IECRE PV SECTOR STATUS
ARESCA TAG'S

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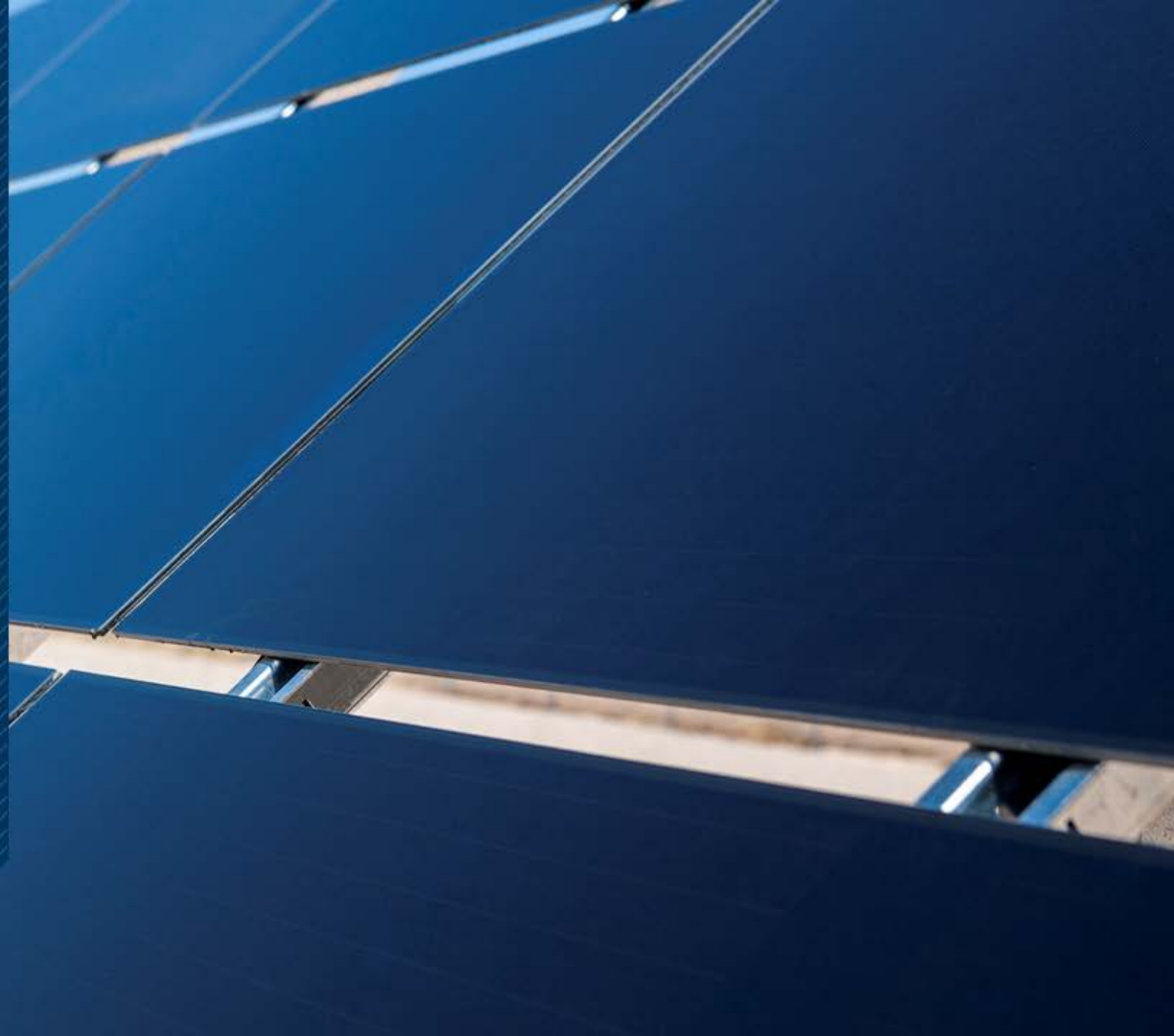
Sept 24
SPI, Salt Lake City

