

Appendix D: Technology Readiness Grading Methodology

Following the initial Technology Applicability screening, CHE-technology combinations with a score of 1 or higher were further evaluated for technology readiness and assigned one of the *Technology Readiness Grades* described in Table D-1.

Table D-1: Technology Readiness Grade Descriptions

Technology Readiness Grade	Description
Development	The CHE-technology combination is still in the development phase and is not yet ready for deployment: • Early product development to pre-production • CHE-technology combination in testing for CHE in controlled experiments • Includes combinations for which staff found no evidence of development¹
Demonstration	Further demonstrations are required to prove the technology before broad deployment: • Early/limited commercial availability* • Not yet fully demonstrated in all environments or not yet reliable in desired environment
Limited	The CHE-technology combination can be deployed on a limited basis: • Commercially available • Manageable lead times • Possible delays with original equipment manufacturer (OEM) support and replacement parts • Possible delays with international technical support • May experience minor reliability issues that do not keep CHE from operating • Likely first-generation equipment
Equivalence	The CHE-technology combination operates equivalently, or better than, diesel-powered CHE and is ready for full-scale adoption at most facilities: • Full commercial availability • Duty cycle equivalence to diesel CHE counterpart • Lead times similar to diesel • OEM repair support comparable to diesel • Reliable, with up-times comparable to diesel • Achieves operational equivalency when OEM operating procedures are followed • Likely 2nd, 3rd, or later generation equipment

*Note: Commercial availability means the zero-emission CHE is offered to the public by an OEM either on their website or through a dealer or distributor.

Staff evaluated technology readiness using a scoring system with two criteria:

1. Commercial Availability - Up to 500 points, depending on commercial availability or how far it is in the product development cycle. Additional points were given for U.S. commercial availability and lead times and part availability equivalent to diesel CHE.
2. Operational Feasibility - Up to 500 points, depending on endurance, performance, reliability, and logistics equivalent to diesel CHE.

Commercial Availability

Commercial availability means that the CHE is offered to the public by an OEM either on their website or through a dealer or distributor. Staff assigned a score of 300 for commercially available equipment and an additional 100 points if the equipment is available in the U.S. CHE that is commercially available outside the U.S. requires additional lead times to modify the equipment or the associated infrastructure for non-U.S. power systems. They may also require additional certifications. See [Appendix B](#) for a list of commercially available zero-emission CHE. Equipment that is pre-commercial can be found in [Appendix E](#).

Equipment that is pre-commercial (TRL 9) will take longer to acquire due to undeveloped supply chains for new parts, additional permits, or regulatory approvals required to sell the equipment on the open market. Therefore, this equipment achieves a score of 250. Equipment in earlier development phases score lower. Additional points are given for lead times and replacement part availability comparable to diesel equipment.

Staff used weighted scores for Commercial Availability. The most significant contributors receive a higher value. For example, while there are five criteria associated with Commercial Availability, a CHE-technology combination that is commercially available achieves a score of 300 out of 500, or 60% of the total potential points. Staff did not assess what is sometimes called *market maturity*. This can include data such as, how long the equipment has been available, or how many of the zero-emission CHE are in operation. Because mature technology often addresses issues found in newly developed equipment, Operational Feasibility indirectly factors in these attributes. Table D-2 outlines the scoring criteria for Commercial Availability.

¹ In cases where staff found no evidence of development, OEMs may still be developing the CHE-technology combination but have not yet publicly disclosed it. Because a lack of information does not necessarily indicate a lack of development, staff did not create a separate category and assigned these combinations a Grade of Development.

