

## **JSC Uzbekenergo**

Extension of Talimarjan TPP: construction of 2 Combined-Cycle Gas Turbines with the combined capacity of no less than 900MW

### **Non-Technical Summary**

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# 1 INTRODUCTION

JSC Uzbekenergo is proposing to develop a 900MW Combined-Cycle Gas Turbine (CCGT) Power Plant at Talimarjan Thermal Power Station. The project – referred to as ‘Talimarjan Power Plant 2 (TPP2)’ – would add to the pre-existing thermal power generating capacity at Talimarjan Power Station, bringing the total installed capacity to 2,600MW, whilst reducing overall carbon intensity and improving overall efficiency.

**Table 1.** Summary of Installed Capacity at Talimarjan Thermal Power Station

Phase	Description	Total Capacity	Date of Operation
TPPO	Natural Gas-fired Steam Turbine	800MW	2004
TPPI	2 Combined-Cycle Gas Turbines	900MW	2016-17
<b>TPP2</b>	<b>2 Combined-Cycle Gas Turbine Plant</b>	<b>900MW</b>	<b>2022 (Proposed)</b>

The Project is based in Nuristan Settlement, Nishon Area, Kashkadarya Region, Uzbekistan. Talimarjan Thermal Power Station has been operational since 2004 and has since formed an integral component and key employment base within Nuristan. The Project will be based entirely within the existing Thermal Power Station site. The site location is shown under Figure 1, overleaf.

This Non-Technical Summary (NTS) provides a description of the project and describes the potential benefits and impacts associated with its construction and operation. It also describes how these will be mitigated and managed through all phases of the project. In addition, it provides a summary of the public consultation activities and the approach to future stakeholder engagement.

The NTS has been prepared for the potential financing of the Project by the European Bank for Reconstruction and Development (EBRD) and provides supplementary information and updated assessments since the original Environmental Impact Assessment<sup>1</sup> (EIA), published November 2017.

The ESIA is available in [English<sup>2</sup>](#) and [Russian<sup>3</sup>](#).

## 2 WHAT DOES THE PROJECT INCLUDE?

### 2.1 New Project Components

The Project will involve two (2 no.) Combined-Cycle Gas Turbine Units, to provide a combined capacity of no less than 900MW. The precise specification and configuration of the plant will be subject to a Public Tender, in order for the market to provide the most effective solution. However, in principle, the Project will comprise:

- 2 no. Gas Turbines, each equipped with a Heat Recovery Steam Generator (HRSG) and Steam Turbine Generator (i.e. the main components of a ‘Combined-Cycle Gas Turbine power plant’).
- Each unit will be equipped with an 85m high ‘main stack’ and 85m high ‘by-pass stack’.
- A short connection (c.500m) into the pre-existing power evacuation infrastructure (500kV substation and 500kV switchyard).

A schematic illustration of a CCGT plant is provided under Figure 1, overleaf.

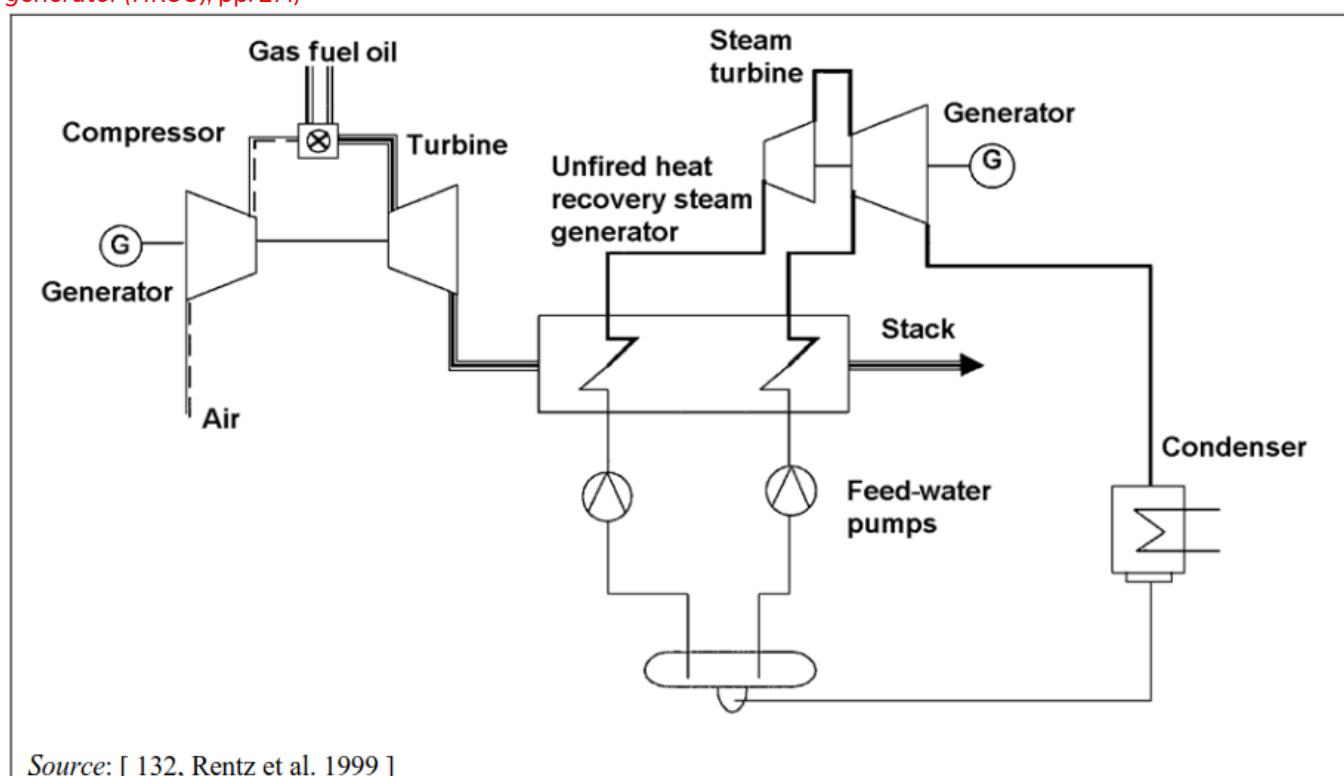
<sup>1</sup> Uzbekenergo, *UZB: Power Generation Energy Efficiency Improvement Project*, Project Number 49253-003, Final Draft, November 2017.

<sup>2</sup> <https://www.adb.org/projects/documents/uzb-49253-003-eia>

<sup>3</sup> <https://www.adb.org/ru/projects/documents/uzb-49253-003>

**Figure 1:** Schematic Illustration of a Combined-Cycle Gas Power Plant

(Reproduced from LCP BREF, *Figure 3.56: Schematic of a combined-cycle power plant with a heat recovery steam generator (HRSG)*, pp. 271)



## 2.2 Associated Facilities

The Project will benefit extensively from the key infrastructure, which was largely installed as part of TPP0 – with some relatively minor infrastructure additions as part of TPP1 developments. The site was first developed during the 1980s when Uzbekistan was part of the Soviet Union and ‘Talimarjan Power Complex’ was planned for 4 no. 800MW(e) units, similar to TPP0 (total 3,200MW(e) capacity). A summary of the pre-existing Associated Facilities is provided under Table 2.

**Figure 2: Project Location**



**Image: 1**



**Image: 2**



**Image: 3**

**Notes:**

**Image 1:** The Project is located in Kashkadarya Province of Uzbekistan, 440km southwest of Tashkent.

**Image 2:** The nearest settlement to the Project is Nuriston, approximately 1km northeast of TPP2. Nuriston has since grown as a result of the employment opportunities and local economic benefits (direct and indirect) of the Talimarjan Thermal Power Station. Mekhnatabad is also a nearby settlement. The indicative locations of both are illustrated on Image 2.

**Image 3:** The selection of Talimarjan Thermal Power Station for the Project means that all prerequisite infrastructure - such as fuel supply, water supply and power evacuation - are already present; significantly reducing the construction-phase development impact.



**Table 2. Summary of Key Associated Facilities Already Installed at Talimarjan Thermal Power Station**

Associated Facility	Description of Existing Facilities	New Facilities Required
<b>Fuel Supply</b>	<p>Natural gas is already delivered to Talimarjan Thermal Power Station to fire TPP0 and TPP1. The gas is sourced from the <i>Shurtan Gas Fields</i>, where it is subsequently treated at <i>Shurtan Gas Chemical Complex</i> (SGCC) – approximately 15km east of Talimarjan Thermal Power Station.</p> <p>The treated gas is then transferred to a Gas Distribution Station, located 3km south of the site, via two (2 no.) 1020mm diameter supply pipes operating at 60kg/cm<sup>2</sup>.</p> <p>From the Gas Distribution Station, gas is delivered via two (2 no.) independent pipelines of 700mm diameter to the power station, each operating at 12kg/cm<sup>2</sup>.</p> <p>Upon entering the site, the gas is fed into a pre-existing fuel header (distributor), which has provision for TPP2 offtake.</p>	<p>No additional infrastructure outside the site boundary is required for TPP2.</p> <p>Within the site, TPP2 will require new gas compressors (3 no. 1 operational, 1 spinning reserve and 1 backup), as well as further gas conditioning and commercial metering.</p> <p>Security of gas supply for TPP2, in addition to confirmation that the existing fuel supply infrastructure is capable of delivering the additional gas, has been provided by the gas supplier, Uzbekneftegas.</p>
<b>Raw Water Supply</b>	<p>Raw water supply will be obtained from the <i>Karshi Main Canal</i> (KMK).</p> <p><b>Water availability, security and impacts are discussed further under Section 4.6.</b></p>	<p>Cooling method selection is still under feasibility review and subject to detailed design.</p> <p>However, a number of potential options have been identified that will be further assessed to minimize the Project's impacts upon water resources.</p>
<b>Water Treatment</b>	<p>The water treatment plant was constructed as part of TPP0 with sufficient capacity to serve TPP1 and TPP2. The water treatment plant provides treated water supply for all Talimarjan Thermal Power Station's needs.</p> <p>In addition, the water treatment plant provides potable water to Nuriston.</p>	<p>No further water treatment facilities will be required for TPP2.</p>
<b>Sewage Treatment</b>	<p>A sewage treatment plant was constructed as part of TPP0 with sufficient capacity to serve TPP1 and TPP2.</p>	<p>No further sewage treatment facilities will be required for TPP2.</p> <p>As part of TPP2, some improvements have been included to the Water Treatment facility, to ensure that it continues to operate in a 'best practice' manner. These are discussed further under Section 7.0.</p>
<b>Power Evacuation</b>	<p>Power from TPP0 is evacuated via a 220 and 500 kV switchyard which was constructed in 2004 and 2015 accordingly.</p> <p>TPP1 is evacuated via the existing 220 and 500kV switchyard and transmission line. This development was financed by the World Bank, specifically in preparation of further development at Talimarjan Power Complex.</p> <p>A 500kV substation, to connect into the existing 500kV transmission line, has also been constructed as part of the TPP1 construction works.</p>	<p>Aside from dedicated transformers, TPP2 will only require 500m of new overhead line to connect into the existing substation. The route of these lines largely falls within the Talimarjan Power Complex land directly, or land within their control, and is clear of any settlements (being located very close to the power complex and within the Sanitary Protection Zone (SPZ) or environmentally significant features.</p>

## 2.3 'No Project'

The 'No Project' outcome – i.e. TPP2 does not proceed – would mean that there are no additional adverse impacts over and above the existing impacts of Talimarjan Thermal Power Station. However, the long-term benefits of the Project would also be lost, such as job creation and increased energy security. Importantly, the implementation of TPP2 will lower the average carbon intensity of Talimarjan Thermal Power Station, as well as install modern, flexible and comparatively clean power generation capacity.

The Project will contribute to the gradual reduction of older, less efficient capacity; that would otherwise be extended. Furthermore, were a different site to be selected, the commercial and environmental benefits of utilising the existing infrastructure at Talimarjan would be lost.

