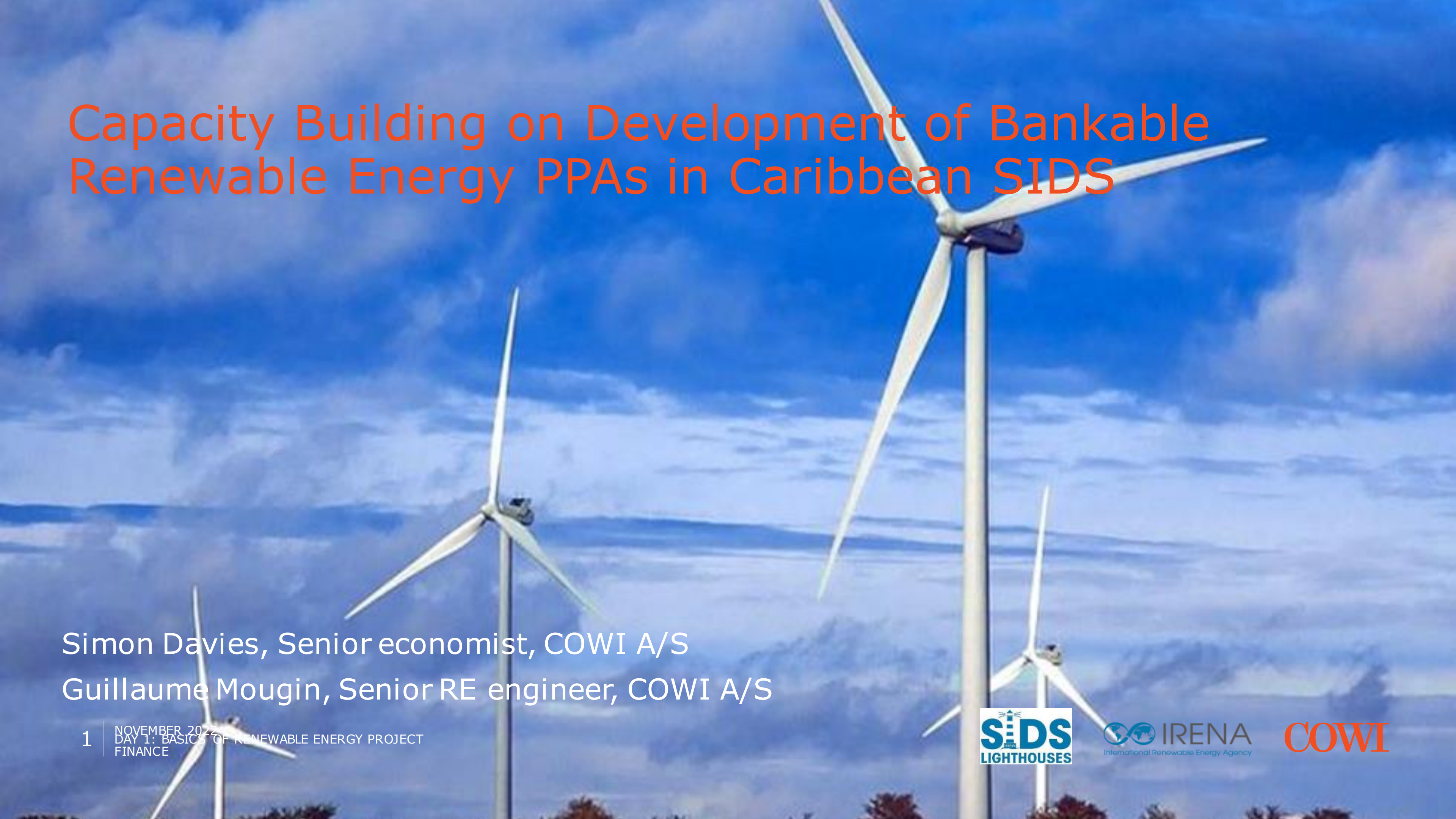


Capacity Building on Development of Bankable Renewable Energy PPAs in Caribbean SIDS

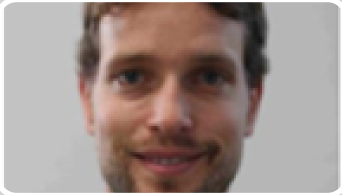
Simon Davies, Senior economist, COWI A/S

Guillaume Mougin, Senior RE engineer, COWI A/S

Who are we?

Simon Davies

- COWI
- Senior economist
- Specialized in power sector modelling looking at financial and power flows



Guillaume Mougin

- COWI
- Mechanical engineer
- Senior specialist in renewable energy with a strong focus on wind

- COWI

Together with customers, partners and colleagues, we shape a future where people and societies grow and flourish. We do that by co-creating sustainable and beautiful solutions that improve the quality of life for people today and many generations ahead.

