[LCoE & Cash Flow Analysis]

[George Xydis]

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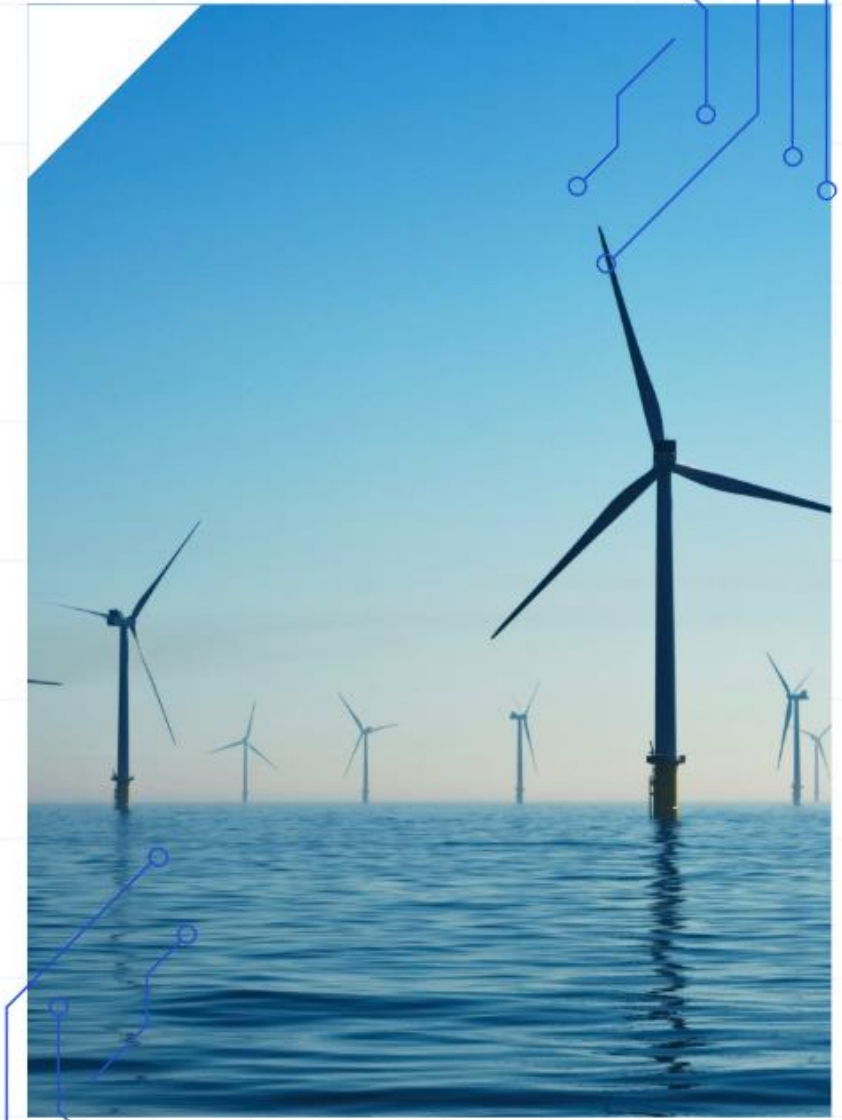
LCOE AND CASH FLOW ANALYSIS IN RENEWABLE ENERGY

This presentation delves into the financial analysis of floating wind turbines and hydrogen production, highlighting LCoE and cash flow management strategies.

GEORGE XYDIS
Aarhus University



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WIND ENERGY ANALYSIS

LCOE & CASH FLOW ANALYSIS FOR WIND ENERGY

An in-depth evaluation of the Levelized Cost of Energy and cash flow dynamics in floating wind turbines and hydrogen production

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INTRODUCTION TO LCOE AND CASH FLOW ANALYSIS

Exploring financial metrics for energy projects

UNDERSTANDING LCOE

LCoE represents the per-unit cost of energy over the lifetime of an energy project, crucial for evaluating cost-effectiveness.

IMPORTANCE OF CASH FLOW ANALYSIS

Cash flow analysis assesses timing and amounts of cash inflows and outflows to ensure project financial viability.

FOCUS ON INNOVATIVE ENERGY SYSTEMS

This presentation emphasizes floating wind turbines and hydrogen production systems, showcasing their financial dynamics.

LCOE CALCULATION TECHNIQUES

Understanding LCoE calculations is vital for comparing different energy projects and making informed investment decisions.

EVALUATING PROJECT VIABILITY

Combining LCoE and cash flow analysis provides a comprehensive view of project feasibility and potential returns.

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OFFSHORE WIND FARM DEVELOPMENT

From Development to Execution to Operation of an offshore wind farm

Through the lens of an Independent Power Producer

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WIND FARM PHASES

Bid Submission

Screening

- Country assessment
- Greenfield assessment
- JV/partnerships
- Land grabbing

Development

- Environmental impact
- Technical assessment
- Business case analysis
- Bid preparation

