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NAMA “Solar Energy Development in Uzbekistan”

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REVISIONS

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LIST OF ACRONYMS

NAMA	Nationally Appropriate Mitigation Actions
ADB	Asian Development Bank
AS	Academy of Sciences
GHG	Greenhouse Gas
BOS	Balance of System
CAC	Central Asia Countries
CAPEX	Capital Expenditure
CCGT	Combined Cycle Gas Turbine
CIGS	Copper Indium Gallium Selenide
CO_2	Carbon Dioxide
CSP	Concentrated Solar Power
DBO	Design Build and Operate
DNI	Direct Normal Irradiation
EOI	Expression of Interest
GHI	Global Horizontal Irradiation
GW	Gigawatt
GWh	Gigawatt hour
HPP	Hydro Power Plants
IPP	Independent Power Producer
ISCC	Integrated Solar Combined Cycle
ISEI	International Solar Energy Institute
kWh	Kilowatt-hour
$ktCO_2$	One thousand tons of CO_2
kW	Kilowatt
MAWAR	Ministry of Agriculture Water and Water Agriculture Resources
MJ	Megajoule
NO_X	Mono-nitrogen Oxides
MSI	Materials Science Institute
$MtCO_2$	One million tons of CO_2
MW	Megawatt
MWh	Megawatt hour
O&M	Operation and Maintenance
PPA	Power Purchase Agreement

PV	Photovoltaic
RES	Renewable Energy Source
SCADA	Supervisory Control and Data Acquisition
Si_3N_4	Silicon Nitride
SO_2	Sulfur Dioxide
TPP	Thermal Power Plant
TW	Terawatt
TWh	Terawatt hour
UFRD	Fund for Reconstruction and development of the Republic of Uzbekistan

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Academy of Science of Uzbekistan
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Joint Stock Company Uzbekenergo
Centre of Hydrometeorological Service at Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet)

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1 SCOPE AND RATIONALE OF THE NAMA “SOLAR ENERGY DEVELOPMENT IN UZBEKISTAN”

The NAMA “Solar Energy Development in Uzbekistan” presents a specific action plan[1] for the deployment of solar energy in Uzbekistan from 2015 to 2030, adapted to the country's energy needs and based on the Roadmap[2] for the development of solar energy in the Republic of Uzbekistan which was approved by Uzbekistan’s Government (1). Approved by Presidential Decree of the Republic of Uzbekistan dated by March 4, 2015 № PD-4707 the "Program of measures for structural reforms, modernization and diversification of production in 2015-2019", is taking into account. To see how this NAMA and Roadmap are related, a scheme can be found in ANNEX: Structure behind the NAMA.

The country is also developing a legal framework for renewable energy in order to improve and update laws as Law of the Republic of Uzbekistan «On rational Use of Energy» (1997) or the Decree of the President of the Republic of Uzbekistan «On measures of further development of renewable energy» (2013). This framework is expected to pave the way for energy transformation of the country facilitating the implementation of renewable energies in Uzbekistan. It is expected that new measures will be presented throughout 2015.

The resolution of the President of the Republic of Uzbekistan No PD-2343 5th May 2015 "On the Program of measures to reduce energy consumption, implement energy-saving technologies in the fields of economy and social sphere for 2015-2019" identifies as a key action expediting the development of renewable energy sources including tested technologies of the use of the solar energy.

Solar energy is an appropriate solution for Uzbekistan as: the country has a good solar resource, the cost of this technology is narrowing the gap with conventional sources, there is a need to increase energy production due to growing of energy consumption, and the country and international organizations have shown their commitment.

Solar energy deployment in Uzbekistan will help meet demand while avoiding burning fossil fuels, with consequent reduction and avoidance in greenhouse gas (GHG) emissions. Furthermore, its implementation will help the industrial development of the country, create jobs, improve access to electricity and directly mitigate climate change.

The development of solar energy in Uzbekistan:

- is **transformational** as it will change the energy matrix of Uzbekistan both at utility, residential, and small and medium enterprises (SMEs) level;
- has the potential to be **replicated and scaled up** in the Central Asia region and with other sources of renewable energy;

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[1] This NAMA, prepared on the basis of the "Guidelines for Nationally Appropriate Action on Mitigation (NAMA)», page 8 confirms that the NAMA is a program.

[2] This roadmap was developed within the Technical Assistance TA-8008 Solar Energy Development in Uzbekistan, through a grant financed by the Asian Development Bank (ADB). The TA Executing Agency Is the Ministry of Finance of Uzbekistan and the Implementing Agency is the Scientific Production Association on Solar Physics (Physics Sun). The road map has been approved and signed by Uzbek Ministry of Finance, Ministry of Economy, Uzbekenergo and Physics Sun, the main public stakeholders.

- results are **measurable and verifiable GHG** reductions through energy production and installed capacity in large scale and small applications;
- will **leverage domestic finance**, in the first stage public funds (Uzbekenergo and the Fund for Reconstruction of Uzbekistan) and in the second stage private financing once policy and human capacity and knowledge have been built up;
- is **sustainable** as the solar energy costs will reach parity with conventional sources and the cost for society will reach break-even before the end of the implementation period;
- is **nationally-embedded** as the Uzbekistan government has consistently shown its commitment with solar energy development supporting the main aspects: policy, research and national capacity building, international cooperation and investment;
- will **provide co-benefits** to the whole society in Uzbekistan supporting the sustainability and diversification of the economy, improving the local environment and and local economic activity (specifically at rural areas).

2 OVERVIEW

2.1 DESCRIPTION OF THE MITIGATION ACTION

2.1.1 Introduction

The NAMA for Solar Energy Development in Uzbekistan, taking into account the main stakeholders involved, proposes nationally appropriate actions and sets priorities to reach plausible solar development goals and targets for Uzbekistan from 2015 to 2030. It is closely linked to the Roadmap[2] for Solar Energy Development in Uzbekistan (1). The implementation will lead to:

- Increasing use of renewable energy (solar) to meet growing energy demand.
- Reducing GHG emissions.
- Reducing the dependence on fossil fuels and the use of domestic gas for energy production.
- Attracting investment in the whole value chain of solar energy (from research to operation).
- Developing more efficient and environmentally friendly solar plants adapted to Central Asia conditions.
- Setting up utility-scale and distributed generation using solar technology.
- Developing a local industry, specifically SMEs
- Developing national capabilities and skills on solar energy related activities.
- Modernizing, maintaining and refurbishing electric infrastructure and procedures.
- Improving access to electricity and security of supply.
- Becoming a hub for solar energy in Central Asia.

Concerning the environment, the use of solar energy technologies implies the reduction of greenhouse (mainly carbon dioxide CO_2 and mono-nitrogen oxides NOx) and prevention of toxic (sulfur dioxide SO_2 and particulates) gas emissions when compared with thermal power plants. Due to growing demand of energy in Uzbekistan, solar energy can provide part of its future needs while helping stopping climate change.

The specific action plan is summarized in the following epigraphs.

2.1.2 Mitigation actions from 2015 to 2017

From 2015 to 2017, actions to support the development of solar technologies and to reduce the costs and increase the efficiency of solar energy generation plants are going to be implemented[3].

Starting in 2015, security and sustainability of the deployment process should be shown to the stakeholders to make the support credible, to promote the creation of a projects pipeline for the next five years, and to boost the components industry and capabilities.

Distributed generation and small applications of solar energy will be deployed based on pilot projects, grants and concessional loans. Support to local industry and technology transfer will be relevant to assure a sustainable process.

Capacity building for all stakeholders will be relevant at this stage to increase their support and participation in the following years.

At the end of this period, are forecasted 103 MW of installed solar power. From 2015 to 2017, It is expected that the accumulated solar energy, produced during this period, will rise up to 300 GWh; avoiding 170 $ktCO_2$[4] accumulated from 2015 to 2017.

2.1.3 Mitigation actions from 2017 to 2024

Based on the momentum created, relevant parts of the industry value chain should already be on place to supply the Republic of Uzbekistan and the neighboring countries.

Further demonstration projects will be developed to increase solar energy capacities in Uzbekistan while reducing the required financial support from multilateral banks and UFRD. Commercial banks and private investors shall start to play a role.

At this stage the situation of the energy market and the regulations chosen by the Government will decide the outcome and the growth rate for coming years. An adequate combination of concessional loans on public projects and Public Private Partnerships (PPP) such as Build Operate and Transfer (BOT) will provide support to growth. The process will be accelerated if the energy market is regulated as to allow Independent Power Producers (IPP) with mechanisms such as feed-in tariffs (FITs).

