

REN21 Renewables 2015 Global Status Report: Heating and Cooling

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Webinar Presenter

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Sean Esterly

Hello everyone, I'm Sean Esterly with the National Renewable Energy Laboratory, and welcome to today's webinar, which is hosted by the Clean Energy Solutions Center in partnership with REN21, and today's webinar is focused on the REN21 Global Status Report and its findings related to heating and cooling. And one important note of mention before we begin our presentations is that the Clean Energy Solutions Center does not endorse or recommend specific products or services.

Information provided in this webinar is featured in the Solution Center's resource library as one of many best practices, resources reviewed and selected by technical experts. And I just want to go over some of the webinar features for you. You do have two options for audio. You may either listen through your computer or over your telephone. If you choose to listen through your computer, please select the mic and speakers option in the audio pane. Doing so will eliminate the possibility of any feedback and echo. And if you choose to dial in by phone, please select the telephone option, and a box on the right side will display the telephone number and the audio PIN you should use to dial in.

If anyone is having any technical difficulties with the webinar, you may contact the Go to Webinar's help desk at 888-259-3826 and they can assist you there. And we do encourage anyone from the audience to ask questions at any point during this webinar. If you have a question for the panelist, please go ahead and submit it in the questions pane, and we'll receive those through that. If you're having difficulty viewing the materials through the webinar

portal, we will be posting PDF copies of the presentations at cleanenergysolutions.org/training, and you may follow along as the speakers present. Also an audio recording of the presentations will be posted through the Solutions Center training page within about a week of today's broadcast and will be added to the Solutions Center YouTube channel where you will find other informative webinars such as—as well as video interviews with thought leaders on clean energy policy topics.

Now today's webinar agenda is centered around the presentations from our guest panelist, Christine Lins and Gerhard Stryi-Hipp. These panelists have been kind enough to join us to discuss REN21's Global Status Report and its findings regarding heating and cooling. Before speakers begin their presentations, I'll provide a short, informative overview of the Clean Energy Solutions Center Initiative, and then following the presentations, we will have a question and answer session where the panelists will address questions submitted by the audience, and then some closing remarks and a brief survey for the attendees. Now this slide provides a bit of background in terms of how the Solutions Center came to be formed, and the Solutions Center is one of 13 initiatives of the Clean Energy Ministerial, which was launched in April 2011, and is primarily led by Australia, the US, and other sim partners. Some outcomes of this initiative include support of developing countries and emerging economies through enhancement of resources on policies relating to energy access, no cost expert policy assistance, and peer to peer learning and training tools, such as the webinar you're now attending.

And there's four primary goals for the Solutions Center. The first is to serve as a clearing house of clean energy policy resources. Second is to share policy best practices, data, and analysis tools specific to clean energy policies and programs. Third is to deliver a dynamic services that enable expert assistance, learning, and peer to peer sharing of experiences, and then finally, the center fosters dialogue on emerging policy issues in innovation around the globe. Now our primary audience is energy policy makers and analysts from governments and technical organizations in all countries, but the Solutions Center also strives to engage with the private sector, NGOs, and also civil society.

This slide has information on one of the marquee features of the Solutions Center, which is the no-cost expert policy assistance known as Ask an Expert. The Ask an Expert program has established a broad team of over 30 experts from around the globe who are each available to provide remote policy advice and analysis to all countries at no cost. So for example, in the area of buildings, we're very pleased to have Cesar Trevino, leader of the Mexico Green Building Counsel serving as one of our experts. So if you have a need for assistance in building efficiency or any other clean energy sector, we do encourage you to use this valuable service. And again, the assistance is provided to you free of charge.

So if you have a question for our experts, please submit it through our simple online form at cleanenergysolutions.org/expert, or if you want to find out more about the Ask an Expert Service and how it can benefit your work,

please feel free to contact me, Sean Esterly, directly at Sean.Esterly@nrel.gov, or give me a call at 303-384-7436. And we also invite you to spread the word about this service to those in your networks and organizations. Now I'd like to provide a brief introduction for today's panelists. Our first speaker today is Christine Lins, the executive secretary of the Renewable Energy Policy Network of the 21st Century, also known as REN21. And with other 18 years of experience working in the field of renewable energy, Ms. Lins helps convene international organizations, governments, industry associations, and academic and NGO representatives active in the field of renewable energy.

And our second speaker today following Christine will be Gerhard Stryi-Hipp. Gerhard is the head of energy policy at the Fran Hoffer Institute for Solar Energy Systems where he also coordinates smart energy cities. An expert on technologies, market development, and policies in renewable energy systems, Gerhard now designs urban energy systems and serves as a consultant to cities in energy transition. He is currently a member of the CO International Advisory Council and the president of the European Technology Platform on Renewable Heating and Cooling. And so with those brief introductions, I would now like to turn things over to Christine.

Christine Lins

Thank you very much, Sean. Good afternoon, ladies and gentlemen. It is my great pleasure to be here with you today at today's webinar, and it is great that we will be speaking about a topic which is very close to my heart, namely heating and cooling and how we can increase the share of renewables in this sector because if we want to be successful in the global _____ with a transition to renewables, we need to pay in the future more attention to the heating and cooling sector. So in a nutshell, REN21, as Sean has mentioned, this is a stakeholder network committed to the rapid uptake offering you're managing worldwide. I'm very happy that since beginning of October, both NREL, the National Review of Energy Laboratory, and the government of the United States of America are members of REN21.

