ALASKA STATE LEGISLATURE
SENATE RESOURCES STANDING COMMITTEE
January 19, 2024
3:30 p.m.

MEMBERS PRESENT

Senator Click Bishop, Co-Chair
Senator Cathy Giessel, Co-Chair
Senator Bill Wielechowski, Vice Chair (via teleconference)
Senator Scott Kawasaki
Senator James Kaufman
Senator Forrest Dunbar
Senator Matt Claman

MEMBERS ABSENT

All members present

COMMITTEE CALENDAR

PRESENTATION: ALASKA CENTER FOR ENERGY AND POWER: RAILBELT DECARBONIZATION PROJECT RESULTS

- HEARD

PREVIOUS COMMITTEE ACTION

No previous action to record

WITNESS REGISTER

JEREMY CASPER, Director
Alaska Center for Energy and Power (ACEP)
Fairbanks, Alaska
POSITION STATEMENT: Provided an overview of the Railbelt Decarbonization Project.

PHYLICIA CICILIO, PhD, Research Assistant Professor
Power Systems Engineering
Alaska Center for Energy and Power (ACEP)
Fairbanks, Alaska
POSITION STATEMENT: Outlined Railbelt Decarbonization project goals.

STEVE COLT, PhD, Research Professor

Alaska Center for Energy and Power (ACEP)
Fairbanks, Alaska
POSITION STATEMENT: Provided an economic analysis on required capital investment.

MATT RICHWINE, Founding Partner
Telos Energy
Saratoga Springs, New York
POSITION STATEMENT: Provided an overview of the transmission analysis conducted by engineers at Telos Energy.

DEREK STENCLIK, Founding Partner
Telos Energy
Saratoga Springs, New York
POSITION STATEMENT: Provided an overview of the generation analysis.

JEREMY VANDERMEER, Research Assistant Professor
Alaska Center for Energy and Power (ACEP)
Fairbanks, Alaska
POSITION STATEMENT: Provided an outline of project results.

ACTION NARRATIVE

3:30:16 PM
CO-CHAIR GIESSEL called the Senate Resources Standing Committee meeting to order at 3:30 p.m. Present at the call to order were Senators Claman, Dunbar, Kaufman, Kawasaki, and Co-Chair Giessel. Senator Wielechowski joined the meeting via teleconference. Co-Chair Bishop arrived thereafter.

PRESENTATION: ALASKA CENTER FOR ENERGY AND POWER: RAILBELT DECARBONIZATION PROJECT RESULTS

3:31:08 PM
CO-CHAIR GIESSEL announced the consideration of a presentation on Railbelt Decarbonization Project Results by the Alaska Center for Energy and Power. Telos Energy will review the current project of a pathway toward 100 percent decarbonization by 2050.

SENATOR WIELECHOWSKI joined the meeting via teleconference.

3:33:01 PM
JEREMY CASPER, Director, Alaska Center for Energy and Power (ACEP), Fairbanks, Alaska, provided an overview of the Railbelt Decarbonization Project. He stated that when he was first hired at ACEP, Co-Chair Bishop recommended that he listen to experts

in the organization. When ACEP leaders, Dr. Phylicia Cicilio and Ms. Gwen Holdmann advised him to move forward with the project, he gave it the green light.

Resources were provided by the Office of Naval Research and the State Capitol fund. A large project, it was the first time the organization took on the Railbelt Energy system. Dr. Ciclio mentored five undergraduate interns through the process, involved Ms. Alexis Francisco, and invited Telos Energy, a top modeling company in the country.

3:34:51 PM
PHYLICIA CICILIO, Research Assistant Professor, Power Systems Engineering, Alaska Center for Energy and Power (ACEP), Fairbanks, Alaska, outlined Railbelt Decarbonization project goals. She explained that ACEP is an applied research institute within the University of Alaska Fairbanks, meaning most projects have a direct community partner.

The goals are to strive toward energy solutions in Alaska. The aim of the Railbelt Decarbonization project is to explore energy solutions in Alaska, reaching toward 100 percent Railbelt decarbonization by 2050. She clarified that ACEP is focusing on the electric grid rather than other energy sectors such as heating and transportation.

