INTEGRATED MASTER PLAN · CONCEPT V2.5 · HORIZON 2032

Uz Silicon Tech
The Full Value Chain

From mining to finished product — quartz mine · metallurgical silicon · polysilicon · wafer · closed-loop waste recovery (ZLD + STC) · ~1 GW firm power · workforce and education system. Analysed through eight expert lenses.

INITIATOR: KUZIEV MUMIN ULASHBOEVICH **LOCATION:** NAVOI / JIZZAKH / SIRDARYA

STATUS: PRE-FEASIBILITY CONCEPT

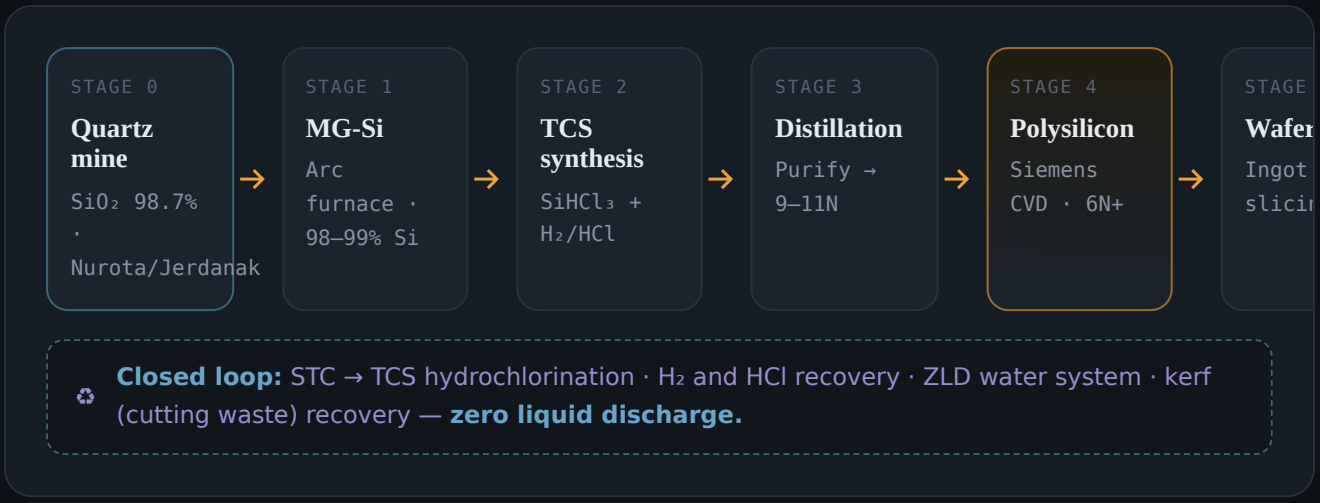
100 kt POLYSILICON/YR · TARGET	**20 GW** WAFER/YR · PROPOSED
~1 GW FIRM POWER	**~2,800 ha** TOTAL LAND
~6–8 k DIRECT JOBS	

CONTENTS

01 Value chain — overview

GEOLOGIST · PROCESS ENG.

The project is not a single plant but a **fully vertically integrated cluster:** quartz is mined, purified stage by stage, and processed all the way to wafer. Every waste stream is recovered in closed loops. Uzbekistan's advantage is precisely here: **Oman imports its raw material — we take ours from the ground.**



02 Geology and mining

GEOLOGIST

The geologist's view: domestic quartz is **no longer an assumption.** The Tashkent Institute of Chemical Technology (Nomazov & Aripova, 2025) measured the composition of quartz from Uzbek deposits:

SOURCE	SiO_2	Al_2O_3	Fe_2O_3	ASSESSMENT
Nurota vein quartz	98.74%	0.45%	0.02%	High purity
Jerdanak quartzite	97.72%	0.77%	0.12%	Illite admixture

✓ What is confirmed

The SiO_2 grade is **sufficient for MG-Si (metallurgical silicon).** Uzbekistan has 20+ quartz deposits and beneficiation experience (JSC "Kvarts"). This is a real advantage against Oman's "import dependency" weakness.

