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Determining Future Energy Efficiency Potential across Sectors: Case Study on Germany

—Transcript of a webinar offered by the Clean Energy Solutions Center on 7 November 2017—
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Webinar Presenter

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Katie Contos Hello, everyone. I'm Katie Contos, and welcome today's webinar, which is hosted by the Clean Energy Solutions Center in partnership with Enerdata. Today's webinar is focused on determining future energy efficiency potential across sectors: case study on Germany.

Before we begin I'll quickly go over some webinar features. For audio you have two options. You may either listen through your computer or over the 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 feedback and echo. 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 audio pin you should use to dial in. If anyone is having any technical difficulties with the webinar, you may contact the GoToWebinar's helpdesk at (888) 259-3826 for assistance.

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Finally, one important note of mention before we begin our presentation 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 Solutions Center resource library as one of many best practices resources reviewed and selected by technical experts.

Today's webinar agenda is centered around the presentation from our guest panelist, Dr. Manfred Hafner, who has joined us to discuss the main energy efficiency drivers as sectoral and end use levels and their impact on future energy conception. Before we jump into the presentation I'll provide a quick overview of the Clean Energy Solutions Center. Then, following the panelist's presentation we will have a question and answer session where the panelist will answer questions submitted by the audience. At the end of the webinar you'll automatically be prompted to fill out a brief survey as well, so thank you in advance for taking a moment to respond.

The Solutions Center was launched in 2011 under the Clean Energy Ministerial. The Clean Energy Ministerial is a high-level global forum to promote policies and programs that advance clean energy technology, to share lessons learned and best practices, and to encourage the transition to a global clean energy economy. Twenty-four countries and the European Commission are members covering 90 per cent of the clean energy investment, and 75 per cent of global greenhouse gas emissions.

This webinar is provided by the Clean Energy Solutions Center, which focuses on helping government and policy makers design and adopt policies and program that support the deployment of clean energy technologies. This is accomplished through the support and crafting and implementing policies related to energy access, no cost expert policy assistance, and peer-to-peer learning and training tools such as this webinar. The Clean Energy Solutions Center is cosponsored by the governments of Australia, Sweden, and the United States, with in-kind support from the government of Chile.

The Solutions Center provides several clean energy policy programs and services, including a team of over 60 global experts that can provide remote and in-person technical assistance to government and government-supported institutions, no-cost virtual webinar trainings on a variety of clean energy policy topics, partnership building with development agency and regional and global organizations to deliver support, and an online library containing over 5500 clean energy policy-related publications, tools, and videos, and other resources. Our primary audience is made up of energy policymakers and analysts from government and technical organizations in all countries, but we also strive to engage with private sector NGOs and civil society.

The Solutions Center is an international initiative that works with more than 35 international partners across its suite of different programs. Several of the partners are listed above and include organizations like IRENA, IEA, and programs like SEforALL and regional-focused entities such as ECOWAS Center for Renewable Energy and Energy Efficiency.

A marquee feature that the Solutions Center provides is a no-cost expert policy known as Ask an Expert. The Ask an Expert service matches policy makers with more than 60 global experts selected as authoritative leaders on specific clean energy finance and policy topics. For example, in the area of energy efficiency programs, we are very pleased to have Benjamin Curnier, Associate Director of Southern African Carbon Trust, serving as one of our experts. If you have a need for policy assistance in energy efficiency

programs or any other clean energy sector, we encourage you to use this valuable service. Again, this assistance is provided free of charge. If you have a question for our experts, please submit it through our simple online form at cleanenergysolutions.org/expert. 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 panelist. Our panelist is Dr. Manfred Hafner, who is a partner and vice president of consulting at Enerdata. Dr. Hafner is a recognized expert on energy scenario building, supply-demand assessment, energy policy analysis, market and strategy studies on all energy sources, with a specific focus on gas and power markets. During his almost 30 years of working in that field of energy, in which he has consulted extensively for energy companies, governments, and international organizations, he has gained considerable worldwide working experience, and in particular on European, Middle Eastern, North African, Russian, and CIS markets. And now, with that brief introduction I'd like to welcome Manfred to the webinar. Manfred?

Manfred Hafner Yes. Hello. Good afternoon, or good morning for our friends in the US. I'm going to talk about how to determine and our exercise at Enerdata in determining future energy efficiency potential across sectors, with a case study for Germany.