Distributed generation and small applications of solar energy will be deployed based on grants, concessional loans, microcredits and private financing. Local industry is expected to play a relevant role on system integration and maintenance of systems.

At the end of this period, the forecasted accumulated solar energy capacity shall have produced ≈6 TWh[5], avoiding ≈3.2 $MtCO_2$[6] accumulated from 2015 to 2024.

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[3] In 2015, a demonstration PV installation has been put in operation in Pap of Namangan region and, in 2016, a 100 MW PV solar power plant will be start construction in Samarkand.

[4] All figures are for Neutral Scenario

[5] Forecasted year 2024 (accumulated solar energy, neutral generation scenario)

[6] All figures are for Neutral Scenario of the three considered and later described: optimistic, neutral and pessimistic.

2.1.4 Mitigation actions from 2024 to 2030

At this stage, grid parity could have been reached and solar energy technologies might be able to commercially compete with conventional energy production.

At the end of this period, the accumulated installed solar power capacity from 2015 to 2030 shall have produced ≈21 TWh, avoiding ≈10.8 $MTnCO_2$[7] accumulated from 2015 to 2030.

2.1.5 Description of small scale solar mitigation actions

Even though the Roadmap (1) is focused on large scale power plants, it also includes the supply to remote regions and the contribution to grid stability in areas with shortage. Stable electricity supply is a basic need for medical centers, schools and other social care institutions. Solar energy can be a solution for remote rural areas under situations of absence or intermittence of electricity supply. Large power production systems connected to the grid can be complemented with smaller autonomous systems installed at demand site[8] and small power plants integrated in standalone or connected smart grids.

Pumping and desalination using solar energy is applicable to provide both drinking and agricultural water in rural communities.

2.2 SOLAR ENERGY SECTOR IN UZBEKISTAN

2.2.1 Energy sector

In Uzbekistan, the joint stock company Uzbekenergo is responsible for power generation, transmission and distribution. Uzbekenergo is 100% state-owned and controls thirteen "unitary" generation enterprises, three heat production enterprises, an electricity transmission enterprise and fifteen regional distribution enterprises. The share of power plants that are not part of Uzbekenergo is less than 3% (320 MW).The other power generation company, Uzsuvenergo under the Ministry of Agriculture and Water Resources (MAWR), focuses on development and operation of the small hydropower plants on water reservoirs and irrigation canals managed by the MAWR.

Total production of electricity amounted to 52.7 TWh in year 2011. Total installed generating capacity is equal to 12.3 GW in 38 power plants, including 10 thermal power plants (TPP) with a total capacity of 10.9 GW and 28 hydropower plants (HPP) with a total capacity of 1.4GW.

The energy mix in Uzbekistan is dominated by fossil fuel-fired thermal power stations: 93.5% of them use natural gas, 1.3% fuel oil and 5.2% coal (2).

[7] All figures are for Neutral Scenario of the three considered and later described: optimistic, neutral and pessimistic.

[8] Both Government and the Academy of Science have acknowledged and shown commitment to support the development of energy supply for remote regions, promoting their autonomy and sustainability.

Uzbekistan has an ambitious plan to upgrade and increase capacity; currently, it holds around 50% of the total Central Asia interconnected system capacity (3). Solar energy could provide part of this growing demand.

Table 1 forecasts the demand of energy from 2015 to 2030. In Republic of Uzbekistan, demand is to be satisfied using national power plants as described in the Roadmap for solar development in Uzbekistan (1) where three consumption scenarios are defined:

- Conservative consumption scenario
- Intermediate consumption scenario
- Proactive consumption scenario

The ‘Conservative’ scenario is based on lower growth rates and lower energy intensity of demand, whereas the ‘Proactive’ scenario assumes higher economic growth rates and higher energy intensity.

Energy consumption scenarios (TWh)	2015	2020	2025	2030
Conservative consumption scenario	58	63	68	75
Intermediate consumption scenario	58	70	85	105
Proactive consumption scenario	58	75	98	130

Table 1 Energy consumption [TWh] according to 3 scenarios. Source: (1)

From 2015 to 2030 installed Capacity should be increased to fulfill the forecasted growing demand and also there is need to update existing power plants. This environment favors solar energy deployment. The new solar power plants will not replace existing ones but will avoid the construction of new ones, thus they will not compete with existing ones.

2.2.2 Introduction to solar energy in Uzbekistan

Solar experimentation has been going on in the country since 1925 with actinometrical measurements at the Uzbek Hydro meteorological institute. Since then, research and development has been carried out and a landmark was established in 1987, when a large 1 MW solar furnace was set in operation and "Physics-Sun" was organized within Uzbekistan Academy of Science. Uzbekistan has a good technical capacity and knowledge in Concentrated Solar Power, materials and photovoltaic technology, and an incipient solar component industry.

In Uzbekistan, there are locations which are suitable to set up solar energy power plants, both Concentrated Solar Power (CSP) and Photovoltaic (PV)[9], as shown in Figure 1,

[9] Common practice sets, for PV and CSP power plants to be feasible in a location, threshold values of GHI above 205 Wh/m^{2}y and DNI above 230 kWh/m^{2}year, respectively. As part of the Technical Assistance TA-8008, launched and financed by the ADB, the potential of solar energy in Uzbekistan was checked; in six areas where, a priori, feasible solar power plants

Direct Normal Irradiation (DNI), and in Figure 2, Global Horizontal Irradiation (GHI). The first one is correlated with CSP potential and the second with PV potential.

After some small scale both isolated and grid connected installations, the first commercial scale (100 MW) power plant is going to be built In Samarkand[10].

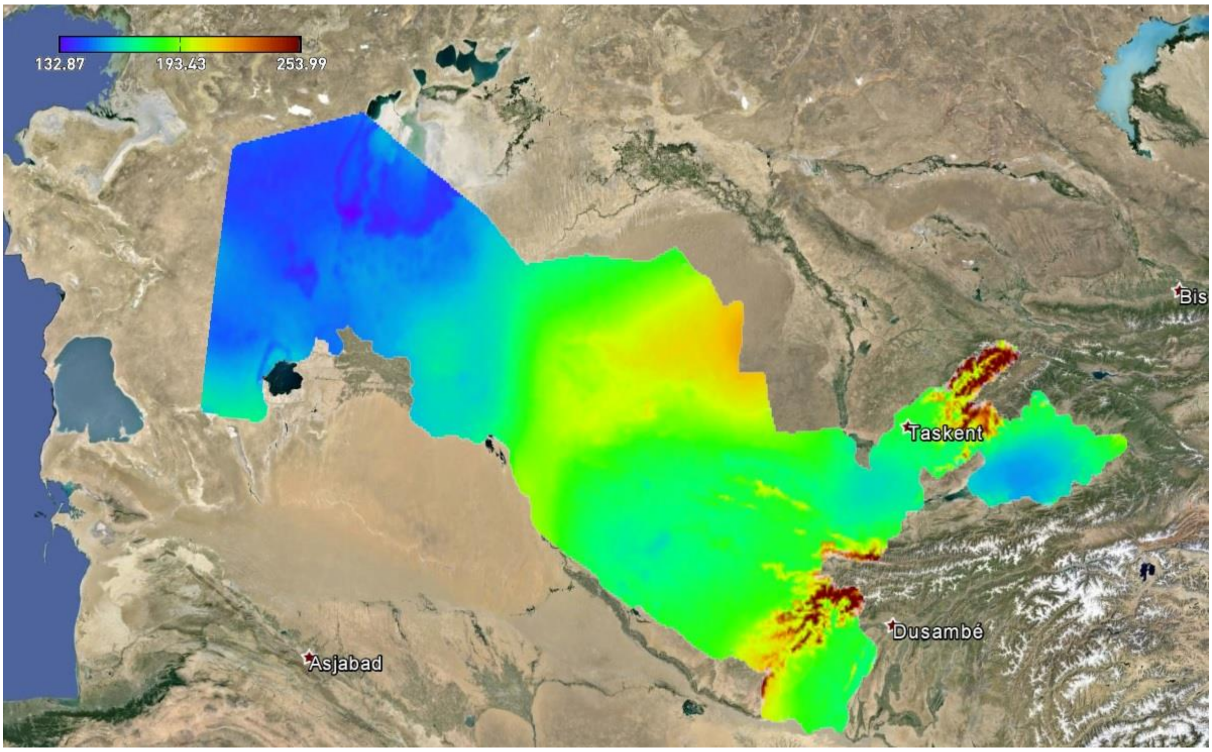

Figure 1 Direct Normal Irradiation (DNI) (W/m² year)

could be built, ground meteorological one year measurements have been correlated with 13 year satellite data to estimate the long term solar resource in the selected sites.

