

LAPLACE RENEWABLE ENERGY TECHNOLOGY CO., LTD.

Powering Global Solar Manufacturing

Technology | AI | Facilities | Services | Operational Excellence

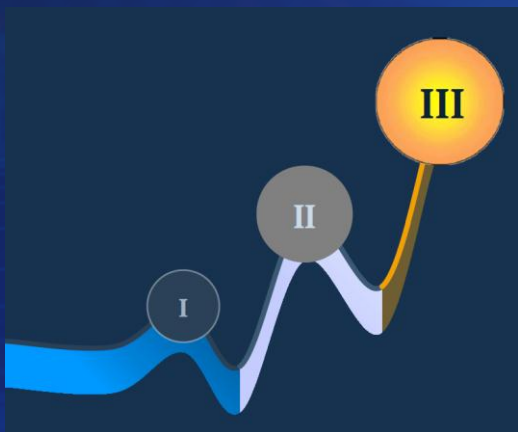
Speaker: Dr. Kamel Ounadjela

Oct. 13-14 | PV CellTech USA 2026

LOOKING BACK | THE MW-SCALE ERA

THE THIRD WAVE

Presentation by Charlie Gay
Solar Manufacturing 2026, USA



Watts → from kW → MW → GW

Every price drop opened a bigger market

EXPERIENCE FROM THE SECOND WAVE



2010 60 MW

Sunnyvale, California
20 miles from here

CaliSolar | Sunnyvale
Co-founded by Kamel
Ounadjela

Integrated Silicon ingot,
wafer and cell
manufacturing

FROM EARLY U.S. SOLAR MANUFACTURING TO TODAY'S GIGAWATT SCALE

THE NEXT CHAPTER | GW-SCALE MANUFACTURING



	SECOND WAVE 2010	THIRD WAVE 2026
Factory capacity / year	60 MW	min. 1 GW (1 wet line)
Printing throughput	~1,200 w/h	>9000 w/h
Cell efficiency	~ 16%	~ 26%
Module power	250 W (60 full cells, 18.0 ft ²)	670 W (66 full cell eq., 29.1 ft ² , 66% more power per area)
Global module price / W	~ \$2.3 ¹	~ \$0.09 ¹

¹ VDMA ITRPV, 17th Edition (2026); inflation-adjusted to 2025 dollars

2026

THE NEXT CHAPTER OF U.S. SOLAR MANUFACTURING

Applying two decades of
global manufacturing
progress to U.S.
gigawatt-scale factories.

- CLOSING THE LOOP: BRINGING GLOBAL SCALE BACK TO U.S. MANUFACTURING
- LESSONS FROM THE SECOND WAVE: WHAT DID WE LEARN IN THE 2ND WAVE THAT WILL ENABLE TO MAKE THE THIRD WAVE SUSTAINABLE

