[Conversation #3] - The importance and the know-how of recovering waste heat to produce energy

In this episode, we spoke with Pascal Moisy, Head of Communications and Corporate Social Responsibility manager at ArcelorMittal, Luxembourg, about the process of waste heat recovery and its significance, and about an innovative heat-recovery optimization tool that has been the result of a longstanding partnership between LIST and ArcelorMittal.

Paramita

LIST and ArcelorMittal have been partners for quite some time now. In 2019, the two companies signed an agreement to improve energy efficiency and responsible use of resources. One of the objectives was to optimize energy efficiency measures as well as heat recovery and electricity generation from excess heat. Out of this particular collaboration was born a project and then a tool called Heat2Power. I'm very happy to welcome today, Pascal Moisy, Head of Communications and the Corporate Social Responsibility manager at ArcelorMittal, Luxembourg, to talk about this project but also about the ongoing partnership with LIST.

Welcome to Tech Advantage, Pascal. Thank you very much for being here.

Pascal

Hello Paramita

Paramita

I thought we'd start... as it's very, very cold outside, it's been snowing for a while now. I thought maybe we'd talk about the process, about heat recovery in itself. So, what is the significance of heat recovery, especially in industries such as ArcelorMittal?

Pascal

In fact, recovering the heat, what we call the residual heat in a steel production process, has two advantages. The first is that it would allow us to produce energy with heat, which is by definition omnipresent and abundant. It's everywhere in a steelworks, so it's available and in any case it's lost because it escapes from the process. So this allows us to recover something that is abundant and then, as it is heat that can be used to create energy from this abundant heat, it is in fact energy that is not fossil energy. So it actually makes it possible to produce steel in a more carbon-free way.

Paramita

What is this waste heat?

Pascal

Throughout the steel production process, we have two things. Firstly, we need to cool the installations, particularly because, for example, during rolling, when the rolling bars enter the rolling stands, the rolls that turn and crush the steel sections need to be cooled, otherwise they will break. So, we need to cool these rolls, and so this water, which is in contact with very, very hot parts, comes out very hot, and this water has to be cooled simply so that it can be reused, because we're in a closed cycle. But at some point, this water is very hot, so we could recover it and use an exchanger to recover hot water and therefore heat. That's one aspect. The other aspect is in fact our, our installations in several places and to put heat in the electric furnace obviously, it's very hot, the

melting point of scrap. To be able to make liquid steel, it's between 1520 and 1540 degrees Celsius. When you get to the beginning of the rolling process, you have sections that are at 1,200 degrees, ending at 800 degrees.

And when they arrive at the very end of the process, at the end of the rolling process, they're put on what's called a cooler, as we've said, where they're put until they cool down, until their temperature drops, until they can be assembled and shipped. So, waste heat is everywhere, in fact, in steelworks. We thought it might be a good idea to try and recover it at some point.

Paramita

And reuse this heat for something else in fact.

Pascal

Simply reuse it to produce energy. Well, that's kind of the basis of it... the project that was set up with LIST. It was to say, here we have heat, which is available on one side, and on the other side we have energy needs, if possible non-fossil, non-fossil energy. So, we can bridge the gap between the two.

Paramita

This partnership is called The Forge.

Pascal

So yes, we have, we've signed a partnership agreement. As you said at the beginning, we started in 2019 and created what we called The Forge. The idea at the outset was to say we're going to put all the ideas that come to mind on the table. And then we'll see if they're interesting or not. So, we're going to explore them. We don't censor ourselves, we don't have any preconceptions, we just put them on the table. If it's of interest, we study it, go all the way and see what comes up. And the idea was that we weren't sure every time that it was going to lead to something concrete. But we gave ourselves the right to study it anyway. So, it's a bit of an original approach, you might say, because we weren't under any obligation to achieve results.

And that also explains why, this Forge in fact, is financed not by a steel plant or by ArcelorMittal's research and development, but by the Corporate Responsibility part because we know that a plant or an R&D centre needs a clear return on investment to be able to commit funds. So, we said to ourselves that we're going to look at subjects that we wouldn't naturally go into because we're not sure that they'll lead to anything concrete. And we're not sure we'll make any money out of it. But we're still going to look at what we can do. That was the idea behind the Forge in the first place.

Paramita

We don't hear much about projects like that, where there's really no ROI objective behind. But we're going through anyway, because we had this idea of doing something with, as you said, residual heat. And so, you have...

Pascal

We did have a number of common themes. Obviously, we had the whole issue of decarbonisation in mind. So, we said to ourselves how our activities by themselves could enable us to produce carbon-free steel without going looking for something very complicated. So, one of the ideas was to recover this heat. Well, I'd say that was one of the aspects we studied. But in fact, from the moment we

started talking to each other, between Arcelor Mittal and LIST, we realised that there were lots of other subjects that could be interesting. We realised, for example, that at LIST there was real skill and expertise in the study of forest assets. It just so happens that ArcelorMittal owns several hundred hectares of forest in Luxembourg, and we thought, well, there might be a subject there that we can work on together in the same way. We also explored a whole, a, a, a, a, a topic on the recovery of plastics and polystyrene in our factories.

