IEC Standards Development and the IECRE Conformity Assessment System

4th Annual Atlas / NIST Workshop on Photovoltaic Materials Durability

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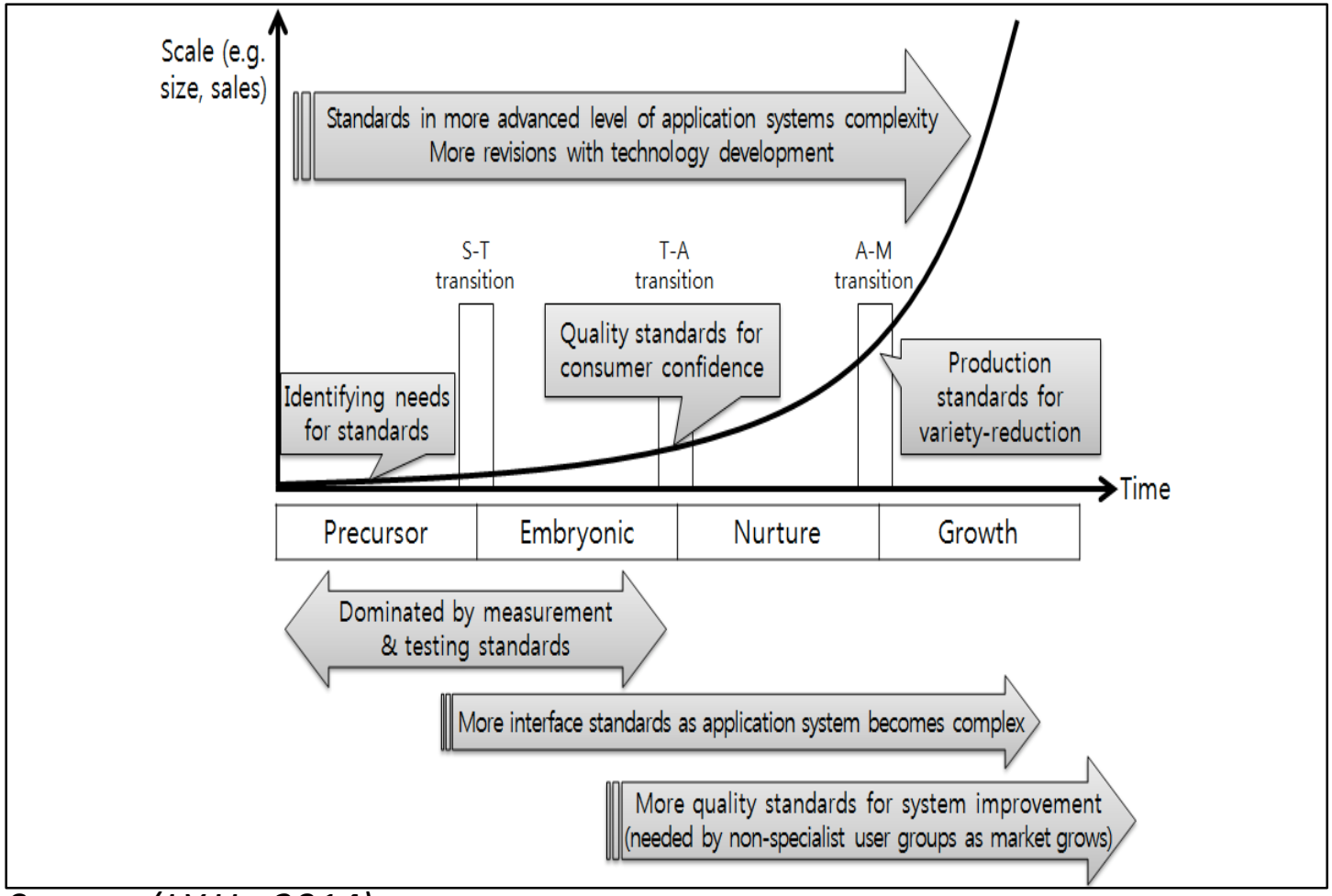
International Electrotechnical Commission
Technical Committee 82 - Solar photovoltaic energy systems

Context and Background

- Industry growth
  - Demand increasing 20%+ per year
  - Significant increase in large commercial plants
  - Transfer of manufacturing base to China
- Concern for quality / bankability
  - Doubts about adequacy of existing standards
  - Need for improved understanding of reliability
  - Validation of product lifetime for investors
- International PV Quality Assurance Task Force (PVQAT)
  - Formed 2011; currently 12 task groups
  - Mainly focused on scientific methods to characterize and predict possible failure modes
  - Work feeding into TC82 for NWIPs