Official strategic recognition: Uzbekistan's **Critical Elements list** includes silicon (Si) and **high-purity silica/quartz** — with vast, largely untapped potential (Mirkamalov et al., 2025). That is, the state recognises this material as strategic.

✗ Still required for Gate-1 — and the JORC question

Today we have **chemical composition** (TKTI), but **no JORC-compliant resource statement.** Uzbekistan uses the GKZ (Soviet) classification, but international investors (IFC, banks) require a resource statement to the **JORC or NI 43-101** standard: tonnage + grade + confidence category (measured/indicated/inferred). Only a **drilling programme** delivers this.

Gate-1 Resource Assessment — full checklist

ITEM	REQUIREMENT	STATUS
Candidate deposits	Jizzakh · Navoi · Sirdarya + Nurota/Jerdanak	⚠ To select
SiO_2 range	≥98% (confirmed for MG-Si: 97.7–98.7%)	✓ Have
Boron (B) + phosphorus (P) ppm	Most critical for polysilicon — not yet measured	✗ Needed
Post-beneficiation purity	Does it reach 6N (pilot test)	✗ Needed
30-year reserve	~9 Mt quartz (JORC-compliant)	✗ Drilling
Mining cost	$/tonne → confirm the $1.3/kg feedstock estimate	✗ Needed

Signal to UzSIF / Geology committee: "We hold scientifically confirmed initial evidence; we are ready to begin Gate-1 (drilling + B/P + JORC)."

B/P — the most critical parameter

For polysilicon, boron (B) and phosphorus (P) are the most important, because they corrupt the semiconductor property and are extremely hard to remove from quartz.

ELEMENT	TARGET (INDICATIVE)	METHOD
Boron (B)	< 0.1 ppm	ICP-MS
Phosphorus (P)	< 0.3 ppm	ICP-MS

No B/P measurement currently exists for any Uzbek deposit — this is normal. Only an ICP-MS lab + international assay + JORC expert can establish it. Final polysilicon spec is even tighter (ppba level).

Pilot beneficiation test (6N potential)

After beneficiation, Al_2O_3, Fe_2O_3, TiO_2, CaO, MgO must drop to ppm levels. Pilot test stages:

- 1 · Crushing → 2 · Magnetic separation → 3 · Chemical washing → 4 · Acid leaching → 5 · Drying → 6 · ICP-MS analysis
- Result: confirms (or rejects) the quartz's eligibility to enter the **MG-Si → TCS → polysilicon** chain

Drilling programme (for JORC)

PARAMETER	MINIMUM (INDICATIVE)
Drill holes	~12 (more possible depending on deposit size)
Depth	150–200 m
Output	3D geological model · tonnage + grade + confidence category
Duration	~6 months · certified by a JORC expert

Gate-1 deliverables

- B/P ppm assay (ICP-MS) · JORC-compliant resource statement (Inferred → Indicated → Measured)
- 30-year reserve confirmed (~9 Mt quartz) · post-beneficiation purity
- Mining cost ($/tonne) · logistics map · feedstock readiness for MG-Si

◆ Official signal to government (executive sentence)

"*According to preliminary scientific data, the Jizzakh and Navoi regions hold promising quartz resources for a polysilicon industry. Their suitability must be confirmed through independent laboratory assay, drilling and a JORC audit.*"

⚠ Geological accuracy (Engineering DD safeguard)

Only **confirmed high-purity quartz** is presented as the feedstock base: Nurota vein quartz (98.7%) and Jerdanak quartzite (TKTI). Uzbekistan has a broad mineral base, but **silica sand ≠ polysilicon quartz**, and each deposit (e.g. Jeroy — a phosphorite deposit, not polysilicon) must be verified separately. Maintaining this distinction preserves credibility before the geology committee.

03 Process technology

PROCESS ENG. · ENG. DD

From quartz to polysilicon there are 5 chemical-physical stages. Each requires distinct equipment, energy and a safety regime.