WHO IS LAPLACE

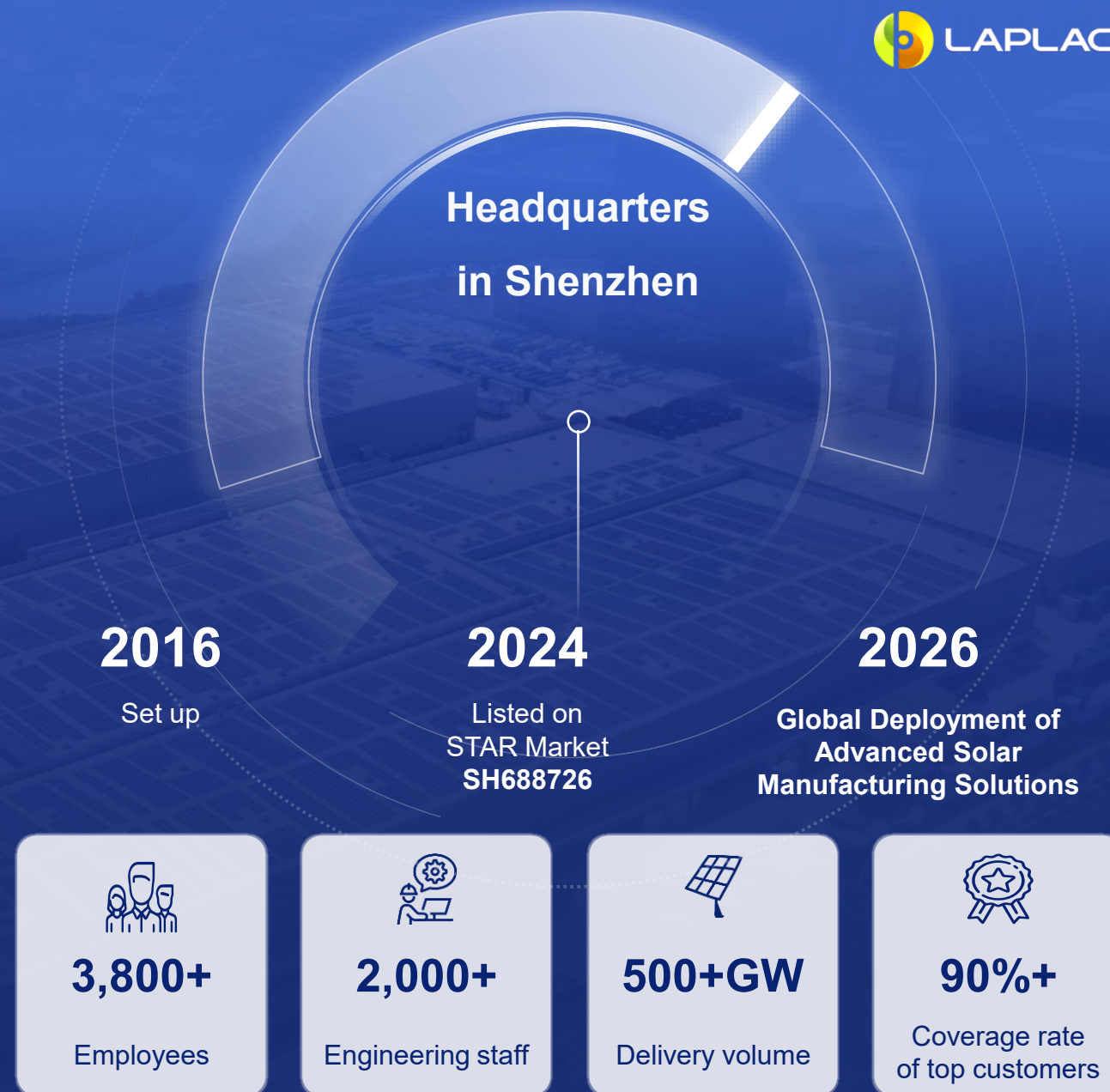
FROM TECHNOLOGY PIONEER TO GLOBAL MANUFACTURING PARTNER

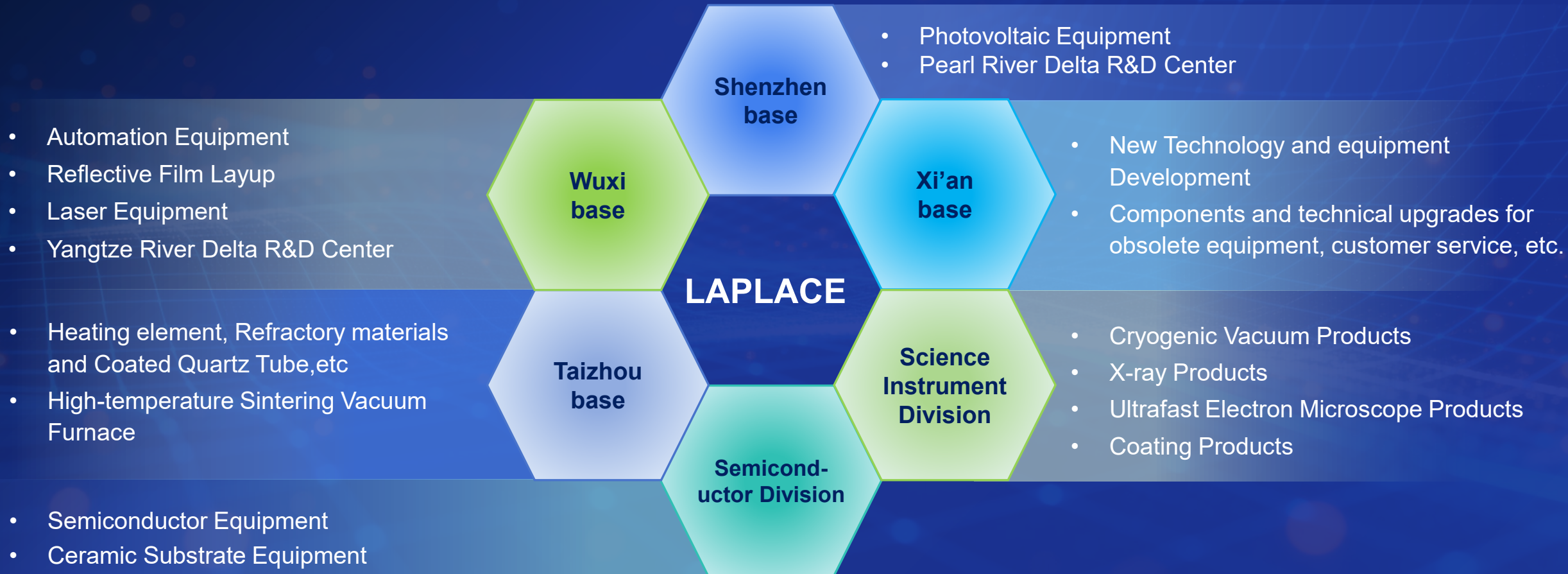
COMPANY OVERVIEW



Multiple Breakthroughs in Solar Innovation :

- Pioneer of TOPCon for mass production
- Vanguard of TOPCon+
- Innovator of Back Contact (BC) with 100% market share
- New deposition platform for perovskite-based tandem





LAPLACE INTERNATIONAL SINCE 2023



SUPPORTING INTERNATIONAL EXPANSION IN PV OUTSIDE CHINA

INTERNATIONAL CUSTOMERS

- USA
- INDIA
- SOUTH EAST ASIA
- TURKEY
- EUROPE
- AFRICA



LAPLACE USA

Supporting the Growth of U.S. Solar Manufacturing



PROVEN U.S. CUSTOMER BASE

Working with leading U.S. solar manufacturers



Supporting projects from equipment and technology delivery through manufacturing scale-up and ramp-up.