Standardization in Technological Innovation



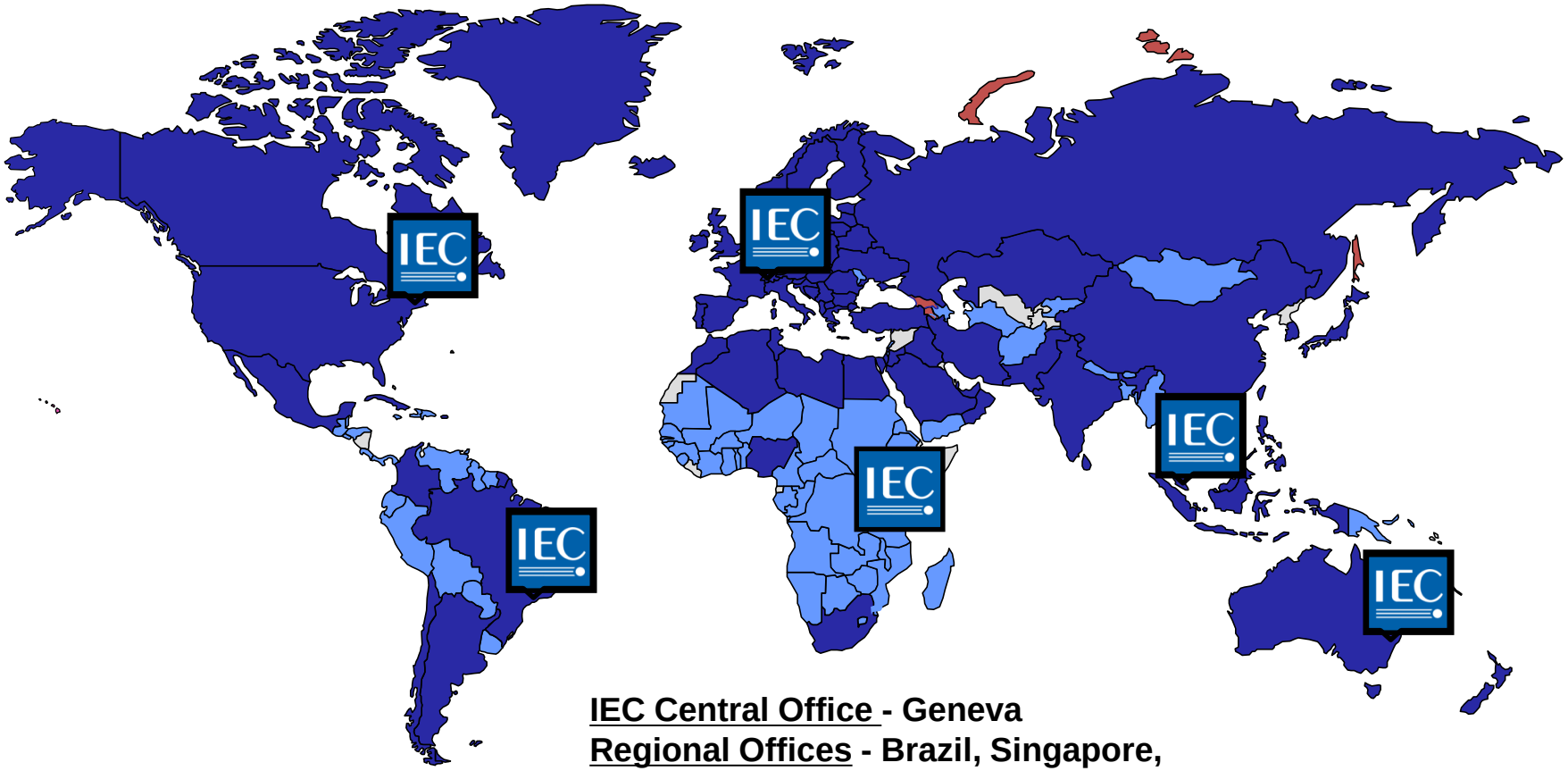
Source: (J.Y.Ho 2014)

PV Standards Organizations

Standards Development Organization		Membership	Focus of Activities
International Electrotechnical Commission	IEC	National Committees	Performance and Safety of Products, Systems and Services
ASTM International (formerly American Society for Testing and Materials)	ASTM	Individual Experts	Measurement Principles and Specialty Tests
Semiconductor Equipment Manufacturers' Institute	SEMI	Member Companies	Primarily Manufacturing-related (materials and equipment)
Underwriters' Laboratories	UL	Invited Experts	Product Safety
International Code Council	ICC	Invited Experts	Building and Fire Codes
Institute of Electrical and Electronics Engineers	IEEE	Individual Experts	Grid Connection Codes

