THE GLOBAL ENGINEERING CONFERENCE ON SUSTAINABLE DEVELOPMENT AND WORLD FEDERATION OF ENGINEERING ORGANISATIONS EXECUTIVE COMMITTEE MEETINGS.

15th - 18th October 2024, Kigali, Rwanda

# Theme: Engineering Innovations for a Sustainable Future

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# Unlocking economic potential through assessment of viability and cost effectiveness of floating solar photovoltaic systems

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# PRESENTATION OUTLINES

- ABSTRACT
- BACKGROUND AND MOTIVATION
- PROBLEM STATEMENT
- RELEVANT PREVIOUS RESEARCHES
- GENERAL OVERVIEW OF FSPV
- METHODOLOGY
- RESULTS ANALYSIS/DISCUSSION
- CONCLUSION AND FUTURE PROSPECTS

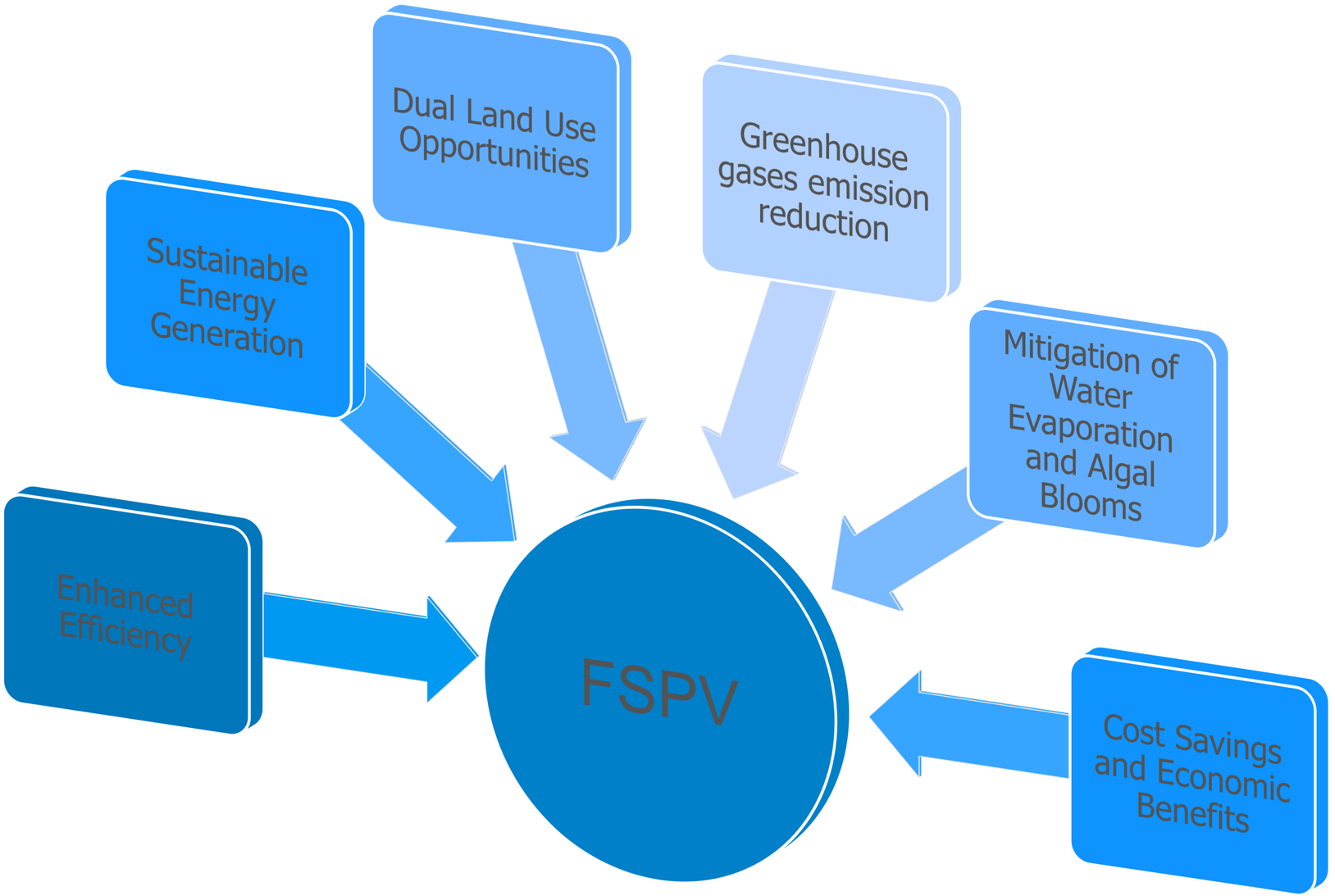
# ABSTRACT

The paper evaluates the economic feasibility and benefits of floating solar photovoltaic (FSPV) installations, using case studies to explore best practices. It highlights advantages such as land use optimization, water conservation, and reduced land acquisition costs by utilizing water bodies. The analysis covers CAPEX, OPEX, LCOE, and ROI to demonstrate FSPV's financial viability. Key factors for success include proper site selection, detailed planning, and stakeholder engagement. The paper also emphasizes FSPV's potential to boost agricultural productivity, support renewable energy, and contribute to climate change mitigation.

