CLEAN ENERGY SOLUTIONS CENTER

Smart Grids Model Region Salzburg

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Webinar Panelists

Irmgard Herold	AIT Austrian Institute of Technology
Daniel Reiter	Daniel Reiter
Sara Ghaemi	AIT Austrian Institute of Technology
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This Transcript

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Sean Esterly

Welcome to today's webinar hosted by the Clean Energy Solutions Center. We are very fortunate to have Irmgard Herold, Daniel Reiter and Sara Ghaemi joining us today.

This great group of panelist will be discussing the Smart Grids Model Region Salzburg. 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 resource library as one of many best practices resources reviewed and selected by technical experts.

And for the go-to webinar platform, uh, I just wanna go over some of the features. We do have two options for audio. You may either listen to your computer or over your telephone. If you choose to listen to your computer, please select the mic and speakers option in the audio pane. Doing this will eliminate the possibility of feedback and echo, and if you select the telephone option, a box on the right side will display the telephone number and the audio pin that you should use to dial it.

Again panelists, we just remind you to please mute your devices while you are not presenting, and if anyone has any technical difficulties with the webinar, you may contact the go-to webinar help desk at 888-259-3826. And throughout the webinar, we encourage everyone to submit any questions that they might have. Those questions will be presented to the panelist during the question and answer section. You can submit question through the question pane in the go-to webinar panel. And if anyone is having difficulty viewing the materials to the webinar portal, we will be posting PDF copies of the presentation to cleanenergysolutions.org/training, and then you may follow along as our speakers present. Also, there will be an audio recording in the presentations posted to the Solutions Center training page within a week or two of the presentation.

We have a great agenda prepared for you today that is focused on the Smart Grid Model Region Salzburg. Now, before our speakers begin their presentations, I will just provide a short informative overview of the Clean Energy Solution Center initiative, then following the presentations, we will have a question and answer section. We will address the questions from the audience, and then some closing remarks and a very brief survey for the attendees.

So this slide provides a bit of background in terms of how the Solutions Center came to be. The Solutions Center is an initiative of the clean energy ministerial and is supported to a partnership with UN energy. It was launched in April of 2011 and is primarily led by Australia, the United States and other CEM partners.

Outcomes to this unique partnership includes support of developing countries to enhancement of resources and qualities relating to energy access, no cost expert policy assistance and peer-to-peer learning and training tool such as the webinar you're attending today.

So the Solutions Center has four primary goals. The first goal is that it serves as a clearinghouse for help on clean energy policy resources. Second is that it tries to share a policy best practices, data and analysis tool, specifically clean energy policies and programs, and third, the Solutions Center delivers dynamic services that enabled extra policy assistance, learning, and peer-to-peer sharing of experiences, and then lastly, the center who fosters dialogue on emerging policy issues and innovation around the globe. Now, the primary audience is energy policy makers and analysts from government and technical organizations in all countries, but then we also strive to engage with the private sector, NGO's and civil society. One of the marquee features that the Solutions Center provides is expert policy assistance. This is known as ask-an-expert and it's a valuable service offered to the Solutions Center and it's great because it's offered at no cost. So we have established a broad team of over a 30 experts from around the globe who are available to provide remote policy advice and analysis to all country. For example in the area of Smart Grid, we are very pleased to have Bruno Lapillone as vice president and co-founder of Enerdata, serving as our expert. So if you ever need policy assistance on Smart Grid or any other clean energy sector, we encourage you to use this useful service. Again this assistance is provided free of charge.

So to request assistance, you may submit your class by registering to our ask-an-expert feature at cleanenergysoluations.org/expert. We also invite you to spread this word to those in your network and organization. So in summary, we encourage you to explore and take advantage of the Solutions Center resources and services, including ask for policy assistance and subscribe to our newsletter and participate in webinars like this. So now, I'd like to provide brief introductions for our expert panelists and our moderators today.

Our first speaker is Irmgard Herold of the AIT Austrian Institute of Technology GMBH. Irmgard will be providing an overview of ISGAN and will also moderate today's question and answer session of the webinar. And following Irmgard, we will hear from Daniel Reiter of Salzburg AG, and then following Daniel, our final speaker today will be Sara Ghaemi of AIT Austrian Institute of Technology GMBH. And so with those brief introductions, please join me in welcoming Irmgard to the webinar.

Irmgard

Thank you for your kind introduction and a warm welcome. Good morning or good afternoon to you ladies and gentlemen.

So, I will give a very brief intro on ISGAN and [inaudible] [00:06:10] and then in particular on annex I where we are doing our webinar today and then I will let you know what AHE stands for.

So ISGAN is short for the IEA implementing agreement for cooperative program on smart grids. The aim really is to advance the development and deployment of smart grid technologies, practices and systems. So first of all, it's about to improve the understanding of smart grid technologies. What's the definition which is very different from continent to continent, but also from region to region really? And it's also about addressing gaps in different countries. So all countries have to give first different focus on what smart grids might be.