First Solar

ARESCA
American Renewable Energy Standards and Certification Association

IEC

IECRE

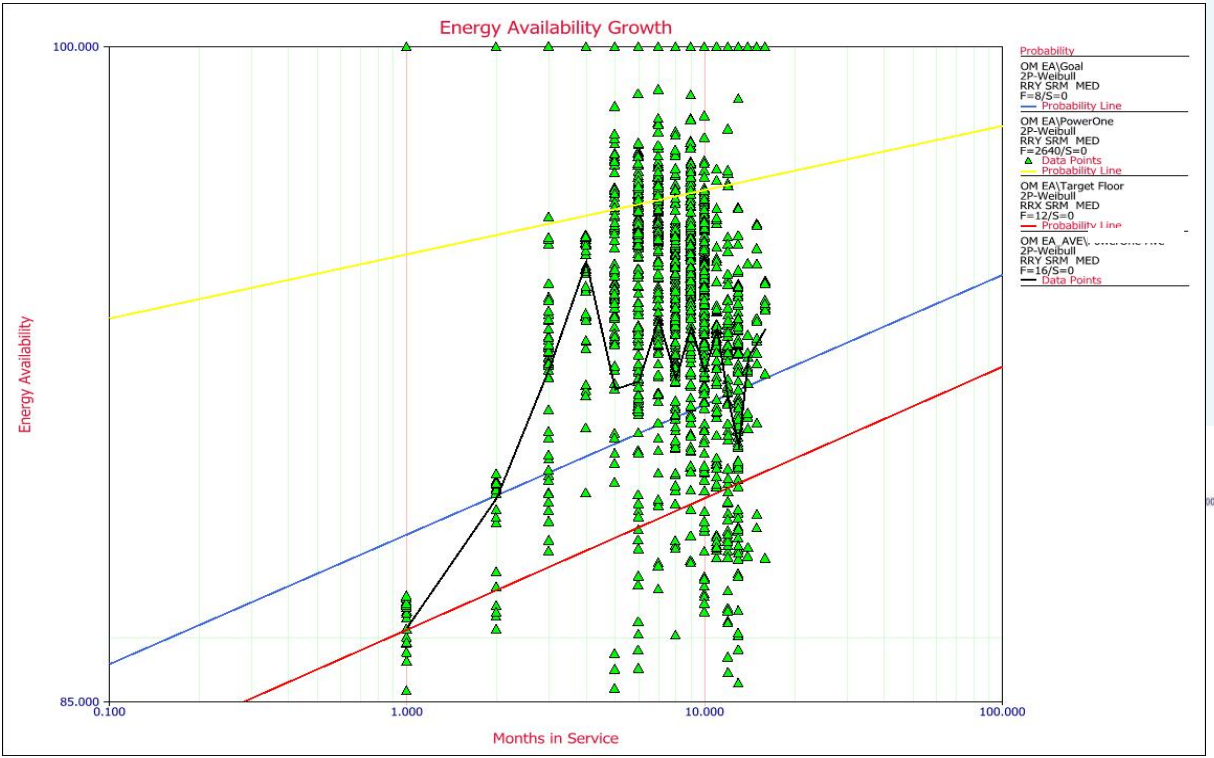


FUTURE STATE CRITICAL THEMES → SCALE

“TRUST IS THE MOST HARD WON COMMODITY IN LIFE”

“IN GOD WE TRUST, ALL OTHERS BRING DATA”

PARADIGM METRIC – SYSTEM EFFECTIVENESS
FIELDED AVAILABILITY GROWTH METRIC



Blue line is Goal Line

Red line is the floor (lower 90percentile)

Yellow Line is the growth line for this inverter since introduction in FS fleet

Black line is Average value of EA for this inverters

Slope of yellow line is lower than the blue line indicating slower reliability growth.

Months in Production	2	4	6	8	10	12	14	15	16	18	24	26	36	42	48
Target Floor	93.10%	95.00%	96.00%	96.60%	97.00%	97.30%	97.45%	97.55%	97.70%	97.90%	98.30%	98.60%	98.80%	98.90%	99.00%
% Below Floor	32.00%	0.00%	3.72%	21.38%	7.55%	34.73%	0.21%	0.50%	4.09%						
Cost of Lost Energy	$78,101	$16,571	$71,490	$64,158	$61,193	$53,350	$3,023	$2,575	$1,049						

Source: First Solar Systems Reliability Group – Fielded Reliability Growth Metric Illustration

PARADIGM METRIC – LIFE CYCLE COSTS
COST OF OWNERSHIP (COO) BENCHMARK

Cost of Ownership per Inverter

Note: All costs are cumulative

	Time (Yr)					
Inverter	**1**	**2**	**3**	**4**	**5**	**6**
Supplier 1	$1,125	$1,458	$1,526	$1,527	$2,008	$2,884
Supplier 2	$15,637	$15,875	$19,238	$32,671		
Supplier 3	$3,841	$5,076	$5,088	$5,496	$6,243	
Supplier 4	$8,319	$12,763	$15,730			

Cost of Ownership per MW

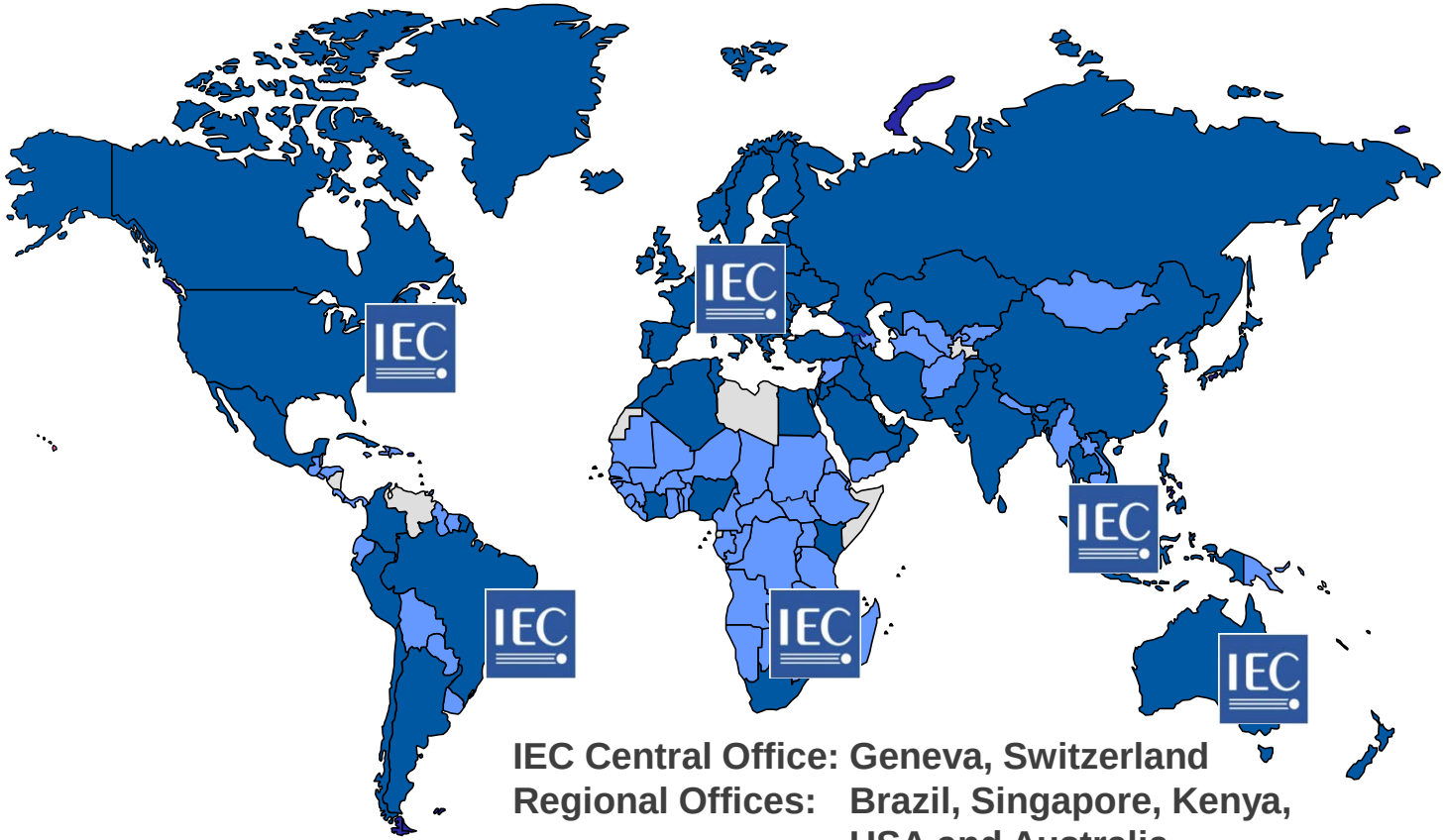
	Time (Yr)					
Inverter	**1**	**2**	**3**	**4**	**5**	**6**
Supplier 1	$1,562	$2,025	$2,119	$2,121	$2,789	$4,005
Supplier 2	$10,425	$10,583	$15,390	$26,137		
Supplier 3	$2,845	$3,760	$3,769	$4,397	$4,995	
Supplier 4	$2,080	$3,191	$3,932			