Ms. Cicilio moved to slide 3. Efforts were made to quantify the economic and reliability implications of the decarbonization scenarios to create useful info for Alaskan stakeholders, as well as build in-state capacity using industry-standard tools and analysis to develop the modeling and research.

Ms. Cicilio moved to slide 4 and said that in addition to ACEP, a large team consisting of Information Insights, the Alaska Microgrid Group, and Telos Energy were involved in project development.

3:36:48 PM
MS. CICILIO noted that Telos Energy is a leading expert in island grid systems. Alaska is an electrical island, so Telos' expertise is directly relevant to the energy problems that the state is seeking to solve.

Furthermore, ACEP has a Technical Advisory group, involving engineers and managers from each of the four electrical cooperatives across the Railbelt, as well as the Alaska Energy Authority and the Railbelt Regional Coordination group. ACEP met with this group for approximately one hour every other week for over two years. The group's input contributed to data development and review, ensuring accuracy in the results. She acknowledged that funding was from the Office of Naval Research in the state of Alaska.

3:37:36 PM
MS. CICILIO moved to slide 7 and briefly highlighted six main project components:

- Scenario Development
- Load Forecast
- Resource Selection and Sizing
- Generation Analysis
- Transmission Analysis
- Economic Analysis

3:38:27 PM
MS. CICILIO moved to slide 9. Four scenarios were developed in 2022 following a stakeholder survey:

- Business as Usual
- Wind/Solar/Hydro
- Wind/Solar/Tidal
- Wind/Solar/Nuclear

The Business as Usual (BAS) scenario is a reference case as the base to the three low-carbon scenarios, which outline major generation technologies. All scenarios involved the same load, to demonstrate an "apples to apples" comparison. Battery storage is involved in each.

3:39:32 PM
MS. CICILIO moved to slide 11 and spoke to the chart on monthly electricity demand which represents the load forecast for 2050 compared to 2021 data. The data also includes the load from electrification, primarily due to heat pump additions and electric vehicles.

3:40:13 PM
SENATOR DUNBAR inquired about the study's population growth projection considering Alaska's declining population. He questioned if the results account for improvements in building and product efficiencies and whether project results overestimate the amount of energy needed.

3:40:57 PM
MS. CICILIO responded that the amount of load based on population growth was about 12 percent, indicating a minimal increase from heat pumps and electric vehicles. The load doubles from 2021 to 2050.

3:41:34
Co-Chair Bishop arrived.

3:41:36 PM
SENATOR DUNBAR asked about the level of market penetration for electric vehicles assumed in the model.

3:41:47 PM
MS. CICILIO said that electric vehicles depicted the greatest growth at about 79%. This number was benchmarked against other places in the country and globally and is lower as would be expected in a Northern climate.

3:42:15 PM
MS. CICILIO moved to slide 12 regarding resource selection and sizing. The process determined project size among several Alaskan regions and resource type (hydro, wind, solar, residential solar, tidal, or nuclear).

3:42:31 PM
JEREMY VANDERMEER, Research Assistant Professor, Alaska Center for Energy and Power (ACEP), Fairbanks, Alaska, provided an outline of project results. He spoke to slide 13 and pointed out that the goal of resource selection and sizing was to identify plausible projects for each of the resources of interest. The method demonstrates sizing needs for each resource scenario. The projects are either pre-existing or are currently in the proposal or research stages. New projects were added for wind and solar scenarios.

3:43:23 PM
MR. VANDERMEER moved to slide 14 and mentioned that a partial optimization was to help solve sizing difficulties.

[Original punctuation provided.]

Resource sizing method

- **What size to build each project?**
- **Predetermined project sizes for each scenario**
    - Hydro, tidal, and transmission

- **Size remaining projects based on cost**
    - Wind, solar, battery, nuclear, and fossil fuel
    - Iterate until converge on lowest cost portfolio
- **Only partial optimizations**
- **Not all projects were sized based on cost**
    - Stability costs were calculated at a later stage

Mr. Vandermeer said that scenarios were predetermined so these are not total optimizations seeking the cheapest path, but an attempt to build illustrative scenarios of various large infrastructure projects. Optimization iterated on system portfolios until lowest cost systems were reached.

He provided an overview of results on slide 15.