As this is a government-to-government collaboration, it promotes adoption of related [inaudible] [00:07:05] policies, which is very important here as well. ISGAN was launch in 2010 by CEM which is to clean energy ministerial. This is a meeting of energy and environment ministries of 23 countries. The [inaudible] [00:07:25] implementing agreement was 10 then organized in 2011. By now, there are 25 member countries of ISGAN. Naturally, there is a high number of member countries in Europe like and those in North America and it includes even South Africa and a couple of countries in the Asian pacific region. [inaudible] [00:07:50] Brazil Denmark and Turkey are invited to join the implementing agreement.

There are a number of ISGAN projects which occur and exist and they have been established for various smart grid technology domains. So you see, the first four annexes: global smart grid inventory, smart grade case studies, benefit cost analyses and insights for decision makers. Those are the major projects that were founded first and then there are three new ones which is the body infrastructure, the power system itself, which we have proved in the last year.

All of those projects of those annexes, they seek interphase with existing network, so initiative and they try to use those synergies, and it's also very important is to wait to avoid duplication of ongoing activities.

Regarding annex I, there are many countries which are already developed and demonstrated much great technologies and systems. They have assessed infrastructure needs, they have evaluated demands and practices and they have measured other aspects of smart grids. And so, the objective really is to identify the specific drivers for smart grids in different countries and to catalogue this wide range of activities and to organize them for ISGAN participants [inaudible] [00:09:26] as well for the global audience.

One of these projects being in this catalogue is to [inaudible] [00:09:37] and we, here in Austria, we are [inaudible] [00:09:41] to have such a pioneer European level. AIT has been mainly [inaudible] [00:09:46] in many subprojects and so they have to [inaudible] [00:09:49] to support the [inaudible] [00:09:51] coordinator of the entire program [inaudible] [00:09:53] to present the findings of HGMS. That's why I am going to quickly introduce AIT, the Austrian Institute of Technology as well.

So, we are about 1100 employees and with that, we are the largest non-university research institute and we provide research and technology development for infrastructure in the field of energy mobility, safety and security, health and environment, which is then supplement by the competence of innovation systems and then we also have two subsidiaries which Seibersdorf laboratories and nuclear engineering Seibersdorf as well.

There is much brief topic that is covered in the energy department and this department is smart cities and region department, complex energy systems with thermal energy systems with smart grids and photovoltaics. And that's it. I would like to hand over the Daniel Reiter which is going to talk about a few details of the model region.

Daniel: Thank you, Irmgard for the introduction. It's a pleasure to me to introduce you the Smart Grid Model Region Salzburg program. I will start with an overview about the Smart Grid Model Region, then Sara will continue with details on projects in the field of demand-side management and I will go on with active distribution grids and [inaudible] [00:11:29] smart grids.

First of all, I'd like to give you an idea about Salzburg and my company Salzburg. Here, we can see Europe and in the heart of Europe, in black, Austria, and Salzburg is a province of Austria, which can be seen in this slide in dark green, and then there is the City of Salzburg, which is the capital of the province, and has the same name.

Salzburg is a multi-utility company, majority owned by the province and the City of Salzburg and we supply about half a million inhabitance with electricity, gas, district heating, water, telecommunications and public transport services. In this slide, you can see some numbers of customers and some other figures just to give you an idea. They have some impressions from Salzburg, so for example, you can—here you can see high voltage line which reaches an altitude of 2,200 meters, here a pumped storage power station, the famous castles in the City of Salzburg in our headquarters, also in the City of Salzburg.

Next, a few words about motivation; why we deal with smart grids. We think that there are three major drivers that forces—driving forces for the energy transition and why smart grids are getting more and more important.

First of all, the ambitious and energy and climate policy targets at EU, national, regional level. Then there's a great development of technologies especially in ICT and there are also social trends, for example, in Austria, a lot of people have the ambition to become self-sustaining regarding energy and we think that the mixture of these drivers will lead to energy transition and traditional structure of the energy industry will be turned upside down in the coming decades, and yeah, we want to actively prepare for these challenges that we are facing especially in the grid department. In this chart, you can—we can see that development of the model region program which is combining five major fields to a holistic approach.

On the right hand side, we see the timeline and the bubbles, uh, that projects so green ones are completed and yellow ones are in progress with started in the field of distributed generation and retro bulk lands about 10 years ago, then there were some activities in the field of active distribution networks and then there were also ideas for demand-side management, ICT, in the field of distribution systems and also the grid integration of immobility and at that point, we decided to include all these projects in one program, the smart grid model region Salzburg with the aim to implement an overall concept and putting the different fields together to a holistic approach.

So we submitted the bundle of projects in a call of the Austrian Climate and Energy fund in 2009 and we're awarded as first Austrian Smart Grid Model Region. The objectives of the model region program are to get a critical mass of smart grid applications so that we can analyze synergies, dependencies and interchange between these applications to integrate challenges from the different fields as mentioned before and to realize them in network segments with real world challenges and customers. So summing up, we don't want just to draw ballpoint slides but to test the solutions in reality.

My company, Salzburg, DSO and multi-utility company, is the leader of the consortium, and we are supported by an interdisciplinary team; for example Salzburg Wohnbau, which is a property developer, Siemens as technology vendor and the AIT as research partner, and there are several further research partners as indicated in the slide. So that was a brief introduction to the Smart Grid Model Region in general. I'd like to hand over to Sara for the projects on demand-side management.

