NOVEMBER 2025
No 388

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Research papers

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Simulating the Employment and Inequality Impacts of the Energy Transition in Mexico: An Input–Output Approach

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Abstract

This paper examines the distributive and labor market impacts of Mexico's transition from fossil fuels to renewable energy using a multisector input–output model calibrated to the 2020 national accounts and projected to 2030. Four scenarios—optimistic, pessimistic, realistic, and a new 38% renewable target—are simulated to estimate direct, indirect, and induced employment effects across sectors and states. The results indicate that all transition pathways generate net employment gains, though with strong regional and gender asymmetries. Job creation is concentrated in wind and solar industries, while fossil-fuel-dependent states such as Tabasco and Veracruz face employment losses and rising income inequality. National effects on labor income inequality are modest, but regional disparities remain significant. The findings highlight the importance of targeted industrial, educational, and social policies to ensure a just and inclusive energy transition in Mexico.

Keywords

Energy transition; Employment impacts; Input–output analysis; Regional inequality; Gender and labor markets; Just transition; Mexico.

JEL codes

D63, Q43, J21, O13

Original version

English

Accepted

September 2025

Résumé

Cet article analyse les effets distributifs et sur le marché du travail de la transition énergétique du Mexique, du passage des combustibles fossiles vers les énergies renouvelables, à l'aide d'un modèle input–output multisectoriel calibré sur les comptes nationaux de 2020 et projeté à l'horizon 2030. Quatre scénarios — optimiste, pessimiste, réaliste et celui correspondant au nouvel objectif de 38 % d'électricité renouvelable — sont simulés afin d'estimer les effets directs, indirects et induits sur l'emploi par secteur et par État. Les résultats indiquent que toutes les trajectoires de transition génèrent des gains nets d'emploi, mais avec de fortes asymétries régionales et de genre. Les créations d'emplois se concentrent dans les secteurs éoliens et solaires, tandis que les États dépendants des combustibles fossiles, comme Tabasco et Veracruz, enregistrent des pertes d'emploi et une hausse des inégalités de revenu. Les effets nationaux sur l'inégalité des revenus du travail sont modestes, mais les disparités régionales demeurent importantes. Les résultats soulignent l'importance de politiques industrielles, éducatives et sociales ciblées pour garantir une transition énergétique juste et inclusive au Mexique.

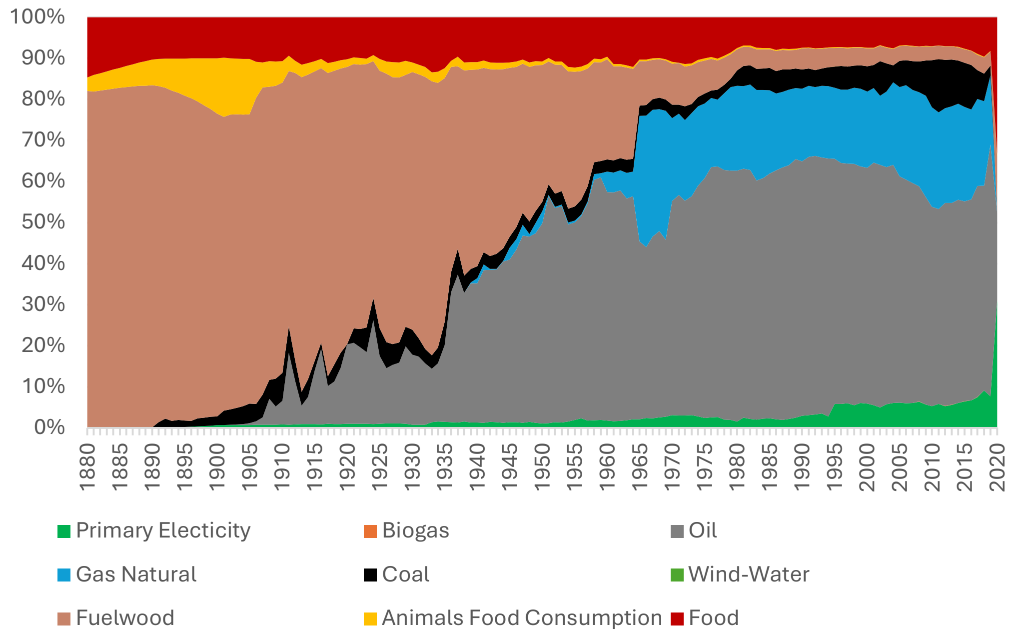
Mots clés

Transition énergétique ; Effets sur l'emploi ; Analyse input–output ; Inégalités régionales ; Genre et marché du travail ; Transition juste ; Mexique.

1. Introduction

Energy transitions are not a novel phenomenon in the world nor in Mexico. Reconstructions of Mexico's energy history (Castañeda Garza 2021) extend back to the mid-19th century and reveal at least five energy transitions: from fodder to coal, oil, gas, hydraulics, and ultimately to new renewable sources. This pattern of continuously ongoing energy transitions is prevalent in at least 13 other countries with available reconstructions of primary energy consumption and national energy accounts.[1] The concept of energy transitions encompasses changes in both the primary energy source utilized for broad-based work and technological advancements that facilitate economic gains and related uses of more efficient energy sources. Notably, all energy transitions throughout history have been characterized by a technological component, which has been associated with the three industrial revolutions that have transpired over the past 250 years.

Figure 1: The Mexican Energy Transitions.
Source: Castañeda Garza (2021)



[1] See Kander et al. 2014 for a comprehensive take on the historical energy transition in Europe.

The primary distinctions between our current energy transitions and those of the past lie in the required speed of the transition. Traditionally, new energy sources have taken an average of 80[2] years to become established and dominant sources of energy. Given our current circumstances with the climate emergency, it is imperative to compress the development time of both new energy sources and the technologies that enable their efficient utilization. The second distinction is that our societies are reasonably concerned with the distributive impacts of these changes, who gains and who loses? As with all economic and technological transformations throughout history, the current energy transitions will have effects on people, job creation, and job destruction. Taking these impacts into consideration and attempting to minimize their costs while compensating those who lose is why societies are concerned with a "just energy transition." In this research article, the concept of a "just energy transition" is defined as outlined by the International Labor Organization (2015). This definition encompasses a just energy transition that greens the economy while being fair and inclusive, creating jobs, and ensuring that no one is left behind. This project will simulate the distributive effects of the energy transition in Mexico, focusing on the short to medium term, specifically the year 2030. The article will analyze the winners and losers in terms of employment and income distribution, with a particular focus on significant regional dynamics.

2. Literature Review: Employment Impacts of the Energy Transition and the Pursuit of a Just Transition in Mexico

The present global energy transition, the shift from fossil fuel-based systems to renewable energy, represents one of the most significant socioeconomic transformations of the 21st century. While this transition is crucial for mitigating climate change, its employment

[2] The studies that account for the historical energy transitions of different countries have found that on average the time it takes between the point in which a new primary energy source enters the energy matrix of country, and it reaches a level of at least 10% of its energy consumption is around 80 years. 10% is the level at which an energy source is sufficiently developed or mature to continue to a phase of accelerated growth.

implications are complex and uneven. On the one hand, renewable energy sectors such as solar, wind, and hydropower are projected to generate millions of jobs worldwide; on the other, the decline of fossil fuel industries threatens livelihoods in regions historically dependent on coal, oil, and gas (IRENA, 2023). The concept of a "just transition," popularized by the International Labor Organization (ILO), has emerged as a framework to address these disparities, emphasizing social equity, worker rights, and inclusive policymaking (ILO, 2015). Mexico, a nation with deep ties to fossil fuels but significant renewable energy potential, exemplifies both the opportunities and challenges of this transition. This review synthesizes global trends in energy transition-related employment, evaluates Mexico's progress toward a just transition, and identifies critical gaps in policy and practice. This framework is underpinned by three key pillars: (1) job creation in sustainable sectors, (2) social protection for workers displaced by decarbonization, and (3) participatory decision-making to address regional disparities (Heffron and McCauley, 2018).

Scholars such as Newell and Mulvaney (2013) assert that a just transition must address structural inequalities inherent in energy systems. For instance, fossil fuel industries often accumulate wealth and influence or capacity to lobby typical among economic elites, while renewable projects can replicate similar dynamics if communities are excluded from planning processes (Sovacool et al., 2020). Critics caution that without proactive policies, the energy transition risks exacerbating existing disparities, particularly in developing economies where informal labor and weak governance prevail (Stevis and Felli, 2015).

