Marin Clean Energy
Technical Committee Meeting
Monday, March 10, 2014
9:00 A.M.

San Rafael Corporate Center, Boro Room
750 Lindaro Street, San Rafael, CA 94901

Agenda

1. **Board Announcements (Discussion)**
2. **Public Open Time (Discussion)**
3. **Report from Executive Officer (Discussion)**
4. **Approval of Minutes from 2.10.14 Meeting (Discussion/Action)**
5. **Presentation by Stion on US-Based Solar Module Manufacturing and Thin-Film Technology (Discussion)**
6. **Demand Response Update and Options (Discussion)**
7. **MCE 'Shared Solar' Program (Discussion/Action)**
8. **Members & Staff Matters (Discussion)**
9. **Adjourn**

1 (888) 632-3674
mceCleanEnergy.org

781 Lincoln Ave., #320
San Rafael, CA 94901

Agenda material can be inspected in the Marin County Sheriff's lobby, located at 3501 Civic Center Drive, San Rafael, CA 94903. The meeting facilities are in accessible locations. If you are a person with a disability and require this document in an alternate format (example: Braille, Large Print, Audiotape, CD-ROM), you may request it by using the contact information below. If you require accommodation (example: ASL Interpreter, reader, note taker) to participate in any MEA program, service or activity, you may request an accommodation by calling (415) 464-6032 (voice) or 711 for the California Relay Service or by e-mail at djackson@mceCleanEnergy.org not less than **four work days** in advance of the event.

MARIN CLEAN ENERGY
TECHNICAL COMMITTEE MEETING
MONDAY, FEBRUARY 10, 2014
9:00 A.M.
SAN RAFAEL CORPORATE CENTER, BORO ROOM
750 LINDARO STREET, SAN RAFAEL, CA 94901

Roll Call

Present: Kate Sears, County of Marin, Chair
Emmett O'Donnell, Town of Tiburon
Ford Greene, Town of San Anselmo
Ray Withy, City of Sausalito

Absent: Carla Small, Town of Ross

Staff: Dawn Weisz, Executive Officer
Jamie Tuckey, Communications Director
Jeremy Waen, Regulatory Analyst
Justin Kudo, Manager of Account Services
Rafael Silberblatt, Program Specialist
Emily Goodwin, Internal Operations Coordinator
Kirby Dusel, Technical Consultant

Action taken:

Agenda Item #6 – Feed In Tariff Application Process (Discussion/Action)
Kirby Dusel introduced adjustments to the Feed In Tariff Application which had been discussed in the January Technical Committee meeting and further refined by staff. The adjustments include a reservation mechanism for interested applicants as recommended by Board members. Mr. Dusel, Dawn Weisz and Rafael Silberblatt responded to questions from the Committee members and the public.

M/s Withy/Greene (passed 4-0) recommendation to approve the proposed Feed In Tariff Application. Director O'Donnell and Small were absent.

_____

Kate Sears, Chair

ATTEST:

_____

Dawn Weisz, Executive Officer

Stion Demonstrates 23.2% Efficiency Thin Film With "Simply Better™" Tandem Technology

February 27, 2014 02:07 PM Eastern Standard Time

SAN JOSE, Calif.--(BUSINESS WIRE)--Stion, a leading US-based manufacturer of high efficiency thin-film solar modules, announced that it has produced a 23.2% efficiency thin-film cell based on its proprietary tandem junction technology. Stion has already scaled this technology at or above 20.0% efficiency on a prototype module (20 cm x 20 cm) and expects to soon scale to monolithic modules (65 cm x 165 cm) in the 20-22% efficiency range.

> "Achieving 23.2% cell efficiency and 20% mini-module efficiency on this state-of-the-art technology clearly demonstrates Stion's commitment to technology differentiation and its deep IP portfolio"

A pioneer in tandem module technology, Stion is the first to demonstrate fully integrated thin film devices at such high conversion efficiencies using scalable commercial processes. Stion will continue to implement the key technical innovations behind the 23.2% cell on its pilot production line in San Jose, CA in preparation for the commercialization of thin-film modules with >20% efficiency.

"Achieving 23.2% cell efficiency and 20% mini-module efficiency on this state-of-the-art technology clearly demonstrates Stion's commitment to technology differentiation and its deep IP portfolio," said Howard Lee, Stion's Chief Technology Officer, Founder and Sr. Vice President of Technology. "Showing initial results of 20%+ is a strong validation of scalability, and our ability to provide Simply Better™ solutions to our customers using this technology. We expect the technology to keep improving with production experience."

Stion’s unique approach to CIGS leverages proprietary materials and device expertise along with a robust, high-volume manufacturing process based on readily available, standardized equipment. Combining the simplicity of thin-film manufacturing with ultra high performance products greater than 20% efficiency is yet another example of how Stion is striving to be Simply Better™ than the competition.

About Stion:

Stion is a leading US-based manufacturer of high-efficiency thin-film solar panels based on state-of-the-art materials and device technology and proven production processes. Stion was founded in 2006 and is backed by Khosla Ventures, the largest institutional investor in clean technology ventures in the US. Stion opened its first mass production facility in Hattiesburg, MS in 2012. For more information, visit www.stion.com.

