

Hawaiian Electric Integrated Grid Planning Technical Advisory Panel: Progress Update

Presentation to IGP Stakeholder Technical Working Group

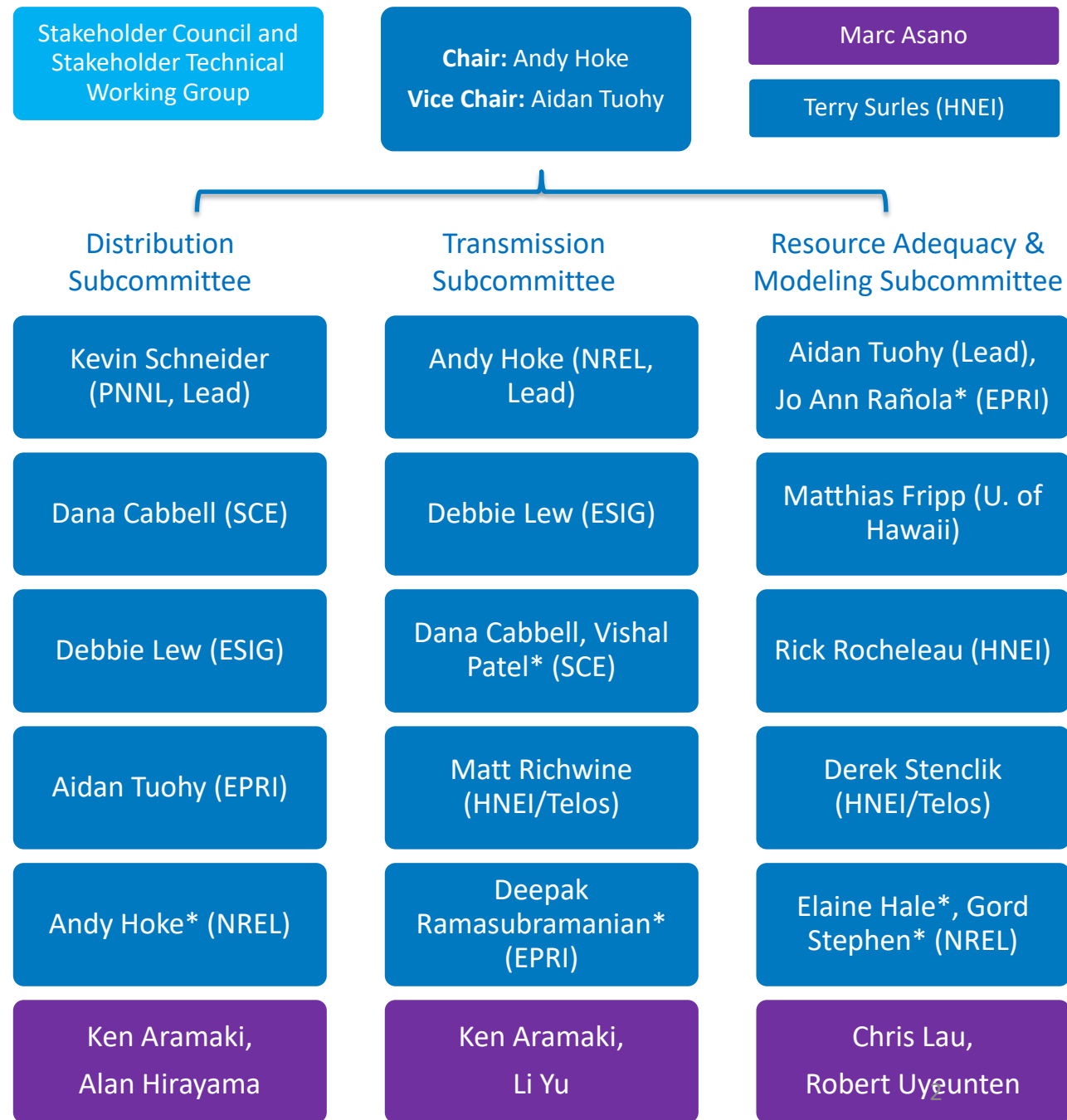
August 4, 2022

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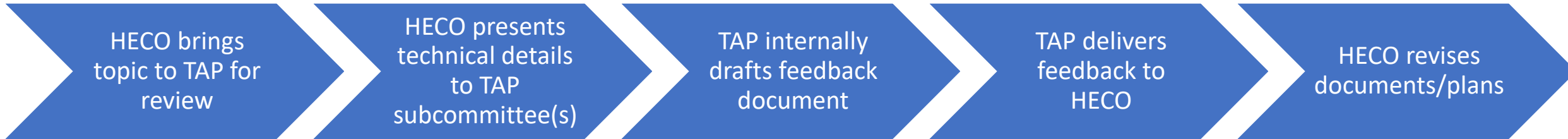
IGP TAP Structure