Well, it turns out that ArcelorMittal has signed the zero plastic use charter, which means eliminating all single-use plastics from its processes. And in fact, we're realising that, often in offices, it's not very complicated. All you have to do is remove the plastic cups from the coffee machines. That's easy, but the volumes are very small. When we receive our raw materials, for example all the electrodes that arrive to operate the electric furnaces or the ladle furnaces, it's the graphite that's protected in polystyrene packaging. So, what do we do with this polystyrene afterwards? Is there a real recycling industry for polystyrene, is it profitable? Polystyrene is very light, so transport costs are high.

A lorry can be filled very quickly with polystyrene, but the price per kilo, per tonne isn't great, so we asked ourselves all these questions. And indeed, thanks to this partnership, we've cleared up a lot of ground that we probably never would have explored if it hadn't been for the Forge.

Paramita

So now let's move on to the heart of the matter. Heat2Power... This was a project that really grew out of this partnership. Can you tell us a bit about the origins of this project? How did it come about? Why was it created, how was it created? A bit of background...

Pascal

Well, as I was saying, heat is everywhere in our facilities. So, we said to ourselves, this heat is actually wasted heat, let's try to recover it. That was the idea at the start. So, um, with this whole system we're looking at how we can recover the water that cools our facilities but stays hot and which, somewhere, through an exchanger, can generate energy. In fact, all our thinking has been based on this principle. We have energy that's being released, and for us the energy is super important because this energy, this heat, can recreate energy. So obviously we can't recreate the same amount of energy, but we can still recover some of it. So the idea - and this is what gave the project its name - is to go from heat to energy. So Heat2Power is exactly this idea, which was to take this heat and turn it into energy.

Paramita

For this project in particular, why did you think of LIST?

Pascal

We had a few ideas in mind, but we didn't necessarily have the skills or the resources available to bring them to fruition. So, we said to ourselves, we know that at LIST there are skills, a fairly specialised expertise that might enable us to make progress on these subjects, which are, moreover, not directly profitable subjects. So being able to devote in-house resources to something that doesn't immediately produce steel wasn't necessarily easy to set up. So, we decided to work with LIST, because we were familiar with its expertise. And we also knew that LIST had an extensive network of contacts not only in industry but also elsewhere that could be inspiring for the projects we had. So we started from this point of view, saying to ourselves that with LIST we were going to

have a partner who would enable us to combine research, technology and knowledge of the state of the art and come up with practical solutions at the end of the project.

Paramita

Can you give us a little idea of how the tool works? We're not going to go into too much technical detail, but we'd like to know a little bit about how it works, how we recover this heat.

Pascal

In fact, Heat2Power is a software package based on a mathematical model which, depending on the environment, i.e., where you are, in a factory, etc., identifies how the heat can be recovered, what is the best solution for recovering it and possibly what is the best combination of different technologies for recovering this heat. So, there are several types of solution. There's the Rankin organic cycle thermodynamic machine, for example, which I didn't know about until I got into H2P. There's the steam turbine, which is a little simpler, and so we wondered how we could combine these technologies to produce energy, and the mathematical model makes it possible. In the end, H2P isn't the invention of a new heat recovery system. It's a software tool for choosing and optimising a solution. And to be able to, to, to build this software, we had the support of the National Research Fund.

Because there's a real interest for ArcelorMittal, but also for other types of industry, in using this kind, this kind, of, of resources.

Paramita

What are / were the challenges?

Pascal

When you want to reuse waste heat there are a number of technical constraints. First of all, is it feasible to recover this heat at location X or Y in the installation. Then there are organisational constraints. For example, the availability of a cold source nearby is a requirement of the process. But there are also, above all, economic constraints, because the investment cost is high, and the payback period can be just as long. And, given that the cost of energy varies, we can sometimes wonder whether the investment is worthwhile. But today, we know that energy prices are on the rise. So today it's actually more attractive to go for this type a solution. We've really seen a difference in terms of interest between the beginning of the project... We've seen a real difference in terms of interest since the start of the project - before the periods of tension on the markets linked to the Covid epidemic on the one hand and the conflicts in Ukraine on the other - when suddenly the scarcity of certain energy sources meant that the price of energy rose. So, we realised that in the end we needed to think seriously about these topics... heat recovery to produce energy made sense, especially when energy prices are tight.

Paramita

And when you say that you've seen increasing interest, have you seen this within ArcelorMittal, in the group or in other sectors?

