

WIND PROJECTS CONSULTANCY SERVICE

For Investors and EPC Companies

Proposal
Presentation

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Introduction

This proposal presentation is aimed to support Investors and EPC Contractors before and after execution of a standard Wind Projects.

A wind farm consists of wind turbines and other infrastructure which is referred to as the balance of plant. A large portion of the balance of plant composed of Electrical transmission, Substation and Civil works that includes foundation for each wind turbine, site grading, drainage, access roads, crane pads, etc.

Due to the size of a wind farm, the sequence of procurement of the wind turbine components is also in key role.

Turbine components arrive on trucks, and several deliveries are required for each turbine. Typically, rotor blades are transported individually within the wind farm, and the tower components and nacelle may be shipped on several trucks.

If components arrive out of sequence, it is possible that the infrastructure may not be available to support delivery. For this reason, management of the procurement and construction schedule is another challenge.

For some projects, the wind turbine components offloaded and stored at the wind turbine site or components may be erected as they arrive to avoid double handling.

Before above-mentioned implementation, Owner should complete review of Technology selection (Including O&M, Transportation and Installation Manuals), determination of Country of Origin, Equipment Procurement Specification, Concept Design, Detail Design, Contractor Agreement, Third Party Agreement and realistic schedule.

About IEC and IECRE

The IEC manages the operation of worldwide Conformity Assessment (CA) Systems. These CA systems represent the only globally standardized approach to testing, inspection and certification, including how the laboratories can measure the power performance of the turbine.

The IEC System for Certification to Standards Relating to Equipment for use in Renewable Energy Applications (IECRE) aims to facilitate international trade in equipment and services for use in the sector.

To be part of the IECRE system, the technical laboratories have to prove that they themselves can perform correctly and test wind turbines correctly.

The IECRE proficiency test report is that no matter the test lab you use, no matter who is doing the job, the results will be the same. Any manufacturer in the world can trust that labs in the IECRE system will provide the same results.

IECRE is the new certification scheme that replaced the well-established IEC 61400-22 which has been withdrawn with effect from 1st of September 2018.

Definitions and Acronyms

IEC stands for the International Electrotechnical Commission: An organization that prepares and publishes international standards for all electrical, electronic and related technologies.

IECRE, The IEC System for Certification to Standards Relating to Equipment for use in Renewable Energy Applications (IECRE) aims to facilitate international trade in equipment and services for use in the renewable energy sectors.

REMC refers to IECRE Management Committee

IECRE Participation System: IECRE Certification Bodies (RECBs), IECRE Testing Laboratories (RETLs), IECRE Customer Test Facilities (RECTFs) and IECRE Inspection Bodies (REIBs) approved by the REMC in accordance with the Basic Rules may participate in the IECRE Scheme(s).

Type and Component Certification includes design, Implementation of the design-related requirements in production and erection, evaluation of Quality Management and prototype testing. It verifies that the parts of wind turbines are designed, manufactured and tested to comply with specific standards.

Project Certification also includes environmental situation with conceptual design issues for structure strength and safety. It has also direct relation with Component and Type Certification, furthermore it covers almost all project stages starting from design to commissioning.

Conditional Project Certification, Document issued upon commissioning and initial operation of project.

Re-Certification is the certification that needs to be issued after modification, revision and/or maintenance on the part.

Renewal of Existing Certification is the certification that the existing Wind related certification expired and so need to renewal it.

CE Marking, In the European Union (EU) CE marking has been introduced to ensure that the original equipment manufacturer (OEM) follows relevant standards. Therefore, in general, in EU, all products should have a CE marking. The CE marking is a self-declaration of the OEM. An involvement of a third party is not required.

IAF, The International Accreditation Forum is a worldwide association of accreditation bodies and other bodies interested in conformity assessment in the fields of management systems, products, processes, services, personnel, validation and verification and other similar programs of conformity assessment.

EAC, The European Accreditation Center (EAC) is an independent organization that promotes product and service trust.

Certificate of Conformity (CoC): Document issued upon successful completion of project certification. Procedural requirements for issuing certificates of conformity are specified in the relevant **ODs**.

Conformity Assessment is the activity of verifying that a standard or technical specification was applied in the design, manufacturing, installation, maintenance or repair of a device or system. This activity must be carried out according to a set of well-defined rules to ensure consistent and replicable results. The IEC and ISO have therefore developed and published a series of international standards specifying how conformity assessment should be carried out.