Contacts

Stion
Frank Yang
408-284-7205
fyang@stion.com

Stion residential installations in the US and Europe. Stion's Gen 2 tandem-based product will deliver superior energy density for smaller, space constrained projects, as well as the same all-black aesthetics featured in Stion's Gen 1 module. (Photo: Business Wire)

Better Design Leads to Superior Performance

January 2014

STION

BETTER PERFORMANCE THROUGH DESIGN

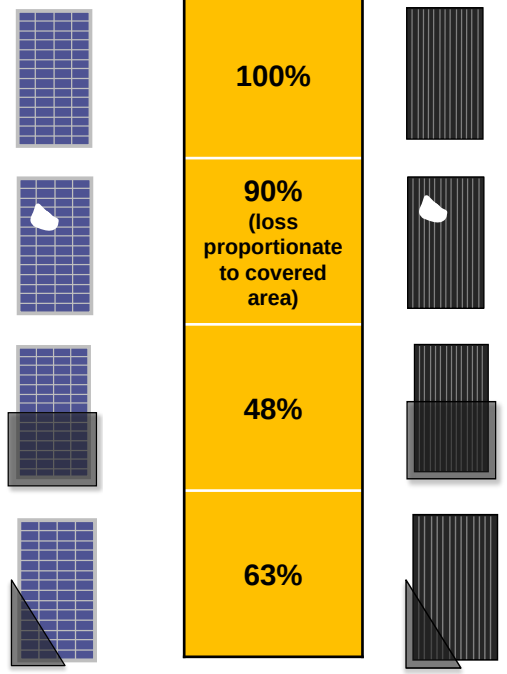
SIMPLY BETTER DESIGN ADVANTAGES

- Unique combination of materials and superior device design
  - Temperature coefficient of -0.26%/^{o}C
  - Exceptional kWh/kW performance in virtually any geography

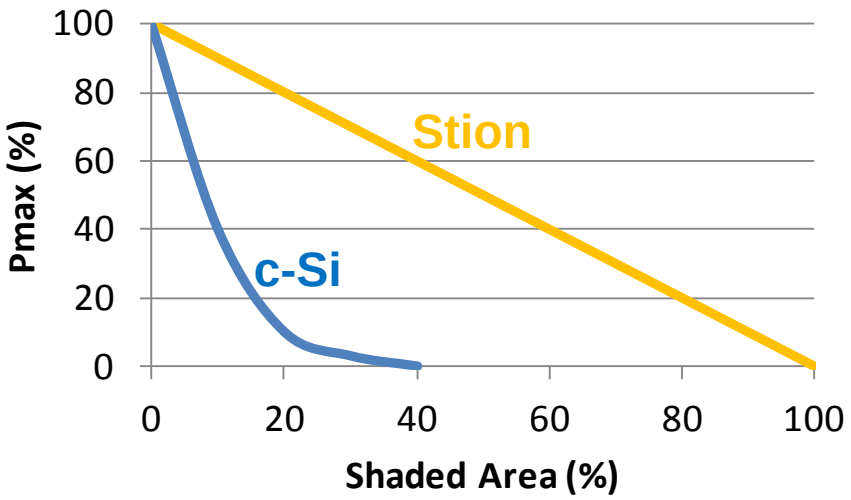
- Long cell architecture creates excellent shade tolerance

MORE POWER IN REAL WORLD APPLICATIONS

Shading	Silicon Modules: Percent Full Power	STION: Percent Full Power
None	100%	100%
Debris	33-66%	90% (loss proportionate to covered area)
50% vert	1%	48%
12.5% diag	49%	63%



- In partial shade conditions Stion's vertical cell patterning minimizes power loss



*Stion module vs. c-Si module under STC conditions

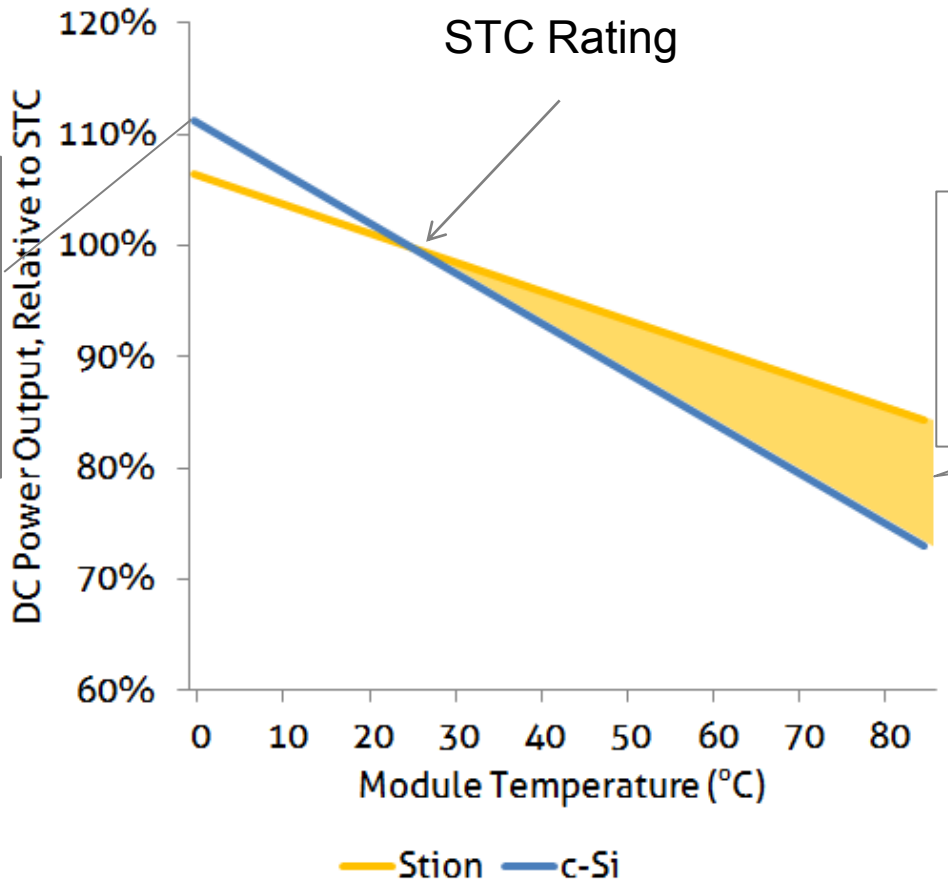
WHEN THE HEAT IS ON, STION DELIVERS THE POWER

