

Terminal Automation in Southern California: Implications for Growth, Jobs, and the Future Competitiveness of West Coast Ports

By Dr. Michael Nacht and Larry Henry

Executive Summary

Since mid-2020, United States West Coast ports have been at the forefront of an enormous and sustained wave of containerized cargo, pressing regional and national supply chains to their breaking points. A surge in business and consumer demand for imports from Asia and commercial disruptions due to the Covid-19 pandemic have caused months-long vessel backlogs, impeding the flow of goods.

Nowhere have these pressures been more pronounced than at the San Pedro Bay Port Complex. The ports of Los Angeles and Long Beach are the nation's largest container ports and handle roughly 40% of containerized U.S. imports from Asia. Record cargo volumes during the pandemic have at times forced upwards of 100 ships to anchor offshore awaiting berths. The spectacle vividly exposed a supply chain choked at every link: marine terminals, truck and rail transport, warehouses, and distribution centers.

Restoring this vital distribution network will require investment in the workforce, technology, and additional capacity systemwide. And that begins at the maritime gateways in Los Angeles and Long Beach. These economic engines anchor a network of 29 West Coast ports that supports 12.5 million jobs and generates nearly 9% of U.S. Gross Domestic Product.¹ In the Los Angeles Metropolitan Statistical Area alone, the two ports support 232,082 direct, induced, and indirect jobs and accounts for about 25% of California's GDP.²

The recent backlog, however, foreshadows challenges to the primacy of the San Pedro Bay ports in the U.S. supply chain, underscoring the value of automation – a hallmark of the world's leading ports – in enhancing efficiency, expanding capacity, and lowering costs. Even before the pandemic, Los Angeles and Long Beach were steadily losing market share of discretionary cargo – Asian imports headed to destinations beyond Western states – to ports on the East and Gulf Coasts, as well as in British Columbia. The San Pedro Bay complex is projected to reach capacity by 2028. With limited potential to physically expand their marine terminals, the two ports risk further loss of discretionary cargo, threatening jobs, wages, and tax revenue essential to Southern California's economic vitality.

Increasing automation will enable the largest West Coast ports to remain competitive, facilitate both cargo and job growth, and reduce greenhouse-gas emissions to meet stringent local environmental standards. With virtually no potential to expand, the principal strategy to accommodate higher volume must be densification – or increasing container capacity on the existing port footprint. The two automated terminals operating at Los Angeles and Long Beach have demonstrated that, from autonomous vehicles that move containers around the terminal and cranes that stack them higher and closer together, automation has boosted throughput and cut supply-chain delays. Since the pandemic surge, these terminals have processed Twenty-Foot Equivalent Units (TEUs) twice as fast as the San Pedro Bay's conventional container terminals;³ container throughput per acre has been, on average, 44% higher.⁴

¹ Martin Associates, "The Economic Impacts of the West Coast Ports," May 2022, 10-11.

Direct: workers in longshore, trucking, rail, warehouse, other maritime services, etc. Induced: jobs resulting from money spent by direct workers in their communities with businesses. Indirect: additional jobs created to support businesses transacting business within the maritime trade. This does not include the economic value generated by the California importers and exporters moving containers through the port complexes.

² Martin Associates research.

³ Martin Associates, "The Anatomy of the Container Terminal Logistics Supply Chain Congestion Issues at the San Pedro Bay Ports During the Covid-19 Pandemic – An Update," October 13, 2021, 14.

⁴ Pacific Maritime Association and Ports of Los Angeles and Long Beach data.

The International Longshore and Warehouse Union (ILWU), which represents workers at West Coast ports, has accepted the terminals' right to automate, but, worried about job losses, it has resisted efforts to introduce the technology. Yet contrary to the ILWU's concerns, automation at San Pedro Bay ports has added work, not come at its expense. From 2015 (the last year before automated operations) through 2021, the ILWU workforce in Los Angeles and Long Beach grew 11.2%, compared to 8.4% for the rest of West Coast ports.⁵ Over the same period, paid hours at the two automated terminals rose 31.5%, compared to 13.9% at the non-automated terminals, driven by efficiency gains that more than doubled the number of containers processed by these two terminals.⁶ Moreover, the adoption of automation has provided workers with opportunities to be retrained and upskilled for new jobs as port operations evolve.

Automation is critical to boosting the capacity and preserving the competitiveness of West Coast ports. Higher cargo throughput will create port-related jobs and add employment throughout the supply chain. Conversely, failing to adapt threatens to drive cargo to other ports, with a cascading loss of jobs on the docks and throughout the regional economy.

