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LOCALIZATION OF SEMICONDUCTOR GRADE SILICA IN INDIA

Opportunities and Challenges for an Emerging Economy

Presented by

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INTRODUCTION

Semiconductor manufacturing is among the **most materials-sensitive industries** globally. Ultra-high purity silica is a basic and critical requirement for:

- High purity quartz crucibles
- Fused silica components & Photomasks
- Advanced ceramics for wafer fabrication

Production is currently concentrated in Spruce Pine (USA), China, Norway, and Russia, creating **strategic dependencies** for emerging economies like India

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THE $100B DISCONNECT

THE INSIGHT: We are building the roof (Fabs) without the foundation (Materials)

$100B+

Massive downstream Investment

$10B, $90B

Govt PLI scheme, Tata Group Commitment

85000

Engineers Target in next 10 years

UPSTREAM GAP

Without silica localization, all downstream investments remain vulnerable to supply disruptions & geopolitical risks

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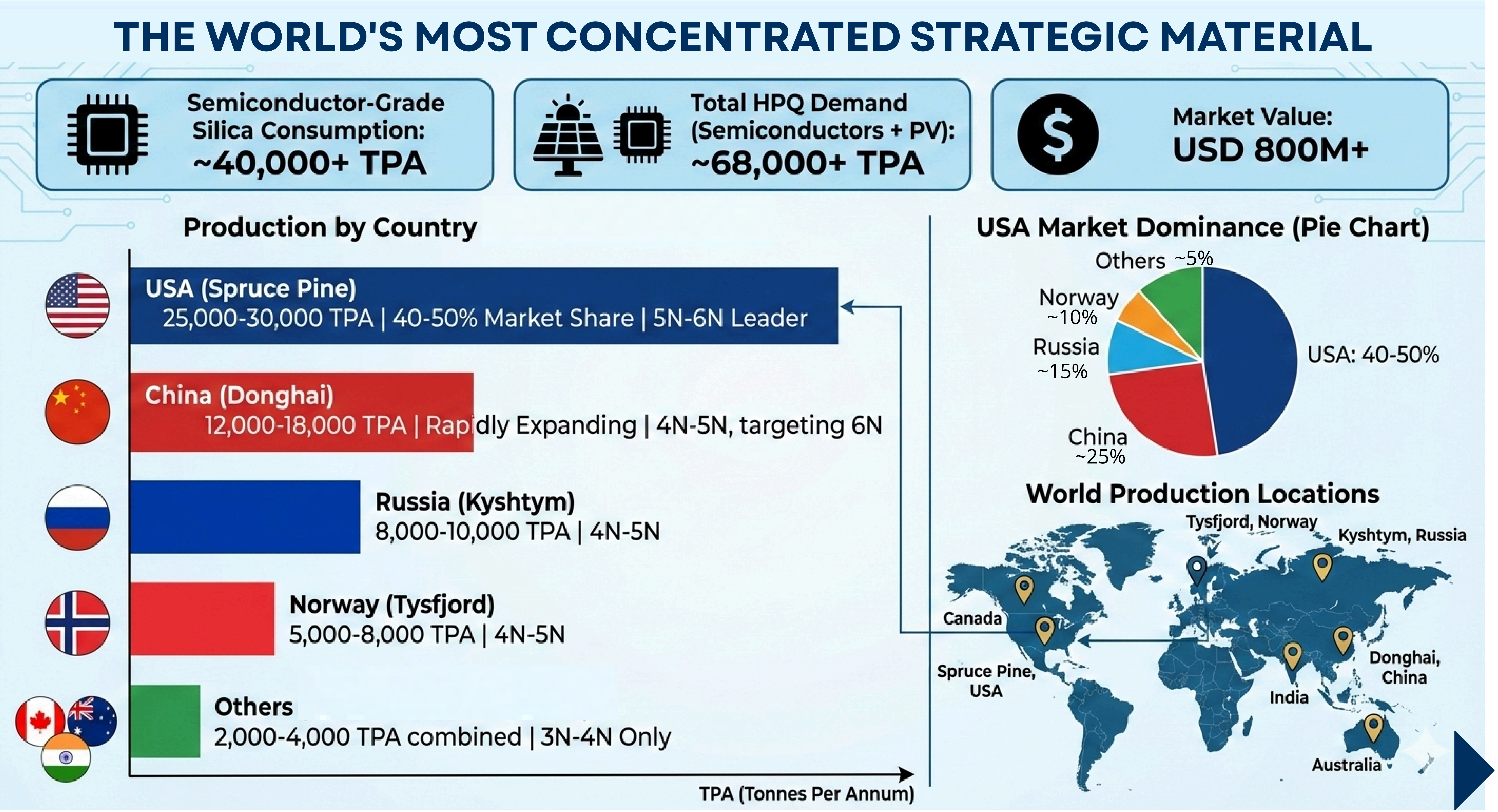