And that is—that joining and the use a _____ of over 55 organizations both from the private and the public sector, all active in promoting renewables globally. We have—the network has a small secretariat that is based at the United Nations Environment Program in France in Paris from where I am speaking today. And what I'm going to present to you is basically the key findings of the REN21 Renewables 2015 _____ report which provides an annual look at the tremendous advances in renewable energy markets, policy frameworks, and industries globally. Each report uses formal and informal data to provide the most up-to-date information available.

This year's report marks the ten years of REN21 reporting, and I'm happy to say that not only renewables have quite significantly increased over the past decade, but also our contributors community has significantly increased. And the report as of today benefits from a multi-stakeholder community of over 500 experts from all around the world who provide information about this—about their fields of expertise. The report covers all technologies, all sectors from power, heating, cooling, and transport, and all the data that we collect in

this exercise is available in the revamped renewables interactive map that you can access from the REN21 website, and also the GSR, the Globe Status Report is available free of charge for download on the REN21 website.

So in a nutshell, where do we stand in the field of renewables today? The evolution of renewable energy over the past decade has really surpassed all expectations. During this last decade, we saw a steady increase in the global demand for renewable energy, global installed capacity, and production from all renewable technologies have increased substantially. Most technologies have seen significant cost reductions. We have seen support policies spreading throughout the world, and with this in mind, we must not forget that the state of renewables today is much different from what it was a decade ago.

In the early 2000s, we saw upward trends in global investments, but yet, the—nobody really predicted the remarkable and extraordinary expansion of renewables that we saw happen in the coming years. However, when you look at the development, we see a lot that has happened in the power sector to some extent. Those are the field of heating and cooling, especially as far as solar, what water heating is concerned. But clearly, most advances that we've seen in the last decade were in the power sector. So when we look at the global picture, we see that renewables provide an estimated 9.1 percent of global final energy consumption with the share of modern renewables increasing and the share of traditional biomass slowly going down.

However, this has to be seen in light with the sustainable energy for all campaign after _____ Secretary General Ban Ki-moon, which aims at doubling the share of renewables in the global energy mix from a baseline share of 18 percent in 2010 to 36 percent in 2030. So when we look at this, we see that there is still a long way to go. And we see that renewables are rising, but we also see that energy demand in general is rising, and so the advances that are made are not seen so much in absolute terms when it comes to the renewable energy share in final energy consumption, and also because yes, there's a lot of advancement in electricity, but in the heating and _____ sector is still a long way to go. When looking into the champions, it's interesting to note that in absolute terms, when you look at investment figures in arena of power and fuels, you see China, United States, Japan, UK, Germany, and this is coming from former energy finance. However, when you look at investment relative to annual GDP, the list reads differently. You see Burundi, Kenya, Honduras, Jordan, and Uruguay.

So we clearly see that emerging economies in developing countries are putting quite a high focus on renewables in their investments. So when we now look at the power sector, we stand renewables account for about 28 percent of global power generation capacity, and about 23 percent of global electricity demand. I think it's quite interesting to note that renewables made up for 59 percent of net additions to global power capacity in 2014, and we saw renewable power capacity increase of over 18 and a half percent compared to 2013. So a lot happening in this sector. We have situations that reliable renewables achieve high levels of penetration in some countries. For

example, throughout 2014, wind made about 40 percent of electricity demand in Denmark, 27 percent in Portugal, 21 percent in Nicaragua, and solar PV in operation at the end of 2014 was enough to meet the estimated eight percent of electricity demand in Italy, 7.6 percent in Greece, and seven percent in Germany.

So very clear, quiet, some advances. As far as heating and cooling is concerned, there was growing interest in the use of advanced collectors for district heating systems, for solar cooling, and for industrial applications. Also advanced systems represent a small fraction of the global market. We must not forget that energy use for heat accounted for about half of total final world energy consumption in 2014, and about half of the world's final energy consumption was used to provide heat for buildings and industry with modern renewables, mainly biomass generating approximately eight percent of these shares. So we see that the renewables are prominent. However, we also see that these—there is a vast potential for solar, for _____ and for geothermal technologies, and using this potential is absolutely key for succeeding the energy transition.

If we're to complete this on transport, renewables accounted for an estimated 3.5 percent of global energy demand for road transport in 2013. That is an increase compared to a couple of years before. However, also there is still a lot of space for growth. So the Global Status Report then goes into very much detail for providing overviews about development—technology development in the different areas. I just brought here the graph for solar PV where we see that last year, there was a lot of additions, 40 gigabyte edit totally globally, bringing the total capacity to 177 gigabytes. And what is very interesting to note is that more than 60 percent of all PV capacity in operation worldwide at the end of 20104 was added over the past three years. So we see it as cost of technologies have come down, and the solar technologies are valid options for many parts in the world.

And however, we have succeeded when we look at solar thermal that some of these very rapid solar PV development had a negative impact on the heating and cooling technologies, and there was cannibalization going on. So when we look at bio-energy, we see the demand continue to grow steadily for bio-energy both in heating in the power and transport sector. The globally biomass was used to produce an estimated 12,500 terabyte hours of heat in 2014. That was an increase.