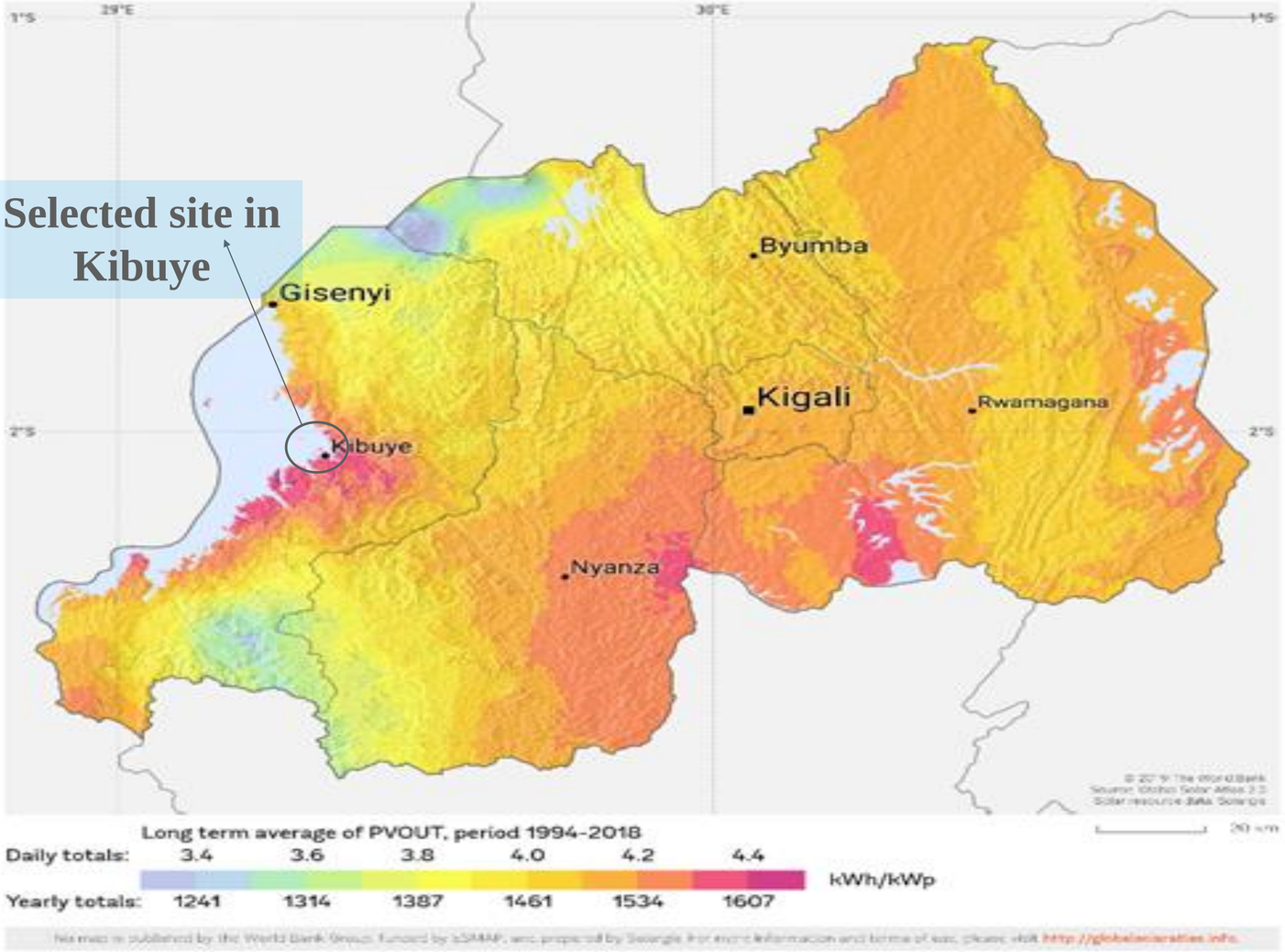
# BACKGROUND

- Innovative renewable energy technology that involves installing solar panels on bodies of water, such as lakes, reservoirs, or oceans.
- Traditional ground-mounted solar panels farms
- Land scarcity, competition for agricultural land, and the impact on ecosystems
- Only generate clean energy but also reduce water evaporation, improve water quality, and can coexist with aquaculture or other water-based activities
- Global exploring floating solar as a viable alternative to conventional solar PV installations.

# MOTIVATION


Dual Land Use Opportunities
Greenhouse gases emission reduction
Sustainable Energy Generation
Mitigation of Water Evaporation and Algal Blooms
Enhanced Efficiency
FSPV
Cost Savings and Economic Benefits

# STUDY AREA




**Key consideration:**

- Average annual solar irradiation on the horizontal plane of 1.92 MWh/$m^2$
- Photovoltaic power potential of 1.607 MWh/kWp
- Water body available
- Existing facility of Kivu Watt power plant

# PROBLEM STATEMENT

- Green house gases emission
- Increasing demand for renewable energy
- Over exploitation of land
- Solar energy resources not harnessed
- Land scarcity and environmental concerns.
- Economic potential of FSPV
- Promotion of sustainable energy development
- Policy and Economic Incentives for Floating Solar PV Deployment

**Nuclear Power Plant** (Source: Energy World)

Coal **Power** plant (Source: Rudmer Zwerver@shutterstock)

# GLOBAL ENERGY CHALLENGES

**Global renewable energy targets and the transition from fossil fuels**

**Limited land resources for large scale solar power plants**

**FSPV innovative solution to bridge the gap**

# BENEFITS OF FSPV

- Reduction of water evaporation and improved water management
- Maximize the use of existing power plant infrastructures
- No land acquisitions costs
- Preservation of agricultural land and ecosystem
- High efficiency due to cooling from water
- Maximize the land for  agriculture

**Figure1: Ground Mounted SPV**

**Figure2: Floating SPV**

# RELEVANT PREVIOUS RESEARCHES

- Technological advancements (bifacial solar panels)
- Efficiency optimization (cooling effects & hybrid systems)
- Environmental impact assessments (ecology &mitigation strategies)
- Economic viability and cost analysis (cost benefit analysis and financial models)
- Policy and regulatory frameworks (policy& incentives programs)
- Case studies and pilot projects(globally)
- Integration with smart grids (grid &storages)

