Minutes from meeting of IRP Stakeholder Technical Advisory Group (STAG)
Meeting 6 – November 1, 2023

Overall takeaways:

1. Ascend presented the modeling results from 5 of the 6 scenarios, with the exception of GWP's third scenario, which will look largely the same as GWP's first scenario, but with a portion of the renewable energy projects replaced with offsets.
2. The scenarios' cost differ widely, with the price highly dependent on whether natural gas resources are being completely retired, or if they're still able to run at very low capacity for reliability. The cost of transitioning natural gas units over to hydrogen is a significant portion of the costs for GWP 2 and all of STAG's scenarios.
3. STAG, GWP, and its consultants continued to discuss the likelihood of some of the model's technology assumptions becoming true, namely its assumptions around the availability of hydrogen and long-duration storage. Ascend described that the modeling results all point for a need for technological innovation to meet clean energy goals.
4. All scenarios result in nearly identical actions over the first 5 years of the IRP period, although there are differences in rooftop solar buildout. From there, they diverge depending on their clean energy timeline, whether certain resources are being retired, etc. Ascend described that the near-term similarity of all these scenarios means there are several "no-regrets" planning investments GWP can make now to create progress for the next 20 years.

Ascend Analytics introduction to modeling results:

1. Ascend's modeling included several phases:
    a. The scenarios were first run through a "capacity expansion" model. The results of this modeling select resources that are available to meet GWP's energy needs.
    b. The "production cost" model then shows how GWP's system would operate with the resources selected in the capacity expansion model. It simulates transmission constraints and has to match the selected resources with Glendale's anticipated load.
    c. Ascend also does some "hand adjustments" based on the results of these models. For instance, the models like batteries, especially 8-hour batteries, and choose to build a lot of them. But then these batteries only get cycled 50 times a year, which isn't really a good investment. Ascend sees this dynamic happening and manually tries to replace those batteries with other things to correct it.
2. Capacity expansion inputs/assumptions (slide 4):
    a. The capacity expansion model considered a variety of resources.
        i. Geothermal:
            1. All California utilities would like to get more geothermal, but it's scarce and they can't find it. Geothermal is a great resource because it's clean and firm (i.e., around the clock) energy. There are a couple companies looking at enhanced geothermal to get past its scarcity.
            2. Ascend limited the geothermal buildout to 50 MW. In inland California, that would come in through the SWAC transmission line.
        ii. Wind:

1. Wind could be located in the Washington state area and come to Glendale via the Pacific DC Intertie transmission path.
2. We're in a weird world right now with wind. Wind is very constrained. Idaho and other areas are facing those constraints: there are developers who want to build, but interconnection and permitting are all backlogged. There will be wind soon, though.

iii. In addition to utility-scale solar, each scenario had a different amount of behind-the-meter solar.

iv. Basically every model says build geothermal, then wind in the Pacific Northwest. Then bring in solar through the SWAC line.

v. Long-duration storage was also considered to be available in the future.

3. Production cost models (slide 5):
   a. The outputs from the production cost model are where you can see how much carbon emissions are generated, how much energy is generated by each resource in a realistic setup, and what the market interactions are.
   b. Ascend ran the production cost models, made adjustments, and ran them again in an iterative process.
4. Clean vs. zero carbon emissions (slide 6):
   a. California's 2045 clean energy mandate applies to retail sales. Of every 100 MW you generate, at least 90 of it needs to be clean, because roughly 10 of it is lost in transmission.
      i. The upshot is that, according to SB1020, you can have *some* natural gas in your system post-2045, but you can't use it very much.
      ii. Right now, this is calibrated annually, rather than hourly (i.e., on a 24/7 basis).
   b. Zero carbon emissions is more strict. This definition says no greenhouse gas emissions, pure and simple. That means no natural gas in the system at all.
   c. GWP 1 and 3 adhere to California's definition of clean energy, while GWP 2 and all of STAG's scenarios achieve zero carbon emissions.
5. Scenarios (slide 7):
   a. GWP 3 results are not presented today because the production cost model is wrapping up. But it's basically a spinoff of GWP 1 and will look similar, but with substituting some amount of renewable generation with renewable energy credits.
6. Key findings (slides 8-10):
   a. A transition to a clean energy system relies on technical progress.
      i. Models that rely on wind, solar, and four-hour batteries aren't sufficient.
      ii. We need at least medium duration batteries (8-10 hour), and ideally long duration batteries (multi-day).
         1. There's a company called Form Energy that makes batteries that can store 100 hours' worth of energy, called iron air batteries.
         2. Ascend assumed that the most LDES that could be built was 50 MW.
         3. The good thing about these batteries is they're very environmentally inert. But they require a large amount of land (3 MW/acre).
         4. The drawbacks are they don't make these batteries yet. But the company exists and they're doing pilots.