First of all, a few words about Enerdata for those of you who should not know us, even though I think most people will know us. Enerdata is a global energy intelligence company. It is independent; it is not related to any government organization or company interests. It is indeed a spinoff of a public research center in France. It has a global outreach. Its experts—it has a lot of experts, 40 people who do analysis and forecasting of global energy and climate issues. We do have in-house globally recognized databases and forecasting models. I'm going to talk about some of them today. We are headquartered in Grenoble in the French Alps, but we have offices in Paris, in London, in Singapore, and we have a global reach in the sense that our clients are in Europe, but in Asia, in the Americas, in Africa, and we work globally. The—one of the most important issues of Enerdata is it's an energy information and energy consulting company.

Now, today I'm going to talk about energy efficiency scenarios, the case study on Germany. First, a few slides on Germany. What is Germany? Germany is the largest country in Europe, in Western Europe. It is the largest country as far as population is concerned, as far as GDP is concerned, and it is the largest energy consumer in Europe. It has launched—it is quite an interesting country because it has a very ambitious policy on energy transition towards low carbon policies. It has launched in 2010 its energy concept, which is a comprehensive strategy with a long-term pathway to 2050 in order to decarbonize its economies. The goal is to become one of the world's most energy efficient and environmentally friendly economies. The policy is mainly based on promoting renewable energy, which is a cornerstone for future supply. But obviously, also, energy efficiency is an important part of the policy.

Now, when in 2010 this energy concept was developed the idea was to phase out—the phase out of nuclear, which had been decided by a previous red-green government under Schröder and the Greens. And the idea here was to postpone this nuclear phase-out. But then, in 2011, as you know, in March, the 11th of March of 2011 the Fukushima Daiichi nuclear accident happened, and Germany did a second U-turn, undoing this policy of the 2010 year, and therefore phasing out—deciding to phase out all nuclear power plants in Germany even much faster than originally planned, and by 2022. So, the idea is that by 2022 there will be no more nuclear power plants in Germany, while traditionally nuclear represented about 20 to 25 per cent of the power generation mix, therefore making it even more difficult, this energy transition, because obviously nuclear is—has a positive impact on nuclear, on the energy transition on low carbon—transition to low carbon mix. And therefore, renewables became even more important, as did the energy efficiency. So far, nine nuclear power plants have already been shut down since 2011.

Now, in 2011 we have therefore the second energy package, which we call "Energiewende," or in English "energy transition," with seven legislative measures to support it. One, a very strong access and focus, as I said, on renewable energy. Second, on grid expansion, because this is what you need in order to integrate renewables. Third, very important, to promote energy efficiency. And how to fund the reforms. And then, to phase out the nuclear by 2022, as I already said.

As far as energy efficiency targets are concerned, the targets are as follows: By 2020, the decision was taken in 2011 to have a reduction compared to 2008 by 20 per cent of primary energy demand in 2020, and by 50 per cent by 2050. So, by 2050 the idea was—is that you are only allowed to consume 50 per cent less energy than you consumed in 2008, but obviously you still want to increase GDP, you still want to have a wealthier society and a wealthier country. As far as electricity consumption is concerned, reduction levels are much more modest. Why? Because the energy transition goes hand in hand with electrification of the energy mix, and therefore you will move more towards electricity also because the renewables are very—to a large extent power-based, just like wind energy, solar energy, and therefore—PV energy, PV cells and solar—and therefore the energy transition goes hand in hand with an increased electricity demand. So, the electricity demand reduction by 2020 compared to 2008 will be by 10 per cent, and by 2050 compared to 2008 by 25 per cent—half the level, half the share, the reduction compared to primary energy demand.

Now, the sectoral targets. For the building sector, for instance, the decision was taken to make a very strong effort on building renovation on the old building stocks, to renovate not one, as was previously thought, what was the previous target, but now two per cent per year of the building stock, to renovate it, every year. Obviously, this is extremely important because yes, it is important to have building codes for new buildings, and Germany has very advanced building codes for new buildings, but you also need to address the existing buildings in existing cities. This is much more expensive and difficult. But—so, the aim was to double the effort and to reduce therefore

heating requirements compared to 2005 by 20 per cent in 2020, and then by 80 per cent in 2050. In other words, by 2050 the country should only consume 20 per cent of energy for heating purposes compared to 2005.

Also, the transportation sector, very important reductions. But obviously, as we know, it's much more difficult to implement reductions, at least in the short run, because the internal combustion engine is still there and—even though efficiency improvements are expected. And so, by 2020 the target is to have a 10 per cent reduction in the consumption of the transport sector, and 40 per cent by 2050 compared to 2005. How to do that? Well, the government provided €2 billion funding for the CO2 building renovation program, which was financed by the KfW energy efficient building and refurbishment funding programs.

