Projects undertaken

Solar Irradiation

- Analysis of solar irradiation– DNI, GHI and GDI – for CSP, CPV and PV projects with and without tracking in:
- Portugal, Spain, California, Australia, India (all country and in particular 6 states), Pakistan, Bangladesh, Maldives, Namibia, Cambodia, Vietnam, Thailand, South Africa, Russia, Iraq and Saudi Arabia, Senegal, Madagascar, Togo

Solar PV

Feasibility studies, masterplans and advisory

- PV feasibility study for > 1 MW plant, India, 2010
Evaluation of sites, radiation, technologies and technical solutions as well as financial analysis support

- Solar rooftop concept for the Maldives, Maldives, 2011
Support to the Maldivian Government project Carbon neutral 2020: solar PV rooftop concept for the Maldives and specific for the Male Region: site visits, evaluation, analysis of technical constraints, solar resource in the islands, cost estimate and elaboration of a savings model.

- Feasibility study in Cambodia for PV development, 2013
Analysis of the energy regulation, analysis of the solar resource, GIS study of the whole country, identification, evaluation and selection of the sites, evaluation of current electrical generation in Cambodia – hydro, coal and diesel. Including scenarios for PV/diesel hybrids. Cost estimates and financial analysis. Discussions with main stakeholders, site visits and inspection as well as final results.

- Feasibility study of Afghanistan for PV development, 2013
Analysis of the energy regulation, analysis of the solar resource, GIS study of the whole country, identification, evaluation and selection of the sites, evaluation of current electrical generation in Afghanistan – coal and diesel. Scenarios for centralized and decentralized generation as well as PV/diesel hybrids. Cost estimates and financial analysis.

- Study of PV power generation technology options for the Far East Federal District (FEFD), Russia, 2013
Overview of PV module technologies, inverter technologies, charge controller technologies, battery controllers, CAPEX and OPEX costs, on-grid and of-grid PV systems, PV/diesel hybrids, design, layouting and simulation for several villages with several configurations including LCOE and payback analysis for all options (diesel generators from less than 100 KW to 3000 KW), analysis of the SMA Fuel Save for the FEFD, meeting and discussion with stakeholders.

- Solar options and assessment for the Great Male region, Maldives, 2014
Technology analysis, best practices from other island nations, solar potential assessment,

solar rooftop potential, analysis of expected demand growth and generation options, cost estimates and LCOE analysis, capacity building

- RE options, Samoa, 2014
Advisory role on RE options and RE grid integration. Standard PPA presentation and discussion. Support for PPA negotiation with private sector.

- Solar and wind options, Comoros, 2014
Pre-feasibility study for solar options with site inspections and discussion with local stakeholders and the private sector. Options/alternatives for distillation of ylang ylang using RE

- Market research for Renewable Energy opportunities, Mauritius and Maldives, 2014
Reports encompassing country profile, power generation analysis and tariffs, Renewable energy potential and supporting policies (including SREP for the Maldives), Micro-grid or solar power projects in development and key players.

- Market research for countries and Island nations to develop PV hybrids, 2015
Report encompassing the opportunities for PV hybrids in 27 countries across 3 continents focussing on PV and PV hybrids based on the activities of the development banks.

- Advisory on the 750 MW REWA solar park project, India, 2015-2016
Analysis of the structure, technical analysis, solar resource analysis, solar park design, costs, inter connection, PPA, capacity tests

- Solar parks development and integration in the grid, India, 2016 - 2019
DPR development and review, grid stability and integration, control Systems for Developers & Operating Manual, Health and Safety Manual, Centralized Solar Park Monitoring System, Capacity Building, Support to the Joint Working Groups in the framework of the EU-India Energy Panel.
- Review of the DPR for 100 MW Tezu solar park in Arunachal Pradesh
- Review of the DPR for 55 MW solar park in Haryana
- Review of the DPR for 1000 MW solar park in Odissa
- DPR for 440 MW solar park in Uttar Pradesh
- DPR for 20 MW Meghalaya solar park
- DPR for 80 MW PV plant in Assam, for Assam Power Generation company (APGCL)
- Solar policy development of Uttar Pradesh
- Solar policy revision of Assam

