



Scale PV Projects - Managing the Risk – Technical Due Diligence

Astrom Technical Advisors (ATA)

June 2016



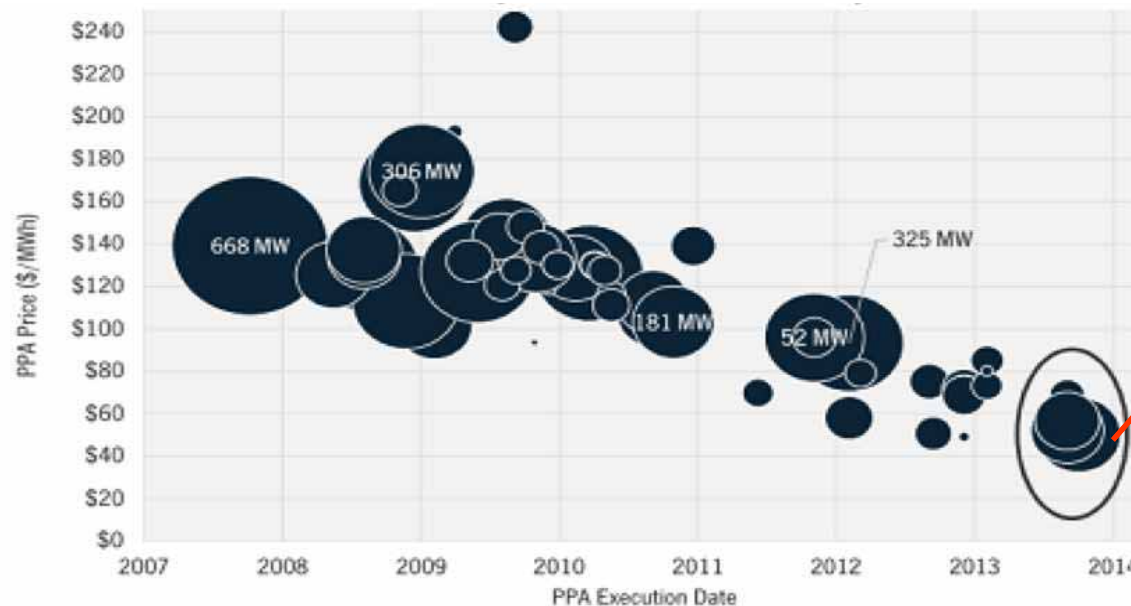
By Pablo Valera
CEO of ATA

Confidential: Only for Training Purpose

Utility Scale PV Projects

kWh Price

- Utility-scale PV projects have experienced tremendous growth in the world in the last years; in the US, China, South Africa, Chile, India, Middle East and Japan, above all
- The considerable budget of such projects requires special development and financing methods.



3.87 centsUSD/kWh
Nevada 100MW PV Project
with First Solar CdTe
modules

Recently, 2.9 centsUSD/kWh
800MW Bid in Middle East

PPA Price (\$/MWh) by PPA execution date in the US (Source: GTM Research)

Managing the...

Risks

Tools to Reduce the Risks

- **Project Finance**
- Technical Due Diligence (including solar resource and annual energy production analysis)
- Product Due Diligence
- Monitoring during Construction
- Simulations of Different Operating Strategies
- Monitoring of the Provisional Acceptance Tests
- Operational Monitoring
- Monitoring of the Final Acceptance Tests



Do you know the technical risk profile of your project?

Managing the...

Risks

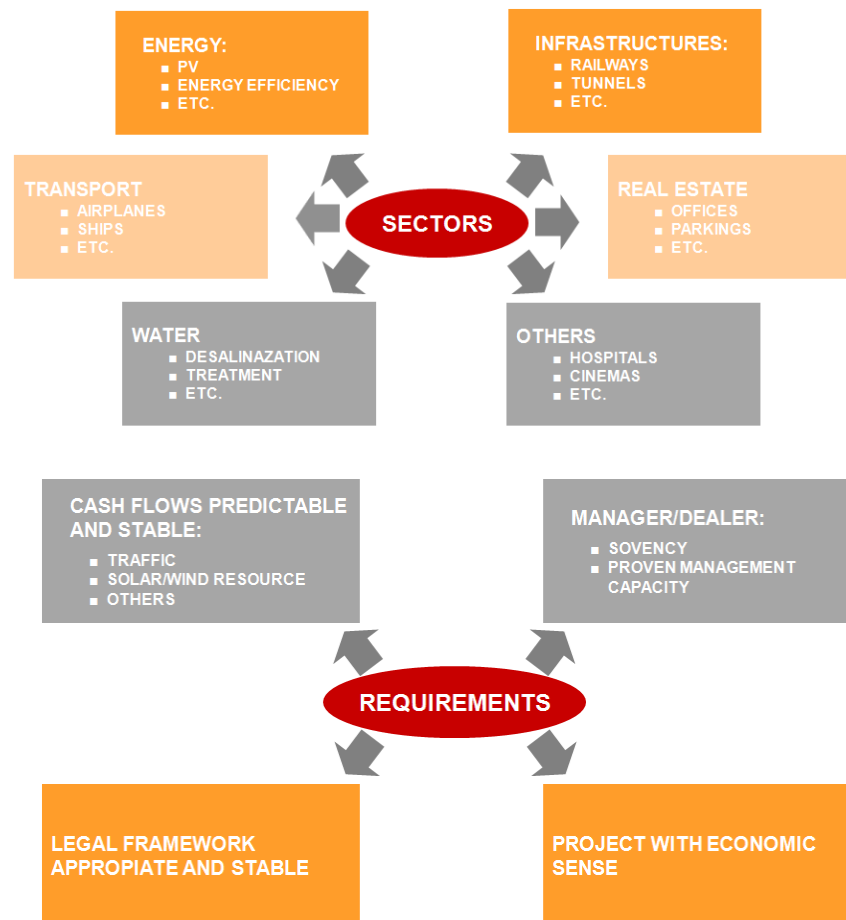
Project Risks

- Technology, Principal Contractors and Suppliers
- Project Design and Solar Resource
- EPC experience
- Contracts (EPC and O&M)
- Warranties (Materials, Equipment, Performance, e
- License, Permits and Authorizations
- Construction
- Start Up and Initial Tests
- Operation and Asset Management
- Other: environmental, monitoring system, security system, etc..



Managing the...

