

2023 RENEWABLES IRP

PACIFICORP

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1 INTRODUCTION

PacifiCorp (Owner) retained WSP to evaluate various renewable energy resources in support of the development of the Owner's 2023 Integrated Resource Plan (IRP) and associated resource acquisition portfolios and/or products. The 2023 Renewable Resources Assessment (Assessment) is screening-level in nature and includes a comparison of technical capabilities, capital costs, and operations and maintenance costs that are representative of renewable energy and storage technologies listed below.

It is the understanding of WSP that this Assessment will be used as preliminary information in support of the Owner's long-term power supply planning process. The level of detail in this study is sufficient to provide screening level data required for the IRP planning process. Past the IRP modeling and selection, technologies of interest to the Owner should be further investigated to refine design, major equipment selection, value engineering, and specific project scope adjustments.

1.1 EVALUATED TECHNOLOGIES

- Geothermal
- Solar
- Wind
 - o On-Shore
 - o Off-Shore
- Energy Storage
 - o Lithium-Ion Battery
 - Flow Battery
 - o Gravity Battery
 - Compressed Air
- Solar + Energy Storage
- Wind + Energy Storage
- Wind + Solar + Energy Storage

1.2 ASSESMENT APPROACH

This report accompanies the Renewable Resources Assessment spreadsheet files (Summary Tables) provided by PacifiCorp (PAC) and Burns and McDonnel (BMcD). The Summary Tables are broken out into three separate files for Geothermal, Solar, Wind, and Energy Storage options. Using the assessment for these individual technologies, this assessment also includes technology combinations of Solar + Energy Storage, Wind + Energy Storage, and Wind + Solar + Energy storage. The costs are expressed in mid-2022 dollars for a fixed price, turn-key resource implementation. The Summary Tables can be found in Appendix A: Summary Tables.

This report compiles the assumptions and methodologies used by BMcD, the National Renewable Energy Laboratory (NREL), the Department of Defense (DoE), the International Renewable Energy Agency (IRENA), the Pacific Northwest National Laboratory (PNNL), and existing WSP experience during this assessment. Its purpose is to articulate that the delivered information is in alignment with PacifiCorp's intent to advance its resource

planning initiatives. Each technology and grouped technology have been assessed with a ten-year forecast cost trend.

1.3 STATEMENT OF LIMITATIONS

Estimates and projections prepared by WSP relating to performance, construction costs, and operating and maintenance costs are based on experience, qualifications, and judgment as a professional consultant. WSP has no control over weather, cost and availability of labor, material and equipment, labor productivity, construction contractor's procedures and methods, unavoidable delays, construction contractor's method of determining prices, economic conditions, government regulations and laws (including interpretation thereof), competitive bidding and market conditions or other factors affecting such estimates or projections. Actual rates, costs, performance ratings, schedules, etc., may vary from the data provided.

2 STUDY BASIS AND ASSUMPTIONS

2.1 SCOPE BASIS

Scope and economic assumptions used in developing the Assessment are presented below. Key assumptions are listed as footnotes in the summary tables, but the following expands on those with greater detail for what is assumed for the various technologies.

2.2 GENERAL ASSUMPTIONS

The assumptions below govern the overall approach of the Assessment:

- All estimates are screening-level in nature, do not reflect guaranteed costs, and are not intended for budgetary purposes. Estimates concentrate on differential values between options and not absolute information.
- All information is preliminary and should not be used for construction purposes.
- All capital and operations and maintenance (O&M) cost estimates are stated in 2022 US dollars (USD).
 Escalation is excluded.
- Estimates assume an Engineer, Procure, Construct (EPC) fixed price contract for project execution.
- Capital costs estimates shall be American Association of Cost Engineering (AACE) Class 3 unless otherwise specified.
- Unless stated otherwise, all wind and solar options are based on a generic site with no existing structures or underground utilities and with sufficient area to receive, assemble and temporarily store construction material. Battery options are assumed to be located on existing Owner land.
- Sites are assumed to be flat, with minimal rock and with soils suitable for spread footings.
- Wind and solar technologies were evaluated across five states within Owner's service areas: Washington, Oregon, Idaho, Utah, and Wyoming. The specific locations within each state for potential wind/solar sites were determined by Owner.
- Geothermal technologies were evaluated based on the Owner's existing Dual Flash Blundell Plant and Binary Greenfield Plant.
- All performance estimates assume new and clean equipment.
- Electrical scope is assumed to end at the high side of the generator step up transformer (GSU) unless otherwise specified in Appendix B (most notably for compressed air energy storage).
- AACE Class 5 demolition costs were included for each technology. Costs were developed from published literature from BMcD, NREL, PNNL, DoE, and WSP's experiences; actual rates may vary based on technology and location. Recycling costs are included in the demolition figures; however, re-sale value of materials is excluded as that can vary significantly depending on metals pricing and competition in the currently expanding recycling market. Demolition costs are seen as an optional cost, as Owner could choose other options including repowering the plant.

The current market is being impacted by various trade tariffs on materials as well as on solar modules. Predicting future trends or impacts of these tariffs is beyond the scope of this study. While these costs are intended to

represent a snapshot of 2022 pricing, additional volatility could occur when looking at future pricing of these options. These factors may also change the declining costs curves presented in the accompanying spreadsheets.

Energy storage technologies evaluated in this assessment are expected to take advantage of less expensive, off-peak power to charge the system to later be used for generation during periods of higher demand. These storage options provide the ability to optimize the system for satisfying daily energy needs. Energy stored off-peak and delivered on-peak can help reduce on-peak prices and is therefore beneficial to consumers. Additionally, energy storage has a direct benefit to renewable resources as it can absorb excess energy that otherwise would need to be curtailed due to transmission constraints. This could increase the percentage of power generated by clean technologies and delivered during peak hours. Costs and options shown in this assessment represent storage technologies that are designed for one full cycle per day in a scheduled use case. Other use cases such as frequency regulation, voltage regulation, renewable smoothing, renewable firming, and black starting are not accounted for in the options presented in this study. Different use cases will impact the capital cost, O&M, and performance of the various technologies.

The following project indirect costs are included in capital cost estimates:

- Equipment and Materials
- Construction management & Labor Costs
- PII (Permitting, Interconnection, Commissioning)
- Startup spare parts
- EPC Markup
- Owner's contingency
- Builders Risk Insurance
 - Local sales taxes applied to Solar and Wind technologies based on their assumed location.
- Other taxes, such as State taxes, were estimated to current rates and applied based on technology's assumed location.

2.3 OWNER COSTS

Allowances for Owner's costs are not included in the pricing estimates. The cost buckets for Owner's costs are to be determined by PAC. Owner's costs for project development, project management and legal fees vary slightly by technology.

2.4 COST ESTIMATE EXCLUSIONS

The following costs are excluded from all estimates:

- Financing Fees
- Interest during construction (IDC)
- Performance and payment bond
- Off-site infrastructure
- Utility demand costs
- Land Acquisition or Lease costs

2.5 O&M ESTIMATE ASSUMPTIONS

Operations and maintenance (O&M) estimates are based on the following assumptions:

- O&M costs are in mid-2022 USD.
- Nominal 2.5% inflation rate year-over-year
- Fixed O&M Costs
 - o Are not dependent on the usage profile of the system
 - Measured in dollars per kilowatt-year (\$/kW-yr.)
 - o Includes labor costs, fixed maintenance fees, contracted service fees, operational costs, property taxes, land lease, and allowance for future part replacement.
- Variable O&M Costs
 - o Are dependent on the usage profile of the system
 - Have been included in fixed O&M costs for all technologies due to limited, inconsistent and/or contradictory public and industry data
 - o Includes cleaning and maintenance (scheduled, unscheduled, and general maintenance on technology and transformer(s))

3 GEOTHERMAL

3.1 GENERAL DISCRIPTION

This evaluation, as outlined in the scope of work, includes cost estimates for both Dual Flash expansion of the Blundell Plant, Utah, and general Greenfield Binary Plan (ORC). All cost estimates are based on 200 MW generation with a commercial life expectancy of 40 years or longer. The WSP New Zealand team provided additional help for the Geothermal technology cost estimates, as they have prior experience with both types of plants. The team used a combination of NREL Annual Technology Baseline (ATB) data, International Renewable Energy Agency (IRENA) data, and the "Assessment of Current Costs of Geothermal Power Generation in New Zealand (2007 Basis)" publication from Sinclair Knight Merz for the basis of their analysis. Additional details can be viewed in this deliverable, titles "PacifiCorp Geothermal Project Estimate Support". A summary is provided below.

3.2 PERFORMANCE

All data provided and reviewed from the New Zealand team fits with current industry standards, including reservoir temperature and well production flow rates. The team had to extrapolate costs from 20 and 50 MW scenarios into two 200 MW scenario for the Dual Flash Expansion of the Blundell Plant and the Greenfield Binary Plant, as requested. Additionally, costs had to be converted from \$NZ to \$US for years 2007 to 2021; based on cost data, project costs were then project to 2022 \$US. It is assumed that the Greenfield Binary Plant is in a similar geographic area as the Blundell Plant. Resulting data is provided in Section 3.3.

3.3 COST ESTIMATES

The total capital expenditure (CAPEX) costs for the Blundell Expansion and the Greenfield Binary Plant are \$807.66MM and \$1,167.99MM, respectively. The primary reason for the discrepancy is the cost of the power plant itself. On a per kW basis, these CAPEX costs result in \$4,038 and \$5,840 per kW, which both fit within IRENA and NREL estimates. A sample of the EPC cashflow over a 30-month project duration is shown below in Chart 3-1. This cashflow incorporates a relatively slow early construction phase, then spending picks up during the bulk of the construction, followed by a slower pace before the commercial online date in month 31. O&M costs are \$23.0MM for both plants. Demolition costs, although very high level given the lack of decommissioned plants, are \$23.4MM for both plants. O&M costs for both Dual Flash Blundell and Greenfield Binary Plants, represented for 2022, is \$115.00/kW-yr. which falls within a close range of NREL's \$105.562/kW-yr. as referenced in Chart 3-2.

Chart 3-1 Geothermal EPC Cashflow

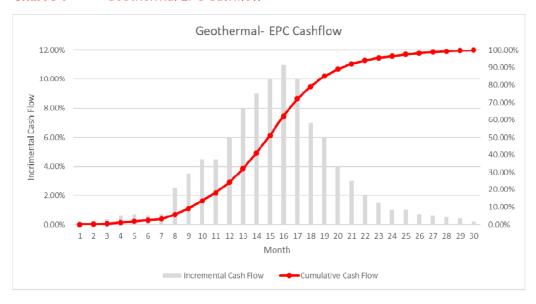
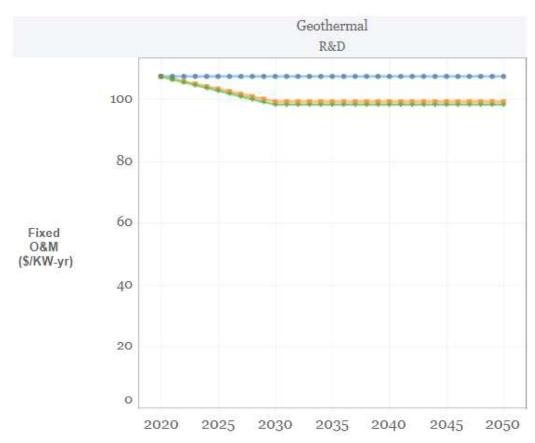


Chart 3-2 Geothermal O&M Cost Trends



Source: "Electricity Annual Technology Baseline (ATB)", NREL, 2020

4 SOLAR PHOTOVOLTAIC

4.1 INTRODUCTION

This evaluation, as outlined in the scope of work, includes cost estimates for both 20 and 200 MW AC single-axis tracking photovoltaic (PV) systems both with a 1.3 DC-AC ratio. All cost estimated are on an AC-capacity basis. PacifiCorp provided performance characteristics of the various location including AC capacity factor, 25-year commercial life, module degradation, and annualized energy production. The five project locations span across PacifiCorp's service territory, as shown below:

Rocky Mountain Power	Pacific Power
Idaho Falls, Idaho	Lakeview, Oregon
Milford, Utah	Yakima, Washington
Rock Springs, Wyoming	

4.2 COST ESTIMATING METHODOLOGY

Cost estimates for this evaluation were based upon widely used public information, including the National Renewable Energy Laboratory (NREL), Solar Energy Industries Information (SEIA) data, Lawrence Berkeley National Laboratory (LBNL or "Berkeley Lab"), Pacific Northwest National Laboratory (PNNL), previous WSP project proposals and internal databases, as well as original equipment manufacturer (OEM) and EPC quotes. Locational adjustment factors for the five project locations are from the U.S. Energy information Administration's (EIA) utility-scale capital cost estimates. All publicly available data used for these estimations is found in the bibliography.

EPC overnight project capital costs are presented in 2022 dollars. These costs include the modules, inverters, structural/electrical balance of system (BOS), installer overhead/Labor, and EPC overhead (equipment and material). Additionally, owner's costs include engineering/development overhead, transmission interconnection fees, permitting costs, and developer profit. It is assumed that PacifiCorp will provide the owner's project management, development, and legal cost data points. Overnight capital cost estimations for projects built in future years is shown in Appendix A.

Operations and maintenance costs are presented in 2022 dollars. These costs include cleaning, vegetation management, inspection, replacement, taxes, insurance, asset management, land leases, and operations administration. These costs are calculated as flat yearly rates, and do not change based on the energy output of the system, for the respective system capacity sizes. It is assumed that the land for all five project locations is leased throughout the project lifetime. As land lease rates vary within a single site location, this line item has been reserved for Owner input. Project demolition costs are provided in 2022 millions of dollars, based on multiple publications quoting \$30,000 per MW. As noted above, demolition costs are very uncertain, and this estimate does not include the potential to re-sell any equipment.

Total EPC costs are similar for all locations with a 20 MW AC capacity with a range of \$21.24-\$22.91. This is similarly the case for the 200 MW AC systems, with a range of \$174.35-\$188.07MM. These costs align with the literature and previous project experience analyzed for this report, which falls between \$1,300-\$1,400/kW. Although the cost of solar PV development has steadily declined over the past two decades, recent U.S. tariffs

along with price increases related to supply-chain shortages and worldwide inflation have provided more uncertainty on cost estimations. WSP believes the projections in this report fall within +/- 30% of the true cost, as is consistent with an AACE Class 4 cost estimate classification system. Estimated EPC cash-flow values for solar PV are shown below in Chart 4-1. This chart shows the low spend months during pre-construction, followed by large spends on procurement. The next phase is the bulk of the construction, with that process finishing in month 24 resulting in a commercial online date in month 25. Ten-year CAPEX and O&M cash-flow estimations are provided for all locations in the accompanying spreadsheets. These also include ten-year trend tables for overnight CAPEX estimations.

