

Navigating ethical sourcing and compliance in PV supply chains

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Agenda

1. Current State of Play
2. Strategy 1: Big tried & tested top-tier mainland Chinese suppliers
3. Strategy 2: Smaller less scrutinized suppliers in SE Asia and India
4. Role of On-site Traceability Audits
5. Q&A

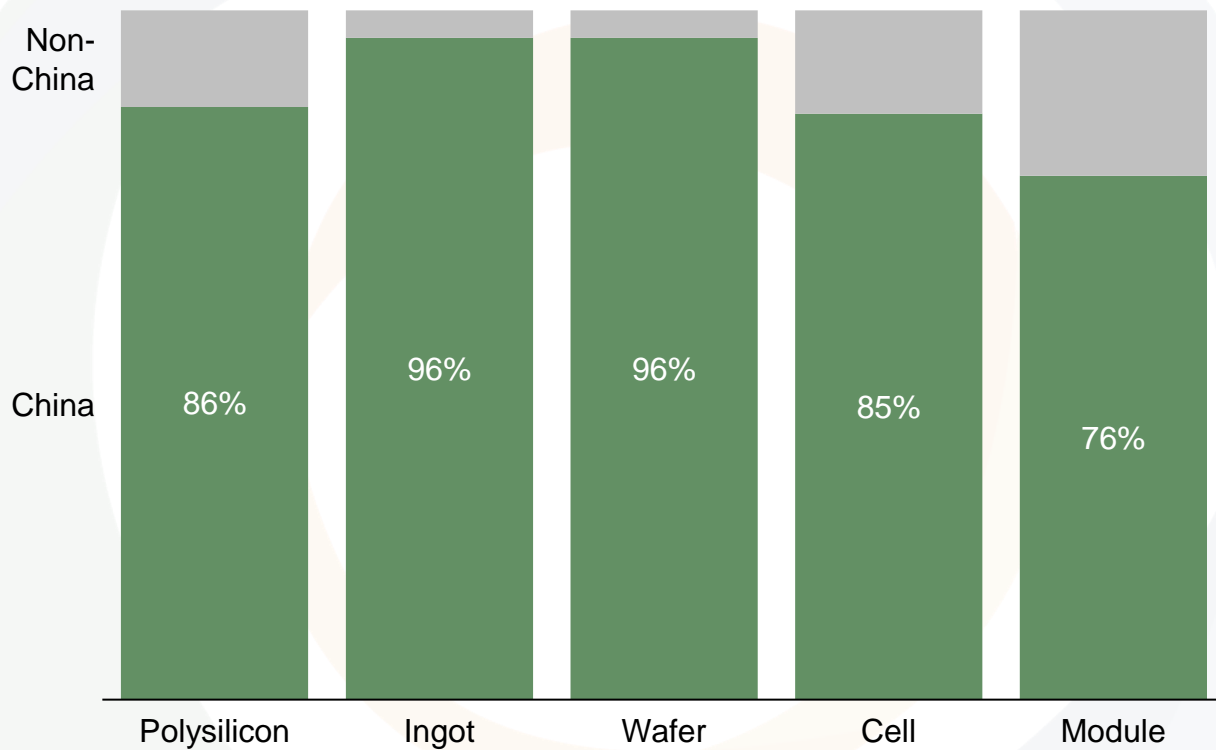
Poll-1: Are you currently using any traceability strategy for PV module procurement?

- Yes, we have our strategy in place
- I have some knowledge but not entirely sure how to implement our strategy
- No, we don't have a strategy in place
- Not Applicable

China maintains 70%+ of the silicon metal to module supply chain

Understanding the flow of raw materials is crucial due to the increased risk and uncertainty that exist in today's global PV supply chains

Supply chain capacity by location (%)



Market shifts in North America and Europe



United States: *Uyghur Forced Labor Prevention Act*
Canada: *Fighting Against Forced Labor & Child Labor in Supply Chains*
Germany: *Corporate Due Diligence Obligations in Supply Chains*



