Growth Lab

Green Growth Opportunities for Hermosillo: Supplying the Global Energy Transition

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Executive Summary

As the world decarbonizes, demand for products which enable the green transition will increase rapidly. Solar panels and wind turbines will be needed to generate renewable energy, and critical minerals like copper and lithium will be required for wiring and batteries. Many other products and services within supply chains for such "green products" have a similar dynamic but are less widely known. While reducing carbon emissions often comes in conflict with economic development goals, producing the products that enable the world to decarbonize presents a significant opportunity for places to diversify their economies and generate income for their citizens.

This section analyzes Hermosillo's opportunities to produce green products. We analyze the industries which produce these green products and Hermosillo's capabilities in those industries in the most granular detail that data currently allows. We find not only that Hermosillo can produce products needed for the green transition and thus capture new sources of income for its people and businesses, but also that many of these products are good stepping stones for future economic activities. In the process of learning how to produce these products, Hermosillo can better enable further diversification opportunities. We classify these opportunities accordingly, along both the intensive margin — industries in which Hermosillo already has a revealed comparative advantage — and the extensive margin, in which it does not.

The most immediate green opportunity for Hermosillo lies in the mining of metals. Critical minerals required for the green transition, such as lithium and copper, are present in Sonora, but recent federal policy changes threaten expansion and productivity. The Government of Sonora needs to leverage its experience dealing with mining interests, environmental issues, and the demands of local communities to help co-produce mining policies which are both sustainable and productive. These can have positive spillovers in Hermosillo in the form of mining services growth and the location of mining company headquarters in the city, as in the past.

Overall, Hermosillo has opportunities to leverage the green transition to help diversify its economy, but is not as well positioned as peers. Hermosillo will need to coordinate investment efforts in order to compete with peer cities, who are better positioned to take advantage of these opportunities today. Industries such as manufacturing of electronic components and semiconductors and manufacturing of plastics products are among the more feasible and attractive industries for Hermosillo to target for promotion. Coordinating the manufacturing of green inputs with efforts to take advantage of solar energy resources is a strong strategy for the city. Large solar parks will need to be constructed to harness the cities' solar energy resources. By using the planned build-out of these industries as a source of final demand, Hermosillo may be able to out-compete peer cities in attracting a solar panel OEM, which would help diversify the city into electronic components and semiconductors, as well as into the manufacturing of electric generation equipment.

1. Introduction

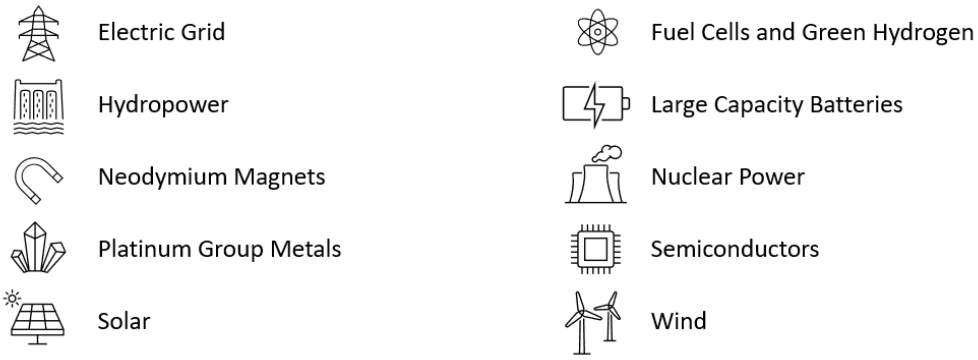
Decarbonizing the world economy will require producing and trading many products to enable electrification and changes in production processes. In this report, we will refer to these as "green products". To understand the growth opportunities for Hermosillo that arise from the increase in demand for these products, it is necessary to both identify specific products in green value chains, and to characterize Hermosillo's current economy. This will allow us to overlay these green opportunities against Hermosillo's capabilities and explore both the feasibility and the attractiveness of green opportunities.

Global decarbonization could create new opportunities for Hermosillo to advance existing industries and to diversify its economy. Hermosillo may improve on both the intensive and the extensive margin in supplying products and technologies involved in green value chains. Taking advantage of opportunities on the intensive margin would mean making sure that industries which are already more mature in Hermosillo increasingly produce products that are needed in green value chains. Taking advantage of opportunities on the extensive margin would mean diversifying into new or very nascent industries which produce the products needed for green value chains.

Decomposing green value chains into their intermediate products informs the set of green growth opportunities. For example, solar panels require silicon wafers, glass, and copper, while large-capacity batteries require cobalt, lithium, and steel heat exchangers. The Growth Lab formed an understanding of these green value chains and several others by analyzing several reports published by the US Department of Energy, the International Energy Agency, and other reports relevant to their respective fields.[1] These reports were analyzed by a team of researchers at the Growth Lab, together with algorithms using semantic matching using word embedding, and few-shot learning using LLM's by OpenAI. Ultimately, this work produced detailed, decomposed value chains for critical green technologies in the form of 6-digit product codes. These value chains are listed in Figure 1 below.

[1] In February 2022, the U.S. Department of Energy (DOE) published "America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition", the first comprehensive US government plan to build an Energy Sector Industrial Base. The strategy examines technologies and crosscutting topics for analysis in response to Executive Order 14017 on America's Supply Chains and is part of a whole of government approach to chart a course for revitalizing the U.S. economy and domestic manufacturing by securing the country's most critical supply chains.

Figure 1: Green Value Chains



To understand Hermosillo's opportunities within these value chains, one must evaluate industries rather than products due to data availability. For this report, we map green value chain product codes to industry NAICS codes to identify industries that produce these green products, which then allows for merging with Mexican data from the Economic Census, Population Census and the Directorio Estadístico Nacional de Unidades Económicas (DENUE). The list of relevant green industries, at the 4-digit SCIAN level, is produced in Figure 2 below. It is important to note that the process of moving from 6-digit product codes to 4-digit industry codes introduces noise.[2] Despite the noise introduced by these data limitations, this work still produces a useful signal in identifying feasible and attractive green opportunities for Hermosillo's economic growth prospects. As Figure 2 demonstrates, the located industries are focused in the manufacturing and mining sector. This reflects the fact that they produce physical inputs needed to build green technologies in the value chains highlighted above.

[2] As an example, products as specific as "semiconductors" are found to be produced at the 4-digit level by industry 3344, the "fabrication of electronic components", which is a far less specific designation. Therefore, if a city has a presence in this industry at the 4-digit level, it does not imply that that city is producing semiconductors. In this report, we treat this presence as implying that the city is closer to having the capability to fabricate semiconductors than a city which does not have presence in this industry. As such, measures of "presence" are similar to measures of "proximity," and we treat them accordingly in this analysis.

