IRENA PROJECT NAVIGATOR

IRENA
International Renewable Energy Agency

Renewable Energy Project Facilitation

Roland Roesch & Carlos Ruiz

Universität Bonn

21 December 2017

IRENA Lecturers

Roland Roesch is the Senior Programme Officer, Renewable Energy Markets and Technology Dialogue at the International Renewable Energy Agency (IRENA). Preceding that he worked in the Oil & Gas and Utilities Industry and as an Energy Market Consultant for Lahmeyer International and as researcher for renewable energies.

Carlos Ruiz is a Associate Programme Officer at the International Renewable Energy Agency. Carlos has been working on the Project Navigator for the last three years developing technical guidelines for different RE technologies. Before joining IRENA, he worked in Spain monitoring and analyzing O&M performance of solar power plants.

International Renewable Energy Agency

MANDATE

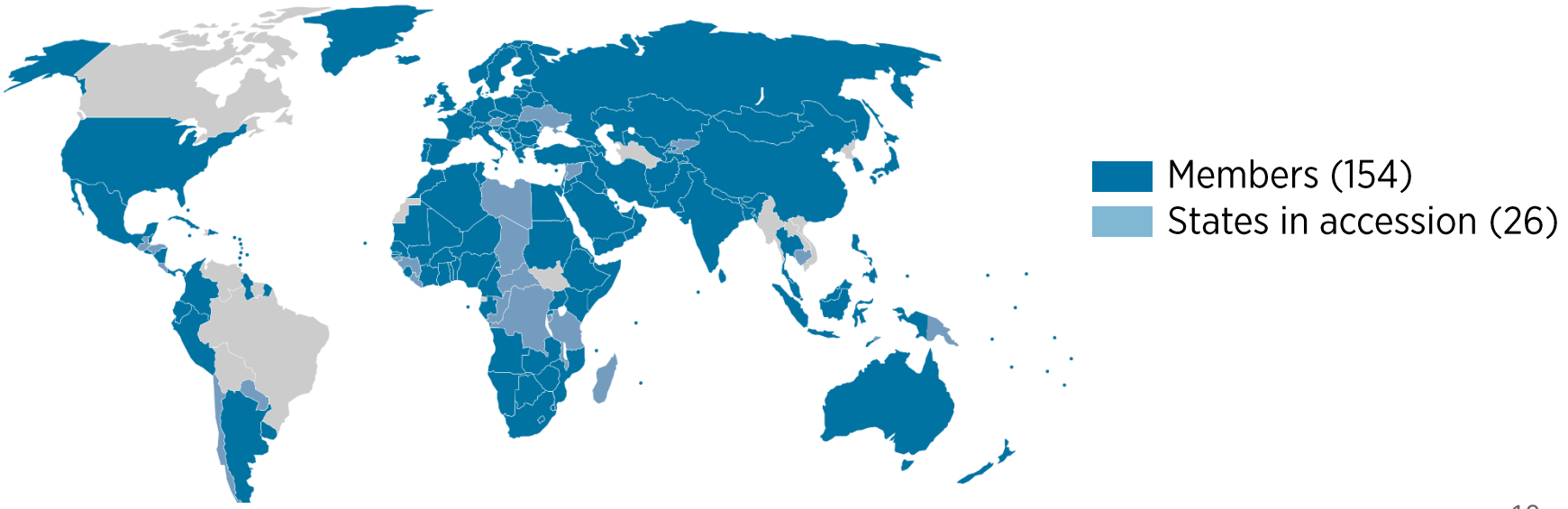
To promote the widespread adoption and sustainable use of **all forms of renewable energy (RE)** worldwide

OBJECTIVE

To serve as a **network hub**, an **advisory resource** and an **authoritative, unified, global voice** for renewable energy

SCOPE

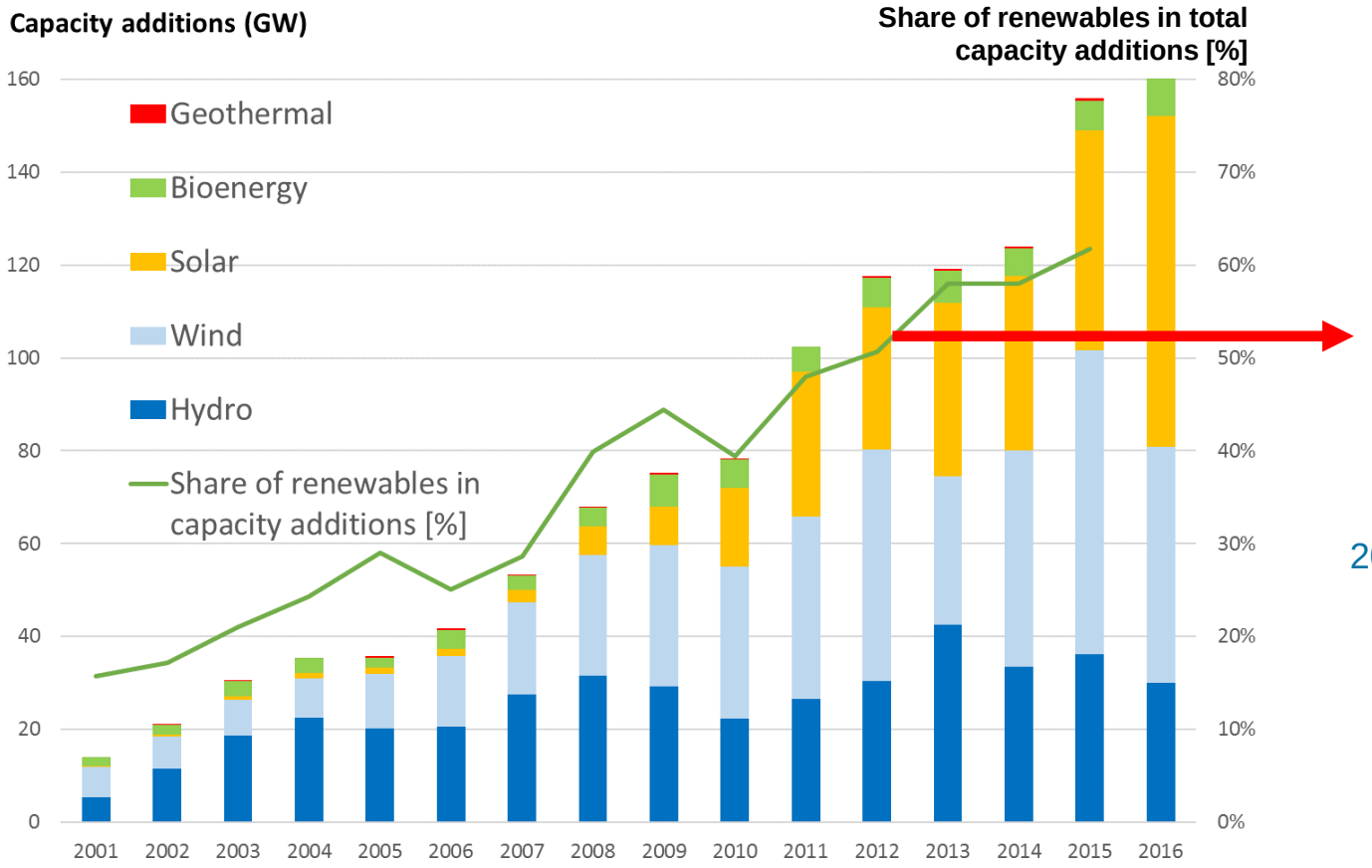
All renewable energy sources produced in a **sustainable manner**



Outline

- The case for renewables
- The challenge of RET project development
- IRENA's project facilitation tools
- The project development process
- Examples and case studies

On-going power sector transformation



Since 2012 >50% of total capacity additions

Source: IRENA statistics

- Around **25%** renewable power generation share worldwide
- Growing by **0.7 percentage** per year

2016

2006 GW RE power generation capacity in place

Annual RE capacity addition 161 GW (+8%/yr) of which:

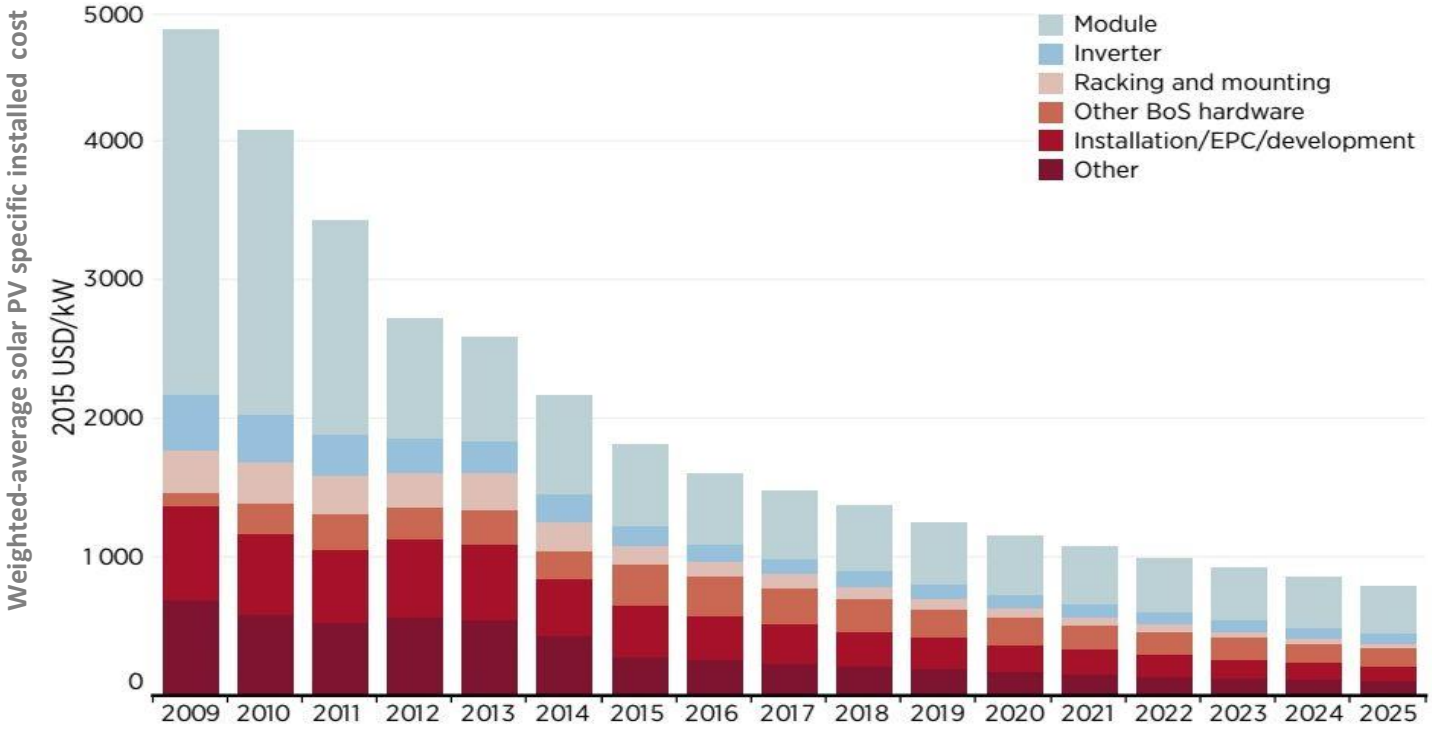
- 71 GW solar
- 51 GW wind
- 30 GW hydropower
- 9 GW biomass

Solar PV cost reduction potential

IRENA
International Renewable Energy Agency

#ProjectNavigator

The global weighted-average installed costs of utility-scale PV systems is estimated to fall by 57% between 2015 and 2025



Note: Installed cost value are given for the year during which the project is commissioned. .