Execution

- Contract preparation and signing
- Installation

Operation

- 25-35 years
- Maintenance
- Potential divestment

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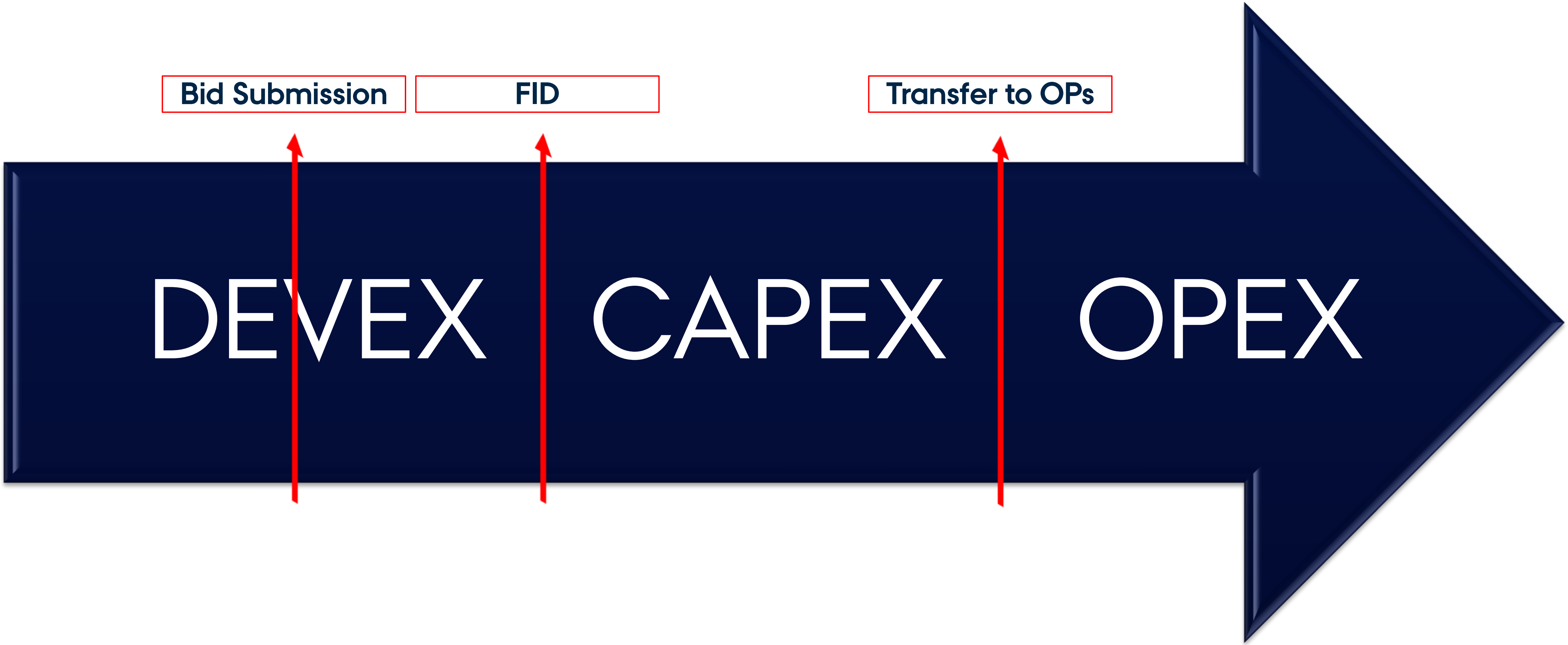
COST TIMELINE & LCOE



LCOE

The **Levelized Cost of Energy (LCOE)** is a key metric used to compare the cost of different energy generation technologies over their lifetime. It is calculated using the formula:

$$LCOE = \frac{\text{Total Lifetime Costs}}{\text{Total Energy Produced Over Lifetime}}$$

$$LCOE = \frac{CAPEX + OPEX + DEVEX + ABEX}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Where:

- **CAPEX (Capital Expenditure):** Upfront investment costs, including equipment, installation, and infrastructure.
- **OPEX (Operational Expenditure):** Ongoing costs like maintenance, fuel, and operational labor.
- **DEVEX (Development Expenditure):** Costs associated with project development, including permitting, feasibility studies, and environmental assessments.
- **ABEX (Abandonment Expenditure or Decommissioning Costs):** Costs for dismantling and restoring the site at the end of the project's life.
- E_t **(Energy Produced at Time t):** The amount of electricity generated in year t.
- r **(Discount Rate):** The weighted average cost of capital (WACC) or another appropriate discount factor.
- n: Project lifetime in years.

LCOE

LCOE expresses the "levelized" unit cost of 1 MWh over the lifetime of the wind farm by taking the sum of the discounted lifetime costs relative to the sum of discounted energy production at the time of the financial investment decision.
LCOE can therefore be expressed as:

$$LCoE = \frac{Present\ value\ (Cost)}{Present\ value\ (Production)}$$

The sum of discounted energy production (the denominator) is the present value of the energy production. The sum of discounted energy production is independent of perspective.

$$Production \sum_{t=k}^{T} \frac{E_t}{(1+W_r)^t} = \frac{E_{year\ 0}}{(1+W_r)^0} + \frac{E_{year\ 1}}{(1+W_r)^1} + \cdots + \frac{E_{year\ T}}{(1+W_r)^T}$$

The discounted lifetime costs (the numerator) is the present value of all expenditures associated with the wind farm. The sum of discounted lifetime costs can be formulated as:

$$Cost \sum_{t=k}^{T} \frac{I_t + O_t + A_t}{(1+W_n)^t} = \frac{I_{year\ 0} + O_{year\ 0} + A_{year\ 0}}{(1+W_n)^0} + \frac{I_{year\ 1} + O_{year\ 1} + A_{year\ 1}}{(1+W_n)^1} + \cdots + \frac{I_{year\ T} + O_{year\ T} + A_{year\ T}}{(1+W_n)^T}$$

Definition of variables:

t	Is the time period
k	Is the earliest period with cash flows or energy production; discount is applied to period 0
T	Is the latest period with cash flow
I_t	Is the cash flow at time t from invest at time t including both nominal DEVEX (development expenditures) and CAPEX (capital expenditures)
O_t	Is the cash flow at time t from nominal OPEX (operational expenditures)
A_t	Is the cash flow at time t from nominal ABEX (abandonment cost)
E_t	Is the electricity production at time t
W_r	Is the real WACC (weighted average cost of capital)
W_n	Is the nominal WACC

