

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 shall we start the first question?

Interviewee 21

Yes.

Interviewer

So [Name of Interviewee 21], in your experience, what is the current level of knowledge in the building industry regarding the application of multifunctional facade components that integrate solar cooling technologies?

Interviewee 21

So as far as I see it in the markets in the Netherland, solar cooling technologies are not common. I haven't seen it for façades. The only thing is I see what you just mentioned on the roofs, there you see the water piping stuff, but then in the facades....no components. There is one innovation from DeGroot & Visser, which is another façade company. They did an innovation where they installed a kind of a panel together with an installation technique in the building *Circle* Amsterdam, from the ABN AMRO Bank, and there they installed a one panel. So that's kind of the same idea, but it never went to next projects where they did it on a big scale. So the only thing in façades is just a normal PV installations, not combine with whatever, yeah.

Interviewer

OK. I see. Now the second question is what are the motivating factors for the application of multifunctional facade components that integrate solar cooling technologies? What are the motivations?

Interviewee 21

I think motivations are rules from the government. Regulations for the construction sector. These are just getting more strong....yeah more complex. The rules are getting more higher. So that could be something to just go to next kind of systems, like this.....Yeah, and what we see like investors in real state or so. They're just also more and more willing to develop buildings with a sustainable label, and I see this probably also as a possibility to integrate for a more sustainable building, yeah.

Interviewer

Got it. So now I asked about the motivations. So what are your concerns regarding the application of such technologies or such facade products? So what are your concerns regarding the application of multifunctional facade components integrating solar cooling technologies?

Interviewee 21

Yeah the first thing...We have to develop a lot...like it's completely new to implement it. So we need to do the product design, system design, etcetera. The weight. I have no idea what the weight is of the system. Can the construction handle these kilograms? And a very important is the building sector in Holland is very conservative. Can they adapt this kind of new ideas. That's also a concern of this kind of new.....I see it as something new in Holland to do this.

Interviewer

OK, so you mentioned some concerns. Are there some ways to address these concerns? For example, new technologies for people and they are conservative? Are there some way that we can address such concerns?

Interviewee 21

Regarding new things, new innovations, we also developed new products, and what I see is how to address....just keep on telling the story, come up with pilot projects, show them that it works and how it works. Create good business cases, because investors, architects, and developer are just.....You help them with a good business case...and, yeah, maybe what is also good is to find partners like bigger companies with more track record.

Interviewer

So what do you mean by partners and big companies? Could you just elaborate more about it?

Interviewee 21

Yeah like in the façades, solar panels in the façades, there are more and more companies investing in it. You have a lot of starters, but also you have the bigger part is like glass fabricators. They are also developing and they are really big like worldwide companies. So they maybe can help to get this a bit further, to address this with good backgrounds of companies, yeah, like financially in a good situation.

Interviewer

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

Interviewee 21

I think it's not so much regarding the type of project but I think it is more about who is the investor in the project, like is it a government? Is it a private investor? Is it a fund? You know, and what is the ambition of this party.....I think it is more important than the project itself.

Interviewer

OK. So for example, are there some differences between government or private?

Interviewee 21

Yeah, yeah, definitely yeah. Every situation is completely different like housing companies in Holland, they have to renovate their existing buildings to a higher level, more energy performance. So they have to because they are half-government companies. So there you have better chance to put this kind of innovations than just a developer developing for the cheap and where money is only playing a role and not sustainability, and they are never enthusiastic about this kind of new stuff....But like TU Delft campus real estate, for instance, they are just more wider, like OK we are here on the campus, we develop things and we do research and science. So we are on earth to bring it to a step further. So why don't we do it in our own buildings. Complete different ideas, and I think that's more important than the project itself. Who is the owner and what is his intention to do with his property?

Interviewer

OK. So what about the building type, office, residential.....?

Interviewee 21

I think it can be all. Like for the offices, yes it works. For residential, yes it works. They all have to deal with the energy situation today.