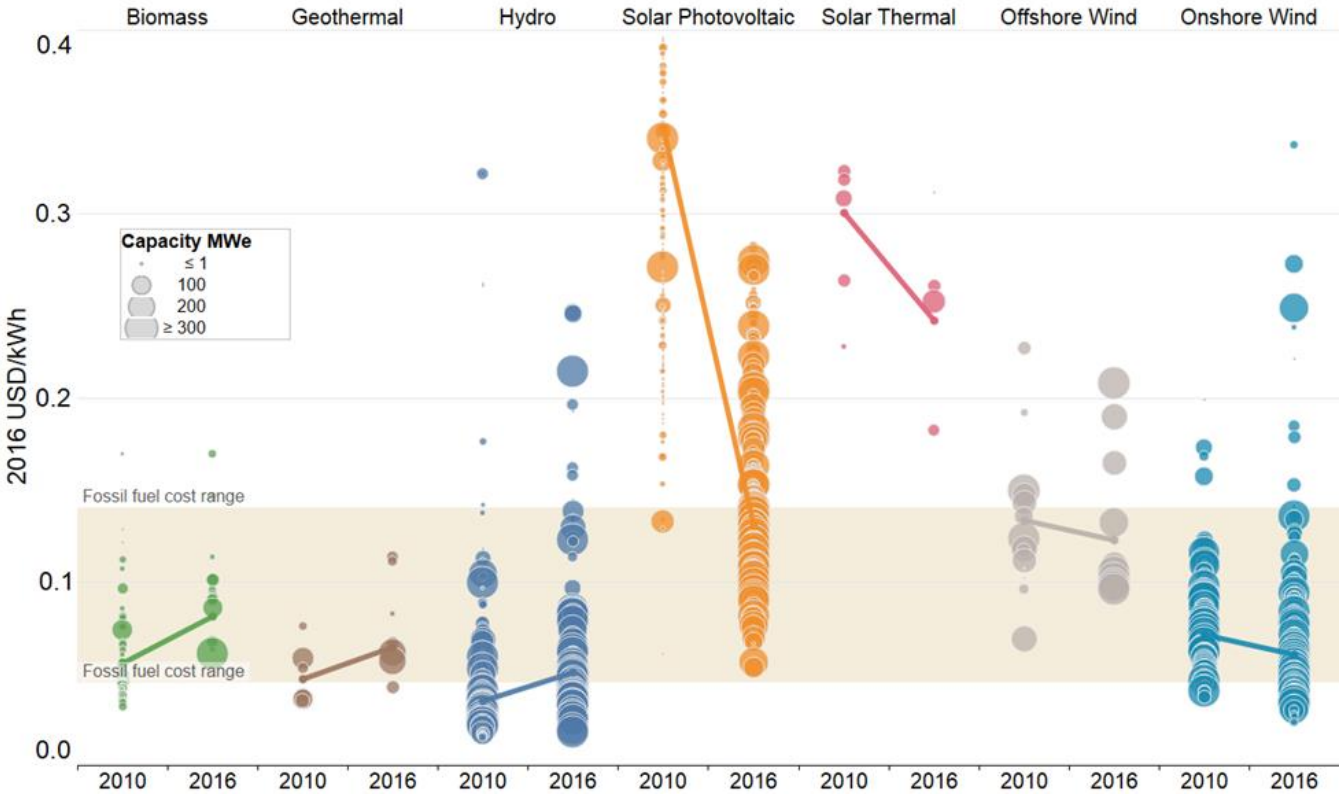
Source: IRENA (2016), The Power to Change: Solar and Wind Cost Reduction Potential to 2025

ELECTRICITY COST

International Renewable Energy Agency

#ProjectNavigator

Renewables: Highly competitive for new capacity



Traditional renewables highly competitive

Cost reductions for wind and solar, make them increasingly competitive

Cost rise for average hydro projects, geo & biomass data needs more work

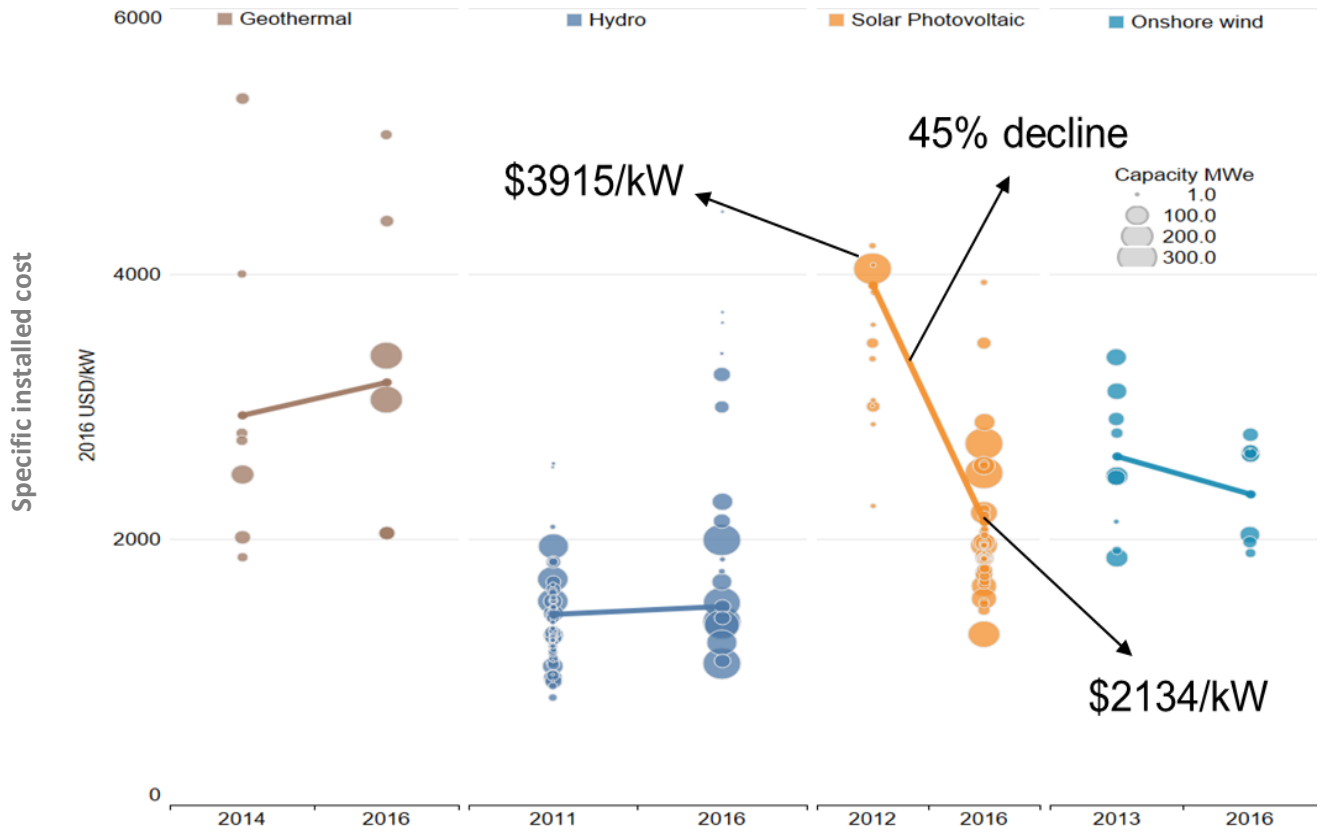
Each circle represents one project, centre of circle is LCOE value on Y axis, diameter is size of project. Year is the year commissioned.

Cost reduction potential

IRENA
International Renewable Energy Agency

#ProjectNavigator

Solar PV has seen the most significant cost reduction from 2012 to 2016, with a 45% decline in 4 years which is in line with global cost reduction



Note: Installed costs and LCOE calculations are given for the year during which the project is commissioned.

Source: IRENA Renewable Costing Alliance

Outline

IRENA
International Renewable Energy Agency

- The case for renewables
- The challenge of RET project development
- IRENA's project facilitation tools
- The project development process
- Examples and case studies

RE project development challenge

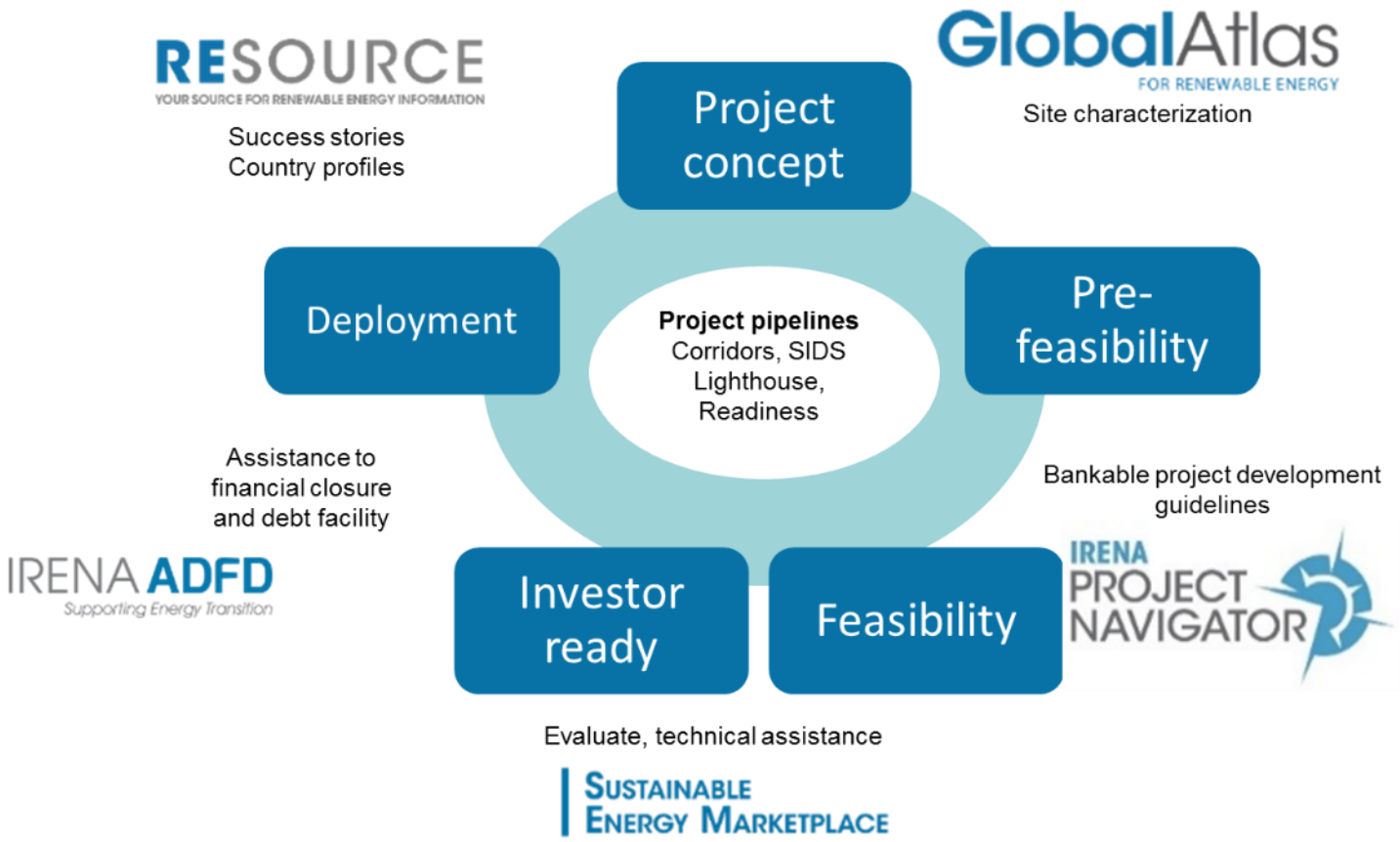
- Most countries know they have RE potentials. However, they lack the projects to achieve the desired deployment.
- Conditions inherent to certain countries/regions translate into high costs and financial risks, *e.g.* SIDS.
- Stakeholders involved in a project often lack the know-how to complete a bankable project proposal.
  - This leads to higher project development costs and risks.
- Fund securement process and financing options themselves aren't transparent.