IEC Global Reach

83 Members **87 Affiliates**

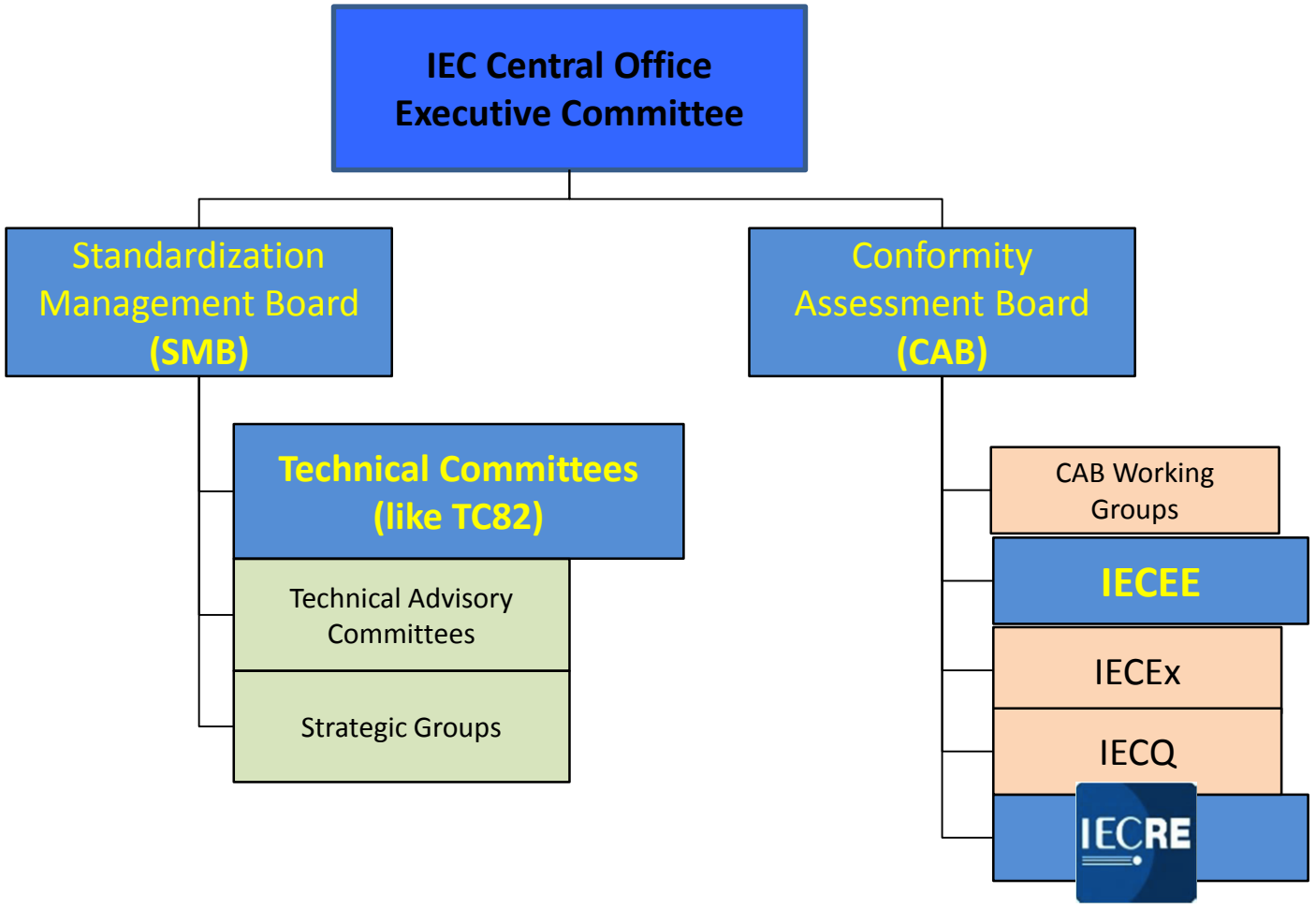


IEC Central Office - Geneva
Regional Offices - Brazil, Singapore, Kenya, US and Australia

Roles & Responsibilities

- Standards Management Board (**SMB**)
  - Technical Committees => Write the standards
  - Manage nomination of experts and voting by National Committees (Member Bodies)
- Conformity Assessment Board (**CAB**)
  - Assessment Schemes => Evaluate implementation of standards in specific situations
  - Manage accreditation of Certifying Bodies

IEC Organization



IEC Standards Process

- 170 countries represented
  - 83 “member” and 87 “affiliate” countries
  - One vote per country (national committee)

- 203 Technical Committees / Subcommittees
  - Scope and Work Programme for each TC approved by vote of participating national committees
  - National committees appoint experts to participate in each project
  - Minimum 5 participating countries for a new project

- Rules defined under ISO/IEC Directives

Standards Development Fundamental Principles

- Established by World Trade Organization
  - Common to ISO, IEC, ITU
- IEC procedures are intended to ensure:
  1. Transparency
  2. Openness
  3. Impartiality and consensus
  4. Effectiveness and relevance
  5. Coherence
- And to address the concerns of developing countries

Development Tools

- IEC website: www.iec.ch
  - Up-to-date information on all projects
  - Access to all working documents
  - Electronic voting / commenting
  - Templates for drafting standards
  - Web-conferencing & collaboration tools

- Experts Management System (EMS)
  - Administered by national committees
  - Online registration for TC meetings

TC 82 Scope

- To prepare international standards for systems of photovoltaic conversion of solar energy into electrical energy and for all the elements in the entire photovoltaic energy system.

- In this context, the "photovoltaic energy system" includes the entire field from light input to a photovoltaic cell to and including the interface with the electrical system(s) to which energy is supplied.

TC 82 Structure

- Established 1981
- 51 countries represented
  - 40 “participating” and 11 “observing” member countries with 350+ experts
  - 10 active working groups
- TC82 has the **LARGEST** work programme of all IEC committees
  - 103 publications
  - 66 projects underway (43 new, 23 revisions)
  - This is good – if they get finished !!

