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ESMAP
Energy Sector Management Assistance Program

THE EMPLOYMENT BENEFITS OF AN ENERGY TRANSITION IN MOROCCO

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Energy Sector Management Assistance Program (ESMAP) is a partnership between the World Bank and 24 partners to help low- and middle-income countries reduce poverty and boost growth through sustainable energy solutions. ESMAP's analytical and advisory services are fully integrated within the World Bank's country financing and policy dialogue in the energy sector. Through the World Bank Group (WBG), ESMAP works to accelerate the energy transition required to achieve Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable, and modern energy for all. It helps to shape WBG strategies and programs to achieve the WBG Climate Change Action Plan targets.

This report on Morocco is one of three country case studies under the umbrella project **The Disruptive Energy Transition and Opportunities for Job Creation in the Middle East and North Africa**. This project, made possible by funding from the ESMAP, was initiated in 2019 in response to requests from various Middle East and North Africa (MENA) governments to explore the nexus between the clean energy transition and employment. The umbrella project is led by Tu Chi Nguyen and Ashok Sarkar (MENA Energy and Extractives Global Practice, World Bank) and includes Abdellatif Touzani, Alona Kazantseva, Arslan Khalid, James Barrett, Kabir Malik, Laure Grazi, Manjula Luthria, Mark Njore, Sarah Moin, Skip Laitner, and Yao Zhao.

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Overview

This report estimates the job creation potential of Morocco's ambitious renewable energy and energy efficiency targets. To do this, it uses the Clean Energy Employment Assessment Tool (CEEAT), an Excel-based input-output model that can simulate the economywide net direct, indirect, and induced employment impacts of clean energy technology pathways. CEEAT is currently calibrated for six such pathways: (i) utility-scale solar, (ii) concentrated solar power, (iii) industrial solar, (iv) rooftop residential solar, (v) utility-scale wind, and (vi) energy efficiency of buildings. Achieving Morocco's targets for these technologies would yield an estimated 762,000 net job-years over the next 30 years, equivalent to an average of 25,000 additional new job opportunities per year. This is 8.5 percent of the country's overall 300,000 annual jobs shortfall. The results could be even more impressive, if other clean energy technologies were to be considered, offering a more complete picture of the energy transition in Morocco.

The early results of the analysis showcase important benefits of striving for a sustainable energy pathway, even for an emerging economy. Not only would jobs be gained, which could inform future strategies for workforce development, but some jobs would be displaced, or possibly shifted. A just transition framework is thus needed to mitigate any negative impacts and maximizing the employment co-benefits of a green economy.

Front cover photo Chouara Tannery at the heart of Fes medina

1. Introduction to Clean Energy Employment in Morocco

The ongoing transition to clean energy allows countries across the world to achieve their climate change targets and enhance energy security while creating much-needed new jobs, especially important amid efforts toward economic recovery from the COVID-19 pandemic. The renewable energy (RE) sector employed at least 12.7 million people worldwide, directly and indirectly, in 2021 (IRENA and ILO 2022). Yet, employment opportunities remain concentrated in a handful of countries, with China, Brazil, the United States, India, and members of the European Union in the lead. The same holds for jobs created in the design, installation, and manufacture of energy efficiency (EE) products and services, which in 2019 were estimated at about 730,000 in China, 472,000 in Canada, 33,000–62,000 in Brazil, and 2.38 million in the United States (NASEO and EFI 2020; IEA 2020). With the transition from conventional energy (fossil fuels) to RE and EE scaling up rapidly, many more jobs can be created in developing countries as well. Recent International Renewable Energy Agency (IRENA) estimates suggest that the 1.5°C-aligned energy transition[1] promises the creation of 2.5 million additional RE jobs and 58.3 million extra jobs in EE, power grids and flexibility, and hydrogen by 2030, compared with 2019, which more than offsets losses of jobs in the fossil fuel and nuclear industries (IRENA 2022). Meanwhile, widespread support for a green, resilient, and inclusive recovery from the COVID-19 pandemic could accelerate the clean energy transition in many countries and bring about significant employment benefits.

Considering the RE and EE potential of the country and its ambitious clean energy targets, Morocco is well positioned to enjoy the employment opportunities offered by the energy transition. Morocco has significant RE potential with high solar irradiation and a long coastline with high wind speed. Its clean energy targets are among the highest in the world, with the goal of 52 percent of its electricity capacity from renewables and 30 percent energy savings by 2030 (IEA 2019). The government has designed policies that are conducive to achieving its ambitious RE and EE targets, including regulations and laws to favor RE and EE expansion; establishment of institutions to manage, supervise, and promote RE and EE projects; and implementation of major financial investments. According to the Office National de l'Electricité et de l'Eau potable (ONEE), the country reached 37 percent of its generation capacity from RE by the end of 2020.

PHOTO 1.1 Noor II: Concentrated Solar Power Parabolic Trough Power Plant of the Ouarzazate Solar Complex.

Non–World Bank photograph: © https://helioscsp.com. Used with the permission of HELI SCSP, Asociación Española de la Industria Solar Termoeléctrica (info@protermosolar.com). Further permission required for reuse.

[1] IRENA's 1.5°C pathway positions electrification and efficiency as key drivers of the energy transition, enabled by renewables, hydrogen, and sustainable biomass.

