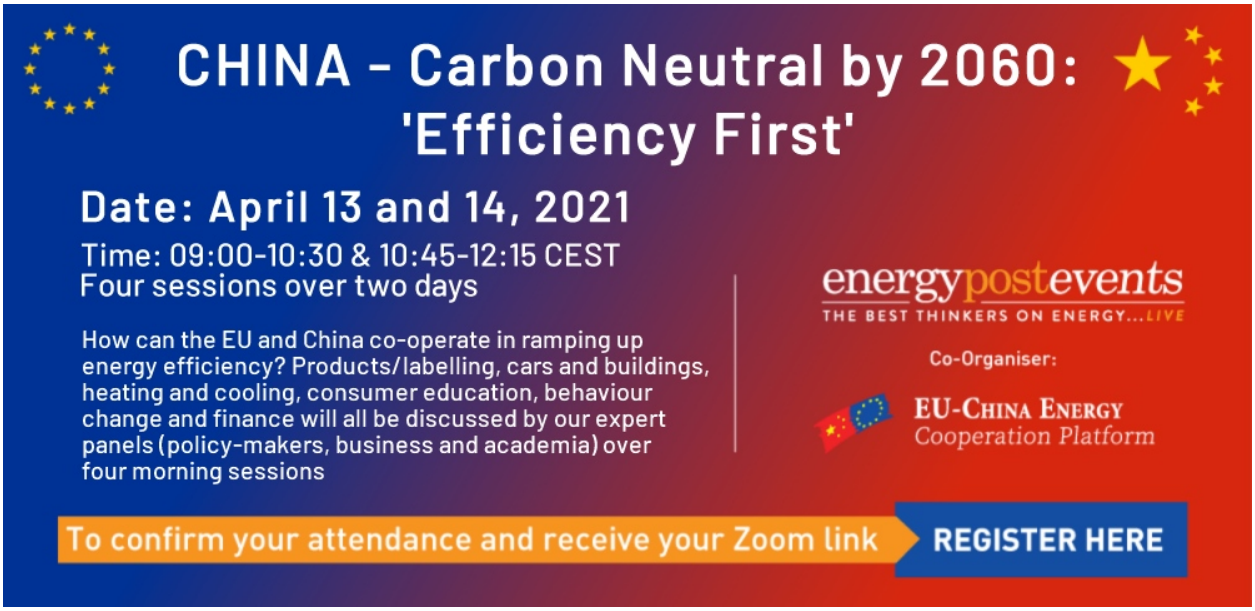
China – Carbon Neutral by 2060: “Efficiency First”

An online panel event held on 13rd and 14th April 2021



Session Three: Heating and Cooling

Participants

Thomas Nowak - Secretary General, EHPA (EUROPEAN HEAT PUMP ASSOCIATION)
Lipeng Zhang - International Consultant District Energy, representing VELUX China
Valdas Lukoševičius - President, LITHUANIAN DISTRICT HEATING ASSOCIATION
Alexandra Tudoroiu - Head of Policy, COGEN EUROPE
Alessandro Provaggi - Head of DHC+ Platform, EUROHEAT & POWER
Matthew James (Moderator) - Energy Post

Highlights

Europe’s and China’s heating systems will need to decarbonise to meet both goals for net zero emissions by mid-century, and the technology to do that largely exists today.

Combined heat and power, heat pumps and district heating can all be shifted to more renewable energy sources - both power and gas - to reduce emissions and increase efficiency. Different technologies will

work better for different cities or regions, depending on the availability of industries and waste plants, data centres (for waste heat), climate and government policy.

The biggest barrier is cost, giving different results for different regions. Lithuania's renewable heating, for example, relies on biomass for 70 percent of the share. Government policies are being introduced to subsidise other technologies.

Cold temperatures are still seen as a barrier to heat pumps, especially in northern China. The industry, however, argues that the technology will work at -20 degrees Celsius for a few weeks per year, and that it can be built as a hybrid with backup fuel. Most heat pumps now use sea water or air to pump the heat, but heat from data centres are seen as the up-and-coming source of limitless energy.

There is strong scope for China and Europe to work together in expanding zero-emissions heating systems, and for Europe to provide expertise based on years of practice and legislation.