Automation in a Broad Context

In the past decade, robotics, self-driving cars, drones, additive manufacturing, and a range of other "smart" technologies have propelled "automation" – nominally defined as the use of technology to perform tasks with reduced human assistance – to the forefront of industrial planning and labor-management negotiations. These innovations' disruptive, potentially revolutionary impact on the workforce has been the subject of popular fascination, fear, and, increasingly, academic research.

MIT formed a multi-department task force, which spent over two years examining emerging technologies in a wide variety of industries. In a 2020 report, "The Work of the Future: Building Better Jobs in an Age of Intelligent Machines," the researchers wrote: "We see no trade-off between improving economic security for workers and embracing ongoing technological change and innovation. Achieving both goals will require both technological and institutional innovation."⁷ Among the report's six conclusions:

- Technological change is simultaneously replacing existing work and creating new work. It is not eliminating work altogether.⁸
- Fostering opportunity and economic mobility necessitates cultivating and refreshing worker skills.⁹
- Investing in innovation will drive new job creation, speed growth, and meet rising competitive challenges.¹⁰

The evolution of the logistics industry, for one, has relevance for port automation. Long before surging consumer demand during the pandemic overwhelmed the supply chain, the study noted that e-commerce was transforming distribution. Even as companies like Amazon and FedEx adopted automation, warehouse and storage industry jobs more than doubled to 1.1 million, and trucking added 130,000 jobs. "If we think of logistics employment as a tug of war between job gains from e-commerce and job losses from automation, job gains are winning decisively at present," the study said.¹¹

⁵ PMA, 2015 and 2021 Annual Reports, 64.

⁶ PMA and Ports of Los Angeles and Long Beach data. Paid hours excludes mechanics and port guards.

⁷ David Autor, David Mendel, and Elisabeth Reynolds, "The Work of the Future: Building Better Jobs in an Age of Intelligent Machines," November 2020, 76.

⁸ Ibid, 4.

⁹ Ibid, 6.

¹⁰ Ibid.

¹¹ Ibid, 43.

Far from predicting an imminent onslaught of robots, the MIT task force found that automation is being adopted incrementally and can take decades to have a profound impact on labor, affording time to “craft policies, develop skills, and foment investments to constructively shape the trajectory of change toward the greatest social and economic benefit.”¹²

Also in 2020, McKinsey & Co. company published “The Imperatives for Automation Success,” which reported the growing use of automation, most commonly in robotics and business-process management, among the companies it surveyed. Of the three imperatives McKinsey identified, two centered on people, not technology: Identify and focus on the most critical business processes, invest in people and new ways of working, and encourage cross-functional collaboration.¹³

To be sure, technological advancements have and will continue to displace some workers. But the pace and scope of job losses – as well as new opportunities – due to automation will differ among industries. For now, automation is taking hold slowly but surely, necessitating close cooperation between labor and management to achieve success.

Port Automation

As with most other industries, automation at ports is still in a nascent stage. Yet it is a growing global trend and a hallmark of the most modern, productive container terminals. Some 40 ports around the world currently operate or plan to open automated terminals. (Exhibit 1. *See Appendix A for a more detailed map*) Leading ports in Rotterdam, Singapore, and along China’s coast are technological marvels that fuel world trade. For its size, the United States lags behind in the number of automated terminals and cargo volume handled by them.

Exhibit 1
Ports with Operating and Planned Automated Terminals



Automation offers considerable operational, economic and environmental benefits. Remotely-controlled software-assisted cranes unload ships around the clock; autonomous vehicles efficiently move containers around the terminal; automated mobile cranes stack them, organizing the container yard overnight for fast, efficient loading onto on trucks and trains the next morning; and digital checkpoints reduce delays for trucks – speeding the flow of cargo into the supply chain. Moreover, as throughput grows, greenhouse-gas emissions

¹² Ibid, 5.

¹³ McKinsey & Company, “The Imperatives for Automation Success,” August 2020, 6-7, 9.

decline thanks to the combination of zero-emission electric cargo-handling equipment and more-efficient logistics. Quicker truck turnarounds sharply reduce idling times for diesel-powered semi-trailers.

Terminal operators have been slow to adopt full automation because it requires capital investment of billions of dollars. It can take 15 years or more to implement and, therefore, to pay off through productivity gains, despite lowering relative labor costs. As a result, some terminals opt to automate only some cargo-handling functions. U.S. terminal operators, in particular, have the added hurdle of resistance from labor unions.