2.1. Global Employment Trends in the Energy Transition

The renewable energy sector has emerged as a significant employer, with 13.7 million jobs globally in 2022, representing a substantial 70% increase from 2015 (IRENA, 2023). Solar photovoltaic (PV) systems account for the largest share of these jobs, employing 4.9 million individuals, followed by hydropower (2.5 million) and wind energy (1.4 million). These jobs encompass various sectors, including manufacturing, installation, operations, and maintenance, although the quality of employment varies significantly. In advanced economies such as Germany, Sweden, Denmark and the United States, renewable jobs often provide unionized positions with comprehensive benefits. Conversely, in developing nations like India and Brazil, informal and precarious labor remains prevalent. (ILO, 2022)

Simultaneously, fossil fuel industries are experiencing contraction due to market shifts, climate policies, and technological advancements. The International Energy Agency (IEA) projects that approximately 6 million jobs in the coal, oil, and gas sectors could be lost by 2030, with regions such as China, India, and South Africa bearing the highest risks (IEA, 2021). These job losses are seldom compensated for on a one-to-one basis by renewable energy sources, as the latter necessitate distinct skill sets and geographical distributions. For instance, wind farms are frequently constructed in rural areas, while oil refineries tend to cluster near urban centers (Vona, 2021).

A critical challenge lies in aligning the skills of fossil fuel workers with those demanded by renewable energy sources. Oil and gas workers, for instance, often possess mechanical expertise but may lack training in electrical engineering or digital systems required for solar or wind projects (IRENA, 2023). Geographic mismatches further exacerbate this issue, as renewable jobs may emerge in regions distant from traditional energy hubs, necessitating workers to relocate—a costly and socially disruptive process (Stevis and Felli, 2015).

2.2. Mexico's Energy Landscape: Fossil Fuel Legacies and Renewable Potential

Mexico's contemporary economic landscape has been significantly shaped by the utilization of fossil fuels. The national oil company, Pemex, established in 1938 following the expropriation of foreign oil assets, has historically symbolized economic sovereignty (Grayson, 2020). Pemex directly employs over 120,000 individuals and indirectly supports millions more through its extensive supply chains, particularly in oil-rich states such as Tabasco and Veracruz (Martínez, 2021). Historically, oil revenues accounted for more than 48% of the federal budget, reinforcing the dominance of fossil fuels in Mexico's political economy (Tetreault, 2021). However, due to the combination of increased fiscal resources and the decline in oil production, oil revenues now constitute approximately 20% of the federal budget (CIEP, 2024). While not explicitly part of this analysis, the energy transition in Mexico has significant budgetary implications that should not be overlooked.

Mexico possesses abundant renewable resources. The country ranks among the world's top 15 for solar and wind potential, with solar irradiance in Sonora exceeding 5.5 kWh/m²/day and wind speeds in Oaxaca averaging 8–10 m/s (IRENA, 2020). The 2013 Energy Reform, which ended Pemex's monopoly and opened the sector to private investment, catalyzed renewable growth. By 2022, wind and solar accounted for 23% of electricity generation, up from 15% in 2015 (SENER, 2022). Major projects include the 1,000 MW Villanueva solar plant in Coahuila and the 396 MW Tres Mesas wind farm in Tamaulipas (Hernández, 2018).

President Andrés Manuel López Obrador (AMLO), elected in 2018, reversed course, prioritizing fossil fuels over renewables. His administration canceled renewable energy auctions, slashed clean energy budgets. AMLO argued that strengthening Pemex was essential for energy sovereignty, but analysts warn this approach undermines Mexico's climate commitments and green job potential (García, 2023). However, the new administration led by President Claudia Sheinbaum seems to have renewed Mexico's commitment to greener sources of energy and a just transition. For example, the Mexican government has announced an acceleration plan for the energy transition within the National Energy Plan with an investment of 23,400 millions of dollars or the 51 projects in the Plan for the Expansion and Strengthening of the National Electric System[3]. Another illustrative example that underscores Sheinbaum's heightened emphasis on the transition is the "Solar Schools" program. This program proposes that the public sector would leverage its influence to augment solar panel production and utilization, thereby providing power to schools.[4]

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[3] https://www.gob.mx/presidencia/prensa/presidenta-presenta-51-proyectos-de-electricidad-del-plan-de-fortalecimiento-y-expansion-del-sistema-electrico-nacional-2025-2030

[4] https://www.eleconomista.com.mx/politica/palabra-cumplida-instala-primera-escuela-solar-20250320-751356.html#:~:text=La%20Escuela%20Primaria%20Ignacio%20Romero%20Vargas%2C%20se,primera%20institución%20educativa%20de%20este%20gran%20proyecto.&text=Uno%20de%20los%20principales%20beneficiarios%20de%20esta,se%20reducirá%20drásticamente%20el%20gasto%20en%20electricidad.

2.3. Employment Challenges and Opportunities in Mexico's Energy Transition

Mexico's energy transition is driven by a confluence of global climate imperatives and domestic socioeconomic pressures. As per the National Greenhouse Gas Inventory (SEMARNAT, 2022), the energy sector accounts for 68% of the country's total emissions, predominantly originating from fossil fuel-based electricity generation and oil refining. Transportation subsequently emerges as the second-largest contributor, responsible for 24% of emissions, primarily attributed to rapid urbanization and the reliance on gasoline and diesel vehicles. Industrial activities, encompassing cement and steel production, contribute an additional 8% (Mexico's Climate Change Midterm Review, INECC, 2023). These disparities underscore the imperative of sector-specific decarbonization strategies.

Key drivers shaping this transition include Mexico's international commitments under the Paris Agreement, which mandate a 35% reduction in renewable electricity generation by 2030 and a 22% decrease in greenhouse gas emissions compared to business-as-usual scenarios. Economic shifts also play a pivotal role: solar photovoltaic costs have declined by 80% since 2010, while wind energy costs have decreased by 60%, rendering renewables increasingly competitive with fossil fuels (Renewable Power Generation Costs, IRENA, 2023). Social pressures further accelerate this shift, particularly in regions such as Tabasco and Veracruz, where communities affected by pollution and health crises linked to fossil fuel extraction are advocating for cleaner alternatives (Zárate-Toledo et al., 2019). However, policy volatility remains a challenge. While the 2013 Energy Reform initially stimulated renewable investments, the López Obrador administration (2018–2024) prioritized fossil fuel sovereignty, resulting in regulatory uncertainty. Recent policy adjustments under President Claudia Sheinbaum, including a $23.4 billion investment in renewable energy infrastructure outlined in the revised National Energy Plan (SENER, 2024), signify renewed alignment with climate objectives.

In this context a further challenge in the Mexican energy sector is Pemex. Pemex's decline—driven by $113 billion in debt, aging infrastructure, and volatile oil prices—has led to layoffs and labor unrest. In 2021, Pemex cut 4,000 jobs, sparking strikes in Tabasco (Martínez, 2021). Workers in oil-dependent regions face limited alternatives; a survey in Veracruz found that 72% of oil workers lacked skills transferable to renewables (Zárate-Toledo et al., 2019).

Renewables have created jobs, albeit unevenly. Wind and solar projects generated 12,000 direct jobs in 2022, primarily in construction and engineering (AMDEE, 2023). However, only 20% of these jobs are unionized, and wages average 15% lower than Pemex salaries (Hernández, 2021). Most positions are temporary, tied to project construction phases rather than long-term operations. Mexico's energy workforce is marked by informality and inequality. Over 60% of workers in renewables are informal, lacking access to social security or labor protections (INEGI, 2022). Women are particularly marginalized, holding fewer than 15% of technical roles in wind and solar—a disparity rooted in cultural norms and limited STEM training opportunities (García, 2022).

Example: The Isthmus of Tehuantepec Wind Corridor

The Isthmus of Tehuantepec, situated in Oaxaca, one of the world's most windy regions, comprises 28 wind farms that collectively generate 5,500 megawatts (Dunlap, 2020). While these projects have generated employment opportunities, indigenous communities such as the Zapotec and Huave have experienced exclusion from decision-making processes and limited economic benefits. Notably, less than 10% of the jobs created by these projects are allocated to local residents, with the majority of technical positions being filled by individuals from outside the region (Sosa, 2021). Land leases, frequently negotiated without obtaining free prior informed consent, have been the subject of protests and legal challenges, highlighting the conflict between renewable energy expansion and social justice (Zárate-Toledo et al., 2019).

According to Mexico's 2020 Population and Housing Census (INEGI, 2020), only 12% of Oaxaca's working-age population has completed tertiary education, compared to the national average of 19%. Vocational training programs tailored to renewable energy—such as wind turbine maintenance or electrical engineering—are virtually absent in the Isthmus, as noted in the *Diagnostic Report on Technical Education in Oaxaca* (Secretaría de Educación Pública [SEP], 2022). The local workforce remains concentrated in informal sectors, with 65% of employment in Oaxaca classified as informal (vs. 55% nationally), primarily in agriculture (42%) and low-skill services (INEGI, 2022). While basic construction labor aligns with some project needs, specialized roles (e.g., turbine technicians, grid engineers) require certifications unavailable locally.