Pascal

Within our team. We said to ourselves, in the end it was a good idea to go down that road. Because at the start of the project it was, let's say, a route that was taken without necessarily looking for quick profitability and so on. But then we saw the prices of gas and electricity rise, because the price

of electricity is based on the price of gas, which has completely exploded. We realised that there was a real interest in becoming an energy producer, or in any case in recovering our heat to produce energy in a market that was tight on energy.

Paramita

We know that the project was completed at the end of August/beginning of September 2023. Have you already started using this tool at ArcelorMittal?

Pascal

The software is actually up and running. It's been tested and it's produced the results we wanted. So, we're not using the software yet. We're actually in the process of trying to build a project to really use it. The idea is to use all the data we've collected to feed the software and see how we can deploy it here in Luxembourg. But eventually, it could also be used at other ArcelorMittal sites around the world. Thanks to this software, the LIST teams have made a calculation, and at the end of this calculation, in fact, with the use of this software and therefore this heat recovery, we could generate 150 gigawatt hours of electricity per year, which corresponds roughly to 15,500 tonnes of CO_2 saved per year. And if we go up to European level, we're looking at a production of 13,000 gigawatt hours per year, which is much more substantial, and more than 4,400 tonnes of CO_2 saved per year.

So, we're realising that there's a real and very significant potential if we're able to use this software on installations across Europe.

Paramita

You've already answered my question a little bit, because my question was, do you see in the group a concrete potential for this system, not just for the tool as such, but for this system of converting heat into electricity.

Pascal

In fact, that's exactly it. The objective is to roll it out. We'd like to be able to set it up in Luxembourg, and beyond. If we manage to deploy it in a certain number of comparable sites at ArcelorMittal, because we're on similar installations and we think, here we are, in this place, we can collect equivalent data and therefore run the software in the same way, there's no reason why we shouldn't. We're not going to hesitate. There's no reason why we shouldn't do it. Obviously, if we're able to generate energy from all the heat that evaporates in our installations, there's a real advantage.

Paramita

And not just in the steel industry.

Pascal

Yes, that's it, not just in the steel industry but in other industries too. In fact, potentially all industries that have to deal with, let's say residual heat loss. We could apply the H2P software to any installation where we find that there is heat loss. That's what the software is for. It's designed to assess whether it's interesting or not. For example, there will be places where there is a lot of heat, which is lost but very difficult to capture. For example, if you're in a place where it's 1000 degrees all

the time, that heat escapes. But it's complicated to go and recover it, maybe it's not feasible, and it's better to go and recover the heat in a place where it's at around 200 degrees, but where it's much easier to get to, and so it's much easier to have facilities that will run there.

So, this tool should enable us to determine the right balance to be struck between accessibility, quantity of heat and the resulting energy production.

Paramita

Let's talk about the project now. Where are we, now that the tool has been released, or at least it's due to be deployed, what are your expectations?

Pascal

Today we're thinking about a version... a phase 2 of the project i.e., we had Heat2Power and now we're moving towards what we call Heat4Steel um i.e., effectively also recovering heat but from other places, or even recovering certain heat emanations more simply through the capture of cooling water but by going to look for it where there's heat which is lost. So it will be in the slag, for example. When we produce steel, we have some sort of waste that is produced naturally because it's a chemical reaction and it's very hot. We're currently looking into the possibility of recovering the heat at this point to produce energy. So, we're thinking about it. We're going to say another stage in the project, which we've renamed to show that it's another phase and that we can still produce energy. The other stage in Heat4Steel is also to study the decarbonisation of steel production, in particular through the electric furnace process and DRI (Direct Reduced Iron).

So, DRI is the reduction of iron ore using hydrogen, which would make it possible to produce decarbonised steel, but also to recover the heat emanating from these new types of process, and in particular what we call the heat from solid flows, which is in particular the whole part of preheating scrap metal, preheating semi-products before rolling... and so on, all these stages in the process where we could recover the heat to produce energy as well, so then we move on to... and here we are actually studying... all the advantages we could gain by recovering heat from the new production processes that will be set up to produce carbon-free steel...

Paramita

My last question is actually a bit related to this... How do you see the partnership with LIST in the future? Do you have any other projects on the horizon?

Pascal

So, with Heat4Steel we're working on this project to develop these technologies to produce energy from waste heat, and to do that we've also submitted a project to the national research fund, and we could have the answer by the end of the year (2023), so if the project is accepted, we'll have a great project to launch in 2024. In this partnership between ArcelorMittal and LIST, there's one point that's just as important, and that's that throughout this partnership, I'd like to emphasise the quality of the exchanges we've had. There has been a high level of expertise, a very good level of collaboration and this has always been in a spirit of conviviality that was really very pleasant. And we've realised that for a partnership to work, if we can bring together the skills, the collaboration and the good understanding between the different players in general, it works very well.

Paramita

Thank you very much Pascal, thank you again for being here and talking to us, and I hope to see you next time!