- Solar parks development, India, 2016-2018
DPR development and review, technical support, assessment of transmission infra-structures, due diligence, preparation of loans
- Review of the DPR for 700 MW Banaskanta solar park in Gujarat
- Review of the PFR for 200 MW Kasarogod solar park in Kerala
- Review of the DPR for 440 MW Uttar Paradesh solar park
- Review of the DPR for 260 MW West Bengal solar park
- Review of the DPR for 2000 MW Karnataka solar park
- DPR for 200 MW Kasorogod Solar park in Kerala
- PPR for 30 MW Nagaland solar park

- Support to Scaling Solar projects of the WB group worldwide, 2015 - 2018
PV projects structuring, technical requirements, feasibility studies, detailed studies,

financial analysis, grid integration, environmental and social aspects

- Technical transaction leader in "Scaling Solar", Senegal, 2016-2018
Leading and supervising the technical side of the Scaling solar projects in Senegal

- Technical transaction leader in "Scaling Solar", Madagascar, 2016-2018
Leading and supervising the technical side of the Scaling solar projects in Madagascar

- GIS analysis for PV plants deployment, Senegal, 2016
Gathering of GIS layers and scenarios to analyse suitable sites for PV utility scale deployment

- GIS analysis for PV plants deployment, Madagascar 2016
Gathering of GIS layers and scenarios to analyse suitable sites for PV utility scale deployment

- Advisory for deployment of utility scale PV projects, Cambodia, 2016-2017
Site analysis and grid constraints analysis.

- Advisory for deployment of utility scale PV projects, Afghanistan, 2017
Feasibility studies review, desktop analysis on potential sites, grid constraints analysis.

- GIS analysis for PV plants deployment, Togo, 2017
Gathering of GIS layers and scenarios to analyse suitable sites for PV utility scale deployment

- GIS analysis for PV plants deployment, Ethiopia, 2017
Gathering of GIS layers and scenarios to analyse suitable sites for PV utility scale deployment

Owner's engineering and EPC support

- EPC projects for more than 20 MW and even 100 MW, India, 2010
EPC contracts/tenders: evaluation of site, detailed PV engineering and solutions, procurement and construction support.

- PV power plants development, 30 + 18 MW, 2011, Portugal
Site analysis, evaluation and selection, grid connection and connection costs, grid analysis; full analysis of the sites: legal, technical, environmental and for grid connection. Grid transmission lines location and several scenarios for connection to the grid, cost analysis, study of the existing utility electrical substations and possible connection routes.

- Design of microgeneration PV schemes (<=3,68 KW), 2009, 2010, 2011, Portugal
Small domestic rooftop projects with and without trackers (Portuguese scheme): business model, evaluation of suppliers, installation cost and profitability.

- Design of minigeneration PV schemes (<= 250 KW), 2011, 2012, Portugal
Medium commercial and industrial rooftop projects with and without trackers (Portuguese scheme): business model, evaluation of suppliers, installation cost and profitability.

- Review of Tenders for PV projects in 7 islands, the Maldives, 2011

Support to the Maldivian Ministry of Housing and Environment on reviewing and capacity building for the high priority tenders on PV systems for remote islands.

- Review of RFP PV 5 MW in Bangladesh, 2012
Support to Bangladesh Power Development Board and full review of the RFP documentation with gap assessment and required improvements

- Owners engineering and advisory to the 150 MW PV Ilanga portfolio of Eskom, South Africa, 2014
Site analysis, project development, basic and detailed engineering, cost estimates, tender preparation and implementation and advisory services

- PV power plant development, 10 MW, Namibia, 2016-2017
PV project development, detailed engineering and technical drawings, land lease negotiation, structure of the SPV, financial analysis, negotiation with lenders, guidelines on the way forward, support for tendering process.

- PV power plants development, 2 MW, 2017, Portugal
Site analysis, detailed engineering review, 3D simulation in PVsyst, list of recommendations for the supervision of the EPC contract.