Gender disparities further compound these challenges. Women, who represent 51% of Oaxaca's population, hold fewer than 5% of technical roles in renewable projects, a disparity rooted in cultural norms and limited STEM education access (García, 2022). For example, the Eólica del Sur wind project reported that 80% of engineers were recruited externally due to a lack of qualified local candidates, particularly women (Zárate-Toledo et al., 2019).

To address these gaps, evidence-based solutions could draw from international models. Brazil's *Lei do Conteúdo Local* (Local Content Law), which mandates that 20% of technical roles in energy projects be reserved for local apprentices, offers a replicable framework (Baker & Phillips, 2019). Domestically, partnerships with institutions like the Regional Technology Institutes to establish technical schools in the Isthmus—similar to Nuevo León's *Agencia de Energías Renovables*—could bridge skill deficits. Additionally, gender-inclusive initiatives, such as South Africa's Renewable Energy Independent Power Producer Procurement Programme, which ties project funding to women's participation quotas (Clancy & Feenstra, 2019), could be adapted to Mexico's context.

3. Methodology

This article quantifies employment changes under four scenarios (optimistic, pessimistic, realistic and the new 38% target) aligned with Mexico's 2030 climate goals. Utilizing input-output matrices, we estimate direct, indirect, and induced employment effects, integrating data from Mexico's National Institute of Statistics (INEGI), the Ministry of Energy (SENER), and the International Renewable Energy Agency (IRENA).

Input-Output Framework

The input–output approach, originally developed by Leontief, is particularly well-suited for this type of analysis because it quantifies the interdependencies among sectors in a highly disaggregated economy. By tracing how output in one sector drives demand in others, the model allows us to capture not only direct employment effects within targeted industries but also the broader ripple effects across upstream supply chains and downstream consumption patterns. The Leontief model (Raa, T, 2009; Verma and Ram 2011) calculates employment impacts in the following way:

$$\Delta L = e(I - A)^{-1}\Delta Y \qquad \textbf{(1)}$$

Where:

- ΔL: $Change\ in\ employment\ (jobs)$.
- $(I - A)^{-1}$: $Leontief\ inverse\ matrix\ (capturing\ direct\ and\ indirect\ effects)$.
- ΔY: $Change\ in\ final\ demand\ (output)\ by\ sector\ (million\ MXN)$.
- e: $Employment\ coefficients\ (jobs\ per\ million\ MXN\ output)$.

The model distinguishes between three types of employment effects. Direct employment refers to jobs created or lost within the sectors immediately influenced by the transition, such as solar panel manufacturing or oil extraction. Indirect employment arises in sectors that supply goods and services to those industries, for example, steel production, construction, or logistics. Induced employment reflects additional labor demand generated by household consumption as workers in directly and indirectly affected sectors spend their income. These three channels are operationalized through the use of employment multipliers. Type I multipliers incorporate both direct and indirect effects, whereas Type II multipliers extend the analysis to include induced effects.

Scenario Assumptions

To capture the structure of Mexico's economy with sufficient precision, the 2020 input–output matrix — which contains 57 sectors aligned with the North American Industry Classification

System (NAICS) is used. Furthermore, in order to model the energy transition employment effects, the following sectors are disaggregated: fossil fuels, renewables and auxiliary Sectors. The following table summarizes the disaggregation for each of these key sectors:

Table 1: Disaggregated sectors for the analysis
Source: The author

Fossil Fuels	Renewables	Auxiliary sectors
Oil & gas extraction and utilization	Solar / Wind manufacturing	Construction (turbine installation, grid infrastructure)
Coal mining	Wind farm construction	Manufacturing (Steel, cement, solar panels)
Petroleum refining	Hydropower operations	Services (engineering, maintenance)

To ensure that the model adequately reflects the structural changes expected over the coming decade, the alignment of the 2020 input–output matrix with 2030 projections incorporates not only sectoral growth rates derived from SENER's energy demand forecasts, IRENA's employment trends, and Mexico's NDC commitments, but also the broader policy objectives that frame the country's decarbonization strategy. These objectives are anchored in Mexico's pledge to generate 35 percent of its electricity from renewable sources and to reduce greenhouse gas emissions by 22 percent relative to a business-as-usual trajectory by 2030. Together, these targets establish the expected scale and pace of the energy transition and define the economic and technological adjustments required across key sectors. Building on these policy benchmarks, four alternative scenarios, detailed in Table 2 below, are constructed to capture a range of possible pathways toward 2030, each reflecting different assumptions regarding investment levels, policy ambition, and institutional capacity.

Table 2: Input-Output Scenarios
Source: Conversations with industry leaders.

Scenario	Key Assumptions and investment targets	Fossil Fuel Phase-Out
Optimistic	Full compliance with NDC; $10B/year renewable investment; strong labor policies.	Oil/gas: -36% Coal: -75% Refining -33%
Pessimistic	Policy stagnation: fossil fuel subsidies continue; low renewable investment ($3B/year).	Oil/gas: -12% Coal: -25% Refining: -4%

Realistic	Partial NDC compliance; $6B/year renewable investment; moderate retraining programs.	Oil/gas: -24% Coal: -50% Refining: -19%
New 38% target scenario	22,377 million dollars of new investment according to the CFE expansion plan 2025-2030.	Oil/gas: -38% Coal: -85% Refining: -38%

The scenarios presented aim to delineate the potential outcomes that the prevailing political climate, the availability of resources, and the government's commitments render more probable. Considering Mexico's historical trajectory during the past administrations and the fiscal constraints faced by the government due to a limited budgetary space, the feasible scenarios were narrowed down to the four outlined in Table 2. The optimistic and pessimistic scenarios are somewhat extreme and represent deviations in which Mexico either disregards or fully commits to its National Development Goals (NDCs). Both scenarios are less probable. The realistic scenario and the new 38% target scenario are more likely outcomes because they are more aligned with the current resource availability and government priorities. Consequently, the realistic scenario is the preferred one.

Employment Coefficients and Multipliers (realistic scenario)

Estimating the employment effects of the energy transition requires not only projections of sectoral output but also an understanding of how changes in output translate into jobs. This conversion is made possible through the use of employment coefficients and multipliers derived from input–output analysis. Employment coefficients measure the number of jobs created per unit of output — expressed here as jobs per million Mexican pesos — in each sector. They are calculated from national employment and output data published by INEGI and reflect sector-specific labor intensities. Multipliers, by contrast, capture the broader employment effects across the economy by accounting for the intersectoral linkages described earlier.
In the context of this study, two types of multipliers are used. Type I multipliers combine direct employment effects — those occurring within the sector under consideration — with indirect effects generated in upstream industries that supply inputs to that sector. Type II multipliers

extend the analysis further by incorporating induced effects, which result from the additional household consumption stimulated by new income earned in directly and indirectly affected sectors. These multipliers provide a more comprehensive view of how sectoral expansion or contraction propagates through the broader economy.

Table 3 presents the estimated employment coefficients and corresponding multipliers for the main sectors analyzed. The results show significant variation in labor intensity across sectors. For example, solar and wind manufacturing exhibits an employment coefficient of 8.7 jobs per million pesos, reflecting the relatively high labor requirements associated with component production and assembly. Wind farm construction displays an even higher coefficient of 12.4 jobs per million pesos, underscoring the employment potential of large-scale infrastructure projects. In contrast, oil and gas extraction and petroleum refining are markedly less labor-intensive, with coefficients of 5.2 and 4.3, respectively. This divergence illustrates an important structural characteristic of the energy transition: renewable technologies, particularly during their construction and deployment phases, tend to generate more employment per unit of investment than traditional fossil fuel industries.

Table 3: Employment coefficients (e) and multipliers derived from INEGI data

Source: Author's calculations.

Sector	**Direct Jobs (Million MXN)**	**Type 1 Multiplier**	**Type II Multiplier**
Oil & gas extraction	5.2	1.8	2.3
Coal mining	6.1	1.6	2.0
Petroleum refining	4.3	2.0	2.5
Solar/wind manufacturing	8.7	2.2	3.0
Wind farm construction	12.4	1.9	2.4

Note: Type I*: Direct + indirect jobs*. Type II*: Direct + indirect + induced jobs.*

The magnitude of the multipliers further reinforces this conclusion. While fossil fuel sectors such as petroleum refining exhibit Type II multipliers in the range of 2.0–2.5, renewable sectors tend to generate higher economy-wide effects. For example, solar and wind manufacturing reaches a multiplier of 3.0, indicating particularly strong backward and forward linkages, while even wind farm construction — though slightly lower at 2.4 — remains broadly comparable to or above most fossil fuel activities. These results suggest that shifting investment from fossil fuels to renewables not only transforms the structure of energy production but also amplifies employment creation through supply-chain and consumption channels.