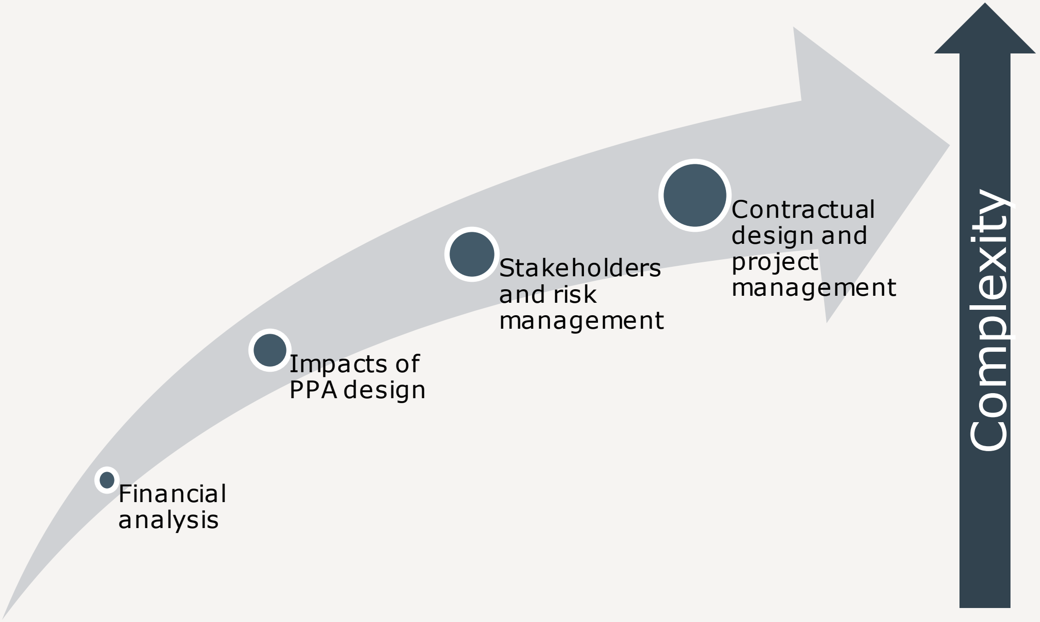
Our starting point is gaining a deep understanding of our customers, their aspirations and concerns. This is what sets us apart and how we deliver long-term value.

Primarily located in Scandinavia, the UK, North America and India, we currently number 6,800 people, who offer our expertise in engineering, architecture, energy and environment.

Focus on the PPA

- Agreement between producer and off taker of electricity on the price, quality, quantity etc.. of electricity
- Ensures stability, confidence and transparency
- Necessary for long term loan financing
- Draws on private equity
- Ensures the off taker receives what it is paying for
- Without a PPA? No private equity, no financing.

Course concept



Course overview

Day 1
- Basics of renewable energy finance
- Basic exercises on RE project finance

Day 2
- Financial modelling of PPA contracts
- Exercises on PPA modelling

Day 3
- Stakeholders and risk management
- Roleplaying exercises on PPA bidding

Day 4
- Complex negotiations for finalizing PPAs
- Recap and Open Q&A

Keep it simple

- Making things complex and difficult is easy
- Simplifying and streamlining is very difficult
- But the rewards for simplifying are that much greater
- Learning

DAY 1

Basics of Renewable Energy Finance

- How Renewable Energy projects are financed
- Technical aspects: Renewable energy technologies, Energy Production Profiles, Curtailment, Descriptions of the concept and importance of P50 versus P90/P95 estimates of yield.
- Basics of cash flow modelling and importance of financial indicators
- Basic exercises on RE project finance i.e. not in consideration of PPA contract aspects yet

Financing Renewable Energy

Project financing vs corporate/balance financing

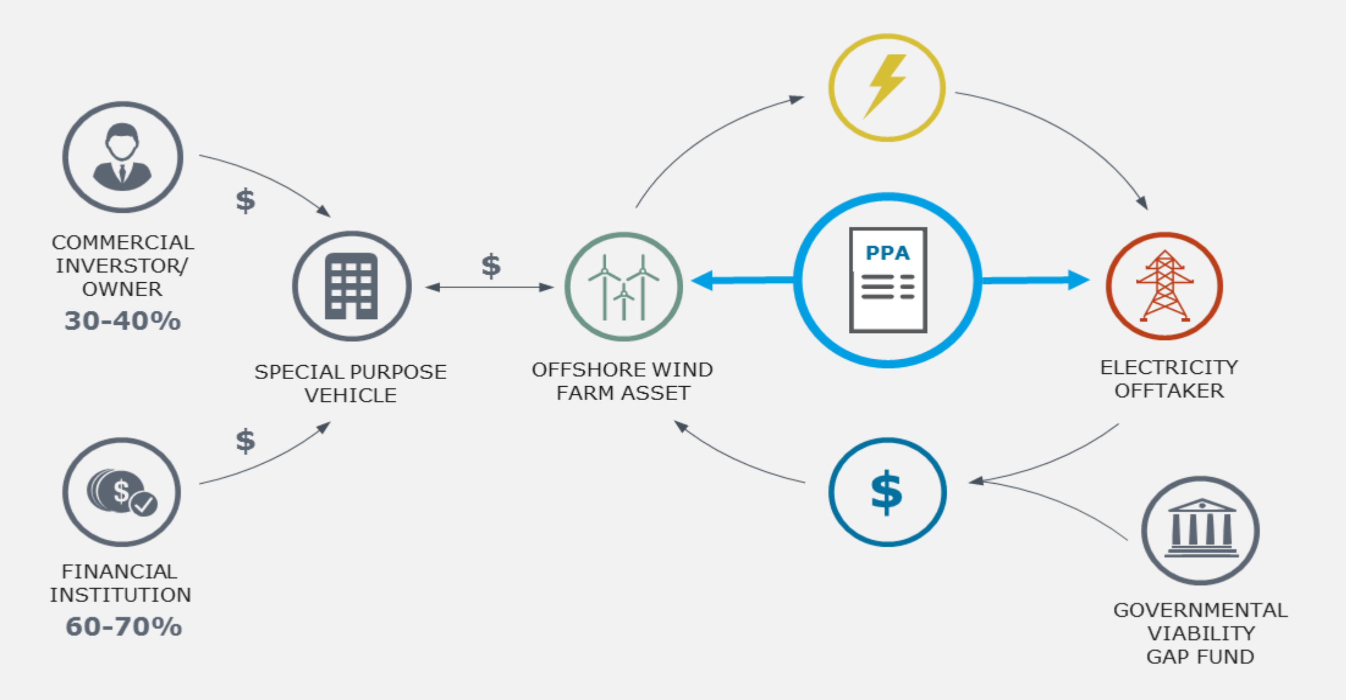
Project financing

- Renewable energy projects are very often structured around a “Special Purpose Vehicle”
  - Owns and operates the RE assets
  - Is a separate unit
  - Loans taken by the SPV have no recourse outside the SPV
    - only security is the assets and the revenue stream from those assets