Gap Analysis, A gap analysis is mainly done at the beginning of the certification journey to assess what is currently in place against the set of requirements for which every standard is to be implemented.

CAB refers Conformity Assessment Board

Certification Body (RECB): An organization that conducts conformity assessments and has been accepted according to the IECRE Rules and which issues Certificates and Certificates of Conformity. (Renewable Energy Certification Body)

Availability, as used in the wind industry, is a measure of the potential for a wind turbine or wind farm to generate electrical power. If the turbine is “available” and grid-connected, and the wind and other conditions are within the turbine specification, then the power will be generated.

Reliability is defined as the probability of a product performing its intended function under stated conditions without failure for a given period of time.

Capacity Factor, Wind farms are variable due to the natural variability of the wind. For a wind farm, the capacity factor is determined by the availability of wind, the swept area of the turbine and the size of the generator. Transmission line capacity and electricity demand also affect the capacity factor.

Wind Turbine Rated Capacity is the maximum amount of power by which a wind turbine can produce that is the rated output or the peak production at a specific (usually high) wind speed, and different manufacturers use different wind speeds to determine rated output. The amount of energy a wind turbine actually produces is a function of the capacity factor:

SODAR and LIDAR, both remote sensing methods have increasingly been applied in wind energy research projects, as well as in support of the commercial development of wind farms (both on and offshore), over the past decade. These methods allow an efficient means of detailed mapping of the wind fields around potential sites.

EYA refers Pre-construction Energy Yield Assessment

PCYA refers Post-construction Energy Yield Assessment

Technical Due Diligence. This type of Due Diligence focuses on the technical aspects of the project, including the estimated production of renewable assets, the technology used, the civil and electrical design, the status of permits, licenses, and authorizations, etc. In addition, this review may also include visits to operating plants or sites, audits of equipment manufacturers, monitoring of asset construction, etc.

Aside from technical due diligence, a financial audit and corporate and legal audits are also usually performed to cover all the areas of a full project risk assessment.

Codes, Standards and Regulations

Even there are lots of standards related with Wind Turbines, EN 45012 and IEC 61400 can be mentioned at the initial stage for further steps.

These Wind Turbines standards also address measurement techniques, gearboxes, power performance for electricity producing turbines, lightning protection, structural testing and much more.

It is also supported with conformity testing and certification with the inclusion of lots of subpackages.

The scope of those group of standards is to specify essential requirements to the use of design, manufacturing and construction criteria and measures in order to ensure the structural and mechanical integrity of wind turbines.

EN 45012, The purpose of the document is to specify general requirements that a Third Party body operating quality system registration and certification meet the requirement.

IEC 61400, Wind Turbines Package provides the design requirements for various types wind turbines including small and offshore wind turbines.

IEC 61400-22 defines rules and procedures for a certification system for wind turbines (WT) that comprises both type certification and certification of wind turbine projects installed on land or off-shore. IEC 61400-22 has been withdrawn with effect from 1st of September 2018.

OD refers IECRE Operational Documents

IECRE-OD-501 – Type and Component Certification

IECRE-OD-502 – Project Certification

IECRE-OD-007– Checklist for Certification Body

ISO/IEC 17011 Conformity assessment - General requirements for accreditation bodies accrediting conformity assessment bodies.

ISO/IEC 17067 describes the fundamentals of product certification and provides guidelines for understanding, developing, operating or maintaining certification schemes for products, processes and services. It is intended for use by all with an interest in product certification, and especially by certification scheme owners.

ISO/IEC 17020 is Conformity assessment– Requirements for the operation of various types of bodies performing inspection.

ISO/IEC 17021 is Conformity assessment – Requirements for bodies providing audit and certification of management systems.

ISO/IEC 17024 Conformity assessment – General requirements for bodies operating certification of persons

ISO/IEC 17025 is General requirements for the competence of testing and calibration laboratories.

ISO/IEC 17043-23 is Conformity assessment – General requirements for the competence of proficiency testing providers.

ISO/IEC 17065 is Conformity assessment – Requirements for bodies certifying products, processes and services.

Certification Scheme and Procedures

In wind projects one of most major issue is verification of standards about technology providers and manufacturers in accordance with related mandatory requirements.

