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How Distribution Grids Can Integrate More Renewable Energy: Lessons Learned from the GRID4EU Project

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For more information, see the clean energy policy trainings offered by the Solutions Center.

Webinar Panelists

Rémy Garaude Verdier	Electricité Réseau Distribution France (ERDF)
Lars Jendernalik	Westnetz
Daniele Stein	Enel Distribuzione S.P.A
Thomas Drizard	Electricité Réseau Distribution France (ERDF)

This Transcript

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Tim Reber

Hello, everyone. I'm Tim Reber with the National Renewable Energy Laboratory, and I'd like to welcome you to today's webinar, which is hosted by the Cleaner Energy Solutions Center in partnership with the International Smart Grid Action Network, or ISGAN.

Today's webinar is focused on lessons learned from GRID4EU, a European project on integrating renewable energy. 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 Solutions Center Resource Library as one of many best practice resources reviews and selected by technical experts.

Before we begin, I'll quickly go over some of the webinar features. For audio, you have two options. You may either listen through your computer or over your telephone. If you choose to listen through your computer, please select the mic and speakers option in the audio pane. Doing so will eliminate the possibility of feedback and echo. If you choose to dial in by phone, please select the telephone option, and a box on the right side of your screen will display the telephone number and audio PIN you should use to dial in.

If you would like to ask a question, and we ask that you please do, please use the questions pane also on the right side of the screen, where you may type in your question. If you are having difficulty viewing the materials through the webinar portal, you will find PDF copies of the presentations at cleanenergysolutions.org/training, and you may follow along as our speakers present. Also, an audio recording and the presentations will be posted to the Solutions Center training page within a few weeks, and will be added to the Solutions Center YouTube channel, where you'll find other informative webinars, as well as video interviews with thought leaders on clean energy policy topics.

Today's webinar agenda is centered around the presentations from our guest panelists, Remy Gauraude Verdier, Lars Jendernalik, Daniele Stein, and Thomas Drizard. These panelists have been kind enough to join us to discuss original approaches used in GRID4EU, and how GRID4EU increases the hosting capacity for renewable energy resources in distribution grids without jeopardizing quality of supply.

Before our speakers begin their presentations, I will provide a short, informative overview of the Clean Energy Solutions Center initiative. Then following the presentation, we will have a short question and answer session, where the panelists will address questions submitted by the audience, finish with some closing remarks, and a brief survey.

So this next slide provides a bit of background in terms of how the Solutions Center came to be. The Solutions Center is one of 13 initiatives of the Clean Energy Ministerial that was launched in April of 2011, and is primarily led by Australia, the United States, and other Clean Energy Ministerial partners. Outcomes of this unique initiative include support of developing countries and emerging economies through enhancement of resources on policies relating to energy access, no cost expert policy assistance, and peer to peer learning and training tools, such as the webinar you are attending today.

The Solutions Center has four primary goals. It serves as a clearinghouse of clean energy policy resources. It serves to share policy best practices, data, and analysis tools specific to clean energy policies and programs. It delivers dynamic services that enable expert assistance, learning, and peer to peer sharing of experiences. And finally, the center fosters dialogue on emerging policy issues and innovation around the globe.

Our primary audience is energy policy makers and analysts from governments and technical organizations in all countries, but we also strive to engage with the private sector, NGOs, and civil society.

One of the marquis features that the Solutions Center provides is a no cost expert policy assistance known as Ask an Expert. The Ask an Expert program has established a broad team of over 30 experts from around the globe who are available to provide remote policy advice and analysis to all countries at no cost.

For example, in the area of regulatory and utility policies, we are very pleased to have J. Riley Allen, research director at the Regulatory Assistance Project, serving as one of our experts. If you have a need for policy assistance in regulatory and utility policy or any other clean energy sector, we encourage you to use this valuable service. Again, the 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, or to find out how the Ask an Expert service can benefit your work, please contact Sean Esterly directly at Sean.Esterly@NREL.gov, or call him at 303-384-7436. We also invite you to spread the word about the service to those in your networks and organizations.

And now I'd like to provide brief introductions for today's panelists. First up today is Remy Gauraude Verdier, a smart grids project manager with Electricite Reseau Distribution France, ERDF. He is a civil engineer with an MBA from Lausanne IMD in Switzerland. He has worked in a variety of jobs during a ten year career at EDF Group, including managing the integration of the EDF Group's SAP solution to its new nuclear build division in the UK and the US, and managing the purchase and engineering domains in the biggest SAP deployment completed to date.

Our second speaker is Dr. Lars Jendernalik. Lars is responsible for the regional grid operation of primary substations in the region of Ruhr-Niederrhein of Westnetz, the largest distribution system operator in Germany. Previously, he worked in different positions of asset management for more than ten years. He is engaged with questions of distribution systems, the grid integration of decentralized energy resources, and especially the development of asset management, grid planning, and grid operation for more than 15 years.