3.1. Capturing Indirect and Induced Employment

Estimating the total employment effects of the energy transition requires going beyond the measurement of direct job creation in specific sectors.

The Leontief model calculates total employment effects as:

$$\Delta L = \Delta Ldirect + \Delta Lindirect + \Delta Linduced \quad \textbf{(2)}$$

- Direct Jobs: Employment within the target sector (e.g., solar panel installation):

$$\Delta Ldirect = e \cdot \Delta Y \quad \textbf{(3)}$$

While direct employment — for example, workers engaged in solar panel installation, wind turbine assembly, or oil extraction — is the most visible outcome of changes in energy investment, it represents only part of the overall impact. A significant share of employment gains or losses emerges indirectly, through the supply chains that support these sectors, and is further amplified by induced effects, as new income circulates through the broader economy. Accurately capturing these dynamics is essential for understanding the full scale of the employment consequences of decarbonization.

- Indirect Jobs: Employment generated in upstream supply chains (e.g., steel for wind turbines):

$$\Delta Lindirect = e \cdot \left[(I - A)^{-1} - I\right] \Delta Y \quad \textbf{(4)}$$

Indirect employment captures the demand for goods and services generated upstream of the targeted sector. For instance, an expansion in wind power capacity does not only employ workers on-site; it also stimulates employment in the steel industry producing turbine components, in construction firms building foundations and transmission lines, and in logistics companies transporting equipment. These supply-chain effects can be substantial, particularly in economies with diversified industrial bases and complex intersectoral linkages, as is the case in Mexico. As mentioned previously, they are measured by applying Type I multipliers, which account for both direct and indirect employment generated per unit of final demand.

- Induced Jobs: Employment from worker spending (e.g., retail, healthcare):

$$\Delta \text{Linduced} = \text{e} \cdot [(I - A)induced^{-1}]\Delta \text{Y} \quad \textbf{(5)}$$

Induced employment refers to a second layer of effects that arises from the spending of additional income earned by workers in both the directly and indirectly affected sectors. As wages increase and household consumption expands, new employment opportunities are created in sectors such as retail, housing, transportation, health services, and education. These effects are captured by Type II multipliers, which extend the model to include consumption feedback loops. Although induced employment is more diffuse and harder to observe than direct or indirect effects, it can represent a substantial proportion of total employment gains, especially when the newly created jobs offer stable incomes and are concentrated in regions with high consumption multipliers.

The magnitude of indirect and induced employment depends on several structural features of the economy. Sectoral interlinkages play a crucial role: industries that rely heavily on domestic supply chains generate larger indirect effects, while those dependent on imports create more limited spillovers. Similarly, household spending patterns and labor market characteristics — particularly the prevalence of informality — influence the size of induced effects. High levels of informality, which remain pervasive in Mexico's energy sector, tend to dampen induced employment because informal workers often earn lower incomes and spend a smaller share of their earnings in the formal economy. In regions such as Oaxaca, where informality exceeds 60 percent, this reduces the employment multiplier relative to states with more formalized labor markets.

A simple illustration highlights the scale of these effects. If solar manufacturing exhibits a direct employment coefficient of 8.7 jobs per million pesos and a Type II multiplier of 3.0, an investment of 100 million pesos would directly create 870 jobs. The same investment would generate an additional 1,740 jobs through indirect and induced effects, bringing the total employment impact to approximately 2,610 jobs. This amplification underscores the importance of considering economy-wide interactions when assessing the labor consequences of the energy transition. It also highlights the critical role of policy interventions aimed at strengthening domestic supply chains, promoting formal employment, and stimulating local consumption, all of which can significantly enhance the employment benefits of decarbonization.

In order to estimate the employment effects for the different Mexican states it is thus necessary to adjust the coefficient to the state economies using the following variables:

1. Location Quotients (LQ)**:** To estimate regional specialization. For instance, Oaxaca's wind sector LQ = 2.1 (twice as concentrated as national average).
2. Informality Rates**:** Informal workers constitute 65% of Oaxaca's labor force vs. 55% nationally (INEGI, 2022). This reduces induced job multipliers by 15% in high-informality states.
3. State GDP Contributions**:** E.g., Sonora contributes 12% of national solar output but only 2.8% of GDP.

After applying these adjustments, we obtain a set of state- and sector-specific employment coefficients and multipliers that are reported in Table 4 here below.

Table 4: State-specific coefficients derived from INEGI's *System of National Accounts (2021)*

Source: Author's calculations.

State	Sector	Direct Jobs / Million MXN	Type II Multiplier	Informality Adjustment
Oaxaca	Wind construction	14.2	2.8	0.85
Sonora	Solar manufacturing	9.1	3.2	0.90
Tabasco	Oil extraction	5.6	2.4	0.75
Nuevo León	Manufacturing	10.3	3.5	0.95

Note*:* Multipliers account for regional supply chain linkages. For example, Nuevo León's advanced manufacturing base yields higher multipliers due to localized component production.

The resulting coefficients preserve national consistency while capturing regional heterogeneity: states with deeper industrial linkages and lower informality, such as Nuevo León, display larger total multipliers even when direct labor intensity is moderate, whereas high-informality states such as Oaxaca exhibit dampened induced effects despite strong direct intensity in activities like wind construction. These subnational coefficients are subsequently combined with the scenario-specific demand shocks to generate the state-level employment estimates discussed in the following sections.

3.2. Examples

To illustrate how the input–output methodology translates into concrete employment outcomes across regions and sectors, this section presents three representative case studies: wind power development in Oaxaca, solar energy expansion in Sonora, and the contraction of oil production in Tabasco. examples were chosen because they reflect distinct trajectories of Mexico's energy transition and embody the contrasting dynamics of job creation and destruction. Oaxaca represents a region with exceptional renewable potential but persistent structural constraints; Sonora illustrates how favorable resource endowments and industrial capabilities can combine to generate significant employment gains; and Tabasco exemplifies the socioeconomic risks faced by fossil fuel–dependent economies during the transition

a) Oaxaca's Wind Energy

Oaxaca hosts 28 wind farms (5.5 GW capacity) employing 3,200 workers directly (AMDEE, 2023). However, only 320 jobs (10%) go to local indigenous communities, with most technical roles filled by outsiders from Puebla and Mexico City. Most technical positions are held by workers from other regions, reflecting the scarcity of specialized training programs and the region's historically limited integration into industrial supply chains (Fernandez Martinez et al., 2025).

2030 Projections (Realistic Scenario)

In the realistic 2030 scenario, Oaxaca is expected to attract an additional 2.4 GW of wind capacity, equivalent to an investment of approximately 48 billion pesos. Applying the state-adjusted employment coefficients yields an estimated 681 direct jobs per year in construction and operations. Indirect employment effects, concentrated in upstream industries such as cement production in Chihuahua and turbine blade manufacturing in Guanajuato, generate approximately 1,032 additional jobs. Induced employment, arising from local spending by these new workers, accounts for a further 463 jobs. The total annual employment impact thus reaches about 2,176 jobs. However, a large proportion of indirect jobs — around 70 percent — are informal and offer limited social protection, illustrating the importance of complementary policies aimed at formalization, training, and local capacity-building.

New Investment: 2.4 GW additional wind capacity (ΔY = 48 billion MXN).

Direct Jobs: 48,000×14.2 = 681 jobs/year.

Indirect Jobs: Supply chain effects in cement (Chihuahua) and turbine blades (Guanajuato):

$\Delta L_{indirect}=681\times(2.8-1.0)\times0.85=1{,}032$ jobs.

Induced Jobs: Local spending by workers: $\Delta L_{induced}=681\times(2.8-2.0)\times0.85=463$ jobs.

Total Annual Employment: 681 + 1,032 + 463 = **2,176 jobs**.

Note: 70% of indirect jobs (e.g., construction) are informal, with no healthcare or pensions.

b) Sonora's Solar Power

Sonora provides a contrasting case. The state combines high solar irradiance with proximity to export markets, positioning it as a strategic hub for solar energy development. Existing solar farms with a combined capacity of 4.2 GW currently employ approximately 1,850 workers directly. Sonora's relatively advanced industrial base, including manufacturing clusters in Hermosillo and glass production facilities in Monterrey, enhances its ability to capture supply-chain benefits and retain more value-added employment locally.

Under the optimistic 2030 scenario, Sonora is projected to add 8.5 GW of solar capacity, corresponding to an investment of roughly 127 billion pesos. This expansion is expected to generate around 1,155 direct jobs annually. Indirect employment effects, including jobs in component manufacturing and materials supply, contribute an additional 2,294 jobs, while induced effects from increased household spending add another 1,247 jobs. In total, the employment impact approaches 4,696 jobs per year. The Sonora case demonstrates the potential for renewable investments to drive not only direct job creation but also broader industrial development when aligned with existing economic capabilities and supportive policies.