[10] This plant is going to be built by Uzbekenergo with financing from UFRD and ADB.

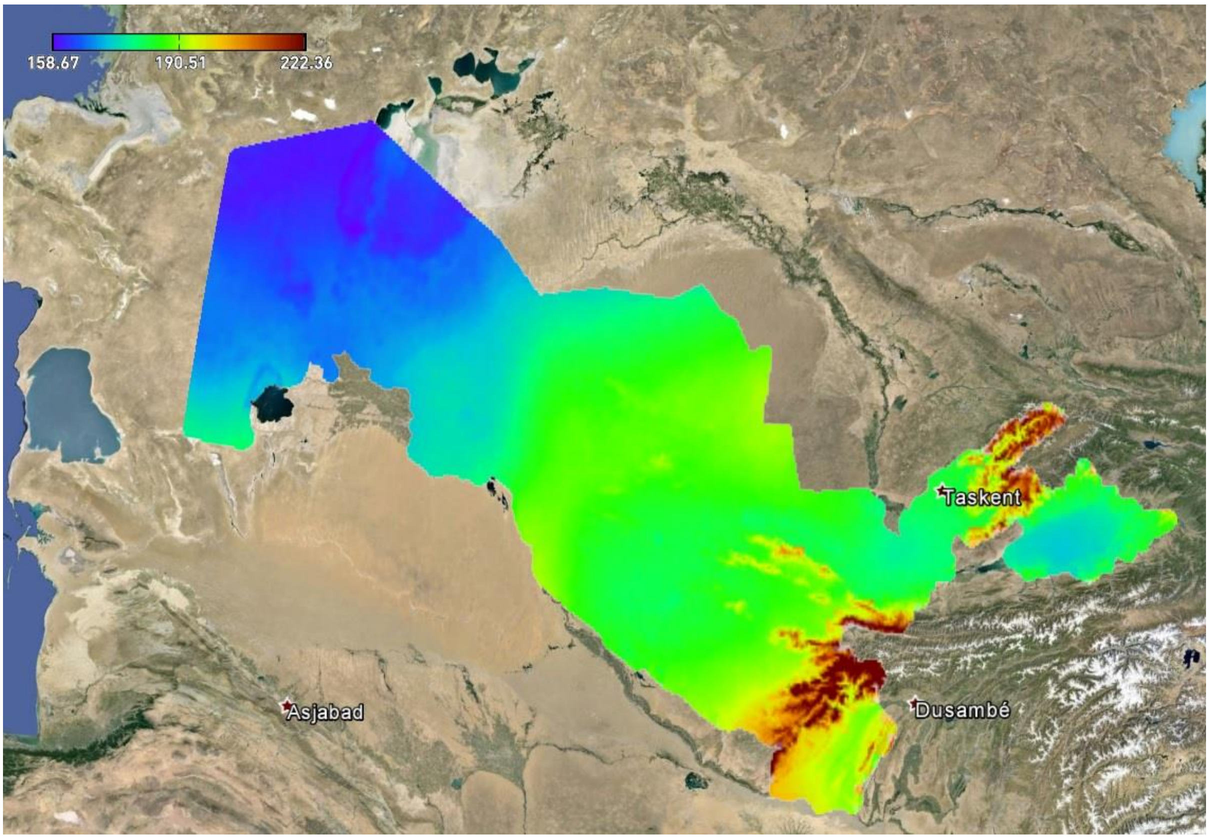

Figure 2 Global Horizontal Irradiation GHI (W/m^2 year)

2.2.3 Solar energy deployment scenarios

In the Roadmap (1), three generation scenarios have been defined for solar energy deployment: neutral generation scenario, optimistic generation scenario and pessimistic generation scenario.

2.3 TECHNOLOGY

2.3.1 Photovoltaics (PV)

Photovoltaics is a commercially available technology which has the potential to be implemented in nearly any country (4). The 100MW PV power plant currently under development in Samarkand, Uzbekistan, is an example. It will be owned by Joint Company Uzbekenergo and financed by Asian Development Bank (ADB) and Uzbekistan Fund for Reconstruction and Development (UFRD). The PV plant will rank among the 10 biggest photovoltaic power plants in the world. The technology to be implemented is crystalline silicon modules with fixed structure.

The basic building block of a PV system is the PV cell, which is a semiconductor layer that converts solar energy into direct current electricity. PV cells are interconnected to form a

PV module, typically up to 50-200 Watts (W). The PV modules combined with a set of additional application-dependent system components (e.g. inverters, controller, batteries, electrical components, and mounting systems), form a PV system. PV systems are highly modular, i.e. modules can be linked together to provide power ranging from a few watts to hundreds of megawatts (MW).

2.3.2 Concentrated Solar Power (CSP)

CSP technology can provide renewable energy generation in countries with clear skies. CSP uses only direct solar irradiance. Not only clouds lower CSP generation but also dust or high humidity in the atmosphere, as they scatter the sun’s irradiation reducing the direct fraction. There are areas in Uzbekistan where the values of direct solar irradiance are enough for this technology.

CSP technology can supply base or peak loads by means of thermal energy storage; the plant is able to operate in a similar manner as a conventional thermal power plant during cloudy periods or at night time. CSP is able to follow demand, supply ancillary services and stabilize the grid, complementing PV.

The different approaches to CSP technology are:

- Parabolic trough systems
- Power tower systems
- Linear Fresnel systems
- Dish/engine systems

3 COSTS

3.1 COST OF IMPLEMENTATION

The forecasted annual and aggregated investment to implement the solar plan, according to the different generation scenarios, is shown in Figure 3.

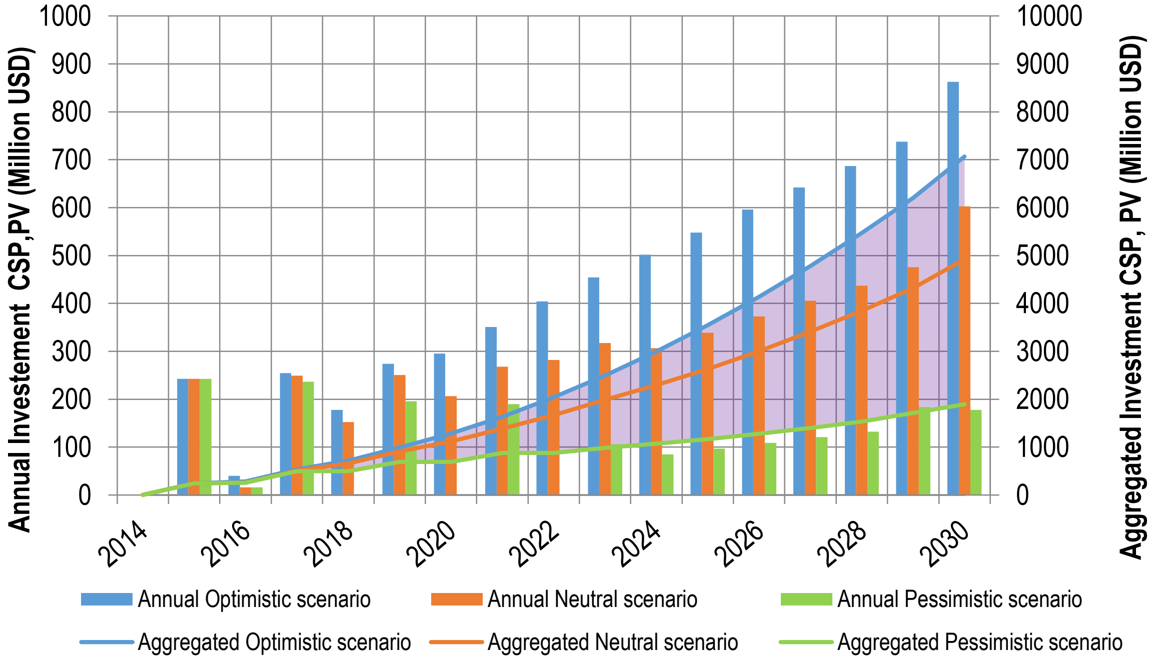

Figure 3 Forecasted annual and aggregated Investment for solar deployment (combining CSP and PV). Millions of US dollars.