Following Lars, we will from Daniele Stein. Daniele is a smart grids project manager for ENEL Distribuzione S.p.A.. He has worked in different network management areas, from network planning to operation and maintenance, and he has gained experience on network automation and control. In the last four years, he has been deeply involved in the development of European and international projects. Within GRID4EU, Stein is the operational leader of the Italian demo.

And our final speaker today is Thomas Drizard. Thomas is a smart grids project engineer within Electricite Reseau Distribution France, or ERDF. He graduated from Ecole Centrale Paris and Berlin Institute of Technology as an industrial engineer. He worked as an energy storage consultant at Clean Horizon in Paris, specialized in energy storage business cases. He joined ERDF within the GRID4EU French Demo, also called NICE GRID, where he is in charge of grid storage operation, islanding tests, and cost-benefits analysis.

And finally, with those four introductions, I'd like to go ahead and hand it off to Remy and welcome our panelists.

R. Gauraude Verdier Thank you, Tim. My name is Remy Gauraude, working for ERDF, and today I will briefly present what is GRID4EU, then I will leave the floor to the demo leader.

So what is GRID4EU? GRID4EU is leading European smart grid project supported by the European Commission. _____ 50 _____ on this project, and it will end in the coming January. This is also a huge project in terms of cost, with 54 million euros, which is something like $60 million US.

_____ large-scale demonstrators, this project is – it focuses on increasing the _____ capacity from renewable energy in the distribution grid without jeopardizing quality of supply. And the project _____ _____ to the creation of the European _____ model for smart grid, by implementing _____ solutions that are economically viable and technologically sound.

As you can see on this slide, the project brings together six major DSOs, distribution system operators. We are working all together. ERDF is the coordinator. RWE in Germany is in charge of demo, Watenfall in Sweden as well, Cez Distribution _____, Enel in Italy is in charge of the demo, and is also technical director of the project, and Iberdrola in Spain is in charge of the demo as well, and is the chairman of general assembly. And today, we will have an overview of what is going on in the French demo, the German demo, and the Italian demo.

GRID4EU is focusing on six innovative streams. So in the different demos, we are working on active demand, renewable integration, _____ voltaic innovation, islanding, storage, and low voltage innovation. As you can see on the _____, all the – each demo is testing one of several _____. For example, in the German demo, Lars is working on failure management in MV network and also in decentralized grid operation on the MV network, and he will have an overview on what's going on this demo.

The consortium, the GRID4EU consortium, also _____ collaborative approach that includes the scalability and applicability analyses, and a unified economical assessment framework that covers the identification of benefits and beneficial _____. So in the smart grid deployments, it is key for us to have a complete understanding of what – where the value is in smart grid.

This table shows the repetition of innovation streams by demonstrators. The integration of renewable energy is a major focus of GRID4EU. It is directly analyzed by three demonstrators, in Germany, in Italy, and in France. As my partners will show, these three locations are representative of the _____ renewable energy _____ landscape.

The schedules now show that we are in an advanced stage of the project. As mentioned previously, the project will end at the coming January, so we are in the most exciting part of GRID4EU. We have some results coming from the experimentation from the field. _____ _____ the final evidence from GRID4EU will be in January in Paris. And now I will leave the floor to Lars Jendernalik from RWE. He will present you the German demo part _____.

Lars Jendernalik _____ thanks for that introduction. Hello, everybody. My name is Lars Jendernalik. I'm working with the Westnetz Company in Germany, the largest distribution system operator in Germany. It's a large company, RCRWB.

As you can see from mine, Short Presentation about German Demo, you can see that the integration of renewable energy is one of the major concerns and challenges that we face for the last decade in Germany. As we can see from the figures in this chart, you'll see that in the last decade, coming from nearly zero to now more than 35, 38 gigawatt installed photovoltaic plants, and also half the same amount for wind. You can see that we are now in Germany about 76, 78 gigawatt installed renewable energy. And most of these plants, single plants that we see, are installed in the low voltage or medium voltage networks.

So a situation can be characterized by massive increase decentralized generation, meaning also huge grid investments, and also less predictable power flow. We see more reverse power flows coming from the lower voltage levels up to the extra high voltage network in Germany, not only for hours a day, but also for days and parts of weeks per year.

So the main objective of our German demo is the integration of an increasing number of decentralized energy resources, especially in the medium voltage networks. That is the focus of this project, but also low voltage networks are the focus of other projects.

So the typical direction may be a classical network expansion, meaning more cables, meaning more substations, but that also means that we have the question _____ now familiar with, _____ lacking _____ and therefore, we are looking for some intelligent, some better solutions to implement these increasing number of decentralized energy resources.

