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Oral Discussions on Session: "Energy Storage and Distributed generation" – Part II

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Abstract

This paper contains the second part of the transcribed oral discussions of Session "Energy Storage and Distributed generation" of the 2013 IREP Symposium - Bulk Power System Dynamics and Control, held on Friday morning, August 30, 2013. Papers [1]-[5] were presented.

Discussion

Costas Vournas (NTUA): I'm just taking the opportunity to make a few reminders and I would like to apologize to Mr. Mancarella for mixing up in the program his country affiliation to Italy instead of UK…

Pierluigi Mancarella (University of Manchester): No, it's all right.

C. Vournas: I wanted to say that I made a list of things that were not perfect in this conference. So thanks for pointing this out. The country alocation was done automatically by the openconf system depending on the corresponding author, but we should have made sure that all the countries listed should be in the program. And I also apologize for those that are not able to read the lower part of the projections.

Chair: I think Costas' list of things that are not perfect must only be may be at most two items. It is a short list. So, I thing Rodrigo starts with the questions.

Rodrigo Ramos (University of São Paolo): My question is to Sandro Corsi [1]. First of all, congratulations on the presentation. You've shown two different topologies on your presentation and on the paper. One is a meshed grid and the other one is a radial feeder. I'd like to know, and this is sort of a curiosity of mine, which one of them is most common in Europe and in Italy, in particular.

Sandro Corsi: Thank you for the question. The scheme is very simple because the primary cabin has its own feeders with loads and generators and then the grid of the primary cabin has in some way autonomous link with the primary cabin itself. In some particular circumstances you need to feed the isolated grid of the primary cabin by the nearby HV connected primary cabin, but this is a very rare operating condition. Generally speaking each cabin has its own grid and then its control is autonomous related to its own feeders and generators.

R. Ramos: OK. So that brings me to just a quick follow-up. Translating it to Brazilian reality, in Brazil we have many synchronous generators connected as distributed generators to low and medium voltage feeders. And they are mainly willing to sell active power with no reimbursement whatsoever for providing reactive power or voltage control. Do you see any conflict or any other solution other than imposing them mandatorily to maintain the voltage in their terminal busbars?

S. Corsi: I want to say that those generators should have their step-up transformers, I suppose. So they have the local voltage control at the low voltage side, at the stator edge of the generator. This should work like in the transmission. The generator is exactly the same, no conflict. I do not get your point about those generators not allowed to deliver reactive power. Even if not required, they continue to deliver or absorb reactive power as imposed by the grid.

R. Ramos: It's not that they are not allowed. It's that they make a contract with the utility to sell active power. So they have a power factor controller instead. And they sort of lose the ability to control voltage.

S. Corsi: Good. Any automatic control on power factor or voltage does not limit the active power production. In principle, the power factor control should guarantee reactive power production-absorption in given amount but it comes from the system static analysis and is not adequate for a true grid voltage dynamic support. I want to say, in terms of ancillary services, the control I propose properly contributes to the MV grid voltage control and simplifies the recognition of the support to the voltage servicing without limiting the active power production. If you have

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a generator that is limited by narrow capability curves, so it's not allowed to deliver/absorb reactive power, obviously it simply delivers active power, but its available contribution in terms of the voltage ancillary services cannot be recognized because not used. I don't see any conflict between active power production and grid voltage support, because the two automatic controls can be managed in parallel.

