Exceedence Finance Manual

1 Exceedence Finance OVERVIEW

Exceedence Finance is a techno-financial marine renewable energy tool that can be used to assess the feasibility of wave, tidal and offshore wind projects. The program contains a database of marine renewable locations together with technical information on leading devices. The user can add to these databases by uploading their own location or device information. Using this information Exceedence Finance calculates the amount of energy a particular device will produce at a particular location.

The financial section of Exceedence Finance allows the user to input all the costs associated with planning, installing, commissioning, operating and decommissioning a marine renewable project. Exceedence Finance combines the financial information with the energy output data to produce a cash flow sheet for the entire duration of a project. It returns financial indicators such as Net Present Value, Internal Rate of Return and Payback Period. With this information users can explore which devices and locations are the most promising in terms of future marine renewable deployments.

1.1 Product uses

Exceedence Finance can be used to answer the following key questions

- **What is the best device for my location:** Exceedence Finance contains a database of leading marine renewable devices allowing the user to compare the performance and match devices to their location based on the techno-commercial performance.

- **What is the best location for my device:** Exceedence Finance's database of high potential marine renewable locations allows device developers to tailor device designs for optimal energy and financial performance at prime locations.

- **What is the optimal MW size of my project:** Project developers can use Exceedence Finance's advanced sensitivity modules to optimise the MW size of their project as well as establish the project elements that pose the greatest risk to project viability.

- **What level of subsidy support is required:** Governments can use Exceedence Finance to establish the level of subsidy support required to provide project returns under various development scenarios.

- **How long will it take for my project to make a return:** As well as the energy performance of projects, Exceedence Finance returns financial indicators such as NPV, IRR, LCOE and payback period allowing the user to establish the financial returns of the project.

1.2 Exceedence Finance Inputs

1.2.1 Projects

A Project is a farm comprising of wave, tidal or offshore wind devices. The farm can also comprise any combination of the three renewable technologies. The farm is modelled at a single location and Exceedence Finance can be used to calculate the energy output of the farm at that location together with the financial returns of the project.

1.2.1.1 Farm Technology

This defines the type of farm that the user wishes to model. Exceedance Finance allows for four different project configuration types

1. An Offshore Wind farm
2. A Tidal Farm
3. A Wave Farm
4. Co-location farms made up of any mixture of the above three technologies.

1.2.1.2 Currency

The user selects the currency that they wish the project financial results to be calculated in. Exceedence Finance contains over 20 currencies that projects can be modelled in.

1.2.1.3 Preferred Farm Size

This is the farm size in MW that the user wishes to model.

1.2.1.4 Operating Years

The operating years in Exceedance Finance refers to the number of years of power generation from the farm.

1.2.1.5 Pre-Development Years

This specifies any pre-development years in a project.

1.2.1.6 Decommissioning Years

This specifies any extra decommissioning years in a project.

1.2.2 Resource Data

Exceedence Finance resource database contains resource data for high potential marine renewable locations. The user also has the option of adding their own resource data in either hourly time series or summary data.

1.2.3 Device Data

Exceedence Finance contains a database of leading offshore wind, wave and tidal devices. The user also has the options of adding their own device directly into the database.

1.2.4 Energy Factors

Based on the selected Resource and Devices, Exceedance Finance calculates the energy output of the project. Prior to the energy calculation the user can set the final farm size by adjusting the number of devices. They can also account for loss factors such as availability and transmission losses. After the energy is calculated a breakdown of the energy output results can be viewed.

Losses factors include

- Curtailment Loss Factor
- Constraint Loss Factor
- Transmission Loss Factor
- Array Loss Factor
- Availability Loss Factor

1.2.5 Capex

The Capex is where the user accounts for the projects Capital Expenses. Exceedence Finance allows for Capex to be entered in one of three ways:

- Total Capex per farm
- Simple Breakdown of Total Capex per farm
- Detailed Capex per device: This is the most detailed Capex input option. There are four main breakdown headings of Device Costs, Mooring/Foundation Costs, Cabling/Piping Costs and Balance of Plant costs. Under each of these headings there is a list of components that make up each section. This list is editable to allow the user to create a list that matches the cost items they have. Costs for each item in the list can be entered as either € or €/MW or percentage of device costs.

1.2.6 Opex

The Opex is where the user accounts for the projects annual operational expenses. Exceedence Finance allows for Opex to be entered in one of three ways:

- Total Opex per farm
- Total yearly Opex per farm
- Breakdown total Opex per farm

1.2.7 Salvage

This accounts for any salvage or resale value that may be achieved when project assets are scrapped or re-sold at the end of the project.

1.2.8 Decommissioning

This accounts for any decommissioning costs that may be required to decommission the project infrastructure at the end of the project.

1.2.9 Revenue

This refers to the revenue the project will generate. Revenue rates are entered in €/MWh and are calculated annually based on the annual delivered energy of the farm (MWh). Any capital grant income received by the project can also be entered

1.2.10 Discounting Inflation

This accounts for any discounting or inflation factors that apply to the projects cash flows.

1.2.11 Indexation and Escalation Factors

These account for any non-inflation increase in Revenue or Opex rates over time.

1.2.12 Debt/Equity

This allows the user to account for any debt raised in order to fund the project. The Debt/Equity ratio can be specified. The user must specify the debt term (the user specifies the number of years over which the debt is to be repaid) and the borrowing rate (the interest rate to be charged on the borrowings).

1.2.13 Tax & Depreciation

This is where the user can account for taxes. Exceedence Finance only assesses Taxes on the projects profits.

1.2.14 Depreciation

This allows the user to assign any depreciation, also known as Capital Allowances, which can be charged to the profit for tax purposes. Depreciation allocates the cost of an asset to the cash flow sheet over the economic life of the asset. A number of options are available to the user in how they wish to allocate any depreciation.

1.3 Exceedence Finance Outputs

1.3.1 Energy Results

Exceedence Finance produces the following Energy results

- Device Capacity Factor
- Farm Annual Energy Production: This is the estimate of total energy production at the point of power capture of the devices..
- Farm Actual Energy Capture: When Annual Energy Production is modified by Availability and Array losses of the farm it becomes Actual Energy Capture.
- Farm Annual Delivered Energy: When Actual Energy Capture is further modified by the inclusion of electrical transmission losses to the point of grid interconnection (i.e. power output to delivered power), as well as any constraints or curtailment adjustments, it becomes Annual Delivered Energy

1.3.2 Project Results

This is where the user can view the results of the project. Exceedence Finance outputs the following project results

- Net Present Value
- Internal Rate of Return
- Levelised Cost of Electricity
- Simple Payback Period

- Discounted Payback Period
- Equivalent Annual Charge
- Net Present Value per MW

1.3.3 Sensitivity

This allows the user to conduct sensitivity analysis on the project's input parameters to assess the impact on the project results. The user can fine tune the project results by adjusting each factor to establish the project configuration that produces the best return. They can also perform a Goal Seek on the necessary value of inputs required to achieve target results.

1.3.4 Graphical Results

These allow quick and easy access to graphical results from the Resource, Device, CAPEX and OPEX modules.

1.3.5 Excel Export

Excel Export will open an excel spreadsheet which will contains all the project details. This can be used to build bank ready financial spreadsheets.

1.3.6 Project Comparison

This allows the user to select projects existing from saved files to compare. Once 2 – 5 projects have been selected the following project parameters can be compared

- Final Farm Power (MW)
- Farm Annual Delivered Energy (MWh)
- Capital Expenditure (CAPEX)
- Operational Expenditure (OPEX)
- Net Present Value (NPV)
- Internal Rate of Return
- Levelised Cost of Electricity (LCOE)
- Simple Payback Period
- Discounted Payback Period
- Equivalent Annual Charge
- NPV/MW

1.4 Past Papers

Previous Papers produced using Exceedence Finance (previously referred to as 'Exceedence Finance').

1. Dalton G J, Alcorn R, Lewis T, (2010) "Economic assessment of the Pelamis wave energy converter, in Ireland, Portugal and North America". *Renewable Energy*: 35:2: p.443-455.

2. Dalton G J, O'Gallachoir B. (2010) "Building a wave energy policy focusing on innovation, manufacturing and deployment." *Renewable and sustainable energy reviews*. 14:8: p.2339-2358.

3. O'Sullivan D, Dalton GJ, Lewis T. (2010) "Regulatory, technical and financial challenges in the grid connection of wave energy devices". *IET Renewable Power Generation. 4:6:* 555-67

4. Dalton GJ, Lewis T. (2011) "Metrics for measuring job creation by renewable energy technologies, using Ireland as a case study". *Renewable and Sustainable Energy Reviews*: 15:4: 2123-2133.

5. Dalton GJ, Alcorn R, Lewis T. (2011) "A 10 year installation program for wave energy in Ireland, a sensitivity analysis on financial returns". *Renewable Energy*; 40:1: 80-89.

6. Dalton GJ. (2011) "Why wave energy". *OES IA Annual Report 2010* - Implementing agreement on ocean energy systems. pg 93-110.

7. Deane JP, Dalton G J, O'Gallachoir B "Economics of 500MW of Wave Energy in the All Island System". *Energy Policy*. In Press.

8. O'Connor M, Lewis T., Dalton GJ. "Weather Window Analysis of Irish West Coast Wave Data with Relevance to Operations & Maintenance of Marine Renewables". *Renewable Energy*; 52 (2013) 57-66.

9. O'Connor M, Lewis T., Dalton GJ. "Techno-economic performance of the Pelamis P1 and Wavestar at different ratings and various locations in Europe", *Renewable Energy*; 50 (2013) 889–900.

10. O'Connor M, Lewis T., Dalton GJ. "Operational expenditure costs for wave energy projects and impacts on financial returns". *Renewable Energy*. 50 (2013) 1119-1131.

2 Quick Start Case Studies

These quickstart case studies provide a quick guide to some of the basic functionality of Exceedence Finance. Further detailed background information about this functionality, as well as all the other functionality in the product, can be found in the by clicking the information button which is located at the bottom right corner of each page as well as the Theory Manual appendix.

2.1 Location Data

2.1.1 New Location creation

To add a new location to the location database 1st open the location database then click *'Add New Location".* This will open the 'New Location Details' screen as shown in Figure 1.

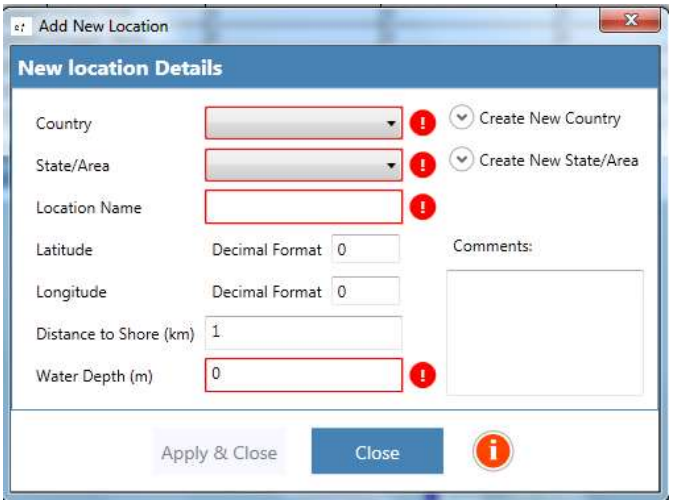

Figure 1: 'Add New Location' Screen.

- Here the user must select the Country and State/Area names from those in the dropdown list. If the country or state/area is not on the list the user can add them be using the 'Create New Country' and 'Create New State/Area'.
- The user must also enter the Location name, coordinates of the location in decimal format, distance to shore and site water depth
- A comments box is provided if the user wishes to add further information about the site.

Once the required information has been entered, clicking 'Apply & Close' will save the new location.

Further information on the process can be found by clicking the pages information button located at the bottom right corner of the page.

2.1.2 Time Series Resource data import

To import time series resource data the user must first open the location which they want to add the data for. Once the location is open click *'Import Time Series'*. This opens the Time Series Import window as shown in Figure 2.

