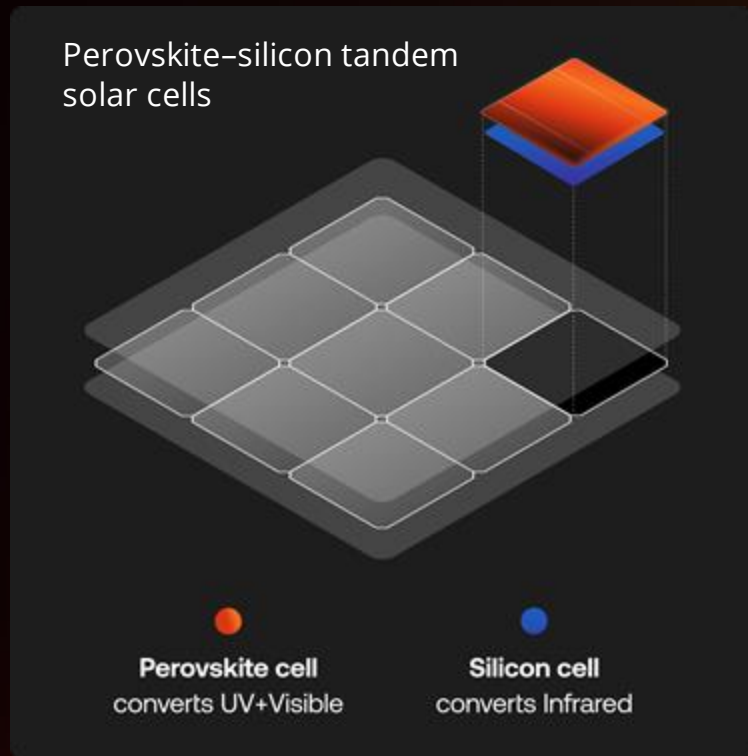


Unlocking the Full Potential of Perovskite Tandem Technology

By Annikki Santala

> Swift Solar is unlocking **perovskite tandem** technology



+50% potential efficiency gain

Enables end-to-end *USA production*

> Swift Solar Overview



- **Founded 2017** as 3-way spinout from MIT, Stanford, NREL with exclusive IP rights
- **~50 team members** in San Carlos, CA
- **US pioneer** in perovskite-Si and all-perovskite tandem PV technology
- **Aim:** produce **high-efficiency cells** and **modules** in US at GW scale
- **Current status**
 - Making **full-size tandem cells** on R&D pilot line
 - Scaling to first commercial production line ~2 years

> Swift's Key Differentiators

Two-terminal (2T) tandem architecture

High-speed vapor deposited perovskite

> Swift's Key Differentiators

Two-terminal (2T) tandem architecture

High-speed vapor deposited perovskite

> 2 Terminal (2T) vs 4 Terminal (4T)

Key Questions:

Which architecture delivers **best final PV module product?**

*Highest **efficiency?***

*Longest **lifetime?***

*Lowest **cost?***

> 2 Terminal (2T) vs 4 Terminal (4T)

Key Questions:

Which architecture delivers **best final PV module product?**

Highest efficiency?

Longest lifetime?

Lowest cost?

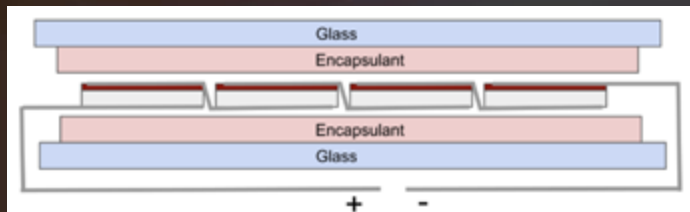
2T

> Swift's 2T architecture outperforms 4T competitors

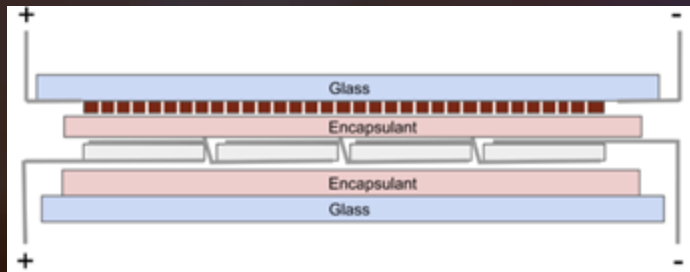
2T tandems enable the highest power potential

Characteristics	Preferred	Reasons
Performance <i>Efficiency & yield</i>	2T	~7% relative higher module efficiency and annual energy production
Cost	2T	~\$0.05/W lower cost due to less TCE requirements
Reliability <i>Lifetime & degradation rate</i>	2T	<ul style="list-style-type: none">- Superior lifetime reliability due to continuous barrier layers, conductive front electrodes and series-connected structure- Better shading tolerance
Market Entry	2T	<ul style="list-style-type: none">- Faster and more capital-efficient- Higher production yields
Technology Potential	2T	Enables triple-junction modules with future efficiencies over 40%

2T cross-section



4T cross-section

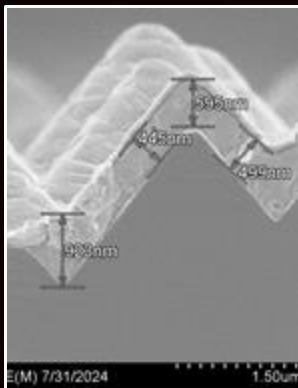


> Swift's Key Differentiators

Two-terminal (2T) tandem architecture

High-speed vapor deposited perovskite

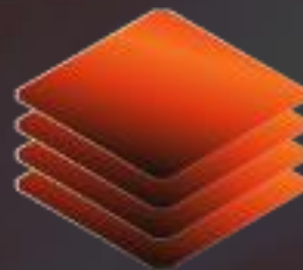
> Key Advantages of Vapor Processing



Conformal coating on
textured bottom cells



Uniform coating
across large areas



Enables ***multi-junction***
perovskite architectures

> Proprietary **high-speed** perovskite **vapor** deposition



Process Method	Practical Efficiency Limits			
Vapor	~30%	~34%	~39%	~44%
Solution	~30%	Difficult	~37%	Very difficult

*Vapor processing unlocks a **higher efficiency** roadmap
10× faster than OTS dry methods*

> In the last 18 months, Swift has **unlocked**...



Efficiency

Exceeding silicon world record



Stability

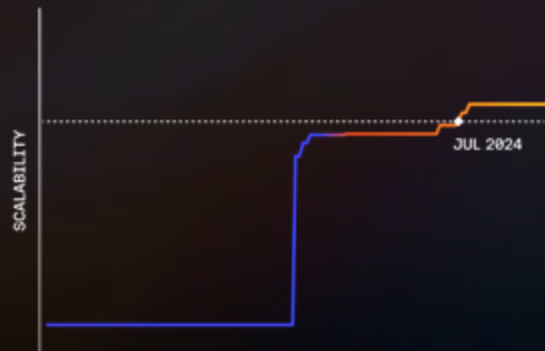
30 years equivalent lifetime¹

¹ Nature Conference on Perovskite & Organic PV, 2024



Scalability

Full-size cell efficiency within 10% of lab record



> Thank You for Your Attention



Visit our website:
www.SwiftSolar.com



Feel free to reach out:
annikki.santala@swiftsolar.com