And approximately nine gigabyte thermal of modern biomass heat capacity were added in 2014, increasing the total global capacity to about 305 gigabytes. Modern biomass heat generation occurs mainly in Europe, in developing countries in Asia, and in also North America. And when we look at demand for modern biomass such as food pellets, we see that the demand is increasing. We also see an increase in international trades. And we see the global production of wood pellets rising by nine percent to just over 24 million tons.

Main wood pellet producing regions continue to be in Europe. Roughly 62 percent of the market. And North America, roughly 34 percent. The top

national producers were the United States, Germany, Canada, Sweden, and Latvia. So when we look at solar thermal heating and cooling, the cumulative capacity of all collected types and operation rose by a net 44 gigabyte thermal for a year-end total of 374.7 gigabyte thermal. We saw it at the solar water heating collectors increased, and most countries focused on placed water collectors with both China and India primarily installing evacuated tube water collectors, and other key markets relying mainly on flat plates collectors.

In the United States, the majority of systems use unglazed water collectors for pool heating, and the only other market of note for unglazed water collectors are Australia and Brazil. In 2014, we saw a slowdown in market growth when—we see that in China, there is a trend away from retail market to commercial projects, and but overall, the developments in the heating and cooling sector are slower than in the electricity sector, as I mentioned before. Now when we look at jobs, according to statistics from IRENA, the International Renewable Energy Agency, an estimated 7.7 million direct or indirect jobs in the renewable energy industry are existing.

We have solar PV as being the largest employer with 2.5 million jobs, most of which are concentrated in China due to its undisputed lead in manufacturing, as well as a rapidly expanding domestic market, but we also have solar—a boost in solar PV employment in Japan in the United States and in Bangladesh. Now when we look at investment, globally there were 270.2 billion US dollars in renewables in 2014. You see that after a decline of three years, it was the first year since 2011 that investment increased again, and the reason for this increase was increasing solar power installations in China and Japan. Investment in solar power was up 25 percent and we also saw record investments in offshore wind projects in Europe.

However, when you look at these 270 billion, they are not equally spread throughout the globe. We have a very interesting development here is when you actually compare the share of developed countries, OECD countries, and emerging economies in developing countries, so these 270 spread half, 139 versus 131 billion. But what I think is very interesting is when you look at how these numbers have increased compared to 2013. Then you see in the OECD countries, the increase was in the auto three percent compared to the previous year, whereas emerging economies in developing countries have increased their investment in renewables by 36 percent compared to 2013. And I think this is very encouraging because these parts of the world energy demand is growing.

So when you look where most renewables growth has occurred, it is in China, it's in Asia, it is in Latin America, and also more and more in Africa and the Middle East. REN21 tracks the development of renewable energy policy since 2005. And they obviously—the last decade has really brought an expansion of renewable energy policy frameworks. There were about 48 countries in 2005 with about some kind of policies and targets. In 2014, this number went up to 164 countries, so a clear spreading. We see that—so 164 countries all around the world have some renewable energy policy targets. Most countries have policies in the electricity sector to promote renewables,

but we see also more and more countries with heat obligation and some heat mandates in 2014 that was in the order of 21 countries altogether.

So lots of advancement on renewables. When we look at the access question, we must notice that still 15 percent of the global population lack access to electricity, and lots of people rely on traditional biomass for cooking. And we note also that distributed renewable energy systems offer and presented opportunity to accelerate this transition to modern services in remote areas, and very often very cost competitive. We also know that often, there is not enough information about the market volumes and about the opportunities that distributed renewable energy can provide.

And so we tried for the first time to quantify it, and we see that often solar PV attracted roughly \$64 billion US dollars of investment in 2014. But it's clear also, yes, there are opportunities with renewables, but if we are serious about the—as for the role objective of ensuring energy access for all by 2030, that was now also confirmed by the _____, Sustainable Development Goal Number 7 on sustainable energy access, then these efforts to speed up excess and to provide the standard solutions with renewables need to be intensified and their deployment needs to be happening more quickly.

So overall, in conclusion, 2014 was an interesting year where renewables continued to grow against backdrop of increasing global energy option, and the dramatic decline in oil prices during the second half of the year. It was a record year in the sense that for the first time in 40 years, economic and CO2 problems have decoupled. Despite rising energy use for the first time in four decades, global carbon emissions associated with energy consumption remains stable while the global economy grew, and this stabilization has been attributed to the increased penetration of renewable energy in the _____ countries, and to the increased penetration of renewables in energy efficiency in China.

So what I would say is that the past decade has really set the wind in motion for a global energy transition, but I think we need to put more focus on the heating and cooling sector as well as in the transport sector, and I think we need to spend also more time on some energy system thinking linking the two sectors in order to really harness their potential and also fostering policy solutions that provide frameworks for renewables uptake in all these sectors. And of course, I think also very important when we think about heating and cooling, we must not forget the demand side, and it is very important that renewable for motion measures are combined with measures on the demand side with a focus on energy efficiency especially when buildings are concerned.

With this, I would like to thank you for attention, and hand it back to Sean.

