WESTERN HEMISPHERE READINESS SERIES

HRS RESILIENCE FOUNDATION

SECTOR READINESS ASSESSMENT 09

# Advanced Manufacturing & Industrial Capacity

*Industrial Capacity, Advanced Manufacturing, and Western Hemisphere Resilience*


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**About this series.** The Western Hemisphere Readiness Series is HRS Resilience Foundation's ongoing program of independent, sector-level research on critical infrastructure and strategic resilience across the Americas. Each Sector Readiness Assessment applies the HRS Readiness Cycle and the HRS Strategic Dependency Test to a distinct sector. This edition addresses advanced manufacturing and industrial capacity.

EXECUTIVE SUMMARY

# Advanced Manufacturing & Industrial Capacity

Manufacturing capacity is more than the ability to produce finished goods. It is the combined capability to transform materials, energy, information, technology, and skilled labor into physical products at the required levels of quality, volume, and speed.

Industrial resilience depends on more than factory count or aggregate manufacturing output. It depends on whether critical production can continue when an upstream supplier fails, whether capacity can be expanded when demand increases, whether damaged equipment can be repaired, whether production can be transferred to another qualified facility, and whether the industrial system can absorb new technologies without creating new single points of failure.

The COVID-19 period, subsequent supply disruptions, geopolitical tensions, and recent defense-production requirements have reinforced the importance of manufacturing depth, supply-chain visibility, skilled labor, production equipment, and surge capacity. U.S. federal policy has increasingly treated industrial capacity as an element of economic and national security. The current U.S. policy environment also places substantial emphasis on reliable and affordable domestic energy as an input to manufacturing; HRS treats this descriptively as a feature of the 2026 U.S. policy environment, not as an endorsement of any particular administration's approach. [1–6][8][9][12][13]

The Western Hemisphere contains a substantial but uneven industrial base. The United States and Canada provide advanced industrial, research, aerospace, defense, energy, and technology capabilities. Mexico is deeply integrated into North American manufacturing. Brazil provides the largest diversified industrial platform in South America, while other countries possess different combinations of manufacturing, processing, resource-based, and emerging industrial capabilities. [17–21]

This assessment examines strategic industrial optionality instead: the existence of more than one credible pathway to produce, repair, replace, or scale critical capabilities. No single country is expected to reproduce the same industrial structure or pursue self-sufficiency across all sectors.

CENTRAL FINDING

*Industrial resilience is determined less by the number of factories than by the number of viable production pathways available when normal conditions fail. A manufacturing system with ten facilities may remain vulnerable if all ten depend on the same machine-tool supplier, software platform, specialized component, material, energy corridor, or foreign production node. The HRS objective is not maximum localization; it is sufficient industrial depth, substitution capacity, and adaptability to preserve strategic choice over time.*

SECTION 01

# Strategic Context

Industrial capacity has historically been treated primarily as an economic variable. That framing is increasingly inadequate for systems that support defense, energy, transportation, communications, health, food, infrastructure, and advanced technology alike. The industrial base determines whether a country can convert resources and technology into physical capability, and how quickly that capability can be restored after disruption.

The Department of Defense has identified industrial capacity as a long-term national-security concern; the 2026 National Defense Strategy describes the defense industrial base as foundational to the ability to develop, produce, sustain, and transport military equipment. The Government Accountability Office has separately documented the complexity of the U.S. defense supply network, identifying foreign-source dependence and limited visibility into lower-tier suppliers as persistent risks. [5][6]

The issue extends well beyond defense. Industrial production depends on energy, materials, ports, telecommunications, digital systems, water, transportation, financing, skilled labor, and regulatory capacity. HRS accordingly treats industrial capacity as strategic infrastructure in its own right — a driver of economic performance, not just a downstream reflection of it.

