**Northwest Power & Conservation Council**
**Systems Integration Forum**
**May 1, 2019**

Massoud Jourabchi, NWPCC, began the meeting at 9:30 by reviewing the agenda.

**General Circulation /Climate Change/Earth System Models and how to select them**
**David Rupp, OSU**
**Questions**
Terry Morlan, independent, noted that more detailed models means a greater burden in developing data. He asked if that was the case with climate change models. Rupp admitted that more data made evaluation more difficult. Morlan said economic models are often checked by running them over historic periods and asked if these models go through that same check. Rupp answered yes adding that they have temperature data from the 1850s and paleo evidence for thousands of years past.

Randy Friedman, NW Natural, asked if the models that have been improved over the decades all move towards the same conclusion. Rupp said they are surprisingly consistent over time.

Mohit Singh Chhabra, NRDC, asked what convergence towards a climate sensitivity means. Rupp explained that as models improve, they should move towards the same answer, adding that right now they diverge. Chhabra suggested defining convergence in a way that accounts for the interplay between more detail and greater divergence. He then asked for an official definition of convergence. Rupp didn't have one and agreed that more detail means greater divergence. Chhabra stated that some high-level metrics to define convergence may be useful for policy.

**An overview of the Representative Concentration Pathways**
**David Rupp, OSU**
**Questions**
Tomás Morrissey, PNUCC, noted that RCP 2.6 is often referred to as "Pie in the Sky" and asked which RCP seems most likely in the next decade or so. Rupp said 8.5 is the closest trajectory right now but didn't think that was permanent, pointing to embedded inertia.

Someone on Chat asked about the state of carbon capture technology. Rupp did not know how feasible, expensive or close the solution is. Chhabra said he's seen two examples and saw that it's nowhere close to yielding efficiencies. Morrissey said he heard of one that wasn't quite working properly.

Jimmy Lindsey, PGE, recalled three-year-old work with OSU that revealed a broad range around the 30 models that go into each RCP. He asked Rupp to comment. Rupp said later slides on climate scenarios touch on this. He called it good that different groups bring different perspectives to their models but admitted that it does cause discrepancies. He added that model resolution matters as does different techniques for solving differential equations.

Someone on Chat asked if more time will be spent on RCP 6.0. Rupp said he has no more slides on 6.0 as there is no load information for it.

Someone on Chat asked if this data focuses on utility emissions or broader global emissions. Rupp answered that these represent broader emissions.

Nicolas Garcia, WPUDA, asked how to incorporate climate model information into an IRP model which is hourly. Jourabchi said proposed methods will be presented later in the day.

Chhabra asked what cost is optimized in RCP 4.5. Rupp did not know.

**Climate Change in Regional Integrated Resource Plans**
**Gillian Charles, NWPCC**
Garcia asked if the expanded centralized market could impact resource availability and decision making [Slide 7.] Charles answered yes, adding that the Plan is still early in the process.

Lindsey reminded the Committee that PGE had directly modeled climate variables in the past including in their 2009 and 2016 IRPs and found that load related outcomes were well within the bounds of uncertainty. Charles added that other utilities found that too.

**BREAK**

**BPA Climate Change Energy Modeling**
**Reed Davis, BPA**
Rose Anderson, OPUC, asked for an explanation of the pre-climate change modeling process and what is now different. Davis spoke about past processes that includes a forecast for each utility and a local weather station to drive the work. He said limited weather streams, just Portland, Seattle and Spokane, require a weighted average for the short-term forecast, concluding that a new normal must be found.

**Planning as Climate Changes**
**Ronda Stauch, SCL**
Charlie Grist, NWPCC, asked how adaptations and other secondary, indirect effects will be explored. Stauch said how people cope and adapt will probably be looked at further down the road but reservoir operations will be adapted with flexible licensing, fire resiliency will be adapted by removing highly-flammable vegetation around crucial buildings and transmission corridors.

Jourabchi asked if she expects more people to move to Seattle. Stauch answered yes, but didn't think it was going into the IRP.

Rupp asked what the optimization tool optimizes. Stauch *answered that it looks at different metrics for different models and selects the model that is most correct for the metric.* Rupp

asked if it was based on what was done in the past or if it projects into the future. Stauch guessed that it looks at past performance, admitting that she hasn't run it.

