Recent Progress and Results from IECRE Activities

2019 NIST/UL Workshop on Photovoltaic Materials Durability

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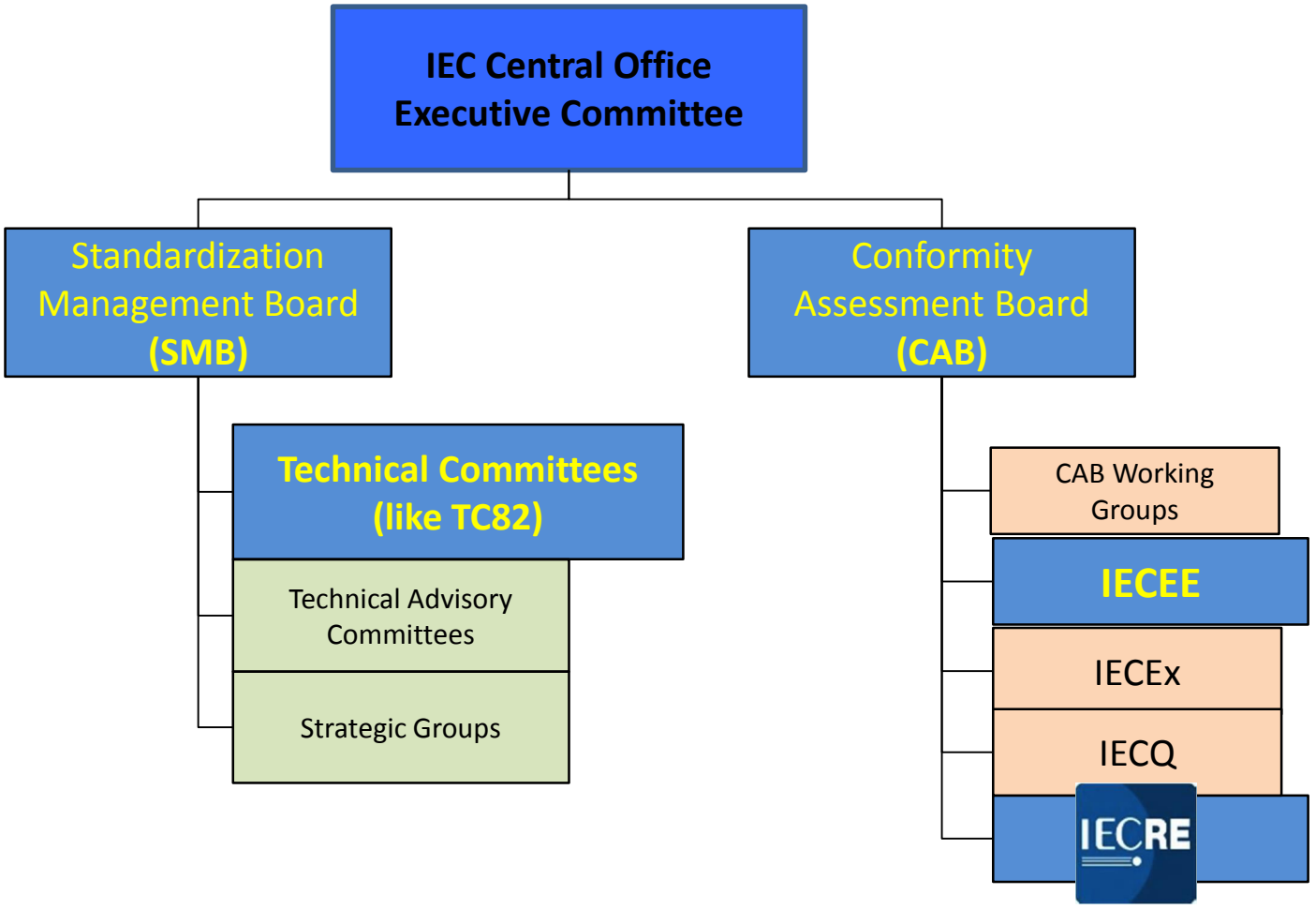
Context and Background