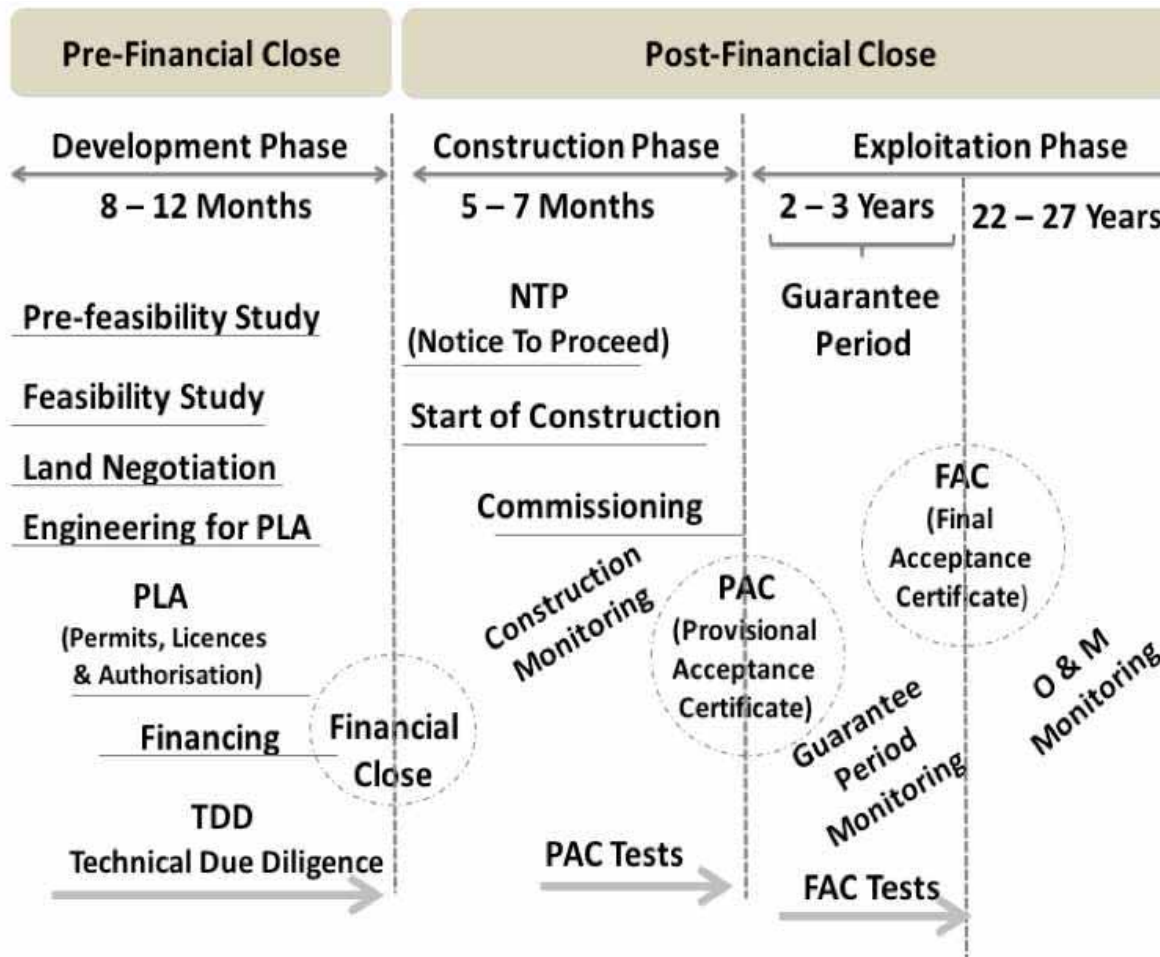
Project Finance



Risks



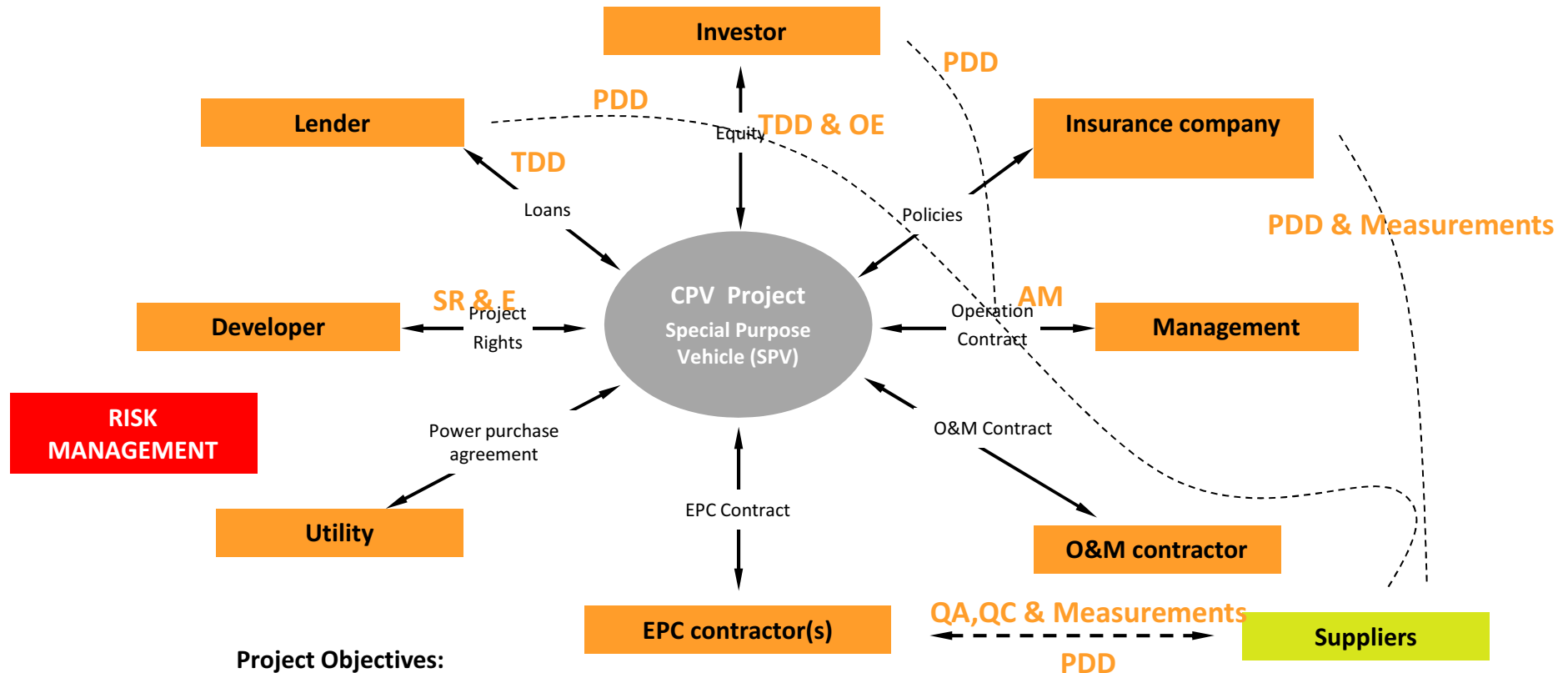
Utility Scale PV Projects



Managing the...