Corporate financing

- Firms may use loan financing to invest in new or replacement capacity
  - Loans have recourse in the firm’s total balance sheet rather than just the asset
  - Perceived as less risky by lending institutions

Public private partnerships



Project cost components

Non-exhaustive list

CAPEX

- Generators
- Civil works
- Electrical infrastructure
- Management

OPEX

- Operations: e.g. salaries of staff and land lease
- Maintenance: Scheduled and Non Scheduled

Penalties

- Delays
- Over/under production

Financial transaction costs

- Cost of capital: Interest on loans, return on equity
- Cash reserves
- Exchange rate risk

Taxes

- Corporate income taxes
- VAT, duties, energy taxes

Project revenues

Energy

- Primary output
- Satisfies demand
- Crowd out fossil fuels

Capacity

- System services, e.g. balancing, reserve capacity, frequency response, inertia

PPA tariff

- Main parameter of the PPA contract
- Guarantee of cash flow for debt service

Curtailment compensation

- Important for variable renewable energy

Capacity remuneration

- Replacing thermal generation can be difficult due to the loss of system services

Renewable energy generation

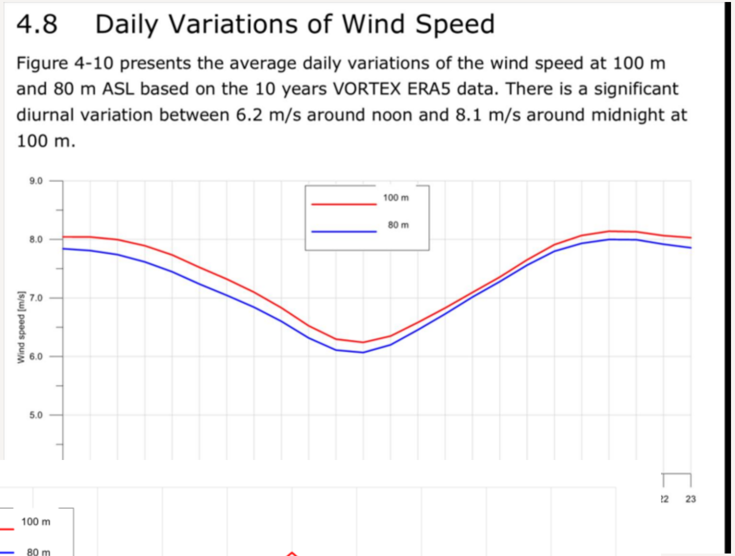
Dispatchable vs non-dispatchable generation

- Dispatchable energy generation refers to technologies where the energy production is controllable
  - The production can be adjusted within a short period of time to match consumption
- Non-dispatchable (variable) generation refers to technologies where the energy production cannot be adjusted to meet demand (at least not 100%).
  - Production can be curtailed which leads to loss of revenue
  - Vital that curtailment is kept to a minimum
  - Little value in requiring non-dispatchable technologies to comply with pre-defined production schedules

- Many RE technologies are non-dispatchable
  - High investment costs per unit of capacity and low operating costs
- Dispatchable units such as fossil-fuelled thermal power have a much lower investment cost per unit of capacity
  - High fuel/operating costs
  - Less sensitive to the total energy generation.

Wind

- Has been deployed in many countries to convert the energy form the wind into electricity
  - Large variation in size from one application to another
  - Small wind turbines sizes start at 50 kW
  - The largest two-digit MW models are deployed in large/utility scale offshore wind projects
  - Can be a very cost-effective technology for variable electricity generation.



4.8 Daily Variations of Wind Speed

Figure 4-10 presents the average daily variations of the wind speed at 100 m and 80 m ASL based on the 10 years VORTEX ERA5 data. There is a significant diurnal variation between 6.2 m/s around noon and 8.1 m/s around midnight at 100 m.

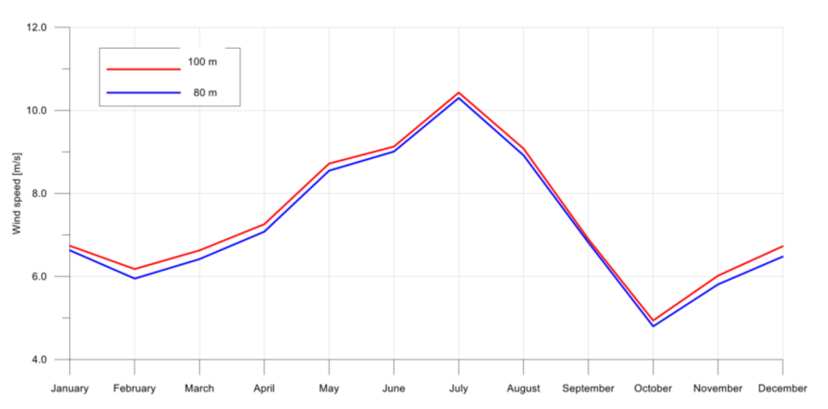
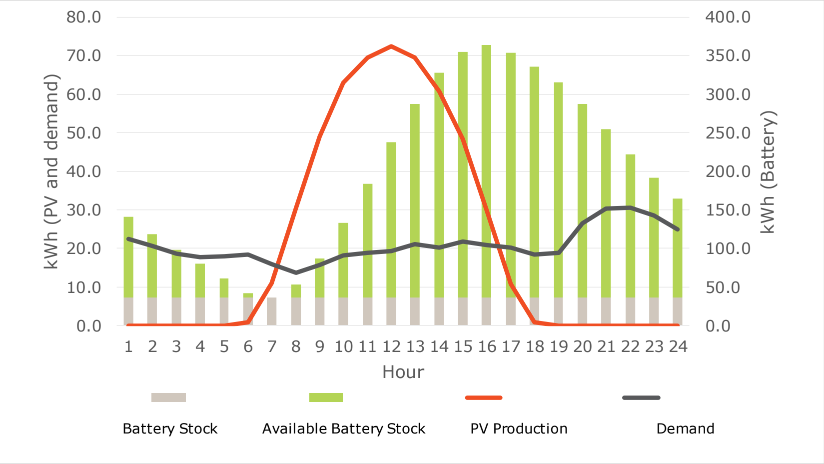


