THE BAHAMAS POWER SYSTEM STABILITY STUDY FOR THE IMPLEMENTATION OF A HIGHER RENEWABLE ENERGY PENETRATION LEVEL

REPORT ON THE TRAINING ON THE STABILITY SIMULATION MODELS IN ETAP

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To:

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CONTENTS

1 INTRODUCTION

This document reports on the Demonstration and Training Event on the ETAP Stability Simulation Models delivered by Energynautics in the project *The Bahamas power system stability study for the implementation of a higher renewable energy penetration level* funded by United Nations Industrial Development Organization (UNIDO).

The objective of the Demonstration and Training Event was to introduce the simulation models prepared by Energynautics to the technical personnel at Bahamas Power and Light Company Limited (BPL) that is expected to work with the models after the conclusion of the present assignment. The training was aimed at explaining how the models have been designed, set up, configured, and run, thus enabling BPL to reproduce the results obtained by Energynautics in the study, and giving a starting point for further model refinement and simulation work.

The purposes of this report are to:

- List the training agenda and provide a link to the training materials,
- List the participants of the event,
- Summarize the questions received and answers provided in the training event,
- Provide brief conclusions on the training results.

The training was conducted as an online meeting in Microsoft Teams on 11 May 2023 at 10:00-11:00 EDT / 16:00-17:00 CEST.

The entire demonstration and training event has been recorded and the recording video has been shared with the participants. A machine-generated transcript (not checked for correctness) is provided in the annex (section 1) of this document.

2 TRAINING AGENDA AND MATERIALS

The following planned agenda was communicated prior to the demonstration and training event in the invitation:

- Power systems overview: New Providence, Eleuthera, Exuma

- Brief intro to ETAP

- Model organization

- How to run a power flow

- Power flow results on the islands

- How to change the power flow model

- Questions?

- How to run a dynamic simulation

- Dynamic simulation results on the islands

- How to change the stability models

- Questions?

The presentation slides used in the event are shared in a separate PDF file along with this report.

3 PARTICIPANT LIST

The participant list as recorded in Teams was the following:
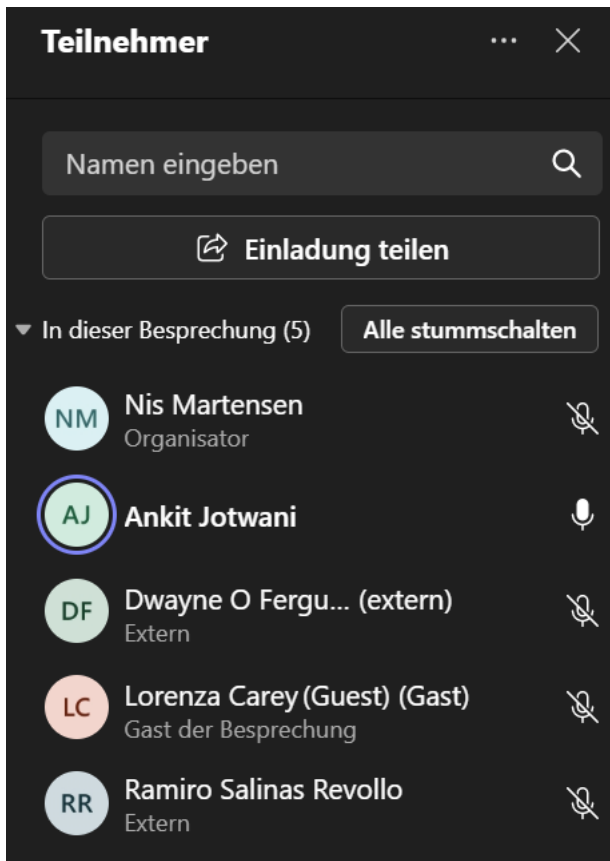
4   QUESTIONS RECEIVED AND ANSWERS PROVIDED

The author's notes contain two questions that were asked by the participants and the provided answers:

Question 1: BPL uses "n-2" for stability considerations, was this criterion used in the disturbance selection for the stability simulations?

Answer 1: No, it was not.

Question 2: ETAP and Revisions - When BPL wants to add more BESS (Battery Energy Storage Systems) to the modeled systems, do they need to replicate the modeling process that forced the Energynautics team to make so many 'revisions' in ETAP?

Answer 2: Yes, this is correct.

5 TRAINING RESULTS AND CONCLUSIONS

The demonstration and training event was carried out successfully and within the foreseen time. The entire training material was covered.

The participants have expressed their satisfaction with the demonstration and training session at the end of the session.

A follow-up session to discuss any questions on the content was suggested at the end of the session; however, this turned out not to be possible due to lack of time within the timing constraints of the assignment.

Nevertheless, Energynautics will do their best to answer questions that may be submitted by BPL staff. No questions have been received in the four weeks between the event and the preparation of this report.

Based on the positive feedback received from the participants, the demonstration and training event can be considered a success that has met its objectives.

6   ANNEX: EVENT TRANSCRIPT

Machine-generated transcript (not checked for correctness):

00:00:10 Nis Martensen (Energynautics)

OK.

00:00:12 Nis Martensen (Energynautics)

Yeah, it's going to be recorded.

00:00:23 Ankit Jotwani (Energynautics)

Hello everyone then I will go ahead and share my screen.

00:00:45 Ankit Jotwani (Energynautics)

I hope everyone can see the screen.

00:00:49 Ankit Jotwani (Energynautics)

Uh, alright, so the objective behind the presentation is to give you a demonstration of the model that we have developed for New Providence and as well as Luthra and Exuma Islands show show you how we model the scene.

00:01:07 Ankit Jotwani (Energynautics)

Videos and to tell you also how to use these models for for future.

00:01:17 Ankit Jotwani (Energynautics)

This part. Yeah. So the agenda would be that I will give you a brief objective of the project, provide you an overview of the methodology and the case matrix regarding how we did the study, provide you some information about the power system development, the information that we received from you and some of the information that we assumed.

00:01:38 Ankit Jotwani (Energynautics)

And then I move over to ETAP.

00:01:42 Ankit Jotwani (Energynautics)

Guide you guide you about how the study was organized and it up tell you a bit about how we did the load flow studies and then finally discussed the transient stability simulations.

00:01:55 Ankit Jotwani (Energynautics)

I will also like switch over in between to ETAP or try to yeah also give you some live demonstrations. Just. Yeah, just to give you a better introduction to the.

00:02:08 Ankit Jotwani (Energynautics)

So we are not very sure. We were not sure which topics.

00:02:13 Ankit Jotwani (Energynautics)

We wanted to cover because we were not sure about how much knowledge you had about it up, so please let me know if you wanted.

00:02:23 Ankit Jotwani (Energynautics)

Yeah, if I should skip something or if I should discuss something more, please stop me and just let me know so that we can cover as much as possible.

00:02:36 Ankit Jotwani (Energynautics)

Uh, so the project objective here. So we were tasked to do a power system stability for the islands for different islands in Bahamas. So in first phase, we did the New Providence Island.

00:02:48 Ankit Jotwani (Energynautics)

And then later on, now we are doing looking at the Lu and Exuma Islands and the objective was to see how ready were they for future integration for renewables.

00:03:00 Ankit Jotwani (Energynautics)

So as per the targets provided to us, the goal was that by 2023 we expected around 5% renewables.

00:03:09 Ankit Jotwani (Energynautics)

In in New Providence and 30% renewables in 2030 and for for Phase 2, we based on the documents supplied to us, we kind of got the estimate that there were some renewables in the system already in 20.

00:03:26 Ankit Jotwani (Energynautics)

83, which accounted to be about 10% as a part of the annual lexity mix, and we assumed an intermediate stage of 2020% renewables and 2026 and then 30% renewables.