SECTION 02

# Industrial Capacity as Strategic Infrastructure

A conventional manufacturing analysis often begins with the finished product. HRS begins earlier: the relevant unit of analysis is the production capability required to create, maintain, repair, replace, and scale the product itself.

| LAYER | EXAMPLES | READINESS QUESTION |
|---|---|---|
| **Materials** | Metals, polymers, chemicals, composites | Can required materials be obtained or substituted? |
| **Production equipment** | Machine tools, furnaces, presses, CNC systems | Can production equipment be obtained, repaired, or replaced? |
| **Components** | Motors, bearings, valves, electronics, sensors | Can critical components be sourced from qualified alternatives? |
| **Manufacturing** | Assembly, machining, casting, forging, processing | Is qualified capacity available at required scale? |
| **Tooling** | Dies, molds, fixtures, specialized tooling | Can production be transferred or replicated? |
| **Software / controls** | CAD/CAM, industrial software, automation, controls | Can production continue if digital systems fail or change? |
| **Quality** | Testing, metrology, certification | Can alternative production be qualified? |
| **Workforce** | Engineers, machinists, technicians, operators | Can skilled personnel be sustained and replaced? |
| **Logistics** | Ports, rail, roads, warehouses | Can inputs and outputs continue moving? |
| **Energy** | Electricity, fuels, industrial heat | Can production remain operational under stress? |

> *HRS principle: the weakest non-substitutable production capability determines the resilience of the entire industrial system.*

SECTION 03

# HRS Analytical Framework

This assessment applies the HRS Readiness Cycle — Baseline, Exposure, Dependency, Continuity, Recovery, Adaptation — combined with the HRS Strategic Dependency Test, which evaluates criticality, concentration, substitutability, recovery time, infrastructure dependence, technology dependence, workforce dependence, and regulatory friction.

| FUNCTION | CORE QUESTION | ILLUSTRATIVE APPLICATION |
|---|---|---|
| **Baseline** | What industrial capability exists today? | Factories, production lines, machine tools, components, and technical centers |
| **Exposure** | What can disrupt it? | Trade restrictions, disasters, energy failure, cyber incidents, equipment loss |
| **Dependency** | What cannot easily be replaced? | Specialized machinery, common upstream components, software, materials |
| **Continuity** | How does production keep operating? | Inventory, alternate suppliers, spare capacity, repair and transfer |
| **Recovery** | How quickly can capability return? | Restart, equipment replacement, qualification, and workforce recovery |
| **Adaptation** | How does the system improve? | Automation, new materials, advanced manufacturing, industrial learning |

THE HRS PRODUCTION OPTIONALITY TEST

*If the primary production pathway fails, how many technically qualified and operationally credible alternatives exist — and how long would it take to activate them? A nominal second supplier does not constitute effective redundancy if both suppliers depend on the same upstream material, machine, software, component, logistics corridor, or foreign processing facility.*

SECTION 04

# Global Industrial Architecture and Strategic Dependencies

Modern manufacturing is distributed across countries and continents. This distribution can increase efficiency while simultaneously creating dependencies that are difficult to observe. HRS distinguishes between geographic diversification and functional diversification; the latter is the more important measure, asking whether critical production capabilities themselves are independently available, regardless of how many countries a supply chain nominally touches.

| DEPENDENCY | STRATEGIC ISSUE | RESILIENCE RESPONSE |
|---|---|---|
| **Machine tools** | Long replacement cycles | Multiple qualified sources and maintenance capability |
| **Specialty materials** | Limited qualified suppliers | Alternative materials and processing pathways |
| **Components** | Common upstream suppliers | Component-level dependency mapping |
| **Tooling** | Specialized production molds/dies | Replicable tooling and backup capacity |
| **Industrial software** | Vendor concentration | Portability, documentation, and alternative systems |
| **Skilled labor** | Long training cycles | Workforce pipelines and cross-training |
| **Energy** | Production interruption | Reliability, backup, and recovery capacity |
| **Logistics** | Corridor disruption | Alternative routes and inventory positioning |
| **Capital equipment** | Long procurement periods | Spare capacity and equipment lifecycle planning |
| **Quality systems** | Slow qualification | Pre-qualified alternative production pathways |

SECTION 05

# The Western Hemisphere Industrial Landscape

The Western Hemisphere is not a single industrial system. It is a network of national industrial bases with different scales, specializations, resource endowments, infrastructure conditions, regulatory systems, workforces, and market structures. The descriptions below identify analytical roles only, in no particular order of importance, and each country retains full sovereign authority over its own industrial, regulatory, and investment policy.