Our company has full knowledge about International Certification requirements and its corresponding mandatory Certification scheme with detail steps therefore fully capable of supporting its customer in accordance with IECRE and related International standards.

Regulations by Ministry of Energy

The term “**YEKA**” (“Yenilenebilir Enerji Kaynak Alanı”) means “Renewable Energy Resource Area.” Based on this statement an official regulation has been issued by Turkish Ministry of Energy then after it is called YEKA Regulation.

According to the YEKA regulation, each Wind Turbine model has a standard and valid “**Type Certificate**” and/or “**Component Certificate**” from accredited organizations in accordance with IEC 17065 and IAF. This certificate is submitted to the chairmanship of the acceptance commission by the Ministry and/or organizations authorized by the Ministry, in stages of the acceptance process of the Wind projects.

Status of TÜRKAK and TSE

Turkish Accreditation Agency (TÜRKAK) which is affiliated with the Ministry of Foreign Affairs of Türkiye is differ from the TSE (Turkish Standards Institution) in both service scope and establishment purpose area which is affiliated with the Ministry of Industry and Technology.

It may be roughly summarized that TÜRKAK is responsible for the general requirements for accreditation bodies accrediting conformity assessment bodies under requirements of ISO/IEC 17011 standard and legal arrangements.

TÜRKAK does not offer conformity assessment services nor engages in provision of consulting services to conformity assessment bodies or any similar activity that may damage its impartiality. TÜRKAK offers training services only to general audience and in general content.

Why need a Consultancy Service

A project supported with consultancy and inspection services will facilitate Customer to reach finance, also increase its bankability and attractiveness of the project for potential shareholders, easy share transfer transactions and finally increase commercial reliability not only for this project but also for Phase II and other next investments.

Also, due to strict inspection and close project interaction, Customer would have;

- Higher reliability
- Higher availability

- Lower project management cost
- Lower maintenance cost
- Lower Insurance cost
- Technical and commercial correspondence support in case encountered international Claims
- Collecting, archiving, classification of technical claim issues under clause of legal terms and transforming them into

legalized commercial issues for customer side benefits

- Transformation of ordinary contract items and mandatory standards into legal claims by considering customer benefits
- Obtaining more detailed supplier documentation so Customer would have more chance for local manufacturing at emergency cases

1) Basics of Consultancy Services

- Owner's engineer throughout all project phases
- Energy yield assessments and wind measurements
- General site selection and turbine micro-siting
- Feasibility studies
- Conceptual engineering, FEED, and detail design
- Drawing up operation and maintenance concepts
- Tendering and contract award for EPC and IPP projects
- Construction supervision
- Wind turbine inspections
- Lifetime assessments
- Due diligence reviews

- Evaluation of measurement-derived wind data (met mast, SoDAR & LiDAR) and wind resource assessments.
- EYA Analysis
- PCYA Analysis
- Wind turbine reference yield and site quality.
- Site selection and plant conceptual design
- Grid network studies
- Support during tendering bid evaluation and contract negotiation
- Project management
- Detailed design review and approval
- Construction and commissioning supervision
- Acceptance tests and verification of plant operation
- Evaluation of O&M performance on annual basis

2) Third-Party Body Requirements for Accreditation

IECRE is the new certification scheme that replaced the well-established IEC 61400-22 which has been withdrawn with effect from 1st of September 2018.

The following are minimum directly required standards that any Third-Party must obey in accordance with its targeted area.

- IEC 17020
- IEC 17021
- IEC 17024 (+MYK authorization)
- IEC 17025
- IEC 17065

- IEC 17043-23 (Will be discussed)
- IEC 17040 (Will be discussed in next stages)
- IEC 17029 (Will be discussed)
- ISO 9001

Supplementary Certifications:

- ISO 14001
- OHSAS 18001/ ISO 45001
- ISO 50001
- ISO 27001

3) Certification Requirements for Manufacturers and Suppliers

The following are the general widely used certifications devoted for each different type of manufacturer. However it is just a preliminary summary, there are still lots of specific certificates that need to be mentioned.

