EXAMPLE OF ASSESSING THE SUSTAINABLE DEVELOPMENT IMPACTS OF A SOLAR PV INCENTIVE POLICY

This document provides an example of carrying out an ex-ante assessment of the sustainable development impacts of a policy, following the steps in the ICAT *Sustainable Development Methodology*. This appendix compiles all the tables related to the solar PV incentive policy example contained in the *Sustainable Development Methodology*. Table and figure numbers in this document are the same as those in the ICAT *Sustainable Development Methodology* to enable cross-referencing.

Describing the Policy or Action (Chapter 4)

Table 4.1: Checklist of recommended information to describe the policy or action being assessed

Information	Description	Example
Title of the policy or action	Policy or action name	"Grid-Connected Solar Rooftop Programme." Throughout this guidance, it is referred to as the "Solar PV incentive policy."
Type of policy or action	The type of policy or action, such as those presented in Table 1.1, or other categories of policies or actions that may be more relevant	Financial incentive policy
Description of specific interventions	The specific intervention(s) carried out as part of the policy or action, such as the technologies, processes or practices implemented to achieve the policy or action	• Description of financial incentives: The policy provides a financial subsidy up to 30% of project/benchmark cost for rooftop solar projects in the residential/institutional and social sectors. It also provides concessional loans to solar rooftop project developers • Description of eligible technology: Grid-connected rooftop and small solar power plants with installed capacity ranging from 1 to 500 kW • Description of eligible sectors: Residential (all types of residential buildings), institutional (schools, health institutions), social sectors (community centres, welfare homes, old age homes, orphanages, common service centres), commercial and industrial facilities • Description of contract and payment duration: Up to 30% of the eligible financial assistance and services charges at the time of sanction of the proposal. The remaining 70% after successful commissioning of the projects after sample verification on submission of requisite claims. • Description of national budget allocated to the policy: Approximately USD 750 million • Other enabling actions under the policy: • Training and capacity building of various stakeholders involved in the programme such as government staff, utilities, regulatory commissions, banks and workers • Development of online portal for rooftop solar systems development programme and registration of partners, approvals and project monitoring

Status of the policy or action	Whether the policy or action is planned, adopted or implemented	The policy has been implemented (currently in effect)
Date of implementation	The date the policy or action comes into effect (not the date that any supporting legislation is enacted)	1 January 2016
Date of completion (if applicable)	If applicable, the date the policy or action ceases, such as the date a tax is no longer levied or the end date of an incentive scheme with a limited duration (not the date that the policy/action no longer has an impact)	The provision of financial incentives ends on 31 December 2022
Implementing entity or entities	The entity or entities that implement(s) the policy or action, including the role of various local, subnational, national, international or any other entities	India's Ministry of New and Renewable Energy (MNRE) implements the policy. Government funds are disbursed by the ministry to state agencies, financial institutions, implementing agencies and other government approved channel partners that includes renewable energy service providers, system integrators, manufacturers, vendors and NGOs.
Objectives and intended impacts or benefits of the policy or action	The intended impact(s) or benefit(s) the policy or action intends to achieve (e.g., the purpose stated in the legislation or regulation)	The policy is intended to increase deployment of solar energy, increase access to clean energy, increase energy independence, create jobs, reduce greenhouse gas emissions, and create an enabling environment for investment, installation, capacity building, research and development in the solar energy sector
Level of the policy or action	The level of implementation, such as national level, subnational level, city level, sector level or project level	National
Geographic coverage	The jurisdiction or geographic area where the policy or action is implemented or enforced, which may be more limited than all the jurisdictions where the policy or action has an impact	India
Sectors targeted	Which sectors or subsectors are targeted	Energy supply (grid-connected solar PV)
Other related policies or actions	Other policies or actions that may interact with the policy or action being assessed	The Government of India targets installation of 100,000 MW of solar power by 2022 of which 40,000 MW is to be achieved through rooftop solar power plants though the solar PV incentive policy.

Source: Adapted from WRI 2014. Example adapted from India's Ministry of New & Renewable Energy (MNRE).

Table 4.2: Checklist of additional information that may be relevant to describe the policy or action being assessed

Information	Description	Example
Relevant SDGs	Sustainable Development Goals the policy or action focuses on or contributes to	The policy is focused primarily on SDG 3 (Good health and well-being), SDG 7 (Affordable and clean energy), SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation and infrastructure), SDG 11 (Sustainable cities and communities), SDG 12 (Responsible consumption and production), and SDG 13 (Climate action), while also contributing to other SDGs
Specific intended targets, such as intended level of indicators	Target level of key indicators, if applicable	The policy aims to install 40,000 MW of rooftop solar PV by 2022. The policy will lead to increased solar power generation in the country, contributing to greater energy independence and increased jobs in the solar PV installation and maintenance sectors. Solar energy will also provide quick alternative power during severe climate changes that may occur.
Title of establishing legislation, regulations, or other founding documents	The name(s) of legislation or regulations authorizing or establishing the policy or action (or other founding documents if there is no legislative basis)	National renewable energy law
Monitoring, reporting and verification procedures	References to any monitoring, reporting and verification procedures associated with implementing the policy or action	Monitoring and evaluation studies of the policy will be carried out during the implementation period as follows: • At the primary level of monitoring, channel partners are responsible for monitoring parameters such as end-use verification and compliance and also compilation of statistical information such as number of companies involved in the installation • National monitors on number of companies and employees active within the sector • National monitors, consultants, institutions, civil society groups, corporations with relevant experience, other government organizations would be involved, for ground verification/performance evaluation on a random sample basis • The electricity generation data should be available at the beneficiary level. However, for projects above 5 kW, the system providers would also make available generation data to the government at intervals specified • For projects 50 kWp and above, 100% field inspection is required
Enforcement mechanisms	Any enforcement or compliance procedures, such as penalties for noncompliance	If evidence is presented that the applicant's information is found to be incorrect, distributed funds will be paid back.
Reference to relevant documents	Information to allow practitioners and other interested parties to access any guidance documents related to the policy or action (e.g., through websites)	For more information, see: http://mnre.gov.in/schemes/decentralized-systems/solar-rooftop-grid-connected/

