

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

So now I'll move to the opening questions. So [Name of Interviewee 17], first of all, 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 17

I think it's really low. Really, really low, yeah. I mean, if you exclude the PV and associated with a heat pump or with the chiller....Well, yeah, that's probably most basic one.

Interviewer

Ok what are the motivating factors for the application of multifunctional facade components integrating solar cooling technologies?

Interviewee 17

The motivating factor....Well could be an energy efficiency and comfort and [...], you know, refurbishments, if possible, where you have like limited space availability, maybe by integrating into one component. So you do the façade. You replace the facade with a new facade which has got additional functions such as cooling.

Interviewer

Ok what are your concerns regarding the application of multifunctional facade components integrating solar cooling technologies?

Interviewee 17

So concerns are.....So my main concern is probably lack of proven and reliable, or at least an understanding examples or past experiences. Definitely there's one.

The other thing is probably the additional complexity that gets introduced into the design process, which makes it a bit entangled with other actors, such as you know the MEP engineer, I suppose....and then, what the other thing is probably the fact that it has to be tackled as soon as possible. So it needs to be like a nearly a client decision in the sense that you can't....I don't think that you can easily integrate it once the design has been developed...to a certain it is difficult...right.

Interviewer

OK. So generally how can we address such complexities related to the design?

Interviewee 17

I think informing clients is a good starting point in the sense that if there's a true motivation, then you know the whole design team just focuses on again addressing the design as early as possible. But then of course you need to have people that know what....I mean technical people being able to design it properly, and probably I'm just thinking loud, having early involvement of the suppliers is a

good thing because, again, maybe each system is different. So you wanna produce a design which is feasible in the end. So again client involvement....so client say motivation, to start with, and second, early involvement of system suppliers into the design stages is good. It's desirable definitely.

Interviewer

OK, got it. So now I'll move to the following question. So how can the type of project, such as new building construction or renovation projects, influences the applicability of solar cooling integrated facades?

Interviewee 17

OK. Well in new builds, you know, you got more freedom. So unless there's a truly economical benefit....I don't think....I don't see a lot of benefits, honestly, simply because you can rely on a standard system and then, you know, let the cooling be used or developed separately. Unless again probably the only motivation could be like....if you look at buildings like in London, for instance, where you know the price per square meter of our building is quite large and go up to, you know, 15 or 20,000 pounds per square meter....if you manage to save space by reducing, you know, the MEP plan room, maybe, I don't know....So if you can save space somehow in new builds by integrating the technology into the façade, that's a possible driver on new builds. I personally see a bit more potential on renovations again because you're working with more constraints, and therefore you may not be able to integrate a separate cooling system somewhere else in the building. So again you are forced to do it in the facade, and therefore maybe you can....yeah, maybe it's a bit more feasible on existing building, but that's my understanding. Of course, cost is a driver. So if it's too expensive, no one wants it, you know. But again, if you can trade off with the initial cost, you know....more usable space or benefits like even thermal comfort simply because of the fact that you've got cooling. Now the climate is changing towards warmer climates. So, you know, like in northern European climates are becoming more similar to southern European climates. So cooling is a necessity. So this is even a good reason for integrating, again, in existing buildings. In new buildings, normally you have cooling somehow. So yeah.

Interviewer

Yes. So now I'll move to the following question. So now I just asked you about the type of project. New building or innovation. So now this question is about the building type. So how can the building type such as office, residential, healthcare, etcetera influences the applicability of such facade products?

Interviewee 17

Well, cooling in offices is definitely more required than in residential as a general rule, simply because of, you know, the higher internal loads. Internal gain is more....It's more crowded. There's more computers and laptops. So you need to cool an office normally and normally, again, thinking about high-rise buildings, they got a lot of glazed areas. So cooling is a problem in offices, and also offices are more...well normally they are managed by a tenant who is, you know, making the operational part more as they are integrated within the cost, especially. So the operational cost is more integrated within, you know, the global financial balance of the company. So they are more interested and even sensitive to financial reasons why....again one should be integrating the cooling and the facade if there is one of course....But again if you have like an existing office without cooling, you need it because you need it, maybe....and so it's an old office, you know, you wanna refurbish it, you can't do other than integrating the cooling into the facade. So you do that because

