

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 Interviewee 11], 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 11

Would I consider this special consultants which take care of the photovoltaic, so it's not directly in the facade business because it's in between facade construction and electricity and division of panel solar radiation orientation. So for the photovoltaic the real specialists which have a special mission in the building. And then we are in the interface with them and we helped them to figure out how the panels could be mechanically fixed. And if the space is large enough and where the electrical cables pass, where the modulator will be, and then they also have to find the interfaces with the fire protection, how the system could be cut off in case of fire. So it's not.....And when you write in the building industry, your question is far too large. There are specialists which have exactly that knowledge, and they work as a separate consultant, which we have an interface with.

Interviewer

OK, got it. So let me 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 11

The motivation of whom?

Interviewer

The motivations of applying solar cooling technologies or integrating solar cooling technologies into building facades. What are the motivations?

Interviewee 11

Yet there's different people which are concerned. First question is always the owner of the building, the investor. So their motivation can be it's the image of the building. We have the case of someone who sells solar cells. So he wants solar cells on the building. I think producing energy it's just very little what can be produced on the facades on the general consumption and the facade is not necessarily the best biggest surface as it is bits and pieces, but as we see in the actual situation, energy is getting more and more expensive. We have to use the surfaces which we have. I personally still believe there's larger and easier accessible surfaces along the motorways on the roof of every supermarket, which will be more efficient, but there are buildings were they used also the small parts in between windows to fill it with Photovoltaic cells to produce electricity, and then it's mainly the image and the participation of an owner of a company to the environment.

Interviewer

I see. Now, let me move to the following question. So I asked you about the motivation. So it's the other way around. So in your experience, what are the concerns regarding the application of multifunctional facade components integrating solar cooling technologies?

Interviewee 11

The biggest concern is probably the investment cost. The return of money up to when it will pay back. It's integrated in the facade. It's mainly not very efficient because the surfaces are small and little. There's sometimes shaded that PV cells will not function properly, but there is a change with the political situation, with the laws coming up, with the building should use less energy, it should be autonomous. That the design from architects change. We have actually little parvenu where they have added enormous sun protection shields, roof surfaces for the photovoltaics so....Yeah, an architecture changes, then you can provide bigger surfaces and also in the design does changes going on that the modules have different appearance that they could be also like a part of the building, like an integrated design.

Interviewer

OK, now do you have some ideas about how we can address such concerns that you mentioned, for example, the investment cost and the payback?

Interviewee 11

Yeah, clever design. Use large surfaces that investment cost will drop per square meter, and make other energy more expensive that the investment cost is smaller compared to conventional energy or pay subsidies that people are interested in.

Interviewer

OK, now let's move to the following question. So how can they type of project, such as we have a new building construction or we have renovation projects....so how the type of project can affect the applicability of solar cooling integrated facades?

Interviewee 11

I think that's not really limited to a type of a project. Often it's skyscrapers because there's no shade on the top area. So on the South East and West facade you can apply it.

Interviewer

So for the type of projects, you didn't see any effect on the applicability.

Interviewee 11

Yeah if the project is too small, it won't normally work, but now we have a one story flat pavilion and that it made the design to make it work. So I think it's really the aim right in the beginning. If you want to integrate it and create the coating surfaces, during so but from types of buildings that could be....for conferences, for offices that but also now we have a project with housing where they apply the elements. Certainly, big industrial roofs are very efficient because they have a big surface.

Interviewer

OK, so you so you don't see that there is an effect like the type of the building office, residential healthcare on the applicability?

Interviewee 11

No, no.

Interviewer

OK, now let's move to the following question. I think you already talked about the location of the building, but let me ask you in more details. So how do locations and the climate conditions of buildings affect the performance of solar cooling integrated facades?

Interviewee 11

For the South you go, the more cooling you need, which is clear. But on the other part, I think it's not only the solar protection...or elements, it's also the thermal mass. It's the natural ventilation during night time to drop temperature. It's the green around which can evaporate water to cool down. So there's lots of additional factors which can be integrated in, yeah, town planning, in architecture to have solar effects. It's not only the active means you're talking of. I think it's important to also consider passive elements in the design. And from the location. Constrain it from Europe, it's the whole South of Europe until yeah, in Germany. But I think even UK and. The Nordic countries, probably with the climate change that it's getting warmer, that they also require it....but more sun, logical the better it works, but also the more they need it.

Interviewer

So generally the recommended location you generally, so you mentioned the southern Europe for example, more sun. So do you have other aspects or other ways to suggest locations for applying facade products integrating solar cooling? So you mentioned like the more sun or more cooling demand like in the Southern Europe.

