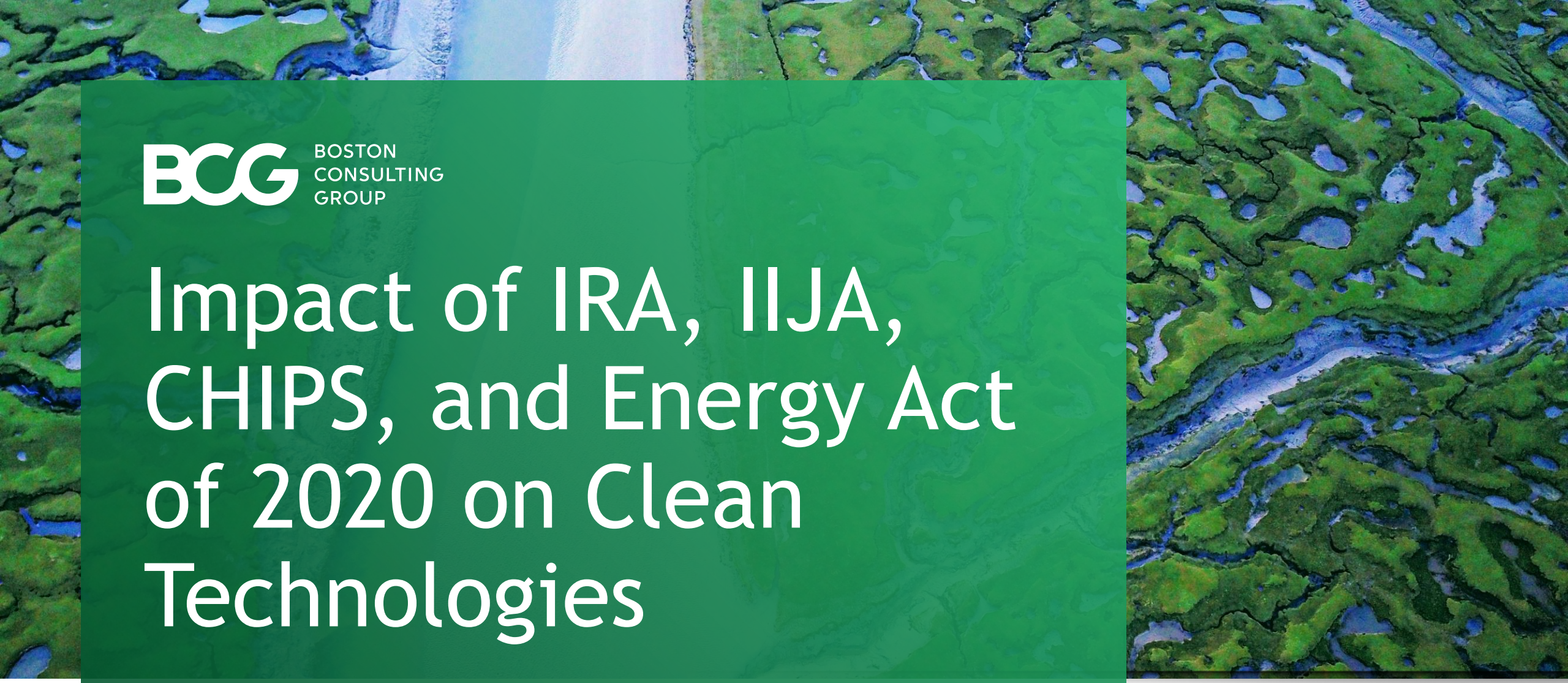


BOSTON CONSULTING GROUP

Impact of IRA, IIJA, CHIPS, and Energy Act of 2020 on Clean Technologies

Deep Dive | Long Duration Energy Storage

APRIL 2023

Background | Objectives and context of this work

Objective

- Explore impacts of recent legislation[1] on U.S. opportunity and remaining challenges for emerging clean technology deployment

Stakeholders involved

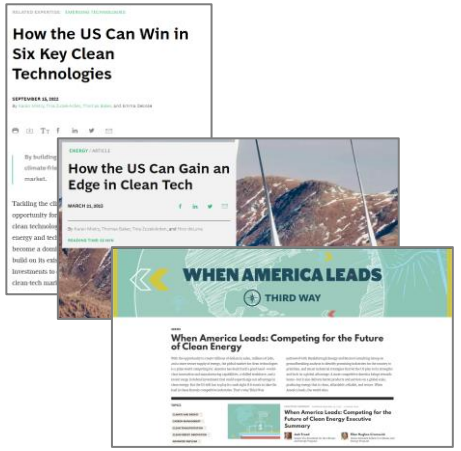
- Analysis was commissioned by Breakthrough Energy and Third Way, with input from stakeholders across the public and private sectors