Figure 2: Green Industries at the 4-Digit SCIAN Level

SCIAN	SCIAN Description	Industry Complexity Index, 2020	Number of Products	Green Value Chains	Example Products
2122	Minería de minerales metálicos	-0.70	23	Electric Grid, Fuel Cells and Green Hydrogen, Large Capacity Batteries, Neodymium Magnets, Nuclear Power, Platinum Group Metals, Semiconductors, Solar, Wind	Aluminum, Antimony (Sb), Chromium, Cobalt, Manganese, Titanium (Ti), Van...
2123	Minería de minerales no metálicos	-0.63	8	Electric Grid, Large Capacity Batteries, Solar	Fluorspar (CaF2), Clay/Sand, Flourspar/Apatite/ Cryolite, Kaolin, Petunt...
3261	Fabricación de productos de plástico	1.33	7	Electric Grid, Fuel Cells and Green Hydrogen, Large Capacity Batteries, Solar, Wind	Bushings, Conservator Bladder, Fiber Reinforced Polymer Rod, Polymer, Du...
3311	Industria básica del hierro y del acero	0.50	22	Electric Grid, Fuel Cells and Green Hydrogen, Large Capacity Batteries, Nuclear Power, Semiconductors, Solar, Wind	Anti-corrosion steel pipes, Low-carbon pipeline steel, Stainless Steel, ...
3313	Industria básica del aluminio	2.00	5	Electric Grid, Fuel Cells and Green Hydrogen, Neodymium Magnets, Nuclear Power, Solar, Wind	Alumina, Aluminum, Plates, Aluminum (Al) alloys
3314	Industrias de metales no ferrosos, excepto aluminio	1.75	34	Electric Grid, Fuel Cells and Green Hydrogen, Large Capacity Batteries, Nuclear Power, Platinum Group Metals, Semiconductors, Solar, Wind	Bismuth (Bi), Hafnium, Magnesium (Mg), Cointinuosly Transposed Conductio...
3336	Fabricación de motores de combustión interna, turbinas y transmisiones	2.25	10	Hydropower, Nuclear Power, Solar, Wind	Generator, Governor, Headcover, Hydropower Plant, Hydropower Turbine, Ru...
3344	Fabricación de componentes electrónicos	1.79	15	Electric Grid, Fuel Cells and Green Hydrogen, Hydropower, Large Capacity Batteries, Neodymium Magnets, Semiconductors, Solar, Wind	Arrestor, Ceramic, Converter, Inductor, Resistor, Semiconductor, Tap Cha...
3345	Fabricación de instrumentos de medición, control, navegación, y equipo médico electrónico	2.00	6	Fuel Cells and Green Hydrogen, Neodymium Magnets, Nuclear Power, Solar	Control system, Dispensing system, Fire and gas detection system, Gas in...
3352	Fabricación de aparatos eléctricos de uso doméstico	1.89	3	Neodymium Magnets, Nuclear Power	Flash drums, Wind Turbine Scrap, Auxiliary building exhaust adsorber, Hi...
3353	Fabricación de equipo de generación y distribución de energía eléctrica	2.21	12	Electric Grid, Fuel Cells and Green Hydrogen, Hydropower, Neodymium Magnets, Nuclear Power, Solar, Wind	AC Switchyards, Arc Extinguishing Insulator, Complete Transformer Assemb...
3363	Fabricación de partes para vehículos automotores	0.44	4	Fuel Cells and Green Hydrogen, Nuclear Power, Solar	Filter, Purification tanks, Gas Diffusion Layer, Air intake intake lower...

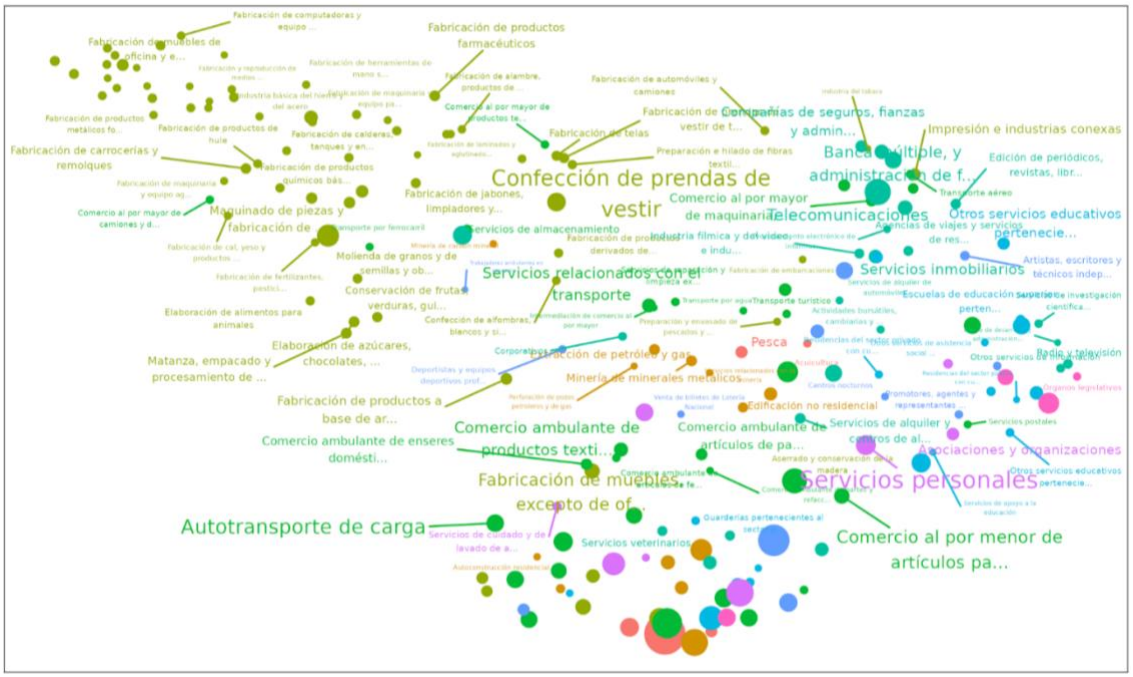
Source: Own calculations from INEGI Population Census 2020; Growth Lab Green Value Chains

2. Overview of Hermosillo's Productive Capabilities

Characterizing Hermosillo's productive capabilities make it possible to evaluate the feasibility of new opportunities. Following Hausmann et al., 2014, we use patterns of industry presence to characterize the productive knowledge of each Mexican city. Places with more productive knowledge will have the ability to successfully host a diversity of industries, while places with less productive knowledge concentrate in fewer and simpler ones. Since places tend to successfully diversify into industries which require similar capabilities, characterizing the productive capabilities of a place is useful for determining the feasibility of targeting a particular industry for diversification (the subject of the next chapter).

Hermosillo's productive capabilities can be visualized using an industry space. The industry space shown in **Error! Reference source not found.** uses the 2020 population c ensus of Mexico to identify co-location patterns of industry employment in cities across all of Mexico. This is constructed using industry categories at the 4-digit SCIAN level, imputing data to more precise levels using the DENUE as a reference where appropriate. Each node in this space represents an industry and sizes represent job totals. The nodes are sized according to the total employment in that industry in 2020, and are colored by their sector, as defined by the first digit in the SCIAN classification.

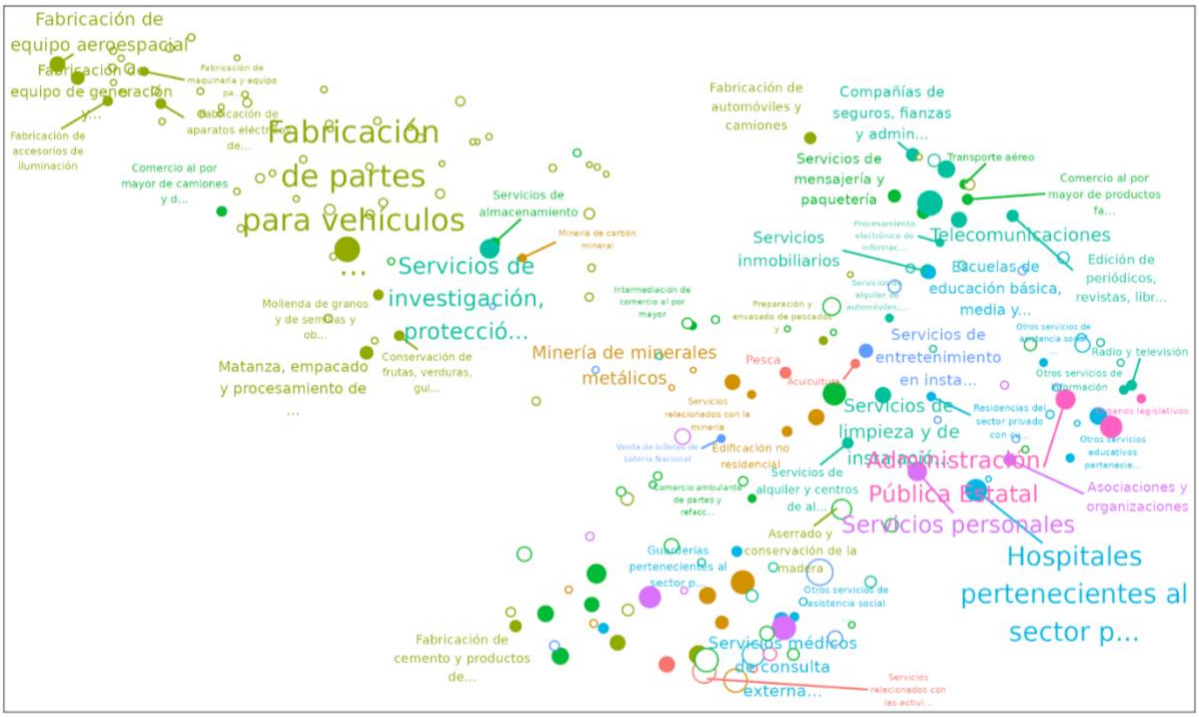
Figure 3: Mexico's Industry Space



Source: Own calculations from INEGI Population Census, 2020

The complete industry space captures empirical patterns of industry relatedness in Mexico. Industries that are nearby to each other likely require similar productive capabilities. When this two-dimensional space is plotted to best capture observed industry similarity based on co-location patterns, there are several noteworthy features that result. There is a clear manufacturing cluster in the upper-left corner, indicating that these industries are most commonly found in the same places. The bottom of the chart contains the agriculture industry (the largest red-colored node in the bottom) and a host of other low-complexity "primary" industries such as construction, drink production, the retail of groceries, and the retail of street food. The right side of the chart shows mostly education services, hospital services, other professional services, and public administration. Figure 4 shows Hermosillo's position within Mexico's industry space. That is, it shows in which industries Hermosillo expresses a "revealed comparative advantage" in. These are industries in which Hermosillo has a larger share of its employment than the national average. Here, nodes are sized by industry employment in Hermosillo.