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|--|---|---|
| <ul style="list-style-type: none"> • IEC 61400-1 • IEC 17065 • EN 10025 • EN 10113 • EN ISO 3834-1/2/3/4/5 • EN-1090-1+ A1 • EN ISO 14731 • EN ISO 15614 | <ul style="list-style-type: none"> • EN ISO 15609 • EN ISO 9606 • EN ISO 10683 • EN ISO 10684 • EN 14399-4 • EN 12944 • EN 14732 • ISO19392 • EN 10204 | <ul style="list-style-type: none"> • IECRE Standards • IEC Standards • ISO 9001 • ISO 14001 • OHSAS 18001/ ISO 45001 • ISO 50001 • ISO 27001 |
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4) Scope of Consultancy Service

In Türkiye market, Owner or EPC company request Consultancy Services directly or this service may be imposed indirectly in frame of subcontractors' demand who should also obey subclause of the same mandatory IECRE standards.

4.1 Review Sodar/Lidar Measurements

Both remote sensing methods have increasingly been applied in wind energy research projects, as well as in support of the commercial development of wind farms (both on and offshore), over the past decade. These methods allow an efficient means of detailed mapping of the wind fields around potential sites.

4.2 Review EYA Analysis

This process estimates the potential energy production of a wind farm over its operational life, providing essential data for stakeholders to evaluate the project's viability and profitability.

4.3 Review PCYA Analysis

Another important aspect of a wind farm performance assessment is to recalculate the expected long-term energy yield of the wind farm, based on the operational data, via a post-construction energy yield assessment (PCYA). Pre-construction energy yield assessments (EYA) can sometimes overestimate the wind farm's energy yield. Compared to EYA, PCYA reduces annual energy production uncertainty by 50%. This is particularly important in the case of refinancing the project or for a project acquisition.

4.4 Pre-Construction Activities Review

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| <ul style="list-style-type: none"> • Sufficiency and availability of Installation, Transportation, Commissioning and O&M Manuals | <ul style="list-style-type: none"> • Installation Manual review in accordance with IECRE standards • Commissioning Manual review in accordance with IECRE standards |
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| <ul style="list-style-type: none"> • Transportation Manual review • Contractor’s Construction and Commissioning procedures review | <ul style="list-style-type: none"> • Temporary and Final Acceptance Procedure review |
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4.5 Contract and Specification Review

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| <ul style="list-style-type: none"> • Main Contract review in frame of IECRE and IEC 61400 mandatory standards | <ul style="list-style-type: none"> • Procurement specification review • Subcontractor’s contract review |
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4.6 Conceptual Evaluation

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| <ul style="list-style-type: none"> • Review Technology selection, comparing site and design conditions • Wind Turbine proposals comparison and review • General Design Criteria Documents (Civil, Mechanical, I&C, Electrical and Automation Design Criteria) • Certification procedure and scope review in frame of IECRE mandatory standards. | <ul style="list-style-type: none"> • Review Availability calculation in accordance with IECRE standards. • Review Reliability and Bathtub Curve • Review Capacity Factor Calculation • Review Design Life of each component in accordance with IECRE standards • Review the project in accordance with IECRE series of standards |
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4.7 Basic Engineering Review

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| <ul style="list-style-type: none"> • Detail Civil projects • Detail Mechanical projects | <ul style="list-style-type: none"> • Detail Electrical projects • Detail I&C projects |
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4.8 Civil Works Review

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| <ul style="list-style-type: none"> • Geotechnical report and Soil investigation review and validation of exploration results • Foundation, reinforcement, rebar, steel structure, concrete “Mix Design” details • Supplementary standards for static and dynamic analysis (Life Analysis, fatigue, cycling, vibration, etc) | <ul style="list-style-type: none"> • Review Mandatory International and local Engineering standards for Civil foundation design • Requirement for Mobile Concrete Batching Plant |
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4.8.1 Geotechnical Investigation

Once a foundation concept has been selected and a foundation design is commenced, the geotechnical issues need to be reviewed.

The geotechnical report should also include evaluation any findings made during the field investigation with appendices dedicated to any boring logs, laboratory tests or geophysical techniques used to characterize the site.

Additionally, the report should clarify whether the use of ground improvement features is necessary to reinforce the strength of the soil profile for adequate support of the foundation and tower structure.

4.8.2 Foundation Design

Wind turbines are commonly supported by a slab foundation or a pile foundation.

The foundation design should be based on the site geotechnical conditions, turbine manufacturer design requirements, site drainage management and standards.

The foundation should also be designed to withstand the worst-case scenario event including fatigue analysis. The foundations must be adequate to support the turbine under extreme loads. Normally the design load condition for the foundations is the extreme wind speed by considering last decades. The foundation (including reinforcement and rebar) construction should be designed and stamped by a professional engineering company licensed to practice in the state or territory.