TC 82 Working Groups

WG 1: Glossary
WG 2: Modules, non-concentrating
WG 3: Systems
WG 6: BOS components
WG 7: Concentrator modules
WG 8: Cells

JWG 1: Off-grid PV systems
JWG 4: Grid Code Compliance (SC 8A)
JWG 32: Electrical safety of PV system installations (TC 64)
JWG 82: Secondary cells and batteries for renewable energy storage (TC 21)

TC 82 Impact

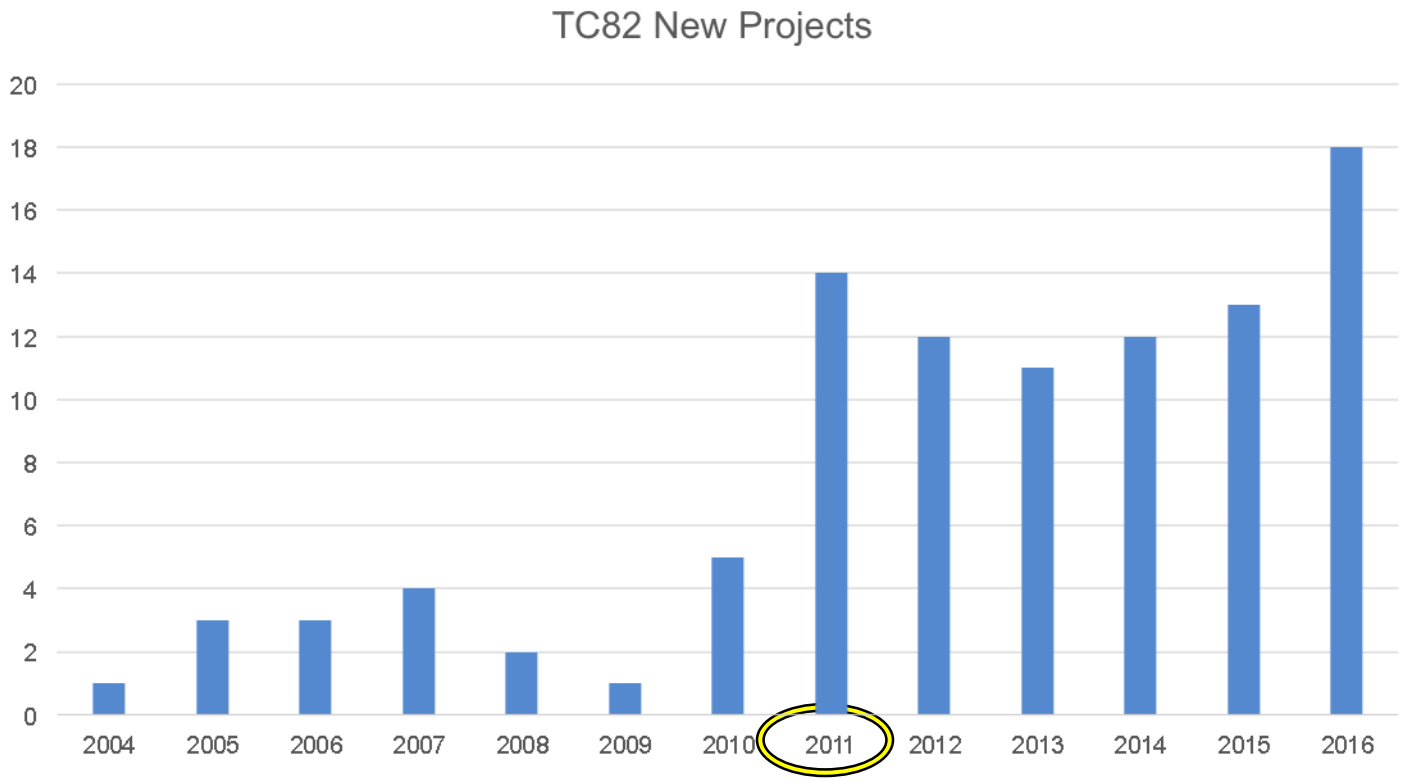
IEC TC 82 standards, implemented in all major markets, have contributed in the last 35 years to:

- ✓ High quality and reliability systems
- ✓ Cost Reduction
- ✓ Innovation
- ✓ Transparent markets and trade
- ✓ Safety

Standards Development

- Comprehensive review of existing international and national standards conducted by TC82 experts in 2014
- Determination of which standards would most likely be required to conduct conformity assessments
- Consideration of all IEC standards and others where appropriate (ASTM, UL, VDE, etc.)
- Used to prioritize the work of TC82 and supporting efforts by PVQAT
- Results presented at IEEE PVSC in Denver June 2014

“PVQAT Effect” on TC82



Remarkable development, demonstrating importance and visibility of IEC standards in PV

Anticipated areas of activity

- WG2 Modules
  - Module component specs & tests
  - Quality system
  - Reliability & comparative testing
  - Closely tied to PVQA Task Force efforts
- WG3/6 Systems/BOS
  - Safety standards for specific components
  - System design & installation
  - System commissioning and O&M
    - Coordination with work in other SDOs
- WG7 Concentrators
  - Power & energy rating; solar simulator

IEC System for Certification to Standards
Relating to Equipment for Use in Renewable Energy Applications

Background

- Industry Growth
  - Demand increasing steadily >20% per year
  - Significant increase in large commercial plants
- Concern for Quality / Bankability
  - Doubts about adequacy of existing standards
  - Need for improved understanding of reliability
  - Validation of product lifetime for investors
- Need for Conformity Assessment
  - Assurance of security for investments in PV
  - Objective evidence of performance

Conformity Assessment

- Evaluation against international standards
  - May use national or regional standards if no international standard is available
- Improved quality and performance
  - Assurance that PV plant will operate as designed for its expected lifetime
- Increased confidence for investors
  - Financial return meets expectations
  - Risk is reduced

Benefits of Certification

- Independent assurance of conformance with appropriate international standards
- Evaluation by accredited inspection bodies in open and transparent process
- Objective evidence of best practices for investors and financial institutions
- Common need in Renewable Energy (RE) systems across multiple industry sectors
  - PV Solar, Wind, Marine, and others?