[Original punctuation provided.]

Resource sizing results

- **Generation from wind and solar was cheapest**
    - Curtailment costs limited their installed capacity
    - Additional stability costs were identified in the Transmission Analysis
- **Firm sources of power were needed**
    - Hydro, nuclear, fossil fuel, and batteries
- **Nuclear was not competitive with LNG**
    - W/S/Nuclear scenario assumed no LNG imports
    - Hydro and tidal competitiveness was not investigated
- **Cost projections are uncertain**
    - Especially for nuclear and tidal
    - Sensitivity analyses were run

Mr. Vandermeer said that a portfolio was generated for each scenario, which demonstrated that wind and solar were consistently cheapest, with a caveat that these sources could only supply a limited amount of load. Firm sources of power were determined as necessary.

3:47:17 PM

SENATOR CLAMAN asked for clarification on the cost of the nuclear scenario compared to LNG.

3:47:44 PM

MR. VANDERMEER responded that after removing the liquefied natural gas (LNG) option when sizing scenarios based on cost assumptions, nuclear proved as a lower cost option compared to other scenarios.

3:48:20 PM
CO-CHAIR GIESSEL asked about the exclusion of hydrogen in the study.

3:48:34 PM
MR. VANDERMEER confirmed that hydrogen was left out and said it would be a good follow-up study.

3:48:44 PM
DEREK STENCLIK, Founding Partner, Telos Energy, Saratoga Springs, New York, provided an overview of the generation analysis. He spoke to slide 17:

[Original punctuation provided.]

Generation Analysis

Simulate **grid operations** across the Railbelt across **all hours of the year,** considering changing load, wind and solar availability, reliability needs, and operating constraints.

- How are resources scheduled (dispatched) to meet load in a least cost manner?
- How can grid operators manage variability and uncertainty of wind and solar generation?
- How should batteries be scheduled to charge, discharge, and provide reliability reserves?
- How do transmission flows change across different weather conditions and load levels?
- Which generators are displaced by new renewables and what are the fuel cost savings?

Mr. Stenclik said that much of the data was provided by Railbelt Utilities. ACEP wanted to ensure that their models accurately reflected grid operations.

Mr. Stenclik moved to slide 18.

[Original punctuation provided.]

Power system operations methods

Detailed plant and system details
- Load profiles
- Wind and solar profiles
- Hydro water budgets
- Gas, coal, and oil plant characteristics (efficiency, cycling constraints, etc.)
- Operating reserve requirements
- Transmission constraints

Production cost simulation
Least cost, security-constrained, unit commitment, dispatch, and resource scheduling across all 8760 hours of the year
Utilizes third-party, industry recognized optimization software

Operations and Economics
- Plant operations and starts
  - Stability analysis
- Fuel consumption and cost
  - Economic analysis step
- Emissions

Mr. Stenclik noted that a central focal point of the study was for capacity building by using global industry tools within ACEP and the university.

3:51:57 PM
CO-CHAIR GIESSEL asked Mr. Stenclik to clarify his role as a consultant to ACEP.

3:52:10 PM
MR. STENCLIK said that Telos Energy provides analytics and engineering consulting services and grid modeling across the country around renewable integration studies. Telos Energy works with utilities, research organizations such as ACEP, and its counterpart in Hawaii. The Hawaii National Energy Institute involves different systems than the Alaska Railbelt but is similar to Alaska as a remote grid reliant on imported oil.

3:52:57 PM
MR. STENCLIK spoke to the bar chart on slide 19 and said that most emissions come from hydro resources. Wind and solar are the energy backbone, providing over 50 percent of the output, proving as the "least regrets," and lowest cost options, especially when they bring in federal funding. The uncertainty

is with technology and costs and that is why they ran three different scenarios.

3:54:15 PM
MR. STENCLIK said there is concern with balancing hourly generation, especially on a typical winter day. He moved to slide 20 and said there is more variability in wind and solar scenarios. The goal is to ensure effective management of system operations throughout the day and year.

3:55:21 PM
CO-CHAIR GIESSEL acknowledged a baseload of gas alongside renewable energy scenarios.

3:55:39 PM
MR. STENCLIK relayed that in annual production, gas remains a large component, but grid capacity will require substantially less gas. On cold winter days, gas is still a useful resource.