As such, it is determined that – subject to implementation of the ESIA mitigation and controls, as well as requirements of the Environmental & Social Action Plan (ESAP) – the Project benefits outweigh potential impacts.

## 2.4 Alternatives Analysis

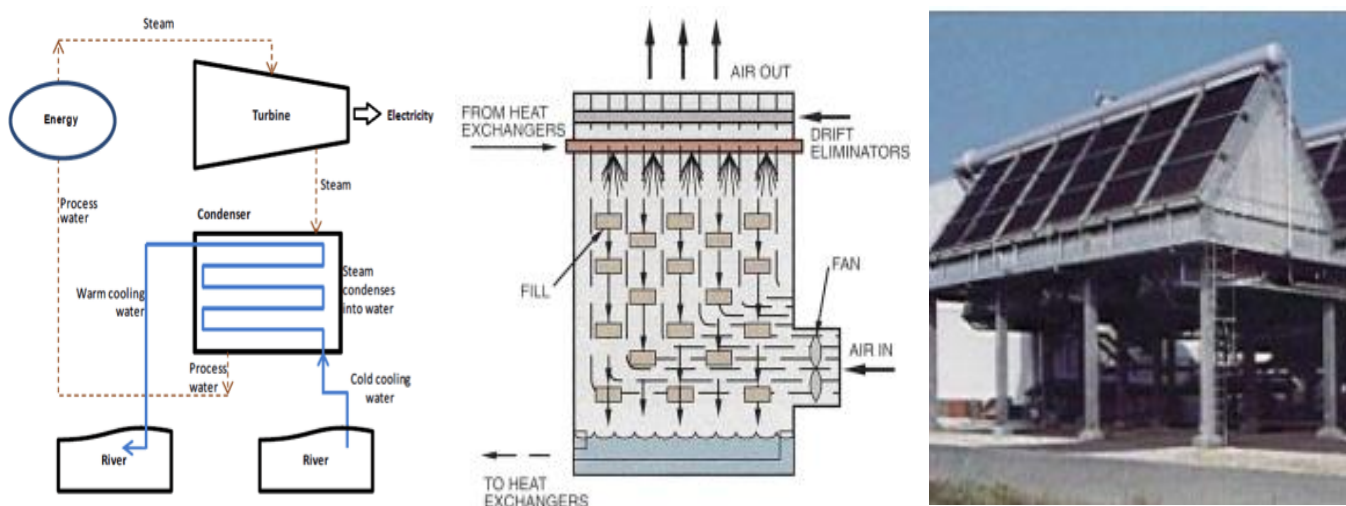
In terms of the configuration of TPP2, a number of alternatives have been considered, including: technology; gas turbine manufacturers; plant layout; and configuration. A full Feasibility Study is currently ongoing to identify and confirm the preferable solution which balances technical efficiency, operational risk; and environmental impacts.

### Cooling Methods: Ongoing Detailed Alternative Analysis

Cooling methods is a particularly key aspect of the alternative analysis. Water availability in Uzbekistan, and specifically in the area of relevance for the Project, is highly variable and relatively scarce, and as such, the Project's water demands are under close consideration and will be under analysis throughout the ongoing detailed design and tender stage discussions. Indicative water requirements and losses for each cooling method are shown under Table 3,

A range of cooling techniques were considered as part of the Project's feasibility studies. A summary of these options, including the advantages and disadvantages, are summarised under Table 3, overleaf. Of the available cooling methods, *Natural Draft Cooling Towers* and *Evaporative Sprays* are not considered suitable for the Project. Shortlisted cooling methods comprise: wet cooling methods; forced draft cooling towers; and air-cooled condensers. Examples of these methods are illustrated below:

**Figure 3: Illustrative Examples of Wet Cooling; Forced Draft Cooling Towers; and Air-Cooled Condenser Methods.**



**Wet Cooling Methods:** Schematic of a once-through cooling system abstracting cool water, and discharging warm water, into a river (such as the KMK).

**Forced Draft Cooling Tower:** Schematic representation of a forced draft tower with counter flow design (Reproduced from IPPC, *Reference Document on the Application of Best Available Techniques to Industrial Cooling Systems*, December 2001.)

**Air Cooled Condensers:** example of an air-cooled condenser of turbine exhaust steam. (Reproduced from IPPC, *Reference Document on the Application of Best Available Techniques to Industrial Cooling Systems*, December 2001.)

**A summary of the key cooling method alternatives is provided under Table 3, overleaf.**

**Table 3.** Summary of Cooling Options, Typical Water Requirements and Indicative Water Losses

Cooling Method	Advantages	Disadvantages	Typical Water Requirements <sup>1</sup> (m <sup>3</sup> /h/MW(th))	% Of Consumed Water that is Lost <sup>2</sup>	Technology Selected
<b>Wet Cooling Methods, including</b>					<p>X</p> <p><b>Subject to Detailed Feasibility Studies</b></p> <p>Majority of required OTC infrastructure is already installed.</p>
<b>Once-through Cooling (OTC)</b> (Abstraction from KMK and Discharge downstream in KMK)	<ul style="list-style-type: none"> <li>During periods when water availability is sufficient, and when ambient water temperatures are cool, OTC offers the highest efficiency.</li> <li>Minimal water losses, meaning that abstracted water is almost entirely returned to the watercourse.</li> <li>Relatively low energy requirement to operate pumps.</li> </ul>	<ul style="list-style-type: none"> <li>Susceptible to water security risk. OTC required relatively large volumes of water as compared to other methods. When there is insufficient water, OTC will not be able to operate.</li> <li>Susceptible to high ambient water temperature, which significantly reduces efficiency.</li> <li>Thermal discharge (i.e. release of warm water into receiving water body) needs to be carefully controlled and can further restrict acceptable periods of OTC operation.</li> </ul>	86	<1% <sup>4</sup>	
<b>Evaporative Cooling in Towers</b> (Enclosed spray system with fan driven air)	<ul style="list-style-type: none"> <li>More efficient than natural or forced draft cooling towers.</li> <li>Smaller installation, lower noise, lower energy requirement and lower capital cost requirement than Full Indirect Cooling.</li> </ul>	<ul style="list-style-type: none"> <li>Risk of plume formation, which can freeze in winter conditions (although this is typically a highly infrequent event, only occurs under very specific conditions e.g. low wind and low temperature, and can be mitigated by air-side freeze protection).</li> <li>Plume formation risk can be reduced through design and use of 'hybrid evaporative cooling towers'.</li> </ul>	1.5	45% <sup>4</sup>	
<b>Natural Draft Cooling Towers</b>	<ul style="list-style-type: none"> <li>Low ongoing operational and maintenance costs.</li> </ul>	<ul style="list-style-type: none"> <li>High capital costs.</li> <li>Additional factors include potential freezing of system, large footprint and visual impacts (the plume is visible).</li> </ul>	1.5	. Average c.4% (Range >1% - <8% dependent on ambient conditions)	



**Table 3.** Summary of Cooling Options, Typical Water Requirements and Indicative Water Losses

Cooling Method	Advantages	Disadvantages	Typical Water Requirements <sup>1</sup> (m <sup>3</sup> /h/MW(th))	% Of Consumed Water that is Lost <sup>2</sup>	Technology Selected
<b>Forced Draft Cooling Tower</b> (Closed-circuit Cooling Towers with Air Cooling Fans)	<ul style="list-style-type: none"> <li>No vapour plume, and therefore, no formation of ice during winter months.</li> <li>Minimal water losses.</li> <li>Preferable in areas of water restriction or heavily controlled water discharges.</li> </ul>	<ul style="list-style-type: none"> <li>Less effective cooling than other technologies requiring more load for the same amount of cooling output thus reducing overall plant efficiency and output under certain climatic conditions).</li> <li>Higher energy demand to drive fans, reducing net efficiency of plant.</li> <li>High capital cost.</li> <li>Relatively limited experience of this technique in Uzbekistan.</li> <li>Higher maintenance costs (repair of fans, blades and motors).</li> </ul>	1.5	Average c.3% (Range >1% - <6% dependent on ambient conditions)	X <b>Subject to Detailed Feasibility Studies</b>
<b>Evaporative / Atmospheric Sprays</b>	<ul style="list-style-type: none"> <li>Cost effective (where there is sufficient space).</li> </ul>	<ul style="list-style-type: none"> <li>Susceptible to high water loss due to pond leakage and evaporation during high temperatures.</li> <li>Limited space/capacity to accommodate TPP0, TPP1 and TPP2 on a cumulative demand basis.</li> </ul>	c.35	4% - 12% (Dependent on creating an appropriate reservoir)	
<b>Air Cooled Condensers (ACC)</b>	<ul style="list-style-type: none"> <li>Minimal water requirement / demand.</li> <li>Generally, and subject to detailed design, ACC can deliver comparable efficiency to evaporative cooling methods during periods of cold ambient air conditions (&lt;20°C).</li> </ul>	<ul style="list-style-type: none"> <li>Efficiency penalty during periods of high ambient air temperatures, with significant deterioration as compared to wet methods.</li> <li>High capital costs, particularly where the design is based on operation at conditions &gt;20°C.</li> <li>Large ACC configurations can result in high energy demands to operate fans, require a large footprint, and generate noise.</li> </ul>	0.02 <sup>3</sup>	<1% <sup>3</sup> (Process Water Losses Only)	X <b>Subject to Detailed Feasibility Studies</b>

**Notes:**

<sup>1</sup> Typical water requirements for different cooling systems reproduced from IPPC, *Reference Document on the Application of Best Available Techniques to Industrial Cooling Systems*, December 2001.; Table 3.3, pp. 72. For all cooling methods, the actual water requirements will be dependent upon the available water quality. Water requirements of 'Evaporative / Atmospheric Sprays' has been obtained from TPP1 ESIA, based on a daily water requirement of 120,000m<sup>3</sup>.

<sup>2</sup> Water loss occurs as a result of: *Process Losses* which are leakages within the steam circuit, and generally are <1% the water requirement; and *Evaporative Losses* which affects water cooling systems where some of the cooling water evaporates away, therefore, requiring further water to be abstracted.

<sup>3</sup> Although the water cooling requirements for ACC are '0' (since it is air cooled), the CCGT system will need to be filled with 'process water'. Process water leakages are typically <1%, and in many cases, <0.5%. In addition, 'make-up' water is required in order maintain the appropriate water chemistry in the system. This generally equates to 1.5% the requirement of Forced Draft Cooling Towers,

<sup>4</sup> Water losses have been taken from current Talimarjan Power Complex water balances – see Tables 7 & 8, herein.

However, after consideration of the advantages and disadvantages of each cooling option it is considered that there are **three potential cooling options** for the Project, all of which are potentially viable. These are listed under Table 4, below:

**Table 4. Summary of Cooling Options – Subject to Feasibility Study & Detailed Design**

Cooling Option	Indicative Relative Raking (1= Best; 3 = Worse)	
	Capital Costs	Water Sensitivity
<b>Cooling Option A: Wet Cooling Techniques</b> TPPO and TPPI both currently operate using wet cooling methods, a combination: <ul style="list-style-type: none"> <li>• <i>Once-through Cooling</i>: Abstraction from KMK during periods of high water availability, which is then discharged downstream into the KMK, with minimal water losses. This represents a high-efficiency cooling option; and</li> <li>• <i>Evaporative Cooling Towers</i>: During periods of relatively low water availability, or unsuitable ambient water conditions within the KMK (e.g. high ambient water temperature), cooling will be via the existing evaporative cooling towers, with make-up provided by Talimarjan Reservoir.</li> </ul>	1 <sup>A</sup>	3
<b>Cooling Option B: Forced Draft Cooling Towers</b> A solution which requires less water throughput than once-through cooling with the ability to operate in mixed climatic conditions. However, due to the number of fans required, together with the energy demand to drive the fans, this causes an adverse impact to plant net efficiency. The cooling technique is also less thermally efficient than once-through cooling.	2/3 <sup>B</sup>	2
<b>Cooling Option C: Air Cooled Condensers (ACCs)</b> With the exception of relatively small volumes of process water, the use of ACCs would effectively remove the Project's requirements for any cooling water, significantly insulating the Project from future potential water availability risk. However, ACCs will require a significant capital cost to construct, and indicatively, will be prone to power and efficiency losses when temperatures are materially above 20°C – unless excessive capital costs are incurred as a result of designing for >20°C.	2/3 <sup>B</sup>	1
<b>Notes:</b> <b>A</b> The required infrastructure, including the evaporative cooling towers, have already been installed at site. <b>B</b> Subject to the final design solution and tender proposals.		

