

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 opening questions. So [Name of the interviewee], according to your experience, what is your opinion about the current level of knowledge in the building industry regarding the application of multifunctional facade components integrating solar cooling technologies?

Interviewee 5

I think it's quite low. Quite low. Because in general, let's say there is not big literatures on that topic and we must admit that there are very few products on the market and very few, let's say attempt to integrate solar cooling into the façade of the building.

Interviewer

I see. So in your opinion, what are the motivations to develop facade the products integrating solar cooling technologies?

Interviewee 5

The motivation?

Interviewer

Yes.

Interviewee 5

OK, in terms of motivation, let's say there are few advantages which are let's say very relevant. It could be very relevant. In my opinion, one of the let's say most important motivation would be to expand, let's say the futures of a façade, which is normally used for water tagging and for of course for installation and for aesthetically refining with the building. But if we add some additional features, these could be, let's say, very very important because let's say the facade is the skin of the building. And if we, let's say, make it more performing, of course the building itself would be like that better.

Let's say so the motivations are of course quite clear. But so in terms of, let's say drivers, I would say it would be very, very important to have ready to install systems, so modular system, silent system.

And systems which have easy maintenance from inside of the building.

Because I don't think it's imaginable to make maintenance from outside because it will be too much expensive.

Imagine a big tower. You are on the 20 level and then you have to go outside to change a filter or to repair a leakage.

So I think this is crucial to have let's say a modular system which can be accessed from inside the building and, of course this must be very reliable and say in terms of electric resistance and so on, but also in terms of water tightness.

In terms of I don't know...use of risky gas like ammonia and so on.

And then I think the chance could be only related to very simple systems and modular system. So I personally I don't think that is possible to integrate, let's say, a complex concept, I don't know which requires for example water tanks, solar collectors, pipes, plumbing and so on, which then is inserted let's say inside the facade. No, I don't think so because solar cooling is already complex, is already not always reliable and it's not imaginable to put this problems inside let's say the façade structure.

So in case we managed to do it, we should focus on modular, simple systems. Which can be, let's say, integrated to the façade itself before the installation process.

Interviewer

OK, got it. I see so.

What are your concerns regarding the application of multifunctional facades integrating solar cooling technologies?

Interviewee 5

OK, I already mentioned.

I think system complexity.

OK. You like related to water leakages and loudness of fans and other components, and let's say the sizes of the system itself, because normally our quite bulky.

And also the insulation reduction. So problems related to reduction of performance in terms of installation depth and so on.

Interviewer

So I can tell that the main issues that can be considered for your concerns could be having modular systems, isn't it?

Interviewee 5

Yes.

Interviewer

OK modular system should be considered for somehow addressing such complexities.

Interviewee 5

This could be, let's say, solution to the potential issues, yes.

Interviewer

OK.

So can you tell me how different types of projects such as the new building construction or renovation projects, can affect the application of solar cooling integrated facades?

Interviewee 5

Of course, in new buildings the situation is quite easier because of course then the solar cooling system is integrated also at design level, so a lot of issues can be avoided at design level.

In refurbishing, I think it's still thinkable, but of course only if let's say an external and additional model and additional facade is put on top of the old facade.

Interviewer

OK, so now let me move to the following questions. What about different types of buildings, office, residential, healthcare? Can you tell me what is the effect of different types of building on the application of solar cooling integrate facades? Office, residential healthcare....

Interviewee 5

Yes. Yes, I think from that point of view, we must consider that one of the advantages of having solar cooling system, or in general HVAC systems integrated in a façade, is that we can decentralize ventilation. We can make decentralized ventilation systems. Because again, the facade is the skin of the building and the skin transpires. The skin need to make water and air exchange. So from that point of view, it makes sense to have a system which make an air change for example.

OK, so from that point of view, of course, public buildings or offices whenever ventilation is required, that could be, let's say, that could make sense to have an integrated HVAC inside the façade.

Not the same, I would say for residential building at least in Europe, which is not, very related to air or ventilation systems.

Interviewer

OK. I got your point. We talked about the different types of projects. We talked about different types of buildings. So I got your point regarding office or public versus residential. Now the following question is how different locations of buildings or climate conditions can affect the performance of solar cooling integrated facades?