The forecasted expending includes:

- Development and construction of six solar plants. This includes the solar plant already under development in Samarkand.
- Development of local capabilities and technology improvement in Uzbekistan.
- Land and associated infrastructures (water, grid improvement, access, etc.)
- Improvement of R&D infrastructures, demonstration projects and test bed facilities
- Rural electrification projects
- Capacity building

The first six projects are identified in the Roadmap for solar energy development in Uzbekistan (1). Among them - the Samarkand Solar power station – Feasibility Study was performed and approved, construction process on its preparation process, the other two stations has been identified as priorities in the Decree of the President of the Republic of Uzbekistan dated by March 4, 2015 № PD-4707:

- Construction of solar photovoltaic 100 MW station in Namangan region.
- Construction of solar photovoltaic 100 MW station in Sherabad district of Surkandarya region.

The first six projects are represented in the Table 2:

Project	Size (MW)	Estimated Cost (Million USD)	Status
Solar photovoltaic station in Samarkand	100	210	The Feasibility Study has approved, the construction process is being prepared.
Solar photovoltaic station in Namangan region	100	210	Approved. The pre-Feasibility Study has been completed.
Solar photovoltaic station in Sherabad district of Surkhandarya region	100	210	Approved. The pre-Feasibility Study has been completed.
Solar photovoltaic station in Kashkadarya	100	210	The pre-Feasibility Study has been completed.
Solar photovoltaic station in Navoi	130	230	The pre-Feasibility Study has been completed.
Solar photovoltic station in Tashkent	10	60	The pre-Feasibility Study has been completed.

Table 2 Projects which have been identified in the Roadmap for Solar Energy Development in Uzbekistan

3.2 INCREMENTAL COST OF IMPLEMENTATION

Development of Solar Energy in Uzbekistan (1) will lead to profits for society in the long run due to: narrowing of the existing gaps between solar and conventional energy generation costs (Figure 4), decreasing greenhouse gases (GHG) emission (possible source of income) and increasing energy supply security and price stability.

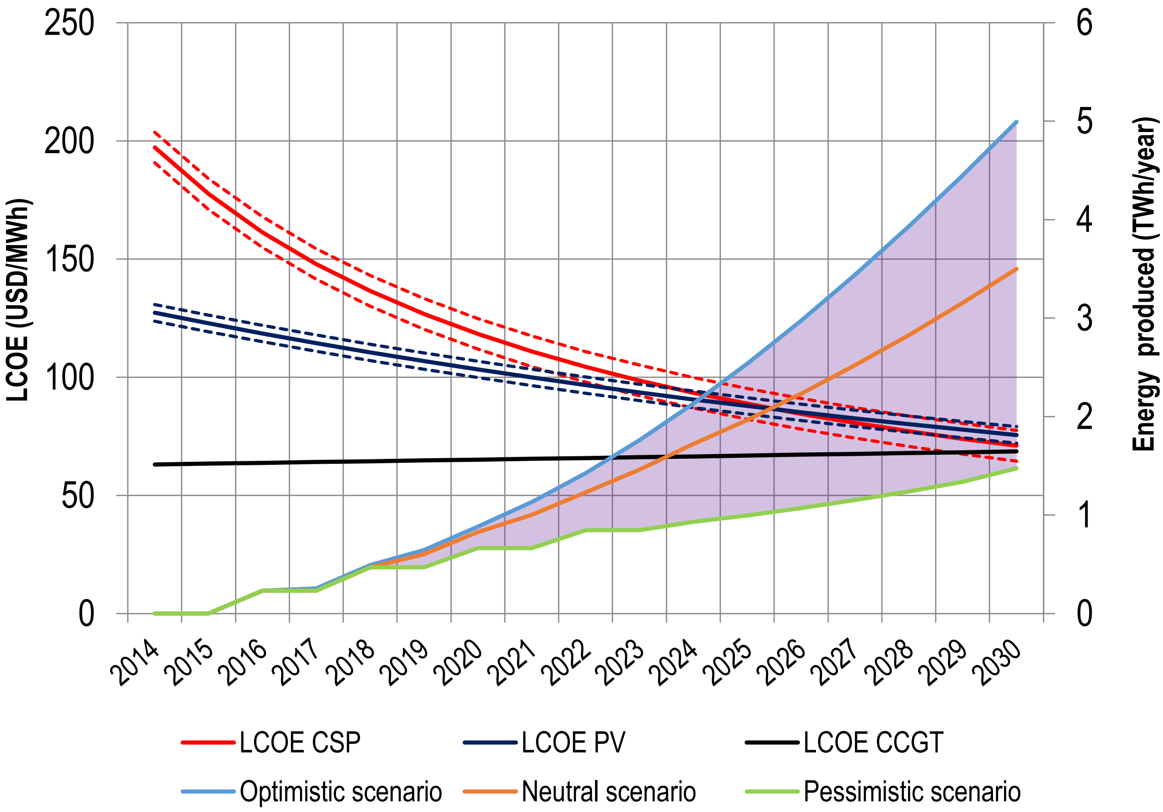

Figure 4 Calculated values of energy production scenarios and cost of energy comparison between CCGT, CSP and PV technologies.

The incremental cost for implementation compares the cost for society that the solar energy development will have on Uzbek population if compared to a fully conventional energy generation scenario. From the Levelized Cost of Energy (LCOE) for PV and CSP, the forecasted incomes due to the liberated natural gas, which now can be sold in the international market (5), have been subtracted. This has led to a costs which can be compared with Combined Cycle Gas Turbine (CCGT) generation costs.

The cost for society, calculated comparing conventional and solar option for the three generation scenarios, for the whole life of the power plants are shown from 2015 till 2030 in Figure 5.

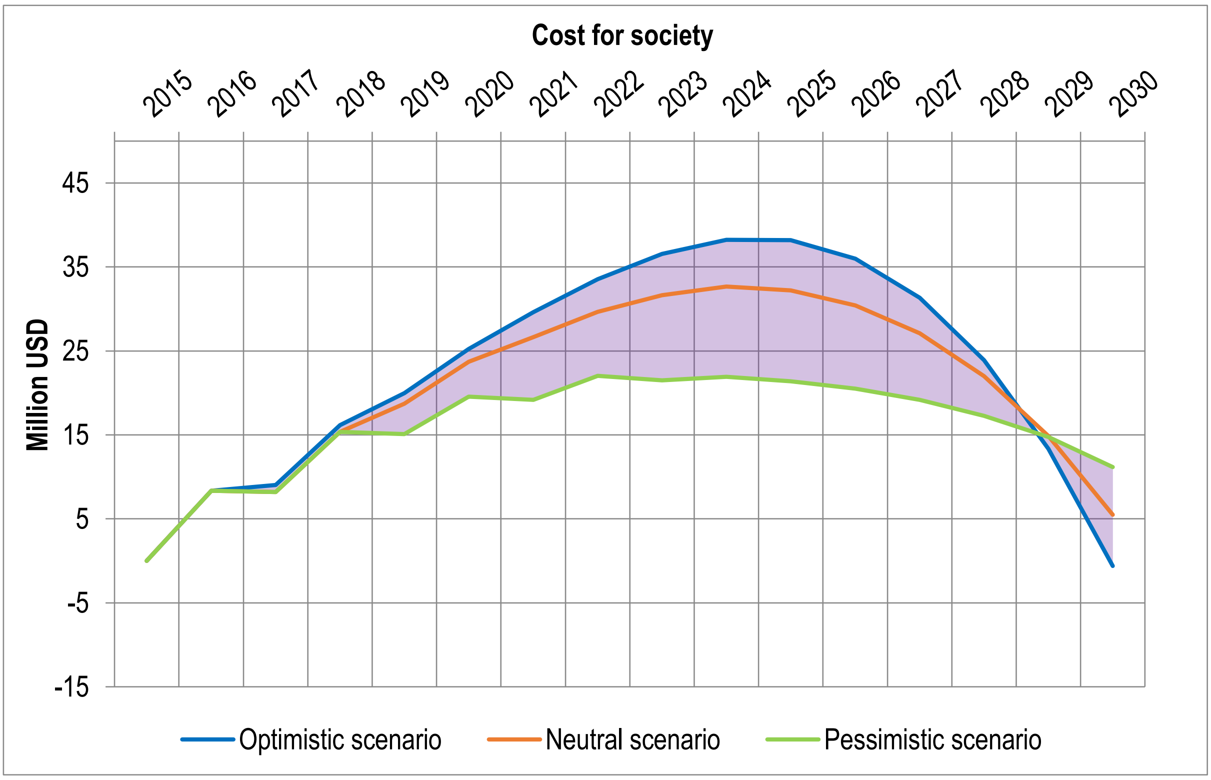

Figure 5 Cost for society evolution over the years (Mill USD). All scenarios.