Equipment

Process & Tool
Delivery

Integration

Factory & Data
interfaces

Ramp-Up

On-site manufacturing
support

LOCAL EXECUTION

**Global expertise.
Local U.S. support.**

Dedicated U.S. Team

Project • Service • Engineering

Growing Local Capability

Service • Spare Parts • Supply Chain

**Backed by Laplace's global
engineering organization**

GLOBAL PV MANUFACTURING EXPERIENCE → LOCALIZED FOR THE U.S.

TECHNOLOGY & IP STRENGTH

SUPPORTING CUSTOMER FREEDOM TO OPERATE

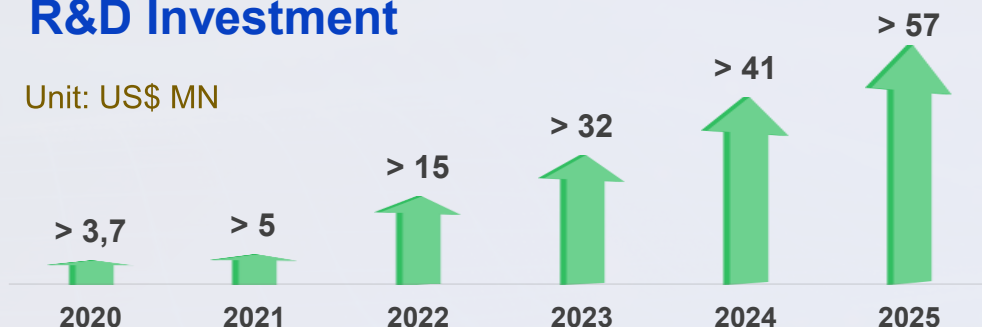


STRONG R&D FOUNDATION

\$146M+ cumulative R&D investment supporting continuous process and equipment innovation.

R&D Investment

Unit: US\$ MN

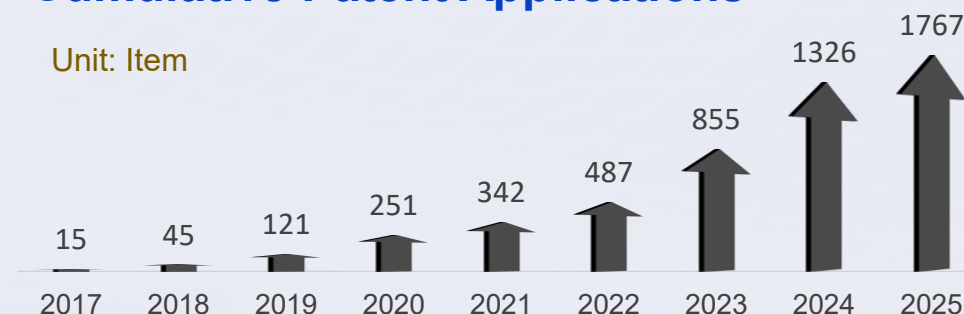


EXTENSIVE IP PORTFOLIO

1,700+ patent applications | 1,000+ granted patents protecting key equipment and process innovations..

Cumulative Patent Applications

Unit: Item



CONTINUOUS FTO MONITORING

Active monitoring of the global patent landscape helps identify IP risks early and supports timely technology adaptation.

CUSTOMER FTO SUPPORT

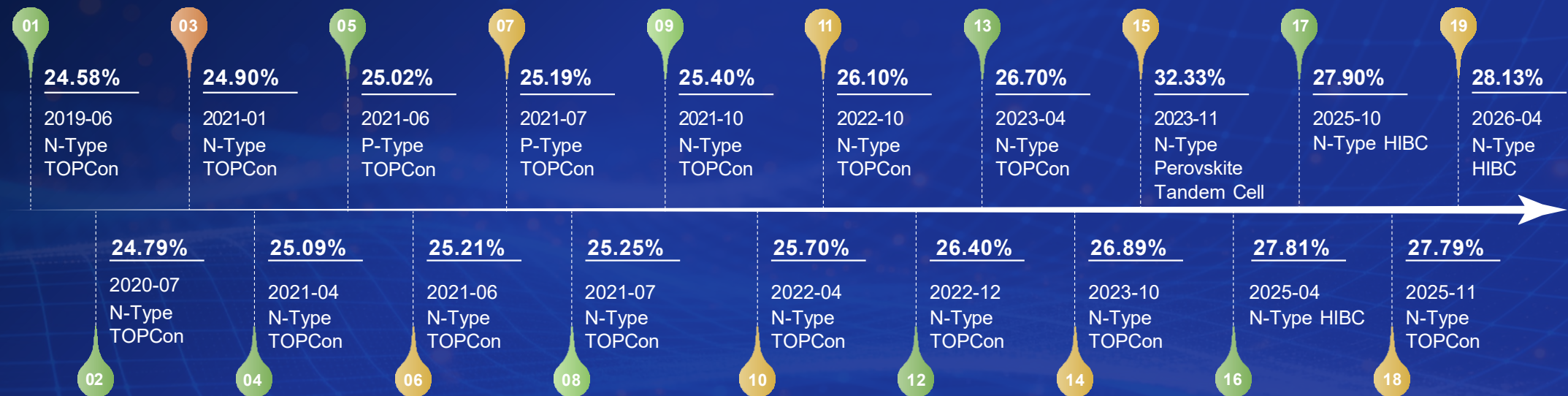
Laplace's proprietary TOPCon process and LPCVD with ex-situ doping provide customers with a differentiated technology pathway for global markets, including the U.S. and Europe