Heating in Europe

- Europe is on its way to steady decarbonisation of the heating networks.
- In Lithuania, district heating is well developed and the renewable energy share is now 70%, mainly biomass and a bit of geothermal, with some small solar.
- Lithuania's priority is to diversify its renewable source by introducing more waste energy, hydro and geothermal.
- Gas accounts for around 40% of the energy mix, followed by 30% renewable energy.
- Through the comprehensive assessment on efficient and renewable heating and cooling, member states look at their overall demand and supply and look ahead at what sustainable solutions are cost effective for their countries.
- Europe can provide best practices. High efficiency "combined heat and power" (CHP), high efficiency district heating and heat pumps are all very well defined.
- In Lithuania, the main criteria for heat sources is the cost - and biomass is cheap and available. State policies now seek to support renewables and other sources, including raising the subsidies for non-biomass sources.
- District heating has been around a long time but is very flexible so could remain.

Heating in China

- In 2017, half of Chinese heating came from coal-fired CHP, one-third from coal boilers, most of the rest from gas and 4% from a mix of heat pumps and geothermal.
- Waste heat recovery has potential.
- Heat pumps have potential, but there are questions about whether they can cover heat demand on cold days in the north.
- The fuel mix is dominated by coal but there is a lot of opportunity to switch to gas.

- The government is paying more attention to clean heating, with eight national policies related to it in 2017. Cities that aim to develop clean heating systems can look at the national policy for specific methodology.
- China has a proposal to create a big network between nearby big cities powered by industrial waste heat and natural gas to power peak load.
- China should also be thinking about leapfrogging gas wherever possible because otherwise it may find itself with stranded assets in 20 years.

CHP: “combined heat and power”

- Asia is the biggest market for cogeneration to date. 40% of the cogeneration installed across the world is mainly in China and Japan, followed by Europe.
- In China, the economics of using gas for CHP are challenging, because electricity prices are capped low and gas prices are high.
- Europe has a very good manufacturing base for CHP and a good legislative framework that defines high-efficiency CHP.
- CHP in Europe is currently fuelled by 30% renewables (mainly biomass), but a large part still comes from coal, oil and gas, which will have to decarbonise.