Interviewer

I see. So now I'll have a question about the location and the climate conditions. So in your experience, how do the locations and the climate conditions affect the performance of solar cooling integrated facades?

Interviewee 21

I think it does a lot, yeah, like it's all about the availability of the sun. So that's one of very important, like when you are in a city and you have a lot of buildings, then it can create a shadow and that's not what you want to do. So the location is very important in that sense, but also in which country, like where in the world. How much sun will be shining there.....and conditions of buildings, like efforts you see in offices, like almost, always cooling systems because you need it to get a higher performance from employees.....but in a residential world, yeah, in my home I don't have air-conditioning, no cooling at all....But in office, it is everywhere an issue.....So maybe there, you can split it.

Interviewer

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

Interviewee 21

The first thing is cities, but there in cities you have the problem that there are a lot of buildings. So you have a lot of opportunity of not functioning because of the shadows coming up around. So then I see, yeah, the cost side maybe where you have the sun the whole day, a lot of performance....More outside....Like all areas where the buildings are not really close to each other. Yeah, maybe there.

Interviewer

OK got it. 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 facade products in a particular building project?

Interviewee 21

I think yes. I have in mind the situation of today because of the gas prices and the gas situation around where it comes from, etcetera. The war in the Ukraine....And people are just moving to electrical heating systems, heating pumps and everything is much over demand at this moment.

Interviewer

OK, now I'm done with all opening questions. So now I'll move to the key questions. I'll start with technical and product related, then financial, and then process and stakeholders. So let me start with the technical and product related. In your opinion, what makes solar cooling integrated facades complex products?

Interviewee 21

Because of the electricity point, like you get some electricity. So you need to have the certifications to install it. The integration in systems is complex because you need to do a new product development. So that costs a lot of energy, a lot of money to set it up....And the major complex, so the product development needs to be done. How can you combine these systems? Yeah this is technical, yeah.

Interviewer

But what do you mean by a certification for installing them?

Interviewee 21

Yeah like we as a facade builder, we are not allowed to do electric installations. We are not allowed to even to plug a connector.

Interviewer

OK. So do you have something in mind about how we can address such complexities....for example the aspects that are related to the certification.

Interviewee 21

We don't work together with an installation company, with an electrical installation company. So we have already two different disciplines, professions on one product. That makes it complex. You know, like what we do now, we replace the facades, and then the electric party just connecting everything and make sure that they will work. So then the second question is, are they working for us or are they working directly for the building owner or are they working for the main contractor? So like this more like organization, technically issue, but yeah.

Interviewer

Do you have something in mind how we can address challenges related to the space availability or interrupting other building services when we integrate such technologies into building facades?

Interviewee 21

I think interrupting in the installation sector is...first just show that it works and how it works, I think. Here we have...what they call it....green village....when they do the showing of all the houses. Like just show what it does and what the opportunities are and what benefits are of this kind of new product? And then you can address your new ideas, you know. Just show it with samples.

Interviewer

Now I'll move to the following question. What are the key aspects to consider for the maintenance and durability of such facade products that integrate solar cooling technologies?

Interviewee 21

The key aspects of maintenance and durability is the lifespan, but also the possibilities to upgrade the system after many years. An example is that the PV systems we installed.....after 25 years, they say the performance will be lower of PV. The generation of energy will be lower because of.....Yeah, they don't know actually, but what they normally do is just get everything off and place on something new back.....But I heard about some research where they said OK, it's not that the PV cells are degrading that the performance is degrading, but it is about the wiring, which is like getting corrosion, and that's the reason why the electricity is not getting through easily. So why don't we change only the wiring so that we can hold the panels, give them a new performance lives, a new 15 years, 25 years. So durability, but also there's a possibility to upgrade, possibility to only replace components, you know. That's something what I think about is very important....and maintenance, yeah, panels are getting dusty and then the performance will be lower. It's very important to take into account.

Interviewer

So [Name of Interviewee 21], I'll move to the last question in the product related aspects before moving to the financial aspects. So how do you see the role of aesthetics in the widespread application of building facades integrating solar technologies?