Due diligence

- PV projects due diligence (ground mounted, rooftops and greenhouses), total of 42 MW, Italy, 2010/2011
- PV projects due diligence (ground mounted), total of 35 MW, Bulgaria, 2010/2011
- PV projects due diligence (ground mounted and rooftop), total of 25 MW, Germany, 2010/2011
- PV projects due diligence (ground mounted), total of 15 MW, Romania, 2011
Due diligence: legal, technical, financial. Site analysis, available radiation, equipment analysis, EPC analysis, bankability issues.
- Evaluation of PV project based on Renewable Energy credits, 50 MW, Rajasthan, 2010, India
Full analysis on the project, due diligence, evaluation of the site: land, water availability, grid connection, radiation analysis; FiT/PPA, utility clearance and green certificates mechanism.

- PV projects due diligence (ground mounted, total 200 MW), India, 2012
Due diligence: technical and financial. site analysis, available radiation, equipment analysis, project report evaluation, capacity building.

- Evaluation of PV projects, Mexico, 2013
Site and system analysis, evaluation of the project “Small scale PV projects connected to the grid”, discussion with stakeholders

- Technical due diligence of 24,5 MW PV plant, Kazakhstan, 2015
Analysis of the solar resource, environmental data, geotechnical study, main components, technical drawings, sizing and layout.

- Technical due diligence of site for PV plant development, Zambia, 2015-2016
Analysis of the geotechnical report, soil analysis, topographic map, geology report, seismic report, hydrological report and overall suitability of the location.

- Technical due diligence on 500 kW rooftop project, Bangladesh, 2016
Analysis of the detailed project report including solar resource, sizing, roof mounting, plant design and costs

Off-grid and mini-grids projects, including hybrid systems

- PV projects for hospitals and industries (500 KW to 4 MW), Pakistan, 2010, 2011
- PV Off-grid projects for measurement equipments and monitoring stations (40 W size, several stations), Portugal, 2011
- PV off-grid and hybrid projects (wind and diesel) for telecom towers (20 to 100 KW), Nigeria, 2010
- PV off-grid and hybrid projects (wind and diesel) for military projects (40 to 70 KW), Jordan, 2010
- PV off-grid and hybrid project (solar and diesel) for military (100 KW), Angola, 2012
- PV on-grid for the PT telecom towers (solar and wind) (~1,5 MW total), Portugal, 2014
- PV systems for a hotel (100 kW), Guine Bissau, 2015
Feasibility study, basic design of the system, sourcing, evaluation of suppliers and guarantees, installation definition, operation and maintenance procedures and training.

- PV micro-grid (transmission and distribution) and hybrid project for 3 villages (1,3 MW total), Mozambique, 2012
Preparation of the technical bidding documents and local support for an EPC company, including plant layout, construction method and plan, schedule, operation including generator emergency operation, material and packaging supply including logistics and transportation plan, spare parts, guarantees and warranties, project safety and security plan, project health and safety, quality control plan, Environment Management plan, education and training plan, Commissioning and test plan, maintenance plan, site organization and staffing, conformity of equipment and price/cost estimates

- PV micro-grid (transmission and distribution) for 60 villages and more than 1300 households (~1 MW total), Vietnam, 2013
Preparation of the technical bidding documents and local support for an EPC company, including plant layout, construction method and plan, schedule, operation including generator emergency operation, material and packaging supply including logistics and transportation plan, spare parts, guarantees and warranties, project safety and security plan, project health and safety, quality control plan, Environment Management plan, education and training plan, Commissioning and test plan, maintenance plan, site organization and staffing, conformity of equipment and price/cost estimates. Site visits and discussion with local partners,

Procurement

- Sourcing of PV modules for projects, from kW to MW.
Analysis of module manufacturers, quality, certifications, inspections, guarantees and warranties – focus on Chinese manufacturers.

Concentrated Solar photovoltaics

- Evaluation of patents in CPV, USA, 2010
- Evaluation of patents in CPV, India, 2010
- Evaluation of a Thermal hybrid system - CPV and CSP – USA, 2009/2010.
Analysis of potential business opportunities, SWOT analysis, way forward

- CPV product development – 3 projects: USA, India, Portugal, 2009/2010
Focus on optical, heat transfer and overall system design

Solar thermal

- Analysis of Chinese manufacturers, 2010, 2011, 2012
Certificates, quality and price

- Solar Thermal projects for offices, public buildings, Masdar, UAE, 2010
Design, sizing, engineering and bid support

- Policy development on Solar cooling, Thailand, 2013
Study and definition of a solar cooling policy (including solar thermal cooling and solar PV driven cooling) for the Thai government (DEDE), including technology review, assessment of international benchmarks, site visits to representative installations nationally and internationally, workshop with stakeholders, policy discussion and final suggestions and international study tour with DEDE.