00:03:39 Ankit Jotwani (Energynautics)

Finally, in 2030, so this is how this was basically the targets that we were trying to keep.

00:03:47 Ankit Jotwani (Energynautics)

So the methodology that we followed here was in the first step, we tried to get as much information as possible about the system.

00:03:54 Ankit Jotwani (Energynautics)

So we looked at the different energy resources available that enable targets. We received the existing single line diagram of the system from you. The also we received some information about the expansion plans for new provider.

00:04:07 Ankit Jotwani (Energynautics)

You also helped up with helped us with the dynamic unit unit parameters for the different generating units in New Providence.

00:04:14 Ankit Jotwani (Energynautics)

So we got all that data, but there was also some data missing. I think especially for the newer generators and for the rental generators. So we had to assume some things up here.

00:04:27 Ankit Jotwani (Energynautics)

The next step was we used the data and the available information about the generation capacities.

00:04:35 Ankit Jotwani (Energynautics)

Uh, come up with a mix of renewables needed to meet the targets so.

00:04:43 Ankit Jotwani (Energynautics)

So basically we did some optimization studies in Homer, the software Homer and came up with the dispatch profile and dispatch hourly profile for the entire year.

00:04:54 Ankit Jotwani (Energynautics)

And from that dispatch profile, we selected a few cases which we thought were like the critical cases to do.

00:05:02 Ankit Jotwani (Energynautics)

We have to do the study.

00:05:04 Ankit Jotwani (Energynautics)

So for 2020, uh, we, uh. So basically, yeah, the cases that we identified were the peak load case which occurred sometime during evening.

00:05:13 Ankit Jotwani (Energynautics)

We identified the high Photovoltage case which occurred during mid day and then we identified the light load case which occurred more during midnight, 2:00 AM or so and then we kept these.

00:05:25 Ankit Jotwani (Energynautics)

Cases in all 3 years so 20202023 and 2030.

00:05:31 Ankit Jotwani (Energynautics)

The we we still had to keep year 2020 because the study was commissioned before 2020 and that was the initial plan.

00:05:39 Ankit Jotwani (Energynautics)

But then we had some delays and yeah, but we still decided to treat 2020 as the base here for the phase one study in 2030, we assumed 2 possible pathways, so there was.

00:05:52 Ankit Jotwani (Energynautics)

The one pathway in which we said there's a high chance that there would be large scale utility photovoltaic installation.

00:05:59 Ankit Jotwani (Energynautics)

And the second case, we assumed that there would be large scale, sorry, there would be a larger installation from the distributed units.

00:06:06 Ankit Jotwani (Energynautics)

The difference between these 2 cases and why we considered it like this is because for larger installations for utility installations there is a stricter grid code requirement.

00:06:19 Ankit Jotwani (Energynautics)

With regards to frequency and voltage support. While yeah, well, while that doesn't necessarily apply to the distributed, for the smaller scale residential PVS, so we yeah.

00:06:31 Ankit Jotwani (Energynautics)

We tried to look at both these cases to, uh, understand the system stability in 2030.

00:06:39 Ankit Jotwani (Energynautics)

So once we had the cases ready, we updated the provided single line diagram by incorporating these cases by incorporating the future expansions and then selecting the appropriate dynamic models for governors, for exciters for enables in the system.

00:06:57 Ankit Jotwani (Energynautics)

So that's that's how we completed the basic dynamic modeling in.

00:07:03 Ankit Jotwani (Energynautics)

And the final step was doing a stability analysis. So we had to to do the stability analysis. The first step is like while ensuring the mid merit order and making sure that there are no voltage violations observed for the different buses in the system. We tried to do some basic simulations to to make sure that.

00:07:23 Ankit Jotwani (Energynautics)

All the control models were working as expected and once we were sure about their behavior, we then tried to look at different contingencies in the system to to see all possible operational scenarios for the system.

00:07:39 Ankit Jotwani (Energynautics)

Uh, so the contingencies are majorly targeted at look, basically we look at frequency, frequency events. We look at voltage events.

00:07:48 Ankit Jotwani (Energynautics)

So for also we also look at loss of generation. So yeah, so basically like frequency voltage stability and angular stability. So these are the events that we cover.

00:07:59 Ankit Jotwani (Energynautics)

With these studies.

00:08:04 Ankit Jotwani (Energynautics)

So the case matrix for the system looked something like this. So for each of the years we had peak load, high photovoltaic and light load, and for each of these cases then we looked at frequency stability, rotor angle stability and voltage stability. So for frequency stability we usually.

00:08:25 Ankit Jotwani (Energynautics)

That took out the largest generator in the system or the largest converter unit.

00:08:30 Ankit Jotwani (Energynautics)

This becomes important, like in 2030 when you have a larger share of renewables in the system. For rotor angle stability, we looked at fault at the beginning or end of the line and then the subsequent removal of the line and for voltage stability we looked at, yeah, we identified some buses and we tried to do a fault simulation there to see how the system responded.

00:08:53 Ankit Jotwani (Energynautics)

Yeah. For 2030, we had the high floating and high distributed PV scenario and we did the same studies for both of them.

00:08:59 Ankit Jotwani (Energynautics)

So in all we ended up with 4 grid states in the system and there were a 360 or so study cases that we were looking at.

00:09:08 Ankit Jotwani (Energynautics)

So this information is roughly based on the data we receive from you.

00:09:11 Dwayne O Ferguson (BPL)

Can I ask the question right there on the previous slide?

00:09:17 Dwayne O Ferguson (BPL)

So basically, you're looking at stability with uh, in, in, in response to disturbances and and uh and normally is correct transient.

00:09:29 Dwayne O Ferguson (BPL)

We use uh the generation level and -2.

00:09:35 Dwayne O Ferguson (BPL)

Where we consider our integrity of our our network, of the loss of our 2 highest.

00:09:44 Dwayne O Ferguson (BPL)

Generating assets, highest capacity, generating assets.

00:09:48 Dwayne O Ferguson (BPL)

Would you have factored in an N -2 level of criteria with this study?

00:09:55 Ankit Jotwani (Energynautics)

Uh, Amit, so with the studies we only looked at N -1.

00:10:01 Ankit Jotwani (Energynautics)

Contingencies. So not not too.

00:10:05 Dwayne O Ferguson (BPL)

Thank you. OK.

00:10:11 Ankit Jotwani (Energynautics)

So so moving on to the development of the power system. So in so this is for New Providence. So in 2020 we you have, we have the Blue Hills Power Station and the Clifton Pier Power station over there. And then yeah, we had no information about the renewables except that there is a small there's a commercial PV.

00:10:31 Ankit Jotwani (Energynautics)

And at the stadium.

00:10:34 Ankit Jotwani (Energynautics)

For 2023 also, I mean there were there were some assumptions involved here. We were not sure if the rental generators were there or not there and the same for 2030.

00:10:43 Ankit Jotwani (Energynautics)

So we assumed some figures here and the information about the renewables for for yeah, for commercial and utility PV, it was based on the studies study results that we got.

00:10:56 Ankit Jotwani (Energynautics)

Uh here in 2030, the first set of figures is when the residential PV installations dominate, and the second set of figures is when the commercial. Sorry when the utility PV installations are dominate.

00:11:12 Ankit Jotwani (Energynautics)

Then we, uh, these are the figures for Exuma. So I've been in Exuma. We have the Georgetown Power station and then we have our rental generation fleet.

00:11:23 Ankit Jotwani (Energynautics)

Again, based on these 30 by WPS, I think sometime back they said that they estimated this much amount of renewables in the system now. So we kept some figures here.

00:11:34 Ankit Jotwani (Energynautics)

And yeah, we just expanded them in the future Ayush.

