

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 let us move to the questions. So [Name of Interviewee 1], according to your experience, what is your opinion about the current level of knowledge in the building industry regarding the application of multifunctional facades components that integrate solar cooling technologies?

Interviewee 1

It's funny actually, I didn't. I thought I also made notes. Anyway, that's I thought I may notes anyway.

What is the level?

Well, I think I mean in terms of PV really is advanced, yeah, I mean it's kind of and still it's developing.

Uh, so for me, actually, I mean talking about the facade, we have a roof facade and we have a kind of a, you know, what kind of vertical facade and everything is in which is in between, is it?

And on both, feel PV developed quite, quite strong. It's kind of.

So on rooftops we have PV, you know very efficient cost efficient PV, and on the facades we have.

Well, you can use the same PV, but we also have architectural PV. Obviously moving on the market. So I think it's very yeah, I mean there's enough material to play around with this as architects in, and building engineers I expect.

Interviewer

OK.

Interviewee 1

And that's different from the solar thermal.

I think they are lacking behind. I mean the development has been done in the 80s using this kind of. So even you know the more advanced systems like I. I still see that you know and then we have to vacuum tube things and so on. But it's already developed in the 80s or 90s. So and it didn't.

My opinion, I think it didn't really develop any further.

Interviewer

OK so.

Interviewee 1

There's a bit of an in between.

Where we have the, you know, the PVT, where you have the PV combined with the thermal, which is kind of a relatively and then it's kind of there are few companies currently on the market which were not on the market before.

So that's the kind of a new field I think where that comes up now.

Interviewer
OK, I see.

Interviewee 1

And I think the PVT is, I mean it's missing a bit in your overview.

Because it's the kind of could be a relevant one for our typical I, our, our, our countries as well so.

Interviewer
OK, I see. So generally like a like usually the PV is more advanced there widespread is better than the thermally driven technologies.

Interviewee 1

Yeah.

Interviewer
OK. So in your personal opinion, what are the drivers to develop future building products integrating solar cooling technologies?

Interviewee 1

Well, for us, actually, you know it's all about.

I would say the aesthetics of the facade, because I mean mainly what we're talking about is probably the facade, isn't it? I mean, I'm not sure because you're in the facade group, but maybe you also talk about roofs. You know, I don't know whether so I mean.

The big chunk is about, you know, everything which is on roofs. Then it's about competing with other functions on roofs. You know yeah that's what it is.

And everything that moves through the facade, it's all about, you know, the aesthetics. You know, it's kind of so how does, yeah, what how? How does it influence actually the aesthetics of the facade and the appearance of the building in the in the neighbourhoods and the so that that's a very important element.

Interviewer
OK.

Interviewee 1

And next to costs, obviously, and they you don't want to spend too kind of a lot of money on something that doesn't perform.

So it should at least have a kind of an acceptable payback.

But on the façade you know, you could really think about the payback of 15 years or something that doesn't need to be five years or something like that.

But it needs to be checked and acceptable, and that's the thing. And then you know, the aging is also an issue, I think not in terms of the technical aging, but more kind of the looks of the building in the, you know, not easily used materials in the facade.

And which, you know, five years, five years later, you think it's old fashioned.

Interviewer

OK.

So like those are, so those are you consider them as your concerns not the drivers.

Interviewee 1

Uh, yeah, I think both the other way around. I mean, concerns if you if you solve the concerns then then these are, oh, you mean really, why do we do this kind of things? Well, I think, you know, the, the, the main thing why we do these things actually that what we want to let's say try to bring our carbon footprint of our buildings down. That's what we want to do.

Interviewer

OK.

Interviewee 1

And input and having and having a comfortable indoor space. So the first thing is OK we want to have any comfortable indoor space for that. We need a lot of energy and for that we might be more smart on the facades, uh to uh reduce the energy consumption while still maintaining the indoor comfort. That's the driver, I believe.

Interviewer

OK, but your concerns are related to the aging and the and the pay back? As well as the aesthetics.

Interviewee 1

Aesthetics. Yeah, yeah, yeah.

Interviewer

Yeah. So the concerns, aesthetic payback and the aging.

Interviewee 1

Yeah, yeah.

Interviewer

OK, I got your point. So, OK, now there are different types of buildings in the in the market or different types of projects. We have the new building construction and we have the renovation projects. So [Name of Interviewee 1], what is your opinion about like having such variation? Do you think that can such variation in the projects can affect the widespread application of solar cooling integrated facades?

Interviewee 1

Yeah.

Yeah. Well, I think we can, we can use it. I mean we should consider it that all places.

It's kind of in and you know it's a bit.

So you're really looking in the field of cooling, but you know, I do projects all around. So sometimes cooling is the biggest issue. Sometimes it's heating the biggest issue.

Uh, but if I look at coding just because there's also question, where do you think you use it? Well, that's the countries where there's more cooling demand than heating demand I believe that's where you start thinking about this.

So you know, it's kind of, yeah. Probably you know the Middle East countries, the countries where.

Well, they also have money to spend on the on facades.

Because in general the facade will be more expensive than using activation cladding, the local [...] cladding. So as soon as you try to use these materials then it easily becomes more expensive and in initial cost maybe you have a payback but.

It's a long payback, but I mean if you...I discussed these things on projects in the Emirates to do.