4.8.3 Tower Design

Most large wind turbines are delivered with heavy steel towers, which are manufactured in sections of different lengths with flanges at either end. Also, hybrid types are available.

The design of the tower may demand an iterative procedure to get from an initial design to the final design for acceptable toughness and safety factor by using an approved software.

The tower must be designed per the applicable standards that address extreme loads, buckling, fatigue life, stability and resonance.

4.8.4 Site Preparation, Mobilization and Logistic Plan Review

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| <ul style="list-style-type: none"> • Site Layout plan • Laydown area plan • Transport plan • Loading and Unloading plan • Site condition for constructability • Mobilization and demobilization • Equipment safe storage condition | <ul style="list-style-type: none"> • Site access availability condition for the next decade periods • Distance between Concrete Batch plant and site • Sequence of operation plan in Custom area. |
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This section includes procedures, plans and drawings for proper site execution by considering laydown area, transportation, road routing, mobilization, demobilization plan, pre-assembling area, site lighting, fence, security, storage area, waste area, placement of crane and supplementary equipment (like Diesel Generator), turning radius area, sequence of operation starting from port (including consideration for a separate temporary port area) to unloading.

The transport vehicles and its supplementary devices are still developing by designing new model hydraulic lifting, self-steering mechanism and lifting adapter. Those new models provide suitable cost-effective safe condition for transporting large and very long rotor blades even having hard road conditions.

Site planning work may include engineering, procuring and constructing offices therefore it shouldn't be considered an ordinary job.

Review for verification and marking of the existing utility drawings, pollutant discharge, protect wildlife connections or new systems for electrical power, potable water, sanitary facilities, gas distribution, telephone, and other utilities as required to accomplish the installation.

4.9 Mechanical System Review

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| <ul style="list-style-type: none"> • Review Dynamic load analysis • Review Fatigue analysis • Review Lifecycle analysis • Review Corrosion protection | <ul style="list-style-type: none"> • Checking extreme design conditions, comparing software inputs with design conditions • Review all mechanical equipment |
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4.10 Automation System Review

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| <ul style="list-style-type: none"> • Turbine Performance Monitoring • Turbine Condition Monitoring • Review Cybersecurity | <ul style="list-style-type: none"> • Vibration Monitoring of Wind Turbines • Structural Health Monitoring of Turbines • Review Data Owner |
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Starting from hot commissioning to the Warranty stage all data are monitored and recorded by considering not only for steady state energy supply but also for further performance and maintenance tuning process.

During this period, proper automated systems able to identify wrongly allocated downtime, missing performance, out of service duration for further evaluation progress.

Review of reports that are generated by the system will provide Owner for detailed analysis for each equipment and OEM.

Proper Automation systems also able to calculate efficiency, availability and lost production including downtime.

Compatibility of wind farm connection agreements and frequency control also be achieved by support of a proper system.

Generally, satisfactory automation can be described by constant monitoring of specific parameters and comparing them with the previously recorded parameters' behavior in order to provide proper operational algorithm and safe system protection.

Wind turbine condition monitoring is aimed at detecting changes in wind turbine behavior as early as possible, it is focused on monitoring wind turbine drive components. (like shafts, bearings, gearboxes, and generator)

When Condition Monitoring applied for structural components like foundations, blades, and towers is termed Structural Health Monitoring (i.e vibration monitoring). It allows Owners to control all potential risk starting from Warranty stage till end of plant life.

4.11 Electrical System Review

MV cable routing, transformers, Switchgears, Grid connection agreement criteria, substation location and its required performance should be compatible with not only IEC standards but also local regulations.

The electrical system of a grid connected wind turbine includes all components for converting mechanical power into electric power as well as the auxiliary electric system.

A control system is necessary to ensure proper operation of the wind turbine under all conditions.

The power generated by wind turbines over time is characteristically unstable due to the unpredictable nature of primary power sources and so local requirement for grid connection criteria should also be considered. All instruments and electrical equipment procurement specifications, manufacturing stages, test procedures and stages should be closely followed.

4.12 Fire Detection, Protection and Extinguishing System Review

The specification should include the provisions of the Fire Detection, Protection and Extinguishing Design Basis Documents which should cover not only NFPA but also local requirements.