INNOVATION THAT DELIVERS PERFORMANCE — WITH IP STRATEGY BUILT IN

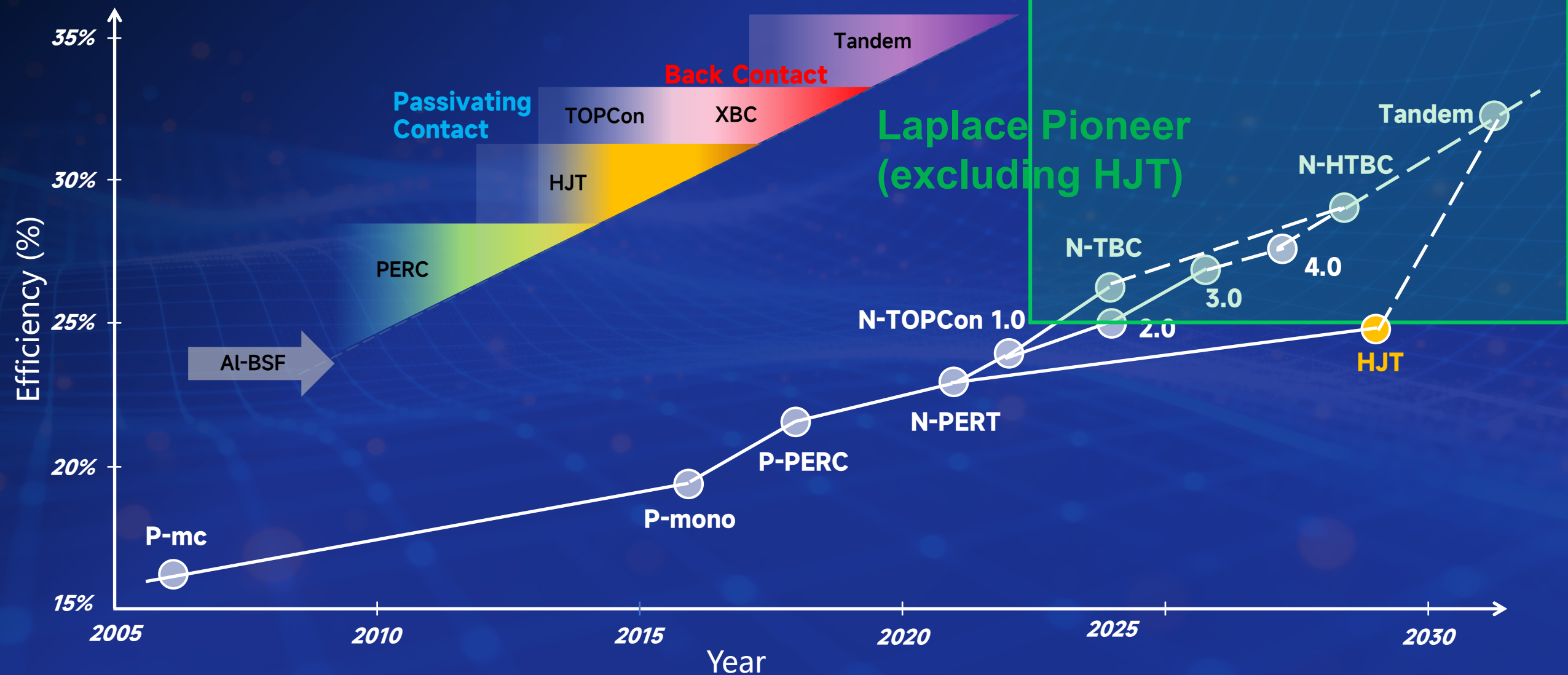
WHERE LAPLACE LEADS

FROM TECHNOLOGY BREAKTHROUGHS TO MASS PRODUCTION

ENABLING CUSTOMERS TO REACH NEW EFFICIENCY RECORDS



LAPLACE CELL TECHNOLOGY ROADMAP



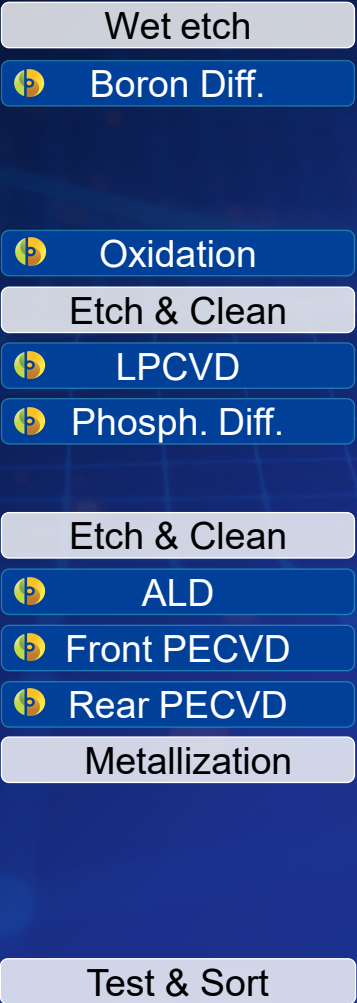
LAPLACE TOPCON TECHNOLOGY ROADMAP



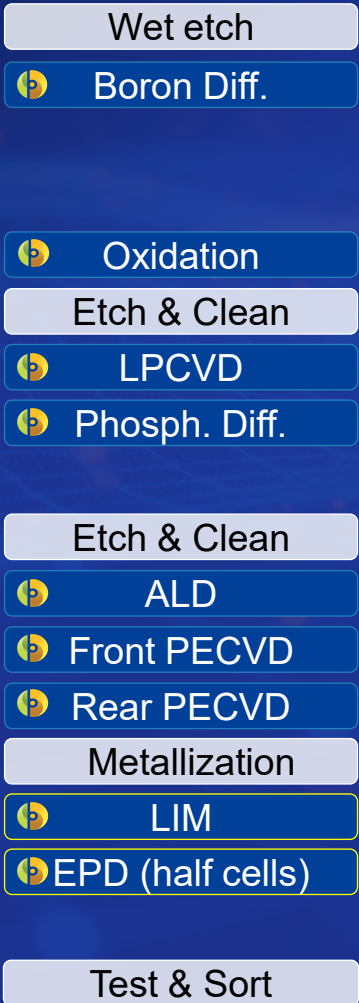