Risks

Project Finance Scheme – Technical Advisor Roles



Project Objectives:

- Risk management vs Crisis management
- Implementation of a long life power plants with high energy yield and availability
- Proper and safe operation complying with the relevant requirements
- Low cost, high return on investment

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Utility Scale PV Projects

Opportunities

- Base Case
- MRA
- Degradation
- Availability
- Guarantees scheme
- PR
- Peak Power/Nominal Power Ratio
- Design
- Life
- Assets Management
- CAP and CAF Tests
- O&M optimization
- CAPEX and OPEX
- etc



Table of Contents

Company Overview

Managing the Risks

Services Under Development

- Project Finance
- Solar Resource and Energy Estimations
- Technical Due Diligence

Services Under Construction

- Monitoring of Construction
- WBS
- Lean

Services Under Operation

- Monitoring of O&M
- Assets Management



Our Company: About Us



ata (Astrom Technical Advisors) is an **independent** engineering and consultancy firm operating **worldwide** in renewable energy (RE), including PV, CSP, wind, biomass, energy efficiency and other RE technologies. We are a privately-owned company.

ata was founded in 2005 by Pablo Valera, who has constructed an international team of first-class professionals.

ata has acted as technical advisor and owner's engineer for RE projects representing over 25 billion Euros of non resource Project Finance Technical Due Diligence. Among our customers are more than 300 financial institutions, top developers, first-line equipment manufacturers and equity investors all over the world.

ata has participated as independent engineering and technical advisor in more than 17 GW of RE projects and has inspected over 150 factories.

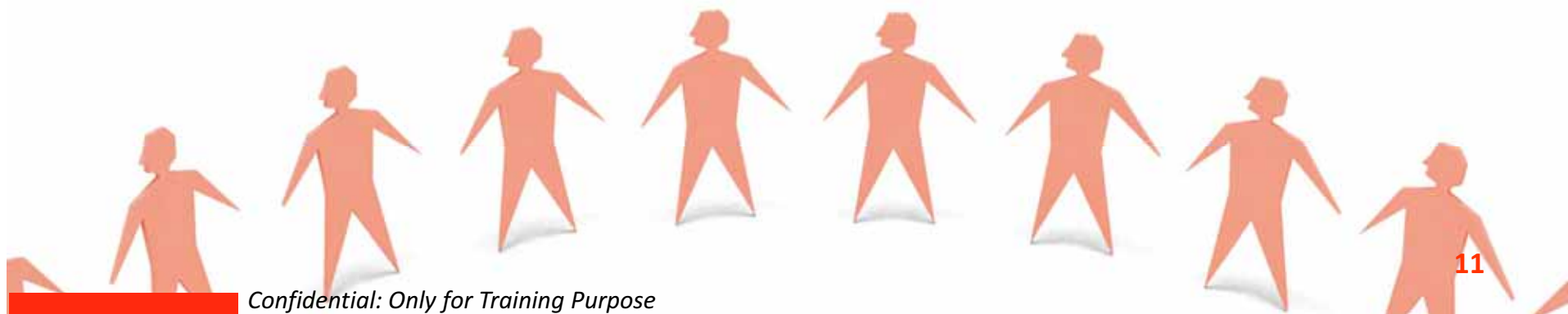




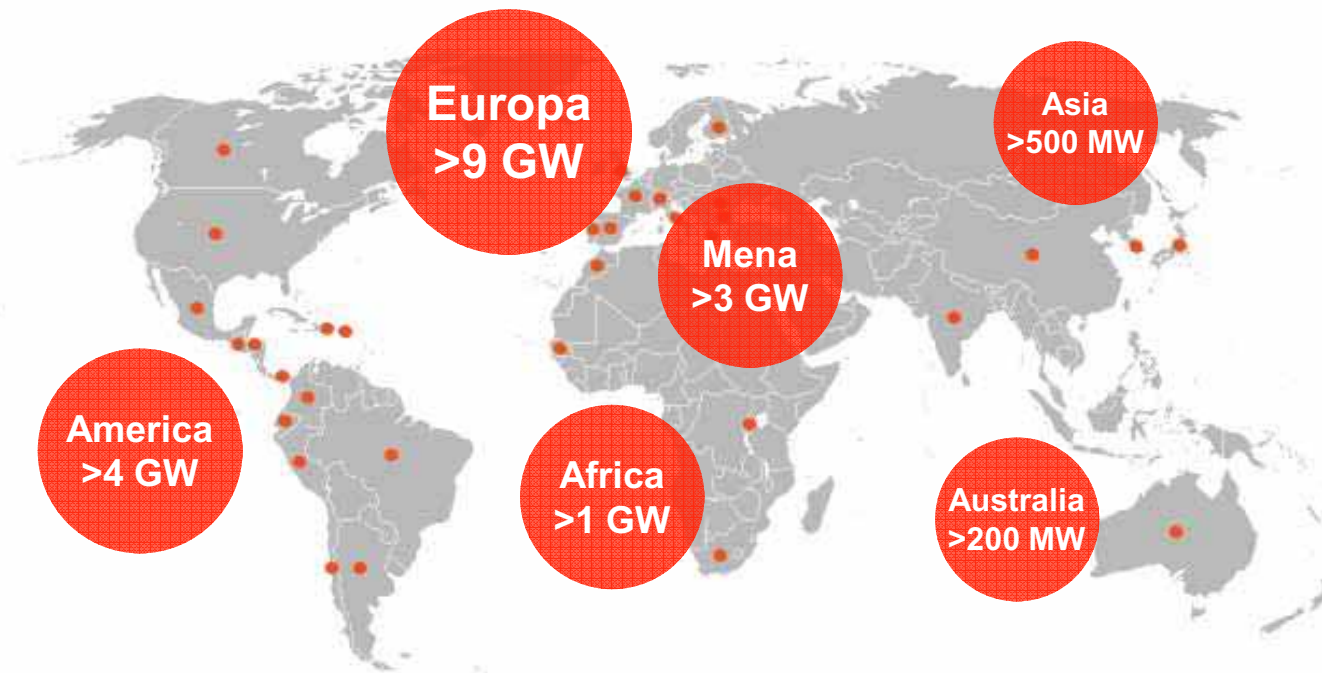
Our Company: **ATA's Team**

ata's team is composed of more than 30 engineers trained and formerly working at key players and institutions in the RE industry like Abengoa Solar, Iberdrola, Alatec, Universidad de Jaen, Universidad Politécnica de Madrid y de Sevilla, Universidad Complutense, Universidad de Barcelona, Georgia Institute of Technology, ICAI, IESE, Instituto de Empresa, etc...