Breakthrough Energy

THIRD WAY

Related publications

- BCG report | How the US Can Win in Six Key Clean Technologies
- BCG report | How the US Can Gain an Edge in Clean Tech
- Third Way publication | When America Leads: Competing for the Future of Clean Energy



1. Legislation assessed here includes Inflation Reduction Act (IRA), Infrastructure Investment and Jobs Act, CHIPS and Science Act, and the Energy Act of 2020
Source: BCG analysis

Electrochemical LDES | Executive Summary

- LDES is a nascent technology crucial for a zero-carbon grid, as it enables high levels of renewable deployment by providing reliability against multi-day weather events and scenarios which limit solar/wind generation
- While LDES deployments are limited today, new policies are projected to drive ~20 GW of LDES in the US by 2030 by addressing commercialization & demonstration challenges
- IRA & IIJA will significantly increase LDES deployments by supporting tech demonstrations through grant funding (~$500M for 10+ projects) and by increasing LDES demand due to improved project economics (from ITC for storage projects) and increased renewable deployments (from expanded ITC/PTCs for renewables)
- Expanded deployments are projected to drive unsubsidized costs from ~$3,400/kW today to ~$1,600/kW in 2030 as companies scale manufacturing to deploy commercial scale projects; this is projected to create 6k jobs and ~$3B in exports through 2030
- To further support LDES growth, the US should reform grid planning methodologies to enable monetization of LDES deployments which primarily act as reserve capacity. Along with continued RD&D support & renewables deployment, this would enable the US to fully decarbonize its grid and export LDES solutions abroad

1. Assuming each GW of LDES displaces 1 GW of natural gas peaker and ~1 Mt CO2e emitted per GW per year of natural gas peaker 2. Total # of positions created through 2050; incremental new jobs calculated as the sum of all non-negative one-year differences in # job-years (e.g., 2021 job-years minus 2020 job-years gives 2021 new jobs); incremental new jobs added to sum from prior period for cumulative calculation
Note: All numbers on lefthand side are based on projections from the IEA's 2021 Announced Pledges (APS) scenario for all value chain segments and are cumulative from 2020-50, except U.S. exports that only include prioritized segments (OEM, O&M).
Source: DOE, IEA, BCG Analysis

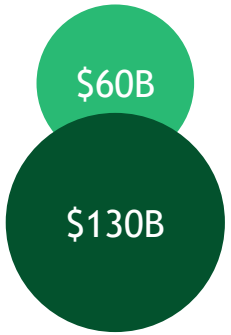
Recent US policies (e.g., IRA, IIJA) have significantly increased the projected size of accessible market, exports, and jobs within LDES

Impact of recent US policies (incl. IRA, IIJA) on cumulative market & job creation from 2020-2030

US domestic market

US cumulative domestic market through 2030 increased from ~$60B to ~$130B after IRA/IIJA due to increase in domestic deployments from storage ITC

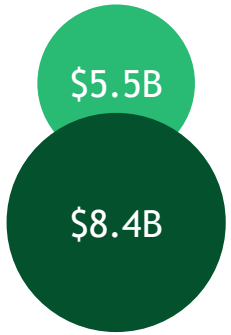
$B in market size



US exports

US cumulative exports through 2030 increased from $5.5B to $8.4B after IRA/IIJA due to expanded domestic manufacturing base and first mover advantage increasing US global competitiveness

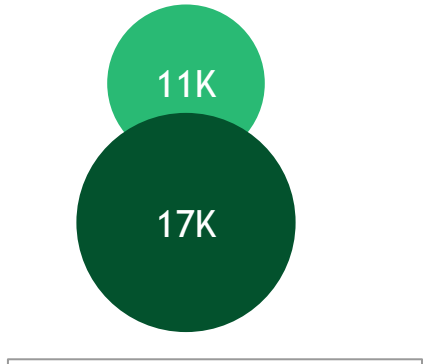
$B in exports



US job creation

New job creation in US LDES industry through 2030 increased from ~11k to ~17k after IRA/IIJA due primarily to increased domestic deployments