STAGE	PROCESS	MAIN EQUIPMENT	ENERGY (KWH/KG)
1 · Carbothermic	$SiO_2 + 2C \rightarrow Si + 2CO$ (1800°C)	Submerged arc furnace (SAF)	~11–13
2 · TCS synthesis	$Si + 3HCl \rightarrow SiHCl_3 + H_2$	Fluidized-bed reactor	~5
3 · Distillation	Fractional purification (remove B, P, metals)	Distillation columns	~8
4 · Siemens CVD	$SiHCl_3 + H_2 \rightarrow Si$ (1100°C, grows on rods)	Siemens reactors (CVD)	~45–50
5 · Crushing/packing	Crushing, quality control, packaging	Clean room, automation	~2
Total (to polysilicon)			**~70–75**

◆ **Process-engineer note: 6N vs 11N**

The base target is **solar-grade 6N (99.9999%)** — for solar panels. **Semiconductor-grade 11N** (microchips) is an entirely different, far more complex level; only 5 companies manage it (Wacker, Hemlock, OCI, Tokuyama, Mitsubishi). It is left as a **later, separate phase.**

⚠ **Eng. DD: technology owner and power quality**

Who is the licensor/EPC? The Siemens process and STC closed loop require know-how (Western options: centrotherm and others). **Power quality:** a Siemens reactor cannot tolerate even a one-second interruption — this makes firm baseload power mandatory in the energy system.

04 Waste: ZLD + closed-loop STC

PROCESS ENG. · GOVT (ESG)

This is the **heart of the project's ESG / "low-carbon" certification** and what the EU buyer demands. The two main waste streams of the polysilicon process — **silicon tetrachloride (STC, $SiCl_4$)** and **wastewater** — are fully recovered.

Three closed loops

- **STC closed-loop (hydrochlorination):** $STC + 3H_2 + Si \rightarrow 4\ SiHCl_3$ — waste STC converts back to TCS and returns to the process. This sharply reduces purchased chlorine and feedstock.
- **Off-gas recovery:** H_2, HCl, $SiHCl_3$ are separated from reactor gases and recovered.
- **Zero Liquid Discharge (ZLD):** all wastewater is treated by evaporation/crystallisation — **zero liquid waste discharged.** Mandatory in the desert zone (Navoi) due to water scarcity.

◆ Government/ESG view

ZLD + closed-loop STC raises capex by ~10–15%, but it: (1) solves water scarcity, (2) earns the "green" certificate (EU premium condition), (3) lowers operating cost by reducing chlorine/feedstock purchases. Oman built exactly this system.

05 Wafer plant

PROCESS ENG. · MARKET

The wafer stage is built in Uzbekistan by a Turkish partner. Polysilicon → ingot → wafer. This is your product's **adjacent, immovable buyer.**

STAGE	PROCESS	WASTE RECOVERY
Ingot growth	Czochralski (CZ) — monocrystal pulling	Pot remnant → re-melt
Slicing	Thin wafers via diamond wire saw	**Kerf loss** (cutting powder) → recovery
Wash/sort	Cleaning, quality control, packaging	Connects to the ZLD water system

- **Capacity:** 20 GW/yr → consumes ~46–50 kt polysilicon (half of 100kt)
- **Export route:** wafer enters the EU freely via the Turkey–EU customs union
- **Energy:** ~210 MW firm additional (CZ pulling is energy-intensive)

06 Offtake map (buyers)

MARKET · INV. BANK

The 100kt of polysilicon splits in two and reaches the EU via wafer. **This is the project's clear answer to "who buys it?"**

BUYER	VOLUME	WHY THEM	MARGIN* (ALL-IN $7.8/KG)
🇹🇷 **Turkey wafer (in UZ)**	~50 kt	Adjacent · non-China · Turkey–EU customs union	premium
🇮🇳 **India**	~50 kt	Building 20+ GW wafer, ~zero domestic polysilicon, ALMM policy	+$2/kg (thin)
🇪🇺 Europe (via wafer)	—	~63 GW/yr demand; €2.2 bn EU programme	+$12/kg
🇺🇸 USA (optional)	—	UFLPA/FEOC mandate non-China	+$16/kg

*Margin from the Energy-Cost model (separate Excel file). India is price-sensitive; US/EU premiums are wider.