TOPCON PROCESS FLOW AND EVOLUTION



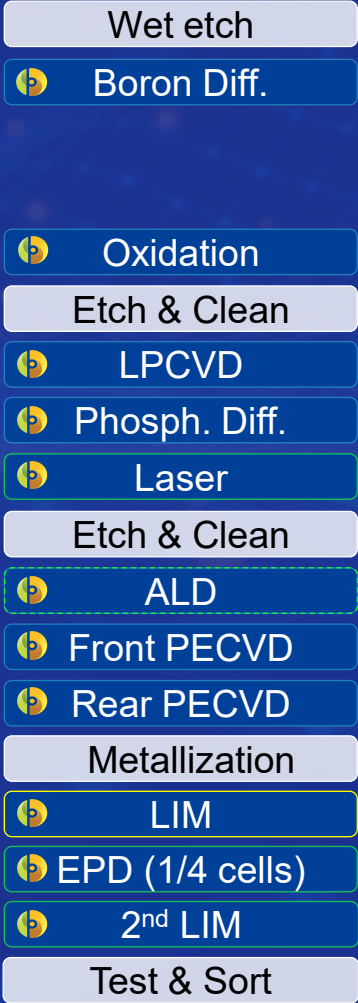
First to enable HVP TOPCon 1.0



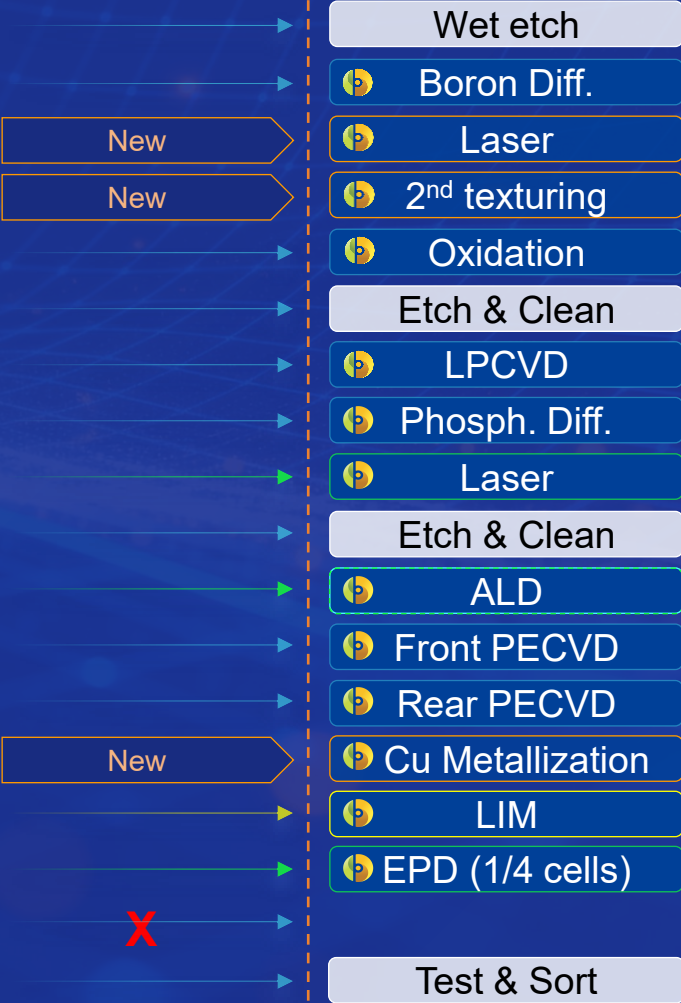
First to enable HVP TOPCon 2.0



Only Equipment maker for TOPCon 3.0



Pilot test/production TOPCon 4.0



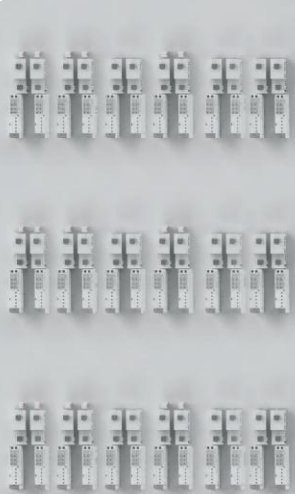
A fully integrated layout optimized for manufacturing performance, cost, and speed