➔ IRENA aims to strengthen the project development base, enhance the quality of proposals and increase their bankability, attracting better financing conditions.

Outline

- The case for renewables
- The challenge of RET project development
- IRENA's project facilitation tools
- The project development process
- Examples and case studies

IRENA's project facilitation tools & platforms



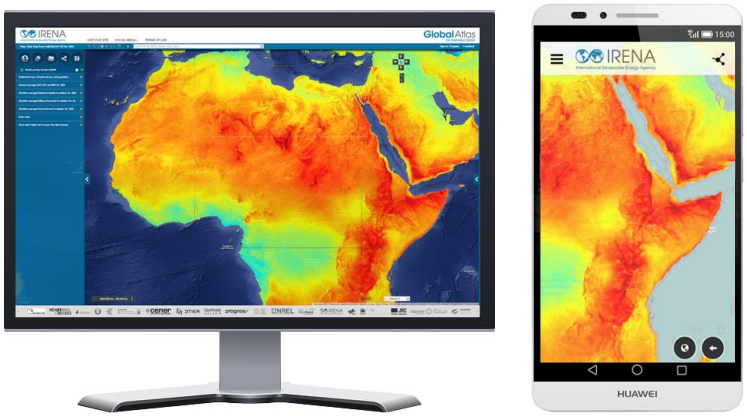
Global Atlas for Renewable Energy

IRENA
International Renewable Energy Agency

Global Atlas
FOR RENEWABLE ENERGY

The Global Atlas for Renewable Energy:

IRENA's renewable energy prospector



www.irena.org/globalatlas

Global Atlas *pocket*
Mobile App

Sustainable Energy Marketplace: a virtual Market Place for RE Projects

IRENA
International Renewable Energy Agency

Objectives

- Increase visibility of RE and EE projects.
- Increase visibility of financing opportunities.
- Promote project initiation and development.
- Support building a pipeline of investor ready projects.
- Boost investments in renewable energy.
- Mobilise public and private finance.

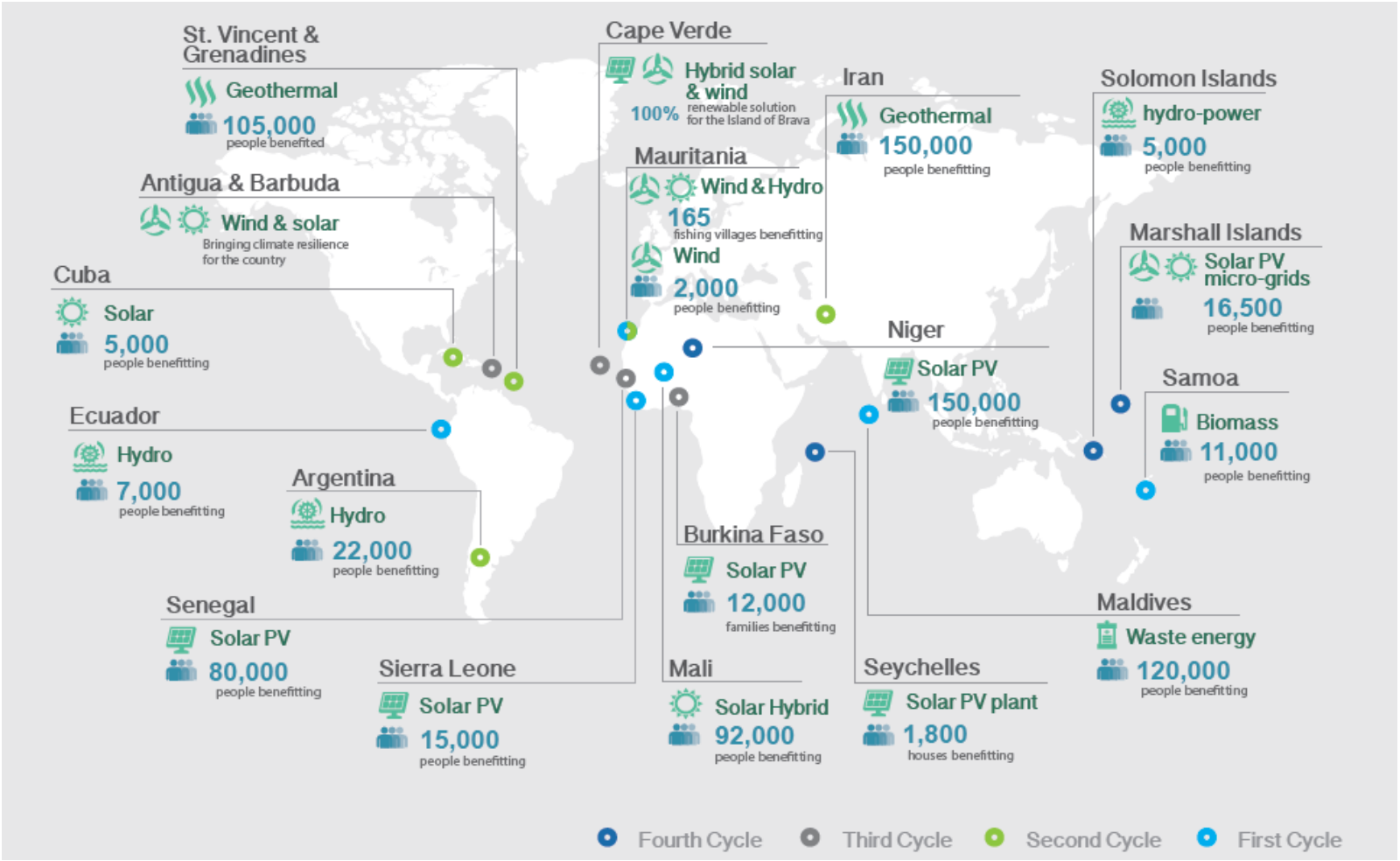
SUSTAINABLE ENERGY MARKETPLACE

Methodology

- Provide an integration platform for stakeholders in the market.
- Enhanced user interface and experience.
- Regional hubs for focused partnerships.
- Seamless linkage to IRENA tools and services.
- Advanced search functions.

Providing concessional funding

IRENA
International Renewable Energy Agency



IRENA ADFD
PROJECT FACILITY

www.irena.org/adfd

What is the IRENA Project Navigator?

The challenge of RET projects

- Failing to prove project bankability to funding institutions
- Insufficient knowledge on project proposal development
  - Higher project development costs
  - Higher risk of project failure

Objectives

- Increase the bankability of projects by:
  - Strengthening the project development base
  - Enhancing the quality of project proposals
  - Reducing costs and mitigating risks through proper planning and efficient use of funds
  - Facilitating effective implementation

Scope

- All RETs
- Different finance types: grants, loans, equity
- Project sizes: from individual use to utility scale projects
- Global: all geographical regions

The Project Navigator Platform

Learning Section

- Project development and technical guidelines
- Best practices
- Examples & Case Studies

Start a Project

- Personal and private workspace
- Tools, templates, checklists
- Stepwise approach
- Track your progress
- Export documents

Financial Navigator

- Information on multiple funds
- Filter by region and technology
- Information includes fund types, requirements and contact details among others.

IRENA PROJECT NAVIGATOR

www.irena.org/navigator

Feature #1: Learning section

Project development Guidelines

- Clear project development process
- Tools
- Key Actions
- Control questions and deliverables
- Contract templates

Technical Concept Guidelines

- Land and resource assessment
- Technology selection and sizing
- Contractual aspects
- Lessons learned from previous projects

How others did it

- Find examples
- Case studies
- Templates

Feature #2: Interactive workspace

Create your own workspace

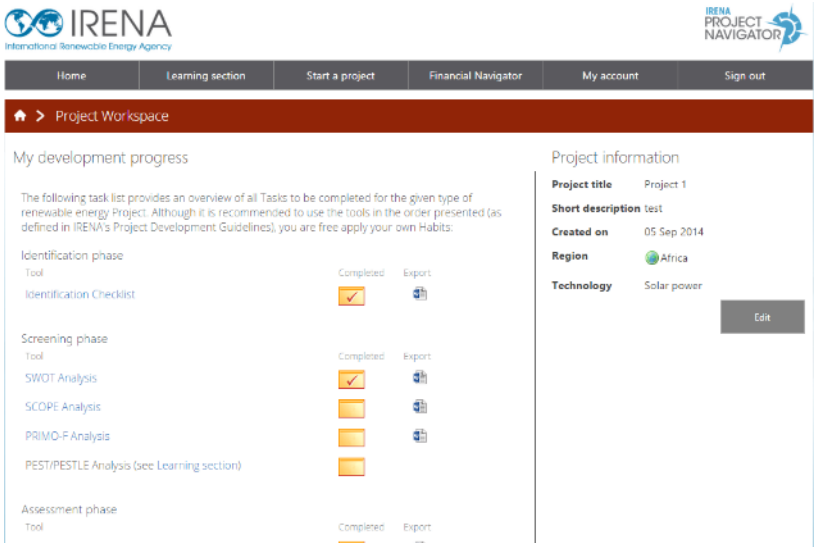
- Password protected workspace
- Interactive tools
- Store up to three projects

Follow a clear project development process

- Clear objectives
- Interactive tools
- Control questions to ensure that nothing important has been overlooked

Track your progress

- Store your data
- Keep track of your project
- Export and download reports



Identification Questionnaire

I Stakeholder Analysis and Target Group Selection	
Who is involved?	Investors, government, manufacturers and suppliers, electricity buyers, local community and competitors.
Who has power/control over the benefits?	Investors, government, customers, community
What needs have to be met?	Environmental and legal frameworks, market price must cover production costs, quality of electricity supply.
Who are the direct recipients (directly affected target groups)?	Electricity buyers/consumers
Who are the ultimate beneficiaries (benefit from the long-term outcome)?	Government, local community
II Problem Analysis	
What is the core problem that the project should help to solve?	Limited electricity access.
What are its causes?	Insufficient grid infrastructure and geographic isolation.