Uh. And then...what was your...?

Interviewer

Now the question is we have a new building construction, we have renovation projects. So can such variation?

Interviewer 1

Oh yeah, yeah. So we can.. I would say you can use it on every project except from monumental projects, so listed buildings it's a no go.

So if the building has a, you know, kind of an existing building which has a, you know, a cultural heritage or something like that, then and that there's hardly a go and see for having these kind of techniques

Interviewer

OK.

Interviewee 1

But you know, if there's no, uh, if there's a renovation on a non-listed building, yes, you can use it and you can also use it on new building. So that's I don't see that problem.

Interviewer

OK, so now OK, we need them and renovation and new construction, but nothing heritage to just preserve...

Interviewee 1

Yeah.

Interviewer

But OK, what about we have, regardless of the type of project, we have different type of buildings, we have office, residential healthcare. So what's your opinion about the application of such technologies and different projects? Do you think that it would vary from one project to another?

Interviewee 1

Well, that depends a bit on...I would expect something on the, you know, the amount of money you're allowed to spend per floor area. That's what it is.

I mean, first of all, you need to have cooling demand. Let's assume that there's always a cooling demand, whether you've got residential or offices or, or hospitals or whatever, and then...or schools or whatever, and then it depends, yes, well, you know..uh, how much budget is there actually suspend on the facade?

Interviewer

OK, I see.

I got it then, OK, what about, uh, let us now you raised this point. So now I reached this question. So considering there are different locations and climate contexts. So you say that the most promising locations for climate context that are the ones that have always more cooling demands such as you give example for, I think the Middle East and do you have in mind other locations or climate contexts?

Interviewee 1

No, I mean that's what it is, isn't it?

I mean if you move towards the equator, then it becomes harder and that's where it becomes more, more kind of an issue to think about cooling and less about heating. That's what it is I think.

And the thing you also need to consider is obviously that you also compete with, you know, other functions of the facade. So you want to have daylight and you want to have views. So you know, I mean it's kind of.

For daylight reasons you easily take 30% of the façade already off because you want to have openings for that view and daylight and then it goes up to 50%. That's my opinion.

So about 50% of the façade probably left for other purposes.

Interviewer

OK, I see. Uh, so I get your point.

Interviewee 1

And the other thing maybe is also important in that sense is you know the orientation of the of the building in relation to the sun. So that's the thing as well. Also in terms of architecture. So you don't want to put any sort of solar devices on facades which are not to the to the sun oriented, which actually could mean that you know you got certain parts of the facades that look different from other sides of the buildings and that's not something architects in general really like to do, you know they.

They always most of architects like to work with, kind of an all sided. So you've got you know if you're on the South side, east Side, West side of North Side, you always have more or less the same type of you know architecture.

So that makes it difficult actually. How you using these kind of techniques?

Interviewer

So, OK, take account such difficulties. What are the potential solutions for that? For architects to consider, do you think?

Interviewee 1

Well, then you need to do. You need to understand what this PV material this kind of material is, how it looks like and you know how you would whatever use that as an architectural feature also all around the building. So imagine you could easily use whatever black panels on one side and go around on the other side, which would become PV panels or something like that. That's the kind of a way of working with it, isn't it or?

You start working with, you know kind of a gradient on the building where you know it's kind of there's more black on the on ... kind of absorbing a panels on the on the sides of the sun. Well, if you go to the other side, it becomes more of kind of more light or something like that. So these kind of things you should play around with like think in in terms of it's an architectural. Yeah. Can you can architectural assignment then to work with.

Interviewer

OK. Yeah, so now this is the last point I think in the in the opening questions. So it was about like we have electrically driven. So such variation kind affect the. So we have the electrically driven ...thermally driven, so the question was like do you think that such variation has an effect on the application of multifunctional components, and you arise it from the beginning that electrically driven or the PV, I remember, like you said, that it's more advance than the thermally driven in terms of the maturity.

Interviewee 1

Yeah, yeah.

Interviewer

OK, I get it to your point.

So now let us move to the key questions. So as I mentioned from the introduction that we have different technical and product related challenges, we have financial challenges and we have process and stakeholder related challenges. So the key questions that I'm going to ask are start from the technical. I have a few questions about technical, then I'll move to a few questions about financial and then we'll end up with the questions about process and stakeholders. So the questions are related to the challenges.

So now I'll start with the technical questions. So now take into account that there are different complexities, product complexities or the required space available availability. For example some of the cooling technologies, the chillers do have massive sizes and we have sometimes the integration we have some complexities like for example interrupting other building services. So now the question is what are the potential solutions that can be considered to address the challenges related to the complexities such as the required space availability, interrupting other building services...?

Uh, So what are the potential solutions that we can consider for such a technical challenge?

Interviewee 1

What is for the technical challenge? I'm just trying to figure out and so the scheme of the PV with compression chillers is a kind of you know it's not advance then it is if you're not using the electricity of the PV for chilling then you would use it for something else then so that's the kind of an easy way around. So thermal part is more kind of a little bit more difficult.

And because it's kind of nearly one by one connection. Yeah, you can make buffers or whatever.

It's not that...so I don't know how to solve it...the thermal...

Interviewer

OK.