Interviewee 5

I can make this remark saying that form south applications, let's say on the south façade, it's more suitable maybe to have it in northern sides, of course. But for Easter and Western façade, I would say similar, or I don't see very, let's say particular differences between the sides.

Interviewer

So I can tell now the recommended locations and the climate conditions could be the South facade.

So I got your point. South could be like the location or orientation, but what about the climate conditions?

Interviewee 5

Yes, I said that so the application on the South façade could be more appropriate for northern sites northern climates because the let's say the rays of the sun are lower. So that's why in that case it makes sense.

For example, I don't know, in South Italy, if you go on the South façade during the summer, you don't get a lot of sun if you are talking about putting the solar collector on the facade itself. Because

otherwise we also can imagine to have solar collector on top of the building and having let's say the active cooling machine inside the facade. We could have like a network like a hidden network inside the building, a normal hidden or also existing hidden network and using let's say the space inside the facade to integrate the machine.

Interviewer

I see. OK, now I got your point regarding the building location and the climate conditions.

Can you tell me how different types of solar technologies such as electrically driven or thermally driven such as solar thermal collectors can affect the application of solar cooling integrated facades?

Interviewee 5

Yes, let's say even if I'm being working on thermally driven systems, I must admit that Photovoltaic based systems could be easier to integrate because conventional buffer compression chillers or technologies are very compact and easier to be installed.

Interviewer

OK, I got your point. Now I have just finished all opening questions. So [Name of Interviewee 5] now I'll move to the key questions. So I'll start with the technical and product related aspects then financial aspects and finally process and stakeholder related aspects. So now [Name of Interviewee 5], I think you already answered it, but you maybe can elaborate more. What are the potential solutions to address challenges related to product complexities such as required space availability or interrupting building services? I remember you mentioned already modular systems.

Interviewee 5

Modular systems and I think packaged HVAC system, but no chillers. I don't think it is possible to have a chiller inside the façade. There is no base for that I think.

Interviewer

OK, I got your point.

OK, now can you tell me what are the important issues needed to be considered for the maintenance and the durability of solar cooling integrated facades?

Interviewee 5

OK. Again, easy maintenance from inside the building. It's required, needed, and then periodic inspections inside, let's say the space where the various components are set.

And from that point of view, again, let's say public buildings where technicians are already skilled and prepared to pay maintenance. It's a better situation.

Interviewer

OK. I got your point. Now let me move to the following questions. How do you see the role of aesthetics on the widespread application of solar cooling integrated facades?

Interviewee 5

Crucial. Very very important, I think.

I think that you don't have to see, let's say the component inside or from outside the facade....should be very similar to normal modules which are not integrating active components.

Interviewer

Ok. Now I will have few questions about financial aspects. So [Name of Interviewee 5], can you tell me in your opinion, what are the main issues needed to be considered to develop affordable and financially feasible facade products integrating solar cooling technologies?

Interviewee 5

OK, so starting from the fact that solar cooling is expensive in general, let's say the idea to make it smaller, maybe as a smaller scale, and so not so bulky anymore and very well integrated aesthetically and so on. It's a an additional problem that we have to face in terms of cost effectiveness.

The only thing that I think that I noticed that can be an advantage in terms of economics is that part again that the building designer can avoid cost related to the air channelling inside the building because I think that we have to use, let's say the façade, so the envelope, to make air change and avoiding additional costs for or reducing at least additional costs for ventilation of the other, let's say rooms or any.

So we should maximize, let's say this opportunity, I think. We have a decentralized system.

Interviewer

OK, decentralized.

OK, Generally in your opinion, what are the potential financial incentives that can support the widespread application of solar cooling integrated facades?

Interviewee 5

I'm not sure I can give you an answer but I would suggest you have, let's say, financial incentives which are based on the energy savings which are based on the estimations of the contribution to the cooling of the building.

And but I don't know at the moment if there are such incentives in Europe.

Interviewer

Got it, OK. So now we'll move to the last part before the closing questions, which will talk about the stakeholders and process related aspects. So you can see from this chart, we have different stakeholders that are involved in the facade design and construction. So in your opinion, who could be the main potential supporters to the application of solar cooling integrated facades?