Benchmarked technologies have to be evaluated under the same fiscal and economic conditions to obtain reliable results. Therefore, CCGT energy generation has to be stripped of any subsidy or privileged policy that represents a difference towards PV and CSP energy generation.

4 SUPPORT REQUIRED FOR THE IMPLEMENTATION OF THE MITIGATION ACTION

4.1 FINANCIAL SUPPORT

The public sector and donors have a role on supporting the first solar power plants as the first consolidated projects with reliable results which will encourage potential investors to finance solar energy in the future.

The Government of Uzbekistan, JSC Uzbekenergo, the Fund for Reconstruction and Development of Uzbekistan (UFRD)[11] and Multilateral Development Banks such as the Asian Development Bank are helping to overcome the initial investment needs.

Fist stages of the solar program are bonded to Uzbekenergo’s investment program. It is worth noting that Uzbekenergo is playing a role also on financing research and development of new technologies.

It is expected that, after the first steps, the dependence on Multilateral Financing Institution’s funds will decrease and finally cease.

Therefore, financial support is required for first projects on:

- Utility scale solar power plants
- Research and implementation of new technologies
- Small facilities to supply public services such as schools, clinics, sports facilities, etc.
- Distributed generation at domestic consumers and SMEs.
- Installations for agricultural facilities.
- Local smart grids
- Water supply for solar energy use in rural clinics, agricultural irrigation, small industries, etc.
- Support to local industry development (credits for SMEs and large industrial projects implementation)
- Pioneer technologies
- Capacity building

[11] Since 2006 the Uzbekistan Reconstruction and Development Fund has been financing development programs of high importance and impact on Uzbek economy. The Fund started with 1 billion USD charted capital in 2006 provided by the Ministry of Finance of the Republic of Uzbekistan and the five largest banks in Uzbekistan.

4.2 TECHNOLOGICAL SUPPORT

4.2.1 Local Industry Capacity Development

To develop local industry potential, technological support will be needed in the form of technical assistance, technology transfer, joint ventures, etc.

The development of solar industry requires materials and parts that can be either imported from countries that already have the needed technology or manufactured locally. Not all the pieces or materials used in both PV and CSP equipment can be produced in any country, as the level of complexity increases the cost of manufacturing.

Substituting imports by local products might represent an advantage for local industry and therefore for society.

A differentiation between the components of CSP and PV regarding the degree of complexity on the manufacturing process is shown in Figure 6 and Figure 7.

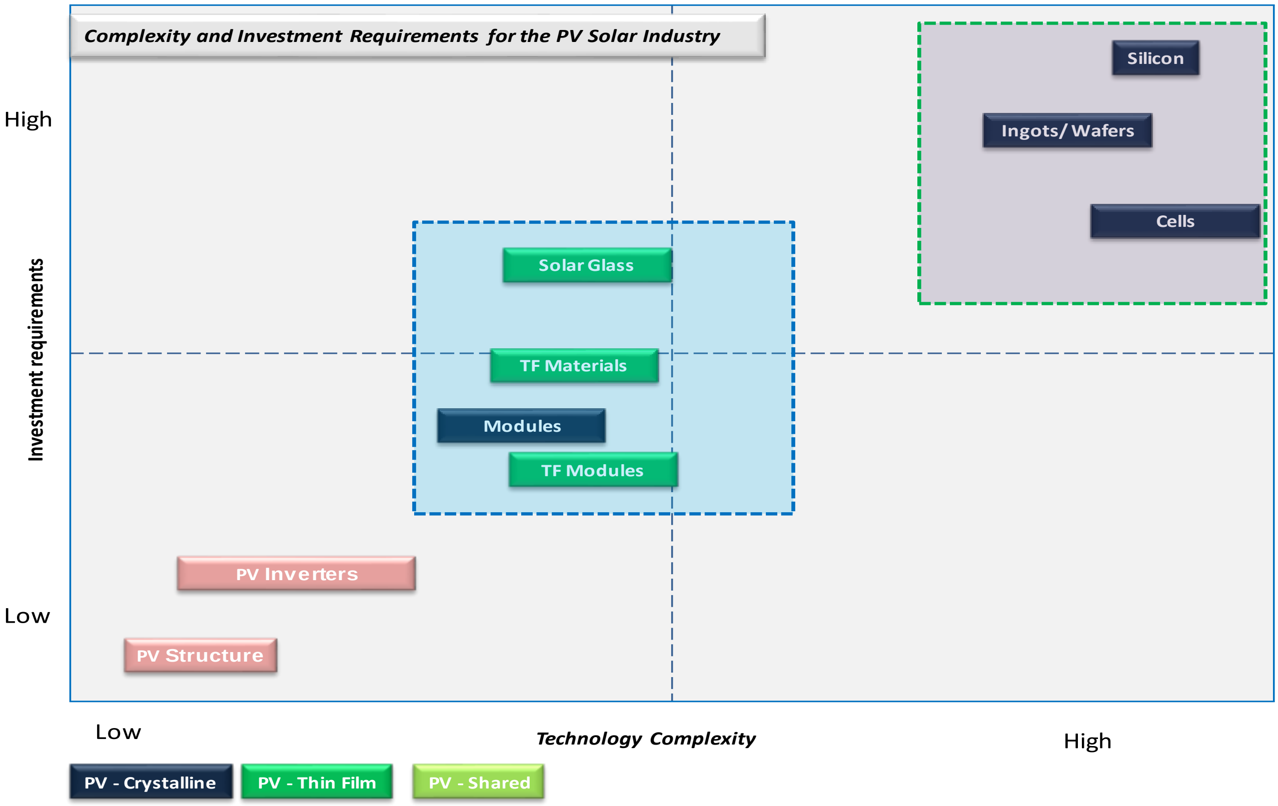

Figure 6 PV complexity and corresponding investment requirements.

Silicon, ingots[12] and cells have a higher technology complexity and a higher investment is required. Government of Uzbekistan is currently considering projects for the production of solar grade silicon in the country and production of photovoltaic panels in Navoi Free Industrial Economic Zone (FIEZ), for this projects technological support and technology transfer will be needed.

In addition, adapting domestic industry to be able to manufacture the pieces and materials has to be evaluated. Inverters and structure for PV modules can be manufactured by local industry and they are common for both PV technologies, namely crystalline and thin film. Thin film materials and modules have manufacturing processes complex enough to be at the border of feasibility, together with crystalline modules.

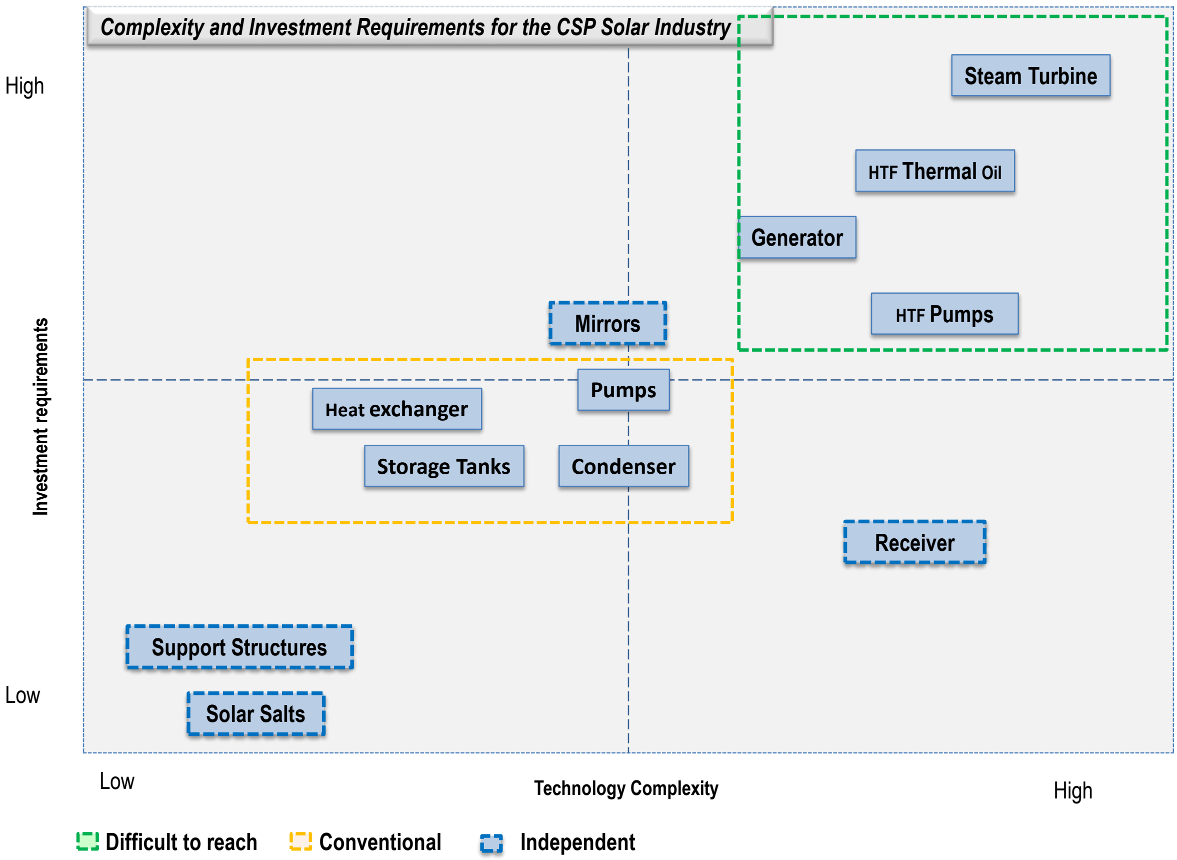

Figure 7 CSP complexity and corresponding investment requirements.