5. Long-duration batteries have only 60% efficiency (so you lose 40% of the energy). Medium-duration batteries have 90% efficiency.

iii. Also need clean and firm generation that's dispatchable (i.e., can be ramped up and down quickly to meet needs).

1. Clean hydrogen, carbon capture and storage, renewable natural gas, and nuclear small modular reactors are all options.
2. We picked hydrogen to fill this role because we think it's most likely.

b. A full transition requires replacement of in-basin natural gas resources (Grayson 9, internal combustion engines, and Magnolia) with firm, clean options.

i. With no new resource additions, you'd have 372 MW of resources in GWP's baseline portfolio. But you need 416 MW of capacity to meet load growth. So you need to add 44 MW of new local capacity to meet that load growth.

ii. In several scenarios, we're taking out local fossil resources, so we need to build replacements for those.

iii. The reason we have to build them in Glendale is because we're worried about the weak point of having only two central transmission lines.

c. Geothermal, storage, hydrogen generation, and wind are selected most by the model.

i. Solar isn't selected even though it's cheap and abundant. The model didn't automatically pick solar because it doesn't provide that high of a value for the time of day at which it generates energy. Ascend manually added solar by replacing a portion of the model's suggested wind generation with solar.

7. Summary of results (slide 12):

a. The cost numbers are net present value for the next 23 years. They reflect total costs.

i. These numbers show what happens when you go fully clean. The large price difference between the scenarios is mostly a function of hydrogen cost, which comes into play when you retire gas plants and transition them to hydrogen.

ii. **NOTE: The cost numbers presented at this meeting have since been updated. The figures presented in this slide do not reflect the most recent results.**

b. STAG member question: Why does STAG 1 achieve so much more than 100% clean energy in 2035?

i. Ascend: STAG 1 is generating a lot more than you need at times. That's because there's a lot of rooftop solar in that scenario, as well as more utility-scale solar. The result is that the clean energy generated in a given year would be well over Glendale's actual energy use. The excess is either sold into a market, curtailed, or not used. This doesn't mean the clean energy generation is high all the time – it just means that, on average over that year, that scenario did overgenerate energy.

ii. This is also the case for other scenarios that go over 100% clean energy.

c. STAG member question: Can't GWP make money from selling excess generation?

i. GWP: You're not necessarily making money from overgenerating. Oftentimes you're losing money. The overgeneration from the middle of the day (like when solar produces) goes into negative pricing. In some cases, you'd have to actually pay someone to take that energy.

ii. A STAG member commented that the energy could also be stored in a battery.

Modeling results: California Policy scenario (GWP scenario 1):