Table D-2: Scoring Criteria for Commercial Availability

#	Criteria	Assessment	Potential Score
1	Is the CHE commercially available?	Yes	300
		No	0
2	Is the CHE commercially available in the US?	Yes	100
		No	0
3	Are the lead times for new CHE purchases comparable to diesel equivalents? • Small Equipment (e.g., Forklift, Side Handler, Top Handler, Yard Truck, Utility Truck) < 6 months ² • Large Equipment (e.g., Large Crane, Log Stacker, RMG, RTG) < 6 months to 1 year ³ • Custom Equipment (e.g., STS Crane, Mobile Harbor Crane) 6 months to more than 1 year ⁴	Yes	50
		No/Unknown	0
4	Are replacement parts readily available, equivalent to diesel (</= 2 weeks)?	Yes	50
		No/Unknown	0
5	If the CHE is not commercially available, what is the technology readiness level (TRL1-TRL9)?	TRL 9	250
		TRL 8	200
		TRL 6-7	100
		TRL 4-5	50
		TRL <4	0
Total Potential Commercial Availability Points			500

Operational Feasibility

Operational feasibility consists of four criteria:

- Endurance - Can the CHE meet the expected operational runtime?
- Performance - Can the CHE perform on par with diesel baseline (power, torque, speed, etc.)?
- Reliability - Is the CHE reliable (similar up/down-time to diesel)?
- Logistics - Can the CHE be filled/charged such that operation is not significantly impacted relative to diesel baseline (fueling/charging can be accommodated within typical work breaks, lunches, other downtime)?

² Staff survey of dealers, distributors, technicians, and web search.

³ Ibid.

⁴ Ibid.

Scoring for Operational Feasibility is based on discussions between staff and facility operators at California seaports and intermodal railyards in 2024, interviews with CHE OEMs, as well as research of the demonstration, pilot, product launch, and prototype projects listed in [Appendix E](#). For each criterion and each type of CHE, staff combined the results from the reports from these sources to provide an overall score for each CHE-technology combination.

Endurance

The varying endurance criteria for container CHE and non-container CHE are due to the differences in operations at container facilities. Container terminals at seaports often operate at least two shifts per day. While this two-shift requirement may not be the case for all CHE at all container facilities, staff observed this while visiting several seaports. One terminal operator at the Port of Long Beach indicated that if a demonstration yard truck could not operate for two shifts on a single charge, the demonstration “would be considered a failure right from the very start of the project.”⁵ If container CHE cannot operate for two full shifts with one opportunity charge or refuel between shifts, additional CHE may be required to complete the shift at some facilities. This could require additional capital investment. Thus, the low score of 50 for container CHE that are unable to meet the two-shift criteria. Likewise, to achieve a score greater than 0, non-container CHE must be able to complete a full shift with, or without opportunity charging to avoid the potential need for backup CHE to complete the shift. One potential advantage that hydrogen fuel cell CHE has over battery-electric CHE is the ability to fuel the CHE in similar timeframes to diesel, more quickly than it takes to recharge batteries. Therefore, refueling fuel cell CHE may be more feasible for facilities than recharging batteries between shifts. More fuel cell CHE demonstrations are necessary to make this determination.

When there was feedback and reports from several facilities and various models, the Endurance score from CHE that achieved the highest score was used. As with other new technologies, as one OEM makes breakthroughs and improvements, it often drives the market to match capability. For example, when one OEM announced the ability for its CHE to operate for two shifts without opportunity charging, this became the benchmark for the industry for that type of CHE.

Performance

Performance is a measure of the ability of the equipment to match the operational characteristics of diesel-powered CHE. This includes criteria such as speed, torque, hauling capability for yard trucks, lifting capacity for cranes and other cargo-lifting CHE, and similar operational characteristics for other CHE. For example, it is a common practice for yard

⁵ Southern California Edison, “Final Evaluation report: California Transportation Electrification Priority Review Projects,” April 22, 2021. <https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/sb-350-te/california-te-prp-final-evaluation-report-presentation.pdf>. Staff received similar feedback from other seaport terminal operators.

truck operators to use the lubricated fifth wheel top plate as a “lifting wedge” when backing the truck into the container chassis hitch. Using yard trucks to do this can put extra stress on the fifth wheel (especially if it’s not properly lubricated), but it saves time from lowering and changing the angle of the fifth wheel for better vertical alignment. One operator noted that some early-generation battery-electric yard trucks did not have enough power to do this when backing up to load chassis.

A full score of 125 is given when there are 2 or more reports that provide positive feedback and there is no report with negative feedback. A partial score of 75 is given when there is only 1 report that provides positive feedback or when the report(s) give mostly positive feedback, but with some minor issues that need to be resolved in the future. A minor issue is one which did not keep the CHE from operating. A score of 0 is given when the feedback was mostly negative, or there was a major problem that kept the CHE from operating, or there were no available reports.