3:56:07 PM
MR. STENCLIK moved to slide 21 and said that ACEP screened through thousands of hours of operations to evaluate transmission reliability and stability in more detail. The analysis demonstrates a "dispatch condition" or the biggest challenges within a year of operations.

3:56:29 PM
CO-CHAIR GIESSEL said slide 21 showcases battery as a huge piece.

MR. STENCLIK reiterated the "lower regrets option" of wind and solar energy and emphasized enabling technologies, including a transmission network and battery storage, which is a key enabler to reaching high penetrations and providing grid stability.

3:57:20 PM
MR. STENCLIK spoke to the graph on slide 23 demonstrating the timing of resources and appearance on the grid.

[Original punctuation provided.]

> ***Timing* of wind and solar generation will vary significantly across the year**
>
> - A portfolio with 50 percent wind and solar will see periods exceeding 100 percent of total load (due to battery charging)

- Inverter-based resources (IBRs) like wind, solar, and batteries have different controls and interactions with the grid
- Periods of high penetration (see chart) must be evaluated in further detail for transmission reliability.

3:58:50 PM
MR. STENCLIK moved to slide 24 showing an Alaska Intertie Flow Duration Curve chart and Load Regions of Alaskan's Railbelt. He reiterated that transmission is a key enabler for portfolios and flows across the network from the Fairbanks region to the Central Anchorage center. Under the BAU scenario, the central black line shows a supplemental but underutilized transmission. The three additional scenarios demonstrate much more flow in both directions. The grid needs to be larger to transfer more power, as well as more operationally flexible to manage load flows. In this case, the load most often moves from the Kenai Peninsula to the Northern load center in Anchorage.

3:59:58 PM
CO-CHAIR GIESSEL confirmed that (BAU) is the acronym for "Business as Usual."

4:00:12 PM
SENATOR CLAMAN asked if the part of the model demonstrates a significant increase in solar and wind capacities, while not in their entirety, may substitute current Cook Inlet gas power. He asked if increased solar and wind capacity could partially replace the more expensive Cook Inlet Gas as a source of power.

4:00:48 PM
MR. STENCLIK concurred and said that while natural gas plants remain vital, wind and solar can provide energy and reduce the amount of natural gas used. Wind and solar energy sources are considerably cheapest, especially when utilizing a 30-50 percent federal tax credit.

4:01:20 PM
SENATOR CLAMAN asked if the scenario is dependent on battery technology for capacity storage.

MR. STENCLIK responded yes, at a certain point. For grid stability purposes the Railbelt system is a relatively small, low-inertia grid, so batteries would increase reliability and help avoid a potential rolling blackout. Battery storage is also helpful to shift energy from one time period to another.

4:01:57 PM
SENATOR BISHOP asked if the 50 percent wind and solar subsidy from the federal government is attached to Inflation Reduction Act (IRA) funding with a ten-year cap. He questioned if the state would require a renewal on the IRA.

4:02:33 PM
MR. STENCLIK confirmed that it is ten-year money. He explained that there is an Investment Tax Credit (ITC) and Production Tax Credit (PTC), so a plant must be built before the IRA expires to realize federal tax benefits. Even if the plant operates for 20-30 years, it will realize the benefit in the first year. The PTC is a ten-year benefit based on production, so the developer can choose whether money is obtained up front on the capital or the ten-year production.

4:03:27 PM
MATTHEW RICHWINE, Founding Partner, Telos Energy, Saratoga Springs, New York, provided an overview of the transmission analysis conducted by engineers at Telos Energy.

[Original punctuation provided.]

What is Analyzed?

Steady State Analysis
Can the grid sustain operations in all credible grid conditions?
- Thermal □ look for overloading of lines
- Voltage □ ensure enough voltage support

Dynamic Analysis
Can the grid recover from the "shock" of a sudden disturbance?
- Frequency Stability
- Voltage Stability

Transmission analysis is performed on "snapshots" in time – Stability must be satisfied at every moment

Mr. Richwine said that engineers used a Steady-State analysis for several unforeseen contingency events and Dynamic analysis, which covers the ability for grid recovery, such as a lightning strike on the transmission system. These analyses are performed by all Railbelt and global utilities. The engineers involved are specialized. Their work requires a unique skillset that is in high demand across the industry. The team has successfully applied lessons obtained across the nation. Evaluation of reliability is based on planning criteria used by utilities as provided in Grid Planning document.

