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pv magazine webinars

Quantify the impacts of cell cracking in the field

25 May 2020

4 PM – 5 PM | CEST, Berlin
10 AM – 11 AM | EDT, New York
7.30 PM – 8.30 PM | IST, India

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FIRST SOLAR: DIFFERENTIATED PV TECHNOLOGY

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May 25, 2020

First Solar®

LEADING THE WORLD'S SUSTAINABLE ENERGY FUTURE

FIRST SOLAR AT A GLANCE

Over **25 GW** shipped worldwide and over **$17B** in project financing facilitated

Strongest **financial stability** & **bankability** in the industry

Partner of choice for leading utilities and global power buyers since 1999

Lowest environmental impacts of all PV technologies on a life cycle basis

Solar energy that is **economically competitive with fossil fuel**

Industry-leading global PV **recycling** program

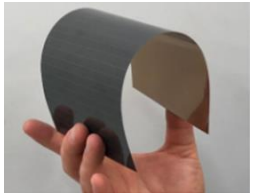
25 GW SHIPPED WORLD WIDE

>5,600 MW

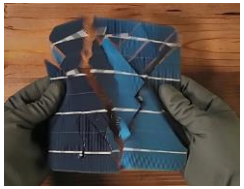
Series 6 Shipped

COMPARING CONSTRUCTION OF THIN FILM VS. TRADITIONAL C-SI

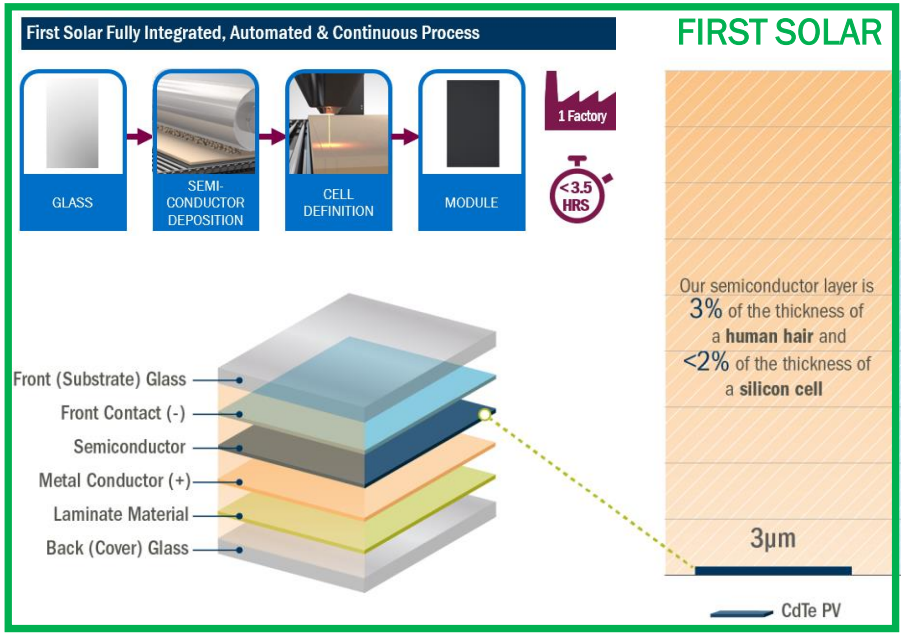
Thin Film

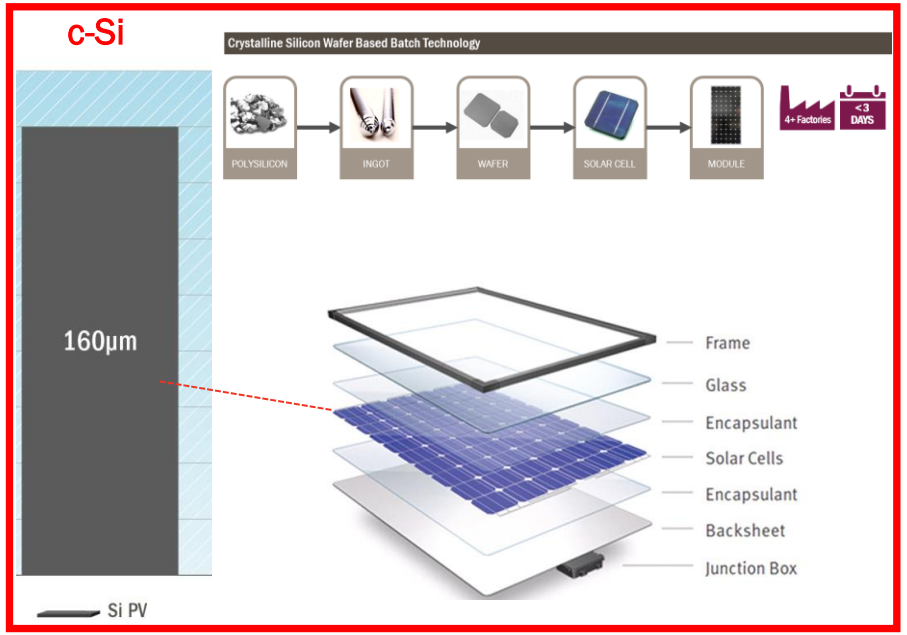


vs.



c-Si

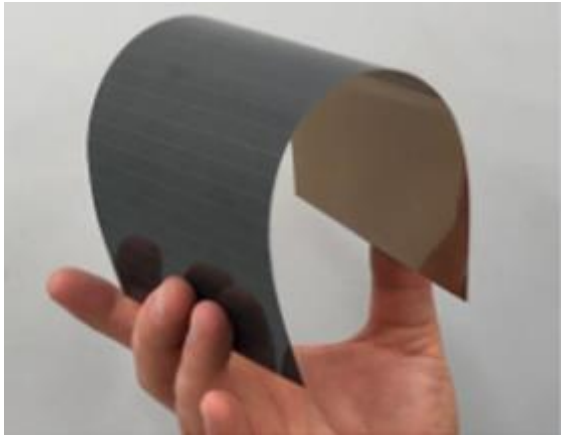




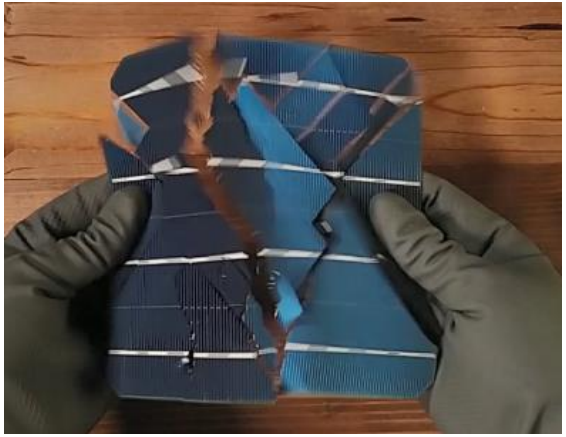
COMPARISON OF PV MODULE CELL TECHNOLOGIES

First Solar's thin-film CdTe cells are **immune to cell cracking** due to their minimal thickness that cannot fracture under stress[1]

