

Northwest Power and Conservation Council  
Systems Analysis Advisory Committee Meeting  
November 3, 2014

Attendees

Tom Eckman	NPCC
Chris Shaw	Snohomish PUD
Sandra Elverod	PGE
Michael McCoy	Power Systems Research
Tom Chisholm	Army Corps
Jim Litchfield	Consultant Idaho Council
Tomas Morrissey	PNUCC
Dick Adams	PNUCC
Peter Williams	BPA
Eddie Abadi	BPA
Matt Tanner	Navigant
Erik Gilbert	Navigant
Cory Welch	Navigant
John Fazio	NPCC
Carol Winkel	NWPCC
Brian DeKiep	NWPCC /Montana
Elizabeth Osborne	NWPCC/WA Dept of Commerce
Shirley Lindstrom	NWPCC/Idaho
James A. Yost	NWPCC/Idaho
Sandra Hirotsu	NPCC
Michael Schilmoeller	Michael Schilmoeller, LLC
Ben Kujala	NPCC
Clint Kalich	Avista
Bud Decker	NPCC
Zac Yanez	Snohomish PUD
Fred Huetten	NW Energy Coalition

Attendees via GoToMeeting

Michael Deen	PNGC
Cory Welch	Navigant
Greg Nothstein	WA State
Mike Hoffman	Pacific NW National Lab
Barbara Miller	Army Corps
Dan Liska	
David DeVeney	
Robert Petty	BPA
Robert Diffely	BPA

Jessica Mitchell	Snohomish PUD
John Ollis	NPCC
David Frank	
Sibyl Geiselman	eweb
Phillip Popoff	Puget Sound Energy

Ben Kujala, Northwest Power and Conservation Council, opens the meeting. The Committee and the Council introduce themselves. Kujala reviews the RFP for the new Regional Portfolio Model's redevelopment. He also reviews the scope of the project including how to coordinate the RPM with other models. He talks about the how the new model was developed and reviews the timeline.

Cory Welch, Navigant, introduces himself and his team. He discusses the itinerary which will include a walk-through of the model. Welch discusses the multiphase approach. He relates how this model was designed to stay true to the original.

Welch covers the process of creating the new version of RPM. He notes that Phase 2 is well underway.

Welch shows a "snapshot" of the user interface. (Slide 2.4)

Welch explains how he compared "resource strategies" of this RPM to the old RPM. He explains the four bookend strategies he used: least risk, least cost, minimal strategy and maximal strategy. Welch notes the outputs he used. He notes that distribution of outcomes. He states that he does not have all of the details but a more detailed set of documents exist. Kujala states that most of a public slide deck was presented at past meetings and is available.

Jim Litchfield, Consultant to the Idaho Council, asks for clarification on what Slide 2.7 and 2.8 are really showing. Welch clarifies. Litchfield asks about the efficient frontier from the Sixth Plan, noting that there are many extreme points at either end. Litchfield then asks which one Welch picked. Welch answers that they are on the efficient frontier stating that they used least risk that came at the least cost. Kujala asks Michael Schilmoeller, Michael Schilmoeller LCC, to weigh in.

Schilmoeller states that those are the extreme points. He states that on the efficient frontier you look at the least risk/highest cost and the least cost/highest risk strategies. Litchfield asks about the other two graphs. Welch states that they are not on the efficient frontier but are extreme conditions.

Welch says these are the outputs for Phase 1. He moves to Phase 2 explaining slide 2.9. He notes that these are non-linear, non-smooth optimization problems which are the most challenging class of problems. Welch notes that some solver engines work better on this than others. He says he is working on finding the best solver engine for the job.

Clint Kalich, Avista, notes that non-linearity is difficult and Avista has avoided the problem. He asks Welch to explain the non-linearity they kept as opposed to linearizing them and going with a MIP. Welch

answers that the core of the model is fundamentally nonlinear and can't be turned into a linear model. He gives examples of why.

Schilmoeller adds that the kind of optimization Kalich is referring to works if you have perfect foresight into fuel prices. He notes that this is a different approach with an underlying assumption that you cannot predict the future.

Welch shows the user interface. He then moves to next steps and discusses possible enhancements. He notes a critical one, auto generation of the futures. He talks about improving the logic of Demand Response. He speaks about the importance of transparency noting that the model can be accessed through a web-interface. Welch also notes the importance of a faster run time which is a factor of 5. He states that's still not fast enough so they may want to run the model in a distributed computing environment. Litchfield asks what the run time is. Welch answers .08 per future, stating 750 futures run in about a minute. He says that is still not fast enough which is why they are looking at distributed computing. He explains a distributed scenario. He notes that there are some difficulties with distributed computing but he is in a close relationship with Lumina which will facilitate easily exploring the potential.