R. Ramos: Thank you.

Claudio Cañizares (University of Waterloo): Let me start by congratulating Costas. An excellent, an outstanding meeting. He was saying that it wasn't perfect, but for me this is pretty close to perfection. So congratulations to Costas. Second, I would like to briefly comment on Pierluigi Mancarella's work [3]. I mean we've been working with this for a few years, following the lead from Professor Andersson [6] on the concept of energy hub systems, in which you have this holistic view of energy. Not only electricity, you have to look at thermal and many other energy vectors. And I believe that this is the way to go. We plan for a center in Canada, where we are basically looking at energy from a transportation point of view, thermal point of view, electricity point of view, you cannot just do it independently. In fact there is a company now in Ontario, Impala is its name, in which they are basically using thermal systems to provide frequency control services to the IESO. So actually that is happening. And I believe we can fully agree that's the way to go. Now my question is for Sandro Corsi [1]. You posed an interesting problem, which is the coordinated regulation, but not only through the feeder. You are working on coordinated voltage from the feeder, but now you go even beyond and you are mentioning the possibility of looking at coordinating not only the control at that level but also further up the line. I guess conceptually it makes sense, but the problem we are having with this idea is that first of all you have a lot of conflicting interests. So the generation, and this was previously mentioned by Rodrigo, might not want to regulate the voltage because that costs money, money from incentives fair enough, but what kind of incentives? We already hardly know to get the big generators to coordinate voltage at the transmission level. So if you start now thinking about little generators down the line, it's a bit of a problem. The other issue that I see is that now you have also loads regulating voltage. In Ontario, for example, we are working on a project right now throughout the province of Ontario on how to implement basically voltage regulation at low voltage levels, in which they are trying now to save energy; basically we have incentives; when they have incentives, they are getting paid for that and it is good for them, as energy reduction. In that context it's not only the generators now. You have loads involved in the voltage regulation at the feeder level. So conceptually it's an interesting idea. I am just questioning the practicality of it. Given what we know about the generation voltage coordination at the transmission level. Can you comment on that?

S. Corsi: Thank you Claudio for this interesting question that allows me to better clarify the proposal. First of all I do not understand the reason why the small generators voltage control has a cost higher than the one they already have. All of them produce and absorb reactive power and to save energy a good grid voltage coordinated control is required, even including active loads. You also ask the question of the coordination between the voltage control in the transmission and the voltage control in the distribution. This topic is very important. When I talk about the link between the regional dispatch at the transmission and the distribution control center I was just referring to this need to exchange information. At the distribution level you cannot properly control the voltage without coordination with the operating decisions at the near-by transmission grid. If they move autonomously, obviously a big problem arises in the distribution to manage. I also said that you can control the primary cabin high voltage bus-bar, but only in case the voltage bus control at the transmission level is electrically far from this primary cabin. You cannot select the primary cabin high voltage bus-bar to compete with the other voltage control in the transmission. In this case the control in the medium voltage bus-bar is the solution. The decision of the primary cabin voltage control structure must also be defined according to the situation and information exchanged between regional dispatcher in the transmission and the local distribution dispatcher. Also according to the primary cabin voltage reactive power contractual agreement there could be cases with different need. In one case you may have the generator there at the MV bus-bars to provide support to the transmission. Therefore the generator can be requested to deliver active power, reactive power and so on to control the primary cabin MV or HV voltage. Other cases, as you said in Canada, are interested to control the voltage in the local load. According to that, the showed control solution in some way controls the voltage in the load, even if inside the control band.

Chair: Thank you

S. Corsi: Inside the band. So, this is a simplification. If you want a very integral control of the given load obviously this solution does not allow this kind of control in the load. But the proposed solution allows the voltage to be controlled inside a given band. But generally speaking this is enough.

Chair: Thank you. Pierluigi, do you want to respond to Claudio's comment?

P. Mancarella: Thanks Claudio for the comment. I agree that this sort of framework is needed really, because otherwise the idea of all this work trying to capture the synergies and to understand how you can extract value from the interaction of energy vectors has no meaning. We talk a lot about the value of flexibility in power systems and sometimes we don't realize that actual flexibility and value can be extracted from other energy vectors. That's really the idea of the framework. I am aware of the publication that suggests that. Thank you for your comment.

Gregor Verbic (University of Sydney): I have a question for paper [4]. You seem to be assuming the wake model to estimate the wind speed for the second row of the turbines.This relates to the second point of your methodology. How reliable is this given the variability of the wind speed and the changing direction?

Luis Vargas (University of Chile): Could you rephrase your question please? I couldn't quite catch it.

G. Verbic: You seem to be using a model to estimate the wind speed taking into account the wake effect. My question is: how reliable is this? Do you trust the model given the turbulent nature of the wind? Or do you maybe have an idea how you can benchmark the model against measurements?

L. Vargas: We actually just took the model that we presented in the paper. We did not make any testing for the reliability, nor did we compare our results with experimental or field test measurements. Because the main objective of the paper was actually towards assessing the dimension of operating reserves: of the impact on operating reserves of the huge penetration that this small system is going to receive in the next future. But we didn't actually go into that detail in testing the model.