LOWER TEMPERATURE COEFFICIENT

Stion = -0.26 %/°C

c-Si = -0.40 %/°C to -0.50 %/°C

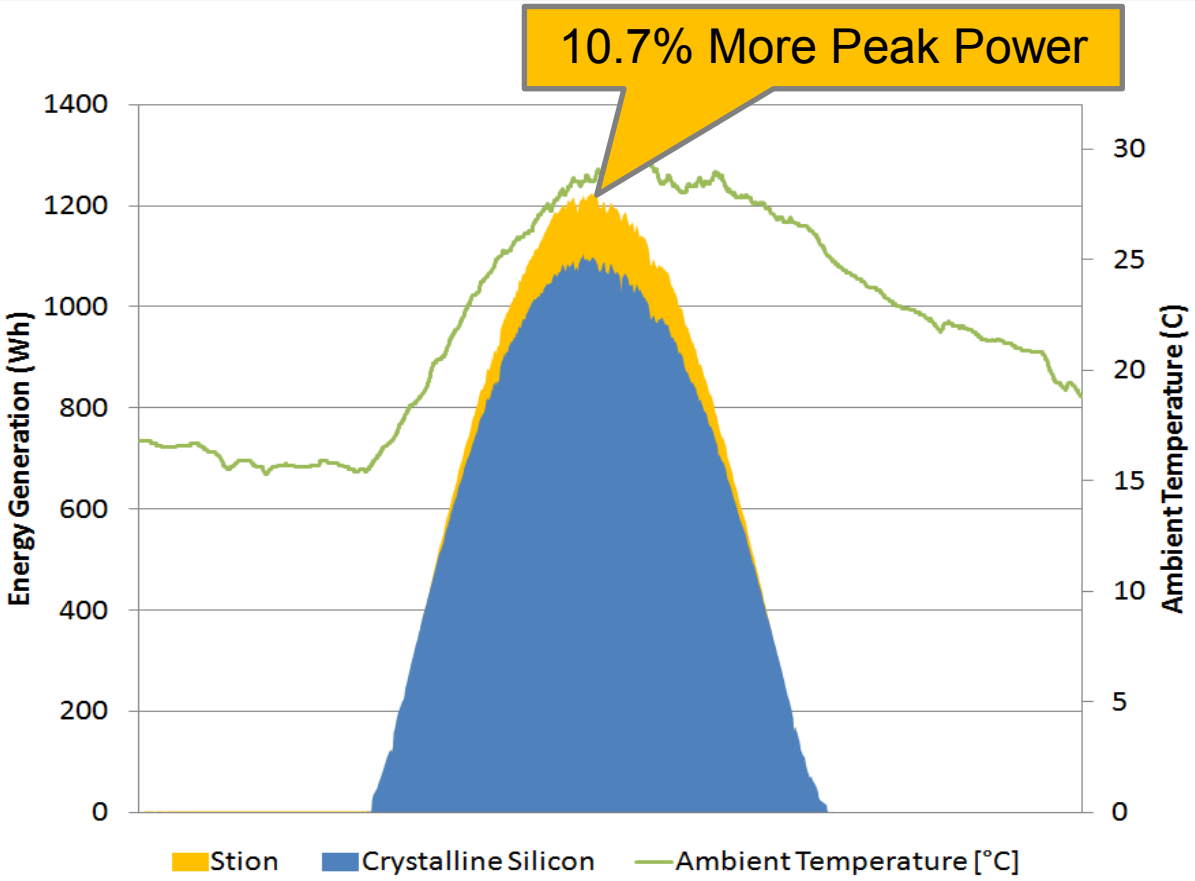
Lower cold temp. peak power → smaller inverter for same nameplate power