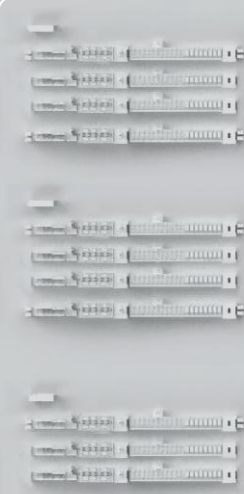
TOPCon 1.0



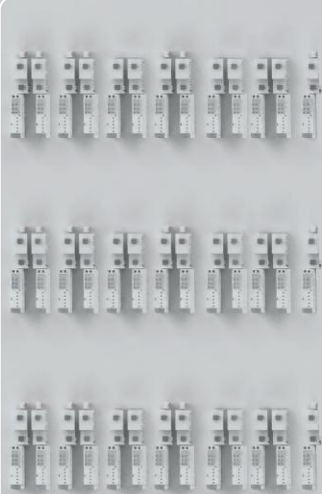
Batch
Texture



Boron &
Oxidation

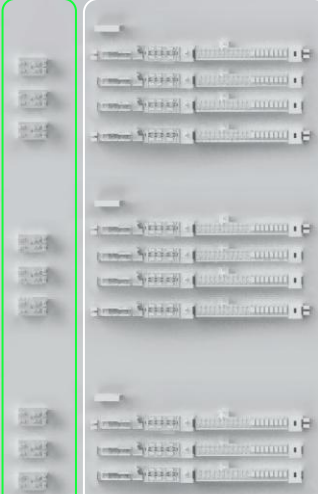


BSG Removal
& Polish

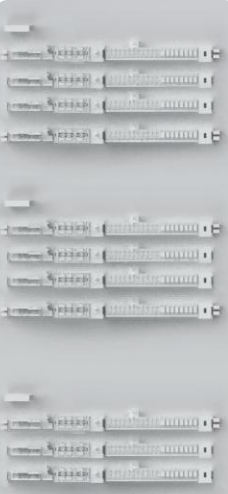


LPCVD Phosphorus
Diffusion

TOPCon 3.0



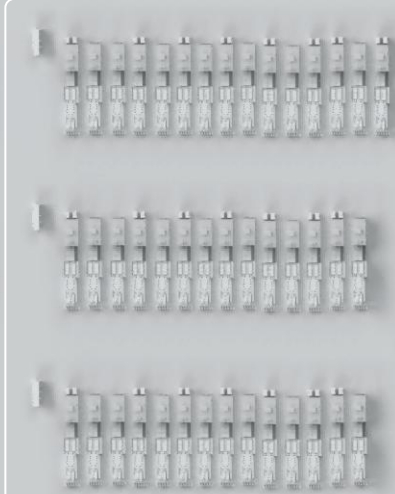
Poly
Finger



PSG Removal &
RCA

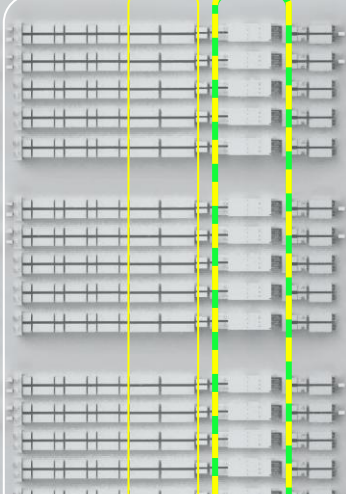


ALD



Front
PECVD Rear
PECVD

TOPCon 2.0



Printer LIM
EPD Test &
Sorter

LAPLACE Equipment Portfolio



Boron Diffusion



LPCVD



ALD



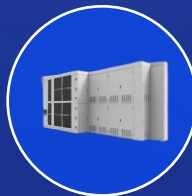
Laser induced
Metalization (LIM)



Poly Thickness
Removal via Laser
Ablation



Oxidation &
Annealing



Phosphorous
Diffusion



PECVD



Loading, transfer, up to
full automation for entire
cell line



Laser film
opening for
xBC



Atomic Edge Passivation
Complete
Solution

LAPLACE — BACK CONTACT LEADERSHIP AT SCALE

FROM FIRST PILOT LINE TO 100+ GW DEPLOYMENT



Leading Equipment maker for BC

- Wet etch
- Rear LPCVD1
- Rear Boron Diff.
- Laser
- Etch & Clean
- Rear LPCVD2
- Rear Phosphorus Diff.
- Laser
- Etch & Texture
- ALD
- Front PECVD
- Rear PECVD
- Metallization
- Test & Sort

2021

2022

2023

2024

2025

First TBC Pilot Line

Efficiency Record + 20 GW Deployment

43 GW Mass-Production Deployment across two customers

Support of 8 BC Manufacturers

100+ GW BC Equipment Shipped

Full-process equipment portfolio
From high-temperature to coating, laser & automation

Integrated Process Optimization
Deposition → Diffusion → Laser opening

Optimized for Mass Production
Matched capacity • Wide process window • Lower CAPEX

100+ GW BC Experience
Proven P-Poly / N-Poly solutions

WHAT LAPLACE IS DOING IN THE USA

GLOBAL EXPERTISE. LOCAL EXECUTION.

LAPLACE USA

Supporting the Growth of U.S. Solar Manufacturing



COLLABORATING WITH U.S. CUSTOMERS

Supporting U.S. solar manufacturers



Supporting projects from equipment delivery and integration through manufacturing ramp-up.