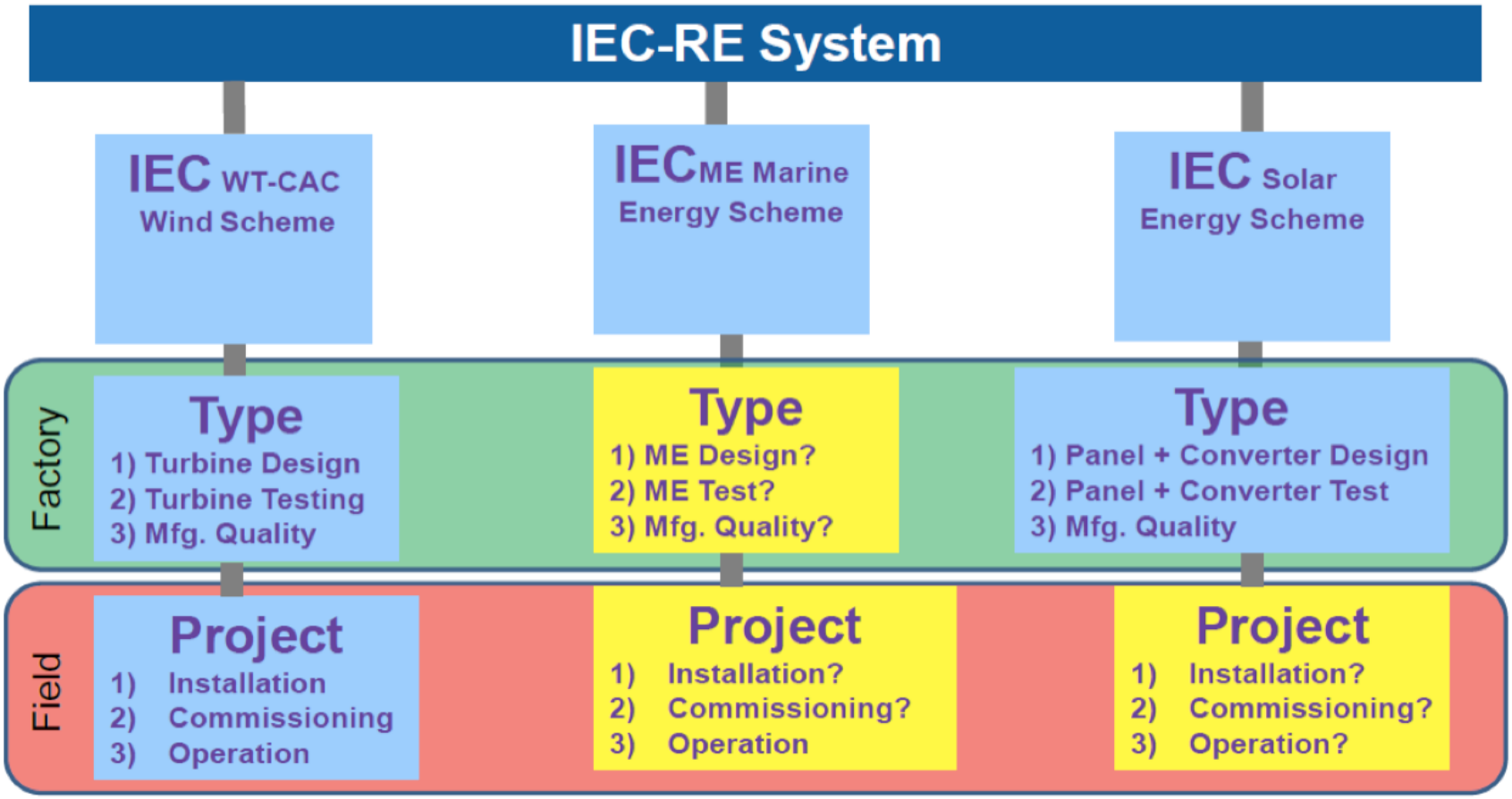
Benefits of IEC Systems

- IEC Brand
  - Global recognition – multiple industries
  - International recognition (e.g. WTO + UN)
  - IEC Reports and Certificates used nationally
- Open and Transparent Process
  - Clear Rules in process and results
  - Consistency in processes among participating Certification Bodies & Test Labs
- Industry and market provide direct input
  - CA systems driven by market demand

Wind Turbine History

- Wind industry identified the need to address the "system aspect" of large complex projects
  - Not covered by any existing CA scheme
- Formed Wind Turbine Conformity Assessment Committee (WT-CAC) in 2011
  - IEC structure / policy requires separation of standardization and CA activities
- Concept developed for new CA system (IECRE)
  - Similar requirements exist for large Solar PV power plants as well as Marine Energy projects
  - Specific differences and details apply for each industry