Sara

Thank you, Daniel. Good evening, afternoon, or maybe morning everyone, depending on where you are. I would like to welcome you all to this international webinar.

Let me first confirm that you guys see my slides on the screen over there. Okay. I'm going to start out through with a little of background information about the motivations for why we are doing demand-side management research and what we hope to contribute to the evolving nature of the electric power system here in Austria. We are facing the number of challenges in the power system.

To ensure stability on the electricity grid, we should keep the balance between electricity supply and demand in real time. Uptake integration of renewable resources which is the case in Austria like wind and PV, they turn out dispatchable, needs more flexibility on the demand-side to balance the unforecastable supply.

So, demand-side management helps us with providing this flexibility. Demand-side management is set of interconnected and flexible programs which customize an active role in the evolved electric energy system and liberalize energy market. And it is also used as an umbrella, covering several objectives including load shifting or demand response and energy efficiency.

There are various technologies which can be introduced as demand-side management solution. Energy feedback system is one of these technologies which take the consumer in to the energy system loop. The user receives information about his energy consumption and can decide whether to change it or not.

Normally, these feedback system leads customer to reduce their energy consumption and achieve energy efficiency goals. However, by including some external information to the feedback system like the real time price signal or the availability of renewable energies or even the congestion of the grid, consumer not necessarily reduce their total consumption, but he can shift his consumption to [inaudible] [00:19:49].

Since the optional response of the customer is not forecastable and not plannable, it will make sense to integrate these energy feedback systems into home automation system, to get the automatic and assured response. So with this background, we have tried in the framework of Salzburg model region to implement various demand-side management solutions and find out the potential benefits or drawback of base systems from the aspect of consumers as well as the utilities. Here, you see the big picture or our projects categorized in to five different activities.

As Daniel mentioned already, I will concentrate on the projects related to demand-side management as you see him distinguish with these red circles. So as Daniel mentioned, the projects with green color has been already finalized and yellow colors show the projects which are still ongoing.

So, I'm gonna, like, present you a chart in three finalized projects and one ongoing project we have in Salzburg model region. I'll start with consumer to grid project. This project focused on impact flexion various feedback system on the amount and pattern of electricity use. So we try to answer the following key question in this project. Is that possible to encourage customer to reduce the electricity consumption effectively by energy feedback system?

In order to answer this question, we have implemented five different energy feedback system range from annual bill or monthly bill, that portal in home display and real-time feedback systems, for example, of 288 households. In this slide, you see the general concept of the project and how we integrate the consumer in the loop.

As you see, the energy consumption of each individual household has been measured by [inaudible] [00:22:06] smart meter and the measured data has been transferred to central database server.

This data have been processed and have been sent back to the customer in a form of annular or monthly bill or they get their energy feedback via web portal or in-home display. And then they could decide if they are able to reduce their consumption or not. In this slide, I would like to show you some of our feedback system, especially here in this slide, you see, the in-home display and web portal system which are developed and implemented within the consumer to grid project.

Also, on the very top right side of the slide, you see, that's a feedback system which is a commercial product that delivers real-time energy feedback. So they are the systems that we have used in consumer to grid project.

After developing these feedback systems, they had been implemented in the field test of the consumer to grid project including 288 households and have been operated for one year. The result of this project is summarized in this blue table. It shows the amount of energy saving of different test groups using management feedback methods.

So here, you see, in this column, the energy consumption of the reference here and next to it, 2012, you see the consumption affected by installed feedback system. So compared with the reference here, the average reduction in electricity consumption across all groups is about 7% with a minimum response of 2% for monthly billing and maximum response of 11% for web portal users.

So once more, I'll just summarize all results of these projects. So visualizing the energy consumption using feedback system and engaging consumers in the household sector reduces the total electricity consumption by about 7% per year. Energy feedback systems raise awareness of users at home. In the beginning, users question their own behavior. It leads to change their pattern of consumption, but this response faded over the course of the time.

Using energy feedback system alone has no lasting value for the user. So as a conclusion, I would like to mention that permanent presence of the feedback system is advantageous. And beside electricity use feedback, additional functionalities should be provided to obtain user interest over the long term.

Following consumer to grid project, we have started another project. Its name is PEEM, Persuasive End-User Energy Management. In PEEM project, we have developed and implemented a noble feedback method named FORE-watch, you see it here and fore stands for forecast of renewable energy.

This feedback method not only gives consumer information about their energy consumption but also uses colors to inform two groups of users about the availability of renewable resources or grid congestion in the next 12 hours. Prognostic adaptation notify the users, then it is a good average or even bad time for using renewable resources or for the power system to use electricity respectively.

The goal was to develop and test a noble app for demand-side management to be used on in-home display and to research its influence on the end-users' energy consumption and consumption behavior. The explicit goal was not to save the energy in this project, but to guide the end-users to shift the energy consumption to other times according to the current status of the local distribution grid or the availability of renewable energy in this region.

Here, in this slide, you see two pictures of our fore-watch feedback system. As I mentioned green color means availability of renewable resources for one test group and new congestion in a grid for the other test group, yellow and red show the time for average and bad situation respectively. So this prototype was designed according to the following principles.