Red → Actuals >50% from predicted
Orange → Actuals 20-50% higher from predicted
Yellow → Actuals 10-20% higher from predicted
Green → anything lower than predicted or <10% greater.

Source: First Solar – Systems Reliability Group – COO Benchmark Illustration

IEC – International Electrotechnical Commission

Global Reach: 86 Members + 86 Affiliates = 172 Countries

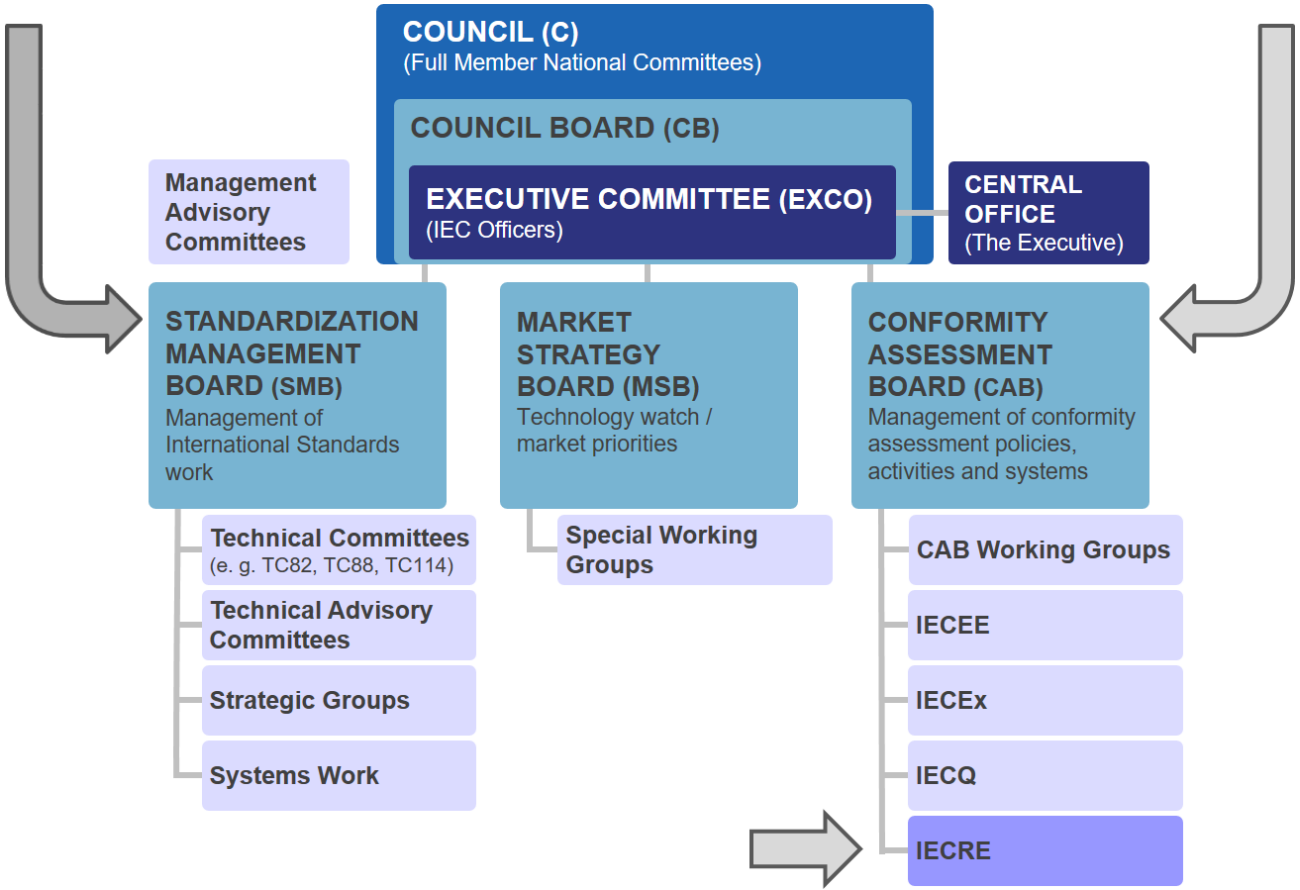


IEC Central Office: Geneva, Switzerland
Regional Offices: Brazil, Singapore, Kenya, USA and Australia