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WHO CONTROLS THE SUPPLY? Four Countries. Four Companies. One Strategic Vulnerability.

Global High Purity Quartz (HPQ) Production Overview

	Country	Key Companies	Production (TPA)	Purity Grade & Focus
	USA – Spruce Pine	The Quartz Corp (Norsk Mineral + Covia JV), Sibelco	25,000-30,000 TPA	5N-6N leader | 40-50% global share
	China – Donghai County	Pacific Quartz, Jiangsu Pacific Quartz	12,000-18,000 TPA	Aggressively scaling | Pursuing synthetic 6N route to replace US sources
	Russia – Kyshtym	JSC Russian Quartz	8,000-10,000 TPA	Serves Russia, Europe, Asia
	Norway – Tysfjord	Norsk Mineral	5,000-8,000 TPA	Strong in specialty glass, limited semiconductor share

India does not appear as an independent category in global HPQ production data

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URGENCY OF LOCALIZATION

01

2030 Demand Gap - Current supply: 50,000-65,000 TPA. 2030 forecast: 80,000-95,000 TPA. Gap: 15,000-45,000 TPA shortfall = India's entry window. Capturing 5-10% = USD 50-100M+ annually

02

- A Strategic Imperative: Essential for national technological self-reliance and value-chain integration.
- Mitigates supply bottlenecks from highly concentrated global production.

