CFV
solar test laboratory

TESTING — CERTIFICATION — INNOVATION

Overview of Module Characterization as Inputs to Performance Models

Jim Crimmins
General Manager, CFV Solar Test Laboratory

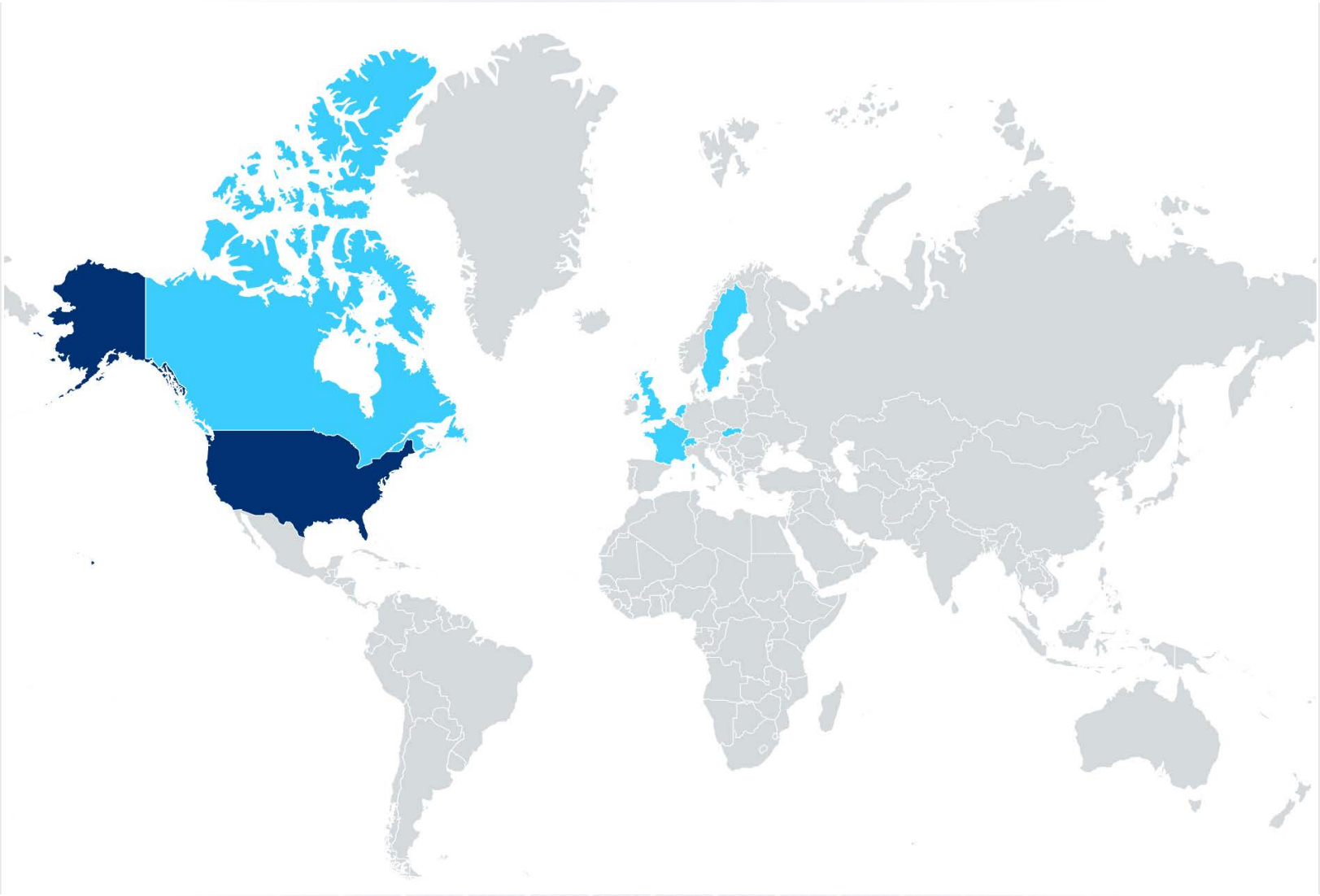
PV Systems Symposium, May 2018

JOINTLY OWNED BY: CSA INTERNATIONAL | Fraunhofer ISE | Fraunhofer USA

CFV Solar Test Laboratory

- CFV Solar Test Laboratory, located in Albuquerque, New Mexico, U.S.A., is a state-of-the-art PV test center.
- CFV is ISO 17025-accredited by the American Association for Laboratory Accreditation (A2LA) and is an IECEE CBTL.
- CFV is majority-owned by CSA Group, an international testing and standards organization, Fraunhofer ISE and Fraunhofer.
- CFV performs certification, performance and reliability testing for PV modules of all technologies, as well as PV racking and tracking systems.