Also, in 2009 first and then in 2014, thermal standards for new buildings have been strongly improved, and new regulations was also introduced to replace from 2015 on all oil and gas boilers which are more than 30 years old because the new ones, they have much better energy efficiency standards, and to implement for all new buildings by 2020 the climate-neutral building standard. So, very aggressive, very strong policies to reduce emissions, and in particular here, to promote energy efficiency.

Now, I'm going to say a few words on Enerdata's country energy demand forecasts. I'll give you a service description of what we do. Now, we have, as I told you before, we have different models. Here we use a specific model which we call MedPro, which is a bottom-up, very detailed model to allow—to do energy demand forecasts by country but also, if necessary, by region inside a country up to 2030, 2040. In this case we do it up to 2035. And in this case, we—so, this model is—can—is by sector, and by end users we will see, and in this service, we provide two scenarios: a reference scenario, which is a scenario based on the country targets and plans, and an energy efficiency scenario, which is a much more focused scenario promoting even more energy efficiency in the different countries.

So far, this service covers six European countries. They are Germany, France, Spain, the UK, Italy, and Belgium. But obviously, other countries can be addressed, and we can develop scenarios for other countries, as indeed we do on an ad hoc basis. The particularity and the very interesting thing of this service is that it allows to do sensitivity analysis on some key drivers. So, yes, there are two different scenarios, a reference scenario and an energy efficiency scenario, but then the user is able to play around with some specific key drivers, as we will see later on, either related to the macroeconomic scenarios, or demography, or energy prices, or the modal shift, the energy efficiency in buildings, et cetera, et cetera.

A few words on the model, which we have developed in-house. Enerdata exists for about 30 years and this is also the—from the very beginning Enerdata has worked on this model, MedPro, which originally called MEDEE. But it's a model which exists since the mid-1970s and which has been further developed by experts who worked at Enerdata or still work at Enerdata. It's a techno-economic model. It has been used worldwide in about

60 countries to provide energy demand forecasts and analysis by various actors of the energy sector. We have worked for companies, for governments, for policy makers.

And fundamentally, this model, MedPro allows us to do energy demand long-term forecasts by sector and end use up to 2040, and also to calibrate other scenarios which are top-down scenarios which do not have such a detailed bottom-up representation of the energy sector—so, to calibrate more econometric scenarios on the demand of our very detailed MedPro modeling exercise. It also allows us to evaluate energy efficiency policies and measures and to calculate specific energy indicators related to energy efficiency, for instance. And finally, it allows us to simulate sector by sector and end use greenhouse gas emissions related to specific policies and to evaluate the specific strategies to reduce greenhouse gas emissions from the demand side.

Some recent references where we have used this model include the French Ministry of the Environment, where we have had regular projects since 2008, but also earlier; the French Energy Efficiency Agency; the Tunisian Energy Efficiency Agency; the Moroccan Energy Efficiency Agency—the Moroccan Ministry of Energy, Mines, Water & Environment; the Turkish Ministry of Energy. But these are just the very latest and some examples of references on this model we have worldwide.

Now, just to give you an idea what the type of model and how we have modeled what we are going to present you for the case of Germany: This is one slide, the last slide on this model. How it works, very briefly, there are some input variables. These are socioeconomic variables like GDP, population, value-added, energy prices, productivity. And then, there are some technological input variables like fuel efficiency, mileage of cars and trucks, new equipment performance, and so on. And then, there are various modeling options. There is a very flexible disaggregation level by branch, by end use, by vehicles—cars, bus, modal transportation, and so on—by different zones of course. But also, flexible endogenization of different parameters like the number of vehicles, the production of energy-intensive industries, building stocks, and so on. And then, the outputs of the model are sectoral—so, there is a transportation sector, industry sector, residential sector, tertiary sector, agricultural sector, each of which is broken down by end use, like passenger freight by mode, the different modes, or thermal electricity and non-energy users, like cooking, hot water, space heating, air conditioning, lighting, or other electric users, like thermal and electricity uses, public lighting and so on. Or, for the agricultural sector, tractors, water pumping, and so on. So, very, very detailed disaggregation of the system.