The broader context or significance of the policy or action	Broader context for understanding the policy or action	The current energy mix mainly consists of imported fossil fuels. Coal power remains a dominant source of power generation in India. BMI Research forecasted in 2017 that coal will contribute 66 per cent to India's power generation mix in 2025 and coal electricity generation will increase by 5.8% between 2016 and 2025. In 2000, 67% of emissions in India were from energy generation and use. India plans a rapid increase in the renewable energy share in national electricity generation mix, including plans to install 175 GW of renewable generation capacity by 2022. Solar is projected to contribute 100 GW of installed capacity by 2022 from the current 4 GW, where recent auctions have resulted in record low tariffs of Rs 3 per kWh (USD 0.0446 per kWh). Rooftop solar has significant potential to contribute to national energy supply. Rooftop solar installed capacity reached 525 MW in 2015. This accounts for less than 10% of the installed utility-scale solar capacity and a very small portion of the total power consumption in the country. The government's target of 40 GW of solar rooftop capacity by 2022 has injected increased ambition into the sector.
Key stakeholders	Key stakeholder groups affected by the policy or action	Households, institutions (schools, health institutions), businesses, project developers, workers, utilities, banks, energy access programmes, women's organizations and cooperatives, micro-credit institutions, and others
Other relevant information	Any other relevant information	Various implementation models are possible under the policy: • Solar installations owned and operated by consumer • Solar rooftop facility owned by consumer but operated and maintained by a third party • Solar installations owned, operated and maintained by a third party • Solar lease model, with sale of electricity to the grid • Solar installations owned by the utility or distribution company

Source: Adapted from WRI 2014. Example adapted from India's Ministry of New & Renewable Energy (MNRE).

Choosing Which Impact Categories and Indicators to Assess (Chapter 5)

The assessment chooses eleven impact categories to assess as demonstrated in Table 5.2.

Table 5.2: Impact categories included in the assessment for a solar PV incentive policy

Dimension	Impact category	Relevant ?	Significant ?	Included in the assessment boundary?	Brief description (rationale for the determination of relevance and significance)
Environmental	Climate change mitigation	Yes	Yes	Yes	The policy is expected to significantly reduce greenhouse gas (GHG) emissions by replacing fossil energy with solar energy
	Air quality / health impacts of air pollution	Yes	Yes	Yes	The policy is expected to significantly reduce air pollution by replacing fossil energy with solar energy
	Waste generation and disposal	Yes	Yes	Yes	The policy is expected to have both positive and negative impacts on waste by reducing fossil energy waste and increasing solar energy waste (e.g., replacement of PV panels or batteries)
	Energy	Yes	Yes	Yes	The policy is expected to significantly increase renewable energy generation by replacing fossil energy with solar energy
	Availability of freshwater	Yes	No	No	The policy is not expected to significantly affect these impact categories
	Land use change	Yes	No	No	
	Biodiversity of terrestrial ecosystems	Yes	No	No	
	Soil quality	Yes	No	No	
	Nuclear radiation	Yes	No	No	
Social	Access to clean, affordable, and reliable energy	Yes	Yes	Yes	The policy is not expected to increase access to energy, since all eligible households and buildings are already connected to the electric grid, but the policy is expected to significantly improve access to clean, affordable and reliable energy
	Capacity, skills, and knowledge development	Yes	Yes	Yes	The policy is expected to significantly improve training for skilled workers in the solar manufacturing, installation and maintenance sectors
	Quality and safety of working conditions	Yes	Yes	Yes	The policy is expected to improve working conditions by having more workers in the

					solar sector and relatively fewer in the fossil fuel sector
	Diseases	Yes	No	No	The policy is not expected to significantly affect these impact categories, though reduced energy costs may reduce poverty
	Freedom of expression	Yes	No	No	
	Access to safe drinking water	Yes	No	No	
	Poverty	Yes	No	No	
	Gender equality	Yes	No	No	Gender equality is a high policy priority and some solar energy policies are expected to increase women's participation in the labour force through new jobs and women's entrepreneurship through new business opportunities, but this specific policy design is not expected to have a significant impact.
	Mobility	No	No	No	This impact category is not relevant to the assessment or policy objectives and was not expressed as a priority of stakeholders
Economic	Jobs	Yes	Yes	Yes	The policy is expected to create a significant number of new jobs in the solar manufacturing, installation and maintenance sectors
	Income	Yes	Yes	Yes	The policy is expected to lead to significant financial savings for households, institutions and other organizations through reduced energy costs
	Wages	No	Yes	No	The policy is expected to increase wages for workers in the solar sector, but assessing wages is not relevant to the objectives and was not expressed as a priority of stakeholders.
	New business opportunities	Yes	Yes	Yes	The policy is expected to create a significant number of new business opportunities in the solar manufacturing, installation and maintenance sectors
	Energy independence	Yes	Yes	Yes	The policy is expected to lead to significant improvement in energy independence by reduced energy imports
	Economic activity	No	No	No	The policy may affect these impact categories but the impact is not expected to be significant. They are also not
	Economic productivity	No	No	No	

	Prices of goods and services	No	No	No	relevant to the assessment or policy objectives and were not expressed as a priority of stakeholders.
	Balance of payments	No	No	No	

Identifying Specific Impacts Within Each Impact Category (Chapter 6) and Qualitatively Assessing Impacts (Chapter 7)

The assessment maps the causal chain as demonstrated by Figure 6.4. The specific impacts identified are listed in Table 7.5 together with qualitative assessment results.