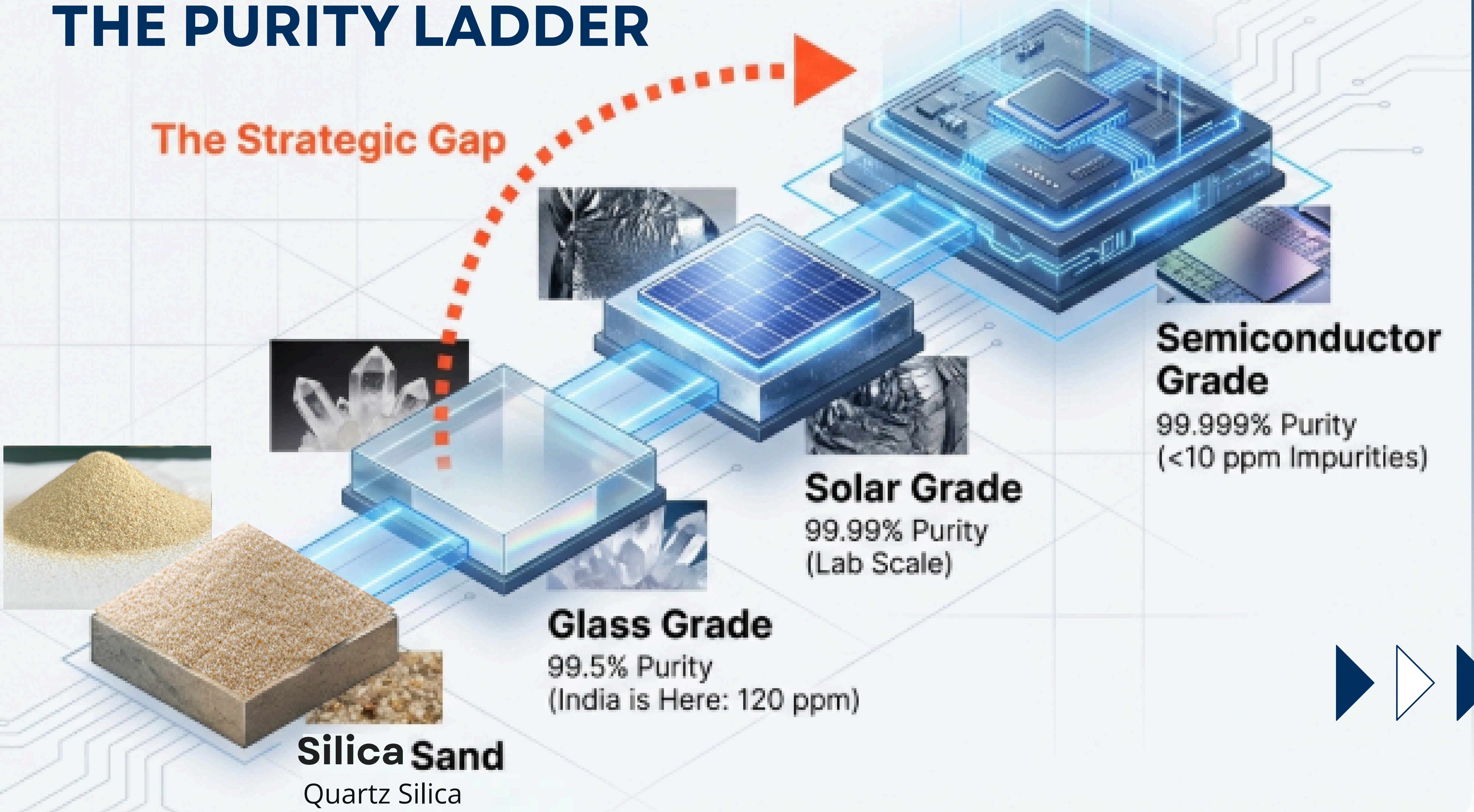
03

Unmet Challenge: Commercial-Scale Extreme Purity

- Requires parts-per-million/billion purity; precise control of trace elements (Fe, Al, Ti, B, Li, Na, K, P).
- Achieving consistent purity at scale remains an unsolved materials engineering problem.

The most strategic square on Earth - BBC

THE PURITY LADDER



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[Sand to Silicon Chip]

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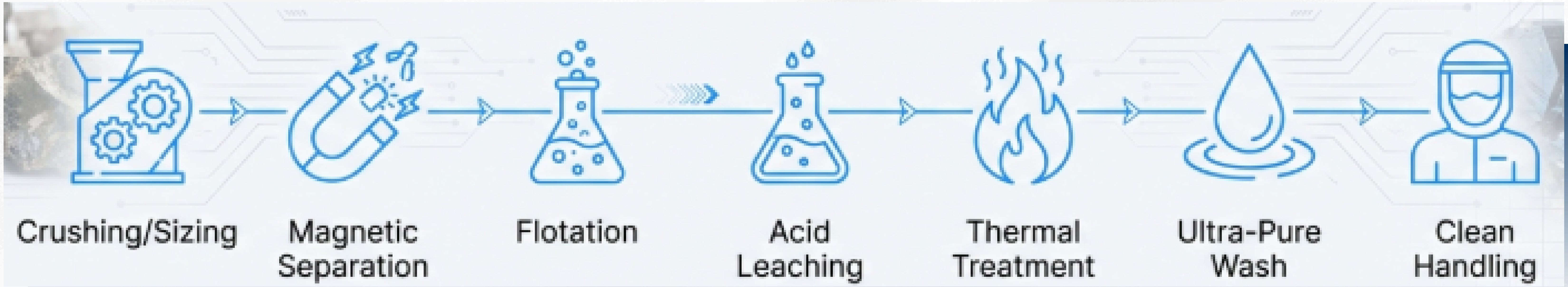
PROCESS JOURNEY



Liberating impurities without re-contamination.