Figure 4: Hermosillo in the Industry Space



Source: Own calculations from INEGI Population Census, 2020

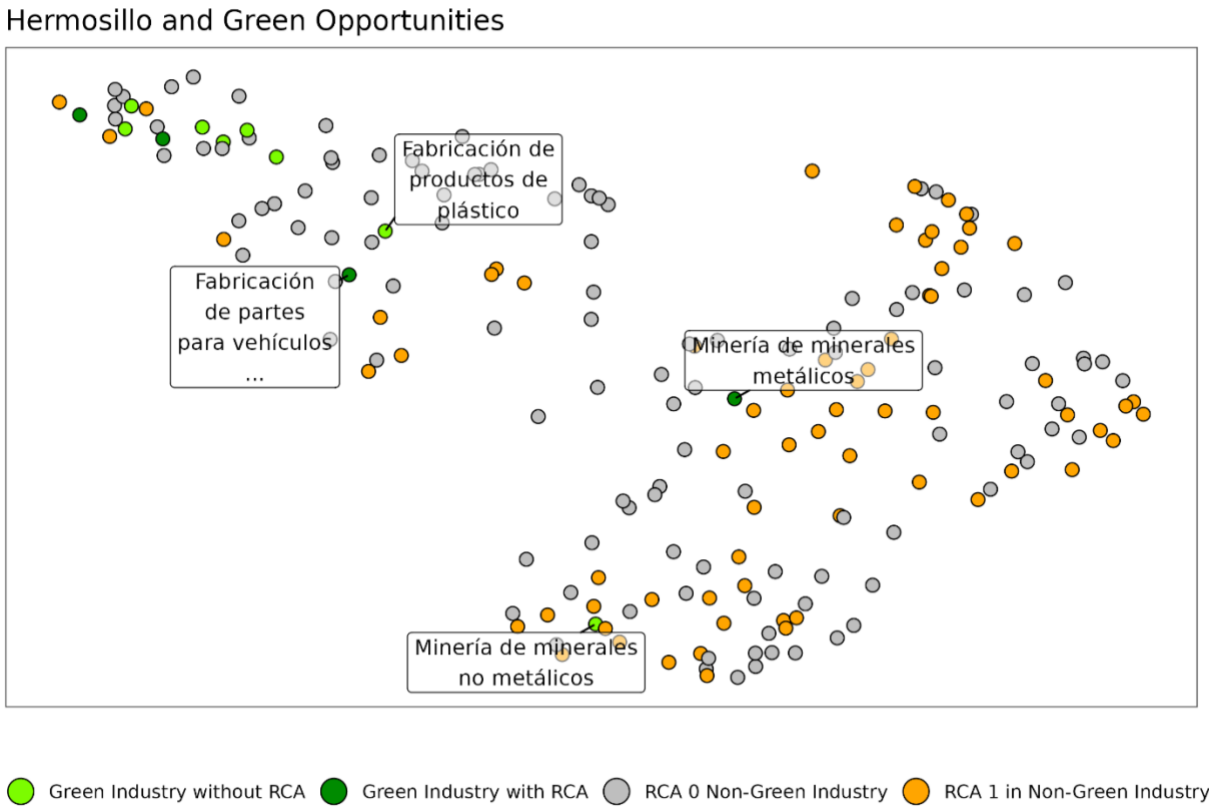
Hermosillo's manufacturing capabilities are heavily concentrated in the manufacturing of vehicle parts. This figure demonstrates that Hermosillo's manufacturing sector is concentrated in the fabrication of parts for vehicles, but it is also present in aerospace manufacturing and the production of electricity generation equipment. Mining of metals and mining services show in orange nodes towards the middle of the space. In the upper-right corner of the space, we observe Hermosillo's

significant presence in many professional services industries as well. Given the green industries shown in Table 1, manufacturing and mining industries are especially important in the analysis of this report.

3. Feasibility of Green Industries in Hermosillo

Since green industries are known and Hermosillo's productive capabilities are known, identifying the most feasible industries is essentially about looking for the overlap between the two. In Figure 5, we overlay industries that produce green products onto the above-mentioned industry space to visualize Hermosillo's relative position to these opportunities. This again captures that many of the industries that make products used in green value chains are in the manufacturing sector. It shows that Hermosillo has presence in a few, such as the fabrication of electricity generation equipment, and electrical apparatus for domestic use, which are highlighted in dark green. In light green are industries that produce products for green value chains in which Hermosillo does not have a revealed comparative advantage currently.

Figure 5: Hermosillo and Green Industries



Source: Own calculations from INEGI Population Census 2020; Growth Lab Green Value Chains

Hermosillo has several prominent green growth opportunities that appear to be mature in Hermosillo today (dark green nodes where RCA>1 in Hermosillo). Several

of these industries are labeled in the figure. The following table (Figure 6) also lists promising green industries with several descriptive statistics. However, due to the noise that results from matching highly granular products to less granular industry categories, Hermosillo's presence in dark green industries (such as the manufacturing of electricity generation equipment) does not guarantee that these industries are already producing green products. It does imply that Hermosillo likely has related capabilities, though. Capitalizing on these opportunities (the intensive margin) would mean making sure that firms in these industries produce products needed for green value chains and scale up connections with buyers, especially in international markets.

Hermosillo also has a set of not-yet-mature industries that represent green growth opportunities. The light green opportunities represent opportunities on the extensive margin. These are industries in which Hermosillo is not yet as mature (e.g., manufacturing of plastic products where RCA=0.25) or in which Hermosillo has little to no employment currently (e.g. basic iron and steel production where RCA=0). Following Hausmann et al., 2014, we expect that it is more feasible for places to diversify into industries that are near their existing industries in the space. We quantify this feasibility metric as "density", which is the average distance from Hermosillo's present industries to the target industry. Figure 6 provides a simple table of the green industries ranked by density. The table shows the complexity index of the industry, Hermosillo's presence in that industry in 2020 based on RCA, the density of that industry to Hermosillo, and the Complexity Outlook Gain to Hermosillo. These are all relevant variables to consider when targeting industries for active investment promotion or other industrial policies.