Additional energy generation from Stion, same nameplate power

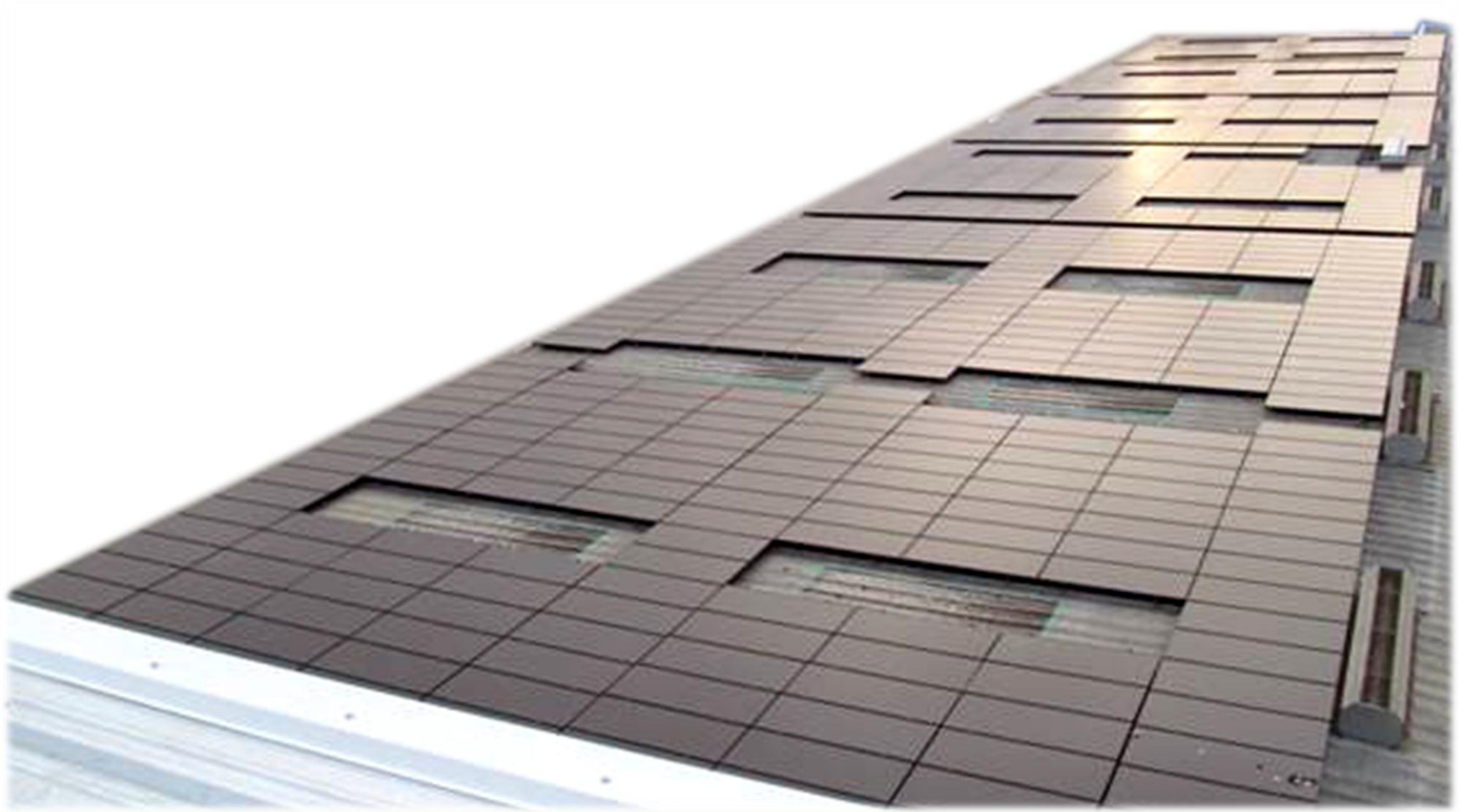
ENERGY YIELD ADVANTAGE

- 1.2 kW Side-by-side:
  - Tier 1 c-Si
  - Stion SN 120
  - Identical array design
- Stion outperforms:
  - 10.7% more peak power
  - 7.9% more daily energy generation
- Middle East Desert Climate
- Typical day in March



- Stion SN 120:
  - Temperature coefficient = -0.39%/°C
- New STO 150
  - Temperature coefficient = -0.26%/°C , will outperform c-Si by 10-15%

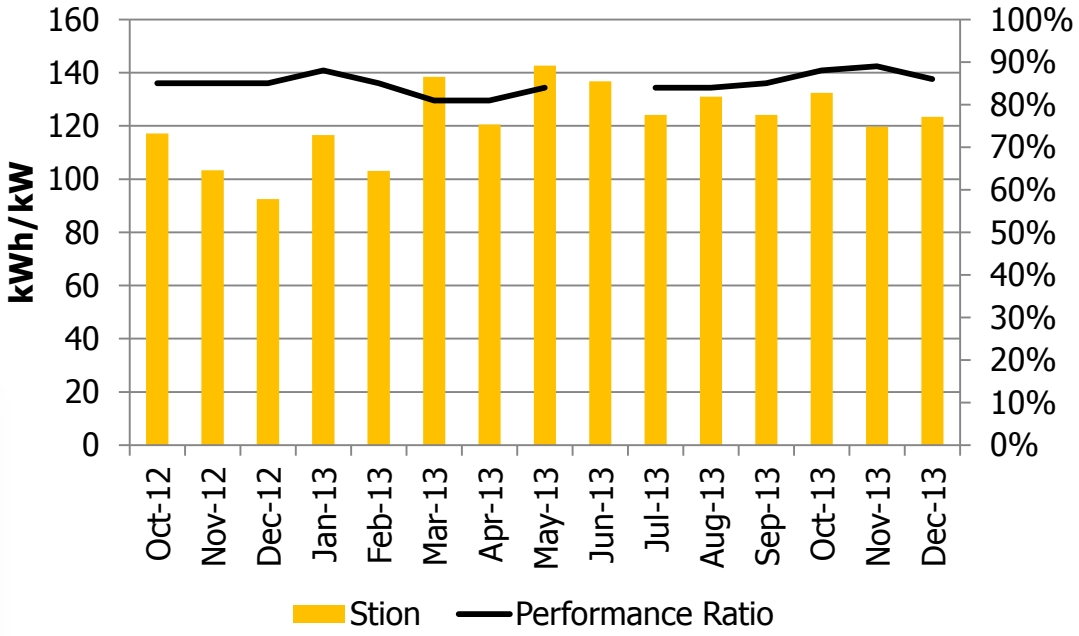
PERFORMANCE DEMONSTRATION SITES



NATIONAL RENEWABLE ENERGY LAB

GOLDEN, CO

- System size = 1.82 KW
- Module Type: STN 130
- Commission date = Sept 2012
- Performance Ratio > 85%



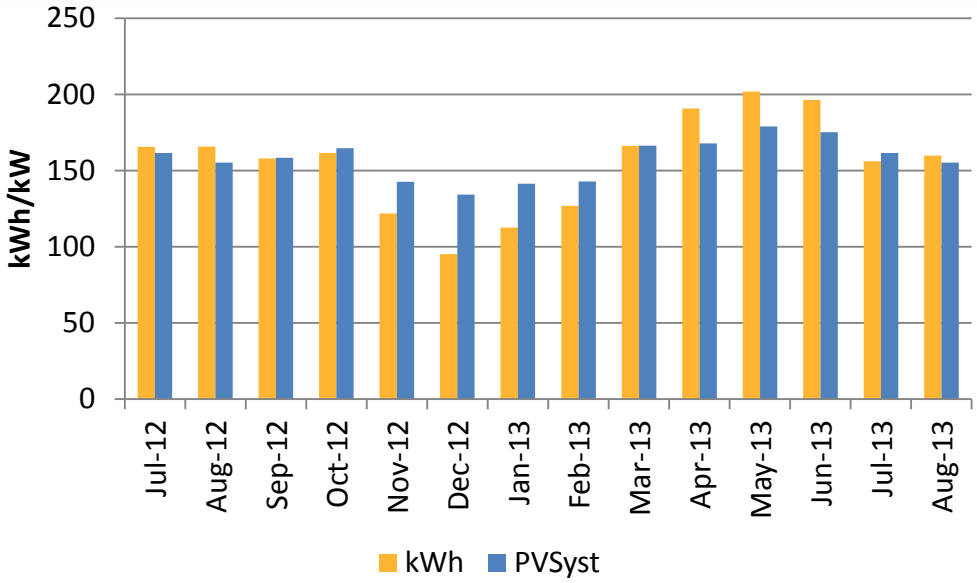
NREL NATIONAL RENEWABLE ENERGY LABORATORY