And then, as the outputs we get energy demand globally, we get some specific outputs by—for industrial sector, for the transportation sector, for the residential sector, for tertiary and agricultural sector, and some very—some specific consumptions, like energy intensive products, vehicle types, end use, appliances, and so on. And specific indicators, like energy intensity, energy expenses by household, for instance, CO2 emissions and others.

Now, this was just a general introduction and explanation of what kind of model we use. This is a model which has been developed by Enerdata experts and by Enerdata itself. And now, I'm going to present to you the scenarios which we define in general. So, this is the reference scenario and the energy efficiency scenario in this—in the framework of this service.

Now, the reference scenario, as I said earlier on, is based on the national targets or the national energy demand outlook, based on current trends and existing policies, or policies which a country has decided to implement. It is based on the continuous but limited improvements in energy efficiency due to technological progress, but again, based on the targets and objectives of the individual countries. The second, energy efficiency scenario, which is a scenario which is much more ambitious policies. Here, we use the same macroeconomic assumptions as in the reference scenario, but we reinforce the building codes, we reinforce the renovation rate of old buildings, we use much more efficient appliances. We try to see how far we can go from using an economic optimum. We are not going to go to the very maximum you can go but to an economic optimum to push even further than countries presently do in their policies to see what the potential could be for that. The—to improve industrial processes, obviously, to have an increased modal transfer from private cars to public transportation, and greater improvements in energy performance of vehicles and of the transportation sector in general.

Now, let's come to Germany and let's look at the cross-sector analysis. First of all, the German case. This is—on the left-hand side we can see the reference scenario. So, we can already see that already now Germany has a policy to strongly reduce energy consumption by 2035. And if in 2013 consumption was about 210 million tons of oil equivalent, by 2035 it is expected to go down to 170, 175 million tons of oil equivalent. In our energy efficiency scenario on the right-hand side this reduction is much more pronounced, much stronger, and we come down to a consumption level, demand level by 2035 of less than—of about 140 million tons of oil equivalent. So, the final energy consumption growth is negative, obviously. It's a decrease in the reference scenario of 0.7 per cent per year on average over the period. And for the energy efficiency scenario it's more than double: It's a decrease of 1.6 per cent per year.

It is quite interesting to notice that the strongest decrease happens in the residential and the transportation sector in both scenarios. Why? Well, simply because the services sector, and in particular the industrial sector, has always been a focus by the main players. The big industries, they have a specific—always had a specific person. Energy consumption was very important for the sector, and they implemented a lot of easy measures already while, as we know, the residential sector, it was much more difficult to implement them. It's a much more decentralized sector. And we all have much too high a psychological discount rate in order to implement the right policies, even if they would make sense for us as well without any public intervention. And so, with a specific focus on new policies targeted, among others in particular also to this sector, which by itself does not do what it should do by itself, the potential and the catch-up potential is much higher for the residential sector

and also for the transportation sector compared to the sectors like industry, where you always had one person very often in charge of a company's energy consumption.

Now, here you can some global trends in final energy consumption. So, GDP is expected to grow from 2013 to 2035 by about 25 per cent. And the total final consumption is decreasing both in the reference scenario and in the energy efficiency scenario. Now, Germany is one of the countries—and this was one of the aims and the goals of the Energiewende and the previous policies to decouple energy consumption compared to economic growth. So, energy demand has already been decoupled in the past, but the idea is to decouple it even further in the future. And we can see here the red and the blue lines, which compared to the green line, which very beautifully illustrates this decoupling. As a result, you can see that the final energy intensity of GDP, which is the unit, the amount of energy you need to produce one unit of GDP, declines strongly. And it declines obviously more in the energy efficiency scenario compared to the reference scenario.

So, here with the decline of the energy intensity in the energy—reference scenario represents about 1.8 per cent per year, and this decline in the energy efficiency scenario would be about 2.6 per cent per year on average over the period.

Now, you can see here that the energy, the final energy consumption by energy is changing. So, not only is the total demand reducing, but also the shared mix of this energy demand is changing. In 2013 about 68 per cent of energy, final energy demand was based on fossil fuels, in particular oil and gas and some coal for industry. In the reference scenario, this level is expected to come down to 60 per cent by 2035, while in the energy efficiency scenario it is expected to come down even much more, and down to a level of 52 per cent.