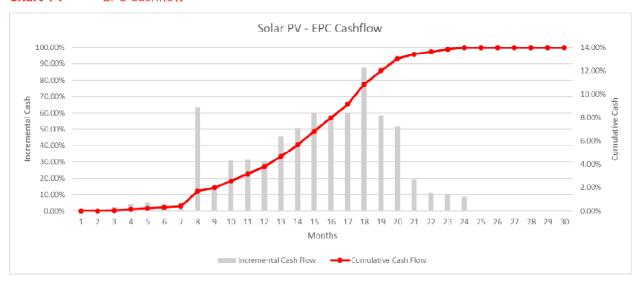


Chart 4-1 EPC Cashflow

4.3 ASSUMPTIONS

All assumptions not stated thus far for solar PV cost estimates are provided below. Please see Appendix A for a full list of solar PV assumptions:

- Third party long-term service agreement O&M costs are included in the "asset management and security" line item.
- It is assumed that the 20 and 200 MW AC PV systems will take up a 160- and 1600-acre footprint, respectively. The land lease is assumed to be \$55,000 and \$547,000 yearly cost, respectively.
- Owner's contingency (3%) and Builders Risk Insurance (0.317%) were developed from available literature and previous project history. These values represent the stability of the technology and thus vary for different technologies. PacifiCorp should review these values and update them as necessary.
- State tax assumptions were provided by PacifiCorp and implemented based on available literature. Pollution control values were omitted as the applicability of the tax is hard to define and is heavily location dependent. Owner should assess this tax separately for each location.
- WSP retained fewer OEM quotes than expected, and although the available ones fit with the report outputs, Owner should engage in vendor outreach for more detailed EPC values and delivery times.

5 WIND

5.1 ON-SHORE

5.1.1 GENERAL DISCRIPTION

The purpose of wind turbines is to convert the kinetic energy in the wind to rotational motion of the turbine itself. This rotary motion is then converted to electrical power that can be distributed across the grid. Wind turbine technology in its modern form is a mature technology, with over 50 years of research and operation behind it. Modern wind turbine designs are classified into two unique sub-sets:

- 1 Horizontal-axis wind turbines, which operate with the axis of rotation parallel to the prevailing wind direction.
- 2 Vertical-axis wind turbines, which operate with the axis of rotation perpendicular to the prevailing wind direction.

Almost all utility scale wind turbines constructed today are horizontal-axis turbines. These turbines consist of four main components: rotor, drivetrain, nacelle, and tower. The rotor consists of the turbine blades and the hub on which the blades are mounted, which transfers rotational energy to the drive train. The drivetrain utilizes a gearbox and rotary shafts to transfer power to the electrical generator. The nacelle houses the drivetrain and all other electrical components at the top of the tower, while the tower supports the rotor and nacelle at the prescribed height of the turbine.

The power available to be extracted from the wind is a function of the cube of the wind speed. As a result, if the wind speed were to double the available power would increase by a factor of eight. However, the ability of the turbine to extract this power is directly corelated to the area swept by the rotor blades. Thus, the two most important factors when considering the output of a potential wind energy project are the wind speed at the location and the size of the turbine.

5.1.2 PERFORMANCE

The wind resource assessment and capacity factor analysis of five different onshore sites in Idaho, Oregon, Utah, Washington, and Wyoming are summarized in this section. Generic project locations were selected in the area specified by owner.

The NREL's publicly available wind data source is utilized to perform a desktop study to determine the relative availability of wind resources in each site. The wind resource data is extracted for three fiscal years at 100m height. The wind resource assessment is performed based on 1-hour wind data. WSP selected the GE 3.4-137 wind turbine for this analysis. The wind turbine specifications are presented in Table 1. The maximum tip height of this turbine is under 500 feet, which means there are less likely to be conflict with the Federal Aviation Administration (FAA) altitudes available for general aircraft. One generic power curve at standard atmospheric conditions for each of the sites was assumed for the GE3.4-137.

Table 1 Wind Turbine Specifications

Rated power	3400 kW
Rotor Diameter	137m
Hub Height	85m
Blade Length	67.2m
Maximum Tip Height	153.5m

The Annual Energy Production (AEP) was estimated for five different sites. The wind speed data is adjusted to the wind turbine hub height before the power production assessment. The equation below is used for estimating the wind speed at hub height:

$$V_h = V_d \left(\frac{H_h}{H_d}\right)^{\alpha}$$

Where V_h is the wind velocity at wind turbine hub height, V_d is the dataset wind speed value at 100m height, H_h is the wind turbine hub height, H_d is the height wind speed dataset (100m), and α is the wind shear factor. We assumed that the wind shear factor is 0.15 in this analysis.

Table 2 shows the summary of gross and net annual capacity factors for each site. The annual losses for each wind site were assumed as 15 percent, which is a common assumption for screening level estimates in the wind industry. This loss factor was applied to the gross capacity factor estimates to derive a net annual capacity factor for each potential site.

Table 2 Onshore Wind Annual Gross & Net Capacity

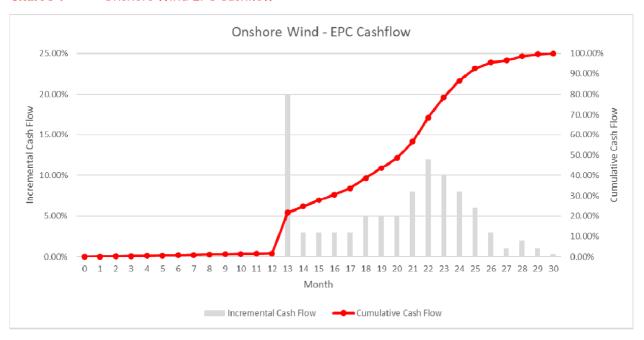
		GE 3.4 MW	
Location	Gross Annual Energy	Net Annual Energy	Net Capacity Factor
Location	Production (GWh)	Production (GWh)	Net Capacity 1 actor
Pocatello, ID	8.841	7.515	25%
Arlington, OR	13.742	11.681	39%
Monticello, UT	13.952	11.859	40%
Goldendale, WA	10.745	9.133	31%
Medicine Bow, WY	17.175	14.599	49%

5.1.3 COST ESTIMATES

The Capital Expenditure (CAPEX) and Operation Expenditure (OPEX) estimations of each wind energy project is summarized in Appendix A. WSP referenced internal and public information to derive the cost estimates, and the CAPEX value (\$/kw) aligns with the latest 2022 DoE land Based Wind Market report of ~\$1,500/kw, which is 7-10% higher than the previous year due to inflation & supply chain constraints. The OPEX costs, were derived from the NREL 2022 ATB (\$43/kw-yr.). Chart 51 below shows an estimation of EPC cashflows for onshore wind, with a slow

start to spending during preconstruction and a large procurement guarantee followed by the majority of construction in months 14–30. It is assumed that the commercial online date would begin in month 31. The decommissioning costs are meant to represent the efforts to return the project site back to native conditions. This includes the decommissioning and demolition of all wind turbines as well as the associated infrastructure. Also included is the transportation cost associated with moving the turbines off-site to recycling or landfill locations. As shown in Chart 5-1, the decommissioning cost for 20MW wind farm is \$1.19MM and for 200 MW wind facility costs \$11.89MM to demolish the wind farm.

Chart 5-1 Onshore Wind EPC Cashflow



5.2 OFF-SHORE

5.2.1 GENERAL DISCRIPTION

Offshore regions of the United States boast some of the strongest and most consistent wind resources currently available. These higher average wind speeds offer a more consistent form of clean energy production than their onshore counterparts. To capture these resources wind turbines must be constructed in waters ranging from 50 to over 1000 feet (300m) in depth, which provides unique challenges. However, innovations in underwater foundation construction and transmission have made offshore wind a viable and attractive energy source.

5.2.2 PERFORMANCE

Like the onshore wind sites, the NREL's publicly available wind data is used for the wind resource assessment and power factor estimation of offshore wind facility. The site location is at West of Klamath River, CA, which was selected in the area specified by owner. WSP selected the GE 6-150 wind turbine for this analysis. The wind turbine specifications are presented in Table 3. A summary of the gross and net annual capacity factors of the offshore wind facility is presented in the Table 4.

Table 3 Wind Turbine Specifications

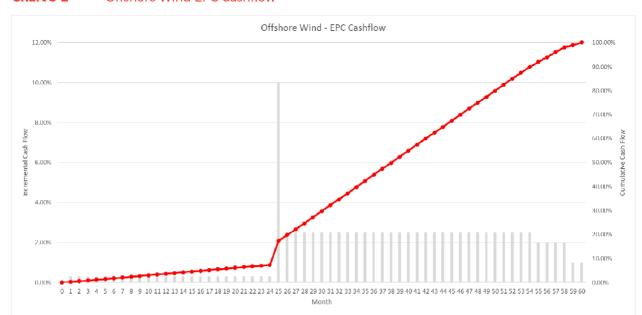
Rated power	6000 kW
Rotor Diameter	150m
Hub Height	100m
Blade Length	73.5m
Maximum Tip Height	173.5m

Table 4 Offshore Wind Annual Gross & Net Capacity

		GE 6.0 MW	
Location	Gross Annual Energy Production (GWh)	Net Annual Energy Production (GWh)	Net Capacity Factor
West of Klamath River, CA	29.002	24.652	47%

5.2.3 COST ESTIMATES

The cost estimation summary of CAPEX and OPEX of offshore wind site is shown in Appendix A. The entire cost estimation of offshore wind facility is referenced from NREL's 2022 IRP report for the cost of offshore wind in California and are assuming the Offshore wind farm is in the Humboldt Call Area. Similar to onshore wind, offshore wind sees a slow increase of cash flows in the first stages of the project. In this case, this phase lasts about two years. Then, there is the large procurement payment followed by three years of construction. It is assumed that the commercial online date is in month 61. The decommissioning cost without locational adjustment factor is \$31.6MM for a 200 MW, and \$158.23MM for a 1,000 MW offshore wind facility.



Incremental Cash ——Cumulative Cash

Chart 5-2 Offshore Wind EPC Cashflow

6 ENERGY STORAGE

Energy storage is a rapidly developing field with technologies at a different stage of maturity. While some are established and allow the development of relatively high-fidelity project budget estimates (e.g., Li-Ion battery), others are only undergoing initial commercial roll-out (e.g., gravity energy storage, compressed air energy storage) and therefore their cost and technical performance can be expected to significantly change over the next 5 years. Please see Appendix B for side-by-side comparison of the key technical parameters of the energy storage technologies included in this Report.

6.1 LITHIUM-ION

6.1.1 GENERAL DISCRIPTION

Aside from pumped hydro, Li-Ion battery energy storage is currently the most established and proven energy storage technology for grid-scale applications. This analysis is focused on systems utilizing LiFePO4 (LFP) battery chemistry, which have recently become dominating in this space. A relatively standardized set of technical parameters has been developed by utilities and there are many vendors offering substantially similar systems, allowing for robust competition. Regulatory compliance requirements are still evolving but generally well-understood by vendors and EPCs. Contractual technical support schemes such as Long-Term Service Agreements (LTSA) have been developed and implemented on numerous projects. A solid track of record of performance has been established both for the technology itself as well as for the leading OEMs. At the same time, recent supply chain challenges, relative scarcity of raw materials, shortages of manufacturing capacity and competition from the transportation sector with its rapidly increasing demand for Li-Ion cells and systems lead to increasingly long lead times for the Li-Ion battery systems and prevent the realization of the forecasted decrease in the per/kWh energy storage cost using this technology.

6.1.2 PERFORMANCE

Li-Ion based energy storage systems are well-suited for grid-tied systems designed for daily cycling including load shifting, demand response, peak shaving, and rapid response grid support applications such as voltage and frequency support. Li-Ion systems projected to last 15 to 20 years before decommissioning or re-powering projects. Due to calendar and cycle-driven capacity degradation they typically require several capacity augmentations events throughout their lifetime on order to maintain nameplate performance. Reference Appendix B for side-by-side comparison of the key technical parameters of Li-Ion battery systems with other energy storage technologies included in this Report. Below are EPC cash flow estimates for the battery equipment (storage block and power equipment) and the rest of the EPC line items. As shown, the equipment cash flow requires a high up-front payment, which has become more standard in recent years. The following payments make up the rest of the total cost, but many manufacturers require that early commitment to guarantee their product will be used. The EPC cash flow starts reasonably slow, and then has three spikes of large payments for the various other EPC inclusions. These cash flow estimates are for lithium-ion batteries and the percentages were provided by PacifiCorp, assuming a two-year project duration before the commercial online date in month 25.

Chart 6-1 Energy Storage - EPC Cashflow



Chart 6-2 Energy Storage – Equipment Cashflow



Chart 6-1 and 6-2: Cash-flow percentages derived from previous WSP and PAC projects, along with current industry standards. Equipment costs include the storage block and power equipment, EPC costs include all other EPC line items from the Energy Storage spreadsheet. Assuming project duration of 2 years.

6.2 FLOW BATTERY

6.2.1 GENERAL DISCRIPTION

Flow Batteries utilize electrolyte solution that changes its chemical state when flowing through a cell. This change is reversible and is accompanied with consumption or release of energy. Large volumes of electrolyte are stored in tanks designated for high and low energy states of the system (State of Charge). This technology allows a significant reduction of the cost of cells with their electrodes, easy upgrade or change of electrolyte without exchanging cells and changing electrodes without affecting electrolyte, limited capacity degradation that is also easier to manage and the resulting longer life span and lower lifetime costs as compared to Li-Ion batteries.

Flow batteries are relatively new technology with only few established OEMs and a limited number of full-scale commercial installations and limited track record. Several competing chemistries exist with significantly different technical parameters, with no clear leader established at time of writing this report. A standardized set of technical parameters has not yet been developed by utilities. Regulatory compliance requirements are still evolving and may not yet be fully well-understood by vendors and EPCs. Contractual technical support schemes such as Long-Term Service Agreements (LTSA) have been developed but have seen very limited implementation to date.

Lower projected lifetime costs as compared to Li-Ion, very linear performance through the entire state of charge (SoC) range, easy scalability, and the ability of flow battery systems to cost-effectively provide longer-duration energy storage (8-24 hrs.) position this technology as an emerging competition to Li-Ion-based systems.