Sean Esterly

Great, thank you very much, Christine, and we will move right ahead now to Gerhard for his presentation.

Gerhard Stryi-Hipp

Okay, so can you see my screen?

Sean Esterly

Yes, we can. Perfect.

Gerhard Stryi-Hipp

Okay. Hello, welcome everybody to my presentation. I want—introduce _____ for Solar Energy Systems here in Freiburg, Germany. Also president on European technology platform on renewable heating and cooling, and I want to focus on the question of how we can strengthen renewable heating and cooling. Christine already mentioned two important things. We have to put more effort in the development of the sector from our point of view, and secondly, we have to have also kind of system thinking and test more how heating and cooling and transport and electricity sectors working together. I will come back to that point later on.

So let me start with the renewable heating and cooling technology platform. This is your European technology platforms are an invention of the European commission several years ago, and therefore are very different technologies. These platforms are existing, and we brought together the solar thermal technology, the biomass sector, the geothermal sector, and the heat com sector together in one technology platform promoted by the European commission because it was clear that there is a lot of interaction and interdependencies between the different panels.

And we have also a lot of technologies which we are working with in the same way, and you therefore you see the structure. We are structured in four panels, four technology panels, and the fifth panel which is a cross-cutting technology panel where we are talking about hybrid systems, about district heating. So technologies which are—and storage technology. Technologies which are used for all the other panels, all the other technologies as well. We have one board, which is representing the overall technology panel and secretariat and about 600 members from industry, from research, and also from the public sector.

And working on the topic since 2008. And there are the first steps of a technology platform in the European way are always the same. First, we work on a region to work out and describe what could be expect from the sector, from the technology in this sector by 2030. So we develop this common vision in 2011 already, and then we worked on the strategic research priorities, identified most promising technologies, and innovations in the different sectors. And you'll see we first started with, yeah, this research priorities for a different technologies. And then we finalized the work by preparing research priority for the overall sector.

And the last step which we finalized last year was to develop based on the research priorities, the identified concrete technology road maps until 2020. The sectors, and then the sector as a whole to describe which projects we expect, which research programs we need, which research topics are for most importance in order to achieve specific goals which we quantified for the year 2020. So if you're interested either in a single technology or in the potential of the renewable heating and cooling technologies as a whole, please go to the website and you'll find there the documents.

And it shows in general I think this was a very important message, a very important result of that work that the innovation capacity of the sector is much bigger and much higher than expected before. And therefore, we are aiming not only for running these programs, but also to increase the research budget to be able to do that research and achieve these goals. I want to give coming from the technology sector a very brief overview of what we understand, yeah, what is a part of this technologies. You know, yeah, the technologies differs a lot from country to country, and it is important to realize the diversity and heterogeneity of the sector to understand also the challenge to improve and to develop the sector.

Starting with solar water heating, Christine showed that the market is quite good developing over the last years globally. Unfortunately in Europe, we saw a reduction in the market over the last two or three years. So unfortunately, we don't have a good market development at the moment, besides the fact there is a great potential. The characteristics are very clear. Solar radiation is for free, and that is everywhere. I think this is also on a global scale very important. Solar thermal energy can be used everywhere. However, we have to deal with the _____, and all solar variation, so we have challenges to enlarge the type of applications, increase the solar of action for building and each operation that we use costs.

The right hand side, you see the different types of technologies, which are now pictures from Europe. However, the type of application is more or less the same all over the world. We are doing rule meeting for one, two multi-family homes, household, hospitals, district meeting, but also multi-functional facades is a topic of the future, technology which will be used in the future, PV, thermal hybrid collectors, and the second important field or sector to an application sector is the process heat sector where we are dividing technologies up to 100 Celsius degrees.

There are a lot of industrial and commercial applications which are below 100 Celsius degrees, which can be where heat can be generated without concentration. Then we have a medium temperature sector up to 250 Celsius degree where we are using concentrating collectors, and we do have solar assistance cooling and refrigeration. So this is a very brief overview. If you go to the biomass sector, you'll see here it is much bigger. Also we have seen that from the figures of Christine, this is also true for Europe. The biomass sector is the main supplier of renewable heat today in Europe.

The huge advantage is that it is storable, however it is limited, and what is very important if you talk about biomass use, it should be produced in a sustainable way because we have a lot of unsustainable production worldwide, but this is not really long-lasting, and therefore we have to define sustainable production criteria, and this is implemented. But if you talk about sustainable production, then also the potential is lower than any other case.

Challenges are there. We have to develop sustainable biomass supply change. We have to define sustainability criteria. We have to increase the efficiency of burning biomass, and we have to increase the efficiency by using combined heat and power and cooling biomass plants. The type of application

you see on the right hand side, you have small burners and single family house, for example, but we have also the district heating and cooling sector with very large heating plants, combined heat and power plants, or heat only plants which are mainly using wood in a way of pellets, wood chip boilers.

But also waste and agriculture feedstock is used. In general, we are not talking only about solid biomass. This is the main sector today. However, we do have also a growing sector of bio-gas used and bio-fuels used. The geothermal sector, this is, yeah, also very important. However, at rather low-level today, I have here only numbers on the heat pumps to give you an idea. The geothermal heat pumps using underground heat is only 0.1 million sold last year in Europe. However, the _____ thermal heat pumps sold are 1.6 million. You see that geothermal use in combination with heat pump is much lower than the use of heat pumps which are based on aérothermal—yeah, using the ambient energy. Characteristic is it is a constant heat source, that's a huge advantage or benefit.