The selection of the above cooling options will be subject to ongoing feasibility studies and detailed designs. Generally, the adoption of a particular cooling method will be subject to:

- capital costs;
- water demands;
- future availability and cost of water;
- ambient conditions (e.g. air temperature, humidity, wind and KMK water temperature) which can present particular impacts on the efficiency and performance of all cooling options)
- fuel costs; and
- associated environmental and social impacts of each cooling option.

It is noted that **combined solutions** have been chosen elsewhere, including Europe. A combined approach provides flexibility in balancing water and climate risk, whilst seeking the highest plant efficiency. The use of ACC would provide benefits in the long-term operations and remove the risk associated with future water availability.

Water availability, security and wet-cooling demands are discussed in greater detail under Section 4.5.

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## 2.5 Project Status

The project has undergone significant analysis and feasibility studies, including sector reviews; engineering design and cost estimates; economic and financial analysis; as well as Environmental and Social Impact Assessment. The mitigation identified within the ESIA has been factored into the Project in order to avoid impacts as far as possible; with minimisation, mitigation and management controls applied thereafter.

Draft bidding documents have been prepared and a 2-Stage International Bidding Process will be undertaken in order to procure a cost-competitive solution, to be delivered under an EPC (Engineering, Procurement and Construction) Contract. The outline parameters, including the ESIA mitigation of the Project, will be included within the Bidding Documents to enable the market to propose a modern and competitive design solution.

An indicative Project Implementation timeline is provided below:

- **Month 0**                      EPC Contract Approval
- **Month 6**                      Civil Works Commence
- **Month 36**                    TPP2 Unit 1 Commissioned
- **Month 42**                    TPP2 Unit 2 Commissioned

## 3 WHY IS DEVELOPMENT REQUIRED?

Uzbekistan is an energy intensive country. Investment in CCGT technology will assist Uzbekistan in transitioning to a low-carbon economy, whilst also providing a modern and responsive technology to help meet rising energy demand. In developed energy markets, the flexibility of CCGT has allowed more intermittent sources of power generation, particularly renewables, to be embedded within the generation mix. The selection of CCGT technology, over other technology such as conventional coal- and oil-fired plant, will result in a more efficient, and less carbon intensive, method of power generation.

In addition to meeting domestic power demands, Uzbekistan is actively involved in energy trading with neighbouring countries and is an active participant of the *Central Asia Regional Economic Cooperation* (CAREC). In 2008, the CAREC member countries defined their long-term strategy for developing the region's energy sector as "*to ensure energy security through the balanced development of the region's energy infrastructure and economic growth through energy trade*". The use of more efficient power generation plant, will reduce domestic gas consumption and make more gas available for export.

## 4 WHAT HAS CHANGED SINCE THE ORIGINAL ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT?

The Environmental and Social Impact Assessment for the project was produced in November 2017. Since this time, there have been numerous progressions and general developments of the project.

This section provides an update on this information. Further assessments will be undertaken as part of the agreed Environmental and Social Action Plan (ESAP) for the project, which has been fully updated alongside this project Non-Technical Summary (NTS).

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#### 4.1 Gas Turbine Technology & Performance Guarantees

At the time of the ESIA, it was proposed to use “Advanced F-Class” gas turbine technology, in parallel with an emissions guarantee for NO<sub>x</sub> of 51mg/Nm<sup>3</sup> – in line with the emissions guidelines set out by the World Bank Group<sup>4</sup>.

Since this time, it has been proposed that the Project will be tendered on the basis of achieving a NO<sub>x</sub> emissions performance of 30 – 40mg/Nm<sup>3</sup>.

Such an emissions performance would bring the Project into line with recently established and stricter European guidelines, comprising:

- **Daily Average Nitrogen Oxides (NO<sub>x</sub>):** 40mg/Nm<sup>3</sup>
- **Annual Average NO<sub>x</sub>:** 30mg/Nm<sup>3</sup>

The Bidding Documents will still require the use of “Advance F-Class” technology, since this is the best option for Uzbekistan, considering factors such as: spares strategy with other CCGT in-country; domestic operational experience and expertise built on F-Class CCGT technology; potential logistical constraints in transporting larger (H- and J-Class) technology; as well as general considerations on plant reliability and sensitivity. It is noted that F-Class is a current technology widely adopted throughout Western Europe and can achieve the above emission targets.

The reduction of NO<sub>x</sub> emissions will result in a reduction in predicted air quality impacts – which based on the previous 51mg/Nm<sup>3</sup> limit – were still demonstrated to be acceptable and in compliance in relation to European and World Health Organization (WHO) Ambient Air Quality Guidelines Values, as well as within Uzbek Ambient Air Quality Limits. The ESIA and studies undertaken by the ADB has not shown the area to be associated with degraded air quality and the emissions from the plant will not result in significantly adverse air quality impacts.

More notably, these performance guarantees would be the most stringent applied at Talimarjan Thermal Power Station.

#### 4.2 Analysis of Best Available Techniques (BAT)

BAT is a concept which requires that available techniques – i.e. technology and operational practices – are adopted to prevent, or minimise emissions or impacts on the environment. The European Commission produces *Best Available Technique Reference Documents* – or BREF Notes – which contain BAT conclusions for specific industries and define emission limits – referred to as ‘BAT AELs’ (BAT Associated Emission Limits).

New BAT conclusions for Large Combustion Plants (LCPs) – of which TPP2 falls under – were published in August 2017<sup>5</sup> and the accompanying revised BREF document was published in December 2017<sup>6</sup>.

A supplementary review of the Project against the recent BREF document has been undertaken and is provided under the Appendix (Section 12). In summary, subject to the reduction in NO<sub>x</sub> emission guarantees discussed under Section 4.1 above and finalization of a technical solution that maximizes electric generation and water usage efficiency, the Project is considered to materially reflect BAT, given the particular location and site characteristics.

Some of the design criteria forming part of the BAT Assessment are subject to the detailed design proposals during the Tender and final feasibility studies. However, by setting out key performance criteria – such as NO<sub>x</sub> Performance Guarantees and a Net Electrical Efficiency of ≥54% – the Contractor can provide the best complete solution to achieving BAT AEL compliance.

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<sup>4</sup> World Bank Group, *Environmental, Health, and Safety Guidelines: Thermal Power*, 19 December 2008. Table 6(B) *Emissions Guidelines (mg/Nm<sup>3</sup>) for Combustion Turbines*. Natural gas-fired turbines are advised to achieve 51mg/Nm<sup>3</sup> (or 25ppm) Nitrogen Oxides (NO<sub>x</sub>) (Dry Gas Excess O<sub>2</sub> Content 15%).

<sup>5</sup> Conclusions on Best Available Techniques (BATs) for Large Combustion Plants (LCPs), Commission Implementing Decision (EU) 2017/1442, 31 July 2017.

<sup>6</sup> Joint Research Centre (JRC) Science for Policy Report, *Best Available Techniques (BAT) Reference Document for Large Combustion Plants*, EUR 28836 EN, December 2017.

### 4.3 Carbon Intensity

The ESIA presents a Tier 1 Greenhouse Gas (GHG) Emissions Calculation. This assessment uses default emissions factors published by the IPCC<sup>7</sup>. There are three tiers of emissions calculation for energy projects ('Tier 1' to 'Tier 3'), with Tier 3 considered the most accurate.

Using a fuel specification of the Shurtan Gas<sup>8</sup>, it has since been possible to undertake a Tier 3 GHG Emissions Calculation. A summary of the TPP2 GHG Emission Estimates is provided below:

**Table 5. Summary of Tier 3 Greenhouse Gas (GHG) Emissions**

Phase	Capacity	Natural Gas Fuel Consumption (Nm <sup>3</sup> /yr)	Operating Hours (Annual)	Power Production (GWh)	GHG Emissions <sup>B</sup> (tCO <sub>2</sub> (eq))	Carbon Intensity (gCO <sub>2</sub> (eq)/kWh)
TPPO	800MW	1,621,813,000	7,335	5,868	3,178,442	542 (gross)
TPPI	900MW	1,278,750,000	6,500	6,860	2,506,104	365 (gross)
<b>TPP2</b>	<b>900MW</b>	<b>1,278,750,000<sup>A</sup></b>	<b>7,500<sup>A</sup></b>	<b>6,750<sup>B</sup></b>	<b>2,477,646</b>	<b>371 (net)</b>
<b>Notes:</b> <b>A</b> ADB (2017) Republic of Uzbekistan: Power Generation Efficiency Improvement Project (Second Talimarjan Power Project), ESIA. <b>B</b> Calculated – capacity multiplied by operating hours – as presented in ADB (2017) Republic of Uzbekistan: Power Generation Efficiency Improvement Project (Second Talimarjan Power Project), ESIA.						

In summary, the estimated GHG emissions of TPP2 are within the World Bank Group (2008) Net Carbon Intensity Guideline of 348 – 374gCO<sub>2</sub>(eq.)/kWh. In addition, the estimate is comparable with the current European Investment general guideline of 350gCO<sub>2</sub>(eq.)/kWh; and furthermore, significantly below the average carbon intensity of power production in Uzbekistan (536gCO<sub>2</sub>(eq.)/kWh<sup>9</sup>).

As the Project undergoes final design and feasibility analysis, it is possible that further opportunities will be discovered for improving plant efficiency and further reducing the carbon intensity of the plant.

### 4.4 Talimarjan Reservoir

The Project ESIA identifies Talimarjan Reservoir as an Important Bird Area (IBA). However, further assessment has since been completed on the potential impacts upon sociable lapwing *Vanellus gregarius* (IUCN Critically Endangered), which migrate across the region and have recently been discovered in internationally significant numbers at the Talimarjan Reservoir.

Potential impacts upon this species as a result of the Project include collision with additional cooling towers, scorching as a result of tower emissions, and barrier effects to movement resulting in increased energy expenditure to the birds as they migrate.

With this in mind, further surveys will be undertaken to ascertain the migratory behavior of this species (i.e. the migration routes that are taken, and the likely sensitivities associated with the Project), in order that any subsequent measures can be implemented to ameliorate potential impacts to this species.

Notwithstanding the above, the potential impacts of TPP2 – which will include 85m stacks – beyond those already established by TPPO (270m stacks, built in 2004), are considered likely to be minimal at this stage.

<sup>7</sup> Intergovernmental Panel on Climate Change (IPCC) (2006), National Greenhouse Gas Inventories

<sup>8</sup> Section B.5.2.4 of the ESIA provides an analysis of the fuel supply gas, dated 2007.

<sup>9</sup> UNFCCC (CDM) data is from 2011, and as such, the average carbon intensity is likely to have fallen (particularly given the recent developments at Navoi and Talimarjan TPPI). However, no recent data is available from UNFCCC, and therefore, the 2011 values have been provided for indicative purposes. Notwithstanding, TPP2 is likely to have a lower carbon intensity than the present average for Uzbekistan.



#### 4.5 Water Supply & Current Cooling Techniques at Talimarjan Power Complex

In summary, the water available to the site is abstracted from the Amu Darya River; transferred along the Karshi Pumping Cascade (KPC); and abstracted from the Karshi Main Canal (KMK). The KPC terminates at Talimarjan Reservoir, which was constructed to act as a water reserve that could be used to make up flows in KMK in times of shortage.