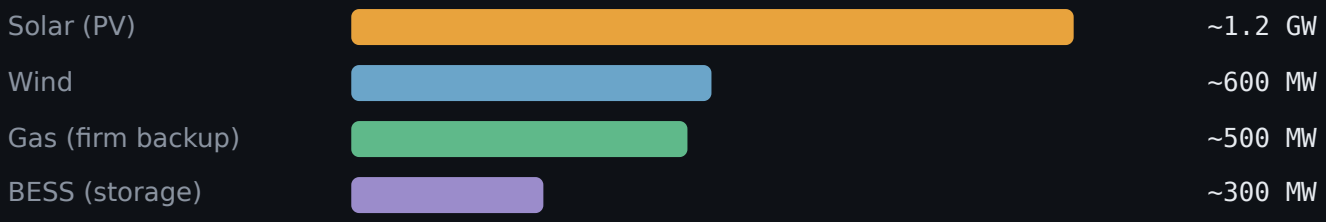
◆ **Market expert**

The non-China premium is real but the window is narrow — Oman (100kt), Qatar and the US are filling it. The adjacent Turkey wafer plant + India offtake keep you in this race. An **early LOI/MOU** turns "demand" into "a buyer".

07 Energy supply

POWER · INV. BANK

The full chain (MG-Si + polysilicon + wafer) requires **~1 GW of firm (continuous) power** — ~8,800 GWh per year. ACWA Power / Masdar IPP model: they build it, you buy via a 20–25 year PPA.



METRIC	VALUE	NOTE
Firm power (full chain)	~1 GW	MG-Si + poly + wafer
Electricity cost	~$2.6–2.8/kg	Better than grid $4.4; above China $1.65
Energy cluster capex	~$2.5–3 bn	Owned by ACWA/Masdar (PPA)
CO_2 footprint	~14 kg/kg	Within "low-carbon" range (China ~36)

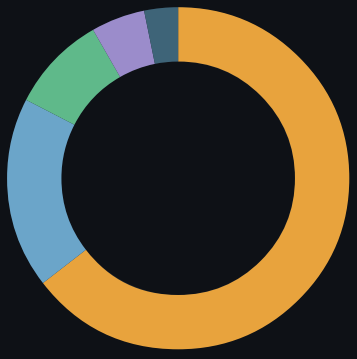
◆ The core trade-off + Excel companion

More gas = cheaper/firm, but higher CO_2 (weakens the premium). More renewables = clean, but higher capex. This balance is computed in a **separate Energy-Cost Excel model** — varying the gas/renewable share shows $/kg cost, firm-coverage % and CO_2 footprint in real time.

08 Land and infrastructure

GEOLOGIST · ENG. DD

Total area **~2,800 hectares** — mostly the solar farm. Industrial core ~600 ha.



