Project Management Symposium
18 - 19 Dec. 2018 ■ Riyadh

PMI KSA

VISION 2030

Utility Base and Distributed Renewable Energy (RE) Project Design and Management

Martin Erath

Managing Director

ILF CONSULTING ENGINEERS

30+ International and Renowned Speakers

36 Seminars

4 Technical Workshops

Utility Base and Distributed Renewable Energy (RE) Project Design and Management

Large-scale and Demand side based RE application

- **Design Excellence**
- Design Process (design criteria, plant configuration, optimization)
- Technology and component selection (technical and economic factors)
- System integration

- **Management Excellence**
- Process and Interface Management
- Contract Management Challenges and Lessons learned

Martin Erath

Specialized in:

- Energy, Utilities, Smart Grids, Renewables, Infrastructure, Sustainability

25+ years Professional Experience:

- Regional Director GCC: Siemens Power Transmission and Distribution – Turnkey Solutions
- CEO Middle East: GOPA-Consulting Group (Intec)
- Managing Director: ILF Consulting Engineers KSA

Highlights:

- Dubai EXPO 2020 smart grid and renewable energy
- UAE: Largest Energy Storage System Program (BESS)
- Siemens: R&D and pilots in multi-functional power links

Education, Certifications and Awards:

- Master in Electrical Engineering/MBA Finance
- World Sustainability Congress 2017: Awarded 100 Most Sustainable CEOs