The overall professional experience in RE of ATA represents:



Our Company: International Presence



ata has delivered services all over the world including Europe with more than 9 GW, and also Northern and Central America, Mena, Africa, Asia and Australia.

Headquarters at Madrid (Spain)

Local offices at:

- Johannesburg (SA)
- Rome (Italy)
- Santiago de Chile (Chile)
- **M**exico DF (México)
- Miami (USA)
- Paris (France)

Why Technical Advisory Services Add Value

ata enables the Client to focus the internal resources on its core business. Furthermore Clients take advantage of ATA's experience and know-how and access to a broad range of professional skills.

Adding value to the Client

- Integrity and independence
- Risk Management
- Respect of confidentiality and intellectual property rights
- Placing first the interest of the Client
- Goal oriented and committed to deadlines
- Flexible solutions to meet complex requirements
- Quick response for urgent requests
- Sensitive to Customer values and culture
- Priority to long term Client relationship



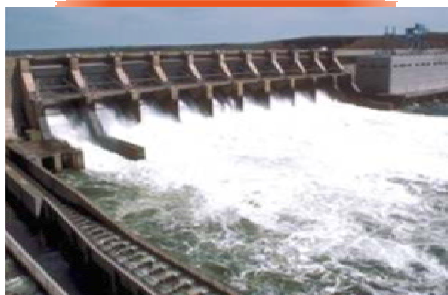


What We Do: Range of Technologies and Expertise



Renewable energy technologies:

- Photovoltaics (PV)
- Concentrated Photovoltaics (CPV)
- Concentrated Solar Power / Thermo solar Power (CSP)
- Wind
- Biomass
- Mini-Hydro



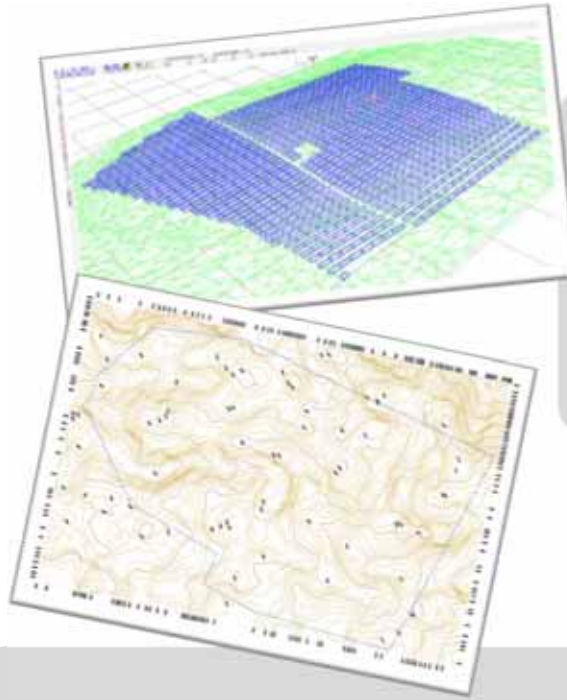
Areas of expertise:

- Independent Technical Advisory
- Audit and inspection
- Construction Management
- Engineering

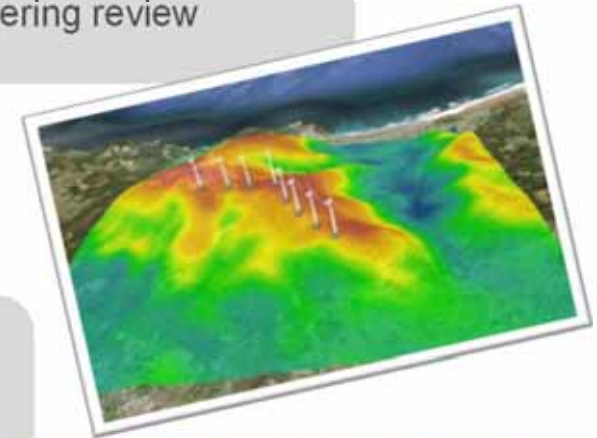


Services for Projects under...

Development



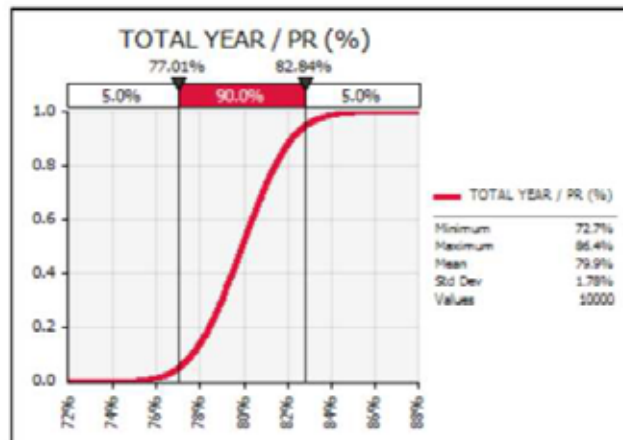
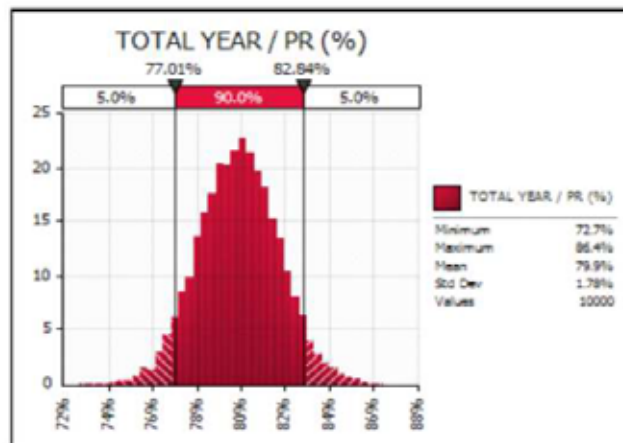
- Natural resource assessment
- Energy yield and plant production estimation
- Site feasibility and micro-siting
- Grid integration analysis
- Project design and engineering review



- Regulatory compliance
- Technical support for contract negotiation (EPC, O&M, PPA)
- Full or specific Technical Due Diligence
- Quality evaluation of equipment suppliers
- Development of technical documentation for tender bids
- Product manufacturing due diligence for bankability



Solar Resource and Energy Production Estimate



Modeling and estimation of solar energy yields (P50, P90):