Figure 6.4: Causal chain of the assessed solar policy

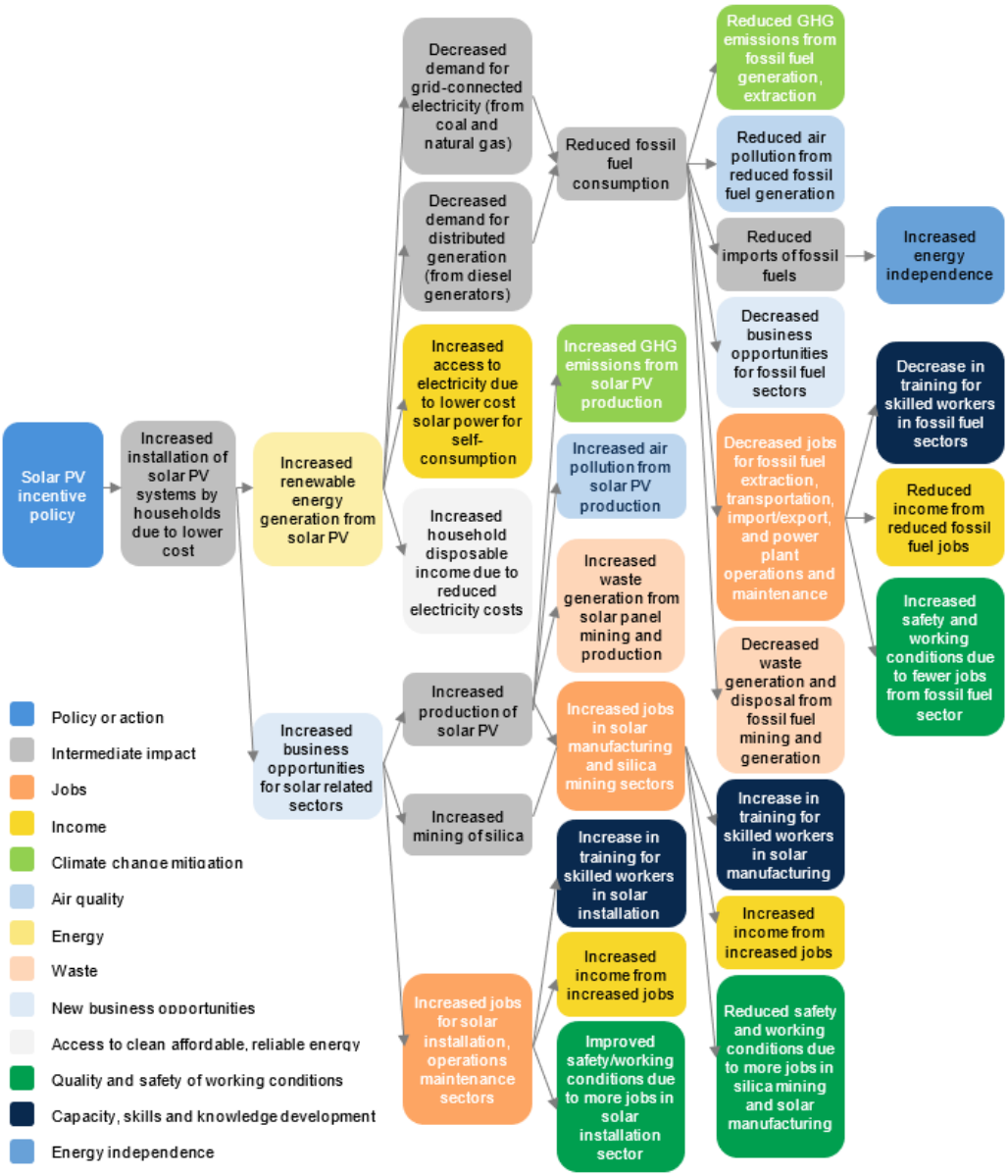

Table 7.5 Qualitative assessment results for the solar PV incentive policy

Chapter 5	Chapter 6 (Identify specific impacts)			Chapter 7 (Qualitatively assessing impacts)						Chapter 8 (Defining the quantitative assessment boundary)		
Impact categories included in the assessment	**Specific impacts identified**	**In- or out-of-jurisdiction**	**Type of impacts (optional)**	**Likelihood**	**Magnitude**	**Positive or negative impact**	**Significant?**	**Summary of qualitative assessment results for each impact category**	**Methods/sources used**	**Feasible to quantify?**	**Included in the quantitative assessment boundary?**	**Justification for exclusions or other comments**
Climate change mitigation	Reduced GHG emissions from grid-connected fossil fuel-based power plants	In		Very Likely	Major	Positive	Yes	Major positive impact from displacing fossil fuel electricity with solar electricity. While negative impacts do exist, they are insignificant.	Stakeholder consultation	Yes	Yes	Included
	Reduced GHG emissions from distributed fossil fuel generation	In		Unlikely	Moderate	Positive	No		https://india.blogs.nytimes.com/2012/07/31/the-diesel-generator-indias-trusty-power-source/)	No	No	Impact is not significant
	Reduced GHG emissions associated manufacturing of new fossil fuel generation plants	In		Unlikely	Minor	Positive	No		Stakeholder consultation	N/A	No	Impact is not significant
	Reduced GHG emissions from fossil fuel extraction and transportation	Both		Possible	Moderate	Positive	Yes		http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available
	Increased GHG emissions from solar production, transportation and installation	Both		Likely	Minor	Negative	No		http://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think	N/A	No	Impact is not significant
	Increased GHG emissions from increased production of goods and services due to increased income	In		Likely	Minor	Negative	No		Household energy consumption in the UK: a highly geographically and socioeconomically disaggregated model." Energy	N/A	No	Impact is not significant

									Policy 36(8): 3167–3182.			
Air quality / health impacts of air pollution	Reduced air pollution from grid-connected fossil fuel-based power plants	In		Very Likely	Major	Positive	Yes	Major positive impact from displacing fossil fuel electricity with solar electricity. While negative impacts do exist, they are insignificant.	Stakeholder consultation	Yes	Yes	Included
	Reduced air pollution from distributed fossil fuel generation	In		Unlikely	Major	Positive	No		Stakeholder consultation	No	No	Impact is not significant
	Reduced indoor air pollution from traditional use of biomass	In		Very Likely	Major	Positive	Yes		https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2568866/	No	No	No reliable data/methods available
	Reduced air pollution from manufacturing of new fossil fuel generation plants	In		Likely	Minor	Positive	No		Expert judgment	No	No	Impact is not significant
	Reduced air pollution from fossil fuel extraction and transportation	Both		Possible	Moderate	Positive	Yes		http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available
	Increased air pollution from solar production, transportation and installation	Both		Likely	Minor	Negative	No		http://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think	N/A	No	Impact is not significant
	Increased air pollution from increased production of goods and services due to increased income	In		Likely	Minor	Negative	No		Household energy consumption in the UK: a highly geographically and socioeconomically disaggregated model." Energy Policy 36(8): 3167–3182.	N/A	No	Impact is not significant
Waste generation and disposal	Decreased waste generation and disposal from less fossil fuel generation (e.g., coal ash)	In		Very likely	Moderate	Positive	Yes	Major positive impacts from reducing fossil fuel extraction, transportation and	http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available