Utility Base and Distributed Renewable Energy (RE) Project Design and Management

by Martin Erath

Major Categories in Renewable Energy Projects

Utility Scale

10 Megawatt – Gigawatt

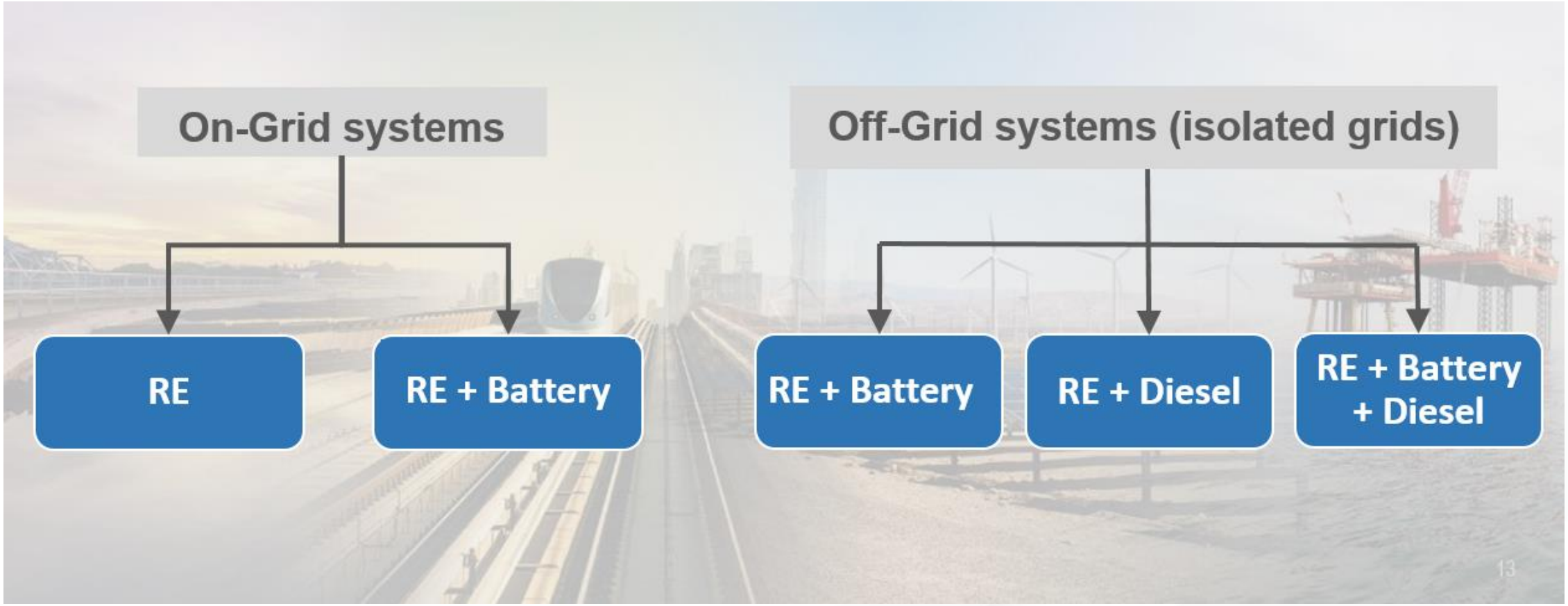
Commercial & Industrial

100 Kilowatt – 10 Megawatt

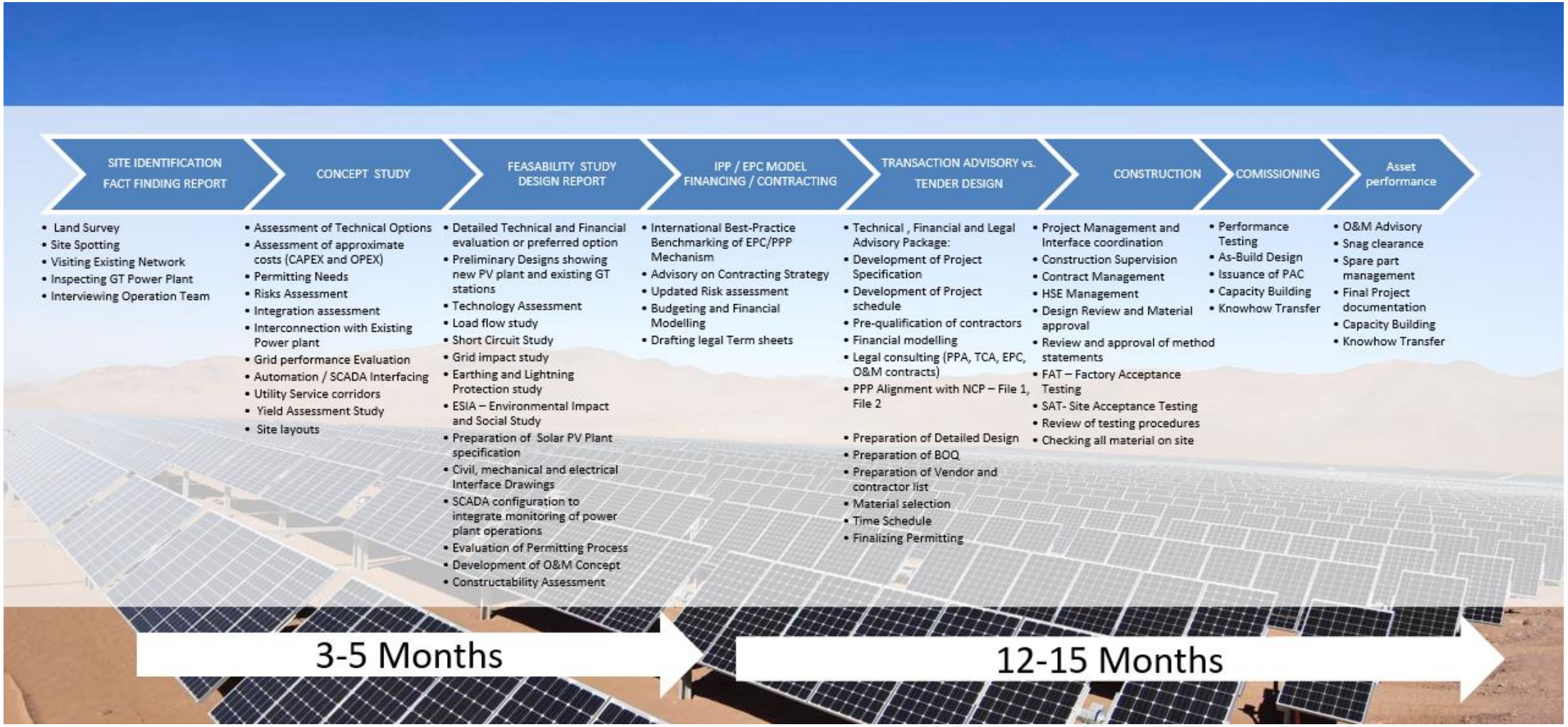
Residential

1kW to several 100 KW

Various types of Renewable Energy Systems



Typical Design Development and Management Process

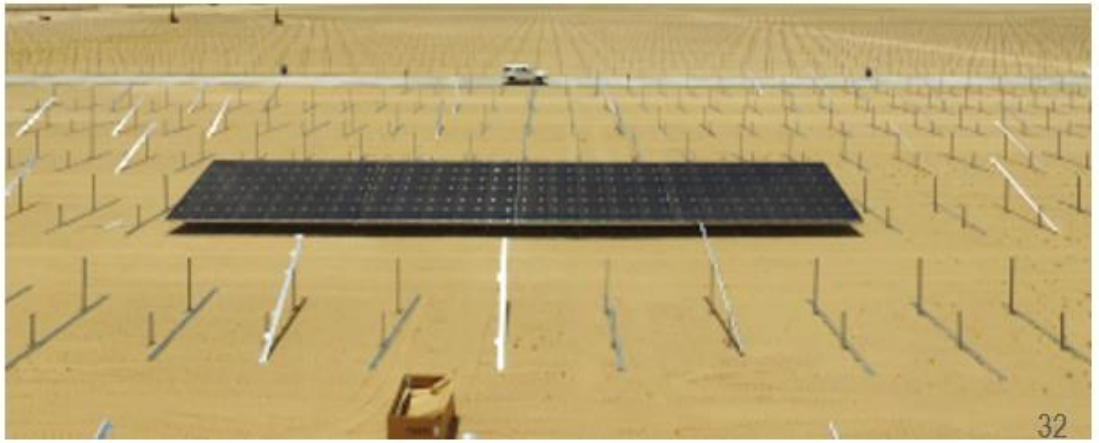


International Best-Practice – Maldives – 166 Islands

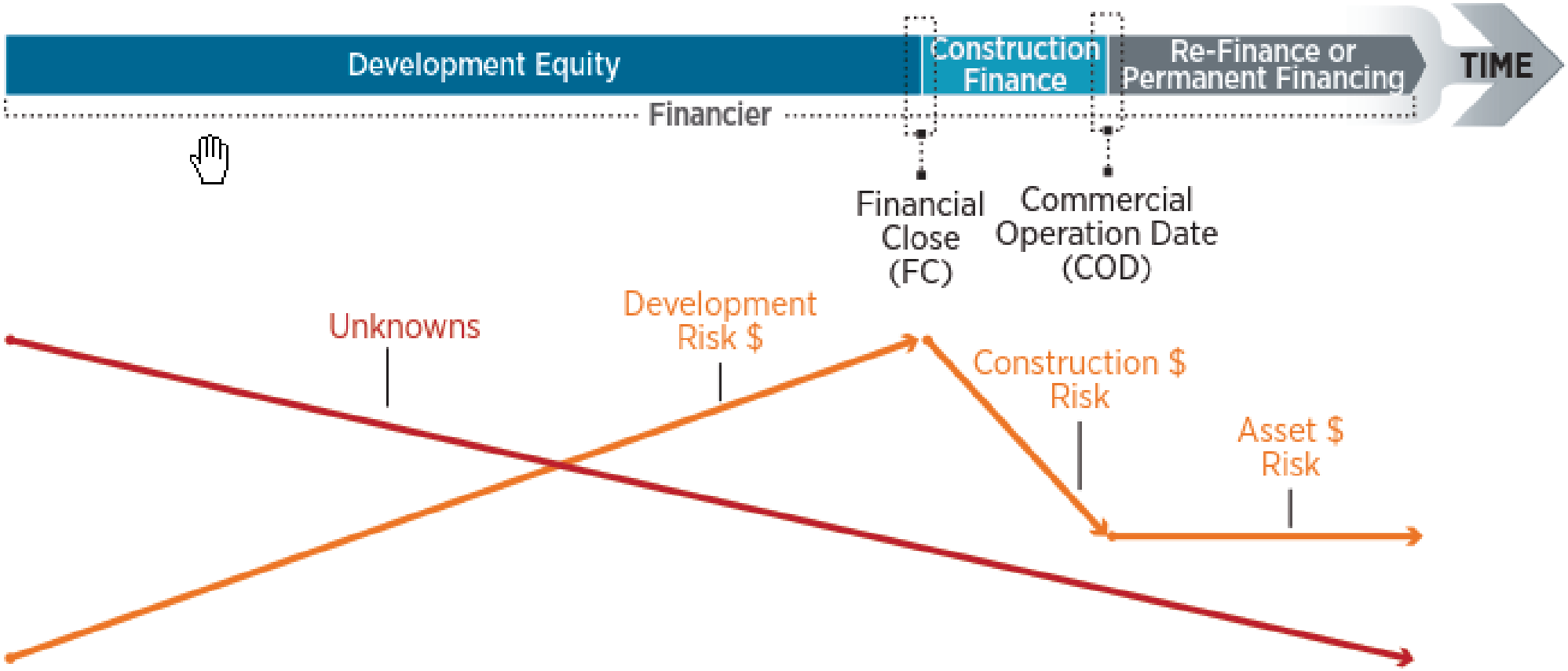
Project Name	POISED - Preparing Outer Islands for Sustainable Energy Development, the Maldives
Project size	25 MWp PV, 44 MW Diesel & 8MWh Battery
Location	166 Islands on Maldives
Year	2015 – ongoing
Client	Maldives Ministry of Environment and Energy / Asian Development Bank (ADB)
System Type	• Off-grid systems • Mini grids comprising of PV - Battery - Diesel Hybrid Systems
Role of ILF	Owner's Engineer responsible for the overall project management & all services related to the Hybrid System
Scope of Work	• Feasibility Studies • Tender design and preparation of RfP • Design Vetting • Factory Acceptance Tests (FATs) • Site Supervision, Construction & commissioning

International Best-Practice 260 MWp Solar PV UAE

Project Name	Shuaa Energy 1, P.S.C.
Project size	260 MWp
Location	Dubai, UAE
Year	2014 - 2017
Client	DEWA and ACWA Power
System Type	• Grid connected to 132kV • Thin film modules • Fixed tilt system
Role of ILF	Owner's Engineer
Scope of Work	• Design Vetting • Factory Acceptance Tests (FATs) • Commissioning • Site Supervision • Warranty period services



Risk Management – A Key Success Factor



A Selection of Risks and Mitigation Measures

RISK	DESCRIPTION	MITIGATION
Solar / Wind Resource	Variation - Actual from study	Technical consultant, various data sensitivity
Reduced Energy Yield	Failure to deliver the project energy output	Technical due diligence
Technology	Lack of performance	Selection / PQ process , Testing, Certification Insurance, extended warranties
Delay	Delay commercial operation	PQ of contractors, Proper scheduling Increase LDs, NOC management
Quality Off-take Agreement	Reliability of payment	PPA review regarding risk transfer, Dispatch, termination, Fixed tariff, compensation
Grid connection	Delay in connection to Transmission grid	Comply with Specification be familiar with grid connection procedures Technical Consultant OE
O&M	Poor Operation and Maintenance	Technical advisor PQ of O&M O&M Contracts with incentive

Interface Management is Key to Success

UNDERSTANDING THE INTERFACES IN PPP

Using Expertise and Professional Tools

BCDEAL® - ENABLING PROJECT TRANSPARENCY

ILF CONSULTING ENGINEERS

Cover & Profile

Input Details

- Economics
- Price/tariff
- Volumes
- CAPEX
- OPEX
- Financing

Scenarios

1	2	3	4	5

Analytics

- Volumes
- Revenues
- CAPEX-Assets
- OPEX
- Results:
  - CF
  - P&L
  - Balance sheet

Output

- Financial statements
- Printable reports

Sensitivity

- Assumptions modified
- Indicators
- Graphs

Risks

- Probabilities

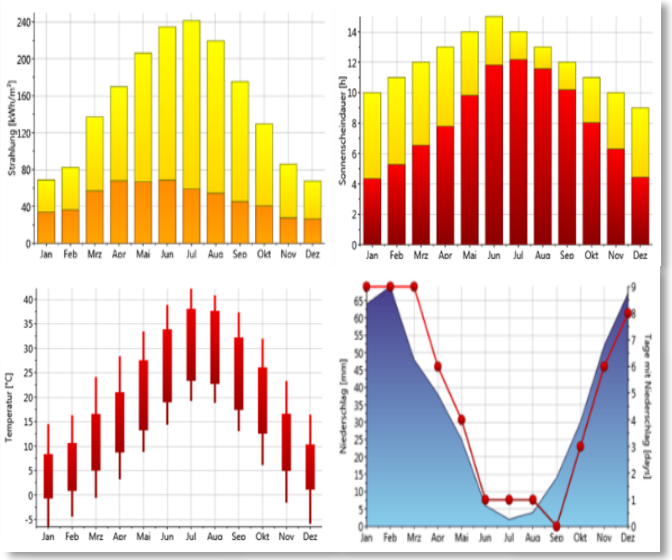
Graphs

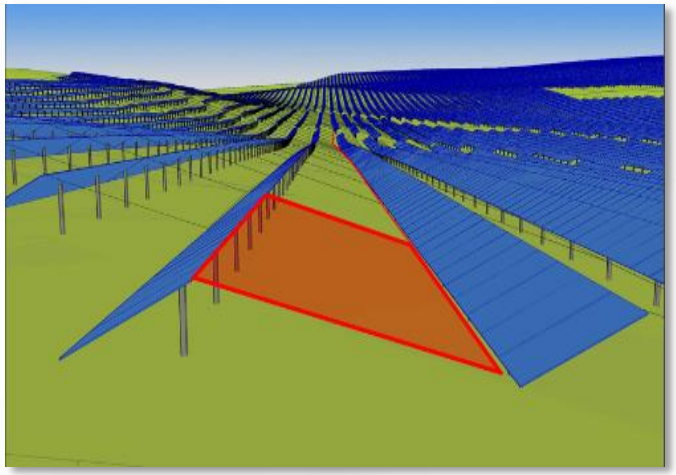
REN Risk

De-Risking Projects based on solid bankable Study

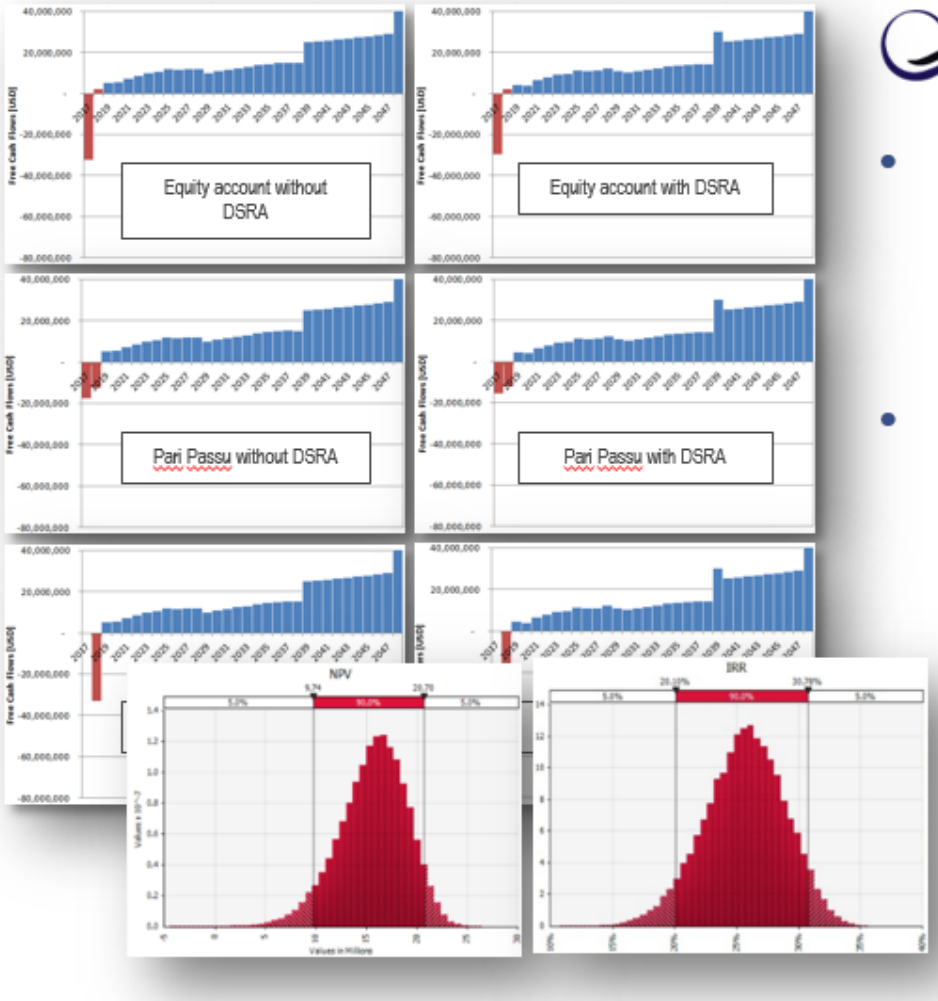
Feasibility study (PV power plant)