Fred Huetter, NW Energy Coalition, asks if a distributed approach could be done on a commercial platform or on a specialty arrangement. Welch answers by saying they have a three pronged development phase approach. The first is easiest; multiple cores on a single machine. The next is multiple machines in house and the third is looking to distribute the process with a rented service like Microsoft Azure. That solution has some risk but there is a long term view to it.

Huetter suggests running things in house and then scale up as needed as the rental solution is probably not cheap. Welch agrees. Huetter asks if it's a straight forward parallelization approach or is there lots of upfront work. Welch believes that this is a straight forward parallelization approach and explains the idea behind it.

Litchfield asks where the non-linear optimization comes in with distributed computing. Welch refers back to chart 2.9 and explains the process behind it.

Schilmoeller states that this is how it was done for the Fifth and Sixth Plan. He explains that the real risk is the extensions and Analytica, can they be made cost effectively and in a timely manner. Welch agrees with that but states that the development should be small. Still they will use a phased approach.

Kujala states that the main intent is a model that will comparably run on one machine when it took several machines last time. But we want to shrink that amount of time to about 1/10<sup>th</sup>. How we do it is in the details but the intent is to have a faster-running model. Litchfield agrees but states that he's not clear about the optimizer. He gives an example. Welch asks if Litchfield is really wondering how the optimization works. Litchfield says yes, what's the objective function, what are the constraints. Welch explains that it is set up as an optimization function with engines taking a guess and telling you how to

climb the hill. He then says when you get to a non-linear approach you will always have uncertainty if you've reached global optimum but there are a lot of solver engines to help.

Kujala states that there will be graphics to explain this as the meeting progresses.

Huette asks about the selection of the solver engine. He notes there are many possibilities. He asks if this is really about run-time efficiency or can the chosen engine shape the outputs in a significant way. Welch answers that there is no one best solver engine and the one chosen depends on the type of problem. So you have to apply the best engine to correct class of problems. Some are great with linear problems but can't solve non-linear ones. Welch states that the ones he has been focusing on do better at solving non-linear, non-smooth programs something called a meta-heuristic approach.

Huette asks what Welch means by "does better." Welch explains that one may do better on cost. He states that you can never prove you've reached a global minimum but you can find that at some point the improvements are so small it's immaterial.

Kujala moves the group on. He stresses that within the 750 future, one single resource strategy none of these algorithms are what we are talking about within that. He states that this is how you move between those strategies. Huette adds that going down the road someone could say if you used a different solver you would have gotten a different resource. Kujala states that the model can use multiple solvers and will be able to test if a solver would get a better answer if the Council has access to that solver. Huette again brings up the choice issue. Kujala reiterates that they will look at important levers in the model that affect the output.

Kujala moves PNUCC Comments

Dick Adams, PNUCC, states that he likes that they are comparing the new tool to the results of the Sixth Plan but notices that in the Key Outputs there is no comparison of resource development. Kujala explains that Navigant added capital costs for resource development because that's what they had so they used it as a proxy. Welch says it would be prohibitive to compare actual optimization results. Adams restates that in the Sixth Plan they show 6000 megawatts of conservation being developed over 20 years. Can you compare that kind of statistic with the Sixth Plan model with the new model?

Welch said we can do that but didn't focus on it. Instead we looked generating capacity additions. Adams asks if they did it in money and not in megawatts. Welch answers yes. Kujala adds that going forward you will see it in megawatts and that the new model has lots of visibility.

Adams states that the schedule of expected value resource development is the most important information to come out. Welch says you will see them at the demonstration

Adams states that the most important thing the Council has to do is the scenario analysis. He points to Washington Governor Inslee asking to look at a carbon free or no coal solution and states that the RPM

is the core for answering those questions. He states that at this juncture it's important that we see outcomes or metrics that answer those questions.

Adams compliments the Navigant report but states that it brings up a few questions. The first is how the tool is going to address capacity and flexibility. Your document brought up the constraint of energy and in Phase 2 or 3 getting to capacity. Adams thinks they should flip that. Capacity and flexibility are more interesting to the region than energy.

Kujala answers that this is a seams issue; how well we can tie the RPM to Genesys because Genesys is where we look at capacity. Kujala continues stating that RPM also has a sense of capacity with a distributional look at the system but the way we tie RPM to Genesys is with an energy value. He further admits that it would be better if we could add capacity as an interlink with Genesys so we could get a closer result.