United States and Canada actively detain PV imports



E.U. Forced Labor Ban adopted



Individual company ESG policy compliance concerns grow



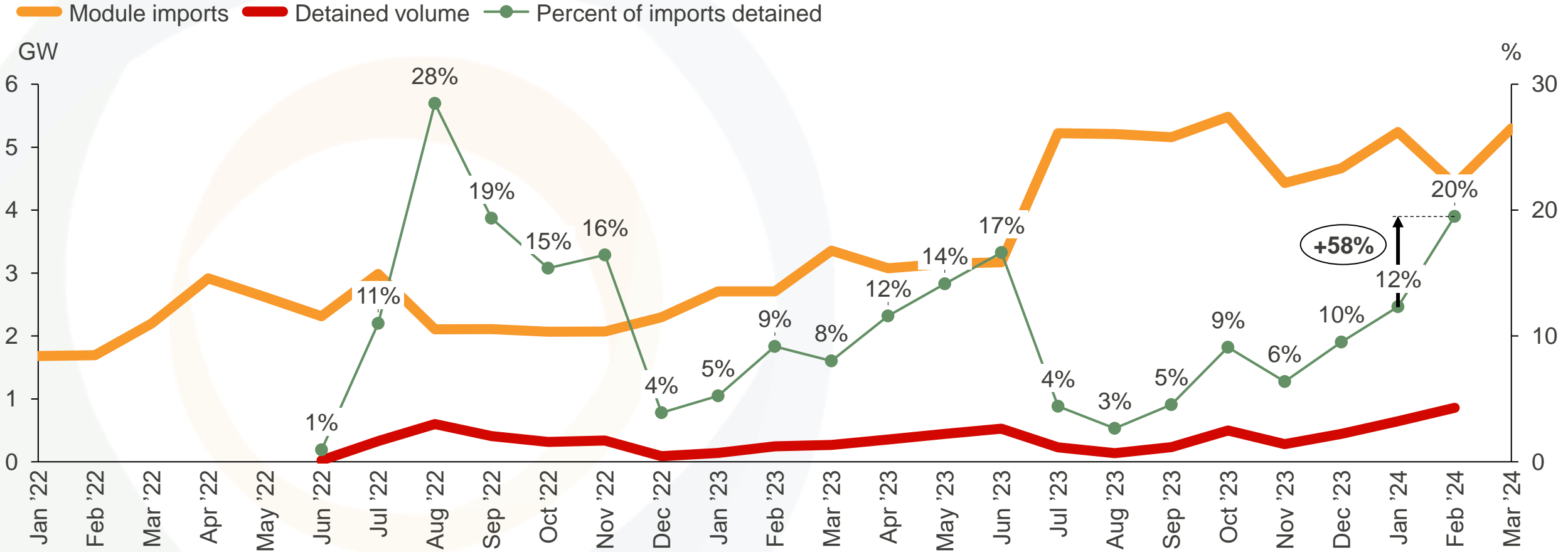
PR and shareholder apprehension on negative supply chain press rises

Notes | Quartz and silicon metal data are reported by the United States Department Of The Interior's Mineral Commodity Summaries and the Dongzheng Derivatives Research Institute (2021 end-of-year figures). Polysilicon to module manufacturing is tracked and reported by CEA based on supplier interviews, disclosures, press releases, and audits (2023 end-of-year figures).

Percent of U.S. imports detained hits second highest level on record

Detentions nearing ~1 GW per month in latest Customs' data

United States PV detentions vs. imports (GW, left) and detention rate (% , right)

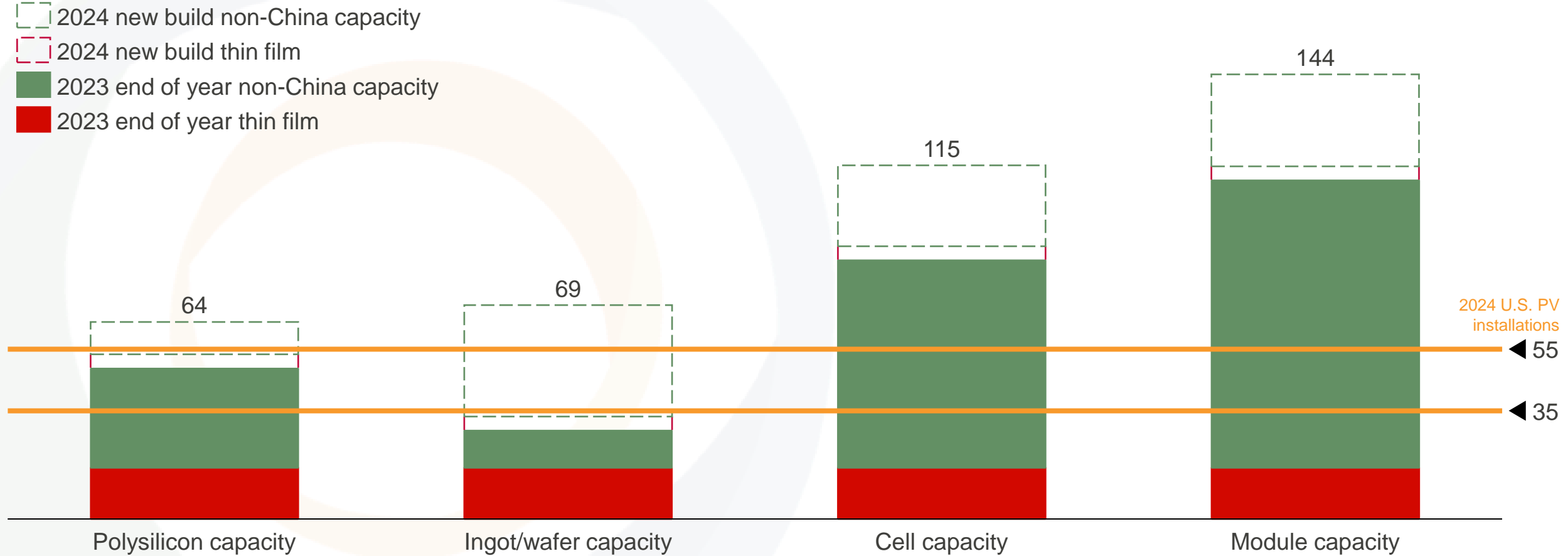


Notes | PV import data were reported as of February 29, 2024, by Datamyne using a conversion of 1 tonne = 0.017 MW (c-Si modules), 1 tonne = 0.012 MW (CdTe thin film modules). Detentions are calculated using a flat \$0.30/W transaction price from June 2022 to February 2024 where detention values are reported by Customs and Border Protection (CBP) for electronics.