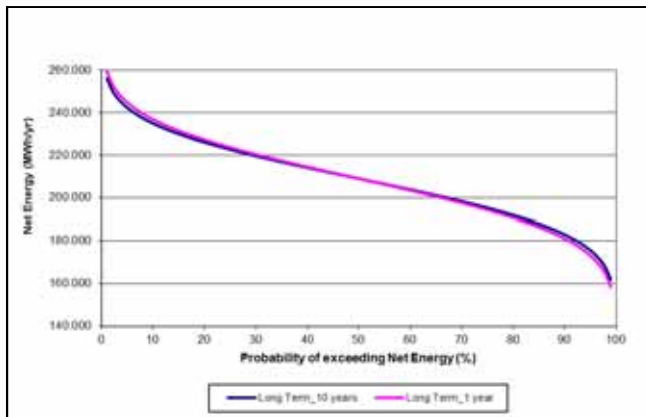
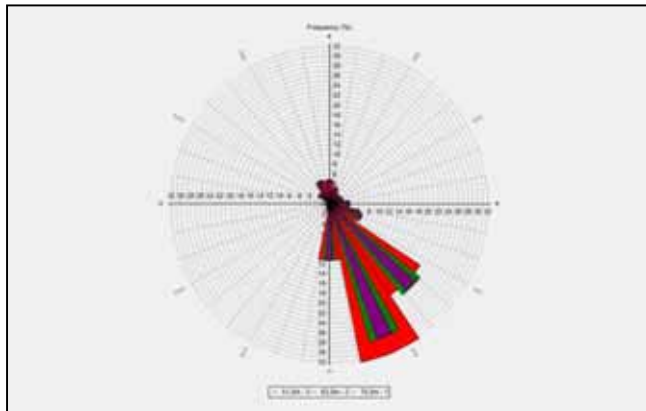
- Installation and operation of meteorological stations
- Analysis of terrestrial databases, on site records and satellite data
- Evaluation and design of typical meteorological year (TMY) and probability estimations
- Analysis of cloud transients
- Energy yields are modeled using industry wide practices and statistical analysis, incorporating ATA's proprietary methodologies and taking advantage of the large worldwide database for renewable energy established by ATA
- Final results are benchmarked against standard industry modeling software and real world results



Services for Projects under...

Development

Wind Resource and Energy Production Estimate



Modeling and estimation of wind energy yields (P50, P90):

- Installation and operation of wind data stations
- Analysis on site records and wind data mesoscale models
- Evaluation and design of wind data reference period and probability estimations
- Analysis of long term wind
- Energy yields are modeled using industry wide practices and statistical analysis, incorporating ATA's methodologies and taking advantage of the large worldwide database for wind energy established by ATA
- Final results are benchmarked against standard industry modeling software and real world results

Technical Due Diligence

- Natural resource, losses and yield estimation
- Analysis of technologies track record
- Fit for purpose and technological evaluation of equipment and plant design
- Equipment supplier evaluations: references, previous experience and delivery periods.
- Contract Evaluation (EPC, O&M, PPA, etc.)
- Evaluation of authorizations, licenses, permits
- Environmental evaluation
- Technical Evaluation of the base case: price, expenses, revenue, MRA





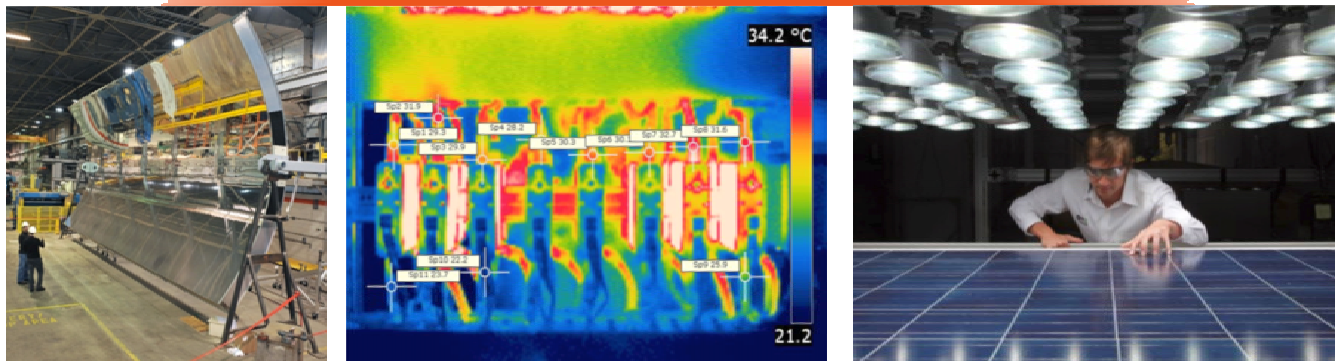
Services for Projects under...

Development

Product Due Diligence

ata helps Clients to achieve bankability for their products (PV modules, inverters, mirrors, wind turbines, etc.)

- More than 150 factories and suppliers, ranging from raw materials, component suppliers, sub-assemblies and final assemblies
- On-site quality control during manufacturing
- Quality audits and compliance
- Environmental auditing
- Component testing and verification
- Product certifications
- Product acceptance testing and fit for use evaluations



Services for Projects under...

Construction



- Quality control inspections
- Setting out works
- HSE management
- Progress reports
- Payment drawdowns certifications



- Construction monitoring (KPI)
- Engineering supervision
- EPC management (WBS / Lean)
- Plant commissioning tests
- Monitoring of Provisional Acceptance Test



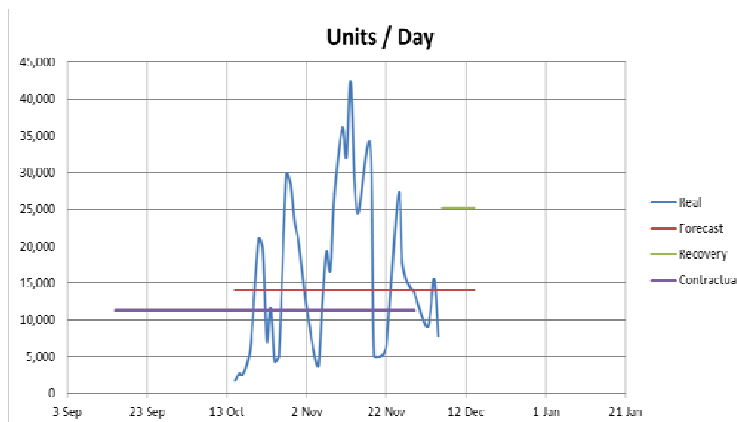
Services for Projects under...

