



# 15 years of thin film PV recycling

Lessons Learned and Future Challenges

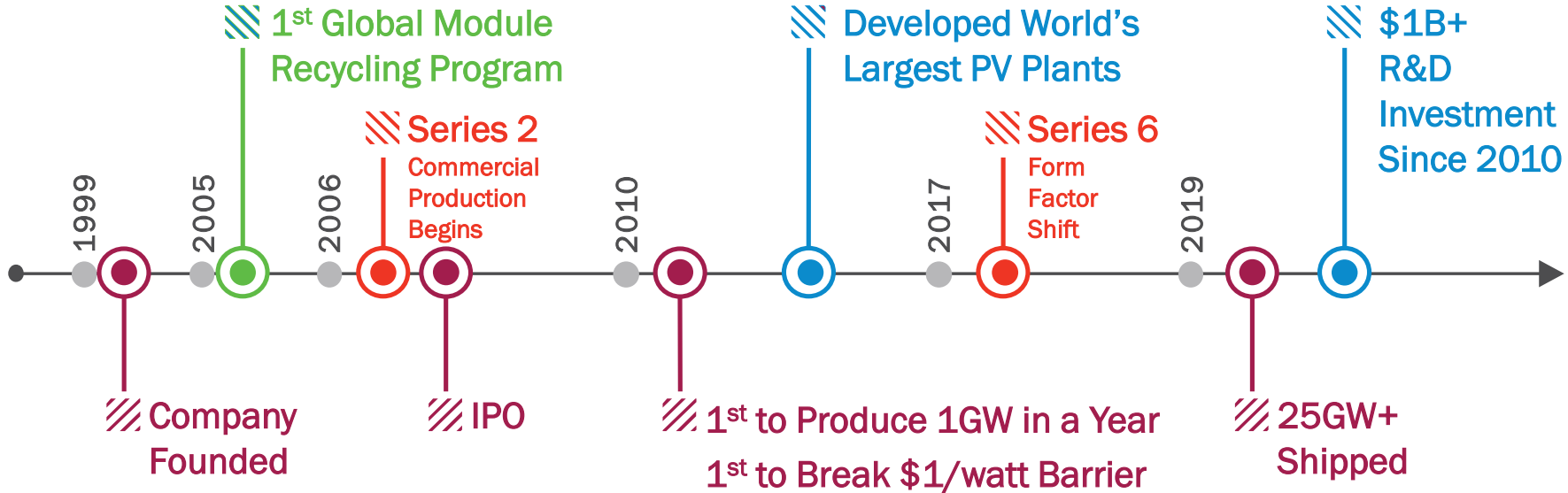
Peter Staudt-Fischbach



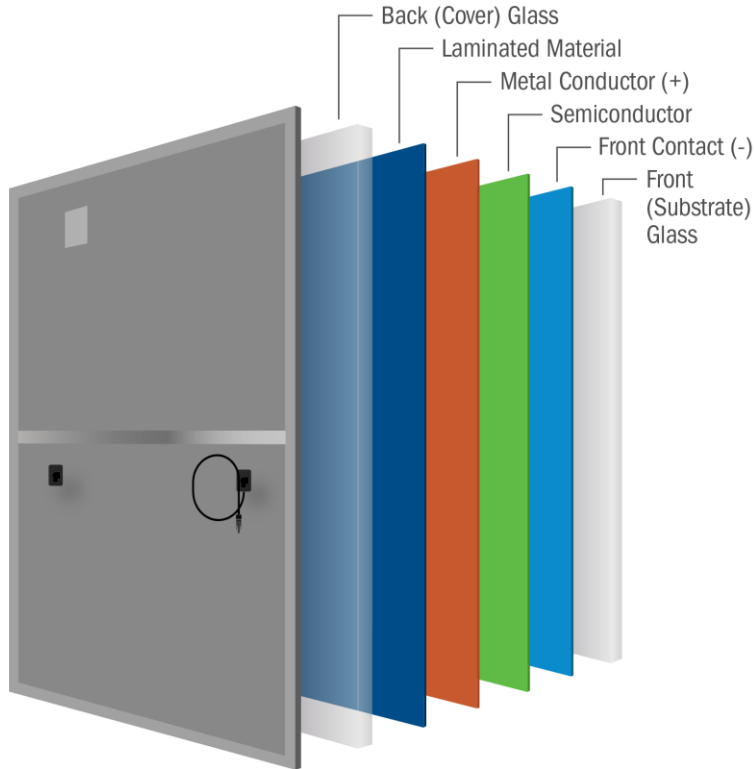
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# First Solar's Background: 20+ Years of Innovation