RE and EE jobs can help the Government of Morocco to address slow job growth and create more opportunities for women and youth. Job creation has not been sufficient to absorb the inflow of the working-age population. Table 1.1 shows that the growth of the working-age population is faster than the number of jobs added per year, leaving an average annual jobs shortfall of 300,000 between 2010 and 2019 (World Bank 2021), and this gap is expected to continue growing until 2030. Another challenge faced by the labor market is lack of inclusion of youth and women. Female labor force participation is at 23 percent, while both inactivity and unemployment are high for youth in the 15–24 age group, with a steady NEET (not in education, employment, or training) rate of about 29 percent (World Bank 2021). New jobs created in RE and EE sectors have the potential to bridge the annual shortfall of jobs.

TABLE 1.1 Key Population, Economic, and Energy Data for Morocco

Indicator	2010	2020	2030 (projected)	Annual growth (%)
Population (millions)	32.3	36.9	42.0	1.3
GDP (billion USD 2017 PPP)	207.9	276.4	367.9	2.9
Electricity generation (terawatt hours)	23.7	40.0	67.7	5.4
Working-age population (millions)	21.0	24.4	28.3	1.5
Jobs (millions)	10.6	11.0	11.5	0.4

Source: Data on population, GDP, working-age population are from the World Bank. Data on electricity generation are from the International Energy Agency. Data on jobs are from Enquête Nationale sur l'Emploi, by the Haut Commissariat au Plan Morocco. The data for 2030 are preliminary working projections using the compounded annual growth rate.
Note: GDP = gross domestic product.

Initial numbers in RE and EE sectors are promising. RE direct employment in Morocco in 2018 was estimated at 9,900 people (IRENA n.d.). Around 3,700 of these jobs were in wind power, which added 200 megawatts (MW) of new generation capacity in 2018. Hydropower, which accounted for around 40 percent of the total renewable capacity in the country,[2] employed 2,700 people. Most of these hydropower jobs are in the operation and maintenance (O&M) of existing hydropower plants. Solar photovoltaic (PV) and concentrated solar power (CSP) are rapidly growing technologies in Morocco and their workforces were estimated at 1,800 and 1,400, respectively, in 2018. Most of these solar jobs have been generated at the Noor Ouarzazate solar facility, which consists of three CSP plants and one PV assembly (World Bank 2018). The second phase of the Noor Ouarzazate complex is expected to create 11,000 new jobs. The site's construction has already created 4,000 positions for Moroccans, ranging from low-skilled work in construction to high-tech positions in engineering and management (World Bank 2018). Provisions for a safe and positive work environment for women to work in the complex could encompass a range of roles, from traditional ones such as catering, cleaning, and administration to technical roles in quality control, health and safety units, topography (to optimize the siting of panels), and welding.

Developing local manufacturing capacity and the local supply chain would allow Morocco to strengthen the national economy while creating more local jobs. Localization of the value chain has been an important aspiration. The Moroccan Agency for Sustainable Energy (MASEN), in collaboration with the National Agency for Employment and Capacity Promotion (ANAPEC), has encouraged the use of local staff and materials. On average, the share of Moroccan nationals at the Noor facility runs to 70 percent, of which people from the local area represent a little less than half (World Bank 2018). CSP presents great opportunities to develop local

[2] Total renewable electricity capacity in 2018 was 3,263 MW, made up of shares of hydropower (1,306 MW), wind (1,202 MW), concentrated solar power (530 MW), and solar PV (206 MW).

manufacturing capacity for both the domestic market and exports (World Bank 2011). Just local manufacturing for CSP could employ up to 10,000 by 2025, with up to 73,000 jobs cumulatively created by CSP developments (Fraunhofer Institute 2014). In the short term, most RE technologies (e.g., solar panels) will be imported from countries that offer them at competitive prices, such as China. As such, jobs will not be created immediately in manufacturing but rather in import trading, project development and management, installation and construction, and O&M. In the longer term, Morocco would benefit from developing local industries related to manufacturing, especially in segments where global markets are saturated and there is potential for international partnerships for technology transfer. This would also involve permanent jobs in research and development, engineering, and other support sectors, with socioeconomic benefits for surrounding communities.

While it is expected that the clean energy transition will have a net positive impact, some types of jobs are at risk of being substituted or eliminated, requiring mitigation measures to ensure a just transition. As the sector transitions from conventional to clean energy and its associated value chain, certain job profiles will change, along with skill requirements,[3] some will be relocated to other industries or locations,[4] while others will be eliminated entirely.[5] Whether a particular job is transformed, substituted, or eliminated will likely depend on the degree to which the country depends on the fossil fuel value chain. It is critical that policies promote employment searches and matching, reskilling and reorientation, and labor mobility to facilitate reallocation from fossil fuel sectors to clean energy sectors and from one region to another (such as through the use of relocation grants, urbanization policies, and other initiatives). In case of job elimination, stronger social protection policies and programs are required, including early retirement benefits, severance benefits, unemployment benefits for affected workers, and local development programs for affected communities.

This study looks at the direct, indirect, and induced net employment impact of the large-scale transition to clean energy resources in Morocco on a macro level. It examines six different technology paths—utility-scale solar PV, utility-scale wind, CSP, residential rooftop solar, industrial distributed solar, and building EE—and estimates net employment gains, based on the Government of Morocco's targets for each technology. Our literature review found some analyses on jobs created by the clean energy transition in Morocco, but most focus on RE and have been done at a micro scale, focusing on direct impact, while neglecting the broader employment effects of EE and RE development. The employment impact is derived not only from the investments in each technology but also their associated supply chain and the overall shift in the economy, which benefits from energy and cost savings. Therefore, a broader assessment of the economywide impact on jobs, on both the positive and negative sides, is needed.