We try to make this feedback system as simple as possible. So we have considered simplicity in our development. The abstract information should be integrated into the household, so, we have considered ambient in this design. The fore-watch renders hints and tips to the end-users on how they can adopt their energy consumption and it also renders up the real time feedback on the current energy consumption in the household.

So again, I put the results of this PEEM project altogether in some lines. So, you see that by including external information like the availability of renewable resources or great congestion to the feedback system, the consumer to responded to the received signals continuously without losing interest. Consumer responded to this received information and adopted use of household appliances like dishwasher, washing machine, dryer as much as they could.

The response of group one who is like responding to the availability of the renewable energy was dependent to the information of fore-watch. Since this information, they received change every day so they have to always consider this information from the fore-watch feedback system. But the other group, group two, they are able to adopt their consumption after learning phase even without using fore-watch feedback system. So loss of comfort and habit changes was the main obstacle of the consumers.

So on one hand, this technology provides residential customers with supportive information to change their behavior and their attitude toward more sustainability. But on the other hand, all habits and customs are the main barriers for consumers to change their energy consumption pattern, which could be solved by introducing automatic demand response technologies in the household sector.

So the conclusion of PEEM project was clearly new feedback system has perceptible benefits if the color indicators assigned also to time of use tariffs and also integrating the proposed feedback system into automated controlled system of electrical appliances like home automation can boost the beneficial results.

Due to the findings of these two projects; consumer to grid and PEEM project focusing on providing feedback and the electricity use is only of marginal interest. In order to achieve the sustainable results, it is also necessary to combine this information and services from additional resources.

With these information and presentation of these two projects, I would like to introduce another project building to grid. Based on the results of the previous studies, it makes more sense to integrate the feedback system which provides consumption data and time of use prices in to the home automation system to make the response independent from the user in order to get like optimized results without loss of comfort and permanent attentiveness of the user.

In this project building to grid, we try to answer the following question. How can buildings contribute to peak load reduction and enhanced energy efficiency in power grids by intelligent load management? So for answering this question, we have tried two approaches. What is direct load control and another is flexible home automation system. Considering the direct load control, in this approach the grid operator switched on and off the easily accessible flexible loads like electric heating system or hot water system according to predefined regulator times.

Since this method does not get any feedback from the indoor or hot water temperature and does not consider the comfort of the users in the building. It is considered as, like, non-flexible solution which is also limited to predefined hours within a day. With this background, we try to just put special focus in this project and the flexible home automation system methods. Within this project, we have developed a building energy agent, you see it here in this picture, which acts as the communication interphase between home automation of the building and the electric power system and fulfills the following tasks.

So, building energy agent is responsible for prognosing the energy consumption of thermal components in the building. It is responsible for estimating the flexibility of these components based on outdoor temperature and optimize the time of shift according to the energy price. And also, it is responsible for optimizing the utilization of on-site generated energy from portable [inaudible] [00:32:55] units using these flexible loads. But how we can base and consider all these aspects all together in order to optimally integrate active buildings into the smart distribution grid. Not only grid congestion should be considered available renewable resources also should be optimally exploited.

So in this regard, we have developed a traffic light model, which has been suggested for this project in which grid-friendly buildings reacts to the market signals to use the available green energy from renewables as long as the critical threshold values on the power grid have not been reached. So as long as we are in a green light, we can sell our flexibility to the energy markets. When the grid gets closer to its voltage boundaries like yellow lines, the market based mechanism gets optimized considering technical constraints on a grid side, for sure. And when the voltage limits are exceeded, then the grid operator can act to stabilize the grid without taking the market into the account. I would like just to skip this slide. And here, you see the result of building to grid project. At first, let me try direct load control.

We have seen that we can up to 10% of the peak load in a part of the grid with higher density of installed electric heating, but this system doesn't get any feedback from the indoor or hot water temperature and it doesn't consider the comfort of the consumer in a building. So, we have considered this method as a non-flexible solution which is also limited to predefined hours within a day. But after trying this flexible home automation system, we have seen that by using building energy agent, we can save about 350 kilowatt for 10 selected buildings which were like included in our test field.

For one building including one residential flat, technically and practically, it was possible to curtail loads up to 3.7 kilowatt within 6 hours. However, I have to mention that this potential varies with the outdoor temperature. So again, as a conclusion for building to grid project, direct load control is a non-flexible solution for load curtailment and integration of feedback system into the home automation system enhance and assure the response of end users. Here, the last project, our ongoing project, HiT Buildings as interactive smart grid participant. The results and learned lessons of previous projects were valuable input for our HiT project which pursues various smart grid applications in the context of building in an innovative housing community. So in this project, we are gonna explore how various smart grid application in a context of building can be grouped together in an innovative housing community.

The objectives of the project are optimized planning, construction and operation of the block of flats in Salzburg. The project already has been started in January 2011 and will be finalized in May 2015. So currently, the construction of the buildings and the energy center are completed and then apartments have been also occupied in September 2013, so we are gonna also start installing—I think that installation of these smart devices and feedback system is also finalized so we are gonna start like doing our test period. Here, I would like you to see just the energy concept of this leading [inaudible] [00:37:37] in Salzburg. You see here in the center, the building complex that is supplied by on-site distributed generations like micro-CHPs or photovoltaics.