	Decreased waste generation and disposal from less fossil fuel production and transportation	Both		Very likely	Major	Positive	Yes	consumption outweigh moderate or insignificant negative impacts from solar related mining and solar panel disposal.	http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available
	Increased waste generation and disposal from more solar production (e.g., silicon tetrachloride waste)	Both		Likely	Moderate	Negative	Yes		http://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think	No	No	No reliable data/methods available
	Increased waste generation and disposal from discarded solar panels (e.g., cadmium and tellurium)	In		Possible	Minor	Positive	No		http://spectrum.ieee.org/green-tech/solar/solar-energy-isnt-always-as-green-as-you-think	No	No	Impact is not significant
Energy	Increased renewable energy generation from more solar generation	In		Very likely	Major	Positive	Yes	Major positive impact from increase solar electricity	Stakeholder consultation	Yes	Yes	Included
Access to clean, affordable, and reliable energy	Increased access to clean, affordable and reliable electricity	In		Very likely	Major	Positive	Yes	Major positive impact from increased solar electricity outweighs unlikely, insignificant negative impact.	Stakeholder consultation	Yes	Yes	Included
	Decreased access to electricity due to fewer new coal power plants	In		Unlikely	Minor	Negative	No		Stakeholder consultation	N/A	No	Impact is not significant
Capacity, skills, and knowledge development	Increase in training for skilled workers in solar relevant sectors	Both		Likely	Major	Positive	Yes	Major positive impact from solar sectors. While a negative impact exists, it is insignificant.	Stakeholder consultation	Yes	Yes	Included
	Decrease in training for skilled workers in fossil fuel sectors	Both		Possible	Minor		No		Stakeholder consultation	N/A	No	Impact is not significant
Quality and safety of working conditions	Increased safety and working conditions due to more jobs from the solar installation sector, where workers	Both		Very Likely	Major	Positive	Yes	Major positive impact from solar sectors. While negative impacts	Stakeholder consultation	No	No	No reliable data/methods available

	have better working conditions							exist, they are insignificant.				
	Increased safety and working conditions due to fewer jobs in coal sector, where workers have worse working condition	Both		Likely	Moderate	Positive	Yes		http://www.catf.us/resources/publications/files/Cradle_to_Grave.pdf	No	No	No reliable data/methods available
	Decreased safety and working conditions due to more jobs from silica mining and solar cell manufacturing, where workers have worse working condition (e.g., the lung disease silicosis, exposure to Hydrofluoric acid and cadmium)	Both		Unlikely	Moderate	Negative	No		Reference: https://qz.com/760079/indias-solar-dreams-too-are-made-in-china/	N/A	No	Impact is not significant
Jobs	Increased jobs in the solar installation, operations maintenance sectors	In		Very likely	Major	Positive	Yes	Major positive impacts from solar power plants and solar panel sectors outweigh moderate negative impact on coal extraction, transportation and import/export sectors.	http://www.thesolarfoundation.org/wp-content/uploads/2016/10/TSF-2015-National-Solar-Jobs-Census.pdf	Yes	Yes	Included
	Increased jobs in the solar panel manufacturing sector	Both		Very likely	Major	Positive	Yes		http://www.thesolarfoundation.org/wp-content/uploads/2016/10/TSF-2015-National-Solar-Jobs-Census.pdf	Yes	Yes	Included
	Increased jobs for solar and grid technology sectors, and mining of rare earth for solar cells	Both		Possible	Minor	Positive	No		Stakeholders consultation	N/A	No	Impact is not significant
	Decreased jobs in the fossil fuel power operations and maintenance sectors	In		Likely	Minor	Negative	No		Stakeholder consultation	N/A	No	Impact is not significant

	Decreased jobs in fossil fuel sectors	Both		Likely	Moderate	Negative	Yes		Stakeholder consultation	Yes	Yes	Included
	Decreased jobs in the fossil fuel generation technology sectors (e.g., super critical and ultra-super critical generation)	Both		Unlikely	Moderate	Negative	No		Stakeholder consultation	N/A	No	Impact is not significant
Income	Increased income for households, institutions and other organizations due to reduction in energy costs	In		Very likely	Major	Positive	Yes	Major positive impact from saving from energy spending.	Stakeholder consultation	Yes	Yes	Included
New business opportunities	Increased business opportunities for solar manufacturing, mining, transportation, solar power plants and grid associated technologies	Both		Very likely	Major	Positive	Yes	Major positive impact from solar sectors. While a negative impact exists, it is insignificant.	https://connectamericas.com/content/opportunities-renewable-energy-value-chain	No	No	No reliable data/methods available
	Decreased business opportunities for fossil fuel extraction, transportation, fossil fuel power plants, and fossil fuel generated associated technologies	Both		Likely	Minor	Negative	No		Stakeholder consultation	No	No	Impact is not significant
Energy Independence	Increased energy independence from reduced imports of fossil fuels	In		Very likely	Major	Positive	Yes	Major positive impact from decrease fossil fuel import. While a negative impact exists, it is insignificant.	Stakeholder consultation	Yes	Yes	Included
	Decreased energy independence from foreign control over scarce resources needed to manufacture solar panels	In		Possible	Minor	Negative	No		Reference: http://foreignpolicy.com/2016/07/12/decoder-rare-earth-market-tech-defense-clean-energy-china-trade/	N/A	No	Impact is not significant

Estimating the Baseline (Chapter 8)

The assessment period is 2016–2025. The quantitative assessment boundary including impacts and indicators to be quantified is outlined in Table 8.1.