- Site inspection
- Review of the following studies and interpretation of results
  - Topographic
  - Geotechnical
  - Hydrological
  - Grid interconnection
- Conduct the hydrological study (if supplied with raw data)
- Conduct the grid interconnection study (if supplied with grid map)
- Site assessment
- Technology assessment and selection
- Energy yield assessment
- Security and monitoring system
- Legal framework review
- Project implementation
- O&M concept
- Finance and economic analysis





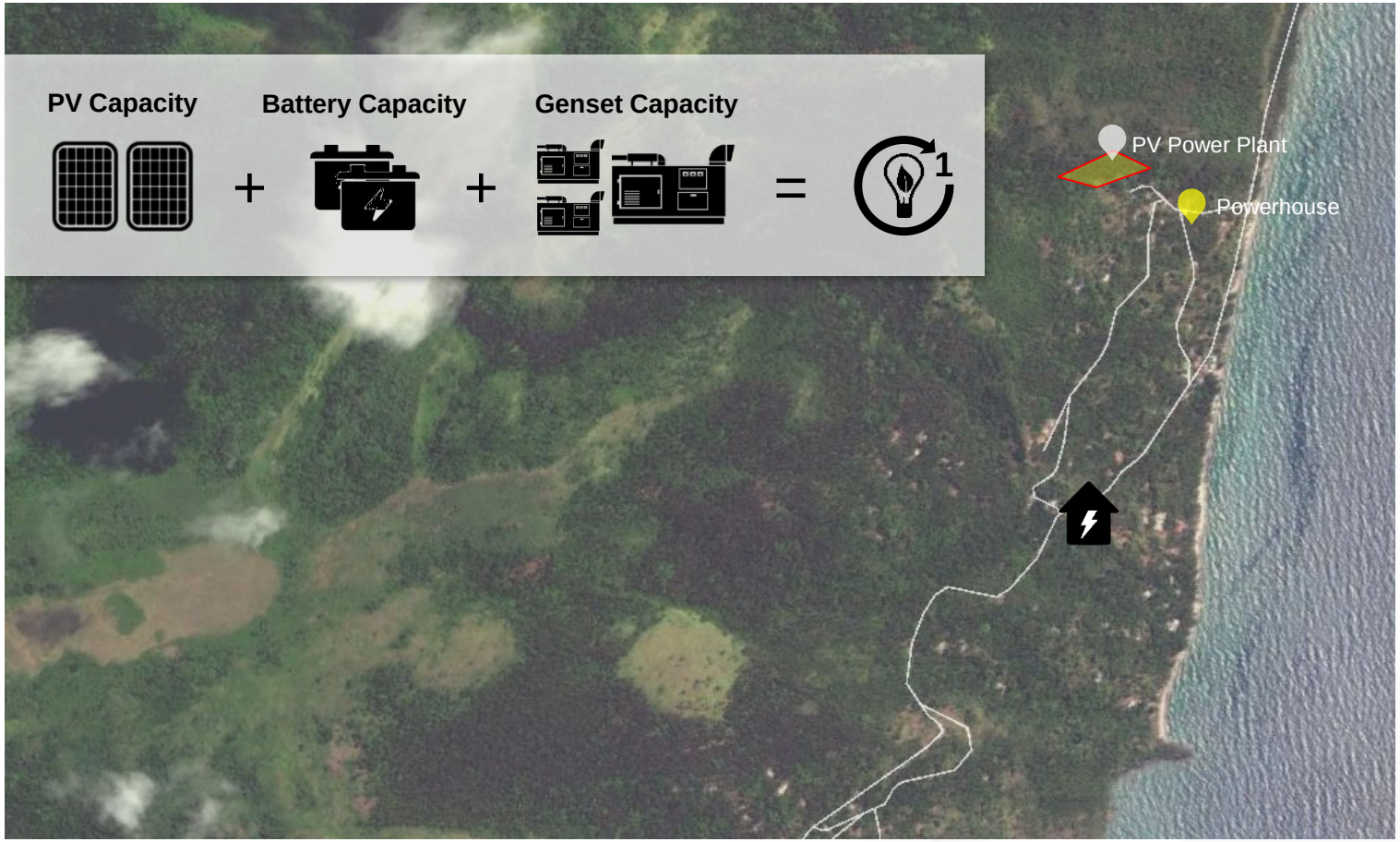
Using Techno-Financial Due Diligence “Tool”



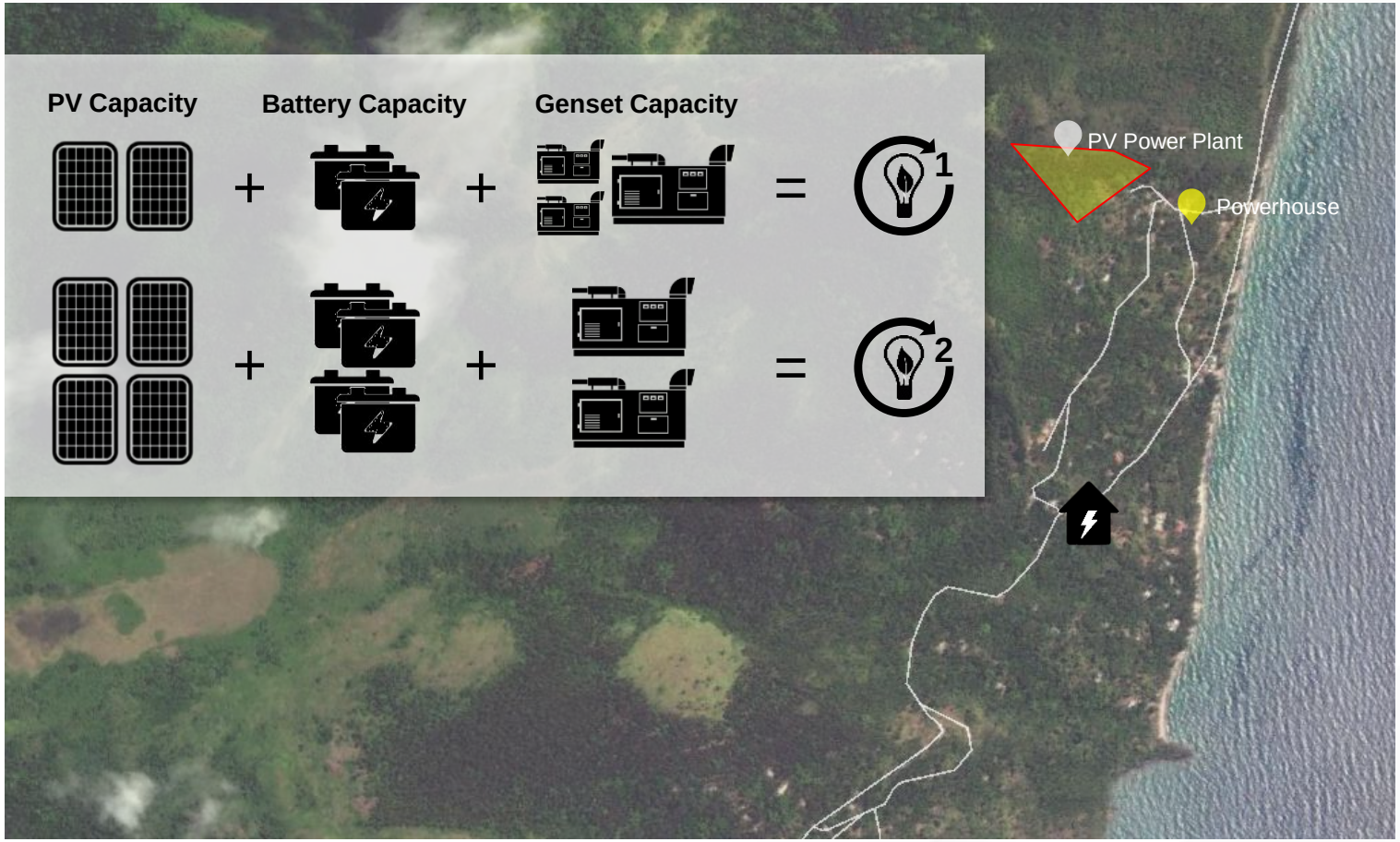
REN Risk for:

- **Techno-Financial Due Diligence** of:
  - Wind Parks
  - Solar PV Parks
- **Financial Optimization**:
  - Financial Risk Analysis:
    - Loan Covenants
    - Default risk
  - Financial Structure Optimization:
    - Leverage Ratio
    - Equity Contribution