you have to and therefore....so there's a kind of physical constraint, but there may be also some other advantages such as, I don't know, if it's not as expensive as building a new building just for the cooling plant. Then it could be a good reason why. On the residential, again, probably there's less of a need for integrating the cooling into the facade. I think we need to also talk about the facade types within which you can integrate this new technologies but, you know, the quickest and direct thing is to put a split system and then you've got cooling in residential. Even in office but also in residential. So that's probably the benchmark you need to work against, you know....Why is it more convenient than a split system with some PV integrated into the roof? Yeah. I don't know the answer.

Interviewer

Now I'll move to the following question. So in your experience, how do the locations and the climate conditions of buildings affect the performance of solar cooling integrated facades?

Interviewee 17

Well I don't think I've got the knowledge to talk about the performance in the sense that I'm not aware of the efficiency of those systems. So it's quite difficult for me to answer. You know normally the climate influences....and the climate along with the building shape and, you know, window-to-wall ratio and a lot of other environmental parameters....they influence on the choice of whether or not using a cooling system, normally. So sometimes you don't need it. But how the environment influences the performance of the solar cooling? I don't know honestly. It's very difficult for me to answer. I don't have the experience on that, honestly.

Interviewer

Yeah, yeah but generally which locations or climate conditions would you suggest to apply such facade products?

Interviewee 17

Well, I don't think there are any different from climates that require traditional application of cooling, I would say. Maybe like cities, they could be better suited for those technologies rather than, you know, countryside....But definitely southern European climate and all the warm climates around the world, definitely. Again, probably if you're building a new build in the middle of nowhere, probably you don't need it but I'm not sure. Definitely I mean....and then you also need to distinguish between integrating like energy production into the facade versus integrating solar cooling into the facade. So it's similar but different in the sense that one thing is producing electricity, and the other thing is producing like refrigeration in the façade. So yeah....it is a difficult question honestly.

Interviewer

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

Interviewee 17

Can you repeat the question. Sorry.

Interviewer

OK. Yeah. Do you think the choice of a solar cooling technology such as electrically-driven or thermally-driven?

Interviewee 17

Yeah.

Interviewer

Would affect the application of such facade products in a particular project?

Interviewee 17

So you're asking....

Interviewer

About the selection of the technology. Like you have different technologies.

Interviewee 17

So, given a specific project.

Interviewer

Yes. Like your opinion about the selection of the technology, either electrically driven or thermally driven.

Interviewee 17

OK.

Interviewer

In a particular building project. How do you see the selection of a particular technology? How do you see the effect?

Interviewee 17

Well, again, it's a bit technical but when I think about the thermally-driven one, it looks bulkier to me. It's easier to convey electricity than to convey liquids in general. So that's the main thing I think about you know. So electricity is just a tiny cable and then thermal it's you need hot water flowing through the façade. So it has s complexity to the design. So maybe....Yeah.....It looks a bit more risky to me and therefore if it's more risky, it's probably not good for some applications. I mean, obviously the least risky solution is the best one normally, but. Yeah.....I mean unless you really conceive the building....and again this links back to the client wanting it....So if you if you have a specific idea of a building which is designed for that specific technology, I think that's the best solution, especially for the thermally-driven one. Maybe the electrically-driven one is less of a problem because you know it can integrate PV into the facade and then you achieve cooling.

Interviewer

OK, so now I'll move to the technical questions. So since you are talking about the complexity, maybe you can elaborate more because the first question in the key questions is about the complexity. So in your opinion, what would make solar cooling integrated facades complex products?