# What's Inside 20+ Years of Innovation?



- Leading-edge performance derived from \$1 billion+ in R&D investments
- Continuous technology enhancements lower LCOE and boost module efficiency consistently year-over-year
- Ultra-thin semiconductor film is 3% the thickness of a human hair
- Durable and encapsulated glass-on-glass construction stands up to rigorous lab and field testing
- Optimized design from manufacturing through shipping, installation, and recycling

# First Solar's Module Recycling Process

more than 200000 metric tons of modules recycled, roughly 100000 tons in Frankfurt (Oder)



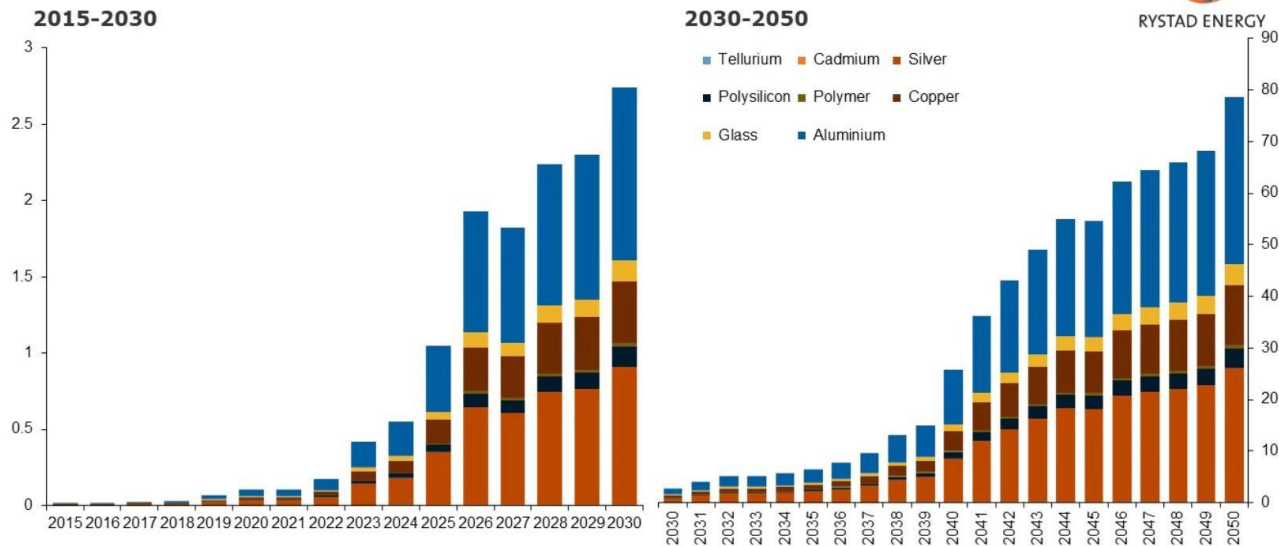
+ 90% Recycling of Semiconductor Material and ~ 90% Recycling of Glass

# A sneak peek into the future

**Estimated PV panel recyclable material value\***  
Billion USD



RYSTAD ENERGY



\*Forecasted value from material recovered from PV panels as current implementations reach end-of-life  
Source: Rystad Energy SolarSupplierCube, EnergyScenarioCube, Rystad Energy research and analysis

Where is the  
Tellurium?

# Global Boundary Conditions

To assess the situation and its development, I choose as my first point of reference the [system model](#) of the [Club of Rome](#). Beyond all criticism, it has proven to be frighteningly accurate over the last 50 years, although it has never claimed to make concrete predictions. In its current version, the model suggests that problems should no longer be glossed over as opportunities or challenges.