Thin Film CdTe



c-Si



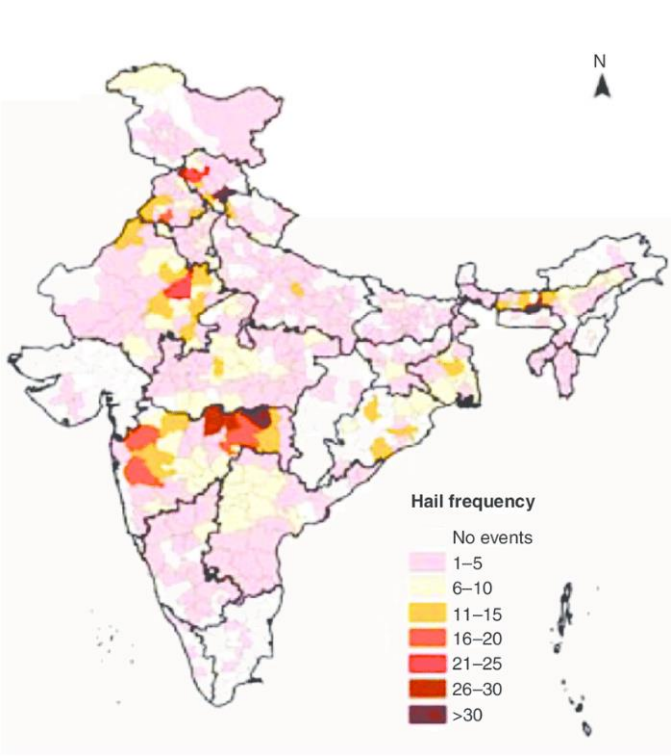
https://www.enrg-inc.com/solar-pv

- First Solar's thin-film semiconductor cells are just a **few microns thick** and **conform to substrate surfaces**
- **Multiple applications** of thin-film PV cell technologies like CdTe in flexible solar applications **have been demonstrated**

[1]https://www.researchgate.net/publication/267869230_High-efficiency_flexible_CdTe_superstrate_devices

CELL CRACKING: HAIL IMPACT RISK FOCUS

HAIL RISK IS A GLOBAL CONCERN



Areas prone to hailstorms in India. Rao et al. (2014).

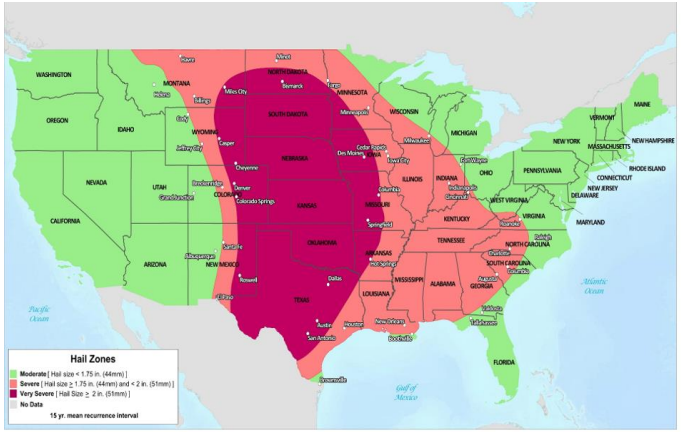


Fig.C-1. Hailstorm hazard map for the contiguous United States (p= 0.7g/cm²)

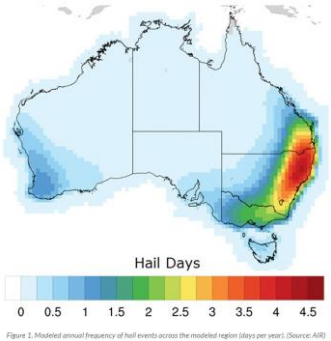
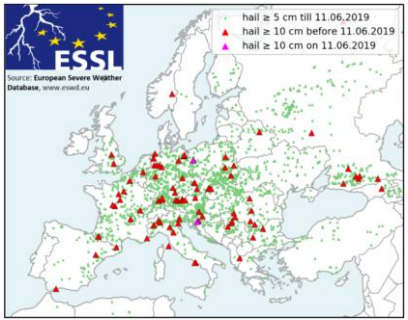


Figure 1. Modeled annual frequency of hail events across the modeled region (days per year). (Source: AIR)



Very large and giant hail reports across Europe based on the European Severe Weather Database (www.eswd.eu).

https://www.air-worldwide.com/blog/posts/2019/1/australias-costliest-catastrophe-in-2018-and-hail-risk/

Ch, Srinivasrao & K.A., Gopinath & Prasad, J.V.N.S & Channalli, Prasannakumar & Singh, Anil Kumar. (2016). Climate Resilient Villages for Sustainable Food Security in Tropical India: Concept, Process, Technologies, Institutions, and Impacts. Advances in Agronomy. 140. 10.1016/bs.agron.2016.06.003.