## United States

The hemisphere's largest advanced industrial platform, with major capabilities in aerospace, defense, semiconductors, advanced machinery, pharmaceuticals, chemicals, energy equipment, automotive, digital manufacturing, industrial software, and research and development. The HRS issue of interest is the depth and recoverability of lower-tier suppliers and the ability to expand capacity rapidly. [4][5][7][11]

## Canada

Complementary industrial capabilities in aerospace, automotive, advanced materials, metals, energy, machinery, defense, and research. Its manufacturing relationship with the United States creates both scale and interdependence. [17]

## Mexico

One of the hemisphere's most important manufacturing platforms, deeply integrated with the United States in automotive, electronics, medical devices, machinery, electrical equipment, textiles, and aerospace. Plan México seeks to strengthen domestic manufacturing and supplier networks. [18]

## Brazil

The largest diversified industrial platform in South America, with capabilities in aerospace, automotive, steel, chemicals, machinery, oil and gas equipment, food processing, pharmaceuticals, biotechnology, and agricultural machinery. [19]

## Argentina

Capabilities across automotive, agricultural machinery, food processing, chemicals, pharmaceuticals, energy-related equipment, industrial services, and specialized manufacturing. INTI provides industrial technology and technical services to the sector. [20]

## Guyana

An emerging industrial node rather than a mature diversified manufacturing base. Industrial development is connected to energy, agro-processing, fertilizer, construction, food processing, mining-related activity, and industrial estates. [21]

## Chile

Industrial capabilities strongly associated with copper, mining equipment and services, advanced materials, chemicals, food processing, and energy technologies; recent initiatives emphasize greater value addition within the country rather than raw export alone. [22]

## Peru

Mining, food processing, chemicals, metalworking, textiles, construction materials, and industrial services. Current industrial-policy work emphasizes modernization, investment, industrial parks, digitalization, and competitiveness. [23]

## Colombia

Established manufacturing across food processing, chemicals, pharmaceuticals, automotive, metalworking, textiles, and industrial services, with reindustrialization efforts aimed at strengthening productive capacity. [24]

## Paraguay

Manufacturing associated with maquila operations, agro-processing, food, chemicals, plastics, and metalworking, providing an export-oriented production and assembly platform. [25]

## Uruguay

Food processing, forestry products, pulp and paper, chemicals, pharmaceuticals, specialized manufacturing, and logistics. Industrial-policy work toward 2050 emphasizes productivity, technology, and diversification. [26]

## Central America

A collection of specialized nodes in electronics, medical devices, pharmaceuticals, textiles, electrical equipment, agro-processing, light manufacturing, and logistics; capabilities differ substantially by country. [14][27]

## Caribbean

Smaller but strategically relevant industrial systems including agro-processing, pharmaceuticals, food production, maritime and logistics services, and specialized export manufacturing. For smaller economies, continuity of and access to external capacity may matter more than broad domestic coverage. [27]