Feature #3: Financial Navigator

IRENA
International Renewable Energy Agency

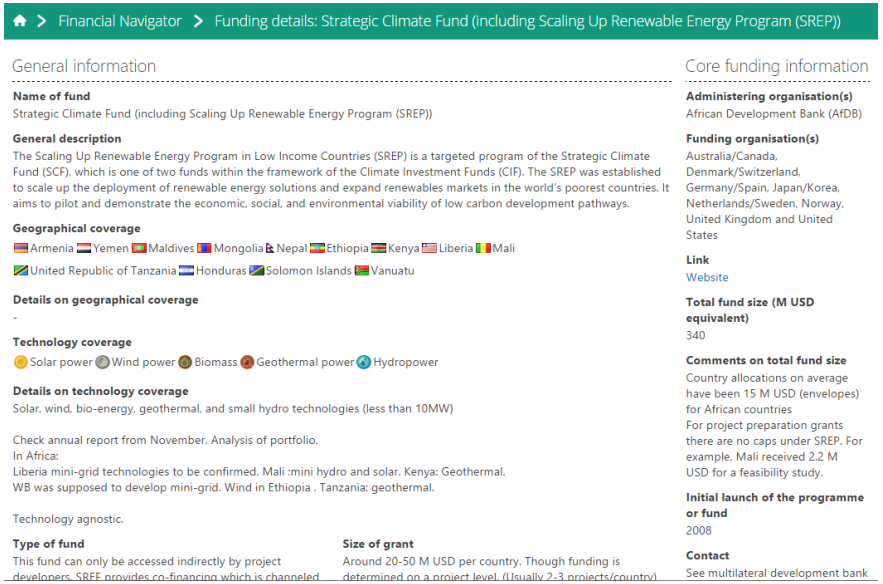
Find a fund that suits your project

The Financial Navigator is a detailed database of funds that actively provide finance to renewable energy technology projects.

It increases the transparency of the funding process and helps project developers identify potential funding opportunities

The available information includes:

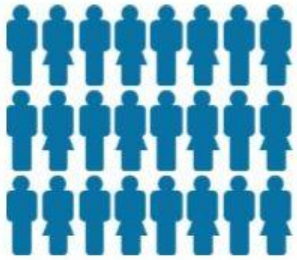
- Geographical Coverage
- Technological Coverage
- Type of fund
- Project Size
- Funding requirements
- Administrating organization
- Contact details



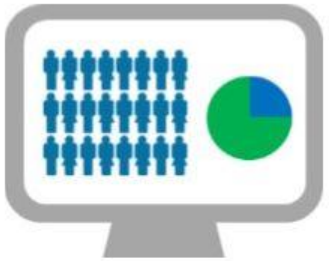
Project Navigator: impact

The IRENA Project Navigator supports project developers in applying best practices to transform their power sectors with renewable energy and address the challenges of affordable energy and climate change.

4,500 users
registered on the platform



700 developers
trained in workshops



3,000 people
reached through webinars

IRENA Project Navigator outreach outcomes in 2017

users from
190+ countries

1,300 projects
created on the platform

7 Technologies
and a SIDS module

Technical Concept Guidelines

IRENA
International Renewable Energy Agency

Onshore Wind Power

Harnessing the energy of moving air to generate electricity with wind turbines located on land

Utility-scale Solar PV

Large scale use of solar photovoltaic cells to convert solar radiation from the sun into direct current electricity

Small Hydropower

Electricity generated using the energy of moving water with a reservoir and a dam controlling flow to an electric plant

Woody Biomass

Ligno-cellulosic biomass coming from branches and tops of woody plants such as trees, bushes or shrubs for the production of solid biofuels (i.e. wood pellets)

Minigrids

Improve reliability of energy supply in remote areas by combining small-scale renewable energy generators and storage in a smart distribution grid

Geothermal

Sustainable access to Earth crust's natural heat often associated with volcanoes to pump hot water or steam up from deep wells to generate electricity

Solar Home Systems

Stand-alone solar PV systems that offer a ost-effective mode of supplying vital power for lighting and appliances to remote off-grid households

Technical Concept Guidelines

IRENA
International Renewable Energy Agency

Learning section > Technical Concept Guidelines > Mini-Grids

- Home
- Introduction
- Overview
- Identification
- Screening
- Assessment
- Selection
- Pre-development
- Development
- Construction
- Operation & maintenance
- Decommissioning
- References

Pre-development

Preliminary economic and financial analysis

On this page

- Key Performance Indicators
- Cost estimation
- Revenue streams
- Economic indicators
- Financial indicators

Outline

Economic and financial analysis is based on a clear understanding of how cost estimates are made and how robust are contractual agreements to guarantee enough revenue streams during the project lifetime. These information should be laid down and documented in a business plan. This analysis is backed by a series of indicators that are of interest for different stakeholders.

Resources

Toolkit

- Project Brief Template
- Bankability Checklist
- Risk Assessment Tool
- Project Evaluation Model - Mini-Grids

Case study

- Mini-Grids - Case Study India

Links

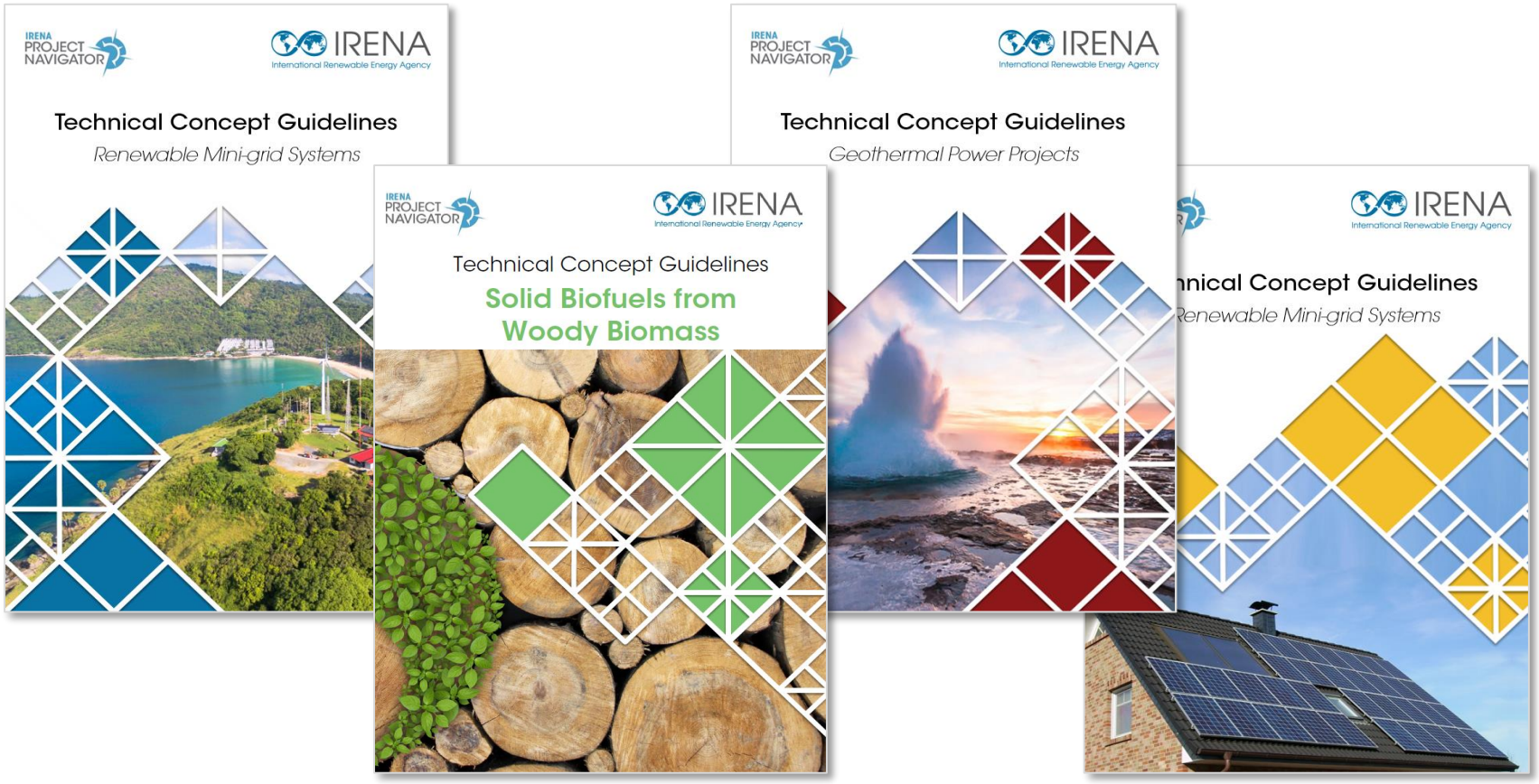
- IRENA Inspire
- IRENA Global Atlas
- IRENA/ADFD Financing Facility

Quick Access to Tools

Summary of activities

Menu and navigation

Technical Concept Guidelines



And more…

Project Navigator: outreach

To organize project development training workshops, IRENA will build on previous successful dissemination approaches blending online and physical activities such as:

Training workshop in West Africa

Residential PV entrepreneurship facility for Africa

60 African project developers trained

Training workshop in the Middle East

Utility-scale Solar PV training workshop in Iran

100 local project developers trained

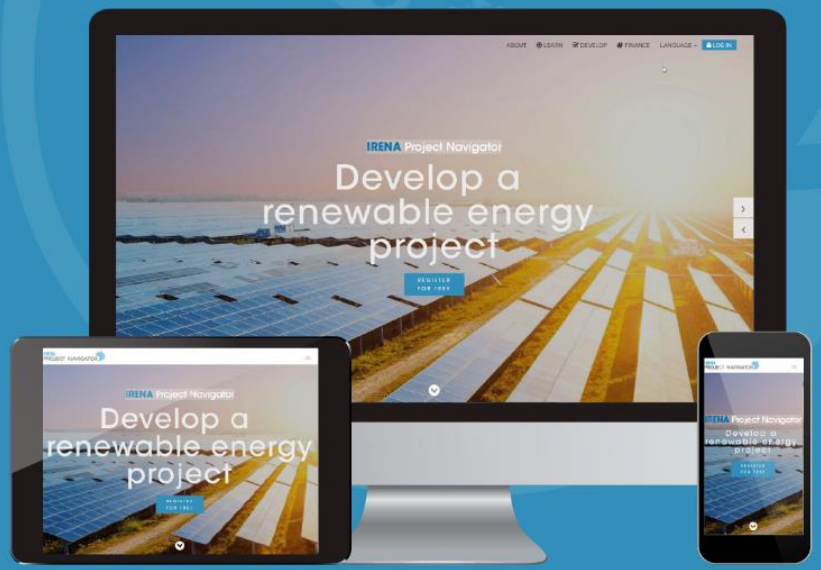
Mini-Grids Webinar

Mini-Grids training webinar

500+ participants remotely trained

IRENA PROJECT NAVIGATOR

Access practical information, tools and guidance for the development of bankable renewable energy projects



- A **learning section** with easy-to-access knowledge materials
- An **interactive workspace** to develop projects and track progress
- An **online search engine** to find renewable energy funding sources