# OVERVIEW OF FSPV

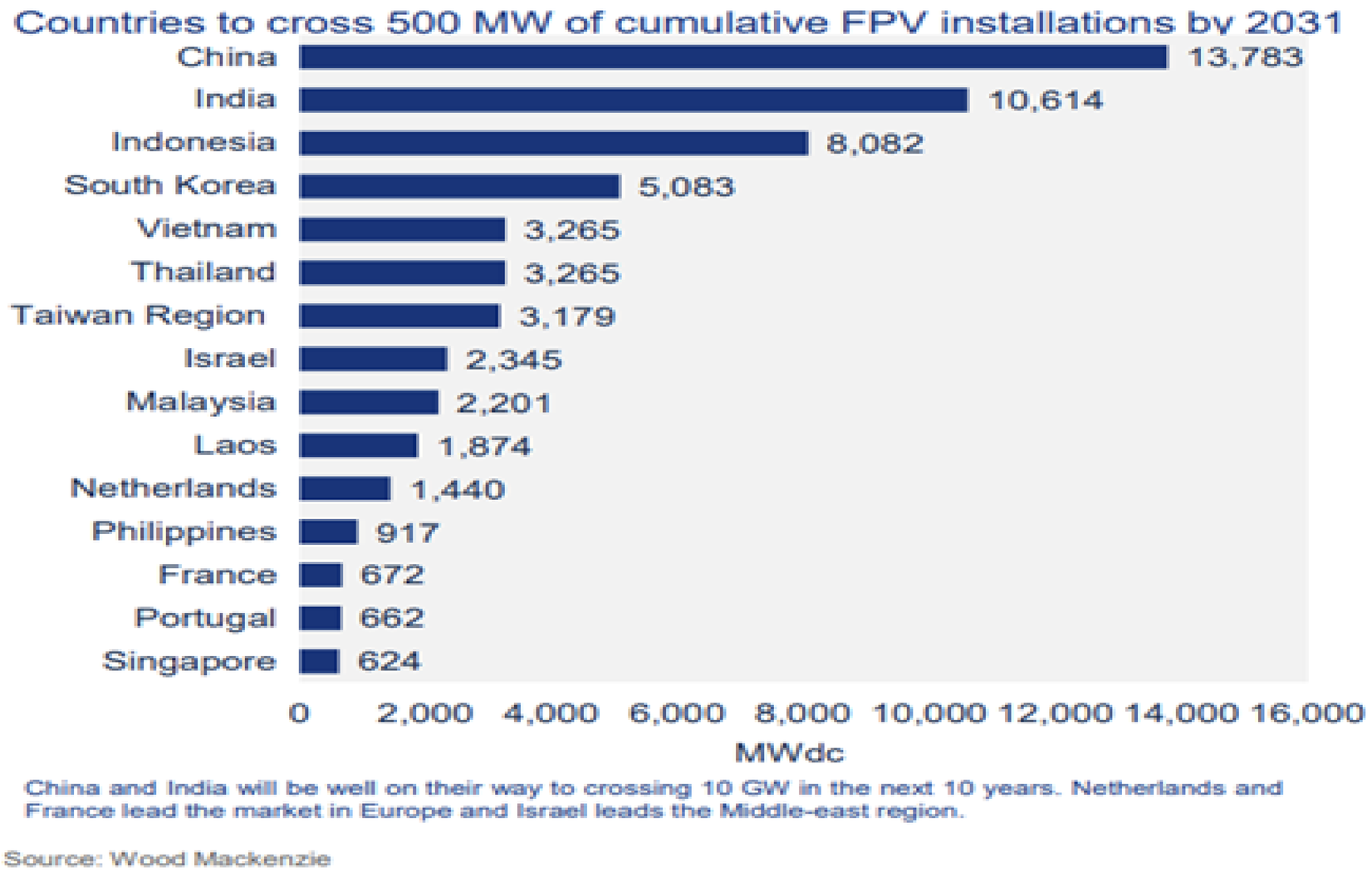