4:05:41 PM
MR. RICHWINE moved to slide 29 and spoke to the challenges around the Railbelt and the issues causing further stress on the grid.

[Original punctuation provided.]

What are the Challenges?

Steady-State

- New resources + retirements = different flow patterns
- Different flow patterns □ different needs/locations for voltage support

Dynamics

- Sudden loss of a power plant □ loss of power and voltage support must be quickly recovered
- Sudden loss of a tie line □ power and voltage support must be quickly reallocated
- Successful recovery is a matter of sufficiency & timeliness of response from the remaining resource

  This is true for all grids, but the Railbelt is especially challenged because of the small size, isolated nature, and grid separation that occurs

4:07:07 PM
MR. RICHWINE moved to slide 30. He said that engineers look at the system as conventional synchronous machinery, rather than inverter-based or computer code-driven technologies. Part of the big shift in the transition utilizes different technologies rooted in software:

[Original punctuation provided.]

Resource Technologies

Synchronous Machines (SM) (i.e., Fossil, Nuclear, Hydro)

- Frequency Response: Inertia (fast/immediate) + Governor Droop (slower, seconds)

- Voltage Support: Grid strength (fast/immediate) + Voltage Regulation (slower, seconds) Behavior dominated by physical geometries Inverter-Based Resources (IBR) (i.e., Wind, Solar, Battery, Tidal)
- Frequency Response: Droop (slower, seconds)
- Voltage Support: Voltage Regulation (slower, half a second - seconds) Behavior dominated by firmware code

4:08:13 PM
MR. RICHWINE spoke to slide 31. The goal was to determine if the grid would survive challenging scenarios based on two criteria:

1. Time periods with the most resources online
2. Time periods with a lot of flow on Alaska and Kenai intertides, so intertie loss would cause a shock to the system.

4:09:25 PM
MR. RICHWINE moved to slide 34.

[Original punctuation provided.]

Potential Mitigation Approaches

Operational Mitigations
- Force more SM to remain online; not recommended for long-term action; not pursued here

Capital Investment Mitigations
- Synchronous Condensers - a connected synchronous machine that does not produce power or consume fuel
- Inverter Tuning for Performance - adjusting the configuration of IBR for more aggressive responses
- Grid-Forming Inverters (GFM) - an emerging, commercially available inverter technology that can stabilize the grid much as synchronous machines do

Other mitigation options were considered to reach stability and reliability. The simulations demonstrated problems and instability with run-of-the-mill technologies.

4:11:20 PM
MR. RICHWINE moved to slide 35. Even amidst challenging conditions or mitigations, grid forming inverter technology allows the system to remain reliable and is applied to resources such as wind and solar, and battery energy storage systems in particular.

4:12:32 PM
MR. RICHWINE moved to slide 36.

[Original punctuation provided.]

Emerging Technology: Grid-Forming Inverters

What is it?
Grid-forming (GFM) technology is largely a controls technology
- BESS: no changes to hardware are needed
- Wind: likely to be controls-only

What does it do?
Attempts to capture the "best of both worlds" from SM and IBR
- Immediate responses of SM (inertia, grid strength) + resilience of synchronization from IBR

He said that the new technology is rooted in software-based technology intended to combine the strengths of conventional machinery with inverter-based technology. The technology has emerged over the past five years.

Mr. Richwine moved to slide 37 which listed the following projects:

[Original punctuation provided.]

GFM - Industry Experience

Recent Industry GFM Installations (Utility-Scale)
- 2017 St. Eustatius BESS (SMA)
- 2018 Dalrymple BESS, Australia (ABB/Hitachi)
- 2018 Kauai BESS projects (Telsa)
- 2019 Dersalloch Wind, Scottland - (Siemens)
- 2019-2020 IID BESS for Blackstart, California (GE)
- 2022 Wallgrove BESS, Australia (Telsa)
- 2022 Hornsdale BESS, Australia (Tesla)
- Others I've likely missed…

More on the Horizon: HECO Stage 2&3, Australia 8 BESS GFM Projects, NationalGridESO, etc.