Figure 4-11 Monthly variation of wind speed.

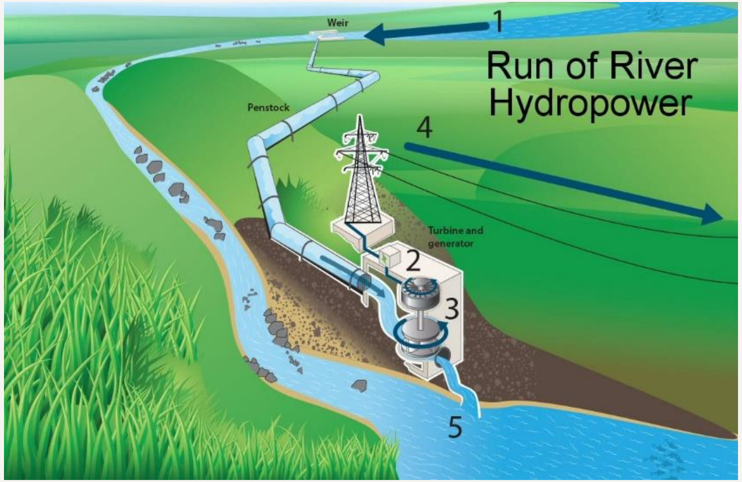
Solar

- One of the fastest growing energy sources in the world
  - Is expected to overtake all other RE sources during the next decades
    - Steep cost reduction curve
    - Modularity features
    - Low operational impacts (e.g. no noise, emissions, moving parts)
  - Small distributed rooftop energy production to large scale solar plants of 200 MW and more
- Resource is readily available
- Non-dispatchable i.e. variable production
- Energy storage to even out day-night cycle is feasible



Hydro

- Hydropower plants are a well matured technology based on natural water cycles
- Hydropower alone contributes to approximately 15% of the world's electricity production and a very large portion of the world's RE generation
- When a reservoir is present, hydropower can benefit from storage and power production regulation with minute-by-minute responses to demand fluctuations and grid stability needs
- Plant sizes can vary from single turbines for localized generation to several GWs such as the 14 GW Itaipu project in Brazil and the 22.4 GW Three Gorges project in China.
- Requires a quite steep gradient and a source of water
- Dispatchability depends on type and water source
    - Reservoir allows for dispatchability and scheduling
- CAPEX can be high if building a reservoir in additional to higher environmental impacts incl. flooded areas

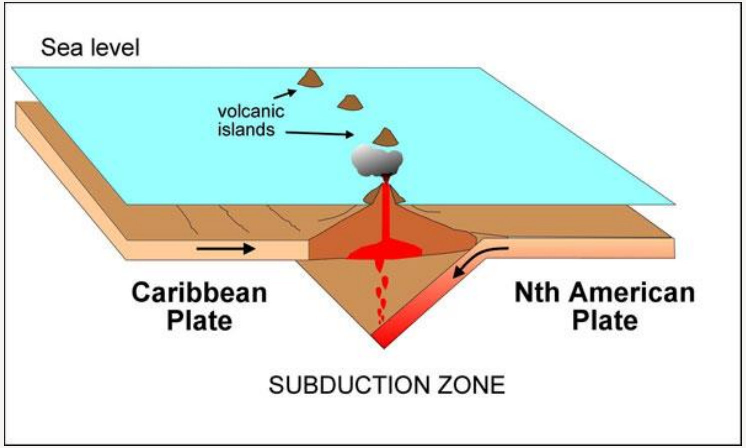


Thermal biomass

- Consists of converting the energy from feedstock sources into electricity and potentially heat as well
- The most common biomass-to-energy technology is combustion plants using a water/steam boiler
  - Plant sizes typically vary from 1 to +40 MWe
- Types of biomass/feedstock sources:
  - straw, bamboo, corn cobs, manure, banana peels, etc
  - Each with different calorific values and application processes
- Best with a local source of sustainable biomass
  - Certification!
- Production is predictable IF! feedstock is available

Geothermal

- Geothermal activity in the Earth's crust creates heat that increases the temperature of the water reservoirs, which produces steam.
- The steam can either be used to rotate turbines generating electricity or used for heating purposes.
  - High enthalpy – temperatures above 150 ^{0}C necessary to produce electricity
  - Usually found in in areas with high tectonic activity such as the Caribbean where the North American plate is being subducted under the Caribbean plate, e.g. the Sumatra-Andaman subduction zone
- Geothermal energy is independent of the weather and has capacity factors of 90%
  - Useful for production of baseload energy or for balancing other RE productions