Adam rephrases his question: will RPM not be making build decisions on capacity needs? Kujala replies we would look to Genesys to make a Planning Reserve Margin that would then be used in RPM to create a capacity build. He continues saying it's not perfect knowledge but it creates a path and you can plan within the constraints of that path. Kujala also notes that each future has its own path and we are thinking of incorporating them; however it's on the enhancement list. Our original contract is to redevelop the methodology and we have some leeway for enhancements but we don't want a creeping scope.

Adams states how he thinks RPM works now: to make a build decision it looks at different tests. The first is an investment recovery what he calls the Independent Power Producer Model. The second is an energy test which looks at supply/demand balance. He asks if there is time and resources available, to add a third test, one that would be a planning margin developed through the RAAC. Kujala replies yes and explains the idea of a planning reserve margin and the difficulties with achieving this.

Zac Yanez, Snohomish PUD, asks if this is a "great enhancement or a critical component?" Kujala says the strategies work now but we could make them better. He says the old RPM has a sense of capacity but it might not be the best way to get to capacity. Kujala continues stating that they will try to enhance RPM to include capacity and flexibility but in the end any model will require a human element looking at results. He states that this model will be very open and show that analysis.

Eckman notes that the Council is due to talk about capacity, flexibility and the seam issue in the January meeting and it will be finalized in March. Addams adds that this is a fundamental requirement. Eckman states that we're looking to solve the issue before we start running the Portfolio Model so it may be a side model but there will be a solution.

Adams moves to the question of Demand Response calling it much different than conservation or base load gas plants that... Kujala states that it has occurred to us that capacity coordination would help with

that. Adams asks how the planning will tell the difference between the different kinds of gas turbine technologies. Eckman states that we will need your help with the math on that.

Huette asks if this will involve changes to Genesys as well. John Fazio, NPCC, states that we will continue to enhance Genesys but no big changes are planned.

Adams brings up integration costs particularly with wind noting studies that site the cost of integration changes as the penetration of that resource increases and asks how the model will capture that. Eckman answers that some studies conclude that it's "more art than science" which means we will always need a human element. Adams states that he doesn't expect the model to calculate the costs but to perhaps capture the changes. Eckman restates the questions as "Do we have integration mechanics to capture the input?" Eckman notes that we've been integrating wind and we should have information on what it used to cost. We could use that to generate a trend line that would be more informative for planning.

Adams asks if the model has a way to put in a range of costs. Welch states that the bigger issue is the data but so far nothing Adams has asked would be a problem. Kujala concurs, saying that we could have several buckets of wind with different costs. Eckman notes that a scaler could be added.

Michael McCoy, Power Systems Research, notes the trouble with generating futures is they are built on the present moment which is inherently limiting.

Tomas Morrissey, PNUCC, asks if the model is granular enough to assess any flexibility challenges. Welch answers currently no as the old RPM does not. Kujala states that a real sense of flexibility is not in the RPM's DNA. What we really need is other models that tell us about flexibility that would go into RPM as a constraint.

Adams asks about conservation and risk premium noting that the model has other slots for them. He asks that you develop risk premium in a way that other people can understand what the components are and what the concepts are. He notes that these are probably not a model problem. Eckman agrees that this is a narrative issue for the Council and Committees to understand how the number is arrived and what it means.

Adams says this is the place to have that conversation not in the Conservation Committee. Eckman agrees stating that it is a modeling issue. Adams asks for clarity in the number you put in for the premium. Eckman says that we don't put a number in for the premium, it's an output. Kujala states that it is one of the decision variables in the optimization. Welch further explains the variable.

Adams counters that if the focus is on energy then we miss the bigger issue of capacity. Eckman states that if we get the model structured correctly it will reflect both.

McCoy asks if it's an output and a decision variable do you have the ability to clarify what brought you to that number. Welch answers that you have the same ability that you would with any other variable.

McCoy asks if that is a 0 or 1. Welch answers that that comes with understanding and running the model. He notes that sensitivity analysis around a solution is also included.

Schilmoeller adds that this is basically a deterministic model where you can drill in and analyze the details and the futures. McCoy restates that he wants to know how you get to the number. Kujala counters that it will become clear when we look at the optimization. Welch restates the question: what is embodied in the number, what does it protect you against? Are you asking for a qualitative description of that number? McCoy says yes that's close.

Kujala says we should look at the model so you can see it better. Adams asks if there is a similar logic applied to the generation side, wondering if there is there a premium for building wind. Welch states that maybe there should be and notes that certain resources might have some benefits that are not being captured. We've thought about adding decision variables to each generating resource. Kujala adds that an add-on like this also adds time to the model but just looking at sensitivity logic might be enough.