High-intensity removal of iron (99% efficiency req).

Surface chemistry to remove feldspars, micas, and clays.

Chemical purification using HCl, HF, and H_2SO_4.

Calcination/Quenching to expose embedded impurities.

DI water rinsing to remove residual acids.

Packaging in Clean-room conditions.

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OPPORTUNITY

SUPPLY SECURITY

Reducing import dependence and enhancing resilience against global supply disruptions.

VALUE ADDITION

Enabling higher margins and industrial sophistication in high-tech value chains.

SKILL DEVELOPMENT

Creating high-quality technical jobs aligned with India's demographic dividend.

ECOSYSTEM INTEGRATION

Anchoring upstream supply chains to support national semiconductor missions.

EXPORT POTENTIAL

Positioning India as a reliable alternative global supplier once certified

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CHALLENGES

Seven Structural Barriers

- **GEOLOGY RARITY**
  Few deposits meet specs (Rajasthan, Odisha, Jharkhand need characterization)
- **PROPRIETARY TECHNOLOGY**
  <10 ppm processes = Trade secrets, not available for transfer
- **CAPITAL INTENSITY**
  $200M+ for greenfield facilities
- **LONG QUALIFICATION**
  12-24 months, lot-to-lot consistency demands
- **ENVIRONMENTAL COMPLIANCE**
  HF/H_2SO_4 effluent, silica dust management
- **ECOSYTEM GAPS**
  Limited downstream fabrication, logistics
- **TECHNOLOGY BARRIERS**
  Cannot rely on tech transfer, must develop indigenous R&D

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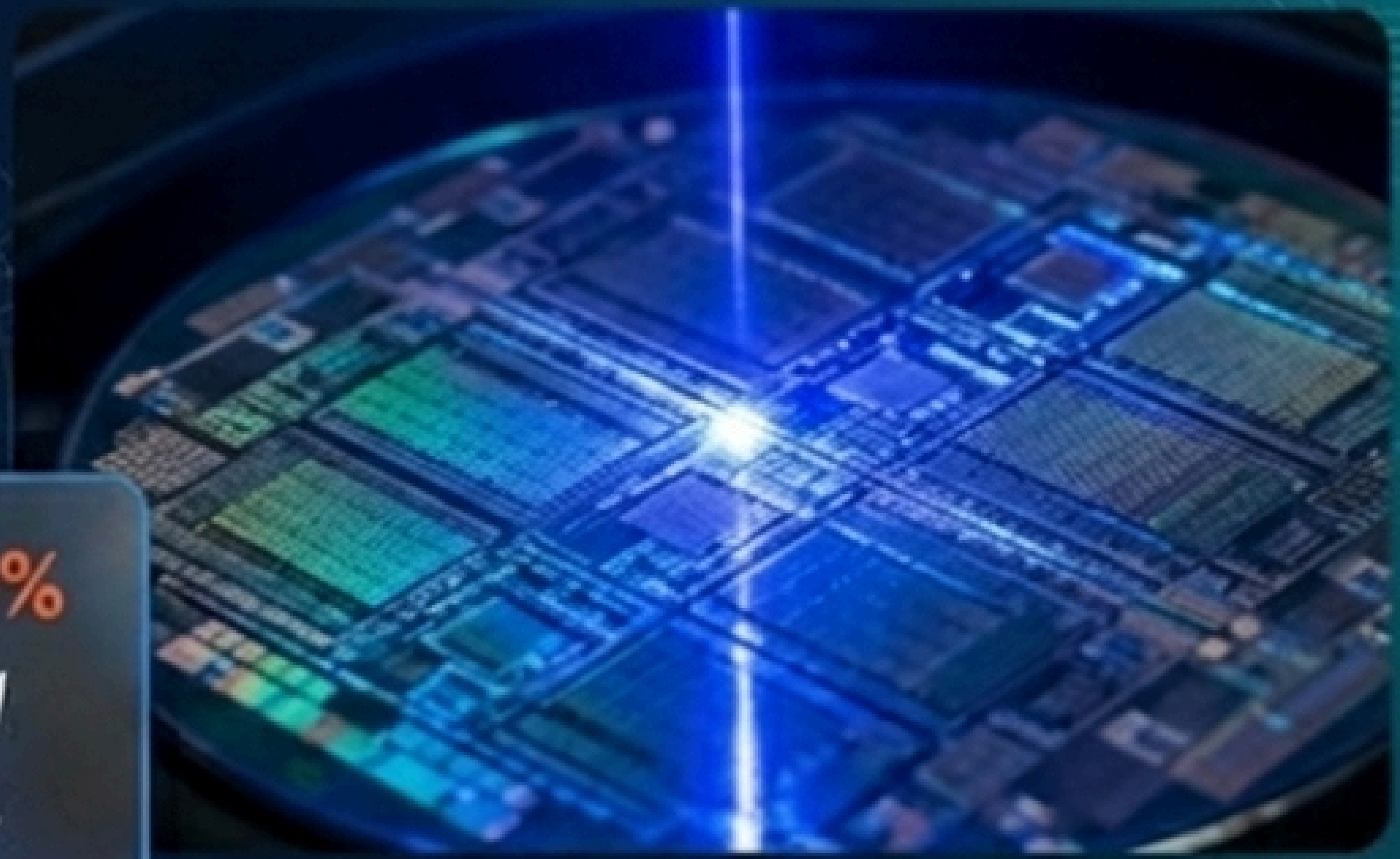
A Shift in Discipline, Not Just Spec