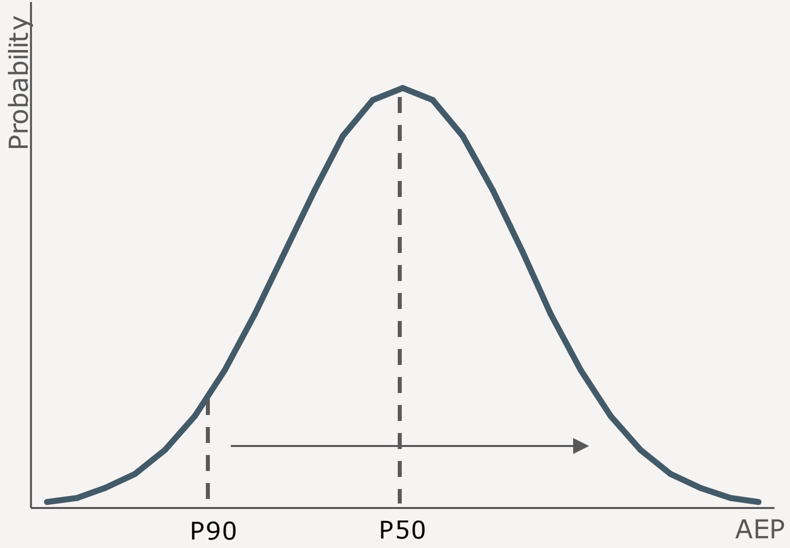
Battery

- Lithium-Ion batteries have fast become the standard most used energy storage technology
  - high-power short-term storage or high-energy longer-term storage
  - Different setups required depending on the use case, short term vs long term or energy vs power
- Battery capacity should match the RE installation for the lowest cost
  - Rule of thumb: 3 MWh battery capacity per 1 MW RE nominal capacity
  - High uncertainty on this!

Pxx estimates

Uncertainty of variable renewable energy generation

- The uncertainty of RE generation is managed by probability exceedance estimations (the PXX values)
- Uncertainty sources include:
  - Resource data and yield modelling
  - Electrical loss and performance estimates
- The expected energy yield is calculated for different probability levels
  - P50: is the net yield before uncertainties i.e. the median value
  - P90: accounts for uncertainty (in the form of a standard deviation, σ) and denotes the expected yield in the 10th percentile case
    - 90% probability of being exceeded



Variable energy production and contractual obligations (Caribbean)

- Variable generation presents a challenge in terms of balancing and system integrity
  - PPA contracts will often specify commitments in terms of energy and capacity
- The variation in generation is specific to each technology
  - Commitments and penalties need to take this into account
- In the Excel tool, variation is reflected in the "AEP time series" option under energy production
  - This replaces the static Pxx estimate with an annual time series
  - Does not capture all aspect of variability, but it is an approximation

Time horizon	Solar PV	Wind	Hydro	Geothermal	Biomass
Intra/ inter day variation	Binary day/night variation	No consistent day/night variation	May depend on precipitation	Dispatchable, with very high ramp rates	Dispatchable in the short term
Weekly/ seasonal variation	Cloud cover may be more prevalent in some seasons	High seasonal variation	Dry/wet seasons	Dispatchable, depends on reservoir	Depends on the supply of biomass
Inter annual variation	Little variation	Little variation	Droughts and dry/wet years	Dispatchable, depends on reservoir	Depends on the supply of biomass

Basics of project financial analysis

Cash flow modelling

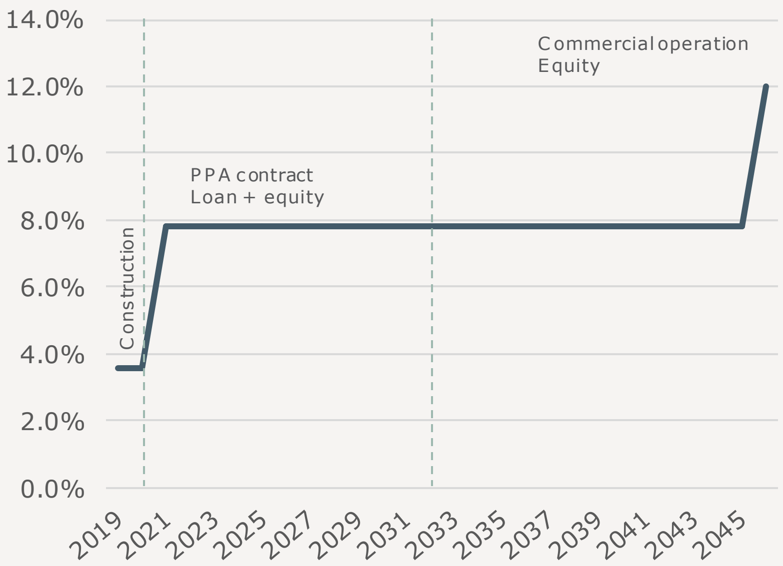
- The cash flow waterfall is one of the most important elements in project finance
  - Allocates available cash to different recipients by seniority/priority
  - Vital in demonstrating that the cash flow generated by the project is enough to cover all liabilities
- In order from top to bottom is:
  - Interest income
  - Tax
  - Maintenance CAPEX
  - Senior and junior debt service
  - Movements in the debt reserve account DSRA
  - Cash sweep
  - Returns to equity.

