



## Mid-term evaluation

Title of the programme: **Intelligent home of the new generation designed on smart appliances and wood**

Acronym of the programme: **IQ HOME**

S4 priority area: **Smart buildings and home with wood chain**

Evaluator:

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### 1. Introduction: basic data on the project and mid-term evaluation

The project IQHOME (Intelligent home of the new generation designed on smart appliances and wood) presents three major programme pillars: 1) advanced building with wood chain, 2) intelligent appliances and 3) intelligent home management. The project covers a very broad range of research topics, as 25 research and development projects (RDPs) were originally proposed and 26 partners are involved in the project.

The documents used for the mid-term evaluation are:

- progress report, sent to this evaluator on 21.03.2019 by the Ministry of Education, Science and Sport;
- the original project proposal;
- the printed presentations that were given during the on-side evaluation on 15.04.2019. An electronic version of the presentations has been also provided.

During the on-site evaluation, the project partners were able to present the achievements in each RDPs with suitable time for discussion. There was also an appropriate time slot for visit of the laboratories of the lead partner Gorenje. Several prototypes were also available during the presentation or in a room close by.

The agenda for the on-side visit was:

10.00-10.15	Introductory greeting and presentation of the IQ HOME program
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10.15- 11.45	Presentation of activities and results of 1-8 RDPs
11.45-12.00	Coffee break
12.00-12.40	Presentation of activities and results of 9-18 RDPs
12.40-13.20	Lunch (Gorenje - partner)
13.20-14.30	Visit of the laboratories (Gorenje - partner)
14.30-16.00	Presentation of activities and results of 19-25 RDPs

The on-side visiting was perfectly organized, and it was very effective to fully understand and evaluate how the project has been developed, how the achievements are coherent with the original proposal and how the partners have effectively collaborated.

The structure of this mid-term evaluation report is based on the instructions received for this external assessment.

## **2. Assessment of the progress made with regard to the objectives outlined in the project proposal of the programme and its research and development projects.**

The progress report clearly describes the major achievements obtained in the project. It is worth to highlight that, in spite of being a mid-term evaluation, the IQ HOME programme ended in February 2019, i.e. before the on-side visit. Thus, the major achievements of the whole program can be evaluated in this mid-term evaluation.

As reported in the original proposal, there were a large set of objectives tagged to the three programme pillars, which are 1) advanced building with wood chain, 2) intelligent appliances and 3) intelligent home management. For the first pillar, the major developments were planned in the field of new environmentally-friendly and advanced materials and building blocks, of intelligent construction systems and of wood-based motivational furniture. For the second one, i.e. intelligent appliances, the major objectives were mainly in the development of advanced technology to increase energy efficiency of appliances and to increase silence of appliances, in the development of advanced technology of microbiological sensor systems for monitoring freshness of food products, of magnetocaloric cooling and of advanced heat pump. For the third pillar, i.e. intelligent home management, the major developments were planned in the field of advanced energy management and optimization at building/home level, of advanced hardware platform for smart home and of artificial intelligence for home management.

The original plan was also targeting the realization of 25 individual RDPs, the achievement of at least 13 patents and the development of at least 24 new products until TRL6.



## **2.1. General observations with regard to mid-term report and visit**

In general terms, the progress report is very well organized, including a short summary of the achieved results and then a detailed description of the activities and the results of each of the 25 RDPs. The description of the activities and the results clearly outline the whole program development and summarize the project achievements. This organization was indeed useful also for this evaluator to understand how the program has been developed; thus, it can be clearly concluded that the activities have been developed according to the original proposal. It is worth mentioning that all 25 RDPs have been developed without incurring any problem or change, as claimed in the progress report. This is quite unusual in an advanced research project, as some possible deviations from the original proposal are usually quite common in a high technological research field.

The mid-term report is then completed with a final table with the program results and impacts, that is a very useful way to summarize the main achievements. Indeed, 25 RDPs have been completed, 19 patents and 25 innovations are mentioned, 27 new products and services up to TRL 6 and 31 new technology, process and organization solutions.

The organization of the visit was excellent from many perspectives. The organization with a combination of several presentations with the availability of some prototypes and the laboratory visit in the afternoon gave the chance to this evaluation to have a full picture of what has been performed in the project. A few presentations went in a high-level of details, not always needed in a 1-day on-site visit, without giving the full explanation on why such a research has been developed and what is the related background with respect to what had already been achieved in the state of the art. In any case, all of the presentations were very clear and with a very good set of slides. Last, but not least, I found an excellent hospitality and all the visit was running in a very pleasant way.

## **2.2. Key highlights: which achievements stand out in your opinion**

All the 25 RDPs bring remarkable positive achievements, which range from a very good to an excellent level. Among the proposed RDPs, I will focus to the ones which, based on the documents provided and the on-site visit, can be considered at excellent level. All the others, even if not mentioned in this section, are in any case at very good level or close to excellent level.

In RDP1, the research was focused on new materials based on nanoparticles, wood-polymer composite material, with phase change characteristics and thermo-adaptive waterproofing. All results were at excellent levels, even if at low TRL. Several laboratory samples are also present to verify the effectiveness of the proposed solutions. In RDP2, an advanced generation of thermo-adaptive polymer-bitumen waterproofing membrane has been proposed together with advanced techniques of installation. The results are remarkable, and several patents have been filed. In RDP3, the development has focused on the insulation of advanced residential units based on extruded thermal insulation with nanoparticles. Even



in this case, the achievements are excellent, and a patent has been filed. In RDP3, the project has developed technological solutions for wood-polymer composite in the advanced home segments. Results are excellent, a patent is proposed and a nice sample of wood plastic composite for use in pipe systems of residential units was available during the presentation. All RDPs between 2 and 4 are at TRL 5-6.