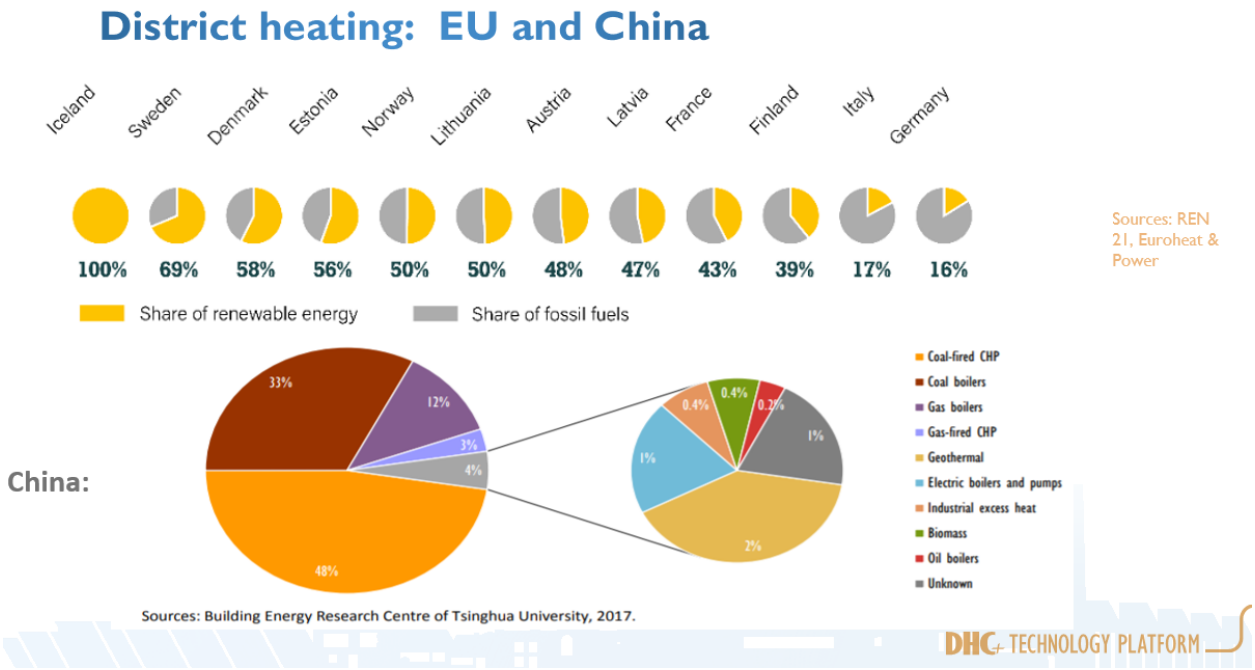
Heat pumps

- They can use renewable energy, reduce CO2 emissions and are available for residential, commercial and industrial applications as well as district heating.
- Most of Europe’s biggest heat pumps operating in district heating systems are in Scandinavia, its coldest areas.
- 10% of residential heating demand is now provided by heat pump technology, mostly with renewable energy.
- The sale of heat pumps in China increased by a factor of 80 between 2015 and 2018 to nearly 4,000 units.
- The temperature is not a problem, there are solutions for -20C. The refrigerant cycle works at -20C.
- Scandinavian countries mainly use sea water at the moment.
- Data centres are up and coming and can be a limitless sources of waste heat energy.

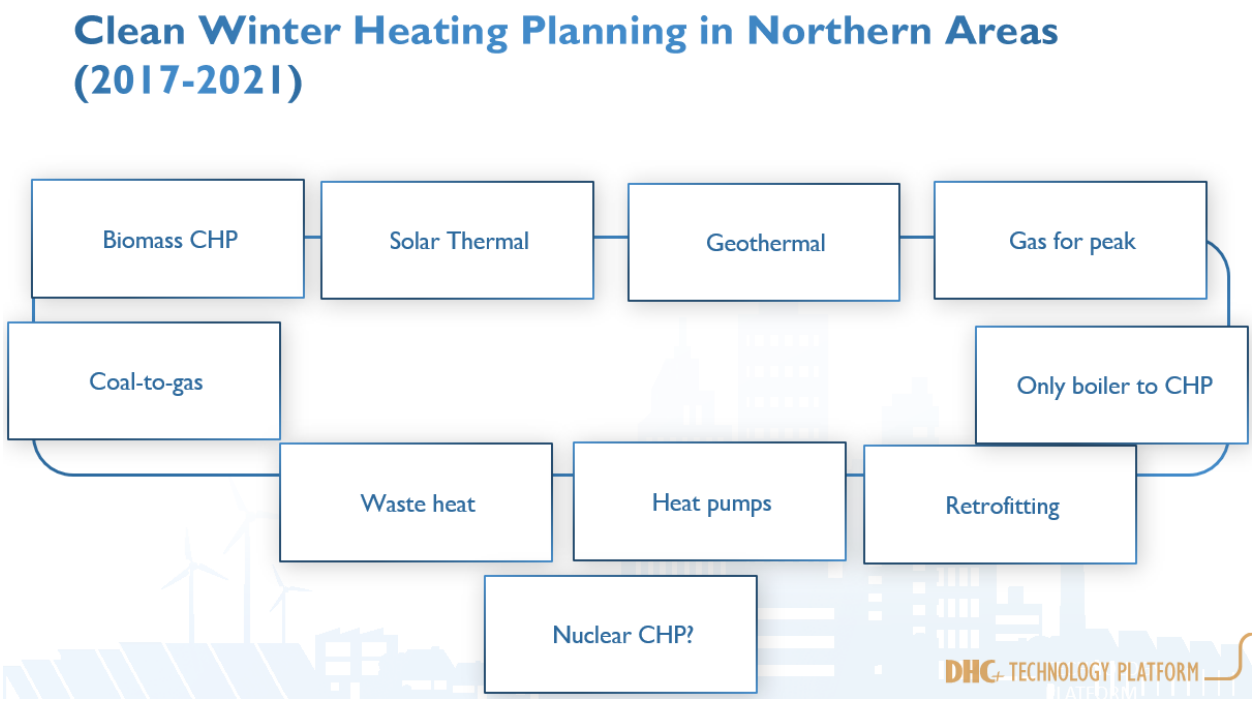
Session Three Summary

This is a summary, not a verbatim transcript, of the key points made during the online panel event.