As a nice side effect, as we can see, we also get some advantages in the – according to higher reliability or maybe shorter recovery times after grid failures. And also, when we speak about German middle voltage networks, we often have _____ that these are more or less passive networks, so getting more automation and more remote control in these networks also means that we can _____ better monitoring, see what is the situation at the network, and do a better job of failure management. Also loss reduction is something that we can take as a side effect of these new and intelligent solutions.

So the basic idea of our German demo is extension of the automation level, especially focused on the middle voltage network, and what we are taking is an autonomously acting multi-module system which may be explained in the next few slides.

The partners of our demo are RWE as a network system operator with Westnetz, ABB as a manufacturer, and the Technical University of Dortmund for the algorithms and the smart solutions.

Boundary conditions _____ we have taken into account is that we have taken a typical community in Germany in the northwestern part of Germany, _____ Reken. We have there a typical network with about 100 secondary substations. Then we have installed 7 new switching modules, 11 measurement modules, and we see at the moment an almost balanced ratio between the maximum load and as installed decentralized generation. But we also see massive increase in decentralized generation. That also means _____ power flow only a few hours, as you can see here. This is a typical example chart. But also for many days now, 2015, especially in the summer months, where PV is in charge, and also wind.

So the concept is quite simple. _____ is an autonomously working module and a very lean control center, not a SCADA system, but a very lean center located in the primary substation. The modules are installed in the secondary substations, and seven of them, giving them the opportunity to _____ control the switching gear of these secondary substations.

Those modules can communicate amongst each other, and what is important, that these set of modules also can devise the decision, what is the right topology of my open _____ medium voltage network for the _____ _____. That's _____ is facing at the moment. So not only we have a _____ topology with an open switch at one secondary substation for _____ time of a year, and the basic idea of this demonstration is to make a dynamic change of this open switch from one substation to another, according to the scenario that we are facing, _____ are coming from the _____ and the nodes at the moment or the next 24 or 48 hours.

So this might be a pre-stage of a small and lean middle voltage SCADA system, or might be integrating from existing system, as we have done it here, to minimize the central asks and to _____ with your existing SCADA systems. So the main idea is to act and optimize locally the _____ decisions _____ inside your network.

The hardware implementation _____ _____ the last year. We had three options regarding the condition of the secondary substations where we wanted to install the additional switching gear and the intelligent solutions. The first option, when we saw a substation was in bad condition, there was the option of a full replacement of this complete station. The second option was a replacement just of the existing switching gear and the implementation of additional intelligence, where the rest of the substation was in a good condition. And the third option was a dedicated cabinet solution, when we didn't have the opportunity to replace the existing substation or to go inside and replace some parts on it.

Some first indicative simulations results. You can see here is a simulation of the switching action. As you can see here, we have an example of a critical voltage stage coming over 10.7 kV in the middle voltage network. We have time to trigger that is going to start the process of the _____ system, which is then making the decision. _____ other possibility of another topology to change the open switch inside the rim structure.

And as you can see here at state three, the system decided to make this switching operation, to close the rim the first time, and then to open another switch here. And there you can see the voltage violation was resolved. We get a voltage under the critical state of 10.7 kV, and the system is then running in a fine status after this – an open decision _____.

We also see a dramatic impact on the network reliability. Coming from the current state, you see here some example figures of SAIDI and ASIDI of this network. And we see that with the implementation of the new system, you can just _____ these very _____ existing system as a side effect, using it for shorter fail times and _____ better customer service.

The field test phase is ongoing in 2015, and what we have done, speaking about an autonomous operating system is a step-wise approach. Dealing with phase zero, meaning just recording the measured values and signals. No switching. We have just _____ name. Phase one is the question of switching via the SCADA system, so getting the information and the idea of what would be the best topology. That switching via the SCADA system has an engineer that is sitting there.

Phase two, _____ giving the opportunity to the central center, the central RTU in the primary substation to do the switching on its own. And last but not least, phase three is then the question of a real autonomous switching system, after the successful implementation of the first three phases. Our test cases include of these three test phases, the use cases that we have seen, and also our test components.

So concluding, what we have seen, one of the main use cases and one of the main parts of our demo with integration of a high number of renewable energy. Field implementation is finalized, and the first simulation results show a potential – show potential of this autonomous middle voltage operating system. So we have just started the field test phase in this year, and are now gaining experience, and some _____ results.

Thank you very much for your attention. I will now leave the opportunity for to the Italian _____ Daniele Stein.

Daniele Stein

Thank you very much, Lars. Hello, everybody. My name is Daniele Stein, and I work for ENEL in Italy. In my presentation, I will give you a quick overview of the Italian demonstration in the framework of GRID4EU.

The demonstration is developed by ENEL in partnership with Cisco, RSE, Selta, and Siemens. The objective of our demo is to increase the medium voltage network hosting capacity for distributed energy resources, in particular PV, introducing active control and demand response of medium voltage generators, controllable loads, and storage.