2030 Projections (Optimistic Scenario)

New Investment: 8.5 GW added capacity (ΔY = 127 billion MXN).

Direct Jobs: 127,000×9.1=1,155 jobs/year.

Indirect Jobs: Manufacturing in Hermosillo and glass production in Monterrey:

$$\Delta L_{indirect}=1{,}155\times(3.2-1.0)\times 0.90=2{,}294 \text{ jobs.}$$

Induced Jobs: Services in Ciudad Obregón: $\Delta L_{induced}=1{,}155\times(3.2-2)\times 0.90=1{,}247$ jobs.

Total Annual Employment: 1,155 + 2,294 + 1,247 = 4,696 jobs.

c) Tabasco's Oil Production

Tabasco illustrates the opposite side of the transition: the employment risks associated with declining fossil fuel activity. The state's economy remains heavily dependent on oil extraction, with Pemex directly employing about 45,000 workers and indirectly supporting another 80,000 jobs in linked sectors such as transportation, hospitality, and services. A gradual decline in oil demand, compounded by Pemex's financial constraints, is expected to result in substantial job losses if alternative sources of employment are not developed.

2030 Projections (Pessimistic Scenario)

In the pessimistic scenario, where fossil fuel phase-out proceeds slowly and renewable investment remains limited, Pemex's operations in Tabasco are projected to shrink by 12 percent by 2030, corresponding to a reduction of roughly 58 billion pesos in output. This contraction leads to an estimated 325 direct job losses each year. Indirect job losses in supplier industries, particularly in Coatzacoalcos, amount to about 341 jobs, and induced job losses resulting from reduced household consumption add another 98. The total employment impact is a loss of approximately 764 jobs per year. Beyond the numerical decline, these losses are concentrated in well-paying, unionized positions, which amplifies their social consequences and increases the urgency of implementing targeted transition policies such as retraining, economic diversification, and social protection schemes.

Output Decline: Pemex reduces operations by 12% ($\Delta Y = -58$ billion MXN).

Direct Job Loss: $58{,}000 \times 5.6 = 325$ jobs lost/year.

Indirect Job Loss: Supplier industries in Coatzacoalcos:

$$\Delta L_{indirect} = 325 \times (2.4 - 1.0) \times 0.75 = 341 \text{ jobs lost.}$$

Induced Job Loss: Reduced consumer spending in Villahermosa:

$$\Delta L_{induced} = 325 \times (2.4 - 2.0) \times 0.75 = 98 \text{ jobs lost.}$$

Total Annual Job Loss: 325 + 341 + 98 = 764 jobs.

These three examples illustrate the heterogeneous nature of Mexico's energy transition. In regions like Oaxaca, the primary challenge lies in transforming potential into inclusive development by overcoming structural barriers in education, informality, and community participation. In Sonora, the opportunity is to leverage existing industrial strengths to maximize local benefits from renewable growth. In Tabasco, the priority is to manage economic decline responsibly and protect workers and communities from the negative effects of fossil fuel contraction.

3.3. Scenario Analysis

The scenario analysis builds on the input–output framework developed above to explore how different policy and investment trajectories could shape the employment impacts of Mexico's energy transition by 2030. The four scenarios — optimistic, pessimistic, realistic, and the new 38% target — represent alternative pathways that vary according to policy ambition, investment intensity, institutional effectiveness, and the degree of alignment with Mexico's international climate commitments. They are not forecasts but counterfactual simulations designed to capture the range of plausible outcomes and to illuminate the trade-offs that policymakers must navigate when designing transition strategies.

Fossil Fuel Phase-Out Projections

Based on SENER's energy demand forecasts and NDC targets, the fossil fuel phase-out projections and the projected growth in renewables (IRENA 2023) are summarized in Table 5 here below.

Table 5: fossil phase-out scenarios.
Source: Author's calculations.

Sector	**2022 output (billion MXN)**	**2030 output (optimistic)**	**2030 output (pessimistic)**	**2030 output (realistic)**	**New 38% Target**
Oil & gas extraction	1,250	800 (-36%)	1,100 (-12%)	950 (-24%)	775 (-38%)
Coal mining	80	20 (-75%)	60 (-25%)	40 (-50%)	12 (-85%)
Petroleum refining	890	600 (-33%)	850 (-4%)	720 (-19%)	552 (-38%)

Coal mining experiences the most significant losses, averaging 58.75% across all scenarios. However, it also ranks as the least valuable sector among the fossil energy sectors. Oil and gas extraction is the second most impacted sector, with an average impact of 27.5%. Petroleum refining concludes the list with an average impact of 23.5%. While oil and gas extraction and petroleum refining exhibit a substantially lower impact from the transition, they collectively represent a significantly higher output value.

Parallel to the fossil fuel contraction, significant expansion is expected in renewable energy sectors (Table 6).

Table 6: Renewable expansion scenarios.
Source: Author's calculations.

Sector	2022 output (billion MXN)	2030 output (optimistic)	2030 output (pessimistic)	2030 output (realistic)	New 38% Target
Solar/wind manufacturing	120	500 (+317%)	200 (+67%)	350 (+192%)	600 (+400%)
Wind farm construction	180	800 (+344%)	300 (+67%)	550 (+206%)	900 (+400%)
Hydropower	90	150 (+67%)	100 (+11%)	120 (+33%)	150 (+67%)

Table 6 presents a contrasting perspective to Table 5, highlighting the energy sectors that anticipate a surge in their output value as a consequence of the transition. Notably, wind farm construction emerges as the sector that reaps the most significant benefits, with an average output value increase of 254%. Solar and wind manufacturing closely follows, averaging 244% in output value increase. Hydropower, on the other hand, ranks last with an average output value increase of 44.5%. While the output value increases are substantial, their relative magnitude renders them insufficient to fully offset the losses observed in Table 5. Although this result is not a part of the objectives of this study, it highlights the tension between the transition and its potential wider aggregate economic costs.

3.4. Direct Employment Calculations

Jobs Lost in Fossil Fuels

The employment implications of these output shifts are substantial. Tables 7–10 present the projected direct job losses in fossil fuel sectors under the four scenarios. Using Type II multipliers to capture total employment effects:

Table 7: Fossil direct job losses (optimistic scenario)
Source: Author's calculations.

Sector	Job losses
Oil & gas	5,382
Coal	732
Refining	3,118
Total fossil job loss	**9,232**

Table 8: Fossil direct job losses (pessimistic scenario)
Source: Author's calculations

Sector	Job losses
Oil & gas	980
Coal	350
Refining	770
Total fossil job loss	**2,100**

Table 9: Fossil direct job losses (realistic scenario)
Source: Author's calculations

Sector	Job losses
Oil & gas	2543
Coal	510
Refining	2,347
Total fossil job loss	**5,400**

Table 10: Fossil direct job losses (New 38% scenario)
Source: Author's calculations

Sector	Job losses
Oil & gas	19,140
Coal	3,600
Refining	11.900
Total fossil job loss	**36,640**

Tables 7 through 10 show that the newly adopted 38% target, implemented by the new administration, resulted in a higher number of job losses due to its accelerated transition. Conversely, a more realistic scenario that aligns more closely with Mexico's fiscal capacity indicates that the job losses could be significantly lower compared to those associated with the new target (5,400 versus 36,640).

Jobs Gained in Renewables

The corresponding job gains in renewable energy sectors (Tables 11–14) are consistently higher than the losses in fossil fuels, even under conservative assumptions.

Table 11: Renewables direct job gains (optimistic scenario)
Source: Author's calculations

Sector	Job gains
Solar / Wind	9,918
Wind construction	18,374
Hydropower	600
Total renewable job gains	**28,892**

Table 12: Renewable direct job gains (pessimistic scenario)
Source: Author's calculations

Sector	Job gains
Solar / Wind	2,731
Wind construction	4,630
Hydropower	89
Total renewable job gains	**7,450**

Table 13: Renewable direct job gains (realistic scenario)
Source: Author's calculations

Sector	Job gains
Solar / Wind	6,313
Wind construction	11,478
Hydropower	429
Total renewable job gains	**18,220**

Table 14: Renewable direct job gains (New 38% scenario)
Source: Author's calculations

Sector	Job gains
Solar / Wind	21,924
Wind construction	40,176
Hydropower	1935
Total renewable job gains	**63,035**

The new 38% target scenario, which aligns with the most recent commitment by the Mexican administration, leads. However, this scenario may not be the most realistic considering the previously mentioned fiscal challenges faced by the Mexican state. The realistic scenario indicates the creation of 18,220 new direct jobs, which is significantly lower than the 38% scenario (63,035). Nevertheless, the key takeaway from these tables is that regardless of the chosen scenario, the direct jobs created consistently compensate for the job losses.