U.S. DEPARTMENT OF ENERGY

EXCELLENT WARM CLIMATE PERFORMANCE

SANDERS, AZ

- System size = 59.6 KW
- Module Type: SN 120
- Commission date = June 2012
- 1863 kWh/kWp/yr
  - 1st year performance within 2% of PVSyst estimate

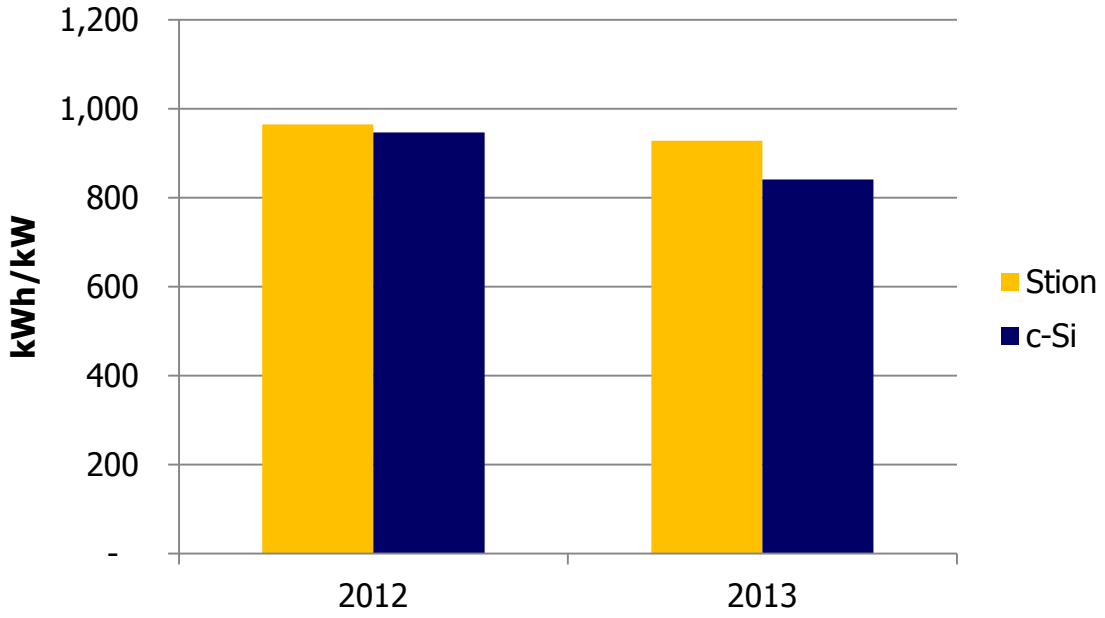


Stion Model	Temperature Coefficient (%/°C)	Predicted performance increase above Stion SN at this location
SN	-0.39	
STN	-0.34	4%
STO/L	-0.26	10%

OUTPERFORMING c-Si in Cold Climates

BELGIUM

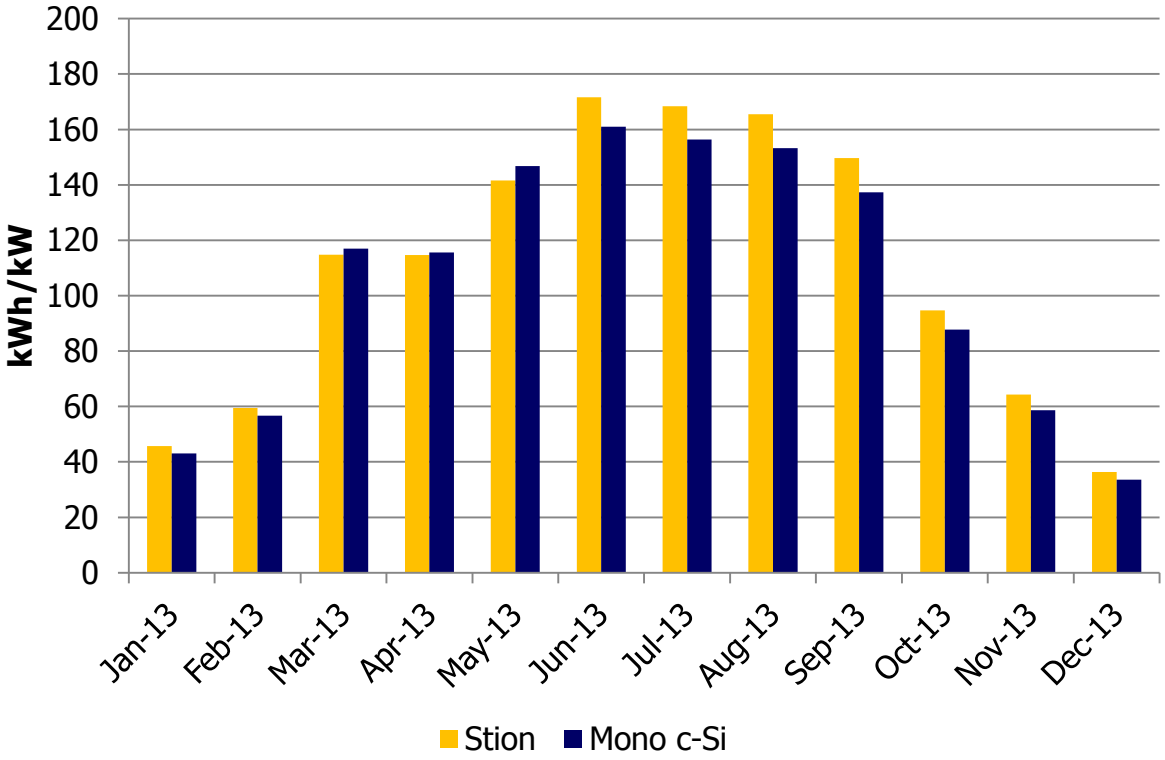
- System size = 5.4 KW
- Commission date = Dec 2011
- Customer demonstration site
- Module Type: SN 120
- Outperforming Tier-1 c-Si by 5.7%
  - 24 month totals
    - Stion = 1887 kWh/kW
    - c-Si = 1776 kWh/kW
  - Cold climate relative to most of US