Interviewee 11

You have to develop your building to take into account the climate context. So now I talked about Europe, but then for India or China, depends how much it rains. If you have to collect the rain that there's several where where's the sun? How much sun is there? How do you protect it? How big windows you do? This is a much larger topic.

Interviewer

Ok now let's move to the following question. So this is the last question in the opening questions. So do you think the choice of solar cooling technologies, namely electrically driven or thermally driven, would affect the application of such facade products in a particular building project?

Interviewee 11

Sorry, what? Can you repeat the question? Does not clear for me.

Interviewer

OK. Do you think the choice of solar cooling technology, namely electrically driven or thermally driven, would affect the application of such facade products in a particular project?

Interviewee 11

The application doesn't make sense because if you apply the products, they always have an impact on the appearance of the building and you have to integrate them. Yes, every piece you add to a project has an impact.

Interviewer

OK. So do you have any aspects to be considered when we need to select the technology or some important factors that should be considered when selecting the technology, either electrically driven or thermally driven?

Interviewee 11

Yeah, you have to do global concept of the building and figure out how you can use passive means already to reduce solar gain and then you still have maybe some watt, kilowatt to fight which you will then do with these active solar technologies. But the first thing is always what can you already do passively that it works on its own before you add then the active ones, and that's the mechanical engineering who has to do the set out. So it needs a...And energy concept for the whole building. The facade is then driven by the energy concept, but facade also has an impact on the dimensions of the windows on the glass you choose on the G value of the glass, which kind of external sun protection you have. How you manage that. It's I think a lot of different variable parameters which will play a role. It's not just two technologies which you can use as an add on.

Interviewer

OK, so now let me move to the key questions. So in the key questions, I'll ask questions about technical and product related aspects. Then I'll move to the financial aspects and then finally end up with the questions about stakeholders and processes. The first part, which is technical and product related aspects. So in your opinion, what makes the integration of solar cooling technology into building facades, what would make them complex products?

Interviewee 11

Like complex products....Yeah, they are in a way complex because they add things towards the facade...There's cabling which penetrates the facade. They take surfaces, they need structural supports. They have to resist the wind load. They bring running electricity, which is a problem during fire. The elements producing warm water, I can't tell you. I've never used that into facades. I think they are mainly on roofs.

Interviewer

OK. So are there some ways to address these complexities? For example, the cabling, these aspects?

Interviewee 11

They have to be solved individually for each project. There is not a standard solution. Yes, there's more on other cables which will run through the facade, so they have to be water tight, airtight, but there special fittings where the cables can run through. But you have to provide the space and the fixing for it.

Interviewer

OK. Now I have a question about some other complexities. So let's move to the following question. How could we address challenges related to the space availability or interrupting other building services?

Interviewee 11

You have to plan it. You need a facade consultant to plan the interfaces. You need competent people to discuss it and find solutions.

Interviewer

OK. Now, what are the key aspects to consider for the maintenance and the durability of solar cooling integrated facades?

Interviewee 11

It has to be accessible. So that depends how large the building is. Can you access it from the inside? Do you have maintenance catwalks? Do you have to do it from the outside? Do you access by cherry picker? Do you access by cradle? How can you replace them? What is their weight? Can they be easily disconnected? Yeah, I think that's the whole batch to solve, to assure maintenance.

Interviewer

OK, now let me move to the following question. How do you see the role of aesthetics in the widespread application of building facades integrating solar technologies?

Interviewee 11

It's very important. It's I think one of the key topics is the aesthetics.

Interviewer

Do you have in mind that some factors we need to consider for the aesthetics of façade products integrating solar cooling solar technologies?

Interviewee 11

They want to develop elements which are easily accepted by architects. Then you have to be open to modify these products individually. So have custom made dimensions, surfaces, colours.

Interviewer

OK, so now I'll move to the second part of the key questions, which is the financial aspects. Then I'll move to the stakeholders aspects. So I have two questions in the financial aspects. The first question....In your experience, how can we industry develop affordable and financially feasible facade products integrating such technologies?

Interviewee 11

That's just the opposite. It's by mass production, certainly, with clever production, and that the payback time is very short, and the investment cost is lower, and gain you achieve earlier. So that means if electricity is getting more and more expensive, the interest is growing to invest, and maybe with the war at the moment is also to be autonom that you have your own electricity to keep up, at least basic needs...and the non-dependence of international system.

Interviewer

OK, I got it. So I'll move to the second question about the financial aspects. What are the potential financial incentives that can support the widespread application of facade products integrating solar cooling technologies?

Interviewee 11

It's from subsidies, from the government. It's always when it's politically driven, people will....when they get paid for, they're more willing to do it. The other part is reputation. I think those are the two aspects.