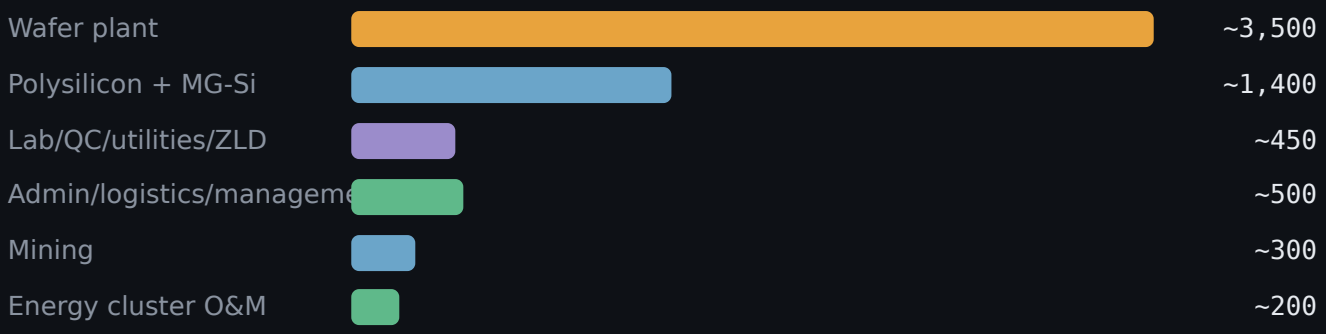
Solar farm	~1,800 ha
Wind zone (spacing)	~500 ha
Polysilicon + MG-Si plant	~250 ha
Wafer plant	~120 ha
Gas/BESS/substation	~40 ha
ZLD/water/logistics/buffer	~90 ha

Location factors: Navoi — Masdar solar experience, industrial zone, but water-scarce (ZLD mandatory). Jizzakh/Sirdarya — water/logistics may be better. Final choice assessed by proximity to the quartz mine + energy + water + rail connection.

09 Human capital (workforce)

GOVT · OPERATIONS

The full cluster generates ~**6,000–8,000 direct jobs** (2–3× more indirect). The largest need is at the wafer plant.



LEVEL	ROLE	FIELD
Engineer / PhD	Process, R&D, quality	Chemical engineering · metallurgy · materials science · power
Technician	Equipment, automation, maintenance	Instrumentation · mechanical · electrical
Operator	Furnace, reactor, CZ, slicing	Chemical operators · clean room
HSE / environmental	Safety, ZLD, chlorine chemistry	Industrial safety · environment

10 Education and workforce training

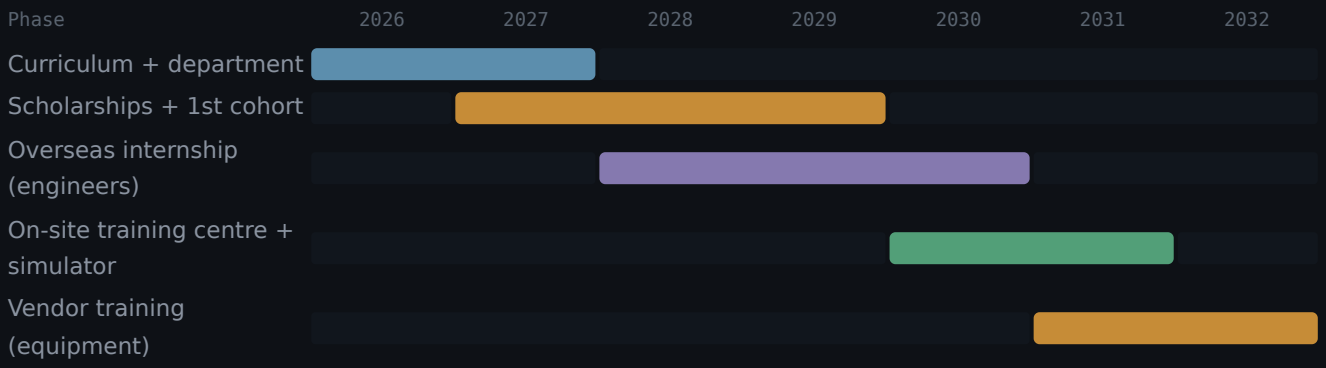
GOVT · UNIVERSITY

The most critical timing factor: training must start in 2028–29, not in 2032. If it does not begin 3–4 years ahead, there will be no qualified workforce when the plant commissions.