Figure 6: Green Industries in Relation to Hermosillo

SCIAN	SCIAN Description	Industry Complexity Index, 2020	RCA in 2020	Density to Hermosillo	Complexity Outlook Gain to Hermosillo
3363	Fabricación de partes para vehículos automotores	0.44	1.39	0.67	0.00
2122	Minería de minerales metálicos	-0.70	8.60	0.66	0.00
2123	Minería de minerales no metálicos	-0.63	0.94	0.66	0.43
3261	Fabricación de productos de plástico	1.33	0.25	0.55	2.09
3344	Fabricación de componentes electrónicos	1.79	0.45	0.50	2.55
3352	Fabricación de aparatos eléctricos de uso doméstico	1.89	1.05	0.50	0.00
3353	Fabricación de equipo de generación y distribución de energía eléctrica	2.21	1.97	0.49	0.00
3311	Industria básica del hierro y del acero	0.50	0.00	0.48	1.30
3313	Industria básica del aluminio	2.00	0.07	0.46	2.77
3345	Fabricación de instrumentos de medición, control, navegación, y equipo médico electrónico	2.00	0.34	0.45	2.69
3336	Fabricación de motores de combustión interna, turbinas y transmisiones	2.25	0.28	0.43	2.66
3314	Industrias de metales no ferrosos, excepto aluminio	1.75	0.02	0.42	1.70

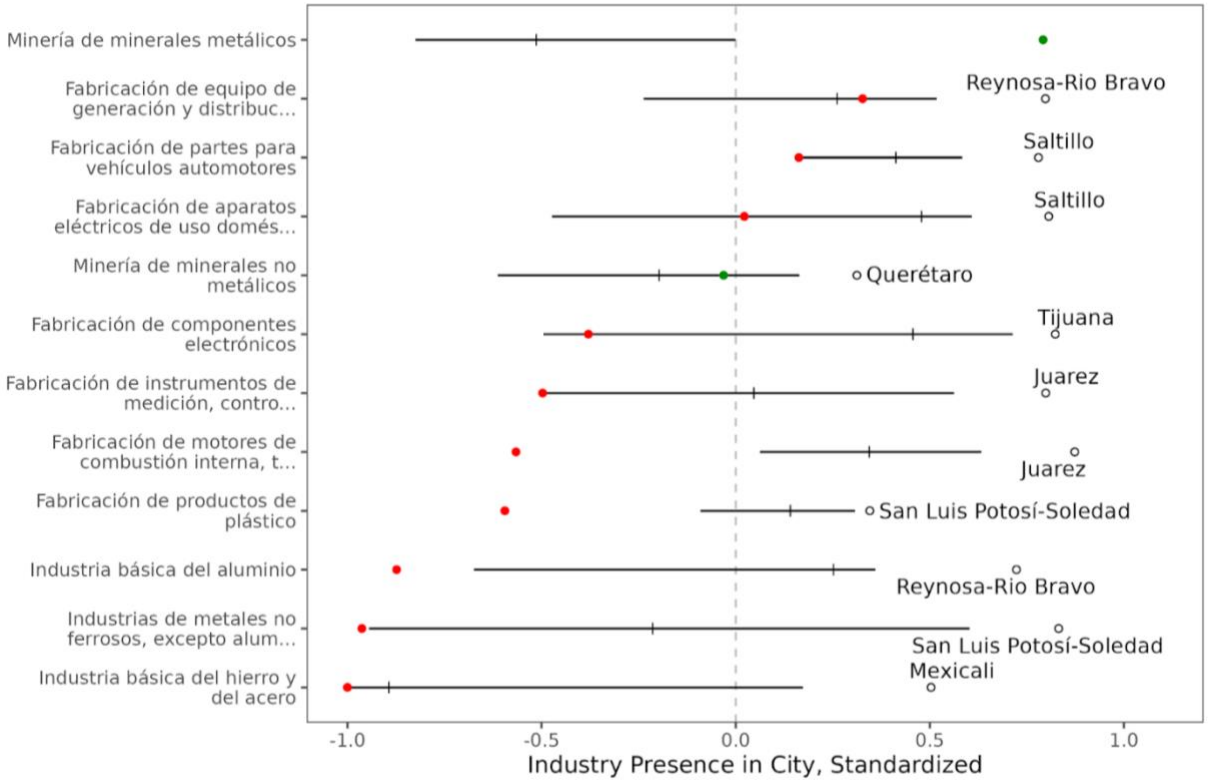
Source: Own Calculations from INEGI Population Census 2020

Comparing industry presence to peers illustrates a potential challenge for diversifying into more green industries. Since peer cities will be competing with Hermosillo to take advantage of green opportunities, relative presence and feasibility are important metrics to consider when targeting industries. Figure 7 visualizes Hermosillo's presence in industries that produce green products relative to peers[3]. The line range on each industry shows the span between the 25th and 75th percentile of peer presence, while the circular point shows Hermosillo's presence in that industry. An industry would be scored zero if the share of employment in the city for that industry is the same as the share of employment in that industry across all of Mexico. Below zero indicates that the employment share in that industry is lower than average, and above zero the opposite. The point is colored green if Hermosillo is 'nearer' to this industry than the median peer and colored red if it is not, based on density. The peer with the highest relative presence is also highlighted and labeled using a hollow point. The figure demonstrates that Hermosillo has a differentiated advantage over peers for the mining of metals. However, Hermosillo is not as well positioned as its peers in other industries, where it has relatively lower presence and density. This does not mean any of these industries are infeasible, but this indicates that expansion into these industries may face more difficult competition

[3] Peers are: Aguascalientes, Tijuana, Saltillo, La Laguna, Chihuaha, Juarez, Guadalajara, Monterrey, Puebla-Tlaxcala, Queretaro, San Luis Potosi-Soledad, Reynosa-Rio Bravo, and Mexicali

from peer cities in Mexico, potentially requiring significant coordination to attract FDI and kickstart the sector.

Figure 7: Hermosillo's Presence in Green Industries Relative to Peers



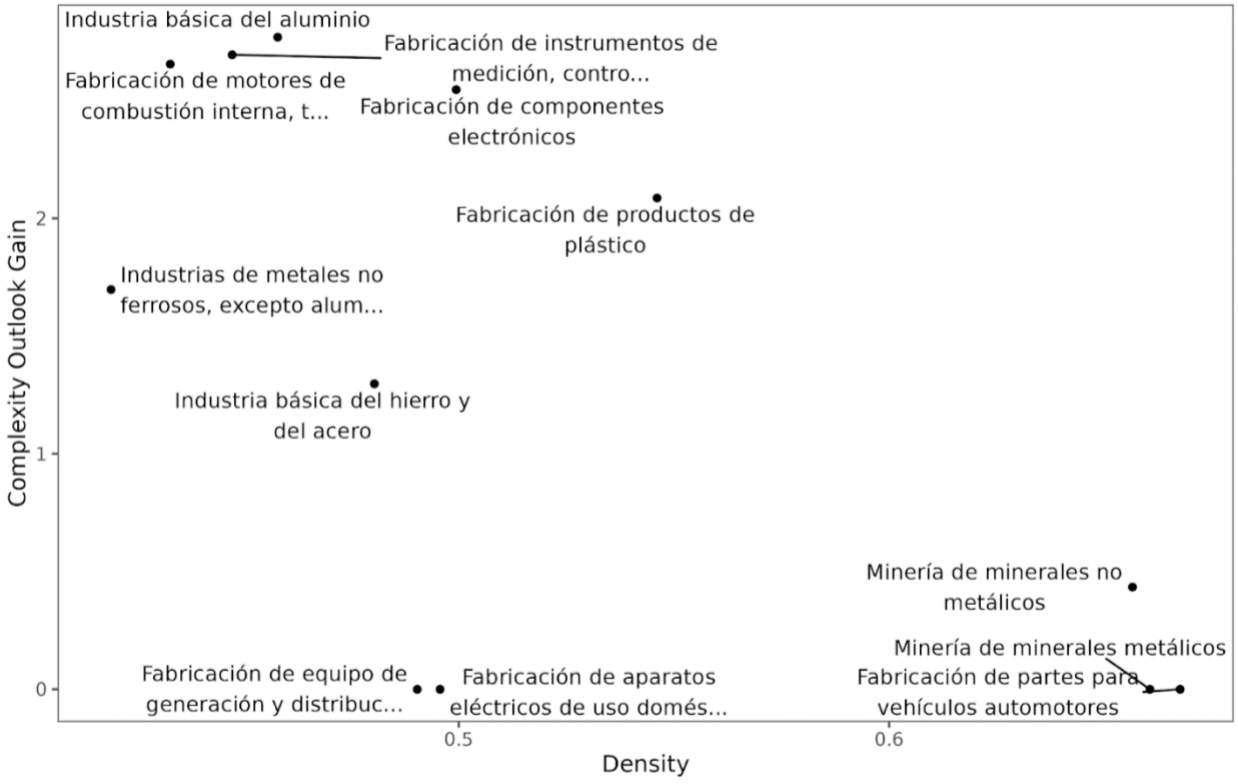
Source: Own Calculations from INEGI Population Census 2020

4. Attractiveness of Green Industries for Hermosillo

Some green opportunities would better position Hermosillo for diversification into high-complexity industries in the future than others. The analysis so far has considered metrics that reflect the feasibility of industries based on RCA and density. In addition to asking which industries are most feasible, policymakers in Hermosillo should also ask which industries are most attractive in terms of benefits to the local population and the long-term development of the economy. There are often tradeoffs at play when it comes to strategy as the most feasible opportunities are rarely the most attractive while the most attractive opportunities are rarely the most feasible. In terms of attractiveness, this analysis focuses on the measure of *Complexity Outlook Gain,* which captures how well connected a new opportunity is to other complex opportunities in the industry space. As such, it is a forward-looking measure. Growth Lab diagnostic analysis of Hermosillo has identified a risk that the economy is not diversifying enough to sustain strong growth and good jobs into the future, so this measure is an important variable to inform strategy setting.