Interviewee 1

Uh how to make how to improve that scheme actually is a kind of it's a... Just I mean there's only one thing I can say that I've got the feeling that didn't really developed.

Interviewer

OK, I got it.

Interviewee 1

And that's maybe because you know you've got all kinds of different parties working on. So if you've got the you know the, the absorption chiller is kind of a market of people while you know the solar collectors is a different market. So I mean it's kind of. So you know the reason, moment, where I reconsidered this again was you know, I did this kind of you know the concept design for the [*specific project*] in Dubai, and they started, you know, the client said, you know, we want to make it carbon into a building and so on, blah blah blah billion. And so I said OK, then we need to collect a lot of solar, so they need to be solar park on top of the roof.

And then, well, what, where do we need it actually for is kind of and that was actually for cooling the space, that's what it was.

Yes, I'm for the lighting, but most of the energy was actually for cooling.

And so we actually put it the two schemes on the table again PV with the chiller, compression chiller.

And then absorption chiller with..

And then I discovered that, you know, taking the numbers into account, so the efficiency numbers, it's the scheme of electricity and compression cooling is more efficient than the absorption scheme, the thermal boilers and absorption chiller.

And I didn't really looked into the, you know, the financial numbers, but I'm sure that's to the PV option was also cheaper. So we decided for the PV job at the end also because of reasons that it was easier for us to work with. Kind of a market we already knew.

Interviewer

So you like generally coupling PV with the conventional mechanical equipment is much more simple than the solar thermal collectors and the absorption chillers.

Interviewee 1

Exactly. I mean, so I mean you can run also the chillers if there's no sun.

Interviewer

OK.

Interviewee 1

Well, you know, if you got an absorption, then yeah, what do you need? You know what? When you defy a gas or something like that to make heat to run the oil, you should never.

And the and the compression to the next to it is something that isn't it?

Interviewer

OK, OK.

Yeah.

Interviewee 1

So that's why in you know in emirate you still cool even if the sun is down then it's still cool space.

Interviewer

OK, OK, I get your point. OK now.

Interviewee 1

So I think it's a very difficult field actually the thermal part.

And but you know, people should start, let's say, challenging it, I mean maybe there are super nice techniques. I mean I remembered also this you know uh, this more kind of vibration techniques, you know where you start uh, you know the sorry, somebody's working here.

You know the kind of the vibration engines where you use direct heat execution to make kind of a vibration going on and then that actually the vibration can use for chilling.

These kind of techniques are could be very interesting I think. But you know there had hardly any people, let's say uh doing research on it. I mean it probably can count them on one hand.

Interviewer

OK.

OK, got it.

Interviewee 1

So that's not really going. Yeah, that's what it is, isn't it? I mean, that's some techniques that cause very fast because there are a lot of people working on it.

And then something needs. They are potentially may be very good, but you know the research is not focusing on it. And no, we'll never get there.

Interviewer

OK, I got it. So now let us move to the second question. So considering the life cycle of the product, so any product like this like this mobile phone is a product that has a life cycle from the manufactured from...tell me I'm the user then we have the end of life. OK let us focus about like as a facade integrating solar cooling technologies. So now what do you think about the important issues needed to be considered for their maintenance and the durability?

Interviewee 1

Umm yeah. Well, I think I mean using this kind of materials in a facade, the most important thing is that it should still be attractive also after five years or 10 years.

Interviewer

OK.

Interviewee 1

That's a bit of a I think, a challenge. And like I said, I don't care too much about that. The performance goes down and maybe after 15 years it doesn't perform anymore. But it's still needs to look nice.

Interviewer

OK. So OK, you focused, so you see the role of their aesthetics is important, but let us move a little bit, OK, so you need to focus about the aesthetics. I got your point and that still needs to look nice even after a couple of years, but now, OK, what about let us assume that they are integrated. So

what are the things that are focused about mainly about their maintenance and durability? What do you think the main issues needed to be considered for their maintenance and the durability?

Interviewee 1

Yep.

Well, I think you know it's you know if the material itself tends to bit more towards glass, isn't it? So you want to keep it clean because then the performance is the highest.

Interviewer

And OK.

Interviewee 1

So it's a bit like you know that's, that's what when one of the maintenance things you need to do, I mean if you do this kind of things in the Emirates and every year you've got the sand storms. So you need to clean your facade, so you need also not only clean the glass, but also clean the PV, whatever or the elements on the facade that collects the heat.

Interviewer

Cleaning.

Interviewee 1

So that's one thing I think the other thing is that you need to be sure that if one panel damage is whatever because of whatever mechanical failure or someone like that is somebody fills a stone against it or whatever, that you could easily replace it so it's still replaceable.

And even though I mean if one is not performing well then obviously the whole facades it's should also still perform well. You know, that's a bit of the inverter discussion I believe you know, I mean every panel you should have in inverted and I expect.

So, so or whatever, you should have some kind of strategy on that so.

Interviewer

So let me focus. OK. Yeah, let me just ask you about replaceable. So do you mean like, it's easy that we can disassemble and assemble? This is what you meant.

Interviewee 1

Well, it's. It's about the ease, maybe not that important. I mean they should be available.

Interviewer

OK.

Interviewee 1

I mean this shouldn't look different.

Interviewer

OK, I got your point.