University departments (partners)

INSTITUTION	FIELD	ROLE
Tashkent Inst. of Chemical Technology (TKTI)	Chemical engineering, quartz beneficiation	Core partner (the quartz study came from here)
Navoi State Mining & Tech University	Mining, metallurgy	MG-Si and mining workforce
Tashkent State Technical University	Power, automation, mechanics	Technicians and engineers
Turin Polytechnic (Tashkent)	Materials science, mechatronics	International-standard engineers
Foreign partner (Germany/Korea)	Siemens process, CVD know-how	Mentorship, internship, licensing

Training schedule



◆ **Practical approach**

1) Send the first wave of engineers in 2028–29 to plants in China/Korea/Germany for **hands-on training** (the fastest route). 2) Build an **on-site training-simulator centre.** 3) Training contracts with equipment vendors. 4) Redesign university programmes to **fit real needs.**

11 CAPEX breakdown (detailed)

AUDITOR · INV. BANK

The first table UzSIF asks for. Each stage separately, with owner and model. **Note:** wafer and energy are carried by partners (Turkey, ACWA/Masdar), so Uz Silicon Tech's own capex is ~$4.5–5.5 bn.

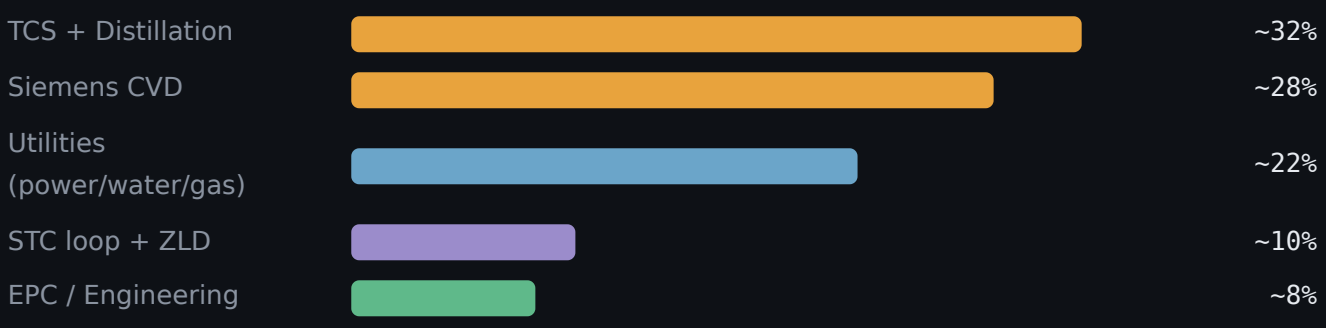
COMPONENT	CAPEX (PRELIMINARY)	OWNER / MODEL
1 · Quartz mine	~$0.1–0.2 bn	Uz Silicon Tech / state
2 · MG-Si (arc furnace)	~$0.4–0.5 bn	Uz Silicon Tech
3 · TCS synthesis	~$0.5–0.7 bn	Uz Silicon Tech
4 · Distillation (purification)	~$0.5–0.7 bn	Uz Silicon Tech
5 · CVD (Siemens reactors)	~$1.8–2.2 bn	Uz Silicon Tech (largest)
6 · ZLD + closed-loop STC	~$0.4–0.6 bn	Uz Silicon Tech
7 · Land + infrastructure	~$0.3–0.5 bn	Uz Silicon Tech / state
Your portion (1–7)	**~$4.5–5.5 bn**	Uz Silicon Tech
8 · Wafer plant (20 GW)	~$2.0–4.0 bn	🇹🇷 Turkey partner (JV)
9 · Energy cluster (~1 GW)	~$2.5–3.0 bn	ACWA/Masdar IPP (PPA)
TOTAL CLUSTER	**~$9–12.5 bn**	Multi-party

◆ **Important for the auditor**

"$1.5–2 bn" (v1.0) is outdated. The fully integrated cluster is ~$9–12.5 bn. But due to the **asset-light structure** your balance sheet is ~$4.5–5.5 bn — the rest is off-balance via partner/PPA.

Polysilicon plant CAPEX structure (industry-typical)

For the polysilicon core only (TCS→CVD), ~$3.6–4.2 bn. MG-Si, wafer and the energy cluster are outside this.