4.13 Maintenance Agreement Review

Maintenance intervals, requirements for maintenance, estimated part life, part replacement in regular intervals should be clearly stated in O&M Manuals. which should be appended to Contract in order to allow Owner to evaluate its OPEX cost not only within warranty stage but also within intended plant life.

In the contract, not only contents of technical requirements but also commercial obligations and penalties should also be clearly stated in order to reach technical requirements in the specifications.

4.14 Warranty Stage and Spare Parts Review

As the wind turbines approach the end of their warranty, wind farm automation system can identify defects and support Owner. Those can be obtained by following.

- Monitoring performance and reliability during Warranty stage
- Monitoring performance and reliability after Warranty stage

Defects can be resulted with huge costs like wind turbine constraining due to vibration or high gearbox temperature.

Vibration measurements are taken while the turbine is in operation in order to detect potential failures and misalignment of the drive train mechanism. The measurement result may be a sign of a serious problem in one of the systems.

Recording and regular monitoring of the chemical and physical changes in a lubricant, taken from the wind turbine gearbox, generator or hydraulic system can also provide an early warning of potential failures.

Sometimes Owner may choose to run any equipment to failure, but by submitting the defect prior to end of warranty the replacement cost of this equipment can be compensated by the OEM even it is totally failed due to Owner insistence to operate.

The supplier may be responsible for performing an inspection of the wind turbine with an Owner representative witness before the end of the warranty period in order to document the condition of the wind turbine against all possible claims.

Also list of spare parts should be issued before Contract signature and should be appendix of Contract.

4.15 Claim Management Service

Generally, this period involves contract management, administration of disputes, encompassing various stages such as reporting, investigation and evaluation, which should be fully supported with certified evidence technical documents before and after official submission of following documents. Therefore, some of Owner may suffer from inadequate documentation that should be disciplined in order to obtain desired results in frame of international court rules.

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| <ul style="list-style-type: none"> • Mechanical Completion Certificate • Commissioning certificate • Take over certificate (TOC) • Provisional acceptance • Final acceptance | <ul style="list-style-type: none"> • Contractor technical obligation and its indirectly related corresponding penalty issues • Sub-Contractor technical obligation and its indirectly related corresponding penalty issues |
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4.16 End of Warranty Inspection Service

Once the wind farm warranty ends, predictive maintenance becomes more important. Proper automation system and monitoring service helps the wind farm owner and service contractor proactively maintain wind farm assets.

Before end of warranty stage most of Owner make agreement with a Third-Party inspection service to control all above mechanism in order to keep its rights and preparation for claim letters.

Inspection services include inspections, examining wind turbine components, identifying deficiencies and failures of critical components and preparing the detailed evidentiary reports required to take advantage of valid warranties.

4.17 Site Supervision Service

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| <ul style="list-style-type: none"> • Pre-Construction Service • Construction Service • Commissioning Service • Witnessing the critical equipment tests | <ul style="list-style-type: none"> • Witnessing Performance and Acceptance Tests • Maintenance procedure Service • Warranty stage Service • Operational stage Service |
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4.17.1 Commissioning Service

Commissioning wind turbines requires coordination between various parties. It is essential to follow manufacturer guidelines and industry best practices to ensure the safe and efficient operation of the turbines.

There are two main activities for commissioning after getting MCC (Mechanical Completion Certificate) from installation teams, one is Cold commissioning(pre-commissioning) and another is Hot Commissioning.

The Cold Commissioning of a wind turbine is an adjustment, tuning and control activities performed to confirm that the wind turbine has been correctly installed and it's ready for Hot Commissioning for functional test.

Commissioning tests include electrical assessments for both the turbine and electrical infrastructure, as well as inspection of mechanics and regulatory civil engineering quality records. Stringent testing at this stage is vital to ensure a high quality and efficient wind farm is delivered and maintained.

Tower vibration test and visual structure inspection, foundation inspections of the plant give an impression of the general condition of the wind turbine. Thus, damage, cracks, corrosion as well as in particular damages at the sealing joint and water drain can be identified.

While commissioning for an individual turbine can take several days, an average onshore wind farm the size could take months.