OUTPERFORMING c-Si in Cold Climates

HOLLAND, MI

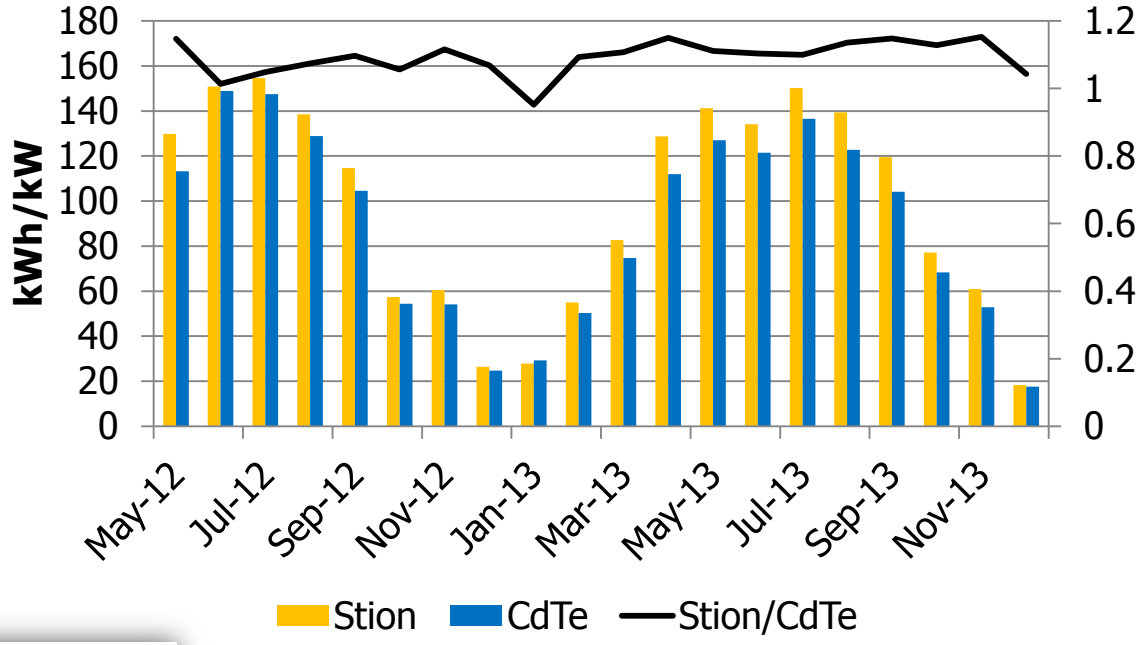
- System size = 10.5 KW
- Commission date = Jan 2013
- Customer demonstration site
- Module Type: STN 130
- Outperforming Tier-1 c-Si by 7-10% per month



OUTPERFORMING CdTe

ALBANY, NY

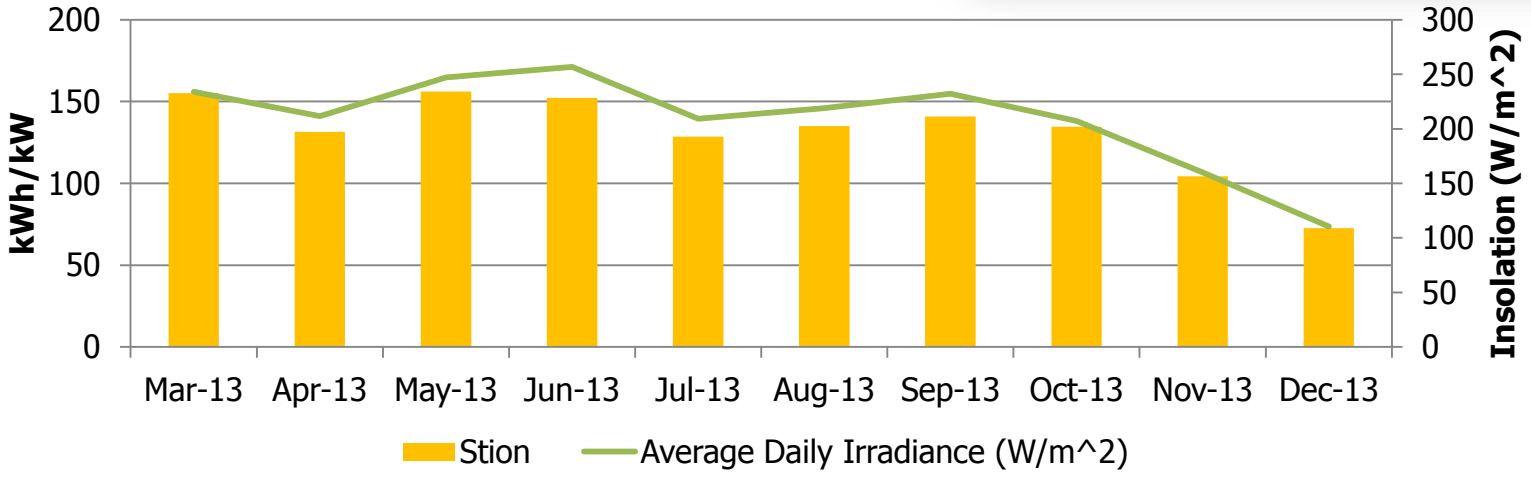
- System size = 23.8 KW
- Commission date = January 2012
- Application = Commercial Roof
- Module Type: SN 110
- Outperforming CdTe by 9.5%



MISSISSIPPI POWER
5 KW DEMONSTRATION PROJECT

GULFPORT, MS

- System size = 4.8 KW
- Commission date = February 2013
- Module Type: STN 135
- Stion executed the entire project from permitting to interconnection to system installation.