6.2.2 PERFORMANCE

Flow energy storage systems are well-suited for grid-tied systems designed for daily (especially longer-duration) cycling including load shifting (especially for wind), short- and long-term demand response, peak shaving, and some grid support applications. Flow battery systems are projected to last between 12 and 50 years (depending on chemistry) before decommissioning or re-powering projects. They do not require capacity augmentation events (aside from electrolyte change) during their lifetime on order to maintain nameplate performance and do not have a lifetime cycle limit. Their response time and ramp rate are typically slower than Li-Ion batteries, and they do have a marked difference between "hot" and "cold" standby modes and the resulting response times. In some applications flow battery systems can provide significant advantages as compared to Li-Ion; however, a careful attention must be paid to key differences from Li-Ion and the resulting potential limitations for other applications. A project-level analysis of critical performance requirements is recommended prior to considering this technology. Please see Appendix B for side-by-side comparison of the key technical parameters of flow battery systems with other energy storage technologies included in this Report.

6.3 GRAVITY ENERGY STORAGE

6.3.1 GENERAL DISCRIPTION

Gravity energy storage is an emerging technology that uses the differential of potential energy of a body of a large mass (solid or liquid) depending on its elevation on the Earth's gravity field as the means to store energy. This potential energy is converted into kinetic energy driving a generator to extract the stored energy (to discharge it). Conversely, kinetic energy of electric motors is used to increase the potential energy state of this system (to charge it). Technically, the well-established pumped hydro is a form of gravity storage. New systems being rolled out use solid weights (in elevated structures or in deep shafts), water in deep shafts, or a combination of the two (a solid piston creating water pressure).

Gravity energy storage is a new technology with only few established OEMs and a limited number of commercial pilot installations, and a very limited track record. At the same time, the basic physics behind these systems is very well understood and most of the required equipment is off-the-shelf industrial systems. This means that most of the risk lays in implementation rather that technology itself. A standardized set of technical parameters has not yet been developed by utilities; however, it can be easily modeled after pumped hydro. Regulatory compliance requirements are still evolving but are expected to fall within existing categories of heavy construction machinery. Contractual technical support schemes such as Long-Term Service Agreements (LTSA) have not yet been developed.

Advantages of gravity storage systems include extremely long lifespan low lifetime costs, very linear performance through the entire state of charge (SoC) range, easy scalability, and the ability to cost-effectively provide longer-duration energy storage (from days to weeks or months). If thought of in terms of this being a variation of pumped hydro, it should be relatively easy to assess applicability of this technology to specific project needs and develop a set of key technical parameters.

6.3.2 PERFORMANCE

Gravity energy storage systems are well-suited for grid-tied systems designed for daily (especially longer- and very long-duration) cycling including load shifting (especially for renewable generating resources with long-term variability such as wind), long-term demand response, peak shaving, and some grid support applications. Gravity systems are projected to last longer than 40 years before decommissioning or re-powering projects. They do not require capacity augmentation events during their lifetime on order to maintain nameplate performance and do not have a lifetime cycle limit. Their response time may be slower than Li-Ion batteries but like pumped hydro, a project-level analysis of critical performance requirements is recommended prior to considering this technology. Please see Appendix B for side-by-side comparison of the key technical parameters of gravity energy storage systems with other energy storage technologies included in this Report.

6.4 COMPRESSED AIR ENERGY STORAGE (CAES)

6.4.1 GENERAL DISCRIPTION

Compressed Air energy storage (CAES) is an emerging technology that uses large volumes of compressed air as the means of energy storage. To charge the system, electrically driven compressors fill a designated air storage container (such as underground cavern, underwater bladders, etc.) To discharge the system, the compressed air is routed to turboexpanders that drive electric generators. A recent variation of the technology is Adiabatic CAES (A-CAES) which recovers the heat produced during compressing the air into a thermal storage system; this energy is then used to reheat the air during expansion cycle, significantly improving system round-trip efficiency. The technology uses a lot of relatively standard turbomachinery based on gas turbine and industrial gas handling systems. One of the variations of A-CAES technology currently in the pilot stage uses CO₂ as a working fluid, enabling a theoretically higher system efficiency but requiring large storage for unpressurized CO₂.

CAES is a new technology with only few established OEMs and a limited number of commercial pilot installations, and a very limited track record. At the same time, the basic physics behind these systems is very well understood and most of the required equipment is based on standard industrial systems (with modifications). This means that the risk is divided between technology as such (mostly the air storage systems) and the implementation of packaging of turbomachinery and control systems. A standardized set of technical parameters has not yet been developed by utilities; however, requirements associated to simple cycle and CCGT power plants can be used as a basis. Regulatory compliance requirements are still evolving but are expected to fall within existing categories of industrial structures, mining, and turbomachinery. Contractual technical support schemes such as Long-Term Service Agreements (LTSA) have not yet been developed.

Advantages of CAES include long lifespan, low lifetime costs, the ability to cost-effectively provide longer-duration energy storage (from days to weeks or months).

6.4.2 PERFORMANCE

CAES systems are well-suited for grid-tied systems designed for daily (especially longer- and very long-duration) cycling including load shifting (especially for renewable generating resources with long-term variability such as wind), long-term demand response, peak shaving, and some grid support applications. CAES systems have projected lifespan of over 60 years (the longest projected lifespan among new technologies in PNNL reports) before decommissioning or re-powering projects. They do not require capacity augmentation events during their lifetime on order to maintain nameplate performance and do not have a lifetime cycle limit. Their response time may be slower than Li-Ion batteries but similar to a simple cycle (for CAES) or CCGT (for A-CAES) power plant. A project-level analysis of critical performance requirements is recommended prior to considering this technology. Reference Appendix B for side-by-side comparison of the key technical parameters of CAES systems with other energy storage technologies included in this report.

6.5 COST ESTIMATES

Table 5 Energy Storage CAPEX Costs

Capacity	Lithium-Ion Battery	Flow Battery	Gravity Energy Storage	Compressed Air Energy Storage
200 MW	338.55	458.19	657.74	350.60
500 MW	827.38	1,026.46	1,515.07	876.50
1000 MW	1,612.33	2,128.06	1,889.84	1753.00

Note: All values in MM\$ and exclude taxes/locational adjustment factor.

Table 6 Energy Storage Expected Lifetime Costs

Technology	Lith	ium-Ion Ba	ittery	1	Flow Batter	y	Gravit	y Energy S	torage	Comp	ressed Air Storage	Energy
Capacity (MW)	200	500	1000	200	500	1000	200	500	1000	200	500	1000
Lifetime Costs (MM\$)	554,75	1355,75	2642,00	547,12	1186,79	2389,63	1092,27	2418,75	3281,92	743,18	1779,75	3404,47
Annual Lifetime Costs (MM\$/yr.)	27.74	67,79	132,10	21,88	47,47	95,59	21,85	48,36	65,64	12,39	29,66	56,74

Table 6 shows the expected lifetime costs of the various energy storage technologies. These calculations consider CAPEX values (Table 5) along with O&M values for the expected life of each technology. Inflation of 2.5% per year is included. The design life for lithium-ion, flow, gravity energy storage, and compressed air energy storage are 20, 25, 50, and 60 years, respectively.

6.6 EMERGING ENERGY STORAGE TECHNOLOGIES

Due to a current low maturity level for grid-scale storage, high predicted costs and (for some technologies) low round-trip efficiency in their current form, the below technologies were not yet considered for the cost analysis section of this Report. The discussion below is provided for reference and a potential inclusion into future versions of the IRP. As a technology nearing technical maturity for grid-scale energy storage, the Iron-Air energy storage is included in Appendix B.

6.6.1 GENERAL DISCRIPTION

IRON-AIR

The technology is based on the interaction of iron with oxygen. The oxygen necessary for the reaction is taken from the ambient air, eliminating the requirement for the cell to store it. The high energetic densities with 1,200 Wh/kg produced by metal-air batteries are attributed to these component savings. Compared with the usual lithium-ion that has 600 Wh/kg, iron-oxygen batteries store more energy on the weight basis. Ferrous electrodes are also theoretically extremely durable, capable of withstanding over 10,000 full cycles. Iron-oxygen batteries are also resilient to overcharging, overcurrent, and partial discharge. A rechargeable iron-oxygen battery can supply 100 hours of energy at operating cost compared to traditional power stations and less than a tenth of the price of lithium-ion batteries. On the downside, the round-trip efficiency is quite low for the current offering (~38%), which limits this technology for applications addressing extremely high-power generation curtailment rates. There is currently one vendor offering commercial-scale systems.

NAS THERMAL

Sodium Sulfur batteries operate at elevated temperatures of 300-350C. The active materials in a NaS battery are molten sulfur as the positive electrode and molten sodium as the negative. The electrodes are separated by a solid ceramic, sodium alumina, which also serves as the electrolyte. This ceramic allows only positively charged sodium-ions to pass through. During discharge electrons are stripped off the sodium metal (one negatively charged electron for every sodium atom) leading to formation of the sodium-ions that then move through the electrolyte to the positive electrode compartment. The electrons that are stripped off the sodium metal move through the circuit and then back into the battery at the positive electrode, where they are taken up by the molten sulfur to form polysulfide. The positively charged sodium-ions moving into the positive electrode compartment balance the electron charge flow. During charge this process is reversed. The battery must be kept hot (typically > 300 °C) to facilitate the process (i.e., independent heaters are part of the battery system). In general, NaS cells are highly efficient (typically 89%). There is currently one vendor offering NaS systems, with 190 systems installed in Japan and fifteen in UAE, with the combined capacity of 378MW/2,268MWh. The systems appear to be most suitable to 6+ hrs. duration storage.

ULTRACAPACITORS

Electrochemical capacitors (ECs) – sometimes referred to as "electric double-layer" capacitors, "Supercapacitor" or "Ultracapacitor" – provide a compelling set of characteristics – high energy density, extremely high cycle life, extremely fast response time. ECs have specific energy values that approach 206Wh/kg and up to 496W/kg power density. Because of their high power, long cycle life, good reliability, and other characteristics, the market and applications for ECs have been steadily increasing. There are dozens of manufacturers, and more are entering the market because of market growth. Aqueous electrolyte asymmetric EC technology offers opportunities to achieve exceptionally low-cost bulk energy storage. There are difference requirements for energy storage in different electricity grid-related applications from voltage support and load following to integration of wind generation and time-shifting. Symmetric ECs have response times on the order of 1 second and are well-suited for short duration high-power applications related to both grid regulation and frequency regulation. Asymmetric ECs are better suited for grid energy storage applications that have long duration, for instance, charge-at-night/use-during-the-day storage (i.e., bulk energy storage). Some asymmetric EC products have been optimized for ~5-hour charge with ~5-hour discharge. Advantages of ECs in these applications include long cycle life, good efficiency, low life-cycle costs, and adequate energy density.

7 CO-LOCATED PLANTS

7.1 GENERAL DESCRIPTION

WSP was tasked with analyzing three separate colocation scenarios, including Solar + Energy Storage, Wind + Energy Storage, and Wind + Solar + Energy Storage. All cost information (Capex and O&M) can be found in Appendix A. The colocation analysis was conducted by adding the separate scenarios, with a few tweaks, as discussed below.

7.2 SOLAR + ENERGY STORAGE

The solar plus energy storage models combine the 200 MW AC PV systems with a 200 MW Li-Ion battery by colocating the projects together. It is assumed that the battery is AC coupled with the PV system. This layout requires a separate inverter for both the PV system and the battery, as was modeled in the separate PV and battery scenarios. There are benefits and constrains to the AC coupling method including cost and PV curtailment. WSP suggests that Owner conduct further analysis on DC and AC coupling to better understand what is needed for a given PV and energy storage scenario. One of the benefits of co-locating the two technologies together are cost reductions. NREL's "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks: Q1 2021" states that co-located PV and Energy Storage plants see a 6-7% total cost reduction through cost savings resulting from site preparation; land acquisition; permitting and interconnection; installation; labor; hardware (via sharing of hardware such as switchgears, transformers, and controls); overhead; and profit.

The PV and energy storage spreadsheet was developed by combining the two separate scenarios into one. The only change aside from the 6% co-location cost reduction was the ability to use the DoE/EIA location adjustment factor for the Li-Ion battery now that there was a specific location tied to the energy storage system. This allowed for a more defined estimate of both capital and operational cost estimates for the battery. It should be noted that the addition of energy storage to a renewable energy plant can greatly increase the profit of the plant. Although the location plays a major factor, NREL's "Influence of Hybridization on the Capacity Value of PV and Battery Resources" discusses the economic benefit that could come from co-location. These intricacies were outside of the scope of this project but should be investigated by Owner to fully understand the economics of co-location.

7.3 WIND + ENERGY STORAGE

Similar to the PV and energy storage section above, there are assumed cost savings from pairing wind and energy storage. Although there is not a specific cost reduction factor published by a major national laboratory, WSP is confident that similar colocation savings would be present within a wind and energy storage combined power plant. Thus, the 6% cost reduction was also applied to these scenarios. Similar to Solar + Energy Storage, the battery costs were scaled by the DoE/EIA location adjustment factor given the location of the project.

7.4 WIND + SOLAR + ENERGY STORAGE

As stated above, there is an expected 6% colocation savings when energy storage is paired with a wind or solar plant. Additionally, NREL's "Potential Infrastructure Cost Savings at Hybrid Wind Plus Solar PV Plants" describes how the colocation of Wind + Solar can see cost savings of at least 7%. The report adds that, depending on the capacities of each, these savings can be much higher. Even though Owner could expect savings higher than 7% for a Wind + Solar + Energy Storage plant, the estimates provided contain a conservative margin of 7%.

8 CONCLUSION

This technology assessment is intended to provide PacifiCorp with greater insight into the associated costs of various renewable energy systems. The purpose of the document, and its accompanying spreadsheets, is to assist in the planning efforts regarding PacifiCorp's upcoming 2023 IRP. It should be noted again that this work has been done at a screening level and should be investigated further for any future project development.

Although recent inflation and tariffs have impeded the reduction in implementing renewable energy technologies, there is still a strong confidence that most, if not all, of the referenced technologies will continue to see cost declines over the next decade. Solar PV and onshore wind are proven to be cost-effective, and thus have lower associated risk. Offshore wind, although not heavily deployed in the United States, shows extreme potential—especially in PacifiCorp territory. This assessment investigated various energy storage technologies, each with different benefits and drawbacks. The ability to co-locate solar PV and wind with energy storage (and each other) can result in reduced EPC costs and incur even more cost savings throughout the project lifetime.

This assessment is intended to highlight high-level cost information, and not to provide a recommendation. Different technologies have various use cases, especially regarding a large utility that incorporates all kinds of grid services within their day-to-day work operations. The WSP Team has provided the conclusion of our research to assist with these specific operational decisions.