SECTION 06

# Regional Manufacturing and Capability Nodes

| REGIONAL FUNCTION | ILLUSTRATIVE NODES | ANALYTICAL ROLE |
|---|---|---|
| **Advanced Production** | United States, Canada, Mexico | Advanced manufacturing, R&D, machinery, aerospace, defense, and technology |
| **Diversified Industrial Production** | United States, Mexico, Brazil, Argentina, Colombia | Broad industrial bases across multiple sectors |
| **Resource Processing** | Canada, Brazil, Chile, Peru, Argentina, Guyana | Converting resource endowments into industrial inputs and products |
| **Specialized Manufacturing** | Chile, Uruguay, Colombia, Costa Rica, selected Caribbean economies | Higher-value or sector-specific capabilities |
| **Export Manufacturing / Assembly** | Mexico, Central America, Dominican Republic, Paraguay | Export-oriented production and assembly |
| **Emerging Industrial Platforms** | Guyana and selected regional nodes | Potential to deepen processing and manufacturing as infrastructure and investment develop |

SECTION 07

# Critical Enablers: Energy, Materials, Logistics, Technology and Workforce

Industrial capacity cannot be separated from the infrastructure supporting it.

## Energy

Manufacturing requires reliable electricity and, depending on the process, industrial heat and fuels. The current U.S. policy environment explicitly links reliable and affordable energy with manufacturing capacity and national security; HRS treats energy reliability as an industrial readiness variable. [1][2][9]

## Materials

Materials connect this assessment directly to Sector Readiness Assessments 03 and 04. The central industrial question is whether minerals can be processed into industrial-grade inputs at sufficient scale, with alternative pathways available — location of extraction alone tells only part of the story.

## Logistics

Factories require ports, roads, rail, air cargo, warehouses, and customs systems — a direct linkage to Sector Readiness Assessment 06. [10]

## Technology

Advanced manufacturing increasingly depends on industrial software, sensors, automation, robotics, digital design, process controls, and additive manufacturing. Technology adoption can reduce some dependencies while creating new dependencies in software, equipment, data, and technical expertise. [7]

## Workforce

Industrial capability cannot be created solely through capital expenditure. Critical skills include machinists, welders, engineers, technicians, maintenance specialists, quality specialists, automation specialists, and industrial programmers. [7]

SECTION 08

# Western Hemisphere Industrial Resilience Architecture

HRS proposes a Western Hemisphere Industrial Resilience Architecture built around seven capabilities.

| CAPABILITY | PURPOSE |
|---|---|
| **01 — Industrial Capability Mapping** | Identify factories, production lines, machine tools, component suppliers, specialized processes, technical centers, and workforce concentrations |
| **02 — Production Depth** | Measure installed capacity, surge capacity, spare capacity, alternate facilities, and production transferability |
| **03 — Equipment & Tooling Resilience** | Identify production equipment whose loss could halt critical manufacturing |
| **04 — Component & Upstream Redundancy** | Map common upstream dependencies rather than simply counting finished-product suppliers |
| **05 — Industrial Workforce Continuity** | Measure workforce availability, training pipelines, replacement time, and knowledge retention |
| **06 — Recovery & Surge Capacity** | Evaluate how quickly industrial output can be increased or restored |
| **07 — Industrial Adaptation** | Measure the ability to absorb new production technologies, materials, automation, and changing requirements |

SECTION 09

# Sector Readiness Assessment Matrix

The HRS matrix compares production depth, equipment, components, tooling, workforce, energy, logistics, technology, surge capacity, and recovery. Its purpose is to identify specific industrial capabilities that could become bottlenecks under disruption.

| DIMENSION | HIGH READINESS | MODERATE | LOW READINESS |
|---|---|---|---|
| **Production depth** | Multiple qualified pathways | Limited redundancy | Single-path dependency |
| **Equipment** | Multiple sources / repair | Partial alternatives | Critical single-source equipment |
| **Components** | Diversified upstream | Some concentration | Common upstream failure point |
| **Tooling** | Replicable / distributed | Partial redundancy | Specialized single source |
| **Workforce** | Deep / replaceable | Moderate shortage | Critical skill bottleneck |
| **Energy** | Reliable / recoverable | Partial backup | High disruption exposure |
| **Logistics** | Multiple validated routes | Primary + alternatives | Single corridor |
| **Technology** | Interoperable / adaptable | Partial portability | High vendor dependence |
| **Surge capacity** | Rapid expansion possible | Limited expansion | Little or no surge |
| **Recovery** | Short restart cycle | Moderate | Long recovery |