'24 U.S. compliant polysilicon to wafer capacity situation improving

But time is still needed until more non-China capacity comes online

2024 non-China PV manufacturing capacity vs. expected U.S. PV installations (GWdc)



Notes | Capacity data aggregated by CEA accounts for ramp times or other production delays but not utilization, and removes capacity plans CEA deems unlikely to materialize. Tonnes of polysilicon production converted to GW at 2.3 g/W. 35 GW projected by SEIA-Wood (bear case, Solar Market Insight Report, 2023), 55 GW projected by EIA (IN-BRIEF ANALYSIS utility, January 2024 + SEIA DG outlook).

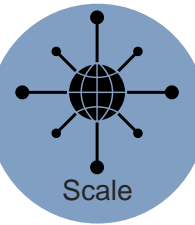
Benefits of using the big top-tier mainland Chinese suppliers

Relatively simpler supply chains – through vertical integration (module to ingot)



Experience being detained & then released by United States CBP, indicating a roadmap to success

Optimized to aggregate documentation at HQ or across facilities and vertical integration continues to move upstream (to polysilicon)



Through scale, they have more leverage upstream on their Polysilicon/MGS/Quartz suppliers



Some have locked in supply agreements for exclusively non-China Polysilicon for the U.S. and E.U. markets

Benefits of using the big top-tier mainland Chinese suppliers

- Immense capital expenditure on **best-in-class technology & quality systems**
- **Very mature traceability IT systems at export-oriented factories**, with more resources invested in ESG and factory operations on labelling/MES/automation

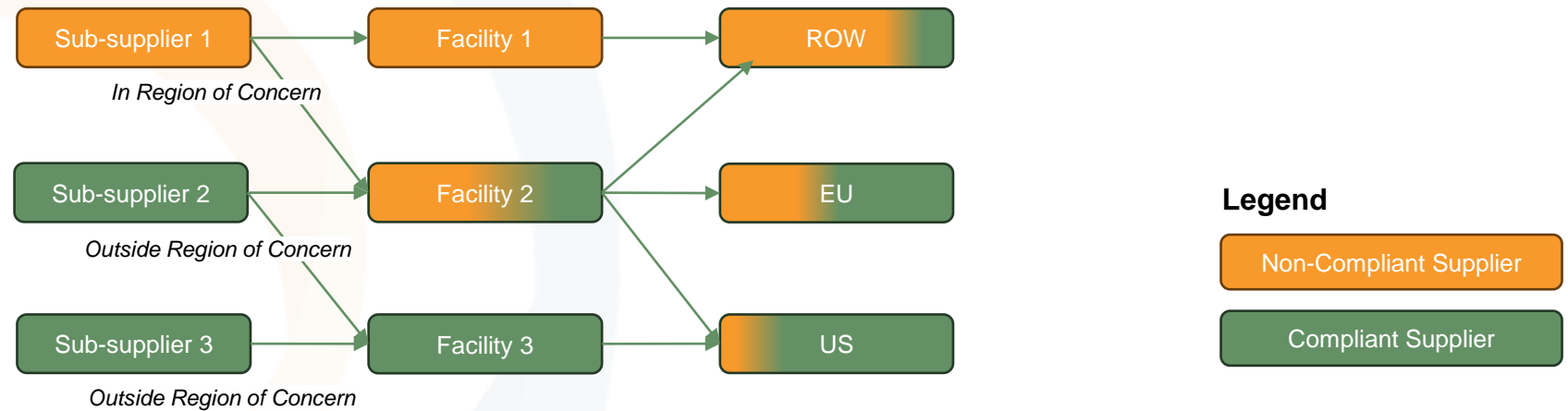


Example	Description
Materiality Assessment	Annual corporate social responsibility reports are complete with materiality analysis that tracks their corporation-wide impacts. The reports align with GRI/SASB Standards, UN Global Compact, and ILO Conventions.
Warehousing	Warehouse is sorted & labelled with vertical racks and exact pallet slots, displayed in the system for reference by operators/robots that will place and pick the materials – with rigorous verification measures with Purchase Orders/BOMs and error messages in case of inaccurate material selection. Warehouse equipped with a Warehouse Management System (WMS).
Workshop	Production workshop is equipped with a Manufacturing Execution System (MES) that logs records on the smallest units in real time.
Identification	Re-worked and Recycled materials are labelled, segregated, and recorded with links to exact projects. Visibly observable tags (QR or Barcodes) are affixed to recycled materials to differentiate them from fresh/virgin materials.