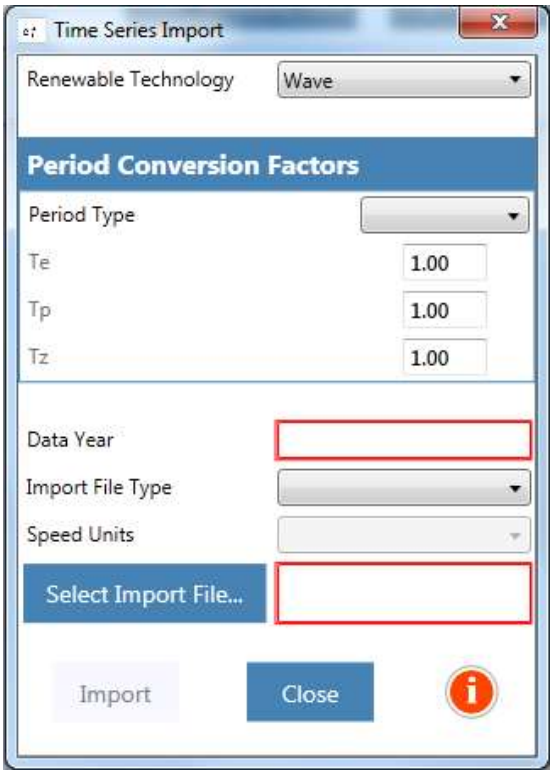

Figure 2: Time Series Import Screen

- First the user must select the Renewable Technology of the time series data they wish import.
- For wave time series they must specify the period type and enter the period conversion factors. For wind they must enter the measuring height and tidal the measuring depth. The data year must also be entered.
- The import file type must be selected from the dropdown list. Exceedence Finance can import files in Excel or CSV format.
- The speed units applies to Wind and Tidal only and is where the user specifies whether the wind or tidal data is in meters per second or knots.

Once the required information has been entered, clicking 'Apply & Close' will save the summary data.

Further information on the process can be found by clicking the pages information button located at the bottom right corner of the page.

2.1.3 Summary Resource data import

To summary resource data the user must first open the location which they want to add the data for. Once the location is open click *'Enter Summary Data'.* This opens the summary data window as shown in Figure 3.

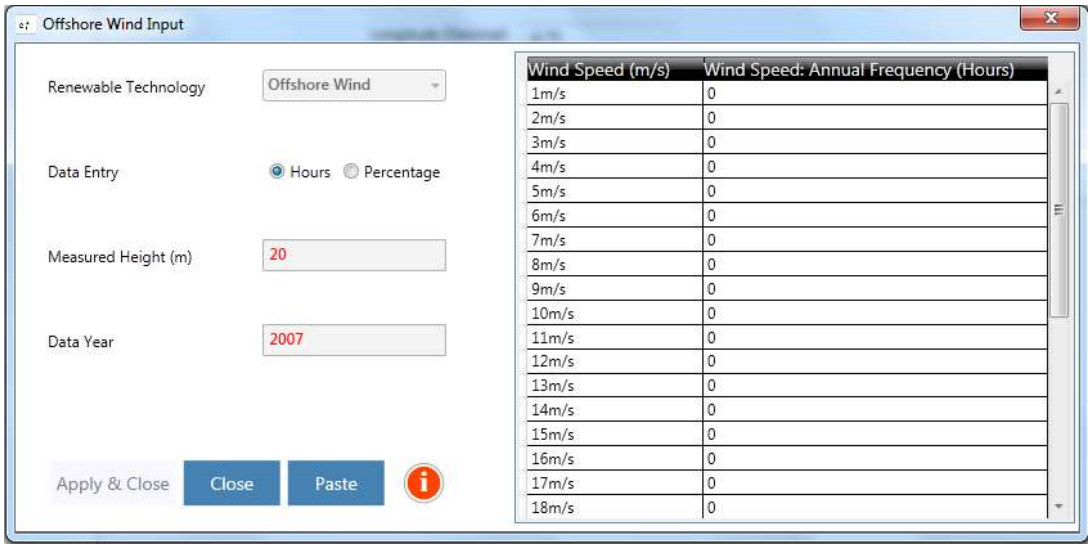

Figure 3: Offshore wind resource summary data import screen.

- First the user must select the Renewable Technology of the summary data they wish import.
- For wave time series they must specify the period type and enter the period conversion factors. For wind they must enter the measuring height and tidal the measuring depth. The data year must also be entered.
- The user must also select whether the summary data entered is in hours or percentage.
- When the required data has been entered clicking 'Continue' will open up the blank table where the data can be typed in or pasted using the 'Paste' button or Crtl-V.

Once the required information has been entered, clicking 'Apply & Close' will begin the importation process and a message will appear notifying the user of a successful import.

Further information on the process can be found by clicking the pages information button located at the bottom right corner of the page

2.2 Device data

2.2.1 Wave device creation example

To add a wave device the user must first open the device database and then click *'Add New Device'.* This opens the initial 'Add New Device window' as shown in Figure 4.

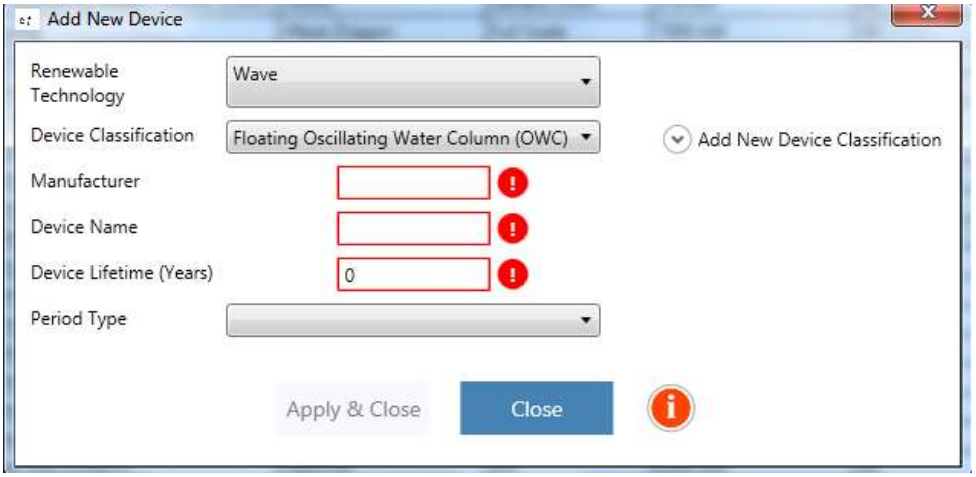

Figure 4: Add new device screen.

- First the user must select the renewable technology of the device they are adding.
- Next the device classification must be selected from the dropdown list. A new device classification can be added to the list by clicking 'Add New Device Classification'.
- The manufacturer, name and expected operation lifetime of the device must be entered by the user.
- For wave the user must specify the period type of the device being entered.
- After entering this initial information clicking 'Apply & Close' will open the next window where the remaining device details can be added. This is shown in Figure 5.

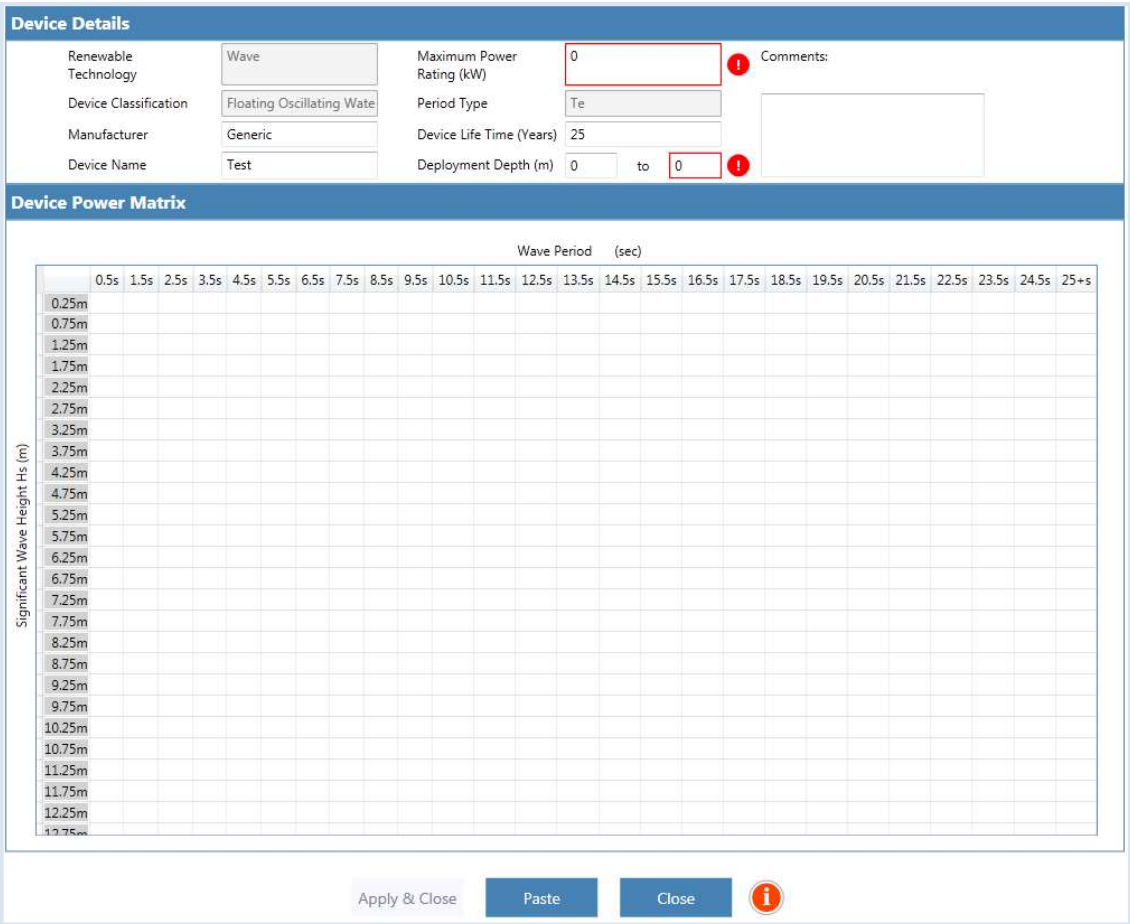

Figure 5: Wave device details import screen.

- On the second device input screen the user must enter technology specific details such as wind turbine hub height, tidal turbine hub depth and range of deployment depths and wave range of deployment depths.
- The power performance data for the device can be typed in or pasted in to the blank table using the 'Paste' button or Crtl-V.
- A comments box is provided if the user wishes to add further information about the site.

Once the required information has been entered, clicking 'Apply & Close' will save the device to the database.

Further information on the process can be found by clicking the pages information button located at the bottom right corner of the page

2.3 Case Study 1: Simple Project

The first case study involves building a project with the following parameters shown in Table 1.

Farm Technology	Tidal Energy
Farm Size	170 MW
Currency	Pounds Sterling
Operating Duration	15 Years
Location and Year	Arklow 2014
Device	Siemens MCT
Capex	£2,600,000/MW
Opex	10% of Capex per year
Revenue Rates	Mixture of Fixed and Variable Rates
Real Discount Rate	6%

Table 1: Case study 1 project details.

Note that the values used in this case study are purely for the purposes of showing the functionality and are not intended to be representative of real projects or the devices used in the case study.

2.3.1 Main Project Details

To build a farm the user must first select 'New Project' on the main menu. This will open a blank Project Dashboard as shown in Figure 6. The project dashboard is where all the modules required to build a project are accessed from. It guides the user through the project building process by sequentially unlocking modules as the user enters the required details in each. The inputs entered in each module are then summarised on the project dashboard as well as the final results when the project is complete.