3.5. National Employment Synthesis (Direct + Indirect + Induced jobs) by scenario

A comprehensive assessment of the employment impacts of Mexico's energy transition requires moving beyond sector-by-sector results to examine the aggregate balance of jobs created and destroyed across the entire economy. The synthesis of direct, indirect, and induced employment effects (Tables 15–17) provides a more comprehensive picture. When supply-chain and consumption linkages are included, net employment gains become even more pronounced.

Table 15: Synthesis of Job Creation
Source: Author's calculations

Scenario	Direct Jobs	Indirect Jobs	Induced Jobs	Net Changes
Optimistic	+ 28,892	+46,201	+ 24,110	**+99,203**
Pessimistic	+ 7,450	+11,920	+6,210	**+25,580**
Realistic	+ 18, 220	+29,152	+ 15,210	**+ 62,582**
New 38% Scenario	+16,025	+33,720	+13,290	**+ 63,035**

Note: Indirect jobs dominate due to Mexico's complex industrial supply chains. Induced jobs are suppressed by informality.

Table 16: Synthesis of Job losses
Source: Author's calculations

Scenario	Direct Jobs	Indirect Jobs	Induced Jobs	Net Changes
Optimistic	-9,232	-14,689	-10,986	**-34,907**
Pessimistic	-2,100	-3,360	-2,499	**-7,959**
Realistic	-5,400	-8,886	-6,426	**-20,712**
New 38% Scenario	-10,400	-19,160	-5,080	**-34,640**

Table 17: Net effect on jobs by scenario
Source: Author's calculations

Scenario	Job gains	Job losses	Net change
Optimistic	99,203	34,907	**+64,296**
Pessimistic	25,580	7,959	**+17,621**
Realistic	62,582	20,712	**+41,870**
New 38% Scenario	63,035	-34,640	**+28,396**

Regardless of the circumstances, the net job creation (direct, indirect, and induced) surpasses the job losses. Consequently, the transition not only constitutes a beneficial environmental policy but also a sound economic policy. However, it is crucial to acknowledge that the fact that more jobs are generated than lost does not imply that the individuals who lose their jobs are subsequently positioned in a more advantageous position. Public policies must be implemented to guarantee that those who lose their jobs are not left behind.

3.6. Gender-Disaggregated Job Projections in Mexico's Energy Transition

Globally, women occupy only 22% of technical roles in the fossil fuel industry and 32% in the renewable energy sector, with even more pronounced disparities in developing economies (IRENA, 2023). In Mexico, structural barriers such as cultural norms, wage disparities, and limited STEM education further marginalize women in the energy sector. To address this issue, we have analyzed data from INEGI's Encuesta Nacional de Ocupación y Empleo (2022) and sector-specific studies (García, 2022) to estimate current gender ratios and project future employment scenarios under distinct scenarios.

Table 18: Women's participation by sector.
Source: Author's calculations

Sector	Women's share	Key barriers / incentives
Oil & gas extraction	12%	Hostile work environments; lack of childcare.
Solar/wind manufacturing	18%	Limited access to technical training.

Wind farm construction	8%	Cultural biases against women in fieldwork.
Hydropower operations	23%	Higher administrative roles dominated by women.

It is important to note that, although much work needs to be done to ensure a more equitable gender distribution in employment share among different energy sectors, that the greener sectors also show a higher share of female participation.

Gender-Adjusted Employment Projections for 2030

Gender-sensitive employment projections to 2030 were developed using the sectoral employment results from the previous sections combined with baseline gender participation rates and plausible trajectories of change under different policy environments. We assume gender parity improves marginally under the **optimistic scenario** (targeted policies such as training programs for women, childcare support, hiring quotas, and mentorship networks) but stagnates in the **pessimistic scenario** (which assumes policy inertia and structural continuity).

Examples

Solar Manufacturing in Sonora (Optimistic Scenario)

For example, in solar manufacturing in Sonora, total employment is projected to reach 4,489 jobs by 2030. If women's share increases from 18 percent in 2023 to 25 percent, consistent with benchmarks from Chile's renewable energy sector, approximately 1,122 of these jobs would be held by women, compared with 3,367 by men. This outcome illustrates how targeted policies can translate macro-level employment growth into concrete gains in gender equity.

Total jobs gained (2030): 4,489 (see Sonora's example above).

Baseline women's share: 18% (2023) → **2030 target**: 25% (benchmarked with Chile's renewable sector).

Jobs for women: 4,489×0.25 =1,122

Jobs for men: 4,489-1,122 =3,367

Oil Decline in Tabasco (Pessimistic Scenario)

In Tabasco, for instance, the decline of oil production under the pessimistic scenario results in the elimination of 764 jobs, of which only about 92 are held by women (12 percent). While men bear the majority of job losses, women are unlikely to capture a significant share of new opportunities without proactive interventions, meaning that the transition could entrench rather than alleviate occupational segregation.

Total jobs lost: 764 (see Tabasco's example above).

Women's share in oil: 12%

Women laid off: 764×0.12=92

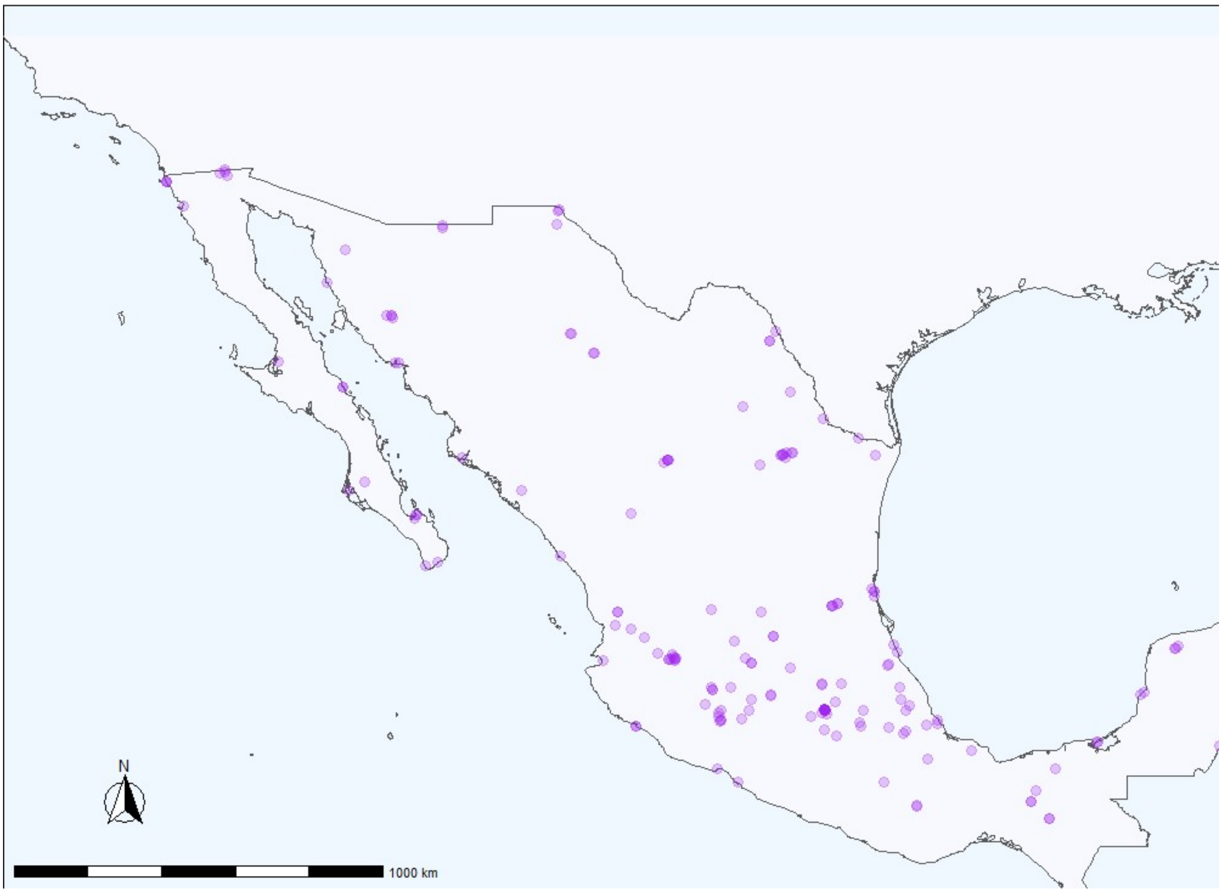
Men laid off: 764-92=672

The evidence suggests that the gender dimension of the energy transition cannot be understood simply as a matter of proportional participation. Rather, it reflects deeper structural dynamics that shape access to opportunities, the quality of employment, and the distribution of social and economic benefits. Women are more likely to be employed in informal, lower-wage, and non-unionized roles, even within renewable sectors, which limits the extent to which new jobs contribute to narrowing gender gaps in income and social protection. Moreover, the skills mismatch is often more pronounced for women, given the lower levels of female participation in STEM education and vocational training relevant to the energy sector. Addressing these barriers requires a comprehensive strategy that integrates gender considerations into industrial, education, and labor policies.