NEW **Obtain project development guidance with 50+ tools for:**

Utility-scale Solar PV | Onshore Wind | Woody Biomass | Mini/ Microgrids | Geothermal Power | Solar Home Systems | Small Hydropower

www.irena.org/navigator

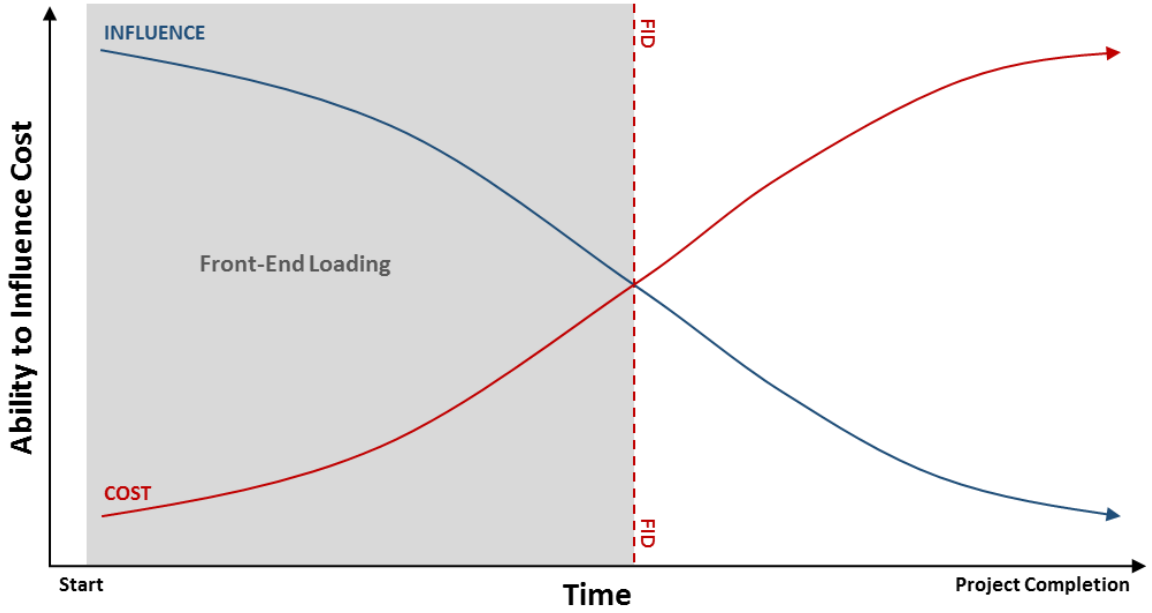
Outline

IRENA
International Renewable Energy Agency

- The case for renewables
- The challenge of RET project development
- IRENA's project facilitation tools
- The project development process
- Examples and case studies

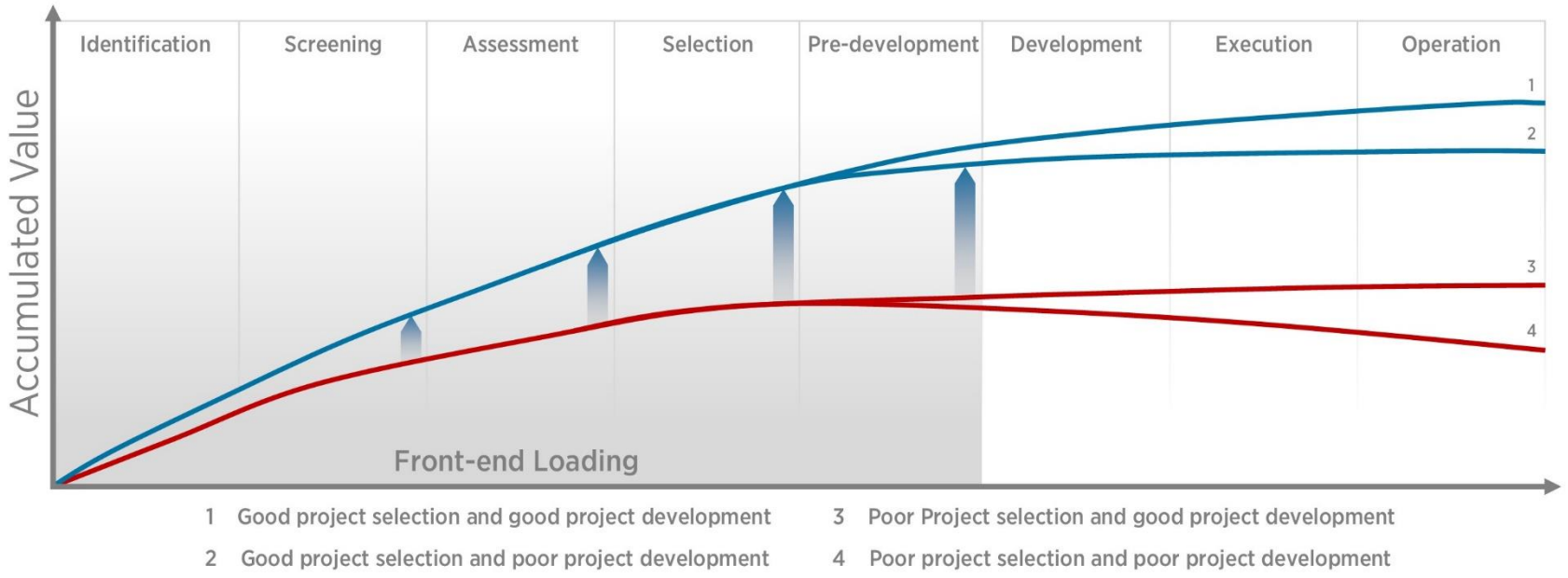
Front-end loading

- Early stages of project development
  - Important decisions and large investments have not been made
  - Changes are easily made and are low cost
- Later stages
  - Decisions and investments have been made
  - Changes imply costs

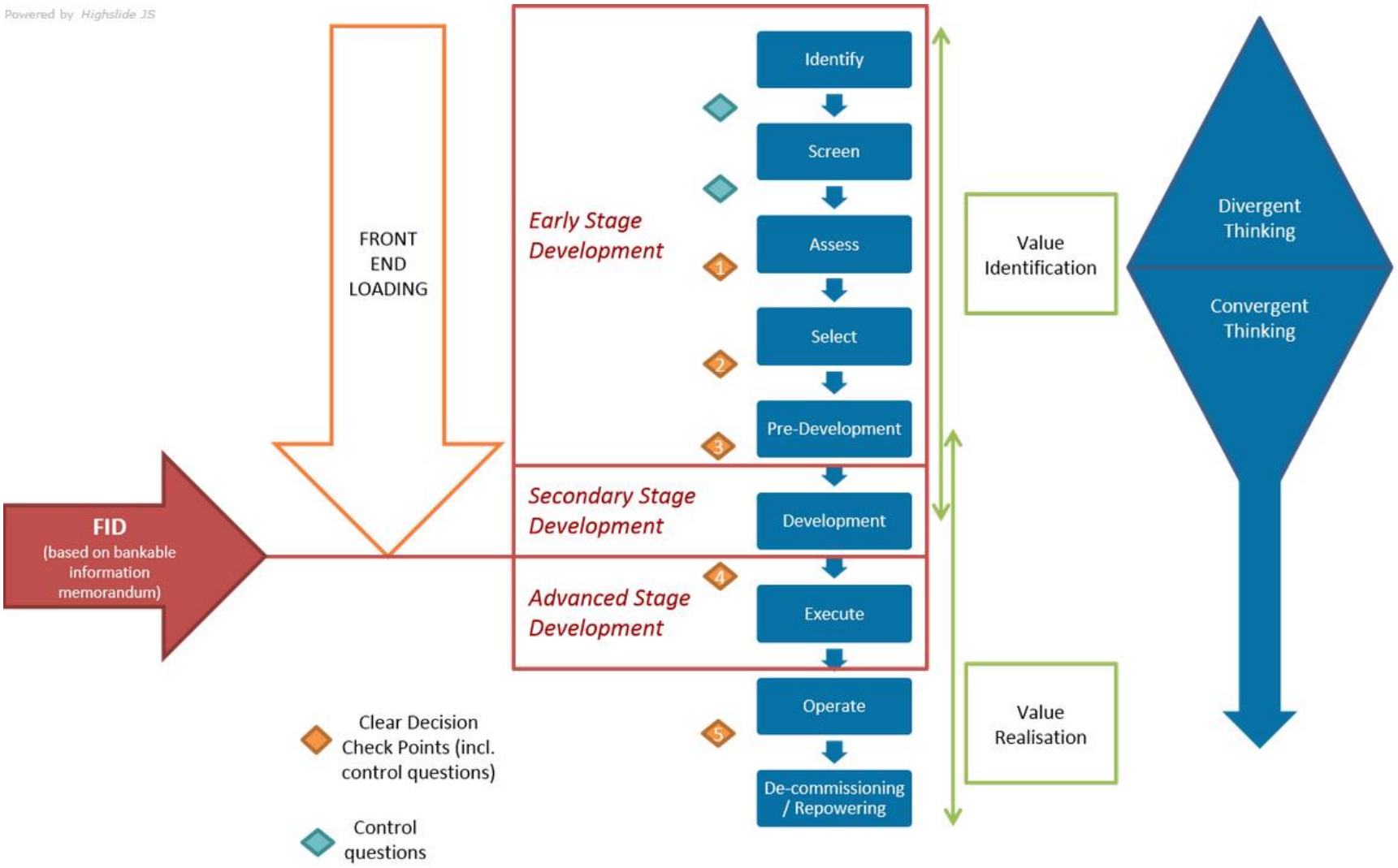


Creating a valuable project

- If a **good project selection** is complemented by a **good execution** of the project, the increase in the value and the quality of a project will be substantial.



Project development process

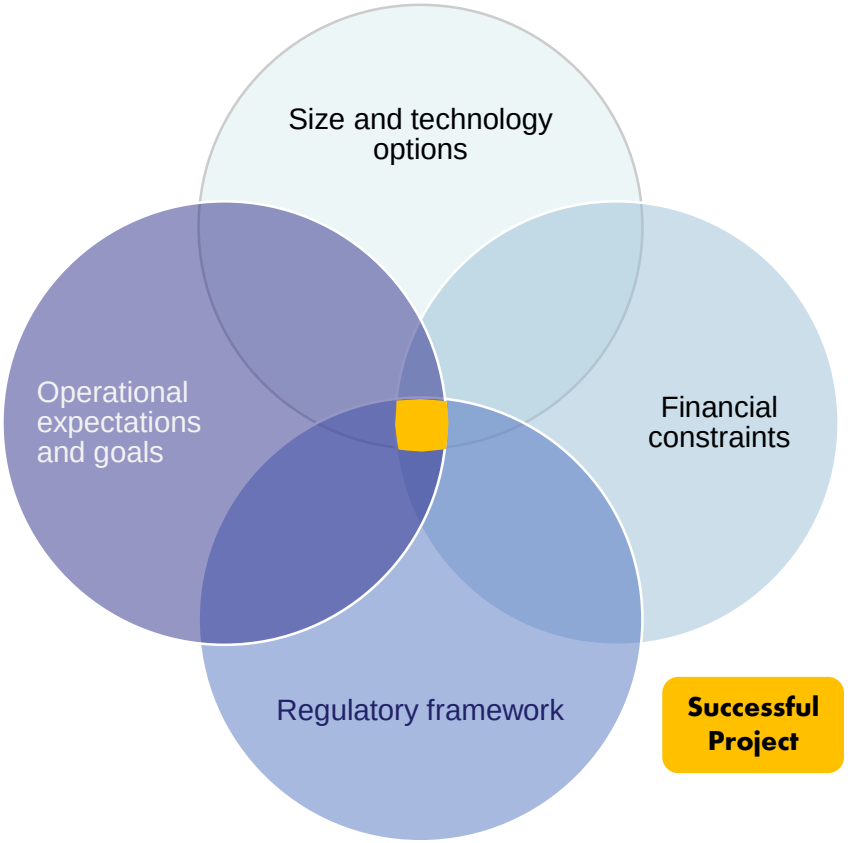


Outline

IRENA
International Renewable Energy Agency

- The case for renewables
- The challenge of RET project development
- IRENA's project facilitation tools
- The project development process
- Examples and case studies

Finding the best solution to a need



Making the most out of opportunities and minimizing risks

Early stage project development phases

IRENA
International Renewable Energy Agency

Identification | Screening | Assessment | Selection | Pre-development | Development | Construction | Operations | Decommissioning

- Identify potential project opportunities
- Screen options and discard unfeasible projects
- Perform a preliminary technical assessment
- Evaluate project options on qualitative and quantitative metrics, and their risks:
  - Operational aspects, financial metrics, revenue certainty, reliability, funding availability, etc.