Interviewee 17

OK. What is it and what would make them complex...It's...well again, I'm not expert in this topic, but if I think about integrating a technology into an existing facade, that would mean that it will interfere somehow with the traditional performances such as...I'm just scared about....I mean I'm not scared but one should look at, you know, understanding how this affects water tightness, for instance, of the façade because I'm expecting penetrations through the airline, the thermal line, and the water proofing even. So that's one thing. The other thing is about again, as I mentioned before, having more integrated process which is good if it works, but if it doesn't work, it's a mess. So meaning that you need to have like MEP engineer being present there and understanding the, you know....well not understanding but contributing towards the design of the facade. And again this adds with the complexity, and....Yeah, again, probably lack of knowledge about the product like in my case. So I need someone, again, a supplier or someone introducing knowledge downstream in the process, so at earlier stages so that we can design something which is feasible.....And, yeah, that's pretty much it.....Well, and of course again, the other thing is the operational part in the sense that I'm not saying it's not gonna work, but you know as soon as you start adding technology like electrical devices or movable devices, you're starting to introducing risks, failure....So maintenance is crucial.....And also adding the maintenance cost on top of the gains that you currently get in terms of, you know, personal energy performance. We need to maybe add more maintenance costs, possibly.

Interviewer

OK, so now how could we address challenges related to the space availability or interrupting other building services?

Interviewee 17

So space availability, you mean in terms of floor area or...

Interviewer

I mean when we integrate these components, how we can address changes related to the required space availability or interrupting other building services?

Interviewee 17

What you say interrupt other building services, you're referring to the fact that....So if there's an existing cooling system, you get rid of it and you substitute it with facade integrated one or is it more.....Sorry can you just rephrase a bit?

Interviewer

Yeah. When we integrate solar cooling technologies, so if someone is afraid about the required space availability or interrupting other building services, so how we can deal with such situation?

Interviewee 17

I'm not fully sure I understand the question actually because I'm just thinking.....I mean space availability again, I'm assuming that the facade will be bulkier, definitely.....will be bulkier so meaning that you need more depth, more façade depth because you need insulation, you need some structure plus you need to add this component. So this may be a challenge but again if this implies reducing or removing part of the MEP plant room, which is normally located in area which are not of particular influence. So I don't think it is a big game but.....again, maybe on some refurbishment, you

can....Maybe if it's the only option....I guess so probably a good application is one in which you don't have any other valuable or possible options, or you go for that.

Interviewer

OK, yeah, so now you were just talking about the maintenance. So the question is what are the key aspects to consider for the maintenance and the durability of solar cooling integrated facades?

Interviewee 17

Again, I think it depends on the technology, but....I'm not sure whether cleaning facade more often may help in the sense that maybe a degradation in the performance of the of the capacity to absorb solar energy. So possibly, again, as I mentioned before, additional maintenance which adds is a cost to the technology and it needs to be understood fully and evaluated against the benefits that arise from using this technology. So there's always a cost versus benefit. Analysis to be done, and yeah, you need to consider a certain amount of time which is the life of the technology in the façade.

Interviewer

Ok, so 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 17

It has got a role. Again, it's non-negligible definitely. That's why the architects, they have to have their own say about it. Of course, the availability of or the possibility to customize somehow, you know, the look of it. It's a positive thing to giving alternatives and possibly integrated different finishes or something, I'm not sure, but colours and textures are important. Again, final client has got its own say on this. So if you have an enlightened client, you can choose the architect based on their own preferences and drive the design of bit better. Yeah.

Interviewer

OK, got it. So now I'll move to the questions about financial aspects because the previous questions were about to product and technical related aspects. Now I'll move to the questions about financial. Then I have questions about stakeholders. So questions about financial aspects. So in your experience, how can we industry develop affordable and financially feasible facade products integrating such technologies?

Interviewee 17

Well, definitely....So I mean something to be affordable needs to be manufactured in big quantities and that needs to be a market demand. That's a basic principle. And for it to be the case, you need to provide certainty about two things mostly....One is the performance, so it needs to work the way it is being designed, and to his reliability in terms of, again, design maintenance. So if you know that you can maintain it with a certain frequency that you're certain that it's gonna work, then you can you can demonstrate to clients that this is a financially viable solution and therefore you're gonna sell more of those products.....And therefore you're going to reduce probably the initial costs which probably are barrier, but I'm not sure....so and by raising the demand for those products, you can increase the production and therefore you can lower the costs and make it financially viable, but definitely you need.....that's my understanding, just simply by looking at it, I'm not expert in this technologies, but you need to be able to look for clients that look at, you know, the initial and the

operational costs at the same time. So not...but again, maybe you can set it for cheap price and then everybody's happy.