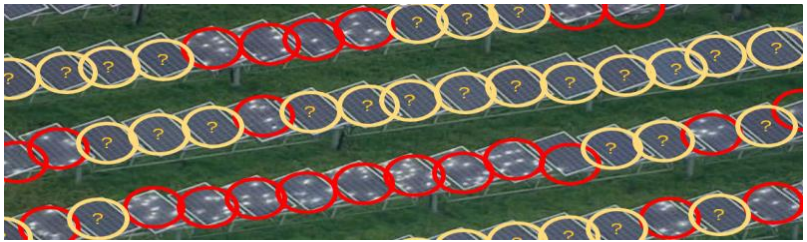
HAIL IMPACTS ON SOLAR PROJECT CASE STUDIES: TEXAS

WWS **replaced/repaired 13,000+ Modules** damaged by hailstorm at 160 MW West Texas Solar Project in July 2019.

24+ WWS Technicians were deployed for 16 weeks to complete hailstorm damage mitigation on arrays taken offline.

Texas Green Energy **replaced 17,920 Modules** at OCI's Alamo 2 Solar Facility.

Following full site inspection, **~33% of site modules required replacement.**

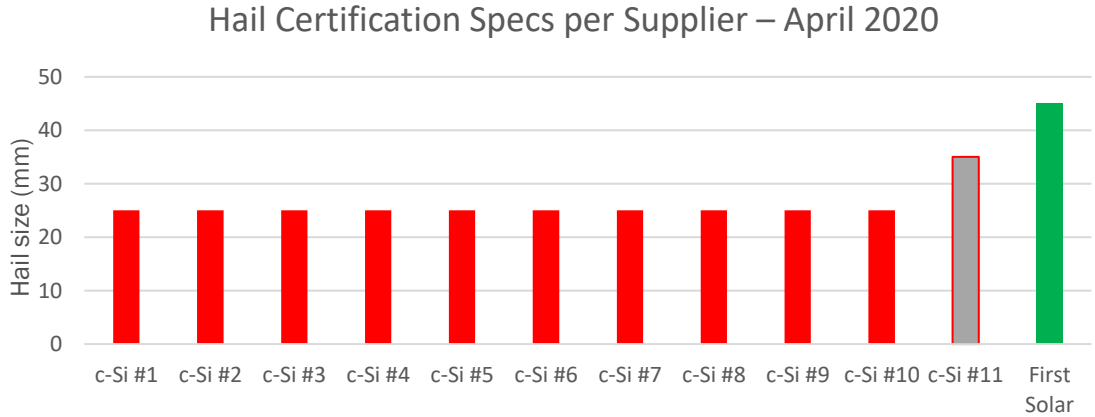


HAIL IMPACT TESTING PER IEC 61215-2 MQT 10.17 STANDARD

IEC 61215-2[1] Test Criteria 11 Impacts, Various Locations

Diameter (mm)	Mass (g)	Velocity (m/s)
25	7.54	23
35	20.7	27.2
45	43.9	30.7
55	80.2	33.9
65	132	36.7
75	203	39.5

Minimum criteria



First Solar S4 Test Oct 2019 (pictured) & S6 Test Jan 2020 per IEC 61215-2 MQT 10.17 45mm diameter hail

[1]http://www.estif.org/solarkeymarknew/images/downloads/QAiST/qaist%20d2.2_r2.16%20impact%20resistance%20test.pdf

DATASHEET COMPARISON – HAIL

"…insurers should notify clients of the **need for reputable supply chain partners** who can **deliver on the quality standard** required to solve this problem and minimise imperceptible damage…"

GCube

First Solar

First Solar Series 6™

NEXT GENERATION THIN FILM SOLAR TECHNOLOGY

BEST IN-CLASS RELIABILITY & DURABILITY

- Manufactured under one roof with 100% traceable QA/QC
- Independently tested and certified for reliable performance that exceeds IEC standards in high temperature, high humidity, extreme desert and coastal applications
- Inherently immune to power loss due to cell-cracking typically seen in extreme weather events such as hail or strong winds
- Durable glass/glass construction with market-leading 45mm hail impact certification