A few opportunities stand out as the most strategic in the tradeoff between feasibility and attractiveness. Figure 8 confirms that there is an inverse relationship between feasibility and attractiveness for most of these opportunities. Several industries have a complexity outlook gain of zero. This is because Hermosillo already has presence in these industries, and so further concentration on these industries will not necessarily improve future diversification efforts for the city. These industries remain strategic to explore because growth opportunities may be immediate, but longer-term transformational impact from this growth is less likely. The chart illustrates that the green industry with the highest complexity outlook gain is the manufacturing of aluminum, however it has a relatively lower density than many of the other opportunities, indicating that it may be less feasible to pursue. On the other hand, the mining of non-metallic minerals shows high feasibility, but would do relatively little to improve Hermosillo's future diversification opportunities. In the middle, the chart indicates that plastics manufacturing offers both a high complexity outlook gain and is relatively feasible to diversify into.

Figure 8: Green Industries by Complexity Outlook Gain and Density



Source: Own Calculations from INEGI Population Census, 2020

5. Building to a Strategy for Green Supply Chains in Hermosillo

Any of these green opportunities could be explored in more detail to inform strategies. We focus on four priority examples based on the considerations above.

This section explores two broad industry categories in which Hermosillo already demonstrates comparative advantage (intensive margin), mining of metals and manufacturing of electric power generation and distribution equipment, as well as two industries in which Hermosillo has some presence but no revealed comparative advantage currently (extensive margin), electronic components and plastic product manufacturing. Figure 9 summarizes these opportunities, including the green products and green value chains associated with each industry. The remainder of this section delves into each opportunity in more detail.

Figure 9: Selected Green Opportunities, Detail

SCIAN	SCIAN Description	Industry Complexity Index, 2020	RCA in 2020	Density to Hermosillo	Complexity Outlook Gain	Number of Green Products	Green Value Chains	Example Products
2122	Minería de minerales metálicos	-0.70	8.60	0.66	0.00	23	Carbon Capture, Electric Grid, Fuel Cells and Green Hydrogen, Large Capacity Batteries, Neodymium Magnets, Nuclear Power, Platinum Group Metals, Semiconductors, Solar, Wind	Aluminum, Antimony (Sb), Chromium, Cobalt, Manganese, Titanium (Ti), Vanadium, Zirconium, Copper, Copper Ore, Iron Ore, Nickel, Tungsten, Chromium, Nickel, Iridium, Iron, Palladium, Co/ Ni Mining, Cobalt and Nickel Separation Concentration and Refining, Iron Concentration and Refining, Iron Mining, Lead, Manganese Mining, Bastnasite, Bauxite residues, Iron scrap, Loparite, Mine tailings, Monazite, Others, Rare Earth Ore, Xenotime, Ion-absorption clays, Uranium oxide (UO2) or Thorium (Th), Chromium ores, Gold ores, Nickel ores
3261	Fabricación de productos de plástico	1.33	0.25	0.55	2.09	7	Electric Grid, Fuel Cells and Green Hydrogen, Large Capacity Batteries, Solar, Wind	Bushings, Conservator Bladder, Fiber Reinforced Polymer Rod, Polymer, Ducts and fittings, Piping (ducts), Polyethylene tanks, pipes, Ethylene vinylacetate (EVA) encapsulant film, Polymeric backsheet, Polyolefin elastomer (POE) encapsulant film, Carbon fiber and composites
3344	Fabricación de componentes electrónicos	1.79	0.45	0.50	2.55	15	Electric Grid, Fuel Cells and Green Hydrogen, Hydropower, Large Capacity Batteries, Neodymium Magnets, Semiconductors, Solar, Wind	Arrestor, Ceramic, Converter, Inductor, Resistor, Semiconductor, Tap Changer, Cell Interconnects, Transformer, Excitation System, CAM/ p-CAM, Silicon-based anodes, Circuit board fragments, Conventional semiconductors, GaN on Si Wafers, Lead frames, Photovoltaic semiconductors, Tick SiC epi-wafers, Wide Bandgap (WBG) semiconductors, Cadmium Telluride (CdTe) modules, Contactor, Crystalline silicon (c-Si) modules, Inverter, Power block, Semiconductor components, Silicon wafers, Solar cells, Surge protector, Terminal block
3353	Fabricación de equipo de generación y distribución de energía eléctrica	2.21	1.97	0.49	0.00	12	Electric Grid, Fuel Cells and Green Hydrogen, Hydropower, Neodymium Magnets, Nuclear Power, Solar, Wind	AC Switchyards, Arc Extinguishing Insulator, Complete Transformer Assembly, Dielectric, Distributed Transformer, Porcelain Housing, Switch/Breakers (Including Relay etc.), Switches and controllers, Switchgear, Rotor, Shaft, Stator, Direct drive generator, Induction generator, Other motor types, Other sub- components, Traction motor, Electrical chase, Equipment cabinets, Generator, Main control boards, Operator's console, Circuit breaker, Drive motor, Fuse, Tracker control panel and power supply, Transformers and switchgear

Source: Growth Lab calculations and analysis of Green Value Chains

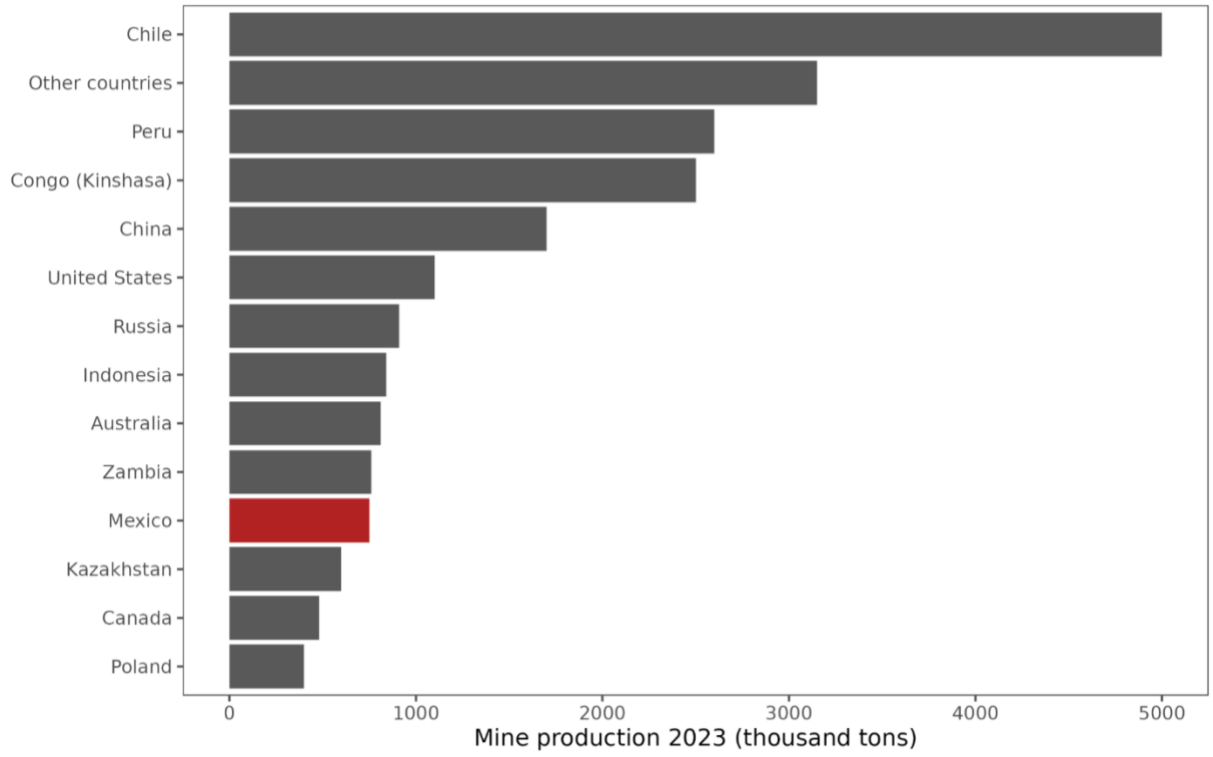
Mining of Metals

The mining of metals represents the clearest green opportunity for Hermosillo on the intensive margin of growth. While there are no mines in the city of Hermosillo, the offices of mining companies acting in Sonora are located there, as well as several mining services companies which, based on the Economic Census of 2020, represent around 5% of the total value added of the services sector in the city. The mining of critical minerals such as copper, lithium, nickel, cobalt and rare earth elements are essential for the green transition. Electric vehicles, solar parks, and wind farms all require increased usage of these minerals in order to function. To meet the Paris Agreement goals, the IEA estimates

lithium demand growing by a factor of 42 by 2040. As a result, the IEA estimates that "some 800 billion USD of investment in mining is required to get on track for a 1.5 degree Celsius scenario to 2040" (IEA, 2024). This presents both an opportunity and a challenge to areas that are endowed with these critical resources, as meeting the rise in demand will require the formation of mining policies which can deliver the necessary production while aligning mining activity with local social and environmental needs.