Reliability

Reliability is a measure of equipment up/down-time compared to equivalent diesel-powered models. When reviewing direct feedback and project reports, staff evaluated if equipment was not functioning due to equipment failure. Unfortunately, many reports did not make the distinction of whether the equipment was waiting for skilled repair technicians or replacement parts. Therefore, there may be some overlap with the criteria for Commercial Availability regarding availability of replacement parts. Scoring for reliability is the same as for Performance. A full score of 125 is given when there are 2 or more reports that provide positive feedback, etc.

Logistics

Logistics is a measure of whether the CHE can be fueled or charged within typical work breaks, lunches, or other downtime. It does not include procedural or operational challenges. For example, with diesel-powered container CHE, it is common for the equipment to be filled nightly during the hoot shift using a wet hose. A gearman drives around the facility in a fuel truck to fill up tanks of CHE operating throughout the seaport or intermodal railyard. Similarly, it must be possible to fill/charge the zero-emission CHE between, or during, shifts for it to operate through the next shift. This is generally only a challenge for battery-electric CHE. Grid-electric CHE does not require filling/charging. Similarly, hydrogen fuel cell CHE can often be filled using a similar wet-hosing approach in about the same time it takes to fill diesel-powered CHE. Therefore, for projects that have available final reports, both grid-electric and hydrogen fuel cell CHE typically score the maximum points for this criterion.

If there were OEM specifications, facility feedback, and demonstration/pilot reports for various models, the Logistics score from CHE that achieved the highest score was used. This provides a forward-looking perspective about what can be achieved for future models. Table D-3 outlines the scoring methodology for Operational Feasibility.

Table D-3: Scoring Criteria for Operational Feasibility

#	Criteria	Assessment (Container CHE and Heavy Lift Forklifts)	Assessment (Non-container CHE)	Potential Score
1	ENDURANCE: Can the CHE meet the expected operational runtime?	2 shifts (16 hours) w/o charge/refuel	1 shift (8 hours) w/o charge/refuel	125
		2 shifts with charge/refuel between shifts	1 shift with opportunity charging or refueling during shift	100
		1 shift (8 hours)	> 6 hours	75
		< 1 shift or unknown	< 6 hours or unknown	0
2	PERFORMANCE: Can the CHE perform on par with diesel baseline (power, torque, speed, etc.)?	Yes		125
		Yes, but with caveats (see reports)		75
		No, or unknown		0
3	RELIABILITY: Is the CHE reliable (similar up/down-time to diesel)?	Yes		125
		Yes, but with caveats (see reports)		75
		No, or unknown		0
4	LOGISTICS: Can the CHE be filled/charged such that operation isn't significantly impacted relative to diesel baseline	Yes		125
		No, or unknown		0
Total Potential Operational Feasibility Points				500

Technology Readiness Grade

The combined score, with a potential maximum of 1,000 points, determined the Technology Readiness Grade. Table D-4 describes the Technology Readiness Grades and includes a deployment assessment indicating how ready the CHE-technology combination is for full deployment.

Table D-4: Technology Readiness Grades based on Technology Readiness Scores

Technology Readiness Score	Technology Readiness Grade	Deployment Assessment
0-199	Development	The CHE-technology combination is still in the development phase and is not yet ready for deployment.
200-699	Demonstration	Further demonstrations are required to prove the technology before broad deployment. Development teams should closely supervise and manage these demonstrations. The CHE-technology combination is not yet ready for full deployment.
700-899	Limited	CHE can be deployed on a limited basis. Owner/operators can use this technology with careful supervision and management. Enforceable customer service agreements with OEMs and equipment vendors are crucial for successful deployment.
900-1000	Equivalence	The technology for this CHE type meets functional and operational equivalency to fossil-fuel powered CHE or has replaced fossil fuel equipment completely, becoming the industry standard. Ready for full-scale adoption at most facilities.

Commercial Availability Scoring

Table D-5 through Table D-7 show the Commercial Availability scoring for battery-electric CHE. Table D-8 and Table D-9 show the Commercial Availability scoring for grid-electric CHE. Table D-10 through Table D-12 show the Commercial Availability scoring for hydrogen fuel cell CHE.