So the main focus is the medium voltage network, and in order to achieve the increase of the hosting capacity of the network, the basic idea is to implement voltage control, power flow control, in the grid.

Here in this slide you can depicted the information related to the main driver of our demonstration. The exponential growth of distributed generation, we have _____ in Italy over the past few years. To give you some figures, at the end of 2014, the connection to ENEL Distribuzione's network, and _____ is the distribution system operator of the group in Italy. The – as I said, the installed capacity was about 26 gigawatt, which represents more or less the 50 percent of the peak load of the country during the summer.

Another key information is that most of the RES power is connected to the medium voltage network, more or less 80 percent. And this is the reason why we are addressing the medium voltage network.

The basic concepts related to the system, we have realized a control system communicating with the renewable generators, with the primary and secondary substation, and with a storage facility. In order to enable the communication, the _____ is represented by always-on standard-based communication solution, relying on mainly our wireless infrastructure, but not only – also power line carrier is tested. And also, last but not least, we use for – as a regulation resource, the storage facility, using lithium ion batteries of megavolt ampere power and one megawatt hour capacity.

A couple of words about the size. The demonstration is being developed in Emilia Romagna region, close to the northeastern part of Italy. The parameter of demonstration is composed by 2 primary substations, over 20 medium voltage _____, more than 100 medium voltage substations, and about 35,000 low voltage customers are impacted, even though not directly involved in the experimentation.

In this area, we have a high penetration of renewable energy sources, mainly PV, along with low consumption area. This is the reason why we are – experiences – we have experienced that we are now experiencing the back feeding phenomenon from medium voltage grid to HV grid, which is a key indicator of a very high penetration of renewable energy sources.

What about the field installations? Here in this image you can see depicted the four elements regarding the installation. Element number one, the primary substations, where we have installed the control system, the central controller of our solution. Then on number two, we have the PV facilities, the generators where we have installed a control interface for receiving the set points from the controller _____ the measurements, the key measurements for field.

And then point number three, we have the secondary substations where we acquire through new ID sensors all the measurements necessary for carrying out the calculation. And in the fourth position, last but not least, the storage facility, the lithium ion battery storage facility.

As I said, the heart of our system is that controller, which is placed in the primary substation, and communicates with all the important nodes of the network through a telecommunication infrastructure. In our case, we have implemented a wireless telecommunication infrastructure relying on a fourth generation technology, long term evolution. The architecture is a hub and spoke architecture, so here, you can see the hub, which is connected through long term evolution infrastructure with the primary substation and the secondary substation.

All the information go from the substations to the hub and then to the other substations. So as I said, it's a hub and spoke infrastructure. It's important also to say that the provider of the communication is a public provider. So it's external out of the corporates.

In this slide, you can see depicted the key elements of the system, and in particular, I would like to spend a couple of words, the voltage control. That is, let me say, the important solution of power demonstration. In the primary substation here, we have the controller, an automatic controller which acquires the measurements from the field here, from the medium voltage network, and carries out the state estimate of the network, and then the optimization, sending out the set points of reactive power for the generators, which are delivered to the regulation interface to the generators. You can see there are here – we have the primary substation, and through the communication system, the set points are delivered to the generators, and also the controller every 15 minutes calculates the optimal position for the overload _____ or the primary substation.

So here, we have essentially two resources or _____ free. One is the on load _____ of the primary substation. The second one are the generators. And the third one, which is not in this slide, but in this _____, is the electric energy storage system, which is used also for achieving voltage control.

So to sum up, the voltage control _____ every 15 minutes – or every 15 minutes or in case of voltage limits, the algorithm is triggered and sends optimized set points to three resources, the HM/MV transformer on load tap changer, to the generators, the local control system for reactive power modulation. It's important to say that the algorithm takes into account the capability of each generators, and also that the active power injected is not modified. So we _____ reactive power in the real field, but the controller is also able to send a set point related to the active power. So the system is also – also enables the power – the active power modulation, even though it will not be tested in field.

And the third regulation resource is the storage system, where I can control both active and reactive power. And here, you can see the capability curve of the storage system, essentially a circular capability of one megavolt ampere.

To conclude, some lessons learned so far in our demo. First of all, there is that according to the first results of the project, the most beneficial resource for voltage regulation and for increasing hosting capacity in case the main limit for increasing in hosting capacity are voltage limits, of course, is the on load tap changer of the primary substation.

The second point is that also the use of reactive modulation from generators can be an effective resource, but in some cases it may lead to losses increase. The electric storage system is able to contribute effectively to the voltage regulation, and it can help also to control, to modulate, the power flow exchange between the primary HV and MV network. Of course, we have to take into account the capacity of the storage system.

Regarding the optimization horizon for the storage system, in other words, sending the set points of active and reactive power to the storage system, we have to take into account the time horizon, because we have _____ strengths, because the storage has a capacity, of course, so we have to take into account also the state of charge time by time.