Andrea Mansoldo (EIR Grid): I have a question for Pierluigi Mancarella [3]. Actually this is a very fascinating topic. What I would like to understand, since your paper deals with ancillary service provision: are you thinking of a top-down approach, with the macro sector represented first, then the electricity sector to incorporate results with traditional tools, or are you thinking of a bottom-up approach instead, so that you create equivalent behavior of load that could then be managed with a traditional tool and have indication of the trade-off between the worth of shifting the policies?

P. Mancarella: Thank you for the question. I would say that you can have a merge of the two approaches actually. So the way that this was formulated was the second approach. We are looking really at the distributed part of the energy system and try to understand the techno-economics of the system. How we can provide services to power system itself starting from the distribution level. But you can incorporate this into a system-level framework, where actually you can create a model of the operation of the system and this will be more related to the first approach. So I would say the way it is now, it is more the second part. But eventually the two things will be merged together.

Alex Papalexopoulos (ECCO International): I have a question for the paper from Italy [3]. I missed part of your presentation so if you have answered this question, I apologize. I am trying to understand the economics of your model. You are talking about some fees, how the exercise fee and the availability fee as set, who pays whom and how these dollars are recovered?

P. Mancarella: Thanks Alex. The idea was to have such system where you can understand the economics of the distributed system subject to market prices. For instance you have real time prices for electricity; you have gas prices and so on. On top of it you also have some sort of signals of the possibility to participate to provision of ancillary services such as reserve services for instance; then, how can you optimize your operation of the system taking into account all the different market contexts? So in this sense the model is really looking at the operation of the distributed system subject to signals that it receives. And in this context the availability fees and the exercise fees are actually sort as parameters coming as signals from the market. So once you have these as an input, you would then optimize your system. So it's not actually the idea of designing the market, it's really like: you receive these signals (the values that we use are sort of typical values you could find in the UK market) and then you see how the economics of this distributed system would be to respond to these signals.

Alex Papalexopoulos: So the availability fee is kind of a capacity signal of some sort?

P. Mancarella: Yes. Basically you enter a contract, where the network operator will say: you may be called upon or not, but you must have this capacity available for the network operator if it is needed and then you would just be paid to make this capacity available to the network operator.

A. Papalexopoulos: But there is no capacity market in UK.

P. Mancarella: No, but you can do this for instance for reserve services. You can enter a reserve contract, which will have different components. So that's why the framework is sort of general to deal with different types of mechanisms. And the reserve market will be of this type. So you enter this market and you are paid the availability fee anyway, because you can provide this reserve, and if you are called upon on top of it, you will also be paid the exercise fee.

A. Papalexopoulos: I see. Thank you.

Göran Andersson (ETH, Zurich): Well this is another question for Pierluigi . First of all, you were looking for a connection between Torino and Manchester, and I have one: Juventus and Manchester are performing equally badly in Champions League nowadays. That's my feeling.

(Laughter from the audience)

P. Mancarella: I have to say, I support AC Milan.

(Laughter from the audience)

G. Andersson: OK, and then I want to concur with what Claudio said earlier. This analysis [3] is very interesting and my congratulations for an excellent work. I have a more technical question. You say here you use an energy-hub-like model. So I would be interested to hear what are the differences between your approach and the energy hub we introduced a couple of years ago [6].

P. Mancarella Thank you for the question. In this case the multi-generation power plant was really modeled as a hub. But there were no network interconnections, so the focus was really on the plant. And the model for the energy optimization is basically your model, the nonlinear model with the matrix representation and so on. Then starting from there, basically, we modeled the provision of ancillary services by forcing the plant to decrease the electricity withdrawn from the grid by a certain amount, for instance. So we slightly modified the optimization problem by adding some constraints, but the backbone is actually your model. And what we did, because the model is intrinsically nonlinear, as you know, you need to look for multi-start optimizations, to look at the initial solution and everything. There are ways to disaggregate the equations and then you may end up with a linear model sometimes, if all the functions are linear, but in this case you also want to take into account the off-design characteristics of the physical equipment. Once you do this, I think it's quite hard to linearize the model. This could be another approach we used in other papers. But in this one the model is really like your model basically.

G. Anderson: OK, just a quick comment: I think you should look into the work of Ian Hiskens and Mads Almassalkhi, did in the University of Michigan [7], because they came up with very nice ways of solving this for large systems.