The resources are principally everywhere, however the quality of deep geothermal resources depend on local geology and depth. Challenge is a huge risk of exploration, and so we have to improve exploration technologies and underground reconnaissance. We have to increase the efficiency and reduce the costs, and we have to deploy AGS, advanced geothermal systems, to have a broader use of the technology. On the right hand side, you see also a huge variety of technologies, geothermal heat pumps, or shallow geothermal underground thermal storage is also an important topic. It can be used for domestic hot quarter space heating cooling process heat, and we have deep geothermal, which is usually below 400 meter, and it is direct heat use, allows direct heat use, and combined heat and power.

So a huge variety there as well, and to give you an idea what we talk about if you talk about cost-cutting technologies, so on the one hand side, district heating and cooling thermal energy storage and high persistent heat pumps, we're also a huge variety of technological innovations are possible end needed in the future to—yeah, to increase the use of renewable and efficient heating and cooling technologies. So what about the future of heating and cooling? This is here a picture or a graph which we developed in our vision document 2011 already, and you see here that today, we are at about between 10 and 15 percent.

Sorry, this is the renewable heating and cooling sector in Europe, and this is the heat demand, and you see that we expect a slowly decreasing demand in Europe on heating and cooling. On the other hand side, we see—we expect and continuously increase of renewable heating and cooling, and therefore, from our vision, we are able to achieve up to 100 percent of renewable heating and cooling in Europe by 2040. From the technology, from the market, from the potential, this would be possible if the right policy is established.

However, it is very important to understand what is the competition in which the renewable heating cooling technologies are. And the first competition is that fossil fuels are against renewable energy sources. On the one hand side,

we have a situation that we expect that on mid and long-term due to scarcity of fossil fuels, due to growing import dependency in most other countries globally, and due to climate change, you do have the de-carbonization goal of G7, and further regulations. We expect fossil fuels will go down, and immediately, renewable will grow. So therefore, we are very optimistic that this goal will happen. However, we see at the moment that the declining fossil fuel prices, it is today more difficult to compete price wise for renewable heating and cooling with fossil fuels than it was two or three years ago.

So this is really becoming more difficult as it was, however, we believe that renewable energy sources will replace fossil fuels on the long run because there is no alternative from our point of view if you want to achieve de-carbonization globally. However, what is very important—so if you talk about the specific technologies if we thought about the competition within the sector. And so there is a competition of solar thermal technology, the biomass, with the geothermal technology, and in the meantime also we have a growing share of heat generated by renewable electricity and heat pumps. And so the single technologies have to improve their performance, their attractiveness, their competitiveness in order to be competitive within the sector.

It's not only important to be competitive against fossil fuels, but also within the sector. I want to show you here this slide to explain a little bit what I mean with difficulty to compete with fossil fuels. Here is an example of heat costs for solar thermal heat generated in Europe. You'll see here the blue line here is the European Union average price for natural gas. So this is at about 7.7 euros then, and this is European Union average price of electricity, and this is 19.3 euro cent. And this, the orange bars are the energy prices, the heat prices from solar thermal systems in euro. And you see it has a huge variety because it depends on the location with your domestic hot water systems and for circulation systems in Southern Europe.

For domestic hot water, they have a price between three and 12 euro cent. In Central and Northern Europe, the systems—the heat price is between eight and 19 euro cent. Due to the lower—on one hand side, due to the lower radiation intensity, but also due to higher investment costs buy it because the integration of the systems, this in Central Europe and Northern Europe more expensive than in Southern Europe. So-called _____ systems which in addition support room heating, not only domestic hot water, but as a room heating has a higher cost between 14 and 23 euro cents. They are mainly used in Central and Northern Europe, and industrial process heat systems in South and Central Europe has a price—a heat price between 4 and 12 euro cent.

And we do have a growing share of district heating systems in combination with solar thermal energy. Very much strong development this year happening in Denmark. This is the leading company with district heating and integrating our solar thermal energy, and they are able to enable that at a very low price at about four euro cents. However, if you go to large systems in Germany, also we have seasonal heat storage, then it comes to prices up to 90 euro cent. So therefore, you see there's a huge difference between the lowest

and highest price, and we are here if you complete _____, we have several market sectors where we are already competitive, but we have also in North and especially Central and Northern Europe, a large area or a huge—a large part of the market, which is not competitive yet.

And therefore, it is very important that we in the sector not only in solar thermal energy. This was an example, but in general heating and cooling, which we have to talk about prices, understand the competitiveness, and also clearly understand with which technology and with which prices we have to compete because it's not only that the re-overheating and cooling price differs a lot from country to country, from region to region, but also the heat price.

For example, the gas price is changing a lot or is differing a lot, and therefore it is very important to understand the competitiveness of the technology if you talk about market development. What we identified for all of our technologies that cost reduction is a very important aspect, and this is one of our main goals of the technological development and the research topics we identified.