00:11:39 Ankit Jotwani (Energynautics)

And the same was for Eleuthera, but Eleuthera is a bigger system, slightly bigger system than Exuma. So you have the Hatchet Bay Power station.

00:11:46 Ankit Jotwani (Energynautics)

You have the rock sound power station. You have the Harbor Island Power station. And then yeah, we again assume some figures for the commercial PV residential PV and battery to meet the.

00:11:58 Ankit Jotwani (Energynautics)

Meet the policy targets.

00:12:02 Ankit Jotwani (Energynautics)

So moving over to ETAP, so the idea would be that, yeah, I'll show you how the study was organized.

00:12:10 Ankit Jotwani (Energynautics)

Any tap show you the load flow results, maybe the problem some some of the problems that we face there.

00:12:18 Ankit Jotwani (Energynautics)

And yeah, in case you want to make some changes in the model and then we will move over to dynamic simulations.

00:12:24 Ankit Jotwani (Energynautics)

Look at the different dynamic models. Run some simulations.

00:12:30 Ankit Jotwani (Energynautics)

Yeah. Then look at the results that we got. And yeah, also in case you want to change some models in future, yeah, how to how to go about doing it.

00:12:40 Ankit Jotwani (Energynautics)

So, uh, over to the interface in IE tab. So this is basically the main toolbar in IE tab. So you can do load flow studies here transient stability studies here and then you select the revisions here.

00:12:52 Ankit Jotwani (Energynautics)

So any scenario in ETAP is so ETAP is basically organized as a multidimensional database structure, so you have.

00:12:59 Ankit Jotwani (Energynautics)

Revisions so revision store information about the engineering elements.

00:13:05 Ankit Jotwani (Energynautics)

So basically like the sizes, their impedances are generated parameters, so they are stored as a part of the revision in the revision their in service status is also a part of the revision and the dynamic models associated with these elements with these components also are part of the revision.

00:13:25 Ankit Jotwani (Energynautics)

Then we have the configuration which which.

00:13:29 Ankit Jotwani (Energynautics)

Which has information about these different circuit breaker statuses. It also contains information about the generator control mode. So basically if you want to operate it in the swing mode in voltage control mode or yeah in PQ mode so that information is also is stored as a part of the configuration and then finally we have the study case.

00:13:51 Ankit Jotwani (Energynautics)

So study case stores information about the loading and generation categories, so I'll talk a bit about these loading and generation categories in the next slide.

00:14:02 Ankit Jotwani (Energynautics)

And then information about the simulation length, the time step, the contingencies that you want.

00:14:07 Ankit Jotwani (Energynautics)

To do the.

00:14:08 Ankit Jotwani (Energynautics)

The elements that you want to plot.

00:14:11 Ankit Jotwani (Energynautics)

So all this becomes a part of the study case, so to do, to study any scenario, basically you have to choose a revision. You have to choose a configuration and then the relevant study case and then you run the scenario.

00:14:24 Ankit Jotwani (Energynautics)

So for New Providence, we had basically the revisions that we modeled were this case, which was 2020 in 2023.

00:14:35 Ankit Jotwani (Energynautics)

We did 3 revisions light load, peak load and PV and then 2030. We did 4 revisions so ideally the simple structure should have been that there should be a base case. There should be 2023.

00:14:47 Ankit Jotwani (Energynautics)

And 2030 distributed and 2030 floating and not these other other revisions.

00:14:55 Ankit Jotwani (Energynautics)

The the problem that we.

00:14:58 Ankit Jotwani (Energynautics)

I'll, uh, I'll tell you why it was organized like this in also. I'll also cover it in the next slide.

00:15:07 Ankit Jotwani (Energynautics)

Then these are some of the study cases the that we looked at. So all these events, they represent the various contingencies that we were simulating.

00:15:15 Ankit Jotwani (Energynautics)

LPL they denote the the loading category that we are looking at and yeah, the first value is the year that we are looking at.

00:15:28 Ankit Jotwani (Energynautics)

So for for each element we have different categories wherein we can say what we can define what that particular element is doing. So basically this is the generator menu and we see a peak load category, a light load.

00:15:48 Ankit Jotwani (Energynautics)

Category and a high PV category. So basically yeah. Basically in the study case, we can choose which category we are looking at and then what like then basically decide the response of the generating, decide the response of the unit.

00:16:08 Ankit Jotwani (Energynautics)

So once, yeah, once we have all the revisions and the study case is ready, then we have the scenario wizard wherein we can load all these things up.

00:16:18 Ankit Jotwani (Energynautics)

So we select revision, we select a configuration, we select a study case and we provide a name to the report file and just.

00:16:26 Ankit Jotwani (Energynautics)

And then we just run the simulation.

00:16:29 Ankit Jotwani (Energynautics)

It app allows the possibility to to batch run the simulations also. So this is done via the study Wizard and the Project Wizard.

00:16:38 Ankit Jotwani (Energynautics)

So basically, once you have all the scenarios ready, you just load them in here and you just run them and then yeah, the the SIM. Yeah. You don't have to run the simulation.

00:16:49 Ankit Jotwani (Energynautics)

Individual each simulation individually like it just batch runs all of them.

00:16:54 Ankit Jotwani (Energynautics)

So I'll now talk about how we organize the study and why we had to create so many different revisions.

00:17:02 Ankit Jotwani (Energynautics)

So as I said, ETAP is a multidimensional structure, so you have the revisions, you have the loading generation categories to show which kind of loading scenario it is. You have the study.

00:17:14 Ankit Jotwani (Energynautics)

This is which store information about the contingencies, and then you have the different configurations. So this is more or less the ideal structure that we want.

00:17:23 Ankit Jotwani (Energynautics)

Try to keep but the problem was that in 2023 and 2030 there was a battery involved in the system.

00:17:34 Ankit Jotwani (Energynautics)

And this battery element was doing different things depending upon the loading category we were looking at. So in peak load case, we expected the battery to discharge uh to provide power to inject power into the system and light load case.

00:17:47 Ankit Jotwani (Energynautics)

We wanted it to be there as a as a frequency reserve and in the high PV case we wanted it to, yeah, chart.

00:17:54 Ankit Jotwani (Energynautics)

So uh, in etab the dynamic models, they are not linked to the load flow values, so the dynamic models need to have references set within them basically.

00:18:05 Ankit Jotwani (Energynautics)

So it it meant that in order to have different behavior from the battery element for these loading categories, we had to create 3 different dynamic.

00:18:14 Ankit Jotwani (Energynautics)

Models for the battery element and.

00:18:19 Ankit Jotwani (Energynautics)

Which and which implied that we also needed to change the dynamic model for the battery element when we were studying these different loading categories and which was only possible via revisions. So that's why we broke down each of these revisions into further sub revisions so 2023.

00:18:39 Ankit Jotwani (Energynautics)

You are broken down into. Yeah, peak load, light load and high PV. The only difference being that the battery model in the 3 cases differed. The battery and the subsequent plant controller model. In these 3 cases deferred.

00:18:52 Ankit Jotwani (Energynautics)

Because the references provided to the model were different.

00:18:56 Ankit Jotwani (Energynautics)

And the same goes for 2030 floating and 2030 distributed. So it complicated the structure a bit, uh.

00:19:03 Ankit Jotwani (Energynautics)

But yeah, I mean, based on the way ETAP is at the moment or ETAP version 21 is at the moment like this was the only way we could keep.

00:19:10 Ankit Jotwani (Energynautics)

The Yeah, have the I have the model with.

00:19:17 Ankit Jotwani (Energynautics)

This was the.

00:19:18 Ankit Jotwani (Energynautics)

Only way in which we could do the studies like this.

00:19:26 Ankit Jotwani (Energynautics)

I would stop here for a moment just to check if there are any more any questions here.

00:19:34 Ankit Jotwani (Energynautics)

Or should I continue?