Interviewee 21

The role of aesthetics is very important, yeah, because the standard black panels, which are already on several places and we have to come up with new ideas, new colors, new textures, everything. Yeah, definitely, because in Holland we have the Welstand [ed: Commissie, *commission*] and they just keep into account with all the building permissions, if the aesthetics are OK, fitting in the area development ideas and regulations. So the aesthetic part is very important, and that's also what I see the new startups coming up. I just playing with different type of...how to combine it with different samples. Architecture of panels, etcetera.

Interviewer

So you mean area development there, you mean by the aesthetics with the area development it's related to?

Interviewee 21

Yeah, here we have like....every building permission goes to the Welstand Committee, which are just taking care of the aesthetic performances in cities. Is it fitting in the area? Is it fitting on the street? Is it fitting in the ambitions of the local government?

Interviewer

I see I got your point about it. So now I'll move to the financial aspects. I have two questions about financial aspects. So in your experience, how can the industry develop affordable and financially feasible façade products integrating such technologies?

Interviewee 21

From my side is just try to collaborate with partners. Look for companies who want to collaborate...than do it alone. Also do collaboration with demand side, with clients, potential clients. Develop on the TCO, Total Cost of Ownership. Take that into account because when you have a very interesting product for total cost of ownership, then some parties will pay more for the capital expenditures because they get benefits later during the operational phase.....Yeah, and an integration means that you have to do like the same with PV panels. The PV panel is not an addition, they now have replaced the panel you should have installed already, you know. So you are not investing something extra. That's how you can see this also like roof tiles. You don't need roof tiles anymore because you place PV panels on the roof, so why should you do both. So that they will make impact in your business case. We don't have to pay for the tiles, but only for the PV panels, and that kind of stuff you can think about.

Interviewer

OK, so now I'm going to move to the second question about the financial aspects. So what are the potential financial incentives that can support the widespread application of solar cooling integrated facades?

Interviewee 21

The TCO is an incentive....Energy savings....Energy generation amount, like how much energy you can generate, because you always compare it with a gas price or with an electricity price from the energy companies....What more potential financial incentives....Yeah, to start maybe subsidies. This is also something for new energy subsidies....But maybe also guarantees, how long do you guarantee a good performance. Yeah I think these.

Interviewer

OK, great, so now I'll move to the stakeholders and processes. So [Name of Interviewee 21], you can see from this chart we have different stakeholders involved in the façade design and construction. So in your experience, which of these stakeholders can support the widespread application of solar cooling integrated facades?

Interviewee 21

I think the client, and user, and investor...very important. The architects and consultants. I think we as a façade builder cannot do so much to push it. Of course I can....what I do with other parties, just normal PV panels. We develop ideas how to implement that in our façade systems and that are solutions I can offer to the architect, but it's only one of the 100 solutions you have. And if you are a party who's selling this cooling systems, PV cooling systems and your only interest is to get that into the market, then don't start with the façade builder because the façade builder just maybe....like my main business is facades and not these systems. So when you do it here in this level, then it comes to me as a façade builder via the general contractor or just indirectly. Yeah, that I think how you can see this.

Interviewer

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

Interviewee 21

Yeah education and but how education is important.....maybe in collaboration with...you have like the branch organizations, responsible for companies in this area, like the societies. The branch societies.

Interviewer

What do you mean by....

Interviewee 21

We have like societies who are there for group of the same profession, companies. Like in the façade industry, we have like one society or whatever, and they come up for our belongings and our interests in the market...politics, but also regulations, standards and development of standards from the government.

Interviewer

So these societies like they have a group of companies registered.....?

Interviewee 21

Yeah, yeah. You have to be a member of the Society of the Facade Industry that is the VMRG [ed.: Vereniging Metalen Ramen & Gevels, English: Association of Metal Windows & Facades], and they have like a *Keurmerk*, i.e. regulations and that regulations are higher than the building regulations from the government, and we confirm to them. We are a member, so there are events where they organize and we come together and get knowledge about the sector.....And the same the installation sector also does have some of these societies, and from there also is a good starting point for innovations and getting knowledge and spreading knowledge. You can think about that also.