★ Global benchmark: Oman (United Solar Polysilicon)

The world's largest non-China polysilicon plant — the proven template for our project:

- **100kt · ~$1.6 bn → ~$16,000/tonne** · built in ~22 months
- Financing: IFC $480M + OIA sovereign fund $260M + Waaree + local banks
- FEOC-compliant · ESG · ZLD · free zone · on-site solar
- **Its weakness: it imports raw material** — we overcome this with domestic quartz + MG-Si

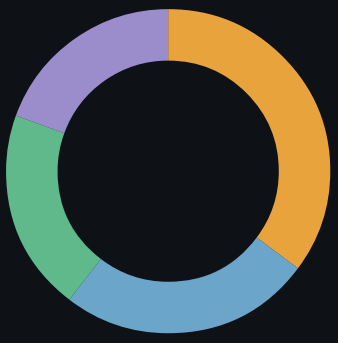
Signal to investors: "Oman built 100kt for $1.6 bn, financed by the IFC + a sovereign fund. We replicate the same model, with a domestic-feedstock advantage."

Note: Oman figures are from confirmed public sources. The CAPEX percentage structure is an industry-typical estimate, not any company's internal number.

12 Shareholding structure

FUND DIRECTOR · INV. BANK

An investor's first question: "who owns it?" This is the indicative cap table of the **polysilicon company (SPV).** Note: energy (ACWA/Masdar) and wafer (Turkey) are separate vehicles; they are primarily **contractual partners** (PPA / offtake), with optional minority stakes.



UzSIF (sovereign fund, anchor)	~30%
Strategic industrial partner	~25%
DFI / IPO / private investors	~25%
Partners minority (ACWA/Turkey, opt.)	~20%

Percentages indicative. Core principle: the state/sovereign fund as anchor (Oman/OIA model), a DFI (IFC) with debt+equity, a strategic industrial partner bringing technology.

13 Financial model + sensitivity

AUDITOR · INV. BANK

Revenue model (100kt): price × volume. Cost from our Energy model — cash ~$5.8/kg, all-in ~$7.8/kg.

POLYSILICON PRICE	REVENUE/YR	EBITDA	EBIT	VERDICT
$12/kg (blended premium)	$1,200M	$620M	$420M	Strong
$10/kg	$1,000M	$420M	$220M	Healthy
$8/kg	$800M	$220M	$20M	Break-even
$6/kg (China price)	$600M	$20M	−$180M	**LOSS**

⚠ Sensitivity — the most important truth

The all-in break-even point is **~$7.8/kg.** At the Chinese commodity price ($6) the project **makes a loss.** So the project works **only in premium markets** ($10+/kg, FEOC/EU) — not in price competition with China. This is the financial proof of the entire "non-China" strategy.

Payback (your ~$5 bn portion): ~8 years at $12/kg · ~12 years at $10/kg. Acceptable for an infrastructure project.

All figures are linked to the Energy-Cost model. Final IRR/NPV is computed in the Feasibility Study with the full financing structure.

14 SWOT analysis

STRATEGIC

S · STRENGTHS

Domestic vertical chain

Quartz+MG-Si in-house (not in Oman) · cheap renewable potential · neutral geopolitics · state support · non-China/FEOC position.

W · WEAKNESSES

Logistics + cost

Landlocked · gas-heavy grid (ESG tension) · no polysilicon experience/workforce · all-in cost above China · subscale risk below 100kt.

O · OPPORTUNITIES

De-China demand

EU/US diversification · India wafer boom (needs polysilicon) · 2028–30 rebalancing · semiconductor ecosystem.

T · THREATS

Non-China oversupply

Oman/Qatar/US/Morocco · premium compression · China price war · gas deregulation · 4-party coordination.

15 Strategic impact for Uzbekistan

GOVT · PRESIDENTIAL ADMIN.