Two terminals in Norfolk, Virginia, and one in New York are semi-automated; the International Longshoremen’s Association opposes fully automated terminals at East and Gulf Coast ports. On the West Coast, where the issue will figure prominently in coming labor talks with the ILWU, four of San Pedro Bay’s 13 container terminals use or plan to use automation:

Los Angeles

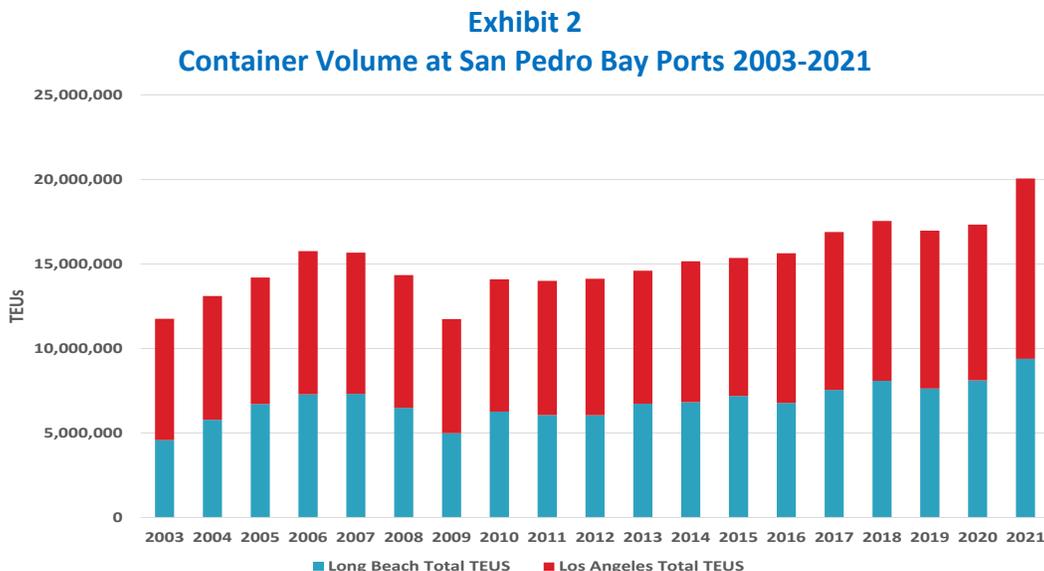
- TraPac invested \$700 million to partially automate
- APM Terminals is in the testing phase of a project to automate one-quarter of its Pier 400 facility

Long Beach

- Long Beach Container Terminal invested \$1.4 billion to fully automate
- Total Terminals International announced in May 2021 that it plans to automate

The Challenge Ahead for San Pedro Bay Ports

Container volume has grown significantly in the past 20 years. (Exhibit 2) In 2021, the San Pedro Bay ports processed 20 million TEUs, 17% more than the previous year, due to the flood of pandemic-era imports.¹⁴



Source: Ports of Los Angeles and Long Beach

The record volume choked the San Pedro Bay complex and the entire supply chain. While the distribution bottlenecks can be relieved in part by building more warehouses and deploying more trains and trucks, physical constraints limit expansion at the Los Angeles and Long Beach ports and elsewhere on the West Coast. Due to the recent import surge, the San Pedro Bay ports are effectively operating at full capacity, though volume may

¹⁴ PMA, 2021 and 2020 Annual Reports, 58.

subside from their current elevated levels. Even before the historic import surge, the ports had been on course to reach full capacity by 2028 based on a conservative estimate of 4% annual growth, according to Larry Nye, who oversees port planning at the marine engineering firm Moffatt & Nichol.¹⁵

Therefore, the twin ports must find ways to process more containers within a finite geographic footprint. Automation is a key tool to achieve densification and transport efficiencies.

For a number of reasons, including higher handling costs, labor uncertainty, and congestion, West Coast ports have for years been losing market share of discretionary cargo from Asia. Lower terminal fees and rail rates to the Midwest have lured shippers to Pacific ports in Canada. Also, the 2016 expansion of the Panama Canal has enabled the largest container ships to bypass Los Angeles and Long Beach and sail directly to the East Coast. Canadian, East Coast, and Gulf Coast ports, respectively, offer savings of up to \$600 and \$1,000 per container of intermodal cargo, according to a 2020 analysis by the transport consulting company Mercator International.^{16 17}

The extreme backlogs of the past two years have added urgency to this challenge. Two rival ports in British Columbia have already begun reconfiguring their container yards in the hope of diverting more cargo from the U.S. West Coast. Major Atlantic ports, like New York, Norfolk, and Savannah, are enhancing their terminal capacities and intermodal-transport infrastructure to get containers off ships and out of the ports faster. Governments have also led major infrastructure investments in harbors and along major waterways to enable the passage of ever-larger container vessels.