WIND FARM SCREENING AND DEVELOPMENT

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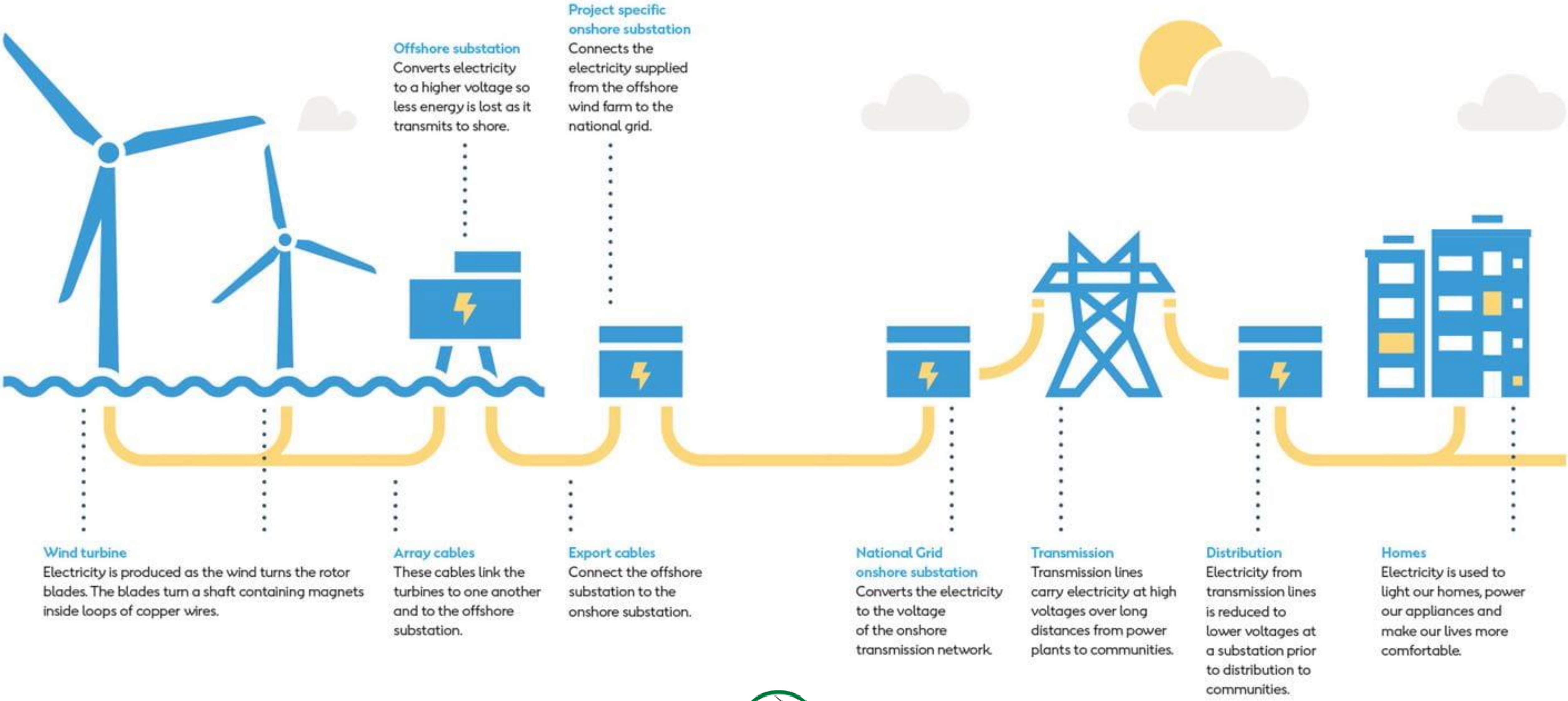
Offshore substation
Converts electricity to a higher voltage so less energy is lost as it transmits to shore.
Project specific onshore substation
Connects the electricity supplied from the offshore wind farm to the national grid.
Wind turbine
Electricity is produced as the wind turns the rotor blades. The blades turn a shaft containing magnets inside loops of copper wires.
Array cables
These cables link the turbines to one another and to the offshore substation.
Export cables
Connect the offshore substation to the onshore substation.
National Grid onshore substation
Converts the electricity to the voltage of the onshore transmission network.
Transmission
Transmission lines carry electricity at high voltages over long distances from power plants to communities.
Distribution
Electricity from transmission lines is reduced to lower voltages at a substation prior to distribution to communities.
Homes
Electricity is used to light our homes, power our appliances and make our lives more comfortable.

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SCREENING OF SITES

Country assessment

- Energy mix
- Other renewables
- Electrical grid
- Electrical market

Political willingness

Overview of potential areas (technical analysis)

Regulatory and offshore wind framework

Market entry

- JV venture or independent entity
- Greenfield analysis
- Land grabbing
    - Lease area auction
    - Gaining site right in other means

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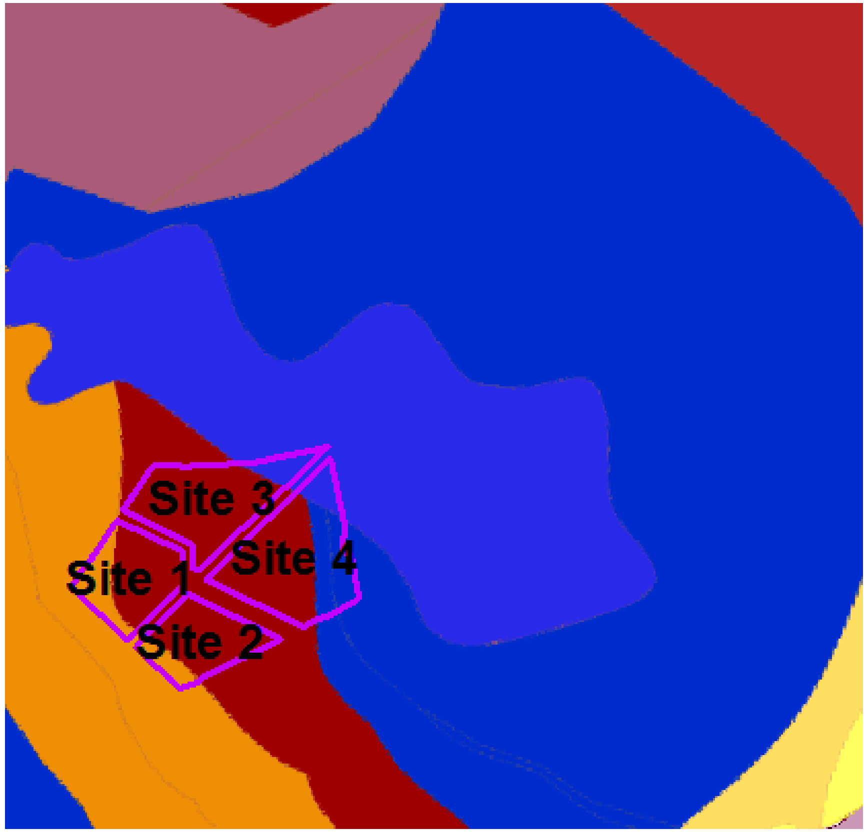
SITE SELECTION