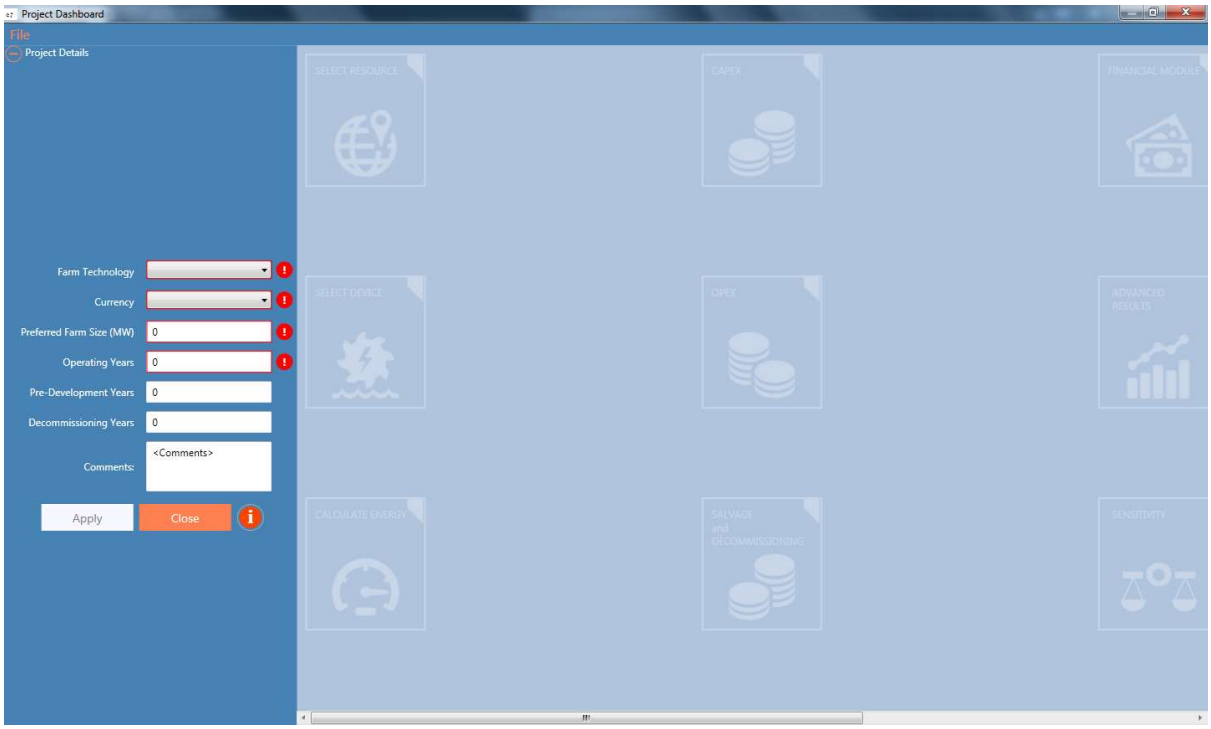

Figure 6: Blank project dashboard.

The blank project dashboard is shown in Figure 6 above. The main project details are located on the left hand side and must be entered before the first module 'Select Resource' can be accessed.

For this case study enter the following in the main project details

- From the Farm Technology dropdown select Tidal.
- From the Currency dropdown select GBP-British Pound
- In the Farm Size enter 170 MW
- In Operating Years enter 15 Years
- This project has no extra Pre-Development or Decommissioning years so these can be left blank.

As the required main project details necessary to build a project have been entered the 'Apply' button should now be enabled. Click 'Apply' to store the details and unlock the next module 'Select Resource'.

2.3.2 Resource Selection

When the 'Select Resource' is clicked on the project dashboard the resource screen is opened. The locations which contain tidal data are listed.

Select 'Ireland' and 'Arklow Bank' as Location and 2014 as the data year. The selection is made by clicking the row in each table after which the selected location/data year is highlighted in blue. This is shown in Figure 7.

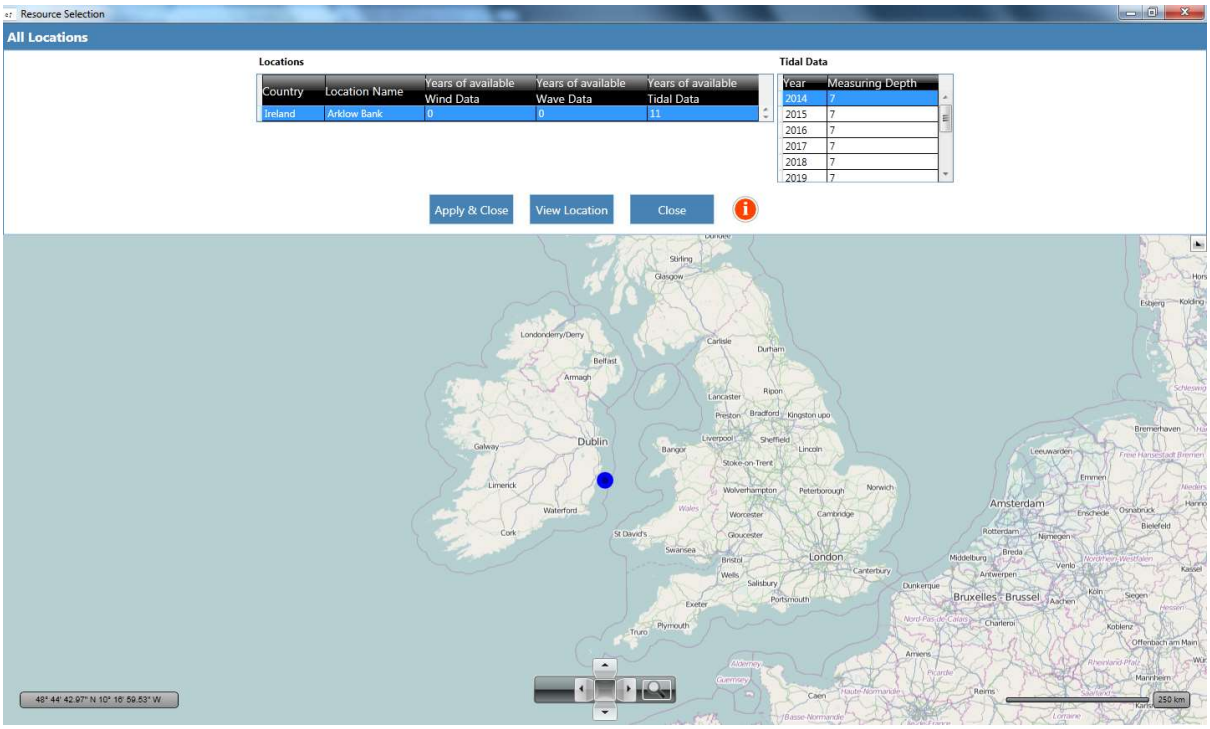

Figure 7: Resource selection.

After the location and data year are selected click 'Apply & Close' to store the selection made. The user will be brought back to the project dashboard and the next module 'Select Device' will be unlocked.

2.3.3 Device Selection

When the 'Select Device' icon is clicked the device module opens and all the tidal devices in the database are listed.
Select the 'Siemens MCT' 1200kW rated tidal turbine from the list. The selection is made by clicking the row which lists the device after which the selected device is highlighted in blue. The user must then click 'Add to Selected Devices' which moves the device from the 'Available Devices' list to the 'Selected Devices' list. This is shown in Figure 8.

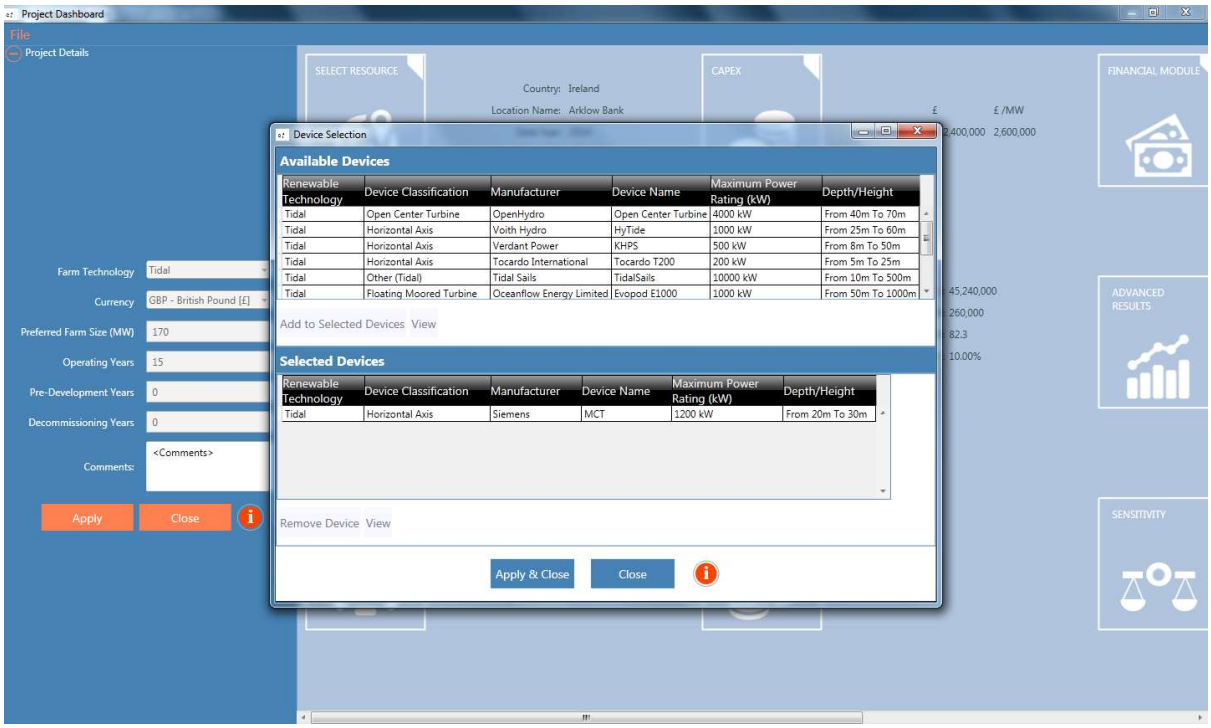

Figure 8: Tidal device selection.

When the desired device(s) has been selected and added to the 'Selected Devices' list click 'Apply & Close' to store the device selection. This will take the user back to the project dashboard and the next module 'Calculate Energy' will be unlocked.
Note: A message will appear informing the user that the water depth at the selected site, 41m, is outside of the range of deployment depths for this tidal turbine. The user is given the choice of continuing with the energy calculation or reselecting a device. For the purposes of this case study click 'Continue'.

2.3.4 Energy Calculation

When the 'Calculate Energy' icon is clicked the Energy Calculation module opens. This contains three tabs. The first allows the user to set the final farm size by adjusting the number of units of each device. The second allows to user to enter factors to account for possible losses in the energy production process and the third lists the energy output results once the calculation has taken place.

On the first tab' Farm Size' the preferred farm size (originally entered on the main project details) is listed as 170 MW. The Final Farm size in the current configuration is 170.4MW with 142 units. Increase this to 174MW by increasing the number of units from 142 to 145. The updated configuration is shown in Figure 9.

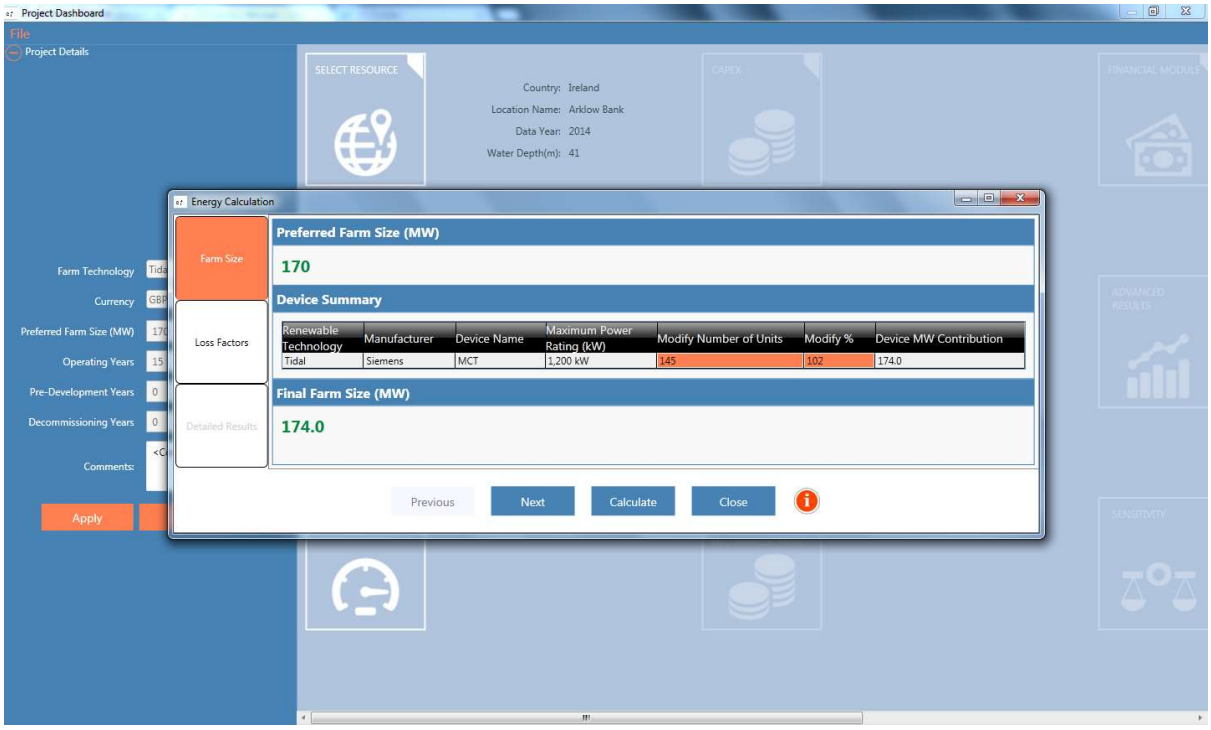

Figure 9: Energy Calculation: Farm Size.