These improvements – coupled with unprecedented supply-chain congestion in California – are eroding the San Pedro Bay’s longheld competitive advantage of being closer to Asia. In October 2021, in fact, it became faster to ship a container from China to New York than to Los Angeles. And the gap grew: By the end of December, New York had a 12-day edge: 33 days’ transit time from departure to discharge, compared to 45 days from China to Southern California.¹⁸

Without greater automation, it is difficult to see how West Coast ports can reduce cargo-handling time and cost differentials in order to win back market share of discretionary cargo.

Port Automation, Productivity, and Labor

Since the Mechanization and Modernization Agreement of 1960, West Coast port workers have accepted the right of employers to introduce labor-saving technology. The landmark 2002 labor contract between the Pacific Maritime Association and the ILWU paved the way for digital technology on the docks. And in 2008, the ILWU explicitly accepted automation by agreeing to allow “fully mechanized and robotic-operated marine terminals,” a principle enshrined again in 2014. (*See Appendix B for more background on the labor agreements*)

With each contract, the union secured wage and benefit enhancements that are among the most generous in organized labor. Since 1965, ILWU hourly wages have grown significantly faster than the national average. (Exhibit 3) Under the current contract, fulltime ILWU workers earn, on average, some \$195,000 – nearly three times the median U.S. household income.

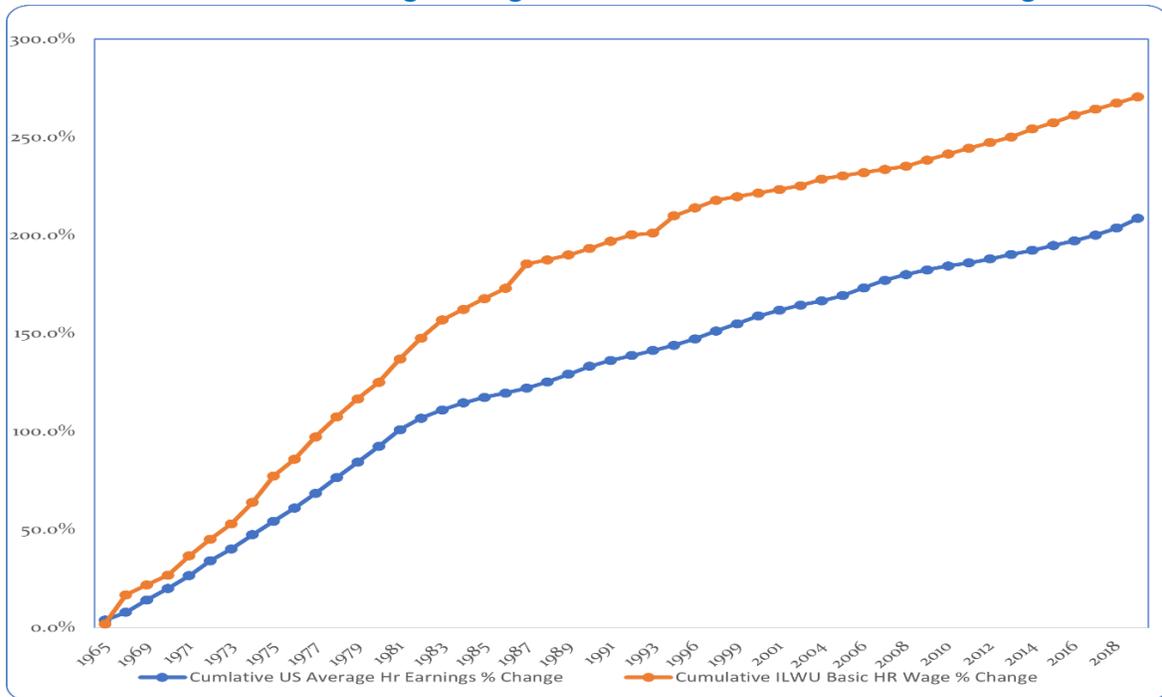
¹⁵ Bill Mongelluzzo, “Latest Long Beach Terminal Automation Draws ILWU Backlash,” *The Journal of Commerce*, May 19, 2021.