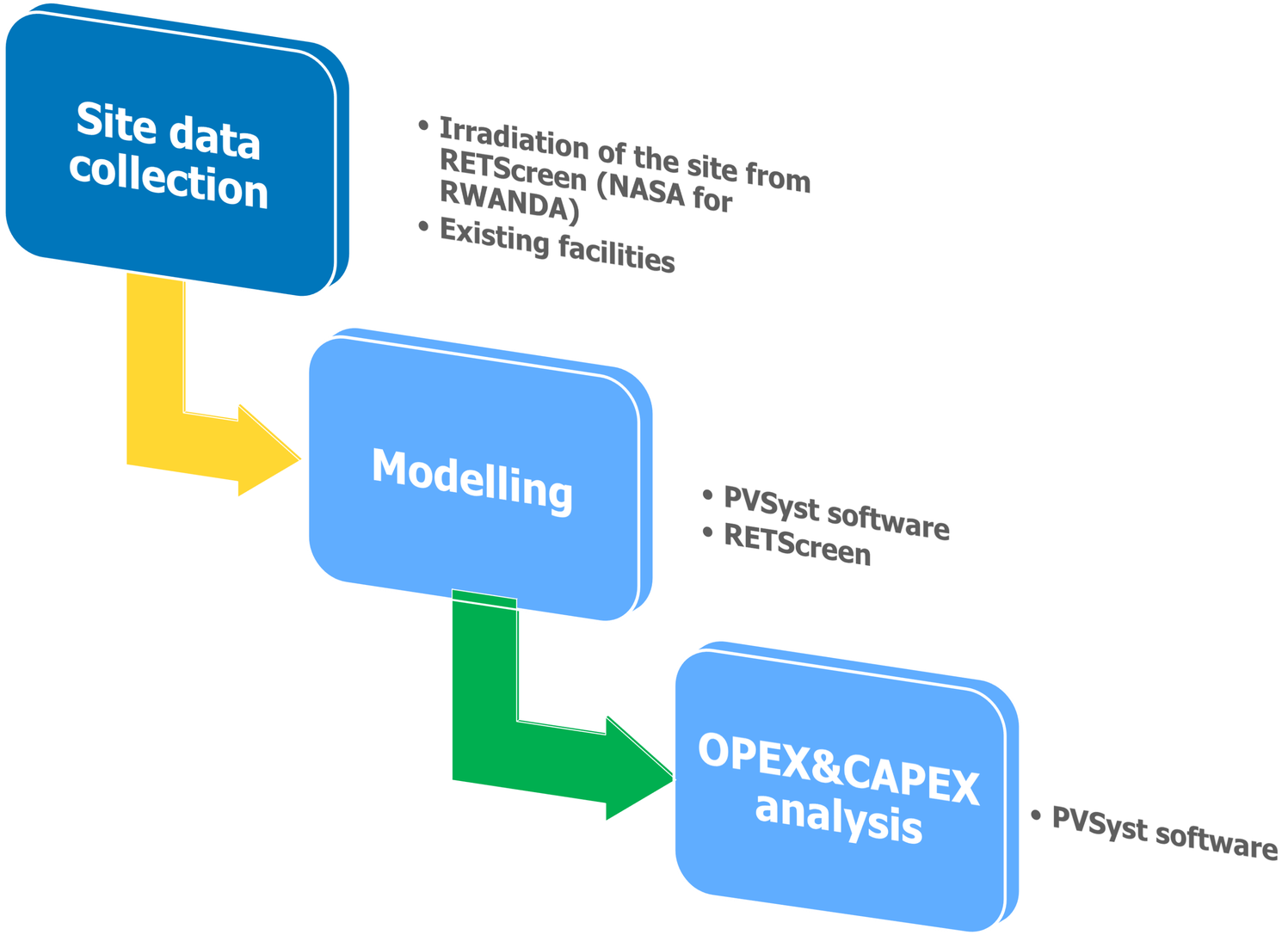