The idea is to integrate the energy feedback system of different kinds to interact with consumers and also integrate the building energy agent to be able to use the flexibility of heat pumps and electric vehicles in this complex. Here again you see this energy concept of this building complex. The electrical energy and the thermal energy, how it is gonna be produced and how it is gonna be used for this complex has been, like, showed in this slide. Based on our experiences from the previous projects, we have revised our developed system in the following base; we integrated the feedback system into the ambient devices in the households.

These feedback systems are permanently present and we will give recommendation to save or even shift energy. We have combined the other energy sources like heat and water also to our feedback system. We installed intelligent devices and heat pump and also electric vehicles to use for this building complex and we are gonna test their flexibility in a course of this project and here, the consumer will get an incentive for shifting their consumption to the green period.

As I explained in our traffic lights model, we see here that the building can participate in the electricity market as long as there is no problem and limitation from the electricity power system. And when we get to the yellow or even red part of these electricity systems, so, the end building energy agent has to follow the comments from the manpower system. So my last slide which is showing this building complex—we have 130 flats available in this building complex for different user groups from young families, to elderly people and even ambient assisted living. And this project, as I told you, gonna be finalized in 2015 and maybe we can present the result of this project in one other webinar.

So the conclusion of our demand-side management programs and projects we had in Salzburg; customer integration has to be combined with additional services, not necessarily from the energy domain. We have also seen that the operators of distributed generation can be smart customers so we can have consumers and we see an additional strategy in optimizing buildings and grid infrastructure all together.

So here, at the end of my presentation, I would like to thank you all for your attention and before giving the word back to Daniel, I would like to ask you if you have—or remind you if you have any question, please just submit those through the question pain. We are gonna try to answer these questions in question and answer session. Thank you everyone. Please, Daniel, you can go ahead.

Sean Esterly — Daniel, if you're there, you might still be on mute.

Daniel

Okay, thank you. So, I will go on with active distribution grids and I'd like to start with a little bit of the technical background. From our perspective, the main challenge of integrating distributed generation in distribution grids is to maintain the permissible voltage bands. That's especially for rural areas and that's illustrated in this chart here. So we can see the transformer station, the different line sections of the distribution grid, and here, we can see the progression of the voltage over this line. So here's the maximum voltage permissible and the minimum voltage and the green line is the voltage over the line. So if you have all the consumers, the voltage always drops over the length of the line. If there are additionally generators, they increase the voltage and that can lead to a violation of the upper voltage limit. So which control options do we have?

The first one is to control the substations so the proportions of bindings on the primary and second deg—the recall is adopted by—adjusted by on-load tab changer and by doing that, you can shift this voltage progression in parallel. So, you take it and shift it in parallel and that's the first option for voltage control that we use. The second option is the control the reactive power of the generators and give way to voltage, uh—becomes—the voltage progression is flattened and yeah, that's also a mean of keeping the voltage in the permissible voltage band.

If that's not enough, you can also control the active bar of generators and consumers. By combining all these options, we get a very voltage progression and so—that we can utilize the grid better and connect more distributed renewable energy sources to the existing distribution system. And that's what we have tested into demonstration projects, one in a medium voltage level and one on low voltage level and I'll give you some more details about this demonstration projects next.

The first is the case of the medium voltage grid in Lungau, which is a rural area in the south east of Salzburg and the red lines are existing. Medium voltage lines in this area that dots (blue, yellow, and green) are the existing distributed energy resources filling in to the grid and there were quite a lot of additional hydropower plants which should be connected to the grid and at that point, we figured out that there is problem with the voltage control and we have the decision either to reinforce the grid or to introduce a new innovative voltage control system and this was done in a field test.

Prior to the field test, there was a calculation done and simulation of this controlled solution and it turned out that as a result of the simulation and economic evaluation, the coordinate voltage control that was developed in the projects was much cheaper than line reinforcement and that was the basis that we decided to implement a prototype of the coordinate voltage control at demonstration project. And this prototype was implanted and in close loop operation from January 2012 to October 2013. We did dynamic control of the transformer between high voltage and medium voltage with and on-load tab changer and we controlled the reactive power of possible hydropower plants.

Two approaches were compared. One was central solution based on SCADA with online state estimation in approach called ZUQDE and a regional solution with the controller in the transformer station in the project called DG DemoNet Validation. Now, to give you some more details about the ZUQDE solution, ZUQDE is a German abbreviation for central voltage and reactive power control for distributed generation. It consists of state estimate, which calculates the states of the distribution grid online and matches it with measurements from the field.

At first, the system was operated in open loop, that means that the system generated set points, but they were not given directly to the transformer and to the generators, but they were manually approved by the operators in the control center and in the next step, the control loop was closed so that there was no manual check and the set points were given directly to the distributed generators and to the transformer.