Table 8.1: Defining the quantitative assessment boundary (i.e., the set of impact categories, specific impacts and indicators to be quantified)

Chapter 5	Chapter 6 (Identify specific impacts)	Chapter 8 (Defining the quantitative assessment boundary)		
Impact categories included in the assessment	**Specific impacts included in the quantitative assessment boundary**	**Indicator(s) to quantify**	**Feasible to quantify?**	**Included in the quantitative assessment boundary?**
Climate change mitigation	Reduced GHG emissions from grid-connected fossil fuel-based power plants	GHG emissions (tCO_2e/year)	Yes	Yes
Air quality / health impacts of air pollution	Reduced air pollution from grid-connected fossil fuel-based power plants	Emissions of $PM_{2.5}$, PM_{10}, SO_2, and NOx (t/year); number of deaths due to air pollution	Yes	Yes
Energy	Increased renewable energy generation from more solar generation	Solar installed capacity (MW); % solar of total installed capacity; % solar of total installed capacity of renewable energy sources	Yes	Yes
Access to clean, affordable, and reliable energy	Increased access to clean, affordable, and reliable electricity	Number of houses/buildings/facilities with access to clean energy resulting from the policy	Yes	Yes
Capacity, skills, and knowledge development	Increase in training for skilled workers in solar relevant sectors	Number of new skilled trainees and workers on the ground	Yes	Yes
Jobs	Increased jobs in the solar installation, operations maintenance sectors;	Number of new jobs resulting from the policy	Yes	Yes
	Increased jobs in the solar panel manufacturing sector	Number of new jobs resulting from the policy	Yes	Yes
	Decreased jobs in fossil fuel sectors	Number of jobs reduced resulting from the policy	Yes	Yes
Income	Increased income for households, institutions and other organizations due to reduction in energy costs	Savings in annual electric bill (USD/year)	Yes	Yes
Energy Independence	Increased energy independence from reduced imports of fossil fuel	Reduction in coal imports from the policy (t/year)	Yes	Yes

Choose assessment method for each indicator

The next step is to choose an assessment method for each indicator—the scenario method, comparison group method, or deemed estimates method, which is a subset of the scenario method (outlined in Section 8.2). In this example, the scenario method is used for certain indicators and the deemed estimates method is used for others. To apply the scenario method, baseline values and policy scenario values are needed for each indicator over the assessment period. To apply the deemed estimates method, only the estimated change from the policy is quantified, without separately estimating baseline and policy scenario values.

Define the baseline scenario and estimate baseline values for each indicator

This example uses a combination of constant baseline scenarios and simple trend baseline scenarios for different indicators. Where the deemed estimates method is used, no baseline values are presented.

A lower level of accuracy, commensurate with IPCC Tier 1 methods, was determined to be appropriate. For example, national level data such as the national average grid emission factor, country-wide rates of solar PV as a percentage of total installed capacity, and national air pollution data can be considered as representative within the impact category assessment boundaries.

Define the most likely baseline scenario for each indicator

A key assumption about what is most likely to occur in the absence of the solar PV policy is that the households installing the solar PV systems would have used grid-connected electricity in the absence of the solar PV policy.

The baseline scenario takes into account India's National Solar Mission, which calls for 100,000 MW of new solar capacity. Of the 100,000 MW of solar power to be achieved by 2022, 40,000 MW is to be met by grid-connected rooftop solar systems (included in the policy scenario), whereas the remaining 60,000 MW are to be met through from ground-based solar systems (included in the baseline scenario).

No other policies or subsidies are assumed to exist for rooftop grid-connected solar PV systems. No other financial incentives, such as soft loans or capital grants for solar PV panels/systems are assumed to be available.

The Government of India is also implementing the "Off-Grid and Decentralised Solar Applications" scheme to promote solar home lights, solar street lights, power plants, solar pumps and mini and micro grids in rural areas of the country, where a significant amount of the population remains without access to electricity. The programme also has an emphasis on Concentrating Solar Thermal (CST) technology. The objective and target user group under off-grid policy is different from the solar PV incentive policy. Therefore, the off-grid incentive policy has not been considered for assessment.

Table A lists key drivers for each impact category being assessed included in the baseline scenario.

Table A.2: Drivers and assumptions for the solar PV incentive policy

Impact categories	Drivers and assumptions in the baseline scenario
Climate change mitigation	No change in emissions limits from power plants and vehicles or compliance rates
Health impacts of air pollution	No change in particulate matter limits from power plants, power generators, or vehicles, and no change in compliance rates

Air pollution	No change in air emissions limits from power plants, power generators, or vehicles, and no change in compliance rates
Renewable energy generation	No change in renewable energy targets, including the proportion of the target to be met by solar
Access to clean, reliable and affordable energy	No significant change in household income, production cost of solar systems, or number of solar companies; No change in awareness of and ability of homeowners to invest in solar PV systems
Skilled labour and worker training	No change in access to or awareness of opportunities for solar PV industry training
Job creation	No change in employment rate for skilled or unskilled labour
Income	No significant change in average household income or inflation rate
Energy independence	No change in the cost of fossil fuels or economic incentives for renewable energy

Define the methods and parameters needed to estimate baseline values

Each indicator has its own estimation method and list of parameters. Selected parameters included are listed in the Table A.3.

Table A.3: Parameters needed to estimate baseline values and data to be collected

Impact category	Parameters needed to estimate baseline values; data to be collected
Climate change mitigation	Grid electricity emission factor in India Installed capacity of solar rooftop systems due solar PV incentive policy
Air quality / health impacts of air pollution	Emissions of $PM_{2.5}$ and PM_{10} from stationary power plants as reported by the Central Pollution Control Board, state pollution control boards, and/or the National Environmental Engineering Research Institute Or Reported levels of $PM_{2.5}$ and PM_{10} in India (micrograms per cubic meter of air (µg/m3)) $PM_{2.5}$ and PM_{10} that is attributable to power generation (%)
	Emissions of sulphur dioxide and nitric oxide from stationary power plants as reported by the Central Pollution Control Board, state pollution control boards, and/or the National Environmental Engineering Research Institute Or Reported levels of SO_2 and NOx in India SO_2 and NOx that is attributable to power generation (%)
Energy	Total installed capacity of solar systems prior to the implementation of the policy (MW)
Access to clean, reliable, and affordable energy	Within the assessment boundary, the households that are assumed to adopt the policy already have access to energy and are simply replacing fossil sources with solar PV, therefore baseline values are not separately calculated
Capacity, skills, and knowledge development	Within the assessment boundary, only the incremental increase in skilled labour associated with adoption of the policy is assessed, therefore baseline values are not separately calculated
Jobs	Within the assessment boundary, only the incremental increase in job creation associated with adoption of the policy is being assessed, therefore baseline values are not separately calculated