Construction

Project Mangement of Construction

With more than 300 MW carried out in Project Management for Plant Construction ATA helps Clients to get the completion of construction works on time and to achieve the quality standards agreed on the EPC contract without extra costs:

- Permanent on-site experienced staff during works period
- Work in progress reporting on daily basis
- Prevention and correction of quality and schedule deviations
- Controversial problem solution upon EPC contract
- Dedicated professionals that seamlessly work with project team
- Direct on-site hands on communication
- **W.B.S. (Work Breakdown Structure) and Lean Construction**





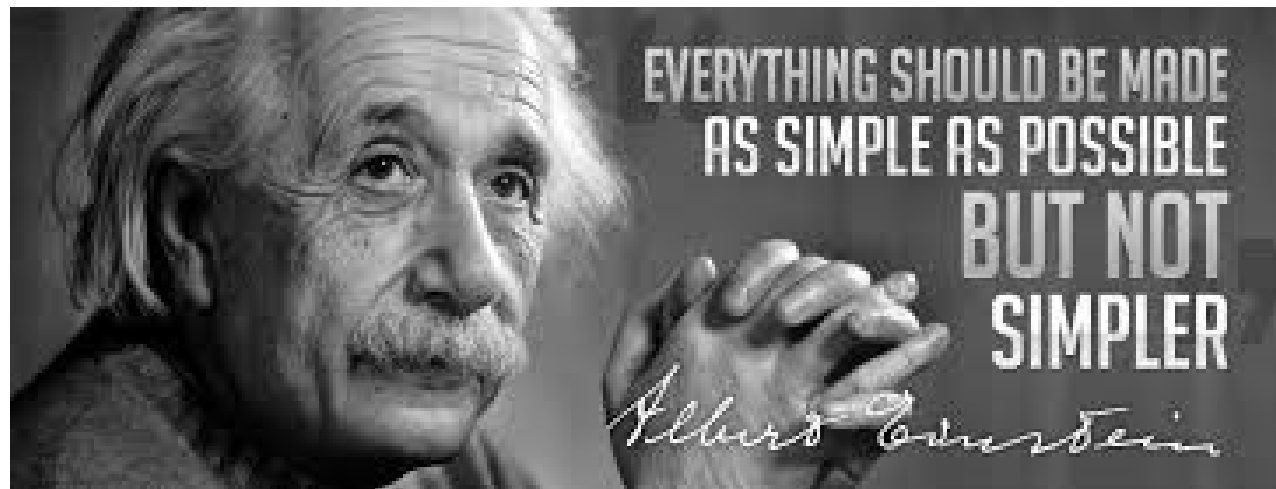
Services for Projects under...

Construction

Work Breakdown Structure



WBS



Services for Projects under...

Construction

WBS

- Standardized decomposition of the projects into work packages
- ATA's Project Management is based on the WBS
- 4 levels

Level 1

- PV Plant
- MV and Junction Center, etc.

Level 2

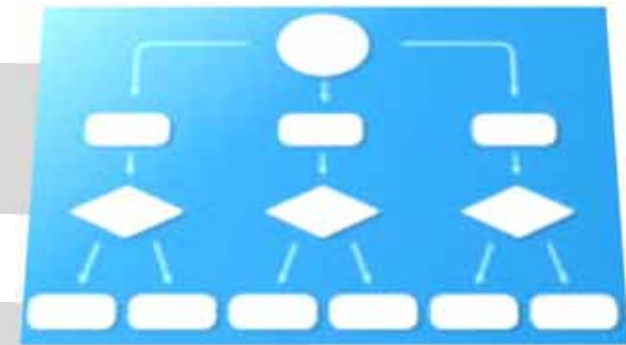
- Civil
- Electrical, etc.

Level 3

- PV Modules
- Combiner Boxes, etc.

Level 4

- Installation
- Cable Laying, etc.



WBS sample

PV Plant

- Mechanical Installation
 - Combiner Boxes
 - Supply
 - Installation
 - PV Modules
 - Supply
 - Installation

Etc.



Services for Projects under...

Construction

Lean Construction

- 1 Understand the work and document It
- 2 Lean it out (minimize 'wastes')
- 3 Standardize the work and update document
- 4 Organize the Standard Work (**Yamazumi**) across people and time to accomplish a specific goal (e.g. 1 Array in 1 Day with 1 Team)
- 5 Build Yamazumis for nearly every aspect of the job (Underground, Wiring, Trackers & Modules, Civil Work, Inverter Pads, Material Management, etc...)

Standard work sheet

Basic info. e.g, rev. date

Descriptions of steps to perform

Illustration through pictures

Safety and quality check points

Material and tools required

Yamazumi

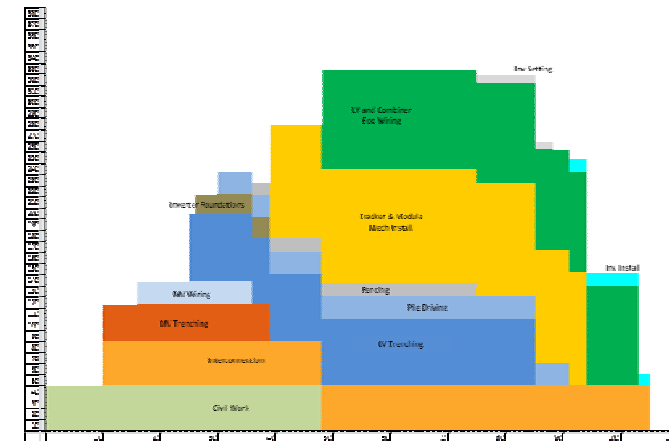
	Ricky	Oscar	Oscar	Steve	Ricardo	Alan	Victor	Gabriel	Edi	Andrew
1:00	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array
2:00	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array
3:00	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array
4:00	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array
5:00	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array
6:00	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array	install DC Array



Services for Projects under...

Construction

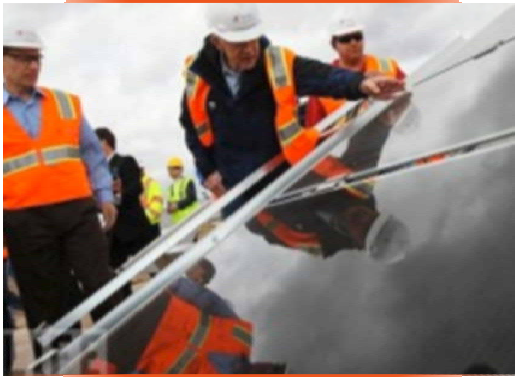
Lean Construction



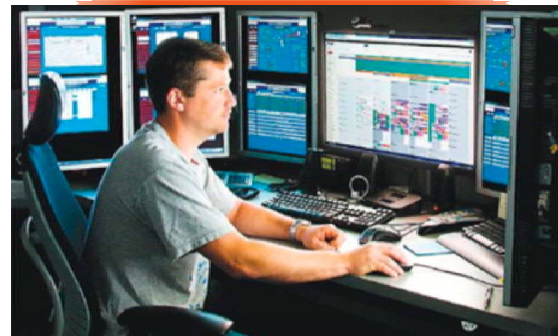
The Yamazumi contains knowledge of the labor, equipment, and tools required to perform the objective

Services for Projects in...