Drawbacks of using the big top-tier mainland Chinese suppliers

Cons

- Still in the **firing line / under pressure from accusations** in PV supply chain reports
 - Specifically, pressure is coming because of bi-furcated supply chains (US, EU vs. Rest of World)
 - The new US CBP Request for Information (RASA) is evidence of pressure increasing, not decreasing



- Confidentiality concerns due to technology and R&D advantages sometimes limit on-site evidence-gathering
 - Some are only undertaking documentary review, but not on-site auditing of their processes for verification

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Drawbacks of using the big top-tier mainland Chinese suppliers

- Vertically integrated suppliers still have **variation in audit results between factories** in the supply chain.
- Typically, there are **gaps in systems standardization & increasing risks** at wafer and ingot factories (suppliers that started at module and worked their way upstream)
 - This is not intentional malpractice – it is a capital resource allocation dilemma

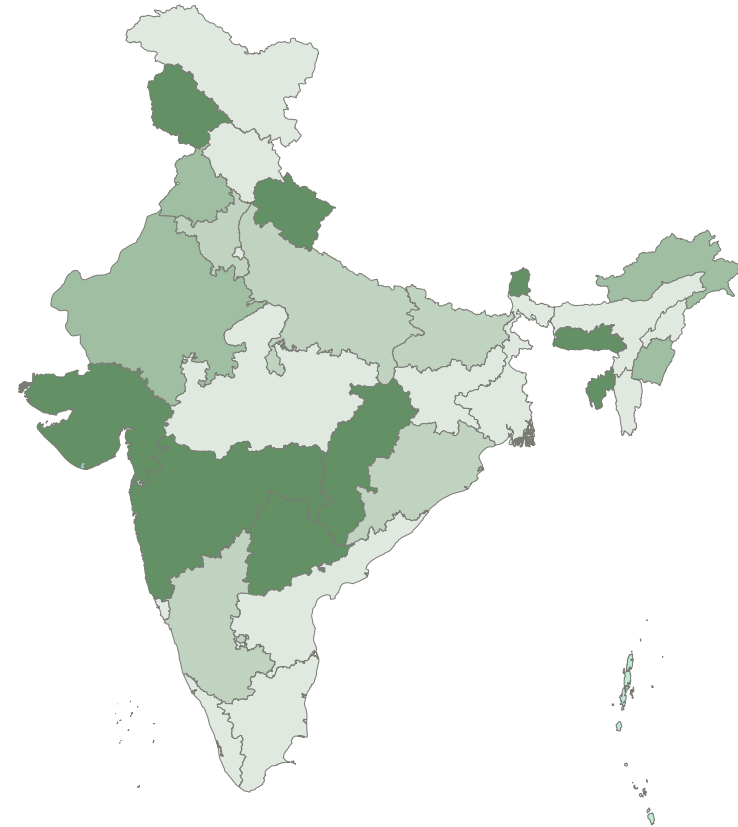
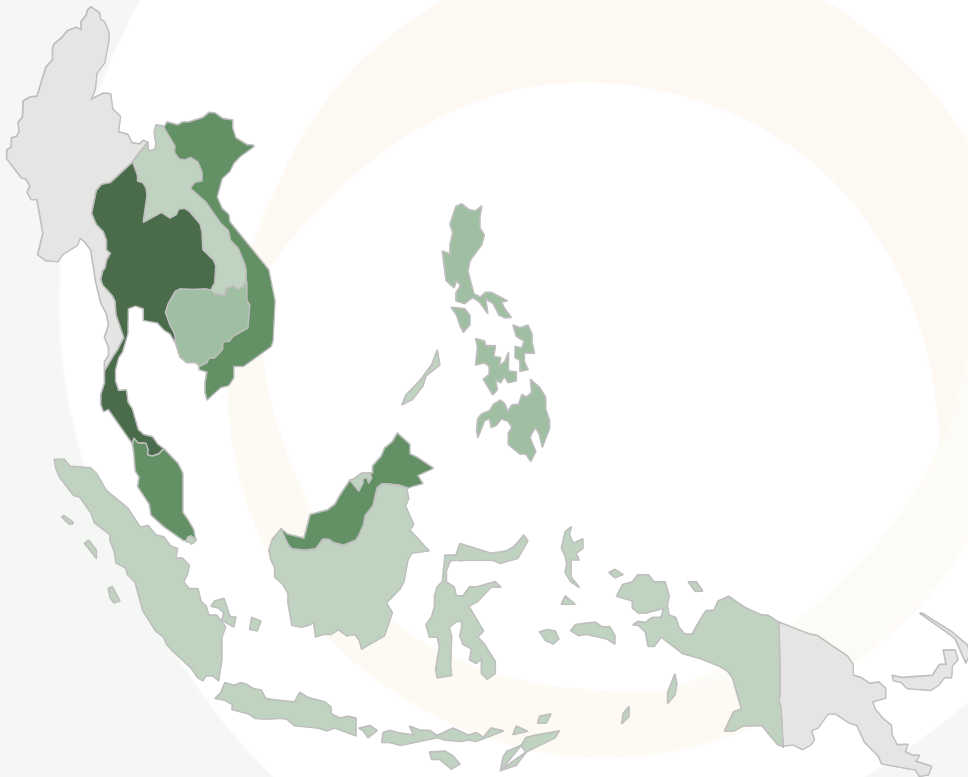
Example	Description
B2B vs B2C dynamic	Factories that are export oriented and customer facing, are typically the flagship. The factories farther away from the end consumer are often less prioritized with Capital Expenditure, as they are churning out generic intermediary goods.
Factory age related issue	<ul style="list-style-type: none">• The newer the factory, the more likely it is to have best in class technology.• There is a noticeable difference between some Chinese supplier's brand-new Thailand/Vietnam/Malaysia operations vs. their older legacy Chinese operations.• Factories that were built and operationalized without the most advanced WMS, or without an MES system, have a much harder time installing one while maintaining the same level of output.