- Continued industry growth
  - Demand increasing 20%+ per year – multi GW/yr
  - 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
- Overall Structure
  - IEC groups generate Standards (TC82)
  - IECRE utilizes Standards to generate Certification OD's
  - ARESCA coordinates US IECRE activities (through ANSI)

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

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

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

How the IECRE System Works

- 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

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

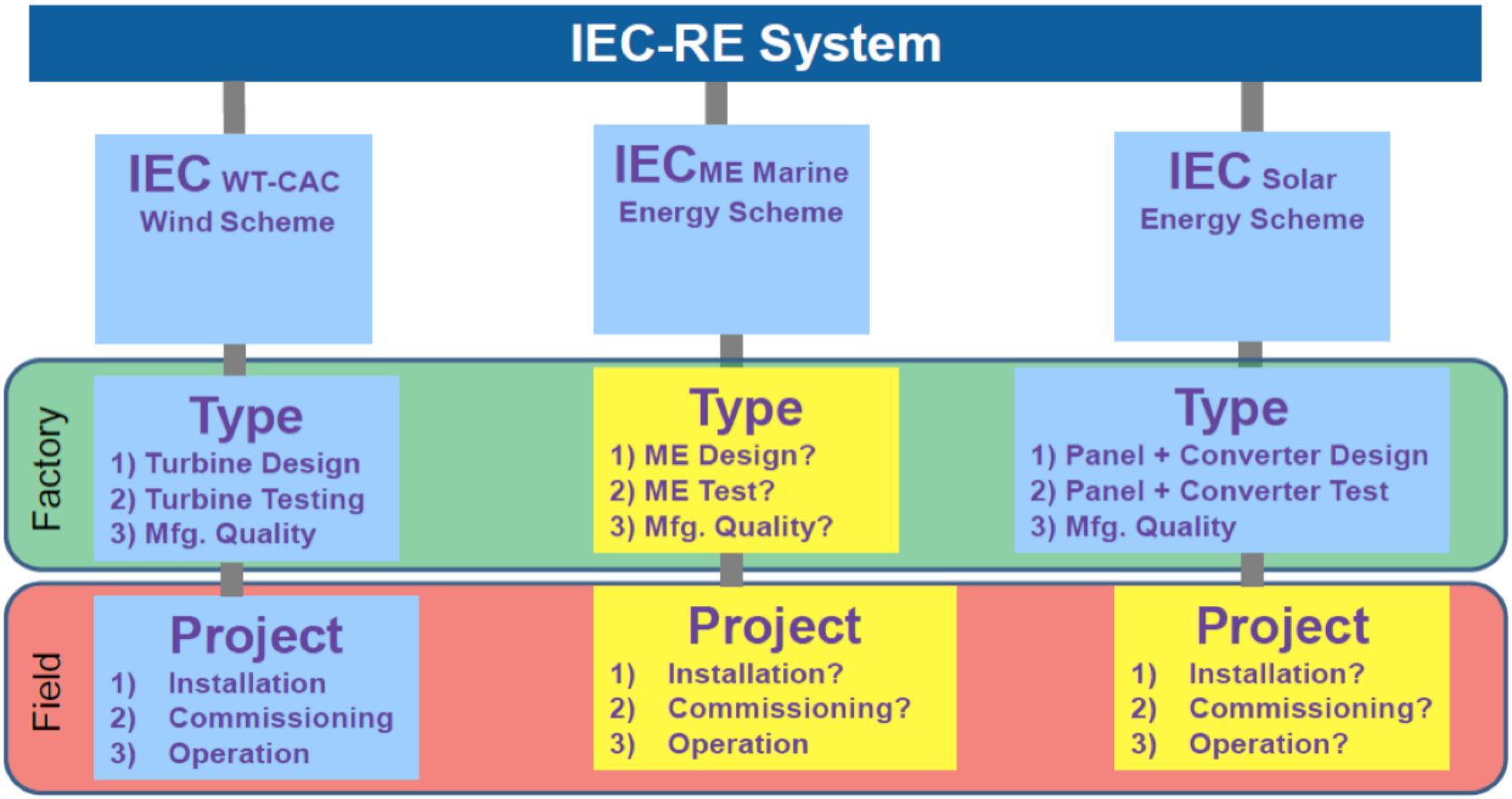
Benefits of Certification

- 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

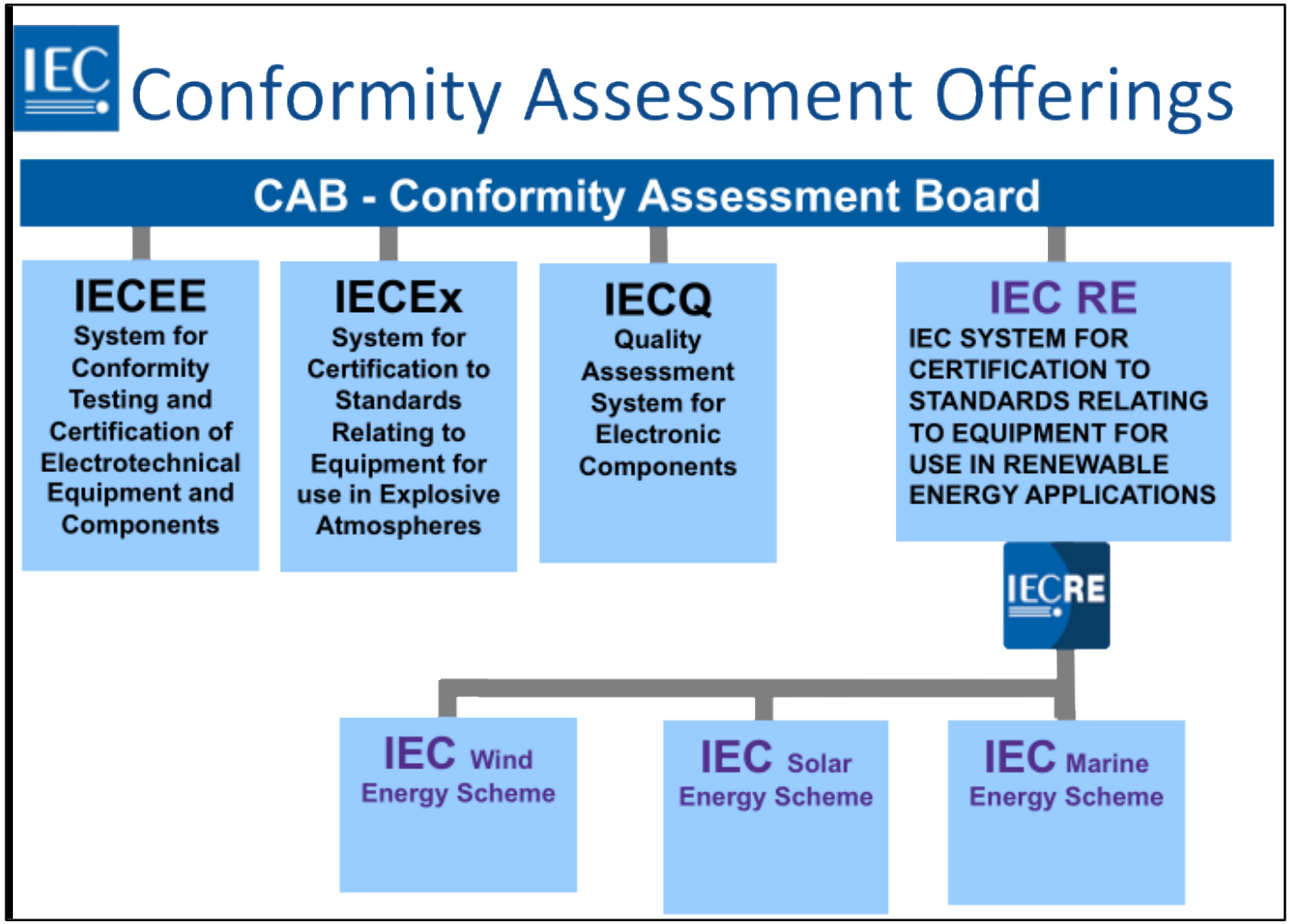
RE Common Elements



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

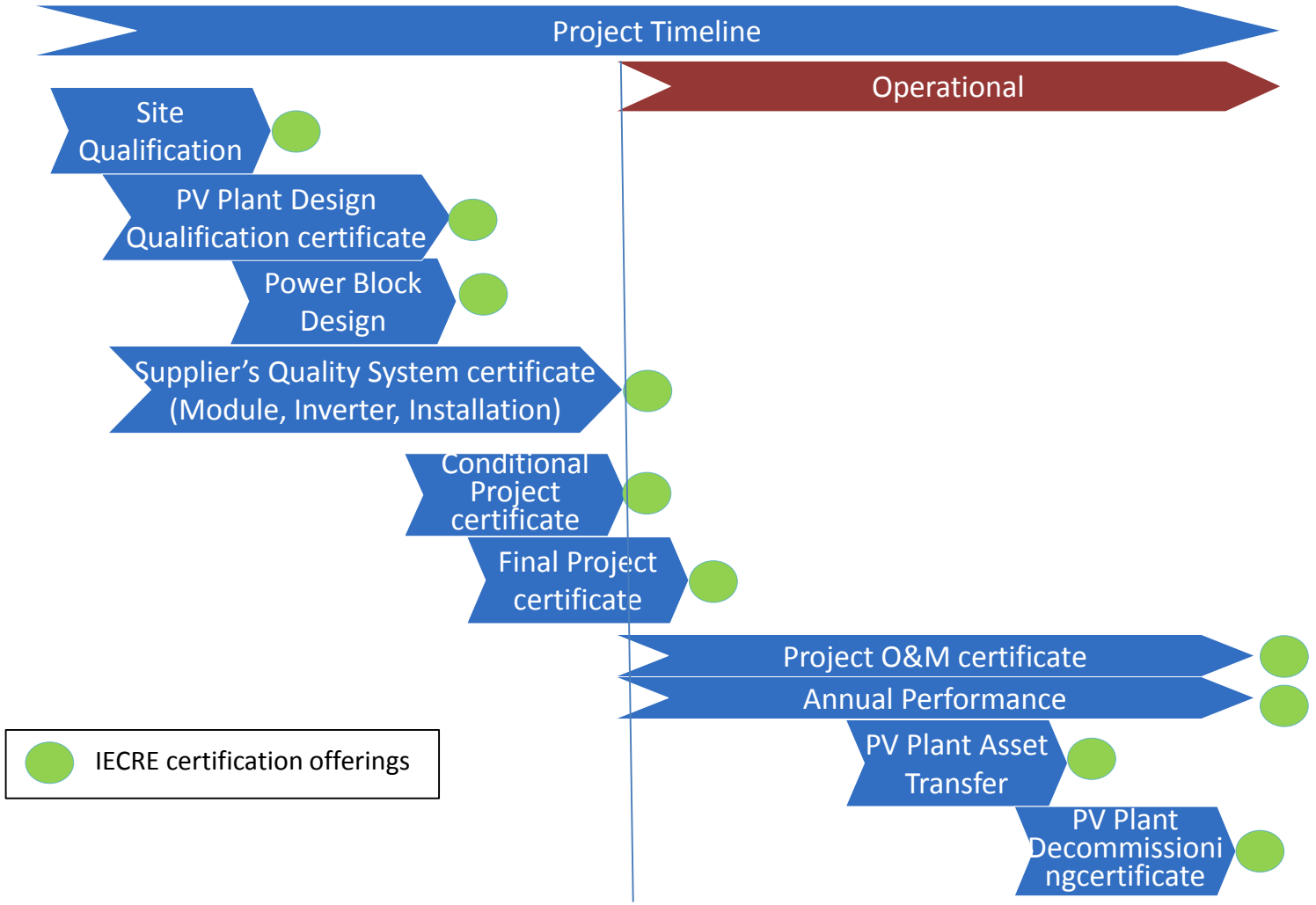
- 12 Countries represented by National Committees