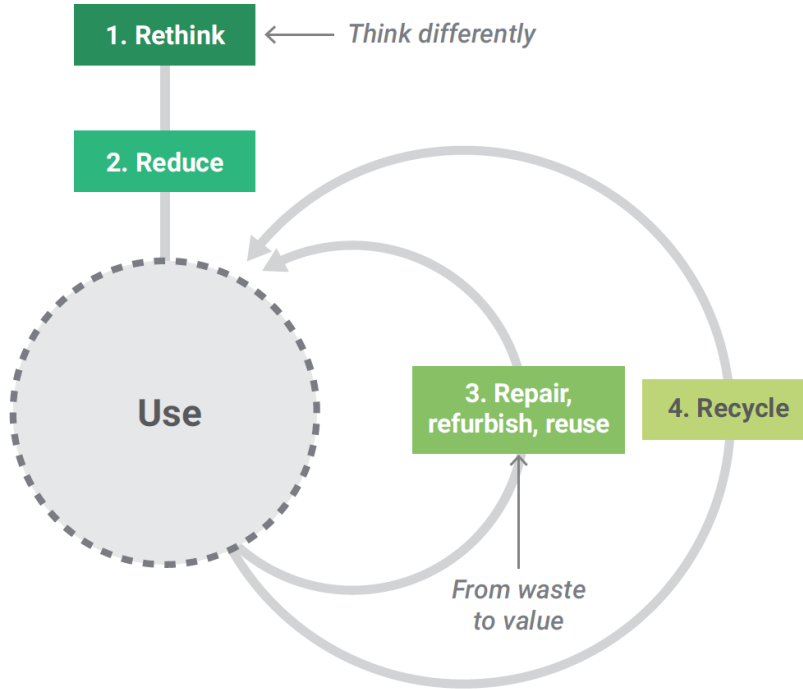
What might that mean for today's webinar?

# Turnaround 5: Transforming the energy system

Call to action: Transform our inefficient fossil energy system to a clean and optimized energy system reaching a 50% cut in GHG emissions by 2030 and net zero carbon and biodiversity loss by 2050 – Ensuring sustainable energy for all.

- Immediately phase-out and redesign fossil-based energy systems and subsidies towards clean and efficient energy solutions.
- Foster smart electrification alongside optimizing greater efficiencies for multiple win wins: save energy, **drive down use of materials** and reduce air pollution.
- Triple investments immediately to >US\$1 trillion per year in new renewables with storage capacity and related infrastructure. All governments to guarantee access to clean energy and protect the most vulnerable from energy poverty.

# Points of attack for improvement



1. This webinar
2. Long life modules (>40 years), no “false” subsidies (e. g. repowering)
3. will probably play a minor role if point 2 is met
4. Let’s talk about it



# Problems and potential solutions

Problem	Solution
Improperly dismantled and significantly soiled modules double the amount of work required for recycling	I don't see a quick solution here, as long as EOL modules have no significant monetary value, a high CO <sub>2</sub> price might help
High logistic costs and CO <sub>2</sub> -footprint (20-50% of total cost) for centralized recycling plant	Mobile recycling units with high purity process (needs appropriate throughput and regulations)
Conflicting laws and fragmented implementation of electric waste regulation create high administrative burden and additional cost	Standardization of international legislation and simplification of administrative interfaces (This is a real Sisyphus job)

# Additional Sources:

- [END-OF-LIFE CDTE PV RECYCLING WITH SEMICONDUCTOR REFINING](#) details and LCA of First Solar's recycling process
- <https://tippingpointstory.podigee.io/> podcast covering the whole history of “Limits to Growth”
- <https://youtu.be/c891j7lnaYk> John Sterman, the Jay Forrester Professor of Management at the MIT Sloan School of Management, gives deeper insight into road blocks to transition
- [https://monoskop.org/images/e/e3/Beer\\_Stafford\\_Designing\\_Freedom.pdf](https://monoskop.org/images/e/e3/Beer_Stafford_Designing_Freedom.pdf) an even deeper look into complex systems (working through the 300 pages of <https://link.springer.com/book/10.1007/978-3-031-14260-4> first helps in understanding the 50 pages above)
- [Mobile recycling units](#) from Flaxres
- [high purity process](#) by ROSI solar



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