So, as I said earlier, renewables is going to increase strongly. Here we are talking about final energy demand, so not renewable—we are talking about renewables like wind and PV, which are producing electricity and therefore are a secondary energy source—but we are talking about final energy, which is to say as far as the renewable sector is concerned mainly warm water heaters, solar applications to warm water. We can see that oil demand, gas demand, electricity demand is decreasing. But as you go to a more energy efficiency scenario, which is also a scenario which is even further low carbon, you go through some electrification of the economy. So, electricity, final energy sector, will become in the energy efficiency scenario the second largest sector, while in the reference scenario it remains the—gas remains the second largest sector as far as final energy demand is concerned, and electricity is third. Gas—oil and gas reduce in market share, both in the reference scenario and even more so in the energy efficiency scenario, while electricity, market share increases—decreases more in the energy efficiency scenario for the reasons I just mentioned compared to the reference scenario.

Now, let's go sector by sector through the different sectors. Let's start with electricity consumption. Electricity consumption is decreasing, both in the reference scenario as well as in the energy efficiency scenario. In the energy efficiency scenario, it decreases more even though, as we mentioned earlier, the share of electricity out of final energy increases. So, the fact is that final energy demand decreases very strongly in the energy efficiency, and much more so than in the reference scenario. But in both electricity demand decreases less than primary energy.

On the right-hand side we can see the energy efficiency scenario by sector, by final sector. And we can see that the industry sector, that energy consumption decreases most in the industry sector. It decreases in other sectors as well, but as far as—it decreases in the residential and in the services sector as well. There's an increase in the share of transportation and a strong decrease in the residential sector of electricity in the energy efficiency scenario.

Now, here we have different final energy demand sectors, and we can see that while the reference scenario would reduce about 30 million tons of oil equivalent final energy demand even though—over these 22 years—even though GDP increases by 25 per cent. Now, where does this total, this 30 million tons of oil equivalent decrease come from? Mainly from the residential sector, as I mentioned earlier on, followed by the transportation sector. I already explained the reasons for this predominant share of residential and transportation sectors, which contribute respectively 53 per cent and 36 per cent of this reduction of 30 million tons of oil equivalent. This is the reference scenario.

If we now go to the energy efficiency scenario, we have a doubling—we can see a doubling of the effort. We can see that the energy demand reduces not by 30 but by 60 million tons of oil equivalent. And again, it is the residential sector which has the largest potential, followed by the transportation sector, respectively 48 per cent and 30 per cent.

If we look at different drivers, what are the drivers of energy demand reduction? We divided them into two groups. There is—so, we can see on the left-hand side—we can see here—this is the reference scenario—this is the total, the 30 million tons of oil equivalent energy consumption reduction, the one we saw, we spoke about earlier. And how—what are the drivers for this decline? Well, on the one hand side we can see activity effect. Activity effect means increased GDP, increased activity, and this brings us an increase of energy demand. But at the same time, we have for each of these sectors—for the industry sector, transportation sector, services sector, and households sector—we have a decrease due to energy efficiency, thanks to energy efficiency. So, the resulting—the sum of these two factors which are going in separate directions gives us the total 30 million tons energy demand reduction. We can see the very strong decrease in energy efficiency, in particular in transportation and in households, while we can see that the services sector is increasing very strongly in Germany. We expect it to increase very strongly in Germany, and therefore additional consumption—in particular of electricity and some heating for the services sector.

On the right-hand side we see the same graph but now for the energy efficiency sector, where we start with—we know that we have a 60 million tons of oil equivalent reduction of energy demand by 2035 compared to 2013. And this can be broken down into the two drivers: activity effect and energy savings. And again, we can see while the activity effect is about the same the energy savings effect is much, much higher. And here we have a very strong additional potential for in the households' sector, which is typically the most difficult to convince to implement the changes, but also in the transportation sector, followed by the services and industry sectors.

Now we have here the next slide. This slide shows us the additional energy savings in the energy efficiency scenario compared to the reference scenario—so, the delta between the two scenarios. And we can see again that most of these savings come from the residential sector, followed by the transportation sector and then the services sector and industrial sector. The residential sector contributes therefore the bulk of the additional energy savings in the energy efficiency scenario, where it represents about 46 per cent, and about 23 per cent—the relative share of the final energy consumption. So, while the residential sector only represents about 23 per cent of the final energy consumption, about half of the reduction of energy demand is due to this sector. So, it has twice as high an impact compared to, on average, the other sectors.