Late stage project development phases

IRENA
International Renewable Energy Agency

Identification | Screening | Assessment | Selection | **Pre-development** | **Development** | Construction | Operations | Decommissioning

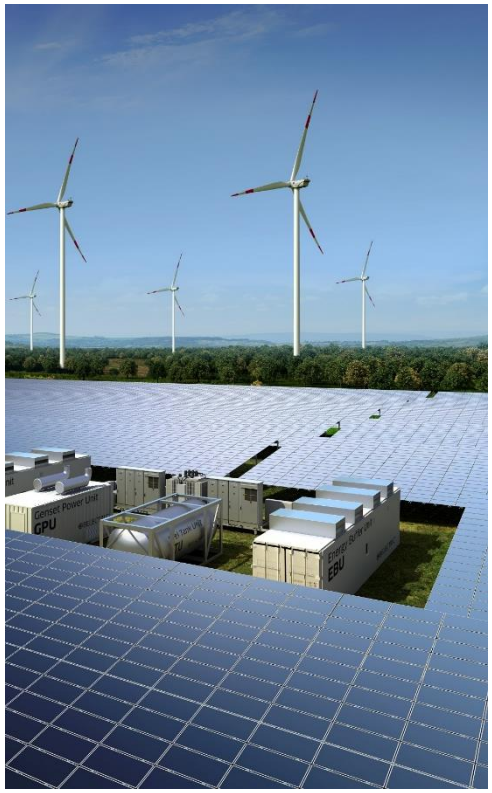
- Preparations for detailed design, financing and construction of the project:
  - Define suitable technologies.
  - Identify operational and site constraints.
  - Estimate preliminary costs and obtain technical specification sheets.
- Model performance based on historical and projected loads, yield estimates, tariffs and operational regulations.
- Finalize financial model and risk management plan
- Finalize contractual agreements and permits

Project implementation and operation

IRENA
International Renewable Energy Agency

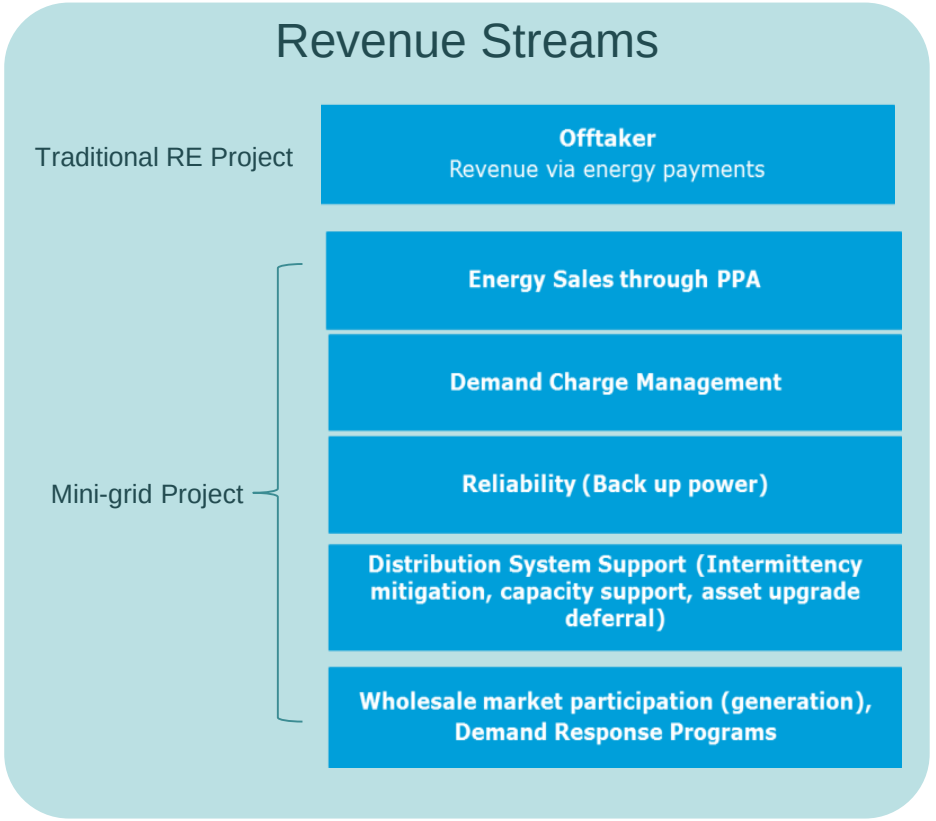
Identification > Screening > Assessment > Selection > Pre-development > Development > **Construction** > Operations > Decommissioning

- Start construction of the project; ensure it is completed on time and on budget
- Testing and Commissioning
- Execute and audit O&M procedures to achieve contractual performance guarantees
- Refurbishing or decommissioning

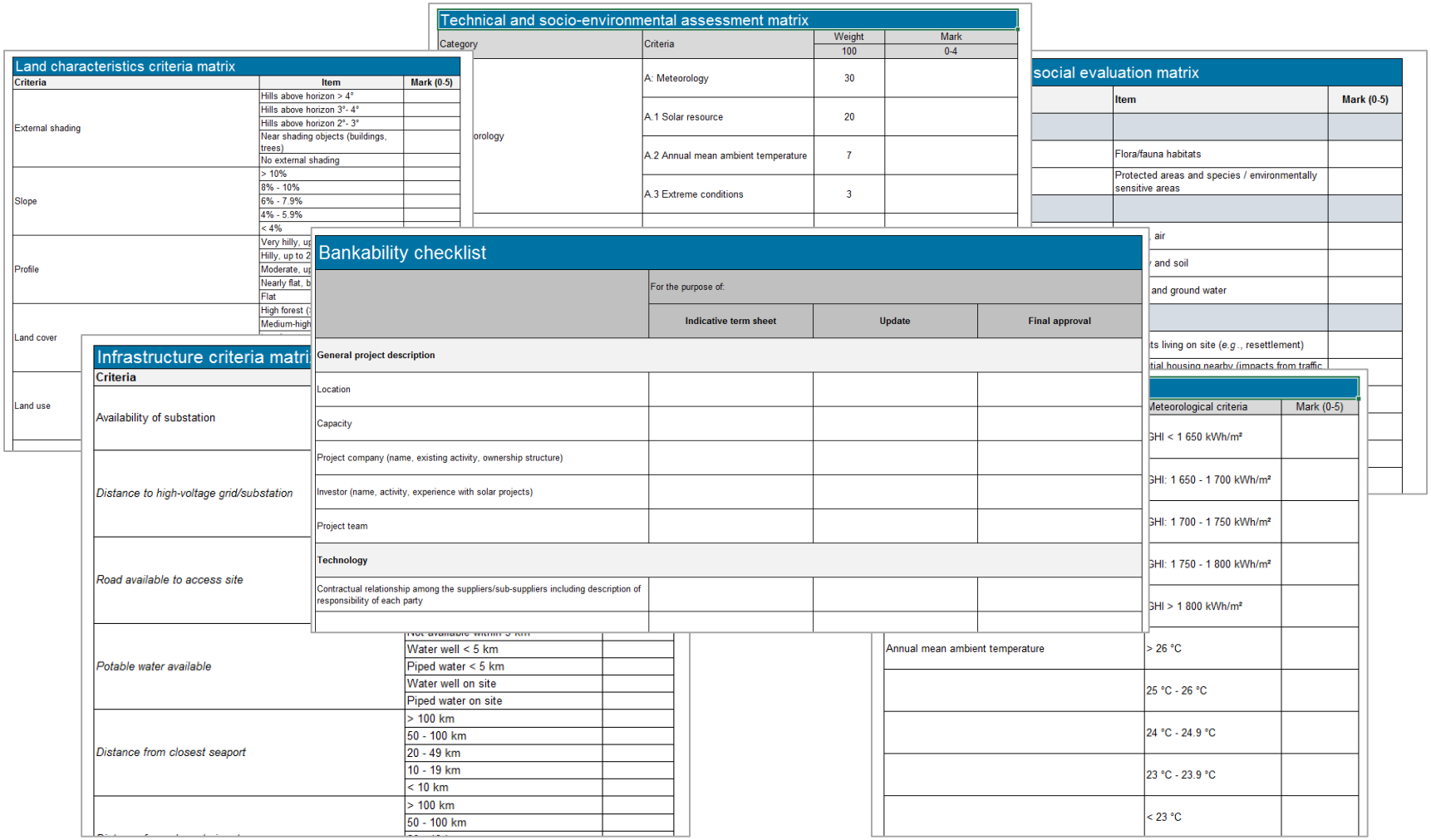


Sample of Bankability requirements

- **Revenue certainty**
- Conservative estimates:
  - Fixed and variable expenses
  - Revenues
- Warranties and guarantees
- Independent verification of assumptions



Project Navigator platform



Technical and socio-environmental assessment matrix

Category	Criteria	Weight	Mark
		100	0-4
orology	A: Meteorology	30	
	A.1 Solar resource	20	
	A.2 Annual mean ambient temperature	7	
	A.3 Extreme conditions	3	

Land characteristics criteria matrix

Criteria	Item	Mark (0-5)
External shading	Hills above horizon > 4°	
	Hills above horizon 3°- 4°	
	Hills above horizon 2°- 3°	
	Near shading objects (buildings, trees)	
	No external shading	
Slope	> 10%	
	8% - 10%	
	6% - 7.9%	
	4% - 5.9%	
	< 4%	
Profile	Very hilly, up	
	Hilly, up to 2	
	Moderate, up	
	Nearly flat, b	
	Flat	
Land cover	High forest (>	
	Medium-high	
Land use		

Bankability checklist

	For the purpose of:		
	Indicative term sheet	Update	Final approval
General project description			
Location			
Capacity			
Project company (name, existing activity, ownership structure)			
Investor (name, activity, experience with solar projects)			
Project team			
Technology			
Contractual relationship among the suppliers/sub-suppliers including description of responsibility of each party			