Solar chemistry

- Solar UV collector development, Portugal, 2013 - 2014
Concept development, study and analysis of the optical system, basic and detailed engineering, support to implementation of the prototype

- Solar UV development, 2017
Technical evaluation and simulation of a new optical system

Concentrated solar thermal

Feasibility studies, masterplans and advisory

- CSP feasibility study – India, 2009

Full analysis of radiation in India – 23 sites were considered with measured radiation and available statistics - technology analysis and selection, costs of equipments and Indian development, procurement and construction costs and prices.

- Master plan and detailed project report of 3000 MW of solar power (PV and CSP) - India, 2011 - 2016

Policy analysis, site analysis and selection, infrastructure analysis, grid connection and

connection costs, grid analysis, water availability, resource analysis, cost estimate, solar park layout, presentation of the results in international forums, investor meetings and execution of Detailed Project Report for the Solar Park.

- Advisory to the largest Thermal Power Company in India, 2011

Analysis of the CSP pipeline, detailed project reports, site visits and evaluation, technology analysis, water needs, resource analysis, layout, power yield estimate, cost estimate, financing structure, EPC model versus turnkey, own development, capacity building, technical meetings for bids, structuring of bids.

- Feasibility study and basic engineering of parabolic trough 20 MW CSP power plant with 8 hour storage, Pakistan, 2011

Local policy analysis, site analysis, infrastructure analysis, grid connection and connection costs, grid analysis, water availability, resource analysis, technology analysis and selection, layout, EPC analysis, cost estimate, financing solutions, structuring of the project.

- Advisor to the Ministry of New and Renewable Energy in India, 2011, 2012, 2013

Structuring the technical bid requirements and bid design for large scale CSP projects, technologies, Indian features, selection of projects, definition of technical criteria for evaluation, solar field and BOP (Balance Of Plant) analysis, tariff definition, budgeting, full site analysis and selection, financing options and requirements

- Advisory, analysis and structure of CSP technologies and opportunities for a leading oil company, Saudi Arabia, 2011-2012

Strategic analysis and advisory to define a market entry strategy in the CSP sector.

- Pre-feasibility study for CSP development in Namibia, Renewable Energy and Energy Efficiency Institute, Ministry of Mines and Energy

Solar Irradiation analysis, GIS study of the whole country, Site selection and site visits, CSP basic engineering, layout and power yield, Financial analysis, Gap assessment and capacity transfer program for Namibia, CSP development plan

- Advisory role to Ministry of Mines and Energy of Namibia on CSP development and presentation of a CSP business opportunity to the national utility, 2013

Preparation and presentation of a business infomemo.

- Support to the DOE and CEF in South Africa to structure 5000 MW solar corridor initiative (PV, CPV, CSP), South Africa, 2013, 2014

Supervision of the feasibility Studies, stakeholder consultation, financing Solutions, policy

analysis, local manufacturing opportunities, presentations and recommendations, integrated report execution and submission for cabinet deliberation.

- Advisory to the CSP augmentation projects in coal power plants of Eskom, South Africa, 2014

Advisory to the RE department and technical support on site identification, technology solutions, suitable CSP technologies.

- CSP Capacity building assessment and implementation, Namibia, 2015-2016

Assessment of the capacity building needs and implementation in Namibia among all sectors to increase the local content for the deployment of CSP power plants. Local workshops, reports and documents and support to the Ministry of Mines and Energy and other local stakeholders on deploying the first CSP power plant in Namibia.

Due diligence

- Due diligence of 2 x 50 MW parabolic troughs CSP power plant analysis – Spain - 2010

Analysis of the site, radiation, energy yield, technology, water availability, grid distance and connection, injection point, overall development cost and EPC cost estimate, project finance analysis, CAPEX and OPEX.

Owner's engineering and EPC support

- Compact Linear Fresnel, troughs, power towers technology development, 2009 - 2011

New concepts for optical receivers, testing of new cavities, economizer, control strategies, mechanical structures, new aluminium surfaces, new frames, usage of steam and storage solutions.