An indicative routing of the water, along the KPC, Talimarjan Reservoir, and KMK to the site, is illustrated under Figure 4, below, and Figure 5, overleaf. This representation incorporates improvements to the Once-through Cooling System that have been included within the TPP2 Project.

In terms of the agreements in place to convey water transboundary:

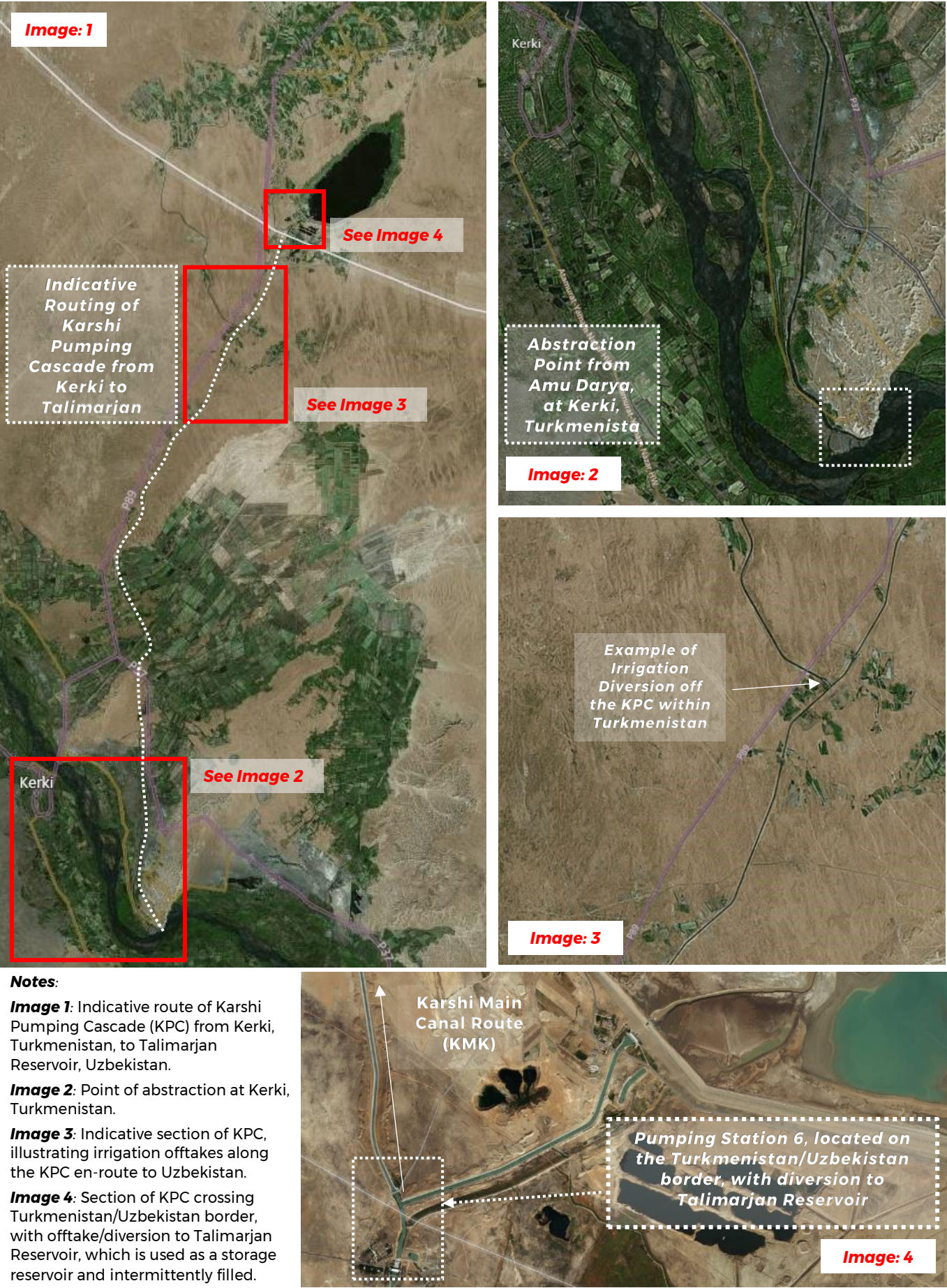
- **Amu Darya River - International Waterway:** The Amu Darya is an international waterway, involving Afghanistan, Tajikistan, Turkmenistan and Uzbekistan. All three countries have a water sharing agreement, with Uzbekistan and Turkmenistan equally sharing the flows measured at Kerki on the Amu Darya (just below Tajikistan).
- **Karshi Pumping Cascade - Land Access:** The Karshi Pumping Cascade (KPC) runs from its intake on the Amu Darya, in Turkmenistan, to Talimarjan Reservoir, in Uzbekistan. Along the KPC there are numerous Pumping Stations (PS); with PS6 located on the Turkmenistan / Uzbekistan border. The strip of land required for the intake, together with PS1 – PS6 cascade, is leased from Turkmenistan by Uzbekistan, under a Land Lease Agreement that was signed in April 1996. The Karshi Pumping Stations are powered exclusively by Talimarjan Power Station, using most of the power produced by TPP0.

**Figure 4: KMK and Talimarjan Thermal Power Station Once-through Cooling System**





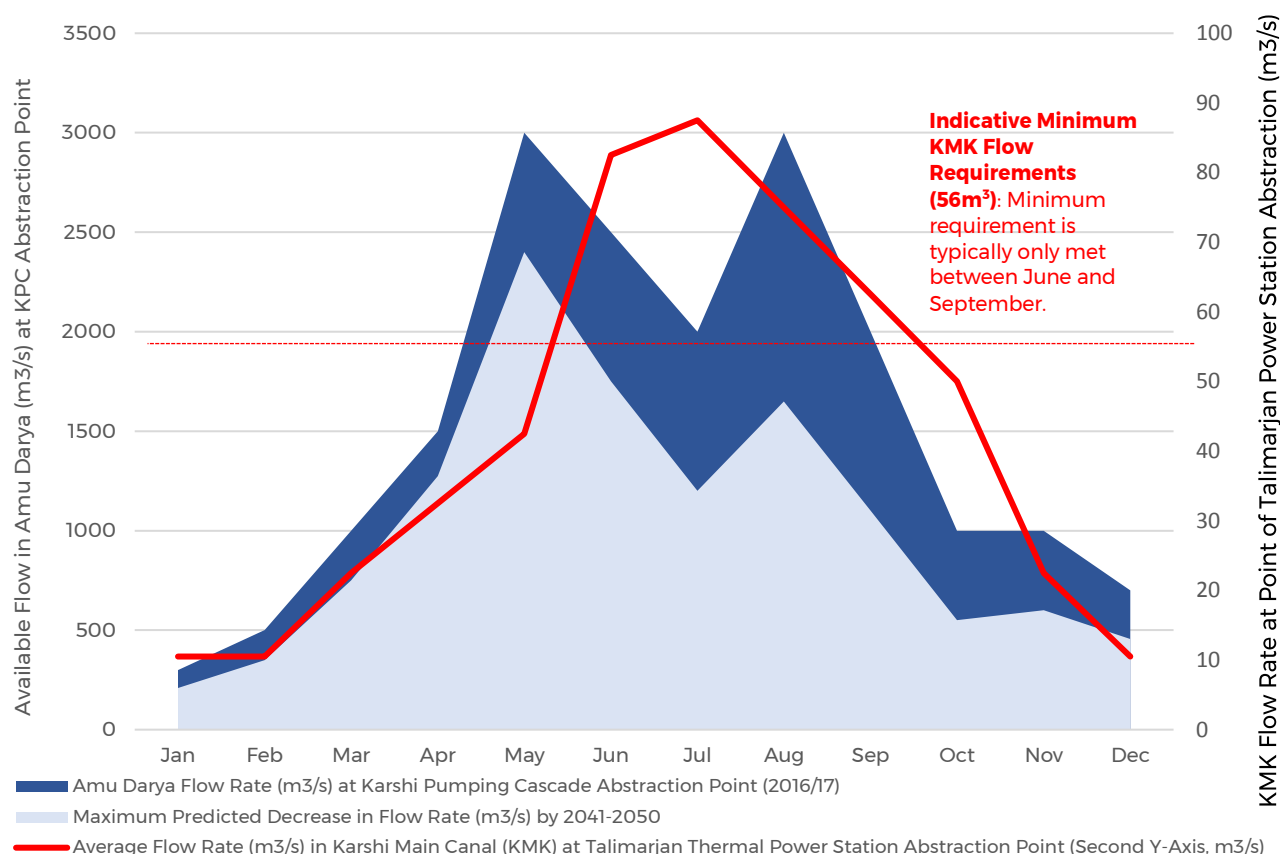
**Figure 5:** Indicative Routing of Karshi Pumping Cascade (KPC), Talimarjan Reservoir, Karshi Main Canal (KMK) and Talimarjan Thermal Power Station



The flows at the point of abstraction on the Amu Darya have been recorded during 2016/17. In addition, the flows have been recorded within the KMK, at the point of Talimarjan Thermal Power Station abstraction (2017). Between the Amu Darya and Talimarjan Thermal Power Station, there are a number of irrigation off-takers, in addition to periodical diverting of water to Talimarjan Reservoir. This results in a significant reduction of available flows at the point of abstraction by Talimarjan Thermal Power Station, from the KMK.

Furthermore, the potential impacts from climate change by 2041-2050 have also been screened<sup>10</sup>. A summary of the anticipated flow, climate change impacts, and Talimarjan Thermal Power Station requirements (as a % of available flow) is illustrated below<sup>11</sup>:

**Figure 6:** Indicative Flows Available on Amu Darya (2016/17), Potential Climate Change Impacts (2041 – 2050), and Available Water Flows at Talimarjan Power Complex Abstraction on KMK (2016/17)



In general, the following observations are made:

- **Amu Darya Flow Reduction:** Predictions of climate change impacts on flow indicate a maximum reduction of 45%, during August – October.
- **Available Flows at KMK Abstraction:** Generally <5% of the total available flows on the Amu Darya. Tabulated flows are provided below:

**Table 6.** Summary of KMK Flow Rate (m³/s) at Talimarjan Power Complex Abstraction Point

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
10.5	10.5	22.5	32.5	42.5	82.5	87.5	75	62.5 <sup>^</sup>	50	22.5	10.5
<sup>^</sup> See footnote 11.											

<sup>10</sup> Data based on ADB's Climate Change Screening report prepared for the Project and presented in the Project's ESIA.

<sup>11</sup> KMK flows data during September have been determined to be erroneous, and as such, a conservation estimate of 50m³/s has been substituted. Recommendations for further monitoring of the KMK are included within TPP2, and discussed under Section 7.0, herein.



## Current Cooling Techniques at Talimarjan Power Complex:

### Wet Cooling Methods – Once-through Cooling and Recirculated Cooling Methods

A summary of the water balance requirements of Talimarjan Thermal Power Station, in both once-through and re-circulated cooling modes, is provided under Table 7 and Table 8, below.