¹⁶ Mercator, “Competitiveness of Routes for Asia-Origin Intermodal Import Containers Through Alternative US Gateway Ports,” September 2020, 29.

¹⁷ Mercator, “Competitiveness of Transpacific Routes Through North American West Coast Ports,” September 2020, 26.

¹⁸ Martin Associates, “Assessment of The Impacts of Congestion at San Pedro Bay Ports on Market Share and Future Utilization of Atlantic and Gulf Coast U.S. Ports,” May 2022, 10.

Exhibit 3 Cumulative Wage Change 1965-2019: ILWU vs. National Average



Source: Federal Reserve Bank of St. Louis and PMA

The ILWU did not accept modernization without a fight. In 2002, a labor dispute shut down West Coast ports for 11 days during contract negotiations, and even after subsequent agreements, union leaders continue to resist moves to automate. Despite their fears of job losses, since the start of the “technology era” in 2002, the registered ILWU workforce at West Coast ports has grown 52%.¹⁹ Importantly, the “automation era” has produced faster employment growth in Los Angeles and Long Beach than the other 27 West Coast ports: 11.2% versus 8.4% between 2015 and 2021.²⁰

Automation at Long Beach Container Terminal (LBCT) and TraPac is driving much-needed efficiency and productivity gains – benefiting ILWU workers. Between January 2020 and February 2022, throughput rose to an average of 510 TEUs per acre, compared to about 350 TEUs per acre at San Pedro Bay’s conventional container terminals.²¹ LBCT and TraPac also processed containers up to twice as fast.²² (Exhibit 4)

¹⁹ PMA, 2002 Annual Report, 62.

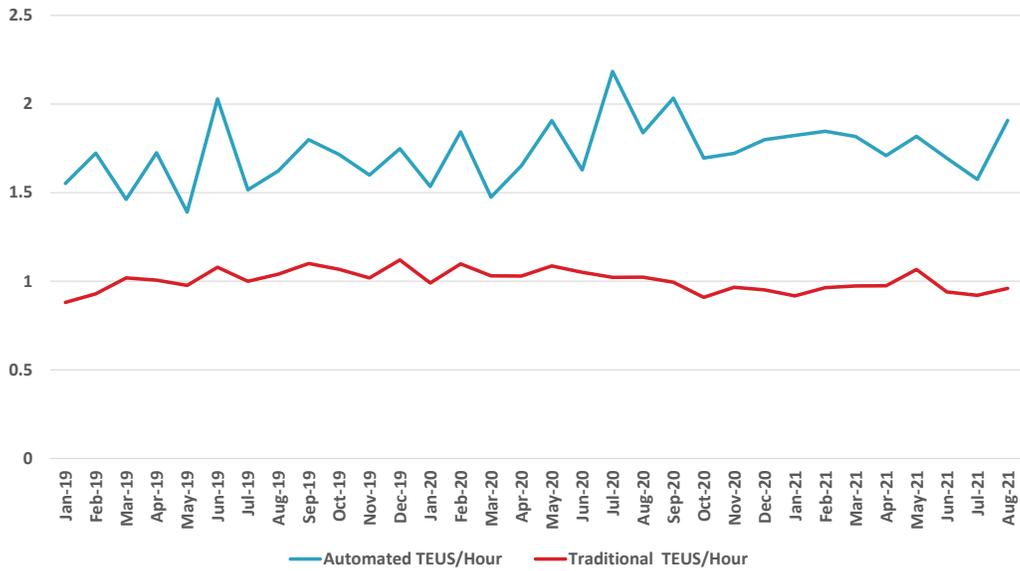
²⁰ PMA, 2015 and 2021 Annual Reports, 64.

²¹ PMA and Ports of Los Angeles and Long Beach data.

²² Martin Associates, “The Anatomy of the Container Terminal Logistics,” 14.