Infrastructure criteria matri

Criteria		
Availability of substation		
Distance to high-voltage grid/substation		
Road available to access site		
Potable water available	Water well < 5 km	
	Piped water < 5 km	
	Water well on site	
	Piped water on site	
Distance from closest seaport	> 100 km	
	50 - 100 km	
	20 - 49 km	
	10 - 19 km	
	< 10 km	
	> 100 km	
	50 - 100 km	

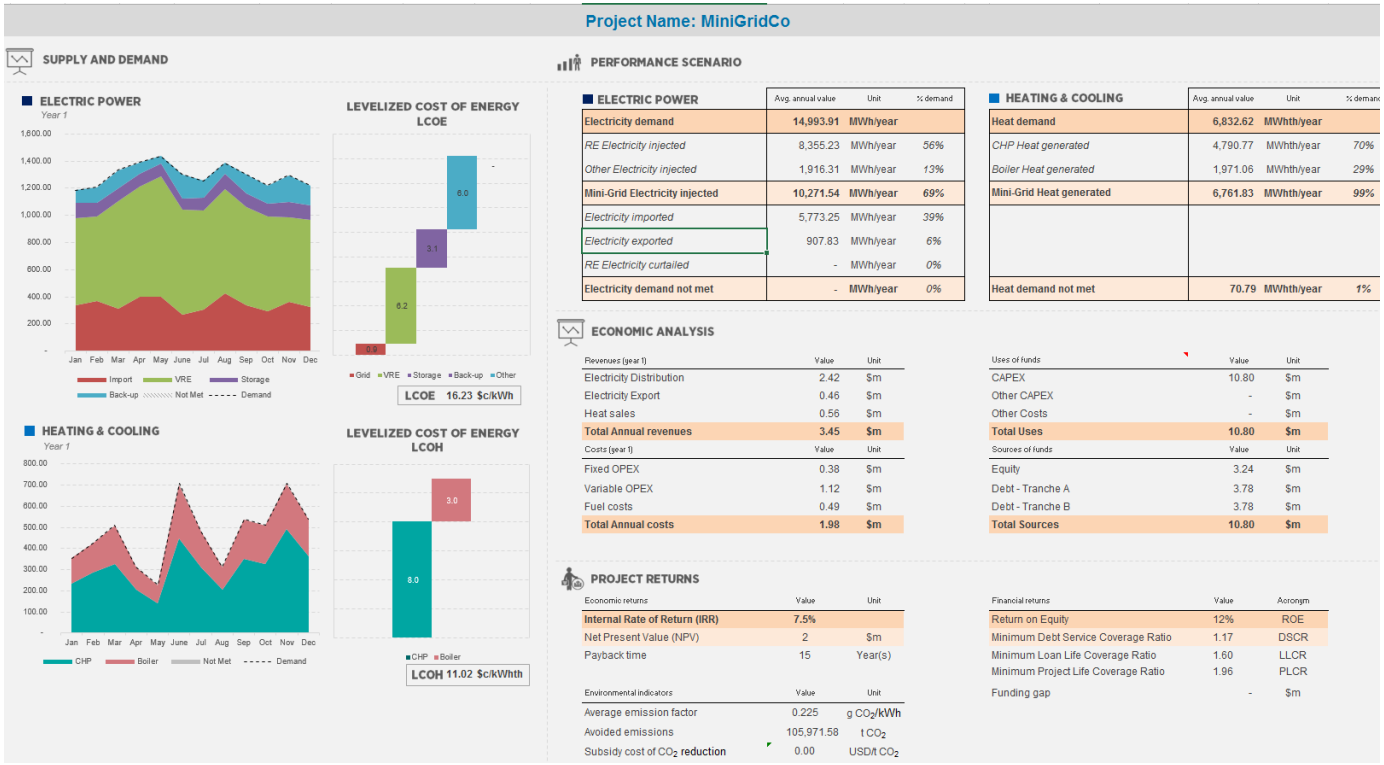
social evaluation matrix

	Item	Mark (0-5)
	Flora/fauna habitats	
	Protected areas and species / environmentally sensitive areas	
	air	
	and soil	
	and ground water	
	ts living on site (*e.g.*, resettlement)	
	tial housing nearby (impacts from traffic	

Meteorological criteria	Mark (0-5)
GHI < 1 650 kWh/m²	
GHI: 1 650 - 1 700 kWh/m²	
GHI: 1 700 - 1 750 kWh/m²	
GHI: 1 750 - 1 800 kWh/m²	
GHI > 1 800 kWh/m²	
Annual mean ambient temperature > 26 °C	
25 °C - 26 °C	
24 °C - 24.9 °C	
23 °C - 23.9 °C	
< 23 °C	

Toolkit: Project Evaluation Model

IRENA
International Renewable Energy Agency



Project developers can understand relationship between system performance & project returns

Toolkit: Checklists & Tools

IRENA
International Renewable Energy Agency

IRENA Project Navigator - Technical Concept Guidelines for Mini-Grids

IRENA PROJECT NAVIGATOR

1 - Project Screening Tool

				Total Screening Score	Option 1 30%	Option 2 34%	Option 3 24%	Option 4 33%
1	*Siting & Logistics*	Criteria	Guidance on criteria	Impact on Project	Score 28	Score 32	Score 22	Score 31
	1.1	Land availability	How available and suitable is the real estate?	Real estate may not be not be available. Real estate suitable under single ownership is more ideal than multiple ownership	Fair	Fair	Good	Fair
	1.2	Leasing/owning requirements	What is the complexity of the leasing/owning requirements?	Complex leasing or ownership requirements may have a negative impact on the project in terms of cost and scheduling.	Good	Excellent	Poor	Good
	1.3	Distribution system infrastructure	What is the quality of the distribution system infrastructure (a non-existing distribution system would be graded "poor")	Construction of distribution system may entail additional costs and planning requirements. 3rd party entity ownership and operation of the distribution system may require additional resources to be included in the project.	Excellent	Fair	Poor	Fair
	1.4	Renewable production capability	What is the quality of the solar/wind production capability?	Environmental conditions may inhibit renewable production, or substantial investment is required to modify topographical or site conditions for renewable production. Production may be too low because of low solar insolation or low wind production capability	Fair	Very Good	Fair	Fair
	1.5	Fossil fuel access	How convenient is the access to fossil fuel reserves ?	Substantial investment may be required for direct access to fossil fuel reserves.	Good	Excellent	Fair	Very Good

1 - Risk assessment

					a) Initial risk assessment				b) Post-mitigation risk assessment			c) Risk mitigation effectiveness
#	Project phase	Risk category	Risk description	Impact category	Likelihood	Impact severity	Risk rating (initial)	Proposed mitigation measures	Likelihood	Impact severity	Risk rating (post mitigation)	Risk mitigation effectiveness
2	1) Identification	Research	Having insufficient information; Site visit and desk study do not provide enough information (on expected temperatures and subsurface permeability) for having confidence in the presence of a geothermal resource.	Financial	Likely	Severe	High		Unlikely	Significant	Medium	Effective
2	1) Identification	Construction	Working area is not appropriate; An appropriate working area cannot be selected, because other activities on site are blocking an eventual concession-right for the geothermal project.	Financial	Certain	Significant	High		Likely	Significant	High	Not effective
3	1) Identification	Market	No financial possibilities; No financing possibilities found, for the geothermal development in the area	Financial	Rare	Moderate	Low		Rare	Minor	Low	Not effective
4	1) Identification	Organisational	Political and regulatory instruments have not been identified yet; Political and regulatory instruments have not been identified yet and e.g. geothermal friendly policies have not been found	Financial	Unlikely	Significant	Medium		Likely	Significant	High	Detrimental
5	2) Screening	Organisational	Stakeholders are not properly known	Financial	Unlikely	Significant	Medium		Unlikely	Minor	Low	Effective
6	2) Screening	Social	No public acceptance; The issue of public acceptance has not been addressed	Financial	Unlikely	Moderate	Medium		Unlikely	Minor	Low	Effective
7	2) Screening	Contracts and agreeme	Missing surface exploration permit; A surface exploration permit has not been assigned for phase 3 'assessment'	Financial	Unlikely	Moderate	Medium		Unlikely	Minor	Low	Effective
8	2) Screening	Contracts and agreement	Incomplete identification of concession rights and licence issues	Financial	Likely	Moderate	Medium		Likely	Moderate	Medium	Not effective

Project Specifications

A company has developed a 1 MW power plant.
The selected site looks very promising and suitable for the construction and operation of a photovoltaic power plant. The figure below shows the site. All contracts were signed (e.g. EPC, O&M, Facility Agreement with lenders) and construction of the plant was about to start.
The key data are as follows:

- Site is 3.4 ha and has a suitable shape (rectangular)
- High irradiation in the site
- Capacity of 1 MW
- Grid connection approval available
- Grid connection directly at the site
- Site is not complex and is flat
- Access to the site is available
- No obstacles like trees or large buildings present

Land Securing and Availability

In the final analysis, the site proved to be not suitable for PV development. After further investigation before the actual start of construction, a number of issues were identified that had a negative impact on the actually usable area:

- irrigation line (south)
- main water pipe (NW)
- MV power lines crossing with MV poles
- building on site.

The final suitable area was only 60% of the initial site. Furthermore, due to the various obstacles (exclusion areas), the site was parceled up into several sub-plots that made the site unsuitable overall for further project realization.

Land Securing and Availability

How could this happen?

- Invisible obstacles like underground pipes are not always entered into cadastral maps
- Not all of the purchased land belonged to the land owner
- There was no official feedback from the grid utility with regard to minimum distance to MV lines and MV poles
- There was no answer from the grid utility with regard to installation of modules under the MV line
- It was not clear whether or not the MV lines and poles could be removed

Mitigation: Careful site assessment at project start

PV Project

Item	Setbacks	Mitigation actions
• **PV Modules** – Technical properties – Certificates and guarantees – Product testing conditions • **Inverters** – Testing and suitability for extreme conditions – Long term agreements and warranties • **Structure** Suitable design and calculation for 25 years • **Grid connection** – Evacuation of electricity – Permitting	• Underperformance of modules that might reduce production, e.g. – extreme degradation – potential induced degradation – delaminating – Soiling and shading • Risk of acquiring products not suitable for the environmental conditions. • Interconnection difficulties, grid instability. • Difficulties for finding financing entities or investors for the projects • Economic underperformance as a result of defects and need for corrective measures	• Factory inspections of PV module production lines • Reviews of track record, certificates and guarantees • Reviews of technical characteristics of inverters and operation conditions • Verifying long terms guarantees for main components. • Revision of support structure design and structural verifications • Assessment of grid connection point and electrical lines' suitability to evacuate the electricity produced.