Now, further analysis related to—further sectoral analysis, sector by sector. Let's look at the residential sector. Let's go down—and I told you earlier on that our analysis allows to have a very detailed bottom-up analysis by energy usages, by final energy usages. So, here in the residential sector we can see that yes, there is a certain potential for the residential sector, which is the largest one, as we have seen so far. But inside this residential sector it is indeed the space heating which has the highest effect. It's 90 per cent of the total, is about space heating, followed by water heating and other captive electricity. Captive electricity is hot water, is lighting, is electrical appliances. Not hot water, but lighting, electrical appliances, and air conditioning, where normally you could use something else, but you don't use something else; you just use electricity.

And thanks to the significant energy efficiency improvement for space heating we can see this very strong decrease of energy consumption per square meter, and therefore there are strong improvements in space heating on the one hand side. Also, the fact that in Germany practically all—most of new buildings, they move away from natural gas as was used earlier on but now use heat pumps. This also has very high efficiency rates. Lighting: LED lamps and other very low efficiency lighting reduced very strongly energy demand, and so energy—the residential sector has a very strong impact in the overall reduction if we compare our two scenarios.

The services sector, we can see here most of the change. Here we can see the difference, the trend of the two scenarios, the reference scenario and the energy efficiency scenario in 2035 compared to 2013, and we can see that captive electricity and space heating represents the two most important parts

of this decrease. And we can see that the tons of oil equivalent per employee will decrease from slightly above 0.7 tons to below—to around 0.58 tons by 2035. And this again is achieved thanks to very high energy efficiency gains, in particular for space heating, but also the captive electricity.

Now, transportation. Transportation, we have two effects. On the one hand side we have the effect of strong new regulations. Also, for the residential sector. Also, for the space heating section, we—the driver is very, very strong: improved regulation. But also, as far as car fuel economy is concerned. But also, modal shift, the idea that people will—their policies which will bring people—also due to congestion, but also due to policies, to bring people marginally away from individual cars and more to public transportation systems.

We can see here on the left-hand side that the reference scenario is already a very strong improvement, a strong reduction in energy, final energy demand in 2035 as compared to 2013. And there's an additional potential for the energy efficiency scenario. Most of it relates to road transportation. The—on the right-hand side we can see there are some modal shifts. People will use less cars and more buses and rail transportation—but we can also see that the difference is not that big. So, most of the change is due to higher energy efficiency. A small part is due to modal shifts.

Industry. Industry, there are some very strong energy-consuming industries which have already done a lot of effort, but which can continue to do important efforts. Energy—unit consumption of energy for the paper issue, for the cement industry, for the steel industry, which is industries which are very highly energy—with high energy unit consumptions can still further be decreased, and they are decreased in the reference scenario, but the assumption is made here that they can be further, much further decreased in the energy efficiency scenario, or quicker decreased. And this allows to decrease energy intensity as well of the industry sector, as we can see on the right-hand side of the graph. The energy intensity decreases much faster and reaches a level—and decreases on average 1.3 per cent per year in the energy efficiency scenario compared to about a decrease of 1.0 per cent a year in the reference scenario.

Now, the interesting thing of this type of analysis which Enerdata produces and makes available as a service to its customers is that you can make your own sensitivity analysis. So, there are these two—reference scenario and the energy efficiency scenario—but the user at the end of the day can play around with very important main drivers and change some of these. Can change GDP annual rate of growth, for instance, or the yearly new dwellings, or the dwellings with air conditioning in 2030, or the yearly replacement rate of service buildings, or the saturation of car ownership, and so on. Population growth, average household size by 2030, and so on. The dematerialization of the economy, I'm going to give you an example later on this. In other words, the share of industry in GDP, the share of services in GDP. Or energy prices. You can play around assuming what happens if energy prices for the industrial sector increases or decreases, if the residential sector increases

or decreases, and so on. Or transportation sector, if there are additional prices or if fuel prices increase for whatever reason, what will be the effect on the energy demand on global and by sector and per usages?

So, just one example. Here we have on the left-hand side—this is the reference scenario. These are our two scenarios—the reference scenario and the energy efficiency scenario—with our assumptions that you may want to play around. You may want to see what happens if I dematerialize even further the German economy by 2030. What happens if the share of industry in GDP gets reduced by two per cent and the share of services in in GDP by 2030 gets increased by two per cent. And then, you—we did that for you on the right-hand side, but this is something typically which you can do yourself. And then, you can see the difference on the right-hand side graph compared to the left-hand side graph, and you can see that industry, for instance, since it will represent a larger share, the—sorry, the industry gets reduced, so you will have a difference in the two—in industry and in the service sector. On both sides you have an increase in demand for the industry sector and you have a decrease, a much further decrease of demand in the service sector.