Interviewee 1

You know, it's kind of because that's a bit of a trick. And I mean, if after 5 years and the supplier doesn't whatever make it anymore and then you still have this, whatever this broken element, isn't it? So how do you solve that?

Interviewer

I got your point, yeah.

So the other thing that I was going to ask about the aesthetics, but you are raised already that it's still important that it looks after five years look nice. OK got your point.

Interviewee 1

And that's the kind of a difficult part because, you know, architects in general, they have a kind of baggage of buildings they've seen and they've seen building aging and so on. That's what you bring with you. And then suddenly you've got this product and you don't know. So you need to take that risk or something like that or whatever is kind of even. It's not only the architects but also the clients, you know, they also ask themselves, OK, what, how does it going to look like after I mean it's not only for PV. This also for other new products on facades it's the same thing. I mean if you talk about bio based materials on facades, they are the same thing. You know it's kind of how it will look like after five years. I don't know you know it's kind of.

Interviewer

OK, got your point. Yes, because that we consider that

Interviewee 1

And that's one type of aging and the other type of aging is obviously what I said, the bit like the fashionable one, you know, it's kind of if you got PV panels on the facade, which looks very techy, whatever now.

After five years, you could look at the news. Ohh like, these are really kind of old fashioned PV panels. I don't like that designs and kind of.

Could be nice to celebrate that old fashioned PV panels. Maybe you should start with old fashioned PV panel so they already old. It's kind of. Anyway, I think that's the thing. I mean, it's kind of.

And most of the times, I mean we just see in most architectural solutions that it's best actually not recognize it as PV.

Interviewer

OK.

Interviewee 1

Just as a black panel or something like that, kind of a. Just don't recognize it as PV then then people are fine with. It's gone.

Interviewer

OK, I got it. So let us let me move to the questions about financial aspects.

Interviewee 1

Yeah.

Interviewer

So now like in your opinion how cost effective facades products integrating such technology or solar cooling technologies can be considered to be able to penetrate to the construction market.

Interviewee 1

Well, I think, I mean, there's still a surplus on costs, and that makes it a bit not really difficult, but I mean it's not, I mean it's kind of the surplus you need to cover.

And one easy way is actually that you just stay within the total budget.

Then you know then there's probably not big discussion, but if you need to discuss kind of an additional fee because of the PV or the kind of you know the solar cooler, then you get into the discussion of operations of the building.

And you know, most of people of kind of people who are involved in building developing projects, they are not involved in operation of the buildings.

Interviewer

OK.

Interviewee 1

So they again need to sell this kind of operation story also to their clients.

And they don't like that text you to do. It's just they just went to.

Interviewer

You mean? Yeah. You mean like, clients sometimes they just focus about the cost and the construction. They don't consider, like, the operational cost.

Interviewee 1

Not no. It's the initial cost. That's the big thing. And then the issue initial cost go into the kind of thing that you want to have a kind of a profit on selling the building to somebody who's going to operate it.

Interviewer

OK.

Interviewee 1

And it's always a discussion, you know what kind of inefficiency comes with the building?

Interviewer

OK.

Interviewee 1

So it's kind of a, it's a yeah. But I my opinion is actually that you should stay within the.

First, I'd stay within the total budget.

Interviewer

So the total budget.

Interviewee 1

And you just say, you know, instead of putting kind of natural stones and marble or whatever inside of the building, you just take that off.

Leave it, just use the you know the concrete.

Interviewer

So the...yeah, but the total budget for the construction?

Interviewee 1

They from that and then spent the money on the facade.

Interviewer

But you mean the total budget for the construction, isn't it?

Interviewee 1

Yeah, yeah.

Interviewer

Not to not including the operation.

Interviewee 1

The total square meters. Yeah. Sorry. Yeah.

Interviewer

OK.

Interviewee 1

If you could stay within that then chances are biggest, I believe

Interviewer

If it's the integrated, uh, total, like if the cost of the product is within the budget of the project, it's OK. It can help the penetration, OK.

Interviewee 1

Yeah, and then it improves the efficiency. That's a nice benefit.

But don't try to make a financial discussion out of that. You know that you know, OK, the building is a bit more expensive if you buy it, but you know you'll get the money back because there is a PV panel, thing on. I think it just OK you got the same button can this is the price, the normal price and ohh you know what you get actually is also the efficiency.

Interviewer

OK.

Interviewee 1

At least for five years or ten years or whatever, as long as the PV function.

Interviewer

OK. Yeah.

Now, in your opinion, what are the potential financial incentives that can support the widespread application of façades integrating solar cooling technologies?

Interviewee 1

I think I mean, you really need to look for kind of...how.

I mean in you need to at least touch upon the you know the performance of a normal facade.

So it should perform as a normal facade. You know it should be waterproof, it should have durability. It should come with guarantees should come, you know only with, you know the mechanical thing of it, you know, not really about the function in the efficiency of the cooling system and so on. But it should be, you know, should be fireproof. It should be you know all the all the things you have on normal facilities should also be ... you should....yeah take all these boxes.

Interviewer

OK.

And you were like a.... financial incentives. First of all, it should perform like a normal facades on these things.

Interviewee 1

Yeah, that's I think what it is about.

Because that comes with the financials, isn't. I mean, that's what you buy as a, you know, a so you know that you're spending whatever certain amount of yours per square meter of facade.