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 17

The financial incentives.....Again one is, as I said before, one is, but I'm not sure if it's a financial incentive, is the reduction of area. So lower plant rooms, but it depends on the project again because again normally plant rooms are not used as.....I mean it's not a big issue, plant rooms.....but being able to introduce cooling in specific buildings, such as offices as the unique alternative....it's a driver, you know....it's a good reason for using it....so yeah.

Interviewer

OK, so now I've finished with the key question about financial assets. Now I have questions about process and stakeholder related aspects. So I'll start with the stakeholders. As you can see from this chart, we have different stakeholders involved in the facade design and construction industry. So the question is....which of these is stakeholders can support the application of solar cooling integrated facades?

Interviewee 17

Automatically, everybody.....but well, of course....I think suppliers....Supplier....I mean here yeah.... Well, there are already some initiatives like [...] they are developing their own system which integrates split systems or cooling. So normally partnerships between, you know like facade system supplier....just not [...] but it is like WICONA or Schüco, those guys....working on their own sites... you know, MEP suppliers....Doing a shift developing products.....It's I think it's the starting point in the sense that. It can't be like client or an architect thinking about it, although it may happen, but I think it's less likely to occur and from there, you know....there needs to be, you know, dissemination of knowledge about the existence of those products to start with.....and 2nd about, you know, the reliability and the expected performances of it....and so definitely it's a kind of a bottom-up type of approach, rather than top-down....But then definitely it needs to be conveyed somehow to the client and client needs to be aware of it and all the rest.

Interviewer

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

Interviewee 17

Well, it's a....by doing like....Well you need to inform them somehow....It is not unusual in big architectural and engineering firms to have people spending one hour doing company presentations about specific products as part of the, you know, the CPD [Continuing professional development]. So the continuous professional development of people. So in the same way as people get educated about specific installation or a novel insulation or a novel glass coating or a novel technology that gets brought to market. You can do something similar. So you inform those people and make them aware of the opportunities that arise from this product. So, yeah, maybe it is a possible way.....you

know then there is events....sponsoring events. You know there's a lot of commercial strategies that you can....the one can adopt to, but yeah definitely you need to spend some time with technical people and educate them.

Interviewer

OK, great. So now I'll move to the following question. So now I have a question about the standards or guidelines for architects or engineers. So the question is, what are the key elements that should be in standards or guidelines for architects and engineers which are related to the integration of solar cooling technologies to building facades?

Interviewee 17

Well, you know, for the standards, they govern the performance of the facade and the way it is installed and.....I don't see a radical change other than.....just.....I don't know.....you know normally standards they divide into....they inform technical people about, you know, different facade typology that there are...and each facade typology sometimes they've got different calculation methods and etcetera. You know, like the U-value of arranged screen is different from the way it is calculated from the U-value of curtain wall, but you know the fundamental principles are identical.....So maybe simply letting the technical person be aware of the fact that there are.....the technologies is probably a required in the standards...but...you know, I'm just thinking about, you know, air tightness testing. I expect this facade to present more weak points because of the perforations of the electrical cables and everything, but you know as long as you specify performance, that's reasonable....then when it's OK, of course, if I were to design a facade like this for the first time, I would have probably no clue about the air tightness. So what I would do, I would contact a manufacturer and try to get help, but the standards and norms, they don't help you, you know. It's up to you to specify this. You know there are like permeability classes for air tightness, for instance, and which permeability class a specific facade belongs to is not informed by the standard. You know it's agnostic to certain extent in terms of facade technology and type and system. So, yeah, I mean, I'm just thinking loud....probably, of course, if you want to design the facade from an energy point of view, so to understand let's say active type of performance or the fact that it produces energy, then this is more an MEP type of problem...so it's....is there a problem to design? You know the appropriate power to design for the cooling system. So yeah...that's it...You know.

Interviewer

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 facade products?