Interviewee 5

The façade system producer, I think, because they have, let's say, the market on their hands and they know they the customers. They can offer solutions to the customers. So in that sense, they can play a relevant role.

Interviewer

So facade system producers...do you mean by facade builders or...?

Interviewee 5

Yeah, big companies which produces façade, yes, systems or solutions. Of course they have to work together with architects, consultants and so on. But let's say the big rock that can change the game at the moment I think is the façade system producers.

Interviewer

OK, got it. Now can you tell me, in your opinion, how to increase the technical knowledge and experience of architects and engineers about technical aspects related to the facade integration of such technologies?

Interviewee 5

Again, first we need to let's say more products on the market available, and then we can start let's say you make courses and to make...to let architect know about this technology, but I don't think it's the main problem at the moment, honestly. I mean there's very few products, there's very few solutions. So the problem is not that the architects don't know very, very ready on the market solutions at the moment.

Interviewer

OK, so the main problem is the we have few products.

Interviewee 5

I think yes.

Interviewer

Ok now let us consider that, OK. If you'd like to have design standards or guidelines. So in your opinion, what are the core elements that are needed to be included in designing standards or guidelines related to the facade integration of solar cooling technologies?

Interviewee 5

Well I think that let's say the main issues are related to the standardization of the modules, which must have, let's say, specific features in relation to size, for example, and loudness, water tiding, and yeah the most important thing I think is to have standard models.

Interviewer

OK, got it.

Now let's move to the following questions. In what way can the industry increase the variety of products that would attract customers to apply solar cooling integrated facades?

Interviewee 5

From the customer point of view, I must say that they must be economic, of course. They must seem similar to standard facade modules, not to be very, very different. And safe and silent.

Interviewer

In your opinion, [Name of Interviewee 5], what are the potential solutions that can help in improving the future interest of designers, developers and the clients about solar coding integrated façades?

Interviewee 5

You mean technical solution?

Interviewer

I'm talking about the interest. How we can improve the future interest of designers, developers and the clients about solar cooling integrated facades.

Interviewee 5

Potential solution that can help in improving the future interest. I'm not sure I get the point of this question.

Interviewer

I mean like how can for example, we how can we make people either designers, developers are interested in in applying or adopting such technologies in projects.

Interviewee 5

Presenting products which are reliable, cost effective and performing well. I think again, I think the problem is not related to the designers or could be an additional but Yes future problem....It's not the main problem at the moment I think. As far as I know, there's not a big market which is pushing and it's not let's say growing because of architect don't know the solution and so on. I don't think so. I think the problem is related to the to a lack of solution, technical solution.

Interviewer

Technical solutions.

Interviewee 5

I think so.

Interviewer

Yeah, which are related, as you mentioned before to the complexities, those things.

Interviewee 5

Yes.

Interviewer

OK, got it.

Interviewee 5

But so also I must say that also, let's say in general also form bubble compression technologies, HVAC, for example, there are only few attends only few projects that I had where researcher tried to integrate such components inside the building facade. I mean, it's not so common. It's not so common, let's say problem also for very conventional technologies.

Interviewer

I see.

Interviewee 5

Because normally we have to face that normally the facade is filled by different company which builds the HVAC system. So they don't go together normally. They are separated and the integration of both aspects can be an additional cost, general. Can be an advantage from a certain point of view, but in general it's more expensive I think.

Interviewer

OK, I got it. Now let me move to the following questions.

Generally, how would legal legislations affect the application of solar cooling integrated facades?

Interviewee 5

Maybe problems related to the reduction of insulation or to loudness or water tightness. These aspects can be maybe, can be taken into account on that legal level, but not sure.

Interviewer

OK. Now let me move to the last part before the closing questions. So you can see from this chart we have the processes to develop façade products. We have the design phase, production phase, assembly, operation and then the end of life. So [Name of Interviewee 5], do you think that there are particular phases that are considered to be the most important ones?

Interviewee 5

I think system design and then execution design. So let's say the design I would say.

Interviewer

And why?

Interviewee 5

Because we have to solve possible problem related to the integration with the facade.

How the pipes can go through during the building of the façade. How I can connect the pipes without problems of water tightness during the production of the façade. How can I access for the maintenance. How can I make it aesthetically acceptable. These issues are crucial.