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APPENDIX

A - TECHNOLOGY COST ASSESSMENT

A-1 Geothermal

PROJECT TYPE	- 0.0 0.0	5
PROJECT LOCATION (Note 1)	Dual Flash Expansion of Blundell Plant	Greenfield Binary Plar
BASE PLANT DESCRIPTION	200 MW	200 MW
Reservoir Temperature (deg C)	245	245
Enthalpy (kJ/kg)	1,066	1,066
/IW Generated per Blundell Well (MW/well)	7.7	6.7
Production Wells Required	27	31
Total Flow (kg/s)	1,926	2,221
Orilling Failure Rate (%)	20%	20%
Production Wells Drilled	33	38
Reinjection Ratio (Production Flow/Reinjection Flow)	0.77	0.77
Reinjection Wells Required	22	25
Reinjection Wells Drilled	27	30
Average Well Decline (%/yr)	3%	3%
Plant Capacity Factor (%)	95%	95%
ESTIMATED CAPITAL AND O&M COSTS		
EPC Costs, 2022 \$MM	\$689	\$1,000
Drilling (Note 2)	\$264.34	\$304.3
Steam field Development	\$105.69	\$90.3
Power Plant	\$310.26	\$503.7
Interconnection	\$8.24	\$8.2
Owner's Costs Without Contingency, 2022 \$MM	\$36	\$47
Engineering & PM	\$26.62	\$33.8
Legal Cost	\$4.68	\$6.8
Land Cost	\$0.56	\$0.6
Permitting	\$0.19	\$0.2
Geoscience & Environmental Assessments	\$0.47	\$0.5
Well Testing	\$0.47	\$0.5
Assessment Infrastructure	\$2.58	\$4.4
Feasibility Reports	\$0.19	\$0.2
Subtotal - Capital Cost, 2022 \$MM	\$724	\$1,047
Owner's Contingency (5%)	\$36.2	\$52.4
State Taxes (Utah)	\$47.2	\$68.5
Total CAPEX, 2022 \$MM	\$807.66	\$1,167.99
otal Screening Level Project Costs, 2022 \$/kW	\$4,038	\$5,840
Demolition Costs (end of life cycle) 2022 \$MM	\$23.40	\$23.40
D&M Cost, 2022 \$MM/yr	\$23.0	\$23.0
D&M Cost, 2022 \$/kW-yr	115.0	\$115.0

Note 2: Assumed drilling depths 2500m for production wells & 2000m for reinjection wells

A - 2 PV Solar

PROJECT TYPE						
PROJECT LOCATION		Idaho Falls, ID	Lakeview, OR		Millord, UT	
SASE PLANT DESCRIPTION	20 MW	200 WW	20 MW	210 MW	20 MW	200 MW
Nominal Output MWdc	28 28	280	26	280	R 8	260
Annualized Energy Production, MMh (Yr 1)	45,676	456,760	48,355	483,552	52,910	529,104
AC Capacity Factor at POI (%) (Note 1)	15 Tage	26.1%	27.6%	27.6%	30.2%	30.2%
Assumed Land Use, Acres (Note 2)	160	1600	081	1600	160	1600
TV Invertor Loading Raio (DC/AC)	1.30	150	1.30	1.30	1.30	1.30
PV Degradation, %/yr (Note 2)	After 1st Year 0.5% per vear	After 1st Year 35% oer vear	After 1st Year 0.5% per year	After 1st Year 0 5% per vest	After 1st Year 0.5% per year	After 1st Year 0.5% per year
Lechnology Katng	Matture	Mature	Mature	Mature	Mature	Mature
Permitting & Construction Schedule, year	2	2	2	2		26
Sast Invited - Fets Ordering Base Load Performance ((Amual Average) Net Plant Output IV)	20,000	200,300	20,000	260,000	20,000	200,000
ESTIMATED CAPITAL AND OAM COSTS						
EPC Project Capital Costs, 2022 MMS (w/o Owner's Costs)	\$17.1	\$140.8	\$17.1	\$140.8	1715	\$140.8
Modules	28.7	\$86.8	56.7	8.88.8	5.8.7	\$66.8
Son criteria BOS	210	520	87.0	\$8.0	\$1.0	28.0
Eectrical BOS	7 2	\$10.0	\$2.4	\$10.0	275	1018
Installer OH (Labor Costs) EPC OH (Equipment and Material) EPC OH (Equipment and Material)	222	\$20.0 \$10.0	54 55 55 55 55 55 55 55 55 55 55 55 55 5	\$20.0	\$1.6	\$100
the water	0.00	000	0.00	0.00	876	0.00
Owner's Costs, 2022 NMS	075	\$24.0	\$3.0	\$24.0	\$30	\$24.0
Taramasion Line	31.0	920	30.20	24.0 32.0	30.20	82.0
PII (permitting fee, interconnection, commissioning)	8.08	\$80	80.8	58.0	80.8	58.0
Carried Acquisition (Note 3)	80.0 N S	800	0.00	0.08	\$200	80.0
Owner's Project Management	PAC to mput values	PAC to input values	PAC to input values	PAC to input values	PAC to input values	PAC to input values
Owner's Legal Costs	PAC to nput values	PAC to input values	PAC to input values	PAC to input values	PAC to input values	PAC to input values
Contingency and Insurance, 2022 MMS	20.7	\$5.5	\$0.7	\$5.5	\$0.7	\$5.5
Owner's Contingency (3%) (Note 4) Builders Risk Insurance (317%) (Note 4)	\$0.1	\$0.5	\$0.0	\$0.5	\$0.6 \$0.1	\$4.9
Total Bereaning Level Project Coats, 2022 MM\$	\$20.7	\$170.3	\$20.7	\$170.3	\$28.7	\$170.3
A THE PERSON NAMED IN	4	4 0 0	6 6	4 4	ž	4
State Issues (None 4) State Issues (None 4) Labor and Services	90.289 90.13	\$7.25	200	0.08	\$102 \$102 \$0.1	\$8.27 \$8.27 \$1.2
CADEX 2022 1465	21.60	64.28.24	\$20.76	\$170.27	\$2190	\$179714
Location Adjusted GAPEX 2022 MIMS Location Adjusted GAPEX 2022 MIMS Total Screening Level Project Coats, 2022 StWdc Dennoitson Coats (end of file cycle) 2022 StWds Dennoitson Coats (end of file cycle) 2022 MIMS (bote 5)	\$1.34 \$1.866.77 \$1,386.80 \$0.59	\$176.14 \$17.00 \$1,139.41 \$5.88	\$21.78 \$21.78 b1.089.17 b1,445.92 \$0.63	\$170.25 \$170.25 \$170.20 \$1.162.07 \$6.30	\$21.24 \$2.106.18 \$1,306.18 \$1,398.04 \$0.58	\$174.15 \$125.79 \$1,073.53 \$5.62
O&M Cost, 2029 MMS/rr (Note 6)	10.4	\$42	\$0.4	\$4.2	\$0.4	\$4.2
Module ceaning	50.043	\$0,433	\$0.043	\$0.433	\$0.043	\$0.433
Vegetation and or Pest Namagement System inspection and monitoring	50.045	\$0.156	\$0.046 \$0.046	\$0.156	\$0.045	\$0.158
Component parts replacement	\$1.033	\$0.327	\$0.033	\$0.327	\$0.033	\$0.327
Inverter replacement	870.02	\$0.779	S0.078	977.08	\$0.078	\$0.779
Land Lease Protectivity	\$0.055	\$0.547	\$0.055	\$0.547	\$0.055	50.547
Insurance	\$0,051	\$0.507	\$0.051	\$0.507	\$0.051	\$0.507
Azek management and security (Note 6) Operations administration	\$0.004	\$0.057	\$0.000	\$0.057	\$0.008	\$0.057
OSM Cost, 2023 \$/kWsc-yr	520.87	\$20.87	\$20.87	\$20.87	\$20.87	\$20.87
Note 1. Solar capacity factor suspited by PAC. Note 1. Solar capacity factor suspited by PAC. Note 2. Base plant descriptions provided by PAC. Note 3. Land is assumed to be leased throughout the project lifetime and is thus included in yearly O&M values. This included in yearly O&M values and the project lifetime and is what a Shart has remained by PAC. Note 6. Demolition costs are seen as an optional end-of-life cost, as other viole 6. Demolition costs are seen as an optional end-of-life cost, as other						
options for repoverent the plant are available. Third perly brighten service agreement cools are included in the asset management and security line item.						

PACIFICORP RENEWABLE TECHNOLOGY ASSESSMENT SUMMARY TABLE SOLAR GENERATION

A - 3 PV Solar (Cont.)

PROJECT TYPE				
PROJECT LOCATION	Rock So.	rings, WY	Yakim	a. WA
BASE PLANT DESCRIPTION	20 MW	200 MW	20 MW	200 MW
Nominal Output, MWac	20	200	20	200
Vominal Output, MWdc	26	260	26	260
Annualized Energy Production, MWh (Yr 1)	48.944	489.439	42.389	423.894
C Capacity Factor at POI (%) (Note 1)	27.9%	27.9%	24.2%	24.2%
wailability Factor, % (Note 2)	99%	99%	99%	99%
ssumed Land Use, Acres (Note 2)	160	1600	160	1600
V Inverter Loading Ratio (DC/AC)	1.30	1.30	1.30	1.30
V Degradation, %/yr (Note 2)	tst year: 2%	2nd year: 2%	1st year: 2%	2nd year: 2%
	After 1st Year: 0.5% per year	After 1st Year: 0.5% per year	After 1st Year: 0.5% per year	After 1st Year: 0.5% per ye
echnology Rating	Mature	Mature	Mature	Mature
Permitting & Construction Schedule, year	2	2	2	2
STIMATED PERFORMANCE lase Load Performance @ (Annual Average)				-
Net Plant Output, kW	20,000	200,000	20,000	200,000
ESTIMATED CAPITAL AND O&M COSTS				
County at the same and a manufacture of the same and the	59550 V	The State of the S		
PC Project Capital Costs, 2022 MM\$ (w/o Owner's Costs)	\$17.1	\$140.8	\$17.1	\$140.8
Modules	\$6.7	\$66.8	\$6.7	\$66.8
Inverter	\$1.0	\$8.0	\$1.0	\$8.0
Structural BOS	52.4	\$20.0	\$2.4	\$20.0
Electrical BOS	\$2.4	\$10.0	\$2.4	\$10.0
Installer OH (Labor Costs)	\$2.2 \$1.6	\$20.0 \$10.0	\$2.2 \$1.6	\$20.0 \$10.0
EPC OH (Equipment and Material) EPC Markup	\$1.6	\$10.0 \$6.0	\$1.6 \$0.8	\$10.0 \$6.0
La de State Policy	30.0	30.0		
Owner's Costs, 2022 MM\$	\$3.0	\$24.0	\$3.0	\$24.0
Engineering & Development OH	51.0	\$4.0	\$1.0	\$4.0
Transmission Line	\$0.20	\$2.0	\$0.20	\$2.0
PII (permitting fee, interconnection, commissioning)	\$0.8	\$8.0	\$0.8	\$8.0
Land Acquisition (Note 3)	\$0.0	\$0.0	\$0.0	\$0.0
Owner's Project Development	\$1.0	\$10.0	\$1.0	\$10.0
Owner's Project Management	PAC to input values	PAC to input values	PAC to input values	PAC to input values
Owner's Legal Costs	PAC to input values	PAC to input values	PAC to input values	PAC to input values
ontingency and Insurance, 2022 MM\$	\$0.7	\$5.5	\$0.7	\$5.5
Owner's Contingency (3%) (Note 4)	\$0.6	\$4.9	\$0.6	\$4.9
Builders Risk Insurance (.317%) (Note 4)	\$0.1	\$0.5	\$0.1	\$0.5
otal Screening Level Project Costs, 2022 MM\$	\$20.7	\$170.3	\$20.7	\$170.3
AND THE COLUMN TO THE COLUMN T		No. of the last of	100	
State Taxes (Note 4)	\$0.8	\$6.4	\$1.5	\$12.3
Balance of Plant Materials and Products Labor and Services	\$0.79	\$6.44 0	\$1.30	\$10.57
abor and Services	0	ů.	\$0.19	\$1.75
CAPEX, 2022 MM\$	\$21.54	\$176.71	\$22.24	\$182.59
ocation Adjusted CAPEX 2022 MM\$	\$21.75	\$178.47	\$22.91	\$188.07
Fotal Screening Level Project Costs, 2022 \$/kWdc	\$1,047.68	\$859.85	\$1,068.42	\$876.87
Total Screening Level Project Costs, 2022 \$/kWac	\$1,361.98	\$1,117.80	\$1,388.95	\$1,139.93
Demolition Costs (end of life cycle) 2022 MM\$ (Note 5)	\$0.61	\$6.06	\$0.62	\$6.18
&M Cost, 2020 MMS/yr (Note 6)	\$0.4	\$4.2	\$0.4	\$4.2
Module cleaning	\$0.043	\$0.433	\$0.043	\$0.433
Vegetation and/or Pest Management	\$0.016	\$0.158	\$0.016	\$0.158
System inspection and monitoring	\$0.045	\$0.449	\$0.045	\$0.449
Component parts replacement	\$0.033	\$0:327	\$0.033	\$0.327
Module replacement	\$0.007	\$0.075	\$0.007	\$0.075
Inverter replacement	\$0.078	\$0.779	\$0.078	\$0.779
Land Lease	\$0.055	\$0.547	\$0.055	\$0.547
Property tax	\$0.043	\$0.433	\$0.043	\$0.433
Insurance (Note 6)	\$0.051	\$0.507	\$0.051	\$0.507
Asset management and security (Note 6) Operations administration	\$0.041 \$0.006	\$0.410 \$0.057	\$0.041 \$0.006	\$0.410 \$0.057
Oberations administration O&M Cost, 2020 S/kWac-yr	\$20.87	\$20.87	\$20.87	\$20.87
lotes	***************************************	teritoria de la companya della companya della companya de la companya de la companya della compa		
lote 1. Solar capacity factor supplied by PAC.				
Note 2. Base plant descriptions provided by PAC.				
Note 3. Land is assumed to be leased throughout the project lifetime and is				
hus included in yearly O&M values.				
lote 4. State Tax rates provided by PAC.				
lote 5. Demolition costs are seen as an optional end-of-life cost, as other				
ptions like repowering the plant are available.				
lote 6. Third party long-term service agreement costs are included in the				
asset management and security line item.				