Interviewee 17

Well, they need to do R&D stuff. They need to develop and then present. So where do you get the money from, it's not my problem in the sense that I don't know how to do that, but definitely there needs to be funding somehow or again from market force that motivates companies to invest their own funding and time and resources into that.

Interviewer

OK. But overall how can we increase the interest of designers, developers and the clients to apply such facade products?

Interviewee 17

I think, you know, the construction industry is a very pragmatic industry, so I think habitants is required. Proving that it works is required. When I say proving that it works is not only that the system works as expected, but also that it can be integrated easily into the current design, so that if a design team gets it on board, they are capable of designing properly without doing mistakes or errors and then you go on-site and then there's a problem. Yeah.

Interviewer

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

Interviewee 17

That's a good question. Well by making them mandatory....that's the simple answer. Again, you wanna have freedom in terms of design choices so..... So the question is...the original question why is....

Interviewer

No the question is how can changes in the building.....

Interviewee 17

Yeah, I know, I know, I know that.....I'm just thinking loud. I mean, I'm just....I think the original question is how is this system better than a split system, you know? That's the big question because the split system is reliable, it's cheap, it does the job but it's ugly, especially on the exterior. So if you have like some areas which are covered by some regulations by which you can't show outdoor unit, you know this split systems with outdoor units, for whatever reason.....Then....So by enforcing the absence of outdoor units for split system, for instance, that could be a way to favor, you know, the solar cooling strategies, but yeah....and the other thing is, but I'm not aware of, is the efficiency. Split systems are very efficient but they require energy and they require PV. So if you can demonstrate that it is more efficient to have a....from an energy point of view, that it's more efficient to integrate solar cooling into façade, then you know, the building regulator they can restrict and make the regulation tighter and therefore the solar cooling becomes a more viable solution than the split system. But again if you couple split system with PV, I think you get a lot of efficiency. So it's a technical question. I don't know the answer of. Yeah.

Interviewer

OK, so now about the energy policies.....So how can changes in energy policies affect the widespread application of solar cooling integrated facades?

Interviewee 17

Energy policies.....Because normally what we.....Well it's probably about carbon. Can you not demonstrate that the overall.....Again it's similar to the financial aspect. You know carbon and finance, they go together sometimes....but, yeah, if you get stricter on energy requirements, and again if you can demonstrate that those systems are more efficient.....Then why not. But. I'm not sure if they're more efficient. That's the thing, you know.

Interviewer

So now all of these questions were related to stakeholders. So now the following questions are about the processes. So as you can see that we have different processes. We have design phase, production phase, assembly, operation phase and then end of life. So the question is, in your experience, which phase is key for boosting the integration of solar cooling technologies into building facades?

Interviewee 17

Well, the system design. All the predesign, development....but yeah.

Interviewer

OK. So now what are the main aspects to consider during the design phase of a facade system that integrates a solar cooling technology?

Interviewee 17

Sorry, can you just repeat the question?

Interviewer

What are the main aspects to consider during the design phase of a façade system integrating solar cooling technology?

Interviewee 17

So the main aspect is how does it fit with the architectural intent including the panelization....If it's a high-rise or medium-rise building.....The thickness of the facade.....does it make the facade thicker or even heavier? You know the weight of the façade, if you start adding....if you start using water, water is quite heavy. I don't know if there's an increase in the weight of the facade, but this has got an effect on the primary structure....and then of course the....Probably at an earlier stage, even if the system choice. So is it a system that makes the whole building better? So is it more efficient? Or is it, again, the only option? That's not a good question. So can we not integrate cooling in other ways than by using this technology. System design and then once design is chosen, it's influencing those parameters, you know the depth and weight and basic things.

Interviewer

Ok now the following question you talked about it indirectly but maybe you can elaborate a little bit more. So how can we achieve a closer collaboration between various stakeholders and disciplines during early design stages?

Interviewee 17

Well, with education and promotion, definitely, and again showing that risks associated with the technology are low....There's a reliable system that it works.

Interviewer

So OK, now I'll move to the following question. So what are the key aspects we need to consider during the production phase of façade products that integrate such technologies?

Interviewee 17

During the production you mean when you manufacture the units?