SECTION 10

# Strategic Outlook: 50-Year and 100-Year Horizons

HRS evaluates industrial resilience across a 50-year horizon (2026–2076) and a 100-year horizon (2026–2126), with 2030, 2050, and 2075 used as intermediate reference points.

| REFERENCE | STRATEGIC QUESTION | HRS EMPHASIS |
|---|---|---|
| **2030** | Can critical production bottlenecks be reduced? | Supplier mapping, equipment, workforce, energy reliability, and component redundancy |
| **2050** | Has durable industrial depth been established? | Advanced manufacturing, regional nodes, automated production, equipment capability, and workforce |
| **2075–2126** | Can industrial systems adapt faster than strategic dependencies accumulate? | Distributed production, technology transition, industrial learning, adaptable production systems |

The objective is not to predict which technologies will dominate. It is to build industrial systems capable of learning, adapting, reconfiguring, producing, and recovering across multiple technological generations.

HRS 100-YEAR PROPOSITION

*The most resilient industrial system is not the one that predicts the future most accurately. It is the one capable of changing production faster than vulnerabilities accumulate.*

SECTION 11

# Implications for the United States

Western Hemisphere industrial capacity bears directly on U.S. economic and national-security interests. The 2026 U.S. policy environment places strong emphasis on domestic manufacturing, industrial capacity, reliable energy, critical materials, supply-chain security, and defense production. HRS identifies potential areas of relevance for U.S. departments and agencies below as a descriptive mapping only; it carries no recommendation that any U.S. agency intervene in another country's industrial policy. [1–6][8–10]

| U.S. DEPARTMENT / AGENCY | POTENTIAL INTEREST |
|---|---|
| **Department of State** | Economic diplomacy, industrial partnerships, strategic access, and regional capacity |
| **Department of Defense** | Defense industrial capacity, production, maintenance, logistics, and partner capacity |
| **Department of Commerce** | Manufacturing, trade, investment, standards, and industrial competitiveness |
| **Department of Energy** | Industrial energy reliability, advanced manufacturing, and critical materials |
| **U.S. Trade Representative** | Market access, rules of origin, trade barriers, and supply-chain architecture |
| **Department of Transportation / MARAD** | Industrial logistics and maritime capacity |
| **NIST** | Advanced manufacturing standards, measurement, and technology adoption |
| **Small Business Administration** | Small and medium manufacturer participation and capacity expansion |
| **DFC** | Financing of strategically relevant infrastructure and industrial projects |
| **EXIM Bank** | Export financing and industrial equipment markets |
| **USDA** | Agricultural manufacturing and processing capacity |
| **HHS / ASPR** | Medical manufacturing and supply continuity |
| **Department of Homeland Security** | Critical infrastructure and supply-chain security |

## Sovereignty and National Authority

Each country retains sovereign authority over industrial policy, taxation, regulation, investment, procurement, natural resources, national security, foreign investment, and trade policy. HRS evaluates the systemic consequences of industrial conditions, not the legitimacy of national policy choices.

### Foreign Strategic Participation

Foreign investment and foreign technology can increase industrial capacity, capital availability, and technology transfer. They can also create new dependencies. HRS evaluates each case on its own terms — ownership, control, equipment, maintenance, data, replaceability, spare parts, and common dependencies — rather than treating foreign participation as categorically safe or unsafe.