A - 4 ONSHORE WIND

record fire	A					Orshore Wind				
PROJECT LOCATION	Pocatello, ID	0,10	Arling	Arlington, CR	Monto	Montcello, UT	Medicine Bow, WY	Bow, WY	Goldendale, WA	ile, WA
BASE PLANT DESCRIPTION	20 MW	200 MW	20 MW	200 MW	20 MW	200 MW	20 WW	200 MW	20 MW	200 MW
ESTIMATED CAPITAL AND O&M COSTS								W.		
DOD Designet Careful Costs 2009 CMM (with Currents Costs)	02 70	* 5353	NZ 763	6363 4	C. 702	6263 4	634 70	4.063.4	02.70	* 6369
Mod Taking Costs, 2022 Swint (w/o conter's costs)	5/1/2	1,5024	434,79	2624	6/ 150	1,5025	97.47.6	\$263.1	234,79	\$47E 00
Wind Hirthe Landersings	517.50	\$1/5.00	50.75	\$1/5.00	20.25	51/5.00	00715	S1/5.C0	24.50	\$175.00
Vol Masi	97.9	00.100	60.50	91.00	61.05	64440	0.5	641.00	01.00	0.1.00
Assembly & hetallation	24.16	1 1 2 2	36.05	48.57	34.18	6 14 G	24.18	\$ 14.19 \$9 57	24.10	6 14 B
Roads & Crane Pads	50.05	50.00	90.00 S0.05	60,00	20.05	07 03	8.5	\$C.20	20.02	\$0.00 \$0.40
O&M Building	51.15	- 15	100			1.5	2	- 15	511	-
Collection System	21.2	\$12.2	5.59	\$12.2	. 5	812.2	. LS	\$12.5	213	\$12.2
SCADA	30.2	50.4	\$3.2	50.4	\$9.2	\$0.4	\$0.2	50.4	\$0.2	\$0.4
Swithgear/Substation (Note 2 & 3)	35.1	\$15.9	\$5.1	\$15.9	65.1	815.9	53.	\$15.5	55.1	\$15.9
Slep-Up Transformer & Interconnection (Note 4)	\$1,97	\$4.92	\$1.97	\$4,92	51,97	\$4,92	51,97	\$4.92	51.97	\$4,92
Arcraft Detection Lighting System	\$3.93	\$0.00	\$0.00	\$0.00	06.08	00.00	\$0.50	\$C.9C	80.90	\$0.90
EPC Fee (8%)	\$2,53	\$19,43	\$2.58	\$19.49	\$2.58	\$19,49	\$2,58	\$19.49	\$2,58	\$19.49
			;	1	4	1			1	i
Owner's Costs Without Contingency, 2022 SMM	71.2	25.5	8.1.8	26.2	51.2	20.0	\$1.5	\$5.9	81.8	26.4
Project Design	80.2	\$2.0	\$3.2	\$2.0	\$0.2	\$2.0	\$0.2	\$2.0	20.5	\$2.0
Owner's Engineer	\$0.05	50.17	\$0.05	\$0.17	\$0.05	\$0.17	\$0.05	\$C.17	20.05	\$0.17
Land Lease & Development	30.2	\$2,4	\$0.2	\$2.4	\$0.2	\$2.4	\$0.2	52.4	\$0,2	\$2.4
Water Cardina	9.00	0.00	1.19	4.0	0.03	90.0	6.00	51.1	5.00	9.0
Wildlie Studies	20.3	2,00	7	2002	1.50	2004	100	20.Z	- 00	200
		20.00	Included in							200
Capital Spares	Included in C&M	Included in O&M	OBM	Included in O&M	Included in O&M Included in O&M	ncinoed in O&M	ncinded in O&M	Included in O&M	nguđed in O&M	Included in Oak
Subtotal - Capital Costs, 2022 SMM	\$36.0	\$268.5	\$36.5	\$269.3	\$36.0	\$268.6	\$36.3	\$269.0	\$36.7	\$269.5
Owner's Confingency (5% of Capital Cost)	\$1.6	\$13.4	\$1.8	\$13.5	81.8	\$13.4	\$1.8	\$13.5	\$1.8	\$13.5
85										
Total - Costs With Contingency, 2022 SMM	\$37.8	\$282.0	238.4	5282.8	\$37.8	\$282.0	538.1	\$282.5	538.5	\$283.0
State Taxes, \$MM (Note 6)	\$2.0	\$14.7	0.08	20.0	51.7	\$14.3	\$1.8	\$14.7	\$2.9	\$21.5
Balance of Plant Materials and Products	81.5	\$12.5	NA	NA	2+3	8.44.3	513	\$125	5	\$183
Lazor and Services	30.5	\$2.2	NA	NA.	NA	NA	\$0.5	\$2.2	\$0.8	\$3.2
CADEN 2022 CAMA	E30 73	£20E 73	C-30 27	07 5863	E20 A7	22 700.3	E20 03	6267 10	541.47	STOW AG
CAPEA, COLE DIVINI	900.10	\$250.13	2000	6,7076	200.00	20.90.30	430.30	6304.13	7	9304.40
Total Security and Design Court 2022 6 000	\$40.73	01.6524	12.000	9234.10	200000	5303.2	433.03	17.9576	242.23	\$310.33
I oral Screening Level Project Costs, 2022 sixty	35,000.30	10,004,14	41,533,44	91,470.30	32,430.00	10.020,16	90.000	10.174,16	94, 112,40	51,552,70
Demonstron Costs (end of his cycle) 2022 Smin (Note o)	61.16	911.09	61.16	60.116	61.16	311.03	D	60.114	B	511.03
O&M Cost, 2022 \$MMfyr	\$0.5	\$8.6	\$0.9	\$8.6	80.9	\$8.6	\$0.9	\$8.6	\$0.9	\$8.6
OSM Cost, 2022 \$/kW-/rr	\$43.0	\$43.0	643.0	\$43.0	\$43.0	\$43.0	\$43.0	\$43.0	\$43.0	\$43.0
	1,000000000			- Contract				200000000	2000000	

Note a. Permitting cost assumes the permitting matrix from the 2022 Pacifican Alf-Source R-P s ultrad
Note 5. Sate Tax information provided by Pacifican
Note 6. Reclamation costs induced in Demolition costs. Jemolition costs are seen as an optional end-citife cost, as other options like repowering the plant are available.

A - 5 OFFSHORE WIND

PACIFICORP RENEWABLE TECHNOLOGY ASSESSMENT SUMMAR WIND GENERATION	RY TABLE	
PROJECT TYPE	Offsh ore \	V ind
PROJECT LOCATION	Northem	, CA
BASE PLANT DE SCRIPTION	200 MW	1,000 MW
ESTIMATED CAPITAL AND O&M COSTS (Note 1)	_	-
BOP Project Capital Costs, 2022 \$MM (w/o Owner's Costs)	\$673.7	\$3,368.4
Wind Turbine Generators	\$224.84	1124.22
Substructure	\$213.93	1069.66
Port, Staging, Logistics, & Fixed Costs	\$7.62	38.11
Turbine Install	\$25.46	127.32
Substructure Install	\$13.34	66.69
Array Cabling	\$47.6	238.18
Export Cable	\$77.4	387.16
Onshore Spur Line	\$13.5	67.56
EPC Fee (8%)	\$49.90	249.51
EFC Fee (670)	φ49.90	249.51
Owner's Costs Without Contingency, 2022 \$MM	\$67.4	\$336.9
Development Development	\$24.1	120.39
Lease Price	\$15.24	76.22
Project Management	\$12.5	62.36
Insurance during Construction	\$7.8	38.98
Project Completion	\$7.8	38.98
Trojoc completion	V 1.5	00.00
Subtotal - Capital Costs, 2022 \$MM	\$741.1	\$3,705.3
Procurement Contingency	\$36.6	182.75
Installation Contingency	\$13.5	67.56
	*	
Total - Owner's Costs With Contingency, 2022 \$MM	\$791.1	\$3,955.6
CAPEX, 2022 \$MM	\$791.13	\$3,955.63
Total Screening Level Project Costs, 2022 \$/kW	\$3,955.63	\$3,955.63
Demolition Costs (end of life cycle) 2022 \$MM	\$31.65	\$158.23
O&M Cost, 2022 \$MM/yr	\$20.6	\$103.0
O&M Cost, 2022 \$/kW-yr	\$103.0	\$103.0
Notes		
Note 1. Capital Costs are over-night & don't include financing costs		

A - 6

PROJECT TYPE	Offshore \	Mind
PROJECT LOCATION	Northem	, CA
BASE PLANT DE SCRIPTION	200 MW	1,000 MW
ESTIMATED CAPITAL AND O&M COSTS (Note 1)		
BOP Project Capital Costs, 2022 \$MM (w/o Owner's Costs)	\$673.7	\$3,368.4
Wind Turbine Generators	\$224.84	1124.22
Substructure	\$213.93	1069.66
Port, Staging, Logistics, & Fixed Costs	\$7.62	38.11
Turbine Install	\$25.46	127.32
Substructure Install	\$13.34	66.69
Array Cabling	\$47.6	238.18
Export Cable	\$77.4	387.16
Onshore Spur Line	\$13.5	67.56
EPC Fee (8%)	\$49.90	249.51
21 01 00 (070)	ψ+0.50	2.0.01
Owner's Costs Without Contingency, 2022 \$MM	\$67.4	\$336.9
Development	\$24.1	120.39
Lease Price	\$15.24	76.22
Project Management	\$12.5	62.36
Insurance during Construction	\$7.8	38.98
Project Completion	\$7.8	38.98
Subtotal - Capital Costs, 2022 \$MM	\$741.1	\$3,705.3
Procurement Contingency	\$36.6	182.75
Installation Contingency	\$13.5	67.56
Total - Owner's Costs With Contingency, 2022 \$MM	\$791.1	\$3,955.6
CAPEX, 2022 \$MM	\$791.13	\$3,955.63
Total Screening Level Project Costs, 2022 \$/kW	\$3,955.63	\$3,955.63
Demolition Costs (end of life cycle) 2022 \$MM	\$31.65	\$158.23
O&M Cost, 2022 \$MM/yr	\$20.6	\$103.0
O&M Cost, 2022 \$/kW-yr	\$103.0	\$103.0

A - 7 Energy Storage: Li-Ion

TECHNOLOGY		Lithium-ion batteries (Li-lon)	
BASE PLANT DESCRIPTION, MW	200	200	1000
Nel Plant Output kW	200,000	500,000	1,000,000
Capacity, hours	4	4	4
Design Life (Assuming 365 Cycles per Year)	20	20	20
Round Trip Efficiency (AC AC)	83%	83%	83%
Estimated Armual Throughput (MWh) (80% Max Discharge)	960'69	147,740	295,480
kWh	800,000	2,000,000	4,000,000
FSTIMATED CAPITAL AND ORM COSTS (Note 7)			
Storage Block (Note 1)	\$132.00	\$321.62	\$630.64
Slorage BOS (Note 2)	\$30.40	\$74.75	\$146.60
	512.60	\$28.55	\$54.40
Controls & Communication (Note 4)	80.30	\$0.58	\$1.12
System Integration (Note 5)	\$34.40	\$85.55	\$167.80
Engineering, Procurement & Construction (Note 6)	241.60	\$101.82	\$199.68
Project Development (Note 7)	550.40	\$125.78	\$239.60
Grid Integration (Note 8)	63.48	38.36	672.70
EPC Markup (5%)	\$15.28	\$37.35	\$12.19
EPC Project Capital Costs, 2022 \$MM (w/o Owner's Costs)	\$320.96	\$/84.39	51,528.5/
Land Acquisition	Description	pesse	eased
Owner's Project Development	PAC Provided	PAC Provided	PAC Provided
Owner's Project Management	PAC Provided	PAC Provided	PAC Provided
Owner's Lecal Costs	PAC Provided	PAC Provided	PAC Provided
Owner's Costs, 2022 \$MM	\$0.00	80.00	\$0.00
		22.46 - 0.12 (0.12) (0.12)	
Owner's Contingency (5%)	\$16.0481	\$39.2196	\$76.4285
Builders Risk Insurance (0.48%)	\$1.5406	\$3.7651	\$7.3371
Total Owners Costs With Contingency, 2022 \$MM	\$17.589	\$42.985	\$83.766
CAPEX, 2022 \$MM	\$338.55	\$827.38	\$1.612.33
Total Screening Level Project Costs, 2022 \$/kWh	\$423.19	\$413.69	\$403.08
CAPEX, 2022 SKW	\$1,692.75	\$1,654.75	\$1,612.33
Demolition Costs (end of life cycle) 2022\$/kW (Note 9)	\$24	\$24	\$24
O&M Cost 2020 MMS/or	97.85	89.068	540.31
Fixed O&M (Note 10)	58.46	\$20.68	\$40.31
Variable O&M	peprioui	Included	Included
Warranty	Included	Included	Included
O&M Cost, 2020 \$/kWdc-yr	\$42.32	\$41.37	\$40.31
1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	2021	207.0	2007.0
lifetime Cost (MAC)	0,00.2	1335 75	00 CP3C
CHEMINE COST (MINE)	0.400	1333.13	7047

A - 8 Energy Storage: Flow

TFCHNOI OGY		Flow Batteries	
BASE PLANT DESCRIPTION, MW	200	500	1000
Net Pant Output,kW	200,000	500,000	1,000,000
Capacity, hours	4	4	4
Design Life (Assuming 365 Cycles per Year)	75	25	25
Round Trip Efficiency (AC-AC)	%02	%02	%02
Estimated Annual Throughput (MWh) (80% Max Discharge)	49,840	124,600	249,200
kWh	800,000	2,000,000	4,000,000
ESTIMATED CAPITAL AND D&M COSTS (Note /)			
Storage Block (Note 1)	\$208.80	\$484.96	\$950.92
Storage BOS (Note 2)	\$41.60	\$99.34	\$190.20
Power Equipment (Note 3)	\$23.00	\$54.92	\$107.69
Centrols & Communication (Note 4)	\$0.30	SO 76	\$1.50
System Integration (Note 5)	\$38.40	\$38.23	\$187.44
Engineering, Procurement, & Construction (Note 6)	\$43.20	\$107.88	\$215.68
Project Levelopment (Note /)	\$54.40	\$130.20	\$248.00
Grd Integralion (Note 5)	\$4.00	00.016	\$20.00
EFC Mainup (3/0) EFC Mainup (3/0) EFC Mainup (3/0)	\$43.4 30	\$40.34	42 047 EA
EFC TOJECT Capital Costs, 2022 smm (W.O Owner s Costs)	4444.53	451.5.15	06,110,26
l and Acquisition	9	or o	pasea
Owner's Project Development	PAC Provided	PAC Provided	PAC Provided
Owner's Project Management	PAC Provided	PAC Provided	PAC Provided
Owner's Legal Costs	PAC Provided	PAC Provided	PAC Provided
Owner's Costs, 2022 \$MM	\$0.00	\$0.00	\$0.00
المكارية ومعانية من ماسيسان	621 7103	CA9 6266	£400 97E4
Reildere Diek Ineurance (0.4892)	42 1.1 195	67 6710	60,6870
Titlo	neon /#	01 10 48	4440 EE0
Total Owners Costs With Contingency, 2022 \$MIM	\$23.804	\$23.328	900.0TT¢
CAPEX, 2022 SMM	\$458.19	\$1 026 46	\$2 128 06
Total Screening Level Project Costs, 2022 5/kWh	\$5/2.74	\$91323	\$532.02
	\$2,290.95	\$2,052.92	\$2,128.06
Demolition Costs (end of life cycle) 2022\$/kW (Note 9)	834	\$33	233
O&M Cost, 2020 MMS'yr	\$12.88	\$27.42	\$54.99
Fixed O&M (Note 10)	\$11.45	\$25.56	\$53.20
Variable O&M	\$0.03	20.06	\$0.13
Warranty	\$1.40	\$1.69	\$1.66
O&M Cost, 2020 \$fkWdc-yr	\$64.40	\$54.83	\$54.99
Inflation Date (%) (Note 11)	250%	3.57%	2 50%
I fetimo Cost (MMt)	547 12	1186.79	2380 63
Chemine Cost (mms)	71.140	1.00.13	£303.03