00:19:40 Dwayne O Ferguson (BPL)

Think you could continue?

00:19:44 Dwayne O Ferguson (BPL)

So basically at the end of this, as we add more batteries, we will be able to come and model our own.

00:19:49 Dwayne O Ferguson (BPL)

Battery do battery solutions.

00:19:55 Ankit Jotwani (Energynautics)

Uh, sorry, Dwayne, I did not get this. Get it?

00:19:59 Dwayne O Ferguson (BPL)

The the introduction introduction of the best created a the need for the the various different revisions as we as we expand the best to introduce new best sites we would have to then basically do replicate this process. If we continue to use ETAP correct.

00:20:16 Ankit Jotwani (Energynautics)

Yes, yes, yes, that's true. That's true.

00:20:26 Ankit Jotwani (Energynautics)

Yeah. So, I mean, the idea, the idea also is that or what I tried to do is, uh, that I should just in order to load a scenario I shouldn't go into each element and change the dynamic model.

00:20:37 Ankit Jotwani (Energynautics)

I wanted it to be all ready so that I can just like load it and run it without changing anything in the system. So that's why like it was necessary to keep a structure like this to keep things simple.

00:20:47 Ankit Jotwani (Energynautics)

Later on, when when someone else was using the model.

00:20:53 Ankit Jotwani (Energynautics)

Moving over to the load flow, maybe I can now switch over to ETAP quickly and show you the things directly there.

00:21:08 Ankit Jotwani (Energynautics)

So basically here we have the uh scenario wizard uh, which has all the different scenarios uh, loaded and ready to use.

00:21:20 Ankit Jotwani (Energynautics)

Then yeah, this is where we. So if I if I switch to the different scenarios, you will see that the divisions, the configurations and yeah, the the report names, they all change automatically. So yeah, so I'll now maybe try to run a load flow so.

00:21:40 Ankit Jotwani (Energynautics)

Here I take the basic case of the load flow in 2020 with the peak load case and I run it.

00:21:50 Ankit Jotwani (Energynautics)

OK so here.

00:21:53 Ankit Jotwani (Energynautics)

So this was the system and the results can be viewed either through the report manager or through the load flow analyzer.

00:22:02 Ankit Jotwani (Energynautics)

So mostly we have been using load flow analyzer because I mean I feel like it provides a very good overview of what's happening in the system. So the if you go to general.

00:22:13 Ankit Jotwani (Energynautics)

Info it provides you the overall load in the system. The loss is happening the total generation.

00:22:20 Ankit Jotwani (Energynautics)

Similarly, if you go to sources, you can see the total generation from the different sources. Uh in, yeah, total generation from the different sources.

00:22:29 Ankit Jotwani (Energynautics)

But yeah, I think the case that I ran here was the peak load case, and I think I'm selecting the results from a different file. But yeah, I mean, so I ideally I should.

00:22:40 Ankit Jotwani (Energynautics)

Selected this one, so this is the peak load case and here we see that there is no battery because in the year 2020 there was no battery. In 2023 there was a battery involved and.

00:22:53 Ankit Jotwani (Energynautics)

So here for the sources. If I remove this one you see that yeah, there is a battery element here.

00:22:59 Ankit Jotwani (Energynautics)

And yeah, the yeah, you can also see the generation from different sources and then you can also look at the voltages at at the different buses to make sure that to make sure that no voltage.

00:23:14 Ankit Jotwani (Energynautics)

While there is no threshold, violations are happening in the system.

00:23:19 Ankit Jotwani (Energynautics)

The other way to view uh load flow results is via the load flow report manager. I mean, it can be quite useful also to extract information about the different input parameters that have been fed in the different components of the system. So for example, for branch, if I click OK, I mean I can see.

00:23:39 Ankit Jotwani (Energynautics)

I I can see the different branches in the system, what type they are. What are the uh impedance values there?

00:23:45 Ankit Jotwani (Energynautics)

So I mean it could be quite useful in case you want to extract some information about the elements for the system. It also provides you a load flow report here.

00:23:59 Ankit Jotwani (Energynautics)

Yeah. So basically the overall the total load connected to the bus and the total power flows, the power flows happening to the different buses which the concerned bus is connected to.

00:24:16 Ankit Jotwani (Energynautics)

Uh, so this?

00:24:17 Ankit Jotwani (Energynautics)

Was load flow and then we looked at the reports.

00:24:23 Ankit Jotwani (Energynautics)

So moving over to uh, transient stability, so I mean transient stability studies are needed to study the system response for severe transient disturbances such as the loss of generating units or loss of load fault on the different transmission facilities.

00:24:44 Ankit Jotwani (Energynautics)

And we the the idea is to look at frequency stability, voltage stability and router angle stability with RMS simulations.

00:24:55 Ankit Jotwani (Energynautics)

So for doing these studies, it is very important that we choose the right dynamic model. So the dynamic model can be chosen in consultation with the manufacturer.

00:25:05 Ankit Jotwani (Energynautics)

But also there are like standards IEEE standards for choosing the excitation and governor models and there are also generic models available.

00:25:15 Ankit Jotwani (Energynautics)

For our renewable, so in our studies, we relied on generic models. We used vector models for renewables.

00:25:23 Ankit Jotwani (Energynautics)

And also other generic models for the excitation and governors. So for typically for governors we use the GV one model. For excitation systems we relied on the AC 8 B model.

00:25:34 Ankit Jotwani (Energynautics)

Uh, by choosing the model is one set. Uh is one part of it, the other part being that we need to make sure that we select the right parameters for these models, so it is necessary that we choose a realistic set of parameters that mimic the actual component response. So it.

00:25:55 Ankit Jotwani (Energynautics)

It is kind of necessary to do some validation with the chosen with the chosen model and chosen parameters to ensure that the model itself is correctly representing the behavior of the actual unit.

00:26:09 Ankit Jotwani (Energynautics)

So in in in our case we had very limited or no data about the actual responses of the unit, so we completely relied on the information that we received for you from you for the different models.

00:26:23 Ankit Jotwani (Energynautics)

So this was for New Providence, I mean and for Exuma and Luthra we have, we had almost no data at all.

00:26:29 Ankit Jotwani (Energynautics)

So we were, yeah, completely in the dark and there, there were a lot of assumptions that we had to make there to get the system running.

00:26:38 Ankit Jotwani (Energynautics)

Uh, but the idea the the idea from our side is that we we hope that the models can serve as a template in future and that you can incorporate, you can add additional things in it to make sure they correctly represent the behavior of the system.

00:27:00 Ankit Jotwani (Energynautics)

So for transient stability. So here we looked at low flow. So this is the load flow tab and then we have the transient stability tab over here.

00:27:10 Ankit Jotwani (Energynautics)

Uh, so for transient stability, uh, you have the option this this is where you run it and then you have the option to plot the results via.

00:27:19 Ankit Jotwani (Energynautics)

Here I will maybe choose a simpler study because the studies with renewables usually take longer and it takes even longer if you are.

00:27:27 Ankit Jotwani (Energynautics)

Like exporting it to the SQLite database.

00:27:31 Ankit Jotwani (Energynautics)

So yeah, I mean, uh.

00:27:34 Ankit Jotwani (Energynautics)

I I will cover this part later towards the end to show you how we exported the data to SQ Lite database in order to make the plotting easier, but for now I'll just show you how to run the transient stability studies. So I choose a basic study. Let's say I choose the study for the peak load case.

00:27:54 Ankit Jotwani (Energynautics)

Uh, the event here is uh, loss of generation and I that's it. So you see that the the revision, the study case, umm, if I go to the study case you will see the event here is the opening of the circuit breaker at 12:00 seconds the study runs for a total period of 40 seconds.