Support structures and solar salts have the lower combination of technology complexity and investment requirements making them a suitable choice for local industry.

[12] At the moment in Navoi Free Economic Zone has launched the factory on production of technical silicon with production volume of 12000 t/year. In parallel in Angren Free Economic Zone the construction of second factory with annual volume of 600 n/year is conducted.

On top, the construction of a RES power plant has other needs such as civil construction. This is an opportunity for local industry to provide basic materials that need no complex technology to be manufactured. Construction of a CSP plant with 7 hours storage system (6) requires steel, concrete, copper, glass, insulation and storage medium.

The highest share of material falls under storage medium, followed by glass and steel. Here again, to increase the positive impact that developing solar energy may have on local suppliers it is advisable to develop local industry capacity far enough to cope with the basic materials demand.

4.3 CAPACITY BUILDING SUPPORT

4.3.1 Labour Force Capacity Development

To ensure optimal evolution of the action there has to be available workforce, trained and experienced in solar energy technologies. Currently, it is not enough to cover the annual demand for the first projects. Foreign experts could assist on the building processes of the first power plants and could contribute to the training process of local professionals.

The first 100 MW PV power plant will roughly require 400 direct jobs during the first construction year. The following years, smaller plants are forecasted comprising around 300 jobs and 800 jobs on year two and three.

5 ESTIMATED EMISSION REDUCTIONS

According to the latest official consumption data available in Uzbekistan (2011), CO_2 emissions amounted to around 115 million metrics tons (7). The increase in demand (will lead to increased generation what means GHG emissions growth. This NAMA plan, forecasts that in the next 15 years the production of solar energy in Uzbekistan will rise up to 3.4 TWh/year (neutral generation scenario) as shown in the Figure 8.

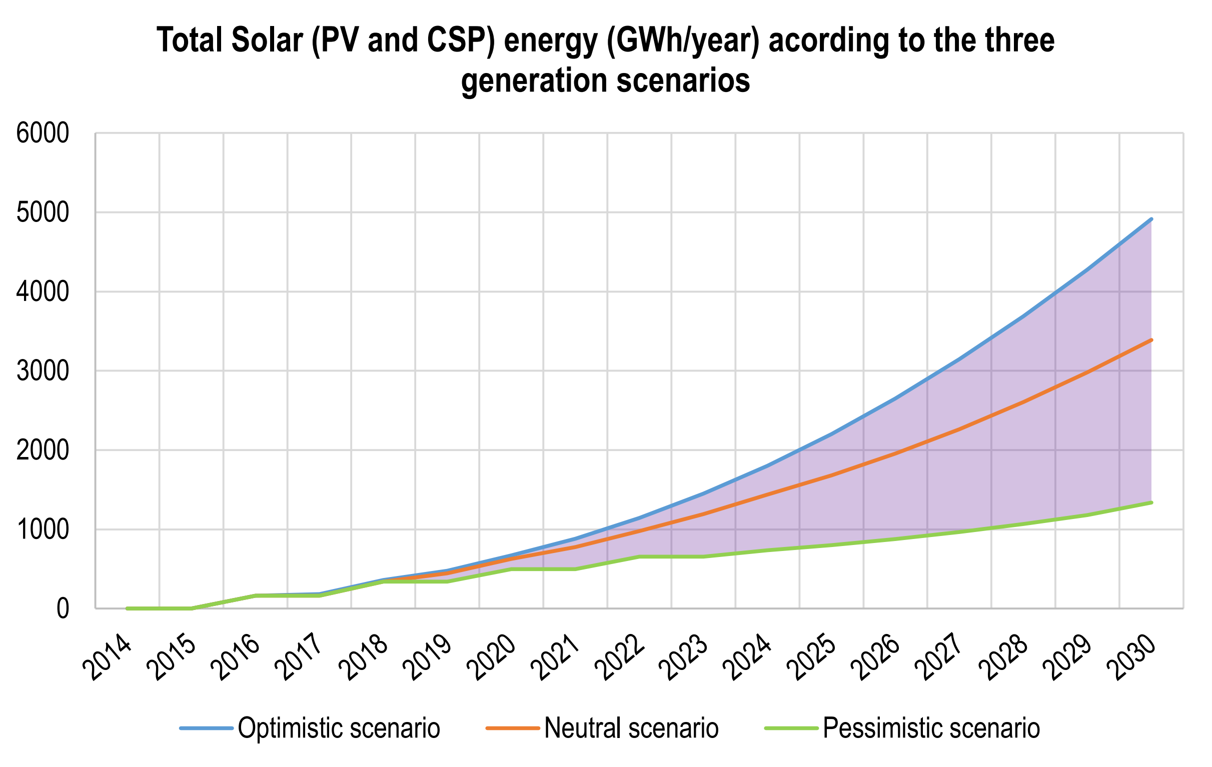

Figure 8 Estimated annual energy produced by PV and CSP

Concerning the environment, the use of solar energy technologies means reduction on the greenhouse gases (mainly CO_2 and NO_X) and prevention of toxic gas emissions (SO_2 and particulates). As demand grows and the need to modernize old plants increases, supplying part of this demand with new solar energy plants will reduce GHGs emissions.

To estimate CO_2 emissions is necessary to take in account energy generation growth forecasts and emission factor expected for that period. The scenarios analyzed to establish emission factors have to take into account the estimated growth of renewable energy, the construction of new plants and the revamping of the least efficient. In order to estimate CO_2 emissions it has been used the projected emission factor developed for UNDP[13] by Ministry of Economy of Uzbekistan (8).

[13] The publication was developed in the framework of UNDP and Ministry of Economy project “Supporting Uzbekistan in transition to a low-emission development path”.

Accumulated CO_2 annual emissions savings expected are shown in the Table 3[14] and Figure 9:

YEAR	Optimistic scenario Mt CO_2/year	Neutral scenario Mt CO_2/year	Pessimistic scenario Mt CO_2/year	Accumulated (Mt CO_2e) neutral scenario
2015	0,0	0,0	0,0	0,0
2016	0,1	0,1	0,1	0,1
2017	0,1	0,1	0,1	0,2
2018	0,2	0,2	0,2	0,4
2019	0,3	0,2	0,2	0,6
2020	0,4	0,3	0,3	0,9
2021	0,5	0,4	0,3	1,3
2022	0,6	0,5	0,3	1,8
2023	0,8	0,6	0,3	2,4
2024	0,9	0,7	0,4	3,2
2025	1,1	0,9	0,4	4,1
2026	1,4	1,0	0,5	5,1
2027	1,6	1,2	0,5	6,2
2028	1,9	1,3	0,5	7,6
2029	2,2	1,5	0,6	9,1
2030	2,5	1,7	0,7	10,8
Accumulated (Mt CO_2e) year 2030	**14,4**	**10,8**	**5,3**	

Table 3 Expected accumulated CO2 emissions savings for each scenario of solar energy production growth.