More challenges yet more resiliency is the risk trade off that developers must consider.

Benefits of using the small Southeast Asian & Indian players

- Smaller suppliers that exist in fewer supply chain nodes have fewer factories to build/maintain
- Do not have the same level of variation between their in-house factories that exists among the big suppliers

- Not mentioned in PV supply chain reports alleging labor violations / not under as much pressure from governments
- Non-China corporate HQ and factory locations at the export-oriented nodes (module and cell)



Benefits of using smaller SE Asian & Indian suppliers

- **Big developers have more leverage over small suppliers**, based on project volume/scale
 - Example contract provisions:



Supply Chain Map

- Supply chain map limitations
- Bill of Materials (BOM) and Whitelist requirements



Best Endeavors

- Supplier must demonstrate Best efforts to get the most information & access possible from upstream supply chain partners



Independent 3rd Party Auditor Requirement

- Documentary audits
- On-site audits
- Traceability Sampling
- Align with chain of custody scope (Corporate social responsibility, Supplier Qualification, Purchasing, Warehouse, Workshop, Packaging)



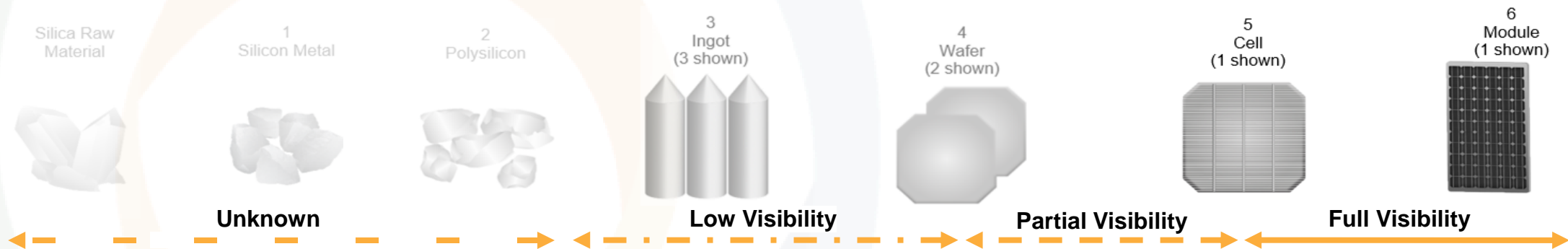
Commitment

- Commitments to continuous improvement
- Sunset clauses in the case of non-cooperation

Drawbacks of using small SE Asian & Indian players

Cons

- **Lack of experience with detentions-release processes**
 - Traceability packages are being prepared in anticipation of future detention, but often still need a lot of improvements especially on story-telling to link the documents together in a digestible manner.
- More **complex supply chains carry more risks for roadblocks** in upstream visibility and audit access at ingot & wafer (as the small players have Less leverage to incentivize cooperation)



- **Supply chains to wafer, ingot, polysilicon and further are still rooted firmly in China**
 - Often smaller players are also using OEMs, and traders that complicate supply chain relationships & limit standardization

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Drawback of using small Southeast Asian and Indian players

- Smaller suppliers have **less resources invested in traceability readiness**.
 - The catch: these suppliers have also faced less pressure/need to invest, specifically because they face less immediate risk of detention.
- The **traceability capabilities are typically weaker** due on record keeping, standardization, and automation.
 - Due Diligence scores, and:

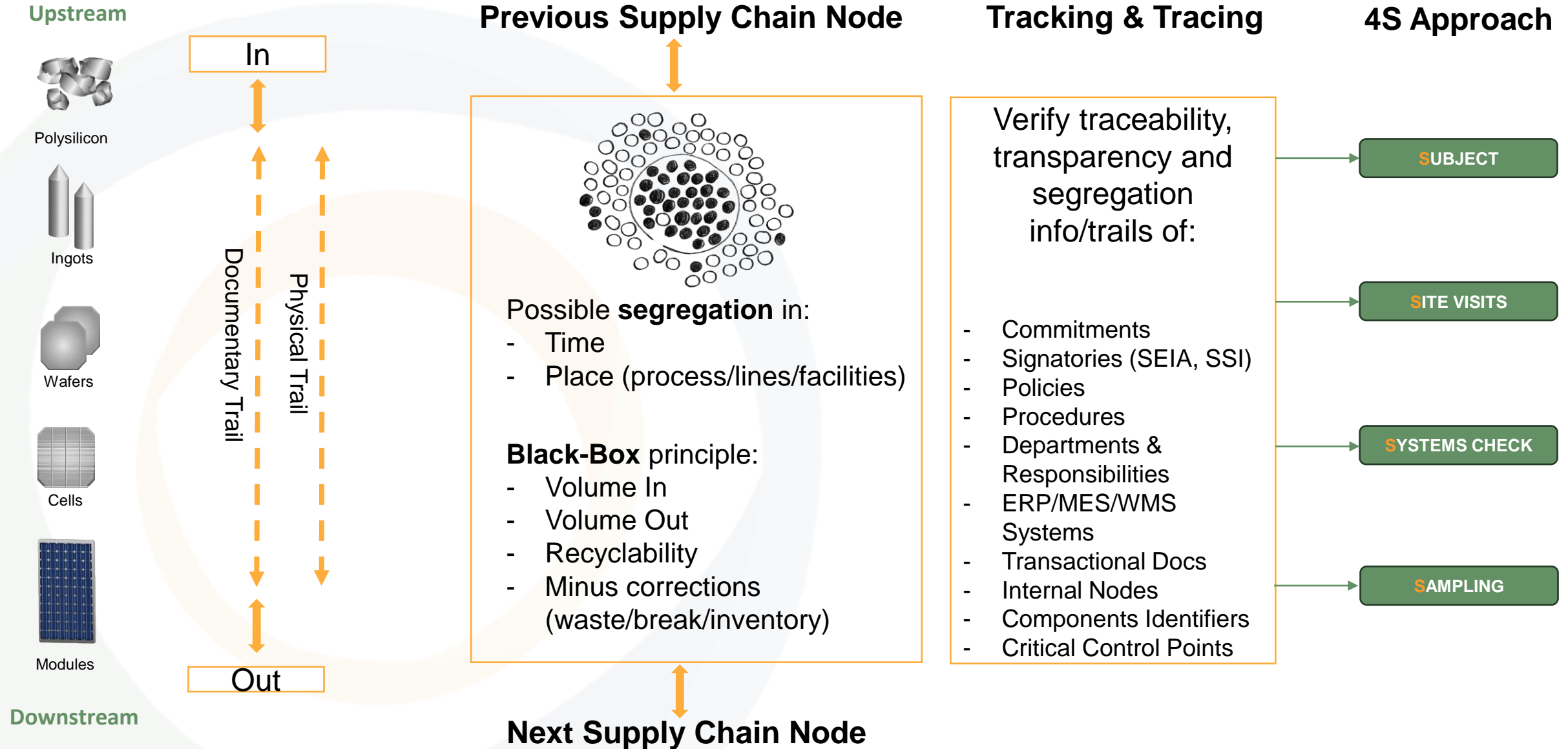
Example	Description
Supplier Qualification	Emphasis on quality & delivery terms, but not evaluating suppliers on ESG and Traceability to check compliance on Code of Conduct.
Purchasing & Warehouse	Can link PO number to incoming materials batches for verification, but does not indicate a specific purchase type indicator for US-market, EU-market, vs. other markets.
Production workshop	Often weaker on warehouse management system (WMS) and manufacturing execution system (MES) integration, and SOPs less codified to trace smallest unit, especially during re-work.

Developer's willingness to engage in deeper due diligence and supplier capacity building must be considered.

Poll-2: How much visibility of your PV supply chain do you currently have?

- Full visibility (Module-to-Polysilicon, MGS, Quartz)
- Partial visibility (Module and/or Cell, Wafer, Ingot, Polysilicon)
- No visibility (Module only)
- Not Applicable

Recommendations for Supply Chain Audit Flow



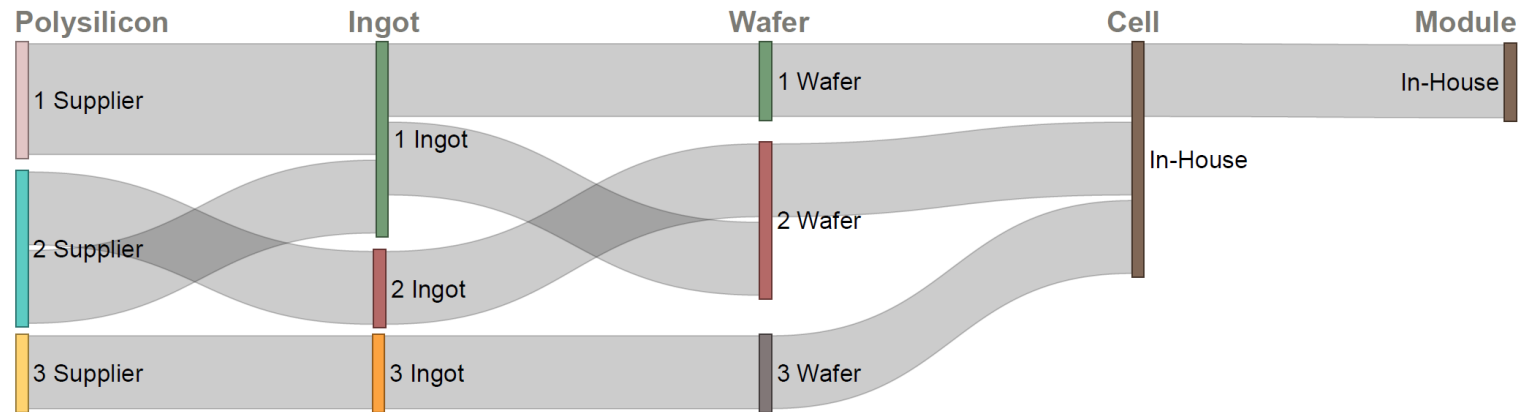
Case Study – Traceability and 4S Auditing Principle