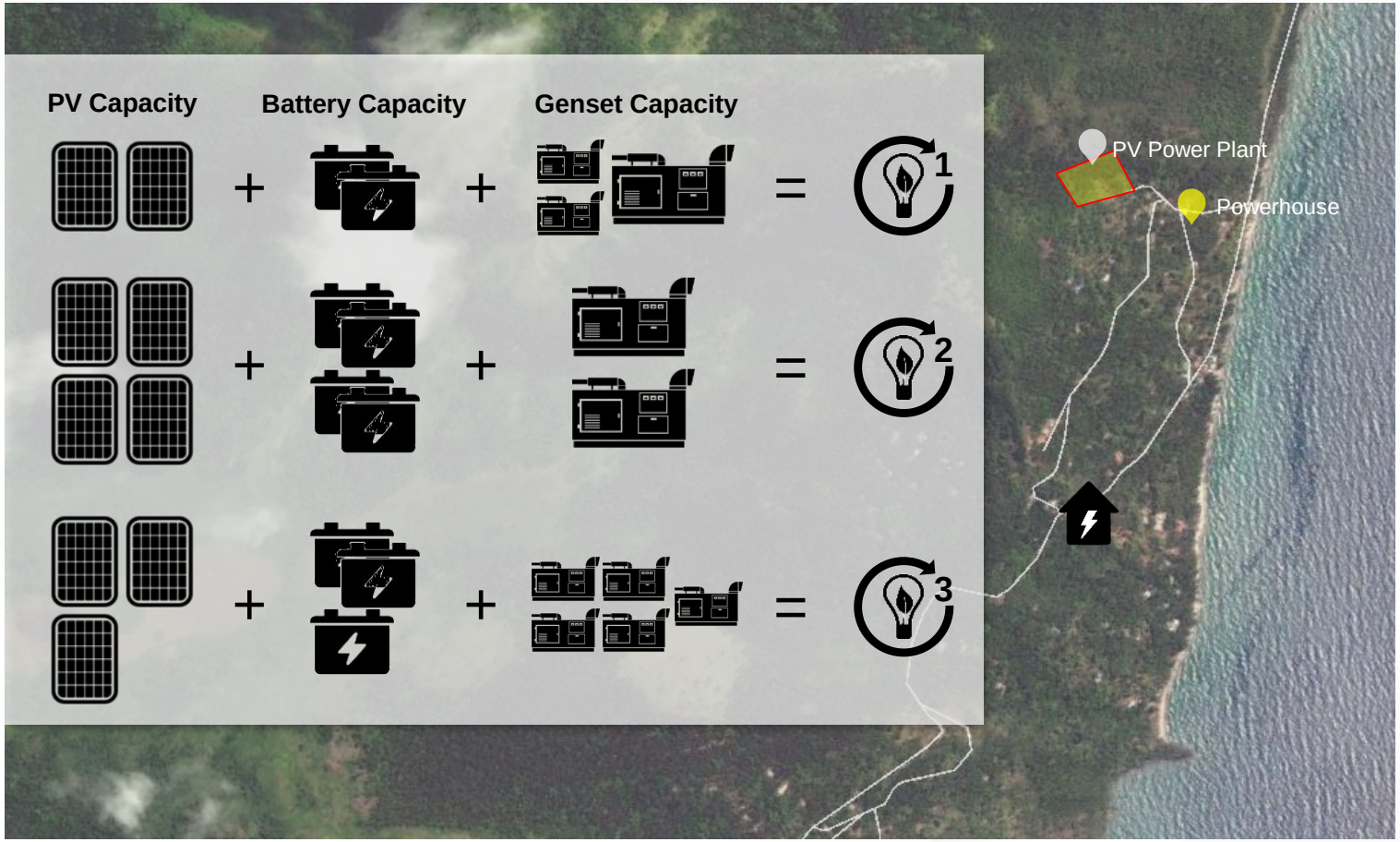
MONTE-CARLO based Optimizing RE Mini Grid



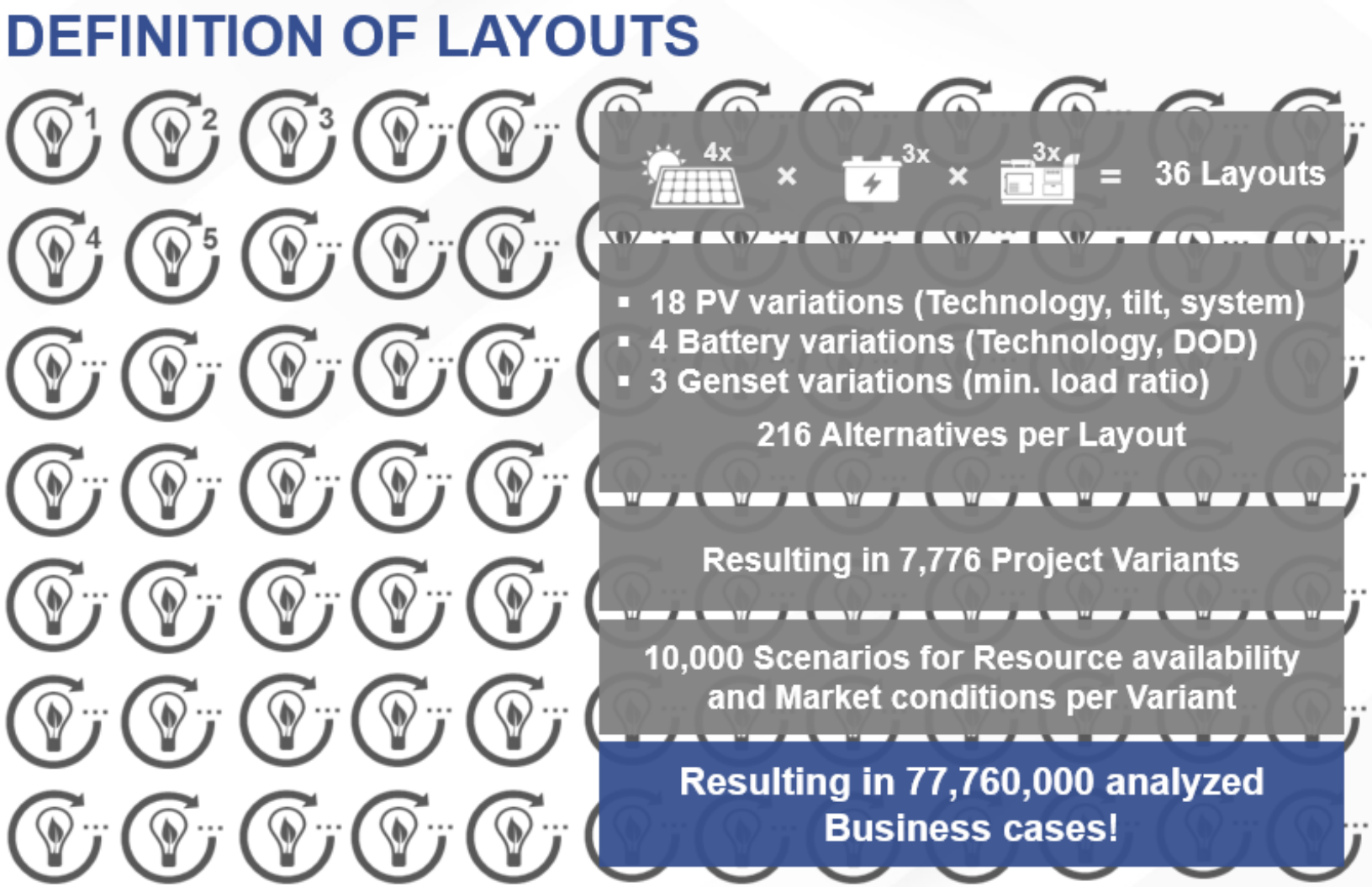
MONTE-CARLO based Optimizing RE Mini Grid