Interviewer

OK.

Interviewee 1

You know that you've got all these kind of normal things coming with it, so that's a bit of the financial incentives I think you should.

Interviewer

OK.

Interviewee 1

And yes, it can be a bit higher and at the end the price can be a bit higher...not too much, because then I mean, if it's the double price, then nobody will go for it. But if it's whatever kind of a surplus of 20%, I could imagine that you could save it on the on the rest of the building somehow.

But if it's double priced and it's too much.

Interviewer

OK, I see. So, OK, let me move to the last part before the closing. So I have a couple of questions about the stakeholders and the processes.

Interviewee 1

Yeah.

Interviewer

So as you can see from this chart, we have different relationship between stakeholders during the facade design and construction. We have different stakeholders. So in your opinion, do you think there are particular stakeholders in the building industry that can play a vital role in supporting the widespread application of solar cooling integrated facades.?

Interviewee 1

Yeah there's one thing that relates a bit to the finance...and what I think is important also is that you should be aware of what you're competing with. You know what are the kind of the alternatives?

Because if you go to, you know, our country....and the way we cool our buildings currently it's very efficient....because we use, as you know, it's kind of, uh, for most of our buildings, our ground source heating cooling systems...and cooling with you know the earth or the water in the earth goes with an efficiency of COP of 10 or even above 10. You know it goes to 12....you never can compete with that in in terms of PV and compression chiller.

Interviewer

OK.

Interviewee 1

But if you don't have that completing advantage on...if you have competing their items...like if you go to the Emirates, I mean that's something I can't do there because that's I mean.

Interviewer

Yeah.

Interviewee 1

And so that's I think is important and then yeah, that's....he needs to know what your competitor is actually. Because I mean, if you go to the Emirates then you know things that pop up with kind of this cooling systems. So that if you suspect there's the cooling systems are might you know these kind of things you could consider.

Interviewer

OK but particularly architects, facade builder, general contractors. So it's first of all regarding the competing....but.

Interviewee 1

But if I mean as soon as you know, OK, I can do something in the fact to whatever do this. So the cooling you use suggesting actually.

Then it's all about I mean this is a kind of a thing that is not being done that much. So you need to do that in a kind of an integrated way. So the architect needs to be interested in it. The engineer needs to be interested as well as the, you know the...if there's already a supplier, yes, I mean you need to take suppliers into account already in the United States of your project specifically for that pattern.

And as well as your client needs to get with the disposal, it's really super integrated approach, because it's not done that much, so it's really needs to have a different approach than selecting, you know, whatever a certain type of normal facade, you know whether it's kind of aluminium facade or you know a ceramic facade, whatever. I mean that's kind of could be a single decision kind of a decision by the architect...proposing it to the rest of the team, the rest of the team will say yes. OK, we're gonna do it

Interviewer

I see.

Interviewee 1

But here actually you need to get all the people in to make it work, because it's not that common.

Interviewer

OK. Yeah, I see. but now considering, OK, you mentioned the architects, but let us take into account that there is a lack of technical knowledge and experience of architects or engineer about the technical aspects related to the technology. What do you think about the potential solutions that can address such problems? The lack of knowledge of architects or engineers about the technical aspects?

Interviewee 1

Well, you need to have good example projects.

You know, projects where you know, you really think about this is cool. What they did this kind of that really helps. I think it's kind of...and....For I mean looking for architecture offices so you know...I partly work in the engineering firms and I'm partly work in architectural offices...and architects really want to touch it. You know, they want to...they still like that somebody comes over and have the material with them and you know, so they can feel it, they can whatever. So it's kind of that's very important for them.

That's not important for engineers. You know engineers they just want to have good technical fact. You know the specs and so on you know. So they can start calculating with it and whatever and they want to have a kind of, you know...good examples of details. You know, it's kind of how could you will you build up your facade in the proper way because every situation is different. That's a bit of a you know a building, building environment, isn't it? We always, I mean we always do things we in a different way. It's different from the car industry, I believe.

Interviewer

OK, I see...but

Interviewee 1

The good technical specs, all this kind of knowledge, you know that should be available. Like I said, you know, all this kind of all those guarantees, all this kind of stuff. So should be good available and then you should touch it. You should also have options to play around with in terms of colour, maybe in terms of texture and all this kind of stuff, it's all important actually for architects do something different...the sizes you know you shouldn't have always the same similar sizes or whatever, it's kind of.

And obviously also it's always good to have different suppliers because then you could whatever choose and you know and negotiate.

Interviewer

OK, now you mentioned uh, specs, warranties. So OK, what do you think about the core issues needed to be considered? If we'd like to design standards or guidelines related to the integration of solar cooling technologies, what are the core issues need we need to be considered if we'd like to develop guidelines for architects or engineers?

Interviewee 1

Well, for, you know, for architects, it's always like particularly I mean you make a decision for these kind of things in early stages. So you need to have a probably two types of guiding they need to kind of the more the conceptual guiding. So in terms of, you know, size differences and also a bit of a kind of a conclusion about, you know, how much will the extra cost and all those kind of things...and that's very important to have actually, because that's a bit what most of these companies don't do. I mean they just make specs for and as engineers we understand the specs, but architects, they don't.