Funding

- Loans are the primary source of financing for RE projects
- Senior loans are long term and the first in line to be repaid from available cash.
  - Securities in the physical assets
- Junior loans with no security in physical assets are sometimes required
  - Significantly higher interest rate
  - Are only repaid after senior loans have been served.
- Special purpose loans during construction are also common
  - High interest rate
  - Very little security in physical assets
  - Converted into senior and junior loans at the commencement of operations
- Duration of the loans (the tenor) does not need to equal the technical life of the project
  - Loan tenors shorter than the project life are common
  - The loan tenor will very likely be shorter than the duration of the PPA contract

WACC

- The Weighted Average Cost of Capital (WACC) is a measure of the average cost of employing the capital needed for the project
- The WACC simply weighs the interest rate of each source of capital by the sources' share of total CAPEX
- Differences in loan tenor, PPA contract duration and technical life can complicate the concept of WACC
- The WACC is a key concept used in several financial indicators such as NPV and LCOE and to asses IRR.



NPV

- The Net Present Value (NPV) of a project is the simplest indicator of a financially sound project
- Positive NPV means the return on investment will be higher than expected
- NPV discounts all costs and revenues from the project to present value by using the WACC as discount rate
- Allows comparison of CAPEX today with a revenue stream in the future

LCOE

- The Levelized Cost of Electricity
- Main indicator for comparison of economic performance of different energy projects
- LCOE compares:
  - Discounted value of all project costs
  - Discounted value of the electricity generated by the project
- LCOE is the average cost of one unit of electricity over the lifetime of the project

- LCOE does not take into consideration:
  - Changes to cash flow
  - Risks
  - Incentives

IRR

- Internal Rate of Return
- A measure of the discount factor needed to make the NPV equal to zero
- Can be compared to the WACC for a quick assessment of the financial feasibility of the project
  - IRR higher than the WACC indicates that the project will yield a higher return on investment than expected
- At times, this value is also referred to as the Project IRR.

$$NPV = 0$$

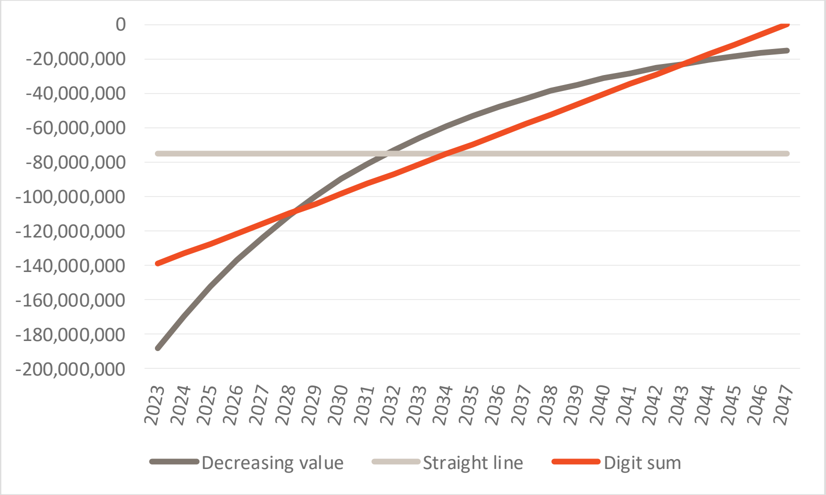
DSCR/DSRA

- Debt Service Coverage Ratio
  - An indicator of the ability of the project to serve its debt
  - Calculated as the cash available for debt service divided by the debt service obligations
  - Calculated for each period in the financial analysis
  - DSCR values above 1 indicate that the project is able to serve its debt in that period
  - Minimum DSCR over the entire project lifetime should never fall below 1, and financial institutions may require a minimum DSCR that is much higher.
    - Typically 1.2 to 1.3

- Debt Service Reserve Account
  - A cash reserve account
  - Targeted at providing additional cash in periods where the DSCR would otherwise fall below the minimum DSCR target
  - In periods with excess cash the DSRA can be filled up again
  - The DSRA is particularly useful in projects with high variability in revenues, e.g. variability in RE generation due to seasonality.

Depreciation

- Depreciation is the gradual decline in the value of physical assets as they are worn down
- Depreciation is an accounting measure
  - It does not have to replicate the exact value of the physical assets
  - Depreciation is often based on rules rather than actual value
- Three common ways to estimate depreciation are:
  - Straight line
  - Decreasing value
  - Digit sum



Taxes

- Corporate income tax
  - Corporate income tax is typically a percentage of earnings after interest on debt has been paid
  - Depreciation can have a big impact on tax payments
- VAT and import duties
  - Relevant especially when project components are imported
- Public funding of RE projects is sometimes achieved via tax credits
  - Partially lifts the tax burden from RE projects

Currency

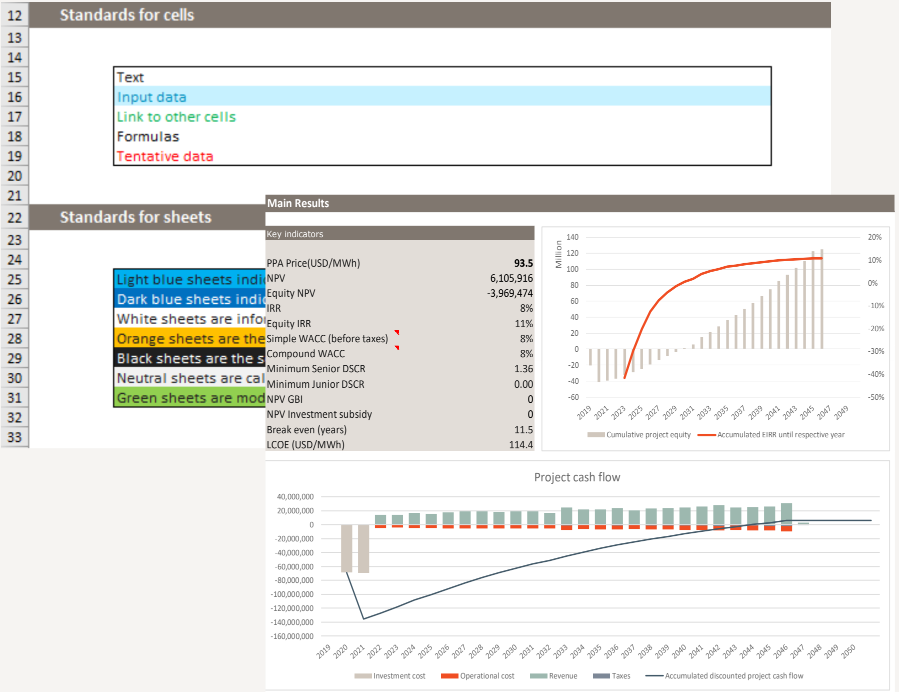
- Many RE projects are funded by International Financial Institutions (IFIs)
  - Loans are provided in an international currency
  - Loans are paid back in international currency
- Revenues and operational costs are often generated in the local currency
- Developments in the exchange rate can severely impact debt service
  - DSCR needs to be evaluated under worst case assumptions on the development in exchange rate