Table D-5: Commercial Availability Scoring for Battery-Electric Bulk Material CHE

Equipment Type	Commercially Available Score	Commercially Available in the U.S. Score	TRL Score	Lead Times Score	Replacement Parts Score	Combined Score
Crane, Material Handling	300	100	N/A	0	0	400
Crane, Mobile	300	100	N/A	0	0	400
Crane, Off-Road	300	100	N/A	0	0	400
Dozer	300	0	N/A	0	0	300
Excavator	300	100	N/A	0	0	400
Forklift, Heavy Lift	300	100	N/A	0	0	400
Forklift, Telehandler	300	100	N/A	0	0	400
Haul Truck	300	100	N/A	0	0	400
Loader or Loader-Excavator	300	100	N/A	0	0	400
Log Stacker	0	0	0 ⁶	0	0	0

⁶ No evidence of development.

Table D-6: Commercial Availability Scoring for Battery-Electric Container CHE

Equipment Type	Commercially Available Score	Commercially Available in the U.S. Score	TRL Score	Lead Times Score	Replacement Parts Score	Combined Score
AGV	300	100	N/A	0	50	450
Rail-Mounted Gantry Crane	0	0	0 ⁷	0	0	0
Reach Stacker	300	100	N/A	0	0	400
Rubber-Tired Gantry Crane	300	100	N/A	0	0	400
Shuttle and Straddle Carriers	300	100	N/A	0	0	400
Side Handler	300	100	N/A	0	0	400
Top Handler	300	100	N/A	0	0	400
Yard Truck	300	100	N/A	0	50	450

⁷ No evidence of development.

Table D-7: Commercial Availability Scoring for Battery-Electric Facility Support CHE

Equipment Type	Commercially Available Score	Commercially Available in the U.S. Score	TRL Score	Lead Times Score	Replacement Parts Score	Combined Score
Aerial Lift	300	100	N/A	0	0	400
Cone Vehicle	300	100	N/A	0	0	400
Railcar Mover	300	100	N/A	0	0	400
Utility Truck, Other	300	100	N/A	0	0	400
Utility Truck, Sweeper	300	100	N/A	0	0	400

Table D-8: Commercial Availability Scoring for Grid-Electric Bulk Material CHE

Equipment Type	Commercially Available Score	Commercially Available in the U.S. Score	TRL Score	Lead Times Score	Replacement Parts Score	Combined Score
Crane, Material Handling	300	100	N/A	0	0	400
Crane, Mobile Harbor	300	100	N/A	0	0	400
Crane, Off-Road	300	100	N/A	0	0	400
Excavator	300	100	N/A	0	0	400

Table D-9: Commercial Availability Scoring for Grid-Electric Container CHE

Equipment Type	Commercially Available Score	Commercially Available in the U.S. Score	TRL Score	Lead Times Score	Replacement Parts Score	Combined Score
AGV	0	0	0 ⁸	0	0	0
Rail-Mounted Gantry Crane	300	100	N/A	50	50	500
Reach Stacker	0	0	0 ⁹	0	0	0
Rubber-Tired Gantry Crane	300	100	N/A	0	0	400
Ship-to-Shore Crane	300	100	N/A	50	50	500
Shuttle and Straddle Carrier	0	0	0 ¹⁰	0	0	0
Side Handler	0	0	0 ¹¹	0	0	0
Top Handler	0	0	0 ¹²	0	0	0
Yard Truck	0	0	0 ¹³	0	0	0

⁸ No evidence of development.

⁹ Two announcements were made for future demonstrations, but there is no evidence of development. See "International Transportation Service Partners with Elonroad on Zero Emissions at the Port of Long Beach," My New Desk, December 17, 2024. Accessed April 10, 2025. <https://www.mynewsdesk.com/se/elonroad/pressreleases/international-transportation-service-partners-with-elonroad-on-zero-emissions-at-the-port-of-long-beach-3360603> and John Hills, "Kalmar and Elonroad trial Potential Dynamic Charging Breakthrough for Heavy Electric Vehicles," Electric Drives, November 28, 2024. Accessed January 3, 2025. <https://electricdrives.tv/kalmar-and-elonroad-trial-potential-dynamic-charging-breakthrough-for-heavy-electric-vehicles/>.