Income	Average expenditure on grid electricity Or Average cost of grid-connected electricity consumed for residential and institutional use (Rs.)
Energy independence	Within the assessment boundary, only the incremental change in energy independence due to the policy is evaluated, so baseline values are not separately calculated

Collect data for each indicator and Estimate baseline values for each indicator

Data is collected for each parameter required for calculations. These are included in Table A.6.

Baseline values are calculated over the assessment period. These are included in Table A.6.

Estimating Impacts Ex-Ante

The following assumptions describe the policy scenario:

- The policy is implemented in India and implemented over the period is 2016-2022.
- The policy aims to install 40,000 MW of rooftop solar PV by 2022. Table A.4 shows the annual and cumulative projected installed capacity of solar PV systems in each year. The table also provides corresponding electricity generated in each year from the solar PV. Each MW of installed solar PV generates 1327 MWh of electricity per year.

Table A.4: The policy's intended electricity generation over the assessment period

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Installed Rooftop Solar PV capacity (MW)	200	4,800	5,000	6,000	7,000	8,000	9,000	0	0	0
Cumulative Installed Rooftop Solar PV capacity (MW)	200	5,000	10,000	16,000	23,000	31,000	40,000	40,000	40,000	40,000
Electricity generation from Rooftop Solar PV (MWh/year)	265,320	6,633,000	13,266,000	21,225,600	30,511,800	41,124,600	53,064,000	53,064,000	53,064,000	53,064,000

Estimate policy scenario values for each indicator and the net impact of the policy or action on each indicator

Policy scenario values are calculated over the assessment period. These are included in Table A.6.

The net impact of the policy or action is calculated for each indicator over the assessment period. These are included in Table A.6.

Table A.5 presents a summary of the net impact of the policy across all impact categories included in the quantitative assessment.

Table A.5: Summary of quantitative results – the impact of the solar PV incentive policy on all impact categories included in the assessment

Impact category	Indicator quantified	Estimated impact (Cumulative impact from 2016 – 2025)
Climate change mitigation	GHG emissions ($MtCO_2e$) from the electric grid	Reduction of 307 Mt CO_2e
Air quality / health impacts of air pollution	$PM_{2.5}$ emissions (t) from the electric grid	Reduction of 1,177,996 t $PM_{2.5}$
	PM_{10} emissions (t) from the electric grid	Reduction of 2,437,234 t PM_{10}
	SO_2 emissions (t) from the electric grid	Reduction of 4,265,161 t SO_2
	NOx emissions (t) from the electric grid	Reduction of 4,062,057 t NOx
	Number of premature deaths per year in India resulting from air pollution from coal plants	Reduction of 32,304 premature deaths
Energy	Renewable energy installed capacity (MW)	Increase of 40,000 MW of renewable energy capacity
Access to clean, affordable, and reliable energy	Increase in number of houses/buildings/facilities with access to clean energy resulting from the policy	Increase of 5,741,889 houses/buildings/facilities with access to clean energy
Capacity, skills, and knowledge development	Number of new skilled trainees and workers on the ground because of the policy	Increase of 40,060 new skilled trainees and workers
Jobs	Change in jobs resulting from the policy (number of jobs)	Net increase of 821,102 jobs
Income	Savings in annual electric bill for households and businesses (USD)	Savings of 27,855 million USD
Energy independence	Reduction in coal imports (t)	Reduction of 57,770,140 tons of coal

Table A.6: Calculations of baseline values, policy scenario values, and the net impact of the policy or action on the indicators included in the assessment

Impact category #1	**Climate change mitigation**										
Indicator	GHG emissions ($MtCO_2e$/year) from the electric grid										
Specific impact	Reduced GHG emissions from grid-connected fossil fuel-based power plants										
Assessment method	Deemed estimates method										
Equation	GHG emission reduced from the solar PV ($MtCO_2e$/year) = Electricity generated from rooftop solar PV (MWh) x Coal generation emission factor (tCO_2e/MWh) / 1,000,000										
Parameters needed	Electricity generated from new solar PV (MWh) = see Table A.4. Coal generation emission factor = 0.945 tCO_2e/MWh (for new coal power plants; emission factor assumed to stay constant over the assessment period)										
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Reduction in GHG emissions ($MtCO_2e$/year) from the policy	0.25	6.27	12.54	20.06	28.83	38.86	50.15	50.15	50.15	50.15	307

Impact category #2	**Air quality / health impacts of air pollution**
Indicator #1	$PM_{2.5}$ emissions (t/year) from the electric grid
Specific impact	Reduced $PM_{2.5}$ emissions from grid-connected fossil fuel-based power plants
Assessment method	Scenario method
Equation	Reduction in $PM_{2.5}$ emissions = Baseline $PM_{2.5}$ emissions – Policy scenario $PM_{2.5}$ emissions Where Baseline $PM_{2.5}$ emissions = Total fossil fuel based installed capacity of the grid (MW) in baseline scenario * $PM_{2.5}$ emission factor (ton/MW) Policy scenario $PM_{2.5}$ emissions = Total fossil fuel based installed capacity of the grid (MW) in the policy scenario * $PM_{2.5}$ emission factor (ton/MW)