8. GWP California Policy buildout (slide 13):
    a. Anything above the "0" line in this graph is added. Anything below is taken out.
    b. Before 2027, all scenarios look essentially the same. In 2025, we add in the Intermountain Power Plant's (IPP) natural gas and hydrogen resources. Then retire its coal resources the following year.
    c. In 2028, the model starts building storage. A little bit of solar is added, too.
    d. By 2035, IPP is fully hydrogen and is therefore carbon free. That transition to hydrogen is reflected by the natural gas resources that appear to be retiring in 2032 and 2035.
    e. The model doesn't remove any natural gas in 2045 because remaining natural gas resources don't run above the 10% capacity allowed under California law.
9. GWP California Policy capacity (slide 14):
    a. Note this is capacity, not energy. Capacity reflects the total technical potential of resources to generate energy, not the energy they actually generate.
        i. That's why the natural gas bars (light grey) are so large here, even through 2045. In this scenario, we aren't retiring natural gas units and they remain available to meet GWP's reserve requirements. They might run sometimes, or they might not ever run. This graph shows the total potential that each resource *could* provide, not the energy it *will* provide.
    b. Early on you see coal (black bar) goes away as IPP is transitioned.
10. GWP California Policy energy mix (slide 15):
    a. In this slide, you can see that natural gas usage is actually much less than its total capacity. This is really Magnolia, which has a minimum generation requirement. It's considered a resource that always has to be online and operating.
        i. The Magnolia contract is complex because there are six cities associated with the project. If any one of them needs energy, all the partners have to take it.
        ii. So for system stability, Magnolia stays on.
    b. STAG member question: Is that contract online after 2045? And do we get dinged every time someone needs to turn it on?
        i. GWP: Magnolia has a much longer life than we would anticipate. There is a study right now in which all owners are trying to make sure Magnolia is kept in our portfolio, but is clean (i.e., transition it to hydrogen or another clean fuel). Believe they're targeting around 2040.
    c. STAG member question: What's causing the big jump in load between 2028 and 2029?
        i. Ascend and GWP: In that year, there are a few new large customers coming online which we took into account in our demand projections. We got the base load forecast from the California Energy Commission, then we adapted it to account for new customers like those.
11. GWP California Policy RPS/clean generation (slide 16):
    a. California's mandate requires that by 2030, renewable resources have to cover 60% of load. That's represented by the green line, which goes along with the righthand Y axis.
    b. The green and blue bars together make up all the clean MWh that GWP is generating. They correspond to the lefthand Y axis.

c. By California policy, “renewable” and “clean” resources mean different things. Clean resources (the blue bars) include things that are carbon free but don’t meet the renewable portfolio standard (RPS) requirement (e.g., nuclear, large hydropower, hydrogen). Renewable resources (the green bars) include wind, solar, geothermal, small hydropower, and landfill gas (like Scholl).
d. You can see from the green line that this scenario will be well in excess of the 60% RPS requirement by 2030. Close to 78% by 2030.
e. As we move through time, the % of renewable and clean energy in this portfolio goes slightly down, because there’s load growth happening.

12. GWP California Policy costs (slide 17):
    a. **NOTE: The cost numbers presented at this meeting have since been updated. The figures presented in this slide do not reflect the most recent results.**
    b. The cost of new resource additions across the IRP is reflected in net present costs.
    c. To arrive at net present costs, we consider the capital cost of all the resources in the model, levelized over a period of time (like the life of the project).
    d. So, for instance, the cost of adding geothermal (red bar) is spread out across the graph. As we move through time, we’re accumulating annual expenses to pay for the resources.
    e. We then add all those bars back into the present value and integrate a 5% discount between each year (meaning the expenses later on are less than the near-term expenses). That then gives us the net present cost of the resource portfolio.
13. GWP California Policy carbon emissions (slide 18):
    a. We remove carbon emissions from IPP early on. Emissions continue to decrease after IPP converts to hydrogen, meaning natural gas carbon emissions become a lot more stable.

Modeling results: Clean by 2035 scenario (GWP scenario 2):

14. GWP Clean by 2035 build out (slide 19):
    a. This scenario differs from the last in that it has a lot more storage.
    b. Natural gas all goes offline here to be completely zero emissions by 2035. That looks like a retiring of natural gas (the large grey bar) and a simultaneous coming online of a hydrogen resource (green bar).
15. GWP Clean by 2035 capacity (slide 20):
    a. You can see a lot more storage at the top of these bars.
    b. By 2035, the capacity has grown a lot. As we get more lower-capacity-value resources (resources that don’t run all the time), we end up overshooting the peak load, meaning overgenerating energy.
    c. You can see in 2035 all natural gas goes away and we’re carbon free from that point on.
    d. The 2035 bar is lower than the rest of them because it reflects the retirement of natural gas in that year. We’re still able to cover the load with the 600 MW of capacity that’s in the portfolio, then, though.
16. GWP Clean by 2035 energy mix (slide 21):
    a. So you can see some differences here from the past slide. In the past slide, geothermal wasn’t that big from a capacity perspective, but since it generates around the clock, it has high energy content. The geothermal here equates to 50 MW.
    b. This particular scenario doesn’t have as much new solar as the others.

