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

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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 from 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.
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 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 °C necessary to produce electricity
- Usually found 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

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

\[
\begin{align*}
2019 & \quad 2020 \\
\$100 & \quad \Rightarrow \quad \$100 \times (1+i) \\
\frac{\$100}{1+i} & \quad \Leftarrow \quad \$100
\end{align*}
\]
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?

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Main Results

Key indicators

PPA Price (USD/MWh) 93.5
NPV 6,105,916
Equity NPV -3,969,474
IRR 8%
Equity IRR 11%

Simple WACC (before taxes) 8%
Compound WACC 8%
Minimum Senior DSCR 1.36
Minimum Junior DSCR 0.00
NPV GBI 0
NPV Investment subsidy 0
Break even (years) 20,000,000

LCOE (USD/MWh) 114.4

Cumulative project equity
Accumulated EIRR until respective year

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Project cash flow

Investment cost
Operational cost
Revenue
Taxes
Accumulated discounted project cash flow

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Standards for cells

Input data
Link to other cells
Formulas
Sensitivity data

Standards for sheets

Right blue sheets in USD (GWh)
Dark blue sheets in USD (GWh)
White sheets are info
Orange sheets are the simple WACC (before taxes)
Yellow sheets are the compound WACC
Neutral sheets are the maximum Senior DSCR
Green sheets are made
NPV (GWh)
NPV Investment subsidy
Book value (years)
LOD 2 (USD/MWh)

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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)

### Gross AEP

<table>
<thead>
<tr>
<th>GWh/MW</th>
<th>Wind</th>
<th>Solar</th>
<th>Biomass</th>
<th>Geothermal</th>
<th>Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>P50</td>
<td>2.9</td>
<td>1.8</td>
<td>2.5</td>
<td>7.9</td>
<td>4.5</td>
</tr>
</tbody>
</table>

### Loss

<table>
<thead>
<tr>
<th></th>
<th>Wind</th>
<th>Solar</th>
<th>Biomass</th>
<th>Geothermal</th>
<th>Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Estimated uncertainty

<table>
<thead>
<tr>
<th></th>
<th>Wind</th>
<th>Solar</th>
<th>Biomass</th>
<th>Geothermal</th>
<th>Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Probability

<table>
<thead>
<tr>
<th>%</th>
<th>Wind</th>
<th>Solar</th>
<th>Biomass</th>
<th>Geothermal</th>
<th>Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>0.67</td>
<td>0.67</td>
<td>0.67</td>
<td>0.67</td>
<td>0.67</td>
</tr>
<tr>
<td>90</td>
<td>1.28</td>
<td>1.28</td>
<td>1.28</td>
<td>1.28</td>
<td>1.28</td>
</tr>
<tr>
<td>95</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
<td>1.64</td>
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</tbody>
</table>

### Net AEP

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

<table>
<thead>
<tr>
<th>CAPEX</th>
<th>mUSD/MW</th>
<th>Wind</th>
<th>Solar</th>
<th>Biomass</th>
<th>Geothermal</th>
<th>Hydro</th>
<th>Chosen</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX1</td>
<td>2.5</td>
<td>1.5</td>
<td>0.9</td>
<td>8.9</td>
<td>8.3</td>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>CAPEX2</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPEX3</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPEX4</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPEX5</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Battery</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Include</th>
<th>mUSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX1</td>
<td>TRUE</td>
<td>28</td>
</tr>
<tr>
<td>CAPEX2</td>
<td>FALSE</td>
<td>0</td>
</tr>
<tr>
<td>CAPEX3</td>
<td>FALSE</td>
<td>0</td>
</tr>
<tr>
<td>CAPEX4</td>
<td>FALSE</td>
<td>0</td>
</tr>
<tr>
<td>CAPEX5</td>
<td>FALSE</td>
<td>0</td>
</tr>
<tr>
<td>Battery</td>
<td>FALSE</td>
<td>0</td>
</tr>
</tbody>
</table>

Total CAPEX: 28
Input data (Caribbean)

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

**PPA contract**

<table>
<thead>
<tr>
<th>Contract length</th>
<th>Length of contract</th>
<th>years</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tariff</td>
<td>PPA tariff</td>
<td>117</td>
<td></td>
</tr>
</tbody>
</table>

**Government incentives**

- VAT: TRUE, VAT included
- Duties: TRUE, Duties included
- PTC (USD/MWh): FALSE

Check the checkboxes 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".
Financial analysis will be 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

<table>
<thead>
<tr>
<th><strong>Equity financing</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of equity</td>
<td>12%</td>
</tr>
<tr>
<td>Equity share</td>
<td>30%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Loan financing</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest during construction</td>
<td>0%</td>
</tr>
</tbody>
</table>

#### Senior

- Financing share: 70%
- Interest rate: 6%
- Loan Tenor (years): 25

#### Subordinate

- Financing share: 0%
- Interest rate: 15%
- Loan Tenor (years): 25

#### WACC

- Simple WACC: 7.80%
- Time variant WACC: 7.50%

#### Choice of WACC for NPV calculation

- **FALSE** Time variant WACC

### Taxes

- **FALSE** Corporate income tax

### Exchange rate

- **FALSE** Include exchange rate uncertainty

### Cash reserves

- **FALSE** Include loan financing of DSRA
- **TRUE** DSRA active

### Depreciation Method

- **Straight line**

- Recovery Period: 25
- 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?