- Soil conditions
- Wind speed and direction
- Bathymetry
- Distance from the shore (?)
- Grid connection
- Harbour vicinity
- Environmental protected areas
- Constraints like: shipping lanes, cables, Unexploded ordnance (UXOs)
- Fisheries

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WIND FARM COMPONENTS

Wind Turbine (WTG)

Foundation/Floaters

Array cable

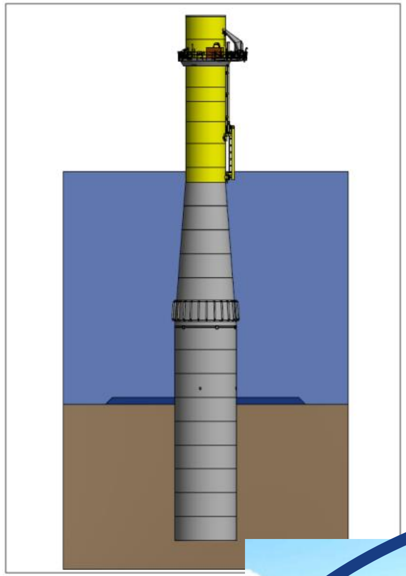
Offshore and Onshore Substation

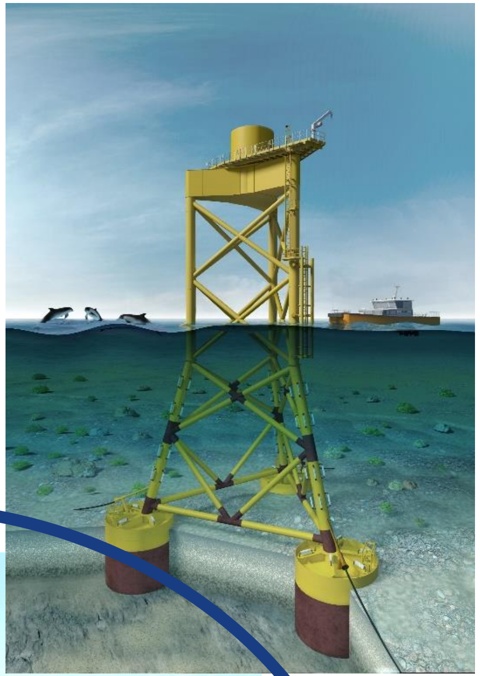
Export cable

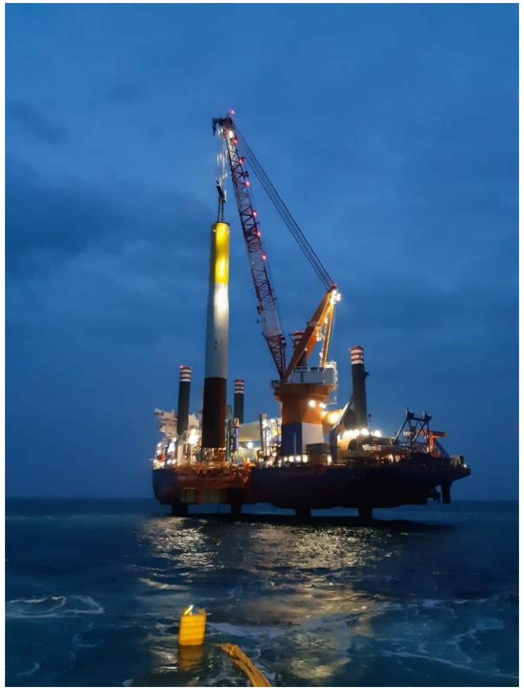
WTG TYPE

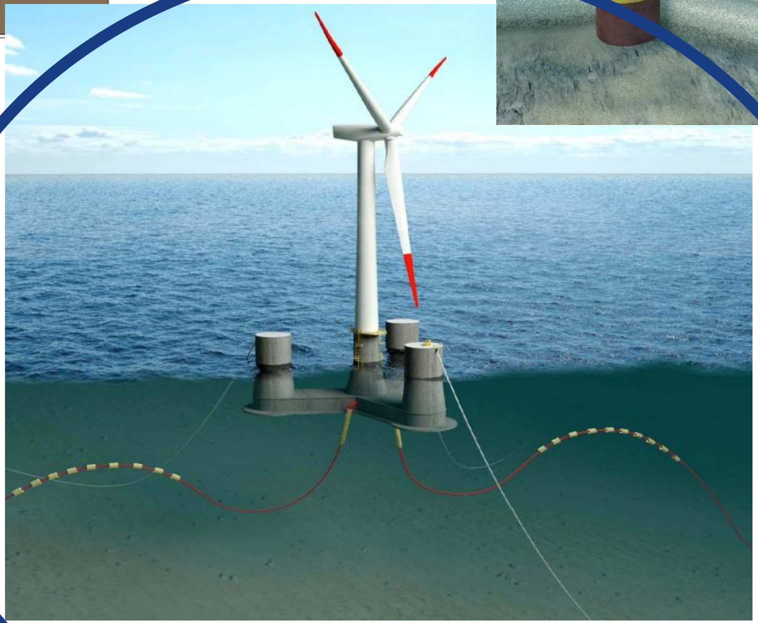
- Wind climate
- Rotor size
- Local content requirements