- Support to the Bhadla Phase I and phase II implementation, 2012 - 2016

Bidding support, bid documentation, pre-bid meetings, project supervision, periodic meetings, commissioning

- Design, sizing and power yield estimate for the following CSP projects, India, 2011, 2012, 2013

- 500ºC operating temperature – 50 to 100 MW
- Hybrid cooling – 50 to 100 MW
- Large storage, up to base load power – two projects of 50 to 100 MW
- CSP with biomass hybrid – several projects up to 30 MW
- CSP with gas hybrid - several projects up to 30 MW
- Coal Augmentation
- Stirling Engines – several projects up to 50 MW

- Design, sizing and power yield estimate for the following CSP projects, Namibia, 2012

- 50 MW tower 500ºC, dry cooling, 8 hours storage (3 sites)
- 50 MW tower 500ºC, dry cooling, 7 hours storage (1 site)
- 50 MW troughs, dry cooling, 7 hours storage (4 sites)
- 50 MW linear Fresnel, dry cooling, hybrid with biomass (1 site)
- 50 MW troughs, dry cooling, hybrid with biomass (1 site)
- 50 MW tower, dry cooling, hybrid with biomass (1 site)

Wind Energy

- Due diligence of a 250 MW Wind park at Gharo or Khutikun Sind, Pakistan, 2011

Technical analysis, feasibility analysis, cost estimates, business model analysis, financial analysis

- Due diligence of wind parks in Romania – 10 to 50 MW, several sites, 2010

Technical analysis, feasibility analysis, cost estimates, business model analysis, financial analysis

- Site feasibility of wind parks in India – 18 sites, 2011

Micrositing analysis, wind resource analysis, planned layout, performance analysis with several wind generators, cost estimates, financial analysis

- Due diligence of wind parks several of 500 MW (total of 2,5 GW), Iran, 2012

Analysis of the site, accesses and infrastructures, resource analysis, layout, yield analysis based on 2 different wind generators, site visits, EPC cost estimates and financial analysis for the development of the parks (under the scenario of the sanctions)

Energy Efficiency

- Municipal energy audit for two municipalities and one city market requalification in Portugal and renewal as well as other assignments by supplying EE and RE solutions for industrial processes and commercial usages, 2010, Portugal.

- Energy efficiency - analysis of energy consuming processes in factories, the type of energy, other options, energy intensity, grid availability, peak electrical consumptions, reactive power, power correction factors, off-grid Renewable energy solutions for direct consumption and on-grid with mixed consumption and excess injection, 2010-2011, Portugal.

- ESCO concepts, 2010

Technical definition up to business plan - for solar thermal (hot water), solar PV (electricity) and steam (using Concentrated solar thermal solutions) for desalination and steam processes

- Energy efficient and low carbon improvements, Portugal, 2010

Detailed design of HVAC systems for hotels, sport halls, industrial buildings, shopping centres, medical facilities, care homes, secondary schools, and office buildings for Portugal and Angola. Also performed Energy and Indoor Air Quality Audits for Offices, Libraries and Conference Centres.

Solar cooling experience in R&D EU projects

EU project – PolySMART - POLYgeneration with advanced Small and Medium scale thermally driven Airconditioning and Refrigeration Technology (www.polysmart.org)

Description: The main goal of the PolySMART project is to support the development of a new market for polygeneration: small and medium capacity tri-generation. This project aims to demonstrate the cost effectiveness and reliability of small-scale Combined Heat Cooling and Power (CHCP) units for a wide range of buildings and industrial applications. Key actors in the project are the majority of today's manufacturers of thermally-driven cooling machines in Europe and manufacturers of Combined Heat and Power (CHP) systems.

The consortium also includes utilities, engineering consultants, energy agencies, end-users and research institutions.

Eight demonstration sub-projects using different thermally-driven cooling technologies are being carried out as a main activity at twelve sites in seven European countries for a wide spectrum of

applications. The operation of the demonstration sub-projects are being investigated in practical applications and assessed with regard to economic and energy performance. Further activities covered in the work plan include a broad market potential analysis of micro-trigeneration systems, the development of component and system models for engineering, the development of design guidelines and tools for professionals, and the production of documents for training and dissemination.