LONGi Solar

Hi-M04

High Efficiency
Low LID Bifacial PERC with
Half-cut Technology

LR4-72HBD **415~435M**

Mechanical Loading

Hailstone Test	25mm Hailstone at the speed of 23m/s

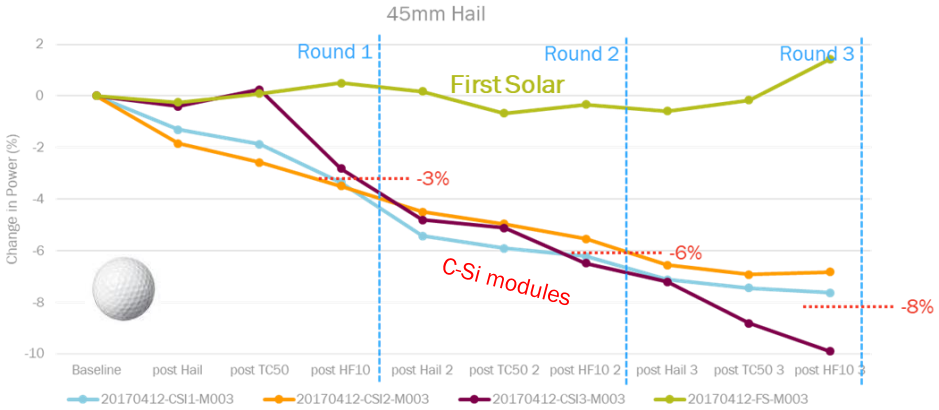
Hail impact certifications performed to IEC 61215 standards - 45mm hail at 30.7m/s (First Solar) or 25mm hail at 23m/s (Longi).

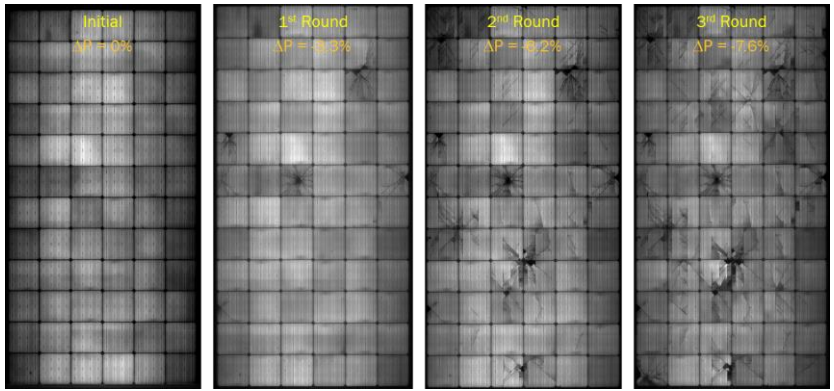
QAiST & Intelligent Energy Europe, Summary Report: Impact Resistance Testing, May 2012.
http://www.estif.org/solarkeymarknew/images/downloads/QAiST/qaist%20d2.2_r2.16%20impact%20resistance%20test.pdf

CELL CRACKING POWER LOSS BLIND SPOT

Power loss due to cell cracking in c-Si modules may not manifest immediately or to its full extent after mechanical loading or hail impact, but with subsequent thermal cycling and humidity freeze cycling ('HF10' per MQT 10.12) simulating real word stress over time, power loss is observed. These post-crack environmental stressors are **NOT** currently required in certification testing.

- Primary required PV module standards: IEC 61215-2: 2016 and UL 61730-2: 2017
- Mechanical load test (MQT 10.16) and Hail impact test (MQT 10.17) referenced by both standards do **NOT** test for effect of continued environmental stresses after c-Si module cell-cracking failures and therefore fail to test sufficiently for cell-cracking power output loss.