So an important result regarding these optimization horizon is that it can cover from minutes to several days. The key aspect is to have reliable forecast system. But from our experience, one day should be a good compromise for the optimization horizon.

And to conclude, a very important aspect related to the smart grids, not only to the demo, but more in general, is that the smart grid system relies very much on telecommunication system. Therefore, it's really important and necessary to foster a sort of convergence, let me say, between _____, between electric distribution system and communication infrastructure, which means find a common point for reliability of the telecommunication infrastructure is really important. Find the right performances from the communication infrastructure in terms of latency and bandwidth, depending on the different applications. And also, there are very important aspects related to cyber security. As I mentioned during my presentation, we have used a public service provider for providing the communication.

And the very, very last hint related to this communication is that projects like these, in our opinion, can help in fostering the diffusion of last generation telecommunication technologies in such areas that are market failure, let's say, for the service providers. So an important point is to foster this diffusion also in these areas through the smart grid systems.

And now I have completed my presentation. I leave the floor to Thomas _____. _____, thank you very much for you _____.

Thomas Drizard

Now I will present the French demonstrator and the results associated to the integration of solar energy in the case of this demonstration.

Before coming to the subject and specific use cases related to the integration of photovoltaic electricity, I want to give a short introduction to the photovoltaic energy in France. And we have saw a sustained growth in installation capacity. The objective for 2020 was before 5.4, and has been corrected last year to 8 gigawatts, and you can see also the repetition – the different French regions. And the demonstration of _____ is located in _____ France in the southeast region, which is second region in terms of photovoltaic capacity.

We have in France _____ right now around six gigawatts of photovoltaic energy, and _____ implementation, we have mostly these decentralized resources are connected to the distribution grid, which forces us to find solutions to integrating more and more of these resources.

Regarding the French demo, we have in the project four use cases. The first use case, in this case _____ day to day optimizing massive PV integration within the distribution grid. The other use cases is we have islanding use case through _____ disconnecting a low voltage district from the main grid and supplying it for a limited duration of time with photovoltaic electricity and energy storage.

The third use case aimed at aggregating different flexibilities on residential industry _____ also storage to cut loads at the high peak demand _____ 3.5 megawatts. And last use case is to give customer a new role within the smart – within grid, which is a prosumer role, the consumer consuming and generating his own electricity.

Some figures about the project. We have around 300 participating clients, so around 15 percent _____ rates. We have around 1.3 megawatts of grid storage installed among the distribution grid. And we have also residential storage, and in the area, we have about 3.5 megawatts peak of installed PV, and distributed among the large installation as well as small residential, so strictly low voltage installation.

In the consortium, we have ten companies. ERDF is sort of coordinator of this demonstration project. SAFT is supply the batteries. EDF plays a role of aggregator and also recruits _____ different customers. Alstom is providing software architecture as well as some hardware components that are involved in storage and to the communication infrastructure. And Socomec deployed battery converters. We have also the Armines University developing for PV generation for _____ platform. The NKE are supplying some hardware components for residential customers, and NetSeenergy playing the role of an – of the industrial aggregator.

Regarding the different flexibilities involved in the project, if the aim is to be able to display – to make match, consumption and generation curves, and we use different plan flexibilities. The first type of flexibility is our residential flexibilities. The three types of flexibilities are deploying the project. The first flexibility is a solar bonus. The solar bonus is aimed at giving four extra off peak hours tariff to the client between 12:00 AM and 4:00 PM _____ high peak generation. And we have around the price of – a peak price around 10 _____ hour on the on peak price, close to 15 _____ megawatt hour.

The smart water tank _____ aimed at using electrical water tank as thermal storage, and to charge this sort of tank between 12:00 AM and 4:00 PM. And the third flexibility is the smart storage use of the battery in combination with photovoltaic _____ to be able to charge the PV energy between 12:00 AM and 4:00 PM. Okay.

Regarding the first results, the first result of the 2015 _____, so we experiment the PV integration during the summer, and we have here the first results, are from June 1 to July 31, regarding solar bonus and the smart water tank. So regarding the solar bonus, you can see here that we have the 20 percent consumption, over consumption, so the – between 12:00 AM and 4:00 PM, we are able to consumer 20 percent more thanks to this solar bonus, thanks to _____ for our clients to consume more during this time. And it's _____ results compared to 2014 results.

And the end of the day, we have also five percent overall over-consumption. We gave some extra off peak tariff to the clients.

Regarding the smart water tank, it's first of all important to notice that the clients having this smart water _____ also had the solar bonus, because we switch on smart water tank during off peak hours, so between 12:00 AM and 4:00 PM. And here, we observe 56 over-consumption during – between 12:00 AM and 4:00 PM means that we can consume 56 percent more electricity during this time period _____ high period generation. And we also switch on this water tank at several times during this period in order to spread the peak consumption of this appliance.