Registration Map 2018



Registration Ranking by Country

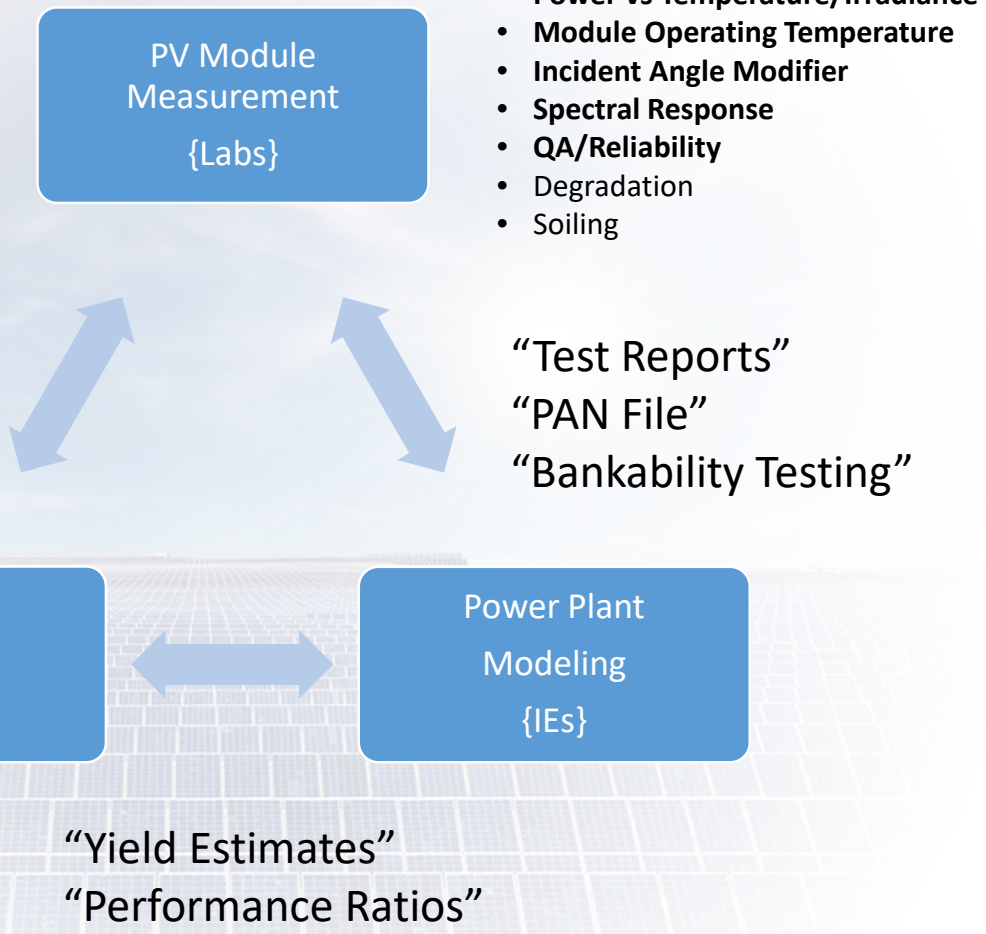
Top customer countries by sales

Ranking	Country	Number of transactions
1	United States	137
2	Canada	5
3	Slovakia	1
4	United Kingdom	2
5	Switzerland	1
6	France	1
7	Netherlands	1
8	Sweden	1

*Cypress not included as one participant chose to pay using alternative methods.

Module Characterization – The Big Picture

This currently works pretty well but is all the information in this loop being used to maximum advantage?



Importance of Module Characterization

- Good characterization measurements enable models to produce yield estimates with lower uncertainty.
- Lower uncertainty yield estimates translates into lower risk investments, which should be able to attract cheaper capital. The probable move to increasing percentage of debt financing in the medium term means all types of project risk reduction are even more important.
- Module characterization has improved substantially over past 5 years but there is still room for more improvement.
- Specific steps that can be taken to decrease risk and improve confidence in module characterization:
  - Measurement Standardization – all labs attempt to characterize modules in the same way.
  - Lab Accreditation – ISO 17025, IEECE CBTL.
  - Information Feedback Loops - data sharing among all stake-holders in the Measurement/ Modeling/ Monitoring process.
  - Continuous Improvement - updating standards and measurement techniques using information from the feedback loops.

Module Characterization Standards

We currently have a robust set of standards of varying maturity describing characterization measurements with at present varying levels of uncertainty.

Characterization	Standards	Standard Maturity	Uncertainty
Pmp @ various temperatures and irradiances	IEC 60904, IEC 61853-1	High	Low
Operating Temperature (NMOT)	IEC 61853-2	Medium	Medium
Incident Angle Modifier (IAM)	IEC 61853-2	Medium	Medium
Spectral Response (EQE)	IEC 61853-2	Medium	Medium
QA/Reliability	ANSI/CAN CSA 450	Low	Medium
Degradation Rate	None	Low	High
Soiling	None	Low	High

STC Poll

- If you sent the same silicon PV module to 2 different labs what is the magnitude of the difference of the STC power measurements you would expect?
  - 1%
  - 2%
  - 3%
  - 4%
  - >4%

Module Pmp Measurements CFV/NREL

Module Type	CFV h.a.l.m. Pmp (W)	NREL MSR Pmp (W)	% Difference
60-cell Mono	254.6	252.9	+.67%
60-cell Mono	271.8	273.2	-.51%
60-cell Mono	279.3	282.0	-.96%
60-cell Mono PERC	296.1	298.3	-.74%
			u=-.38%, s=.73%
Reported Uncertainty	+/- 2.2% (CFV)	+/- 1.1% (NREL)	

- Modules supplied by PSEL at Sandia National Laboratories
- Tests performed in October/November of 2017.

Module Pmp Measurements CFV/ISE

Module Type	CFV h.a.l.m. Pmp (W)	ISE Pasan Pmp (W)	% Difference
60-cell Mono	262.7	260.6	+0.81%
60-cell n-Type Mono	305.6	303.4	-0.49%
96-cell n-Type IBC	316.1	316.2	-0.03%
72-cell Multi	283.0	280.7	+0.82%
First Solar S3	110.7	110.3	+0.36%
			u=0.29%, s=.56%
Reported Uncertainty	+/- 2.2% (CFV)	+/- 1.6% (ISE)	

- Modules supplied by CFV/ISE
- Tests performed in November/December of 2017