But I also want to explain a little bit that it is not only simple to say you have to do some research and development and reduce the cost of the components. Because also here in the example of solar thermal energy, we identified that the price for solar collectors went down variable from 1995 to 2015. You see we started with 195 percent, 2010 this was our reference point, 100 percent, and we expect it further going down. So we see a very good learning curve factor of 23 percent. This is better than in the _____ sector. For standard collectors, which are typically used in Europe, they're the size of 2 to 2.5 square meters. On the other hand side, you see here the green bars, this is the market development.

So with the market growth, we have seen a continuous price reduction, and this is similar to what happened in the _____ sector or the wind sector. However, our problem in the solar thermal sector is that the collector is only about 20 to 40 percent of the overall costs of such a system, and we have a lot of costs for marketing and installation, which is kind of on top. This led to a situation that the price for collector went down over the last 20 to—10 to 20 years, however, the price for the end customers and the heating price by solar thermal was more or less stable over the last ten years.

And this means that we—if you talk about price development and cost reduction of the sector, we have especially focused on the cost reduction at the end consumer because they have to pay for the energy and they only ask how much energy I can generate and what is the price of this energy and how can I compare it with natural gas or perhaps for heating oil or other sources or other sources of heat. And therefore, cost reduction, yes, but we have to go more in detail if we want to understand what we have to do. I want to have a strong discussion in Germany today also on the how developed the heating and cooling sector because also in Germany, we have seen a very good development in the electricity sector for renewables. However, in the heating

and cooling sector, we are today only at about 11 percent of the overall heat demand, and the goal is to have 14 percent in 2020.

This is rather low, and we are now sure if we will achieve the goal. So it is very difficult. This is the result very difficult to stimulate that market. And we have had some studies to understand better why is this the case. And I want to explain or give you an idea of what kind of factors are there in the German and European context, and I'm sure this is also true in a lot of—in most of the other countries. So we have to be aware of the specific characteristics of the heating and cooling markets to understand also what has to be done to improve and further develop the sector. First of all, we have to be aware that there is a high heterogeneity and high complexity in the sector.

Not only on technologies, but also on owners and operators of the systems, on the technologies, on the equipment and system sizes, and also type and system of applications. We have small stoves for single rooms. We have heating—central heating systems for buildings. We have district heating systems, you have process heating systems. So a huge variety, and therefore it's much more complicated than, for example, in the for the _____ sector where you can have one _____ module which can be used for more or less every application.

Secondly, we have a strong dependency on international fossil fuel prices, and we are not sure how the fossil fuel price will develop. We have seen a strong decrease over the last two years, which was very unexpected for most of us, and therefore we also don't know what is the future of it. And we have to take that into account because competitiveness is depending a lot on this international fossil fuel prices. Third point is we see a strong and growing interdependency of the heating and cooling to the electrical sector by heat pumps by combined heat and power, by other power to heat technologies.

And so we do not have—if you talk about the heating and cooling sector, we have not only to develop single technologies—solar thermal, for example, collectors, but we have also to develop heating and cooling technologies and systems as a part of the heating and cooling and electric system. I will come back to that point also on the next slide. The next point is that the future heating and cooling demand is difficult to forecast because it is strongly dependent on efficiency and comfort requirements. We altogether noted there is a huge potential to reuse heat consumption by insulation of buildings, not only in wintertime by reducing heating demand, but also in the summertime to reduce the cooling demand in for buildings which are in hot climates.

So efficiency technologies and distribution plays an important role, and therefore development of the heating and cooling sector is strongly related to efficiency measures and also come for requirements in that sector. This is much stronger than in the electricity sector. And renewable energy sources are able to deliver 100 percent of the heating and cooling demand. I have shown you at least the slide for Europe. However, we have to be aware that this is only possible if demand is limited. We need therefore very high efficient systems. Energy system must be—these energy systems must be optimized, and you have to find the right mix of local resources because the

resources for heating and cooling renewables from heating and cooling are not everywhere in the same way.

We have in southern oriented countries, we have at lower latitudes, we have much higher sun. In northern latitudes, higher latitudes, we have perhaps more biomass, for example, and we have more seasonal differences. This has to be taken into account, and the entire electrical heating and cooling system must be optimized. And last but not least, development of technologies in markets and heating and cooling is necessary. So we have to develop not only the markets itself. We have technologies which are already working today. However, we also see that there is a huge—not only a huge market potential, but also a huge potential on technological innovations. And unfortunately, over the last years indicates, this technological potential was not—people were not aware of, and therefore we don't have large research institutions. We don't have the large R&D programs, and we have to improve that.

We have to spend more budget for R&D in the heating and cooling sector to enable the renewable heating and cooling sector to _____. But what I want to do in the next slide and show to you is what does this mean with the growing interdependency of the heating and cooling with the electrical sector. I want to show you here this slide which shows this connectivity. For example, for a heating and cooling sector, I don't have the cooling here included. It's more a Central and Northern European slide, but we can also include cooling and will be a little bit different, but with the same message. So if you imagine a city which is supplied by only renewable energy, you have on the one hand side the electrical grid, you have some heat networks, and you have a lot of buildings with single heater.