Aspects of Certification

- Conformity assessment will be performed and a 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

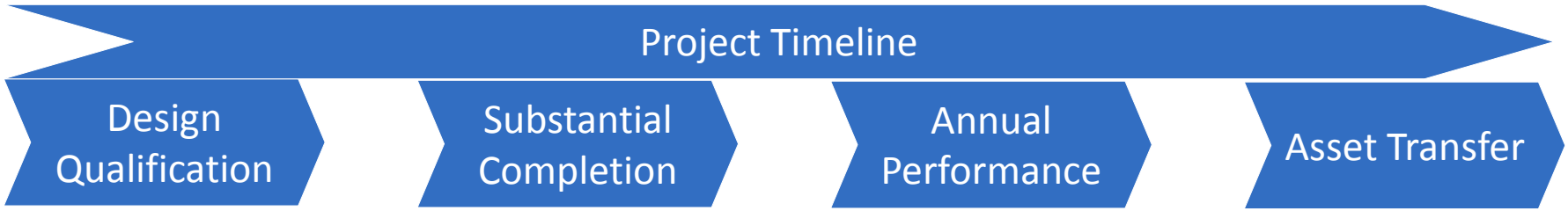
Operational Documents

TITLE	OD	STATUS
Conditional PV Project certificate (commissioning)	401	Published 2016
Conditional PV Project certificate (construction complete)	401-1	Ed 1 approved
Annual PV Plant Performance certificate	402	Published 2016
PV Plant Design Qualification certificate	403	Ed 1 in comment
PV Site Qualification certificate	403-1	Ed 1 in comment
PV Power Block Design Qualification certificate	403-2	Ed 1 approved
PV Asset Transfer certificate	404	Ed 2 approved
PV Decommissioning certificate	409	In stand-by mode
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

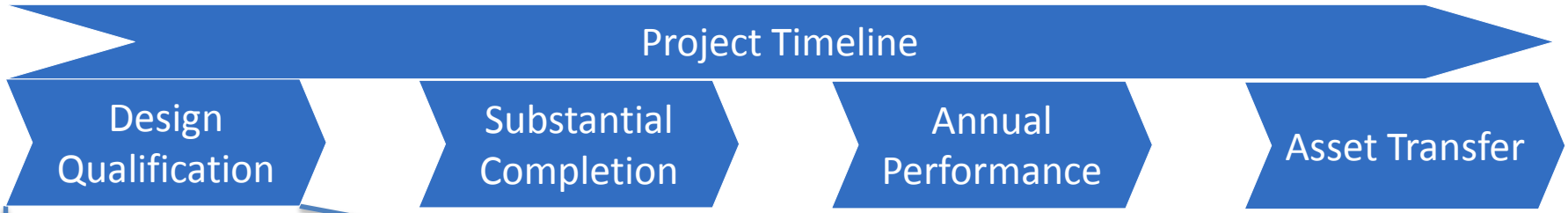
- Design
  - 62548 Array Design (or 62738 Power Plant)
  - 61724-1 Performance Monitoring
- Commissioning
  - 62446-1 Documentation, Test & Inspection
  - 61724-2 Capacity Evaluation
- Operation
  - 62446-2 System Maintenance
  - 61724-3 Energy Evaluation
- Quality Management
  - 62941 PV Module Manufacturing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