MONTE-CARLO based Optimizing RE Mini Grid



MONTE-CARLO based Optimizing RE Mini Grid

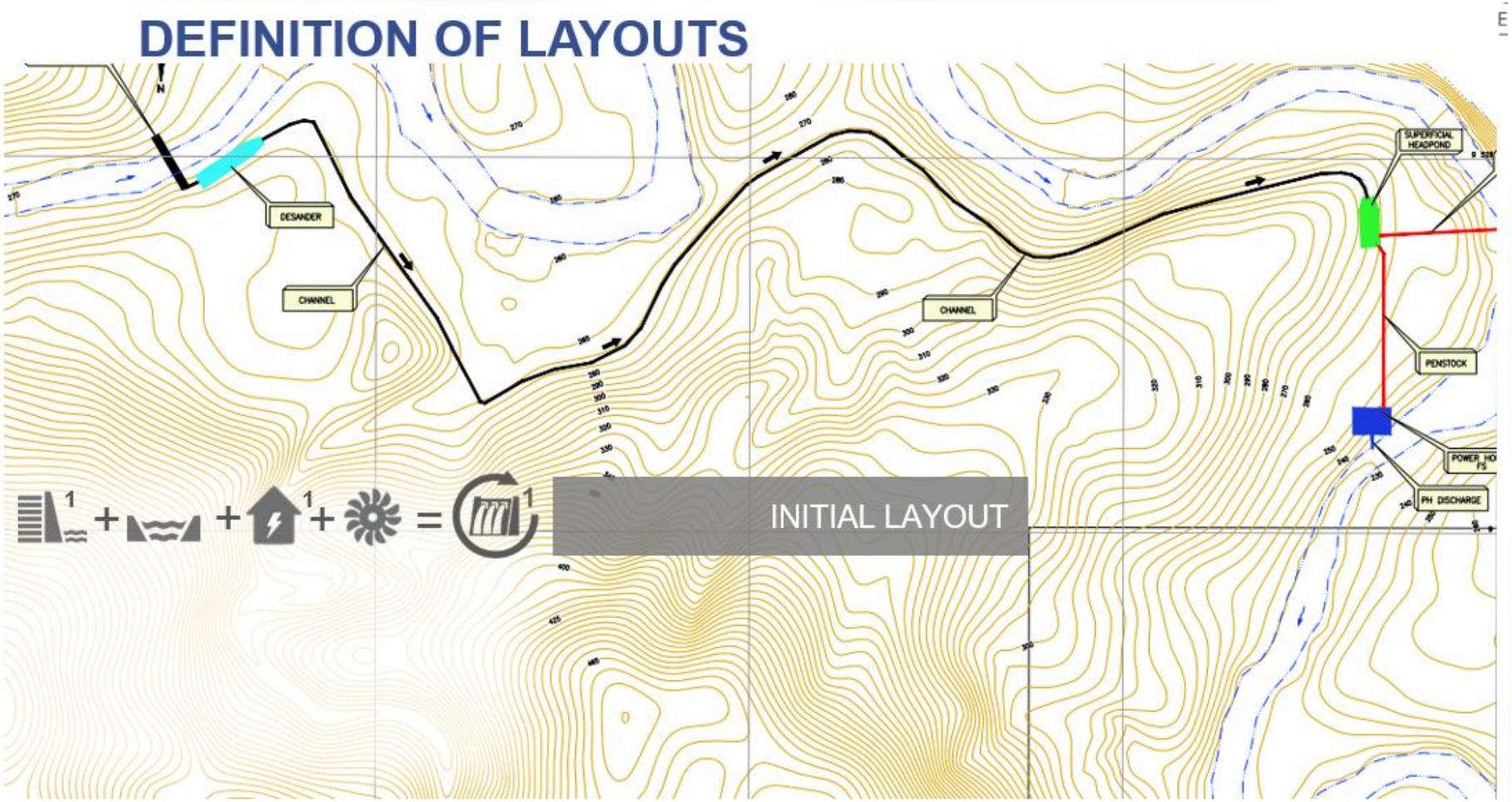


Optimized RE Mini Grid

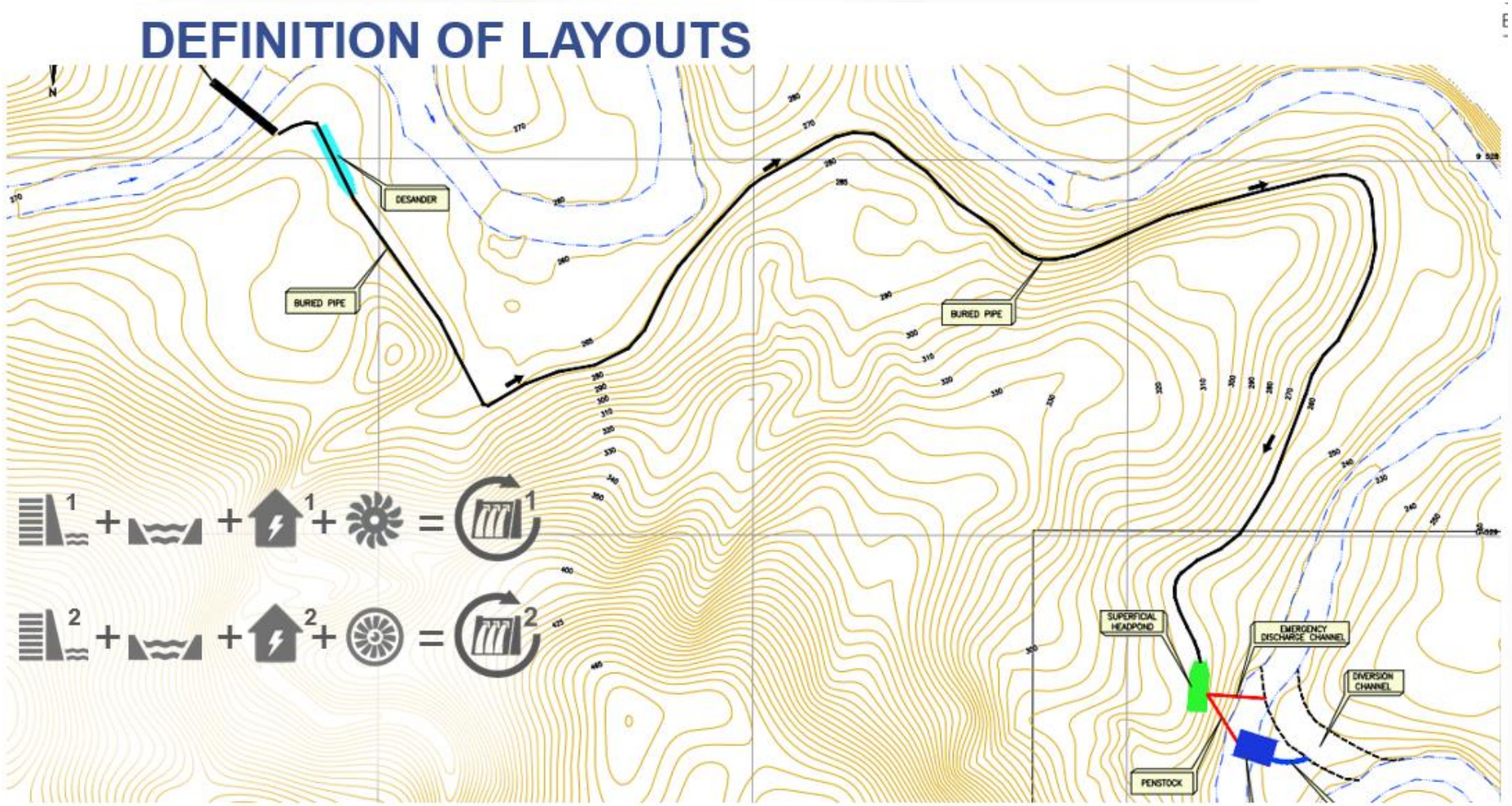
INITIAL LAYOUT		BEST LAYOUT
1,500.0 kWp	PV Installed Capacity	400.0 kWp
4,000 kWh	Battery Installed Capacity	670 kWh
350 kW	GenSet Installed Capacity	350 kW
USD 6.3 MM	Expected CAPEX	USD 1.9 MM
98.75%	Renewable Fraction	50.1%
USD/kWh 0.982	RENRisk™ Electricity Cost	USD/kWh 0.563

RENRisk™ Analysis allowed **reducing** the **Electricity Cost** by more than **40%**, **visualizing** project **Risk** and **creating Certainty** regarding the final project.