**Climate Model/Scenario Selection for the Northwest U.S.**
**David Rupp, OSU**
Morrissey asked how many models the Council will select for the 2021 Plan. Jourabchi answered three, a low, medium and high case, and apply them to economic drivers.

Morlan asked how this information will be folded into the normal ranges of forecasts. Jourabchi explained that temperature profiles will be changed. He continued, saying the generation side will model precipitation effects on the flows. Jourabchi concluded saying they will look into indirect impacts, like a population swell caused by extreme heat, and adjust economic drivers.

Morlan asked if the intent is to expand the high forecast range. Ben Kujala, NWPCC, revealed that some discussion about Climate Change with Council members has begun. He stated that instead of scenarios, this approach brings forward the best information about load, precipitation and effects on the hydro system. Kujala stated that the intent is finding a robust regional resource strategy.

Morlan noted that the normal range is already pretty wide. He asked if the intent is to add a Climate Change assumption to a low/medium/high regular set of assumptions. Kujala answered no, the intent is to look at the best information with Climate Change as part of the consideration.

Alisa Kaseweter, BPA, reviewed the Army Corps of Engineers' optimization model. She suggested a conversation with the Council to explain the tool, metrics, scenarios and how to get at what is important. Strauch described the RMJOC report metrics.

Chhabra suggested picking a range instead of a model. Jourabchi stated that the same model must be chosen for precipitation and temperature. Chhabra confirmed if the same model must be chosen for both. Kujala answered that reliability is one of the things the Council looks at along with adequate, efficient and economic. He said solving for reliability alone may be extreme. Chhabra said his approach could define the bookends. Kujala agreed but said risk is always accounted for and no scenario is deterministic.

Chhabra stated that the spread should inform the bookends while their grades could inform their probability.

Dan Hua, NWPCC, addressed why it's important to use the same GCM model for precipitation and temperature. Chhabra understood the explanation but suggested using them to inform uncertainty ranges.

Stauch understood that resources and load do not need the same model as they are not very correlated, but using the same model has computational advantages.

Grist stated that the optimization tool used by the Army Corps of Engineers sounded promising. He asked if the tool is too hydro focused to work for indirect effects. Stauch didn't know. Kujala noted that the Corps has different considerations, like flood control, that may not translate to Council questions of system expansion.

Lindsey suggested averaging instead of selecting models. Kujala said that averaging would not work with the Council's more detailed, more flexible hydro model. He added that this is just a starting point and consistency is needed going forward.

**LUNCH**

**Methodology for downscaling from Daily Min-Max to Hourly Temperatures and it's application to Load Forecasting**

**Daniel Hua, NWPCC**

**Massoud Jourabchi, NWPCC**

Fred Heutte, NW Energy Coalition, asked how Hua concluded to not rely on historical data after 2005 adding that 30 years of climate data is customary [Slide 5.] Rupp said 2005 is when the historical experiment ends and the RCPs begin. Heutte confirmed that 2005 is not the year a climate signal showed up. Hua answered no, saying that's when the model evolved.

Morrissey asked if historical temperature hour stops at 2005 too. Jourabchi said this just lays down the foundation of the methodology. Hua moved to [2035 Temperature Data Fit 1950] to illustrate the point.

Chhabra asked why he can't use the GCM shapes. Hua explained that they are daily and he needs to get to hourly. Huette noted that dates fall on different day of the week and weather patterns run in multi-day patterns which requires picking an average daily shape. Hua said that will be covered later in the presentation.

Morrissey asked why Jan 2 on [BOI 2035 Temperature Data Fit 1948 -2017] is so flat. Hua answered that the GMC for that day is narrow.

Heutte asked how the weighting for [Regional 2035 Temperature Fit 1948-2017] is based. Massoud answered that it's load adjusted.

Garcia asked about the process on slide [Regional 2035 Temperature Fit 1948-2017 & Average & Closest] Hua explained.

Rupp asked about the value of looking at rainy days versus no rain days. Massoud explained that his short-term forecasts tools mostly look at temperature.

Jim Litchfield, independent, asked if there's evidence that historical hourly load shape will not be affected by climate change. Hua answered that they could be but as he has no future hourly load shapes he's starting with the historical possibilities. Massoud said the goal is an hourly

temperature profile based on the daily temperature profile from the climate change models. Litchfield understood but was troubled by inferring hourly load shapes with historical data from a forecasted T_max and T_min. Jourabchi stressed that these are not load shapes but temperature shapes. Litchfield agreed adding that they will be turned into loads. Hua added that all these shapes have the same T_min and T_max each day from the GCM.