Critical minerals such as copper and lithium are present in Sonora. Lithium is needed for batteries, while electricity networks require vast quantities of aluminum and copper. The IEA describes copper as "the cornerstone of all electricity-related technologies" (IEA, 2024). Sonora already accounts for 75.6% of total copper production in Mexico (Mexico Business, 2024), and Mexico is the 20th largest producer in the world as demonstrated in Figure 10. Lithium deposits have been located in Sonora as well, although production is yet to start (Moore, 2022). For both materials, significant global supply shortfalls are projected by the IEA, as "Anticipated mine supply from announced projects meet only 70% of copper and 50% of lithium requirements" (IEA, 2024). This shortfall illustrates the necessity of these materials for the world's energy transition and highlights the urgency for Sonora to unlock production to its potential.

Figure 10: Copper Production in 2023, by Country

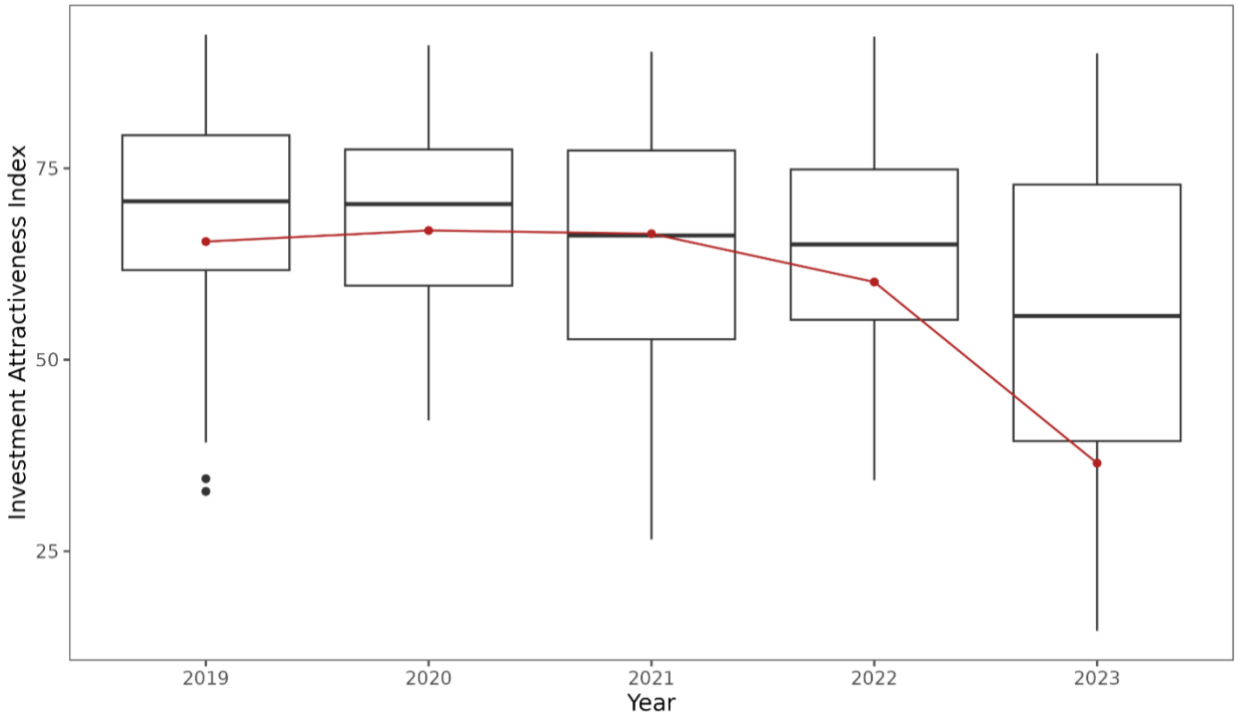


Source: US Geological Survey, 2024

Recent changes to federal mining policy have generated significant uncertainty and reduced investment attractiveness. The recent mining reform was passed on May

8, 2023 and introduced significant changes relating to the granting and scope of mining concessions, limitations on mining exploration activities, and alterations to water concessions for mining among other changes. (Norton Rose Fulbright, n.d.). Prior to the passing of this reform, the Mexican Congress passed a lithium reform in April 21, 2022, which classifies lithium as a strategic mineral, and that lithium exploration and mining would be controlled by the state through LitioMx (Norton Rose Fulbright, 2022). Furthermore, LitioMx will be responsible for the administration and control of the economic value chains of Lithium (Government of Mexico, n.d.), making it central for the procurement of all related equipment, services and other inputs. The combination of these regulatory changes has contributed to dropping Mexico's Investment Attractiveness Index significantly,[4] as illustrated in Figure 11. Furthermore, the uncertainty regarding the administration, interpretation, and enforcement of existing regulations represents a strong deterrent to investment for 44% of the population surveyed.

Figure 11: Mining Investment Attractiveness Index



Source: Own Calculations using Fraser Institute, 2023

To unlock the full potential of its critical mineral resources, Sonora must act as a key intermediary between mining interests, local communities, and federal policies. Based on substantial political reporting in Mexico, changes in mining policy reflect long-standing grievances held by much of Mexican society that mining has caused

[4] The Investment Attractiveness Index is calculated by the Fraser Institute based on surveys conducted with mining firms.

environmental devastation for the benefit of a few local elites and international interests. The policy response has been to nationalize lithium and tighten regulations around exploration, concessions, and environmental impact. However, these changes may preclude mining groups from operating productively at a time when minerals are needed for the green transition. The State Government of Sonora has a long history of managing mining interests and a number of issues, for example the mining disaster in 2014, in which 10 million gallons of copper sulfate and heavy metals contaminated the Sonora River. It must use its position and experience to facilitate productive dialogue between itself, federal interests and mining groups to inform an updated mining policy which better balances environmental and social needs with the urgency of the green transition. Countries like Finland, Canada and Australia appear to have been able to push for increased environmental and community standards while maintaining their attractiveness as investment destinations, according to the index published by the Fraser Institute. All countries have some degree of differentiated responsibilities between national and state governments in mining-related regulations and oversight. By studying these examples and leveraging its experience, Sonora can position itself as a leader in sustainable mining, contributing to both Mexico's green energy transition and global demand for critical minerals.

Manufacturing of Electric Power Generation & Distribution Equipment

The manufacturing of electric power generation and distribution equipment is an attractive industry on the intensive margin of the green opportunities. Hermosillo has an established revealed comparative advantage in this industry and is relatively more specialized than its peers. The industry, characterized by SCIAN code 3353, is responsible for producing products like transformer assemblies, switches, and controllers necessary for the build-out of electric grids. Tapping into the powershoring potential in Hermosillo will require the build out of large solar plants in the area (see complementary Growth Lab report on powershoring). This is an opportunity to tap local firms to provide the necessary inputs for these projects, such as Fusion Mexico S.A. DECV, the most relevant firm in Hermosillo, according to the DENUE. Through this process, gaps may be identified, and plans could be generated to resolve them. If the city can help these firms to learn by doing, these new capabilities could generate new export earnings for products with demand increases forecasted.