2. A Tool to Evaluate the Employment Impact of Clean Energy Investments

This study applied the Clean Energy Employment Assessment Tool (CEEAT)[6] **to assess, ex ante, the employment impact of the clean energy transition.** CEEAT uses an input-output (I-O) table-based approach in Microsoft Excel to estimate the economywide net direct, indirect, and induced employment impacts[7] of various clean energy technology pathways, with a focus on the electricity sector. The tool implicitly compares clean energy investments with comparable investments in fossil fuels (counterfactual) and calculates the net job[8] gain for each clean energy scenario. For each technology pathway, the tool models user-specified RE capacity additions or energy savings from EE, and calculates the size of investments and expenditures in associated

[3] For example, architects will need to have expertise in designing buildings that meet EE standards.

[4] Managers of conventional power plants become managers of renewable power plants.

[5] For example, jobs in the extraction industries or jobs replaced by automation.

[6] CEEAT was developed as part of the same umbrella project as this report. More details on the tool can be found in the *CEEAT User Guide,* available upon request. CEEAT is currently in its Beta version and will be available publicly soon.

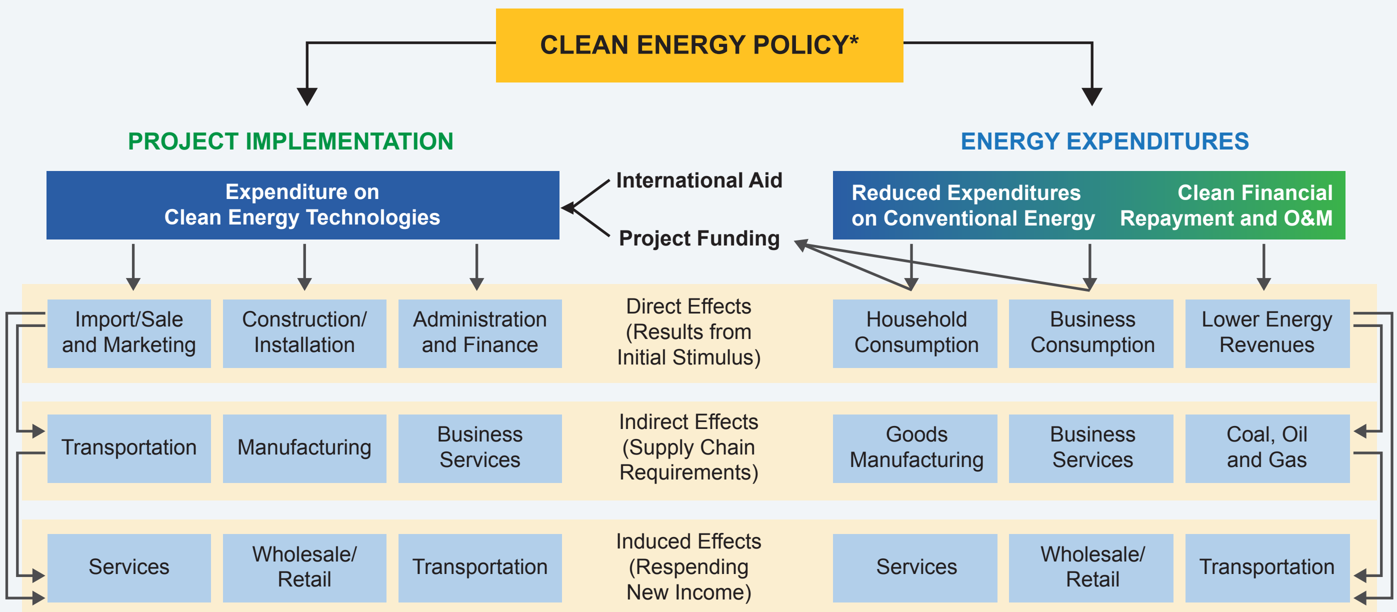
[7] Direct employment involves on-site jobs created by an investment; indirect employment involves jobs in upstream industries that supply the equipment (e.g., manufacturing) and support the core activities of clean energy deployment (e.g., finance). Induced employment entails jobs created as people who are directly and indirectly employed by clean energy systems spend their earnings in the local economy. This could also include jobs in other sectors that are affected by various macroeconomic feedback (e.g., changes in energy prices).

[8] The difference between gross jobs created and existing or future jobs displaced.

sectors. CEEAT then calculates the changes in final demand in each sector that result from these investments and expenditures, how they are financed, and their impacts on energy markets (changes in the costs and revenues faced by energy producers and consumers and other economic actors).

CEEAT estimates the employment impact by tracking the flow of two different groups of expenditures when clean energy investments take place. The first group comprises one-time ***project implementation*** outlays such as the cost to bring a power plant online. It includes all activities required to design and construct the project during its initial implementation phases. The second group involves ***energy expenditures***, which is the potential net electricity bill savings as a result of the lower cost of EE and RE technologies compared with conventional (fossil fuel) generation, after the plant is built and becomes operational. This also includes recurring clean energy expenditures such as financial repayments and O&M. These expenditure patterns occur throughout the lifetime of the project. Figure 2.1 provides a conceptual overview of how these two patterns of expenditure result in direct, indirect, and induced job effects in the economy.

FIGURE 2.1 **Expenditure Flows as They Generate Direct, Indirect, and Induced Effects**



*With non-energy or multiple benefits creating a parallel set of effects beyond those highlighted here.

Source: World Bank.
Note: O&M = operation and maintenance.