17. GWP Clean by 2035 RPS/clean generation (slide 22):
    a. We're actually at over 100% clean energy by 2035.
18. GWP Clean by 2035 costs (slide 23);
    a. **NOTE: The cost numbers presented at this meeting have since been updated. The figures presented in this slide do not reflect the most recent results.**
    b. The big jump in costs in 2035 is what happens when you add hydrogen in the model.
    c. The challenge here is that I don't *know* how much hydrogen will cost in 2035, so there's uncertainty. But we made assumptions based on our best knowledge today, which were developed by Ascend's market research team. They anticipate that later on, hydrogen will be a bit more expensive than natural gas.
19. GWP Clean by 2035 carbon emissions (slide 24):
    a. When you retire natural gas and transition it to hydrogen, all carbon emissions go away.

Modeling results: STAG scenario 1

20. STAG 1 buildout (slide 25):
    a. The results here are similar to the last scenario, but the differences are in the ordering of when these resources come online.
21. STAG 1 capacity (slide 26):
    a. You can see behind-the-meter (BTM) solar is a much larger part of this scenario's capacity than in other scenarios, due to high assumptions on customer solar adoption.
22. STAG 1 energy mix (slide 27):
    a. You can see that the load here (black line) is affected by the larger contribution of BTM solar. In this slide, that solar is built into the load projection (because it impacts people's energy demand) rather than being displayed as a separate resource. When 90 MW of BTM solar comes online in 2028, the load line is lowered.
    b. This scenario also included more aggressive energy efficiency. So that flattens out the load where it would grow otherwise.
    c. STAG member question: Why is there a dip in load only in 2028 and then it goes right back up in 2029?
        i. Ascend: That's because we have all the BTM solar coming online in 2028 and then largely leveling off after that point, with slight increases in adoption after that. Also, the load goes up in 2029 because of the new project coming online, which offsets some of the contributions of solar and efficiency.
    d. STAG member question: What about customer storage? We have wasted power during the day.
        i. Ascend: We didn't give a capacity accreditation to customer storage, although we did assume some growth in customer storage in this scenario.
23. STAG 1 RPS/clean generation (slide 28):
    a. The RPS in this scenario is well over the California requirement, exceeding even 100% in some years.
24. STAG 1 carbon emissions (slide 29):
    a. As with the last scenario, carbon emissions completely go away with the retiring/transition of all natural gas resources.
25. STAG 1 costs (slide 30):

    a. **NOTE: The cost numbers presented at this meeting have since been updated. The figures presented in this slide do not reflect the most recent results.**
    b. In terms of costs of customer resources like rooftop solar, we modeled this scenario with net energy metering. If you install solar panels on your roof, the extra solar that's generated gets sold back into the grid. You're avoiding paying to buy that energy, but GWP is instead buying it from you. So there is a cost to GWP of expanding rooftop solar and other distributed resources displayed here.
    c. As with the last scenario, hydrogen is the largest contributor to costs.

Modeling results: STAG scenario 2 (slides 31-36):

26. **NOTE:** At the time of the STAG meeting, the results from this scenario needed to be validated and some inaccuracies corrected. The accompanying PowerPoint reflects this updated information, but STAG did not talk extensively about this scenario due to the changes required.
27. When looking at the resource buildout for this scenario (slide 31), you can see that the model retires natural gas units at the last minute to be able to meet this scenario's 2042 zero emissions requirement.

Modeling results: STAG scenario 3 (slides 37-42):

28. The main difference between this scenario and the last one is that hydrogen comes online sooner in this case.
29. These results were only quickly highlighted to allow time for questions and discussion.

Open discussion and questions:

1. Scenario costs
    a. Multiple STAG members commented that it's difficult to know what the scenario costs actually mean without knowing how they would impact rates. They requested more information on this point.
    b. GWP shared that the current proposed rate increase amounts to roughly $500 million in total, which is similar to the capital cost of the GWP California Policy scenario. The IRP's cost is different than the current rate increase, though, because it's spread out over 20 years. In certain years, there'd likely be big jumps in cost as resources shift (like 2035).
    c. One STAG member noted that energy efficiency technologies and BTM resources may be counter to GWP's desire to increase revenue.
        i. GWP responded that revenue growth doesn't matter to them. They have fixed costs that go into rates.
        ii. STAG members and GWP discussed where GWP's revenue goes, noting that not all revenue goes into energy production. Some of it goes back to the city for use on other public goods and services. It isn't up to GWP to decide what to do with its revenue – that's largely up to City Council.
    d. One STAG member noted that it's hard to take any cost projections past 2028 seriously due to future unknowns. They said they'd be very surprised if this year's projections remained true in five years.
        i. Ascend underscored this point, noting that projecting across 20 years is a difficult exercise and there are large uncertainties.