¹⁰ No evidence of development.

¹¹ No evidence of development.

¹² No evidence of development.

¹³ See above footnote for grid-electric reach stacker.

Table D-10: Commercial Availability Scoring for Hydrogen Fuel Cell Bulk Material CHE

Equipment Type	Commercially Available Score	Commercially Available in the U.S. Score	TRL Score	Lead Times Score	Replacement Parts Score	Combined Score
Crane, Material Handling	0	0	0 ¹⁴	0	0	0
Crane, Mobile	0	0	0 ¹⁵	0	0	0
Crane, Mobile Harbor	0	0	100 (TRL6)	0	0	100
Crane, Off-Road	0	0	100 (TRL7)	0	0	100
Dozer	0	0	0 ¹⁶	0	0	0
Excavator	0	0	200 (TRL8)	0	0	200
Forklift, Heavy Lift	300	100	N/A	0	0	400
Forklift, Telehandler	0	0	100 (TRL7)	0	0	100
Haul Truck	0	0	100 (TRL7)	0	0	100
Loader or Loader-Excavator	300	0	N/A	0	0	300
Log Stacker	0	0	0 ¹⁷	0	0	0

¹⁴ No evidence of development.¹⁵ No evidence of development.¹⁶ No evidence of development.¹⁷ No evidence of development.

Table D-11: Commercial Availability Scoring for Hydrogen Fuel Cell Container CHE

Equipment Type	Commercially Available Score	Commercially Available in the U.S. Score	TRL Score	Lead Times Score	Replacement Parts Score	Combined Score
AGV	0	0	0 ¹⁸	0	0	0
Rail-Mounted Gantry Crane	0	0	0 ¹⁹	0	0	0
Reach Stacker	0	0	100 (TRL7)	0	0	100
Rubber-Tired Gantry Crane	0	0	200 (TRL8)	0	0	200
Shuttle and Straddle Carriers	0	0	0 ²⁰	0	0	0
Side Handler	0	0	100 (TRL7)	0	0	100
Top Handler	0	0	100 (TRL7)	0	0	100
Yard Truck	300	100	N/A	0	0	400

¹⁸ No evidence of development.

¹⁹ No evidence of development.

²⁰ No evidence of development.

Table D-12: Commercial Availability Scoring for Hydrogen Fuel Cell Facility Support CHE

Equipment Type	Commercially Available Score	Commercially Available in the U.S. Score	TRL Score	Lead Times Score	Replacement Parts Score	Combined Score
Aerial Lift	300	100	N/A	0	0	400
Cone Vehicle	0	0	0 ²¹	0	0	0
Railcar Mover	0	0	0 ²²	0	0	0
Utility Truck, Other	300	0	N/A	0	0	300
Utility Truck, Sweeper	300	100	N/A	0	50	450

Operational Feasibility Scoring

Table D-13 through Table D-15 show the Operational Feasibility scoring for battery electric CHE. Table D-16 and Table D-17 show the Operational Feasibility scoring for grid-electric CHE. Table D-18 through Table D-20 show the Operational Feasibility scoring for hydrogen fuel cell CHE.

²¹ No evidence of development.

²² No evidence of development.

Table D-13: Operational Feasibility Scoring for Battery-Electric Bulk Material CHE

Equipment Type	Endurance Score	Performance Score	Reliability Score	Logistics Score	Combined Score
Crane, Material Handling	125	0	0	125	250
Crane, Mobile	125	75	0	0	200
Crane, Off-Road	125	0	0	125	250
Dozer	125	0	0	0	125
Excavator	125	75	0	0	200
Forklift, Heavy Lift	125	75	0	125	325
Forklift, Telehandler	125	0	0	0	125
Haul Truck	100	75	75	0	250
Loader or Loader-Excavator	75	0	0	0	75
Log Stacker	0	0	0	0	0