Click 'Next' to progress onto the second tab 'Loss Factors'. In this case study no loss factors are applied therefore the energy calculation process can be completed by clicking 'Calculate'.
This should open the 'Detailed Results' tab as shown in Figure 10.

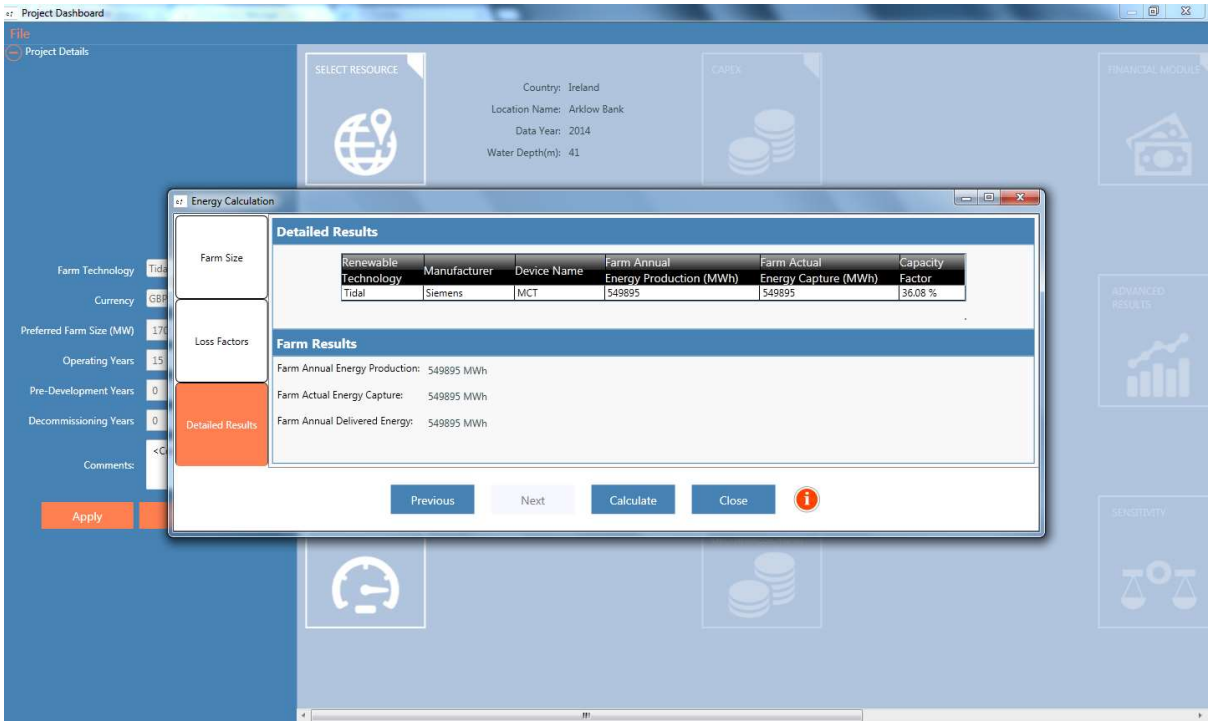

Figure 10: Energy Calculation: Detailed results.

The energy results that should be outputted are listed in Table 2.

Device Capacity Factor	36.08%
Farm Annual Energy Production	549895MWh
Farm Actual Energy Capture	549895MWh
Farm Annual Delivered Energy	549895MWh

Table 2: Case Study 1: Energy Results.

Click 'Close' to store these results after which the user will be returned to the project dashboard and the next module 'Capex' will be unlocked.

2.3.5 CAPEX

When the Capex icon is clicked the user is presented with three options for entering Capex. The first 'Total Capex per farm' is the simplest method and is one number covering the entire project's Capex. The second 'Simple Breakdown of Capex per Farm' is a breakdown of the farm's Capex into four areas. The third option 'Detailed Capex per Device' is the most detailed and allows the user to enter individual Capex cost for each device and project's components.

For this case study select 'Total Capex per Farm' and click 'Apply & Close. Next the user must enter the total farm Capex, in this case enter a Capex of £2.6m/MW in the Capex input box ensuring that the correct units (£/MW) are selected. This is shown in Figure 11.

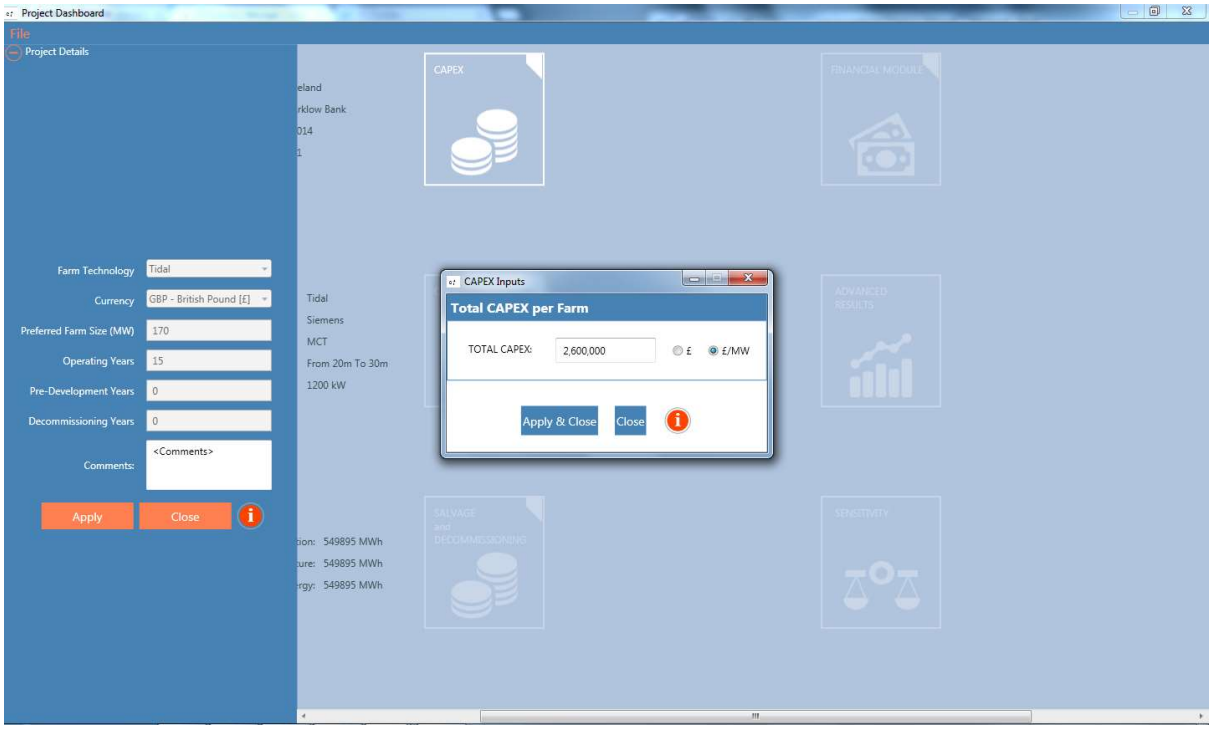

Figure 11: Total Capex per farm.

Click 'Apply & Close' to store the Capex value entered. This will return the user to the project Dashboard where the next module 'Opex' is unlocked.

2.3.6 OPEX

When the Opex icon is clicked the user is presented with three options for entering Opex. The first 'Total Opex per farm' is the simplest method and is one number covering the entire project's annual Opex. The second 'Total Yearly Opex per Farm' is a where the user can enter a single Opex number for each individual year of the project. The third option 'Breakdown Total Opex per Farm' is the most detailed and allows the user to enter individual Opex costs for each device and project component.

For this case study select 'Total Opex per Farm' and select 'Apply & Close'. Next the user must enter the total annual Opex, in this case enter an Opex of 10% of Total Capex. This is shown in Figure 12.

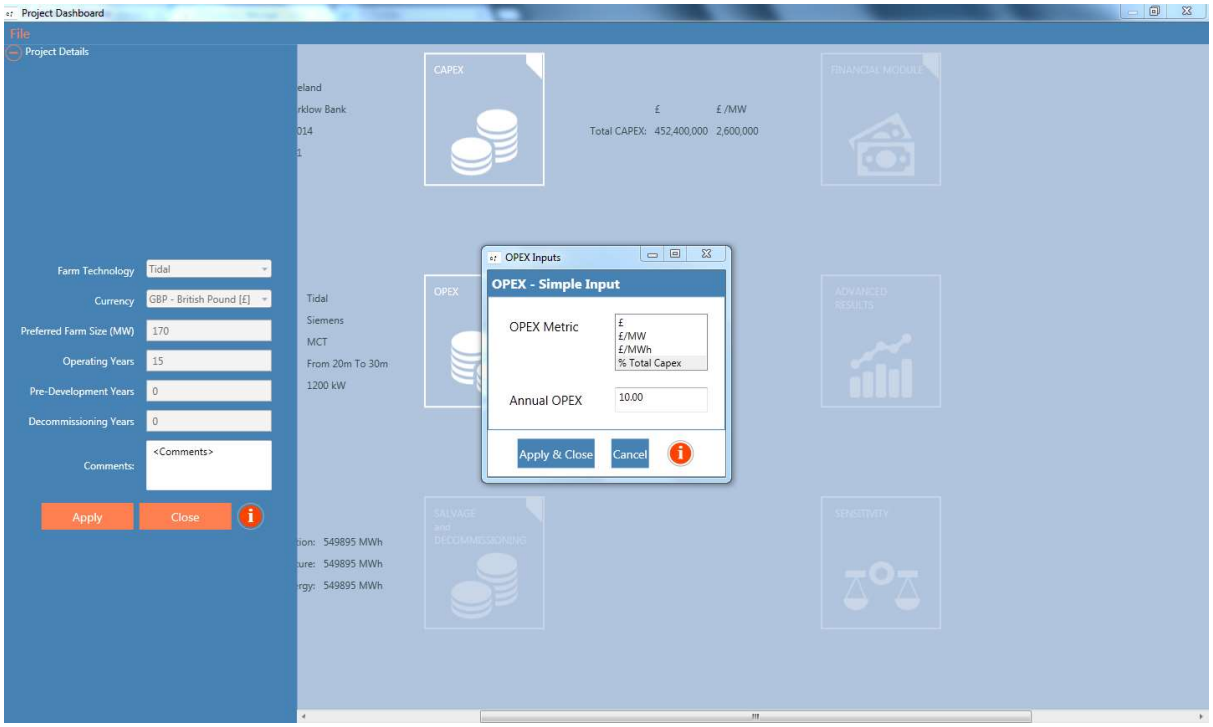

Figure 12: Total Opex per farm.

Click 'Apply & Close' to store the Opex value entered. This will return the user to the project Dashboard where the next set of modules 'Salvage & Decommissioning' and 'Financial Module' are unlocked. In this case study we will skip the Salvage and Decommissioning module.

2.3.7 Financial Module

On the project dashboard click 'Financial Module'. This has four tabs covering Revenue, Discounting & Inflation, Debt/Equity and Tax & Depreciation. In this case study we will only be entering values for Revenue and Discounting.

In the revenue tab under 'Revenue-Basic Inputs' select 'Included' next to FIT to include this factor in the project. Change the default selection from 'Variable' to 'Fixed'. This should open the FIT Input box where a value of £180/MWh should be entered.
We will also include a variable revenue rate by clicking 'Included' next to the 'ROC Equivalent' item. The variable figures are entered directly in the 'Input per Annum' table. In the table enter a value starting at £50/MWh in year 1 and increasing by £1/MWh each year up to £64/MWh in year 15. This completed revenue section is shown in Figure 13.