CEEAT models the net effects of these expenditures as a combination of four positive and negative impacts. While the first two impacts occur during the first year of a project, the third and fourth occur across its lifetime, as it generates (or saves) electricity.

(i) The investment impact refers to the expenditures spent to set up the project (policy planning, financing, installation, manufacturing, etc.). On the one hand, such project implementation expenditures can yield positive impacts due to the economic activity generated by investment in the sectors involved. On the other hand, if the expenditures are financed by the government budget[9], they require an increase in taxes levied on households and businesses, reducing the economic activities in those sectors, hence yielding a negative impact. The net investment impact is the sum of these two opposite impacts.

[9] The model assumes budgets need to be balanced, so government financing will need to be financed by increased taxes. It assumes that deficits, or external borrowing, will eventually need to be repaid, in which case taxes will need to be used. This is a conservative assumption. There can be more job potential if deficits are allowed.

(ii) The investment shift impact is the opposite of the investment impact. The expenditures spent on clean energy technologies take away resources from future conventional (fossil fuel) energy projects, which negatively impact the associated sectors.

(iii) The substitution impact is the result of energy expenditures saved by consumers either through energy efficiency or the price differential between the newly introduced clean energy and the existing power mix[10]. These savings are allocated to the three groups of consumers (residential, commercial, and industrial) depending on the customer structure of each country. These consumers then spend in the economy to generate economic activities[11]. In parallel, the spending on O&M boosts the associated sector but also takes away resources from other sectors. Finally, throughout the project lifetime, the domestic loans incurred to pay for the project investment require interest payments, which result in positive economic activity in the finance sector. Again, the substitution impact is the sum of the three positive and one negative impacts.

(iv) The revenue impact is the opposite of the substitution impact. The energy expenditure savings are beneficial for consumers but create a loss of income for the conventional energy provider (for instance, the utility and the fossil fuel sector value chain).

The final demand (in terms of net expenditures) for each impact is then converted into direct, indirect, and induced employment through employment multipliers (number of jobs per US$1 million) of the corresponding sectors, which are derived from an I-O framework (i.e. from the Social Accounting Matrix 2018).[12] The gross negative and positive employment impacts are then combined to calculate the net change in employment throughout the lifetime of the clean energy investments. Table 2.1 summarizes the drivers and direction (+/-) of the four employment impact categories.

TABLE 2.1 The Drivers and Direction of the Four Employment Impacts

Employment impact channel	Drivers	Job impact
Project investment impact: Investments to support clean energy expansion	Stimulates employment; moves expenditures from capital- to labor-intensive sectors; builds up local supply chain	+*
Investment shift impact: Redirecting funds from other projects or spending to support clean energy investments	Displaces jobs in other sectors (e.g., fossil fuels)	-
Substitution impact: Energy savings from efficiency and renewables respent locally	Stimulates employment as consumers (residential, commercial, industrial) spend savings in the economy	+
Revenue impact: Lost energy company revenues	Displaces jobs in the utility sector	-

Source: World Bank
* This can be net negative if the funding comes from government budget instead of other sources (such as domestic or international loans and grants).

[10] We assume that the entire price differential is passed to the consumer.
[11] We assume all savings from lower energy costs are reinvested in the economy. This could overestimate jobs created because there could be leakage to savings.
[12] Nonetheless, the feasibility of the I-O approach hinges on the availability of statistical data. For Morocco, employment data from provisional accounts and the Social Accounting Matrix tables were integrated with recent I-O tables available through the Organisation for Economic Co-operation and Development to generate reasonable proxies for job multipliers. In addition to the existing economic sectors, a clean energy manufacturing sector was added by the team to assess the economic impacts of the technology pathways.

Built on the existing body of knowledge and employment impact assessment methods, CEEAT offers unique country-specific insights and adds value to other employment impact assessment methods in several ways.

- First, CEEAT is comprehensive: it captures multiple job impact channels from the clean energy transition, on both the positive and negative sides. It therefore provides a more complete view of employment impacts than the employment factor or gross I-O based tools. Furthermore, it measures not only direct and indirect jobs along the clean energy value chain but also induced jobs, hence covering all sectors in the economy beyond the clean energy and associated sectors. This helps decision-makers in evaluating the broader implications of their clean energy plans. It also helps show how clean energy deployment can benefit from, and contribute to, the broader economy of a country.
- Second, it covers multiple clean energy technologies including EE (unlike much other work by IRENA, the International Labour Organization, the International Energy Agency, and others that focus mainly on RE).
- Third, CEEAT is created as a flexible tool such that it can simulate how job results vary according to different policy parameters, which will help policy makers understand which of their policies or country conditions yield the most job benefits.
- Fourth, it looks at the employment impact not only in the short term (during the implementation of clean energy projects) but also in the long term, throughout the life cycle of the assets. Yet, it is less data and effort intensive than general equilibrium models that cover long-term impact.

CEEAT is based on static I-O tables. This limits its ability to emulate structural changes in the economy over the time horizon, a feature that is found only in general equilibrium models. Nevertheless, it incorporates some dynamic features by allowing some parameters to change over time to capture the potential of technological innovations and improvements in the country's conditions (including labor productivity, local manufacturing capacity, energy costs, and clean energy technology costs and performance). Finally, CEEAT's Excel format does not require know-how in a specialized language or platform and makes data flows visible, allowing easy verification.