*Figure3: Global floating solar to top 6GW threshold by 2031*

# METHODOLOGY



# FSPV MODELING

## PV Array Characteristics

**PV module**

| | |
|---|---|
| Manufacturer | Generic |
| Model | DS720 |
| (Original PVsyst database) | |
| Unit Nom. Power | 720 Wp |
| Number of PV modules | 5022 units |
| Nominal (STC) | 3616 kWp |
| Optimizer Array | 93 string x 1 In series |
| **At operating cond. (50°C)** | |
| Pmpp | 3380 kWp |
| U mpp | 2144 V |
| I mpp | 1576 A |

**AMPT String Optimizer**

| | |
|---|---|
| Model | V1550-i50-50 |
| Unit Nom. Power | 77400 W |
| Input modules | 2 * 27 in series |

**Total PV power**

| | |
|---|---|
| Nominal (STC) | 3616 kWp |
| Total | 5022 modules |
| Module area | 15600 m² |

**Inverter**

| | |
|---|---|
| Manufacturer | Generic |
| Model | SUN2000-300KTL-H0 |
| (Original PVsyst database) | |
| Unit Nom. Power | 300 kWac |
| Number of inverters | 16 units |
| Total power | 4800 kWac |
| Operating voltage | 550-1500 V |
| Max. power (=>30°C) | 330 kWac |
| Pnom ratio (DC:AC) | 0.75 |
| Power sharing within this inverter | |

**Total inverter power**

| | |
|---|---|
| Total power | 4800 kWac |
| Max. power | 5280 kWac |
| Number of inverters | 16 units |
| Pnom ratio | 0.75 |



*Figure5: SPV Modeling*

# FSPV MDELING

*Table1: PV System sizing parameters*

| Items | Quantity |
|---|---|
| Total number of modules | 5022 |
| Power rating of one module | 720W |
| Number of structures | 74 |
| Modules of each structure | 64 |
| Number of strings | 93 |
| Series connection | 54 modules |
| String inverters | 16 each of 400kW |
| Energy production yield | 7.87 GW per year |
| Performance ratio | 80% |
| Levelized cost of energy (LCOE) | 12 cUSD/kWh for rigid structures |
| | 10 cUSD/kWh for modular structures |

