

5 to 8 Minutes Introduction

- Collection of information about the interviewee (educational and technical background, field of professional experiences, professional years of experience, involvement in different types of projects).
- Brief introduction about the interview.

Interviewer

Now I'll move to the opening questions. So [Name of Interviewee 18], in your experience, what is the current level of knowledge in the building industry regarding the application of multifunctional facade components integrating solar cooling technologies?

Interviewee 18

Low. That's the truth. I think in fact it is not a question about solar cooling technologies. It's just a question about active solutions. I think that the industry has a really low knowledge about new technologies, new concepts, new things....and they are quite afraid to try to implement this kind of technologies.

Interviewer

OK, got it. So now I'll move to the following question. In your experience, what are the motivating factors for the application of multifunctional facade components integrating solar cooling technologies?

Interviewee 18

As I said before.....I think that it's.....At least in Spain or in.....I work for a company that makes mainly buildings that build buildings, only buildings....is not civil works or whatever, and we mainly do residential buildings and I think that the integration of this kind of new technologies depends on the client. If the client thinks that it's a really good idea to install PV panels, you are going to solve PV panels, but if not, it's really difficult to try to convince the clients that new technologies are good for them. Apart from that, I think that the main point here to try to install PV panels or new technologies is energy saving. The mainly deriving thing here is OK I'm going to save energy, and nowadays in this current moment of course I think it's the main point now.....energy saving and try to avoid gas as the main energy source. I think that's of course a key point now for trying to convince people to install this kind of new technologies....electrical or solar new technologies.

Interviewer

OK, got it. So now we talked about the motivations. So the following question is about the concerns. So what are the concerns regarding the application of multifunctional facade components integrating solar cooling technologies?

Interviewee 18

Of course as I told you before....I think I'm going to answer you not only about solar technologies, but in an overall concept of trying to integrate new technologies in buildings. I think that the main point here is that they think it is a new thing for them, is an innovative thing. They don't know about how it works. So sometimes the main problem that they see is, OK, this is going to cost me more, at the moment of building. Of course the building is going to cost me more, but of course it's going to.....The budget for the maintenance part is going to be higher....So I think it's a question of money because of course this kind of technologies are.....A conventional building is cheaper than the ones

who integrate these kind of technologies.....And they don't see the energy savings. They only see the investment that they have to do now, and the investment that they have to do for the maintenance part....And I think it's a matter of they don't understand that the concept, they don't understand the technologies....they only see....and I think that the last few years, the gates we install a lot of things in buildings that doesn't work, didn't work.....And the experience with new technologies, with new kind of things, they only see problems, problems, problems. Integration is a problem. So sometimes they prefer to avoid this kind of new integrations because they see, OK, I know that bricks....or they works....the conventional heating systems and conventional cooling system works. So I don't want more problems.

Interviewer

OK, got it, but generally how we can address such concerns related to the financial aspects or related to cost or even issues that related to that they'd like to ensure that this works. So how can we address such aspects?

Interviewee 18

I think that it is a problem with trying to convince them that they are going to save energy and save money, for sure. So with this money that they are going to save, they can pay the initial investment. So it's I think that you have to make some figures with them....trying to say, OK, of course you are going to spend more money now, but you are going to save money after that.....And I think that you have to explain them the technologies.....They need to understand how it works, because I think that the industry doesn't know anything about this kind of technologies. So when you say, OK, I'm going to install this here, they only see problems.....So I think that the point here is communication and education. It's a matter of trying to be clear about the pros and cons of these kind of technologies....And I think that now is a really good moment to try to explain clients and subcontractors about this technologies because we are in a really changing world in in terms of energy. So I think that now it's a good moment for that.

Interviewer

OK, I see. So now I'll move to the following question. So in the following question I'd like to talk about the type of project. So how can the type of project, such as the new building construction or renovation projects, influences the applicability of facade products integrating solar cooling technologies?

Interviewee 18

I think going from my point of view, the integration of these kind of technologies in new buildings....it's quite easy because you can integrate the technology from the very beginning of the design phase, but when you have a renovation project, it's more complicated because you have to integrate the technology into the façade, for example, and of course you have to integrate in the active part of the building.....and sometimes you don't have enough space for this kind of new elements or new components, or you have to delay the ones that were before.....And sometimes it's really, really difficult to do that.