00:28:14 Ankit Jotwani (Energynautics)

And the loading category selected here is the peak load category.

00:28:20 Ankit Jotwani (Energynautics)

So and all I have to do is now just run the study.

00:28:29 Ankit Jotwani (Energynautics)

So the the complex the the more the complex complexity increases in the system, for example by adding more renewables in the system or by as the system expands it the the the longer it takes in ETAP to run the study. So yeah.

00:28:48 Ankit Jotwani (Energynautics)

But I think the the wait time has reduced quite a bit and we also tried it with ETAP 22 and yeah, we felt that the wait time has reduced a lot in ETAP 22 compared to 21.

00:29:01 Ankit Jotwani (Energynautics)

But just so you know, it can take some time off for the study to run depending upon the complexity of the system.

00:29:08 Ankit Jotwani (Energynautics)

And the models involved.

00:29:32 Ankit Jotwani (Energynautics)

I think the the last bit of waiting is mostly happening because it is now converting the results to the SQ Lite database file, which takes yeah quite a bit before it finishes the study. But usually if you're not exporting it to the SQLite database file, the study runs much faster.

00:29:50 Ankit Jotwani (Energynautics)

Uh, I'll go back to the presentation, maybe come back to it in a minute or so when the when the results are ready.

00:30:00 Ankit Jotwani (Energynautics)

So talking about the dynamic models, so.

00:30:08 Ankit Jotwani (Energynautics)

As I said, it is very important that we choose the right, uh, dynamic model to represent the the components. Uh dynamic response.

00:30:16 Ankit Jotwani (Energynautics)

Uh, so for synchronous generator we were looking at we we chose jigo one model usually for the gas generators, but also for the fuel based generators.

00:30:28 Ankit Jotwani (Energynautics)

And we also choose chose some D govern models in the system, but mostly like for the for the generator, for the generators.

00:30:36 Ankit Jotwani (Energynautics)

Like lift and Pier Pier, we relied on the GG one models.

00:30:41 Ankit Jotwani (Energynautics)

Uh. For exciter? Uh for the generators, which we had no information about. We chose a simple AC 4A model, but for the other ones also for the newer generation fleet at Clifton Pier, we use the AC 8 B model.

00:30:57 Ankit Jotwani (Energynautics)

For residential PV, we relied on VEC models. So VEC models there exist different VEC models for different purposes. So if it's a small distributed.

00:31:07 Ankit Jotwani (Energynautics)

We, the model used is PV D One model, so the model does not have fault support functionality and it only has downward frequency droop, not upward frequency droop.

00:31:17 Ankit Jotwani (Energynautics)

So it's it's a rather simple model for residential PVS, and this is what we chose for it because we thought that the grid connection grid code connection requirements for residential PV.

00:31:29 Ankit Jotwani (Energynautics)

Would not be as strict As for the commercial or utility PV for commercial and utility PV, we chose the VEC second generation model. This all these models are available in the ETAP Global library.

00:31:44 Ankit Jotwani (Energynautics)

I will also show you in the model on how to access them. We also chose a plant controller model.

00:31:52 Ankit Jotwani (Energynautics)

The RSPCA model, also a VEC model and then we integrated it with the unit model. It was necessary to choose a plant controller model because the information about the frequency droop.

00:32:05 Ankit Jotwani (Energynautics)

The active power control is basically stored in the plant controller model and not in the second Type 4 AB.

00:32:14 Ankit Jotwani (Energynautics)

And the the in ETAP it is necessary that for each model that we choose there should be an associated unit with it.

00:32:21 Ankit Jotwani (Energynautics)

So the for the VEC model we we used, we chose the static generator element and for the plant controller model we chose a lumped load element. But.

00:32:33 Ankit Jotwani (Energynautics)

We we kept the load value to be very small like somewhere around 0.01 MVA, so as to not impact the system we just needed it, needed it as an interface to store the model and yeah to store the model.

00:32:51 Ankit Jotwani (Energynautics)

So and basically these 2 models then interact with each other. If if all the settings are done properly.

00:32:59 Ankit Jotwani (Energynautics)

The same was done for the best model.

00:33:02 Ankit Jotwani (Energynautics)

So any tab we have the best model. It is quite similar to the VEC second type for AB model, except that there's a feature for checking the state of the.

00:33:11 Ankit Jotwani (Energynautics)

Charge of the battery and then we use the plan controller model together with it to have the frequency response.

00:33:20 Ankit Jotwani (Energynautics)

So, uh yeah, the study here is finished. Uh, and I'll, I'll now show you the different models. Uh, maybe how to see the results.

00:33:29 Ankit Jotwani (Energynautics)

Uh, yeah. And maybe also give you an overview of the UDMF editor interface. So there are 2 ways in which you can access the results. So either we go here in transient stability plots.

00:33:40 Ankit Jotwani (Energynautics)

We see the generators the I think in this case there were no.

00:33:45 Ankit Jotwani (Energynautics)

The different buses and yeah, if there are any thing only lump loads can be ported here. But yeah, so I'll choose the synchronous generators.

00:33:57 Ankit Jotwani (Energynautics)

Maybe I choose G one G 2 from Clifton peer and 810 here and so you see the different responses.

00:34:04 Ankit Jotwani (Energynautics)

Here the event here is the loss of generation, so maybe I will also try to keep the day 12 here which is maybe all of.

00:34:16 Ankit Jotwani (Energynautics)

So here you see that the yeah generator DA 12. So this is the electrical power it it is disconnected from the system and the rest of the units respond by increasing their production.

00:34:28 Ankit Jotwani (Energynautics)

So this is the electrical power. What is more important from our governor perspective is the response of the mechanical power. So here we see the mechanical power.

00:34:37 Ankit Jotwani (Energynautics)

I mean in case there are different units involved, let's say a gas unit steam unit, then yeah, the response of a gas based unit or a diesel based unit would be faster than a steam based unit.

00:34:52 Ankit Jotwani (Energynautics)

The other plot that I wanted to show was that for frequency. So let's say for different buses I choose bus at Clifton Pier and.

00:35:04 Ankit Jotwani (Energynautics)

So here we see the frequency response. So we see that the frequency drops to about 97.5 Hertz after the generator is disconnected.

00:35:12 Ankit Jotwani (Energynautics)

The web because of the primary frequency response of the different generators. Yeah, it recovers and somewhere stabilizes at 99.5 99.5 Hertz.

00:35:23 Ankit Jotwani (Energynautics)

The other way of plotting the results is by directly plotting it at the single line diagram. So if I go to the Clifton peer.

00:35:32 Ankit Jotwani (Energynautics)

Here and yeah, just right click here and we say plot and then we can look at the different quantities.

00:35:39 Ankit Jotwani (Energynautics)

So in this case, we are mostly concerned with frequency, so I just plotted the frequency to yeah to ensure that the frequency reaches a stable position after the event.

00:35:50 Ankit Jotwani (Energynautics)

And yeah, this is this is what we see here.

00:35:55 Ankit Jotwani (Energynautics)

Uh ETAP also allows us the option of plotting the internal signals for UD uh for the dynamic models. So this is done via the scope signal analyzer, so you have.

00:36:08 Ankit Jotwani (Energynautics)

To uh select. So this is the excitation model for generator DA 13 and depending upon where you put the the scope in the model, those quantities are plotted. So in this case I think I'm not sure what it is plot plotting but yeah.

00:36:28 Ankit Jotwani (Energynautics)

So I'll now move over to the.

00:36:32 Ankit Jotwani (Energynautics)

To the UD models to show you how the different uh, dynamic models can be accessed. Uh. So maybe I move over to a revision which has the renewables active, so I choose the distribution, but OK. But I mean yeah, I will end the study here. I just wanted to load the scenario.