A - 9 Energy Storage: Gravity

BESS GENERATION			
TECHNOLOGY		Gravity Batteries	
BASE PLANT DESCRIPTION, MW	200	200	1000
Net Plant Output,kW	200,000	200,000	1,000,000
Capacity, hours	*	4	4
Design Life (Assuming 365 Cycles per Year)	909	60	90
Round Trip Efficiency (AC-AC)	83%	83%	83%
Estimated Annual Throughput (MWh) (80% Max Discharge)	960'65	147,740	295,480
kWh	000'008	2,000,000	4,000,000
FSTIMATED CAPITAL AND D&M COSTS (Note 7)			
Storage Block (Note 1)	\$305.30	\$680.98	\$788.00
Storage BOS (Note 2)	\$182.07	\$455.18	PE UESS
Controls & Communication (Note 4)	\$0.00	\$0.00	20.00
System Integration (Note 5)	\$0.00	\$0.00	\$0.00
Engineering, Procurement, & Construction (Note 5) Project Development (Note 7)	\$97.47	\$231.80	\$288.00
Grid Integration (Note 8)			
CPC Markup (5%)	\$29.24	\$68.40	\$85.32
EPC Project Capital Costs, 2022 \$MM (w/o Owner's Costs)	\$614.09	\$1,436.36	\$1,791.66
action to A bare	posco	Posso	posco
Owner's Project Development	PAC Provided	PAC Provided	PAC Provided
Owner's Project Management	PAC Provided	PAC Provided	PAC Provided
Owner's Legal Costs	PAC Provided	PAC Provided	PAC Provided
Owner's Costs, 2022 SMM	\$0.00	\$0.00	\$0.00
Owner's Contingency (5%)	\$30,7043	\$71.8179	\$89.5829
Bulders Risk Insurance (0.48%)	\$2.9476	\$6.8945	\$8.6000
Total Owners Costs With Contingency, 2022 \$MM	\$33.652	\$78.712	\$90.103
	10.00	A. C. C.	****
Total Screening Level Project Costs, 2022 \$1kWh	\$647.74	/0.c1c,1g	\$472.46
	\$3,238.69	\$3,030.14	\$1,889.84
Demolition Costs (end of life cycle) 2022\$fkW (Note 9)	\$0.30	\$0.24	\$0.18
O&M Cost, 2020 MMS/vr	\$16.19	\$37.88	\$47.25
Fixed O&M (Note 10)	\$16.19	\$37.88	\$47.25
Variable O&M	Included	Included	pepnioni
Warranty	Included	Included	Included
O&M Cost, 2020 \$/kWdc-yr	\$80.97	\$75.75	\$47.25
Inflation Rate (%) (Note 11)	2.50%	2.50%	2.50%
Lifetime Cost (MMS)	1092.27	2418.75	3281.92
Annual Hotima Cost (Miletans)	24 05	0000	

A - 10 Energy Storage: Notes

Notes

Note 1. Storage Block includes the price for the most basic direct current (DC) storage element in an ESS (e.g., for lithium-ion, this price includes the battery module, rack, and battery management system, and is comparable to an electric vehicle (EV) pack price).

Note 2. Balance of System includes supporting cost components for the SB with container, cabling, switchgear, flow battery pumps, and heating, ventilation, and air conditioning (HVAC).

Note 3. Power Equipment includes bidirectional invertor, DC-DC converter, isolation protection, alternating current (AC) breakers, relays, communication interface, and software.

Note 4. Controls & Communication includes the energy management system for the entire ESS and is responsible for ESS operation. This may also include annual licensing costs for software. The cost is typically represented as a fixed cost scalable with respect to power and independent of duration.

Note 5. System Integration is the price charged by the system integrator to integrate subcomponents of a BESS into a single functional system. Tasks include procurement and shipment to the site of battery modules, racks with cables in place, containers, and power equipment. At the site, the modules and racks are containerized with HVAC and fire suppression installed and integrated with the power equipment to provide a turnkey system.

Note 6. EPC includes non-recurring engineering costs and construction equipment as well as shipping, siting and installation, and commissioning of the ESS. This cost is weighted based on E/P ratio.

Note 7. Project Development costs associated with permitting, power purchase agreements, interconnection agreements, site control, and financing.

Note 8. Grid Integration direct cost associated with connecting the ESS to the grid, including transformer cost, metering, and isolation breakers. For the last component, it could be a single disconnect breaker or a breaker bay for larger systems.

Note 9. Demo Costs include disconnection, disassembly/removal, site remediation, and recycle/disposal. Gravity Storage Demolition costs are for crane/building-based systems (i.e. Energy Vault).

Note 10. Fixed O&M prices for Lithium-Ion batteries includes estimated augmentation costs for the lifetime of the battery. Variable O&M is included in the fixed O&M for Li-Ion.

Note 11. Average inflation rates over the past decades have averaged 2.5% (US Federal Reserve)

Appendix A

A - 11 Solar + Energy Storage

PROJECT TYPE			SOLAR + ENERGY STORAGE		11
PROJECT LOCATION	Idaho Falls, ID	Lakeview, OR	Milford, UT	Rock Springs, WY	Yakima, WA
IASE PLANT DESCRIPTION	200 MW	200 MW	200 MW	200 MW	200 MW
ominal Output, MWac	200	200	200	200	200
ominal Output, MWdc	260	260	260	260	260
nnualized Energy Production, MWh (Yr 1)	456,760	483,552	529,104	489,439	423,894
C Capacity Factor at POI (%) (Note 1)	26.1%	27.6%	30.2%	27.9%	24.2%
vailability Factor, % (Note 2)	99%	99%	99%	99%	99%
ssumed Land Use, Acres (Note 2)	1600	1600	1600	1600	1600
V Inverter Loading Ratio (DC/AC)	1.30	1.30	1.30	1.30	1.30
V Degradation, %/yr (Note 2)	2nd year: 2%	2nd year: 2%	2nd year: 2%	2nd year: 2%	2nd year: 2%
	After 1st Year: 0.5% per year Mature	After 1st Year: 0.5% per ye Mature			
echnology Rating Permitting & Construction Schedule, year	Mature	Mature	Mature	Mature	Mature
STIMATED PERFORMANCE				-	
lase Load Performance @ (Annual Average)					
Net Plant Output, kW	200,000	200.000	200.000	200,000	200,000
1. 3.00 (CELOSECTION)		7,774	2000000		- 777/50/50
STIMATED CAPITAL AND O&M COSTS					
PC Project Capital Costs, 2022 MM\$ (w/o Owner's Costs)	\$140.8	\$140.8	\$140.8	\$140.8	\$140.8
Modules	\$140.6 \$68.8	\$66.8	\$140.8 \$66.8	\$140.6 \$86.8	\$140.6
Inverter	\$8.0	\$8.0	\$8.0	\$8.0	\$8.0
Structural BOS	\$20.0	\$20.0	\$20.0	\$20.0	\$20.0
Electrical BOS	\$10.0	\$10.0	\$10.0	\$10.0	\$10.0
Installer OH (Labor Costs)	\$20.0	\$20.0	\$20.0	\$20.0	\$20.0
EPC OH (Equipment and Material)	\$10.0	\$10.0	\$10.0	\$10.0	\$10.0
EPC Markup	\$6.0	\$6.0	\$6.0	\$6.0	\$6.0
wner's Costs, 2022 MM\$	\$24.0	\$24.0	\$24.0	\$24.0	\$24.0
Engineering & Development OH	\$4.0	\$4.0	\$4.0	\$4.0	54.0
Transmission Line	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0
Pll (permitting fee, interconnection, commissioning)	\$8.0	\$8.0	\$8.0	\$8.0	\$8.0
Land Acquisition (Note 3)	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Owner's Project Development	\$10.0	\$10.0	\$10.0	\$10.0	\$10.0
Owner's Project Management	PAC to input values	PAC to input values			
Owner's Legal Costs	PAC to input values	PAC to input values			
ontingency and Insurance, 2022 MMS	\$5.5	\$5.5	\$5.5	\$5.5	\$5.5
Owner's Contingency (3%) (Note 4)	\$4.9	\$4.9	\$4.9	\$4.9	\$4.9
Builders Risk Insurance (.317%) (Note 4)	\$0.5	\$0.5	\$0.5	\$0.5	\$0.5
Total Screening Level Project Costs, 2022 MMS	\$170.3	\$170.3	\$170.3	\$170.3	\$170.3
otal Screening Level Project Costs, 2022 MM\$	\$170.3	\$170.3	\$170.3	\$170.3	\$170.3
tate Taxes (Note 4)	\$8.4	\$0.0	\$9.5	\$6.4	\$12.3
latance of Plant Materials and Products	\$7.25	\$0.0	\$8.27	\$6.44	\$10.57
abor and Services	\$1.20	\$0.0	\$1.2	0	\$1.75
APEX. 2022 MMS	\$178.71	\$170.27	\$179.74	\$176.71	\$182.59
ocation Adjusted CAPEX 2022 MM\$	\$175.14	\$178.78	\$174.35	\$178.47	\$188.07
otal Screening Level Project Costs, 2022 \$/kWdc	\$875.70	\$893.90	\$825.79	\$859.85	\$876.87
otal Screening Level Project Costs, 2022 \$/kWac	\$1,138.41	\$1,162.07	\$1,073.53	\$1,117.80	\$1,139.93
emolition Costs (end of life cycle) 2022 MM\$ (Note 5)	\$5.88	\$6.30	\$5.82	\$6.06	\$6.18
SM Cost, 2020 MMS/yr (Note 6)	54.2	54.2	\$4.2	84.2	\$4.2
Module cleaning	\$0.433	\$0.433	\$0.433	\$0.433	\$0,433
Vegetation and/or Pest Management	\$0.158	\$0.158	\$0.158	\$0.158	\$0.158
System inspection and monitoring	\$0.449	\$0.449	\$0.449	\$0.449	\$0.449
Component parts replacement	\$0.327	\$0.327	\$0.327	\$0.327	\$0.327
Module replacement	\$0.075	\$0.075	\$0.075	\$0.075	\$0.075
Inverter replacement	\$0.779	\$0.779	\$0.779	\$0.779	\$0.779
Land Lease	\$0.547	\$0.547	\$0.547	\$0.547	\$0.547
Property tax	\$0.433	\$0.433	\$0.433	\$0.433	\$0.433
Insurance	\$0.507	\$0.507	\$0.507	\$0.507	\$0.507
Asset management and security (Note 6)	\$0.410 \$0.057	\$0.410 \$0.057	\$0.410	\$0.410 \$0.057	\$0.410 \$0.057
Operations administration 8M Cost, 2020 \$/kWac-yr	\$0.057	\$0.057	\$0.057	\$0.057	\$0.057
an ever ever statem.ht	\$20.07	\$20.07	920.01	\$20.07	920.01
co-Located Energy Storage -200 MW x 4 hr Capacity					
Add-On Costs	20000000	0.0500	5300	100000	25555
Capital Costs, 2022 \$MM	\$325.83	\$307.5	\$328.4	\$323.6	\$333.4
Incremental O&M Cost, 2022 SMM/Yr	\$8.46	\$8.5	\$8.5	\$8.5	\$8.5