This was the presentation. I thank you very much. If you have—this was—this is a service which is proposed to you by the unit called Energy Efficiency and Demand. If you have questions, you are welcome to write to the head of this unit, which is Nicolas.mairet@enerdata.net. And we stay available—I am here with a colleague of mine who works in that unit. Her name is Laura Sudris and together we are available to answer your questions. Thank you very much.

Katie Contos

Wonderful. Thank you so much, Manfred, for that outstanding presentation. As we shift to the question and answer portion I would like to remind our attendees to please submit questions using the question pane at any time. We'll also keep several links up on the screen throughout for a quick reference that point to where to find information about upcoming and previously held webinars and how to take advantage of the Ask an Expert program. We've had some great programs from the audience already, so we'll use the remaining time to answer and discuss.

The first question is—Manfred, I know you went into this a little bit at the beginning of the presentation, but can you elaborate on the techniques you use to estimate or forecast future energy efficiency for different sectors?

Manfred Hafner

So, as I mentioned earlier, the—let me just get to my slides. Yes, we have this MedPro bottom-up model, and so we use on the one hand side different users of energy. We start with demand for lighting, demand for passenger cars in transportation, and so on. And then, we have exogenous variables for socioeconomic variables like GDP, population, and so on. We have very specific information on technical economic variables related to technologies and how they evolve over time. And then policies. depending on what type of policies we implement, how fast and how quickly specific targets need to be achieved through regulation, for instance. Then, we can calibrate our MedPro model in order to get some outputs. So, it's a techno-economic model which allows us to use technologies and evolution of technologies. As an input we

have the evolution of GDP, of users, and activities. And as an output we have the different energy design by sector, by users—so, energy intensity indicators, CO2 emissions, energy expenses—which I did not show—per household and so on.

Katie Contos Wonderful. Thank you for answering that. Our next question references slide 16, and Manfred, please let us know if you want us to pass the presentation back to you. "On slide 16 the energy efficiency scenario reflects no change in the transport sector. Can you explain why?"

Manfred Hafner The—on slide 16 there is a change in energy in the transport sector. The transport sector will consume much less. It just happened to be by coincidence that in both scenarios it is 23 per cent of the total, but it is much lower than in the reference scenario. So, the figure is much lower; it just happened to be by coincidence that the share is about the same, while the share has increased for the reference scenario, for—sorry, for the industry and has decreased for the residential sector. In other words, there is a stronger effort being done in the residential sector. It's a less strong effort being done in the industry sector just because, as I explained, the industry sector has done a lot of effort before. And it just—this 23 per cent just means that the reduction of effort in the transport sector are in the same order of magnitude compared the total reduction of energy demand over the 20 years' time.

Katie Contos Great. Thank you so much. For the next question, "What is the reason that the projections for the industrial sector show relatively small decrease in energy efficiency scenario? Is cost effectiveness an available intervention?"

Manfred Hafner So, there are improvements to be done, important improvements to be done in the energy—in the industry sector, but they are less important compared to the residential sector. And the reason is that a lot of the easy stuff has already been implemented. In the industrial sector very often you have industries, and very often for these industries energy is a very important cost factor. And when it is an important cost factor in the company you have one person designated to deal with energy issues. And so, a lot of the easy parts have already been implemented. For—in the residential sector very often we just don't care. We have energy. Electricity is a relatively little expense. We are not specialists on energy. Most of the time we do not try to minimize our energy expenses. And much more importantly, even if it would make a lot of sense to add isolation, to invest today in something which would have relatively short payback times, very often we don't do it because a dollar today for us is worth more than a dollar saved in a few years. Our psychological discount rate is just too high.

And therefore, the—both in the reference scenario and even more in the energy efficiency scenario the policies focus much more on the residential sector because it is a residential sector where from a cost-benefit point of view you can do today more at a lower cost, where in the industry sector you can still do a lot, but the cheap stuff has already been done mostly, while in the residential sector there is still a lot of cheap stuff which you can do. And which needs to be done.

Katie Contos Thank you for clarifying that. The next question is: "Is there some attempt to forecast scarcity of certain energies, the effect on price, and the demand response to that?"

Manfred Hafner Sorry, can you repeat this?

Katie Contos Yes, absolutely. "Is there some attempt to forecast scarcity of certain energies, the effect on price, and the demand response to that?

Manfred Hafner Scarcity of energy…what?

Katie Contos Perhaps fossil fuels or other energies?