Heutte said this issue doesn't look like something that can be solved in this round adding that shapes in the day may look different due to atmospheric conditions. Rupp agreed that this can't be solved right now, but splitting days by precipitation will help solve the bias issue. Jourabchi said they looked at many approaches and the results did not differ by much.

Chhabra asked if it would be better to use the last 15 years instead of 70. Hua said that could be done. Chhabra asked Rupp if there is a reason to weight these shapes more. Rupp said that's worth exploring. Jourabchi said this question comes up repeatedly and there is no easy answer as no climate change model guarantees an extreme event. He with this Plan they are not looking back as much as forward. Chhabra called the approach thoughtful and suggested that a shorter period might provide a better daily shape.

Grist asked Rupp if his rainy/not rainy idea could develop families of temperature shapes that might be better. Rupp agreed, saying the MACA downscaling method uses a similar analog approach.

Chhabra asked where the central economic drivers come from [Slide 19.] Massoud answered Global Insight/HIS Markit. Chhabra pointed to RCP 8.5's underlying economic assumptions and asked if directional alignment would be appropriate. Jourabchi answered that RCP 8.5 contains macro views which are hard to align on a state level. He confirmed that Global Insight has not captured climate change in their models but found some trends that are hard to separate out.

Morlan added that modifying specific industries means adjusting others for total employment. Jourabchi explained he uses floorspace as a parameter for modeling the commercial sector which keeps him from going too far downstream. He added that this a new area for him and the Council staff.

Morlan moved back to scenarios, suggesting that if a climate change scenario is not much different than the baseline, the fine details would matter less. Jourabchi noted that the Seventh Plan had climate change as a sensitivity and found that the energy didn't move much but the peaks went up by 5000 to 6000 mw. Jourabchi continued, saying that understanding has increased, so it's going into the base case.

Pete Eelkama, BPA, asked if the normal temperatures vary by year. Jourabchi explained his method for calculating deviations from average. Eelkama confirmed that the expected temperatures for each year and moth will be the same as normal. Jourabchi confirmed, explaining how to get to the new hourly forecast.

Garcia stated that, despite population growth, loads remain stable or falling. He asked if the model deals with systemic changes in building stock efficiency. Jourabchi said all the effects of standards, codes and trends are captured in the long-term model and brought into this hourly model.

Litchfield asked where Hua's temperature load shapes are applied. Jourabchi said this work comes in as a first step to give an hour-by-hour projection of temperatures to 2050. Litchfield asked if the deltas between them and normal become the delta T's. Jourabchi said yes, explaining his method to get a fuller picture of the effect of temperature on loads.

Litchfield was surprised that after all this exquisite analysis the RPM only uses two statistics, expected quarterly energy and peak load. John Ollis, NWPCC, confirmed, adding that resource adequacy analysis is needs hourly information. Litchfield understood.

**Objective for Climate Change Impacts on EE**
**Charlie Grist, NWPCC**
Tina Jayaweera, NWPCC, noted that staff is exploring using more GCM data and asked for input about how to incorporate things like precipitation or cloud cover.

Morrissey confirmed that shapes are preserved by temperatures are raised [Slide 16.] Hua said yes. Morrissey said this seems simpler than what was shown earlier. Hua said it's the same but this is a monthly look instead of a daily.

Morlan asked for an explanation for the light blue shaded area on [Slide 15] Hua explained.

Chhabra asked about the implications for using slightly different curves for energy savings and load as they should track each other. Chhabra then said solving this equation for A and B doesn't give him a sense of the physical impacts of the daily spread. Hua pointed to sorted TMY data that becomes an ordered set and using the linear equation preserves the order. He added that there are two data points: monthly min and max, so an equation should use those. Chhabra wondered if some granularity between daily and monthly would be valuable.

Grist addressed Chhabra's first question of how these are used for energy savings estimates, saying a simple shift is not a horrible approximation of the effect. Grist added that energy saving models don't do shaping. Chhabra offered alighting load with load shape for future consideration.