Parameters needed	Installed capacity (MW) [see below] and $PM_{2.5}$ emission factor = 4.8 ton/MW per year										
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values – Installed capacity of coal-based power plant (MW)	184274	197976	211677	225379	239081	252783	266485	260571	247422	250106	N/A
Policy scenario values – Installed capacity of coal-based power plant (MW)	184074	192976	201677	209379	216081	221783	226485	220571	207422	210106	N/A
Baseline values – $PM_{2.5}$ emissions (t/year)	885,293	951,120	1,016,947	1,082,774	1,148,600	1,214,427	1,280,254	1,251,841	1,188,671	1,201,568	N/A
Policy scenario values – $PM_{2.5}$ emissions (t/year)	884,332	927,099	968,904	1,005,906	1,038,103	1,065,496	1,088,085	1,059,672	996,502	1,009,399	N/A
Reduction in $PM_{2.5}$ emissions (t/year) from the policy	961	24,021	48,042	76,868	110,497	148,931	192,169	192,169	192,169	192,169	1,177,996

Impact category #2	**Air quality / health impacts of air pollution**
Indicator #2	PM_{10} emissions (t/year) from the electric grid
Specific impact	Reduced PM_{10} emissions from grid-connected fossil fuel-based power plants
Assessment method	Scenario method

Equation	Reduction in PM_{10} emissions = Baseline PM_{10} emissions – Policy scenario PM_{10} emissions Where: Baseline PM_{10} emissions = Total fossil fuel based installed capacity of the grid (MW) in baseline scenario * PM_{10} emission factor (ton/MW) Policy scenario PM_{10} emissions = Total fossil fuel based installed capacity of the grid (MW) in the policy scenario * PM_{10} emission factor (ton/MW)										
Parameters needed	Installed capacity (MW) [see below] and PM_{10} emission factor = 9.9 ton/MW per year										
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values	1,831,640	1,967,834	2,104,027	2,240,221	2,376,415	2,512,608	2,648,802	2,590,016	2,459,319	2,486,003	N/A
Policy scenario values	1,829,652	1,918,135	2,004,630	2,081,185	2,147,800	2,204,475	2,251,211	2,192,425	2,061,728	2,088,412	N/A
Reduction in PM_{10} emissions (t/year) from the policy	1,988	49,699	99,398	159,037	228,615	308,133	397,591	397,591	397,591	397,591	2,437,234

Impact category #2	**Air quality / health impacts of air pollution**
Indicator #3	SO_2 emissions (t/year) from the electric grid
Specific impact	Reduced SO_2 emissions from grid-connected fossil fuel-based power plants
Assessment method	Scenario method
Equation	Reduction in SO_2 emissions = Baseline SO_2 emissions – Policy scenario SO_2 emissions Where Baseline SO_2 emissions = Total fossil fuel based installed capacity of the grid (MW) in baseline scenario * SO_2 emission factor (ton/MW) Project SO_2 emissions = Total fossil fuel based installed capacity of the grid (MW) in the policy scenario * SO_2 emission factor (ton/MW)
Parameters needed	Installed capacity (MW) [see below] and SO_2 emission factor = 17.4 ton/MW per year

Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values	3,205,370	3,443,709	3,682,048	3,920,387	4,158,726	4,397,065	4,635,403	4,532,528	4,303,808	4,350,506	N/A
Policy scenario values	3,201,891	3,356,736	3,508,102	3,642,073	3,758,649	3,857,831	3,939,619	3,836,743	3,608,023	3,654,721	N/A
Reduction in SO_2 emissions (t/year) from the policy	3,479	86,973	173,946	278,314	400,076	539,233	695,785	695,785	695,785	695,785	4,265,161

Impact category #2	**Air quality / health impacts of air pollution**										
Indicator #4	NOx emissions (t/year) from the electric grid										
Specific impact	Reduced NOx emissions from grid-connected fossil fuel-based power plants										
Assessment method	Scenario method										
Equation	Reduction in NOx emissions = Baseline NOx emissions – Policy scenario NOx emissions Where Baseline NOx emissions = Total fossil fuel based installed capacity of the grid (MW) in baseline scenario * NOx emission factor (ton/MW) Policy scenario NOx emissions = Total fossil fuel based installed capacity of the grid (MW) in the policy scenario * NOx emission factor (ton/MW)										
Parameters needed	Installed capacity (MW) [see below] and NOx emission factor = 16.6 ton/MW per year										
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values	3,052,734	3,279,723	3,506,712	3,733,702	3,960,691	4,187,681	4,414,670	4,316,693	4,098,865	4,143,339	N/A

Policy scenario values	3,049,420	3,196,891	3,341,049	3,468,641	3,579,666	3,674,125	3,752,018	3,654,041	3,436,213	3,480,687	N/A
Reduction in NOx emissions (t/year) from the policy	3,313	82,832	165,663	265,061	381,025	513,555	662,652	662,652	662,652	662,652	4,062,057

Impact category #2	**Air quality / health impacts of air pollution**										
Indicator #5	Number of premature deaths per year in India resulting from air pollution from coal plants										
Specific impact	Reduction in premature mortality in India from reduced fossil fuel electricity generation										
Assessment method	Scenario method										
Equation	Reduction in premature deaths per year = Expected premature deaths in baseline scenario – Expected premature deaths in policy scenario										
Parameters needed	Installed capacity (MW) [see below] and Premature deaths = 0.81/MW installed capacity per year										
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. Therefore, it is assumed that other fossil fuel based installed capacity i.e., 9% of total grid (from diesel and gas), will not change in the baseline and policy scenario. The total health risk for mortality is quantified using the relative risk functions and exposure level of $PM_{2.5}$. The premature deaths per MW applied for this example are based on previously published literature and are extrapolated for simplification.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values (Cumulative)	148,821	159,886	170,952	182,018	193,084	204,149	215,215	210,439	199,820	201,988	N/A
Policy scenario values (Cumulative)	148,659	155,848	162,876	169,096	174,509	179,114	182,911	178,135	167,515	169,683	N/A
Reduction in premature deaths (Cumulative)	162	4,038	8,076	12,922	18,575	25,036	32,304	32,304	32,304	32,304	32,304

Impact category #3	**Energy**
Indicator	Renewable energy installed capacity (MW)
Specific impact	Increased renewable energy generation from more solar generation
Assessment method	Scenario method