- Technical Advisory Panel (TAP) purpose:
 - Provide technical review of HECO's Integrated Grid Planning (IGP) plans, methods, and results
- TAP divided into three subcommittees in September 2021
 - Distribution
 - Transmission
 - Resource Adequacy and Modeling
- Allows each TAP member to focus on area(s) of expertise
- Each subcommittee has HECO POCs

*Some ad hoc TAP members brought in by existing members; more SMEs may be consulted as topics arise



IGP TAP Feedback Process



- Process for TAP feedback summarized above
 - TAP open to input to improve process
- HECO presentations to TAP and TAP feedback documents (as written by TAP) available to public:
 - <https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-and-community-engagement/technical-advisory-panel>
- New aspects, based on PUC feedback:
 - Regular TAP leadership meetings with STWG to provide update on TAP activities and opportunity for questions
 - Starting today!
 - HECO increasing communication of how TAP comments are addressed
- TAP continuing to balance need for detailed technical review with need to move IGP process forward in a timely manner by grouping feedback into three categories:
 1. Informational – no action necessarily needed
 2. **Suggest revising before PUC review point**
 3. **Consider revising in future steps or iterations of the IGP process**
- As always, TAP’s role is to provide recommendations and feedback, not to direct

Summary of TAP Activity

November 2021 – July 2022

- Overall TAP met in May and July
- **Resource adequacy subcommittee** held 6 meetings. HECO has made significant changes to Grid Needs Assessment methodology in response to TAP feedback
- **Distribution subcommittee** held 1 meeting. (Distribution planning criteria previously vetted)
- **Transmission subcommittee** held 4 meetings. Provided extensive input to system stability study and UFLS study. HECO has adapted various study plans in response
- In many cases, there is no generally accepted best approach to resource adequacy, transmission planning, or distribution planning for power systems based largely on wind, solar, and batteries
- Need to find a balance between study/discussion/planning and action

TAP Transmission Subcommittee Update

- Four meetings held since November 2021
- Most Transmission Subcommittee members signed NDAs with HECO to allow sharing of sensitive information
- **System stability study** was focus of three meetings
 - Highly detailed study of future dynamic stability of all islands with projected 2028 resource mix
 - Follows on similar 2021 study, with updated assumptions
 - Focuses on system's ability to continue to serve customer load following faults, loss-of generation, and other contingencies
 - Scenarios with very high wind, solar, and battery generation (“inverter-based resources”, IBRs) present new grid stability challenge that has not been addressed for systems the size of Hawaii's 3 main islands
- Study plans and initial results presented in December, January, and May TAP meetings

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TAP Transmission Subcommittee Update

Summary of **system stability study** feedback to date

- Make clear how cases studied relate to production cost simulations; provide basic statistics of each scenario
 - TAP asked about any must-run rules in scheduling. HECO removed minimum inertia rule from planning criteria
- Conventional transient stability software (e.g. PSSE) does not capture some important dynamics in high-IBR, high-DER system.
 - Electromagnetic transient software (e.g. PSCAD) can capture necessary dynamics, but major challenge to simulate entire islands; hours to run one simulation on high-end 50+ core computer
 - This is a known problem facing systems like Hawaii's
- Grid-forming inverters are emerging as a solution to some of the problems facing Hawaii, but are not a fully mature technology
 - PSSE models of grid-forming inverters are beginning to exist in the research domain, but not yet available commercially, and ability to capture key dynamics is an open question

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TAP Transmission Subcommittee Update

Summary of **system stability study** feedback to date

- Uncertainties in DER models and UFLS relay models identified as major risk factor
 - HECO working with NREL to address through laboratory testing
 - HECO ran sensitivity study on DER momentary cessation.
- HECO proposes to reduce DER momentary cessation threshold.
 - TAP agrees that if HECO can get inverter vendors to do this, it will reduce risk greatly. The TAP emphasized the need to start discussion with vendors. HECO currently surveying vendors.
 - Alternatives include additional grid-forming resources
- To validate IBR events in the field, digital fault recorder (DFR) data (or other time-synced waveform-level data) is essential.
- HECO using one specific IBR model to represent future grid-forming resources. TAP suggested future work incorporate other models
- TAP suggested adding additional detail to PSCAD model. Challenge is that additional detail further increases computation time.