Alessandro Provaggi
Head of DHC+ Platform, EUROHEAT & POWER



AP: You can see that Europe is on its way to steady decarbonisation of the heating networks. The picture is different in China. In 2017, half was coal-fired CHP, one-third was coal boilers and the rest was gas - CHP or not. The 4% share of 'others' is a mix of heat pumps and geothermal.



Since 2017, China has come out with a plan for the northern area, where district heating is more concentrated. There are differences and similarities with respect to Europe - there is a promotion of biomass CHP, solar thermal and geothermal - with a lot of investment recently from Chinese actors like Sinpec and the Asian development Bank. And of course there is the coal-to-gas policy.

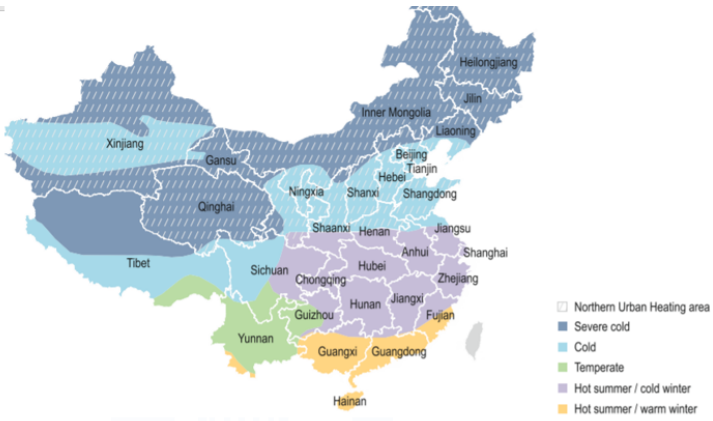
Gas at the moment accounts for around 10% of the energy supply. It was much less five to six year ago, but China is mainly importing gas from Central Asia, Myanmar and recently Russia. That may help to ease air pollution, and can especially be used for peak shaving, using gas instead of coal as back up on very cold days.

Waste heat from industrial processes and heat pumps also have potential. I hope we see more heat pumps in district heating and retrofitting in district heating.

Pathways

Waste heat recovery ?

- Industrial energy consumption constitutes 70% of total national energy consumption
- Industry not always close to heat demand



Heat pump driven district heating ?

- Power also fossil driven, at least for now
- Very cold temperatures make it difficult for heat electrification in the North

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I propose two pathways. One is waste heat recovery. Most energy consumption in China is for industry - that's a difference from Europe, and it means there is a lot wasted.

The second is heat pumps, which are also very promising. The problem is that unlike Europe, power is also fossil fuel-driven, and at least at the moment China continues to build new coal power plants. I see heat pumps as a promising technology also for other parts of China, not necessarily the north. In the north there are very cold days, and there is a question of whether heat electrification can cover the huge heat demand at those times.

Jinan

Waste heat and geothermal, demand-side management, smart meters, energy efficiency measures in building stock

Tibet

Solar district heating plant + heat storage

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Here you see two examples. Jinan is a pilot city, they retrofitted fossil fuels plants and started using waste heat and geothermal, applied demand-side management responses, smart meterings and are working on the building stock. In Tibet, this is an example of solar district heating plants.

We are all in the same boat, we all need to decarbonise, so I think China and the EU can work well together on this.

Matthew James (Moderator)
Energy Post

MJ: Indeed, cooperation is key and our next speaker can highlight that. Lipeng Zhang is an international consultant on district energy and working with companies in China that are focusing on innovative district heating in China.

Lipeng Zhang
International Consultant District Energy, representing VELUX China

LZ: I work as a senior energy consultant for VELUX, because they are trying to expand their energy market in China. Before this, I worked for the UN Environment Programme as an international consultant and I supported the district energy initiative.

Valdas Lukoševičius
President, LITHUANIAN DISTRICT HEATING ASSOCIATION

VL: District heating in Lithuania developed very widely. During the independence period it was renovated and replaced around 40% of pipelines and introduced renewable energy sources in all district energy heating systems. The renewable energy share is now 70%, mainly biomass and a bit of geothermal, with some small solar.

There is now district heating in all cities and all towns and there is a state policy priority to connect more and more consumers to district heating networks. Often this connection is forbidden or at least very difficult, but there is the possibility to use district heating as a tool for the implementation of renewable sources and the expansion and implementation of CHP plants.