Operation



- Monitoring and rating of plant performance
- Monitoring of Definitive Acceptance Test
- Asset management
- Quality evaluation of O&M companies
- Insurance and warranty management
- Energy dispatching back-office
- Technical Due Diligence for asset buyouts
- Repowering and upgrade feasibility
- Product testing and Certification
- Training
- Monitoring of O&M
- **Assets Management**

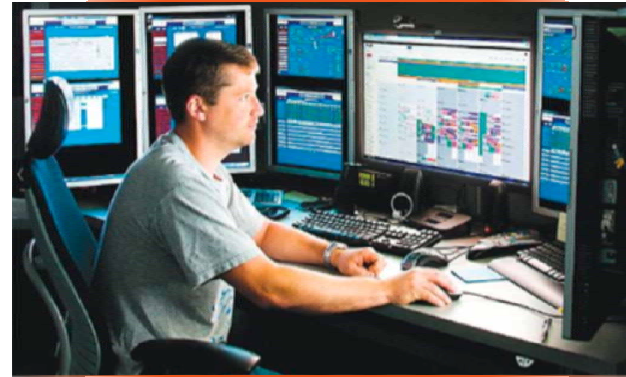
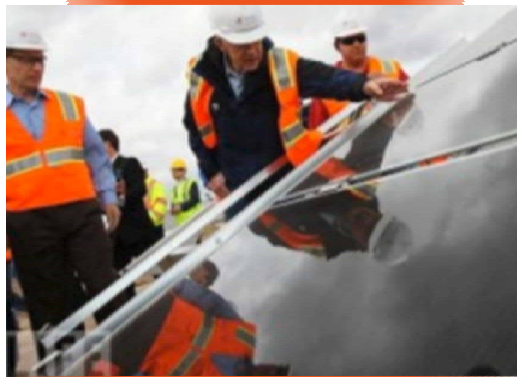




Services for Projects under...

Operation

Assets Mangement



Data Collection

ATA visited the plants and received all the relevant data of the project: contracts signed, engineering, flash reports and historical KPI data

ATA's Analysis

ATA processed all the data and drew up key conclusions for the contract terms and prices, plant availability & performance, etc.

Actions

ATA proposed different actions based on the conclusions

Outcomes

The plant increased the performance by 2% and the costs were reduced more than 15%



Table of Contents

**Annex I: References
and Emblematic
Projects**

Multiple References World Wide (Financial Inst.)

- AFDB
- Ahorro y Corporación Financiera
- AIB
- Australian and New Zealand Bank
- Banca Nuova
- Banco Espiritu Santo
- Banca Popolare di Vicenza
- Banco Popolare
- Banesto
- Bankia (prev. Caja Madrid)
- Bankinter
- Barclays
- Bayerische Hypo-und Vereinsbank AG-London Branch
- BBVA
- BES
- BIIS Intesa San Paolo
- BNL
- BNL Leasing
- BNP Paribás
- Caja Castilla La Mancha
- Caja de Ahorros Inmaculada
- Cassa de Depositi e Prestiti
- Cassa di Risparmio di Volterra
- China Development Bank Leasing
- Coöperatieve Centrale Raiffeisen-Boerenleenbank B.A.
- Credito Emiliano
- Deutsche Bank AG
- Development Bank of South Africa
- Dexia
- Dexia-Sabadell
- Dresdner Bank
- EBN
- EIB
- Emporiki
- GE Financial Services
- HBOS
- HSBC
- HSH Nordbank Bank
- IBRD
- Intesa Sanpaolo
- Investec
- KfW
- La Caixa
- LBBW
- Leasint
- Lloyds
- Mediocreval
- Montepaschi di Siena
- MPS Leasing
- National Australian Bank (NAB)
- Natixis
- Ned Bank
- NIBC
- NordLB
- Pastor
- Rabobank
- Raiffeisen Zentralbank
- RMB
- Royal Bank of Scotland
- Sabadell
- Santander
- Sumitomo (SMBC)
- Triodos
- Unicredit
- Unicredit Bulbank
- Unicredit Leasing
- WestLB
- World Bank
- Etc...

Multiple References Worldwide (Funds & Eq. Invest)

- 360 Corporate
- Abaco Energy
- Abantia
- Abengoa
- Abraxa
- Acciona
- AES
- Alten
- Amplio Partners
- Ancora Advisors
- Barclays Infrastructure Fund
- BioTherm Energy (PTY)
- Bosch
- Bridge Point
- Ecosolar
- Eland Private Equity
- Emgasud
- Enfinity
- Enolia
- Eolia N+1
- Eskom
- Etrion
- FRV (Fotowatio)
- GEA
- Gesfesa
- Gestamp Solar
- Gigawatt Global Coöperatief
- GSF Capital
- Hanwha
- Impax New Energy Investors
- Irradia
- Martlin Patterson
- Masen
- Maxima Invest
- Mitsubishi
- Naturener
- Origis
- Orisol
- Platina
- Plenium Partners
- PSP
- Quintas
- Renovatio
- Santander Asset & Investment
- SDR Energy
- SunEdison
- Técnicas Reunidas
- Triodos Ampere
- T- Solar
- Vector Partners
- Vista Capital
- Voltiq
- White Owl Capital
- Zafia Energy



Selected ATA Credentials (1)

Service scope	Technology	Power (MW)	Project Range	Country	Location
Tech Due Diligence	PV	60	Single plant	Spain	Olmedilla
Tech Due Diligence	PV	34,5	Single plant	Spain	Trujillo
Tech Due Diligence	PV	46	Single plant	Portugal	Moura
Tech Due Diligence	PV	15	Single plant	Spain	Olivenza
Tech Due Diligence	PV	29	Multiple plants	Italy	Campania, Sicilia y Puglia
Tech Due Diligence	PV	26	Single plant	USA	Puerto Rico
Tech Due Diligence	PV	180	Single plant	Australia	Moree
Tech Due Diligence	Wind	120	Multiple plants	Mexico	Tamulipas
Tech Due Diligence	Wind	28,5	Single plant	Spain	Osuna
Tech Due Diligence	Wind	44	Multiple plants	Spain	Jerez de la Frontera
Tech Due Diligence	Biomass	8	Single plant	Spain	Fuente de Piedra
Tech Due Diligence	CSP	50	Single plant	Spain	Extremadura
Tech Due Diligence	CSP	100	Multiple plants	Spain	Granada
Project Developer Tech Assistance	Wind	800	Multiple plants	Mexico	North of Mexico
Project Developer Tech Assistance	PV	52	Single plant	USA	Puerto Rico
Asset Buyout Tech Due Diligence	PV	40	Multiple plants	Peru	Tacna
Asset Buyout Tech Due Diligence	PV	40	Multiple plants	Peru	Arequipa