RDP5 and RDP6 were very effective in proposing intelligent construction design and load bearing elements, all of them at excellent level. Two patents and *a large number* of relevant and interesting contributions, not here mentioned for the sake of brevity, have been proposed.

All the RDPs from 9 to 16, led by Gorenje, present excellent contributions with very relevant industrial applications and impacts. Most of the proposed solutions cover the increase of energy efficiency and silence of the appliances, the development of microbiological sensor and several other advanced technology (including magnetocaloric cooling, technology of low-temperature washing with cavitation, solid state heating with micro-waves and thick film for the use in kitchen appliances) and they are of very high level of innovation and quality with high potential impacts for the future. Moreover, also the activities in RDPs 17 and 18 regarding the next generation of heat pump have been at a high level.

The other RDPs, here not mentioned, have very good (or close to excellent) level and they show very good potentials for future industrial applications. Among these, the hardware part of the Building Energy Management Systems in RDP19/20 was the one that gave me the best impression and very high potentials for future ground-breaking applications of intelligent energy home systems.

### **2.3. Changes: if any changes were made to the project, do you assess them as reasonable and sufficiently well elaborated**

As previously mentioned, the mid-term report does not describe any relevant change respect to the original project. Indeed, based on the documents available and on the presentations and discussions with several different speakers during the on-site visit, it can be concluded that the project has been very well developed following the original organization and plan. This is, indeed, a remarkable result for such a complex project that includes such a large number of partners.

### **2.4. Work plan till the end of the project**

The IQ HOME programme ended in February 2019, i.e. before the on-side visit. Thus, the project is de facto completed.



### **3. Role of the partners in the project: your assessment**

All the partners were able to give strong and relevant contributions to the projects. The overall evaluation is therefore very positive. The most effective ones were the technology partners involved in the hardware development and the Universities.

### **4. Internal (between the project partners) and external communication: assessment on the basis of evidence provided during the visit**

The project had an excellent organization by the project coordinator. Indeed, Gorenje was able to handle in an efficient manner all the partner contributions. As previously mentioned, this is, indeed, a remarkable result, taking into account the very large number of partners. However, it should be also mentioned that with some of them there was a stronger interaction, probably coming also from previous research projects or previous collaborations. This was specifically evident in the contributions presented in the morning of the on-site visit (i.e. up to RDP18). For all the other partners, the integration was indeed very good, but probably not at the same level of what shown in RDPs up to number 18. This is indeed absolutely normal, as it would have been impossible to handle strong collaborations among all the 26 partners. Thus, the overall assessment is very positive.

### **5. Assessment of dissemination and exploitation of the project results in the phase TRL7-9 (during the duration of the programme and in the period after the completion of the research activities)**

As reported in the progress report and as confirmed during the on-site visit discussions, the action plan for the TRL 7-9 phase is still running as originally proposed. Several new important innovations have been developed up to TRL 6 and will contribute significantly to the market (TRL9) in all the three major pillars. In the dissemination section of the progress report there is a list of major developments, as examples of exploitation of the results, in the value chain of advanced constructions with wood chain, of smart devices, of new appliances, and of intelligent home management systems; these examples of exploitation of the results are convincing and they will have high chances to contribute to the market.

As the potential market penetration of the proposed innovations is very high, it is strongly suggested that an additional government and corporate financial support is given to further push such innovations at TRL 9 and to give them more chances of success. The highest potential ones are, in my opinion, those related to RDPs defined as excellent quality in section 2.2.



## **6. Assessment of quality of main scientific achievements (scientific excellence in line with planned, any special success stories)**

The outstanding scientific achievements are summarized in the RPDs between 1 and 18 and they are listed in the excellent evaluations in the previous section 2 (“Key highlights”). It is however to be mentioned that also the other contributions are at very good level.

## **7. Cooperation between public and private partners (assessment of synergies)**

The cooperation between the universities and the private partners was excellent. In many RDPs it was clear that the Universities were able to provide theoretical and model-based contributions to the industrial partners. The overall synergies, based on the impression received during the presentations and on the results reported in the mid-term report, were extremely positive. This is specific positive aspect of this projects as many developments were able to reach an excellent level also thanks to the effective collaborations between Universities and private partners.

## **8. Concluding remarks**

The project can be considered a successful story from many perspectives. First of all, the program has been developed very close to the original proposal. Moreover, the major proposed targets, in terms of patents, innovations, etc., have been completely fulfilled. The program, thanks to the leadership of the main partner, was able to effectively integrate the contributions coming from the different partners. In a large project like this one, this is already a remarkable result. Given the size of the project, it is natural that in some sections the collaboration and integration was more effective – especially between partners that were already used to collaborate - and in other sections slightly less. In any cases, it was clear that the project was the enabling tool also to strengthen the collaboration with all the partners. At the same time, the project was able to enrich the synergies between industrial partners and the universities in a very effective way. Moreover, the overall involvement of all different partners was excellent. From the scientific point of view, there has been an excellent progress in the research and development, with several new ideas, products and patents. The number of new innovations is remarkable, and, in the majority of cases, the quality is outstanding.

Thus, the overall evaluation is very positive, and I do strongly recommend supporting future similar initiatives, as the enabling tool to increase the future competitiveness of the Slovenian industries on a local and global market scale. As the market potentials of the proposed products are very high, additional government and corporate additional investments are strongly suggested to facilitate the transition of the innovations from TRL 5-6 to TRL 9 and to increase the rate of success of their future market penetration.