Interviewer

Yes

Interviewee 17

Well from a design perspective like mine, I think I would be curious to understand how you manage the interface with the rest of the trades, like the roofs and the slabs and everything.....And tolerances.....So how do you...I mean honestly I'm not aware of this...So tolerance and movements of each unit.....Does it affect the performance? So do you need to allow for movement or movement joints? Specific ones. So I don't know if.....I'm not sure if the tolerance with which you manufacture those units is larger or lower. I'm not sure.....but probably yeah tolerance is something you want to look at.....But again I expect it to be like a normal facade frame with the technology integrated into it. So probably the production.....Well probably the other thing is you need to have like an integrated production line because....or maybe you have like modules that get mounted on top of our typical façade....I don't know. Yeah.

Interviewer

Ok now I asked about the design. I asked about the production. So now just moving to the assembly or installation. So now what are the key aspects to consider for the assembly phase of such façade products?

Interviewee 17

For the assembly phase, well it's similar to the manufacturing in the sense that...I think yeah, being able to manage tolerances, but again I suspect that the installation of the facade is...Well, that's the thing, probably because maybe you have one....I mean it depends if you have the facade contractor doing the installation and then who does all the MEP, or the electrical part or the plumbing part. So there is kind of a clash in terms of operations on-site. So install one unit and then you need the plumber to connect something or is the facade contractor doing everything? I don't know....So but interference between operations given that you again you're installing something which is integrated, so you're also integrating the onsite operation. So it's.....and this is probably not good in general because you want the contractor to be free to do what they want. Simply install and then for the next unit and so on. But this can be tackled by doing proper design. Like design for manufacturing and assemblies....yeah.

Interviewer

OK, but about the assembly, do you have something in mind about the required work force?

Interviewee 17

I don't know. I think it depends on the technology. I have no idea. But there....I mean, in terms of skills, they can't be like traditional façade contractor or installers in the sense that if they need to use or connect cables, electrical cables or pipes, you need a plumber or electrician. So again you need you need additional skills.

Interviewer

OK. What about the key aspects to consider for the operation phase?

Interviewee 17

Maintenance. Definitely so maintenance and understand whether you need an additional maintenance.....Well, definitely you need a maintenance plan or a maintenance manual.

Interviewer

Well, OK. What about....For the operation phase, do you have something in mind about the end user knowledge?

Interviewee 17

Well....yes, yes....I mean the end user, I mean the tenant.....Well, yeah, I mean they need to be informed about the use of the technology.....but, again, use and maintenance.....operation and maintenance.....both of them in the sense that maybe they need specific maintenance....So what they use.....I mean the usage is, I think, simple....maybe it has a thermostat that, you know, I think it works as a normal cooling system...I think.

Interviewer

OK, so now what about the key aspects to consider for the end of life?

Interviewee 17

Well there's a lot about embodied carbon, definitely, so....And things that can be dismantled easily. So, nowadays, especially in the UK, they keep on....and they're increasingly looking at the embodied carbon of façade. So this adds up to the embodied carbon, definitely because you're adding stuff rather than removing stuff. But again, if it does it correct....trade-off between the additional embodied carbon and the savings during the life of the building then, yeah....and of course using recyclable material.....it's important.....Yeah.

Interviewer

OK, so now I'm done with all key questions. So now I'll have just few points to ask you in the closing part. So first of all, what are your final remarks about the widespread application of solar cooling integrated facades as building products in the construction market?

Interviewee 17

Well final remarks.....again, as a consultant, I get into those important early stages about system selection and everything, so we play a role as consultants. Of course, we wanna have all clients happy and they are the one choosing in the end....So probably, again, education is crucial along with the reliability of the technology.

Interviewer

OK, so what do you think about the application of such facade products for enabling energy transition?

Interviewee 17

I think it's an opportunity definitely. Again, especially on the refurbishments, I think....So, yeah, I think it's worth looking at.

Interviewer

OK. So last point....do you mind to propose potential participants to be interviewed for this study?

Interviewee 17

I'll think about it.....Yeah....Can you send me a reminder...Maybe in.....