Number of jobs

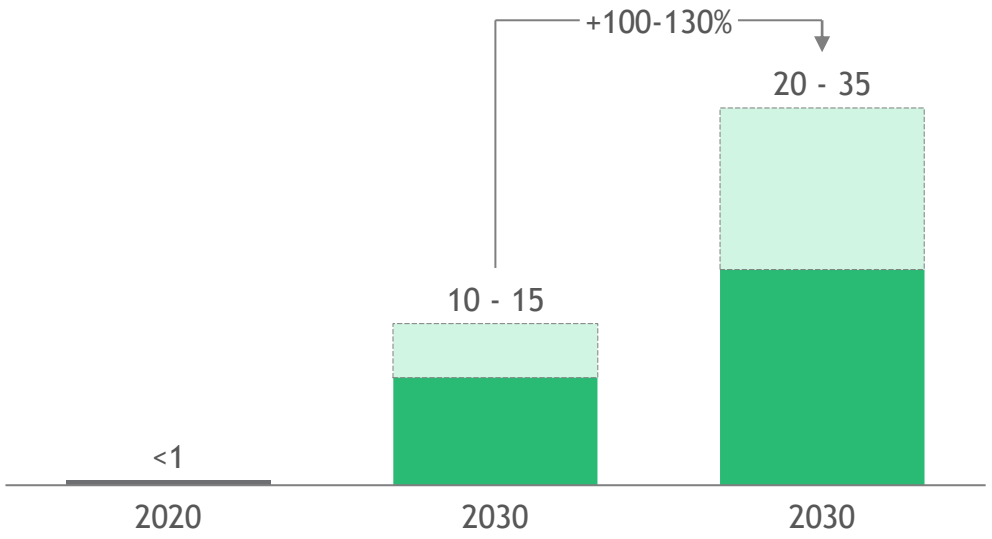


Note: All numbers based on IEA STEPS scenario based on change over timeframe from 2020-2035
Source: BCG analysis

Legislation impacts | Support for LDES to drive up to 130% increase in deployments by 2030 resulting in ~15% additional cost decline

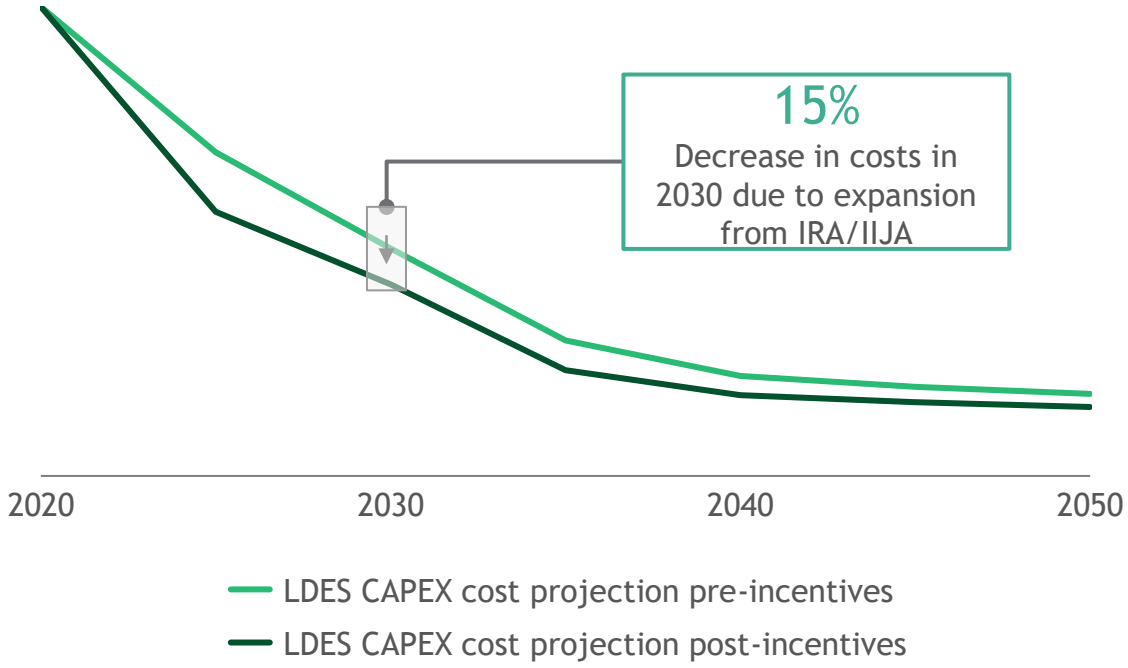
US LDES capacity to increase up to 130% due to IRA & IIJA support for storage and renewables