Interviewer

OK I got your point about it. So now let us assume if we'd like to have standards or guidelines for architects or engineers, which are related to the integration of solar cooling technologies into building facades.

Interviewee 21

Yeah, very important.

Interviewer

So such standards and guidelines...If we would like to have it for architects or engineers, what are the core elements that should be there in standards or guidelines for architects. So what do you think that should be there?

Interviewee 21

I think what is the performances of the systems is very important what they can just fill in the calculation tools of the energy performance, etcetera.....But also design boundary conditions. Maybe instructions how to install, instructions how to engineer the systems. Yeah, just give the boundary conditions to the architects....of the system.

Interviewer

OK. Now let me move to the following question. So generally how can the industry increase the variety of products that would attract customers to apply solar cooling integrated façades?

Interviewee 21

How can they can do it.....If you believe in the product, so you will add it to your portfolio. So you will also look for opportunities to put it into the projects, you know.....that it starts there when you have it, then you.....When you have a product which is really good and with a very good performance, with good very good parties which you can trust behind, which are fair parties which have a good operational chain, then they will find arguments to increase it in the industry, I think. It's kind of a movement you make there.

Interviewer

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

Interviewee 21

Come with nice designs. They will trigger. Come with good performances. Help them with the delivery of good calculation sheets.....Help them with....kind of systems engineering....give the service. Help them to get it implemented.

Interviewer

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

Interviewee 21

It is not only for this but in general.....what we have to change is giving more credits to innovations which attach the aims of the government....and the aims we have now for the...the EU aims and the regulations for more circular, more energy neutral, you know. So when they make it easier to get innovations in the projects....that's more on process....but it is still already possible to put innovations in projects, relating to

the regulations from the local government like we have for building regulations, but there they're doing like the performance....the performance is like the insulation rate is 4.7, and how you reach this rate, you can do it with everything like sheep wool, or like PIR or PUR panels or whatever, or RockWool.....And then if you have another innovation, you can also use it, but they also have a standard how to measure the insulation rate, and maybe these instruments, regulations how to measuring.....maybe there you can just change something to get this kind of new innovations more into the market. We call it the BRL [ed.: Beoordelings Richtlijn Producten, English: Assessment Criteria/Guidelines of Products] like how.... like... what I just said...how to measure.....how to come to the rate you want to have, yeah.

Interviewer

OK, what about changes in energy policies? How would changes in energy policies affect the application of facade products integrating solar cooling technologies?

Interviewee 21

Yeah, I think that's the biggest performance....like when it changes, then this maybe has more impact. You can make impact with changes in that sense.

Interviewer

So now I'll move to the last part before the closing questions. It's about the processes. You know in the façade design and construction, we start from the design, production, assembly, operation, and then the end of life. So the question is....in your experience, which phase is key boosting the integration of solar cooling technologies into building facades?

Interviewee 21

Design phase.

Interviewer

Design phase. Why design?

Interviewee 21

Yeah, you have to implement new systems as early as possible. Otherwise, no one will change to do....Like per definition it is more complex. So the more complexity is more risk. So main contractors don't want risks. So when you have it upfront already in the projects, then you will have benefits at the end.....but still it happens a lot that the innovations from the beginning in their route to the production and implementation will fail, then it is going out because of the risks and it is too expensive...I see everything. The main constructor has a big role in that.

Interviewer

OK.....still keeping in the design phase. What are the main aspect to be considered during the design phase of solar cooling integrated façades?

Interviewee 21

Design phase is just what I said.....How it looks like, and the performances. Yeah.

Interviewer

OK, now how can we achieve a closer collaboration between various stakeholders and disciplines during early design stages?