00:36:54 Ankit Jotwani (Energynautics)

So in this case we have the sorry scenario.

00:37:09 Ankit Jotwani (Energynautics)

So this uh, I think they have improved this feature in ETAP version 22 that it also allows you to load the study directly without having to run it.

00:37:20 Ankit Jotwani (Energynautics)

So that the case can be directly loaded and then yeah, you can check if everything is OK, but so in this case I wanted to look at 20:00 3rd maybe this case.

00:37:32 Ankit Jotwani (Energynautics)

And then I stopped the study here and then I go to the renewable share. So this is the uh, renewable installation at Skyline. Uh.

00:37:43 Ankit Jotwani (Energynautics)

Click here and then we see the different renewable models that are here. So we see this model is for the year 2023 and 30. Floating the size of the installation.

00:37:54 Ankit Jotwani (Energynautics)

Changed. So now we have a different model because the model also contains information about the size of the unit.

00:38:00 Ankit Jotwani (Energynautics)

Itself, and the same goes for 2030. So the model size was different, and since the model itself also contains information about the size of the unit, we need a different udm model.

00:38:18 Ankit Jotwani (Energynautics)

So the this is how a VEC model looks like, so you receive the signals from the plant controller via these red icons.

00:38:29 Ankit Jotwani (Energynautics)

And uh, depending upon the delays and uh, the so basically the model, the signal is then controlled in the first in the upper half which is the RE EC model or the electrical control model.

00:38:44 Ankit Jotwani (Energynautics)

We also have the current limits here, which decide depending upon the priority which is chosen. So for reactive power priority or active.

00:38:51 Ankit Jotwani (Energynautics)

Our priority this is decided over here.

00:38:54 Ankit Jotwani (Energynautics)

Sir, there is also the fault fault group loop here, so there's additional fault. Current injection based on the voltage drop and the fault droop selected which then like injects additional current into the system.

00:39:13 Ankit Jotwani (Energynautics)

Then this is. Yeah. Then we have the generator control model, which again has some limits for current depending upon the voltage situation.

00:39:23 Ankit Jotwani (Energynautics)

Some delays to represent the converter behavior, and finally these signals are fed to the end block, which is the, so the end results are the active and reactive power references which are then fed to the current source block.

00:39:42 Ankit Jotwani (Energynautics)

The same goes for uh. The plant controller model. So for plant controller model you will see.

00:39:54 Ankit Jotwani (Energynautics)

Uh, so the plan controller model. Yeah, allows us to control the voltage at the terminal of the bus or reactive power at the terminal of the bus.

00:40:03 Ankit Jotwani (Energynautics)

And it also allows us to control the the active power depending upon the frequency drops selected. So the references for active and reactive power are basically generated from the plant controller model.

00:40:16 Ankit Jotwani (Energynautics)

And depending upon the quantity that we want to plot. Uh, appropriate. Uh uh scopes or these data plotters can be put in the model and then we can yeah, we can observe the quantity in the model by going to scope signal analyzer.

00:40:36 Ankit Jotwani (Energynautics)

So yeah, this is the model structure that I showed you.

00:40:40 Ankit Jotwani (Energynautics)

Also, just to emphasize again that in the model the the size of the model. So if I go here, so the P that's the PV VEC model, the size of the model is a parameter of the model. So in case you are increasing the size of a unit, you have to also change the.

00:41:00 Ankit Jotwani (Energynautics)

Unit size and inside the model to make sure that yeah, the model response as expected.

00:41:08 Ankit Jotwani (Energynautics)

So yeah, I mean so you cannot use the same model for different units with different sizes. I mean the model also has to change with the size of the unit.

00:41:24 Ankit Jotwani (Energynautics)

Yeah. So I we also wanted to discuss why we went for UD models over the built in models. So and ETAP also has the option of choosing some built-in models. So if I go back to ETAP.

00:41:40 Ankit Jotwani (Energynautics)

You will see that for the yeah, for generation for the winter bind generator, the this is the UM option.

00:41:49 Ankit Jotwani (Energynautics)

But then we have the web option, so this is basically a built-in model inside the software. So, but you cannot access this model, it's a black box. But yeah, I mean you have to.

00:42:01 Ankit Jotwani (Energynautics)

Parameter parameterized the model in in these tabs basically so ETAP has this option. The same goes also for the synchronous generators. So for synchronous generators you will see that.

00:42:15 Ankit Jotwani (Energynautics)

Uh, if you go to the exciter section. So in our case we chose UD models everywhere. Uh, I'll discuss the reason behind it, but yeah, we also have the option of choosing the built in model.

00:42:26 Ankit Jotwani (Energynautics)

So you let's say if you want to have the AC 4 models then you just yeah provide the parameters here. But yeah, you cannot access the block diagram for these models while.

00:42:36 Ankit Jotwani (Energynautics)

For udm models, you can always access the block diagram.

00:42:41 Ankit Jotwani (Energynautics)

So the reasoning behind choosing the UD models was that for the renewables, the built in models in ETAP version 21, they are first generation models.

00:42:51 Ankit Jotwani (Energynautics)

The second generation models are the latest ones and they have a lot of new features which the first generation model slack.

00:42:59 Ankit Jotwani (Energynautics)

Then also uh with the advantage with built in models, was that the you can change the control behavior of the models, you can do modifications to the block diagram, make changes to it to reflect the grid code dependency. It was also kind of needed in our case.

00:43:18 Ankit Jotwani (Energynautics)

Especially because we also were facing some issues with respect to initializations or we changed some things in the model to make sure that yeah, the the system ran for the cases also with higher renewables.

00:43:33 Ankit Jotwani (Energynautics)

The UTM models they allow for easy debuggability. Uh. I mean, since IE tab ETAP is, I mean there are still some problems in in the transient stability when we do the transient stability studies in ETAP. So it's it's with udm models. It's easier to debug.

00:43:52 Ankit Jotwani (Energynautics)

Yeah, because you can plot the internal signals and see where the problem is coming.

00:43:56 Ankit Jotwani (Energynautics)

From then, compared to the built in models, so we face some of the issues that we constantly discussed with the support team and then we just came to the conclusion that it's better to use udm models compared to the built in models.

00:44:11 Ankit Jotwani (Energynautics)

The UDP models also have the benefit that we can interface it with another model. So for renewables we use the plant controller model which hide the frequency group functionality to interface it with the renewable model. This is again not possible with the built in VEC.

00:44:29 Ankit Jotwani (Energynautics)

And then, uh, the UDP models allow the possibility to change the reference set point. So in case during the simulation you want to change the reference set point provided to the PV. This is possible with the UD models and not with the built in models.

00:44:44 Ankit Jotwani (Energynautics)

Also, we also wanted to show you some of the results from the studies that we carried out. So these results were plotted via Plotly. So once we ran the study, the we exported the result database file using the SQLite.

00:45:01 Ankit Jotwani (Energynautics)

Debasis I can also share the script and guide you more about it. It is also described in the help documents.

00:45:12 Ankit Jotwani (Energynautics)

So the we we did it like this because we did not want to select the select the quantities every time we ran a study. So I mean.

00:45:22 Ankit Jotwani (Energynautics)

Once we have the database exported, we can just write a generalized script which then plots the relevant quantities which made the whole process more automated and much more faster compared to if we were doing it individual.

00:45:36 Ankit Jotwani (Energynautics)

So here the the the event is loss of generation. I think this was also the event that I was trying to show you in the in the software.

00:45:46 Ankit Jotwani (Energynautics)

So here the generating unit DA 12 goes offline and then we see the responses of frequency the the relative router angles.

00:45:56 Ankit Jotwani (Energynautics)

And the voltage at the different buses. So we see that there were no threshold, the voltage violations and that the frequency reached a stable position.