US cumulative 2030 LDES capacity (GW)



Growth in US and global deployments is expected to reduce LDES costs by ~15% by 2030

CAPEX cost of LDES ($/W)[1]

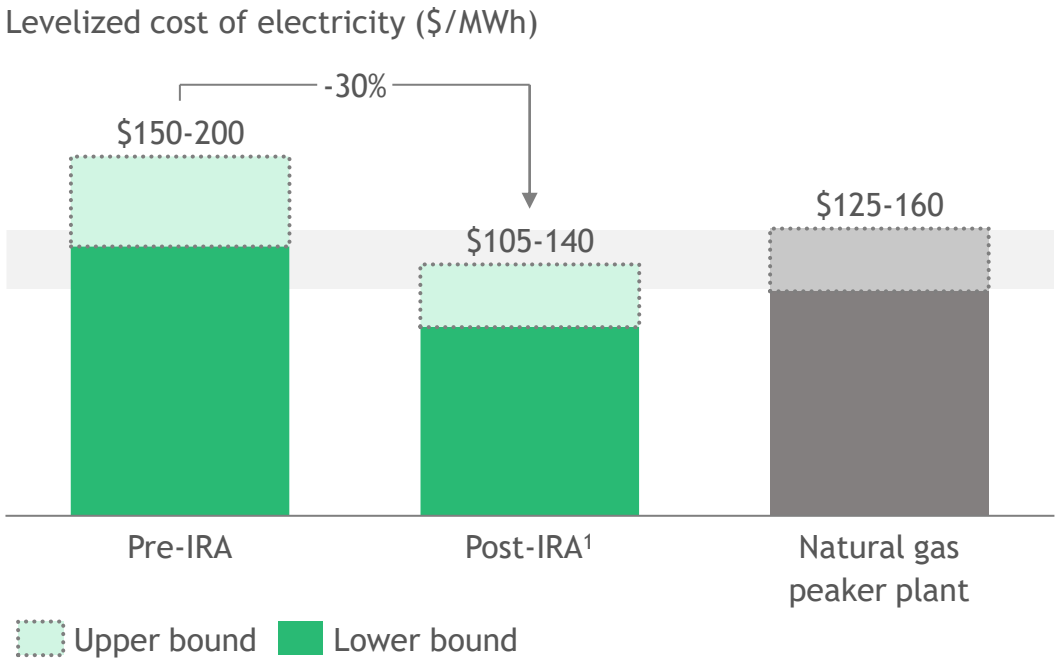


1. Assuming 20% learning rate for LDES (similar to Li ion) and deployments based on IEA projections of storage market
Note: 15% cost decline based on global deployments rather than just US deployments shown on left hand side
Source: IEA, NREL, BCG analysis

Legislation impacts | Standalone storage ITC from IRA and sizable funding pools from the IIJA are the key drivers of this market expansion

Standalone storage ITC significantly reduces costs, making LDES competitive with gas peaker plants

Prior ITC required storage to be paired with renewable generation to qualify. Support for standalone storage projects increases deployment potential and brings costs in line with natural gas peakers



~$8B in funding partially available for LDES from IIJA and CHIPS will support early commercial deployments

$7B

Program Upgrading Our Electric Grid and Ensuring Reliability and Resiliency
Provides grant funding to demonstrate innovative approaches to transmission, storage, and distribution infrastructure with some portion attributable to LDES

$0.5B

Energy storage demonstration projects
Provides grant funding for energy storage demonstration projects (~30% of funding attributable to LDES)