The ZUQDE system can be operated with different target functions. The most important of them, voltage band compliance, but you can also minimize loses or deliver or cover reactive power as a target function. Here are some field experiences from the closed loop operation of the system. It's equivalent to the chart I have shown before, so we see the voltage over the length of line. In this case, for different grid section, different lines, which are connected with the same primary substation, so a normal operation is—if there are a lot of generators, the voltage increases from the transformer to the end of the line and if there are more consumers, the voltage decreases over the length of the line and all the whole distribution here is to stay within the define portals.

If you use the transformer control only, you can shift the whole voltage system in parallel like it is shown here, and if you use transformer and generator control, the deviation between the voltages of the lines is getting smaller, so you have not so much spread and it's easier to stay within the defined portals and it turned out to work very well in the field test.

The next step was to transfer and adopt these voltage control solutions from the medium voltage groups to the low voltage grid, and here, there's additional component which are electrical vehicles so the question is, how can a high share of photovoltaic systems and electric vehicles be optimally integrated in low voltage networks using intelligent planning, real-time monitoring and active network management. The project is called DG DemoNet smart low voltage grid. It's led by AIT. There are four DSO's in the project and two technology vendors. It has a duration of 3 years.

Currently, the field tests are carried out in three locations and one of them is in Salzburg. It's the smart grid model community of Kostendorf and I will give you some more details about this project. Kostendorf is a small village, about 20 km in the north east of Salzburg and there, we have one grid section that is supported by secondary substation PV system in every second roof and an electric vehicle in every second garage. We do a field test of an integrated smart grid solution for low voltage grids. So the aim is to anticipate the future in one grid section and to have localities.

Intelligent solutions can cope with these challenges of the future. So here, we can see the demo area from a bird's eye perspective. The blue are the existing PV systems prior to the projects and yellow are the new PV systems. So you can see it's really on every second house. And the overall installed capacity of PV systems is about 190 kilowatt and the installed capacity of the transformer stations is 250-kilovolt ampere. We have two scenarios which we have to handle with.

The first one is sunny Sunday afternoon, so the sun is shining, PV systems are generating, but nobody is at home, so there is very little consumption that can lead to voltage levels above the upper portal defined in the standard or power quality, and on the other hand side, if we have a winter working day, evening and everybody comes home from work, there is no sun, no generation, everybody blocks in its electric vehicle and we have uncontrolled charging that can lead to voltage levels below the lower portal of the voltage criteria.

So, we implemented a control concept which is consisting of several parts. Smart meters are used as—we call it eyes in the grid so sensors for the voltage control—they communicate with a controller in the substation which controls on-load tab change of the transformer and the controllable PV inverters and electric vehicle charging stations. Here, we can see the controlled concept in more detail.

There are two control loops. The first one is within the house, a so called building energy agent, ensures that as much as possible, the generated electricity is used in house for charging electric vehicles and also for other controllable load such as heat pumps and cooling systems so it control the charging station, the home automation and the inverter of the PV system. The second control loop is within the whole distribution grid section. Here, the so-called smart low voltage grid controller gets the voltage from the smart meters and controls - on a one hand, the controller with transformer and on the other hand, the building energy agent in all the homes which are participating in this field test.

So, overall, there are about 90 buildings in this area and 43 of them were dissipating in the field test. The control concept stepwise and the design proposition is to fulfill the requirements with high quality with the lowest possible engineering effort and system complexity.

Now, in the field test, all the steps of the control concept are tested subsequently starting with the simplest one which is local control and ending with the most complicated one but exactest. That's selective coordinated control with double detection and we want to figure out how far we have to go to cope with high penetrations of photovoltaics and electric vehicles. So that will be a result of the field test which is currently running. When we started the project, we were a little bit scared if we will get enough participants in a project because we needed every second one to participate and we didn't know if they will cooperate with us in this way.

They got subsidies for every system and can rent the e-cars for very good conditions, but nevertheless, they had to take their own money and install the PV systems on the roof and have a lot of effort, so we were not sure. But on the first day, when we offered them to participate in the project, all PV systems and e-cars were contracted so it was no problem to get enough participants and there were more people wanted to take part in the project but it wasn't possible there were no subsidies left and it was a first come, first served principle. So that was a short introduction to our activities on active distribution grids. Now, a few words on ICT for smart grids were we also have two projects in this field—we will go over the details of the project and come to the findings in this field. So if smart grids become reality, ICT systems in the scope of a distribution system operator have to be extended to the customer and public domain and that there are some several challenges; for example, people want to have informational self-determination, so it's very important to give them the control over the information and, yeah.

That's very important for the trust of the people in these technical solutions and also, in the security side, it's important to come from excess security where you, for example, cannot get in to our certain plant, and therefore, it's secure. You have to implement application specific and device specific security. We think that the distribution system operator should act as a neutral data hub in the smart grid who is supplying the data to the customer and to service companies which have the permission of the customers or which have a contract with the customer.

When it comes to security progress and integrity, it's very important to consider from the very beginning, so security and privacy by design and we tried it and implemented it in the smart web grid project. Then generic and easy-to-extend reference architecture is important so that synergies can be used and there is a high degree of flexibility and we think that the internet protocol is preferable, a convergence layer for implementing ICT for smart grids so that you have one layer where it comes together and not a lot of different standards and protocols.