Danielle Walker, BPA, asked if the proposal is to use the blue line on [Slide 17] to estimate potential for the supply curves. Grist answered that the new climate change TMY would go into SEEM and Energy Plus. Walker asked if that will flow through to the RTF and cost effectiveness of measures. Grist answered yes if the RTF picks it up noting that a new Climate Change baseline will now be in all Council analysis.

Rupp said it would be good for consistency if the climate change TMY somewhat matched the 30 years of CCSM 4.

Kathi Scanlan, WA UTC, asked when the Council will use actual savings instead of deemed savings. Grist stated that they never know the actual, it's always an estimate of remaining. Chhabra stated that the RTF uses deemed savings based on actual measurements with calibrations. Grist said all Council work starts with adjusted building simulation models.

Deborah Reynolds, WA UTC, asked if we are moving closer to reflecting the actual impacts of conservation and if incorporating global climate change models make that work easier or harder. Grist said estimating remaining energy efficiency moves us closer to empirically derived estimates. Grist admitted that the starting point for some of those estimates are going to change. Reynolds asked if this makes it better for conservation. Grist said it will be more accurate and reflective of what we think will happen in a new baseline world.

Someone from Tacoma Power noticed that that the CC temperature curve is higher in minimum temperatures than the TMY, noting that she thought the spread would increase. Grist stated that this approach [Slide 14] surrounds the TMY year and it depends on which Climate Change model you look at. Chhabra said this reflects his earlier question about what solving for A and B does in relation to the daily shape. Chhabra said using Rupp's suggested check would be helpful. Person from Tacoma said knowing how low temperatures could go is important for winter peaking utilities. She said [Slide 15] shows TMYs commonly at the bottom and cautioned against biasing high. Grist stated that this is the difference between the TMY and the climate change model.

Rupp said you would expect the TMY min and max to be warmer and this compares TMY to not TMY. Person from Tacoma asked why it's assumed that the minimums would be higher. Rupp based his answer on what the GCMs are showing. Grist admitted that there will still be very cold days but the distribution will look different.

Jim McMahon, LBNL, noted that mins are increasing because greenhouse gas effects are greater at night.

**Resource Adequacy Study Plan**
**Dan Hua, NWPCC**
No questions or discussion.

**Methodology to Incorporate Climate Change Data in the Resource Strategy Analysis**
**John Ollis, NWPCC**
Morlan confirmed that any given future will pick a year and then move sequentially. Ollis said the chronological nature of this method is a strategy to avoid refill studies of the hydro system. Heutte added that this is a way to avoid a mismatch between December and January flows, noting that [Slide 9] suggests that you may have to do the refill work anyway. Ollis said there is a seam issue that may have to be addressed. Heutte offered that it might make sense to do a

random sample without replacement. Ollis said that might be better but will create more risk. Heutte added that the Pacific Decadal Oscillation should be considered too.

Kujala addressed the December to January issue saying that there has always been a sequential sample based on water years.

**Impact on Generation Resources**
**Gillian Charles, NWPCC**
**Mike Starrett, NWPCC**
There were no questions or discussion.

**Natural Gas**
**Steve Simmons, NWPCC**
Morlan stated that this presentation really brings the volatility issue to light, asking how the climate model forecasts that volatility. Simmons said some price volatility will be caught in the RPM with effects from past Polar Vortexes, calling it a direct impact.

Heutte asked what late summer events mean for resource adequacy.

Rupp noted that the question of more polar vortex events has not yet been answered. Morlan asked if it's not yet embedded in the models. Rupp said it would be and the time series could be examined but was not aware of any analysis adding that the *TMY (he said TMI)* misses extremes.

Jourabchi noted that there is no time left to discuss indirect effects and suggested a webinar to follow up.

Morrissey addressed the survey, saying that having a default answer of 10% may bias results. Jourabchi said the 10% comes from population increase work and this is a strawman proposal. Morrissey said a survey should not include a sample response of the answer you're looking for. Morlan said he read it as there would be no change in the structure of the economy except for a shift to multifamily housing. Morrissey said people will naturally gravitate to a default answer. Jourabchi said he can remove it but people ask for a strawman proposal.

Litchfield called this helpful saying the two big decisions are the choice of model and the choice of scenario to drive it. He asked how these decisions will be made. Jourabchi said the differences between the models is not that great within the planning horizon, but it will be brought back up in the webinar. Jourabchi noted that the indirect effects may have a bigger impact than temperature and precipitation.