Guided tour of the model

Exercises Day 1

Getting used to the model

- Always work in a copy
  - That way you can just open a fresh version if something goes wrong
- Open the model
- Navigate to introduction
  - Familiarize yourself with the colour codes
- Navigate to the User Interface
  - Adjust the size of the results pane
  - Play around for a while
    - Don’t be afraid to mess up. You opened a copy – right?

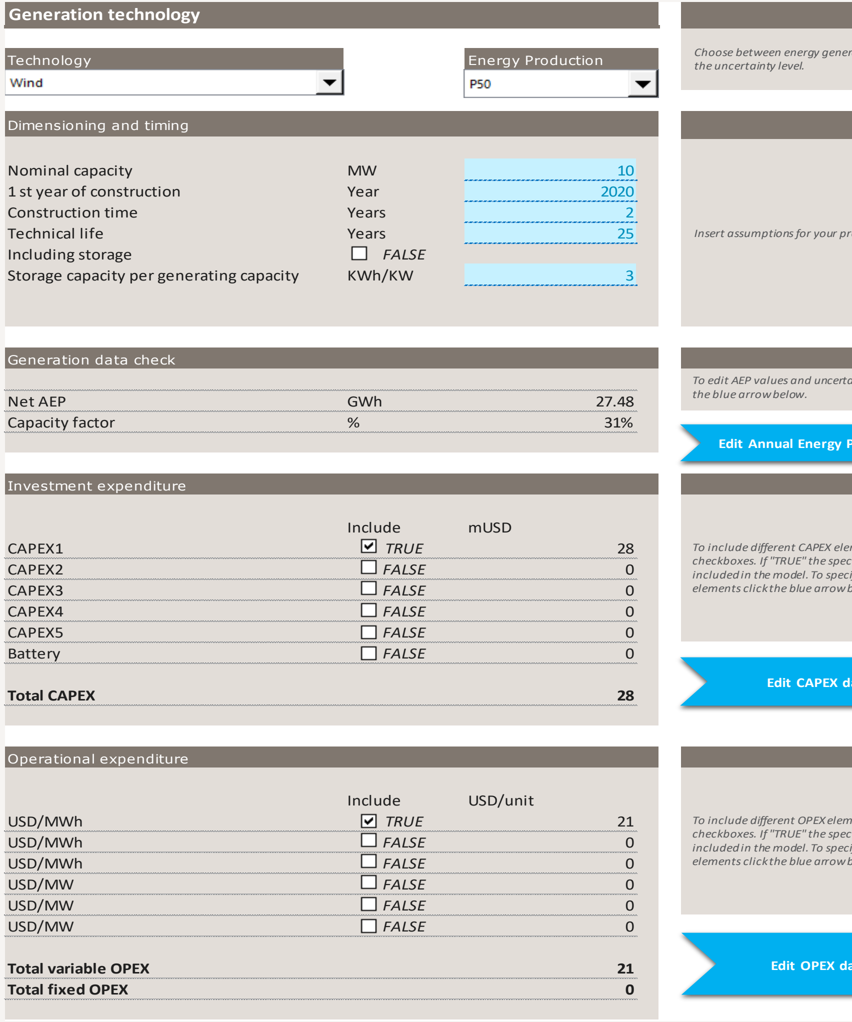


SIDS LIGHTHOUSES IRENA International Renewable Energy Agency COWI

Setting the stage (Caribbean)

- Choose Technology and uncertainty
  - *(In the drop down boxes in row 9)*
- Set Nominal capacity *(row 13)*
- Set first year of construction and construction time *(row 14)*
- Set technical life *(row 15)*

- Try changing uncertainty level to P90 and technology
  - What happens to the results?
  - *(the IRR and NPV decreases when Pxx increases)*



Technical data (Caribbean)

Edit Annual Energy Production

1

Gross AEP

GWh/MW	Wind	Solar	Biomass	Geothermal	Hydro
P50	2.9	1.8	2.5	7.9	4.5

	Wind	Solar	Biomass	Geothermal	Hydro
Loss	5%	5%	5%	5%	5%
Estimated uncertainty	10%	8%	10%	10%	10%

2

Probability

%	Wind	Solar	Biomass	Geothermal	Hydro
75	0.67	0.67	0.67	0.67	0.67
90	1.28	1.28	1.28	1.28	1.28
95	1.64	1.64	1.64	1.64	1.64

Net AEP

GWh/MW	Wind	Solar	Biomass	Geothermal	Hydro
P50	2.75	1.69	2.38	7.49	4.28
P75	2.56	1.60	2.22	6.98	3.99
P90	2.40	1.51	2.08	6.53	3.73
P95	2.30	1.47	1.99	6.25	3.57