Interviewer

So the important aspect that should be considered for the design is design is take into account the accessibility, the water tightness? Your mission also..

Interviewee 5

Yes. Issues related to the loudness of the of the system or problems which could be related to vibrations, for example, for internal components like such as fans or compressors.

Interviewer

OK.

Now let me ask you a question about...In your opinion how to achieve a closer collaboration among various stakeholders and disciplines during the early design stages of solar coding integrated facades?

Interviewee 5

Collaboration between various stakeholder and disciplines.

Interviewer

Yeah, during early design stages.

Interviewee 5

Yeah, I think that in order to design a standard module, a standard sort of cooling module, for example, the architect, the mechanical engineer, and the facade system producer should work together to develop the solution. I don't think....because we are talking about an integrated solution. So it's a new product. It's a new product which includes both aspects related to the facade and to the cooling machine and so on. So I think that it's crucial to have all around the table and they must give restrictions. We need opportunities of let's say in both sides of the of the integrated facade.

Interviewer

OK we talked about the design. So do you have something in mind there are particular issues needed to be considered during the production phase of solar cooling integrated facades?

Interviewee 5

For the production I think the standard modules product produced at industrial scale, let's say, together with the façade module. So I imagine that the facade module which integrates the component comes let's say the place already finished.

We just need to connect, maybe pipes or electrical lines, but otherwise I think should be already produced at industrial scale and in a standardized, let's say line.

Interviewer

I got your point. So now we'll move to the assembly. So what are the main issues needed to be considered for the assembly?

Interviewee 5

Assembly should be easy because we spend a lot of time for the design and for the production for, let's say, standardized production and then the assembly should be very very easy.

Interviewer

So how we can make it easy for the workforce or for mason?

Interviewee 5

Again, it's the design is. It's well done and it's the production is mostly at industrial scale, so not they are doing the building of the beginning. The assembly should be just plug and play, let's say. You plug some pipes or electrical lines control. Yes, I'll be controlled. But not very much.

Interviewer

I see. So ok we talked about the design, production, and assembly. So what are the important issues needed to be considered for the operation phase?

Interviewee 5

Of course a current and periodic maintenance. It is very important.

Otherwise, let's say problems in plants can always come out, but since we are inside the building envelope, we have to avoid any kind of problems or also minimal problems related to water and leakages and so on. Because we are inside the building itself.

Interviewer

Are there important issues needed to be considered for the end users knowledge?

Interviewee 5

For the end user?

Interviewer

Knowledge.

Interviewee 5

No, I don't think it makes a big difference in respect to standard systems because it's always it's all integrated inside. The users or the customers should know very few aspects. I don't think he must be involved very much.

Interviewer

OK, now finally what are the main issues needed to be considered for the end of life of solar cooling integrated facades?

Interviewee 5

Yeah, maybe you have to consider that the fact that normally they are quite bulky, so heavy and also the interconnection between the cooling machine and the facade could be a problems. I don't know maybe during the amounting of the of the system itself. That means if, for example, the facade is still tight, the facade is still good for performance in terms of insulation, but we have a problem on the cooling machine. I think this could be a relevant problem because since the machine has been integrated inside the facade at industrial scale, then if we have to unmount it I think we get a problem.

Interviewer

OK, so how we can address such problem?

Interviewee 5

During the design phase, we have to consider that the cooling machine could be removed. Also doing the let's say the life of the building because in general I think that the cooling machine has a shorter life, technical life, in respect to the facade.

Every component should be repaired, must be easy to be replaced.

Interviewer

OK, I got your point. So now we have finished all the key questions. I have already started with the opening questions. Then the key questions. I asked questions about technical, financial, process and

stakeholders. Then I have just few points to consider for the closing part. So [Name of interviewee 5], what are your final remarks about supporting the widespread application of solar cooling integrated facades as building products in the construction market?

Interviewee 5

I think we have to focus on simple concept and to miniaturization, let's say, of existing concept.

Avoid complexity at all and make very, very silent systems. Of course, good performing, let's say the most important in reality.

Interviewer

So [Name if interviewee 5], do you mind to propose potential participants that can be interviewed for this study?

Interviewee 5

I was thinking to [specific organization]. I don't know if you have contact with them.....