Table D-14: Operational Feasibility Scoring for Battery-Electric Container CHE

Equipment Type	Endurance Score	Performance Score	Reliability Score	Logistics Score	Combined Score
AGV	125	125	125	125	500
Rail-Mounted Gantry Crane	0	0	0	0	0
Reach Stacker	125	75	75	125	400
Rubber-Tired Gantry Crane	0	0	0	0	0
Shuttle and Straddle Carriers	0	0	0	0	0
Side Handler	100	125	75	125	425
Top Handler	125	125	125	0	375
Yard Truck	100	75	75	0	250

Table D-15: Operational Feasibility Scoring for Battery-Electric Facility Support CHE

Equipment Type	Endurance Score	Performance Score	Reliability Score	Logistics Score	Combined Score
Aerial Lift	0	0	0	0	0
Cone Vehicle	0	0	0	0	0
Railcar Mover	125	0	0	125	250
Utility Truck, Other	75	75	0	0	150
Utility Truck, Sweeper	125	75	0	125	325

Table D-16: Operational Feasibility Scoring for Grid-Electric Bulk Material CHE

Equipment Type	Endurance Score	Performance Score	Reliability Score	Logistics Score	Combined Score
Crane, Material Handling	125	0	0	0	125
Crane, Mobile Harbor	125	0	0	0	125
Crane, Off-Road	125	0	0	125	250
Excavator	125	0	0	0	125

Table D-17: Operational Feasibility Scoring for Grid-Electric Container CHE

Equipment Type	Endurance Score	Performance Score	Reliability Score	Logistics Score	Combined Score
AGV	0	0	0	0	0
Rail-Mounted Gantry Crane	125	125	125	125	500
Reach Stacker	0	0	0	0	0
Rubber-Tired Gantry Crane	125	75	75	125	400
Ship-to-Shore Crane	125	125	125	125	500
Shuttle and Straddle Carrier	0	0	0	0	0
Side Handler	0	0	0	0	0
Top Handler	0	0	0	0	0
Yard Truck	0	0	0	0	0

Table D-18: Operational Feasibility Scoring for Hydrogen Fuel Cell Bulk Material CHE

Equipment Type	Endurance Score	Performance Score	Reliability Score	Logistics Score	Combined Score
Crane, Material Handling	0	0	0	0	0
Crane, Mobile	0	0	0	0	0
Crane, Mobile Harbor	0	0	0	0	0
Crane, Off-Road	0	0	0	0	0
Dozer	0	0	0	0	0
Excavator	0	75	75	0	150
Forklift, Heavy Lift	0	0	0	125	125
Forklift, Telehandler	0	0	0	0	0
Haul Truck	0	0	0	0	0
Loader or Loader-Excavator	0	0	75	0	75
Log Stacker	0	0	0	0	0

Table D-19: Operational Feasibility Scoring for Hydrogen Fuel Cell Container CHE

Equipment Type	Endurance Score	Performance Score	Reliability Score	Logistics Score	Combined Score
AGV	0	0	0	0	0
Rail-Mounted Gantry Crane	0	0	0	0	0
Reach Stacker	0	0	0	0	0
Rubber-Tired Gantry Crane	125	75	75	125	400
Shuttle and Straddle Carriers	0	0	0	0	0
Side Handler	0	0	0	0	0
Top Handler	75	75	75	125	350
Yard Truck	125	75	0	125	325

Table D-20: Operational Feasibility Scoring for Hydrogen Fuel Cell Facility Support CHE

Equipment Type	Endurance Score	Performance Score	Reliability Score	Logistics Score	Combined Score
Aerial Lift	0	0	0	0	0
Cone Vehicle	0	0	0	0	0
Railcar Mover	0	0	0	0	0
Utility Truck, Other	0	0	0	0	0
Utility Truck, Sweeper	125	125	0	0	250

Technology Readiness Scoring and Grading

Table D-21 through Table D-23 contain the scoring values used to calculate the Technology Readiness Grades for battery-electric CHE. Table D-24 and Table D-25 contain the scoring values used to calculate the Technology Readiness Grades for grid-electric CHE. Table D-26 through Table D-28 contain the scoring values used to calculate the Technology Readiness Grades for hydrogen fuel cell CHE.