2. Social cost of carbon (SCC)
    a. One STAG member wanted to know more about the social cost of carbon analysis and if data could be presented on total scenario costs with the SCC added.
    b. GWP responded that one challenge with looking at the SCC is that there is no mechanism to collect money or pay any party that value.
    c. STAG members responded that the SCC is meant to reflect costs that individuals and society would pay due to carbon emissions, although not necessarily through utility bills.
    d. GWP also added that the difference between scenarios with regards to their SCC is not as large as you might expect, given that coal is being phased out and GWP already plans to run its natural gas units less frequently in the future.
3. Near-term outlook
    a. Ascend emphasized that, although the IRP looks out to 2045, we're only in 2023. This process will be repeated in 2028, meaning that what GWP does from 2023-2028 matters most. In the near-term, all scenarios show GWP needs to look for more geothermal, storage, solar, and wind, while continuing to plan for the period after that. When the IRP is done again in 2028, new developments are expected (like IPP running on hydrogen), meaning we'll know more about the likelihood of hydrogen technology then.
    b. A STAG member asked how the scenarios differ in the first five years.
        i. Ascend responded that the only scenario that substantively differs in the near-term is STAG 1, which requires a large buildout of customer solar. The other scenarios all indicate you need more geothermal, wind, and a little bit of solar, then to invest in energy storage in the late-2020s. After the first five years, the differences really come down to timing – do you replace natural gas in 2035, 2040, 2042? Or not at all.
30. New models for clean energy
    a. One STAG member raised that there's a local community choice aggregator (CCA), which Glendale seems to be exempt from, and asked why.
        i. Strategen responded that CCAs don't apply to municipal utilities, so using a CCA is not possible in Glendale.
    b. One STAG member asked about community solar and why it hasn't been integrated in the models. They noted that community solar is ideal for tenants and multifamily housing.
        i. GWP agreed community solar is uniquely suited for renters and multifamily housing. GWP explained that the primary community solar model includes a developer creating a solar project shared among community "owners," with the energy generated at that project offsetting part of the participants' electric bills. But they typically require an upfront investment to buy part of that project, which not everyone can afford. As people buy into community solar, they contribute less to utility costs via their electric bills. Those who are left without community solar may then pay a greater share of the fixed cost of electric rates, which can create an equity issue.
        ii. The STAG member noted that subsidies can help offset some of the community solar costs and help more people afford it. They were also curious whether there are other community solar models besides that which GWP described.

c. One STAG member shared an article stating that technologies are available today to reach 100% clean energy, predominantly with solar, wind, etc., but that we need to talk more about efficiency solutions like heat pumps.
d. One STAG member asked if stacking battery storage units is possible to save acreage.
   i. GWP explained there's only one vendor considering stackable batteries at the size they'd need. This vendor is the same one they're considering for the Grayson Repower sites. The company hasn't perfected the technology with regards to withstanding things like earthquakes and fires. But part of the reason GWP selected that company's technology was for the potential that the batteries could stack in the future.

31. Hydrogen
    a. GWP and STAG members discussed the Intermountain Power Project in depth. GWP described that, despite the inefficiencies of converting renewable energy to hydrogen, the project is still critical for reliability and helps GWP meet clean energy requirements. Having hydrogen in its portfolio can also help GWP overcome transmission constraints.
32. Transmission
    a. One STAG member asked whether developing new transmission might be the cheapest way to access clean energy.
       i. GWP responded that people have been wanting to develop transmission for the past 35 years, but none has been built in that time. It's a question of will, rather than cost. Land challenges also come into play, with communities saying, "not in my backyard."

Next steps:

1. Ascend will send out a finalized version of its modeling results to STAG for their review.
2. Strategen will send out a survey to STAG soliciting input on modeling results and members' preferred scenarios after members have a chance to review the final results.
3. GWP will look at STAG's survey results and discuss its options for a preferred scenario. This scenario selection will be presented to GWP Commission on November 6th.