FOUNDATIONS SUPPLY AND INSTALLATION



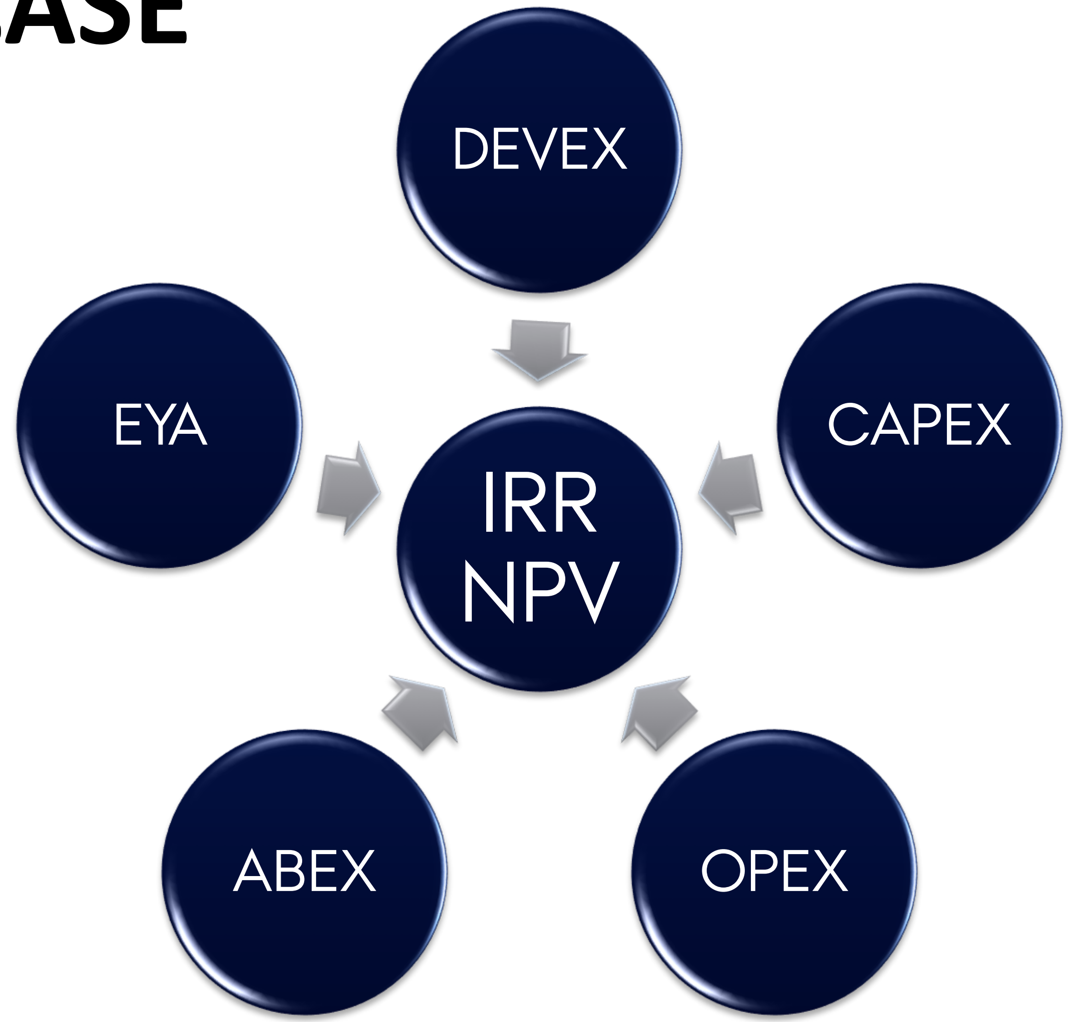






BUSINESS CASE

Important date: **FID**



- Payment plan
- Currency
- Inflation and Exchange rate forecast

AUCTION REGIME

Combination

Beauty contest

- Technical and financial assessment of the developer
- Local content
- Extensive Bid documentation

- Environmental impact assessment
- Supply chain **pain** & Supply chain **plan**

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WIND FARM EXECUTION

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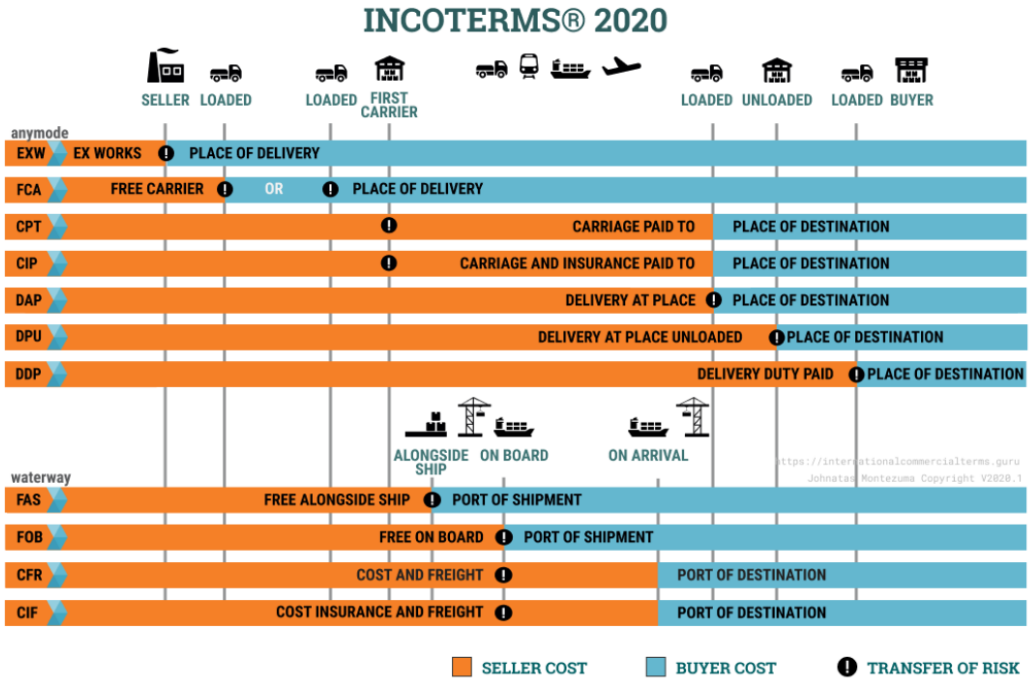
INSTALLATION