4:14:08 PM
SENATOR DUNBAR relayed that the municipality of Anchorage had a large software update that was supposed to cost $9 million but

catastrophically ended up costing $85 million. He asked who would be responsible for maintaining the software.

4:14:51 PM

MR. RICHWINE replied that the software is part of the plant and inverter-based equipment, therefore it is the responsibility of the generation owner. The generation owner submits a model that captures all performance details of the plant to ensure it meets expectations and proves stable on the interconnected system.

4:15:34 PM

SENATOR DUNBAR said that the municipality of Anchorage used Systems, Applications, and Products (SAP). He asked if the entire system would be required to use the same software company or could each unit generation use software capable of communications with the International Organization for Standardization (ISO).

4:16:03 PM

MR. RICHWINE explained that while each plant has its own software, they could update and coordinate when set up properly.

4:16:33 PM

SENATOR BISHOP compared the inverters proposal to Artificial Intelligence (AI) technology with regard to development requirements.

4:17:02 PM

MR. RICHWINE said the software behind this is advanced, but it not necessarily characterizable as AI or reliant on AI. The software was developed by engineering teams to ensure an immediate and accurate equipment response of less than one second.

4:17:54 PM

CO-CHAIR GIESSEL said the proposal sounds expensive.

4:18:00 PM

MR. RICHWINE replied that relative to what is being produced today, the software upgrade is a research and development cost that would be born by the equipment manufacturers. The cost to implement the new technology, specifically for battery resources, is incremental. Activating the technology does not require changes to hardware on large step-changing costs.

4:18:40 PM

SENATOR DUNBAR added that he was scarred by the Anchorage software fiasco. He continued with an example of a similar software upgrade in San Diego, which experienced bankruptcy following the faltering of software updates. He questioned how producers could protect themselves from fines or non-working technology.

4:19:26 PM
MR. RICHWINE said that having a quality and reputable equipment manufacturer is an important factor to consider. If software problems existed and were recognized mandating adjustments, the system operator in Texas, for example, demonstrated a desire to update software through field experiences. It is not always easy to retroactively update some types of equipment. Much of the current equipment available provides an opportunity to magnify, mitigate, and resolve potential risks and challenges in advance. He opined that the issue raised by Senator Dunbar remains important and is something to keep on the radar in the event a manufacturer goes out of business, for example.

4:22:01 PM
CO-CHAIR GIESSEL said that software development is being implemented in other places including Texas.

4:22:08 PM
MR. RICHWINE responded yes. The current inverter technology is widespread and is the basis of wind, solar, and battery energy across the system. Grid-forming inverter technology can enable renewables connected to the system, but is not subject to any higher risk than conventional software-defined projects.

4:22:54 PM
SENATOR BISHOP proposed a hypothetical scenario of 100% hydro-based operation and inquired about the need of inverters on the grid.

4:23:09 PM
MR. RICHWINE replied that a 100 percent hydro-based operation would not include any inverter-based resources.

4:23:31 PM
At ease.

4:23:47 PM
CO-CHAIR GIESSEL reconvened the meeting.

4:24:26 PM

MR. RICHWINE said the North American Electric Reliability Corporation (NAERC) has actively assisted with providing recommendations to addressing risks and moving inverter technology to become more grid friendly, stable, and reliable. NAERC released a recommendation in September 2023 promoting grid performance technology.

4:25:23 PM
MR. RICHWINE spoke to slide 38.

[Original punctuation provided.]

A Note on Analysis Methods & Tools

- Commercially available software (Siemens PSSE)
- Same tools used by Railbelt utilities and numerous others throughout the world
- Many thousands of inputs to the model
- Grid - Lines, transformers, shunts
- Resources - generators, DER, loads
- Engineering judgment and special care is needed with inputs, runs, and interpretation of outputs
- It is critical to know and understand the limits of the tools, and a what point different tools are needed

4:25:50 PM
MR. RICHWINE moved to slide 39.

[Original punctuation provided.]