For example, heat pumps, combined heat and power, solar heaters, wood stoves, and heat pumps with gas. The sources, we do have wind for _____, hydropower for electricity, solar, heat, and geothermal for heat. And what we see is European wide and I will expect worldwide, we see a growing share of heat pumps, electrical heat pumps, and therefore a close connection between electrical and heat sector. We see a growing share of _____, not only on the central level, but also on the buildings combined with storage technologies. We see also electric storage technologies on district level.

Not in every country. Today, we start with that technology in Europe or Central Europe, but also in US, there are several states which are now installing electrical storage on district level. We have increasing share of electric vehicles, which will influence the electrical system, not too much at the moment. However, in Norway, for example, 25 percent of the new cars are electric vehicles in the meantime. With heat storage, which are used seasonal, which are supporting the heat networks, for example, in Denmark, and this will also in the long run from our point of view grow in for other countries, and we also have power to heat technologies where excess electricity, for example, wind and _____ can be used to heat other storage—heat storage if there is not the demand for electricity at the time where this electricity is generated.

We have a gas network, which can be moved to and changed to a biogas network. We have wood which is burned in wood stoves, and then if you have this biogas network, we can also run CHE plants and heat pumps with gas either on the district level, but also on the building level. And we have gas seasonal storage, which are already existing in large gas networks. We can also use that to compensate fluctuations. And perhaps in future, we will see also electrolyzers which are generating hydrogen, which can be used to feed into the gas network or to run cars, or with maturation, we can also generate methane, which is fed into the gas network.

This system can be connected to the region to have enough renewable energy to be supplied, and it can be connected to the electrical—national electrical grid or also national gas grid. But what I wanted to say with that slide is that if you look into the future, the first message is we are only able to have a high share of renewable energy sources where we will have for sure due to the potentials a high share of wind and for _____ and solar thermal which are fluctuating. If we will find a good—an ideal combination of the different sources, it's not one source. We will have a combination and a mix of different sources, and secondly, these different technologies and different sectors has to be combined to have a secure supply of energy and electricity and heating and cooling.

For sure, this picture is more in north oriented countries or higher latitudes for Southern European countries or southern oriented countries, lower latitudes, you will have instead of the heating, large heating demand, you will further rather see more cooling demand, which you can integrate in that system as well. Okay, we are close to the end of the presentation, so I will go through the next slide very fast. I only wanted to add another aspect because you also said we want to say that we are sure we are looking on the European market. However, we also try to understand what is happening in different other markets.

And one example is we have a project in India looking into process heating there, and they realize that there is a lack of awareness, that there is a concern of reliability, and also there is a need for reliable data on performance and on finance. And therefore, we started a project, and you see here these plans which we have money towards to understand what is really the output of the system. And what we understood is that only to give you some ideas that the solar thermal systems are looking very different. The collectors are more or less the same. However, the system technology is very different in India in comparison to Germany. For example, in Germany and in Central and Northern Europe, you only have pressurized systems, and in India, you have almost only non-pressurized systems. In Central Northern Europe, you have mainly glycol mixture the freezing risk is there.

In India, there is mainly not the need to have this, and only water is used. We have in Central Northern Europe only automatically controlled systems. In India, manually operated systems, and there are different system philosophies behind. I don't want to go into detail here, but I wanted to show that slides in order to make clear if you go in detail for the different technologies and

different equipment, we understand that globally there is a huge difference between the different technologies and the status of technologies, but also the culture how to use this equipment in the different countries. And if we really want on a global scale develop these technologies, we have to understand that in order to support and exchange the experience and support other countries by this development.

I come to the conclusions. First of all, the good message is that the renewable heating and cooling sector is growing globally. Christine showed it to us. However, much more slowly than the electricity sector, so there is a great large room to improve and speed up. The main barriers are competitiveness, and as I showed to you and tried to explain, competitiveness means not on a global scale of cost for collectors or something. You really have to go into the single markets to understand how competitive a specific technology is. And secondly, we are competing with fossil fuel price, international fossil fuel prices, which are often subsidized, and therefore also this must be taken into account. Secondly, we are dealing in the heating and cooling sector mainly with complexity, with a higher complexity of systems, and also some concerns and reliability, which is somehow linked to each other.

And thirdly, we have to integrate heating systems and cooling systems more and more in the electric system. This is not everywhere the case, so if you have a single house, you can for sure run your solar thermal system or your biomass burner. However, in a lot of—and we see a growing share of people living in big cities. Then the systems, the energy system is much more interconnected. And the last part, the development of renewable heating and cooling markets needs on the one hand side market oriented solutions, and I must say local market oriented solutions. This means also that no _____ transfer, which we want to have if you want to see is not only to have a transfer of knowledge, but also to adapt technologies. The secondly, increase political support for market deployment is necessary, and—sorry, I have also to write that in bold letters, more R&D, more innovation and more technological development is necessary to make the systems working to reduce the cost to increase efficiency and reliability, and also to enter your market segments.

So this was a broad variety of topics. I hope it was interesting for you, and thank you for listening.

Sean Esterly

Thank you very much, Gerhard, for the presentation. It was extremely informative, and covered the sector really well. We will now move onto the question and answer session. Before we do, I just want to remind the audience that if you have any questions either for Christine or for Gerhard, go ahead and submit those through the question pane in the Go to Webinar panel. And with that, we will move along to the first question. And this question is more for Gerhard. It asks how much electrification of the heating and cooling sector do you expect in the decade to come?