3. Preliminary Results for Morocco

3.1 Base Case Scenario for Morocco

For this paper, CEEAT has been calibrated for Morocco's economy and electricity sector. In the base case scenario, it applies the government's 2030 targets for the six technology pathways as follows:

(i) Utility-scale solar: As per the current government target of adding 1,523 MW evenly divided[13] over the period 2020–30, the base case scenario indicates an average annual delivery of 1.0 terawatt-hours (TWh) of electricity[14] with an estimated levelized cost of electricity (LCOE) of US$66 per megawatt-hour (MWh).[15]

(ii) Concentrated solar power: It is assumed that the total capacity of 1,523 MW will be evenly added over the 2020–30 period. The base case scenario suggests that these systems might provide 2.1 TWh of electricity per year with an estimated LCOE of US$231/MWh. Higher investment and O&M costs induce a higher LCOE.

(iii) Industrial distributed solar: The total capacity evenly added over the period 2020–30 is assumed to be 650 MW. The base case scenario indicates the possibility of 0.5 TWh of average annual electricity production with an LCOE of US$59/MWh. Such distributed energy resources also avoid transmission and distribution losses.

(iv) Residential rooftop solar: With the assumption of adding 1,100 MW, evenly divided, over the period 2020–30, the base case scenario indicates the possibility of 0.7 TWh of average annual electricity production with an

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[13] This may differ from the actual trajectory of investment/deployment. We assume constant annual installations every year due to the lack of details of government plans.

[14] Calculated over the period 2020–50; investments are made over 2020–30 with a life cycle of 20 years up to 2050.

[15] The LCOE is calculated based on the assumed investment and O&M costs, the annual degradation factor, the capacity factor, and how the investment is financed.

LCOE of US$85/MWh. Such distributed energy resources also avoid transmission and distribution losses.

(v) Building energy efficiency: The energy efficiency targets in the base case scenario might reduce Morocco's average annual electricity demand by as much as 0.9 TWh, and it might do so at a cost of US$119/MWh.

(vi) Utility-scale wind: Finally, building on Morocco's large-scale wind resources, with the assumption that 2,926 MW will be evenly added over the period 2020–30, this technology path provides the largest single technology impact with 3.5 TWh of renewable electricity at US$62/MWh in the base case scenario.

Under the base case scenario, these technology paths will displace, on average, 8.7 TWh of conventional electricity generation (89 percent of which will be through RE and 11 percent through EE) per year over the period 2020 through 2050. This analysis covers investments only up to 2030 but assumes a 20-year life cycle of the assets, hence electricity generation (or savings) and associated job benefits continue until 2050. By 2030, when all assets are in operation, the electricity output from these six technologies would add up to 22.7 TWh, which represents 39 percent of the projected electricity demand mentioned in table 1.1. If we compare the technologies, building EE has a share of 11 percent of the embedded energy transition while the various solar technologies deliver 49 percent, and wind energy systems provide the balance of 40 percent of that transition.

Associated investments and expenditures will deliver a positive benefit of 761,914 net jobs per year over the period 2020 through 2050. The net jobs[16] are the result of the creation of jobs through investments and their impact on economic activities and the displacement of jobs due to the substitution of fossil fuel power plants with clean technologies. Even though the government does not plan to further invest in fossil fuel technologies, the result implicitly compares the impact of the government's clean energy targets with a counterfactual in which the targets are not achieved, and electricity demand has to be met by conventional power plants.

The respective shares of the different impact mechanisms (investment impact, investment shift impact, substitution impact, and revenue impact) differ by technology (table 3.1). The majority of jobs are created by savings in energy bills (substitution impact) except for CSP and EE, for which the majority come from the investment impact. These results reflect the comparatively high investments spent on CSP and building EE, while the other clean technologies allow a comparatively low energy cost. If comparing the number of job-years created by millions of US dollars invested, EE allows for the highest number with 7.1 job-years per million US dollars invested, while residential rooftop solar allows for the smallest with 2.3 job-years per million US dollars invested. Utility solar, CSP, industrial distributed solar, and wind allow, respectively, for 4.4, 3.4, 4.6, and 5.0 net job-years per million US dollars invested. In terms of installed capacity, CSP could result in the highest number with 173 net job-years per MW, followed by wind, utility solar, industrial distributed solar and residential solar at 71, 38, 37.5 and 27 net job-years, respectively.

[16] To understand how job growth is predicted in the case of the clean energy transition, it is important to define a few employment terms, such as "job-year" and "full-time equivalent." One job-year is full-time employment for one person for a duration of one year, that is, a job-year is "one job for one year." If one person holds one new job for two years, that's two job-years, as opposed to one job. Often, jobs and job-years are used interchangeably; however, referring to jobs created without a duration (say, the expected length for constructing a solar facility, or the operational life of a wind farm) can be misleading.