Compare installed capacity at each study phase

- Resource Sizing
  - Initial estimates
- Generation Analysis
  - Fossil fuel and battery capacity increased for capacity reserve margin
- Transmission Analysis
  - Battery, shunt capacitor, and synchronous condensers added for stability
- Significant increase above initial estimates

Mr. Richwine said that a possible next step could include rewinding and optimizing, as well as adjusting costs and sizing.

4:27:20 PM
STEVE COLT, PhD, Research Professor, Alaska Center for Energy and Power (ACEP), Fairbanks, Alaska, provided an economic analysis on required capital investment. He spoke to the base capital expenditure (CAPEX) after Investment Tax Credit (ITC) per billion in 2023.

Mr. Colt stated that capital investment for development ranges from $2.2 billion for the BAU case to meet doubling of the load, while the most capital-intensive is the hydro scenario at $9-10 billion. He noted that these amounts are before the application of ITC and adjusting the latest AEA estimates for inflation. After tax credit adjustments, hydro would cost $6-7 billion. Similarly, nuclear and tidal scenarios require a large investment.

Mr. Colt said that ACEP analyzed two types of batteries and other equipment needed to support the grid. The orange bars represent the batteries required in an hour-to-hour generational analysis to smooth the wind and solar, store it and provide operating reserves to the system. The reliability team looked at what it would take to reach stability, resilience, and reliability. One takeaway is that the yellow bar represents a significant addition to the cost, but not overwhelming addition to cost. Stability will be a challenge, but not cost-prohibitive.

4:31:40 PM
CO-CHAIR BISHOP requested the number of megawatt (MW) units used for dam number for CAPEX.

4:32:03 PM
MR. COLT replied that ACEP used 475 MW of addressable capacity, but understands that the output of the project would vary considering water conditions.

4:32:23 PM
MR. COLT moved to slide 42 and spoke to the consumer generation and transmission cost of service under different scenarios. The image indicates the location of this information on a utility bill. The generation and transmission of cost is equivalent to creating and getting to the distribution center. It can be difficult tracing certain costs, as every bill is different. The rule of thumb is that $10 more per MWh on the slide equates to one cent per kWh on a consumer bill.

4:34:23 PM
SENATOR CLAMAN asked about the typical number of kWh units on a consumer's monthly utility bill.

4:34:44 PM
MR. COLT relayed that the shortest answer is about six thousand kW per year, or 500 per month for a Railbelt household. An additional six thousand would be added if a consumer uses an electric vehicle (EV).

4:35:59 PM
MR. COLT moved to slide 43 and said that if Alaska moved from a fossil-fuel-based scenario, it would trade a significant amount of fuel costs for a roughly equally significant amount of paying off capital investment.

He added the following details regarding the chart on slide 43:

The light beige bar represents the fixed costs of wind machine operations. It is a major component of a low-carbon, low fuel world. He said that if the state made the daunting capital investment of $10 billion, it could potentially save $750 million in fuel costs every year for the life of the equipment.

4:37:58 PM
MR. COLT moved to slide 50 and reminded the members that the discussion is in the perspective of 2050. It is difficult to predict how technology will evolve. He referenced telephones as an example. With this perspective in mind, all four scenarios are in the same ballpark. He concluded that after doing the math, evaluating the equipment, and applying sensitive cases to the basic analysis, the costs are in the same ballpark.

4:39:39 PM
SENATOR KAUFMAN conveyed that hydrocarbon generates a lot of revenue for Alaska. He wondered if the economic models consider revenue loss and suggested that solar and wind energy do not demonstrate a royalty-based revenue model as does natural gas.

4:40:46 PM
MR. COLT said that there was no attempt to unpack the royalty or production tax implications of the reduction in natural gas use. He stated that even though almost all of the natural gas was omitted from the proposed scenario, the focus was on the Railbelt grid specifically. There would still be an abundance of natural gas consumed for other uses.

4:41:27 PM
CO-CHAIR GIESSEL added that natural gas could potentially replace diesel in rural areas.

4:41:36 PM
SENATOR KAUFMAN said that there is a broad spectrum of possibilities. Buying and shipping gas is costly. He opined that Alaska could enjoy a successful revenue model if it developed and transmitted gas to the Railbelt. In considering all the risks of transitioning to different power sources, it's important to understand how hydrocarbons fit in with the current revenue model in Alaska.