Electronic Components Manufacturing

Electronic components manufacturing is an attractive industry for Hermosillo's diversification on the extensive margin of green opportunities. Green products produced by this industry include conventional semiconductors, photovoltaic semiconductors, silicon wafers, resistors and inverters among others. While it does not exhibit a revealed comparative advantage in this sector today, Figure 7 shows that more

than a quarter of peer cities have less presence than Hermosillo in this industry. This is notable, given Hermosillo's relative presence in other extensive-margin industries. Hermosillo today has several large firms operating in the sector, such as TE Connectivity, Necontech de Mexico, and EDS MFG Mexico (companies listed in Figure 12). These firms appear to largely specialize in the manufacturing of electrical harnesses and sensors, often as inputs to vehicle manufacturing, but in combination with other industries present in Hermosillo we observe that workers in the city have the skills needed to expand this industry. This is illustrated in Figure 13, which shows that for the occupations most needed in this industry, Hermosillo has a significant population of existing workers, although they are often working in other industries within the city like the manufacture of transport equipment.

A strategic push to attract an original equipment manufacturer (OEM) could be fruitful, but this would require further study. For example, attracting a solar panel OEM could help Hermosillo expand into electronic components manufacturing. Solar panels require photovoltaic semiconductors, as well as the assembly of the panel apparatus. If Hermosillo takes advantage of its solar energy potential and builds out large solar parks, it can make the case for an OEM to locate a plant in the city. As demonstrated in figure, the city has the skills needed to expand in this industry, and would also be able to offer an initial source of demand for the panels produced. The strategy would align with the scale-up of the manufacturing of electric power generation and distribution equipment industry as well. There is precedence for attracting an OEM in Mexico. In 2015, SunEdison started producing solar panels with its manufacturing partner Flextronics (now Flex) in Ciudad Juarez. The plant reportedly had the capacity to produce 1.3 million panels per year and occupies 1,100 employees (Grajeda, 2015). A key reason cited for the selection of Juarez was the proximity to the US market, as well as strong road and rail infrastructure, which Hermosillo would similarly be able to offer, with the addition of significant local sources of final demand.

Hermosillo may also be positioned to take advantage of its lower labor costs versus the U.S. within certain value chains. One value chain of note is batteries for electric vehicles and for other energy storage uses, given Hermosillo's dual presence in motor vehicle manufacturing and electronic components as well as large projects across the border in Arizona that have been supported by the U.S. Inflation Reduction Act incentives. Recently, multiple advanced manufacturing investments have been launched by LG Energy Solutions in Arizona. In this case, Hermosillo is poorly positioned to attract OEMs but would be strategically positioned to be a base for companies that provide the most labor-intensive steps in battery manufacturing, which includes the manufacturing and assembly of battery packs out of battery cells.

Figure 12: Electronics Components Establishments in Hermosillo

SCIAN Code	Establishment Name	Settlement Name	Occupied Persons
334410	EDS MFG MEXICO	EL LLANO	251 y más personas
334410	TE CONNECTIVITY	EL LLANO	251 y más personas
334410	TE CONNECTIVITY	LAS ISABELES	251 y más personas
334410	TE CONNECTIVITY	HERMOSILLO NORTE	251 y más personas
334410	NECONTECH DE MEXICO	SAHUARO	101 a 250 personas
334410	SONORA S PLAN CREATIONS ATS	LATITUD	101 a 250 personas
334410	TE CONNECTIVY	EL SAHUARO	101 a 250 personas
334410	MANUFACTURAS PITIC	EL LLANO	11 a 30 personas
334410	AMPHENOL PAPAGO	RIO SONORA	0 a 5 personas
334410	AMPHENOL PITIC	PARQUE INDUSTRIAL DINATECH	0 a 5 personas
334410	BODEGA TE CONNECTIVITY	GOMEZ MORIN	0 a 5 personas

Source: DENUE, 2020

Figure 13: Occupations for the Manufacturing of Electronics Components

Occupation Code	Occupation Description	Mexican Industry Occupation Share	Hermosillo Industry Occupation Share	Hermosillo Industry Occupations	Hermosillo Occupations	Top 3 Industries with Occupation in Hermosillo	Hermosillo Top 3 Industries Count
821	Assemblers and assemblers of tools, machinery, metal and electronic products	0.41	0.19	156	10374	Manufacture of transport equipment, Manufacture of accessories, electrical apparatus and electrical power generating equipment, Insufficiently specified descriptions of activity subsectors of sector 31-33 Manufacturing industries	7330, 1792, 842
820	Supervisors in assembly and mounting processes of machinery, tools and metal, electrical and electronic products	0.07	0.00	0	795	Manufacturing of transportation equipment, Manufacturing of accessories, electrical appliances and electric power generation equipment, NA	727, 68, NA
264	Electrical, electronic, telecommunications and electromechanical equipment technicians	0.04	0.08	68	6070	Masonry work for plumbing and electrical installations and outdoor work, Telecommunications, Repair and maintenance services for equipment, machinery, household and personal items	1539, 934, 794
923	Support workers in the industry	0.04	0.00	0	4048	Automobile and truck repair and maintenance services, Food industry, Retail trade of groceries, food, beverages, ice and tobacco	924, 779, 426
819	Other operators of industrial installations and fixed machinery, not previously classified	0.04	0.00	0	3630	Insufficiently specified descriptions of activity subsectors of sector 31-33 Manufacturing industries, Manufacture of transport equipment, Chemical industry	2410, 475, 208
313	Workers in archiving and warehouse and storage control	0.03	0.00	0	3872	Retail trade in self-service and department stores, Storage services, Manufacturing of transport equipment	487, 384, 206
263	Mechanics and technicians in maintenance and repair of mechanical equipment, motor vehicles, industrial instruments and refrigeration equipment	0.03	0.16	130	11966	Auto and truck repair and maintenance services, Equipment, machinery, household and personal goods repair and maintenance services, Specialized construction work	4801, 1509, 725
810	Industrial Machinery Operator Supervisors	0.03	0.09	69	1922	Manufacture of transport equipment, Insufficiently specified descriptions of activity subsectors of sector 31-33 Manufacturing industries, Food industry	414, 393, 275
224	Electrical and electronics engineers	0.02	0.00	0	726	Generation, transmission, distribution and marketing of electric energy, Professional, scientific and technical services, Food industry	196, 139, 70
999	Unspecified occupations	0.02	0.00	0	9304	Insufficiently specified general descriptions of the entire classification, Insufficiently specified descriptions of subsector of activity of sector 31-33 Manufacturing industries, Manufacture of transport equipment	2254, 1246, 726
227	Researchers and professionals in computer systems	0.02	0.08	66	3287	Professional, scientific and technical services, Publishing of newspapers, magazines, books, software and other materials, and publishing of these publications integrated with printing, Higher education schools belonging to the public sector	748, 263, 260
225	Chemical, mechanical, industrial, mining and metallurgical engineers	0.02	0.08	64	1773	Manufacture of transport equipment, Mining of metallic minerals, Insufficiently specified descriptions of activity subsectors of sector 31-33 Manufacturing industries	803, 251, 191
311	Secretaries, stenographers, typists, data entryists and office machine operators	0.02	0.00	0	12165	State Public Administration, Federal Public Administration, Hospitals belonging to the public sector	1130, 1012, 981
899	Other industrial machinery operators, assemblers and transport drivers, not previously classified	0.01	0.08	64	1741	Insufficiently specified descriptions of activity subsectors of sector 31-33 Manufacturing industries, Manufacture of transport equipment, Wholesale trade of trucks and new parts and spare parts for cars, vans and trucks	845, 407, 147
265	Assistants and technicians in computer science and communications and recording equipment	0.01	0.00	0	1949	Photography and video recording services, Publishing of newspapers, magazines, books, software and other materials, and publishing of these publications integrated with printing, Radio and television	333, 262, 196
251	Assistants in administration, accounting and finance	0.01	0.00	0	5793	Professional, scientific and technical services, General descriptions insufficiently specified throughout the classification, Federal Public Administration	1313, 356, 334
299	Other professionals and technicians not previously classified	0.01	0.00	0	2891	Federal Public Administration, Professional, scientific and technical services, State Public Administration	402, 400, 394
812	Machine and equipment operators in metal fabrication, machinery manufacturing and metal products	0.01	0.00	0	1113	Manufacture of transport equipment, Manufacture of metal products, General insufficiently specified descriptions of the entire classification	523, 258, 134
161	Coordinators and area managers in agricultural, industrial, construction and maintenance production	0.01	0.08	63	2267	Manufacture of transport equipment, Insufficiently specified descriptions of activity subsectors of sector 23 Construction, Water collection, treatment and supply	456, 275, 207
271	Education assistants and technicians, instructors and trainers	0.00	0.08	64	3788	Other private sector educational services, Entertainment services in recreational facilities and other recreational services, Insufficiently specified descriptions of activity subsector of sector 61 Educational services	1025, 595, 522
525	Workers in other personal services	0.00	0.08	66	335	Personal services, Manufacturing of computer, communication, measurement and other electronic equipment, components and accessories, Entertainment services in recreational facilities and other recreational services	198, 66, 64