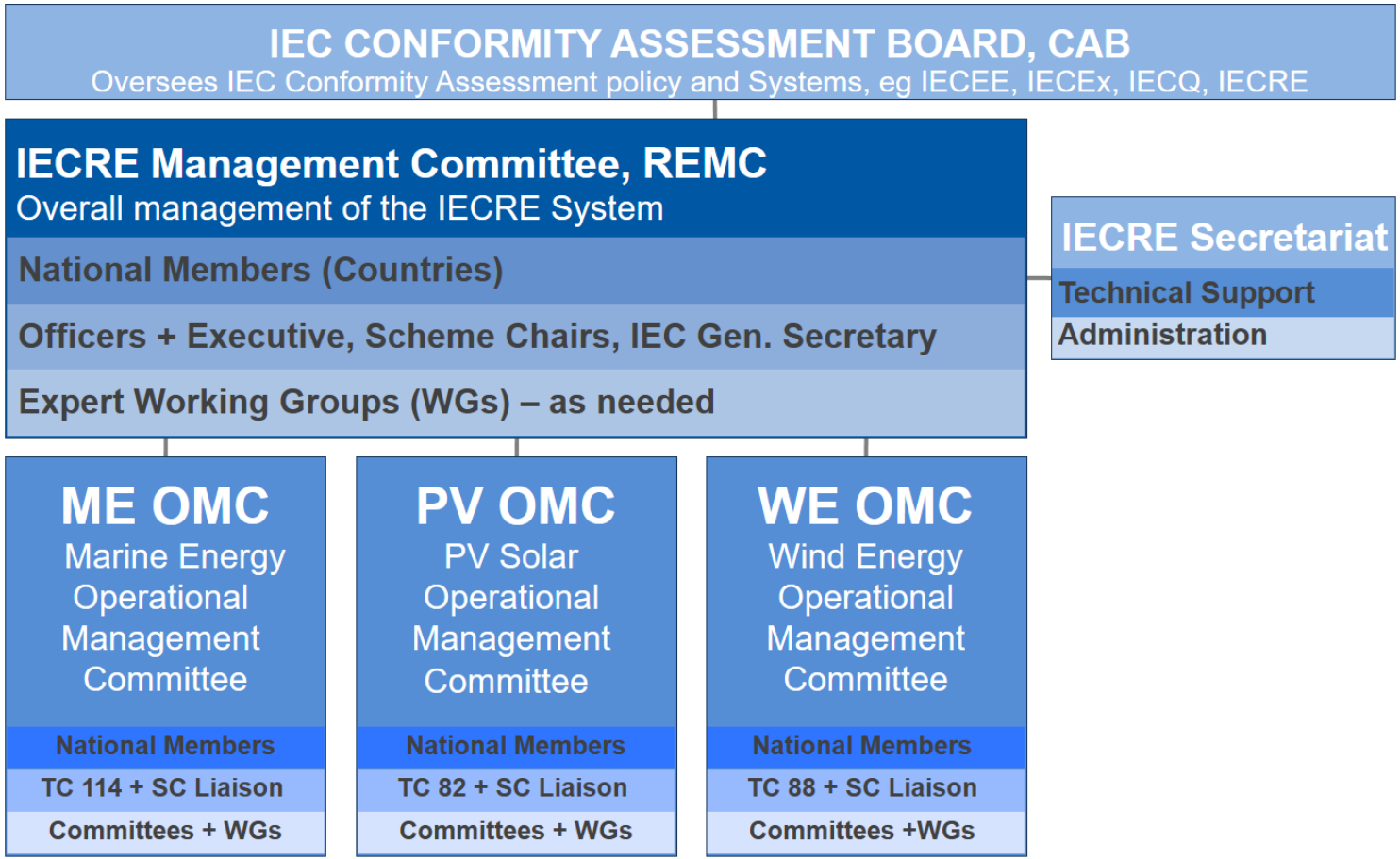
IEC Management Structure

Standards

Conformity Assessment



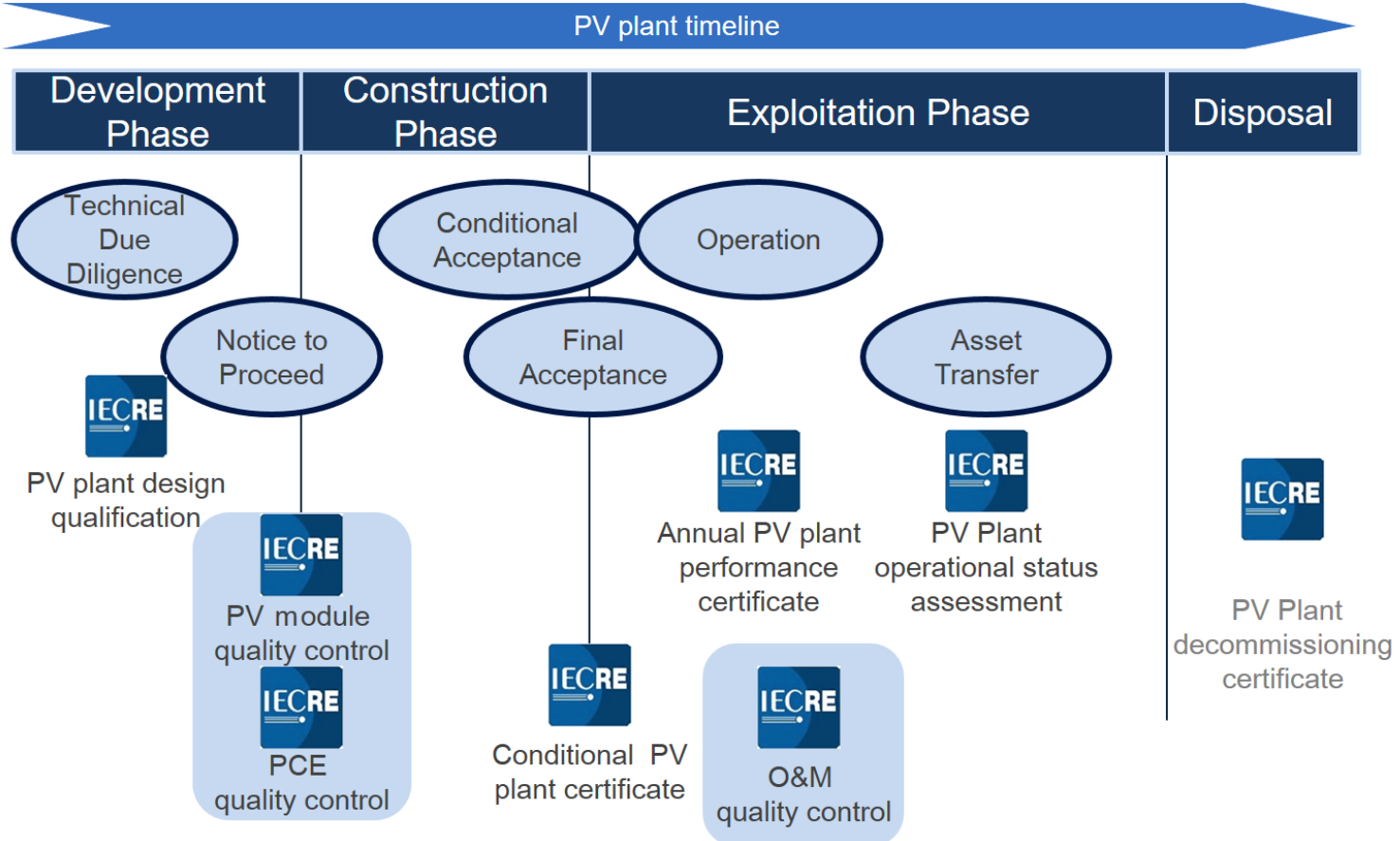
IECRE Management Structure



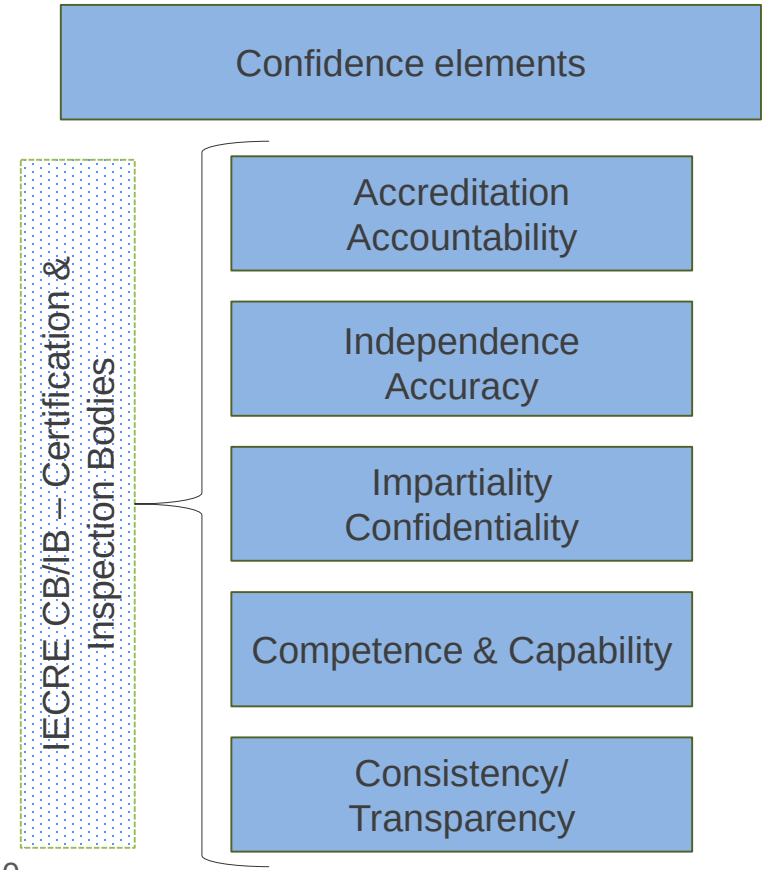
How does the IECRE system work ?

- IECRE itself does not certify, but administers the system and provide its framework through a systematic approach that system participants who issue certificates are qualified
- Qualified registered participants are competent to assess RE equipment and projects
  - RECBs (RE Certification Bodies)
  - REIBs (RE Inspection Bodies)
  - RETLs (RE Test Laboratories)
- Competence validation through regular, revolving peer assessment
- Proper IEC and other international standards are referenced insuring appropriate interpretation of standards
  - New standards and requirements can be adopted at any time if required by stakeholders (includes policy makers) and if fitting to the system
- Transparency
- Influence for all stakeholders
  - All stakeholders have a voice (RECBs, REIBs, RETLs, OEMs, end users, policy makers)
  - All national member bodies have a vote
  - All participating RECBs recognize & accept IECRE certificates

The concept is to offer certification throughout the lifetime of a PV power plant