Interviewer

So now I am done with the financial questions. I asked you all the questions about technical and product related, and financial. Now I'll move to the questions about stakeholders and processes. So I'll start with the stakeholders and then I'll ask questions about the processes. So as you can see from this chart, we have different stakeholders that are involved in the facade design and construction industry. So we have different relationships between stakeholders and we have different stakeholders. So in your experience, which of these stakeholders can support the application of solar cooling integrated facades?

Interviewee 11

Support is a different question as decide. The client and the user and investor, they are key people making the decision. The architect is also key person because he develops the general concept of the building and can then provide an impact on the environment. The consultant can help with the technical parts. While it's then more the mechanical engineer consultant who can provide or calculate the needs of energy production to cool the building. The facade consultant can only help with the integration, so provide space and fixing while space is often already the architects....or the façade consultant I see more in the interface. The facade builder has been already the defined specifications, so they are not key deciding people because they rather execute what was already developed. And the general contractor, that's very important, when the general contractor comes on board. Is the general contractor already very close to the investor or is he close to the architect? Or is he really only general contractor for the execution?

Interviewer

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

Interviewee 11

OK. That's very interesting and very good question. I think to provide comparative information. So like sum up the products which on the market, the dimensions, the investment cost, deep appearance....That people already know if they use one or the other product. What is the impact that the architect sees if I for example use these kind of products and I need so many square meters that could be the game. So yeah, like a very easy chart of decisions. What I would like was like a big booklet was all the different photovoltaic cells. What are the dimensions? What is the production? What is the payback and materials used? Because if you need energy to produce glass, you need energy to bake the solar cells. So how much embodied energy is already in the different products? Because if you have to run them eight years to pay back, for the embodied energy that it's really the

question and how long will they live? If they live 15 years and you already need eight years and it's only seven years weather productive, then it should get to improve the product to make it more efficient, I think that would be very, very helpful.

Interviewer

Yeah, actually it's nice from me that you almost answered two questions. So I this question I was asking you about the how we increase the knowledge and then you answered, and then the following question I was going to ask you about what are the key elements we need to consider for standards and guidelines and then we discuss the things that we need in the booklet. So I will skip that question because you've given me lots of information about the these elements that we need to consider for standards, the guidelines....So it's good that you answered.

Interviewee 11

Yeah that would be really helpful because at the moment there's maybe some consultants who have a certain deep technical knowledge, but if you could provide that to architects and facade consultants earlier, then we could integrate that in competitions and make a choice or already use modules in the right dimension. We just had a project where they came from 5 inch to 6 inch and that changed then in the end it geometry of the building because we had to go a bit larger. These changes in a later stage of development have an enormous impact, I would say on time. Or they're coming so late that you can't integrate them anymore because building permission is already given. So the more the information is received in the beginning and maybe also the space which is required, in addition. You know what kind of boxes you need to get cables together. How many cables come out of the PV cells which are the different types like. Where the cables can come out? How they have to be protected?

It's mainly the geometry and the space question as well as, yeah, the appearance that the architect can say here I've got a wide range of colours. There's a limited range and these dimensions can be modified and these are fixed. I don't know how much you work with Revit. A very clever idea could be to do very basic modules as Revit families, where you have the parameters which are fixed and where the parameters which can be changed and that's not only dimensions, it could be like colours. You could tick on. Cable connections, which you could take on. Wind resistance.

Interviewer

I see. So let me move to the following question. How can the industry increase the variety of products that would attract customers to apply facade products integrating solar cooling technologies?

Interviewee 11

Yeah as I said before that the industry is flexible to produce products made to measurement. We have at the moment a project where they change the surface of the outer glass to give it a structured glass or a glass in a different texture in a different colour. A printed glass that the architects design, is not constrained by the product that it doesn't look like an add-on product, but that it looks part of the global design.

Interviewer

OK, got it. So let me move to the following question. So in your experience, how can we increase the interest of designers, developers and the clients in solar cooling integrated facades?

Interviewee 11

Yeah, that was what I was saying. I have a big flexibility in the appearance of the products and to give good technical comparative information.

Interviewer

OK. So I'll move to the following question. So how can changes in building regulations affect the widespread application of solar cooling integrated facades?

Interviewee 11

That's already ongoing that it's now I think for new buildings or by 2030 it is a must to integrate solar panels, PV panels, and there again....Hopefully our cities won't look like a big mess, so there should be also architectural or urban design guidelines to protect old cities and not to allow every owner of the house just to have an add on product somewhere on the building. I don't know if you're in South of Europe, there's some buildings where everybody has their little climate box or in the Asiatic area they have all the climate boxes sticking out of the window, and it looks horrible. It's not efficient and it looks horrible. I think if politics now force too much only on the production of energy, then our built environment will look horrible, so it needs quite some design intelligence to integrate those elements in an aesthetic way.