They just....so they even have difficulties that to be finding the conceptual architecture. So in the early stages....difficulties of finding you know the size of the panels are the size of the....so that's the kind of it's very important actually to well....

Interviewer

To consider.

Interviewee 1

To consider to have this kind of...bring this knowledge to architects.

Interviewer

And what about the? So you have the conceptual things. What is the other thing to be considered?

Interviewee 1

Well, I mean, as soon as you a made a decision, this kind of...you need to make decisions on very kind of things which you never done before. So there's obviously a kind of a tendency maybe to make some details as soon as possible to make sure a bit that you know you could whatever make it later.

But that's also a bit, you know, I mean you should have these kind of an overview of that. Yes you can solve it also in, in later stages you know you have different options all always to whatever do the detailing later.

It's kind of that that security should come. You know, it's it shouldn't come with a fixed only one go solution or something like that.

Interviewer

OK.

Interviewee 1

And that's where the engineers come in as well. You know that's where you know they could help architect say all we don't we can solve that. But you know before an architect an engineer say yes we can solve it.

He wants to have it in the baggage already, you know. Yes, I have different options actually to do this.

Interviewer

Umm. So like OK, if you'd like to have different options. So the question is, what are the issues needed to be considered for providing various types of facade products integrating the solar, for example, solar cooling technologies?

Interviewee 1

I think I mean all these different options, I mean you could even go in more than you could say you know, how do you actually connect actually PV panels to a facade and can you do it to every facade and how do you how does it....? How is actually solved in terms of fire proofing? Do we always need to ventilate actually the cavity between the PV...for facade and the and the rest of the facade for fire reasons, or for improvement, or you know and not losing efficiency of the of the big heat panels.

So do I need to have cavities? You know, kind of between it...? So what all this kind of things we need to know, actually, this kind of you need to bring forward this kind of that's what it is. But that's kind of a detailing that should be there but you shouldn't bother a kind of in the conceptual phase.

You shouldn't bother architects too much with that. The only thing you know yeah it's the kind of the play between the engineer and the architect.

Where the architect only wants to know. OK, what kind of sizes can I have? Can I have these sizes? Can I? and so on.

And if there is always needs to be a gap in between, then yes, we need to tell. I mean then he needs to know because then the gap between the different PV panels they become part of the architecture.

Interviewer
Yeah, I see

Interviewee 1

It's kind of it's all about in...there was also the super nice the short movie I was looking at YouTube from the Google, the new Google, Google Compass building, from Heatherwick and BID that worked together actually, and they have this kind of a, you know, sort of buffalo type of uh roofs.

And on these roofs the PV panels are tiled. Actually they are lying over each other a bit like.

And that's what it is about, isn't it? This kind of because you can see it, it's part of the architect here. But you know they wanted to do something that they had the concept of, you know, letting light into the building so they're daylight openings. It's important to have light in the buildings. And they said, OK, but part of the light we have too much light. So OK, all the light we keep out of the building.

If we want to make it a kind of a absorb energy, you know that's what they wanted to do, but it should be architecture and then they started thinking about, OK, how can we do this? How can we make this whatever this absorption and what options do I have, what kind of PV manufacturers are delivering, what kind of materials? And I'm currently working on the project in the Amsterdam where we also have a PV roof and then we go with, you know, with the architect to Munich actually to the PV.

And like yeah this year...exhibition... where all the manufacturers, come actually. And then we, you know, this kind of that's where we start selecting our materials as you know as building materials not as you know not directly I mean we look at the performances and all that stuff but we just want to see it touch it and...

Interviewer

So let's move a little bit to a macro scale. So OK, how we can improve the interests of not only designers, but also developers and the clients to let them apply the integration of solar cooling technologies, how we can improve their interest? the market.

Interviewee 1

I think maybe in, in, in general, I would say you know, I mean if we could and never did this actually. But that's kind of if we can prove that, you know, having to see it on the facade, integrating them facade is an extra cost. But you know doing the same type of electricity production somewhere else, putting a wind turbine in the north sea or making this kind of wind of the solar fields in the in the countryside.

But if you would compare those two, then you might be at the same level. That would be great, because then you've got some kind of a, you know, it's kind of on that field on the macro field. You also competing, isn't it? So not only on the building, building elements sites or on the building site,

but also you say no, this is a kind of a super contribution actually to the nation. If every surface that absorbs solar is actually converted to solar into to energy.

Interviewer
OK.

Interviewee 1

And if that's not, if that's on the facades really you know much more expensive than you know, having these fields in architectural I environments, then we might maybe say, why shouldn't we push that so hard.

Do you know? Do you know if it's really competing?

I don't know, actually, I never make that this count actually to see what? Because I know. I mean, if I mean they talk about the wind energy from the North Sea, they already do for five cents per kilowatt per hour. I just wonder if I can do this on the façade.

Interviewer
OK.

Interviewee 1

I never did this count, but for macro I think maybe it's good to important to have a notion about it.

Interviewer
OK.

Interviewee 1

Because on micro, kind of on project level, you know, we had to discuss this. We only want, I mean, there's more kind of a tendency or maybe that's an important one that goes down a bit. It's kind of a tendency in in general to make our buildings carbon neutral.

Interviewer
OK.

Interviewee 1

That's the kind of a push, actually, to also think about, you know, as much produce as much on site as possible. And you know, producing on site there's only one way using solar because there's no other way of producing any renewables on site.