Profile:

- Client with Traceability Requirements from their Lenders
- Well-known PV supplier offering semi-vertical integrated BOM solution.
- Buyer-Seller Agreed BOM included one medium risk supplier at Ingot/Wafer node (referred in a PV supply chain report)
 - All Polysilicon suppliers whitelisted due a ESG-Market Intelligence work (Virtual Supply Chain Map)
 - Ingot-1 and Wafer-1 affiliated companies
 - Ingot-2 and Wafer-2 affiliated companies w/ reference to historically have purchased from Region of Concern
 - Ingot-3 and Wafer-3 non-affiliated companies



Polysilicon	Ingot	Wafer	Cell	Module
Supplier 1 ●	Ingot-1 & Wafer 1 ●		In-House ●	In-House ●
Supplier 2 ●	Ingot-2 & Wafer 2 ●			
Supplier 3 ●	Ingot 3 ●	Wafer 3 ●		








Problem: Verification of Silicon-based materials on the produced modules.

Solution:

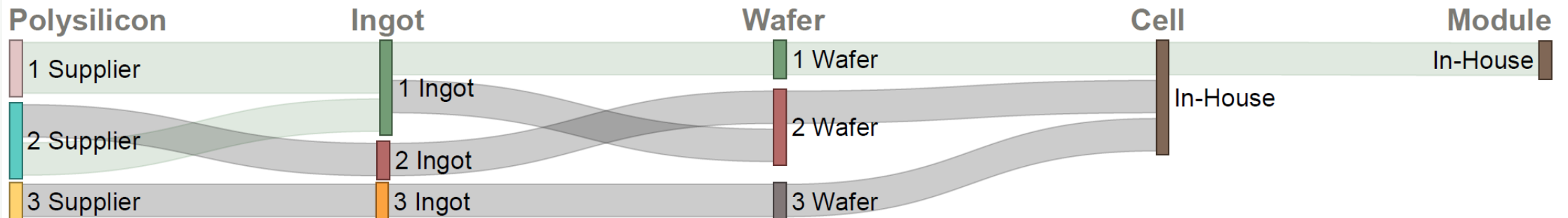
Desktop Review + Onsite Audit + Traceability Provenance Sampling

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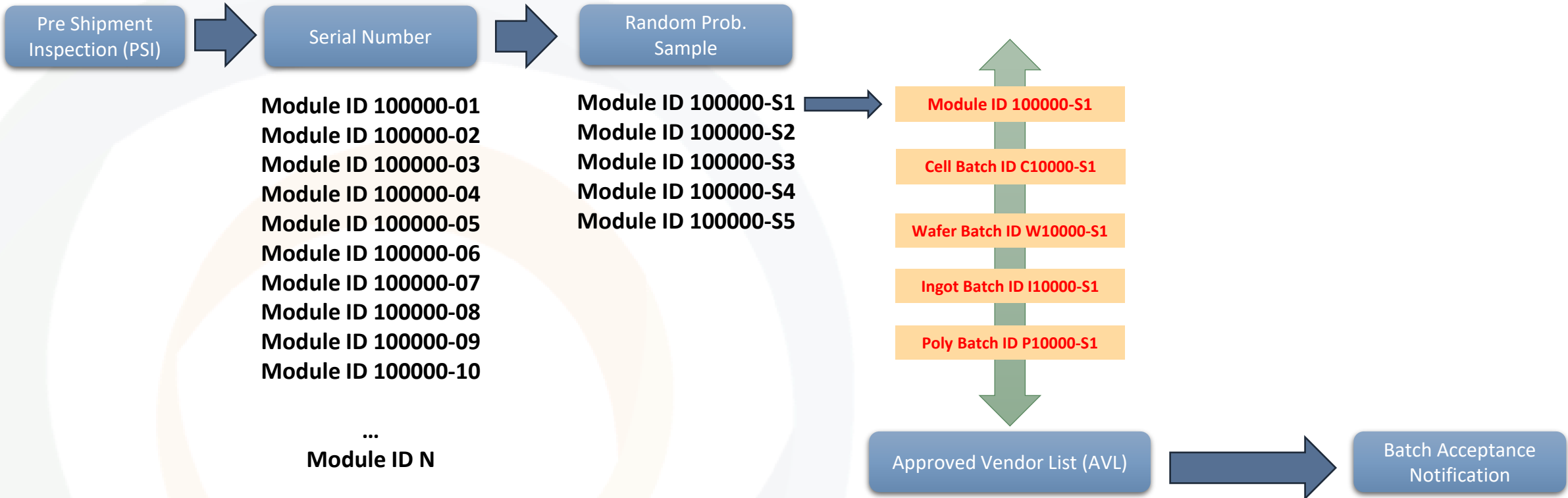
Case Study – Traceability Storytelling

				
Module	Cell	Wafer	Ingot	Polysilicon
Module Supplier Ltd. (In-House)	Cell Supplier Ltd. (In-House)	Wafer-1	Ingot-1	Polysilicon Supplier 1 & Supplier 2