And we have an overall over-consumption of seven percent, which is mainly due to the fact that we have solar – we have off peak hours.

We have also another type of flexibility deployed into the grid, which is solar on load tap changer transformer, so this on load tap changer are usually deployed on primary substation. The innovation is to place this transformer at the secondary substation to be able to change the voltage ratio between primary and secondary voltage dynamically as a function of the _____. As you can see in the graph, the voltage has to be kept into the plus or minus ten percent value on the low voltage grids, which is challenged by the massive deployment of the – for the photovoltaic electricity _____ of grids.

You can see here where it's – our idea in the project is to give set points, different set points. For example, during the night, we have a pretty high set point for the voltage, because we have no PV generation, and during the day, whenever – when it's sunny, we lower the set point from – to 404 volts. And we can also correct it dynamically using the light sensors, which can indicate whether we have the presence of clouds, which lowers the PV generation. On our graph, you can see the correlation between the measured solar radiation in red and the voltage measured in blue.

The last type of flexibility used is a large scale grid storage. We have four large scale grid storage installed among the distribution grid. One of the strengths of the project is to experiment storage at different level of the distribution grid. Regarding PV integration, we have three storage _____. So one storage located close to a secondary substation in a specific district with high PV generation, and two other storage located in residential area.

For the first _____ storage, we are located in a secondary substation of an industrial area with three large PV _____ we can see in the geography of the district. We have a secondary substation, and we have a very large amount of PV energy compared to the consumption. And we have every day high export of PV electricity from the _____ to the _____ network. As you can see in the graph in the red _____ shows the _____ generation and the _____ shows only the consumption of the district.

The idea of this battery is to be able to limit export of PV electricity to the medium voltage. We have no voltage constraint issue in this case. The idea is to be able to reduce this export to be able to optimize the size of the transformer.

In the other case, we have here a residential area. You can see the detail of the grid, the red – where the red part is medium voltage grid, and the yellow part is the low voltage grid. You can see the difference. PV generation, I said was a small one, _____ 3 kilowatts peak, and we have a large one close to the battery of 25 kilowatt peak. And we have a 33 kilowatt, 106 kilowatt hour storage system, which is able to change the voltage value by plus or minus 3 percent, which is quite useful, to be able to offset the voltage disturbance from the PV generator.

As you can see also in the graph, that we are able to store the – to charge the battery between 12:00 AM and 4:00 PM, keeping also an eye on the voltage value, on the – at the connection point of the storage.

In conclusion, so we have the residential client results are preliminary, and will be consolidated at the end of summer, which are – we are now _____ results. Regarding the smart water tank, as you can see, we have kind of different peak, so we have – so our R&D team are working on an _____ smart water tank which is _____ limiting the peak and smoothing the electricity consumption. The smart transformer plug and play solution works dynamically and is regulated directly locally with a light sensor, which is a _____ solution. Grid storage is very responsive and efficient, but reacts to – we have to mention that the storage – on the low voltage network, storage acts on the three phases with the same – in the same way, and sometimes we have dis-equilibrated unbalanced between different phases on the low voltage grid, which makes the solution not optimal.

The real time storage management can be implemented in 2016, in order to be more efficient and to work more – in a more automated way. And regarding the storage installed on the secondary substation in the industrial district, we have also the ability to island the system for four hours. The first tests were done successfully on September the 6th, and we are performing next week extensive islanding tests in order to extend islanding duration.

So thank you for your attention.

R. Gauraude Verdier Okay. Thank you, Thomas. Thank you, Daniele, and thank you, Lars, for the _____ detailed presentation of the German, the Italian, and the French demo. As a global conclusion _____ to ease the replication of promising approaches developed and tested in the GRID4EU demos, we put the emphasis on transversal activities. And in particular, concerning replication and scaling-up, the six _____ in GRID4EU in charge of more than 50 percent of the European metered energy. Thus, the project relies on a consistent play for scaling-up and replication.

And the scalability and replicability analysis performed within the project already started benchmarking quantitative technical outcomes, and is currently carrying wider quantitative analyses, including social and regulatory aspects.

At the end of this task, we will have a complete understanding of which techniques or technology we can replicate or scale-up, first as _____ and then probably at the European level. And the final results will be presented during the _____ in the final deliverables of the project, and during the GRID4EU final event on January 19th in Paris. It will be a public event, so you are all fully welcome.

If you want to keep in touch with GRID4EU, you can visit – please visit the GRID4EU website. On the website, you will be able to download all GRID4EU public deliverables. And there is also a YouTube channel. On the channel you will have access to the GRID4EU videos, and you will see a lot of Daniele and Thomas presenting what is going on in the field. Thank you very much.