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TAP Transmission Subcommittee Update

Summary of **system stability study** feedback to date

- TAP suggests investigating levels of unbalanced voltage seen on single-phase DER trips, and possibility of unintended protection tripping. HECO studied and found no issues so far.
- TAP agrees obtaining grid-forming IBRs is very important to stability of HECO's planned operating scenarios and encourages HECO to look for ways to obtain grid-forming IBRs as soon as possible, including working with Stage 1 RFP vendors to convert to grid-forming, even if there are additional costs.
- TAP provided feedback on potential benefits of synchronous condensers. HECO performed sensitivity study on synchronous condensers. Results showed synchronous condensers do not help with DER momentary cessation events, which are a key system weakness.
- TAP requested additional detail on many aspects of HECO's models and assumptions. HECO provided. TAP generally found reasonable.

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TAP Transmission Subcommittee Update

Summary of **system stability study** feedback to date

- HECO presented field data from two large PV plants showing tripping that does not comply with interconnection requirements
 - TAP agrees this presents a major system risk and should be remedied
 - TAP also acknowledged this is a nationwide problem that some large plant owners and major inverter vendors have repeatedly failed to fix
 - Part of solution is making sure inverter models match hardware behavior going forward. HECO cannot fix this alone.

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TAP Transmission Subcommittee Update

Conclusions on system stability study feedback

- The TAP generally supports the various recommendations of the system stability study
- Overall, HECO has addressed or is addressing the highest-priority TAP comments
- Many longer-term TAP comments remain to be addressed in future work
- Some study results still to be presented to TAP
- Ensuring the stability of high-IBR grids is one of the major industry-wide challenges today. HECO is near the front of this challenge, especially given the very high levels of DERs. HECO needs to obtain operational experience with grid-forming IBRs.

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TAP Transmission Subcommittee Update

February meeting: **Underfrequency load-shedding (UFLS) study plans**

- HECO presented proposed plan for UFLS study
 - Near term, study for all large plants should include ensuring plant is not behind UFLS breaker
 - UFLS is an essential system protection. In Hawaii, it is also used as a form of frequency control due to small system sizes and economic considerations
 - Consider potential future forms of FFR, and how they could trade off with the use of UFLS technically and economically
 - TAP recommends surveying customers to understand the relative priorities of cost versus reliability of electricity
 - Study impacts of UFLS on FFR1 and FFR2 resources
 - When considering fast-responding resources to reduce UFLS use, proportional responses are preferable
 - Adaptive ULFS on Hawaii appears effective. Consider for all islands
 - Consider equity aspects of adaptive UFLS in a high-DER system
 - UFLS study can include PSCAD simulations, but they should not be the focus
 - No need to repeat work already done in other studies
- TAP expects to review results of UFLS study when ready

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TAP Transmission Subcommittee Update

- July 7, full TAP call related to [PUC GNA order](#) – Transmission portion
 - HECO requested TAP input on the order to define details of **when Grid Needs Assessment (GNA) would require iteration to evaluate mitigations of system security violations**
 - The TAP feels it should be possible to define a set of possible mitigation methods and the likely degrees of iteration that each method would require before the August GNA filing deadline. The TAP offers to help with this.
 - HECO requested TAP input on the order to **re-incorporate of inertia- and FFR-related criteria in the GNA**
 - The TAP believes it should be possible to incorporate new constraints into the capacity planning and resource scheduling steps of the GNA that approximately capture the ability of each type of resource to provide emerging grid security-related services such as inertia, inertia-like services, and FFR.
 - There is currently no consensus on exactly how to do that. However, incorporation of approximate thresholds for services with approximate capabilities assigned to different resource types will hopefully reduce the need for iterations of the GNA.
 - Since there is no consensus on emerging grid services, the GNA should be permitted to try various approaches rather than tying it to one single approach
 - The TAP offers to work with HECO on this

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TAP Distribution Subcommittee