3.7. State-Level Employment Gains and Losses (2030 Realistic Scenario)

While national employment balances provide an essential overview of the aggregate labor market effects of the energy transition, they inevitably obscure the significant spatial heterogeneity underlying these results. The geography of energy production, industrial specialization, labor market structures, and infrastructure endowments means that the costs and benefits of decarbonization will be distributed unevenly across Mexico's territory. Understanding these regional disparities is crucial for designing policies that promote territorial cohesion, mitigate localized dislocation, and prevent the widening of existing inequalities between states.

Figure 2: Map of the fossil fuel electricity generating plants.
Source: INEGI-DENUE.



Already from Figure 2, it is possible to distinguish an important geographical component to energy production in Mexico. Fossil fuel produced electricity is produced at different sort of plants (carbon based thermal power, gas powered thermal power, combined cycle, etc.) states such as Veracruz, Coahuila, Nuevo León, Guanajuato and Jalisco concentrate a large amount of the plants. This concentration leaves these states exposed to job losses if they move from fossil fuels to renewables.

Using data from INEGI (2020 I-O table), SENER (2022), and state-level GDP reports, Table 19 summarizes the projected employment impacts under the realistic 2030 scenario for the ten most affected states, capturing both job gains in renewable sectors and job losses in fossil fuel activities. The results reveal stark regional contrasts.

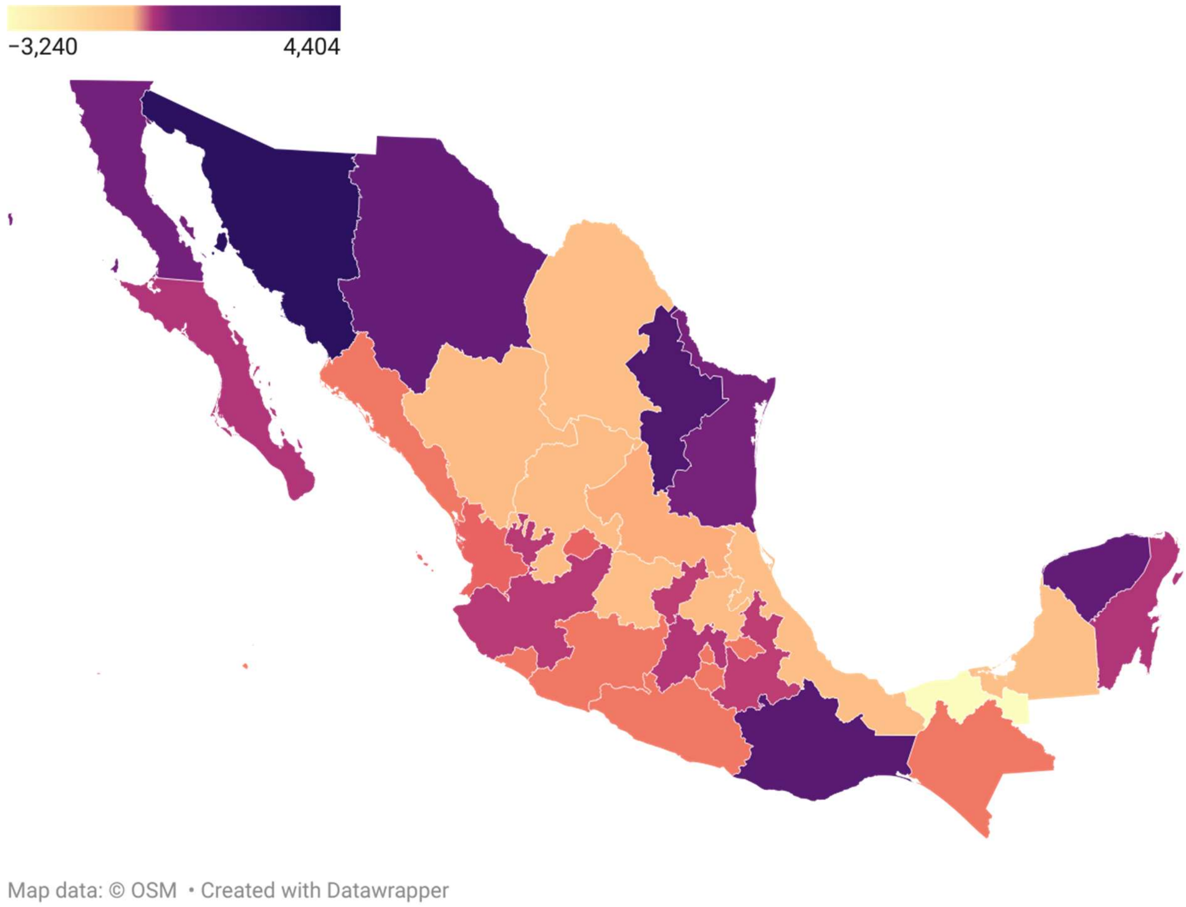
Table 19: Job gains and losses in the most impacted Mexican states.
Source: Author's calculations

State	Sector	Jobs Gains (Renewables)	Job Losses (Fossil Fuels)	Net Change	Women's Share in Gains	Women's Share in Losses
Oaxaca	Wind construction	2,176	120 (gas)	+2,056	14%	10%
Sonora	Solar manufacturing	4,489	85 (coal)	+4,404	22%	8%
Tabasco	Oil extraction	210 (biogas)	3,450	-3,240	28%	12%
Nuevo León	Equipment manufacturing	3,120	640 (refining)	+2,480	19%	15%
Veracruz	Offshore wind	1,890	2,100 (oil)	-210	17%	13%
Chihuahua	Solar component	1,560	320 (gas)	+1,240	20%	11%
Coahuila	Wind turbine production	980	1,200 (coal)	-220	18%	9%
Baja California	Geothermal	670	150 (oil)	+520	24%	10%
Tamaulipas	Hydrogen production	1,230	890 (refining)	+340	16%	14%
Yucatán	Solar farms	1,450	45 (gas)	+1,405	21%	12%

For instance, the female share of employment gains is less than 25% even in sectors that are considered more progressive, such as solar. Oil-producing states like Tabasco and Veracruz experience net losses, while states with high renewable potential, such as Sonora and Oaxaca, appropriately capture a significant portion of the gains. This reality can exacerbate important regional inequalities, particularly the disparity between relatively wealthy states like Sonora and relatively impoverished states like Tabasco. Furthermore, informality remains a key factor that impedes economic opportunities across different states. The construction of plants and infrastructure is predominantly undertaken using informal or temporary labor.

Figure 3 illustrates the geographical heterogeneity of the effects of the transition. While some states experience gains, others experience losses, resulting in a range of effects that can either amplify or compensate for regional inequalities.

Figure 3: Winners and losers (job creation).
Source: Author´s calculations.



4. Labor Income Inequality Effects

To evaluate the distributive impact of the energy transition, it is imperative to simulate the changes in employment and their corresponding income levels. This can be accomplished by utilizing the Employment Survey (ENOE), administered by INEGI. By identifying comparable jobs that are both created and destroyed, one can construct a synthetic index of inequality. However, employing the ENOE alone enables us to estimate the inequality in labor incomes and significantly underestimates the impact of informal jobs. This limitation underscores the need for caution, as the inequality estimates under these conditions serve as lower bounds. The simulation of the three scenarios presented in this analysis yields the following outcomes.

As can be seen in Table 20 the employment effects of the energy transition in Mexico have a marginal effect in the distribution of labor income. This is because the number of jobs created and destroyed represent a small fraction of national employment. However, as can be seen in the section above, the effects are concentrated in some states, in these states the levels of inequality can display larger changes.

Table 20: National level of inequality of labor income by energy transition scenario.
Source: Author´s calculations.

Gini (optimistic scenario)	Gini (pessimistic scenario)	Gini (realistic scenario)
0.36738	**0.36729**	**0.36763**

To estimate the changes in the 10 states that concentrate the impacts of the energy transition we follow the same approach but restricting the sample to those jobs belonging to each state. The results are summarized in the Table 21 here below.

Table 21: Change in labor income inequality (Gini coefficient) at the state level.
Source: Author´s calculations.