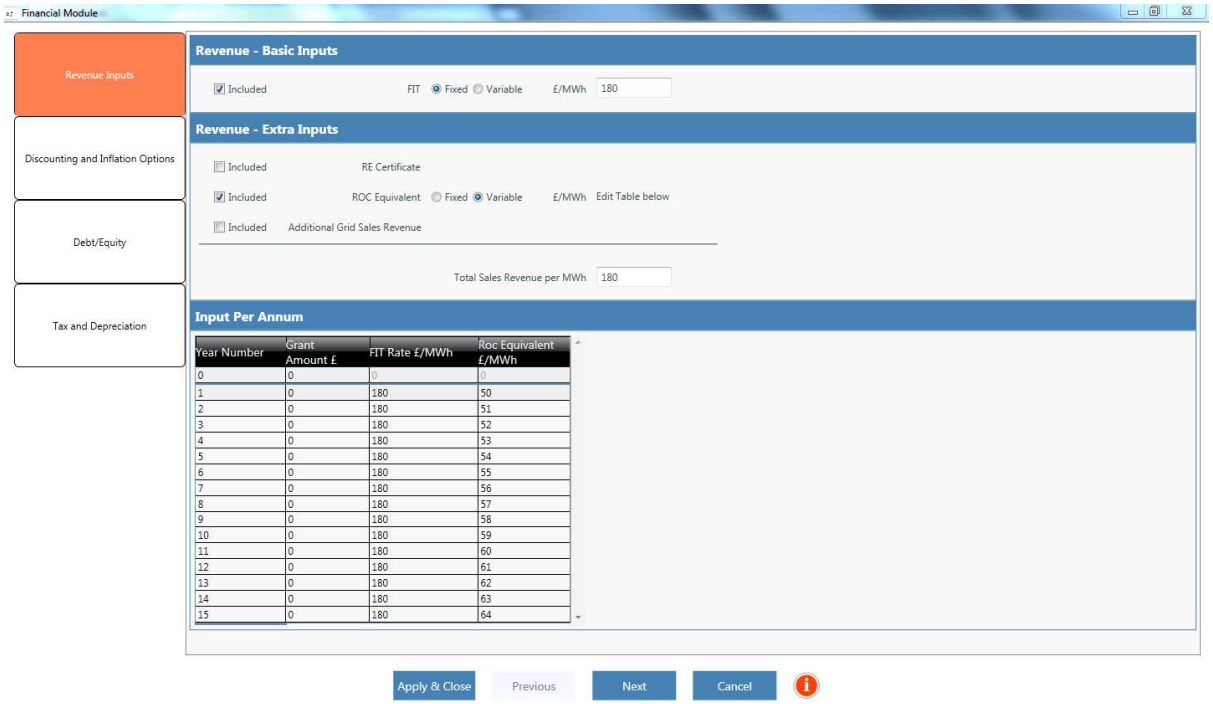

Figure 13: Case Study 1: Revenue.

Click 'Next' to progress onto the 'Discounting and Inflation Options' tab. Here select the third option 'Apply Cash Flows in Real Terms' and enter a Real Discount Rate of 6%. The completed discounting is shown in Figure 14.

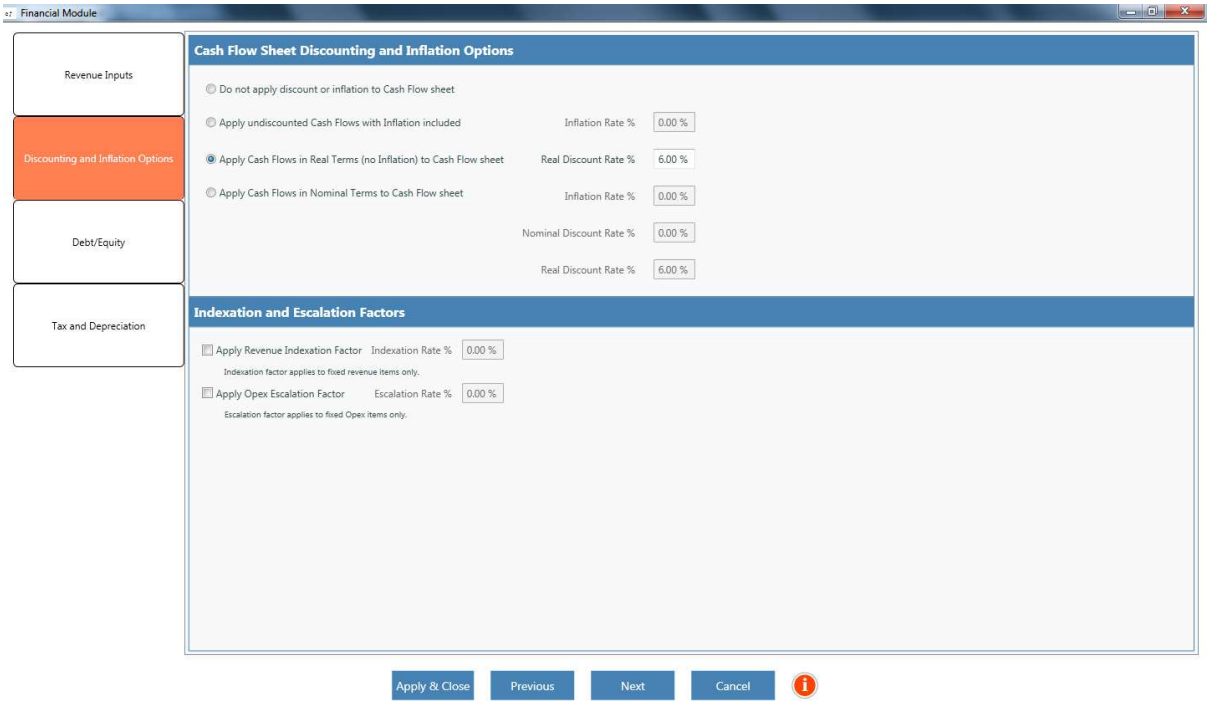

Figure 14: Case Study 1: Discounting.

This completes the inputting of the project details. To calculate the project results click 'Apply & Close' in the Financial Module. This will calculate the final results and return the user to the project dashboard where the output modules Advanced Results, Sensitivity, Graphical Results and Excel Export are unlocked.
The project results that should be returned are shown in Table 3.

Net Present Value (NPV) £	£368,231,991
Levelised Cost of Electricity (LCOE) £/MWh	£166.98/MWh
Internal Rate of Return %	16.65%

Table 3: Case Study 1: Project Results.

2.3.8 Sensitivity

To conduct sensitivity on the project results click on the Sensitivity module. In this scenario we will goal seek the Capex level that is required for an IRR of 20%.
Once the Sensitivity has been opened click 'Goal Seek Sensitivity'. First select the output parameter that you want to perform the goal seek on, in this case IRR. Then input the target value for this output, 20%.
Next we select the input parameter to adjust. This is done using the treeview window. In this select 'Capex' and then in the dropdown 'Capex Total £457,600,000'. Finally click 'Calculate Results' to perform the calculation.

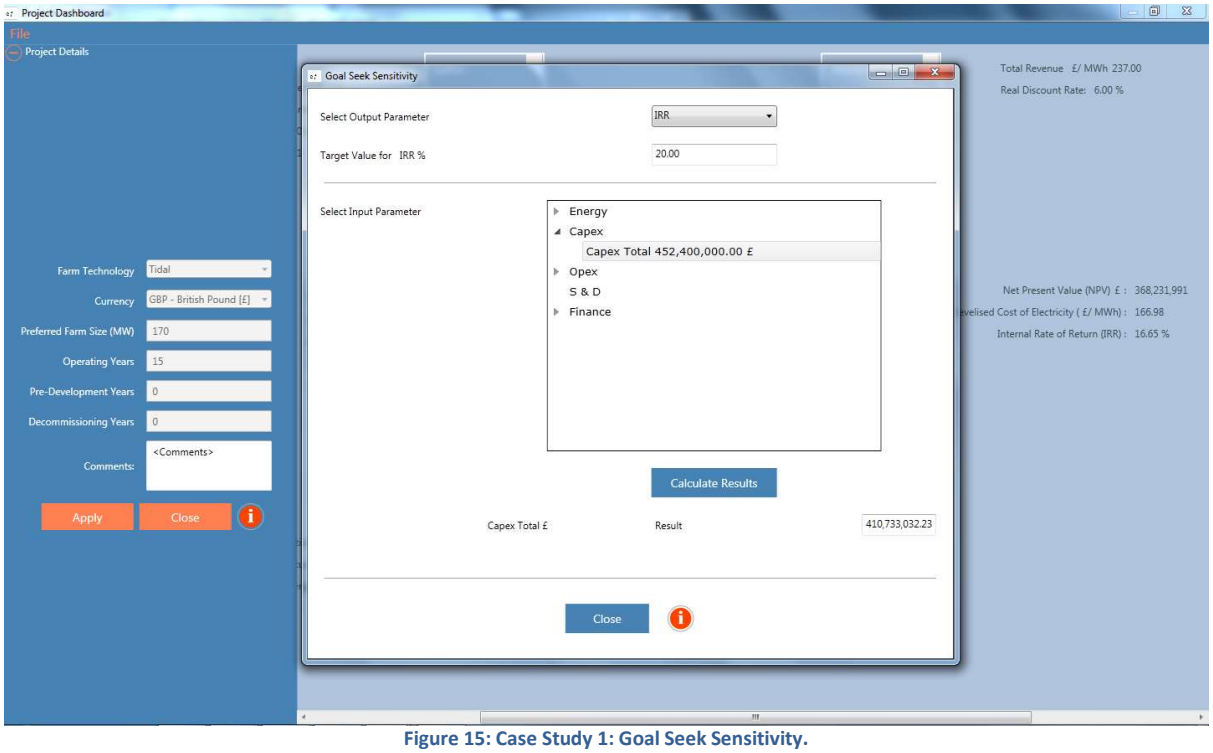

Figure 15: Case Study 1: Goal Seek Sensitivity.

A Capex value of £410,733,032.23 should be returned as shown in Figure 15.

2.4 Case Study 2: Mid-Level Detail Project

The second case study involves building a project with the following parameters shown in Table 4.

Farm Technology	Wave Energy
Farm Size	200 MW
Currency	Euros
Operating Duration	20 Years
Pre-development Years	3 Years
Decommissioning Years	4 Years
Location and Year	Belmullet 50 1995
Device	Generic F-OWC & Generic F-2HB
Capex	Breakdown Capex
Opex	Yearly Breakdown Opex
Salvage	Breakdown Salvage
Decommissioning	€500,000 per decommissioning year
Revenue Rates	Fixed Rate of €400/MWh
Nominal Discount Rate	6%
Inflation Rate	2%
Debt/Equity Ratio	40/60
Tax	Tax Rate 5% with Depreciation

Table 4: Case Study 2: Project Details.

Note that the values used in this case study are purely for the purposes of showing the functionality and are not intended to be representative of real projects or the devices used in the case study.

2.4.1 Main Project Details

To build a farm the user must first select 'New Project' on the main menu. This will open a blank Project Dashboard. The project dashboard is where all the modules required to build a project are accessed from. It guides the user through the project building process by sequentially unlocking modules as the user enters the required details in each. The inputs entered in each module are then summarised on the project dashboard as well as the final results when the project is complete.

The main project details are located on the left hand side and must be entered before the first module 'Select Resource' can be accessed.