[14] Emission factor has been taken as 0.532 Ton CO_2/MWh for 2014 decreasing linearly to 0.51 Ton CO_2/MWh for 2030. (6)

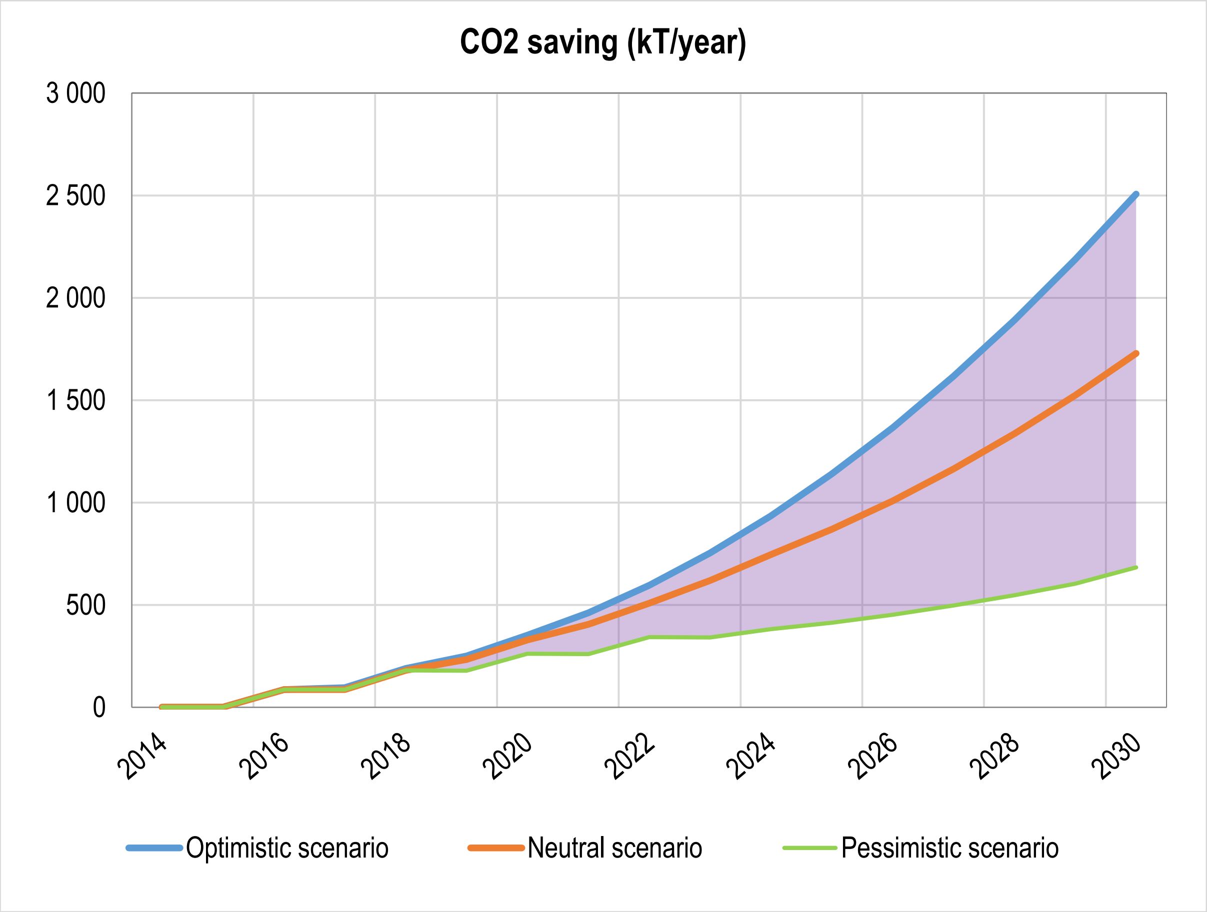

Figure 9 Accumulated GHG reductions (ktCO2/year) which can be directly attributed to the activities under this NAMA since 2014

The reductions are bounded within the limits of the pessimistic scenario and the optimistic scenario.

6 OTHER INDICATORS OF IMPLEMENTATION

6.1 MONITORING

GHG Emissions reduction Indicators:

- Installed capacity. For small facilities and commercial plants.
- Electricity generated. For small facilities and commercial plants.
- Meeting pre-existing government targets.
- Policy impact indicator. Promote the principles of good governance and using impact assessment procedures and monitoring and indicator systems as aids to policy integration and effective policy-making.
- Deployment status indicator. The deployment status indicator is defined by three sub-indicators that all express a different aspect of the Solar Energy Technology (SET) deployment status.
    - Sub-indicator A: Production of SES technology as share in total sector (electricity/heat) consumption. This indicator reflects the relevance of a technology for its energy sector and in how visible it is for policy makers.
    - Sub-indicator B: Production as share of 2030 realizable potential. The indicator reflects in how far the mid-term potential for a specific SE source is already exploited, or, in other words, to what extent the potential that can be realistically developed until 2030 is already tapped.
    - Sub-indicator C: Installed capacity of SET. This indicator serves as a minimum threshold and reflects whether a minimum capacity of this SET has been realized. In that case project developers, investors and banks have gained trust and experience in the national SET market. Even if technologies are proven abroad, only domestic projects are a proof that barriers in permitting, grid integration, support scheme and energy market access can be overcome.

Different countries have implemented different mechanisms through the years. The success of a mechanism depends on the maturity of the technology and conditions of the country. Thus, a mechanism which succeeded in a country may not cause the desirable achievements in other country.

Factors to be considered for evaluating the mechanism are the following:

- **Efficiency**: this feature evaluates the capacity of increasing RES using the lowest possible amount of resources and avoiding unexpected consequences. The ideal scenario is developing the renewable energy sector without numerous changes in policies and with costs for the Government as low as possible.

- **Effectiveness**: this criterion analyses the ability of the mechanism for reaching the objective. Technology development should meet the estimations.

- **Certainty for investors**: it analyses the facility of the mechanism to predict the results for investors. This reduces the risks for investors.

- **Competitiveness**: this factor indicates the capacity of the mechanism to create a sustainable sector in the long term.

6.2 REPORT

Is important to have a transparent communication of selected information to relevant stakeholders. For each specific project it is advisable to design an appropriate reporting process. The reporting frequency and granularity must be defined among the funding, implementing and supporting entities for each project.

For NAMAs, the organizations responsible for coordinating reporting may be the same organization as for measuring but for each project sometimes is better to appoint a working group for this task.

In general, the organization responsible for coordinating reporting of emissions, NAMAs and information on support must handle the following:

1. Incorporate reporting from all ministries and other organizations and keep an updated registry of NAMAs;

2. Report financial flows to policy schemes from national and international sources including disbursements, collaborate with the line ministries, and record the effects of regulatory initiatives compared to baseline scenarios;

3. Oversee the application of relevant methodologies for assessing emissions reduction from concrete project activities;

4. Support national and international verification teams by providing open access to information;

5. Devise principles to avoid double counting of emission reduction for related NAMAs.

6. Build a national emissions inventory system to facilitate reporting of BUR to the UNFCCC secretariat

6.3 VERIFICATION

All quantitative and qualitative information reported for the mitigation action must be verified. Verification ensures a mitigation action is credible and accountable. This part could be done by an Independent national agency, Third-party verification or International auditors.

Verification ensures credibility and accountability of a project's estimated GHG emission reductions. Independence of verifiers (i.e. third party) is needed to ensure confidentiality of industry data and credibility

What to verify must be made clear: Verifiers should only be responsible for data that is easily verifiable.

For each project a number of parameters which are previously collected at the stage of specifying Reporting. Once the data has been analyzed to verify compliance with the objectives and locate weaknesses. This is an ongoing process that must be scheduled in advance at the beginning of each project.

7 OTHER RELEVANT INFORMATION INCLUDING CO-BENEFITS FOR LOCAL SUSTAINABLE DEVELOPMENT

7.1 LAND REQUIREMENT

PV and CSP technologies require land with specific characteristics. Table 4 contains the cumulative necessary surface to build CSP and PV power plants according to the forecasted capacity scenarios.

Aggregated Land for solar (km²)		2016	2020	2025	2030
PV	Optimistic generation scenario	3.2	11.8	30	58.4
	Neutral generation scenario	2.9	10.7	22.6	40.5
	Pessimistic genee scenario	2.9	7.8	12.2	17.4
CSP	Optimistic scenario	0.4	3.8	13.7	29.3
	Neutral scenario	0.4	2.8	9.8	20.7
	Pessimistic scenario	0.4	0.4	2.2	6.2

Table 4 Aggregated land requirements for CSP and PV expressed in km².

7.2 LABOR FORCE

Table 5 shows the total jobs demand for CSP and PV. There are not enough trained labor force in the Republic of Uzbekistan to cover this demand. To face this constraint, developing a training program of specialization is envisaged.