'TC50' = Thermal Cycling test per IEC 61215-2 MQT 10.11; 'HF10' = Humidity Freeze test per IEC 61215-2 MQT 10.12

HOW DO CRACKED CELLS OCCUR?

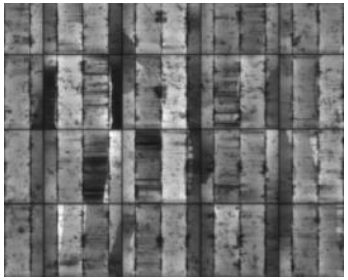
RISK THROUGHOUT ENTIRE LIFE-CYCLE

Cell Fab

Hail

Snow

Shipping



Cracked c-Si Cells

Wind

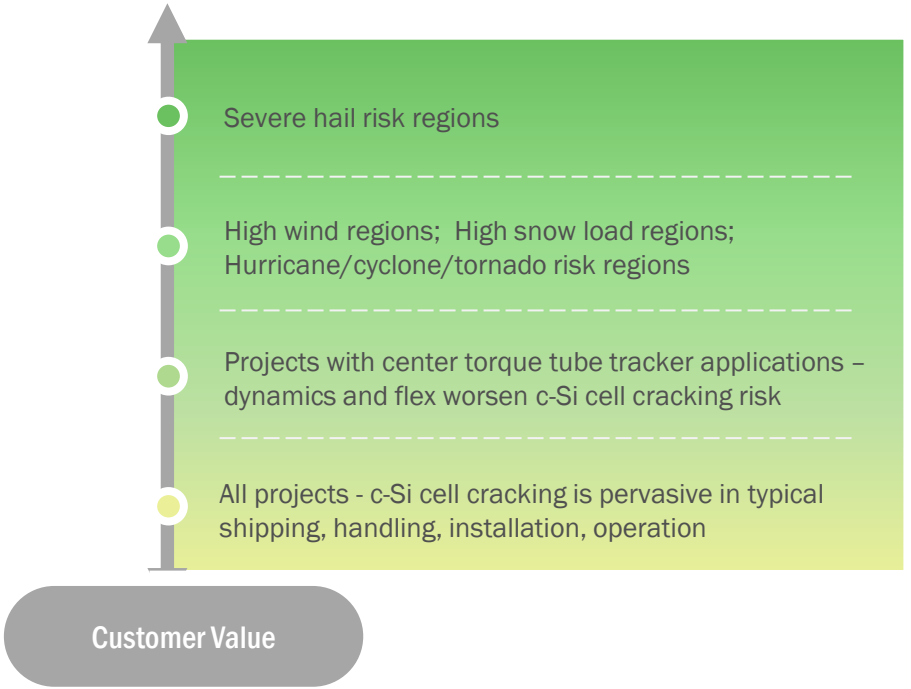
Handling/Installation

Mounting

INDUSTRY'S FIRST HIDDEN CELL CRACKING WARRANTY (MAY 2020)

First Solar now warrants against hidden cell cracking

Who wears risk after severe weather event?	FSLR S6 Module Warranty	c-Si
Hidden cell cracking	FS	Insurer/Owner
Power output loss due to hidden cell cracking	FS	Insurer/Owner
Broken glass	Insurer/Owner	Insurer/Owner



KEY TAKEAWAYS

Cell cracking without glass breakage is a phenomenon that **only occurs in c-Si** PV modules **and cannot be seen by the naked eye.** Cell cracking results in **significant power and energy production loss.** Risk of owner revenue loss is financially impactful.

First Solar modules are immune due to a **fundamentally advantaged module construction** and are the **only modules warranted against hidden cell cracking.** First Solar modules pass **market leading IEC hail impact test level.**

Adoption of **stronger standards** and **risk-appropriate technology selection** can **reduce financial impacts** and **increase severe weather tolerance**

PV plants built with **First Solar modules** are **warranted against hidden-cell cracking** therefore represent **a lower risk profile** that deserves **differential insurance** treatment.

LEADING THE WORLD'S
SUSTAINABLE ENERGY FUTURE