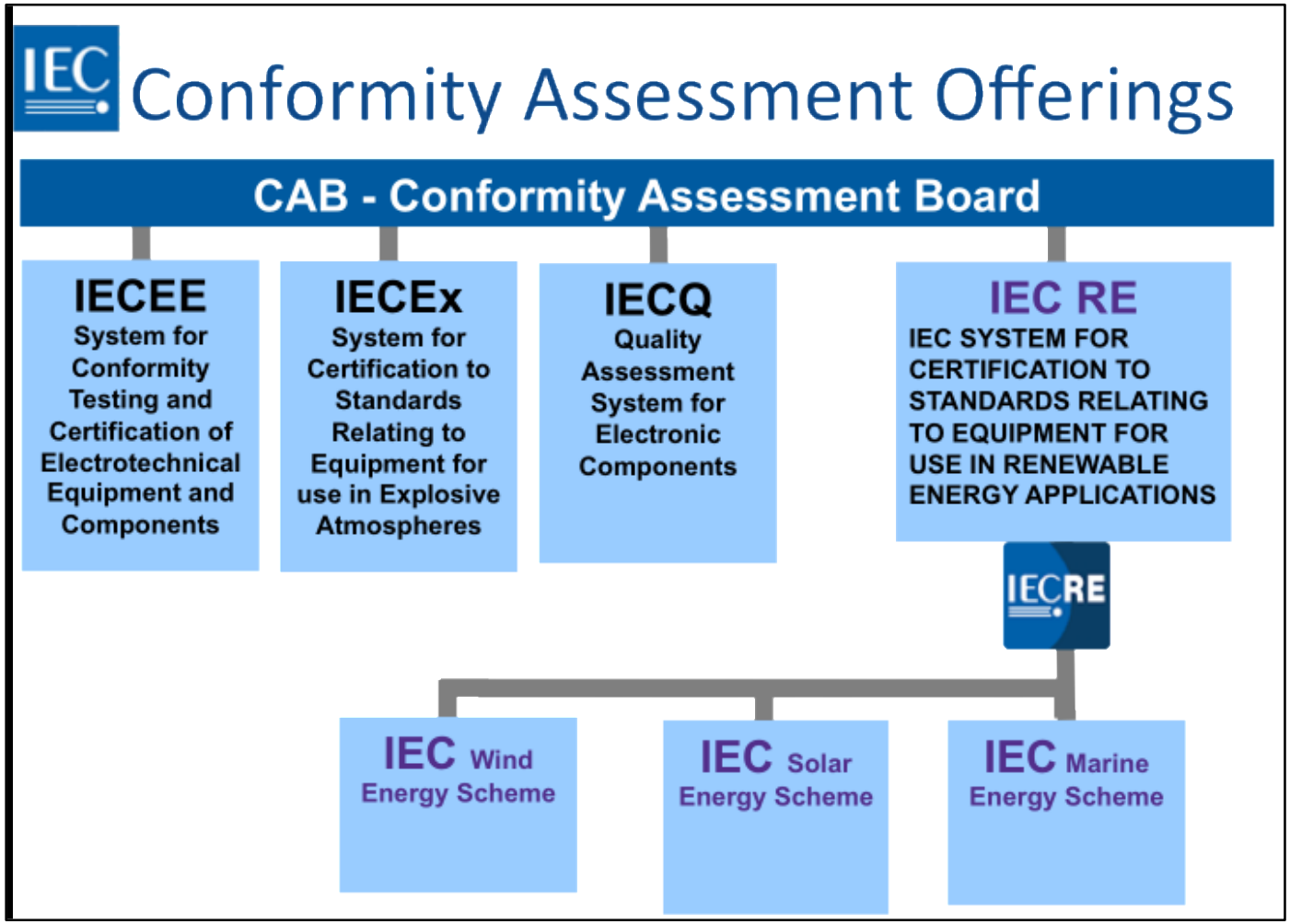
RE Common Elements



IECRE Formation

- June 2013 CAB approves the creation of a Renewable Energy Conformity Assessment System
  - Oct 2013 Kick-off meeting in Aarhus, Denmark
- June 2014 CAB approves the Basic Rules for operation of the IECRE system
- September 2014 First Management Committee (REMC) meeting
  - Each industry sector established an Operating Management Committee (OMC) to address their specific needs and define the certification schemes required
- October 2016 First IECRE Certificates Issued for wind turbines

IEC Conformity Systems



PV-OMC Progress

- Approved Rules of Procedure (RoP) April 2016
  - Updated Ed. 2 balloted in Sept 2017
- The PV-OMC is concentrating on determining the most critical issues for stakeholders and how they can be addressed by certifications
- Operational Documents will describe requirements for different certification offerings
  - Multiple aspects of certification tied to lifecycle / events
  - Certificate often required for financial milestones

