

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 start with the first question. So [Name of Interviewee 15], 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 15

OK. I would like to say that to be honest at the beginning when you contact me, I think it was the first time I heard about this technology, but I mean after that I have read some bibliography to understand how it works and the main concepts, and also I tried to help you in this nice conversation. But in my understanding this technology has the capability to generate electricity or hot water. Let's say it's something that could be similar to the existing PV technologies, but in another way because I think they are more efficient regarding with the sun, but then to be honest, my experience is really short.

Interviewer

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

Interviewee 15

OK, here I would like to say the first one it will be self-energy production. It's one of the main...I mean for at least for my point of view. Then I would like to say to use the building as energy generator so then it can be a building which is....A building has the capability to generate energy or to sell energy. So let's say that it became a positive building. Not only self-energy productions. It can be also a positive building, and then I would like to add also that the limiting geometry of the building. I mean if you have a building with not enough space in the roof, for example, but you have a lot of façade surface. This can be also one of the main motivating topics to apply these kind of technologies in façade. I mean it could be for example like a tower building or something like that. I imagine one of these topics.

Interviewer

OK. Now I'll move to the following question. So in your experience, what are your concerns regarding the application of multifunctional facade components integrating solar cooling technologies?

Interviewee 15

OK here, for example can be the maintenance. Can be one of the topics. Then the best energy performance in summer conditions. And the other one, I think I would like to add, the system could be inefficient in winter seasons but I mean it's always related with the climate zones.

Interviewer

OK, so for such concerns, what do you think....OK. So you mentioned different concerns. What we should consider? What are the ways that we consider to address such concerns? For example you talked about the maintenance, the performance in summer and inefficient...

Interviewee 15

For the maintenance, I think.....For example I would like to propose some systems which are let's say more flexible. It could be something related with plug and play systems. For example, in some projects we are developing now, the main concepts or the main technologies are based on plug and play systems, which is something that it can be connected or disconnected or unplugged or plugged or unplugged easily....and then also, for example, if it's in façade, it should allow the easy access or easy maintenance. If it's located in facade or I don't know I imagine a tall building or a tower building, you know....If you have a lot of solar panels or I don't know placed in the facade but you don't have access to replace them, it makes everything complicated....And regarding the climate conditions, I think it's better to place the strategy or the technology in the most efficient climate zone.

Interviewer

OK. Now we'll move to the following question. OK [Name of Interviewee 15], now how can the type of project such as a new building construction or renovation projects influence the applicability of solar cooling integrated facades?

Interviewee 15

OK, I will start with the renovation ones. OK because it's something that I have, let's say, more experience. For deep renovations, for example, I think it's something complicated because sometimes the existing buildings doesn't allow to install a such as technologies. For example, I don't know, they don't have enough space, they don't have enough space to go through the facilities, through the building....or, I don't know, the existing facilities of the building are really old and sometimes they have problems related to this. I mean when you're thinking to an energy refurbishment or a deep renovation of a building, you have to take into account that it's something really expensive at the end. So not all the companies or the clients, they want to spend the whole money the year 1. So there's.....Well, taking this into account, let's say.....The other topic regarding to the renovation, it's the owners disturbing. I mean sometimes the refurbishment or the deep renovation process, it's through the....while the owners are living or still living there. So then makes everything complicated....And let's say....Sometimes, also I think it's interesting if the new system allows the capability to integrate old systems. I mean, imagine you have some radiators inside of the building or some other components that your new system allows them to still work.

Interviewer

Got it. So...

Interviewee 15

And let's say...just let me add something if you have....

Interviewer

Yes, go ahead.

Interviewee 15

We have developed something similar in the [*Specific project*]. If you have time, you have a look in the website you can check some information. I mean at the end we developed a façade system which is separate of the HVAC system, but façade system allows the capability to integrate all the facilities through the façade. So in the same time you have the capability to let's say...to make better the passive system of the building, because you make a new envelope and then in the other way we make the new HVAC system, which is prepared to be installed through the new façade. So well the problem is solved. What missing the....For the new buildings, right? Regarding the new buildings, I think the climate location I would like to add. The climate location and the orientation of the building are the main factors to be considered.