Sample N	Client-Supplier Sales Contract	Container	SN	Pallet No.	Cell Batch	Cell Invoice	Cell-Wafer Contract	Wafer Delivery Note	Wafer Batch	Ingot Delivery Note	Ingot Batch	Polysilicon Delivery Note	Ingot-Polysilicon Contract	Polysilicon PO	Polysilicon Quantity (Kg)
1	PO-20240410	MEDU8888	M100000-S1	PL1000A20240408	C100000-S1	C-INV-2404-12	Cell-Wafer1 Contract	WDN10012	WB240315-1	I-DN2403-08	IB240222-1B	PDN-X24015-12	Ingot-1 & Supplier 1 Contract	S1PO-20240110	20,500
2			M100000-S2	PL1000A20240406	C100000-S2	C-INV-2404-10			WB240315-3		IB240222-1	PDN-X24015-12			25,500
3			M100000-S3	PL1000A20240406	C100000-S3	C-INV-2404-22		WDN10015	WB240315-1A		IB240223-2A	PDN-X24015-12	Ingot-1 & Supplier 2 Contract	S2PO-20231231	23,500
4			M100000-S4	PL1000A20240407	C100000-S4	C-INV-2404-24		WDN10014	WB240315-4	IB240224-4	PDN-X24015-12	20,500			
5			M100000-S5	PL1000A20240401	C100000-S5	C-INV-2404-30		WDN10018	WB240315-5	IB240223-5	PDN-X24015-12	Ingot-1 & Supplier 1 Contract	S1PO-20240110	23,500	



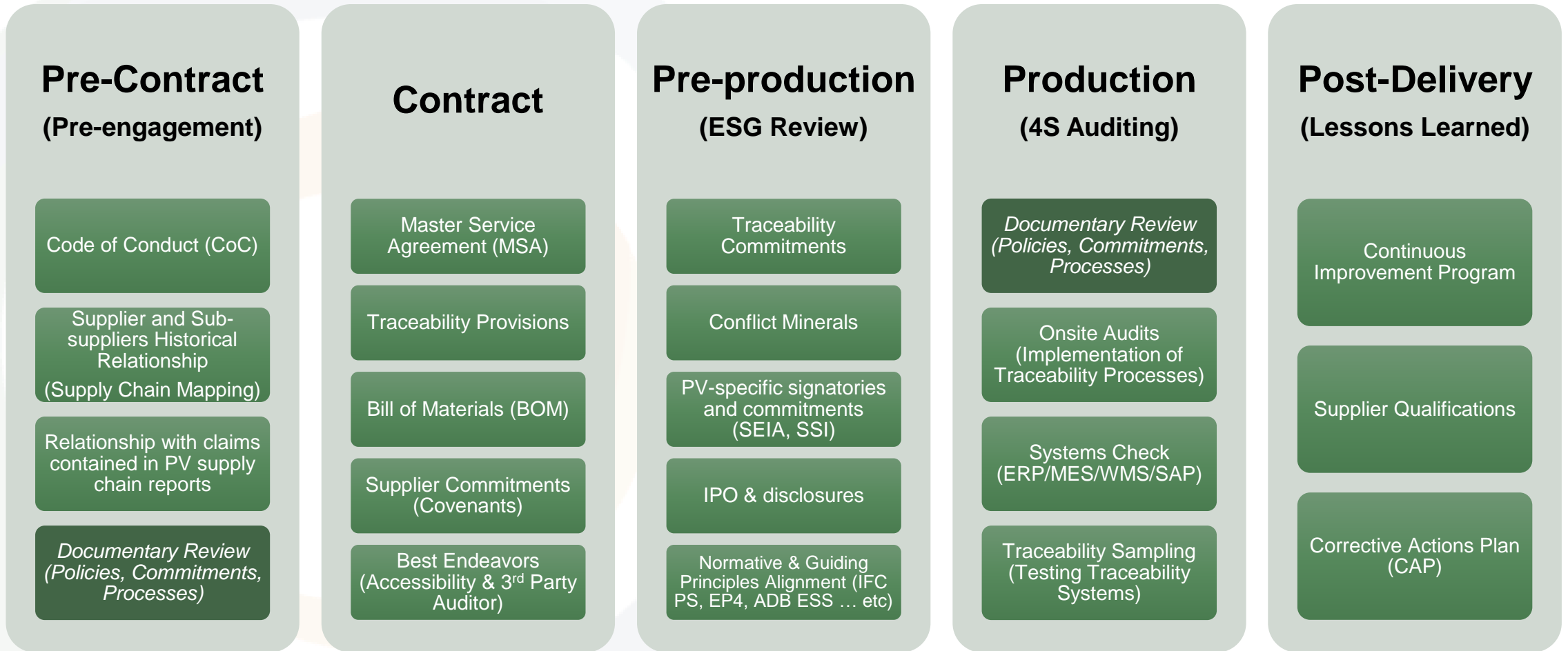
Traceability Provenance Batch Acceptance



Approved Vendor List	Checked
Polysilicon Supplier 1	✓
Polysilicon Supplier 2	✓
Polysilicon Supplier 3	✓
Polysilicon Supplier 4	✓

Recommended Due Diligence Framework Lifecycle

Options for buyers



Poll-3: What is driving your requirement for traceability?

- Market Compliance
- Lenders & Financiers
- Final Clients
- Associations
- Others

Q&A Section

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Thank You

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