PV-OMC Member Bodies

- 12 Countries represented by National Committees

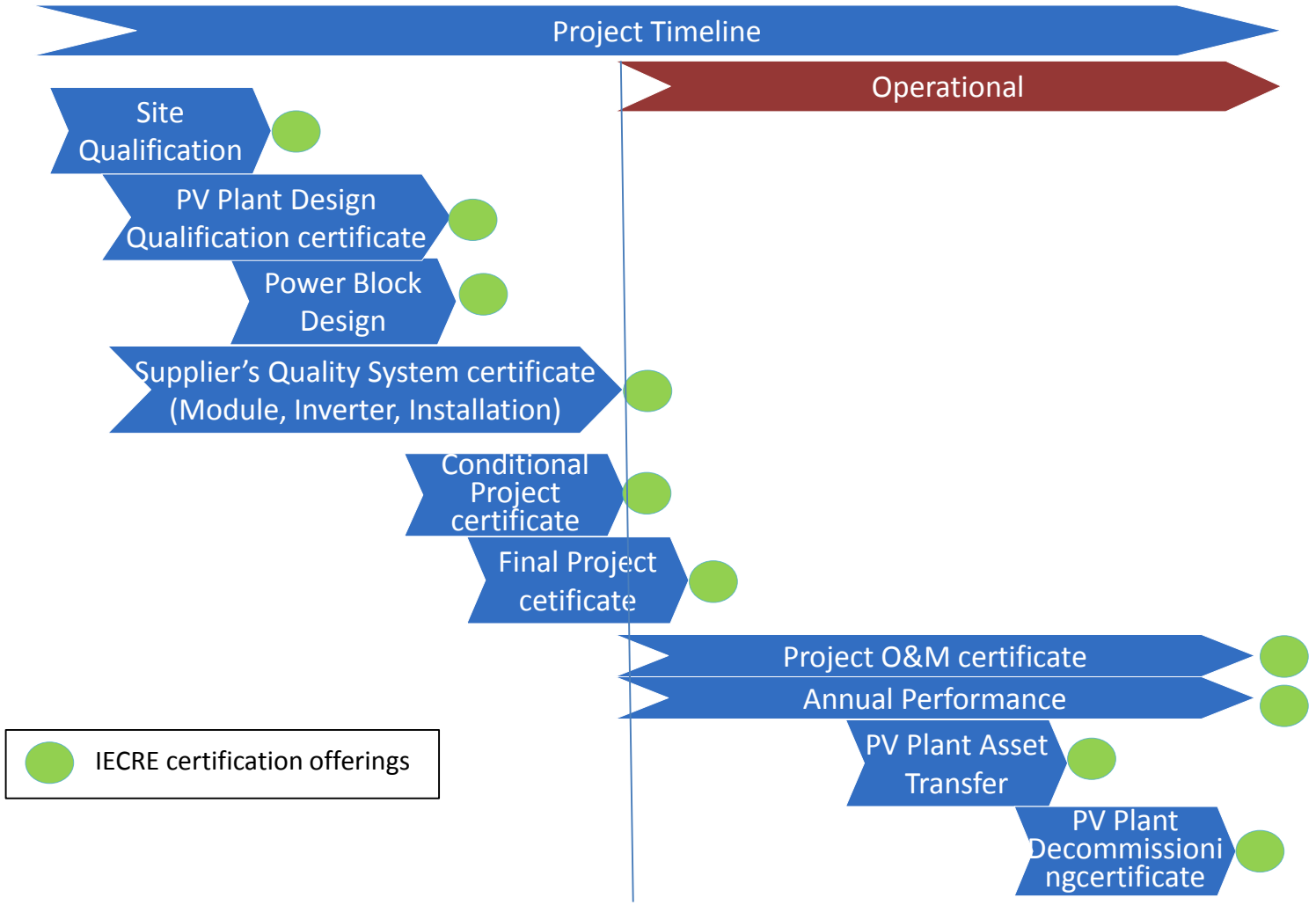
Aspects of Certification

- Conformity assessment will be performed and certificate issued for an individual PV power plant on a specific site

- Design Phase
  - Site evaluation
  - Design evaluation
  - PV equipment evaluation
  - Structural and electrical code compliance

- Implementation Phase
  - Installation
  - Output measurement
  - Commissioning surveillance
  - Operation and maintenance surveillance

System Timeline View



Certificate Categories

- PV Site Qualification certificate
- PV Power Block design qualification certificate
- PV Plant Design qualification certificate
- Conditional PV Project certificate (construction complete / commissioning)
- Annual PV Plant Performance certificate
- PV Asset Transfer certificate
- PV Decommissioning certificate

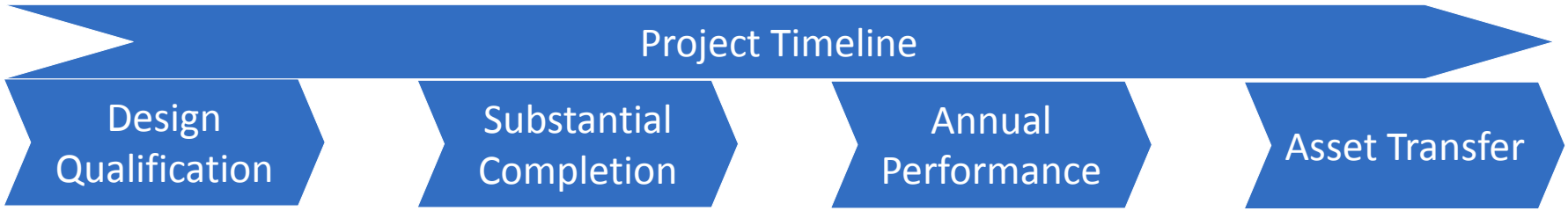
Operational Documents

TITLE	OD	STATUS
Conditional PV Project certificate (commissioning)	401	Published 2016
Conditional PV Project certificate (construction complete)	401-1	Draft in process
Annual PV Plant Performance certificate	402	Published 2016
PV Plant Design Qualification certificate	403	Draft in process
PV Site Qualification certificate	403-1	Draft in process
PV Power Block Design Qualification certificate	403-2	Future work
PV Asset Transfer certificate	404	Draft in process
PV Decommissioning certificate	409	Future work
PV Module Factory QMS certificate	405	Published 2016
PV System Installation QMS certificate	410	Draft in process
PV Inverter Factory QMS certificate	4xx	Future work