Incoterms 2020



HANDOVER TO OPERATION

After complete installation of the entire wind farm and commissioning of the WTGs, it is handed over to operations for the rest of the wind farm lifetime

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AVAILABILITY AND MAINTENANCE

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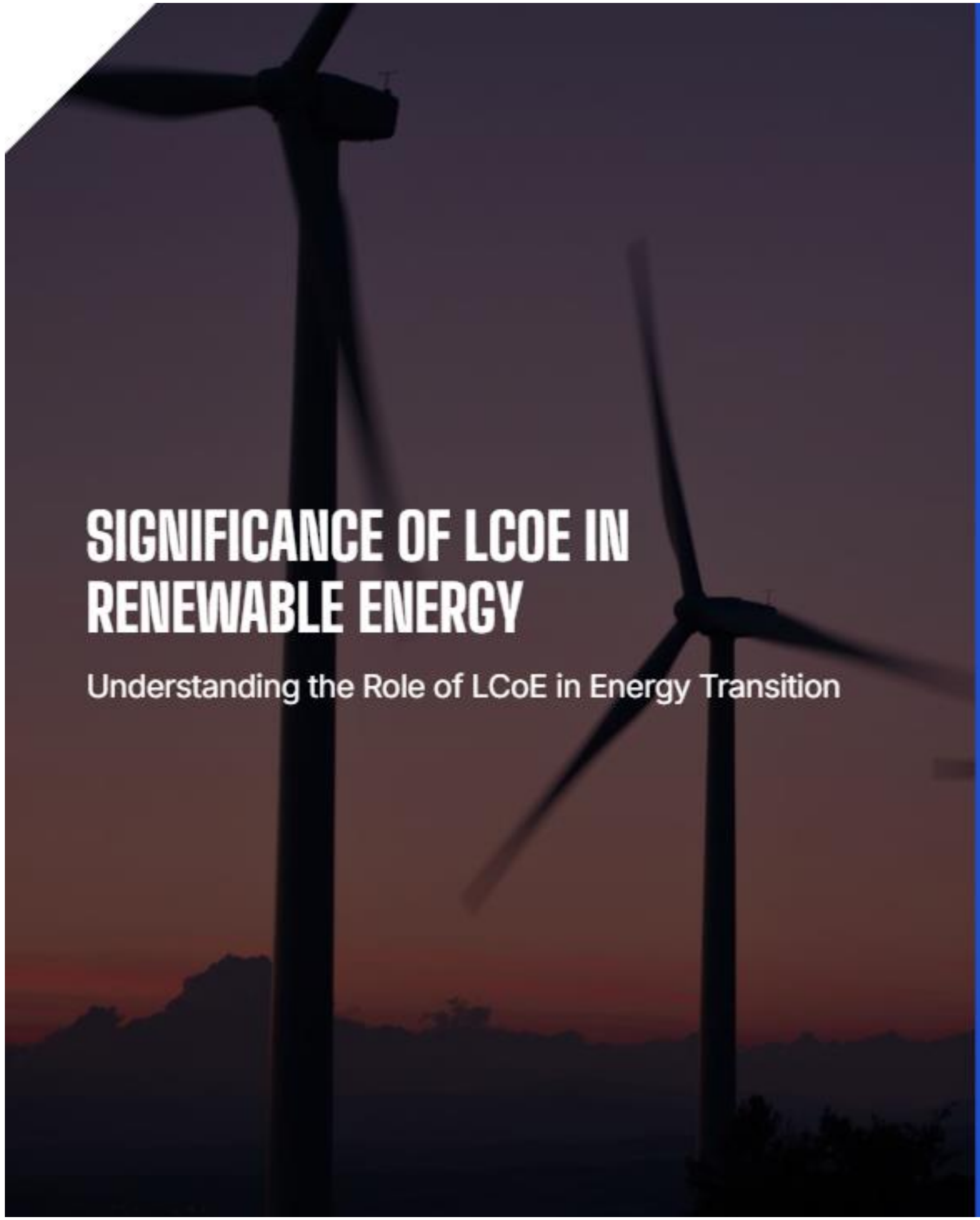

SIGNIFICANCE OF LCOE IN RENEWABLE ENERGY

Understanding the Role of LCoE in Energy Transition

COMPETITIVENESS OF RENEWABLE ENERGY

LCoE determines how competitive renewable sources are against fossil fuels.

INVESTMENT DECISIONS

LCoE aids in making informed investment decisions and shaping effective policy-making.

PROJECT FINANCING INFLUENCE

LCoE significantly influences project financing options and ensures long-term sustainability.

ATTRACTIVENESS OF INVESTMENT

A lower LCoE indicates a more viable and attractive opportunity for investors.

OVERVIEW OF FLOATING WIND TURBINES

Key Features and Advantages of Floating Wind Technology

OFFSHORE WIND TURBINES

Floating wind turbines are mounted on floating platforms, enabling energy generation in deeper waters.

ENERGY GENERATION POTENTIAL

These turbines allow for energy generation where fixed installations can't be implemented due to depth.

HIGHER WIND SPEEDS

Floating wind turbines are located in areas with consistently higher wind speeds, maximizing energy output.

REDUCED ENVIRONMENTAL IMPACT

They minimize visual and environmental impacts on coastal areas, preserving natural landscapes.

SCALABILITY AND LARGER INSTALLATIONS

Floating platforms can support larger installations, allowing for scalability in energy production.