Interviewer

OK, now let me move to a more practical things. What you what do you think about the like, the potential threats associated with legal legislations that can affect the widespread application of solar cooling integrated facades? What are the potential threats associated with legal legislations that can affect their widespread application?

Interviewee 1

To be honest, I don't know that much. Yeah, that you know...I just one thing that pops up in my mind is, you know, the discussion we have currently or something that happened already is the, you know, having PV on roofs and then suddenly, you know, you need to have a different fire insurance you need to pay more because there's a risk that the things get fired as you know something that well, you know it's there with you every step of that.

But you know, this is kind of sort of feeling sort of illegal thing that comes in...well, the other legal things that are important are bit related more to the performance of the building. You know I mean we need to at least cope with the building code performance in all levels, and one of them is actually energy performance. So there's, like as I said, I mean there's more and more tendency towards you know zero carbon buildings also in the legislation. So that's that will push it actually. So that's I think it's important to have that legislations and.... and that's something you know, I mean...never discussed any you know?

Legislations, for instance, directly for the Emirates, that's, I mean the legislations are kind of always copied from the UK...and it's all taking the traditional things with the boxes.

Interviewer

So yeah, I got it...Do you want to have something or move to the final questions?

Interviewee 1

No, I'm, I'm fine with...

Interviewer

Yeah, yeah. I just have a couple of questions. You know, like we do have those processes, we have the design phase, the production phase, the assembly phase, the operation phase and end of life. So it's about... let us consider them as 5 main phases.

Interviewee 1

Yeah.

Interviewer

So what are the core issues needed to be considered in the design phase when we like to design an integration of solar cooling into façade?

Interviewee 1

We discussed quite a lot on design already, maybe it's good also to have a kind of a maybe there's...I don't know whether it's got anything to add to discussion on production phase.

Interviewer

OK.

Interviewee 1

But let me see. That's, you know, on production, I think there is a kind of bit of the wrong feeling about the kind of the type of material use of PV.

You know, it's a kind of a...It's we don't really...Part of it we don't control. I mean particularly the, you know, the cheap relatively cost effective that comes out from China and so on.

You know, we it's, I think it I've got the...I think....Yeah, we lost a lot of production of PV actually in from Europe actually to these countries. So I'm really production size.

And now you see it maybe comes back a bit....because of that reason, you know, yes, we want to control the way we want to produce PV. So it's not only about, you know having renewable energy, but we also want to use proper materials and do this in social, acceptable way of producing. So that's I think in the production phase I would say is from my opinion is an important thing.

And it's also comes in with the design phase I mean as soon as we start discussing PV, then we also start to get kind of having a priority for, you know more local PV.

And which is also the more kind of architectural driven PV. Yeah, so that's comes together actually.

Interviewer
Assembly?

Interviewee 1

And then in terms of assembly, well on the big projects, It's a typical thing, you know, it's...Do somebody is a kind of? There's not much knowledge.

That's one thing, isn't it? I mean, so there. I mean, if you if it's good to the contract and say I want to have you on my first start then OK, then you'll probably end up with two, two people, two contractors and say ohh we did it before and we wanted to do it again and then the others are saying Umm, wait a minute, I need to put an extra risk here because I don't have did it before and so on. So that's a bit where the assembly is still lacking, like I think.

Interviewer
Are there potential aspect to address like this lack of experts in the assembly or installation?

Interviewee 1

Yes, I think it's kind of a different....uh...I don't know. I mean it's...I think it's something we can.

You know, particularly if the facade is prefabed and that's maybe a different the two things.

So you know the facade which is done on building site, you know built up on building site, it's kind of a different.

Uh, if different type of people that do them and you've got the...yeah...the prefab facades.

Interviewer
Prefab building would address such problem, would help in minimizing...?

Interviewee 1

Yeah.

I think the prefab is easier actually to do.

But yeah, but then on the other hand, it's kind of there's a big still in every country. I think it's still a lot of in-situ on site building or façades.

Interviewer
OK.

Interviewee 1

So yeah, that so that's the assembly and you know on site I think it's not that easy actually to do on site. I mean there's not much supplies.

And then the operation phase, I don't really see really a big issue there.

I think what would be nice actually in general for operation also for this is the kind of we should be more interest in the bit more attention to operation, because normally we just log in our stuff when we don't care, you know all the all the services as well. I mean maybe if it you know it creates kind of

a discomfort, you know. If your air conditioning is not working or something like that, then people start let's say looking for it. But if it performs but it just consumes whatever 25% more energy than it needs to, nobody knows it's kind of and that's something kind of kind of risky as well. You know that maybe you know. It's a I mean, there's no not much interest in checking the performance I expect.

I mean that's my experience. You know, nobody called me actually after and when I did this, this nice roof on a nice roof, but kind of particular roof, PV roof, on the [*specific project in The Hague*]...we have this PV panels that do this. It's kind of we kind of doing this kind of old daylight openings and we have someone to defect levels that are you know some are flat lying on the on the facade. It's the kind of the tilted facade to the South....and some are extending rights...right up and everything, which is in between. So we have this kind of a kind wavy movement of PV of the façade.

Interviewer

OK, I see.