According to our policy, several large biomass CHP plants are now under construction, and three large waste-to-energy plants in large cities. Our policy is to gradually replace biomass hot water boilers with CHP plants, in combination with wind plants and some solar in the electricity sector that will help decarbonisation.

A state priority is to gradually diversify renewable sources in parallel with biomass, to introduce more waste energy, hydro and geothermal. In the EU's new financial period we will be supported with the introduction of waste into district heating and the construction of biomass plants.

Alexandra Tudoroiu
Head of Policy, COGEN EUROPE

AT: Cogen Europe represents the European Association for the promotion of cogeneration, so the whole energy value chain. We promote energy efficiency first and energy systems integration, that's what CHP stands for. By combining heat and power you deliver more value to the customer as well as the energy system.

Globally, Asia is the biggest market for cogeneration to date. 40% of the cogeneration installed across the world is mainly in China and Japan, followed by Europe. In Europe we have about 120 GW of cogeneration installed. Gas accounts for around 40% of the energy mix, followed by 30% renewable energy. CHP is becoming more renewable in Europe.

In China, the fuel mix is dominated by coal. There is a lot of opportunity to switch to gas, although there are some challenges in the economics of using gas for CHP. You have to look at the spark spread - the difference between electricity prices and gas prices. In China electricity prices are mostly capped and gas prices are high compared to coal. If energy prices become reflective of the carbon intensity of those fuels, it will help push CHP.

Europe has a very good manufacturing base for CHP, so there are a lot of opportunities for cooperation between Europe and China. We also have a good legislative framework that defines high-efficiency CHP, which incentivises operators to develop CHP projects.

Thomas Nowak
Secretary General, EHPA (EUROPEAN HEAT PUMP ASSOCIATION)

TN: The European Heat Pump Association is cooperating with the Chinese energy efficiency association CECA, which has had a heat pump chapter since 2014.

Heat pumps are a jack-of-all-trades technology. It uses renewable energy and it reduces CO2 emissions as one of the most energy efficient technologies available. It's available for residential, commercial and industrial applications, as well as district heating.

Note that most of the biggest heat pumps that operate in district heating systems are in the coldest zones of Europe - Scandinavia has the biggest heat pump installations. In Europe, 1.6 million heat pumps were sold last year. That adds up to 14.6 million units in the heat pump stock - and that is 10% of the residential heating demand provided by heat pump technology, mostly renewable.

The French, Italian and German markets now see the biggest sales. But Scandinavia is much more advanced in market penetration per 1,000 or 10,000 households. And they work at -20 degrees Celsius.

We have been cooperating with the Chinese association since 2013. Colleagues from Scandinavia have explained to Chinese authorities that their heat pumps work in cold regions. Clean air is also a more important driver for China.

The sale of heat pumps in China increased by a factor of 80 between 2015 and 2018 to nearly 4,000 units. It's a considerable improvement and I'm very positive there is more to come.

LZ: We all know that for the heating system there are three elements - heat source, heat buildings and heat consumers, and there is the energy exchange. The 'pull system' controls all the levels. That means heat consumers can decide how much energy they can extract from the heat source and can design a way to turn off and turn on energy usage. This is a high-efficiency system.

The good news is that China's national government is paying more attention to heating, with new clean heating initiatives launched in recent years. In 2017 there were eight national policies related to clean heating. Cities that aim to develop clean heating systems can look at the national policy for specific methodology.

The right technologies depend on specific cities, as cities have different specificities and solutions.

MJ: Do you feel that the policies in place in Europe and China support the most efficient technologies, are there things we should be watching out for in June? What do you think, Alexandra?

AT: Local planning is key to ensuring that energy efficiency and decarbonisation are delivered, taking into account local conditions. With the current legislative debate on the EU Green Deal we are going in that direction.

Through the comprehensive assessment on efficient and renewable heating and cooling, member states look at their overall demand and supply and look ahead at what sustainable solutions are cost effective for their countries. The latest assessments were submitted at the end of last year.

We've also had a system integration strategy and hydrogen strategy, which are relevant for buildings and heating and cooling, and CHP is part of the solution at the system level. An integrated view on energy systems is really important.

The renewable gas package is important for Europe, because we need to decarbonise gas networks which are well developed across Europe.

Europe can provide best practices. High efficiency CHP, high efficiency district heating and heat pumps are all very well defined; there is an opportunity to learn from the piles of legislation the European Union has developed.