Agenda Item #5: Att. B-Stion Product History and Performance

Simply Better Stability

STION

STABILITY SUMMARY

	Pmax Yearly Change
Shell CIGS @ NREL	0.07% +/- 0.04%
Stion CIGS @ NREL	1.06% +/- 0.62%.
Stion CIGS @ Stion Mississippi	1.7% +/- 2.2%

• Stion and CIGS modules with related construction show Pmax stability overtime.

•Excerpt from Photovoltaic Degradation Rates — An Analytical Review, Jordan & Kurtz, NREL/JA-5200-51664,June 2012

"It was shown that degradation rates can vary significantly depending on module type. Musikowski and Styczynski demonstrated **virtual stability of a CIGS array in Germany**. The performance was evaluated for different temperature and irradiance windows and showed **no measureable degradation after 6 years of operation**. A comparable observation was made by Jordan et al. at NREL in Colorado, USA . Outdoor observation **showed no significant decline after 5 years of operation.** This was confirmed by indoor measurements. Only one out of 14 modules showed appreciable degradation owing to an initial manufacturing defect."

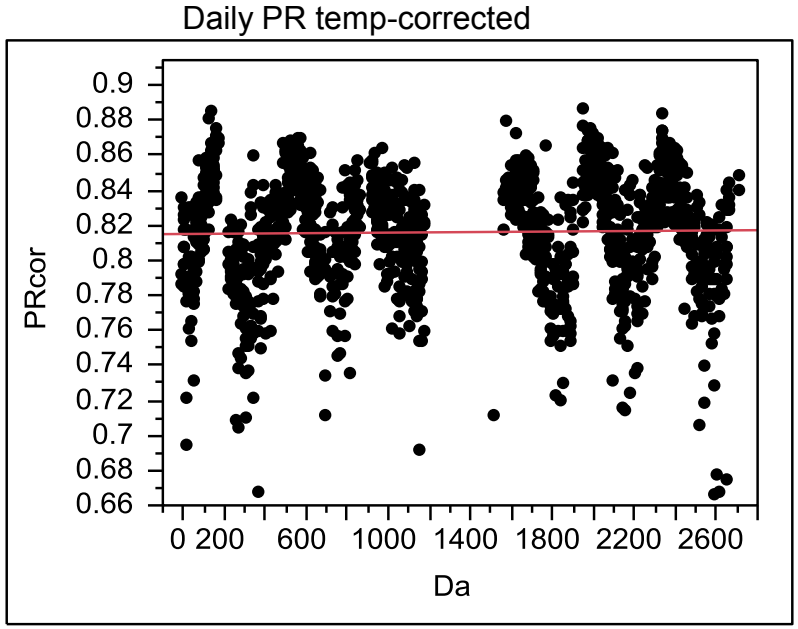
•The modules described above (Shell and Manz) share a similar dual glass, EVA, butyl rubber edge seal construction with Stion. In fact, the Stion design is from the same lineage as the Shell design.

STABILITY MONITORING (NREL)

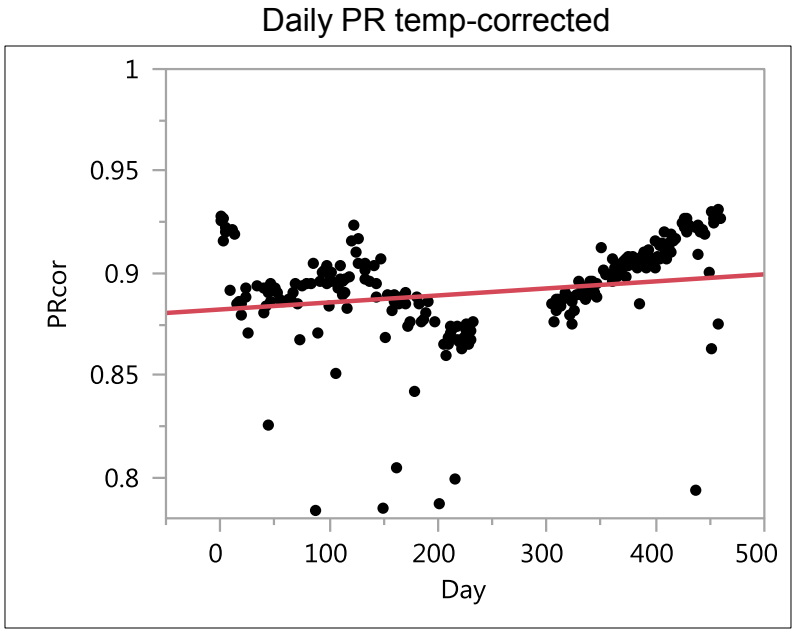
Test site at the National Renewable Energy Lab in Golden, CO

Stion modules are exhibiting similar stability to Shell CIGS array

Shell CIGS 1.12 kW Array
Installed 01/09/2006
Zero degradation after 8 years



Stion 1.82 kW Array
Installed 9/26/2012
Zero degradation after 1.5 years



Shell modules are CIGS on glass with near identical packaging (EVA, butyl rubber edge seal) and circuit creation process to Stion

	Method	Rd (%/year)	Uncertainty (%/year)
Stion	DailyPRcorr Tmod	1.42	0.53
Shell	DailyPRcorr Tmod	0.07	0.04

Data analysis shows that the energy production improved 1.42% +/- 0.53%.

No degradation, just measurable improvement.

STABILITY MONITORING

Hattiesburg, MS

- System size = 58.3 KW
- Module Type: SN 120
- Commission date = April 2012
- April 2013 – Stion randomly selected 8 modules for surveillance after 1 year in the field.
  - No visible sign of damage
  - All 8 were flash tested and compared to the flash test results at time of manufacture.