Total jobs[15] CSP + PV (thousands)	2016	2017	2018	2019	2020	2025	2030
Optimistic scenario	1.10	1.88	2.50	3.45	4.25	8.11	12.60
Neutral scenario	0.34	0.65	0.98	1.11	1.46	2.61	4.03
Pessimistic scenario	0.02	0.04	0.16	0.35	0.23	0.29	0.43

Table 5 Total employees working on installation, operation and maintenance of CSP and PV plants by year. Units: Thousand employees. (6)

It is advisable to train future professionals for all the elements of the solar value chain. Industry and O&M related jobs are, by nature, stable long term jobs. On the other hand, construction jobs can also be considered stable as there is a long term program.

7.3 CO-BENEFITS FOR LOCAL SUSTAINABLE DEVELOPMENT

Benefits for the environment:

- Reclamation of degraded land
- Reduction of the required transmission lines of the electricity grids
- Reduction of pollution
- Decrease gas leaks (part of solar energy replace energy produced by conventional natural gas plants)

From a socio-economic viewpoint the benefits of the exploitation of solar energy technologies comprise:

- Increase of the regional/national energy independency
- Provision of significant work opportunities
- Diversification and security of energy supply
- Support of the deregulation of energy markets
- Acceleration of the rural electrification in developing countries
- Uzbekistan, due to its background, already acquired experience in solar technology and its strategic situation in Central Asia could become a regional knowledge, technology, and energy and production hub.
- Even though the Roadmap (1) focus on large scale power plants. In Uzbekistan, remote regions require different assistance: fresh water supply, house heating and stable electricity supply to improve and guarantee the quality of life.

[15] The values of forecasted created jobs are calculated following The World Bank data (6) complemented with experts' experience.

8 RELEVANT NATIONAL POLICIES STRATEGIES, PLANS AND PROGRAMMES.

Solar Energy is mentioned in a document “On priorities of industrial development of Republic of Uzbekistan in 2011-2015” decree stating that 44 investment projects will be carried out within this period and that one of them is a solar power plant of 50MW installed capacity.

Implementing Uzbekistan Presidential Decree “On further development of alternative of energy sources”, Ministry of Economy jointly with interested ministries and agencies developed the Uzbek Law “On alternative of Energy Sources”. The law project is a step towards creating the favorable conditions for utilization of solar energy from a self-consistent approach.

The draft law “On the rational use of energy” applies to legal and physical persons associated with the extraction, production, refining, storage, transport, distribution and demand of fuel and energy. It guarantees the right to independent producers of energy to deliver the electricity to the grid. Utility companies are obligated to accept and to buy this energy with the prices which must be defined by the Ministry of Finances in accordance with “the established order” (or in “the prescribed manner”).

The legal basis on protection of the environment and natural resources is described by the Law of the Republic of Uzbekistan “On protection of the atmospheric air”, developed by Oliy Majlis of the Republic of Uzbekistan in 1997. According to 3 item of the law, the main tasks of the law are directed to the prevention and reduction harmful chemical, physical, biological and other impacts on the atmosphere (9).

There is a number of National laws and Decrees of the Cabinet of Ministers of the Republic of Uzbekistan, which could serve to develop those technologies and projects that lead to reduction of CO_2 emission. A Decision of Cabinet of Ministers of the Republic of Uzbekistan by 2013 is dedicated to “On additional measures to implement the project "Improving the energy efficiency of industrial enterprises" with the International Development Association”. (10)

Admitted to the execution of the decision of the President of the Republic of Uzbekistan dated May 5, 2015 PD-2343 "On the Program of measures to reduce energy consumption, implement energy-saving technologies in the fields of economy and social sphere for 2015-2019."

To further ensure a favorable state of the environment and natural resource management, integrating environmental foundation of sustainable development in the sector of the economy, the Cabinet of Ministers has developed a Decision “On the Program of Action for Environmental Protection of the Republic of Uzbekistan for 2013 - 2017 years”. 9th item of the decision is dedicated to the main objectives of the greening of economic sectors, improvement of technological processes and environmental activities, which are reducing the impact on the environment and improving the efficiency of rational and integrated use of natural resources through the modernization and reconstruction of industrial enterprises, the introduction of environmentally-friendly and resource-saving technologies, including renewable energy. (11)

9 SUPPORT RECEIVED

Asian Development Bank (ADB) has supported solar development in Uzbekistan with the following actions:

- Small-scale capacity development technical assistance (S-CDTA) for the ‘Design/Foundation and Strengthening of the International Solar Energy Institute’
- Policy and advisory technical assistance (PATA) to assist in the promotion of solar energy development.
- Project Preparation Technical Assistance (PPTA) to assist the preparation of Samarkand 100 MW PV power plant
- Loan to Uzbekenergo for the construction of Samarkand 100 MW PV power plant.
- Technical support provided to ISEI.

10 ANEX: STRUCTURE BEHIND THE NAMA

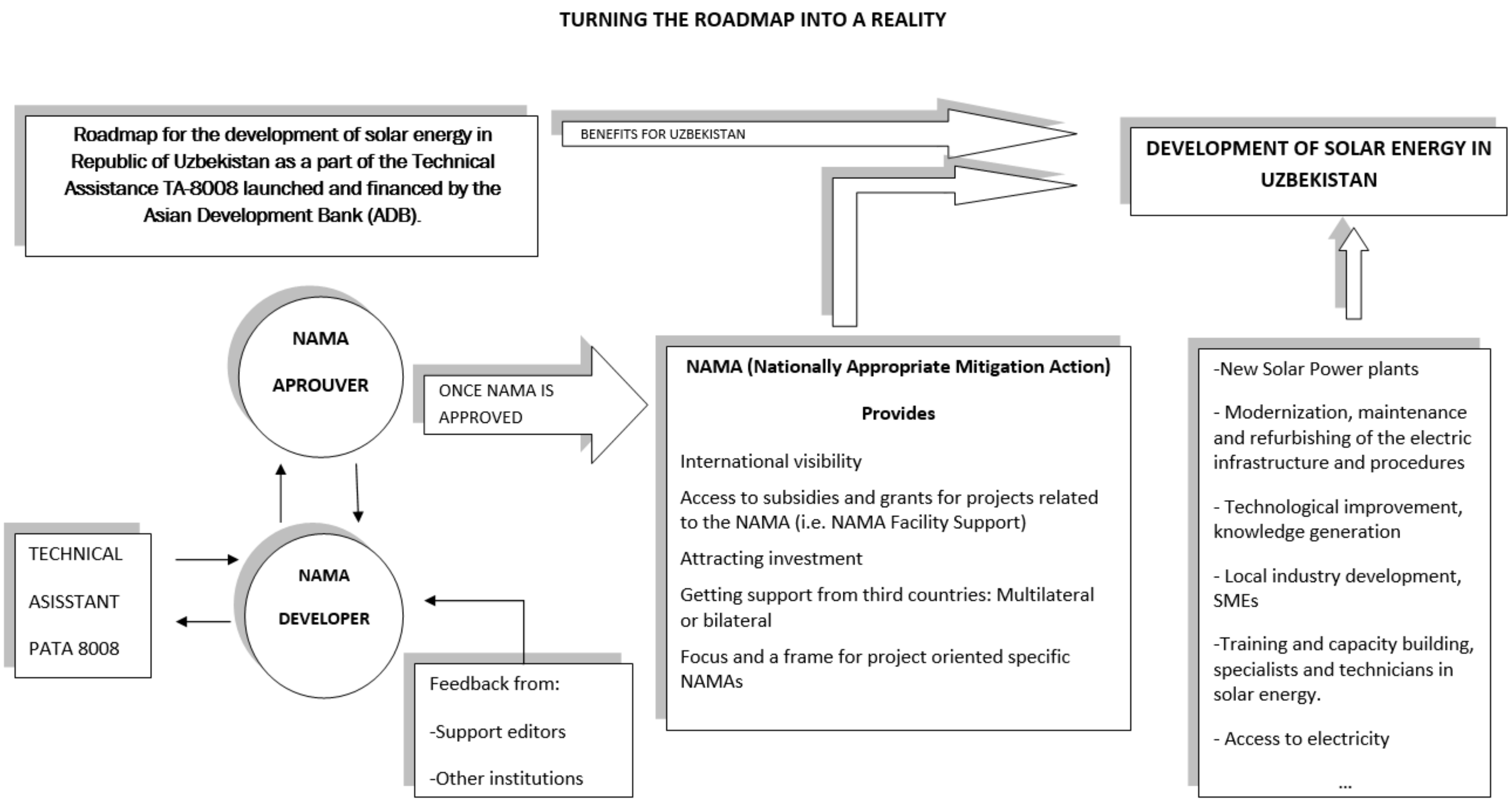

Figure 10 Structure behind the NAMA for development of solar energy in Uzbekistan

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