P. Mancarella: I know the work. I know this work. Thanks.

Yannis Blanas (IPTO): I wanted to say that it was a very good approach from all speakers of this and the previous Session, today. Everything was pretty well approached. But I am asking you… I feel that there is a delay from the industry to respond to all these ideas and, actually, proposals, because they are very clear on what to do. And also I feel there is no standardization behind all these new solutions. Is there any information on this? The question is to all speakers. Thanks.

Lukas Sigrist (Pontificia Comillas University): I will try to answer, at least on what we are doing in Spain. I was presenting the control issues of batteries, which is part of a national grant on storage system on the Canary Islands. We are collaborating with ENDESA. So what is actually going on is that they are still testing these technologies, actually just after the summer break we will get some results of this mentioned super-capacitor in one of the islands, so we get the actual measurements and we will try to validate both system data and system model and the super-capacitor model. But the stage is, as I was saying, "testing" and there is nothing really on. So we are really trying to figure out the best way to operate the storage system. We did an analysis of the multi-tasking of storage systems and it seems to be beneficial for the system in terms of decreasing system cost of 6% - 7% depending on the island. It really much depends on that. It's in testing phase.

L. Vargas: From my side, our work was actually promoted by the ISO of the Northern Interconnected System of Chile. And because this, as my student showed, is thermal and they have no wind power now, but they will expect over 1000 MW in the next three years, so they are really concerned about how to size the impact of this amount of energy in the system. So they actually work all along with us, they provide us with the data of the interconnected system and other scheduling of the power plants and so on. So, yes, in our case, at least, this was very linked with the ISO.

P. Mancarella: Just a quick comment. Yes, talking about the integration of different energy vectors, the idea is certainly that the industry is a little bit behind or quite behind. We have now projects with the National Grid, where we are looking into the integration of the electricity and gas network operation. But even within the National Grid, their businesses are totally separated really and it's hard sometimes to talk between and with them. But they are slowly moving to that direction, because they recognize that they are missing opportunities and they try to extract value from this interaction and optimization, but certainly the industry is a little bit behind. Hopefully, it will re-catch.

Chair: There is a number of students. You haven't asked a question the whole way. There's no lunch, until you ask a question!

(Laughter from the audience)

R. Ramos: My question is to the last presenter [5]. First, congratulations on the presentation. You have shown different types of grids, for which you are proposing your idea. For the isolated grids it seems an interesting proposal. But in large transmission systems we have this concept of "infinite bus" that we use not so carefully sometimes. From the DG viewpoint a similar concept has arisen, which is the "point of common coupling" (PCC), with which you have to be careful, as well, when you use it for dynamic studies. So, my question is: you've been careful enough to use something called a "large area" as opposed to PCC in your first test-system, which is connected to the main grid. How did you model the main grid in these simulations? Was it an equivalent? What type of model did you use to simulate the main grid?

Athanasios Vassilakis (NTUA): How did I model the large area?... I didn't understand exactly the question.

R. Ramos: There is one of the systems in Fig. 5, on page 3, of your work [5]. There is a synchronous generator connected to a large system. You've been careful enough not to put a PCC over there, but a "large area", since you are providing frequency regulation to this system as well. So how did you model this large system? What was the type of model, so that you can get the response of this large system to the frequency regulation you are providing to it?

A. Vasilakis: The large system is just an infinite bus, so there is nothing specific about it.

R. Ramos: So, did you model it as an infinite bus?

A. Vasilakis: Yes.

R. Ramos: So, there would be no frequency deviations in this bus.

A. Vasilakis: Only the transient events. Also the transients due to the transmission line.

R. Ramos: So, the transients will come only from the synchronous generator.

A. Vasilakis: Yes.

R. Ramos: OK. Thank you.

Chair: Still no questions from the students?

Voice off the mike: They are not hungry!

(Laughter)

Chair: Other questions?

Sakis Meliopoulos (Georgia Tech): I have a couple of questions for two authors. My first question is to the virtual synchronous generator [5]. I was not able to read the paper, but in the presentation I have not seen one of the limitations of the system. Specifically if we have an actual synchronous generator, it has a lot of capability to provide a lot of electric current, and so on, but when we are dealing with these systems there is a limitation of how much current they deliver. Have you included in the model the limitation that the current that the system can deliver is limited? And then I will follow with a question for another author as well.