Exhibit 4

TEUS per ILWU Hour

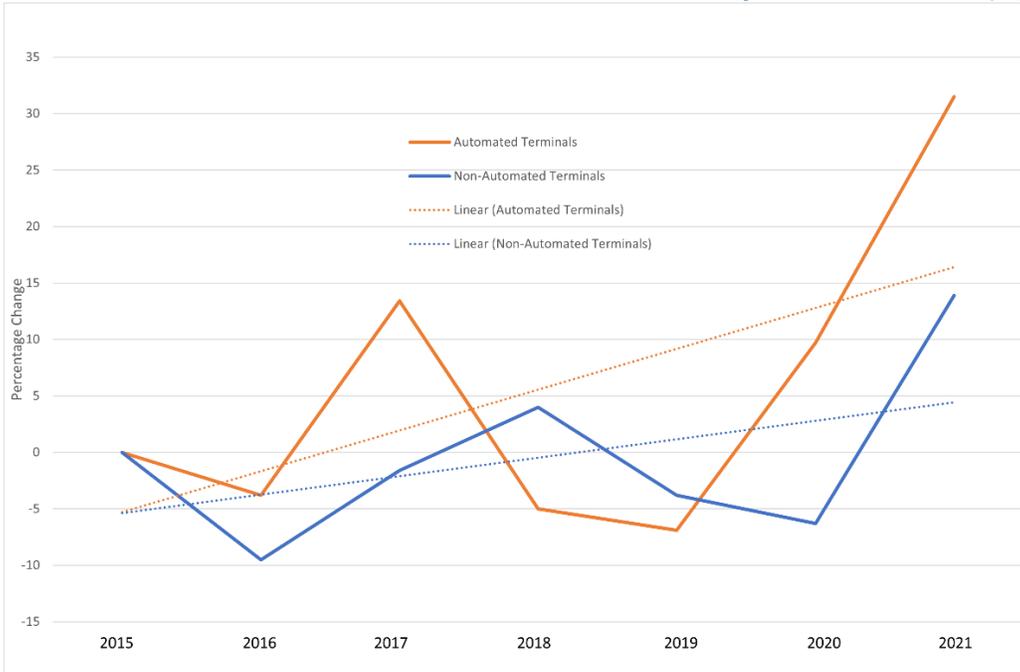


Source: Martin Associates

As a result, cargo handling has grown rapidly, and paid hours for ILWU workers at LBCT and TraPac were 31.5% higher in 2021 than in 2015, before the transition to automation began. (Exhibit 5) That is more than twice the 13.9% growth in paid hours at San Pedro Bay’s non-automated terminals.²³ Rather than reducing work for ILWU members, automation has raised demand for their services.

Exhibit 5

Cumulative Growth in Paid ILWU Hours at San Pedro Bay Ports 2015-2021 (%)



Source: PMA and Ports of Los Angeles and Long Beach

²³ PMA and Ports of Los Angeles and Long Beach data. Paid hours exclude mechanics and port guards.

As mentioned above, while automation may eliminate certain dock jobs, it will also create opportunities for workers to be retrained and upskilled for new jobs that port modernization generates. San Pedro Bay port management and terminal operators have already invested significantly in training programs, and in February, they broke ground on a 20,000-square-foot training center. Workers also have a significant financial safety net. The current labor contract includes a Pay Guarantee Plan that ensures up to 40 hours of weekly income if an eligible ILWU member is unable to obtain fulltime work for any reason, including automation. This weekly income is guaranteed until retirement.

Automation is offering early proof of a win-win strategy: Work gains for ILWU members and productivity and efficiency gains that will drive up growth, drive down cargo-handling costs, and help restore the San Pedro Bay ports' competitive advantage.

Automation and Sustainability

Since we addressed the issue of environmental sustainability planning in 2019,²⁴ the global climate change crisis has only worsened. Ports and ocean carriers around the world are investing billions of dollars to mitigate this crisis, and automation plays an important role. At the most advanced ports in Europe and Asia, automated operations have significantly reduced carbon emissions.

West Coast ports operate under some of the strictest environmental regulations in the country, and the ports of Los Angeles and Long Beach have adopted a plan calling for emission reductions beyond California state regulations. The San Pedro Bay Ports Clean Air Action Plan (CAAP) recognizes the role of automation in achieving sustainable freight movement. It targets the reduction of greenhouse gases to 40% of 1990 levels by 2030 and requires terminals to operate zero-emission equipment by then as well.

Replacing traditional diesel-powered cargo-handling equipment with electric and hybrid-electric equivalents brings measurable environmental and health benefits for workers and residents of neighboring communities. In addition to lower or zero emissions from the autonomous vehicles and cranes themselves, automation reduces emissions by making terminals more efficient so that trucks don't idle as long in the container yard. Emissions of diesel soot, nitrogen oxide (a component of smog), and other greenhouse gases are lower than those at conventional terminals. It is also important to note that electric power on the West Coast is generated largely from clean, renewable sources, with some from natural gas – but none from coal.

A body of research, such as a U.S. Maritime Administration report from 2020 finds that automation is an essential tool in promoting the goal of zero emissions at existing terminals.²⁵ Faster adoption of automation will be needed to comply with the CAAP and the likely calls for even more stringent environment regulations.