Interviewer

I have a question about these things. So just shortly about the climate.

Interviewee 15

OK.

Interviewer

That's good you raise it now. So just in a few minutes I will reach that question. So now we talked about the different type of projects. So now I need to ask about the different type of buildings. So we have office buildings, residential buildings. So the question is how can the building type such as office, residential, healthcare, educational, etcetera influences the applicability of such façade products?

Interviewee 15

OK, this is a really hard question to answer because, let's say the building type, it's....it's one of the main factors to take into account when you are designing a project or you are making, I don't know, some of the main decisions of an energy refurbishment. So in my understanding, for example, in this case, if you would like to apply this technology, the solar cooling technology into a façade or into a building.....With the climate we have in Europe and with my understanding, let's say, in an educational centre, it doesn't really make sense because in the in the summer seasons, the building is closed. So you don't need to generate cooling. But for example in residential or in office buildings then it's more important. Also in the healthcare....but let me add something that is related with the occupancy at the end. For example, the office building for me, it makes more sense than the others because office building it will be used during the day and it's when the solar....this....I mean the technology you are studying it's more efficient because you need to cool the building during the day. So it's....I mean it's not an easy question to answer but I think I give you some ideas.

Interviewer

Yeah. OK that's enough.

Interviewee 15

Because I don't know in my understanding, I mean residential buildings.....Let me say something.....Everything....Or when I'm thinking to this questions, sometimes my answers are related with my, let's say, culture and it's the European culture and the European climate. So maybe this technology applied in another climate or in another culture, it makes more sense than...for me...but....For example, regarding the residential, for example, if it's not something that it's used

100%. I mean for example you are working during the day, so maybe you are in the office and then when you're going back home, it's night. So maybe that technology is not working or doesn't have the best energy performance. So let's say for me, the office building or the healthcare building are the most suitable building types for these technologies.

Interviewer

OK, got it. So now we can move to the following question, which is about the climate. So in your experience, how do the locations and climate conditions of buildings affect the performance of facade products integrating solar cooling technologies?

Interviewee 15

For me, they are the most important concepts. As I told you before, and I think I already mentioned it too much. For me, the climate conditions are the main concepts to take into account. In my understanding about the location of the technology....could make a bad energy performance of the building. So the investment in this technology or in the climate technologies, it won't be done so.

Interviewer

OK. So generally, which locations or climate conditions would you suggest to apply such technologies?

Interviewee 15

I take notes of two, but I don't know if they are the best suitable climates. But for me, in equatorial climate zones and deserts climate zones. This will be for me the most suitable....I mean, at some place where the influence of solar radiation allows to have a good energy performance of the facilities....and....I would like to add that it....I mean it should be taken into account that the performance in the whole year. I mean for example in Europe, in my understanding, if we apply this technology or at least in Spain, it will be useful three months in summer...but then what happens to us in Spain is we have a lack of energy production during winter, which is the main problem for the energy comfort in the buildings. So this my ideas.

Interviewer

OK, I see. So now I'll move to the following question. So generally we have different technologies. We have thermally-driven technologies as I showed before and we have electrically-driven which is PV. So how the choice of solar cooling technology, could be thermally or electrically driven, affect the application of such facade products in a particular project?

Interviewee 15

In my understanding, I think it makes more sense if you have the option to apply these products for energy production or electricity production, let's say. So at least you have the capability to adapt other, let's say, facilities you have in the building or to use other facilities with this technology. But for example, for new buildings, I think I would like to give the choice of the of the technology to the designer with the customer. I mean, I don't know, it can be many things...depends.