Selected ATA Credentials (2)

Service scope	Technology	Power (MW)	Project Range	Country	Location
Construction Supervision	PV	20	Single plant	Argentina	San Juan
Construction Supervision	PV	20	Single plant	South Africa	Northern Cape
Construction Supervision	PV	20,4	Single plant	Portugal	Lisbon area
Construction Supervision	PV	5	Single plant	USA	California
Construction Supervision	PV	3,6	Multiple plants	USA	Arizona
Construction Supervision	PV	70	Single plant	Italy	Rovigo
Construction Supervision	PV	20,4	Single plant	Italy	Campania
EPC Management	PV	62	Single plant	Bulgaria	Plodniv
EPC Management	PV	151	Multiple plants	Chile	Atacama
Feasibility Studies	Wind	160	Multiple plants	Dominican Rep.	Isabela
Feasibility Studies	CSP	20	Single plant	Spain	Valencia
Feasibility Studies	PV	203	Multiple plants	Chile	Antofagasta
Feasibility Studies	PV	30	Single plant	Chile	Atacama
Feasibility Studies	PV	45	Multiple plants	USA	Puerto Rico
Feasibility Studies	PV	100	Multiple plants	Japan	Kagoshima, Nagano
Owner's Engineering	PV	150	Multiple plants	USA	Puerto Rico
Owner's Engineering	CSP	100	Single plant	South Africa	Northern Cape

Relevant Achievements

Olmedilla, Spain

60 MWp PV

Lender's
Technical Advisor



Veneto, Italy

70 MWp PV

Sponsor's
Technical Advisor



Moura, Portugal

46 MWp PV

Lender's
Technical Advisor



Trujillo, Spain

34.5 MWp PV

Lender's
Technical Advisor



Relevant Achievements

Uppington, South
Africa

20 MWp PV

Construction Project
Management



Les Mees,
France

31 MWp PV

Lender's
Technical
Advisor



Karadzhalovo, Bulgaria

60.4 MWp PV

Construction Project
Management



Copiapó, Chile

100 + 50 MWp PV

Construction Project
Management



Relevant Achievements

Dominican
Republic
100 MW Wind
Sponsor's
Technical Advisor



Greece
30 MWp PV
Lender's
Technical Advisor



Puglia, Italy
123.6 MWp PV
Lender's Technical
Advisor

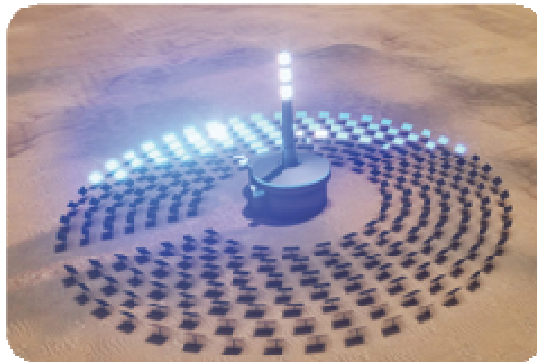


Puerto Rico, USA
30 MWp PV
Sponsor's
Technical Advisor



Relevant Achievements

South Africa
100 MWe CSP
 Engineering
 Design



Valdecaballeros,
 Spain
100 MWe CSP
 Sponsor's Technical
 Advisor



Fuente de Piedra,
 Spain
8 MW Biomass
 Sponsor's Technical
 Advisor



San Juan,
 Argentina
20 MWp PV
 Sponsor's
 Technical Advisor





Relevant Achievements

Tamaulipas,
Mexico
120 MW Wind
Sponsor's
Technical Advisor



Mexico
**800 MW 5 Wind
plants**
Sponsor's
Technical Advisor



Masen, Marruecos
Outsourcing of Tender
Management Process



Kalahari, South
Africa
75 MWe CSP
Lender's Technical
Advisor



ata's Membership and Accreditations



AENOR Asociación Española de
Normalización y Certificación



... and collaborates with the Sub-Committee for the standardization of Solar Thermal Electric Systems in AENOR (Spanish Association for Normalization and Certification)

ata's Membership and Accreditations



ata is accredited by ENAC as a Photovoltaic Inspection Entity for the PV installations compliance with voltage dips. (P.O.12.3)

Currently, ata is one of the few companies in Spain accredited for issuing the field Certificate.

This accreditation implies that ENAC audits ata's quality system annually.



About



cere (Certification Entity for Renewable Energies) is an independent certification entity that was established in 2015 as a part of ATA. CERE is therefore a department of ATA for certification that has its own staff and works **impartially** and also independently of the rest of the ATA team and projects.

cere is being managed by Miguel Martinez. CERE's team has experience for more than: 200 MW of PV inverters tested and certify (> 100 different projects), 1500 MW of PV installations, 250 MW of Wind farms and 350 kW of Wind Turbines. The team has also participated in the **worldwide certification** of different kind of norms in UK, Italy, Spain, Germany, South Africa, Chile, Peru, México, Japan, Thailand, etc.

cere participates in the main standardization committees of renewable energies and grid integration: TC 82(Photovoltaic), TC 88(Wind), TC 117 (Solar Thermal), TC 114 (Marine), TC 8X(Grid integration) and the new certification scheme for Renewable energies (IECRE)





Certification Entity for Renewable Energies

Wind

- **Wind Farm Life Extension Certification:** procedure to certify the life cycle of Wind Farms.
- **Wind Turbine Retrofit Certification:** procedure to certify the wind turbine retrofit in conformity with design requirements.

Marine

- **Design Certification:** Certification of the design according standards and specifications.

CSP

- **Design Certification:** Certification of the design according standards and specifications.

PV

- **Quality Certification of PV plant:** Procedure to certify the quality of the PV plant in different categories: A,B, F,...based on fixed requirements.
- **Quality Certification of PV components:** Procedure to certify the quality of the PV Components in different categories: A,B, F,...based on fixed requirements.

Grid Integration

- **Grid Integration Certification:** Worldwide certification of grid regulations for the Low, Medium and High voltage requirements.

Smart Grid

- **Smart Grid Certification:** Certification of requirements for Smart Grids



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