**Table 7: Water Balance for Once-through Cooling Mode**

	Water Use (m <sup>3</sup> /h)		Water Use (m <sup>3</sup> /s)
Intakes	Talimarjan Reservoir Pumping Station	3,9926	1.09
	KMK Abstraction: TPP2	56,400	15.66
	KMK Abstraction: TPP1	50,280	13.96
	KMK Abstraction: TPP0	90,945	25.26
<b>Total Intake</b>		<b>201,551</b>	<b>55.98</b>
<b>Total Losses (% of Intake)</b>		<b>911 (0.45%)</b>	<b>0.25 (0.45%)</b>
<b>Total Discharge (to KMK) (% of Intake)</b>		<b>200,640 (99.55%)</b>	<b>55.73 (99.55%)</b>

**Table 8: Water Balance for Re-circulation Cooling Mode**

	Water Use (m <sup>3</sup> /h)		Water Use (m <sup>3</sup> /s)
Intakes	Talimarjan Reservoir Pumping Station	8,621	2.39
	KMK Abstraction: TPP2	0	0
	KMK Abstraction: TPP1	0	0
	KMK Abstraction: TPP0	0	0
<b>Total Intake</b>		<b>8,621</b>	<b>2.39</b>
<b>Total Losses (% of Intake)</b>		<b>3,863 (44.81%)</b>	<b>1.07 (44.81%)</b>
<b>Total Discharge (to KMK)</b>		<b>4,758</b>	<b>1.32</b>

During the course of the project preparation studies of TPP2, a number of water savings have been identified by the Technical Due Diligence. The Environmental & Social Action Plan (ESAP) includes a requirement to implement all feasible water savings, and undertake renewed water auditing and savings identification on an annual basis. The objective is that the total losses, under once-through (0.45%) and re-circulated (44.81%) cooling modes, can be further improved.

As can be seen from Figure 6 and Table 6 - based on current water balances and water availability - during the majority of the year, Talimarjan Power Complex will be unable to operate entirely using once-through cooling. In fact, Table 6 indicates that once-through cooling of the entire Talimarjan Power Complex could only occur during June – September; providing that the ambient water temperature and thermal discharge impacts are acceptable.

Talimarjan Thermal Power Station can operate TPP0, TPP1 and TPP2 units in different modes, allowing a flexible response to water conditions, whilst at the same time, maximising overall station efficiency.

The decision on whether which cooling method to adopt will be based on a combination of three factors:

- **Abstraction Permit Restrictions:** The current permit limits abstraction to <31.4m<sup>3</sup>/s during June – September – which would necessitate a hybrid cooling operation (since the once-through cooling demand for Talimarjan Thermal Power Station is 56m<sup>3</sup>/s). A renewed permit will be required, and any such volume or period restraints must be complied with. In relation to re-circulated cooling, Talimarjan Thermal Power Station hold a permit for up to 10m<sup>3</sup>/s abstracted from Talimarjan Reservoir (only 2.39m<sup>3</sup>/s is required for re-circulated cooling of the whole site).
- **Available Flows at KMK Abstraction:** Generally <5% of the total available flows on the Amu Darya. Often, the available flows within the KMK do not meet the required flows for once-through operation (e.g. January - April). This will necessitate either a combination of units, if not all units, operating on a re-circulated cooling method basis, for significant periods of the year.

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- **Ambient Water Temperature in KMK:** During period of warmer water in the KMK, once-through cooling will not be possible due to the impact of thermal discharge back into the KMK. Ambient water temperature upstream, water temperature in the mixing zone, and ambient temperature 100m downstream of the discharge point, will all be monitored on a continuous real-time basis to ensure that thermal impacts remain within the permitted thresholds.

These factors will be carefully monitored by Talimarjan Thermal Power Station management, in order to ensure that the plant's water use remains within the acceptance criteria.

**Alternative Cooling Methods Proposed under the Project:**  
**Forced Draft Cooling & Air-Cooled Condensers (ACCs)**

In light of the water availability constraints, and taking into account the fact that the efficiency gains from wet cooling may only be realised (on a site wide basis) for c.4 months of the year, alternative cooling methods are currently being examined under detailed feasibility studies.

Providing that the efficiency penalties of alternative methods can be justified against the actual realized gains of wet cooling (taking into account the large periods of the year where once-through cooling will not be possible), the Project preference will be for the use of a method that reduces water demands; such as *Forced Draft Cooling Towers* or *Air-Cooled Condensers*.

For illustrative purposes, assuming the use of ACC for the entire Talimarjan Power Complex, the site wide water demand under normal conditions is likely to be  $<0.25\text{m}^3/\text{s}^{12}$  (exact requirements to be determined via ongoing feasibility studies and design). For comparison purposes this would represent a >99% reduction of water demand as compared to once-through cooling method; and c.89% saving as compared to re-circulated cooling.

## 5 WHAT IS THE BENEFIT OF THE PROJECT TO THE LOCAL PEOPLE AND THE ECONOMY?

### 5.1 Construction Phase Employment

During the construction phase, a peak workforce of 800 has been estimated. It is anticipated that these positions will comprise.

- **Skilled Labour:** 58%
- **Semi-skilled Labour:** 20%
- **Unskilled Labour:** 22%

During previous phases of development at Talimarjan Power Complex, the skills base of the local population from neighbouring settlements was significantly upgraded through the interaction with foreign workforce and various capacity building efforts delivered by the Contractor. The project will benefit from the upgraded skills base of local communities by involving them to semi-skilled and skilled roles during the construction period and will help further build up the specialised knowledge locally.

### 5.2 Operational Phase Employment

During the operation phase, the plant will run 24 hours a day, 7 days a week, throughout the duration of the Project's lifetime (25 – 30 years). As the plant will operate 24 hours a day, three full-time shifts will be required. In terms of the skills requirement for the 75 permanent site employees, these are anticipated to comprise:

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<sup>12</sup> The current water losses during once-through cooling are  $0.25\text{m}^3/\text{s}$  (see Table 7, herein). As an indication, this represents the maximum water loss associated with the power plant processes under normal circumstances. Small volumes of water losses will still be incurred as 'boiler blowdown' to prevent salt concentration in the process water.



- **Skilled Labour:** 65 - 70%
- **Semi-skilled Labour:** 15 - 20%
- **Unskilled Labour:** 10 - 15%

Due to the long-term nature of these positions, it is anticipated that they will be filled by the nationals of Uzbekistan. Unskilled labour is likely to be recruited locally.

### 5.3 Indirect Employment & Economic Benefits

Indirect opportunities during the construction period are largely limited to the services and hospitality sector, such as accommodation, catering, cleaning, transport and security services. Local businesses may benefit during the construction phase as there will be increased spending within the area by the waged labour who will have relatively improved buying power.

Indirect opportunities during the operational period will be centred around maintenance activities, and providing goods and services to the Project. For those companies that meet eligibility criteria, they will be 'Approved Suppliers' and entered into the supply chain. This will provide a secure long-term business relationship and an opportunity for local business growth and development.

### 5.4 Labour and Working Conditions during Construction

As there will be large numbers of workers required for construction, special care needs to be exercised to ensure adequate working conditions for both direct and indirect workers. Table 9 below summarizes key areas of potential concern and proposed mitigation measures:

**Table 9: Labour and Working Conditions during Construction Phase**

Aspect	Potential Concern	Proposed Mitigation Measures
<b>Workers accommodation</b>	<p>Considering a large number of workers that will be required during construction peak times, involving both local and foreign workforce, safety and well being of workers at the accommodation camps may potentially be a source of concern. This might include, among others:</p> <ul style="list-style-type: none"> <li>▪ Inadequate welfare facilities</li> <li>▪ Inadequate supply and quality of potable water</li> <li>▪ Inadequate provision of medical examination, first aid and emergency facilities</li> <li>▪ Inadequate conditions of rooms and dormitories facilities.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Workers accommodation facilities to be installed to meet regulations and Workers' accommodation: processes and standards; A guidance note by IFC and the EBRD, September 2009).</li> <li>▪ Contractors and sub-contractors will be required to carry out internal inspections on the accommodation using checklist included in Annex I of the IFC and EBRD guidance note on workers accommodation, and report their findings to the Supervising Consultant.</li> <li>▪ Accommodation camps will be subject to quarterly audits by the Supervising Consultant, and results of audits to be included into the Environmental Monitoring Reports.</li> <li>▪ All workers will have an easy access to the grievance mechanism, allowing for anonymous grievances.</li> </ul>
<b>Labour and working conditions</b>	<p>The project is going to have a complex contracting chains, with multiple sub-contractors and suppliers, including significant number of indirect workers .</p>	<ul style="list-style-type: none"> <li>▪ Contractors and sub-contractors will be required to develop Site Specific Contractor Management Plan, to include Human Resource Policy and relevant procedures for a construction phase to explicitly address the following aspects: <ul style="list-style-type: none"> <li>▪ Working conditions;</li> <li>▪ Terms of employment;</li> <li>▪ Informing workers about their rights and obligations;</li> <li>▪ Child Labour;</li> <li>▪ Forced labour;</li> <li>▪ Equal Opportunities/non-discrimination;</li> <li>▪ Workers organisations;</li> <li>▪ Workers Accommodation, Regulations and</li> </ul> </li> </ul>

Aspect	Potential Concern	Proposed Mitigation Measures
		<p>application of EBRD and IFC Guidance Note, <i>Workers' Accommodation: Processes and Standards</i>, September 2009; and</p> <ul style="list-style-type: none"> <li>Occupational Health and Safety.</li> <li>All workers will have an easy access to the grievance mechanism, allowing for anonymous grievances.</li> <li>An Independent Consultant will carry out Contractor Risk Assessments to evaluate their performance against the requirements of National Legislation, SSEMP, EBRD PR2, and Contractors' own Employment Policy Documents.</li> <li>Project Management Unit and Supervision Consultant will assist in implementing any corrective actions required, as identified by the Contractor Risk Assessments.</li> </ul>

### 5.5 Labour and Working Condition during operation

Current labour and working management practices at Talimarjan Power Complex (TPC) are largely in compliance with the EBRD PR2, and similar arrangements are expected to be in place for TPP2 operation. Among others there is a Trade Union registered within TPC, and 100% of TPC employees are members of the trade union. A collective bargaining agreement is developed, and is valid from 2017 until 2019. The document provides detailed information about employee's rights and obligations. In Uzbekistan, a trade union plays an important role in protecting employees' rights.

However, a formalised grievance mechanism, allowing for anonymous complaints, accessible for all workers on the operational site will need to be developed and implemented by the TPP Human Resource department.

## 6 POTENTIAL ADVERSE SOCIO-ECONOMIC IMPACTS OF THE PROJECT

### 6.1 Land Acquisition & Involuntary Resettlement

Talimarjan Thermal Power Station has been sized to accommodate further development, and the selection of this site for TPP2 means that no additional land acquisition, or resettlement, is required.

### 6.2 Social Interaction & Community Health and Safety

The presence of the Project could affect the health, safety and security of the communities in the area of influence as a result of worker-community interactions, in-migration to the area, increased incomes in the local community that may be used for drugs, alcohol and prostitution, the risk of injury associated with construction and operational activities, increased pressure on health care resources and changes to the environment.