Source: Own calculations from INEGI Population Census, 2020

Plastic Products Manufacturing

Plastics products manufacturing is another relevant opportunity on the extensive margin. Hermosillo does not have a revealed comparative advantage in plastics manufacturing today, however, large firms are present such as Flex N Gate Hermosillo, IACNA Mexico, and Fanosa Hermosillo, among many others (see Figure 14). This industry, SCIAN 3261, produces products for the green transition such as bushings and fiber reinforced polymer rods which are needed for electric grids; polymeric backsheets and ethylene vinylacetate (EVA) encapsulant film needed for solar panels; and carbon-fiber reinforced polymers and composites required for wind turbines. In the case of composites and carbon fiber, Latecoere in Hermosillo is one of the few firms developing structural composites in all of Mexico.

Figure 14: 20 Largest Plastics Establishments in Hermosillo

SCIAN Code	Establishment Name	Settlement Name	Occupied Persons
326192	FLEX N GATE HERMOSILLO	DYNATECH SOUTH	251 and more people
326192	IACNA MEXICO	DYNATECH	251 and more people
326140	FANOSA HERMOSILLO	HERMOSILLO	101 to 250 people
326191	BRH2 PLASTICS	NONE	51 to 100 people
326140	FANOSA CORPORATE	PITIC	51 to 100 people
326120	MEXICHEM INTEGRAL SOLUTIONS	HERMOSILLO	51 to 100 people
326120	PLASTIMARMOL	THE VICTORY	51 to 100 people
326120	COMPOMEX	HERMOSILLO INDUSTRIAL PARK	31 to 50 people
326120	EMMSA	PRIVATE FOREST	31 to 50 people
326110	JUMBOLON FROM MEXICO	WORK	31 to 50 people
326194	THERVAL MANUFACTURING OF PVC DOORS AND WINDOWS	TOBACCO CHIPS	31 to 50 people
326193	DAKAPET PACKAGING	BRICKMAKERS UNION	11 to 30 people
326160	DEMINZON	SANTA MARIA	11 to 30 people
326110	DIRESA PLASTICS	NEW STATION	11 to 30 people
326160	TAPANOSA GROUP	CHOYAL	11 to 30 people
326140	STEEL PANEL	SAHUARO	11 to 30 people
326110	PLASTICS OF THE DESERT	Industrial Park	11 to 30 people
326193	PROVEN MILAN	THE VICTORY	11 to 30 people
326160	REID PLASTICS	SMALL INDUSTRIAL PARK	11 to 30 people
326110	UPLASTIC UP	COOL	11 to 30 people

Source: DENUE, 2020

The skills required to scale up plastics production are prevalent in Hermosillo already. The table in Figure 15 shows the occupations associated with the plastics industry across Mexico, alongside the number of workers in that occupation in Hermosillo already. It also shows in which other industries workers of a particular occupation are located in, within Hermosillo. If plastics were to grow, it is possible that workers from the listed industries would become involved. Finally, plastics manufacturing is also an energy-intensive industry, and Hermosillo can compete against other cities by providing cheaper

electricity as it takes advantage of its renewable energy potential. Overall, despite being less concentrated in this industry than its peers, there is potentially a strong foundation for Hermosillo to expand on in plastics manufacturing.

Figure 15: Occupations Associated with Plastics Manufacturing

Occupation Code	Occupation Description	Mexican Industry Occupation Share	Hermosillo Industry Occupation Share	Hermosillo Industry Occupations	Hermosillo Occupations	Top 3 Industries with Occupation in Hermosillo	Hermosillo Top 3 Industries Count
813	Machine and equipment operators in the chemical, plastic, water treatment and petrochemical industries	0.35	0.29	136	959	Chemical industry, Plastic and rubber industry, Other manufacturing industries	606, 136, 67
923	Support workers in the industry	0.11	0.00	0	4048	Automobile and truck repair and maintenance services, Food industry, Retail trade of groceries, food, beverages, ice and tobacco	924, 779, 426
810	Industrial Machinery Operator Supervisors	0.08	0.14	64	1922	Manufacture of transport equipment, Insufficiently specified descriptions of activity subsectors of sector 31-33 Manufacturing industries, Food industry	414, 393, 275
819	Other operators of industrial installations and fixed machinery, not previously classified	0.04	0.00	0	3630	Insufficiently specified descriptions of activity subsectors of sector 31-33 Manufacturing industries, Manufacture of transport equipment, Chemical industry	2410, 475, 208
263	Mechanics and technicians in maintenance and repair of mechanical equipment, motor vehicles, industrial instruments and refrigeration equipment	0.04	0.00	0	11966	Auto and truck repair and maintenance services, Equipment, machinery, household and personal goods repair and maintenance services, Specialized construction work	4801, 1509, 725
741	Artisans and workers in the production of rubber, plastic and chemical products	0.03	0.00	0	939	Automobile and truck repair and maintenance services, Retail trade of motor vehicles, spare parts, fuels and lubricants, Repair and maintenance services of equipment, machinery, household and personal items	615, 126, 66
313	Workers in archiving and warehouse and storage control	0.02	0.00	0	3872	Retail trade in self-service and department stores, Storage services, Manufacturing of transport equipment	487, 384, 206
999	Unspecified occupations	0.02	0.00	0	9304	Insufficiently specified general descriptions of the entire classification, Insufficiently specified descriptions of subsector of activity of sector 31-33 Manufacturing industries, Manufacture of transport equipment	2254, 1246, 726
311	Secretaries, stenographers, typists, data entryists and office machine operators	0.02	0.00	0	12165	State Public Administration, Federal Public Administration, Hospitals belonging to the public sector	1130, 1012, 981

Source: Own Calculations from INEGI Population Census 2020

6. Conclusion

As the world decarbonizes, demand for products which enable decarbonization will increase. This report has analyzed which industries produce these green products, and Hermosillo's relationship to those industries. This analysis highlights that one of the most immediate green opportunities for Hermosillo lies in the mining of critical minerals required for the green transition, such as lithium and copper. However, recent changes to federal mining policy threaten productivity. Sonora must use its experience and position to help co-produce mining policy that addresses both sustainability and productivity concerns. At the same time, while mining these minerals could constitute a huge income opportunity, it does not immediately expand Hermosillo's diversification opportunities. There are additional opportunities for Hermosillo to leverage the green

transition to diversify its economy, such as the manufacturing of electronic components and the manufacturing of plastic products, but the city will need to compete against peers who are better positioned today in those spaces, especially in attracting new companies.

Acting on these opportunities requires dedicated attention supported by the local and state governments, especially in the form of active investment promotion. This is an area for active research and experimentation, but a few initial observations are provided in this report. If the city pushes to take advantage of its potential in solar energy, it can mitigate these competitive factors, as the build out of large solar parks presents a source of final demand. The city may be able to leverage this, as well as its other strengths, to out-compete peer cities and attract a solar panel OEM to Hermosillo, helping to diversify the economy into electronic components and photo-voltaic semiconductors. Similarly, the build out of large solar parks can be coordinated to attract suppliers in the manufacturing of electricity generation and transmission equipment, in which Hermosillo is relatively well positioned compared to peers. Other focused strategies may be impactful, ranging from targeting certain parts of emerging regional value chains, such as batteries for electric vehicles, and a collaborative effort with existing companies to leverage the cities nascent capabilities in plastic product manufacturing. Since plastics are a relatively, strategies for powershoring may create new opportunities as well. Overall, the city should convene its existing companies in these industries to identify constraints and pain points, which would inform policies to help grow these industries and diversify the economy.

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