Task: Remove 99% of the *remaining* 0.5% impurities.

Glass Industry: 99.5% Purity

Tolerance in Parts Per Million (PPM).
Incremental Improvement.

Semiconductor Industry: 99.999% Purity

Tolerance in Parts Per Billion (PPB).
Fundamental Discipline Shift.

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WAY FORWARD

TARGETED EXPLORATION

Systematic surveys of Indian pegmatites (GSI partnership)

PUBLIC-PRIVATE PARTNERSHIPS

Government de-risk exploration, industry scale commercial

R&D & PILOT PLANTS

Bridge lab (100 ppm) → commercial (<10 ppm)

POLICY ALIGNMENT

Semiconductor Mission, PLI schemes, Atmanirbhar Bharat

SUSTAINABILITY

Energy efficiency, water recycling, acid recovery

GLOBAL STANDARDS

SEMI certification, international qualification

WAY FORWARD: A HOLISTIC ECOSYSTEM APPROACH

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ROLE OF ACADEMIC INSTITUTION

IIT BHU and similar institutions are uniquely positioned to bridge the gap through:

CHARACTERIZATION

Utilizing XRD, ICP-MS to understand purification potential.

PROCESS OPTIMIZATION

Refining leaching kinetics and thermal treatment.

SCALE-UP STUDIES

Bridging the 100 ppm to <10 ppm commercial gap.

WORKFORCE DEVELOPMENT

Training the next generation of materials scientists.