SECTION 12

## Cross-Series Linkage

| ASSESSMENT | CONNECTION TO THIS ASSESSMENT |
|---|---|
| **SRA 03 — Critical Minerals & Strategic Materials** | Provides material inputs and dependency analysis |
| **SRA 04 — Rare Earths & Western Hemisphere Mineral Security** | Provides specialized materials and processing analysis |
| **SRA 05 — Energy Security & Strategic Power Infrastructure** | Provides the energy required for industrial production |
| **SRA 06 — Ports, Logistics & Maritime Infrastructure** | Moves industrial inputs and finished products |
| **SRA 07 — Food Security & Strategic Agricultural Resilience** | Provides agricultural production, processing, and industrial inputs |
| **SRA 08 — Pharmaceutical & Medical Supply Chains** | Provides a sector-specific example of manufacturing depth and critical upstream dependencies |

Sector Readiness Assessment 09 connects these prior assessments through the lens of industrial production capability. Readers assessing hemispheric resilience comprehensively are encouraged to consider the series together.

SECTION 13

## HRS Research Priorities and Decision Framework

| PRIORITY | RESEARCH FOCUS |
|---|---|
| **Industrial Capability Mapping** | Which industrial capabilities are strategically important? |
| **Equipment Dependency** | Which machine tools and production systems have long replacement cycles? |
| **Component Mapping** | Which components create common upstream dependencies? |
| **Surge Capacity** | Where can production be expanded rapidly? |
| **Industrial Transferability** | Can production be moved from one facility to another? |
| **Workforce Readiness** | Which skills are difficult to replace? |
| **Energy Exposure** | Which industrial clusters depend on constrained energy infrastructure? |
| **Technology Adaptability** | Can production systems absorb new technologies? |
| **Recovery Time** | How long would it take to restore lost production? |
| **Investment Feasibility** | Which interventions can create durable operating capability rather than temporary capacity? |

SECTION 14

## Methodology, Research Integrity and Limitations

This publication applies the HRS Readiness Cycle and the HRS Strategic Dependency Test, proprietary HRS Resilience Foundation methodologies developed across the Western Hemisphere Readiness Series. Priority is given to official U.S. Government sources, national government sources, defense and industrial strategy documents, official trade and economic data, established research institutions, and established think tanks and technical organizations.

This assessment stops short of assigning definitive national industrial-readiness scores. Industrial capacity changes continuously through investment, plant closures, technology adoption, trade policy, workforce changes, infrastructure development, ownership changes, and regulatory changes; country roles are therefore analytical descriptions rather than permanent classifications. Company-level procurement or investment recommendations and a single prescribed industrial model for the hemisphere both fall outside the scope of this work.

> **Originality statement.** The analysis and synthesis are original to HRS Resilience Foundation; source material has been paraphrased and integrated into the HRS analytical framework rather than reproduced.

SECTION 15

# Conclusion

Industrial capacity is the physical foundation beneath many forms of strategic resilience. A country may possess abundant resources and advanced technology yet remain exposed if it cannot convert those resources into physical production at sufficient scale. Likewise, a region may possess multiple factories while remaining vulnerable if those factories share the same upstream dependencies.

The Western Hemisphere possesses substantial industrial assets: advanced manufacturing, natural resources, energy, research institutions, skilled workforces, large markets, transportation infrastructure, and specialized production clusters. The analytical challenge is understanding how those assets connect.

> *Not: how much does a country manufacture? But: how many viable pathways exist to produce, repair, replace, and scale what matters?*

HRS PROPOSITION — INDUSTRIAL OPTIONALITY

*A resilient industrial system maintains more than one credible pathway to critical production — supported by equipment, materials, energy, logistics, workforce, and technology capable of sustaining those pathways through disruption and adapting them across generations. The objective is not industrial isolation; it is strategic choice. A Western Hemisphere capable of producing, repairing, replacing, and adapting critical industrial capabilities possesses greater capacity to withstand disruption without surrendering national decision-making or technological flexibility.*

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WESTERN HEMISPHERE READINESS SERIES

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Independent research for institutional readiness, continuity, and 50-year resilience planning across the Western Hemisphere. The Western Hemisphere Readiness Series applies the HRS Readiness Cycle to critical sectors, translating public-source evidence into practical frameworks built to remain valid for governments, infrastructure operators, investors, and institutional decision-makers across changes in technology, suppliers, and political leadership.

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