Yanez asks if the model would deal with a potential non-carbon future as a resource strategy, a future, both. Eckman says that at the minimum it will be a strategy but it might be represented as a future. Schilmoeller adds that it was done as a scenario last time.

Welch begins demonstrating the model starting with the user interface. He gives a high level overview.

Yanez asks why there is no conservation on the resource table. Welch answers that they are generating resources. Yanez asks if you could put conservation input in and ask the model to optimize around it. Welch explains that the inputs for conservation are the market adjustment and the actual conservation supply curves. Yanez asks if you could optimize around conservation if you input the supply curve. Eckman says you could give a constrained supply curve. McCoy asks if you could force a certain type of conservation by saying you could get it for free. Welch explains that you could by making the premium infinite. You could also force it in the optimization by turning it off.

Adams brings this conversation back to his earlier point noting that he is now hearing that a premium is an output if you run it in optimization mode but now I'm hearing if you run the model in another mode you could put in the premium. Welch explains that if you are running an optimization it will be an output. If you are running the core then it is an input.

Welch explains the decision variables. Adams asks if the model spends the money and builds it or just gives and option. Welch says yes builds it.

Welch continues with key outputs noting there are lots of ways to look at them. He goes back to McCoy's questions of what's driving model output and shows him the answer.

Adams asks how you deal with end effects. Welch turns it over to Schilmoeller to talk about perpetuity end effect calculations. Schilmoeller notes that there were no end effects in the Fifth Plan. He adds that a carbon penalty that shows up in the last year of a study and a power plant that's built halfway through

the study if you use those costs you get it all wrong. So it's the 20 years you don't see that are driving that unit. Adams then says that as you are looking at the different "dots" on the end of your efficient frontier are the end effects treated comparably. Schilmoeller says that it's the same methodology in all.

Welch goes back to the modeling platform noting that it is integral that it deals with probably distribution for every variable. He touches on key outputs.

Adams asks if that is the expected value. Welch says yes and shows the symbols for expected and other values. He shows other ways to present the data, noting that it gives the model transparency.

Adams asks if carbon is an output. Welch says yes CO2 emissions are an output and shows them. Morrissey asks if they are over 20 years. Welch says yes. Morrissey then asks if they could break them down by year also. Welch says yes and finds it in the model. He then walks through more of the model.

Morrissey asks if the model can show revenue requirements in the region. Welch says it's in the adder and it will. Kujala says we are going to reproduce the rate calculations from the Sixth Plan. Morrissey adds that when the Council starts diving into environmental analysis one of the outputs you might want to look at is cost per ton. To do that you need something different than NPV over a 20-Year Period. Eckman agrees.

Welch continues by showing a visual representation of the high level interactions and feedbacks.

Morrissey asks how the model deals with future high and sustained market prices. Welch answers it would pull it down and shows how. He notes that if the resource strategy doesn't give the option to build a generating resource under high price scenarios it pushes it toward conservation which might be an expensive solution. Then the optimizers would kick in.

Kalich asks that Welch go back to the interaction with the marketplace. He states that he understands the optionality within the portfolio but asks what the limits on the buy/sell are. Welch explains using an import/export to the model. Kalich then asks looking forward have you thought about how to link Resource Adequacy and RPM. Eckman says yes.

Welch presents a graph to illuminate the point.

Eddie Abadi, BPA, asks if there is a plan on how to deal with documentation in the report. Kujala answers that the red triangles will have comments that go with them. Welch shows some internal documentation noting that there will be a high-level user manual. Kujala states that Doug Logan is working on it.

Morrissey asks if a Committee will vet some of the more important boxes like inputs for market prices for future before they are inputted. Eckman states that they use an electricity market price range that is coming up at a future Council meeting which sets the outer bounds. He continues stating that once the



750 futures are generated we can take them out and vet them. McCoy brings up scenarios peculiar to hydro systems. Kujala states that we will try to identify the elements in this model that are influencing the outputs at the next Power meeting.

Adams asks to go back to a short power scenario. He asks if you are talking about a three month period where the NW is short on energy. Welch clarifies stating that you might have just been short a week. Kujala says it's not every hour; it might be just a few. He continues saying you are adding up a distribution of numbers not a total numbers. Schilmoeller states that it is still a substantial number of hours. He says that if you make it painful enough you will drive the model to avoid it.

Adams says he's trying to imagine that if you have build decisions for adequacy and build decisions for the IPP model you would find yourself short for three months. Welch says you have other resource strategies and explains one. Adams says a dollar value would get lost and would prefer to see how many times you have a shortfall. Welch says you could put that in as an output. Adams would like to avoid it as opposed to put a financial penalty on it.