Interviewer

OK, got it. So now I asked about the type of projects. So now I'll ask you about the type of building. So how can the building type, such as office, residential healthcare, educational, influences the applicability of such facade products?

Interviewee 18

As I told you before, I think that the applicability of this kind of technology depends on the client, the type of client. So from my point of view, if you are the owner of the building, for example, if you are the owner of an office building or healthcare or educational, you are going to be more open to this kind of technologies.....But in the case of the residential buildings.....at least here in Spain that we live in apartment blocks with a lot of tenants and these kind of things....it's quite difficult to convince everyone to install these kind of elements. That's why I think that when you have an only owner for the building, it's easy because you only talk with them and you convince one person.....but when you have multiple tenants or multiple owners, it's difficult. That's my experience, at least with the technologies.

Interviewer

I see. I got it. So sometimes if you have more than one owner or more than one tenant or especially in apartments, it's becoming very complicated. But if the building is owned by one person, you have just a direct communication with one person to discuss the issues.

Interviewee 18

Yeah, that's the point, and you can convince him or her about the benefits of this technology, the energy savings or this kind of things.....But when you have multiple owners, sometimes it's quite difficult, and I think that the best situation is when you are the owner and you are the user of the building. And that case, I think any kind of thing.....They are really open to integrate new technologies that are going to save energy.....But when you are the owner but you are not the user, sometimes it is that easy because they only say "OK I'm going to build the building. Others are going to use that. So it's a problem of them.....the energy savings and the energy cost and these kind of things".....And of course when you have a lot of people living in this building, it's quite difficult to convince all of them because they have different type of lives and type of thinking.....So it's difficult.

Interviewer

OK, I see. So the ownership I can see that it's an essential factor to be considered.

Interviewee 18

For me that it is the most important because from my point of view when I.....for example, we are now trying to develop an R&D project in one pilot and we have a problem because we have the construction company...we want to prove or to make some test in the building, integrating new façade modules and new things. The problem is that we have to convince the owner of the building to integrate that, because I'm not the one who prescribe the materials, the façade. I'm not the one. I'm only the constructor. So it's really difficult for us to integrate because we are.....In my case, I'm really convinced about this, all these technologies and I try to integrate all of them in buildings, but the point is that I'm not the one who is paying the building for the building. So you have to convince that person. If you convince that person and he's really concerned about this kind of things and..... You probably are going to install domotic, you are going to install everything, because he's the one who's going to pay for that. Yeah.

Interviewer

OK. So now I'll move to the following question. So we talked about the type of projects, type buildings and now the question is about the location and the climate condition. So in your

experience, how do the locations and the climate conditions of buildings affect the performance of facade products integrating solar cooling technologies?

Interviewee 18

Of course the climate affects the performance of this type of façade, but I think that is a problem we are trying to adjust the technology to each climate. I'm not the one who thinks of this technology only works in this type of climate. I think that we have to adapt the technologies, the components of the technologies, in order to adapt to the climate. I think that all the technologies works in all the climates. You have to adjust the components and adjust your figures to try to optimize the performance of the technology to the climate. That's my opinion.

Interviewer

So generally which locations and the climate conditions would you suggest to apply such facade products?

Interviewee 18

For me, from my experience, the best climates are the warm.....that the ones that.....You have to have sun but not too much sun. Because at least here in Spain we have a problem with overheating sometimes, and you may have the same problem in your country.....but sometimes, yeah, there is a lot of heat here. So the problem is the overheating. Of course, if you don't have sun, you have problem too due to drive this technology. So I think that the best location is the ones who have sun enough but not too much sun.

Interviewer

OK, got it. Enough sun, but not too much sun.