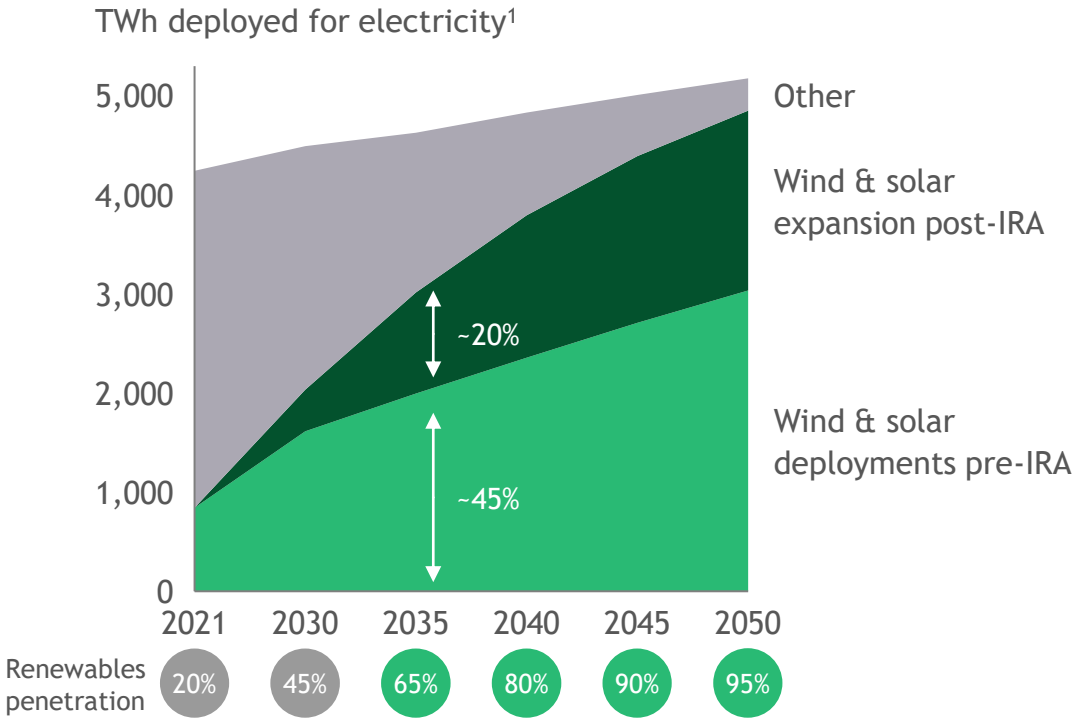
$0.6B

Basic Energy Science Program
Provides grant funding for foundational research in electricity storage systems (including LDES)

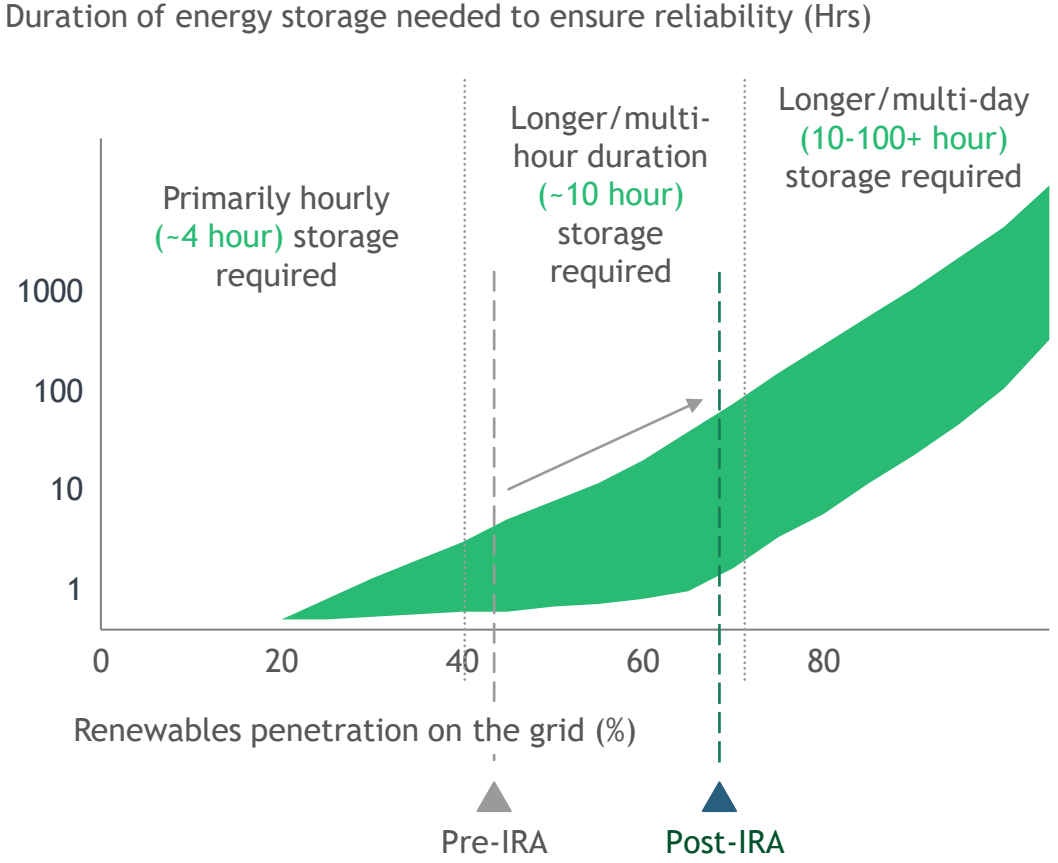
1. Incorporates both ITC for standalone storage and ITC for renewable power generation
Source: Lazard, LDES Council, IEA, BCG Analysis