Equipment

Process & Tool
Delivery

Integration

Factory & Data
interfaces

Ramp-Up

On-site manufacturing
support

LOCAL EXECUTION

**Global expertise.
Local U.S. support.**

U.S. Headquarters

Texas

Dedicated U.S. Team

Project • Service • Engineering

Growing Local Capability

Service • Spare Parts • Supply Chain

**Backed by Laplace's global
engineering organization**

GLOBAL PV MANUFACTURING EXPERIENCE → SUPPORTING LOCAL U.S. EXECUTION

MAJOR ROADBLOCKS IN USA PROJECTS



The challenge is not the process technology alone — it is building a complete manufacturing ecosystem in the USA.

Utility / Facility

- High infrastructure CAPEX (power, gases, HVAC, wastewater)
- Facility readiness delaying the project schedule
- Semiconductor-based overdesign by inexperienced engineering firms
- Limited experienced on Facility/Workshop interfacing in early project phase
- Delays due to permitting and commissioning

Supply Chain

- Long lead times for critical spare parts and consumables
- Limited local supplier base for PV-specific materials and services
- Customs, logistics, and import processes
- Material qualification and supplier development required to ensure stable production

Manpower

- Scarcity of experienced PV manufacturing staff
- High labor cost and slow recruitment
- Greater need for automation and structured training

Digital / Data

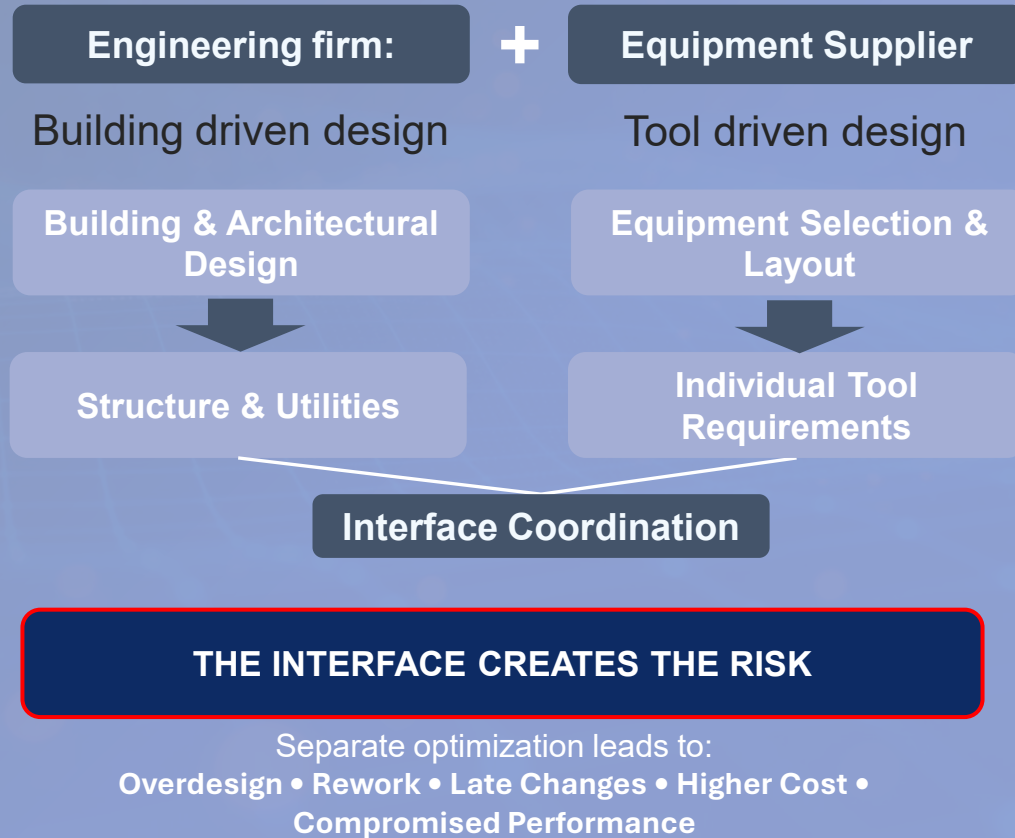
- Traceability
- Local data storage (Cybersecurity and still allowing Secure Remote Access)
- MES / Factory Integration

These roadblocks are interconnected
→ solving them independently creates rework, hidden cost and slower ramp-up.

BEYOND EQUIPMENT: INTEGRATED FACTORY ENGINEERING



TRADITIONAL APPROACH



LAPLACE INTEGRATED APPROACH



**Successful localization requires more than transferring equipment.
It requires adapting the complete manufacturing ecosystem.**

INTEGRATED ENGINEERING = LOWER CAPEX + FASTER RAMP-UP



Optimization moves upstream: first the process, then the factory, then the operating model.

1

Equipment Optimization

- Right-sized tool count
- Optimized process flow
- Higher equipment utilization

2

Factory Optimization

- Avoid utility oversizing
- Shorter distribution & piping
- Smaller footprint + better material flow

3

Operational Impact

- Lower CAPEX
- Faster installation & commissioning
- Faster ramp-up + lower long-term OPEX

Integrated engineering reduces interface risk and aligns facility investment with the actual manufacturing requirement.