00:46:06 Ankit Jotwani (Energynautics)

I mean, of course it doesn't go back to 60 because we did not model any secondary result. We only considered the primary frequency control in the system. Similarly then this is the result.

00:46:17 Ankit Jotwani (Energynautics)

From 2023, so the event simulated here is. This is the high photovoltaic case. The event simulated here is a fault in a high voltage line and then the subsequent removal of the line to clear the fault.

00:46:33 Ankit Jotwani (Energynautics)

Uh, so in this case, uh, we see also see that during the fault there's a frequency excursion. But the when after the fault is cleared, the frequency reaches a stable state. The important results or the more interesting aspects for this case is that is the results.

00:46:53 Ankit Jotwani (Energynautics)

From from the renewables. So here we see the utility PV installation and the battery installation. So the battery was charging in this case because this is the high photovoltaic case and we see that.

00:47:08 Ankit Jotwani (Energynautics)

Uh, the for active power. The response is to support the frequency after the fault is cleared, so they both the units.

00:47:18 Ankit Jotwani (Energynautics)

Yeah, react control their production to basically support the frequency. This also goes for the commercial PV and the same also goes for the.

00:47:29 Ankit Jotwani (Energynautics)

Reactive power. So in our case we the the renewable units, they were operated in reactive power priority mode. So you see that even during fault the the reactive power from the units is the same or a little bit more despite the lower voltage.

00:47:46 Ankit Jotwani (Energynautics)

This is because the reactive current the injection in reactive current increased uh to support the grid. Uh during the fault.

00:47:56 Ankit Jotwani (Energynautics)

And again in this case, we observed that the system reached a stable state after the event. Uh, this is the case with a high amount of distributed renewables in the system.

00:48:11 Ankit Jotwani (Energynautics)

So in roughly in this case, the total generation was 193 and the total amount of renewables was 157.

00:48:19 Ankit Jotwani (Energynautics)

We had to keep some amount of synchronous generator generators operational because ETAP version 21 did not did not allow grid forming.

00:48:30 Ankit Jotwani (Energynautics)

Models. So basically to run the system you still needed some synchronous generators in the system active.

00:48:37 Ankit Jotwani (Energynautics)

Uh, so here we had 3 generators active and the rest of the generation was coming from the renewables. It was a it was quite a difficult case for us to run because I mean also there there are problems with respect to initialization in ETAP also when you are derating the linear builds because in this particular case.

00:48:57 Ankit Jotwani (Energynautics)

The total amount of renewables exceeded the total amount of load. So I mean in some cases we had to derate the utility PV and the commercial PV.

00:49:08 Ankit Jotwani (Energynautics)

So there were some workarounds used which we also tried to describe in the report, but we are also happy to assist you in case you have questions later.

00:49:20 Ankit Jotwani (Energynautics)

Uh, so yeah, in this case, you see that since the commercial PV 's were derated, uh, so after the the after the loss of a unit after the loss of generation the the the units that enable units increased their production to support the to support the frequency.

00:49:40 Ankit Jotwani (Energynautics)

And in here the uh, the.

00:49:42 Ankit Jotwani (Energynautics)

The the the converter units basically respond much faster compared to synchronous generator units and that's why you see a much faster recovery of the frequency in this case.

00:49:58 Ankit Jotwani (Energynautics)

So moving over to uh, what worked for us and ETAP, maybe you have also faced some of the issues like what we are describing?

00:50:06 Ankit Jotwani (Energynautics)

So we just wanted to summarize it here so that, yeah, we can help you out in case you're also facing the same issues.

00:50:14 Ankit Jotwani (Energynautics)

In general, ETAP has a wide variety of UD models. Uh, sorry, I will try to hurry. Hurry it up a bit.

00:50:20 Ankit Jotwani (Energynautics)

Uh, so as to keep the timeline. So ETAP has a wide variety of udm models available. So for enables for synchronous generators, I mean typically we found all the models there, but I mean in case you are lacking.

00:50:35 Ankit Jotwani (Energynautics)

Model. You can also ask the support team and they are quite they're quite helpful. I have to say.

00:50:44 Ankit Jotwani (Energynautics)

Uh. Then with the multi dimensional structure database structure, it's easy to organize large scale studies like this. It also kind of reduces the redundancy.

00:50:53 Ankit Jotwani (Energynautics)

You just have to, yeah, place the different, have the right revisions and the right configurations and it should be easy to rerun the study later with macro Wizards. It's.

00:51:04 Ankit Jotwani (Energynautics)

Simple to reload and batch run simulations and then we have the SQLite database functionality which basically exports all the result as a database file which can then be accessed via Python to plot the relevant quantities so.

00:51:21 Ankit Jotwani (Energynautics)

Basically helping automate the whole process.

00:51:26 Ankit Jotwani (Energynautics)

The issues that we faced were, uh, with respect to model initialization, as I also said earlier, we realized that so the initialization process for renewables differs from that of a governor or an exciter unit.

00:51:39 Ankit Jotwani (Energynautics)

I think what they say, what the ETAP support team says, is they have the iterative initialization for the governor and exciter units.

00:51:46 Ankit Jotwani (Energynautics)

Uh, but for renewables, it's more of a direct initialization. And so basically you always see that the, the, the powers they do not necessarily start from the set points, they start somewhere above or below.

00:52:00 Ankit Jotwani (Energynautics)

I mean, yeah, and especially when you are derating it, they always the the generation always starts from the set point so.

00:52:07 Ankit Jotwani (Energynautics)

We used some work arounds here like basically we tried to say OK if it's less than one millisecond use this value and then later on switch to other value.

00:52:15 Ankit Jotwani (Energynautics)

I mean, we describe this again in the report and we are happy to assist you with it also in future.

00:52:22 Ankit Jotwani (Energynautics)

Then the other problem was that uh, the load flow is not linked to the U DM.

00:52:27 Ankit Jotwani (Energynautics)

'S uh, so?

00:52:28 Ankit Jotwani (Energynautics)

This was a problem, as I said for batteries, because then you need more models to describe the same for you need more models for basically the same unit, and in general it increases the number of models which are which are used.

00:52:43 Ankit Jotwani (Energynautics)

And then it is also quite difficult to handle large number of models because uh, if you want to make a change in a control block in one model, if you have like 50 models, then you have to go through all of them and then make the change. So it becomes quite difficult to handle such a large amount of models.

00:53:03 Ankit Jotwani (Energynautics)

Because of. Yeah, because as the load flow is not linked to udms and the way it the way the udm models are organized.

00:53:13 Ankit Jotwani (Energynautics)

Yeah. And then we also it, uh, the element out of service is a functionality which is stored in the revision uh uh and it can be needed in.

00:53:25 Ankit Jotwani (Energynautics)

Or the same.

00:53:27 Ankit Jotwani (Energynautics)

I mean, we felt that it would have been better to have it as a part of the configuration manager because yeah, then you don't need to create a separate revision in in case you want to keep a unit out out of.

00:53:40 Ankit Jotwani (Energynautics)

Yes. So in general, our recommendations, so I will maybe go through one by one. So first of all, with respect to the transient stability analysis, I think it is very necessary that we have accurate knowledge about the system components, so generators, clients and Transformers.

00:54:00 Ankit Jotwani (Energynautics)

I mean for Luther and Exuma Islands, we basically assumed more or less everything.

00:54:07 Ankit Jotwani (Energynautics)

Here. So I've been then also the results. I mean, yeah, I mean we there's 2 you can only trust the results to a certain extent.

00:54:16 Ankit Jotwani (Energynautics)

I mean, they give you some idea, but yeah, we cannot say for. Yeah, with concreteness what will happen because we all most of the parameters.

00:54:29 Ankit Jotwani (Energynautics)

There is a need also for validation, so for different for the major components that are there to make sure that the system the the model response is actually representing the actual model response and also we need to do some basic validation for overall system such As for faults and for frequency events.