Conclusion

Container volume at San Pedro Bay ports during the Covid-19 pandemic soared to a level that was not projected for several years. In addition to causing short-term disruptions in the supply chain, the import surge spotlighted long-term competitive threats to their dominance as gateways for trade with Asia. To overcome capacity constraints in or to stanch discretionary cargo losses and ultimately win back business from ports on the East Coast, Gulf Coast and British Columbia, Los Angeles and Long Beach must boost throughput and deliver efficiencies that can narrow cost differentials.

²⁴ Michael Nacht, Larry Henry, and John Martin, "Sustaining the San Pedro Bay Community Ports of Los Angeles & Long Beach," April 2019.

²⁵ Ellen Schenk, Edward Carr, James J. Corbett, and James J. Winebrake, "Macroeconomic and Environmental Impacts of Port Electrification: Four Port Case Studies," August 2020.

As it has worldwide, automation can contribute to strategic growth at the San Pedro Bay ports. Accommodating greater volumes can be realized only by densifying the limited, finite space at the complex. As LBCT and TraPac demonstrate, autonomous electric vehicles and stacking cranes are producing significant gains in throughput, productivity and efficiency, resulting in more hours than ever for workers.

Like other technological advancements, automation arouses fears of job losses. Yet the LBCT and TraPac terminals show that it can be a win-win: Cargo-handling growth is yielding gains for labor on the docks. And since ports are at the beginning and the end of the supply chain, they have a multiplier effect on job creation throughout the economy.

“History and economics show no intrinsic conflict among technological change, full employment, and rising earnings,” the MIT study on the future of work concluded.²⁶

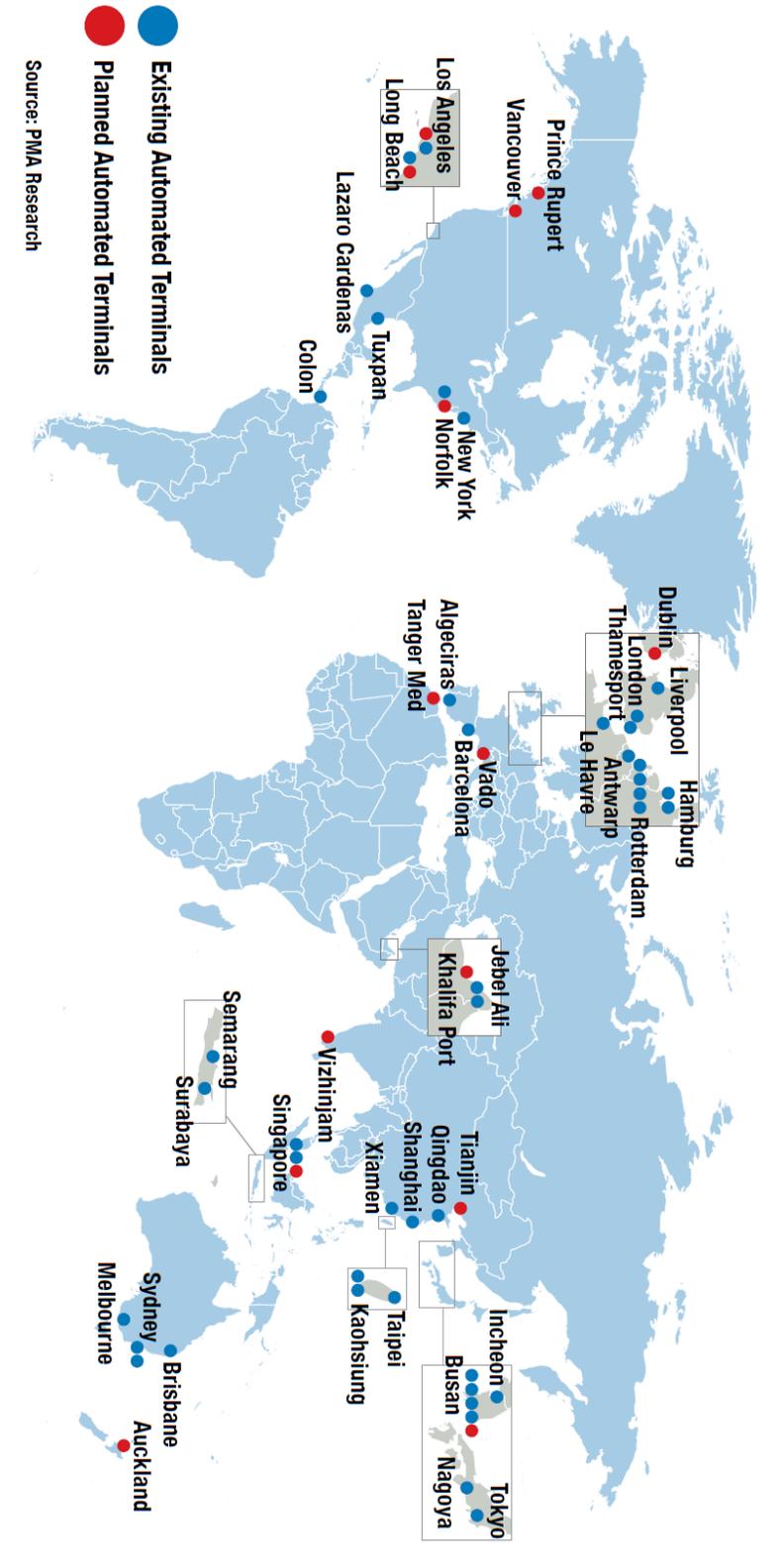
Modernization changes the job mix, requiring investment in training workers for new roles that technology creates. Automation takes years to implement, giving terminal operators and labor unions time to jointly prepare. And not all workers will be affected. In the San Pedro Bay complex, two of 13 container terminals have automated and just two others are currently moving forward with the transition.