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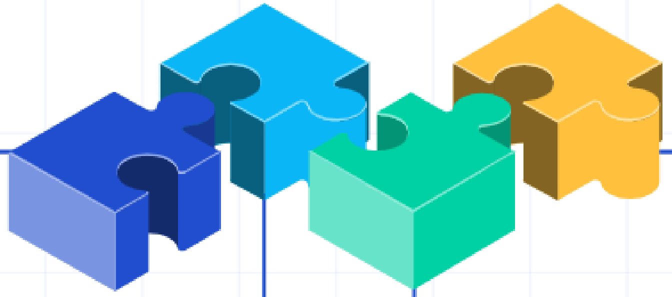
CASH FLOW DYNAMICS IN WIND PROJECTS

Understanding financial aspects of floating wind energy



01

SUBSTANTIAL INITIAL INVESTMENT

Floating wind projects require significant capital for construction and installation.

02

REVENUE GENERATION

Revenue is primarily generated through power purchase agreements (PPAs) alongside government incentives.

03

OPERATING EXPENSES OVERVIEW

Operating costs include maintenance, insurance, and staffing, impacting overall cash flow.

04

SEASONAL CASH FLOW MODELING

Cash flow modeling must consider seasonal variations in energy production and market prices.

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INTRODUCTION TO HYDROGEN PRODUCTION

Exploring hydrogen's role in energy sustainability

01 HYDROGEN AS A CLEAN ENERGY CARRIER

Hydrogen serves as a clean energy carrier, crucial for sustainable transportation and industrial applications.

02 PRODUCTION METHODS

Main hydrogen production methods include electrolysis with renewable energy and natural gas reforming.

03 ENHANCING SUSTAINABILITY

Integrating hydrogen production with renewable energy sources significantly boosts overall sustainability.

04 REVENUE STREAMS FOR WIND PROJECTS

Hydrogen production can create additional revenue opportunities for wind energy projects, enhancing profitability.

CASH FLOW CONSIDERATIONS FOR HYDROGEN SYSTEMS

Understanding financial dynamics in hydrogen production

INITIAL INVESTMENT REQUIREMENTS

The upfront costs for electrolyzers and necessary infrastructure are significant.

REVENUE GENERATION POTENTIAL

Hydrogen sales to industries and transportation sectors can yield substantial revenue.

OPERATIONAL COST FACTORS

Ongoing expenses include energy, maintenance, and compliance with regulations.

ECONOMIC VIABILITY ASSESSMENT

The feasibility of hydrogen systems is affected by market prices and demand fluctuations.

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INTEGRATING WIND TURBINES AND HYDROGEN PRODUCTION

Exploring the Benefits of Dual Energy Systems

SYNERGISTIC BENEFITS

Pairing floating wind turbines with hydrogen production amplifies energy efficiency.

EXCESS ENERGY UTILIZATION

Wind energy can be converted to hydrogen, effectively balancing supply and demand.

REVENUE DIVERSIFICATION

Combining energy and hydrogen production enhances project financial resilience.

CASH FLOW ANALYSIS

Consider both energy sales and hydrogen revenue for comprehensive financial planning.

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KEY METRICS FOR LCOE EVALUATION

Understanding Financial and Operational Factors

TOTAL CAPITAL COSTS (CAPEX)

Consider all initial investments required for the project.

OPERATIONAL COSTS (OPEX)

Evaluate recurring costs necessary for operation over time.

ANNUAL ENERGY PRODUCTION ESTIMATES

Estimate the yearly energy output to assess project viability.

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METHODOLOGY STEPS FOR CASH FLOW ANALYSIS

IDENTIFY CASH INFLOWS

Recognize all sources of cash inflows, such as energy and hydrogen sales, vital for analysis.

ESTIMATE CASH OUTFLOWS

Assess all cash outflows including CAPEX and OPEX to understand total project costs.

DEVELOP CASH FLOW MODEL

Create a comprehensive cash flow model to project financial performance throughout the project lifecycle.

APPLY DISCOUNT RATES

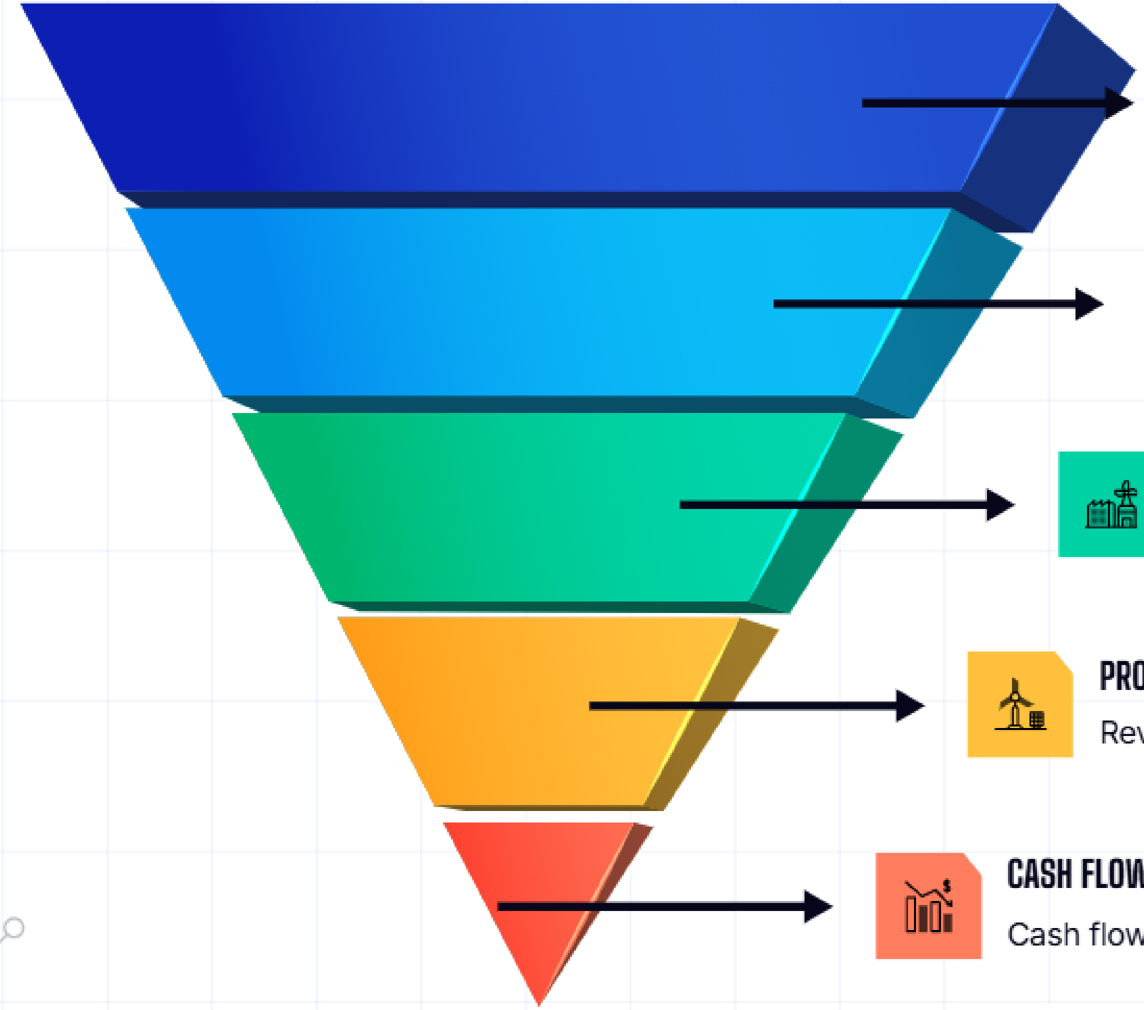
Utilize appropriate discount rates to calculate the Net Present Value (NPV) for better investment appraisal.