Potential social adverse impacts due to the proposed construction and the key areas of mitigation are presented overleaf:

**Table 10.** Environmental Impact Summary & Key Mitigation

Social Impact	Impact Overview	Summary of Mitigation Measures
<b>Workforce, Jobseekers and Social Conflict.</b>	<p><b>Construction Impact</b> Workers from other regions, or other countries may be employed by the EPC Contractor. This could lead to social tensions and potential conflict if these workers are not aware of local customs and practices. An increase in disposable income within the Project area (among Project workers, both local and external) may also result in a change in spending habits and behavior resulting in increase in alcohol and drug abuse, increased incidences of prostitution and casual sexual relations, which poses a threat to community health and safety.</p> <p><b>Operational Impact</b> During the operational phase around 75 people will be employed on the Project. This low number of staff will not create significant social conflict with locals.</p>	<ul style="list-style-type: none"> <li>Regular health and safety training to the construction workers which will include sessions on social and cultural awareness.</li> <li>HIV/AIDS policy and information document for all workers directly related to the Project.</li> <li>An induction programme for all workers related to the Project, including a Code of Conduct.</li> </ul>
<b>Pressure on Social Infrastructure and Services</b>	<p><b>Construction Impact</b> During the construction phase workers will be accommodated on-site and as such there will be no pressure on local housing stock. In addition, the EPC Contractor will also have his own on-site medical facilities. Any serious injuries will be treated in Karshi.</p>	Not applicable
<b>Road Safety</b>	<p><b>Construction Impact</b> Construction of TPP2 will require a large amount of vehicle movements, locally and nationally. These may result in a slight increase in the total number of road traffic accidents between vehicles, pedestrians and vehicles (especially in the areas close to schools and colleges) and livestock and vehicles</p>	<ul style="list-style-type: none"> <li>A traffic management plan (TMP) for the construction phase of the Project. The TMP will include specific conditions for traffic management around Nuriston.</li> </ul>
<b>Air Quality and Noise</b>	See section 7 below.	<ul style="list-style-type: none"> <li>Please see section 7 below.</li> </ul>

## 7 WHAT WILL BE THE KEY ENVIRONMENTAL IMPACTS OF THE PROJECT AND HOW WILL THEY BE MITIGATED?

The potential impacts of the project and the key areas of mitigation are presented overleaf:

**Table 11. Environmental Impact Summary & Key Mitigation**

Environmental Impact	Impact Overview	Summary of Mitigation Measures
<b>Climate Change</b>	The Project will result in the emissions of Greenhouse Gases (GHG), and also, will be subject to water availability risks that are projected to result in lower flows within the Amu Darya River.	<ul style="list-style-type: none"> <li>▪ <b>Minimisation of GHG Emissions</b> through the use of efficient and modern CCGT technology. The projected carbon intensity (371gCO<sub>2</sub>(eq)/kWh) is within World Bank Group guidelines for new CCGT, and also, is comparable to the general target of 350gCO<sub>2</sub>(eq)/kWh within European markets.</li> <li>▪ <b>Hybrid Cooling or Dry Cooling Methods</b>, will allow the Project to respond to variable water availability and significantly reduce demand as needed.</li> <li>▪ <b>Water Efficiency Savings</b> have been identified as part of the feasibility analysis of TPP2. These savings will be implemented where feasible, and reviewed annually if not.</li> <li>▪ <b>Water Auditing</b> will be completed across the entire Talimarjan Thermal Power Station, on an annual basis, to identify new potential savings on an integrated basis..</li> </ul>
<b>Air Quality</b>	<p><b>Operational Impact</b></p> <p>The long term (operational) impacts of TPP2 have been assessed using numerical modelling and risk assessment against European and Uzbek Ambient Air Quality Guidelines (whichever is most stringent).</p> <p>Overall, the impact of the Project, on a standalone basis, and also, in cumulation with existing baseline quality, TPP0 and TPP1, has been found to be acceptable.</p> <p>Furthermore, the air quality impacts are based on the adoption of a NO<sub>x</sub> 51mg/Nm<sup>3</sup> emission limit, and therefore, do not reflect the improvements due to the adoption of a more stringent emission limit (see Section 4.1 for details).</p> <p><b>Construction Impact</b></p> <p>Construction period has the potential to generate short term impacts, particularly the generation of dust.</p>	<ul style="list-style-type: none"> <li>▪ <b>Continuous monitoring of ambient air quality at two monitoring locations.</b> This data will be used to better determine ambient air quality, including CO, SO<sub>2</sub> and benzene – three potential contaminants identified under the Health Impact Assessment. Please note that these contaminants will not be significantly produced by TPP2, and therefore, monitoring data is for the purposes of developing a wider understanding of local air quality.</li> <li>▪ <b>Establish a Meteorological Station</b> in order to allow refinement of any future air impact assessments.</li> <li>▪ <b>Air Quality Management Plans</b> to be prepared across construction and operational phases, to describe air quality limits and detail methods to minimise impacts.</li> <li>▪ <b>Continuous Emissions Monitoring System (CEMS)</b> will be installed on TPP2. CEMS is already equipped on TPP0 and TPP1. CEMS will allow instantaneous measurement of the primary pollutants of concern, as well as other exhaust parameters, in order to ensure that the plant operation remains within accepted criteria.</li> <li>▪ <b>Health Impact Monitoring Programme</b> will be implemented as described under the Health Impact Assessment, presented in the Project ESIA.</li> </ul>
<b>Noise and Vibration</b>	<p><b>Operational Impact</b></p> <p>The long term (operational) impacts of TPP2 have been assessed using a numerical model and indicated that noise impacts will be within acceptable standards.</p> <p>In relation to vibration, operational vibration from TPP2 would be mitigated at source and that there would be no impact.</p> <p><b>Construction Impact</b></p> <p>Noise will be generated by plant movement and general construction activities.</p>	<ul style="list-style-type: none"> <li>▪ <b>Baseline Noise Monitoring</b> will be conducted to augment the current noise baseline data and further refine an analysis of potential noise impacts.</li> <li>▪ <b>Noise Impact Assessment</b> will be conducted should there be any material design change as a result of the EPC Tender and noise ratings of the main plant.</li> <li>▪ <b>Construction Noise Management Plan</b> will be prepared by the EPC Contractor and implemented throughout the construction period of TPP2. This will include all mitigation measures identified in the ESIA.</li> <li>▪ <b>Operational Noise Management Plan</b> will be prepared by Uzbekenergo, including a routine noise monitoring programme, to demonstrate that operational noise impacts remain within allowable thresholds.</li> </ul>

Environmental Impact	Impact Overview	Summary of Mitigation Measures
<b>Water Resources</b>	<p>TPP2 will require additional water intakes from the KMK, in order to provide additional water during once-through cooling.</p> <p>During once-through cooling water will be abstracted and returned to the KMK, at minimum losses (0.45%). However, warmer water will be discharged into the KMK, potentially resulting in thermal pollution.</p> <p>During recirculated cooling, water demands are significantly less, with water sourced from KMK. However, water losses are higher than during once-through cooling (44.81% as compared to 0.45%).</p>	<ul style="list-style-type: none"> <li>▪ <b>TPP2 Pumps</b> will be constructed to limit intake velocities to &lt;0.15m/s and be fitted with a 9.5mm mesh – to reduce risk to fish during abstraction.</li> <li>▪ <b>Continuous monitoring of and ambient water temperature</b> at a range of locations within the KMK, to monitor – in real time – impacts from once-through cooling. This data will be used to ensure that once-through operation only occurs within pre-defined parameters that will not result in excessive thermal pollution.</li> <li>▪ <b>Water Savings</b> have already been identified as part of the feasibility analysis of TPP2, and there will be implemented where feasible to further reduce the water consumption of Talimarjan Thermal Power Station.</li> <li>▪ <b>Water Auditing</b> will be conducted annually in order to identify further savings.</li> </ul>
<b>Wastewater Management</b>	The main impact will result from the discharge from the (existing) sewage treatment plant.	<ul style="list-style-type: none"> <li>▪ <b>Effluent Monitoring</b> to be expanded to include a wider range of parameters and monitoring undertaken on a monthly basis to demonstrate compliance.</li> <li>▪ <b>Rehabilitation of Concrete Drying Pit</b> will be completed as part of TPP2 works, in order to reduce any leakage and potential impacts to underlying ground quality.</li> </ul>
<b>Geology and Land</b>	No key impact area will be present, though controls need to be in place, particularly during construction.	<ul style="list-style-type: none"> <li>▪ <b>Spill Response Plan</b> to be prepared and implemented by the EPC Contractor.</li> <li>▪ <b>Bulk Oil Containment</b> during operation to follow best practices, including bunding / containment.</li> </ul>
<b>Ecosystems and Flora &amp; Fauna</b>	The water will abstract, and discharge, water from the KMK. In addition, Talimarjan Reservoir is an Important Bird and Biodiversity Area (IBA), and habitat to sociable lapwing <i>Vanellus gregarius</i> (IUCN Critically Endangered).	<ul style="list-style-type: none"> <li>▪ <b>Further bird surveys</b> will be undertaken to ascertain the migratory behavior of this species (i.e. the migration routes that are taken, and the likely sensitivities associated with the Project), in order that any subsequent measures can be implemented to ameliorate potential impacts to this species.</li> </ul>
<b>Geohazards / Seismic</b>	The general project area is seismically active.	The engineering detailed design will take account of the Seismic risks in the area.
<b>Waste Management</b>	Waste materials will be generated during construction, mainly excavation waste. Very low levels of waste will be generated during operation.	<ul style="list-style-type: none"> <li>▪ <b>Waste Management Plan</b> to be developed during construction and operational phases. The plan will include measures for the reduction and reuse of waste as a priority, and also, detail methods for the safe storage of wastes.</li> <li>▪ <b>Licensed Facilities</b> will be used for all waste generated by TPP2 construction.</li> </ul>
<b>Cultural Resources</b>	The impact on cultural resources is expected to be minimal, though precautionary mitigation is required.	<ul style="list-style-type: none"> <li>▪ <b>Chance Find Procedure</b> to be developed and implemented by the EPC Contractor throughout construction works.</li> </ul>
<b>Visual and Landscape</b>	TPP2 will be located within Talimarjan Thermal Power Station, and largely fall within the existing footprint and parameters. It is noted that TPP0 stack is 270m high (TPP1 and TPP2 stack heights are 85m high).	No particular mitigation required.



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## 8 WILL THE PROJECT RESULT IN ANY TRANSBOUNDARY ENVIRONMENTAL IMPACTS?

The Project is located c.25km from the Turkmenistan Border, and as such, the Environmental and Social Impact Assessment has had to carefully consider the range of impacts, and determine whether transboundary impact will occur. There are two potential transboundary environmental impacts for the Project, each of which are discussed below:

- **Air Impacts:** The impacts from TPP2 will not result in significant ambient air quality impacts across Uzbekistan's borders. This has been demonstrated by numerical modelling following Good Industry International Practice.
- **Water Impacts:** A legal agreement is in place between Uzbekistan and Turkmenistan, describing the water allocation available to Uzbekistan via the Karshi Pumping Cascade (KPC). The operation of the KPC, together with the allocation of water, is under the control of a separate Uzbek Ministry, and therefore, not under the direct control of the Project. The Project will not result in water abstractions from Turkmenistan that exceed the pre-established water sharing arrangements of Uzbekistan and Turkmenistan.

In conclusion, the Project will not result in any significant transboundary environmental impacts and will not trigger ESPOO Convention Criteria.

## 9 HOW WILL THE PROJECT ENSURE EFFECTIVE MANAGEMENT AND MONITORING OF IMPACTS?

Uzbekenergo has produced an *Environmental and Social Management and Monitoring Plan* (ESMMP) for the project and will maintain a close supervision of Contractors to ensure compliance against these plans, and the general requirements of the ESIA. These documents will be maintained as a live document. Furthermore, the detailed design and the construction contractors will be required to fully implement the requirements of the ESIA, the ESMMP and the ESAP, and audits will be undertaken to ensure that these requirements are fully implemented.

## 10 STAKEHOLDER ENGAGEMENT PLAN (SEP)

A Stakeholder Engagement Plan (SEP) has been developed with the objective of identifying key stakeholders and ensuring that, where relevant, they are informed in a timely manner of the potential impacts of projects. The SEP also identifies a formal grievance mechanism to be used by stakeholders (internal and external) for dealing with complaints, concerns, queries and comments. It will be reviewed and updated on a regular basis. If activities change or new activities relating to stakeholder engagement commence, the SEP will be brought up to date. It will also be reviewed periodically during project implementation and updated as necessary. The SEP includes the following:

- Public consultations and information disclosure requirements;
- Identification of stakeholders and other affected parties;
- Overview of previous engagement activities;

- 
- Stakeholder Engagement Programme (SEP) including methods of engagement and resources; and a
  - Grievance mechanism.

Stakeholders could be individuals and organisations that may be directly or indirectly affected by the project either in a positive or negative way, who wish to express their views.

## 11 FURTHER INFORMATION

Contact information for this project is provided below:

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Copies of the Environmental and Social Impact Assessment will be publicly available at the above address, in addition to the web addresses detailed under Section 1.0, herein.

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# APPENDIX 1:

## 12 ANALYSIS OF BEST AVAILABLE TECHNIQUES

### 12.1 Introduction

Investment in TPP2 by the EBRD requires that the CCGT complies with BAT where possible. EBRD will not be re-financing TPP0 nor TPP1, and therefore, neither of these phases of TPC are required to meet BAT requirements.