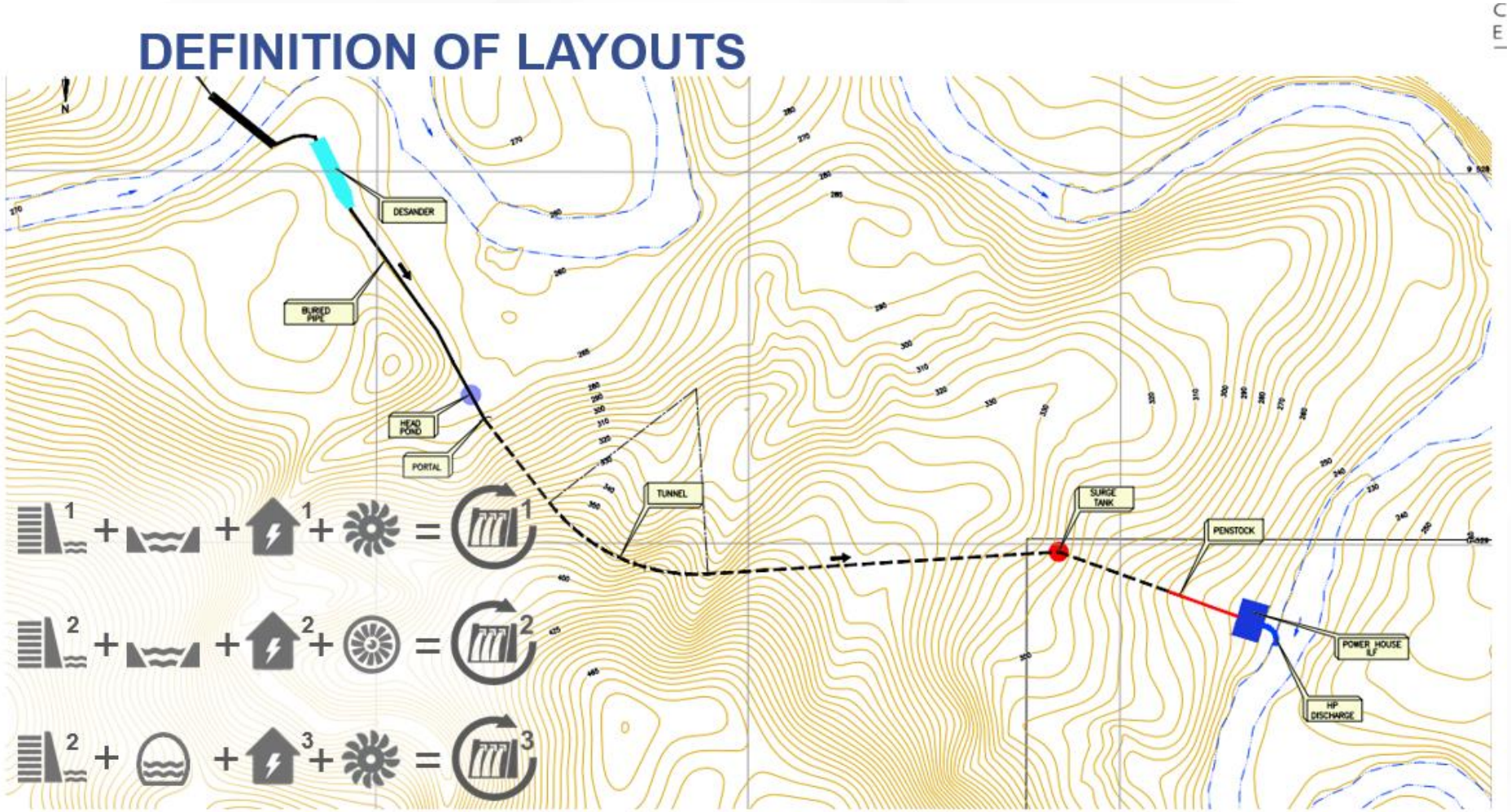
Optimized Hydro Power with Grid



Optimized Hydro Power with Grid

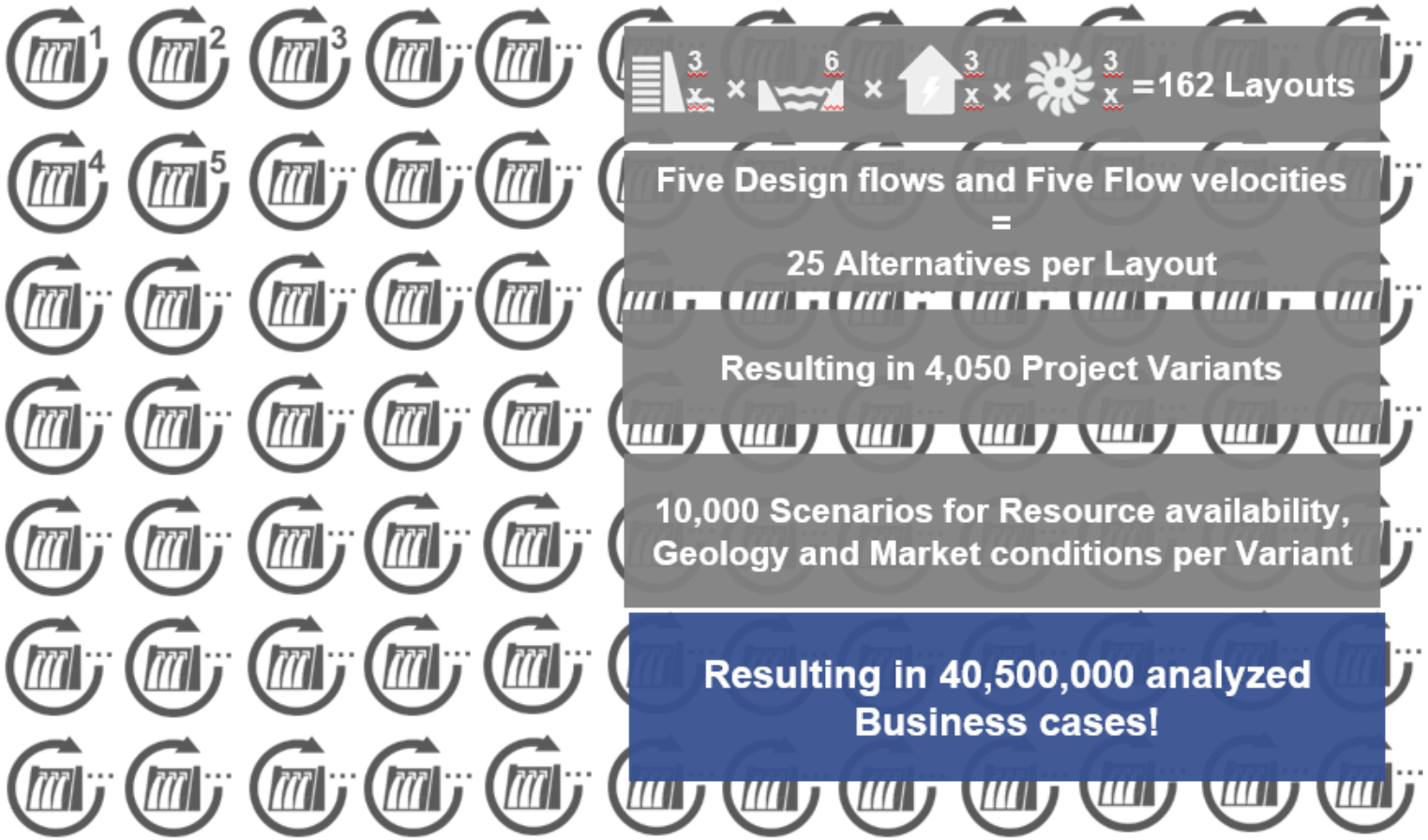


Optimized Hydro Power with Grid



Optimized Hydro Power with Grid

DEFINITION OF LAYOUTS

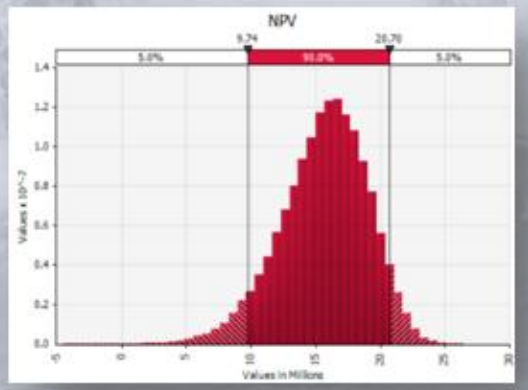


MONTE-CARLO Based Hydro Power with Grid

FINAL RESULTS

INITIAL LAYOUT		BEST LAYOUT
10.0 MW	Installed Capacity	10.0 MW
USD 19.4 MM	Expected CAPEX	USD 20.1 MM
60.5 GWh	Expected Annual Energy	65.0 GWh
24 Months	Construction time	18 Months
23.5%	Internal Rate of Return	25.7%
USD 12.0 MM	RENRisk™ NPV	USD 15.7 MM

RENRisk™ Analysis allowed **increasing** the **NPV** by more than **30%**, **visualizing** project **Risk** and **creating Certainty** regarding the final project.

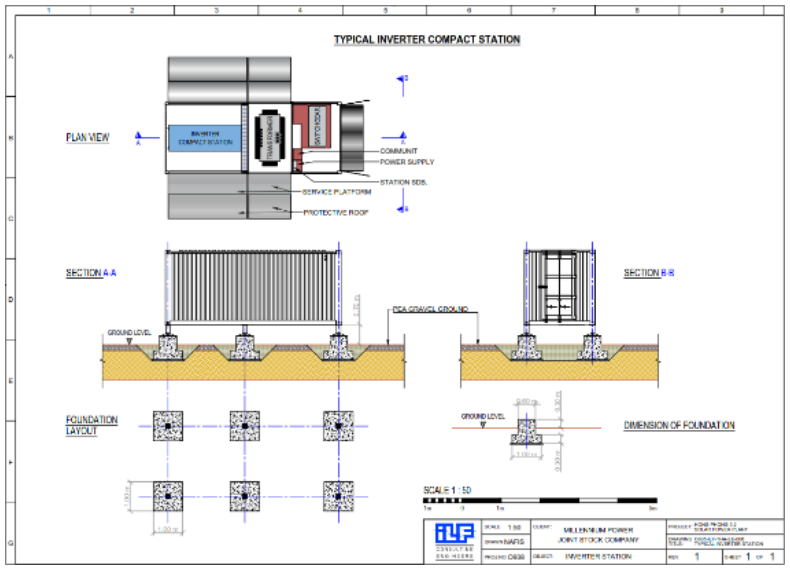


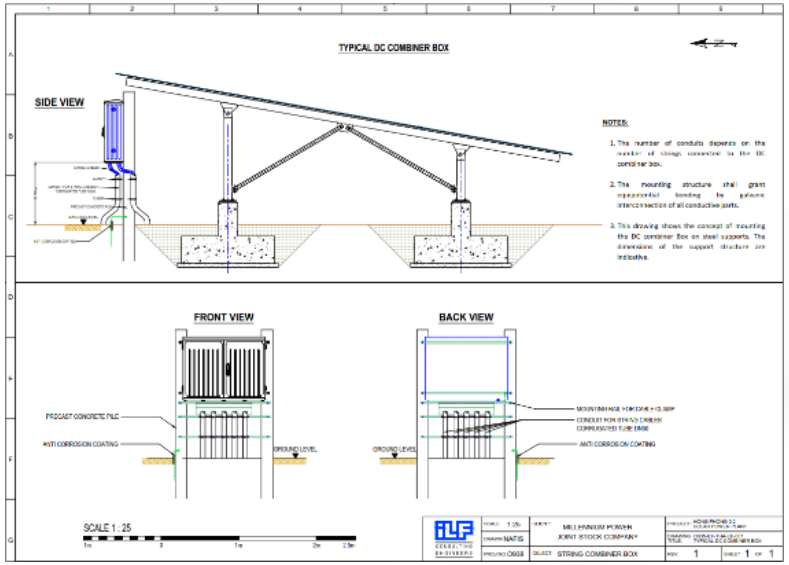
Top-Down & Bottom-up Design

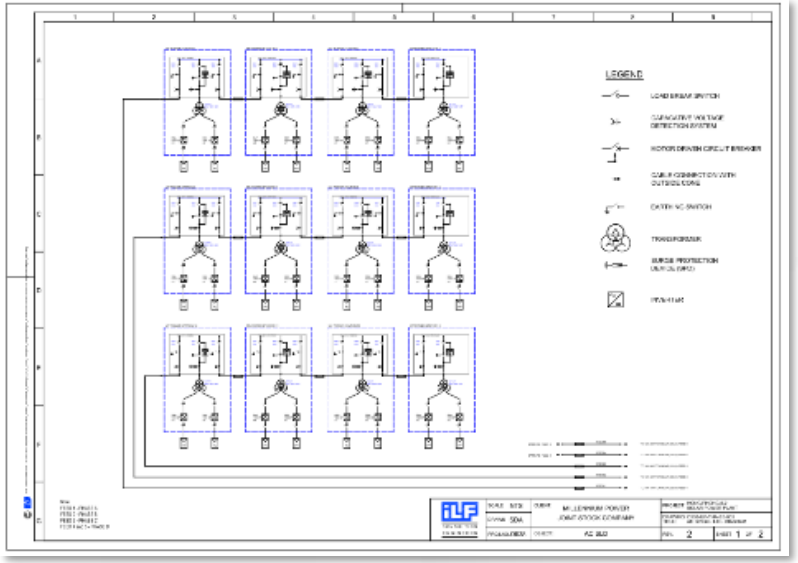
Design Development (Top-down and bottom up)

- Full conceptual design of PV power plant (civil, electrical, mechanical, I&C, etc.)
- Full conceptual design of utility scale transmission line and substation

Engineering based design development is key







Reality Check

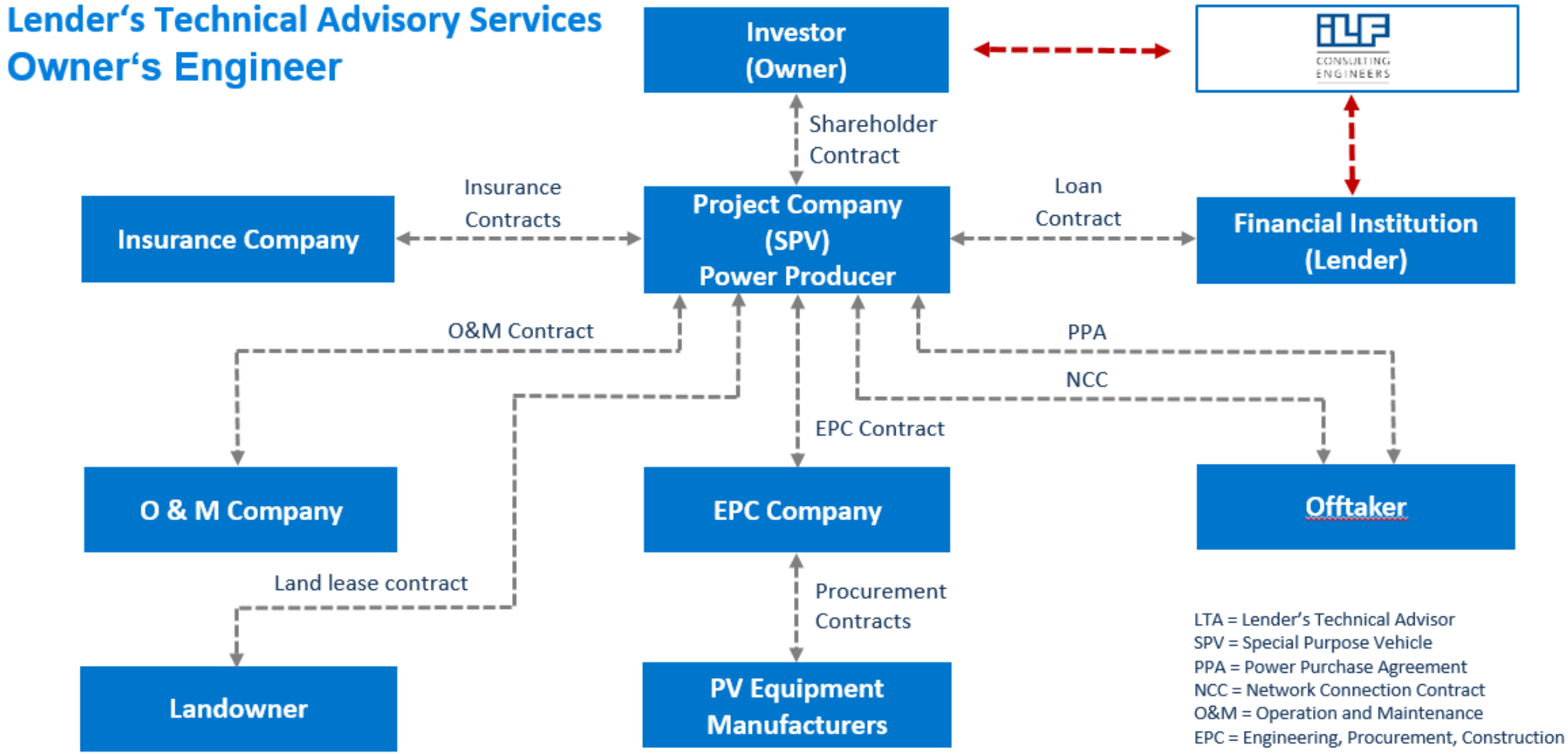
- Sandstorms affecting stability of solar systems on buildings
- Lifetime and energy performance
- Personal safety and operational aspects