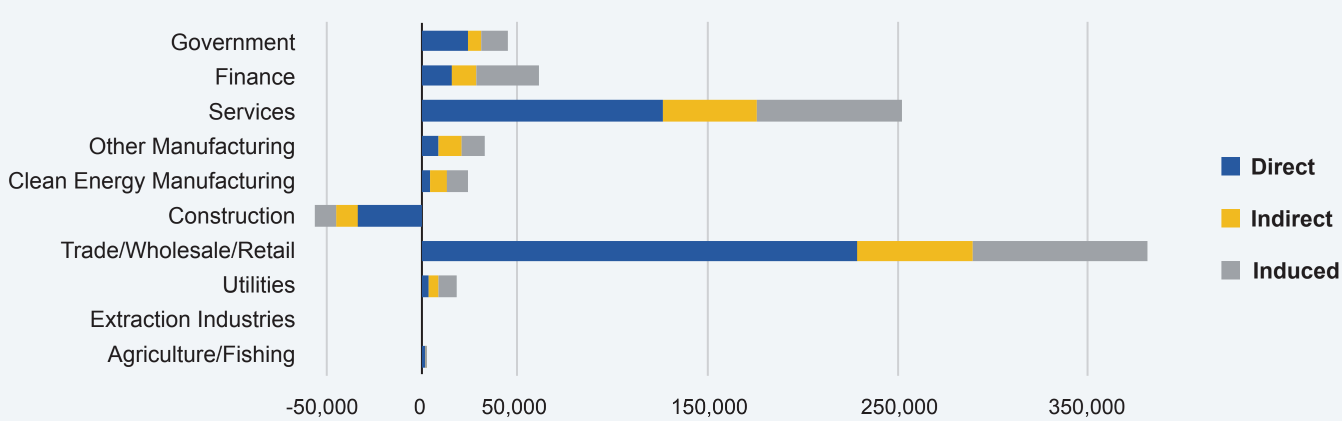
TABLE 3.1 Distribution of Net Job-Year Impacts, by Technology Pathway

	Utility-scale solar	CSP	Industry distributed solar	Residential rooftop solar	Utility-scale wind	Energy efficiency
Investment impact	27,491	213,144	10,184	24,242	85,811	129,534
Investment shift impact	-60,946	-130,598	-26,166	-40,064	-215,758	-41,692
Substitution impact	97,543	194,703	43,035	49,249	358,783	115,494
Revenue impact	-6,176	-13,235	-2,652	-4,060	-21,865	-24,087
Subtotal	**57,912**	**264,014**	**24,401**	**29,367**	**206,971**	**179,249**

Source: Initial baseline assumptions of the CEEAT.
Note: CSP =concentrated solar power.

Trade, commerce, and services sectors expect the largest employment expansion. CEEAT simulates job impact by sector by tracking the destination of the expenditures on clean energy technologies as well as the expenditures respent from energy savings (see figure 1.2). During the investment phase, there is significant spending on imports, sales and marketing, and purchase of clean energy equipment, which creates jobs in trade and commerce. The government will benefit from sales tax and policy development expenditures, while the utilities may need to invest in upgrading the transmission line and electrical system, hence generating more jobs in these sectors. The construction sector would have seen a similar expansion through its involvement in the construction and installation of clean energy projects, but this impact is offset by the reduction in the construction and installation activities of conventional power plants (this is assumed to be the counterfactual if the government's clean energy targets are not met, and investments need to be made in fossil fuel technologies). Throughout the life cycle of the clean energy assets, the repayment of domestic borrowings will benefit the finance sector, and the O&M of assets will create jobs in the services sector. Furthermore, the respending from workers who benefit from direct and indirect job effects and from consumers who save on energy expenditures will benefit the trade, commerce, and services sectors, as most of this spending is for the purchase of consumer goods and services (figure 3.1). It should be noted that, these induced jobs could potentially be underestimated due to the exclusion of induced effects such as improved health (pollution reduction), more productive workforce and more competitive export industries (lower energy costs and innovation).

FIGURE 3.1 Cumulative Direct, Indirect, and Induced Net Job Creation (in job-years) by Sector



Source: Results of the Initial Baseline Assumptions of CEEAT.

3.2 Sensitivity Analysis

By testing the sensitivities regarding the different parameters, CEEAT can help provide insights on how Morocco can overcome potential barriers to achieve an optimal market penetration of clean technologies and maximize the positive employment impact. At least five mechanisms may be examined to determine how different assumptions might increase job creation potential. These include: (i) expanding the scale of investments; (ii) extending the policy initiatives from 2030 targets to a longer 2050 time horizon; (iii) increasing rates of innovation (related to the investment cost and performance of different clean energy technologies); (iv) building up the local production capacity; and (v) utilizing domestic rather than international financing mechanisms with lower interest rates.

This section reviews the impact of more or less “optimistic” values of six parameters: clean energy installed capacity, cost of investment, innovation rate, cost of financing, share of domestic financing, and local content of the clean technologies. Clean energy projects’ benchmarking, a literature review, and expert estimations helped identify ranges for these parameters, as shown in table 3.2.

To understand the job impact of each parameter, the job results are estimated by varying the result of each parameter one by one while keeping the base case scenario values for the five other parameters. Plus, in order to grasp the overall range of the sensitivity in terms of job impact, two additional simulations have been computed. The first simulation combines the less “optimistic” values of all the above six parameters (low clean energy development targets, high investment costs, more expensive financing conditions, low share of domestic financing, and low local content). Conversely, the second simulation includes high targets, low investment costs, less-expensive financing conditions, high share of domestic financing, and high local content.

Clean energy targets: The clean energy targets have the greatest impact on jobs creation: a 10 percent decrease in targets induces a 13 percent drop in job creation and vice versa.

Innovation rate: As defined in the base case scenario, the default assumption in CEEAT is a low innovation rate that supposes that technology investment costs, O&M costs, the annual degradation factor, and labor productivity improve at just 1 percent per year with no improvement in the capacity factor. Changing this innovation rate from 1 percent to 3 percent and assuming the capacity factor will increase by 0.1 percent annually will induce 89,377 additional job-years (+12 percent) compared to the base case scenario. Proportionally, innovation has a stronger impact on job creation for the residential rooftop PV (+40 percent). It is worth noting, however, that whereas improvements in technology costs and performance have a positive impact on job creation, increased labor productivity (as a result of automation, for example) would reduce the number of jobs required for the same level of investments.