# SIMULATION AND RESULTS

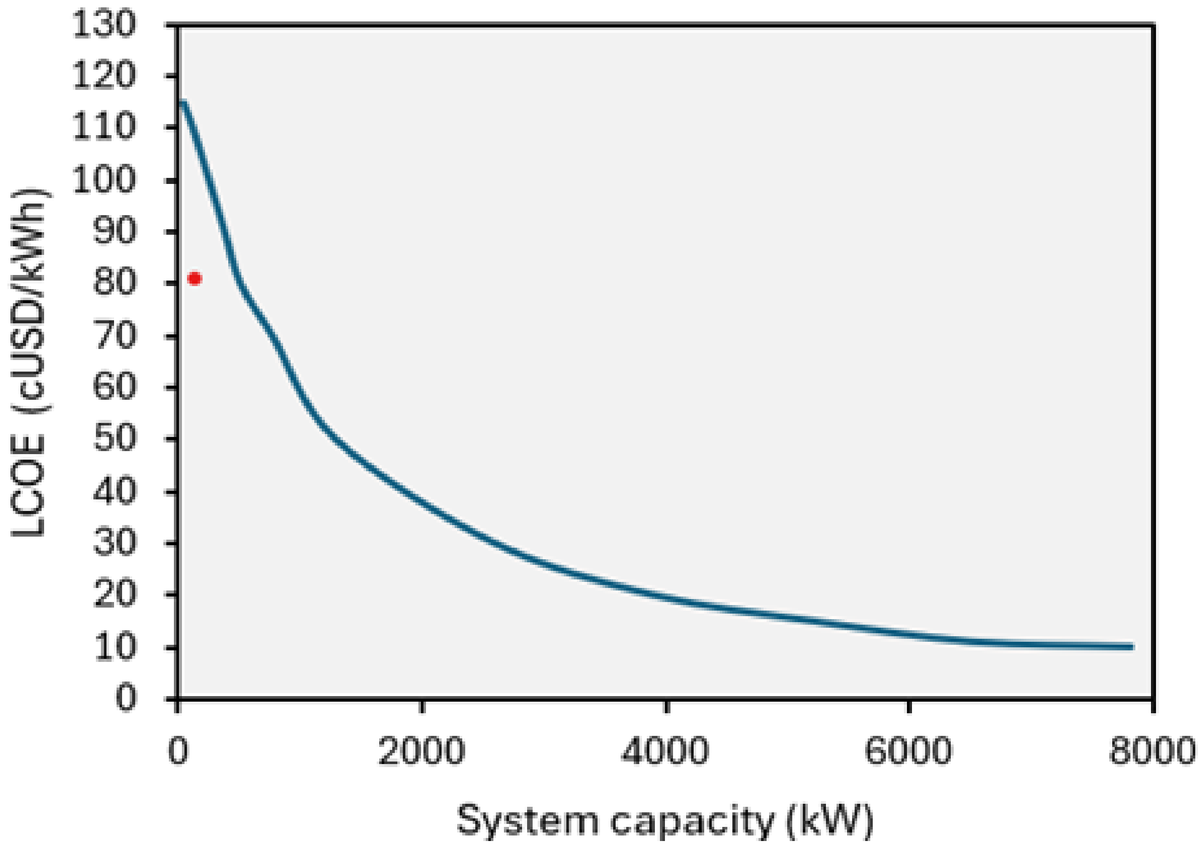



*Figure6: PV System LCOE/KWh*

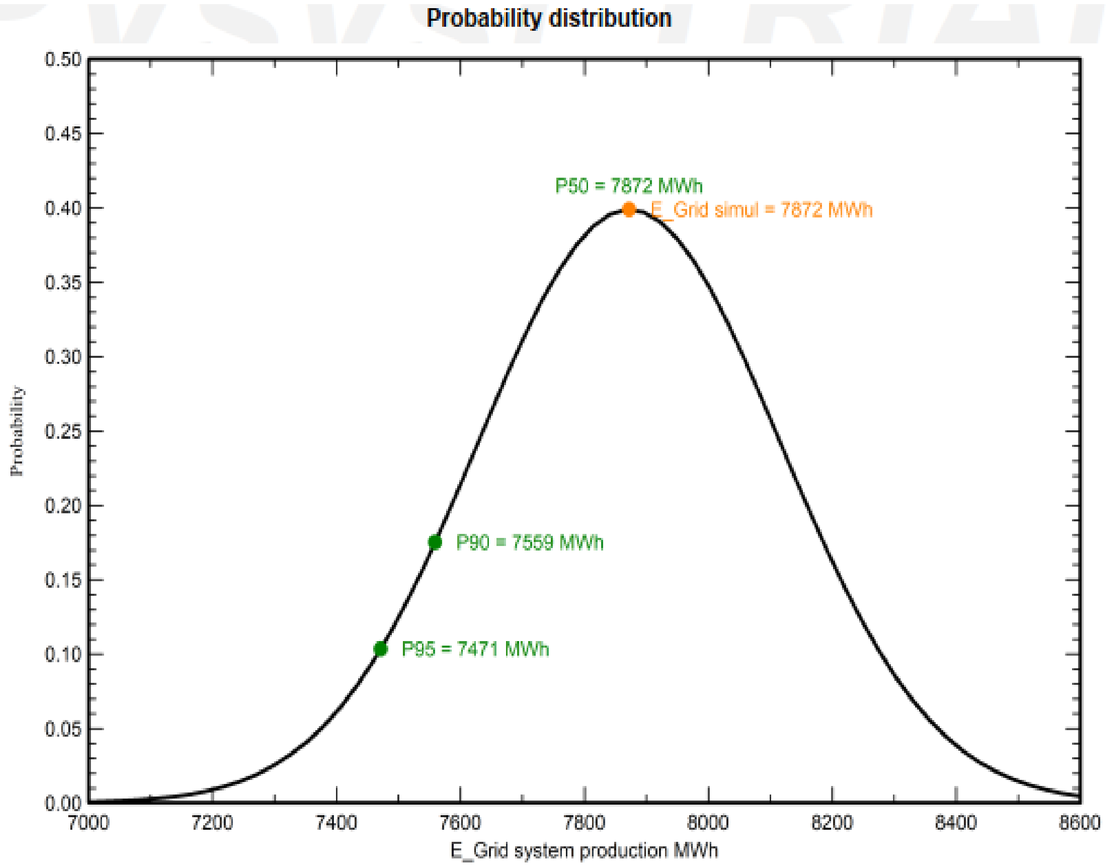



*Figure7: Energy production per year*

# CONCLUSION AND FUTURE PROSPECTS

- FSPV optimizes both energy generation and resource use.
- Improved energy efficiency,
- Reduced land acquisition costs,
- Water conservation make them a compelling solution for meeting global renewable energy targets.
- Economic and environmental benefits of FSPV installations
- Government regulatory support and incentives
- Long-term performance and degradation analysis
- Environmental and socioeconomic impact assessments

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