For this case study enter the following in the main project details

- From the Farm Technology dropdown select Wave.
- From the Currency dropdown select EUR-Euro
- For Farm Size enter 200 MW
- In Operating Years enter 20 Years
- For Pre-development Years enter 3 Years
- For Decommissioning Years enter 4 Years

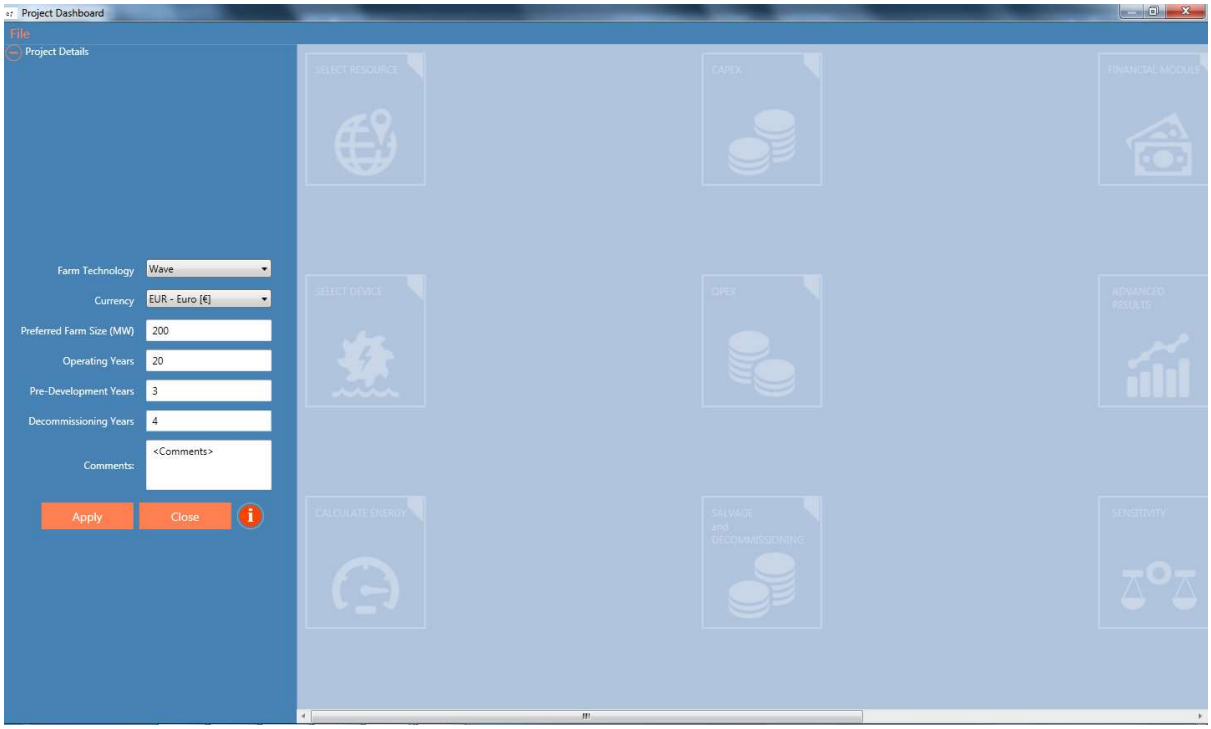

Figure 16: Case Study 2: Main project details and project dashboard.

As the required details necessary to build a project have been entered the 'Apply' button should now be enabled, as shown in Figure 16. Click 'Apply' to store the details and unlock the next module 'Select Resource'.

2.4.2 Resource Selection

When the 'Select Resource' is clicked on the project dashboard the resource screen is opened. The locations which contain wave data are listed.

Select 'Ireland' and 'Belmullet 50m' as Location and 1995 as the data year. The selection is made by clicking the row in each table after which the selected location/data year is highlighted in blue. This selection is shown in Figure 17.

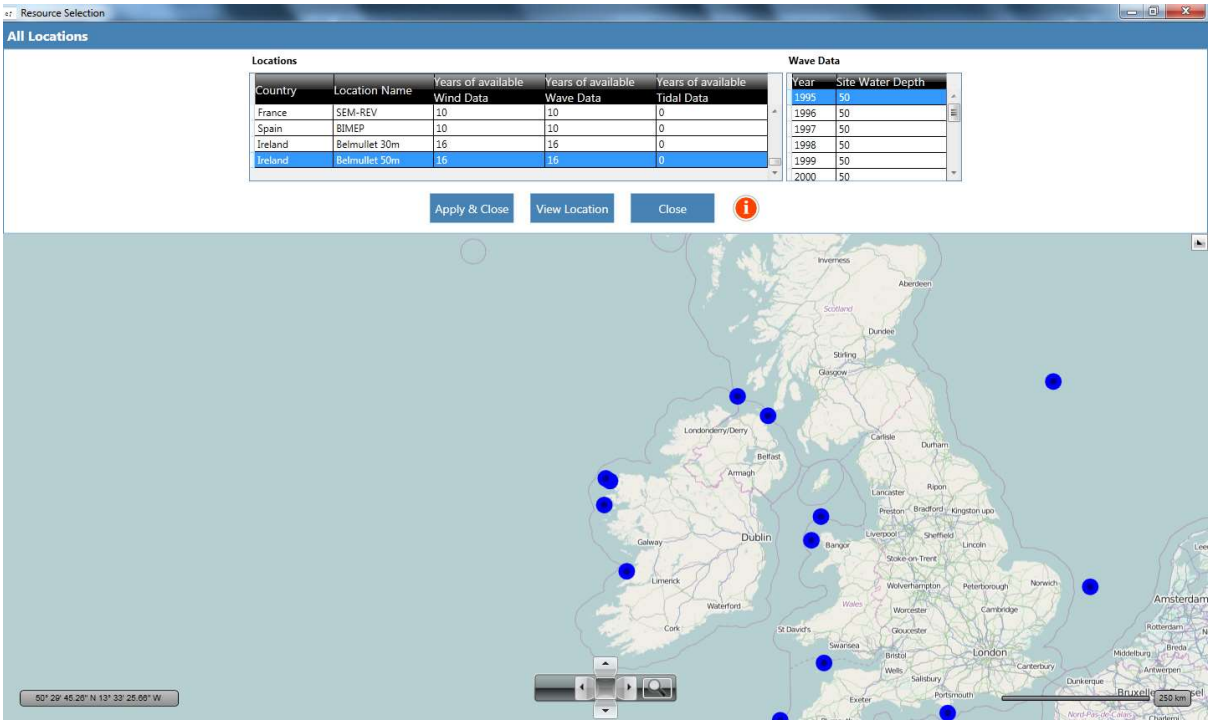

Figure 17: Resource Selection.

After the location and data year are selected click 'Apply & Close' to store the selection made. The user will be brought back to the project dashboard and the next module 'Select Device' will be unlocked.

2.4.3 Device Selection

When the 'Select Device' icon is clicked the device module opens and all the wave devices in the database are listed.

Select both the 'Generic F-OWC' 3310kW and the 'Generic F-2HB' 1000kW rated wave devices from the list. The selection is made by clicking the row which lists the device after which the selected device is highlighted in blue. The user must then click 'Add to Selected Devices' which moves the device from the 'Available Devices' list to the 'Selected Devices' list. More than one device can be selected in this way. The device selection is shown in Figure 18.

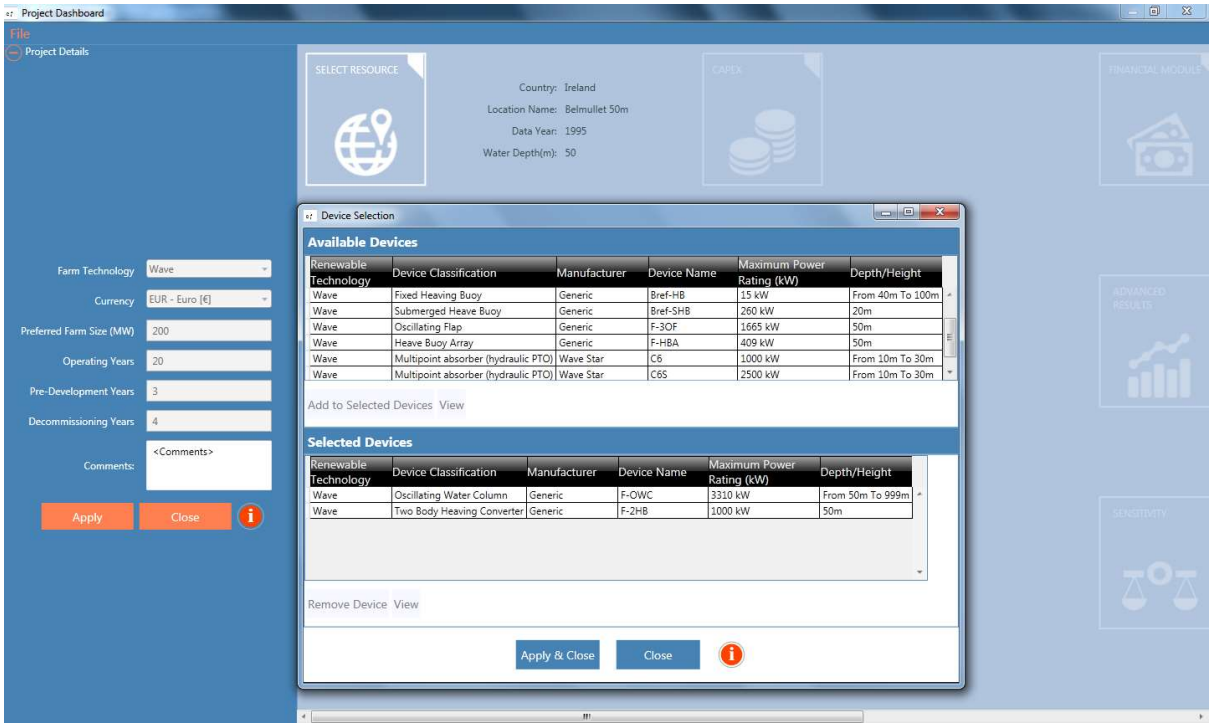

Figure 18: Device Selection.

When the desired devices have been selected and added to the 'Selected Devices' list click 'Apply & Close' to store the device selection. This will take the user back to the project dashboard and the next module 'Calculate Energy' will be unlocked.

2.4.4 Energy Calculation

When the 'Calculate Energy' icon is clicked the Energy Calculation module opens. This contains three tabs. The first allows the user to set the final farm size by adjusting the number of units of each device. The second allows to user to enter factors to account for possible losses in the energy calculation process and the third lists the energy output results once the calculation has taken place. In this case study we will not be adjusting the farm size, therefore skip the first tab 'Farm Size' and move onto the second tab 'Loss Factors'.

In the 'Farm Factor' section enter the following

- Curtailment Loss Factor of 90%
- Constraints Loss Factor of 91%
- Transmission Loss Factor of 92%.

In the 'Device Factors' section energy the following

- For the Generic F-OWC device enter an Array Loss Factor of 95% and an Availability Loss Factor 90%.
- For the Generic F-2HB device enter an Array Loss Factor of 85% and an Availability Loss Factor 80%.

The completed loss factors tab is shown in Figure 19.

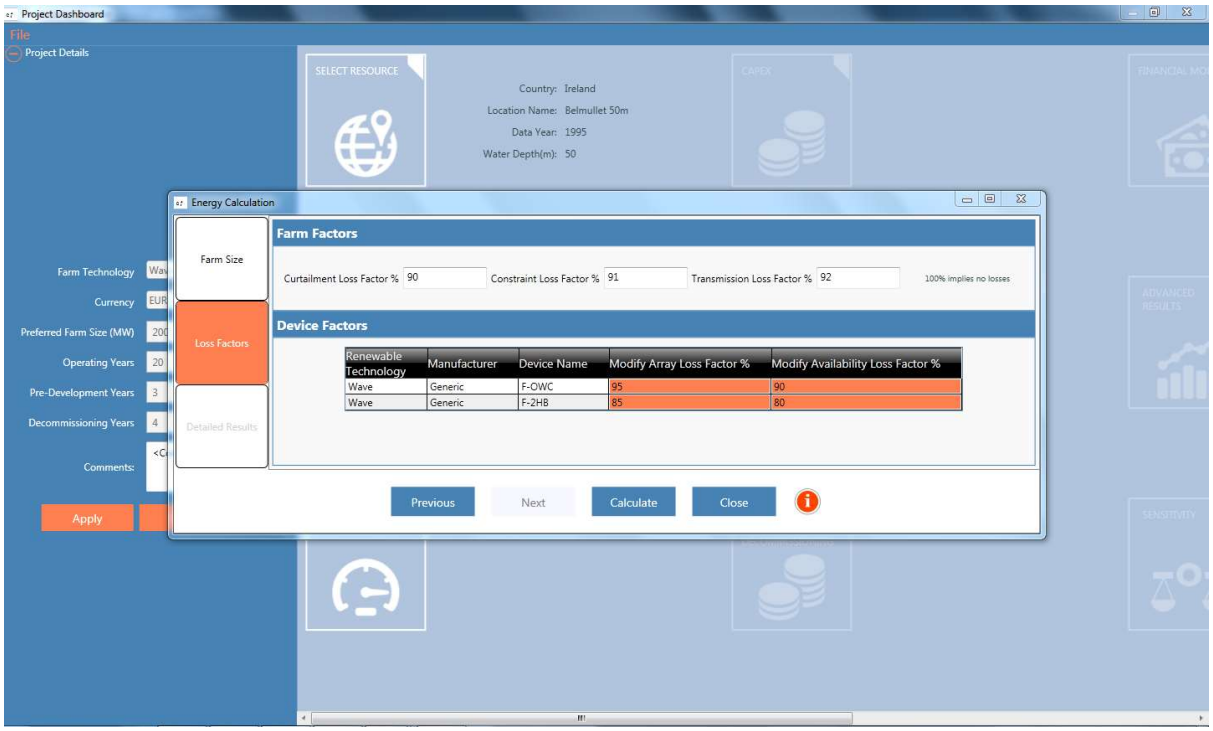

Figure 19: Energy Calculation Loss Factors.