Equation	Total renewable energy installed capacity (MW) = Renewable energy capacity in baseline scenario - Renewable energy capacity in policy scenario										
Parameters needed	Baseline values of total renewable energy without the policy (MW) Policy scenario values of total renewable energy with the policy (MW) per year										
Assumptions	See Table A.4										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Baseline values (Total renewable energy without the policy) (Cumulative)	42,649	54,674	72,739	89,804	105,870	120,935	135,000	139,613	144,226	148,839	N/A
Policy scenario values (Total renewable energy with the policy) (Cumulative)	42,849	59,674	82,739	105,804	128,870	151,935	175,000	179,613	184,226	188,839	N/A
Increase in renewable energy capacity (MW) (Cumulative)	200	5,000	10,000	16,000	23,000	31,000	40,000	40,000	40,000	40,000	40,000
Percent increase in in renewable energy capacity (MW)	0%	9%	14%	18%	22%	26%	30%	29%	28%	27%	N/A

Impact category #4	**Access to clean, affordable, and reliable energy**										
Indicator	Increase in number of houses/buildings/facilities with access to clean energy resulting from the policy										
Specific impact	Increased access to clean electricity										
Assessment method	Deemed estimates method										
Equation	Number of installation = Total installed capacity target in eligible sector i.e., residential, institutional, industrial, commercial and government / standard solar rooftop installation size for each type of installation/1000										
Parameters needed	Standard solar rooftop system size for each type of installation (kW) Total installed capacity target in eligible sector i.e., residential, institutional, industrial, commercial and government (MW)										
Assumptions	The solar PV incentive policy sets target for eligible sectors. Total new installations are estimated using a standard size and target of the eligible category.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**

Residential (number of households)	24,000	576,000	600,000	720,000	840,000	960,000	1,080,000	0	0	0	4,800,000
Institutional (number of buildings)	240	5,760	6,000	7,200	8,400	9,600	10,800	0	0	0	48,000
Industrial (number of facilities)	3,375	81,000	84,375	101,250	118,125	135,000	151,875	0	0	0	675,000
Commercial (number of buildings)	1,050	25,200	26,250	31,500	36,750	42,000	47,250	0	0	0	210,000
Government (number of buildings)	44	1,067	1,111	1,333	1,556	1,778	2,000	0	0	0	8,889
Increase in number of houses/buildings/facilities with access to clean energy resulting from the policy (houses/buildings)	28,709	689,027	717,736	861,283	1,004,831	1,148,378	1,291,925	0	0	0	5,741,889

Impact category #5	**Capacity, skills, and knowledge development**										
Indicator	Number of new skilled trainees and workers on the ground because of the policy per year										
Specific impact	Increase in training for skilled workers in solar relevant sectors										
Assessment method	Deemed estimates method										
Equation	Target for new skilled trainees and workers on the ground per year										
Parameters needed	Target for new skilled trainees and workers on the ground per year										
Assumptions	The solar PV incentive policy includes targets to train new workers to support the policy goals.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Number of new skilled trainees and workers on the ground because of the policy per year	460	5200	6000	8400	8000	8000	4000	0	0	0	40,060

Impact category #6	Jobs										
Indicator	Change in jobs resulting from the policy (jobs/year)										
Specific impacts	Increased jobs in the solar panel manufacturing, construction and installation, and operation and maintenance sectors Reduced jobs in fossil fuel sectors										
Assessment method	Deemed estimates method										
Equation	Total jobs = Total capacity (MW) * Jobs per MW										
Parameters needed	Jobs per MW = Manufacturing (11 jobs/MW, out of which 40% are domestic; Installation (13 jobs/MW); O&M (3.5 jobs/MW), Job in fossil industry (1 job/MW) Installed capacity (MW)										
Assumptions	It is assumed that 70% of planned capacity will likely come from new fossil-based power plants.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Solar panel manufacturing	879	21,097	21,976	26,371	30,766	35,162	39,557	0	0	0	175,808
Construction and installation	2,640	63,360	66,000	79,200	92,400	105,600	118,800	0	0	0	528,000
Operation and maintenance	702	16,848	17,550	21,060	24,570	28,080	31,590	0	0	0	140,400
Fossil fuel sector	-139	-3,143	-3,103	-3,555	-3,984	-4,393	-4,789	0	0	0	-23,106
Net change in jobs (jobs/year)	4,082	98,162	102,423	123,076	143,753	164,448	185,158	0	0	0	821,102

Impact category #7	Income
Indicator	Savings in annual electric bill for households and businesses (USD/year)
Specific impact	Increased income households, institutions and other organizations due to reduction in energy costs
Assessment method	Deemed estimates method
Equation	Savings on electricity bill = Total electricity generated from solar rooftop by sector (kWh) * Tariff by sector (USD/kWh)
Parameters needed	Total units generated (kWh) (see Table A.4) Tariff: household and institutional (USD 0.08/kWh); commercial (USD 0.12/kWh)

Assumptions	The annual escalation in tariff is assumed to be 4%										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
National reduction in electric bills (million USD/year)	27	566	1178	1960	2930	4107	5512	4586	3815	3174	27,855

Impact category #8	**Energy independence**										
Indicator #1	Reduction in coal imports (t/year)										
Specific impact	Increased energy independence from reduced imports of coal										
Assessment method	Deemed estimates method										
Equation	Reduction in coal imports = Electricity generated from new solar PV (MWh) * coal consumption per unit of electricity (t/MWh) * coal import ratio (%)										
Parameters needed	Electricity generated from new solar PV (MWh/year) (see Table A.) Coal consumption per unit of electricity (t/MWh) – (0.74 t/MWh) Coal import ratio (%) – 24%										
Assumptions	It is assumed that in the baseline scenario new coal-based power plants will be added equivalent to the solar rooftop PV capacity addition due to proposed policy and no new diesel- and gas-based power plants will be added in future. It is also assumed the coal reduction will have a proportional impact on import and domestic coal. It is further assumed coal efficiency and coal import ratio will stay the same for the next ten years.										
Assessment period	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Cumulative impact**
Reduction in coal imports from the policy (t/year)	47,121	1,178,021	2,356,042	3,769,667	5,418,896	7,303,729	9,424,166	9,424,166	9,424,166	9,424,166	57,770,140