Interviewee 18

Yeah, yeah. Yeah. Because for example, just a comment....For [*Specific research project*], yeah, we install really a test of the façade, thermoelectric façade.....and here I live in [*Spanish city*] that is in the north of Spain. So our climate is Mediterranean climate but more likely France or England than the South of Spain, that is really hot.....And here we have some problems with overheating during summer, because during summer and now I think that summers are getting worse. We have a lot of problems with.....because the façade was really, really hot. So we have some problems trying to dissipate the heat and was really hot because we thought that we are going to have best results in summer and the test demonstrated it was a problem with overheating.

Interviewer

OK now I'll move to the following question. So do you think the choice of a solar cooling technology, such as electrically-driven or thermally-driven, would affect the application of such facade products in a particular building project?

Interviewee 18

Yeah, I think of course. I think it's a matter also from aesthetic point of view.....this kind of integration....this kind of elements. Of course you have to convince the owner to try to install this kind of new technologies, but also the architects are the ones sometimes that really don't like this kind of technologies because they are ugly for them.....I mean.....At least here in Spain or the Spanish architects, sometimes they think that this kind of new.....Yeah, if you put the PV panels in

the façade, you are really conditioning the view of the building. So they prefer more traditional elements than instead of this new high tech....imagine.

Interviewer

OK, so now [Name of Interviewee 18], I'm done with all opening questions. So now I'll move to the key questions. So in the key questions, I have three categories of questions. I have questions related to technical and product related aspects, then financial aspects, and then after that we have the process and stakeholder related aspects. So let me start with the questions related to the technical and product related aspects. So in your opinion, what makes facade products integrating solar cooling technologies complex?

Interviewee 18

For me and from my experience, the complex part is that you have a lot of things, a lot of components, I mean. When you install a ventilated façade, you just have the external layer, the insulation and these kind of things.....But when you try to install this kind of active element, you have a lot of other things, auxiliary elements that condition the installation of the façade. So from my point of view, you have to deal with all auxiliary elements, the connections between the energy sources and the rest of the building. So sometimes you have to thermal storage, other things and all these elements you have to put in the place in the building and you have to connect all of them. So sometimes it's a matter of the connections on the whole auxiliary elements.

Interviewer

OK but how would you address such complexities related to....or how we can address such complexities when we have lots of components, lots of connections? Are there some ways to address it?

Interviewee 18

For me the solution is to have a really specific design about all of these. Try to think about the technologies from the very beginning of the project, because from the construction point of view, when you go there and you don't have the schemes and this kind of everything on detail, it's a matter of "ohh I don't know where to put this", you know. So if the architect and the designers and technology providers think deeply about the building and how to integrate all these elements.....from me, from the construction point of view, is just a matter of following the instructions. But sometimes if you don't think from the very beginning, you find solutions that are not the optimized one. So for me I understand that the technology, this kind of technology, needs all these auxiliary elements. Of course, if we investigate and we study this technology, trying to make them simple, it will be great of course. But I understand that they need this kind of elements. So if you need the elements, I think that the solution is try to think about integration from the very beginning.

Interviewer

Ok got it. So now let me move to the following question. How could we address challenges related to the space availability or interrupting other building services?

Interviewee 18

As I told you, I think that the point here is think from the very beginning about the technologies, because sometimes you have the building, you have a design and you say "OK now I want you

integrate this technology. I don't know why. I don't know how. I don't know. That's it. But I want to integrate them". It's really difficult.....And so for me the point to integrate any kind of technology is think about it from the very beginning. Think about it with the technology provider, with the architect, with.....trying to collaborate with all the stakeholders, because if not, probably they are not going to work or they are going to be part in assembly, part installed and you are going to have problems. And this technology has to be really good installed in order to work properly. So for me the main challenge is the integration.....I think that we have the technologies developed. We know how to deal with all of things, but the integration in the building is the key point, because.....and of course it's more complex if you are talking about renovation projects. I think that if you want to integrate this kind of things, you have to think, deeply think, how you are going to mix the passive part of the building with the active part of the building. And sometimes we think about these two things separately. We think about the passive part. We think about the thermal....and then we think about how to cool or heat the building. I think that nowadays both things have to be together, and when we think about these two things together, we find a way to integrate new technologies and everything.