Interviewee 1

And but nobody really looked at their performance. Yeah, we made a mock up to see, you know, the mock up was a kind of having the same results as are calculations...but I've never seen any results of how it really performs.

Interviewer

OK like in terms of the operation, I remember like also you added in the beginning, one things is like for the replaceable...yeah, I remember you added something?

Interviewee 1

Yeah.

That right. I mean, that's what I said a bit on that. I mean, yes, I mean if it's damaged and mainly mechanically damaged, I mean, if it's functionally damaged, then it shouldn't affect the total facade.

Is that I mean that's one thing should be an element that's not working fine with it. You know, the rest still works.

That's I think important.

And the other thing is, yeah, if it's mechanically damaged, then you still need to be able to buy, you know, ten years or 15 years later the same panel. Otherwise you've got suddenly, you know, a white element in a in a black facade that's bits like and white. But this kind of you will see it, you know. I mean, that's also with glass and general.

Interviewer

Yeah the availability, the availability.

Interviewee 1

Availability Yeah. Yeah, yeah. So.

Interviewer

OK and the end of life?

Interviewee 1

And then the end of end of life. I think it's very important as well. You know that comes to get in when also on the production side, you know I mean yes, we need to be aware of what kind of

materials are we using for this and it's really you know the best...from the environment perspective the best thing to do.

Interviewer

I see.

Interviewee 1

And we need to yeah...and that's also reusing materials that come back, you know, after 15 years or whatever, if we want to whatever do something with it or maybe after 15 years we just.... you just want to be able to reuse it again now.

Interviewer

Uh, I have a question in my mind. You know it is related to the design ... how close collaboration among various stakeholders or disciplines can be achieved?

Interviewee 1

Wow, you know that always comes with it...The first of all, there's the kind of the market thing, isn't it? So yeah, you just want to keep....you just want to be able to have different options once you go on the market, so you need to decide when do you go on the market. Actually select the supplier.

Uh, it's the same thing for contractors and so on.

So it's kind of that, that's something that comes in there. So I mean, if you if you have a kind of a tendency to move that far away, you know, so everything prepare everything and then go in the market and then the market will compete and you got the lowest price and so on.

That makes it difficult, I think, to work with them. You know, it's kind of, but if you bring them early in, then there's this risk of, well, you know they will only try to sell their product, you know, make the product their product best and whatever it's kind of.

So this is kind of a, uh, always a kind of a tricky thing. You know, what do we, what do we want to do? It's the same thing for other products and not only for this. It's kind of, you know also.

Interviewer

Yeah, yeah.

Interviewee 1

So that's I think one thing and the other thing is just the amount of time you're allowed to spend on designing a building.

You know, I mean it's kind of you've got a fee.

And you need to do you know, the whole building design, the whole building from scratch to you know commissioning, for their fee.

And so as soon as you bring in things which are unknown, then you need to you know, for every party, you want to be sure that do want really to do this because then you need to spend more time on it, and where do I save time? It's the same thing on, you know, on structural cost, like I said, you know, I mean if you, I mean stay within the total budget. Oh then you need to put something out, which you normally would like to select.

And the same thing here. I mean, you know, OK, we're gonna do something. We're gonna do something we never did before. Or is there's little experience, so where do we save in terms of risk on the risk of the project. So don't make the project too complex in terms of shape maybe or yeah, it's kind of.

Interviewer

OK, I see.

Interviewee 1

It's, I mean you can't add it to all the other ambitions, so you need to say, OK, this is what I want to focus on and make it.

So that's our thing is important also in terms of collaborating.

Because we, I mean the engineers also will look at the same way, you know, the architect, look at it and then the architect and the engineer said should you want to have that facade? Hmm I didn't have that calculated in my hours to think about that for you know, I mean can't we have just a simple ceramic or aluminium facade.

Interviewer

OK.

Interviewee 1

So it really comes in terms of how to collaborate, or other opportunities to collaborate.

Interviewer

OK.

Interviewee 1

Are you almost done?

Interviewer

Yeah, yeah, almost done. I just have two points. So do you have any final remarks about issues to be considered for supporting the product wise spirit application of solar cooling integrate versus do you have any additional remarks, so add or in mind?

Interviewee 1

No, maybe not...Maybe there's one remark I want to make it. There's also about competition.

But it's mainly, I mean we were talking about the kind of competing advantage over other techniques and so on. But there was a bit more in this kind of realm of cooling and electricity production and this kind of you know, but it's also the other competing advantage you have on other more innovative way of building things so you know, I mean if you what do we want to do? We want to have this a concrete building with a PV, cooling façade, or do we want to make a....or do we want to make a timber building?

You know, that's kind of a...what is the best thing? Best thing to do actually is kind of that's something we need to teach ourselves.

So don't look on me. I mean, architects will try to do this anyway, but also I think you know as engineers or as you know, developers or whatever, yeah, you need to think about that. Do that? Where do I want to focus on?

Interviewer

OK.

Interviewee 1

And maybe you want to focus on the combination. Could also be you know, I mean there should be something timber...still concrete core and can keep timber a bit simple, but then you know we also can have some PV in. So it's kind of. I think that's.

Interviewer

Yeah.

So just the last point, so do you mind to propose potential participants that can be interviewed for this study?

Interviewee 1

Yeah, I had to on the list because I was going through the my notes, but maybe it's already and.....