LAPLACE AI

Turning Factory data in continuous Improvements

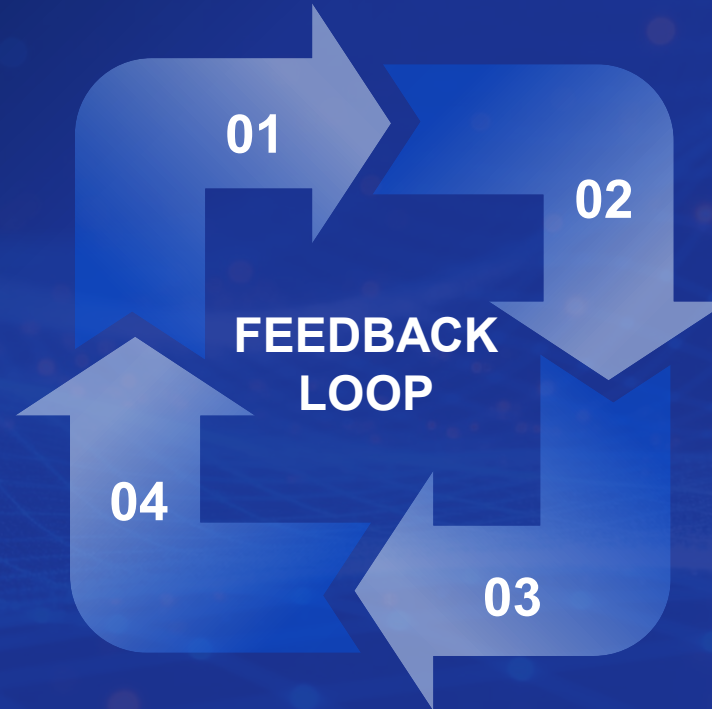


01 Factory Data

- Equipment sensors & alarms
- Process parameters
- Metrology data
- IV / EL / AOI results

04 Continuous Learning

- Validate impact
- Learn from every intervention
- Update models with local data
- Improve recommendations over time



02 AI Analysis

- Detect process drift
- Identify root-cause correlations
- Predict equipment abnormalities
- Recommend parameter adjustments

03 Action

- Process optimization
- Predictive maintenance
- Faster troubleshooting
- Reduced engineering workload

LOCAL DATA STAYS LOCAL



Laplace AI
Results

Engineering Load
↓ **50%**

Process Cpk
↑ **70%**

Uptime
↑ **+3%_{abs.}**

Ramp-Up Time
↓ **20%**

Cell Efficiency
↑ **+0.5%_{abs.}**

O&M SERVICES



A structured on-site service model combining preventive maintenance, rapid response, technical expertise and continuous improvement

ON-SITE SUPPORT

- Dedicated on-site O&M team
- **Equipment health & performance monitoring**
- **Preventive maintenance**
- Customer production interface

RAPID RESPONSE

- **Access to consignment local spare parts and consumables**
- Severity-based response & escalation
- **Fast local troubleshooting**
- **Global expert / remote support**
- Structured root-cause analysis

SMART MAINTENANCE

- **Production-aligned maintenance planning**
- Condition-based maintenance
- Early abnormality detection
- **AI-enabled predictive maintenance**

CAPABILITY & IMPROVEMENT

- Customer maintenance training
- Troubleshooting knowledge transfer
- **Recurring-issue elimination**
- **Uptime & performance optimization**

PREVENT



RESPOND



RECOVER



IMPROVE

From Equipment Support to Ensuring Production Continuity & Continuous Improvements

LOCAL SPARE PARTS – BUILT INTO THE O&M MODEL

Local inventory aligned with maintenance needs to reduce lead-time risk and production downtime.



CRITICAL PARTS

- Local safety stock for high-risk components
- Prioritized by equipment criticality & lead time
- Reduced dependency on international logistics

- ✓ Quartz Components
- ✓ Graphite Components
- ✓ Heating Element
- ✓ Paddle
- ✓ Ceramic Components
- ✓



Local Warehouse

PLANNED INVENTORY

- Consumables & wear parts stocked in advance
- Inventory aligned with maintenance schedules
- Demand forecast from equipment usage & service needs

Planned Supply + Rapid Dispatch

O&M Demand + Field Feedback

O&M INTEGRATION

- Parts demand linked directly to O&M work orders
- Rapid local dispatch for urgent failures
- Inventory continuously optimized from field experience



Customer Site

THE RIGHT PARTS • IN THE RIGHT PLACE • BEFORE THEY ARE NEEDED

FROM TECHNOLOGY SUPPLIER TO LONG-TERM MANUFACTURING PARTNER



01

TECHNOLOGY LEADERSHIP

- Proven TOPCon+ & BC technology at industrial scale
- Reduced tool count and optimized fab layout for lower CAPEX/OPEX
- Strong IP portfolio & customer FTO support

02

INTEGRATED MANUFACTURING

- Process, equipment & facility engineered as one system
- Automation designed to reduce labor dependency
- MES, traceability & secure local data architecture
- Lower CAPEX, faster installation & accelerated ramp-up

03

LOCAL EXECUTION & OPERATIONS

- Growing U.S. project, service & engineering organization
- Local supply chain, spare parts & repair capabilities
- Structured O&M from preventive maintenance to rapid response
- Training, capability transfer & continuous improvement

AI

AI & DATA ACROSS THE MANUFACTURING LIFECYCLE

- Optimize • Predict • Troubleshoot • Learn





THANKS



LinkedIn



Website