Safe and durable design

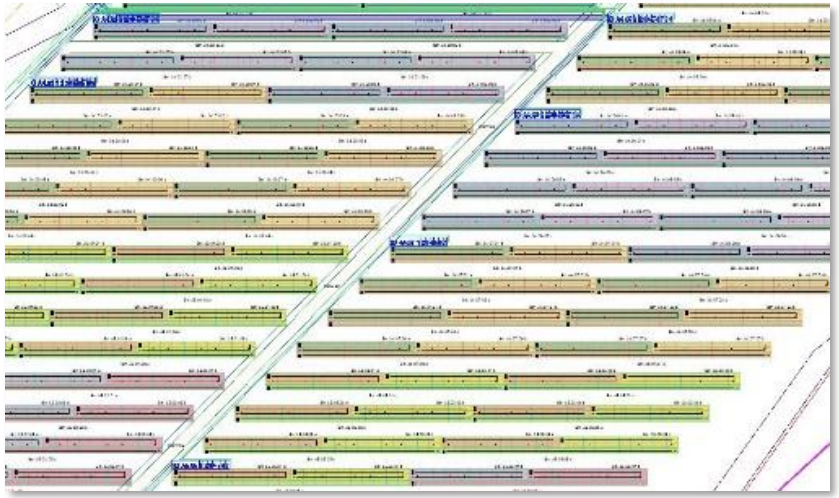
Methods to procure a RE Power Project

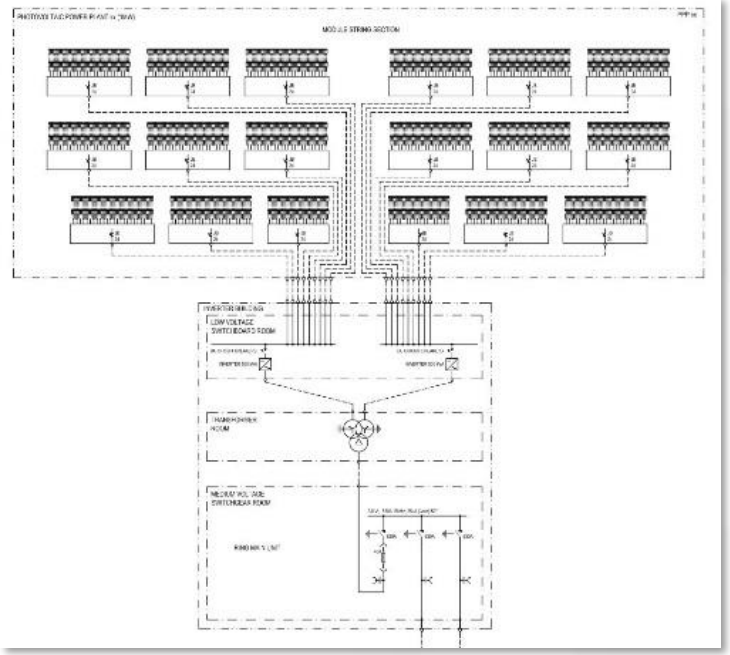
De-risking based on the appropriate Procurement Model

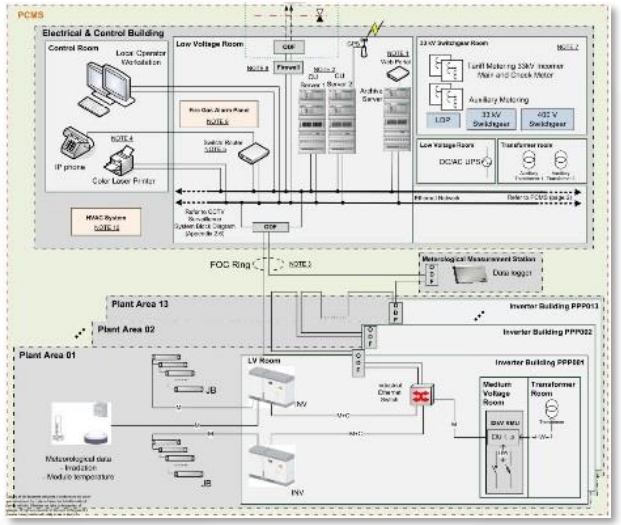
IPP – PM Check-and-Balance Owner vs. Lender

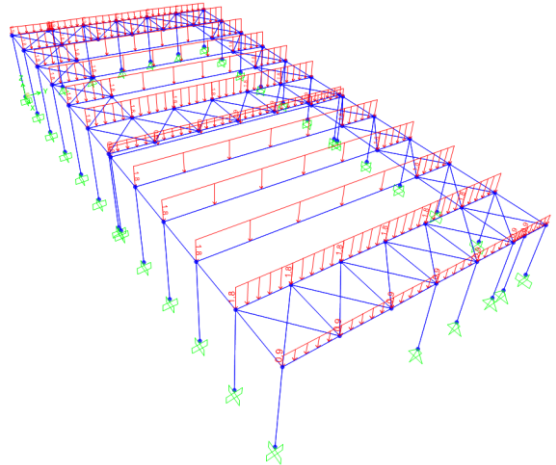


De-Risking using Design and Engineering Q-Gates





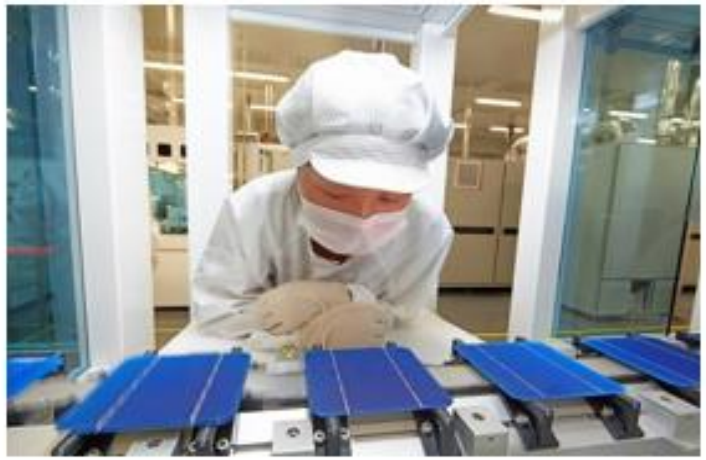




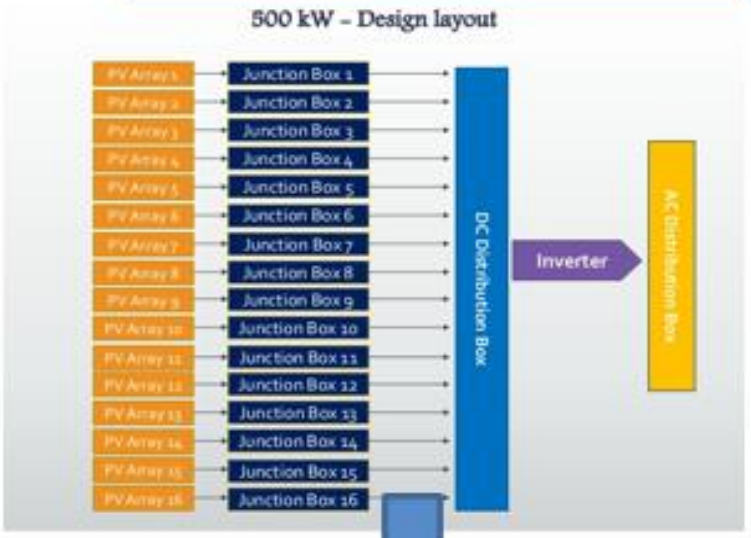
- Design Vetting
  - Full detailed design vetting for PV power plant (civil, electrical, mechanical, I&C, etc.)
  - Full detailed design vetting for transmission line and substation up to 500 kV level

De-Risking using Special Testing Flash Reports

- Deal with the manufacturer to get the best performant modules



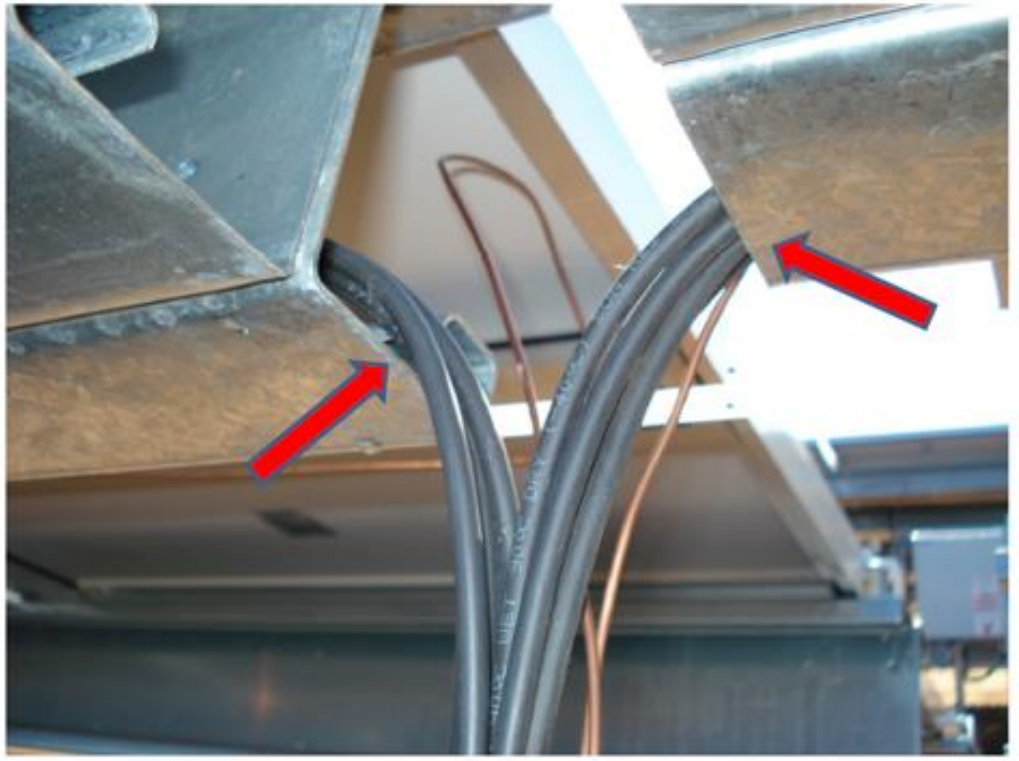
- Sorting of modules based on consistency I_{mpp}
- Optimization of String Configuration