Common Construction Issues

Setback examples

Soil conditions

- incorrect verification of soil conditions (drainage, geotechnical properties) by the EPC contractor
- incorrect foundation selection

Structure and module mounting

- defective mounting by crews or of structure
- damage to PV modules
- wrong cabling installation leading to damage to cables

Electrical installation

- incorrect grounding design
- incorrect installation of inverters leading to damage
- improper cable and electrical connections, leading to fires, injuries and energy losses

Security

- theft of copper and cables, theft of modules

Soil erosion issues





Inappropriate drainage system and enhanced erosion

Severe weather conditions

Mounting structure issues

Site observations

- Mounting structure problems especially in steeply sloped zones: poles, connection plates, washers, module clamps, module positions; improperly attached modules affect manufacturer warranties

Mounting structure issues

Site observations

Mounting structure problems especially in steeply sloped zones: poles, connection plates, washers, module clamps, module positions; improperly fixed modules affect manufacturer warranties

Incorrect mounting & mechanical stress

Plant installation in flooding region

Wrong installation of cables and modules

Cable conduits not buried

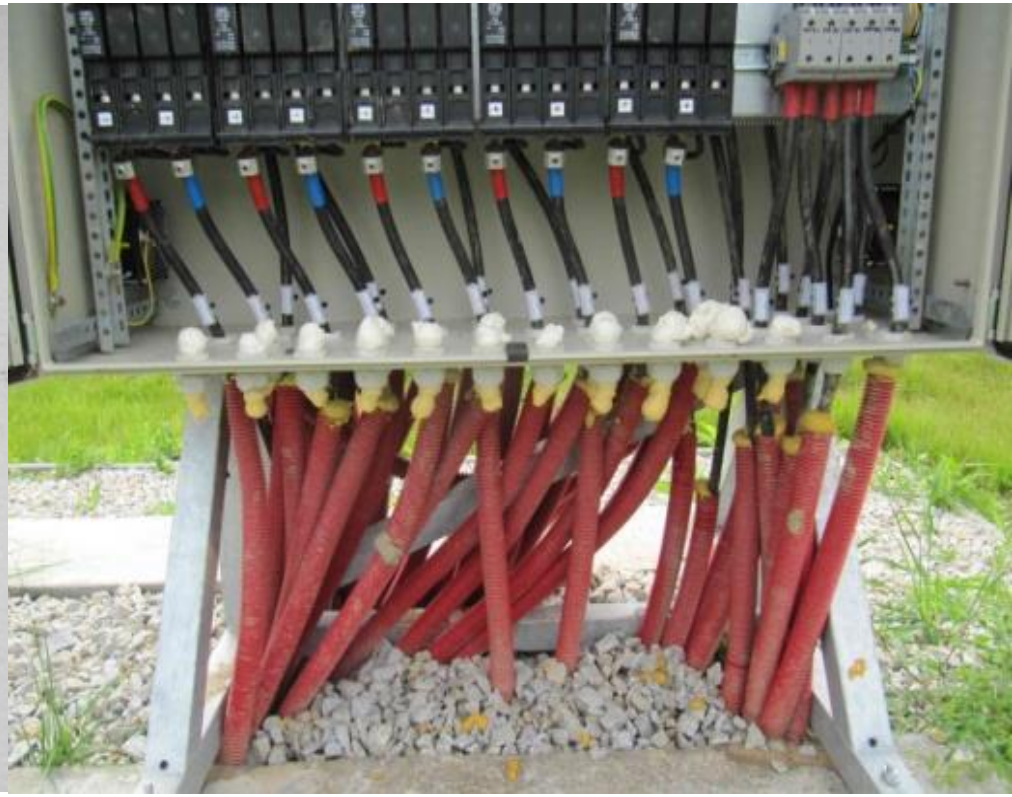
Modules behind a wall

System static stability

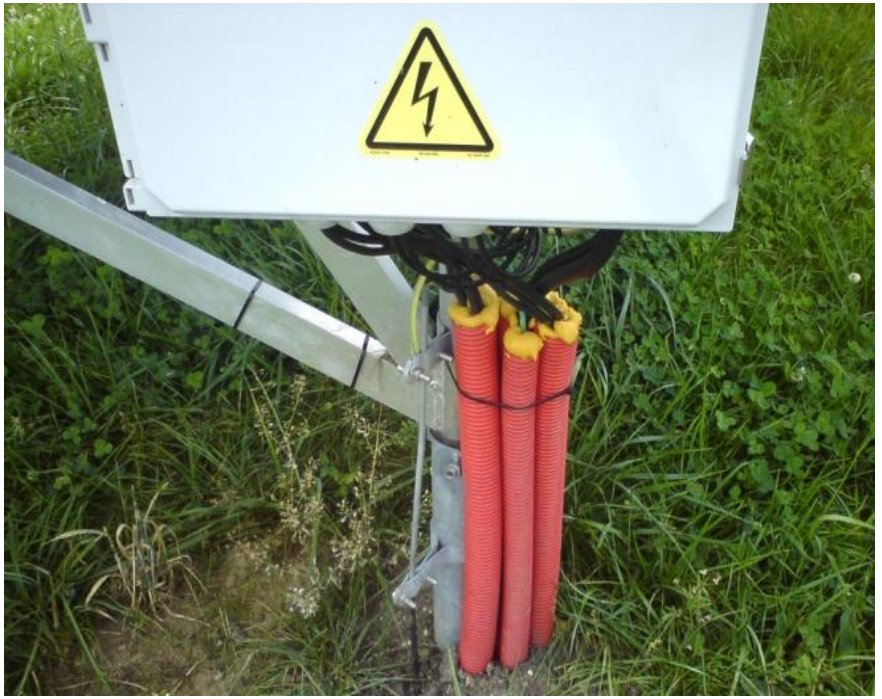
Inadequate installation of cables at PV modules

Water infiltration to sub-combiner box

Foam sealing of combiner box cable entries

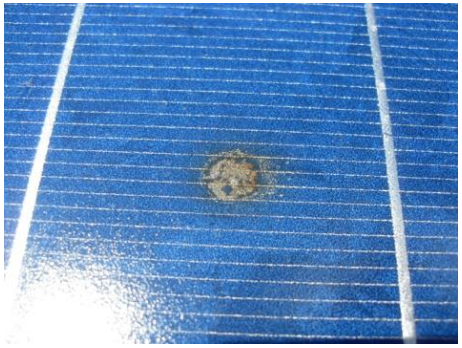


Foam sealing of cable ducts

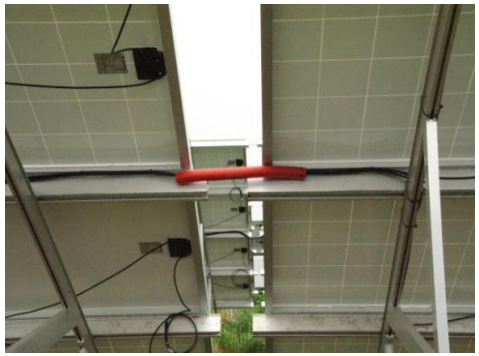


Metal shield protection for cable ducts at combiner boxes

Module defects and required cable sleeves at sharp edges



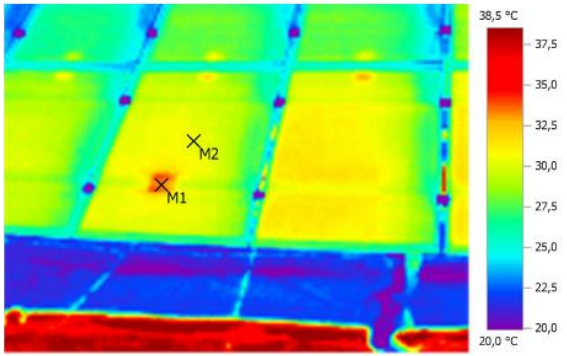


Thermographic imaging fault detection

International Renewable Energy Agency

Device	testo 875-2	Serial No.:	2067495
Task	IR measurements at the PV-Modules		



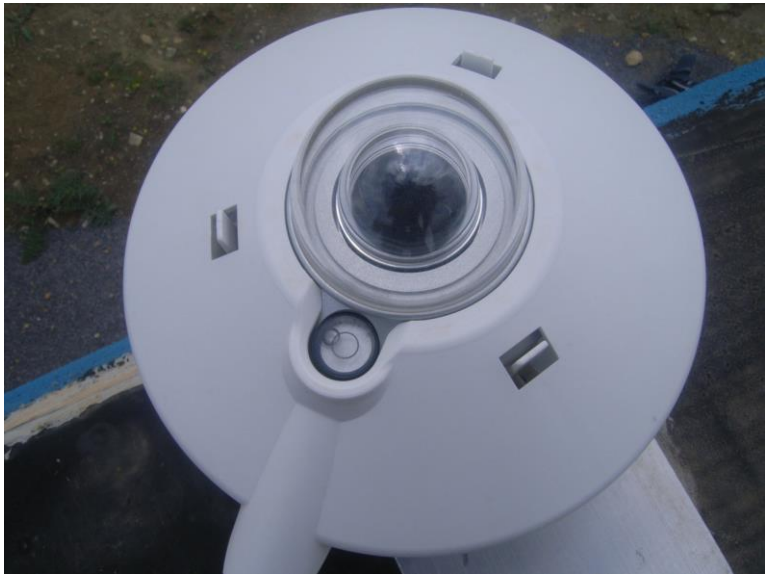
Picture data:	**Date:**	11.05.2011	**Emissivity:**	0,85
	Measuring Time:	12:04:48	**Refl. temp. [°C]:**	-40,0
	File:	IV_00073.BMT		

Picture markings:

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Measure point 1	33,2	0,85	-40,0	Cell defect, visual check shows no result
Measure point 2	30,2	0,85	-40,0	-

Remarks: Module Ser.No. 0718114350400072210

Wrong pyranometer installation

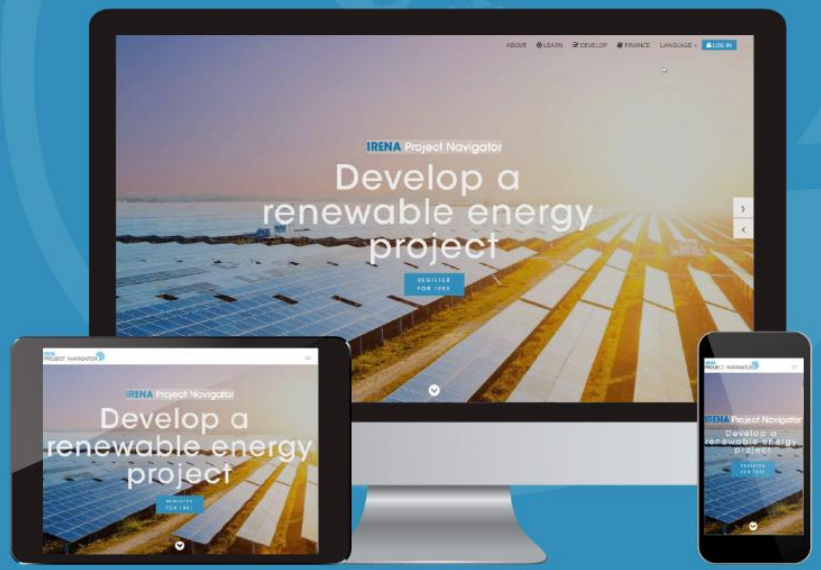


Incomplete cutback of plants and shadowing

Excessive plant growth and its remediation

IRENA PROJECT NAVIGATOR

Access practical information, tools and guidance for the development of bankable renewable energy projects



- A **learning section** with easy-to-access knowledge materials
- An **interactive workspace** to develop projects and track progress
- An **online search engine** to find renewable energy funding sources

NEW **Obtain project development guidance with 50+ tools for:**

Utility-scale Solar PV | Onshore Wind | Woody Biomass | Mini/ Microgrids | Geothermal Power | Solar Home Systems | Small Hydropower

www.irena.org/navigator

IRENA
International Renewable Energy Agency

Thank you for your attention