- One meeting: March 2022
 - HECO requested clarification of TAP concerns **on distribution protection** for periods with very high peak levels of wind, solar, and battery generation (Inverter-based resources, IBRs)
 - TAP clarified that at very high levels of IBR generation, available fault current is reduced, potentially to a level that could lead to reduce ability to clear typical overcurrent-based breakers, relays, and fuses
 - This is an open research question to which the TAP does not know the answer
 - HECO stated they will look into this for future TAP meetings
 - HECO asked which of three load forecasts is appropriate for use in evaluating capital projects or non-wire alternatives
 - The TAP is not aware of an establish approach. Suggest looking for least-regret approaches; evaluate risk of incorrect assumptions
 - HECO presented example of NWA for Waiiau substation (high-MW, short-fuse need)
 - HECO released RFI on Waiiau NWA feasibility
 - TAP feedback did not contain any high-priority items

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TAP Resource Adequacy & Modeling Subcommittee

Summary of previous calls, covered in May meeting

Meeting 1: Nov 1, 2021

- Topic: ERM and HDC discussion
- Feedback: Full probabilistic analysis needed to validate RESOLVE results and iterate

Meeting 2: Jan 20, 2022

- Topic: ERM/HDC discussion and review of results
- Feedback: further discussion on HDC parameters, how to choose percentiles, etc.

Meeting 3: March 10, 2022

- Topic: Review of stochastic modeling
- Feedback: proposed framework is a good approach and justified for first cycle, with discussion on specific assumptions (e.g. number of draws), and metrics examined

Meeting 4: April 28, 2022

- Topic: Draft results for probabilistic RA testing for O'ahu's proposed renewable firm RFP.
- Feedback: Good progress made on the modeling, with adoption of many previous recommendations for TAP. Time series weather data, outage rates should be further explored and refined. TAP also suggested that outage periods could be used to understand thermal contribution to ERM and include that as a contributor to ERM. EUE normalization could be examined further, and need for examining long duration storage as the system becomes more energy constrained.

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TAP Resource Adequacy & Modeling Subcommittee

- 4 meetings since late 2021, plus interactions over email
- November 2021
 - ERM (Energy Reserve Margin): Full probabilistic resource adequacy analysis is still necessary as an additional step to verify the ERM for future portfolios as these are being developed
 - HECO have since implemented this with probabilistic RA studies
 - ERM can help determine resource mixes, backed up by full RA study
 - Hourly dependable capacity (HDC) requires additional consideration and justification which can be addressed in the future, provided that the full resource adequacy analysis is utilized in the near-term.
 - Further look at various options within HDC has helped shed additional light

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TAP Resource Adequacy & Modeling Subcommittee

- January 2022
 - Further discussion and review of results related to HDC analysis performed by HECO
 - Different methods proposed (percentiles, use of daily metrics, etc.), which HECO have considered in recent analyses
- March 2022
 - Stochastic modeling proposed is a good approach that incorporates recent feedback, with discussion and debate focused on specific aspects like number of samples needed for both weather years and outage rates.
 - New metrics, or combinations of existing metrics, could be examined further, for example EUE, and HECO should also work to identify the best way to set criteria
 - TAP suggested follow up topics to allow HECO to continue to refine the work, with the overall approach being reasonable and justified for the first IGP cycle
 - HECO have done a good job of gathering input from the TAP, researching the topic and coming up with a proposal that provides additional modeling detail needed to address adequacy issues.

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TAP Resource Adequacy & Modeling Subcommittee

- April 2022
 - Draft results for probabilistic RA testing for O’ahu’s proposed renewable firm RFP.
 - General agreement that good progress has been made on the modeling, with adoption of many previous recommendations for TAP.
 - Time series weather data should be further explored – longer datasets may be useful and several TAP members will follow up with datasets or sources.
 - For outage rates - further examination may be needed, TAP suggested some potential methods to address the uncertainty in outage rates - additional sensitivities for 2029 cases with the increased outage rates observed in recent years.
 - TAP also suggested that outage periods could be used to understand thermal contribution to ERM and include that as a contributor to ERM rather than including in the need for ERM.
 - HECO were requested to clarify EUE normalization and compare with other regions as well as compare results with HNEI.
 - Potential need for examining long duration storage as the system becomes more energy constrained.
- May 2022 (broader TAP meeting)
 - Further discussion on probabilistic RA modeling and outage rates/weather data
 - Follow up needed on specific items to address additional cases with renewables as well as thermal plan