Interviewer

OK, I see. So I got your point. Now I'll move to the following question [Name of Interviewee 18]. So the following question is about the maintenance and the durability. So in your opinion, what are the key aspects to consider for the maintenance and the durability of façade products integrating solar cooling technologies?

Interviewee 18

I think that we have to change when we install these kind of elements in a façade. We have to change our minds in terms of maintenance because a passive façade....of course they need maintenance, but the maintenance is quite long.....you have to paint the façade or change the elements.....But when you make the façade an active element, I think that the maintenance has to be more frequent and you have to think about it. I think that we have to change the mind because the façade became an active part of the building, is not just a passive part of the build.

Interviewer

Ok so now I'll move to the following question. So this is the last question about technical and product related aspects, before moving to the financial aspects. So how do you see the role of aesthetics in the widespread application of building facades integrating solar technologies?

Interviewee 18

I think it's important. It's a key.....I don't know why when you see these kind of technologies.....I studied in architectural school. So I live together with architects and design people and they only think about imagine and how the building is going to look and these kind of things.....And I don't know why this new technologies always looks really ugly, really industrial. So I think it's important that architect has to be from our part of.....we need to work together, the construction company, the architects, the technology providers, in order to convince the client who is going to pay the building. So for me, if the architect thing that is a really ugly solution, they are not going to convince the client. So I think it's really important.....it's really important thing. And we need to make this technology you use good looking. If not, of course they are not going to be installed.

Interviewer

OK for good looking, how we can say that, OK, this looks good?

Interviewee 18

Well that's the point. I don't know.....of course there is an architect that said "OK it really looks good", but I think the problem is that sometimes when you see all the tubes and the water and the photovoltaics are....you can't change the colour, you can't change the.....Sometimes the architect just wants to change the shape of the building, the colour of the building and when you have PV integration, for example, it's quite difficult to find, I don't know, a specific colour or to adapt to a cure building. So I don't know. I think that we need to improve technologies in order to adapt to this kind of aesthetic things, but of course I think that they are beautiful, so sometimes it's just a matter of an opinion. So I think it's important. I think that the key point here is try to have the possibility to choose between several options. It's of course if I'm going to install this new technology, this new PV system, I want you to choose between 2, 3, 4, 5....different shapes, different colour, different things. If not, the technology provider is the one who is going to decide the imagine of the building because if you only have one solution, I don't have any option. So I think that for the architects, it's just the option to have options.

Interviewer

Ok [Name of Interviewee 18], now I'll move to the second category of questions....about financial aspects.

Interviewee 18

Perfect.

Interviewer

So I have two questions about financial aspects. Then I'll move to the stakeholders and processes. So first of all, in your experience, how can the industry develop affordable and financially feasible façade products integrating such technologies?

Interviewee 18

I think that here the key point is industrialized or prefabricated solution. Plug and play solutions, because if we try to make them as conventional...if we go on-site and trying to install all the elements separately, it's not going to worth it financially. So I think that we need to develop, integrate a plug and play system that you go there that integrates all the active, all the passive elements for everything and you go to the site and you installed that. I think for me, this is the key, the change that we need in order to makes all these elements feasible.

Interviewer

OK, got it. So now this question is about financial aspects. So what are the potential financial incentives that can support the widespread application of solar cooling integrated facades?

Interviewee 18

I don't know. I think that at least in Spain, public grants or trying to....I don't know.....from the public bodies, they try to push this kind of solutions.....of course it is a really good point. But I think that the construction industry works with.....now that we have a problem of energy sources.....I think that

now is a good moment for trying to push this kind of technology that can make the buildings out of grid, out of gas.....So I think that probably it is just a matter of the situation to try to find right moment to try to push this element. Of course I think that public bodies have a key part in order to do that.

Interviewer

OK, I see. So now I'll move to the last category of questions. So I have questions about stakeholders and processes. So first of all, you can see from this chart, we have different stakeholders involved in the facade design and construction industry. So in your experience, which of these stakeholders can support the application of solar cooling integrated facades?