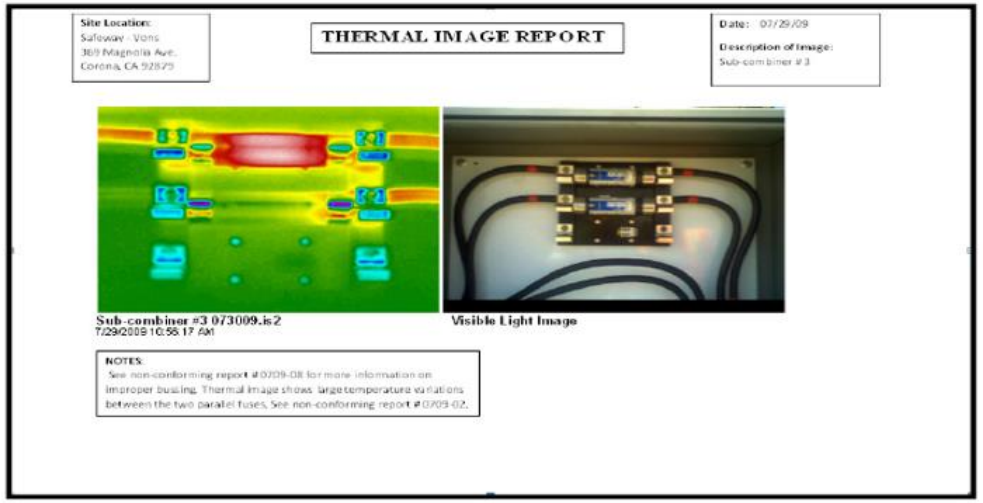


- Reduction of Mismatching Losses (usually 3-5%)

Best Practice to achieve **excellence!**

De-Risking using Q-Gates during Construction





Site Location:
Safeway - Vons
369 Magnolia Ave.
Corona, CA 92879

THERMAL IMAGE REPORT

Date: 07/29/09
Description of Image:
Sub-combiner # 3

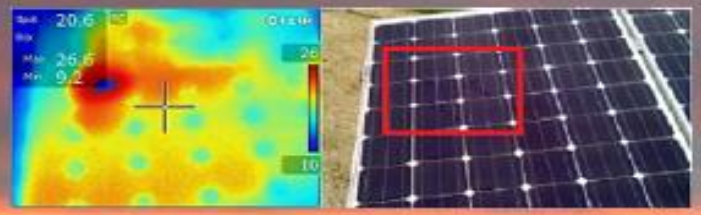
Sub-combiner #3 073009.is2
7/29/2009 10:56:17 AM

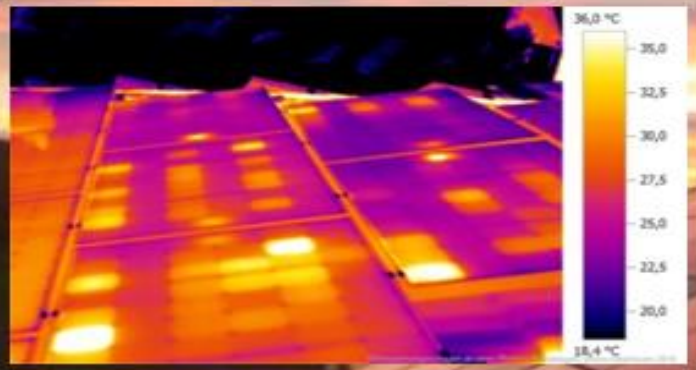
Visible Light Image

NOTES:
See non-conforming report #0709-08 for more information on improper bussing. Thermal image shows large temperature variations between the two parallel fuses. See non-conforming report #0709-02.

De-Risking using Q-Gates “On Site”

Reality Check





- Going operational and ensuring performance requires insight on healthiness of plant

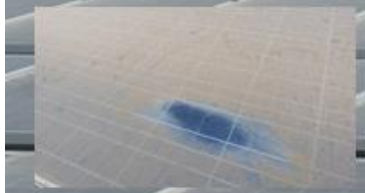
→ Independent Measurement and certification

→ Regular checks to find hotspots and support preventive maintenance

De-Risking – Advising on O&M Concept Development
Asset Performance Monitoring

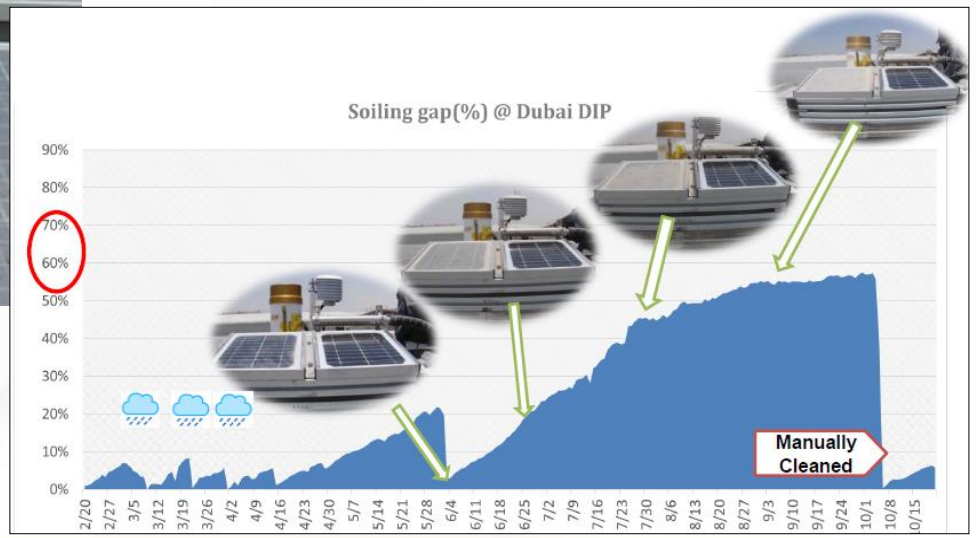
Reality Check

- Dust and Sand minimize Performance
- Daily losses 10-50% in production
- Affecting life-time of products

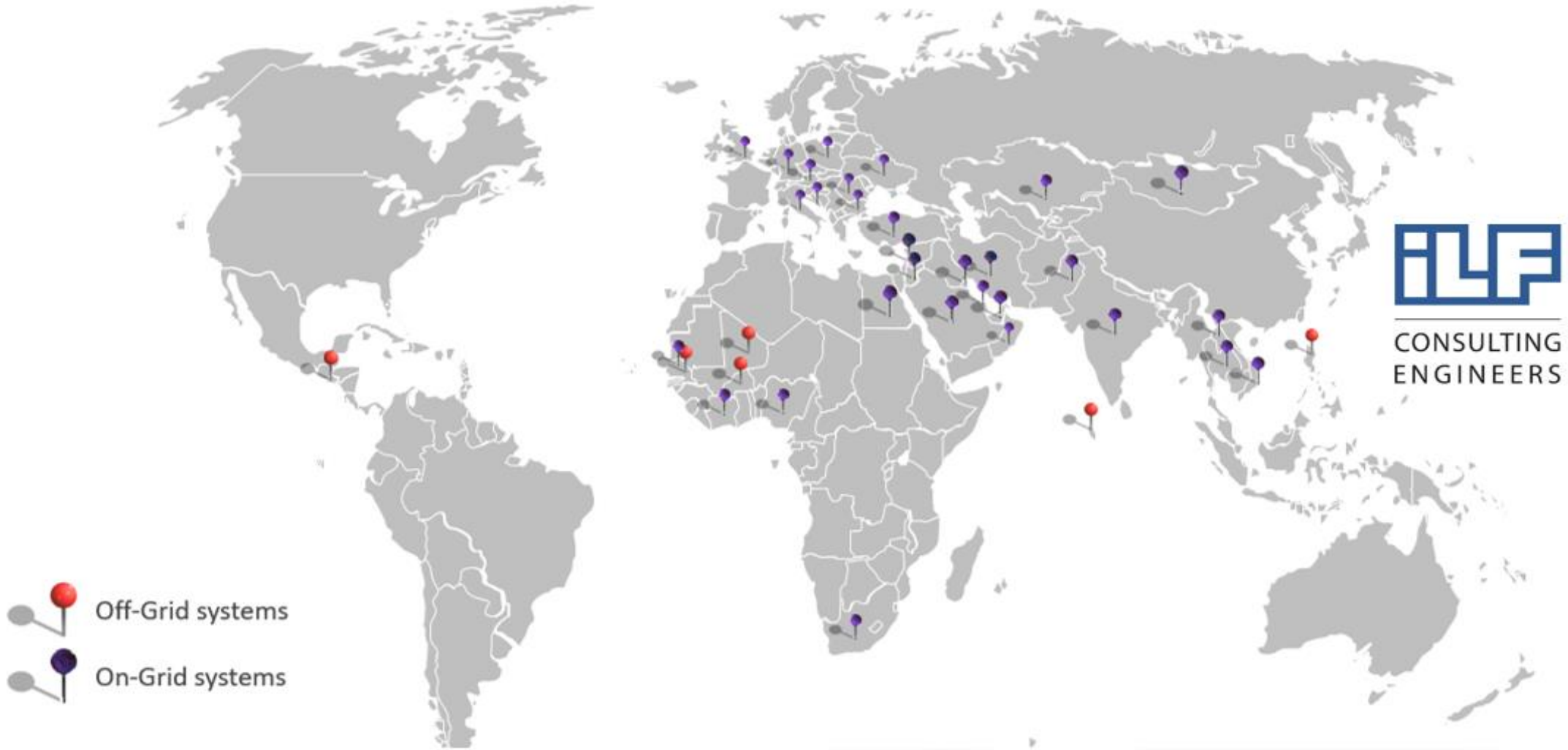


Ensure best techniques and technology solutions

Higher performance through Preventive and corrective maintenance supported by O&M contract intelligence



De-Risking using “International Expertise”



CONSULTING ENGINEERS

THANK YOU!

Session Feedback: https://goo.gl/zopBt8