State	**Gini (real level)**	**Gini (realistic scenario)**	**Net Change**	**% change**
Oaxaca	0.427	0.433	+0.006	**+1.4%**
Sonora	0.400	0.411	+0.011	**+2.7%**
Tabasco	0.408	0.400	-0.008	**-1.9%**
Nuevo León	0.401	0.403	+0.002	**+0.5%**
Veracruz	0.415	0.414	-0.001	**-0.2%**
Chihuahua	0.421	0.424	+0.003	**+0.7%**
Coahuila	0.385	0.393	+0.008	**+2.07%**
Baja California	0.379	0.381	+0.002	**+0.5%**
Tamaulipas	0.381	0.383	+0.002	**+0.5%**
Yucatán	0.412	0.417	+0.005	**+1.2%**
Average	0.4029	0.4059	+0.003	**+0.7%**

Table 21 presents the alterations in inequality among the ten most affected states by the energy transition. Although the changes may appear insignificant, a shift of approximately 1% (0.7%) in the average represents a substantial transformation within a short timeframe. States such as Coahuila, while experiencing job losses and a 2% increase in labor income inequality, are

adversely affected by the energy transition. In contrast, Sonora, despite witnessing job creation, suffers the highest level of inequality (2.7%). Tabasco, on the other hand, exhibits the opposite pattern, experiencing job losses but resulting in lower levels of inequality. These disparate outcomes can be attributed to the distinct labor market characteristics of each state.
Table 21 indicates that any policy analysis considering changes that affect the industrial and labor market characteristics of a country must be approached through the lens of regional economies, as the effects of these changes are heterogeneous.

5. General Public Policy Suggestions

Any policy implementation aimed at accelerating the energy transition and mitigating its potential negative employment impacts necessitates a comprehensive analysis of national and regional economic structures and their interdependencies. This analysis should encompass integration within global, national, and local value chains. The following are initial suggestions for general policies that can guide the energy transition towards a just transition that ensures equitable outcomes for all stakeholders.

5.1. Industrial Policy Recommendations

A first priority concerns industrial policy. Strengthening strategic value chains is essential to ensure that Mexico captures a larger share of the economic benefits generated by renewable energy investments. This can be achieved by designating and supporting regional manufacturing hubs for renewable components, such as turbine blades in Oaxaca or photovoltaic modules in Sonora, through public–private partnerships and export promotion initiatives. The creation of energy-focused technology parks linked to universities and the Secretariat of Science, Technology, and Innovation (SECIHTI) would further reinforce this approach. Such parks could serve as incubators for startups specializing in energy storage, smart grids, and green hydrogen, supported by matched research and development grants and streamlined procedures for intellectual property protection.

A second dimension of industrial policy involves deeper integration of renewable industries into domestic supply chains. The gradual implementation of regional content requirements, beginning with 30 percent by 2027 and rising to 50 percent by 2030 for all state-sponsored renewable projects, would incentivize local sourcing and production. Compliance with these thresholds could be linked to preferential financing terms. At the same time, targeted support for small and medium-sized enterprises (SMEs), including technical assistance, subsidies for quality certification, and access to low-interest loans, would help domestic firms meet the standards required to participate in renewable energy supply chains. Finally, the conversion of underutilized petrochemical zones into dedicated green industrial parks, equipped with shared infrastructure such as grid connections, logistics platforms, and water supply, would facilitate the growth of renewable industries while supporting the diversification of regional economies.

5.2. Education Policy & Dual Formation

Education and workforce development constitute a second pillar of the policy response. Dual vocational training programs, developed through partnerships between energy companies, technical high schools, and regional technology institutes, would align educational curricula with the skills demanded by the renewable sector. These programs should include the development of standardized, competency-based credentials recognized by both employers and the Ministry of Public Education (SEP), covering roles such as turbine technician, solar installer, grid operator, and energy auditor. The integration of green energy modules into secondary and tertiary STEM curricula would further strengthen this alignment, ensuring that future workers are familiar with decarbonization technologies, circular economy principles, and digital tools such as the Internet of Things for energy management. Teacher training is also crucial; a national program to upskill at least 2,000 STEM educators annually in renewable energy topics, developed in partnership with leading universities such as UNAM and the Tecnológico de Monterrey, would enhance the quality and relevance of instruction. In addition, targeted scholarships and stipends for underrepresented groups, including women and indigenous students, would expand access to energy-related education and training programs, with opportunities for short-term study exchanges in advanced international energy institutes.

5.3. Incentives for Businesses

Business incentives represent another critical policy instrument. Investment tax credits of between 20 and 30 percent for capital expenditures in renewable projects and manufacturing facilities could stimulate private sector participation, with eligibility scaled according to local employment creation and formalization outcomes. Allowing accelerated depreciation of green assets — up to 150 percent for corporate income tax purposes — would further encourage investment. The issuance of green corporate bonds, with a portion allocated to a dedicated fund for private renewable developers, would expand access to low-cost financing. Projects meeting specific labor-content and gender-inclusion criteria would be eligible for preferential interest rates from this fund. Performance-based grants could complement these incentives, with matching funds awarded to firms that exceed local hiring and training benchmarks, as verified through annual audits by the Secretaría del Trabajo.

5.4. Social Protection & Just Transition Funds

Social protection measures are indispensable for mitigating the social costs of the transition and supporting affected workers and communities. The establishment of regional just transition funds, allocated according to vulnerability indices based on job losses and informality rates, would ensure that states such as Tabasco, Veracruz, and Coahuila receive proportionally higher support for reskilling initiatives and income assistance. Expanding social security coverage to include informal workers in the renewable sector through co-contributions from employers and the government would extend access to healthcare and pensions. Portable benefits tied to individual worker accounts would further enhance labor mobility and security. For older workers in declining fossil fuel sectors, pension bridging mechanisms and early retirement options would facilitate workforce exit with full benefits. These workers could also be offered part-time advisory roles in vocational training centers, leveraging their experience to support the next generation of energy sector workers.

5.5. Gender Equity & Inclusion

Finally, promoting gender equity and inclusion must be a central objective of transition policies. Mandating that at least 30 percent of hires in all publicly funded or publicly procured energy projects be women would set a clear standard for gender inclusion. Non-compliance could be penalized through reduced subsidies or exclusion from public procurement processes. Providing tax credits or other financial incentives to firms that establish on-site childcare facilities at large renewable installations and industrial parks would help address one of the most significant barriers to women's labor market participation. In addition, the creation of national mentorship and leadership networks for women in the energy sector would foster professional development, build supportive peer communities, and increase women's representation in decision-making positions.

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Appendix: Robustness check

To assess the reliability of the employment impact estimates, a sensitivity test is conducted on three core parameters of the Leontief input-output model:

1. **Investment levels** (±10% variation in renewable/fossil fuel sector demand ΔY).
2. **Employment multipliers** (±10% variation in Type I/II multipliers).
3. **Informality adjustments** (±5% variation in state-specific informality rates).

To simplify, the test compares deviations from the **Realistic Scenario** baseline (net +41,870 jobs) using the formula:

$$\Delta L_{adjusted} = \lfloor 1 - A^{-1} * \Delta Y\_adjusted \rfloor * e\_adjusted$$

where adjusted values Y and e reflect tested perturbations to investment and to the employment multipliers.

The key assumption are the presented in table 1A.

Table 1A: parameters for the sensibility test
Source: Author´s calculations.

Parameter	Baseline Value	Test Range	Justification
Renewable ΔY	$6B/year	$5.4B–$6.6B	Historical budget volatility
Type II Multiplier	3.0 (solar)	2.7–3.3	IRENA (2023) global sector variability
Informality	0.85	0.80–0.90	INEGI (2022) margin of error

Results

Table 2A: Sensibility test results
Source: Author´s calculations.

Tested Parameter	Net Job Change Range	% Deviation from Baseline
Investment (±10%)	+35,612 to +48,128	-15% to +15%
Multipliers (±10%)	+37,683 to +46,057	-10% to +10%
Informality (±5%)	+40,210 to +43,530	-4% to +4%

As Table 2A indicates, the deviation from the realistic scenario (the preferred one) does not alter the outcome of a positive net gain in jobs. The results of introducing variation in investment levels, multiplier values, and informality levels roughly remain within the range of those obtained from the realistic scenario, resulting in a net job creation of approximately 40,000 jobs.

The key takeaway from this results are:

1. Investment Volatility and Employment Fluctuations: Investment volatility leads to significant employment swings, with fluctuations of approximately ±15%. This underscores the crucial role of policy commitments and certainty in mitigating such fluctuations. A 10% decline in investment results in the loss of approximately 6,000 jobs.
2. Multiplier Effects and Fossil Fuel Job Displacement: Multiplier effects exhibit non-linear patterns, with fossil fuel job losses being more pronounced than gains due to a lower baseline multiplier. For instance, the multiplier for oil is 2.3, while for solar energy, it is 3.0.
3. Formalization Policies and Job Creation: Reducing informality by 5% leads to a corresponding 5% boost in job creation. This emphasizes the significance of policies that aim to formalize employment.

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Publication Director Rémy Rioux
Editor-in-Chief Thomas Melonio

Legal deposit 4th quarter 2025
ISSN 2492 - 2846

Graphic design MeMo, Juliegilles, D. Cazeils
Layout PUB
Printed by the AFD reprography service

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