CONDUCT SENSITIVITY ANALYSIS

Perform sensitivity analysis to evaluate the impact of various scenarios on cash flow and project viability.

CASE STUDY: FLOATING WIND TURBINES

Overview and Financial Analysis



PROJECT OVERVIEW

This case study focuses on a pioneering floating wind turbine project.

INITIAL INVESTMENT

The initial investment for the project was $X million.

ANNUAL PRODUCTION

The project aims for an expected annual production of Y MWh.

PROJECTED REVENUE

Revenue from energy sales is projected to reach $Z million per year.

CASH FLOW TRENDS

Cash flow over the first decade shows positive trends post investment recovery.

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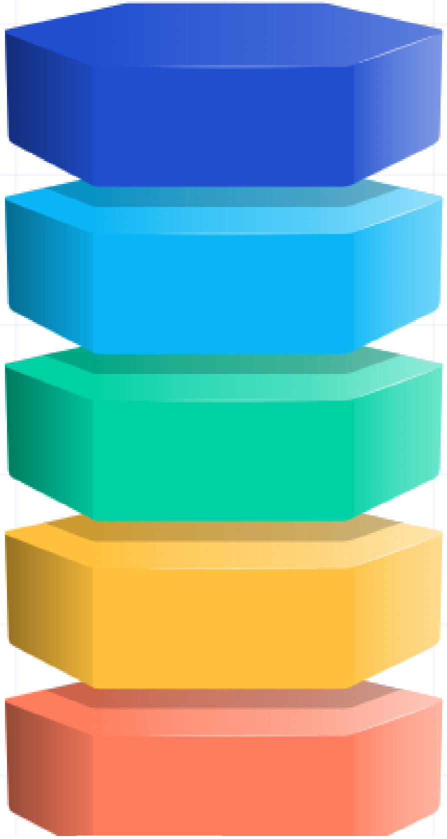
CASE STUDY: HYDROGEN PRODUCTION SYSTEMS

Exploring the financial viability of hydrogen systems



INTEGRATION WITH WIND ENERGY

This facility merges hydrogen production with wind energy, optimizing renewable resource use.

INITIAL INVESTMENT DETAILS

Initial costs are projected at $A million, a crucial factor for stakeholders.

PRODUCTION PROJECTIONS

The facility aims for a hydrogen output of B kg/year, showcasing its capacity.

SALES REVENUE ESTIMATES

Hydrogen sales are expected to generate $C million annually, indicating strong market demand.

PROFITABILITY TIMELINE

Projected cash flow suggests profitability within D years, appealing to investors.

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COMPARATIVE CASH FLOW ANALYSIS OF FLOATING WIND VS. HYDROGEN PRODUCTION

Key Metrics Comparison

METRIC	FLOATING WIND	HYDROGEN PRODUCTION
Initial Investment ($)	X	A
Annual Revenue ($)	Z	C
Payback Period (Years)	P	D
NPV ($)	N	M

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CHALLENGES AND RISKS IN ENERGY AND HYDROGEN SECTOR

MARKET VOLATILITY

Fluctuations in energy and hydrogen prices can disrupt cash flow stability.

REGULATORY CHANGES

Shifts in regulations can significantly impact profitability and operational strategies.

TECHNICAL RISKS

Floating wind technology and hydrogen production methods carry inherent technical challenges.

FORECASTING NEEDS

Accurate forecasting is essential for managing risks and ensuring financial health.

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CONCLUSION AND KEY FINDINGS

Insights on Floating Wind and Hydrogen Integration

01

LCOE AND CASH FLOW ANALYSIS

These analyses are crucial for evaluating the viability of floating wind turbines and hydrogen production systems.

02

SYNERGISTIC BENEFITS OF INTEGRATION

Combining floating wind turbines with hydrogen production enhances economic resilience and operational efficiency.

03

IMPORTANCE OF METHODOLOGIES

Employing comprehensive methodologies and sensitivity analyses is essential for informed decision-making in energy projects.

04

FUTURE RESEARCH DIRECTIONS

Research should aim to refine existing models and investigate policy implications for sustainable energy investments.

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THANK YOU

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