Litchfield said he thought Rupp's presentation showed significant regional impacts in temperature and precipitation based on chosen scenario. Jourabchi said he's constrained to using the RMJOC 8.5 path but there is some choice around the climate model. Litchfield said he

didn't know there was no other choice than the RMJOC. Jourabchi said there is not other alternative.

Kujala called this initial work and staff is still looking for feedback. He added that choosing the GCMs also need feedback but at the end there must be real results around loads and underlying influences. Kujala added that more details and opportunities for feedback will be coming.

Jourabchi closed the meeting at 3:50.

**Attendees**

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| John Fazio | NWPCC |
| John Ollis | NWPCC |
| Adam Schultz | ODOE |
| David Rupp | OSU |
| Randy Friedman | NW Natural |
| Scott Johnson | NW Natural |
| Kent Dittmer | Energy Northwest |
| Jason Eisdorper | OR PUC |
| Ted Light | EES Consulting |
| Kathi Scanlan | WA UTC |
| Amber Ritter | PGE |
| Terry Morlan | Independent |
| Tammy L. | PGE |
| Rose Anderson | OPUC |
| Pete Eelkama | BPA |
| Ronda Strauch | SCL |
| Aliza Seelig | SCL |
| Jack Cullen | ETO |
| Allisa Kaseweter | BPA |
| Lesley Jantarasami | OEOE |
| Tom Potiowsky | NW Economic Research Center/PSU |
| Wendy Gerlitz | NWEC |
| Nicolas Garcia | WPUDA |
| Mohit Singh Chhabra | NRDC |
| Tomás Morrissey | PNUCC |
| Jimmy Lindsey | PGE |
| Fred Heutte | NW Energy Coalition |

**Attendees via Webinar**

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|---|---|
| Aaron Bush | PPC PDX |
| Amber Riter | PGN |
| Andrea Goodwin | NWPCC |

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| Bobbi Wilhelm | Idaho Falls Power |
| Glen Booth | BPA |
| Brandon Charles | |
| Bryan Neff | |
| Cameron | Renewable NW |
| Carol Winkel | NWPCC |
| Chris Velat | Cowlitz PUD |
| Dan Davis | US ACE |
| Dan Kirschner | NWGA |
| Daniel Avery | ODOE |
| David Graves | |
| Nick Dawson | Idaho Power |
| Elizabeth Osborne | NWPCC |
| Erik Pyltak | BPA |
| Gran Forsyth | COO Corp |
| Greg Nothstein | WA Dept of Commerce |
| Shamus Gamache | CenCoast |
| Clint Gerkensmeyer | |
| Gillian Charles | NWPCC |
| Glen Best | |
| Eric Graessley | BPA |
| John Hildreth | Idaho Power |
| Elizabeth Hossner | PSE |
| JP Batmale | Oregon |
| Allison Jacobs | |
| James Gall | Avista |
| James Vanden Bos | |
| Jennifer Langdon | Cowlitz PUD |
| Jennifer Snyder | WA UTC |
| Jim Litchfield | independent |
| Jim McMahon | Better Climate |
| John Goroski | |
| John Lyons | Avista |
| Ken Ross | Fortis BC |
| Kevin Smit | NWPCC |
| Torsten Kieper | BPA |
| Leann Bleakney | NWPCC |
| Lorin Molander | PSE |
| Jennifer Magat | |
| Garrison Marr | Snohomish PUD |
| Michael Cocks | BPA |
| Mike Hoffman | PNNL |
| Mike Hopkins | Fortis BC |
| Mike Starrett | NWPCC |

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|---|---|
| Jessica Mitchell | Snohomish PUD |
| Will Price | EWEB |
| Rebecca Smith | |
| Deborah Reynolds | WA UTC |
| Rich Arneson | Tacoma |
| Richard Devlin | NWPCC |
| Rob Diffely | |
| Ryan Bracken | NW Natural |
| Ryann Tobosa | City of Tacoma |
| Robert Schuster | Fortis BC |
| Selisa Rollins | BPA |
| Shani Taha | UCONNS |
| Shauna Jensen | PGN |
| Shirley Lindstrom | NWPCC |
| Teresa Hagins | |
| Terry Toland | Clark PUC |
| Villamor Gamponia | Seattle City Light |
| Zeecha Van Hoose | Clark PUD |
| Brian Dekiep | NWPCC |