MJ: Valdas, to a certain extent you're a consumer of these drivers of district heating. How do you decide to set up heating solutions and the source of energy? Is it policy driven?

VL: The main criteria for technology solutions is the cost. Heating companies must seek the least cost to compete with other heating sources. At the present, biomass is very cheap and available in good quality, economically it's not possible to use other sources including waste heat. The share of biomass in district heating is now 70%.

But there is a politically-driven state policy to support renewable waste heat sources in this decade. We're considering a new project using waste heat from wastewater utilisation plants, data centres, etc. Large-scale heat pumps are involved, but the biggest barrier is still economical.

That’s why the state's policy now is not to support any more biomass, just CHP plants, and to allocate subsidies of up to 50% for projects that relate to waste heat systems. But even 50% sometimes is not economically, which is why we're discussing with the energy minister to increase subsidies to 80%.

You should keep in mind that our region is cold and in winter we need high temperature networks and in winter heat pumps are not very feasible.

MJ: Economic realities are driving your decision process. Thomas, large-scale use of heat pumps is just not realistic at this time in a country like Lithuania that has cold temperatures and a large reliance on community heating programmes, surely?

TN: The temperature is not the problem. You can find solutions for the technological challenges, -20C can be solved - the refrigerant cycle works at -20C. You need to understand that absolute zero is -273C, and almost everything above that has energy inside.

We have a good example outside Oslo, in Drammen, where they have a district heating system based on ammonia. It provides 90C year-round with an efficiency of around 3.06. Now they're adding cooling and the overall efficiency improves.

Construction wood is getting more and more expensive and at the same time people want to build more biomass. Is it okay that oil and coal and gas are so cheap and electricity in many member states is too expensive, while electricity is the cheapest source and fossil fuels are subsidised? We need a CO2 price applied on all energy sources, especially on the ones used for heating, and this will solve itself.

MJ: Alessandro, on this issue of sustainability and cogeneration, there is a lot of gas at the moment - roughly 40%, and 30% renewables. Is the renewables mainly from biomass, and if so what are the alternatives? And what is the remaining 30%?

AP: The source of district heating is becoming more and more decentralised. We have more heat pumps, more waste heat, and waste heat comes from industrial sources and unconventional sources like data centres or cooling systems or water treatment and so on in cities. Biomass is an important part, it's a transition technology and we try to focus as much as possible on the local dimension. When you have a district heating system in place you can use all the options.

MJ: It puts more of a squeeze on the role of gas in cogeneration.

AT: Cogeneration is an efficiency principle that can use a variety of fuels. If we start saying we will decarbonise by 2050, natural gas will be a big part of the fuel mix, biomass will be a big part, as well as geothermal and waste heat. CHP will make all these fuels more efficient.

Between now and 2050 there is a transitional period, CHP is 30% renewable, and that's mainly biomass. But the growth of biomass uptake has slowed down. 40% of CHP is based on natural gas, which will have to decarbonise and become increasingly renewable. About 50% still comes from oil and coal, but it's concentrated in some countries and going down.

Fuels are not the whole picture, we have to aim for local integration of fuels, energy carriers and endpoint demand reduction and demand response.

MJ: The profile of energy sources for district heating are very different in Europe and in China. Lipeng, what's the profile of energy sources for district heating in China?

LZ: Coal is the dominant fuel in the Chinese heating systems. Around 70% of the heating system is powered by coal. With China’s goal to become carbon neutral in 2060, all cities need to decarbonise their heating systems, so there will be a lot of change in the coming years.

It's hard to say a specific percentage, but China has a proposal to create a big network between nearby big cities powered by industrial waste heat and natural gas to power peak load.

MJ: Is it European technology being deployed for district heating systems in China?

LZ: Definitely between China and European countries there will be more and more cooperation in this sector. Specific technologies depend on specific city conditions.

AP: Most of the technologies we've mentioned today are technology-ready. It's not like green hydrogen for which we have to wait for around 10 years. In Europe we are on the way to delivering green heat through district heating, heat pumps, local biomass. The point I see for Europe is that we need to accelerate this deployment, via policy and via investment.

We need an investment deal flow. In the case of district heating we can prepare a portfolio of projects that can be retrofitted, made sustainable and so forth.

On gas, China should also be thinking about leapfrogging gas wherever possible because otherwise it may find itself with stranded assets in 20 years.