TABLE 3.2 Key Parameters Used for the Sensitivity Analysis

Variables	Less "optimistic" values	Base case scenario	More "optimistic" values
Clean technologies deployment	Solar (utility, CSP, distributed): 4,300 MW Wind (utility): 2,600 MW EE: -15% of BAU in 2030	Solar (utility, CSP, distributed): 4,800 MW Wind (utility): 2,900 MW EE: -20% of BAU in 2030	Solar (utility, CSP, distributed): 5,300 MW Wind (utility): 3,200 MW EE: -25% of BAU in 2030
Investment cost (US$/MW)*	PV (utility/industrial): US$1,000,000 CSP: US$5,830,000 PV (residential): US$1,265,000 Wind (utility): US$1,900,000	PV (utility/industrial): US$850,000 CSP: US$5,300,000 PV (residential): US$1,150,000 Wind (utility): US$1,375,000	PV (utility/industrial): US$790,000 CSP: US$4,770,000 PV (residential): US$1,035,000 Wind (utility): US$1,237,500
Innovation		1% per year	3% per year
Cost of financing	Domestic: 5.25%, 7 years International: 7%, 19 years	Domestic: 5%, 7 years International: 6%, 19 years	Domestic: 4.75%, 7 years International: 6%, 7 years
Domestic Financing	Solar (utility, CSP, distributed): 60% Wind (utility): 50% EE: 60%	Solar (utility, CSP, distributed): 80% Wind (utility): 65% EE: 80%	Solar (utility, CSP, distributed): 100% Wind (utility): 80% EE: 100%
Local content	PV (utility, distributed): 10% CSP: 25% Wind (utility): 10%	PV (utility, distributed): 25% CSP: 35% Wind (utility): 30%	PV (utility, distributed): 40% CSP: 45% Wind (utility): 50%

Source: Parameters derived from a literature review and expert estimates.
Note: *Transmission and distribution costs are set to US$56,000/MW except for distributed technologies. BAU = business as usual; CSP = concentrated solar power; EE = energy efficiency; MW = megawatt; PV = photovoltaic.

Cost of financing and domestic finance: The costs of financing and shares of domestic financing also have a significant impact on job creation. The results of jobs lost or created span from -13,821 (-2 percent) to 37,682 (5 percent) with the simulated range of financing costs. The share of domestic financing is positively correlated with job creation also because the cost of domestic financing (including interest payments) is reinjected into the local economy, contrary to the cost of international financing, which exits the local economy. But this positive impact also depends on the overall cost of financing linked to the interest rate and the term. If we substitute international borrowing of investment funds, which might have a higher interest rate of 6 percent, with domestically supplied capital with an annual interest rate of 5 percent, the average production cost of all clean energy technologies is lowered. In this case, the net gain in jobs is increased by 49,003 (6 percent gain) compared to the base case scenario.

Local capacity: The share of local content in manufacturing is positively correlated with job creation, but the impact is small. The base case scenario assumes the portion of local content is 30 percent for wind turbines, 35 percent for CSP, and 25 percent for solar PV. If we increase local production of wind turbines to 50 percent, of CSP to 45 percent, and of solar PV to 40 percent (assuming that this does not affect the overall cost of investment), the net employment benefit will increase by 11,312 (1 percent gain).

Investment cost: This has a comparatively small impact on the results, leading to a 1 percent change compared to the base case scenario. While the lower cost of investment means less investment is needed in the clean energy and associated sectors, larger energy bill savings are associated with more job creation, neutralizing the impact of the lower investment cost.

The combination of "optimistic" values for all parameters (highest scenario) lowers the average cost of clean energy production by around 36 percent, from US$111/MWh down to US$71/MWh, and boosts the average annual production of clean energy from 8.7 to 11.6 TWh.

Overall, the net job-years created could range from 570,337 to 1,009,963. This is respectively -25 and +33 percent compared to the base case scenario. CSP, wind, and EE technologies remain the main sources of job creation with respectively 202,896, 146,134, and 138,878 net job-years in the case of the lowest scenario and 335,294, 300,840, and 214,018 in the case of the highest scenario. Table 3.3 displays the change in job creation induced by key parameters' variation from the base case scenario.

TABLE 3.3 Sensitivity Analysis Results of the Clean Technology Paths (cumulative net job-years in 30 years)

		Utility PV	CSP	Ind. dist. PV	Res. dist. PV	Utility wind	Energy efficiency	Total job-years	Change in %*
Base case scenario		**57,912**	**264,014**	**24,401**	**29,368**	**206,972**	**179,248**	**761,914**	
EnR targets	Low	52,094	237,491	22,149	26,431	186,106	135,882	660,152	-13
	High	63,882	291,230	27,029	32,304	227,697	222,614	864,757	13
Investment costs	High	56,378	263,571	24,427	27,664	193,015	186,953	752,008	-1
	Low	58,525	264,456	24,391	31,071	210,627	171,543	760,614	0
Innovation	High	64,691	286,376	28,249	41,016	258,390	172,569	851,291	12
Local content	Low	56,680	261,666	24,019	28,958	200,032	179,248	750,602	-1
	High	59,144	266,361	24,783	29,778	213,912	179,248	773,226	1
Domestic financing	Low	54,140	241,670	23,176	25,440	198,123	170,362	712,911	-6
	High	61,683	286,358	25,626	33,295	215,821	188,134	810,917	6
Financing cost	High	57,058	258,958	24,184	28,383	202,384	177,126	748,093	-2
	Low	60,208	277,620	25,034	31,939	219,461	185,335	799,596	5
Lowest scenario		**43,714**	**202,896**	**19,964**	**18,750**	**146,134**	**138,878**	**570,337**	**-25**
Highest scenario		**76,732**	**335,294**	**32,654**	**50,426**	**300,840**	**214,018**	**1,009,963**	**33**

Source: CEEAT results.
Note: *Compared to base case scenario. CSP = concentrated solar power; EnR = **Energy Efficiency and Renewable Energy**; PV = photovoltaic.