00:54:51 Ankit Jotwani (Energynautics)

To uh to ensure that the model represents also the actual system behavior.

00:54:57 Ankit Jotwani (Energynautics)

Uh, the these kind of studies, they can definitely help with increasing system reliability and planning for future expansions because I mean, you can see that.

00:55:10 Ankit Jotwani (Energynautics)

But with increasing that enables what lines would be overloaded or what kind of stability issues we might face?

00:55:17 Ankit Jotwani (Energynautics)

And therefore you can identify critical assets.

00:55:21 Ankit Jotwani (Energynautics)

Uh, so the idea we hope that the models, uh, they can serve as a template. I mean, like you can add additional things in it and maybe change the models or change the dynamic models or change the parameters to in future to make. Yeah, to ensure that they actually represent.

00:55:43 Ankit Jotwani (Energynautics)

The I landed power system.

00:55:48 Ankit Jotwani (Energynautics)

Uh, then? Uh. The other recommendation. Yeah. The recommendation from our side would be that, I mean, for the future units that are coming, especially the converter based units, it is important that we that the manufacturer provide some unit and plant models before interconnection and that the response of these units be studied.

00:56:08 Ankit Jotwani (Energynautics)

In the system, because I mean, the system is rather small, so if the unit is quite big, it might have an impact on the stability of the system. So I mean, yeah, and I think these kind of studies can be easily carried out in ETAP.

00:56:23 Ankit Jotwani (Energynautics)

And uh, yeah, our recommendation would also be to switch to version 22 because there are a lot of improvements in version 22, especially with regards to inverters.

00:56:32 Ankit Jotwani (Energynautics)

So right now you saw that, I mean for inverters, we were mostly using a lumped load model or a static generator model, which are basically current sources to.

00:56:43 Ankit Jotwani (Energynautics)

To model the inverter, but in ETAP version 22 there is also the possibility to include dynamic models for the inverter element.

00:56:53 Ankit Jotwani (Energynautics)

So you have the PV inverter element and a normal inverter element, which can then be incorporated with dynamic models.

00:57:01 Ankit Jotwani (Energynautics)

Uh, so which is quite helpful, because it also allows us to model grid forming inverters which cannot be done in ETAP version 21.

00:57:09 Ankit Jotwani (Energynautics)

There are also some improvements in the interface which we found quite useful. So yeah, our recommendation would be that to use ETAP version 22 in future. But yeah, that's it from us.

00:57:22 Ankit Jotwani (Energynautics)

I'm sorry for the slightly longer presentation, but I hope yeah, we were able to convey the important points from our work.

00:57:40 Dwayne O Ferguson (BPL)

I think we have quite a few questions. It was a very good presentation. Thank you very much for your detailed.

00:57:46 Dwayne O Ferguson (BPL)

Glad we recorded it.

00:57:48 Dwayne O Ferguson (BPL)

Because a lot of my team members couldn't join, so I want to share it.

00:57:51 Dwayne O Ferguson (BPL)

It's a lot to digest. Unfortunately. I have an 11:00 AM meeting.

00:57:56 Dwayne O Ferguson (BPL)

So I can't. I can't delve into deeper into this right now, but what I would like to do is if this if we could get a copy of the recording our go over with our team and then we could reach out and and maybe get something get back together again.

00:58:08 Dwayne O Ferguson (BPL)

I hate to miss this opportunity, but I just. I'm just swamped. I can't stay.

00:58:12 Dwayne O Ferguson (BPL)

Longer, but it All in all is a very good presentation.

00:58:15 Dwayne O Ferguson (BPL)

Very informative for me. I learned a lot.

00:58:19 Dwayne O Ferguson (BPL)

And I and we need to go through this together and also we also having trouble on our end just really playing with the models that you that the copies you've.

00:58:27 Dwayne O Ferguson (BPL)

So we're working with our IT team to to sort those out. So I wanna just, uh, play with the models ourself.

00:58:34 Dwayne O Ferguson (BPL)

Go over the presentation again and we'll get back together.

00:58:41 Nis Martensen (Energynautics)

Sounds good. Thank you.

00:58:50 Dwayne O Ferguson (BPL)

So that sounds good.

00:58:51 Dwayne O Ferguson (BPL)

Uh, I'm gonna have to jump off the call I have.

00:58:54 Dwayne O Ferguson (BPL)

A team waiting in the other room.

00:58:56 Nis Martensen (Energynautics)

OK.

00:58:56 Dwayne O Ferguson (BPL)

For me, and as soon as we can get a copy of the recording, that would be great for us.

00:59:01 Dwayne O Ferguson (BPL)

And then maybe next week, well, next week is.

00:59:03 Dwayne O Ferguson (BPL)

A busy week for us, but we're doing some work on the.

00:59:04 Dwayne O Ferguson (BPL)

Best and we're.

00:59:06 Dwayne O Ferguson (BPL)

Also trying to get some more work done in Exuma but give us some time to to to review this and then we'll try and get back together ASAP.

00:59:14 Dwayne O Ferguson (BPL)

As soon as possible.

00:59:16 Nis Martensen (Energynautics)

Yes, well, we are. We are a little constrained here because Ankit who did the work on it up and is is to be in doing this presentation. He's actually going to leave energy analytics.

00:59:28 Nis Martensen (Energynautics)

So we only have a couple of days left where this can happen.

00:59:35 Dwayne O Ferguson (BPL)

OK. Well, OK, then. Alright. Umm.

00:59:40 Dwayne O Ferguson (BPL)

Alright, we're gonna have.

00:59:40 Dwayne O Ferguson (BPL)

To try and do it again and.

00:59:41 Dwayne O Ferguson (BPL)

Make this happen then, OK?

00:59:46 Nis Martensen (Energynautics)

OK. Thank you for attending. Thank you. Glad it was useful. Yeah.

00:59:46 Ankit Jotwani (Energynautics)

Perfect.

00:59:49 Ramiro Salinas Revollo (UNIDO)

Thank you very much I.

00:59:51 Lorenza Carey (BPL)

Yeah. Thank you. And and get just a quick question. Umm, I know we have the devices, is it possible that we could use data collected from SCADA to help with the modeling process or would you prefer your the data loggers?

01:00:05 Nis Martensen (Energynautics)

Any any data is good for us.

01:00:07 Nis Martensen (Energynautics)

Any data really.

01:00:07 Lorenza Carey (BPL)

OK, OK. We'll see what we can do.

01:00:11 Nis Martensen (Energynautics)

Thank you. Thanks.

01:00:17 Ramiro Salinas Revollo (UNIDO)

He is a great presentation link and also to your colleagues. Again, thank you very much. Thank you Dwayne for the coordination and next steps and yes, we keep in touch.

01:00:29 Dwayne O Ferguson (BPL)

Thank you very much. Yeah, the presentation was awesome. It was very, very informative, very detailed. Thank you very much.

01:00:33 Ankit Jotwani (Energynautics)

You. Thank you. Thank you.

01:00:34 Ramiro Salinas Revollo (UNIDO)

Thank you. Yes.

01:00:38 Nis Martensen (Energynautics)

OK, we tried to get the uh recording uh up to ship and then share it and then, yeah, let's talk again.

01:00:45 Nis Martensen (Energynautics)

Thank you for your time and have a great day.
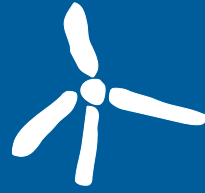
01:00:48 Dwayne O Ferguson (BPL)

You too. Thank you all.

01:00:49 Dwayne O Ferguson (BPL)

Very much. Thank you. Bye bye.

01:00:49 Lorenza Carey (BPL)

Thanks as well.