Interviewee 21

Yeah, this is just one thing and this is how can you come under the eyes of the architects. That's why you have to start, I think, but also advice companies...And how I do it, I have the same question. We have also a new façade concept. It is just a kind of networking. Just going abroad and then meet people and just tell them what you have. Try to get involved in networks. Try to get involved in like parties who can probably give you a stage to tell your story. Yeah.

Interviewer

OK, so now I'm done with design. So now I'll ask you about production, then assembly, then operation, and then the end of life. So what are the key aspects we need to consider for the production phase?

Interviewee 21

Plug and play. As easy as possible. Less risk as possible.

Interviewer

Less risk. What do you mean by less risk, for example?

Interviewee 21

Yeah, risk of complexity like good carpentries are not anymore available in this world. So we have to do everything on...how easier, the better....Yeah, complete full elements, plug and play....that's the best thing for the production.

Interviewer

Assembly...What are the key aspects we need to consider for assembly?

Interviewee 21

As much as possible, make things prefabricated. Prefabricate and less parts on the building site.

Interviewer

OK...Yeah, about assembly....Do you have special things to say about the required workforce?

Interviewee 21

Yeah, required workforce....

Interviewer

Yeah installers, labors.....Do you have something in mind? Some important aspects to be considered for them?

Interviewee 21

Yeah, good guidance. Guidance is very important. I always say the IKEA guidance works. Like from IKEA, you know.

Interviewer

IKEA....You mean guidelines?

Interviewee 21

Guidelines, manuals, workshop manuals. Installation manuals....How to do it....That's why the workforce is very important, because in our business we work only on the building side. I don't know it....The labors just are not on the payroll, so we rent them in, you know. So that you have to be very clear about what they have to do because they are not part of our company in that sentence.

Interviewer

I see. OK operation phase. What are the key aspects you need to consider for the operation phase of a facade product that integrates solar cooling technology?

Interviewee 21

Easy to maintain. Easy to monitor the performance....and the availability of the system, like how much time is it up running and how much time is it down? Downtime, uptime....as high as possible.

Interviewer

So availability you mean by.....The availability of the system you mean by....?

Interviewee 21

Yeah like availability is not the correct word. I mean actually uptime.

Interviewer

Uptime.

Interviewee 21

The time that the product is working, doing what he has to do. Like in the process industry, you see like that 95% uptime. It's working. It guarantees that the product is working and if it's not working, then you get a penalty or you have to repair it in a short time....And with this kind of systems, you have an impact on the cooling and heating of the buildings. So people will get it cold, people will get it hot if the system is not working. So that's why we have an uptime. The higher the uptime the better, because you feel it when it's not working.

Interviewer

I see. So now I asked you about design, production, assembly, and operation. So the last thing.....So what about the end of life? What are the key aspects we need to consider for the end of life?

Interviewee 21

Recycling, reuse...First reuse of course, but before that actually the upgrade possibilities where we can change parts and then it will continue the system for the next few years. And otherwise you will get it apart easily to remelt it or just reuse it. Yeah, that's it.

Interviewer

So [Name of Interviewee 21], so now I'm done with all key questions. I'm just moving to the last part, closing questions. Do you have any final remarks about the widespread application of solar cooling integrated facades as building products?

Interviewee 21

My final remark is I have still not in mind that this is the benefit of the total system in comparison with other systems. So maybe it's good to make a graphic about it or so...like a good graphic which shows this is the system, I think. Just to explain actually what you want to achieve with this idea of cooling. That is good to consider.....Yeah the price....price is very important for the whole concept, I think, to make it or not make it.....And the rest already discussed, I think.

Interviewer

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

Interviewee 21

I think it is a very good idea. I'm also enthusiastic about PVT panels. It's photovoltaics, but there's also combination with cooling. There's also probably something where you are looking at. Yeah, I'm very enthusiastic about these systems. I wish I had a one on my roof, but because of the that it is too expensive I don't do it, and you need a lot of extra insulations to do something with the water. So it's kind of you need to make a total concept, I think that's also the kind of complex.

Interviewer

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

Interviewee 21

Yes, of course.....I also mentioned.....