MJ: Alessandro, you talked about percentages of heat provided by district heating. Should we think of district heating as something from the past, or should it be increased because of the efficiency it delivers?

AP: There are some types of district heating from the Roman Empire, but it's still around because it's a flexible technology. We see many projections of district heating growing in Europe, it can be a very good enabler and offer a lot of flexibility to the electricity grid.

MJ: Will district heating grow in Lithuania?

VL: It is still an important energy infrastructure, but if we combine district heating, cooling, the utilisation of different waste flows available in cities and various sustainable heat sources, and if we use the cheapest and reliable technologies like plastic pipelines, and if there is no disturbance in the city - the future is bright.

The question is how to regulate it; there is still a monopoly. But if we have city planning and sustainable development, district heating will have a place in this process.

Q&A

Romanas Savikas asks: For Thomas, what is the effect of outside temperatures on the viability of heat pumps?

TN: Heat pumps work at -20C, but the efficiency will go down, so you need to take that into consideration in planning. But most of the time it is not -20C all year-round. The application in Switzerland, for example, has about one month of very low temperatures, so then you need to have a hybrid design with two energy sources to cover the peak load. Then you benefit in efficiency and emissions reductions during the rest of the year.

If you need heating and cooling at the same time, then the benefit is to have one installation that provides both services. Efficiency increases tremendously. We have a more optimistic opinion on electrification, I think it will be much more than 50-60% by 2050.

If China is considering gas it should be green gas.

Hans Van Der Sieper asks: In Scandinavia what do they use as a green heat source? If you have ambient air, it's more challenging than if you have other heat sources for which you can heat up to higher temperatures. In Scandinavia do they use air or other heat sources?

TN: They mainly use sea water at the moment. Data centres are up and coming and are great, they are limitless sources of energy. Every country that builds new data centres needs to consider putting it next to district heating systems so big heat pumps can provide all the heating and cooling needed.

Air is available, we're seeing 2, 3, 4MW container-size air source heat pumps because many areas of Europe are not in difficult climates. Air source is easier to use.

If you have 100% renewable or waste heat and 100% renewable energy, you have an emissions-free 100% renewable heating and cooling system. But even if you don't have green electricity, you still have 60, 70, 80% green heat.

Yong Cheng asks: CHP will be important for China in the next decade. Is there any experience in Europe to address uncertainty about the networks and pipelines needed for the coming decades, in case an industry has to be relocated and you lose the source of heat.

AT: Ten years ago we had an economic crisis that hit European industry, and the question of what happens to the CHP. The answer was, we still needed the CHP. There needs to be regulatory certainty. Any support scheme needs to be stable. Indeed the idea of having so-called symbiosis of industry and industrial parks - that can be an opportunity. If you plan at the system level and plan ahead, disruption will hit you less.

Agne Toleikyte asks: Valdas, you mentioned that one of the priorities is to use waste heat from industry. What is the situation now in Lithuania? How many industrial plants supply their heat to the grid? How is Lithuania going to promote this? Is industry motivated?

VL: It depends on the situation in the cities, where there are no large industrial plants that can provide excess heat. Several projects are now under development in Vilnius. The main restriction is economic, and that's why the government is considering support means like investment subsidies of 60% or maybe higher.

MJ: Closing remarks, please.

AT: From our perspective, system integration is key, and system efficiency is key as part of that. It will deliver decarbonisation and a cost-effective pathway to get there. System integration means taking a look at decarbonising heating and cooling in connection with electricity and gas grids and how they will be impacted.

AP: I would like to invite Chinese colleagues to contact us. We want to make this cooperation as practical as possible. I'm looking forward to more cooperation.

TN: We have been cooperating with China for a long time. The technology is ready, so my final word is that we need to give a value to energy efficiency as well as system integration and demand-side flexibility, and that can best be done by looking at the energy prices, by reducing the tax burden on electricity, by increasing the tax burden of fossil energy and by integrating the external effects of fossil fuel use pollution. In that way we will accelerate change.

VL: The advantages of district heating systems have been mentioned, but we need a new approach to regulation, motivation, the pricing system to make the heating system more competitive and safer from an investment point of view.

LZ: China and Europe will have a lot of cooperation in the coming years and VELUX can provide a bridge.

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Summary compiled by Sara Stefanini
Produced by Energy Post