Table D-21: Technology Readiness Scoring for Battery-Electric Bulk Material CHE

Equipment Type	Technology Readiness Score (Combined Commercial Availability and Operational Feasibility Scores)	Technology Readiness Grade
Crane, Material Handling	650	Demonstration
Crane, Mobile	600	Demonstration
Crane, Off-Road	650	Demonstration
Dozer	425	Demonstration
Excavator	600	Demonstration
Forklift, Heavy Lift	725	Limited
Forklift, Telehandler	525	Demonstration
Haul Truck	650	Demonstration
Loader or Loader-Excavator	475	Demonstration
Log Stacker	0	Development

Table D-22: Technology Readiness Scoring for Battery-Electric Container CHE

Equipment Type	Technology Readiness Score (Combined Commercial Availability and Operational Feasibility Scores)	Technology Readiness Grade
AGV	950	Equivalence
Rail-Mounted Gantry Crane	0	Development
Reach Stacker	800	Limited
Rubber-Tired Gantry Crane	400	Demonstration
Shuttle and Straddle Carriers	400	Demonstration
Side Handler	825	Limited
Top Handler	775	Limited
Yard Truck	700	Limited

Table D-23: Technology Readiness Scoring for Battery-Electric Facility Support CHE

Equipment Type	Technology Readiness Score (Combined Commercial Availability and Operational Feasibility Scores)	Technology Readiness Grade
Aerial Lift	400	Demonstration
Cone Vehicle	400	Demonstration
Railcar Mover	650	Demonstration
Utility Truck, Other	550	Demonstration
Utility Truck, Sweeper	725	Limited

Table D-24: Technology Readiness Scoring for Grid Electric Bulk Material CHE

Equipment Type	Technology Readiness Score (Combined Commercial Availability and Operational Feasibility Scores)	Technology Readiness Grade
Crane, Material Handling	525	Demonstration
Crane, Mobile Harbor	525	Demonstration
Crane, Off-Road	650	Demonstration
Excavator	525	Demonstration

Table D-25: Technology Readiness Scoring for Grid Electric Container CHE

Equipment Type	Technology Readiness Score (Combined Commercial Availability and Operational Feasibility Scores)	Technology Readiness Grade
AGV	0	Development
Rail-Mounted Gantry Crane	1000	Equivalence
Reach Stacker	0	Development
Rubber-Tired Gantry Crane	800	Limited
Ship-to-Shore Crane	1000	Equivalence
Shuttle and Straddle Carrier	0	Development
Side handler	0	Development
Top handler	0	Development
Yard Truck	0	Development

Table D-26: Technology Readiness Scoring for Hydrogen Fuel Cell Bulk Material CHE

Equipment Type	Technology Readiness Score (Combined Commercial Availability and Operational Feasibility Scores)	Technology Readiness Grade
Crane, Material Handling	0	Development
Crane, Mobile	0	Development
Crane, Mobile Harbor	100	Development
Crane, Off-Road	100	Development
Dozer	0	Development
Excavator	350	Demonstration
Forklift, Heavy Lift	525	Demonstration
Forklift, Telehandler	100	Development
Haul Truck	100	Development
Loader or Loader-Excavator	375	Demonstration
Log Stacker	0	Development

Table D-27: Technology Readiness Scoring for Hydrogen Fuel Cell Container CHE

Equipment Type	Technology Readiness Score (Combined Commercial Availability and Operational Feasibility Scores)	Technology Readiness Grade
AGV	0	Development
Rail-Mounted Gantry Crane	0	Development
Reach Stacker	100	Development
Rubber-Tired Gantry Crane	600	Demonstration
Shuttle and Straddle Carriers	0	Development
Side Handler	100	Development
Top Handler	450	Demonstration
Yard Truck	725	Limited

Table D-28: Technology Readiness Scoring for Hydrogen Fuel Cell Facility Support CHE

Equipment Type	Technology Readiness Score (Combined Commercial Availability and Operational Feasibility Scores)	Technology Readiness Grade
Aerial Lift	400	Demonstration
Cone Vehicle	0	Development
Railcar Mover	0	Development
Utility Truck, Other	300	Demonstration
Utility Truck, Sweeper	700	Limited