Legislation impacts | Support for wind and solar projected to drive increased penetration of renewables on the US grid, further increasing demand for LDES

Tax credits for solar & wind projected to boost renewables penetration on the US grid by ~20% by 2035

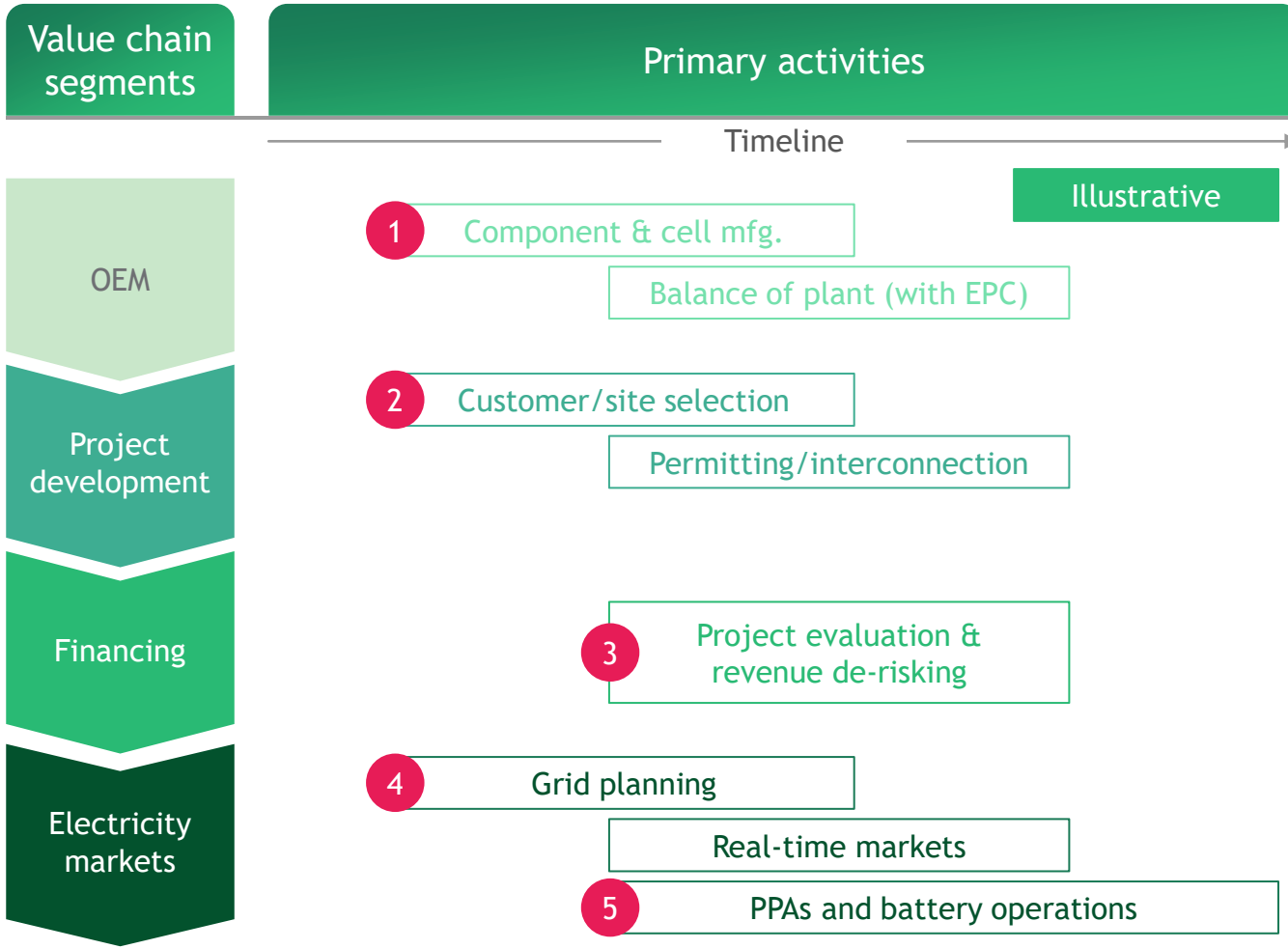


Increased penetration will further drive the need for LDES deployments to improve grid reliability



1. Based on IEA STEPS projections
Source: IEA, Albertus et al Joule (2020), Sepulveda et al Nature Energy (2021); BCG Analysis

Pre-legislation challenges | To support LDES deployment, several areas to be addressed to support monetization and stimulate demand



Key pre-IRA gaps to be addressed

1. LDES technologies remain more expensive than alternatives by a significant margin
2. Limited need for LDES for grid resiliency today; LDES not needed until renewables penetrations exceed ~50% of grid capacity
3. Lack of monetization mechanisms available to compensate LDES for providing >4 hours of storage
4. Insufficient tools for grid planning to optimize usage of LDES for resiliency
5. Few regulations/standards around definition of clean electricity, limiting need for storage to enable 24/7 PPA matching

Source: LDES Council; BCG Analysis

Remaining challenges | Recent legislation supports grid scale storage and renewables but additional policy is needed to accelerate deployment

	Pre-legislation priority challenges	Changes from recent legislation (IRA, IIJA, CHIPS, and EA 2020)	Remaining areas to target with future policies
OEM	1 High cost of LDES technologies relative to alternatives	• R&D funding for novel LDES techs in IIJA to drive down costs • Direct funding for commercial-scale LDES demo projects from IIJA	☆ LDES costs remain higher than Li ion or natural gas peakers with additional commercialization support needed to scale manufacturing and drive down costs