A. Vasilakis: Actually there is ongoing debate about it in the technical community. Some TSOs have incorporated the virtual inertia to support system stability, for example in California. But in Europe the situation is a little bit different. For example the Renewable UK, in a paper a year ago, says that virtual inertia is not the proper way to support a system, but more responsive frequency regulation is required. So this is an ongoing debate about virtual inertia and it remains to see what the technical community will say.

S. Meliopoulos: OK, but no matter how you do it, eventually there are going to be some transients incurred by the control. And then the question is: does the control scheme include the limitation of the current of the systems?

A. Vasilakis: The only problem with the control scheduling is the complexity of the algorithms you try to solve.

S. Meliopoulos: Thanks. I have another question, for Sandro Corsi [1]. Sandro, in your scheme, obviously the issue is that we have the transmission system, we have the generation system, the distribution system and we have the big gorilla on the transmission and the distribution system. One of the issues is basically the limitations at every instant of time. So, first of all, I like the scheme that you propose, but my question is the following: what is the infrastructure that is required for this scheme to work perfectly? In other words, what is the infrastructure that is required to feed the information you need for this controller? Do you think the present SCADA system is enough or we need to move into more reliable and more detailed schemes that will provide the information that is needed for this control scheme?

S. Corsi: Thank you for the question, Sakis. As the proposal moves to a simplification of the control structure, in the same way the solution is open to different ways to be realized. I want to say that mostly is the automation of the substation, the primary cabin substation that should charge the rule of voltage, frequency, reactive power control, according to the need. The simplification, also remember the question that Claudio asked, is that having this automation the distribution control center simply has to send some reference to this primary cabin automation. So the key point is the way to have a real time control according to the automation of the primary cabin and computing, in agreement with the transmission trend, the control setpoints. The automation of the cabin could also charge in a centralized way most of the limiting controls such as the limits of the generators. Differently, you can have also near the generator some decentralized limiting functions. In other words the solution can be simple and flexible in my view, depending on the situation. The recognition of what can be done and what can be the easy thing to do is the required adaptive ability. Obviously the exchange of information with the generators, loads, and the voltage measurements along the feeder coming to the automation of the primary cabin is always required.

C. Cañizares I just wanted to follow up with your last comment, Sandro. The problem I was referring to is that there are now developments at the distribution system level, in which we are now setting up reference points for the feeder to control the voltage in the feeder coordinating with whatever resources you have for voltage management on the feeder, load or generators. These setpoints could be in conflict with the ones you are sending from the transmission system according to the scheme you have in mind. So the transmission system can say that the feeder setpoint should be, for example, 1.1 or 1.05. Whereas, the system on the other side says, no, it should be 0.95. And then you have this conflict where for the system could be good to be high, but for the feeder is good to be low. And that's what I was referring to. You end up with this conflict of interest. Thanks.

S. Corsi: I'll try to give an answer to this point. To clarify: The transmission voltage control does not fix the voltages either in the feeders or at the primary cabin bus-bars. If you manage the control in a way that the primary cabin is an equivalent generator or load, you manage your transmission control taking into account that this primary cabin could be a source of active power, absorbing or delivering reactive power and having a kind of support in terms of voltage. By taking into account what is the need and trend of the transmission, the primary cabin locally controls the voltage at the medium voltage bus autonomously, having the ability to maintain the feeder voltages inside a defined band and, at the same time, remaining in link with the transmission trend and contractual power MV-HV exchanges. This is a help to the transmission too. So, you have this kind of equivalent generator seen by the transmisson that "coherently" controls thein the medium voltage bus and at the same time this kind of generator is something that includes loads whose voltages, with discontinuous controls, are maintained inside a given band. This is the idea and I do not see any conflict with the transmission control.

Chair: Are there any questions? …. So, at this point I conclude the conference, actually. I think it is good to thank the speakers of this session, thank the speakers of the entire week and very special thanks to Costas Vournas who disappeared…

(laughter and applause)

Costas Vournas (NTUA): Thank you all! As I said before, doing IREP a second time is a good advertisement for whoever is going to organize the next one. Thank you all for coming to Crete and let's enjoy our trip to Knossos and Heraklion.

References

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