Interviewee 18

As I told you I think that the key stakeholder here is the client and the user. If they are the ones who are going to pay for the building, so for me they are the ones who are going to invest on that.....but of course, we need that the general contractor, the architect, the consultant, the rest of the stakeholders need to be informed about the solution. For example, for the general contractor, if we don't know how to install or how to assemble these kind of technologies, we are not going to do good our job. So I think it's, of course, the key point is the client that the owner of the building who's going to pay for the solutions, but we need that the rest of the stakeholders to be updated about this kind of solutions and they need to know about them.

Interviewer

OK, got it. So now the following question is about the knowledge and experience. So how can we increase the knowledge and experience of architects or engineers regarding the technical aspects of integrating such technologies into facades?

Interviewee 18

I think that this kind of elements has to be a study in the schools of architecture and engineering because sometimes.....at least in the last few years for study, you need to know about the applied technologies, and I think that this technology is still unknown for the vast majority of the architects and engineers.....because I don't know why, but they know about the type of façade.....they study the passive part....how to deal with the façade.....and the active part....how you can heat, how you can cool the building, but I don't know why they don't think about how we can mix both parts.....how we can make the façade an active part. So I think that of course education is a fundamental point....clear

Interviewer

OK, so now I'll move to the following question. So this question is about standards or guidelines for architects or engineers. So what are the key elements that should be in standards and guidelines for architects and engineers which are related to the integration of such technologies into facades?

Interviewee 18

It's a good a good question. As I told you, I think that it's you can understand the performance of the new technologies. You can understand how the solar collector and the energy sources and everything and you can understand the passive part of the façade, but I think that integration is....we think that the things works properly because they work properly, but sometimes you go there and you install them and then you realize that they are not working that has to supposed to be, and I

think this is a matter of integration. It's a matter of....we see everything separately and we don't see this as a whole building as an integration. So for me, the main part here is the standards that explained the building as a whole. Explained the building not as a façade element, a heating element...it is just....OK the building itself. Everything has to work together in order to perform properly, because if not, it's impossible.

Interviewer

OK, I see. So now I'll move to the following question. So how can the industry increase the variety of products that would attract customers to apply such products?

Interviewee 18

I think that we need, of course, to investigate more about this kind of elements in order to spread or to worldwide this type of elements and technologies.....and of course we need investment.

Interviewer

OK, so now I'll move to the following question. So, generally how can we increase the interest of designers, developers and the clients to apply such technologies?

Interviewee 18

I think that now our point is to make them understand that with this kind of technologies, you can create out-of-grid building. You don't need gasoil [diesel]. You don't need other type of energy sources, and I think that now in this moment, this is the point. Trying to convince them about the energy savings and the sustainability of the solutions.

Interviewer

OK, got it. So now the following question is about building regulations. How can changes in building regulations affect the widespread application of façade products integrating solar cooling technologies?

Interviewee 18

This is a really good question because in Spain we have....At least in Spain. I suppose that in the rest of countries, it is similar....but we have some problems to try to fulfil the Spanish regulations with these new technologies, because you have to demonstrate that you cover some points and some standards....and with these new technologies, it's sometimes quite difficult to calculate them or to demonstrate them. So I think that we need standards or regulations that make easier to calculate or to demonstrate that the building is going to work. As I told you before, sometimes it's that you have to calculate U-value and U-value is just, at least here in Spain, you have to deal with this and it's a stationary element for summer, for winter, for all the seasons...But sometimes with this kind of elements in the façade, it's quite difficult to say "OK this the U-value as standard U-value", because sometimes you have in summer it can change or I don't know. So I think that the standard has to improve or has to move to a new products and new develops.

Interviewer

OK, I see. Now the following question is about energy policies. So how can changes in energy policies affect the widespread application of such facade products?

Interviewee 18

Of course, I think that with the electricity....now that Europe is making electricity that the most important energy source....I think these kind of technologies are going to have a really good space in buildings. Here in Spain we used gas, at least in the residential buildings as the main heating system. So electricity is now cheaper than gas. So probably it's a good thing. Of course, energy policies affect to integrate these kind of technologies.

Interviewer

OK, so now this is the last part before the closing questions. So now we have different processes involved in the design and construction of building facades. You can see different process in design, production, assembly, operation and then the end of life. So in your experience, which phase is key for boosting the integration of facade products integrating solar cooling technologies?