Tim Reber

Okay. Great. Well, thank you so much to all four of you for some wonderful and informative presentations there. We do have a couple of questions from the audience, and those of you listening in, we certainly encourage you to go ahead and ask some questions. Again, you can type in your questions through the questions pane on the right side of your screen there. I will relay those to the panelists.

So we have about 20 minutes, 25 minutes here for some questions, so without any further ado, let's just jump into them.

The first one I guess is for Lars or anybody who wants to comment, but they're specifically wondering about in Germany, what regulatory changes have been made in recent years, if any, to help with some of these grid issues?

Lars Jendernalik

You have seen – speaking of regulation, there's a _____ of our renewable energy law in Germany. The last decade, I would say, we just started _____ more _____ two years. So what we've seen is a change in the thinking of regulation coming from taking each kilowatt hour of delivered energy to the network, coming to the question of eligibility _____ take each _____ kilowatt hour into the network, or _____ the question of just devoting some of these kilowatt hours regarding the necessary expansion of the network capacity.

Therefore, we see a change in regulation coming to make restrictions to the installed capacity of networks or installed plants of photovoltaic and wind, and coming now again from more energy _____ network design to a more power-oriented network design, and the regulatory framework of it.

Tim Reber

Okay. Great. Thank you very much. Moving on here, our next question I believe is for anybody. They're curious about for medium voltage networks, which technologies are most profitable, specifically in regards to wind versus solar PV, or maybe there are other profitable technologies out there for medium voltage grids.

Daniele Stein Actually, this is a very open question, and it – I think it's – this is Daniele speaking – it's very specific to different countries. So different countries have a different let me say plans for connecting renewables, as we have seen from the different presentation.

What I can say from the perspective of the DSO and also coming to our demonstration, we can say that regulating the voltage for the medium voltage network for our perspective is let me say transparent, because we have developed a system for let me say interfacing not only PV generators, even though we _____ demonstration here, we have mostly PV, but also for interfacing let's say hydro-generation, combined heat and power generators, so not only static converters, but also with let me say rotating machines.

So let me say depending on the different capabilities, which are not the same for PV and the wind generator, or let me say combined heat and power, the system takes into account the different capabilities and performs the _____ in accordance.

So let me say starting from the generation mix in each country, you have let me say a quite transparent approach for the different sources.

Tim Reber Okay. Great. Thank you very much. And again, if anybody else – any of the other panelists would like to chime in, certainly please feel free to do so.

Moving on, we have a bit of a technical question, and this one's for Thomas, but if anybody else would like to comment as well, please feel free. In regards to the French demo, what is the cycle depth and cycling frequency per day or per week of the energy storage systems used in that demo?

Thomas Drizard Actually, we are using the storage asset for different use cases. I mean, this use case I developed in this presentation is rated to PV integration, and we have in the project 40 electrical-solar _____, which is most sunny days. In a solar day, we _____ one cycle a day to charge the battery between 12:00 AM and 4:00 PM, so we choose also the different – we have to also to calibrate the charge _____.

But as a function of the grid _____, we do one cycle a day during the solar days. In winter, we also use the _____ storage asset to shave the peaks and to reduce the peak demand between 6:00 PM and 8:00 PM, and also we do one cycle a day. And for islanding, which is a specific use case for the secondary substation battery, we do _____ _____ the _____ cycle, they can fluctuate, because depend on the reserve that we have. We have around one cycle a day when we do islanding, doing _____. So it's never more than the one cycle a day, but we don't cycle the battery every day, because in the framework of our experimentation, we only do several days of experimentation for each season.

Tim Reber All right. Great. Thank you. Our next question is kind of a current events topical question. I guess this question would be mostly for Lars, but it seems like it's an issue that might be applicable to any of the demo sites or countries. I'd be curious to know how the anticipated influx of refugees is expected to affect the country's energy networks and energy systems, and if there's been any plans to accommodate for that influx, if it's anticipated to affect the systems at all.

Lars Jendernalik _____ the current situation in Germany with the refugees, or the – what did your question lead to?

Tim Reber I believe the question was referring to the anticipated influx of refugees, specifically anticipated to be coming into Germany in the next year, and how the country's energy _____ and the country's energy system.

Lars Jendernalik Okay. So I've understood your question. I think that's – the question is how energy intensive might be the situation with refugees in Germany, and we don't think that this would be a large – it would be a large part of our energy _____ that might be – that might be going to this part _____ _____ question of an additional – of additional I would say _____ tariff customers, not more, not less _____. So I think that this is something that won't affect our energy system, especially speaking about _____ integrating renewable energies _____ _____ renewables, medium voltage or low voltage systems.

There might be some additional little construction, some additional _____, maybe, but that's a normal part of daily work, when we think about network planning, building, operation. Speaking about _____ industrial customers, a question of new tariff customers _____ _____ town or community. And so I do not think that there will be much impact. I think we will handle it like we have handled all other challenges for the last 100 years, speaking about the energy impacts, of course.