For the Presidential Administration and the Cabinet of Ministers — national-level outcomes:

6–8 k	$1+ bn	~1 GW	1st
DIRECT JOBS	ANNUAL REVENUE	NEW RENEWABLES	POLYSILICON IN C. ASIA

- **A new industrial sector** — the foundation of the solar and semiconductor materials chain
- **Export diversification** — high-value product, not raw commodity (wafer to the EU)
- **Energy-transition catalyst** — ~1 GW renewable cluster
- **Supply-chain sovereignty** — non-China, strategic independence
- **Indirect impact** — 2–3× additional jobs, workforce and education development

16 Gate-1 → FID timeline

INV. BANK · UZSIF

The most important view for investors: which stage when, and which "gate" stops the project if not passed. **Without passing Gates 1–3, there is no FID.**

FID ~end of 2028 → construction ~3–4 years → **production in 2032**, aligned with the rising demand/shortage cycle.

17 Who this document is for

The master plan is intended for four groups — each reads a different section.

★ PRIMARY TARGET

UzSIF — Uzbekistan Sovereign Fund

Expects exactly this kind of document. Signal: "we are ready, you start Gate-1 and be the orchestrator." Capex + Gate timeline + offtake are for them.

TECHNICAL VALIDATION

Geology committee

The geology section is in the right tone: "we have an assumption, you confirm with JORC." B/P, reserves, drilling are for them.

ENERGY PARTNER

ACWA Power / Masdar

The energy section and ~1 GW firm requirement matter most to them. PPA model + 2 anchor buyers give them bankability.

WAFER PARTNER

Turkish wafer manufacturers

20 GW wafer → 50 kt adjacent non-China polysilicon + Turkey–EU customs route = a golden opportunity for them.

18 Eight-expert verdict

FUND DIRECTOR

Differentiator + sponsor

Vertical integration (domestic quartz) is a real moat. But "who puts in equity?" is still unanswered. A sovereign fund must anchor it.

MARKET EXPERT

Premium real, window narrow

Non-China demand exists, but Oman/Qatar/US are filling it. The adjacent Turkey wafer + India offtake are a strong position.

GOVERNMENT EXPERT

National strategic cluster

~1 GW new power + 6–8k jobs. State orchestration and an energy guarantee are decisive.

INVESTMENT BANK

2 offtakes required

Energy PPA + polysilicon offtake — without both it is not financed. The IFC model (Oman) exists.

FINANCIAL AUDITOR

Capex $8–12 bn

"$1.5–2 bn" is outdated. All-in cost is above China — the business relies on the premium market, not price competition.

ENGINEERING DD

Technology + power quality

Who is the licensor/EPC? The reactor cannot tolerate interruptions → firm power mandatory. ZLD/STC raise capex.

GEOLOGIST

Quartz yes, B/P unknown

SiO_2 confirmed for MG-Si. Boron/phosphorus measurement and reserve estimate are the rest of Gate-1.

PROCESS ENGINEER

5 stages + closed loop

The process is known and proven. 6N is the target; 11N a later phase. STC closed-loop + ZLD is the right approach.

19 Risks and honest caveats

> **⚠ The biggest risk — coordination, not technology**
>
> Four independent mega-decisions (poly · wafer · energy · offtake) must be signed at the same time. Only a **state/sovereign fund as orchestrator** can break this.

- **All figures are preliminary engineering estimates** — to be confirmed in the Feasibility Study. This document is not a basis for an investment decision, but a concept architecture.
- **Energy:** the project dies on the grid; it works only with a dedicated renewable+gas PPA.
- **Quartz is not yet proven to be polysilicon-grade** — B/P testing and pilot beneficiation are required.
- **The premium market** is not guaranteed to last to 2032 — early offtake/LOI is decisive.
- **If workforce training does not start in 2028–29**, commissioning is delayed.

- This document is a Pre-Feasibility concept. All technical and financial indicators are preliminary estimates based on international benchmarks, and must be confirmed through an independent Feasibility Study and Engineering Due Diligence.
- Sources: TKTI quartz study (Nomazov & Aripova, 2025); IEA / pv-magazine / Bernreuter polysilicon data; ACWA Power / Masdar IPP benchmarks; United Solar (Oman) project model.