Features of IECRE PV CA Certificates

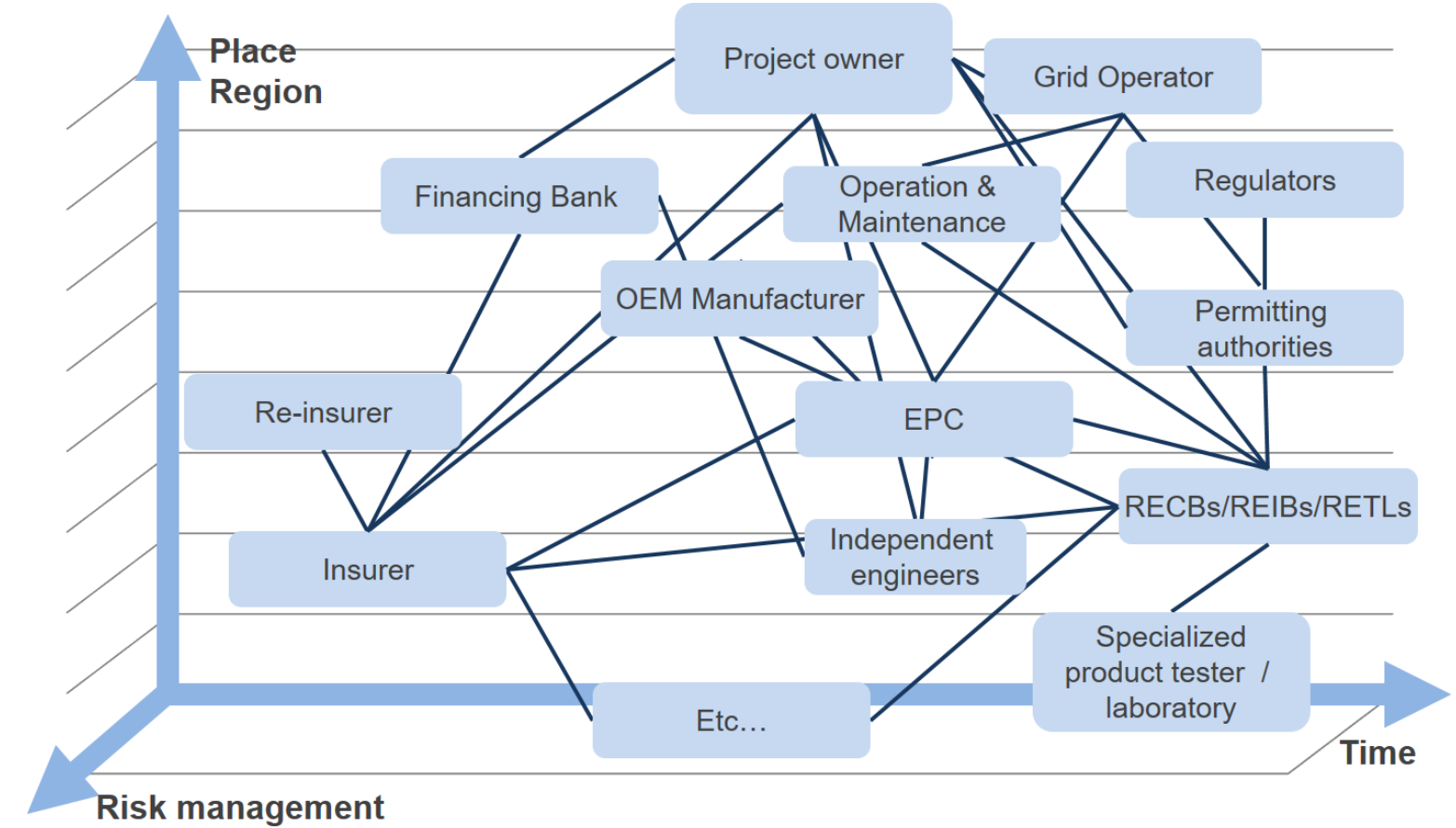


Consensus based standards worldwide

Peer Assessment & Registration

Consistent/transparent process

Who are the IECRE stakeholders ?



What is the Motivation for different stakeholders to participate in the IECRE system?