Project development	2 Limited need for LDES at low renewables penetration	• Expanded ITC/PTC for renewable generation technologies	☆ Need to stimulate demand for LDES in the near term through government procurement, LDES mandates, and other public policy tools
Financing	3 Lack of monetization mechanisms for LDES (esp. for reserve capacity)	• New, standalone storage ITC (30%)	☆ Tough to incentivize investment in LDES over Li ion since LDES is currently not appropriately compensated for its greater resilience by grid planning mechanics
Electricity markets	4 Insufficient tools for grid planning to maximize usage of LDES	• N/A	• Updated grid planning tools needed to optimally manage LDES resources on the grid as renewables penetration increases
	5 Few regulations/standards around definition of clean electricity	• N/A	• PPAs and electricity markets don't account for time of generation, limiting incentives for deployment of storage to enable corporate 24/7 PPAs

☆ Priority areas

Source: LDES Council; BCG Analysis

Summary | Actions to further boost US competitiveness

Key levers that will enable the U.S. to win the LDES market

Reform grid planning and compensation mechanics

Update policies to improve LDES project economics either through de-risking investments with guaranteed returns (e.g., rate-basing LDES for cost recovery) or compensating LDES for providing long-term capacity reserves & seasonal energy shifting

Support robust pipeline of LDES demand

Increase demand for LDES through public policy levers (e.g., government procurements, zero-carbon power incentives, state LDES mandates) to incentivize private investment in manufacturing and R&D

Build a domestic manufacturing base

Support investment in advanced domestic manufacturing by providing manufacturing loan guarantees, domestic PTCs, or incentives tied to domestic manufacturing requirements in order to drive cost reductions

Source: BCG Analysis

Backup | New legislation provides incentives for facilities and production of Long Duration Energy Storage (LDES) (I/II)

