Month	Year 1				Year 2				Year 3				Year 4			
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
KM	x															
MC/SC	x	x		x		x		x		x		x		x		x
WG		x		x		x		x		x		x		x		x
FM																x
STSM			x	x	x	xx	x	x	xx	xx	xx	xx	x	xx	x	x
Mid /Final Conference										x						x
Industry Workshops				x								x				
Educational pack					x	x			x	x			x	x		
Training School						x				x				x		
Web Site	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Milestones M-		1a		1b		2a		2b		3a		3b		4a		4b

## G. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, CH, CZ, DE, DK, EL, ES, FR, HR, IT, MK, NL, NO, PT, RO, RS, SE, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 80 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but

no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

## **H. DISSEMINATION PLAN**

### **H.1 Who?**

The dissemination of deliverables and milestones will only be of value if they reach a sufficient number of people of the target audience. Taking this into account WG4 is set up to organize and manage all dissemination activities so that the work undertaken in this Action will reach the widest possible audience. During the first year of the Action, the dissemination will mainly target existing and prospective participants and partners. This is considered essential in order to collate and harmonise the state-of-the-art information. From the beginning of the second year the dissemination activities will start to focus on the external audience of stakeholders.

**Researchers and Research Institutes:** All scientific papers, reports and test reports will be made available for researchers in order to stimulate and initiate new research projects and new innovative adaptive façade solutions. The database of the state-of-the-art, together with the completed and current research database on adaptive facades will be made available on the Action website and will be a valuable source of information for young researchers.

**Façade Industry, Component Manufacturers and Professional Associations:** One of the main targets of this Action is to transfer new technologies and research results on adaptive facades to the European façade industry and to the various members of the façade industry supply chain (e.g. manufacturers of materials and components etc.). The state-of-the-art reports and journal papers produced from this Action and the website will be of great use to the façade industry and will strengthen their position on the global market. European façade manufactures and others in the supply chain have already expressed their intention to be active participants of this Action. This group of industrial partners will be widened even further during the industry workshops planned in this Action. These workshops will provide useful fast feedback to the Action and will help to further align the Action's activities with the specific needs of industry.

**Practicing engineers and Architects:** The collation of existing knowledge on adaptive facades will be useful for the design and development of new energy efficient façades. The conferences and the educational pack of this Action will be ideal for practicing engineers and architects to widen their knowledge and continue their professional development. Moreover real-world case studies and project applications will be presented by the practicing professionals involved in the network at the workshops, and could be adopted as exemplars of adaptive facades.

**Educational bodies:** Energy efficient adaptive facades are based on new technologies, with a complex interaction between components, and between the physical domains involved, therefore multidisciplinary knowledge is required. This is one reason, why this topic is currently not taught in façade engineering education programs. The educational pack will enable teachers of the partner universities to implement this knowledge into their building and façade engineering programs. Moreover the educational pack will be available on-line so that it could be adopted from other educational bodies, not included at the beginning in the Action. Universities involved in this Action will provide an immediate route for dissemination at undergraduate and graduate level.

**Standards Bodies:** Standards bodies will be involved in order to create harmonized building product standards and to establish harmonized European test methods for adaptive facades. One target of the Action is to form a group of experts, which will promote and initiate the development of harmonized European standards, taking the deliverables of this Action as a basis.

**General Public:** Adaptive facades differ from static facades and their success also depends on the acceptance by the general public. Individuals can learn about this new technology from the knowledge, which will be published on the website, from the newsletters and websites of the various members of this Action. Furthermore several COST countries will host a Management Committee / Working Group meeting during the course of this Action. The hosts will use these events to maximise the interaction with the local general public.

**Building Owners and Building Investors:** The underlying aim of an adaptive façade is to produce a building that outperforms conventional buildings in terms of energy efficiency and occupant comfort / wellbeing. This will provide significant benefits to building owners and building investors (e.g. greener buildings, lower operational energy cost, higher value buildings etc.). Both groups will be reached by the information on the website, conferences and industry workshops. Building owners will be specifically contacted during the Action in order participate in the activities / workshops of WG3 (test and validate the post-occupancy test methods for adaptive and multifunctional facades).

## H.2 What?

**Website:** A website will be created immediately after the launch of the Action and it will serve as the most important and visible platform of the Action. Visitors will get all relevant information about the Action such as the agenda of events, links to research projects and the state-of-the-art report about existing technology and ongoing research projects. Research reports, journal publications and the educational pack will be made as accessible possible. Participating members

will have access to a password protected portal in order to exchange interim documents and other confidential information.

**Internet communication:** Transfer of information and announcements relating to the Action will be performed electronically. A discussion forum will be created on the web site to allow a discussion of important topics, new ideas and research projects. In the periods between physical MC and WG meetings, internet video conferences will be used to accelerate progress.

**Action Poster and Leaflet:** A poster and leaflet with information on the Action and contact details will be created at the beginning of the Action to draw attention to a wider public and to attract new interested researchers and stakeholders. Both media will be presented and distributed by the Action participants at trade fairs, conferences and to professional associations.

**Publications, journal papers and conference papers:** During the Action, results will be published and communicated electronically (state-of-the-art booklet and database, the state of the art reports, education pack and the reports in Section D) and in hardcopy (the conference proceedings and the final report). All publications will be available on the web site, as far as copyrights permit. One objective of each WG is to publish at least one joint peer reviewed scientific journal paper or conference paper per year.

**Educational pack:** The educational pack consists of lectures and educational material, such as pictures, design guides, training courses for new modelling techniques and experimental techniques, and will be made available on the website. This will be targeted to teaching staff at Universities, but it is expected that Early Stage Researchers, practicing engineers and architects will also find it useful for extending their knowledge on adaptive facades. The educational pack will reflect the multidisciplinary approach of the Action and will therefore serve to train the next generation of façade engineers and researchers in this area.

**Events:** WG meetings and Short Term Scientific Missions will allow an intensive exchange of information and knowledge within the Action. One mid-term and a final conference will be organised as part of the Action and will serve to disseminate the results to a wider audience, such as manufacturers, professionals, building owners and researchers not included in the network. Additionally two industry workshops will build strong links with the wider façade industry (material producers and processors, component manufacturers, façade contractors and trade / professional associations).

### H.3 How?

The dissemination activities described in section H2. are one of the principle objectives of this

Action. The focus of WG4, with its Chair the Communication and Dissemination Manager, will be, to initiate, coordinate, and monitor the progress and to review all of these activities. The first task of WG4 will be to establish a detailed dissemination plan where all activities are scheduled with milestones and allocated to the defined external audience of stakeholders. During the Action the impact of all dissemination activities will be evaluated and reviewed by the MC who will ensure their effectiveness.

The Action website is arguably the most important information / dissemination tool (see H.2). This will be created at the launch of the Action and the content will be updated and maintained on a regular basis by WG4. WG4 will also provide coordination support for preparation of technical reports, journal and conference papers. Early-stage researchers will be encouraged to actively participate in this process.

Besides the leading activities of WG4, all participants of the Action will actively contribute to the flow of information within the Action and to all aspects of dissemination and outreach by participating in scientific conferences, meetings and professional networks.