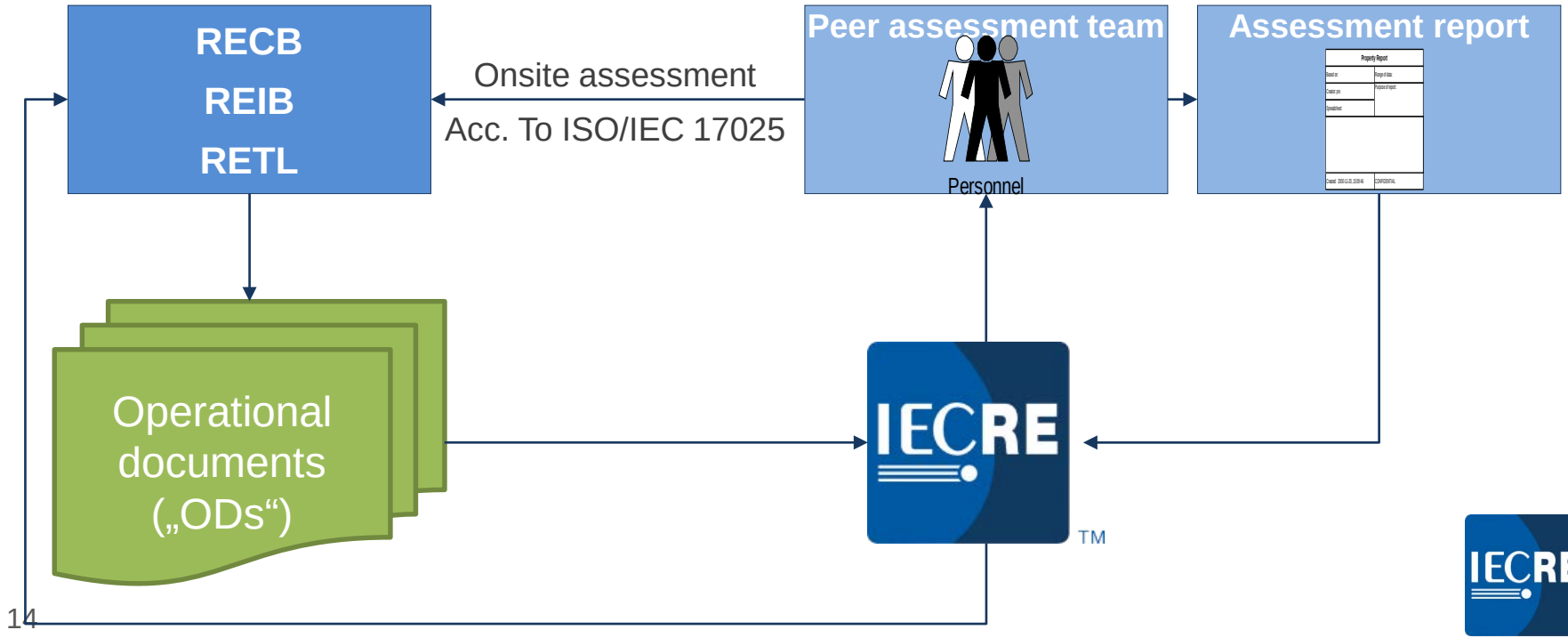
- OEMs, EPCs — Level playing field, mutual acceptance, streamline and reduce audit overheads
- RECBs, REIBs, RETLs — Expanded market, increased value, proven proficiency
- Independent Engineers — Market, value, proficiency
- End Users
  - Developers — Consistency, quality, resale value
  - Operators — Quality, reliability
  - Owners
  - Banks
  - Insurers

  — Risk management, performance, resale value
  - Grid operators — Grid compliance, reliability
  - Regulators
    - Safety
    - Code compliance
    - Avoidance of overlapping references and standards, and therefore, complexity
    - Comparability between different countries within EU and beyond

Features of the IECRE conformity assessment system

- Conformity assessment to relevant IEC standards by IECRE accredited Factory Auditor, carefully selected from experts with good experience and competence in the designated area
- The assessments include both “factory” and “field” aspects of Quality Management system of manufacturers of PV modules and PCEs, and service providers of installation and O&M of PV plants.
  - Module Quality — IEC TS 62941
  - System Installation and O&M Quality — IEC TS 63049
  - PCE Quality — IEC TS 63157 (to be published August 2019)
- Peer assessment by IECRE team examines the competence and independence of the Certification bodies and Factory Auditors
- Obligatory mutual recognition and peer assessment to achieve mutual confidence.
  The principle of obligatory recognition of the other members' certificates and audit results implies that no repeat audits are necessary. It enables faster and more economic entry into distant markets for manufactures and servicers and provides a global assurance that, no matter where an audit was carried out or a certificate was issued, it has the same value

Peer Assessment is crucial for the IECRE System



Assessor Qualification is a Key Success Factor: Example Factory Auditor Requirements

Auditor Grade	Common	Grade specific
Provisional Auditor	Each applicant shall provide responsible RECB with evidence of passing a written qualification exam covering the following content: a. ISO/IEC 17024 and 17021 (relevant clauses) or IEC 63049 e.g.: • Technical Requirements • Quality System • Personnel b. Inspection Methods and Procedures e.g.: • Product review according to product certification documents • Handling Inspection Samples • Records • Inspection Reports and Inspection Certificates. c. Surveillance procedures according to the relevant requirements of the applied scheme. d. Decisions or other additional requirements of the applied scheme e. Requirements for surveillance sample testing and test results evaluation as needed during the performance of PV-Service-Provider Auditor in the applicable product categories. f. Familiarity with the standards listed in normative references of IEC 62941 or63049, as appropriate.	• Either a University degree / College diploma or certified / licensed master craftsman, technician or engineer in the relevant technical working field. • 2 Years, or equivalent work experience • Attended a lead assessor/auditor training on ISO 9001 approved by a accreditation body from IAF Or, Attended auditor training or a training on IEC 62941 or IEC 63049 requirements interpretation
Auditor		• Either a University degree / College diploma or certified / licensed master craftsman, technician or engineer in the relevant technical working field. • 4 Years, or equivalent work experience incl. 2 years, or equivalent of Solar PV specific work experience* • Attended a lead assessor/auditor training on ISO 9001 approved by a accreditation body from IAF Or, Attended auditor training or a training on IEC 62941 or IEC 63049 requirements interpretation • 3 Full Management Systems audit, all elements of audit cycle, 15 days of which 10 on site

Quality Assurance Aspects

System certificate name	Major points of emphasis	Primary normative references	Remarks
QC system certificate for PV module manufactures	• Validation of design lifetime • Control of measurement tool • Monitoring and measurement of a manufacturing process • Post-delivery activities	ISO 9001:2015 IEC TS 62941 IEC 61215, IEC 61730 IEC 62108 IEC 61730-1, -2 IEC 60891, IEC 60904 IEC 61853-1, …	First IECRE certificate issued to First Solar May 2018
QC system certificate for PV PCE (inverter) manufactures	• Design and development validation • Control plan • Monitoring of product and processes during manufacturing and providing for service	ISO 9001:2015 IEC TS 63157 IEC 62891, IEC 62109 IEC 62920 …	IEC TS 63157 published Mar 2019
QC system certificate for PV plant installer and O&M service providers	• Records Requirements • Training programs • Installation Process • Ongoing installation monitoring • Requirements for PV Plant Operations & Maintenance	ISO 9001:2015 IEC TS 63049 IEC 62446-1, -2 IEC 60904, IEC 62109 IEC TS 62738 IEC TS 61724-2, -3 …	IEC 62446-2 is circulated as final draft for publication