R. Gauraude Verdier Remy speaking, and if I can add something related to the GRID4EU project, _____ we are trying to welcome the refugees, to do our best to welcome them. And sometimes, the welcome infrastructure is a bit far from the grid, and in that case, the islanding mode, off grid _____, for example, the one tested in the _____ grid project with battery and solar panels _____ system, could be – could be an option.

So so far in France, we are not facing this situation, but we are thinking about it. So if we have _____ a bit far from the normal grid to welcome refugees, we will be able to provide electricity from an off grid solution, and it could be the one tested in this grid.

Tim Reber Interesting. All right. Thank you very much for both of those responses. We have one more sort of technical question here. So it's in regards to step-up transformers and inverters. I think this question is for Daniele regarding oversizing of transformers and inverters and how much those systems have been oversized in the Italian demo.

Daniele Stein Regarding the size, as I said, the _____ _____ is related to the size of the transformers, and it's being regulated regarding our network to voltage constraints. So when we say the reactive power modulation achieved through the inverters of the PV generators _____ support the voltage regulation with the on-load tap changer of the primary substation, which I – as I said, is the let me say most _____ – the _____ which allows it to achieve the – most of the results.

In case of an over-current, so _____ new transformers, or let me say refurbish the network with the cables or something like this, we have to move to another scenario which is related to the active power modulation, which is actually achieved in our demo through the energy storage system. And in case _____ for the control of the active power injection of the generators.

But as I said, it's _____ enabled. It's not performed in the demo. So to sum up, for voltage problems, which are the main let me say boundary condition for the network, the on load tap changer of the primary substation and the reactive power from the generators is an effective solution. In case of problems of sizing of the network and the transformers, we need to – also to put on the table a de-active power modulation.

Tim Reber Great. Thank you very much. So we have one more question here, and then I think we'll probably wrap up and give each of you a chance to provide any final closing thoughts, and then move into our survey. But before we do that, our last question is wondering about future plans after the GRID4EU demo is finished early next year. The project seems to have quite a bit of attention worldwide, and I think our audience would be interested to know what comes next.

R. Gauraude Verdier So Remy speaking for _____. We have _____ short term objective and a long term objective. The short term objective is first to look at the finalized _____ we still have some months in front of us to get all the expected results, all the data coming from the field, and to provide to _____ communities interesting feedbacks and lessons learned and key takeaways from such _____ or such project. So this is the short term exercise.

Then after the closure of the project, we will see demo by demo what we will do for the equipment. Are we going to leave the equipment on the field? Are we going to remove them? And it will be also interesting to see _____ with the equipment, especially in terms of lifetime asset management, because the equipment are quite new, and there is a lot of questions regarding the _____ of the equipment.

The long term _____ we believe in _____ colleagues _____ is that after such project, we will try to scale up and to replicate the technologies and the mature techniques and technologies in GRID4EU. So for true _____ perspective, _____ we will deploy some of the techniques and technology already tested or currently tested in the _____ grid project.

And I'm sure we'll all be – we'll all be in the coming years to start a new project to test the new technologies and new techniques. So first we will close GRID4EU. Then we will learn about asset management. And then if possible, and if there is a new research framework from the commission for – the European Commission, for example, we will apply for that _____ project, GRID4EU number two.

Tim Reber Great. Well, we'll be looking forward to it. Should be interesting, and I think there'll be quite a few eyes on what happens and what comes next. So that's – that'll wrap up the question and answer session. Before we move into our final survey, I'd like to give each of you just a couple of minutes right here to provide any final thoughts or closing remarks you might have. Or if not, we can just move right into our survey.

Lars Jendernalik Okay.

Tim Reber Okay. Great. So if you look on the screen there, you'll see the first question. Go ahead and please answer this question. Your responses go a long way to help us ensure that the Solutions Center webinars are as useful and impactful to you, the audience, as possible.

Great. Thank you very much. And the second question here. Thank you. And one final question. Great Well, thank you very much, everyone, and for those of you who might have further questions that come up, the presenters presented their contact info on their slides, and those can be found posted to the Solutions Center website, so you can find those emails and reach out to them, if you have any further follow-up questions.

So with that, I'd like to go ahead and thank you, all of our panelists, and thank all of those in attendance for participating in today's webinar. We invite all of our attendees to check the Solutions Center website to view the slides as well as to listen to a recording of today's presentations, as well as previously held webinars, and that recording should be posted hopefully within about a week.

Additionally, you'll find information on other upcoming webinars and other training events hosted by the Solutions Center, and we invite you to inform your colleagues and those in your networks about the Solutions Center resources and services, including our no cost Ask an Expert policy support.

With that, I'd like to invite everyone to have a great rest of their day or evening, as the case may be, and once again, thank all of our panelists, and we hope to see you all at future Clean Energy Solution Center events. With that, thank you, and we will conclude our webinar.