4:42:40 PM
SENATOR BISHOP asked if slide 42 showcased a real bill and if it considers the three scenarios on slide 41.

4:43:09 PM
MR. RICHWINE responded yes. It is an actual current Golden Valley electric bill.

4:43:17 PM
SENATOR DUNBAR asked about the two additional slides at the end.

4:43:51 PM
MS. CICILLIO moved to slide 51 and relayed that ACEP has generated a lot of information and data, so she would like to provide meaning and highlight key findings valuable to Alaska stakeholders. Given the scenario is 27 years in the future and considering uncertainty with costs, the hope is to focus on key challenges, opportunities, and lessons learned for the future. In any of the proposed low carbon scenarios, Railbelt operates will be significantly different than today. These changes will not happen overnight and will be incremental additions.

She moved to slide 53.

[Original punctuation provided.]

Focus on the Challenges and Opportunities

- A future low-carbon Railbelt will operate significantly differently than today or the Business-as-Usual Scenario.
- System stability is more difficult to achieve in low-carbon scenarios. Improvements in the inverter technology of batteries, and wind and

solar energy will be essential for future Railbelt grid stability.

- There is great uncertainty in future costs. The cost of service for the low-carbon scenarios differs by -9% to 25% from the Business-as-Usual scenario depending on varying fuel costs, capital costs, and interest rates.
- This study did not evaluate the cost-effectiveness of near-term renewable additions. The cumulative cost of achieving high levels of renewable penetration is non-linear, due to increased transmission and storage requirements. From now until at least 2030, low-carbon projects will qualify for investment tax credits ranging from 30-50 percent.

4:47:12 PM
SENATOR DUNBAR suggested that legislators are often pitched with carbon capture and storage ideas. One idea is for a coal-fired powerplant with carbon capture technology. He asked if this idea has been analyzed by ACEP and whether it could provide any measure of reliability.

4:47:58 PM
MR. STENCLIK proposed that the coal-fired idea is operationally analogous to the nuclear scenario. It is a high capital cost but low fuel cost, intended to run a very base load. It would provide synchronous generation that could help mitigate some of the grid constraints.

4:48:36 PM
MS. CICILLIO shared that there are other researchers at ACEP specifically looking at carbon capture sequestration for coal-powered plants.

4:48:57 PM
SENATOR KAWASAKI said that while he likes the idea of using electrification to reduce carbon emissions, Fairbanks' concern is space heat. Natural gas can be used for export, heat, and turbines for electricity. He asked if consideration went beyond the electric grid.

4:49:36 PM
MR. COLT appreciated the question. He replied that Alaska's hurdle lays way beyond the electric grid. ACEP concluded that it is too much of a lift to take on more than the electric grid. He hopes the university, energy industry, and the policy community

will embrace new opportunities. It is necessary to look at the whole picture.

4:50:51 PM
CO-CHAIR GIESSEL added that ENSTAR Energy is often left out of the discussion.

4:51:00 PM
SENATOR CLAMAN acknowledged a natural gas shortage in the short term amidst conversations about long-term investment decisions. He asked how state policymakers could influence decisions or make the appropriate choices to invest in solar or wind, for example.

4:51:56 PM
MR. RICHWINE said that while the studies look forward into the future, it does not exclude the opportunity to look at near-term action. A few things came out of the study in terms of least regret options, one was anything thing that could be done toward transmission reinforcements or the ability for plants to be interconnected to the grid.

Wind and solar power could be established in the near-term. From a policy perspective, having an RPS or clean energy standard could provide certainty into the transition and break it down into smaller, more manageable pieces for both policy makers and rate payers.

4:53:11 PM
SENATOR CLAMAN asked if it is important for the legislature to address the renewable portfolio standards.

4:53:25 PM
MR. RICHWINE said that it would be helpful. In the lower 48 states, most projects are being financed in part with an RPS backed by clean energy standards. To have a project that is solely merchant is rare. Policy-backing provides certainty in the market and brings development to fruition.

4:55:18 PM
There being no further business to come before the committee, Co-Chair Giessel adjourned the Senate Resources Standing Committee meeting at 4:55 p.m.