Mainly the following general items need to be considered before Commissioning,

- Review Commissioning Procedures for each OEM scope
- Review OEM Supervision Services availability
- Review OEM Site Tests Procedures
- Review OEM Installation and O&M Manuals
- Review Training Service and Procedures
- Review Grid Availability
- Status of As-Built Drawing

4.17.2 Performance Tests

Successful commissioning is subject to sufficient wind to execute the tests, as a turbine needs to run without fault for a required period of hours (depending on standard and contract requirement) as part of the process. This stage establishes whether the system works efficiently without overheating or abnormal losses. It can lead to delays if not enough wind is available to perform the test.

Performance Testing involves evaluating the wind turbine's ability to generate electricity efficiently in accordance with Power Curve.

Power curve is the relation between the wind and the output of the wind turbine. It is critical that the WTG produce as much as expected otherwise the basic assumptions behind the business model of the project will not be validated.

4.18 Inspection and Witnessing Service at Factory

- Inspection and Control of Manufacturers' condition
- Inspection and Control of Suppliers' condition
- Inspection and Control of Constructors' condition
- Inspection and Control of Service Providers' condition
- Witnessing performance and Acceptance Tests

4.19 Personnel Training and Certification under ISO 17024 accreditation

- Participants will have chance to examine the origins of the standard and learn practical concepts related to structural, resource, process, and management system requirements.
- Importance and usage areas of ISO/IEC 17024 standard.

- Clauses of ISO/IEC 17024 standard.
- Fundamentals and terminology of ISO/IEC 17024 standard.
- Application area about contents of ISO/IEC 17024 standard.

4.20 Subcontractor Analysis (for Manufacturers and Providers)

Analysis and reporting general situation and sufficiency of subcontractors. Renewal of existing certificate, re-certification, Quality Management System Certification, Personnel Training and Certification under IEC 17024 accreditation, Laboratory Service under IEC 17025 accreditation.

4.21 Consultancy for Laboratory Testing under ISO 17025 Accreditation

- Mechanical testing
- Metallurgic testing
- Physical and chemical analysis
- Environmental and corrosion testing
- Performance, endurance and vibration testing

- Electromagnetic compatibility (EMC) testing
- Functional and endurance testing of electrical and electronic products
- Non-destructive testing
- Calibration

4.22 O&M Manual Review

- O&M Manual review in accordance with IECRE standards

4.23 Schedule Review

- Level 1 Schedule review
- Level 2 Schedule review

- Comparing the list of issued documents with the planned ones.

4.24 As-Built Drawing Review

- Review As-Built drawings under coordination with site team

4.25 Quality Management Service

- Review Wind Farm Project Certifications
- Certification validity review of Manufacturers, Suppliers, Constructors and Service Providers' Certificates in frame of IECRE mandatory standards.
- Review Type Certifications

- Review Component Certifications
- Review Prototype Certifications
- Comparing qualifications of documents in accordance with ISO, IEC and IECRE standards.
- Review detailed QC procedures and inspection plans

The contract specification should identify and comply with all applicable international and local statutes, as well as any relevant design codes and industry standards. The latest edition of the nationally recognized codes and any updated supplements in effect at the time of the contract was signed. This will be used throughout the project design, construction and commissioning stages.

Country of Origin of each major parts, type of material certification, procurement specification including sub-parts, Quality Control Procedures and Acceptance criteria should also be declared by Contractor.

For the wind tower project, equipment reliability is paramount as even minor failures can cause interruption or suspension of services resulting in substantial financial losses.

Wind tower quality control inspections carry out in accordance with quality assurance procedures, a checklist relating to specific types of equipment, operational factors, vendor quality control systems and also review the design, specifications, drawings and compulsory standards to meet mandated regulatory demands and high client expectation.

4.26 Safety Management Review

Contractor's safety management system should fully meet the international and local rules and regulations. Even having Contractor's strong safety management system and procedures following items need to be reviewed.

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| <ul style="list-style-type: none">• Proper training and certification of all the workers• Heightened awareness of working at heights and the equipment needed for that work• Adherence to lockout-tagout procedures• High knowledge of electrical safety measures• Having proper fire safety and fire emergency response protocols | <ul style="list-style-type: none">• Safe lifting and rigging practices to reach high places• Having proper weather awareness knowledge• Effective communication protocols between technicians and ground team• Personal protective equipment (PPE)• Using the best lifting equipment during installation or repairs of wind Turbines |
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4.27 Digital Archive System

Review existing archive system or set up new one including Cloud base.