	Apr -2012		Apr-2013	
Serial #	Pmax		Pmax	1 Year Change
12725	113.63		113.6	1.000
13883	113.25		115.1	1.017
13511	114.98		119.8	1.042
13979	108.73		108.1	0.994
12515	113.77		117.5	1.033
13980	107.75		107.5	0.998
13981	108.45		108.5	1.001
12621	113.19		119.0	1.051
			Average	1.017
			StDev	0.022

Flash test results indicate the modules have <u>increased</u> power output by 1.7% +/- 2.2%

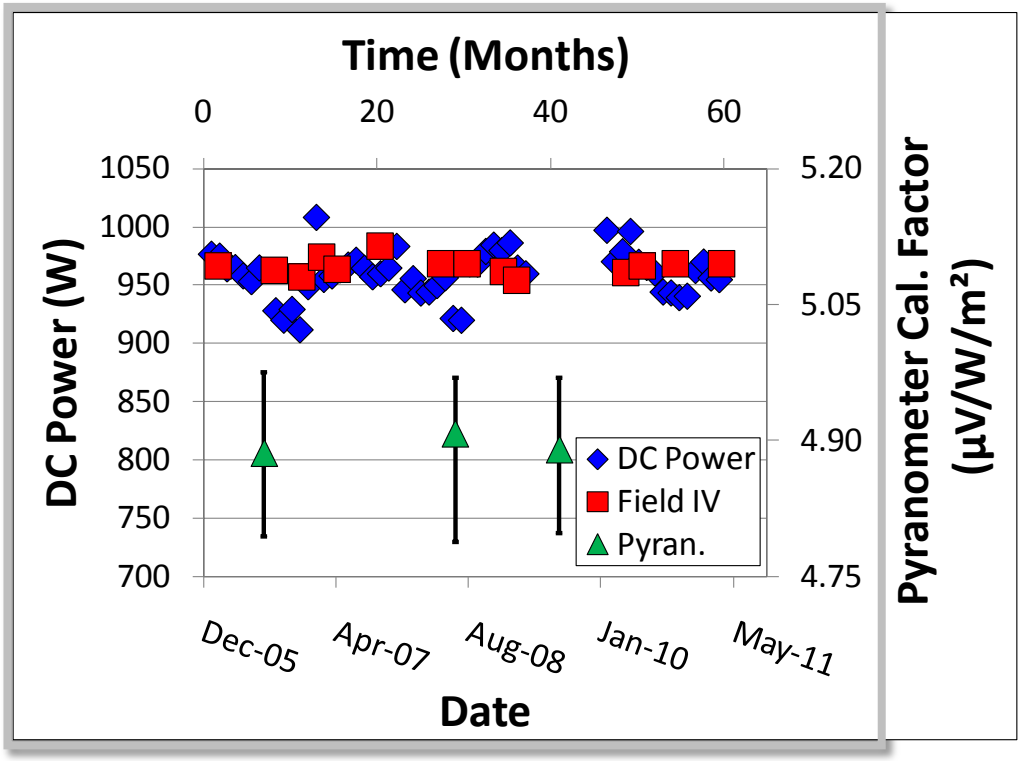
LONG-TERM RELIABILITY OF CIGS ON GLASS

NREL TEST ARRAY

- >7yr stability
- CIGS on glass with near identical packaging and process to Stion
- Zero degradation from PVUSA baseline

1.12 kW CIGSS Array

Source: NREL, D. Jordan



Stable power output after 7 years of field exposure

"The system continues to show no degradation within the measurement uncertainty."
- NREL, July 2013

LESSER THIN-FILM STABILITY

Amorphous Silicon

- Non-crystalline structure formed at low temperatures
  - Weak inter-molecular bonds
  - Staebler – Wronski Effect (10-30% power degradation in first few months of sun exposure)
    - "Amorphous silicon (a-Si) is one of the earliest thin film PV technologies and exhibits a well-known light-induced degradation effect, in which efficiencies degrade by ~10-30% in the first several hundred hours of light soaking [1].

CdTe

- Cu diffuses from the back-contact area through the CdTe absorber
  - "The magnitude of this initial efficiency loss is approximately 4–7% within the first one to three years, depending on climate and system interconnection factors, as shown in Fig. 5."

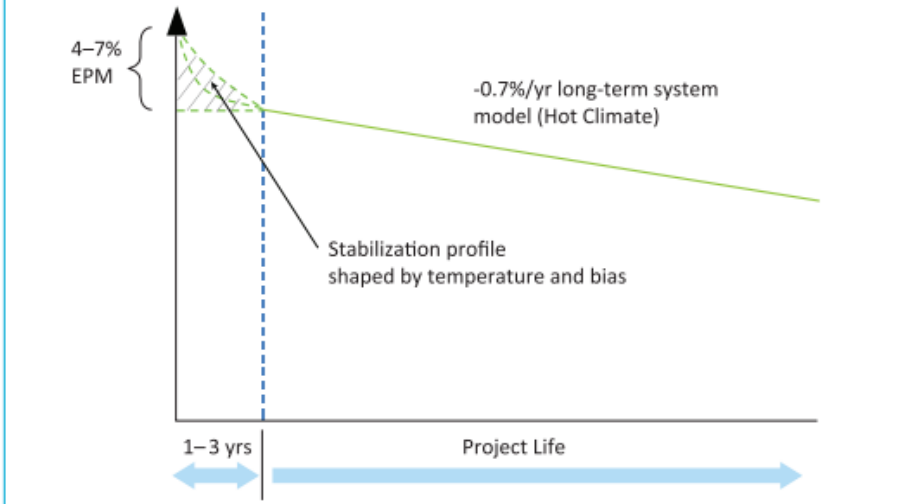


Figure 5. First Solar CdTe PV system degradation profile.

1. A. Luque and S. Hegedus, Handbook of Photovoltaic Science and Engineering. John Wiley and Sons, 2003
2. Cahen, D., Hodes, G. & Gartsman, K. 2000 (August). "Overcoming degradation mechanisms in CdTe solar cells", Second Annual Report, Weizmann Institute of Science, Rehovol, Israel.