EU project – ALONE - Small Scale Solar Cooling Device (www.aloneproject.eu)

Description: The main aim of ALONE proposal is to provide market-ready autonomous solar heating and cooling systems for residential or light commercial applications (small size systems, 5-13 kW of cooling capacity) to contribute to sustainable energy. The expected environmental gains are essentially due to the employment of non-ozone-depleting refrigerants and the use of renewable energy sources. In fact, the single components as well as the design and control of whole system will be optimized in order to maximize primary energy savings and reduction of CO2 emissions within economically feasible terms. This will result also in significant energy cost reduction. The comprehensive approach allows for packaged solution to be developed, which autonomously provide for the complete heating and cooling demand of the application anticipating any additional equipment (no electric compressor needed). The whole system will work in a fully automated way throughout the year.

EU/Portugal Project - SIME I&D, VIVCOOL project- "Development of an absorption chiller for residence climatization"

Description: Development of an absorption chiller to be integrated in a full heating and cooling solar system, with gas backup. The targeted buildings are residences in Mediterranean climate, namely in Portugal. Considering areas of 150m2 or more where the thermal comfort considerations gain a growing importance with the increasing prices of conventional energy. Solar energy with gas backup is the first energetic choice, although other sources such as biomass or co-generators can be used.

Solar desalination experience in EU R&D projects

MEDESOL - Seawater desalination by innovative solar-powered membrane-distillation system

Description: The main objective of MEDESOL Project is the development of an environmentally friendly improved-cost desalination technology to fresh water supply in arid and semi-arid regions in EU and Third Countries based on solar MD. The layout involves the innovative concept of multistage MD in order to minimize specific energy and membrane area required and also to substantially reduce the brine generation. The system is developed to be driven by the most

energy-efficient and cost-effective solar collectors at suitable working temperature, compound parabolic concentrators (CPC collectors). The aim of this work was to evaluate the technical feasibility of producing potable water from seawater by integrating several membrane distillation modules (Multi-step Membrane Distillation System). The aim is to develop systems for a capacity ranging from 0.5 to 50 m3/day. Technical simplicity, long maintenance-free operation periods and high-quality potable water output are the very important aims which will enable successful application of the systems that are based in membrane distillation. The heat source will proceed from an advanced compound parabolic solar concentrator, developed to the specific concentration ratio to achieve the specific needed range of temperatures (90ºC) and the seawater heater will include the development of an advanced non-fouling surface coatings to avoid the deposit formation (i.e. scaling) at such temperature.

Powersol - Mechanical Power Generation Based on Solar Thermodynamic Engines

Description: Main project objective is the development of an environmentally friendly improved-cost shaft power generation technology, based on solar thermal energy, optimized for supplying basic need to rural communities. The proposal focuses in the technological development of a solar thermal-driven mechanical power generation based on a solar-heated thermodynamic cycle (POWERSOL system). This technological development consists in optimizing a solar-assisted thermodynamic cycle that generates mechanical power from low to medium temperature range. The optimization is performed by means of experimental testing of the thermodynamic cycle with selected working fluids and of three solar collector prototypes. Mechanical energy could be either used to direct electricity generation (using a generator) or to brackish or seawater desalination by coupling the output to a high-pressure pump connected to a conventional reverse osmosis system.

PRODES - Promotion of Renewable Energy for Water production through Desalination

Description: PRODES will focus on small and medium-scale desalination, up to 1000 m3 per day. This size can be very well powered by renewable energy. The wide implementation of this combination would make a substantial contribution in the effort to reduce the greenhouse gasses emissions, increase the security of energy supply while contributing to the solution of the fresh water scarcity in Southern Europe. At the same time, European companies that already are active in the field should grasp the opportunity to become leaders of a growing market with significant export potential to the neighbouring counties (Mediterranean) and worldwide (South-East Asia, Sub-Saharan Africa and Latin America). It is also another opportunity for the European RE industry to grow its market.

Extensive research and development efforts have resulted in a plethora of technically viable solutions to use renewable energy technologies for powering desalination. There are at the moment various demonstration units operating, providing drinking water independently of the electricity grid (see for example www.adira.info). Many combinations are possible like, PV or wave

energy with Reverse Osmosis (RO) and solar thermal collectors with distillation technologies. The related costs are following a downward trend and are already competitive to conventional technologies in niche markets.