Interviewer

OK, I see. Now I'm done with the opening questions. So now I'll move to the key questions. The key questions....Before the closing questions. I have three aspects to be to be covered. So I have technical and product related aspects, then financial aspects, then process and stakeholders. So I'll

start with the product and technical related aspects. So in your experience, what would make facade products integrating solar cooling technologies complex?

Interviewee 15

Well, I don't have much expertise in this topic.....So sorry if I cannot help you, but I think it will depend of the knowledge of the near market companies. I mean, if they have expertise or they can provide some components, which is full or equipped, it will be more interesting and it will accelerate also the application.

Interviewer

OK, got it. So now I'll move to the following question. How could we address challenges related to the space availability or interrupting other building services when we integrate such technologies into building façades?

Interviewee 15

Well, as I mentioned before, I think [*Specific project*] we're doing some examples that can be shown....for example....I think when we are thinking to use this technology, we have to think always in what is a deep renovation of a building. I mean, if you are only acting on the active systems, or if you are doing a full energy renovation of the building and you are doing active and passive systems. So, let's say, that I would like to answer in this question that in my experience you have always to combine different technologies for deep renovation. So let's say that for me, the solar cooling system, it should be something that can be easily combined with other technologies.

Interviewer

So now I'll move to the following question. So what are the key aspects to consider for the maintenance and the durability of solar cooling integrated facades?

Interviewee 15

OK, let's say accessibility. Then the availability of spare parts, and the performance of the installation over the time.

Interviewer

OK, now I'll move to the following question. So how do you see the role of aesthetics in the widespread application of building facades integrating solar technologies?

Interviewee 15

In my point of view, I don't see it as a problem. I mean the field of architecture is changing really fast all the time and I think nowadays at least...in my let's say close friends or close companies which I am working on, the main concept right now in Spain is the sustainability. So even if the building is not beautiful or it doesn't allow you to have the best, I don't know façade, the sustainability...it is coming really hard here. So I don't see it as a problem. I mean, I also have to adapt that PV and the solar panel elements have much....I mean they have advanced really much. So they have a nice aesthetic finishes nowadays.

Interviewer

So now I'm done with the first part, which is the product and technical related aspects. Now I'll have two questions about financial aspects. So in your experience, how can the industry develop affordable and financially feasible facade products integrating such technologies?

Interviewee 15

Well, as I told you before, if I don't know if I will be really useful answering this, but in my understanding, I think offering an industrialized system or an integrated solution, it will be a more affordable technology.

Interviewer

OK. Now the following question is what are the potential financial incentives that can support the widespread application of solar cooling integrated facades?

Interviewee 15

Well some of them I already mentioned before, but I think it's self-energy production is the first one. The capability to sell, excess of energy. Better energy performance and low maintenance system also.

Interviewer

So, OK, are there any financial incentives that can support the product widespread application?

Interviewee 15

I mean you ask this related to the construction or related to final...I mean the owner of the building.

Interviewer

Yeah. I mean, the financial incentives that can support the widespread application in the building market.

Interviewee 15

It's the idea of selling these....the best energy performance you could have. Even better from other systems.

Interviewer

OK. Now I'm done with the financial aspects. So now I'll move to the last part before the closing questions, which is about stakeholders and processes. So I'll start with the stakeholder part. So as you can see from this chart, we have different stakeholders involved in the facade design and construction. So in your experience, which of these stakeholders can support the application of solar cooling integrated facades?

Interviewee 15

Let me mention that this is not easy to answer, also again. I mean....Before I was in [*Specific Technology Centre*], I was working in architecture studio, OK. So the main, let's say, strategies of the project were decided by us, for the architect. I mean sometimes the architect has a lot of potential in this case and then the only thing that need to do is to convince the client....But you can have also the other scenario where the client is super focused in some technology and he would like to apply it yes or yes. So they don't give you the chance even to decide....But in my understanding,