Before I come to an end, I'd give you a little information on international cooperation and visibility of the smart grid model region Salzburg. We are part of the IGreenGrid project which is a UE project led by Iberdola and there, smart grid demo projects from six European countries analyze for their scaling up and replication possibilities. And if you are interested in more details, the project website is—there is a link in this slide and we are very proud that recently, the smart grid model region got the EEGI core label.

EEGI is the European Electricity Grid Initiative and the core label acknowledges that a specific project is fully in line with the spirit and the functional objectives of the EEGI. SGMS is one of, so far, only two national funded projects labeled with the EEGI core project—core label. As a conclusion, it can be said that the added value of the smart grid model region Salzburg is to systematically merge all types of smart grid activities in one region—in one ICT layer and from the perspective of all main interest groups. We do real-life field tests which are a laboratory for innovative smart services and applications and it can be summed up with our motto which is "the whole is more than the sum of its parts."

If you are interested in more details, we have a website where all the final reports of the subprojects can be found and there is also a report on results and findings of the overall SGMS from May of this year and it's also available in English on our project website. So, thank you very much for you attention and I'm looking forward to the question and answer session.

Irmgard

Thank you very much Daniel and Sara for your interesting and comprehensive presentation. We now have time for a couple of questions. They are coming in a lot, so—but however, don't hesitate to send us more. We're very pleased to answer them after the current session as well. So, in case some people I see have raised their hands, so you won't be able to talk to us, but please type in your questions for this section. Okay, so let's start with the first question. This one goes to Sara because it's about the consumer to grid demo, have you looked at different grades, e.g. dynamic grades to study their effect on energy savings. If not, why?

Sara

Well, I should say that for consumer to grid project, we didn't apply any different rating or time of use tariffs, but we are planning for this ongoing projects, I introduced you heat project, so we have tried to progress and use and integrate our lesson learned from the other project so it is not easy to, like, implement all the things which are possible in one project. So we try to do it step by step and develop our projects with the time. So maybe I can, like, answer this question after finishing our heat project.

Irmgard	[inaudible] [01:06:39] second questions for Sarah: For the PEEM demo, what are the [inaudible] [01:06:47] rates? Have you quantified the effects of knowing available renewable energy resources on load shifting?
Sara	Yeah, actually, for PEEM project also, we didn't consider time of use prices, but as I mentioned in the presentation, we have already developed our feedback system; this colorful feedback system, so we are gonna also apply different tariffs and time of use tariffs, maybe, for the customer to see that how they react to this different tariffs.
Daniel	I cannot hear you very well, Irmgard.
Irmgard	Oh yeah, sorry, I was on mute. So it's working now. It's a question for you Daniel, a quite short one: what is the time step of your centralized voltage control?
Daniel	It's 15 minutes.
Irmgard	That was a short answer as I assumed. So…
Daniel	But you can adjust it, but in the field test, it was 15 minutes. So, one—every 15 minutes, new set points were given out to the—to the hydropower stations and to the transformer.
Irmgard	Okay. And the next question for you Daniel: do you include loss cost in your economical assessment of voltage control?
Daniel	We could, but minimization of losses is only one target function, but in our case, the more important one was to stay within the defined voltage band, and yeah, if you, for example, sometimes have to higher the voltage on the transformer station so that you get a—you have to lower the voltage on the transformer station so that you stay within the voltage band, then it can also increase the losses. So you can only minimize losses with a high priority if you have no voltage band problem. And so, there was not so much difference in losses from the status quo to the field test, so that was not the real trial for cost benefit analysis, but the trier for the benefits was deferred in resonant in lines, so, yeah. I hope that answers the question.
Irmgard	I just got another question or another information to this question. It's about long-term economical assessment. In [inaudible] [01:10:15] will we reduce the losses.
Daniel	Yeah, of course, if you reduce the losses, you can calculate the benefit also, but yeah, for example, if you build a new line, then you also reduce the loss but you have to invest a lost and the main objective of our project is to minimize the investment for grid reinforcement and get the most out of the existing grid. So it's not—the losses are not so much in focus.

Irmgard Okay. Thank you, Daniel. The next question is on DSN, so it's a question for Sarah: the programs include lots of customer and direction, but how were they actually engaged in the program? In other words, how were they informed about the opportunity to participate? Then it goes on with the incentives and information materials, concerns and so on. If you could reply Sarah, please.

Sara: Yeah, for different projects we have different situations, for example for PEEM projects, we have asked the employees from Salzburg if they are interested to participate. For sure, they have received from, like, incentives, to be motivated and participate in the project—for PEEM project, so they will like special people employees of Salzburg.

For the other projects, we had different people, like randomly selected or like, generally asked if they are interested and motivated to participate in this program and projects we have or not, and they have like different kind of—or they got different kind of incentives to participate in the project, but in this [inaudible] [01:12:28] are connected to any various tariff or time of use tariffs or it has nothing to do with the price of the electricity, but the other incentives that they got for being motivated and participative in these projects. I hope that I answered the question.

Irmgard Thank you, Sara. So we are going on to Daniel again. Question for you: have you investigated the trans inverter factors such as volt-var or power factor control to perform voltage stabilization and distribution system?

Daniel Could you repeat the question please?

Irmgard Yes. Have you investigated a trans inverter factor such volt-var or power factor control to perform voltage stabilization and distribution system?