Kujala says there are two ways to do this; put a financial penalty on it or a constraint. Adams feels that with an \$80 billion net worth a financial penalty would get lost. Eckman says if you set a financial penalty low you will keep banging up against it but if you set it high enough it would be an issue. Adams states that you could never set it high enough to force builds. Kujala says that depends on the perspective you put on those numbers.

McCoy says that the audience is more tuned into and LOLP than a penalty. Fazio says we have a backstop of adequacy thresholds. Adams says he would rather know about each time we run short as opposed to a penalty. Kujala says we are not driving towards 0 outages as that's not the standard. Yanez says the outages are free if there's not more than 5%. Eckman cautions about what outages mean. Kujala explains the average megawatt problem.

Adams reiterates that what he wants is a tick mark every time you bump into that number. Welch says that would be easy to do.

Welch shows the optimization screen and runs through some features.

Adams ask why the graph on slide 2.9 looks so different the efficient frontier we've been looking at for 5 years. Welch states that you are used to looking at a zoomed in model. Schilmoeller says you're putting least cost/least risk and it would fill in if you did both. Welch agrees.

Kujala says topics not covered in this meeting will be presented via a phone meeting. He then opens the floor for a last few questions.

Kalich says assume the model purchased 1000 average megawatts for quarter x. He then asks how the model accounts for the load factor in that period of time. Welch says we calculate a capacity factor for

every resource in every quarter. Kujala notes that it is not the same as a normal production cost model but you could go in and see each one clearly.

Kalich restates the question saying you could have a utility with 1000 megawatts, at their peak there are going to have 2200 megawatts of load so you may say I imported 1000 megawatts of energy to meet the load but in reality you need 2.5 gigawatts of capacity to meet that requirement. So does this model pretend that there aren't 2.5 gigawatts of need and only 1 megawatt of need? Kujala states that within the period there is are correlations that go into the hourly load distribution of prices which determines the energy distribution of a resource.

Kalich says he gets the load side but asks if the resources are actually there. Welch says what you're getting at is capacity vs energy and what you are looking at is not a capacity model. It's one of the limitations identified. Kujala says it has a sense of capacity but you can't think about it as a production cost model. Schilmoeller says it dispatches to price so it's conceivable that the load distribution doesn't match with the price distribution.

Kalich says he doesn't understand the relationship with price. Schilmoeller says that's the enhancement they are looking at.

Kalich says that it is key that we get enough gigawatts to serve peak load. Schilmoeller says in the Fifth and Sixth Plan they backed into that by having criteria for capacity and that was checked after the fact to make sure we weren't too far off the mark. Kujala says we will look very in depth at anything that comes out in this Committee and others.

Morrissey brings up price volatility within a period asking if it's viewable as an output. Welch answers within a period you can gather the input coefficient but in the model it would be in the capacity factor. In the calculations it would be in dispatch. He admits it's complicated and can't be shown on a single number. Kujala says it's in Black Scholes. Morrissey said it would be neat to see how it compares to real world events. Welch says that could be done.

McCoy restates the questions saying if you take a period is the question about plants and how much they run, and imports. Could you meet hourly load. Kalich says lots have changed in 20 years. In the last five to six years the value of new generation was 80% energy 20% capacity and now that's flipped. This model has a chronic weakness and we are missing things as an industry. Throwing subsidies at renewable energy has created an oversupply and undervalues conservation. He sums saying that it's possible that it can't be done in the timeline.

Eckman states that the milestone to look at regional needs is important. He says the Council and Committees need to identify holes in the models going forward. We could find out how big the capacity limitation is over the time frame and back into the issues that way.

Kujala says it could never be perfect without human interaction. McCoy says the classic way to deal with this is to create shadow prices.

Kalich brings up wind integration costs stating the region would benefit from a more robust modeling capability than the council could create. He notes that all capacity isn't created equal and suggests looking to production cost modeling to look at different engines.

Kujala says you are jumping ahead and we are talking about production cost modeling but RPM will not do that. Kujala explains you would put it in as a constraint.

Kalich asks if the Plan will be granular enough to determine the difference between thermal technologies (recips, quick-start, hybrid). Kujala says we are looking at the cost of those technologies but time might be too short to look at the capabilities too. However it will all be taken into consideration even if it's not an output of the model.

Adams says you will be testing extreme what ifs so we will be at the edges. So bringing a no coal scenario to this group will be a good test. I like the use of the tools and conversations with experts. Eckman says that's the game plan with the RSAC and other Committees

Kujala brings the meeting to a close. He notes that RPM is still a moving quantity and they will be open and transparent and bring the work back to the committees.