	Provision	Summary	Type	Total investment
1	IRA Section 13102	6% base up to 30% investment tax credit for energy storage technology with a nameplate capacity of >5 kWh. Potential to achieve max ITC of 70% for facilities meeting certain wage/apprenticeship, domestic content, and energy / low-medium income community requirements	Investment Tax Credit (ITC)	$13.9B through 2024 partially attributed to LDES
2	IRA Section 13701 and 13702	Energy storage facilities subject to the same definition as above may elect either 10 year PTC worth up to $30/MWh (in 2021 dollars, inflation adjusted) or a 30% ITC	Investment Tax Credit or Production Tax Credit (ITC or PTC)	$62.1B for 2025-2032 partially attributed to LDES
3	IRA Section 13703	Provides that any facility that qualifies for credits above is considered eligible for 5-year accelerated depreciation under Section 168 of the Internal Revenue Code for any projects placed in service after 2024	Market Enabler	$624M through 2032 partially attributed to LDES
4	IRA Section 13501: 48C Advanced Energy Manufacturing Project Tax Credit	Extension of the advanced energy manufacturing project credit. Base rate of 6% and 30% tax credit if wage and apprentice requirements are satisfied	Manufacturing Tax Credit	$10B

Source: BCG Analysis

Backup | New legislation provides incentives for facilities and production of Long Duration Energy Storage (LDES) (II/II)

	Provision	Summary	Type	Total investment
5	IRA Section 13502: 45X Advanced Manufacturing Tax Credit	A credit for manufacturers of eligible components produced within the United States. Tax credits include US$45 per KWh of capacity, which consists of (i) US$35 per KWh of battery capacity for battery cells and (ii) US$10 per KWh of capacity for battery modules. 10 percent of the cost to produce "electrode active materials" also qualifies.	Manufacturing Tax Credit	-
6	IIJA Sec. 11403. Carbon Reduction program	Establishes a "Program Upgrading Our Electric Grid and Ensuring Reliability and Resiliency" to provide Grants to demonstrate innovative approaches to transmission, storage, and distribution infrastructure	Grant Funding	$7B through 2026 partially attributed to LDES
7	IIJA Sec. 41001/Energy Act[1] Energy storage demonstration projects	Provides Grant Funding for 50% cost-sharing of energy storage demonstration projects	Grant Funding	$505M through 2026 ($150M specifically for LDES)
8	CHIPS Sec. 10102 Basic Energy Science Program	Extension of the advanced energy manufacturing project credit. Base rate of 6% and 30% tax credit if wage and apprentice requirements are satisfied	Grant Funding	$600M through 2027

1. Program originally approved in Energy Act of 2020 as part of the Better Energy Storage Act
Source: IEA, BCG analysis

Disclaimer

The services and materials provided by Boston Consulting Group (BCG) are subject to BCG's Standard Terms (a copy of which is available upon request) or such other agreement as may have been previously executed by BCG. BCG does not provide legal, accounting, or tax advice. The Client is responsible for obtaining independent advice concerning these matters. This advice may affect the guidance given by BCG. Further, BCG has made no undertaking to update these materials after the date hereof, notwithstanding that such information may become outdated or inaccurate.

The materials contained in this presentation are designed for the sole use by the board of directors or senior management of the Client and solely for the limited purposes described in the presentation. The materials shall not be copied or given to any person or entity other than the Client ("Third Party") without the prior written consent of BCG. These materials serve only as the focus for discussion; they are incomplete without the accompanying oral commentary and may not be relied on as a stand-alone document. Further, Third Parties may not, and it is unreasonable for any Third Party to, rely on these materials for any purpose whatsoever. To the fullest extent permitted by law (and except to the extent otherwise agreed in a signed writing by BCG), BCG shall have no liability whatsoever to any Third Party, and any Third Party hereby waives any rights and claims it may have at any time against BCG with regard to the services, this presentation, or other materials, including the accuracy or completeness thereof. Receipt and review of this document shall be deemed agreement with and consideration for the foregoing.

BCG does not provide fairness opinions or valuations of market transactions, and these materials should not be relied on or construed as such. Further, the financial evaluations, projected market and financial information, and conclusions contained in these materials are based upon standard valuation methodologies, are not definitive forecasts, and are not guaranteed by BCG. BCG has used public and/or confidential data and assumptions provided to BCG by the Client. BCG has not independently verified the data and assumptions used in these analyses. Changes in the underlying data or operating assumptions will clearly impact the analyses and conclusions.


BCG
BOSTON
CONSULTING
GROUP
bcg.com