Automation offers the ports of Los Angeles and Long Beach a strategy for environmentally sustainable growth that benefits the health of local communities and continues to drive the local economy. Conversely, failing to modernize risks further cargo losses, threatening jobs, wages, and tax revenue essential to Southern California’s economic vitality.

²⁶ Autor et al., “The Work of the Future: Building Better Jobs in an Age of Intelligent Machines,” 3.

Appendix A

Detailed Global Map of Existing and Planned Container Terminals



Appendix B

The ILWU, Modernization and Automation

The Mechanization and Modernization Agreement of 1960 marked a historic milestone, and created a framework for the ILWU's eventual acceptance of automation. "No matter how great the members' resistance to change," the ILWU wrote in an account of the 1960 contract, "...Clearly the time had come to reexamine labor relations in the light of the mechanization and modernization of West Coast longshoring."²⁷

The agreement removed restrictions on introducing labor-saving devices, as well as removing unnecessary workers and work practices which impeded the efficient flow of cargo. In return, the union received an unprecedented series of benefits, designed to protect workers from the negative impact of machines on their daily work and job security. Among the provisions:

- The current workforce would not be laid off. If the unhindered introduction of machinery and work methods required reducing the workforce, voluntary retirement would be offered, starting with senior ILWU members. If further cuts were needed, employers could invoke a compulsory retirement provision with higher pension benefits.
- Increased profits would be shared with workers through increased wages and benefits.
- Machines and labor-saving devices would be introduced wherever possible to lighten the burden of hard and hazardous work.

Since the dawn of containerized cargo, technology has been vital to the growth of West Coast ports, creating new efficiencies and environmental benefits, as well as significant employment gains. In the past 20 years, the registered longshore workforce at the ports of Los Angeles Long Beach has grown by 52%. Here are some highlights of relations between the Pacific Maritime Association and the ILWU.

- **2002 – Technology.** The breakthrough agreement introduced modern technology to the waterfront, replacing clipboards and chalk with scanners, GPS and optical character recognition technology, and other improvements that enhanced productivity and enabled greater terminal throughput.
- **2008 – Automation.** The new contract contained provisions – still in effect – that included the right of West Coast port terminal operators to automate. It allowed for "fully mechanized and robotic-operated marine terminals."
- **2010 – Arbitration.** An arbitrator, jointly appointed by the ILWU and PMA, underscored the right to automate in determining "...the quid pro quo in 2008 was that the Union would secure new terminal facilities as maintenance and repair sites along with such work on new automated and longshore equipment which was a huge gain for the Union which in turn agreed to reinforce the Employers' right to utilize automated container handling equipment..."²⁸
- **2014 – New Arbitration.** This agreement carried forward the automation provisions, and added a new arbitration system that has resulted in more consistency and fewer on-the-job disputes.
- **2017 – Extension.** PMA and the ILWU agreed to an unprecedented three-year extension to 2022.

²⁷ International Longshore and Warehouse Union, *The ILWU Story*, <https://www.ilwu.org/history/the-ilwu-story/>

²⁸ Arbitrator's 2010 Decision, C-05-10, 9.