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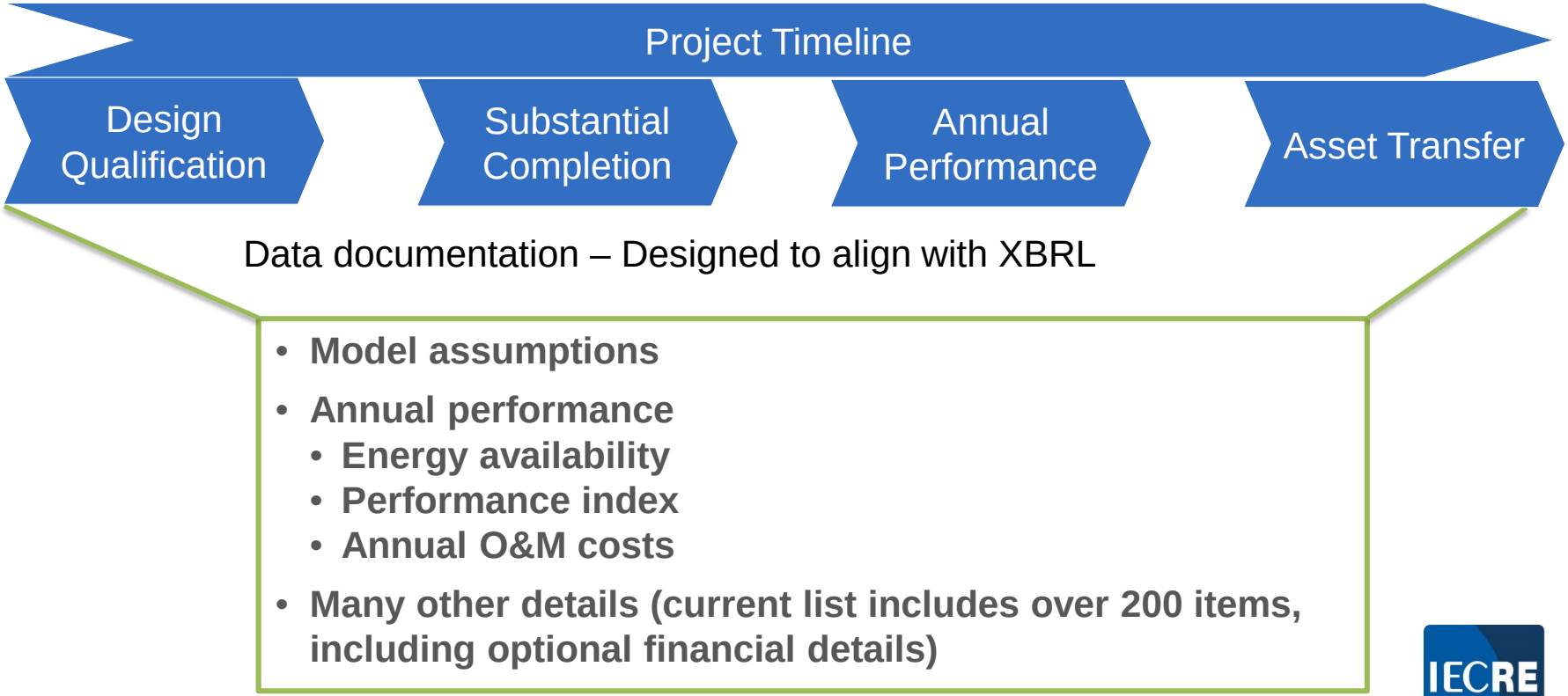

Source: PV Module Reliability Workshop Lakewood, CO 1-Mar-2017 George Kelly – Sunset Technology

ARESCA represents the US member body

- 501(c)(3) non-profit formed Dec 2015
- Website online August 2016
  - Voting / Document distribution
  - General / Reference information
- USNC/IECRE Secretariat (Jan 2017)
- US TAG Administrator (2017 - Present)
  - TC 88 Wind energy generation systems
  - SC 8A Grid integration of renewables
  - SC 8B Decentralized electrical energy systems

Scope of SC8A and SC8B

SC8A

Grid Integration of Renewable Energy Generation

- **impact of a high percentage of renewables connected to the grid, considering that**
- **their variability and predictability impact the functioning of the whole electricity grid.**
- **It covers grid integration standards for renewable energy, aggregating contributions of all grid users and prescribing interaction modes between the grid and power plants. This includes requirements for interconnection and related grid compliance tests, as well as standards or best practice documents for planning, modeling, forecasting, assessment, control and protection, scheduling and dispatching of renewables with a grid level perspective.**
- **Note 1: SC 8A deals with the grid level requirements enabling secure, non-discriminatory and cost effective operation of electricity supply systems with a significant share of renewable generation**

SC8B

Decentralized Electrical Energy Systems

- **Standards enabling the development of secure, reliable and cost-effective systems with decentralized management for electrical energy supply, alternative/complement/precursor to traditional large interconnected and highly centralized systems.**
- **The most popular concept is currently the “microgrid” defined as a group of interconnected loads and distributed energy resources with defined electrical boundaries that acts as a single controllable entity and is able to operate in both grid-connected and island mode.**
- **Decentralized energy systems have applications for developing countries (focussing on access to electricity) as well as for developed countries (focussing on high reliability, black-out recovery and/or services).**
- **Interactions within Decentralized (Multi) Energy Systems should also be considered.**

Participate in the US

ARESCA

American Renewable Energy Standards and Certification Association

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