TPP2 falls under the scope of the EU Industrial Emissions Directive (IED)<sup>13</sup>, Annex I, as follows:

#### 1. Energy Industries

1.1 *Combustion of fuels in installations with a total rated thermal input of 50MW or more.*

TPP2 CCGT actively comprises a Large Combustion Plant (LCP), which is defined in Article 28 of the IED as “any combustion plant with a total rated thermal input which is equal to or greater than 50MW, irrespective of the type of fuel used”. There are a number of exclusions from the scope of LCP, such as gas turbines and engines used on offshore platforms; however, no such exclusion applies to TPP2.

The IED defines minimum requirements for LCP under the special provisions laid down in Chapter III and mandatory maximum Emission Limit Values (ELVs) in Annex V, noting that BAT requirements may lead to the application of lower ELVs than these mandatory ELVs. Mandatory ELVs cannot be exceeded even if a site specific assessment can be used to justify emission levels higher than BAT.

BAT requires that available techniques – i.e. technology and operational practices – are adopted to prevent, or minimise emissions or impacts on the environment. The European Commission produces Best Available Technique Reference Documents – or BREF Notes – which contain BAT conclusions for specific industries and define emission limits associated with BAT AELs (BAT Associated Emission Limits). New BAT conclusions for LCP were published in July 2017<sup>14</sup> and the accompanying revised BREF document was published in December 2017<sup>15</sup>.

The key issues for the implementation of IED LCP using gaseous fuels are:

- Emissions to Air; and
- Energy Efficiency.

### 12.2 Technology Selection

The Project Documentation presents a number of discussions on technology selection, ranging from turbines, cooling method and plant configuration. The key design decisions, BAT recommendations, and justification/commentary are summarised overleaf.

**Overall, the choice of technology to be justified and reasonable, taking into account the country-specific constraints, demands and power sector experience.**

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<sup>13</sup> The Industrial Emissions Directive (‘IED’), 2010/75/EU.

<sup>14</sup> Conclusions on Best Available Techniques (BATs) for Large Combustion Plants (LCPs), Commission Implementing Decision (EU) 2017/1442, 31 July 2017.

<sup>15</sup> Joint Research Centre (JRC) Science for Policy Report, *Best Available Techniques (BAT) Reference Document for Large Combustion Plants*, EUR 28836 EN, December 2017

**Table 12 – TPP2 Technology Selection & BAT Compliance**

Characteristic	Design Rationale	BAT?	Comment
<b>Technology Selection</b> Advanced 'F-Class' Combined Cycle Gas Turbine (CCGT)	<p>Although 'F-Class' technology has been on the market for 20+ years; it has undergone numerous model improvements and is still viewed as an 'advanced choice'. The use of G-, H- and J-Class models are not appropriate given the lack of proven operational experience outside industrialised nations and lack of support for these advanced technologies from the equipment suppliers to the region.</p> <p>The ESIA sets out numerous justifications for the use of F-Class technology, including: <b>sizing; transmission line capacity; fuel usage;</b> and <b>heavy equipment transportation restrictions</b>. In addition, from WSP's site visit discussions, there are also two critical operational factors to consider:</p> <ul style="list-style-type: none"> <li>• <b>Operative Experience:</b> The installation of F-Class as part of TPP1 makes the selection of F-Class technology for TPP2 sensible. More generally, the use of F-Class technology at other plant nationally, such as Navoi Power Plan (which also uses Mitsubishi F-Class GTs<sup>16</sup>), means that Uzbekistan's has a pool of skilled and experienced staff with the capability of operating the equipment, compared to alternative technologies.</li> <li>• <b>Spares Strategy:</b> Given the existing operation of F-Class turbines within Uzbekistan, it can be considered that there is a spares capability in country to support and maintain F class technology, as opposed to more advanced G-, H- and J-Class technology.</li> </ul>	Yes	<p>An equipment supplier (OEM) has yet to be identified; however, the design is based on recent F-Class technology. For comparative purposes<sup>17</sup>, TPP1 utilises Mitsubishi F701F4 for 50Hz application, which also benefits from the low NO<sub>x</sub> technology used in their G-class fleet.</p> <p>It is noted that Mitsubishi has since introduced the F701F5 model, and it is possible that TPP2 will benefit from this latest iteration of the F701 model. In either case, there is little material difference in environmental performance of F701 models.</p> <p><b>F-class technology, and CCGT generally, is proven, reliable and performs favourably with regards to efficiency.</b> In the context of Uzbekistan and the available technology options considered, CCGT can be considered BAT.</p>

<sup>16</sup> Mitsubishi Heavy Industries (MHI) Press Information, *MHI Receives Order for GTCC Power Generation System for Cogeneration Power Plant in Uzbekistan*, No. 1321, 18 November 2009, [www.mhi.com](http://www.mhi.com) (2018).

<sup>17</sup> Please note that as the Tender for TPP2 has yet to be completed, it remains to be seen who will be the OEM (i.e. manufacturer) of the Gas Turbines .

**Table 12 – TPP2 Technology Selection & BAT Compliance**

Characteristic	Design Rationale	BAT?	Comment
<b>Power Block Configuration</b> Single Axis 1 GT + 1 HRSG + 1 ST on Separate Shafts	<p>The ESIA provides a review of configuration options, comprising:</p> <ul style="list-style-type: none"> <li>• <b>Single Shaft:</b> The GT and ST are connected via a solid shaft, or through a Synchro-Self-Shifting (SSS) clutch, to a common generator.</li> <li>• <b>Multi-Shaft (1-on-1):</b> The GT and ST have their own dedicated generators, and are often installed in separate buildings.</li> <li>• <b>Multi-Shaft (2-on-1):</b> Each GT has its own dedicated HRSG, which raise steam for use in a common ST.</li> </ul>	N/A (No specific BAT criteria on configuration)	<p><b>The current design has not fixed the configuration, in order to provide flexibility during the EPC Tender and Detailed Design. WSP concur that this is a reasonable approach, in order to permit OEMs to best configure the plant to their equipment specification, site conditions and performance requirements.</b></p> <p>Notwithstanding, a multi-shaft (1-on-1) configuration – as is the case for TPP1 – is considered likely. If this is the case, such a configuration would present a reasonable compromise between:</p> <ul style="list-style-type: none"> <li>• Reliability and operational flexibility (if allowing a by-pass option and OCGT operation in the event of a steam turbine failure); against</li> <li>• the slightly better full-load efficiency and HRSG economies of a 2-on-1 multi-shaft configuration. Multi-shaft configurations also incur higher CAPEX and O&amp;M costs due to the increased amount of hardware (e.g. generator, transformer, lube oil systems).</li> </ul> <p>2-on-1 equipment would also have larger equipment such as steam turbine and transformer which could be a logistical issue given the remoteness of the site and logistical issues faced by TPP1 construction.</p> <p>In either case, any configuration would allow the use of CHP or fitting of SCR in the future if required.</p>
<b>Fuel</b> Natural Gas	<p>The plant will only operate on natural gas and no firing of secondary fuels, will be undertaken. In particular:</p> <ul style="list-style-type: none"> <li>▪ <b>Security of Supply:</b> The gas supplier, Uzbekneftegas, has confirmed that an additional 4.4million m3/day can be provided via the existing infrastructure and that their projections for gas reserves to 2030 are sufficient. Gas will be provided at 9 bar pressure.</li> <li>▪ <b>Gas Compressor Redundancy:</b> A total of 3 gas compressors will be installed for TPP2 (1 no. operation; 1 no. spinning reserve; 1 no. reserve).</li> </ul>	Yes	<p>The use of gas is favourable from an environmental perspective; and a step-improvement over the existing coal fired plant installed in Uzbekistan.</p> <p>Redundancy in the gas compressor is sensible and in line with expectations for a gas-only fired plant.</p>



**Table 12 – TPP2 Technology Selection & BAT Compliance**

Characteristic	Design Rationale	BAT?	Comment
<b>Condenser Cooling Type</b> Water Cooled	<p>The regional climate of the site is classified as 'continental', with hot summers and cool winters. However, within the Region summer temperatures often exceed 40°C; whilst winter temperature average about -2°C. Furthermore, Climate Change is likely to result in hotter summers and winters within the region, with the 20 year 'medium scenario' resulting in an increase of 1-2.5°C. The decision to use a wet-cooling method, either in open-cycle or re-circulated mode is based on:</p> <ul style="list-style-type: none"><li>▪ Performance compromises of Air Cooled Condenser (ACC) (during hotter seasons), together with its inability to be installed to operate alongside wet cooling methods; and</li><li>▪ A relatively established and pre-installed wet cooling method, using evaporative cooling towers, with minimal losses during once-through cooling operation.</li></ul>	N/A (Condenser Cooling is a Site-specific Consideration)	<p>In light of the water availability constraints, and taking into account the fact that the efficiency gains from wet cooling may only be realised (on a site wide basis) for c.4 months of the year, alternative cooling methods are currently being examined under detailed feasibility studies.</p> <p>Providing that the efficiency penalties of alternative methods can be justified against the actual realized gains of wet cooling (taking into account the large periods of the year where once-through cooling will not be possible), the Project preference will be for the use of a method which reduces water demands; such as Forced Draft Cooling Towers or Air-Cooled Condensers.</p> <p>In either case, the approach needs to be looked at holistically to ensure that the water availability is sufficient during the lifetime of the plant especially as TPP1 &amp; TPP2 appear to not currently have water abstraction permissions.</p>

### 12.3 Emissions to Air

Based on the selected technology, IED LCP are required to implement particular BAT techniques and meet specific standards for emissions to air of Nitrogen Oxides (NO<sub>x</sub>) and Carbon Monoxide (CO), as defined in the BREF Note. These techniques and standards are detailed under the Tables 9 and 10, together with their applicability and current design-compliance.

#### Nitrogen Oxides (NO<sub>x</sub>) Emissions

In order to prevent or reduce NO<sub>x</sub> emissions to air from the combustion of natural gas in gas turbines, BAT is to use one, or a combination of, the techniques provided below.

**Table 13 – BAT Techniques for NO<sub>x</sub> Emission Abatement, TPP2 Applicability & Compliance**

Technique	Generally Applicable	Adopted at TPP2?	Comment
Advanced Control System	Yes	Yes	In advance of the EPC Tender, and in absence of specific turbines (other than 'advanced F-class'), it is not possible to confirm which abatement technologies / strategies will be adopted by the OEM.
Water / Steam Addition	Yes	Yes	<b>Whilst all listed techniques are compatible with F-class technology, the OEM will determine which techniques are most viable to achieve the Tender Specifications.</b> The Project will be tendered on the basis of achieving a NO <sub>x</sub> emissions performance of 30 – 40mg/Nm <sup>3</sup> .
Dry Low-NO <sub>x</sub> Burners (DLN)	Yes	Subject to Tender	This is broadly in line the Tender Specification will reflect BAT ELVs for NO <sub>x</sub> , at BAT Reference Conditions, as follows: <ul style="list-style-type: none"> <li>• <b>Daily Average:</b> 40 mg/Nm<sup>3</sup></li> <li>• <b>Annual Average:</b> 30 mg/Nm<sup>3</sup></li> </ul>
Low-load Design Concept	Yes	Subject to Tender	Including these performance limits would allow OEMs to design abatement accordingly. OEMs should also be provided with high resolution water availability data in order to select appropriate abatement techniques.
Low-NO <sub>x</sub> Burners (LNB)	Yes*	Yes	The specification can detail that the requirement to meet the Tender NO <sub>x</sub> emission requirements can be achieved via: <ol style="list-style-type: none"> <li>1) technology choice alone;</li> <li>2) the identified technology along with a number of the techniques identified here for NO<sub>x</sub> control; or</li> <li>3) the identified technology and selective catalytic reduction abatement equipment fitted as an end of pipe solution.</li> </ol>
Selective Catalytic Reduction (SCR)	Yes	Subject to Tender	

**Note:** \* Not applicable to simple-cycle operation of CCGT.

The applicable BAT ELVs are summarised under Table 14:

**Table 14 – BAT NO<sub>x</sub> ELVs Compared Against Plant Performance (TPP2)**

Plant	Applicable BAT ELV	ELV NO <sub>x</sub> mg/Nm <sup>3</sup>		Plant Performance (NO <sub>x</sub> mg/Nm <sup>3</sup> )	BAT Compliant?
		Yearly Average	Daily Average over Sampling Period		
TPP2	New CCGT, >50MW(th)	10 – 30	15 - 40	30 - 40	Yes

**Notes:**

^ In the absence of any operational data, the proposed performance guarantees has been used. In reality and based on experience, the actual emissions levels achieved are usual well below the performance guarantee levels although a specific level cannot be illustrated until plant design completion, and even then not until after commissioning testing.