When this is complete all the necessary factors have been entered and therefore the energy calculation process can be completed by clicking 'Calculate'. Note a message will appear for both devices notifying the user that Exceedence Finance will perform the energy calculation using the converted scatterplots and not the original. Click OK to both messages.
This should open the 'Detailed Results' tab as shown in Figure 20.

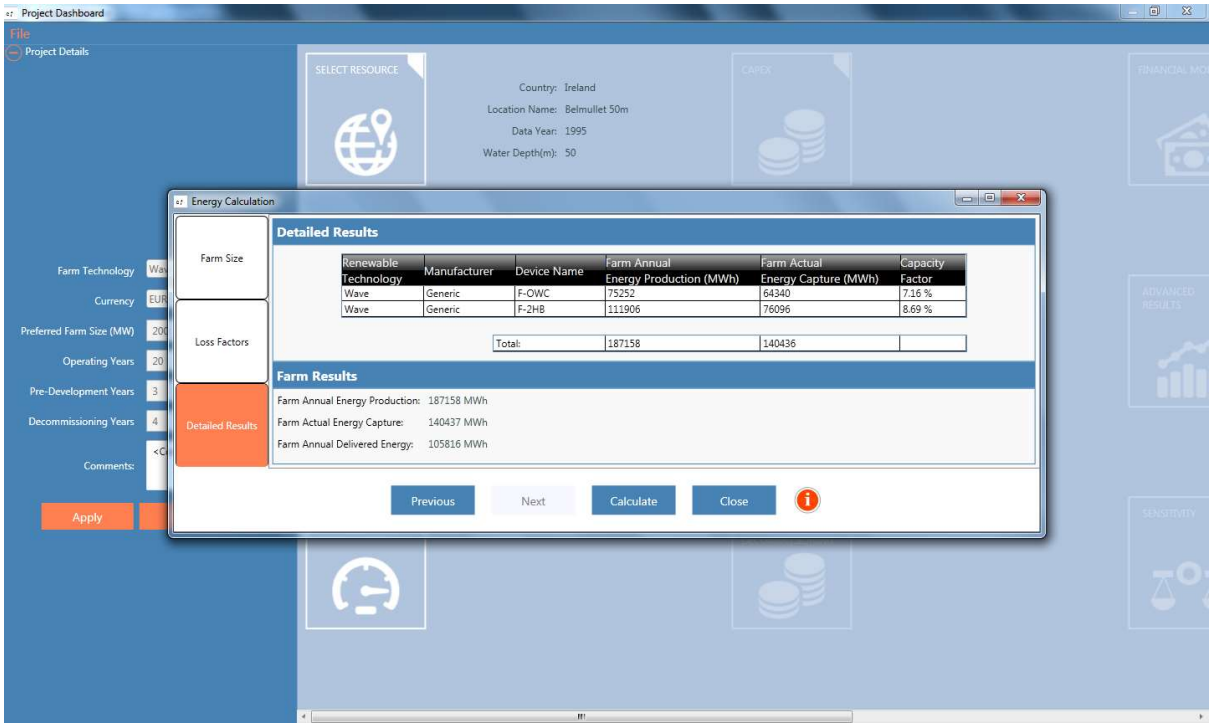

Figure 20: Case Study 2: Energy Calculation Results.

The energy results that should be outputted are listed in Table 5.

Generic F-OWC Capacity Factor	7.16%
Generic F-2HB Capacity Factor	8.69%
Farm Annual Energy Production	187158MWh
Farm Actual Energy Capture	140437MWh
Farm Annual Delivered Energy	105816MWh

Table 5: Case Study 2: Energy results.

Click 'Close' to store these results after which the user will be returned to the project dashboard and the next module 'Capex' will be unlocked.

2.4.5 CAPEX

When the Capex icon is clicked the user is presented with three options for entering Capex. The first 'Total Capex per farm' is the simplest method and is one number covering the entire project's Capex. The second 'Simple Breakdown of Capex per Farm' is a breakdown of the farm's Capex into four areas. The third option 'Detailed Capex per Device' is the most detailed and allows the user to enter individual Capex costs for each device and project components.
For this case study select 'Simple Breakdown of Capex per Farm' and click 'Apply & Close.

Next the user must enter the following

- For 'Device Cost' enter €450,000/MW,
- For 'Balance of Plant' enter €350,000/MW,
- For 'Cabling/Piping' enter €250,000/MW,
- For 'Moorings/Foundations' enter €150,000/MW.

For each ensure that the correct metric '€/MW' is selected. The inputted costs are shown in Figure 21.

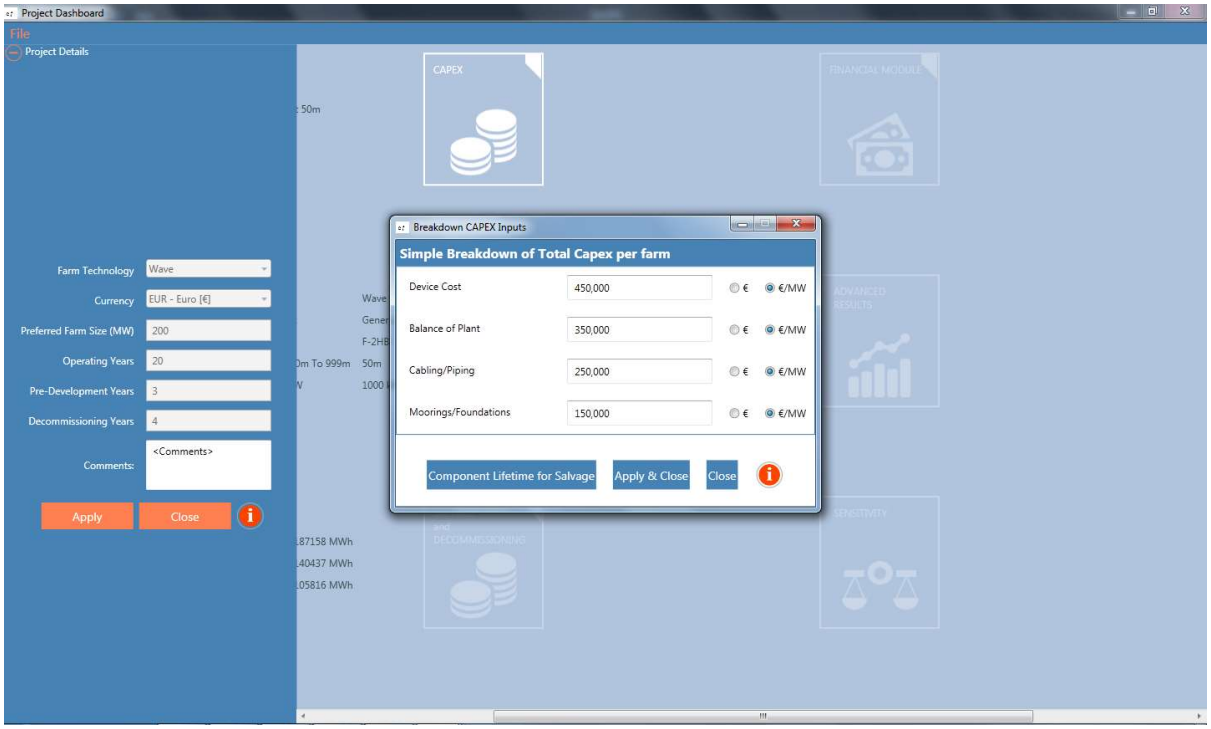

Figure 21: Breakdown Capex costs.

Next click 'Component Lifetimes for Salvage' and enter a Moorings lifetime of 17 years and a Cabling lifetime of 25 years. This is shown in Figure 22.

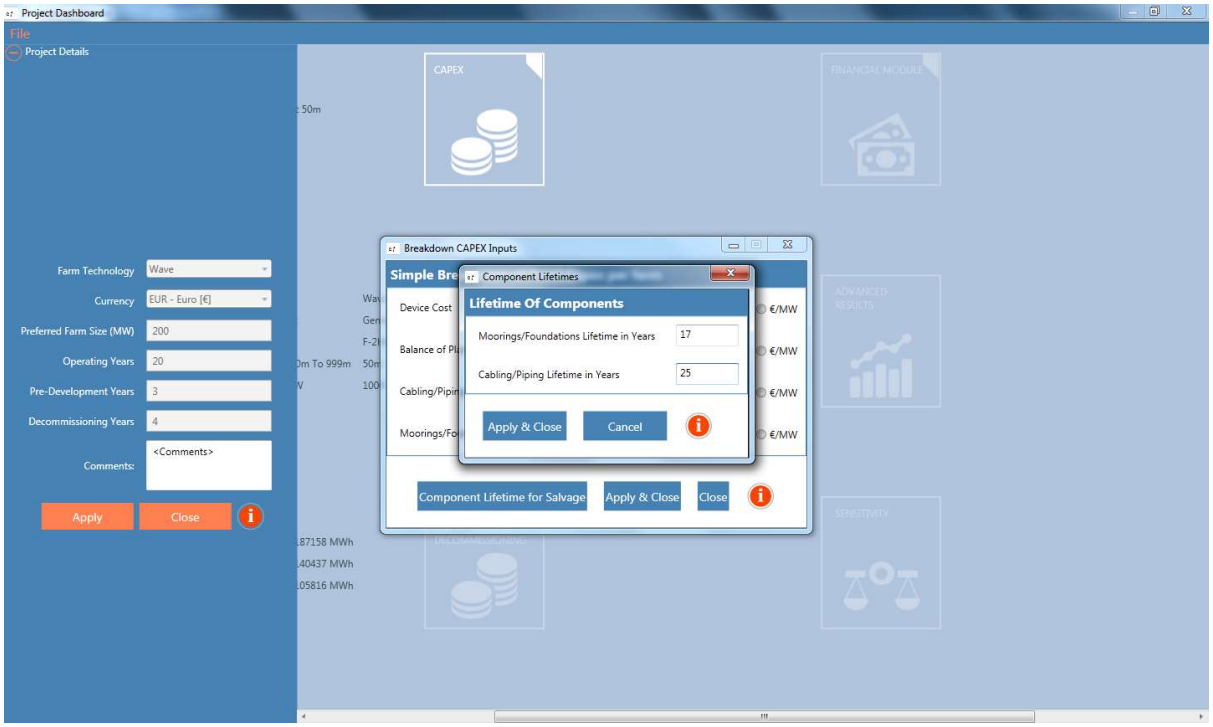

Figure 22: Components lifetime for salvage.

Click 'Apply & Close' for both the Components Lifetime for Salvage window and the Capex window. Prior to returning to the project dashboard the 'Staggered Capex' window opens. As the project has pre-development years the user must allocate when during these years the project's Capex will be charged to the project.

For Staggered Capex enter 10% in Year -3, 20% in Year -2, 30% in Year -1 and 40% in Year 0 as shown in Figure 23.

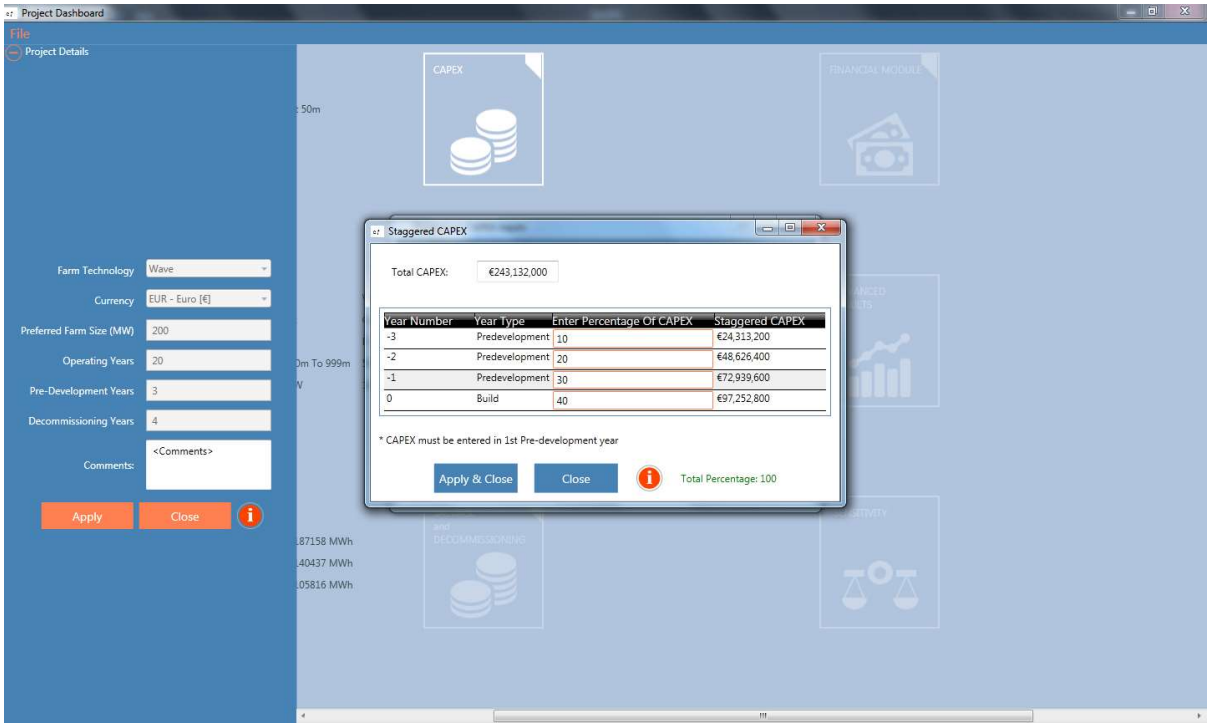

Figure 23: Staggered Capex.