Manfred Hafner Yes. Okay. The general point, the general answer to this question is that compared to a few years ago, today we do not think we have a scarcity of primary energy. We have an oversupply of primary energy. One of the reasons—one of the proofs is that energy prices are very, very low. Obviously, there is always a scarcity, but we might have—the scarcity tomorrow and the constraint today as we see it is not so much the availability of primary energy but rather the possibility to emit into the environment CO2 emissions. So, we may need to have standard resources. We may need not to be allowed to use all the primary energy which we could use cost-effectively if we did not have the CO2 constraint. So, the big constraint today is climate, is de-carbonization, and this is the driver of our analysis, and this is the driver of our policies being used today by the governments.

Demand response, which is the second part of your question, is obviously extremely important. Demand response works with prices, could also work with regulations, with contracts—contract-based, but in the future, with new technology, with a technological shift and a shift of our energy systems towards more and more not only de-carbonized energy systems but also a more digital energy system and a more central energy system. Smart grids will play a more and more important role, and these smart grids will allow us, will allow the final equipment to communicate with the electricity production equipment and with the networks. And whenever there is a bottleneck somewhere electricity prices will increase strongly, and therefore there will be a signal on the level of final energy consumption equipment to reduce demand in order to equilibrate supply and demand and to reduce the bottlenecks.

I think we are in the beginning and progressively going towards a fundamental shift of our energy systems. These are driven on the one hand side politically top-down by our governments to de-carbonize, but also bottom-up by markets, by technology, and this is the digitalization. We have digital technologies which are more and more available, and also, as a result, decentralization. We have more and more—in the future we be more and more prosumers, not just consumers. On the one hand side producers and on the other we will be prosumers. We will be able to consume and produce electricity at the same time thanks to decentralized PV cells, thanks to heat pumps, thanks to many different energy-producing technologies. And all of

this combined will make energy—electricity demand response more important.

I do not think that the challenge is availability of resources. I think the challenge is de-carbonization. We do not want to emit—we want to reduce emissions, and this will oblige us to change fundamentally our energy system. But also, at the same time we have new technologies which allow further demand response and which will make our efforts more easy. And a model like MedPro allows us exactly to model these different components by sector, by usages because you have this granularity of approach which you do not have in—with econometric models where you rely on econometric formulas which do not have the technological breakdown by use, by usage, by sector, as this model has.

We at Enerdata, we also have global models. We also have top-down econometric models—for instance, our global POLES model, which we use a lot for advising governments to help them in their climate energy policies. But then, very often we combine the two, and we have first a very detailed energy demand assessment with our MedPro model, which is a bottom-up technology-based model with a high granularity, and then we calibrate based on MedPro the other model, the POLES model, which allows us to have a—to play around with a lot of—and much more easily with price sensitivities because it is an econometric model.

Katie Contos Thank you so much. For our final audience question today, "You have previously mentioned other countries where there are case studies. Are there any upcoming plans for more countries?"

Manfred Hafner We use the MedPro program on many countries around the world when we do consulting work, when we do consulting work for specific governments in order to advise them in what type of measures they should use to reduce energy demand most efficiently and effectively. As far as what I have presented to you today, we have a certain number of countries in this service—this is a service which Enerdata sells. And in this service today we have six countries. And we plan to include other countries, but we are still in the definition phase for that. But if there are specific demands, please write us and we will take into account your wishes, because obviously we do not wish to produce services which are not a demand, which are not asked by potential clients, by the market. We want to be very close to the market. And therefore, if people think that some countries are very interesting for them, we should be happy and willing to work together with these people to see what we can do in order to help them.

Katie Contos Great. Thank you, again. On behalf of the Clean Energy Solutions Center I'd like to extend a thank you to our expert panelist today and to all of our attendees for participating in today's webinar. We very much appreciate your time and hope in return that there were some valuable insights you can take back to your ministries, departments, or organizations. We also invite you to inform your colleagues and those in your networks about the Solutions Center resources and services, including no-cost policy support through our Ask an Expert service. I'd like to invite you to check the Solutions Center website if

you'd like to view the slides and listen to the recording of today's presentation, as well as previously held webinars. Additionally, you will find information on upcoming webinars and other training events. We are also now posting webinar recordings to the Clean Energy Solutions Center YouTube channel. Please allow about a week for the audio recordings to be posted. Finally, I'd like to kindly ask you to take a moment to complete the short survey that will appear when we conclude the webinar. Please enjoy the rest of your day and we hope to see you at future Clean Energy Solutions Center events. This concludes our webinar.