Interviewer

OK. So you talked about politics, so let me ask you a question. So how can changes in energy policies affect the widespread application of solar cooling integrated facades?

Interviewee 11

Yeah, that's what's already happening. When you do not get a building permit with the integration of solar cooling techniques. So that's if it's a law, then people have to do it. Or if you get a lot of subsidies, then people say I get it for free. I just use it. Without any design or architectural constraints. That's the big problem. Maybe it has always to be an architect who signs it off, that people can't go to the supermarket and just buy it. That way, spoken.

Interviewer

So now I'll move to the last part before the closing questions. I'll ask questions about the facade design and construction processes. So in your experience, which phase is considered to be key for boosting the integration of solar cooling technologies into building facades?

Interviewee 11

Right...certainly the beginning. It's always the design phase. In the beginning, the cantilever was a decision as much bigger than in the end. Yeah.

Interviewer

So OK, let me move to the following question. So what are the main aspects to consider during the design phase for a façade that integrates solar cooling technologies? What are the key aspects we need to consider during the design phase?

Interviewee 11

Geometry, orientation, surface, architectural integration, the demand, the need of energy storage. Do you use it yourself? Do you store it? Do you sell it?

Interviewer

So let me move to the following question. So in your opinion, how can we achieve a closer collaboration between various stakeholders and disciplines during early design stages of building facades that integrate solar cooling technologies?

Interviewee 11

That's always a question how you organize the whole design team. It's very difficult to do it from the outside. It's either the client or it's the architect. It needs key people who drive the whole team.

Interviewer

So organizing the design team from the beginning.

Interviewee 11

Yeah, but then it's character. If there's a person who's keen on doing it, it can motivate the others, then it will work very well...and that's then, yeah. For example, if the client can bring the topic always up and imply the idea in the design team that they know why they do it, that they participate in thinking, how they can find solutions. If it's not the investor, not the client, and sometimes it's the architect who wants a building which stands for energy, low energy consumption.

Interviewer

I see. Now let me move to the following phase. So what are the key aspects to consider during the production phase of a façade product that integrates solar cooling technology?

Interviewee 11

You can just find the right product according to the tender specification.

Interviewer

Which specifications?

Interviewee 11

The tender specification....The whole building your design team...The end of design phase is that you specify...the specification.

Interviewer

OK.

So, OK, what are the key aspects to consider for the assembly phase of a façade product that integrates solar cooling technologies?

Interviewee 11

The interfaces are sorted out correctly that people talk to each other.

And for the operation phase that people using the building, they know how it functions that they have the manuals....How to maintain the products? How to optimize the products? There might be circle back to the design phase compare the energy production defined in the design phase that they can achieve it in operation phase and if they don't do it, why? Are the rights products... did it work the right way? So that there's no knowledge lost from the beginning to the end. Comparison of both results, the theoretical and the practical result.

Interviewer

OK so. Let us focus on...what are the key aspects we need to consider for the end user knowledge?

Interviewee 11

That's what I was saying, that he has to know how to use it, and that made people from the design phase help to use it correctly.

Interviewer

OK. Now I just have a question that...maybe a little back to the assembly phase....What about the required workforce? What are the key aspects you need to consider for the required for workforce during the installation phase?

Interviewee 11

Yeah the assembly phase, it's very important that you can pre-manufacture as much as possible in the factory that is less site work to assure better quality, to have quality checks.

Interviewer

OK, so now we'll move to the last point before to the closing questions. So what are the key aspects we need to consider for the end of life of the facade product that integrates solar cooling technology?

Interviewee 11

Yeah first thing is that the end of life is very, very far in the future.....Can you repair things...that they mechanically assembled...that parts can be replaced...that people can understand easily how it works, that you don't have to throw it away....that the end of life cycle. Yeah. If it's coincident with the building, it's the best. If you have to replace them before then you just replace these parts which are necessary, and then that you can all de-assembly to recycle material.

Interviewer

OK, now I'll move to the closing questions. So I just have few points in the closing question. So do you have any final remarks about the widespread application of façade products that integrate solar cooling technologies?

Interviewee 11

Yeah, require that every modification to the facade is signed by an architect that we will live in an environment which has a certain aesthetic quality.

Interviewer

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

Interviewee 11

It's a part for energy transition and the other parts are the passive solar cooling components which should be considered first.

Interviewer

OK, got it. Now I'm done with all questions....just have one question.So do you mind to propose potential participants to be interviewed for this study?

Interviewee 11

You could interview people who work with the.....