A - 12 Wind + Energy Storage

BASE PLANT DESCRIPTION 200 MW 200 MW 200 MW 200 MW ESTIMATED CAPITAL AND OAM COSTS 200 MW 200 M	TYPE			Onshore Wind + I	BESS	75
Section Sect		Pocatello, ID	Arlington, OR	Monticello, UT	Medicine Bow, WY	Goldendale, W/
BOP Project Capital Costs, 2022 \$MM (w/o Owner's Costs) \$263.1	ANT DESCRIPTION	200 MW	200 MW	200 MW	200 MW	200 MW
Wind Turbine Generators	ED CAPITAL AND O&M COSTS					
Wind Turbine Generators	ect Capital Costs, 2022 SMM (w/o Owner's Costs)	\$263.1	\$263.1	\$263.1	\$263.1	\$263.1
Met Mast			1895/57070		- A TE TANK (Sec.	\$175.00
Assembly & Installation Roads & Crane Pads O&M Bullding S1.1 S1.1 S1.1 S1.1 S1.1 S1.1 S1.1 S1.	Mast		\$1.05	\$1.05	\$1.05	\$1.05
Assembly & Installation S8.5.7 S9.4.9 S9	dations	\$14.19	\$14.19	\$14.19	\$14.19	\$14.19
Roads & Crane Pads S9.49	mbly & Installation					\$8.57
State Stat						\$9.49
Size		100000000000000000000000000000000000000	100000000000000000000000000000000000000	The Contract of	W. 2007000	\$1.1
SCADA		0.00000000	17000000		3,20,200	\$12.2
Switchgear/Substation (Note 2 & 3) \$15.9 \$15.9 \$15.9 \$4.92		0.0000000000000000000000000000000000000	11 10 10 10 10 10	200000000000000000000000000000000000000	1050000000	\$0.4
Step-Up Transformer & Interconnection (Note 4)			(X) = 0 (X)	10000000		\$15.9
Aircraft Detection Lighting System S0.90 S19.49 S		Q 70 (10 (10 (10 (10 (10 (10 (10 (700,700,00		Q2000000000000000000000000000000000000	\$4.92
Signar S		87398873777	51 70 00000			\$0.90
Owner's Costs Without Contingency, 2022 \$MM \$5.5 \$6.2 \$5.5 \$5.9 Project Design \$2.0 \$2.0 \$2.0 \$2.0 Owner's Engineer \$0.17 \$0.17 \$0.17 \$0.17 Land Lease & Development \$2.4		(A. T. C.	1.77.77.77.17	(A)(B)(7)(B)(1)	(7,715,77)	\$19.49
Project Design	ree (8%)	\$19.49	\$19.49	\$19.49	\$19.49	\$19.49
Owner's Engineer Land Lease & Development Permitting (Note 5) Wildlife Studies Eagle Take Permits Capital Spares Subtotal - Capital Costs, 2022 \$MM Owner's Contingency, 2022 \$MM Owner's Contingency, 2022 \$MM Capital Spares Subtotal - Costs With Contingency, 2022 \$MM State Taxes, \$MM (Note 6) Balance of Plant Materials and Products Labor and Services CAPEX, 2022 \$MM Cost, 2022 \$MM Cost, 2022 \$MM Own Cost, 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (Note 6) Subtotal - Costs (end of life cycle) 2022 \$MM (No		\$5.5	7777	17777	7,077	\$6.4
Land Lease & Development Permitting (Note 5) Wildlife Studies So.2 Eagle Take Permits Capital Spares Subtotal - Capital Costs, 2022 \$MM Owner's Contingency (5% of Capital Cost) State Taxes, \$MM (Note 6) Balance of Plant Materials and Products Labor and Services CAPEX, 2022 \$MM Subtotal - Capital Costs, 2022 \$MM Subtotal - Capital Costs State Taxes, \$MM State Taxes, \$MD State	ct Design					\$2.0
Permitting (Note 5) \$0.6 \$1.4 \$0.6 \$1.1 Wildlife Studies \$0.2 \$0.2 \$0.2 Eagle Take Permits \$0.09 Included in O&M Included in O&M Included in O&M Subtotal - Capital Costs, 2022 \$MM \$268.6 \$269.3 \$268.6 \$269.0 Owner's Contingency (5% of Capital Cost) \$13.4 \$13.5 \$13.4 \$13.5 Total - Costs With Contingency, 2022 \$MM \$282.0 \$282.8 \$282.0 \$282.5 State Taxes, \$MM (Note 6) \$14.7 \$0.0 \$14.3 \$14.7 Balance of Plant Materials and Products \$12.5 NA \$14.3 \$12.5 Labor and Services \$2.2 NA NA \$2.2 CAPEX, 2022 \$MM \$299.70 \$294.10 \$305.21 \$294.21 Total Screening Level Project Costs, 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 O&M Cost, 2022 \$MM/yr \$8.6 \$8.6 \$8.6 \$8.6 O&M Cost, 2022 \$MM/yr \$43.0 \$43.0 \$43.0 Co-Located Energy Storage - 4 hr Capacity	er's Engineer	\$0.17	\$0.17	\$0.17	\$0.17	\$0.17
Wildlife Studies S0.2 S0.09 S0.09 S0.09 Included in O&M Included in O&	Lease & Development	\$2.4	\$2.4	\$2.4	\$2.4	\$2.4
Eagle Take Permits Capital Spares Society	itting (Note 5)	\$0.6	\$1.4	\$0.6	\$1.1	\$1.6
Capital Spares Included in O&M Included in	ife Studies	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2
Subtotal - Capital Costs, 2022 \$MM Owner's Contingency (5% of Capital Cost) Total - Costs With Contingency, 2022 \$MM \$282.0 \$282.8 \$282.0 \$282.5 State Taxes, \$MM (Note 6) \$14.7 \$0.0 \$14.3 \$14.7 \$12.5 Balance of Plant Materials and Products Labor and Services \$2.2 NA \$14.3 \$12.5 NA \$12.5 NA \$22.2 CAPEX, 2022 \$MM Location Adjusted CAPEX 2022 \$MM \$299.70 \$294.10 \$305.21 \$294.21 Total Screening Level Project Costs, 2022 \$IkW \$1,498.51 \$1,470.50 \$1,526.07 \$1,471.07 \$11.89	e Take Permits	\$0.09	\$0.09	\$0.09	\$0.09	\$0.09
Owner's Contingency (5% of Capital Cost) \$13.4 \$13.5 \$13.4 \$13.5 Total - Costs With Contingency, 2022 \$MM \$282.0 \$282.8 \$282.0 \$282.5 State Taxes, \$MM (Note 6) \$14.7 \$0.0 \$14.3 \$14.7 Balance of Plant Materials and Products \$12.5 NA \$14.3 \$12.5 Labor and Services \$2.2 NA NA \$2.2 CAPEX, 2022 \$MM \$296.73 \$282.79 \$296.32 \$297.19 Location Adjusted CAPEX 2022 \$MM \$299.70 \$294.10 \$305.21 \$294.21 Total Screening Level Project Costs, 2022 \$/kW \$1,489.51 \$1,470.50 \$1,526.07 \$1,471.07 Demolition Costs (end of life cycle) 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 \$11.89 O&M Cost, 2022 \$MM/yr \$43.0 \$43.0 \$43.0 \$43.0 Co-Located Energy Storage - 4 hr Capacity \$43.0 \$43.0 \$43.0	al Spares	Included in O&M	Included in O&M	Included in O&M	Included in O&M	Included in O&N
Owner's Contingency (5% of Capital Cost) \$13.4 \$13.5 \$13.4 \$13.5 Total - Costs With Contingency, 2022 \$MM \$282.0 \$282.8 \$282.0 \$282.5 State Taxes, \$MM (Note 6) \$14.7 \$0.0 \$14.3 \$14.7 Balance of Plant Materials and Products \$12.5 NA \$14.3 \$12.5 Labor and Services \$2.2 NA NA \$2.2 CAPEX, 2022 \$MM \$296.73 \$282.79 \$296.32 \$297.19 Location Adjusted CAPEX 2022 \$MM \$299.70 \$294.10 \$305.21 \$294.21 Total Screening Level Project Costs, 2022 \$/kW \$1,489.51 \$1,470.50 \$1,526.07 \$1,471.07 Demolition Costs (end of life cycle) 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 \$11.89 O&M Cost, 2022 \$MM/yr \$43.0 \$43.0 \$43.0 \$43.0 Co-Located Energy Storage - 4 hr Capacity \$43.0 \$43.0 \$43.0	Capital Costs, 2022 \$MM	\$268.6	\$269.3	\$268.6	\$269.0	\$269.5
State Taxes, \$MM (Note 6) \$14.7 \$0.0 \$14.3 \$14.7 Balance of Plant Materials and Products \$12.5 NA \$14.3 \$12.5 Labor and Services \$2.2 NA NA \$2.2 CAPEX, 2022 \$MM \$296.73 \$282.79 \$296.32 \$297.19 Location Adjusted CAPEX 2022 \$MM \$299.70 \$294.10 \$305.21 \$294.21 Total Screening Level Project Costs, 2022 \$/kW \$1,496.51 \$1,470.50 \$1,526.07 \$1,471.07 Demolition Costs (end of life cycle) 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 \$11.89 O&M Cost, 2022 \$MM/yr \$8.6 \$8.6 \$8.6 \$8.6 O&M Cost, 2022 \$/kW-yr \$43.0 \$43.0 \$43.0 Co-Located Energy Storage - 4 hr Capacity \$43.0 \$43.0						\$13.5
State Taxes, \$MM (Note 6) \$14.7 \$0.0 \$14.3 \$14.7 Balance of Plant Materials and Products \$12.5 NA \$14.3 \$12.5 Labor and Services \$2.2 NA NA \$2.2 CAPEX, 2022 \$MM \$296.73 \$282.79 \$296.32 \$297.19 Location Adjusted CAPEX 2022 \$MM \$299.70 \$294.10 \$305.21 \$294.21 Total Screening Level Project Costs, 2022 \$/kW \$1,496.51 \$1,470.50 \$1,526.07 \$1,471.07 Demolition Costs (end of life cycle) 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 \$11.89 O&M Cost, 2022 \$MM/yr \$8.6 \$8.6 \$8.6 \$8.6 O&M Cost, 2022 \$/kW-yr \$43.0 \$43.0 \$43.0 Co-Located Energy Storage - 4 hr Capacity \$43.0 \$43.0		200200	New-2004	PER GARAGE	2010 to 1	22222
Balance of Plant Materials and Products \$12.5 NA \$14.3 \$12.5 Labor and Services \$2.2 NA NA \$2.2 CAPEX, 2022 \$MM \$296.73 \$282.79 \$296.32 \$297.19 Location Adjusted CAPEX 2022 \$MM \$299.70 \$294.10 \$305.21 \$294.21 Total Screening Level Project Costs, 2022 \$kW \$1,496.51 \$1,470.50 \$1,526.07 \$1,471.07 Demolition Costs (end of life cycle) 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 \$11.89 O&M Cost, 2022 \$MM/yr \$8.6 \$8.6 \$8.6 \$8.6 O&M Cost, 2022 \$M/W-yr \$43.0 \$43.0 \$43.0	sts With Contingency, 2022 \$MM	\$282.0	\$282.8	\$282.0	\$282.5	\$283.0
Labor and Services \$2.2 NA NA \$2.2 CAPEX, 2022 \$MM Location Adjusted CAPEX 2022 \$MM Total Screening Level Project Costs, 2022 \$/kW Demolition Costs (end of life cycle) 2022 \$MM (Note 6) Self. 43.0	es, \$MM (Note 6)	\$14.7	\$0.0	\$14.3	\$14.7	\$21.5
CAPEX, 2022 \$MM Location Adjusted CAPEX 2022 \$MM Location Adjusted CAPEX 2022 \$MM \$299.70 \$299.70 \$294.10 \$305.21 \$294.21 \$294.21 \$294.21 \$294.21 \$294.21 \$1,470.50 \$1,526.07 \$1,471.07 Demolition Costs (end of life cycle) 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 \$11.89 \$11.89 \$11.89 \$14.89 \$11.89	Plant Materials and Products	\$12.5	NA	\$14.3	\$12.5	\$18.3
Section Adjusted CAPEX 2022 \$MM \$299.70 \$294.10 \$305.21 \$294.21	Services	\$2.2	NA	NA	\$2.2	\$3.2
Total Screening Level Project Costs, 2022 \$/kW \$1,498.51 \$1,470.50 \$1,526.07 \$1,471.07 Demolition Costs (end of life cycle) 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 \$11.89 \$11.89 \$0.8M Cost, 2022 \$MM/yr \$8.6 \$8.6 \$8.6 \$8.6 \$8.6 \$43.0 \$43.0 \$43.0 \$43.0 \$543.0 \$43.0 \$543.	022 \$MM	\$296.73	\$282.79	\$296.32	\$297.19	\$304.46
Demolition Costs (end of life cycle) 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 O&M Cost, 2022 \$MM/yr \$8.6 \$8.6 \$8.6 O&M Cost, 2022 \$/kW-yr \$43.0 \$43.0 \$43.0 Co-Located Energy Storage - 4 hr Capacity \$43.0 \$43.0 \$43.0	Adjusted CAPEX 2022 \$MM	\$299,70	\$294.10	\$305.21	\$294.21	\$310.55
Demolition Costs (end of life cycle) 2022 \$MM (Note 6) \$11.89 \$11.89 \$11.89 O&M Cost, 2022 \$MM/yr \$8.6 \$8.6 \$8.6 O&M Cost, 2022 \$/kW-yr \$43.0 \$43.0 \$43.0 Co-Located Energy Storage - 4 hr Capacity \$43.0 \$43.0 \$43.0	ening Level Project Costs, 2022 \$/kW	\$1,498,51	\$1,470,50	\$1,526,07	\$1,471,07	\$1,552,76
O&M Cost, 2022 \$/kW-yr \$43.0 \$43.0 \$43.0 \$43.0 \$43.0 \$43.0					\$11.89	\$11.89
O&M Cost, 2022 \$/kW-yr \$43.0 \$43.0 \$43.0 \$43.0 \$43.0 \$43.0	† 2022 \$MM/vr	\$9. c	\$9.6	\$8.5	\$9. c	\$8.6
Co-Located Energy Storage - 4 hr Capacity						\$43.0
	ware dutte le	9 10.0	\$10.0	970.0	910.0	470.0
	ed Energy Storage - 4 hr Canacity					
Add-On Costs						
Capital Costs. 2022 SMM \$318 \$301 \$321 \$317		\$219	\$301	\$321	\$317	\$326
Capital Costs, 2022 SMM/Yr \$3.10 \$301 \$3521 \$3517 Incremental O&M Cost, 2022 \$MM/Yr \$8.46 \$8.46 \$8.46			(7,7,7,7)	0.5000000000000000000000000000000000000	2.500.000	\$8.46

Notes

Note 1. 20 MW Substation assumes: Tie in 230kV line through three disconnects, a single 230kV breaker connection, & a 1200A, 34.5kV GIS switchgear housed in a building.

Note 2. 200 MW Substation assumes: Three breaker ring 230kV AIS switchgear & (2) 2500A, 34.5kV GIS switchgear housed in a building.

Note 3. 20 MW Plant assumes (1) 30 MVA (230 kV/34.5 kV) transformer & 200 MW Plant assumes (2) 125 MVA (230 kV/34.5 kV) transformer. I one mile interconnection tie line is assumed for both

Note 4. Permitting cost assumes the permitting matrix from the 2022 PacifiCorp All-Source RFP is utilized.

Note 5. State Tax information provided by PacifiCorp.

Note 6. Reclamation costs included in Demolition costs. Demolition costs are seen as an optional end-of-life cost, as other options like repowering the plant are available.