4. Conclusions and Way Forward

The net jobs created through clean energy investments could help bridge part of the annual job shortfall in the Moroccan economy. In the base case scenario, the current government targets are expected to yield 761,914 net job-years over 30 years, equivalent to an average of 25,397 per year, which is 8.5 percent of the 300,000 annual jobs' shortfall between 2011 and 2019, as mentioned above. With improvements in certain parameters, such as the financing conditions and innovation rate, the job impact could increase by up to 1,009,963 net job-years across the economy[17].

Although the resulting net job impact may indicate a rather small number of jobs in the economy, this provides only a partial picture of Morocco's clean energy transition agenda since it does not yet consider other technologies (electric vehicles, sustainable cooling and heating, battery storage, supply-side EE, demand-side management). The International Energy Agency suggests that a global energy transformation—which entails more aggressive investment in RE and EE, utilizing renewables not only for the electricity sector but also for heating and transport, and promoting EE standards throughout societies and economies—would require investments in the order of billions of dollars. Indeed, in Morocco US$30 billion may be needed to reach current targets for renewable energy systems by 2030. This is 1.7 times the default assumption within the current version of CEEAT, hence the prospects for net employment might be 1.7 times larger. This assumes, of course, that the larger investment follows a similar pattern of cost-effectiveness and technology performance as the default assumptions.

It is important to note that this case study does not intend to provide a precise estimate of the employment potential associated with the clean energy transition in Morocco. Rather, by incorporating multiple impact channels and looking at them on a macro level, it aims to provide policy makers with a better understanding of how and where clean energy investments can create (or displace) jobs across the economy. Furthermore, since CEEAT is dynamic in nature, it allows policy makers to test the impact of different parameters so as to better inform policy making. For example, CEEAT points to the likelihood of a large increase in employment opportunities should clean technologies improve, and Morocco strengthen its local manufacturing capacity. Policies might improve the performance of clean energy systems beyond mechanisms that lower installation costs (such as improved conversion of sunlight or average wind speeds into the production of electricity). Another example might be the integration of multiple systems in ways that reduce transmission and distribution costs, or an improved cost of managing the larger system. *Overall, the analysis clearly underscores the possibility of greater employment potential for Morocco as the nation strives to meet, or exceed, its current energy objectives*. As policy analysts explore different ways CEEAT might be used, new insights may emerge that could further increase both economic and employment benefits.

This methodology, nevertheless, does pose certain limitations. The calibration of CEEAT for Morocco uses data collected from available sources and makes assumptions where data are missing. These data and assumptions will need to be validated and regularly revised to align with the changing reality in Morocco. Moreover, as noted above, in its current version, CEEAT considers only levels of clean energy deployment that might take place immediately as per the government's current targets but does not suggest or compare alternative measures and policy instruments beyond the six technology paths listed. The sensitivity analysis clearly shows that pursuing more ambitious targets could lead to more job creation. It also does not incorporate a general equilibrium model and assess the impact of changes in behavior or the interactions between changes in electricity and other energy prices, and changes in other market dynamics that might amplify or weaken overall job impacts. Certain limitations of the model may lead to over or underestimation of employment. CEEAT excludes price and income effects; assumes homogenous labour and perfect labour mobility across sectors and locations – all of which could lead to overestimation of jobs. However, the exclusion of co-benefits such as improved health, capable workforce, and more competitive and productive industry may lead to underestimation of jobs. Finally, while CEEAT models dynamic aspects of the economy it remains rooted in I/O methodology, which means that as the

[17] We have compared our results with other regional and international studies using different methodologies and found the results to be similar in order of magnitude.

structure of the economy changes in the simulated period (up to 2050), the actual employment is likely to vary from the our estimates.

With further time and discussions with policy makers, many of these shortcomings can be addressed and integrated into a set of tools that might fully capture a larger range of job benefits, leading to entirely new career opportunities. As now set forth, this version of CEEAT can perhaps best be seen as a critical first step in helping Morocco explore the directions to meet its clean energy objectives and optimize the employment co-benefits of such an agenda.

Beyond CEEAT, it is also critical to assess the ability of the Moroccan economy and society to meet the country's job creation potential, which is the purpose of the next steps of this analysis. As noted above, the job creation potential varies according to the extent to which the value chain is localized, such as financing sources, manufacturing, and supply chain. Policies to promote local content, however, should be carefully designed and evaluated to not undermine the cost-effectiveness of the investment. On the labor side, labor market rigidity can slow job creation. Limitations in labor mobility and the inflexibility of the education and training system to provide sufficient opportunities to retool and reskill workers would undermine the ability of workers to move from the conventional fossil fuel and associated sectors to the clean energy sectors and supply chain. Such issues will be explored through an in-depth study of Morocco's clean energy supply chain, private sector, labor market, and skill availability. As a matter of fact, CEEAT, while indicating the sectors where jobs will be created and those where jobs will be displaced, has not identified the skills associated with these jobs. An in-depth study will classify the skills and occupations of jobs created, substituted, transformed, and displaced by the scale-up of clean energy pathways as well as the quality of jobs along the supply chain.

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