Interviewee 18

For me, design is the most important to push because if the architects and the clients prescribe the solution, the rest of the stakeholders have to deal with that.

Interviewer

OK, so now I have questions about each phase. So first of all, what are the main aspects to consider during the design phase of facade products integrating such technologies?

Interviewee 18

I think that you have to think about the building as a whole, and you have to think not only from the point of view of the passive part, of the active....you have to think about both things parallel and simultaneously.

Interviewer

Now OK I have a question also about the design, before moving to the production. So in your experience, how can we achieve close collaboration between various stakeholders and disciplines during early design stages of building facades integrating such technologies?

Interviewee 18

For me, the key point is collaboration....IPD contracts [IPD: Integrated Project Delivery].....It is a lean construction concept, that makes the construction company, the architect and the client have a unique contract. So the construction company, the client and the architect works together from the very beginning of the project. They share risk, they share investment, they share everything. So I think for me, this is the key point....not only for the this kind of integration of technologies, but for the whole industry. If we collaborate from the very beginning, everything is easier.

Interviewer

OK. So again.....so it's called IPD....?

Interviewee 18

Yeah IPD.

Interviewer

OK, got it. So now I'll move to the question about production. So you can see I'm moving phase by phase. So now what are the key aspects to consider during the production phase of facade products integrating such technologies?

Interviewee 18

For me, they should find a solution... a plug and play solution....If they make the solution a plug and play, industrialized...try to avoid most of the work on site.....Probably is the key part.

Interviewer

So I was....OK....So what about the assembly phase? So what are the key aspects to consider for the assembly?

Interviewee 18

I think it's a mix of them. Of course, if we have a plug and play solution, we reduce a lot of time, assembly, and trying to fix all of them.....and I think that we need to collaborate once again between the subcontractors, the assembly subcontractor, and the technology providers in order to find this optimized solution because, of course, I understand that sometimes you have to do work on-site. That's true, but if we reduce it at the minimum possible, I think it's good for everyone.

Interviewer

OK, got it. So now I'll move to the operation phase. So now what are the key aspects to consider for the operation phase of building facades integrating such technologies?

Interviewee 18

I think that they need to understand technologies because of.....Some years ago here in Spain, we installed the standard set that we need to install solar panels in the roofs of the buildings, but most of the clients or the users have turned-off the installation because they don't understand how to work with that. So sometimes it's just a matter of trying to explain them how they work, because the user of the building sometimes say like "OK, I have this thing on the façade or this thing on the roof of my building, but I don't know how it works". So I think that we need to explain them or control them externally...I don't know maybe it's an option is to try to put a maintenance company that really know how to deal with these kind of things.

Interviewer

I see...Great. So now we are at the end of life. So what about the end of life? What are the key aspects we need to consider for the end of life of façade products integrating such technologies?

Interviewee 18

I think that we need to that make them circular components. Of course, we can't create more waste. So for me, another key point here is try to find how to recycle or how to reuse these kind of elements once.

Interviewer

So OK, [Name of Interviewee 18]....So again, now we are in the closing part. So I just have few points to ask you. What are your final remarks about the widespread application of facade products integrating solar cooling technologies?

Interviewee 18

I Think that we need to boost them in order to make them open to all the industry, because the industry doesn't know about this kind of technologies. So we need to explain them that they exist and we also need to make them more easy assembly, more easy to install and to integrate in buildings.

Interviewer

OK, So what do you think about the application of solar cooling integrated facades for enabling energy transition?

Interviewee 18

I think they are going to be a key point. Of course buildings have to change the concept in order to be out-of-grid. They have to be not only consumers but also generators of energy. So these kind of technologies I think they are a really good answer for that.

Interviewer

Thanks a lot actually [Name of Interviewee 18] for your valuable insights. Just the last point is about what you told me before. So you told me about someone that you could suggest for me to interview. So the question was do you mind to propose potential participants to be interviewed for this study?

Interviewee 18

No, not at all. I. In fact, I have two people. Both are.....