Appendix A

A - 13 Wind + Solar + Energy Storage

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PROJECT TYPE			IND + SOLAR + ENERGY STORAG		
PROJECT LOCATION BASE PLANT DESCRIPTION	Idaho Falls, ID 200 MW	Lakeview, OR 200 MW	Milford, UT 200 MW	Rock Springs, WY 200 MW	Yakima, WA 200 MW
Nominal Output, MWac	200 844	200 MW	200 MW	200 MW	200 MW
Nominal Output, MWdc	260	260	260	260	260
Annualized Energy Production, MWh (Yr 1)	456,760	483.552	529.104	489.438	423.894
AC Capacity Factor at POI (%) (Note 1)	26.1%	27.6%	30.2%	27.9%	24.2%
Availability Factor, % (Note 2)	99%	99%	99%	99%	99%
Assumed Land Use, Acres (Note 2)	1600	1600	1600	1600	1600
PV Inverter Loading Ratio (DC/AC)	1.30	1.30	1.30	1.30	1.30
PV Degradation, %/yr (Note 2)	2nd year: 2%	2nd year: 2%	2nd year: 2%	2nd year: 2%	2nd year: 2%
	After 1st Year 0.5% per year	After 1st Year: 0.5% per			
Technology Rating	Mature	Mature	Mature	Mature	Mature
Permitting & Construction Schedule, year	2	. 2		2	2
ESTIMATED PERFORMANCE					
Base Load Performance @ (Annual Average)				200.000	
Net Plant Output, kW	200,000	200,008	200,000	290,808	200,000
ESTIMATED CAPITAL AND O&M COSTS	÷				
THE RESIDENCE OF THE PARTY OF T					
EPC Project Capital Costs, 2022 MM\$ (w/o Owner's Costs)	\$140.8	\$140.8	5140.8	\$140.8	\$140.8
Modules	\$66.8	\$66.8	\$66.8	\$66.8	\$66.8
Invertor	\$8.0	\$8.0	\$8.0	\$8.0	\$8.0
Structural BOS	\$20.0	\$20.0	\$20.0	\$20.0	\$20.0
Electrical BOS	\$10.0	\$10.0	\$10.0	\$10.0	\$10.0
Installer OH (Labor Costs)	520.0	\$20.0	\$20.0	\$20.0	\$20.0
EPC OH (Equipment and Material) EPC Markup	\$10.0	\$10.0 \$6.0	\$10.0	\$10.0	\$10.0 \$6.0
Erc minut	\$6.0	\$6.0	36.0	36.0	36,0
Owner's Costs, 2022 MMS	\$24.0	\$24.0	\$24.0	\$24.0	\$24.0
Engineering & Development OH	\$4.0	\$4.0	\$4.0	\$4.0	54.0
Transmission Line	\$2.0	\$2.0	\$2.0	\$2.0	\$2.0
Pll (permitting fee, interconnection, commissioning)	\$8.0	\$8.0	\$8.0	\$8.0	\$8.0
Land Acquisition (Note 3)	\$0.0	\$0.0	\$0.0	50.0	\$0.0
Owner's Project Development	\$10.0	\$10.0	\$10.0	\$10.0	\$10.0
Owner's Project Management	PAC to input values	PAC to input values	PAC to input values	PAC to input values	PAC to input values
Owner's Legal Costs	PAC to input values	PAC to input values	PAC to input values	PAC to input values	PAC to input values
Contingency and Insurance, 2022 MM\$	\$5.5	\$5.5	\$5.5	\$5.5	\$5.5
Owner's Contingency (3%) (Note 4)	84.9	54.9	\$4.9	54.9	54.9
Builders Risk Insurance (.317%) (Note 4)	\$0.5	\$0.5	\$0.5	\$0.5	\$0.5
	1000		177	1555	1777
Total Screening Level Project Costs, 2022 MMS	\$170.3	\$170.3	\$170.3	\$170.3	\$170.3
State Taxes (Note 4)	\$8.4	50.0	\$9.5	\$6.4	\$12.3
Balance of Plant Materials and Products	\$7.25	\$0.0	58.27	\$6.44	\$10.57
Labor and Services	\$1.20	\$0.0	\$1.2	0	\$1.75
CAPEX, 2022 MMS	\$178.71	\$170.27	\$179.74	5176.71	\$182.59
Location Adjusted CAPEX 2022 MMS	\$175.14	\$178.78	\$174.35	5178.47	5188.07
Total Screening Level Project Costs, 2022 SrkWdc	\$875,70	\$893.90	\$825.79	\$859.85	\$876.87
Total Screening Level Project Costs, 2022 SikWac Demolition Costs (end of life cycle) 2022 MM\$ (Note 5)	\$1,138.41 \$5.88	\$1,162.07 \$6.30	\$1,073.53 \$5.82	\$1,117.80 \$6.06	\$1,139.93 \$6.18
Demonstrate Coars fains of the cycles 2022 mais frace si	33,00	\$6.50	*5.62	30.00	90.10
D&M Cost, 2020 MM5/yr (Note 6)	\$4.2	\$4.2	\$4.2	\$4.2	54.2
Module cleaning	\$0.433	\$0.433	\$0.433	\$0,43,3	\$0,433
Vegetation and/or Pest Management	\$0.158	\$0.158	\$0.158	\$0.158	\$0.158
System inspection and monitoring	\$0.449	\$0.449	\$0.449	50.449	\$0.449
Component parts replacement	50.327	\$0.327	\$0.327	\$0.327	\$0,327
Module replacement	\$0.075	\$0.075	\$0.075	\$0.075	\$0.075
Inverter replacement	\$0.779	50.779	\$0.779	\$0.779	\$0.779
Land Lease	\$0.547	\$0.547	\$0.547	\$0.547	\$0.547
Property tax	\$0.433	\$0.433	\$0.433	\$0.433	50:433
Insurance	\$0.507	\$0.507	\$0.507	50.507	\$0.507
Asset management and security (Note 6)	\$0.410	\$0.410	50.410	\$0.410	\$0.410
Operations administration D&M Cost, 2020 SikWac-yr	\$0.057 \$20.87	\$0.057 \$20.87	\$0.057 \$20.87	\$0.057 \$20.87	\$0.057 \$20.87
Jam Luss, 2020 Sikwat-yr	\$20.87	520.87	920.87	52U.87	\$20.87
Co-Located Energy Storage -200 MW x 4 hr Capacity					
Add-On Costs	2010 Aug 2010 I				20011279
Capital Costs, 2022 \$MM	\$325.83	\$307.5	\$328.4	\$323.6	\$333.4
Incremental O&M Cost, 2022 \$MM/Yr	\$8.46	\$8.5	\$8.5	\$8.5	\$8.5
	Section		8,750		07800
Co-Located Energy Storage - 200 MW x 4 hr Capacity+200 MW Wind					
Add-On Costs	8.750,00040	99000000	0.00000	D-9204/80.00	2293771
Capital Costs, 2022 \$MM	\$599.22	\$575.9	\$606.9	\$591.9	\$616.6
Incremental O&M Cost, 2022 SMM/Yr	\$17.06	\$17.06	\$17.06	\$17.06	\$17.06

Notes
Note 1. Solar capacity factor supplied by PAC.
Note 2. Base plant descriptions provided by PAC.
Note 3. Land is assumed to be leased throughout the project lifetime and is thus included in yearly DAM values.
Note 4. State Tax rates provided by PAC.
Note 5. Demolition costs are seen as an optional end-of-life cost, as other options like repowering the plant are available.
Note 6. Third party long-term service agreement costs are included in the asset management and security line item.

APPENDIX

B - TECHNICAL PARAMETERS

B-1 Energy Storage Technical Parameters

3GY STORAGE - KE	ENERGY STORAGE - KEY TECHNICAL PARAMETERS BY TECHNOLOGY Brancies Liston Teles			njanetra	CASS
	H-Hou		1		Q.
Power capabby, minimum, manaimum (zabk), spirinling reserve	power amwersion unit, There is no power assets of JUNN's ser power amwersion unit, There is no technical limit to the number of which improved a power of the power of the power is which improved seed opens, a "violat global queen to the man power function is inherent, augment of the function to the man power of the power of the power of the power of the power of the designal to support it (privately up to \$25% of state) unemer at designal to support it (privately up to \$25% of state) unemer at designal to support it (privately up to \$25% of state) unemer at chance of the power of the power of the power of the power one of the innerse based systems can provide poliming states a capability without the efficiency loss and the cost of using extra huse	power conversion unit. There are nethrical links to the number of power conversion unit. There are nethrical links to the number of power conversion unit. There are nethrical links to the number of power conversion and conversed in the major in the power and the converse of the number of power and the converse of the number of the number of power and the converse of the number	The basic dover Block has pressery of 3 MW. 300MW. spinning reserve appaising in our between that as innimenter-based spiem it? espected to be versibles. The speam is supprise year long duration. you to 100 fm.).	The annument of setting the content of the content	Componented Air Tearn's florates in the restrict schooling, with several commercial grounding and according from the restrict schooling from the component of the schooling from the component of the schooling from the component of the schooling from the schooling from the component of the schooling from the schooling
Max system power capacity (if applicable, e.g., if there is a limit to the number of paralleled PGS model.	There is no secholical limit to the number of PCS units that can be parelled, within the range of existing power plant output, capacities	There is no rethnical limit to the number of PGS units that can be I paralleled, within the range of existing power plant output cassetities	There is no technical limit to the number of Power Block units that can be paralleled, within the range of a suisting power plant output capacities	There is no technical limit to the number of mechanically or hydroulically-driven generator units that can be parailleled, within the by more of existing power plant output capacities	Thee is no architical limit to the number of turbagenerator units that can be saralleled, within the range of existing power plant output capacities
Voltage/phase	The ministy of Power Cenverion Systems (bi-directional insurement) benefit insured in the insuring in a 180% of resident 2-space. Many PCS systems also have built-in transformer allowing interconnection at medium voltage (e.g. 13 8kV)	The majority of Power Convention Systems (by directional inveners) has been extended as a SIROAC in Selection of Many PCS options also have built-in transformer allowing interconnection at medium votage (e.g. 13.8%)	to information available, expected to be similar to inthe inverte-channel FIX systems.	identity systems use standard industrial/power plant generators shat Cyptently have meeti mescritings evention original (E-1540). Suphase in systems (E-1540).	CAS systems use standard industrial/pover plant generators designed for morine apprications, which apprecially have madissmoothage terminal number [E-ISM), 3-space.
Energy storage capacity for a base unit/minimal functional system size (calable by using mutiple units)	Typicaly ranges from 250kWh to 4 MWh	Typically rengas from 22kWh to 1 MWh.	SSOMWIN	25-20AMMA	Plac OLE plants have been operating at low capacities but a commercially betable CLB hallies currently under development are in the 1000MHr, reseable CLB hallies currently under development are in the 1000MHr. Therefore category (such as PGBE 5 no loaquin CLBs, a 3000MH/UDPy. The existing CLB system uses a scalable, but not modular technology with regret, to their energy stange component.
Max system energy storage copacity le.g., if there is a limit to the number of paralleled ES units)	There is no technical limit to the number of energy storage units that can be paralleled	There is no activated limit to the number of energy storage units. If that can be paralleled	There is no rechnical limit to the number of energy of storage units that can be paralleled	here is no technical limit to the number of energy storage units that T an be pecalished	The E is no achnical limit to the capacity of compressed at energy stonge, within the misting range of power plant capacities
Requires from standby (cold stby, i applicable to specific technology) to 100%	en (necessariue)	of 5 age	Mainformation available, egented to be similer to. White inverter-based ESS systems; however the ramp pare is unknown.	We waithule, technically partitle to match bettery-based technology if serformatice	60.400 are depending on the compressor and expander utilised
Response time: from 100% charging input to 100% output	~2 sec (200 ms in frequency response applications)	-22sc	Vo information available; expected to be similar to other inverter-based ESS systems; however the ramp pate a unknown.	Not available, technically possible to match battery-based technology of performance	60-900 sec depending on the compressor and expander utilized
C-rate range	116		availebile.	bata not available. Typically designed for long duration applications (4-16): !++ hrz, or 25C 125C).	Data not available. Depends on the ratio of storage us compressor/expander capacity. Typically designed for long duration applications [5-10++ hrs., or .2C1C]
C-curve for charging and discharging	Charging capacity is linear 10% true SOC and 75-90% (depending on cell chemistry) true SOC, symptostically islowing above that mage, leading to the practical SOC range not uning the full physical SOC range not uning the full physical SOC range.	<.15 Linear for changing and discharging within full SOC mage	Vo information available	be not available. Charging and discharging casacity is expected to Case in the full SOC range.	Dan not available. Charging capacity is espected to be an Scurve, with platfacent developer from finener at the externer true SQC values. Libely mingsted by setting practical SQC ranges narrower than the true SQC range, similar to U-on bettery based anergy storage.
Round trip efficiency IAC in to AC out), excluding auxiliary loads	PNNL (istorical - 83%, vandor supplied data 91-94% (year 0, including therms) management loads); inventer-only: 98,3% arfull load	65% (Vn-RexOx, PMML); vendor supplied data 3/73%.	38% (at full power, including auxiliary loads and PCS E occas)	13% (PNN.), vendor supplied data - 81-92%	ION (eesi or; for A-CAES), 52% (PNNL, historical)
_	1-10% of name slate power depending on ambient conditions load and coling system efficiency	50% of nancplete power, depending on load	lo information available	bes not available, expected to be rignificantly lower than Li or flow C	Dat not available, expected to be lower than Li or Flow #ESS systems at recises no cooling or disclation pumps required. However, heat recovery for Ar-AKS system may introduce such loads.
Guaranteed system availability	Varies by vendor, "97% is typical	Deta not available	Vo information available	ata not available	Dets not available
_	136/year	41%/year	No information available	No vendor data available, articipated to be 0%/year	No vendor data aveilable, anticipated to be 0%/year
Cyding capacity degradation (assuming full charge-discharge cyce)	vendo data used in performance guarantess - on an average 2.2%/yar (including calendar degradation and cycling degradation as £ cycle per day)	No vendor deta available, anticipated to have low or no cycling of degradation (provided timely electrolyte exchange)	No information available, indirectly - warranty covers 10 years at 13 full cycles peryear	No vendor data available, articipated to be 0%/year	Novendor sits available, anticipated to be 0% year provised proper puromechinery 0&M
Design lifespan of the system essumine 365 cycles per yr.	16 yrs. (PNNL deta); vendor deta: 15-20 yrs.	12 yrs. (Vn-RedOX, PMNL); vendor deta - 50+ yrs.	Vo information available; indirectly - warranty covers is 10 years	endor data - 49+ yrs.	60 pt. (PNN.)
Fet	1FP -m. 3,000-4,000 Equivalent Full Cycles (without Incing more than 20% of initial capacity)	Listimited (with electrolyte and electrode replacement)	U.S.	Inlimited (with proper mechanical machinesy ORM)	Infinited (with proper turbome-hinery ORAS)
Major required cervice and maintenence required during the design lifespen of the system	Cupacity maintenance (adding battery resolute to congenerals for capacity degradation); coolant replacement (for liquid-cooled system)	Electrolyte replacement, scheduled replacement of electrolyte pump and velve components	Vs information syntable	Machanical maintenance (Uorication, bearing and Inlege service C att.); pump and turnine component replacement (for systems using a working field)	Conpressorant surbompander maintenance (Udirizant change, bearing service); circulation pumps and valves service (for A-CAES)