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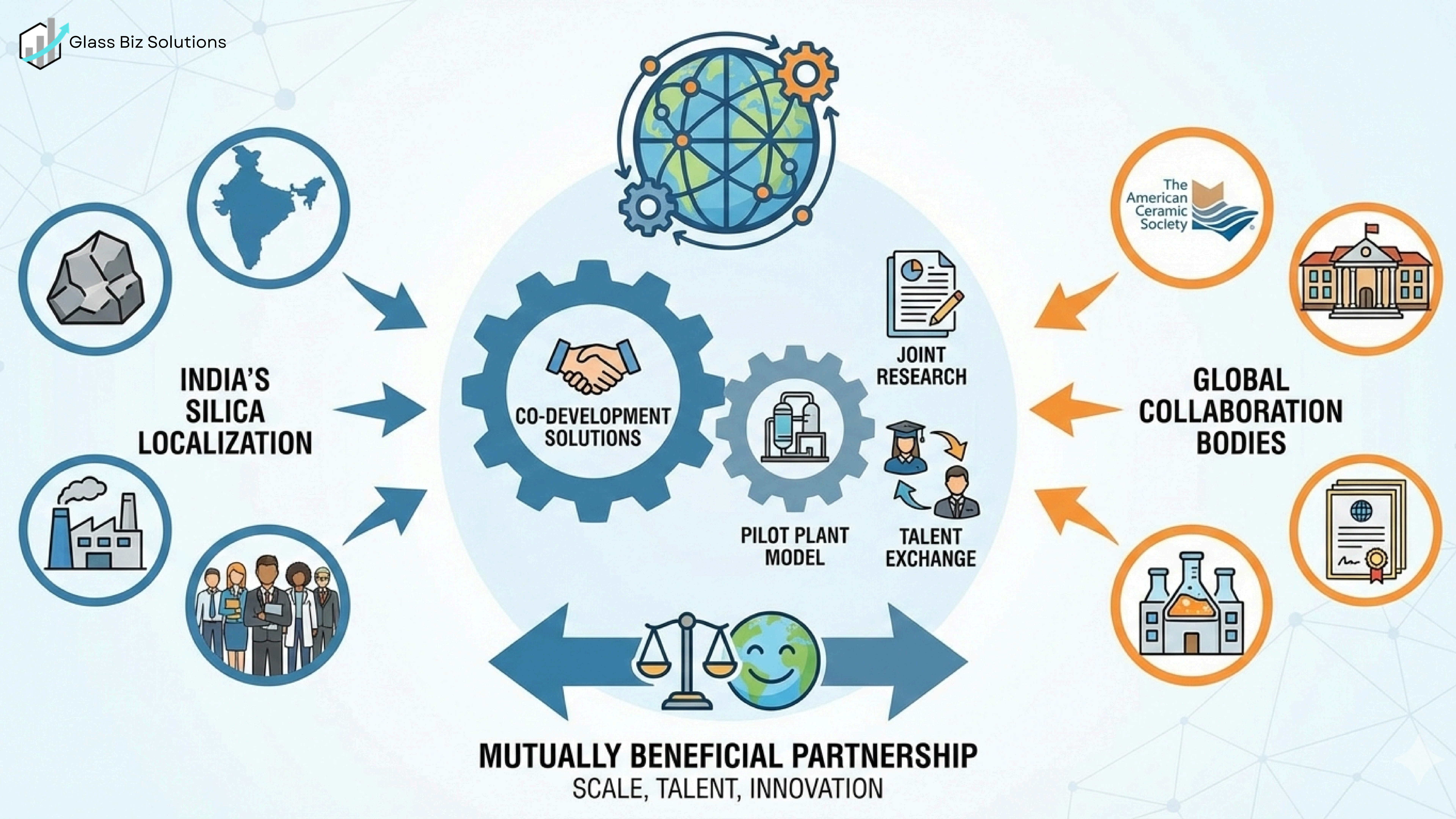
INTERNATIONAL COLLABORATION

Co-development, not technology transfer

INDIA	GLOBAL PARTNERS
✓ SCALE	✓ STANDARDS
✓ TALENT BASE	✓ HPQ EXPERIENCE
✓ GEOLOGY	✓ PROCESS KNOWLEDGE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INDIA'S SILICA LOCALIZATION
CO-DEVELOPMENT SOLUTIONS
JOINT RESEARCH
PILOT PLANT MODEL
TALENT EXCHANGE
The American Ceramic Society
GLOBAL COLLABORATION BODIES
MUTUALLY BENEFICIAL PARTNERSHIP
SCALE, TALENT, INNOVATION

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CONCLUSION

Transforming India from a materials importer to a qualified global supplier in the semiconductor value chain

2030

DEMAND GAP = ENTRY WINDOW

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LET'S CONNECT

For Students: Research mentorship, HPQ purification projects

For Faculty: Joint R&D, pilot plant partnership

For International Partners: Collaborative research, co-development

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