**In conclusion, TPP2 will be tendered to achieve 30-40mg/Nm<sup>3</sup>, broadly in line with BAT ELVs for NO<sub>x</sub>.** This will be through the tender specification and will be met through the use of advanced F-class technology in conjunction with the BAT control techniques for NO<sub>x</sub> as detailed in Table 12

**Carbon Monoxide (CO) Emissions**

In order to prevent or reduce CO emission to air from the combustion of natural gas, BAT is to use one, or a combination of, the techniques provided in Table 15, below.

**Table 15 – BAT Techniques for CO Emission Abatement, TPP2 Applicability & Compliance**

Technique	Generally Applicable	Adopted At TPP2?	Comment
Optimised Combustion	Yes	Yes	TPP2 would include (as this is now standard on these units) advanced combustion control systems which will manage the process to ensure optimised combustion of natural gas for heat output. This will also have the effect of ensuring controls on CO generation as well as primary NO <sub>x</sub> control.
Oxidation Catalysts	Yes	No	Not likely to be required for a modern CCGT.

As an indication, the yearly average CO emissions for new CCGT ≥50MW(th) is <5-40mg/Nm<sup>3</sup>. For plants with a net electrical efficiency (EE) greater than 39 % (as is the case for TPP2), a correction factor may be applied to the higher end of this range, corresponding to [higher end] × EE/39, where EE is the net electrical energy efficiency or net mechanical energy efficiency of the plant determined at ISO baseload conditions.

**In conclusion, TPP2 will be capable of meeting the BAT ELVs for CO**

**Energy Efficiency**

Depending upon the final technology selected, IED LCP are required to implement particular 'Best Available Techniques' and meet specific standards for energy efficiency, as defined in the BREF note. These techniques and standards are detailed below in Tables 16 and 17, and their applicability reviewed in relation to the Project.

**Table 16 – BAT Techniques for Energy Efficiency**

Technique	Generally Applicable	Adopted at TPP2?	Comment
Combustion Optimisation	Yes	Yes	TPP2 is likely to include advanced combustion control systems that will manage the process to ensure maximised combustion of natural gas for heat output.
Optimisation of the Working Medium Conditions	Yes	Subject to Feasibility &	The Project will be tendered to achieve a Net Electrical Efficiency in line with BAT Guidelines

**Table 16 – BAT Techniques for Energy Efficiency**

Technique	Generally Applicable	Adopted at TPP2?	Comment
Minimisation of Energy Consumption	Yes	Detailed Design	(54 – 60.5%). The methods by which this will be achieved will be established via the further design process; however, a number of applicable methods are available for selection.
Pre-heating of Combustion Air	Yes		
Fuel Pre-heating	Yes*	Yes	The design of TPP2 includes fuel-reheating, which is conducted in the gas compressor and filtration compound. For reference, fuel pre-heating is also included in TPP1.
Advanced Control System	Yes	Yes	TPP2 is likely to include advanced combustion control systems which will manage the process to ensure maximised combustion of natural gas for heat output.
Feed-water Pre-heating using Recovered Heat	Yes	Subject to Feasibility & Detailed Design	The Project will be tendered to achieve a Net Electrical Efficiency in line with BAT Guidelines (54 – 60.5%). The methods by which this will be achieved will be established via the further design process; however, a number of applicable methods are available for selection.
Heat Recovery by Cogeneration (CHP)	Yes^	Partial	Has been considered in feasibility but needs to be better considered with regards TPP0 and TPP1 for the optimisation of the power complex.
CHP Readiness	Yes^	Yes	This can be incorporated into the design and there is space to fit additional CHP equipment.
Flue Gas Condenser	Yes^	N/A	Can be included as part of TPP2 if used for a closed loop district heating system.
Heat Accumulation	Yes^	N/A	Can be considered if TPP2 is used in CHP mode.
Wet Stack	No	NA	Only applicable to combustion plant fitted with wet Flue-Gas Desulphurisation (FGD). Not relevant to a gas fired plant.
Cooling Tower Discharge	N/A	N/A	The release of emissions to air through a cooling tower and not via a dedicated stack. Only applicable to units fitted with wet FGD where reheating of the flue-gas is necessary before release, and where the unit cooling system is a cooling tower.
Fuel Pre-drying	No	NA	Only applicable to the combustion of biomass and/or peat. Not relevant to a gas fired plant.
Minimisation of Heat Losses	No	NA	Only applicable to solid-fuel-fired combustion units and gasification / IGCC units.
Advanced Materials	Yes	Yes	Whilst the exact model of GTs to be used within TPP2 is not yet known; it is understood that the specification will be for 'advanced' F-Class technology. Recent F-Class technology; including the Mitsubishi 701F4 used within TPP1, incorporates Advanced Material technology from their G+Class Fleet, in order to operate at higher temperature for improved turbine efficiency.
Steam Turbine Upgrades	N/A	N/A	The CCGT will be a new bespoke system and not requiring upgrades to improve efficiency from commissioning.
Super Critical and Ultra-Supercritical Steam Conditions	N/A	N/A	Not applicable to CCGT.

**Table 16 – BAT Techniques for Energy Efficiency**

Technique	Generally Applicable	Adopted at TPP2?	Comment
Combined Cycle	Yes	Yes	TPP2 is designed to operate in Combined-Cycle mode, with minimum Open-Cycle operation.

**Notes:**

^ Applicable within the constraints associated with the local heat and power demand.

The BREF Note provides numerical guidelines on Net Electrical Efficiency (%), which has been compared against TPP2.

**Table 17 – BAT Guideline Values for Net Electrical Efficiency (%)**

Plant	Applicable BAT Guideline	Net Electrical Efficiency (%)	Actual Electrical Efficiency (%)	BAT Compliant
TPP2	CCGT >600MW(th), New Units	54 – 60.5	≥54^	Yes

**Notes:**

^ Tender specification of ≥56%, which was confirmed.

**12.4 Conclusion**

**Overall, it can be seen that the plant conforms to the guideline Electrical Efficiency values presented in the BREF Note. In general, TPP2's efficiency characteristics are 'competitive' within the market and representative of modern, high-efficient technology.**

F-Class technology is an appropriate selection for the Project, and furthermore, the detailed design will achieve a BAT-compliant Net Electrical Efficiency (54-60.5%) and a carbon intensity in line with current good industry practice. In terms of NO<sub>x</sub> emissions, the Project will be designed to aspire to 30 – 40mg/Nm<sup>3</sup>, taking into account in-country constraints and commercial viability. Achievement of 30-40 mg/Nm<sup>3</sup> would bring the Project into general alignment with BAT Emission Limit Values.



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## APPENDIX 2:

# 13 CARBON CAPTURE STORAGE (CCS) READINESS REVIEW

### 13.1 Carbon Capture and Storage Assessment

The Directive on the geological storage of carbon dioxide (Directive 2009/31/EC) (the Carbon Capture and Storage (CCS) Directive) in the Official Journal of the European Union and came into force on 25 June 2009.

This Directive requires operators of all combustion plants with an electrical capacity of 300 megawatts (MW) or more (and for which the construction / operating licence was granted after date of the CCS Directive) have assessed whether the following conditions are met:

- Suitable storage sites for carbon dioxide (CO<sub>2</sub>) are available;
- Transport facilities to transport captured CO<sub>2</sub> to the storage sites are technically and economically feasible; and
- It is technically and economically feasible to retrofit for the capture of CO<sub>2</sub>.

### 13.2 Space Requirements

For CCGT units with post-combustion CO<sub>2</sub> capture an indicative CCS space requirement of 1.875ha for 500MW is considered the minimum appropriate size. This would mean that for the Talimarjan Power Complex the space requirement would be 3.375ha. At the Talimarjan Power complex there is sufficient space to include for this system if it is required to be retrofitted at a later point.

### 13.3 Technical Feasibility of Retrofitting

Several CO<sub>2</sub> capture technologies currently exist and at the time that this is required to be retrofitted the choice of potential technologies could be greater. The best of the currently available technology options is the capture of CO<sub>2</sub> from flue gases which is post-combustion CO<sub>2</sub> capture via chemical absorption using amine solvents.

For the Talimarjan Power Complex there would be scope to duct the flue gases from the stack to the gas cooling system of the CO<sub>2</sub> capture plant. This can be done in one of two ways. Firstly, including in the design the connection point from where the final flue gases could either be diverted to stack or gas capture plant. Secondly, this could be retrofitted afterwards but would require the plant to be down whilst it is reconfigured to divert the flue gases.

### 13.4 Storage

The nearest gas fields are the Shurtan gas fields, which supplies fuel to the Power Complex, and currently has significant remaining reserves. An assessment would need to be performed as to the gas-fields suitability for the storage of the CO<sub>2</sub> along with any alternative locations.

### 13.5 Transport

Transport from the Talimarjan Power Complex of any captured CO<sub>2</sub> would be by onshore pipeline given the volume to be generated would be far in excess of what could be comfortably transported by road or rail and the site is not near to any large water way to allow for offshore transport. Another negative with regards to road or rail transport would be that the significant numbers of journeys would have deleterious effects on the local environments and communities through emissions from vehicles, dust from vehicle movements, noise from vehicle movements and other general disturbances.

### 13.6 Transport route

Typically, the proposed pipeline route can be in an up to 1 km wide corridor for the first 10 km off the site (where options to alter the route will be more limited) and a much wider 10km corridor after this. However, given the location of the Talimarjan Power Complex it is considered that there is sufficient land

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access nearby for a suitable corridor to be chosen for a pipeline provided that significant development does not occur in the region prior to the retrofitting of any carbon capture equipment.

### **13.7 Economics**

As part of a carbon capture feasibility assessment the likelihood that carbon capture will be economically feasible within the power station's lifetime covering retrofitting of capture equipment, transport and storage should be considered.

This economic consideration should include the efficiency penalties that arise from the operation of the carbon capture equipment from:

- Significant consumption of electricity through the operation of plant and machinery as well as pumps and blowers.
- Post-combustion CO<sub>2</sub> capture technology using amine solvent requires steam to regenerate the liquid amine solvent.
- Substances such as NO<sub>2</sub>, particulate matter and SO<sub>2</sub> have a detrimental effect on the CO<sub>2</sub> capture technology. The effects range from reduction in efficiency (lower capture rates) to the generation of solids which require filtration and addition of makeup liquid amine solvent.

### **13.8 Conclusions**

Should the economic assessment show that carbon capture and storage is appropriate for retrofitting for the TPP2 project during its lifetime then this can be implemented because:

- The site has the available space for the inclusion of the carbon capture equipment.
- A suitable means of geological storage will be required to be located should the Shurtan Gas fields not be suitable at the time of the retrofitting of the power plant with CCS.
- The EPC contractor can be notified during the procurement process to allow for the space for the retrofitting of key ductwork and ancillary equipment to support carbon capture or these can be retrofitted at a later point.
- The adjacent land will allow for the development of a pipeline to the storage location provided that the region does not develop significantly (through industrialisation or urbanisation) prior to the retrofitting of the carbon capture system.