Daniel Yes. That's an important of the Kostendorf filters. So I think that's already implemented in the local control, so the first step of the control concept in Kostendorf—there, the power factor of the reactive power of the inverters is adjusted on local level and with the next steps, the inverters get the power factor, for example, or the voltage, they should ensure from the smart low voltage grid controller, so that's focal point of the Kostendorf filters.

Irmgard Okay. Thank you. So, the next question is for Sara again. Sara, has behavioral demand response been incorporated into this project, e.g. providing information to the customers to let them know how they are doing this for energy saving in comparison with their neighbors in the residential sector?

Sara Uhm, no, actually they got just information about their energy consumption—their individual energy consumption and but, actually, they didn't receive any information about the neighbors or any other participants in the project. Daniel, maybe you want to complete my answers?

Daniel — Yes. There were also interviews with the participants afterwards and they were not really interested in the savings of their neighbors.

Irmgard — Okay. So, uhm, then—we have another question for Daniel: how did you deal with data security and private issues in the projects?

Daniel — As I mentioned, for example in the smart web grid project, we did privacy and security by design so before starting to implement anything, we had a look on how we solve these issues and for all the demand-side management projects, for example, were we collected consumer data—consumption data, we registered these data applications according to the Austrian data security act and, yeah.

So we complied—had very focused to comply with the legal conditions in this field. And maybe another thing that could be mentioned here is that we started research group at the University of Applied Sciences in Salzburg, which is supported by Salzburg and also deals with this specific issue and they support us, so it's the [inaudible] [01:17:26] at the University of Applied Sciences in Salzburg.

Irmgard — Thank you, Daniel. Sara, the next one is for you: you talked about the demand control and dimension that you need the permission of the customers. Your country has developed a specific public policy or law for it or is just an agreement with the customer? And what about the development of public policies to implement electric smart grids?

Sara — I'm not sure, Irmgard, if I understand the question correctly. I would like going to ask you to repeat it once more. I know that it's long, but, uh…

Irmgard — Okay. No worries, I'll repeat it. So, you talked about demand control and you mentioned that you need the permission of customers. So, has your country developed a specific public policy or law for it? Or is it just an agreement with the customer?

Sara — Actually, it as just an agreement with the customer—individual customer if they are interested to participate in these programs or not. So, I don't know, I don't remember if a talked actually about the permission of the customer, but it was just interest of the customer who is interested in participating in this kind of programs. So it is more a matter of motivation and personal interest than the matter of rules and laws of the country.

Daniel — Yeah, but, I'd like to add that all the participants confirmed that they give us the right to use the data. So it was a voluntary permission by the customer and this is also needed according to the national data security act and maybe on the last part of the question, if there are special losses in development, we try to figure out and give the politicians and government and so on, also an idea which requirements we have for the institutional framework which should be changed in order to male the implementation of smart grids easier and that's also a—there's a dedicated section in the report on the results and findings that are mentioned before on this issue.

Irmgard Okay, and—but we are short in time and we have time for only one last question, and that will be one for you again, Daniel: are there any limitations on the use of ZUQDE such as the types and numbers of generators? Who is the vendor for the state estimation system or the ZUQDE system?

Daniel Uhm, there might be limitation somewhere. I don't really know the number but I think there are can be quite a lot of generators included. It's even so that the system works better if more generators are included to the system because then you have—you can adjust the voltage more precisely and the vendor of this system and also of the state estimation is Siemens. Siemens was the project department. We developed it together with them, but Siemens is the [inaudible] [01:21:44].

Irmgard Okay, thank you very much to you both, Daniel and Sara for the great presentation and for answering lots of questions. Thanks to the audience who listened to us today and also a big thank you to the Clean Energy Solutions Center. So, I would like also to let you know that it is a series of webinars on annex I and in the next year, there will be more webinars and probably, there will be one each month. So please stay tuned for other announcements and maybe we will talk to you very soon. Thank you very much.

Sean Esterly And, thank you to all three of you for the presentations and the great question and answer session. Some of the webinars that Irmgard refers to are scheduled and you will be able to find out more of those on the Clean Energy Solutions Centers' training page. Now, I would just like to take a brief moment to ask the attendees to answer three survey questions. It just helps us improve our webinar. So, Heather if you could go ahead and please to play that first question, and that question: is the webinar content provided me with useful information and insight? And the next question, Is the webinar's presenters were effective?

And the final question, does, overall, the webinar meet my expectation? Alright, thank you for answering our survey, and on behalf of the Clean Energy Solution Center, I would just like to extend a thank you to each of our panelists and moderators today and to our attendees who participated in today's webinar. Indeed, we had a great audience, a lot of good questions for generators and we really appreciate your time. I invite you to check out the Solutions Center website over the next week if you would like to view the slides and listen to our recording of today's presentation as well as any previously held webinars including previously held ISGAN webinars. Additionally, you will find information on upcoming webinars and other training events. We also invite you to inform your colleagues and those in your network about Solutions Center resources and services including the no-cost policies support, and we hope everyone has a great rest of your day and we hope to see you again at future Clean Energy Solution Center event. This concludes our webinar.