architects are really interesting topic to address in this case.....But again, the other stakeholders, it's something complicated because I think it's related with the law, sometimes. I mean when you're doing a procurement or you're doing a public building or a private building, there are different laws here. So for a public building, at least in Spain, with our regulations, you cannot choose any company or any product specifically. So then the collaboration between architect or with industry, it's not possible in a public buildings. So it's only possible in a private ones.....But it depends on the regulations in every country, but it's complicated.....But let me tell you that here in Spanish something really common right now with everyone is discussing this topic because the industrialization of buildings, it's in every time more common, and we are facing this problem every time when we are designing a public building or a public procurement with industrialization process because as an architect we make the design, but then you make a procurement and you don't know who will win the procurement because it's related with the cost....and then every company, it can change the project according to their product. So at the end, OK, at the beginning I made the project, but at the end someone will build it with another component, another technology that I was preparing. So in a public it's super complicated, super complicated.

Interviewer

Got it. So now I'll move to the following question. So how can we increase the knowledge and experience of architects or engineers regarding the technical aspects of integrating such technologies into building facades?

Interviewee 15

Also difficult question to answer. I think nowadays the architect became something or someone who is more, let's say....The architect is, let's say, it's the one who's guiding the client or the customer for the final, the investor, right now. So they really don't need to know much about these technologies. The only who needs right now...or also I think engineers, it's some company or some, yeah, I would like to say company who can provide this service....and let's say it is allowed to sell or to provide these systems, offering a nice energy performance, or to give to the client security in what are they selling. But it's my understanding being with the current market, listen here in Spain.

Interviewer

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

Interviewee 15

The only topic came to my mind here is if some regulations constrain or let's say limit the energy performance of the installations.

Interviewer

OK, so now I'll move to the following question. How can the industry increase the variety of products to attract customers to apply solar cooling integrated facades?

Interviewee 15

I would like to answer for me plug and play products. I think it's the best to rise right now. Something that can be easily integrated and it's compatively with other systems.

Interviewer

So now I'll move to the following question. How can we increase the interest of designers, developers and the clients in solar cooling integrated façades?

Interviewee 15

For example, offering energy simulation services or energy performance in time. Offering integrated solutions. But the idea of aesthetic solutions.

Interviewer

OK, now I'll move to the following question. So how can changes in building regulations affect the widespread application of facade products integrating solar cooling technologies?

Interviewee 15

I don't have much expertise in this. I don't know how...I don't know.

Interviewer

OK, now I will move to the following question. So what about changes in energy policies? How can changes in energy policies affect the widespread application of solar cooling integrated façades?

Interviewee 15

I think the same answer as before. I mean the whole answer in this....This is something that can be related, but I told you before with the regulations....I mean.....Usually the regulations are open to different systems. So they allow to use many technologies. So I don't see how it can be this....I don't know.

Interviewer

So now I'm done with the questions about stakeholders. Now I'll move to the questions about processes. So as you can see we have different processes to develop facade products. We have the design phase, production phase, assembly, operation and then we have end of life. So in your experience, which phase which phase is key for boosting the integration of solar cooling technologies into building facades?

Interviewee 15

I would like to say that design phase is the most important one.

Interviewer

Why?

Interviewee 15

I think many decisions have to be taking into account till the beginning of the project. So if you face the idea of this integration from the beginning, you prepare the building for that, you have enough, let's say, background or enough idea about the topic and you integrate it from the beginning, from

the very beginning. I think it will be a success.....But let me add also that in private companies here in Spain, usually the design phase and the production phase it's made together. I mean it's common right now to integrate the production company or the construction company from the beginning. Not always but in the private companies. So when you collaborate from the very beginning with the construction company also, they give you their background or their experience regarding the facilities or whatever so. At the end, you can predict some problems that it will happen during the construction process. So this is why I'm saying that the design phase is the most important because if you collaborate from the beginning with different companies in the design phase, then everything will be solved.

Interviewer

OK. So it's important that.....I need you to elaborate more about the collaboration. So because I have question about it. That's good. So how can we achieve a closer collaboration between various stakeholders and disciplines during early design stages?