Gerhard Stryi-Hipp

That's a very good question which I cannot really—not answer in detail. However, what we know is that the level of electrification is—will grow. However, some people and some experts say we will only see electric heating

in future on the long run. We don't believe in that because there are a lot of reasons why this will not work, but what we see is that we have to understand better how the systems could work together, and we have to develop decision tools and tools to assess the different possibilities of technology. I will give you a short example, a brief example. Today, the share of heat pumps in Germany is increasing, and a lot of people saying, "Okay, that is a good idea. We have cheap _____, solar electricity, and we have heat pumps, and therefore we leave our _____ on the roof. We will heat our buildings."

However, what is not taken into account is that the solar generation is at higher latitudes in Central Europe, for example, in northern climates on a northern area hemisphere. It is mainly in summertime. In winter time, it's much lower, and but heating demand is mainly in winter time. So what we have to do is to better understand how this can work together so a specific share of the heat demand can be covered if heat pumps, but not the entire share. And therefore, I have no clear idea of how much and how fast this will increase, but I am fully sure that we will see also significant share of the heat demand covered by biomass, solar thermal, geothermal, which is directly generating and delivering heat.

Sean Esterly

Thank you, Gerhard. Christine, did you have anything to add? I think you are still muted.

Christine Lins

Yes, I muted myself. I mean I fully agree with Gerhard's assessment. What I do believe, however, is that we are probably going to see in the years to come some innovations on the policy level in the OSED countries, be it in North America or be it in Europe about exactly this integration of the electricity in the heating and cooling sector. I mean I think when we look at the shares where we're right at the renewables are really increasing in the electricity sector, we see that there is probably need for some balancing, and that will be done either through transport solutions or through heating and cooling solutions. And I think that the years to come will also bring not only some technology innovation, but also some policy innovation in that field.

And also that NREL has a whole laboratory looking at these different integration components. Yes, we need more information, and they're realizing the detail, but I think we're going to see some innovation and some developments happen in this part, not only on the technology side, but also on the policy level.

Sean Esterly

Great, thank you both. And the next question we have is for either of you. It asks why is renewable energy deployment in heating and cooling lagging behind power sector developments?

Christine Lins

Well I think that Gerhard's slide outlined that quite well. I mean what we have is a completely different segmented sector. Much more small scale installations that require lots of decisions, and then of course also this inter-linkage between—all this dependence of competitiveness closely connected to fossil fuel prices, oil prices, which is much less the case for electricity. All these for sure make it much more complex, and probably that also longer to see shares and improvement. But on the other hand, this is a sector which also

provides lots of opportunities in terms of value creation, local jobs in regions both for installation, but in also operation maintenance, and I just think that much more needs to be done to really stimulate the potential of renewable heating and cooling technologies in the building sector, both for new build, but also for innovation.

Gerhard Stryi-Hipp Well and I want to add the one thing is the awareness of the sector, which is not as high for the electricity sector. But if policy makers are aware of the sector, they also realize that the sector cannot be stimulated as easy as the electricity sector since due to the—we are missing a grid which is connecting everybody where also it is able to implement policies, support policies, for example, with the _____ or with other policies, which is much easier to implement in the electricity sector because we have one connected—we have one market which is connected where everybody is connected to each other.

And this is not the case here. We have a huge diversity of actors, of technologies, and also of fuels, and therefore it is much more difficult to establish sound and really successful policy. So you have to do—you have more than one insight, more complexity, and you have also to have a broader variety of policies to stimulate the different types of markets. And this is much more complicated and needs more effort, and therefore, also this is a reason why politicians and policies are not so effective in that sector as they are in the electricity sector.

Sean Esterly

Great, thank you, Gerhard. Thank you, Christine. And that is the final question I've received at this point. So we'll move along now to the attendee survey. If we get any more questions in, we can certainly come back and address those. So for the audience, we ask that you kindly take a minute to answer a quick survey we have on the webinar today. And the first question is being displayed. You can respond directly through that portal, and it states the webinar content provided me with useful information and insight. The second statement is the webinar's presenters were effective. Great. And the final one is overall, the webinar met my expectations.

Great, thank you very much for answering our survey. And on behalf of The Clean Energy Solutions Center, I would just like to once again thank our expert panelists for participating and presenting today on the topic. And also to our attendees for joining us. We very much appreciate everyone's time, and thank you for that. I invite our attendees to check the Solutions Center website if you would like to view the slides and listen to a recording of today's presentation as well as previously held webinars. Additionally on the site, you will find information on upcoming webinars and other training events. And also a reminder, we are now posting webinar recordings to the Clean Energy Solutions Center [YouTube channel](#). I do recommend checking that out. We have quite a few webinars up there currently along with some video interviews with thought leaders on clean energy policy topics. For this webinar, please allow a few days for the recording to be posted, although the PDF copies of the slides are currently posted. We also invite you to inform your colleagues and those in your networks about Solutions Center resources and services, including the no-cost ask an expert policy support. And so with

that, I hope everyone has a great rest of your day, and we hope to see you again at future Clean Air Energy Solutions Center events, and this concludes our webinar.

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