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TAP Resource Adequacy & Modeling Subcommittee

- June 2, update with RA subgroup – data and outage rates
- TAP discussed the new distributed PV data based on the NSRDB instead of historic monthly capacity factors, as had been suggested on the last call.
 - Results showed a less reliable system when using new data – discussion focused around the potential need to develop new high quality datasets.
- Reviewed new results based on updated outage rates – these reflected more recent actual outage rate experience.
 - In general, they make reliability results worse, and potentially show the need for firm resources (thermal) in a 2029 case, even if renewables were accelerated at a high level.
 - Several suggestions were made, particularly around additional cases with intermediate levels of renewables between the Base (582 MW) and Base_Accel (2,159 MW) case and firm resource amounts between 0 and 300 MW.
 - Ideally, costs would also be considered to show the reliability-cost-resource tradeoffs.
- The final subject, on using HDC curves for thermal as well as renewables, was covered quickly and will be a focus of future TAP subgroup meetings.

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TAP Resource Adequacy & Modeling Subcommittee

- July 7, 2022, full TAP call related to [PUC GNA order](#) – RA portion
 - Focused on ELCC requirement for adding resources to the system
 - While ELCC is widely recommended today, some resource adequacy experts in California and on the TAP are starting to move away from it for very high renewable scenarios, and the TAP does not see it as the obvious best choice.
 - It is very time-consuming, and heuristic approaches may give the same answer in much less time.
 - The TAP suggests that rather than committing to ELCC, ELCC should be compared to other approaches (mentioned below) by running selected simulations and comparing costs, resource mixes, and time to produce result. Each requires iteration with full model
 - ERM/HDC approach as currently used, but potentially each resource has HDC, not just wind/solar
 - ERM/Hourly Expected Capacity (HEC), where HEC is expected production for each hour of the day for wind/solar, and thermal are derated by forced outage rates
 - PRM/ELCC approach, RESOLVE procures sufficient capacity (ELCC) to meet planning reserve margin (PRM)
 - Based on that comparison, the approach that produces the least cost mix should be used, with approaches that produce results that differ by very little in cost differentiated by selecting the most time-efficient approach.

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TAP Resource Adequacy & Modeling Subcommittee

- July 12, 2022 call
- Topic: Follow up to larger TAP call in May to discuss RA modeling in more detail, with focus on range of results from recent HECO runs
 - Large number of different runs described, allowing for good discussion of different assumptions and how to setup future runs
 - Feedback was provided about how to present results given the wide range of sensitivities, including more details on aspects like what is being retired in each case.
- There was also discussion about what a satisfactory reliability criteria would be, and ensuring that is laid out at the start of the study and then system built to meet those.
 - This would allow for comparison across different renewable levels, from low to high, and identifying how much firm resource is needed for each.
 - If the concern is not getting sufficient renewables, then responses to RFPs can help.
- Some discussion on whether taking approach of least regrets for new generation, where solar plus storage may build out more than higher than expected and can then retire additional generation, is lower regrets than right sizing firm capacity.
 - TAP suggest focus on right sizing firm capacity. Can do this by looking at different levels of wind/solar and seeing firm needs under different load/retirement futures.

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TAP Resource Adequacy & Modeling Subcommittee

- General: TAP feedback has been incorporated in several key ways
 - Probabilistic RA assessment is being carried out
 - Large number of sensitivities being examine that provide additional insight into implications of different resource mixes
 - Further examination on HDC and ERM was carried out (e.g. daily percentiles)
 - Updated some of the wind/solar data and clarified aspects such as demand response
- Further work identified
 - Comparison of ELCC with other approaches
 - Continued focus on outage rates
 - Updates to HDC approach particularly around thermal resources
 - Further analysis of variable+storage vs firm capacity needs for different future assumptions

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Full TAP meetings

- Full-TAP meeting, May 2022
 - Topics:
 - Summary of each TAP subcommittee's topics addressed and HECO's actions in response
 - Preliminary results of grid needs assessment including probabilistic resource adequacy
 - Summary of results of 2028 system stability study and its sensitivities
 - TAP feedback summarized above
- Full-TAP meeting, July 2022
 - Topic:
 - July 2022 Grid Needs Assessment order
 - TAP feedback summarized above
- Next full-TAP meeting likely in Fall

Questions? Comments?



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