Interviewee 15

It depends on the client. I mean it's not easy but.....In my experience, OK, [Name of the Interviewer].....Maybe another will tell you another thing....but you know where design studio we used to collaborate with construction companies, and we always work together, but sometimes the client doesn't like this because they think that you are collaborating always with them and you are receiving some money from the company. This is why it's super complicated. So you have to let's say to gain the confidence from the client and it's complicated. It's complicated.

Interviewer

Got it. Now what are the key aspects that should be considered during the production phase of facade products integrating such technologies?

Interviewee 15

I don't know what can I answer here.

Interviewer

OK. Now I'll move to the following question. So about the assembly. So what are the key aspects that should be considered for the assembly of façade products integrating solar cooling technologies?

Interviewee 15

In my understanding, it's something that, for example, if it's something like we are doing in the [*specific project*], that it's a façade that can integrate a full component in it. The key aspect is to make this off-site of the building construction. So then you can bring a whole component integrated in the final building.

Interviewer

OK, What about the required workforce during the assembly? Is there any anything or are there any aspects that should be considered for the required work force?

Interviewee 15

Thinking on façade always. Right. I'm going back also to the previous question. If it's something which is prefabricated, and it can be assembled on site easily, the workforce will be only plumbing it.

Interviewer

OK, So what about the operation phase? What are the key aspects needed to be considered for the for the operation phase of façade products integrating such technologies?

Interviewee 15

Two things coming to my mind. The first one is....sometimes it's super important to teach the end user how to use the facilities. And the second one, if it's a public building, let's say office or healthcare building....the use of the technologies or let's say to have the final comfort from the building, from the users, from the end user, it should be made from someone who has knowledge about the facilities. I mean nowadays in the offices they have the thermostat. They are blocked usually. So you have the chance to move up or go down the temperature, but it's blocked sometimes because the bad use of the final client, let's say, sometimes makes an inefficient performance of the system.

Interviewer

Ok so now I'll move to the last question before the close of questions. So what about the key aspects we need to consider for the end of life of facade products integrating solar cooling technologies?

Interviewee 15

In my understanding it should be something that it can be disassembled easily and it should be...think of it with a circular economy concepts regarding the construction phase. I mean different components can be separated and reused easily or it can be integrated in another system.

Interviewer

So now I'm done with all questions. So now I'll move to the closing questions. [Name of Interviewee 15], what are your final remarks about the widespread application of solar cooling integrated facades as building products in the construction market?

Interviewee 15

OK for me I think it's an interesting technology and it should be further studied, but my only remark in this topic is that it should be something that collaborates with other technologies. I mean when I'm thinking in the solar cooling products and more in your case that is related with façades, I think it should be something that collaborates with other technologies or with other elements. I mean if it's already working or placed in a façade, let's say that it should be thing with the passive systems and then you are solving the active system which is your technology. Right....And then I think it should also offer a system with the best energy performance, combining with other technologies in active systems. I mean in Europe, for example, which I talked to you before, I imagine technology working really well in summer seasons, but maybe not....they won't have the best energy performance in winter. So what if you can combine this technology with other technologies to achieve the best energy performance during a year....Well, yeah, it's the thing that it came to my mind.

Interviewer

OK, got it. So now I'll move to another question. So what do you think about the application of solar cooling integrated facades for enabling energy transition?

Interviewee 15

OK, let me think.....I mean I see perfect as long if this technology has concepts such as designed to be recycled, designed to be disassembled, or incorporate circular economy concepts in the whole product. I mean at least for me, which I'm more related with the construction sector, let's say, it should be something that integrates an environmental commitment. Even if they have the best energy performance, but if the materials used or the elements are not thinking to be disassembled or whatever, it doesn't make sense because makes the maintenance more difficult. In a long term, it will be a waste.....So it is what I have in mind right now.

Interviewer

Yes. OK. So again, thanks a lot. Just one final point. Not related to solar cooling....Do you mind to propose potential participants that can be interviewed for this study?

Interviewee 15

I should ask them first.....