3

Net AEP

GWh/MW	Wind	Solar	Biomass	Geotherm	Hydro
P50					
P75					
P90					
P95					

Input data (Caribbean)

Edit CAPEX data

- Add a new CAPEX element
  - Use CAPEX2 – rename to something relevant (e.g. your name)
- Return to the User Interface
  - Include the new CAPEX element in the analysis
  - *When changing/adding new CAPEX estimates, please verify that the correct estimates are included in the User Interface rows 31-35*

CAPEX

mUSD/MW	Wind	Solar	Biomass	Geothermal	Hydro	Chosen
CAPEX1	2.5	1.5	0.9	8.9	8.3	2.5
CAPEX2						0.0
CAPEX3						0.0
CAPEX4						0.0
CAPEX5						0.0
Battery						0.0

Investment expenditure

	Include	mUSD
CAPEX1	☑ *TRUE*	28
CAPEX2	☐ *FALSE*	0
CAPEX3	☐ *FALSE*	0
CAPEX4	☐ *FALSE*	0
CAPEX5	☐ *FALSE*	0
Battery	☐ *FALSE*	0
Total CAPEX		**28**

Input data (Caribbean)

Edit OPEX data

- Add a new OPEX element
  - Rename the element to something relevant (e.g. your name)
- Return to the User Interface
  - Include the new OPEX element in the analysis
  - *When changing/adding new OPEX estimates, please verify that the correct estimates are included in the User Interface rows 44-49*

OPEX

	Wind	Solar	Biomass	Geothermal	Hydro	Chosen
USD/MWh	21.0	40.0	40.0	20.0	20.0	21.0
USD/MWh						0.0
USD/MWh						0.0
USD/MW						0.0
USD/MW						0.0
USD/MW						0

Operational expenditure

	Include	USD/unit
USD/MWh	☑ *TRUE*	21
USD/MWh	☐ *FALSE*	0
USD/MWh	☐ *FALSE*	0
USD/MW	☐ *FALSE*	0
USD/MW	☐ *FALSE*	0
USD/MW	☐ *FALSE*	0
Total variable OPEX		**21**
Total fixed OPEX		**0**

PPA contract (Caribbean)

- The modelling of the PPA contract and government incentives will be covered tomorrow.

PPA contract

Contract length		
Length of contract	years	25

Tariff	
PPA tariff	117

Government incentives

Tax incentives			
VAT	☑	TRUE	VAT included
Duties	☑	TRUE	Duties included
PTC (USD/MWh)	☐	FALSE	

Check the checckboxes to include Value Added Tax (VAT), Duties and Production Tax Credits (PTC). For PTC the price should be entered. The duties and VAT can be chosen in the sheet "CAPEX & OPEX".

Financing

- Financial analysis will covered in detail tomorrow
- Set up a financing structure
  - A mix of equity, senior and junior loans
- Investigate how loan tenure and interest rates affect project KPIs
- Input corporate tax rate
- Investigate how exchange rate uncertainty impacts project KPIs
- Is the minimum senior DSCR lower than 1?
  - Include loan financing of a DSRA

Financing

Equity financing				
Cost of equity			12%	*Enter cost of equity and Equity share of funding.*
Equity share			30%	

Loan financing				
Interest during construction			0%	*It should be noted that a constant payment loan is assumed. Furthermore, the financing share indicates the share of CAPEX and delay penalties that will be financed by that loan type.*
Senior				*For both Senior and subordinary loans, enter the financing share, interest rate and the Loan Tenor.*
Financing share			70%	
Interest rate			6%	*Senior loans have the highest priority in the cash flow waterfall and have a lower interest rate than subordinate loans. The tenor of senoir loans will typically be less than or equal to the length of the PPA contract.*
Loan Tenor (years)			25	
Subordinate				
Financing share			0%	
Interest rate			15%	
Loan Tenor (years)			25	
Simple WACC			7.80%	*WACC is before taxes.*
Time variant WACC			7.50%	*Time variant WACC is an average over the project life. If the checkbox is checked, the NPV calculation will be based on the simple WACC.*
Choice of WACC for NPV calculation	☐	*FALSE*	*Time variant WACC*	

Taxes				
Coorporate income tax			0%	*Enter corporate income tax rate*
				Edit VAT and duties

Exchange rate				
	Include		*Percentage change*	
Local currency			USD	*If check box is checked, income and expenses (presumably in local currency) will be reduced by the percentage shown.*
Exchange rate uncertainty	☐	*FALSE*	0%	
Exhange rate (USD/USD)			1	

Cash reserves				
Interest of cash			2%	*If check box is checked loan financing of a DSRA will be included. Dimensioning of the DSRA is based on expected delays in commisioning and the payment schedule.*
Contingency cash			0	
Include loan financing of DSRA	☑	*TRUE*	DSRA active	*Dimensioning of the DSRA is quite simplistic, and may lead to excessive cash reserves. To scale down the DSRA use the custom scaling option. Keep an eye on minim senior DSCR while doing this.*
Estimate of DSRA needed	USD		148,601,430	
Custom scaling of DSRA relative to estimate			100%	

Depreciaton Method				
			Straight line	
Recovery Period			25	*It is possible to choose betweem three different depreciation methods.*
Depreciation Rate			10%	
Salvage value (USD)			0	

- Investigate how loan tenure and interest rates affect project KPIs
  - What happens to NPV when the loan tenure is longer?
  - What happens to NPV when the interest rates are higher?
- Input corporate tax rate
  - What happens to NPV when tax rates increase?
- What happens to NPV when you switch from P50 to P90?