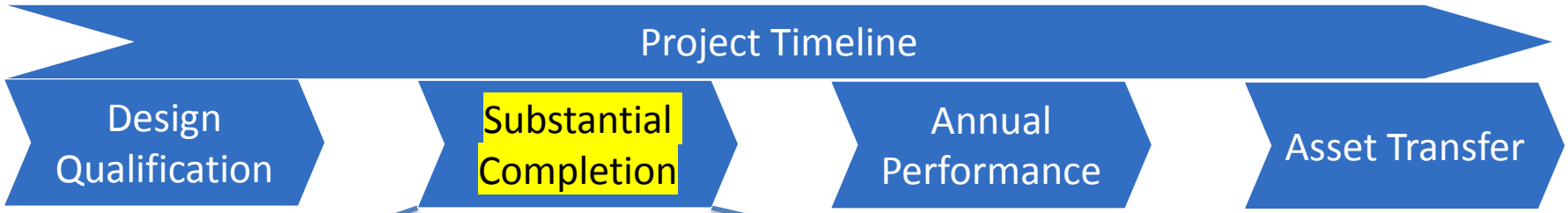
PV System Certificates



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

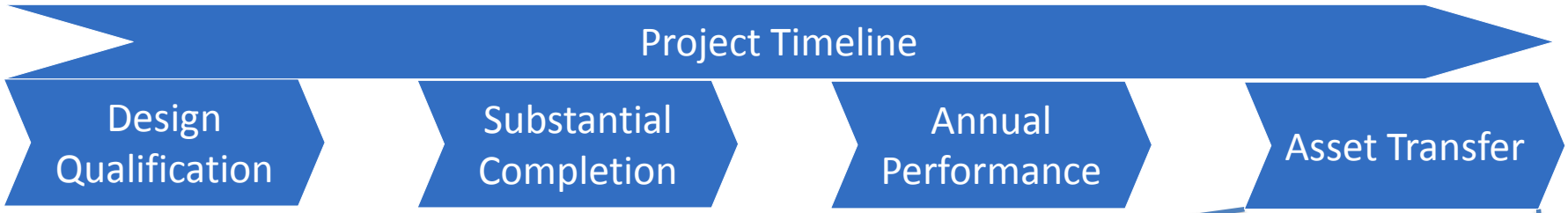
- Local code requirements met
- Commissioning completed
- Component quality verified
- Quality management during installation
  - Workers trained with oversight
  - Any design changes reviewed
  - Continuous improvement
- Performance check
  - Does power output match the design?

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)

Evaluation of OD-401 Commissioning

- ARESCA study funded by NREL
- Three large systems evaluated
- Three inspection bodies used

Findings from Study

Results presented at NREL PV Reliability Conference, February 2019

- Systems were well engineered, and installations were “clean” – conformed to standards
- A massive amount of data being collected – too much??
- Issues found: Cable management; vegetation control; arc flash hazard identification
- Trackers are more common, but standards are not up to speed yet
- CB’s and IB’s need clarification on responsibility
- Some prerequisite certifications are not practical

Challenge to IECRE (PV)

- Establishing value of certification
- Limited participation by IB and CB entities
- Need to establish user groups to promote use
- IEC will continue to support IECRE PV
- World Bank has interest in Rating System
- Existing processes seem to work for traditionally conservative utilities
- How to address smaller systems (cost)

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 2020
- **Market the process and certification benefits**
- Start Issuing Certificates in the PV sector
  - Project Completion
  - Power Plant Performance
  - Module Factory QMS

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Relating to Equipment for Use in Renewable Energy Applications

International Electrotechnical Commission
Technical Committee 82 - Solar photovoltaic energy systems

Thank you for your attention

Questions?

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