“Certifiable” Standards

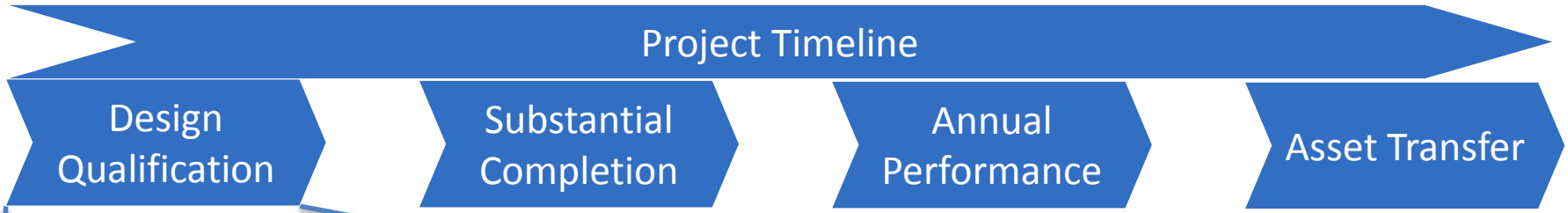
- Design
  - 62548 Array Design (or 62738 Power Plant)
  - 61724-1 Performance Monitoring
- Commissioning
  - 62446-1 Documentation, Test & Inspection
  - 61724-2 Capacity Evaluation
- Operation
  - 62446-2 System Maintenance
  - 61724-3 Energy Evaluation
- Quality Management
  - 62941 PV Module Manufacturing
  - 63049 PV System Installation
  - 63157 PCE Manufacturing

PV System Certificates



- Need confidence that *each step* during a project is completed correctly
- For simplicity, today we will discuss four steps:
  - Design qualification (ready to proceed with construction)
  - Substantial completion (ready to operate)
  - Annual performance (final completion, or annual check up)
  - Asset transfer (define health of plant as basis for acquisition)

PV System Certificates



Example considerations

- Local code requirements met
- **Component selection**
  - **Qualified for application**
  - **Quality control during manufacturing**
- Safety:
  - Restricted access if appropriate
  - Continuously monitored
  - Overcurrent protection
- Good design
  - Shading considered
  - Trenching

PV System Certificates

Example considerations

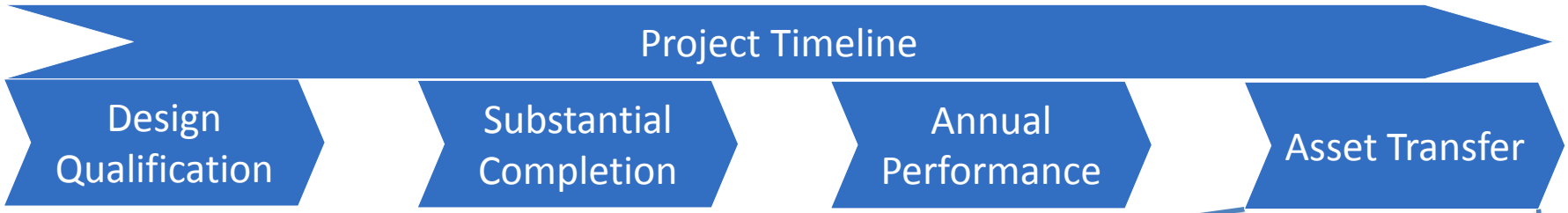
- Local code requirements met
- Commissioning completed
- Component quality verified
- Quality management during installation
  - Workers trained with oversight
  - Any design changes reviewed
  - Continuous improvement
- Performance check
  - Does power output match the design?

PV System Certificates

Example considerations

- Based on measured weather and original model, does plant perform as expected?
  - Energy availability (e.g. if inverters break, the plant could be unavailable)
  - Performance index (measured performance divided by expected performance based on measured weather)
- O&M costs
  - Relative to planned cost, how much did it cost to keep the plant running?

PV System Certificates



Example considerations

- Has plant output been consistent with original model?
- Have O&M costs been consistent with original model?
- Is there evidence of problems to come? (Cracked cells, weeds growing through the modules, hot spots)

Next Steps

- Finish Operational Documents (ODs)
  - Scope and requirements for each certificate offering
- Approve Participant Applications
  - Certification Bodies / Inspection Bodies / Test Labs
  - Begin peer assessment process during 2018
- Start Issuing Certificates in the PV sector
  - Project Completion
  - Power Plant Performance
  - Module Factory QMS

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International Electrotechnical Commission
Technical Committee 82 - Solar photovoltaic energy systems

Thank you for your attention

Questions?

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