# Introduction and Purpose

## Assessment Introduction and Purpose:

The Long-Duration Energy Storage (LDES) Assessment will analyze how long-duration storage technologies that inject and withdraw energy could address some of the reliability issues seen in the 2020—2021 Study Program [2040 Clean Energy Scenarios Study](https://www.wecc.org/Administrative/2040%20Clean%20Energy%20Scenarios.pdf) and [the Variability in Loads and Resources](https://www.wecc.org/Administrative/VLR%20Final.pdf) Study. The former study identified some challenges in attaining a clean energy contribution to the generation mix exceeding 80 percent in the Western Interconnection. For this follow-up assessment, WECC and the LDES Advisory Group will determine whether the identified challenges can be mitigated by employing clean LDES in the resource mix.

## Background

WECC’s Scenarios Work Group (SWG) conducted a series of assessments for horizon year 2040 as part of the 2020-2021 WECC Study Program. That 2040 Clean Energy Scenarios Study (CES) found a critical need for emerging clean energy technologies on the path to a 100% clean energy future. After the CES study report was published, WECC was approached by Strategen and Western Interstate Energy Board (WIEB) to determine whether WECC was interested in conducting a follow-up study focused on one or two emerging technologies that have extensive development support and funding.

## Assessment Leadership:

The LDES assessment will be led by WECC with Stan Holland of WECC as technical lead, Mike Bailey as SME and Kirha Quick as project manager. In addition, the LDES Advisory Group will provide technical guidance for the assessment.

## Key Reliability Questions:

The initial LDES assessment will focus on the key reliability questions listed below.

1. What performance characteristics (e.g., energy availability, peak availability, dispatchability, multi-day availability, recharging time, standby losses, storage losses), are needed for the portfolio of LDES resources to support 100% electric decarbonization?
2. Which LDES technologies could reasonably be expected to be commercially available within a 20-year planning horizon?
3. How would each of these technologies be expected to perform with respect to the preferred performance metrics?
4. How do flexibility needs change as the resource mix changes?

## Assessment Requirements:

To complete the analytical portion of this assessment specific tools and data are required as outlined below.

* **Tools**
* A production cost simulation tool to perform an hourly dispatch solution that matches resources and loads across the whole interconnection
  + Capacity expansion tools, to the extent that other organizations have the tools and are able to perform analysis for this assessment.
  + Other as-yet-unidentified modeling tools that may also be needed to understand more fully how LDES technologies might perform.
* **Models and Data**
  + An existing dataset (2040 Clean Energy Futures Assessment) that can be easily modified to study the key reliability questions.
  + Other data sets as needed to support other tools used in the analysis.
  + Models to represent each LDES technology that is considered.

## Assessment Approach

This assessment will evaluate specific technologies themselves and not infrastructure needed to support them (e.g., fuel transportation).

1. The first phase will address the first reliability question: What performance characteristics are needed for LDES technologies? The outcome of this phase will document the desired performance metrics for each technology considered.
2. In the second phase, the LDES team will develop study cases to model each of the LDES technologies selected for the analysis. The result of this phase will be modeling results that can be used to compare each of the technologies to predefined metrics.
3. The first and second phases of this work will result in a written analysis of the overall project.

## Suggested Performance Metrics

| Metric | Description |
| --- | --- |
| Dispatchability | Ability to change a resource’s output up or down within an hour to respond to changes in loads |
| Availability | Duration in hours or days during which the resource can be dispatched |
| Startup time | Time required to bring the resource from zero output to availability for dispatch to the BES |
| Ramping | The energy output rate (Mw/min) and duration (hours during which this rate can be sustained) |
| Minimum up/down times | Minimum time (hours) that a unit must be kept operating after starting it and the minimum time (hours) that a unit that us shut down must remain at zero output |
| Load following | A resource that can automatilcally increase or decrease its output in response to changes in load |
| Peak shaving or smoothing | A resource that can reduce maximum daily peak demand or reduce variations in hourly peaks |
| System Restoration | The time required to restore stable operation of the BPS after a partial or complete shutdown |
| Ancillary Services | Those services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation of the Transmission Service Provider's transmission system in accordance with good utility practice. |
| Degradation | The reduction of the maximum capacity of a battery energy storage system (BESS) over time as a result of repeated charging/discharging cycling |
| Maximum recharge rate | The maximum rate (Mw/hour) at which an energy storage resource can replace energy |
| Cost per MWH | The cost ($/Mwh) for either generating energy or delivering it to load |
| Cost per Installed MW | The capital cost ($/Mw) for producing energy with a generating resource including construction, permitting and other costs |
| Flexibility to variability ratio constraint | The ability of a resource to vary its output in response to changes in load, expressed as supply variability (Mw/min) divided by load variability (Mw/min) |

## Suggested Reporting Metrics:

| Metric | Description |
| --- | --- |
| Availability of “charging” resources | The period during which an energy storage system is available to provide energy, defined as the hours of supply at a specified Mw output. |
| Unserved load | Quantity (Mwh) and times (hours) when load cannot be served |
| Intrinsic/Extrinsic Value of LDES resources | Value of LDES resources beyond the energy production cost (e.g., the value of operational flexibility and the cost of load loss in the absence of operational flexibility). |
| Curtailment of variable energy resources (VER) | Quantity (Mwh) and times (hours) when VER must be curtailed |
| Locational Marginal Prices (LMP) | LMPs during the year including times when VER are curtailed. LMP is defined as the marginal cost of supplying the next Mw of demand. |
| Transmission Congestion | Constraints on the ability of a transmission system to carry the desired Mw flow. WECC reports locations and hours when transmission path flows are at 75%, 90% and 95% of their rated capacities (based on normal limits). |
| Seasonal Energy Arbitrage | Storing or producing energy during specific seasons of the year based on when prices for storing or producing are most favorable. |

## Project Plan:

| Study Task | Responsible Party | Duration |
| --- | --- | --- |
| **Project Initiation** | | |
| Create stakeholder advisory group | WECC staff | 2/15/22 – 4/25/22 |
| Develop study scope | WECC staff, LDESAG | 3/28/22 – 5/31/22 |
| Set meeting schedule | WECC staff, LDESAG | 4/1/22 – 5/31/22 |
| Determine assessment schedule | WECC staff, LDESAG | 4/1/22 – 5/31/22 |
| **Phase I – Performance Characteristics** | | |
| Select LDES technologies to be studied | LDESAG | 6/1/22 – 7/31/22 |
| Identify performance characteristics for LDES and CFT technologies | LDESAG | 6/1/22 – 7/31/22 |
| Collect data on performance characteristics for each technology | LDESAG | 6/1/22 – 7/31/22 |
| Begin drafting the written assessment, report to capture input assumptions. | LDESAG | 6/1/22 – 7/31/22 |
| **Phase II – Modeling** | | |
| Identify needed modeling tools and needed data | LDESAG | 6/1/22 – 8/31/22 |
| Create study cases | LDESAG | 6/1/22 – 8/31/22 |
| Complete study cases and checks | LDESAG | 9/1/22 – 12/31/22 |
| Complete written assessment that includes modeling and performance characteristics. | WECC staff, LDSAG | 1/02/23 – 1/31/23 |
| **Prepare for Publishing** | | |
| Tech edit | WECC staff | 2/1/23 – 2/28/23 |
| Review by Executive Team | WECC staff | 3/1/11/23 – 3/20/23 |
| Address Executive Team | WECC staff | 3/21/23 – 3/31/23 |
| Final publishing check points | Communications | 4/3/23 – 4/14/23 |
| Publish |  | 4/17/23 – 4/28/23 |