Click 'Apply & Close' to store the values entered. This will return the user to the project Dashboard where the next module 'Opex' is unlocked.

2.4.6 OPEX

When the Opex icon is clicked the user is presented with three options for entering Opex. The first 'Total Opex per farm' is the simplest method and is one number covering the entire project's annual Opex. The second 'Total Yearly Opex per Farm' is a where the user can enter a single Opex number for each individual year of the project. The third option 'Breakdown Total Opex per Farm' is the most detailed and allows the user to enter individual Opex costs for each device and project component.

For this case study select 'Total Yearly Opex per Farm' and select 'Apply & Close'. Next the user must enter the Opex for each operating year of the project. In this case enter an Opex of €20m per year with €40m in the year that the moorings have to be replaced (This year is listed in the Show Additional Info page). The completed opex is shown in Figure 24.

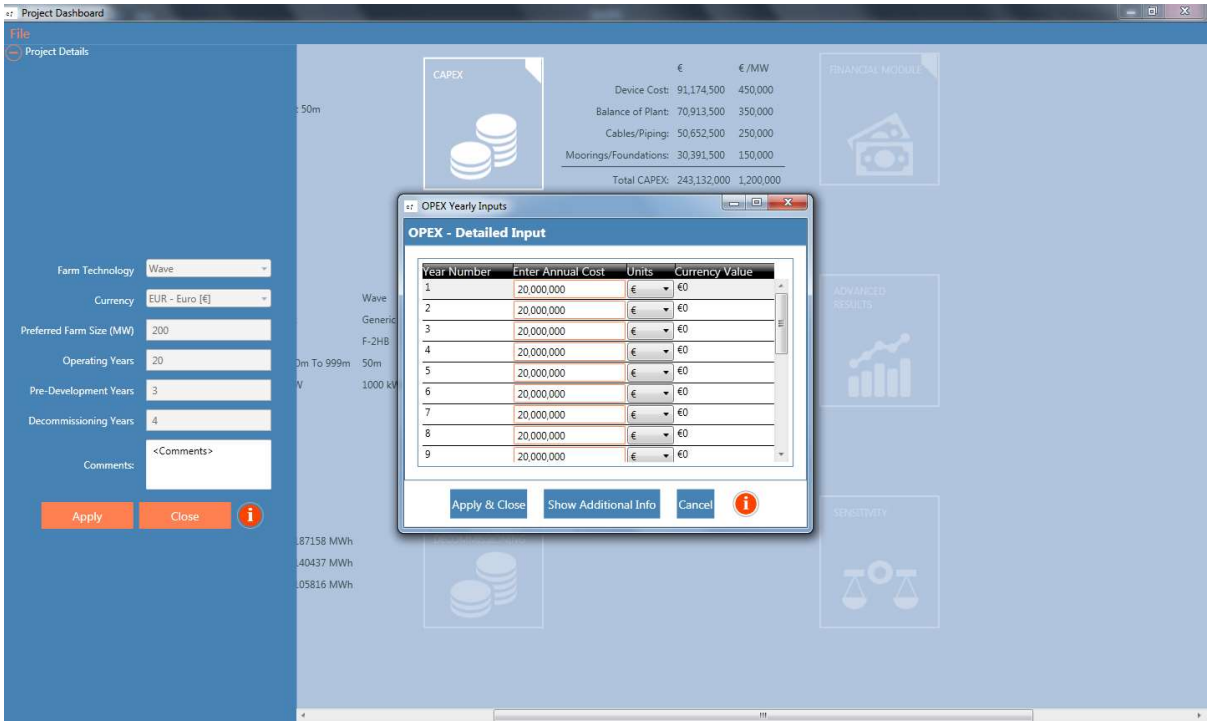

Figure 24: Yearly Opex.

Click 'Apply & Close' to store the Opex value entered. This will return the user to the project Dashboard where the next set or modules 'Salvage & Decommissioning' and 'Financial Module' are unlocked.

2.4.7 Salvage

Click the 'Salvage and Decommissioning' icon on the project dashboard and select the 'Salvage' sub module.
In the Salvage Module enter the following

- Device Salvage as 5% of Device Initial Cost
- Other Salvage as €1m.
- Cabling/Salvage as €10,000/MW,
- Moorings/Foundations Salvage as 10% of Mooring/Foundation Initial Costs.

The completed Salvage module is shown in Figure 25.

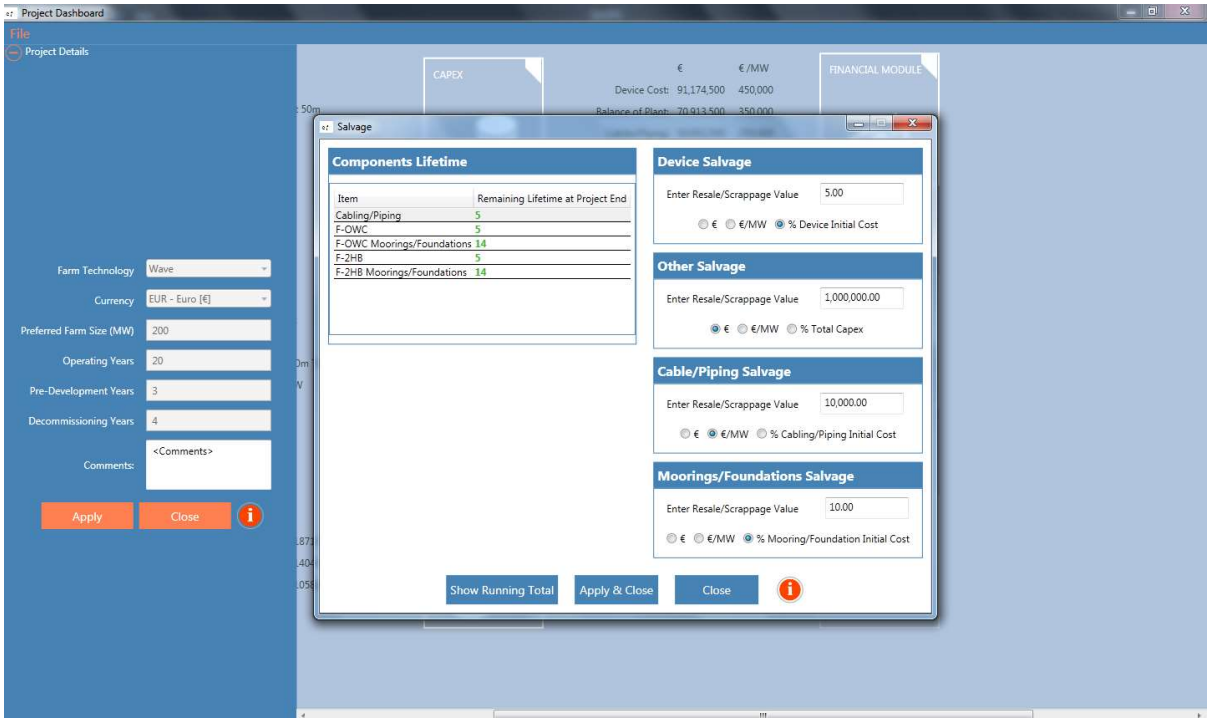

Figure 25: Case Study 2: Salvage.

When the values are entered click 'Apply & Close'. This will open the 'Staggered Salvage' window. As the project has decommissioning years specified the user must allocate when the salvage value will be return to the project. In this case enter 20% per year.

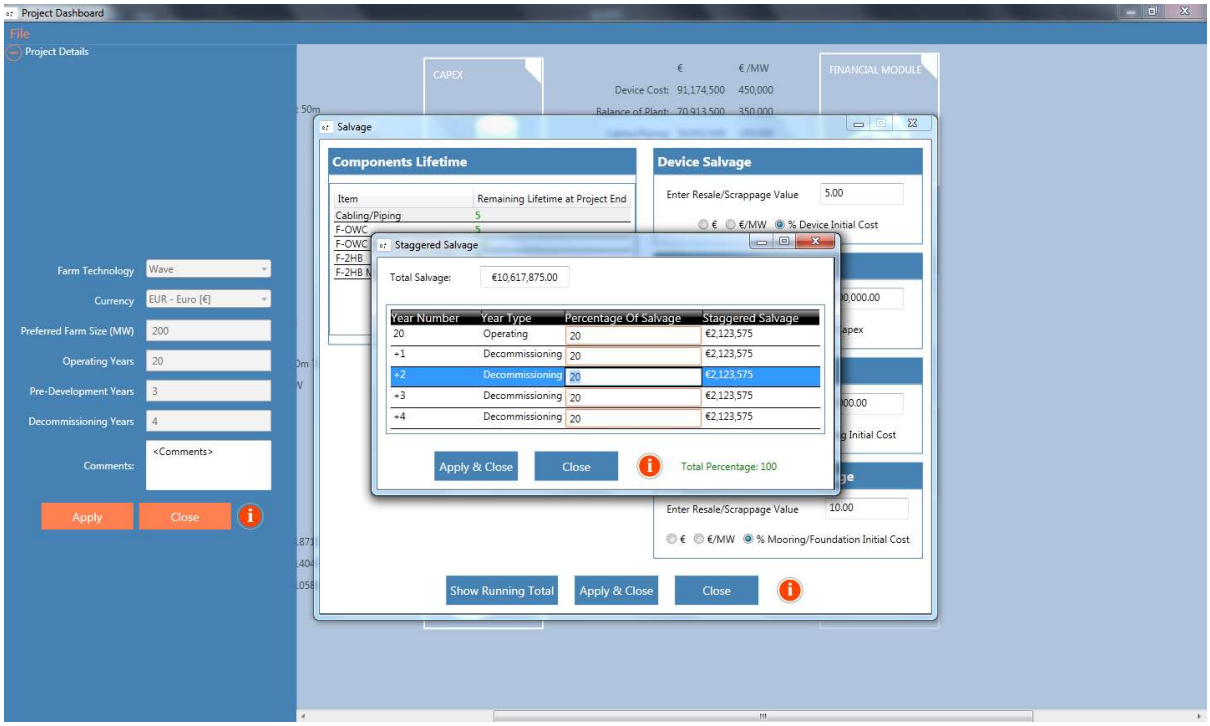

Figure 26: Case Study 2: Staggered Salvage.

The completed staggered salvage is shown in Figure 26.

Click 'Apply and Close' to return to the project dashboard.

2.4.8 Decommissioning

Click the 'Salvage and Decommissioning' icon on the project dashboard and select the 'Decommissioning' sub module.
In the Decommissioning Module enter the following a cost of €500,000 in each year.

Figure 27: Case Study 2: Decommissioning.

The completed decommissioning module is shown in Figure 27. Click 'Apply & Close' to return to the project dashboard.

2.4.9 Financial Module

On the project dashboard click 'Financial Module'. This has four tabs covering Revenue, Discounting & Inflation, Debt/Equity and Tax & Depreciation.

In the revenue tab under 'Revenue-Basic Inputs' select 'Included' next to FIT to include this factor in the project. Change the default selection from 'Variable' to 'Fixed'. This should open the FIT Input box where a value of £400/MWh should be entered. This is shown in Figure 28.

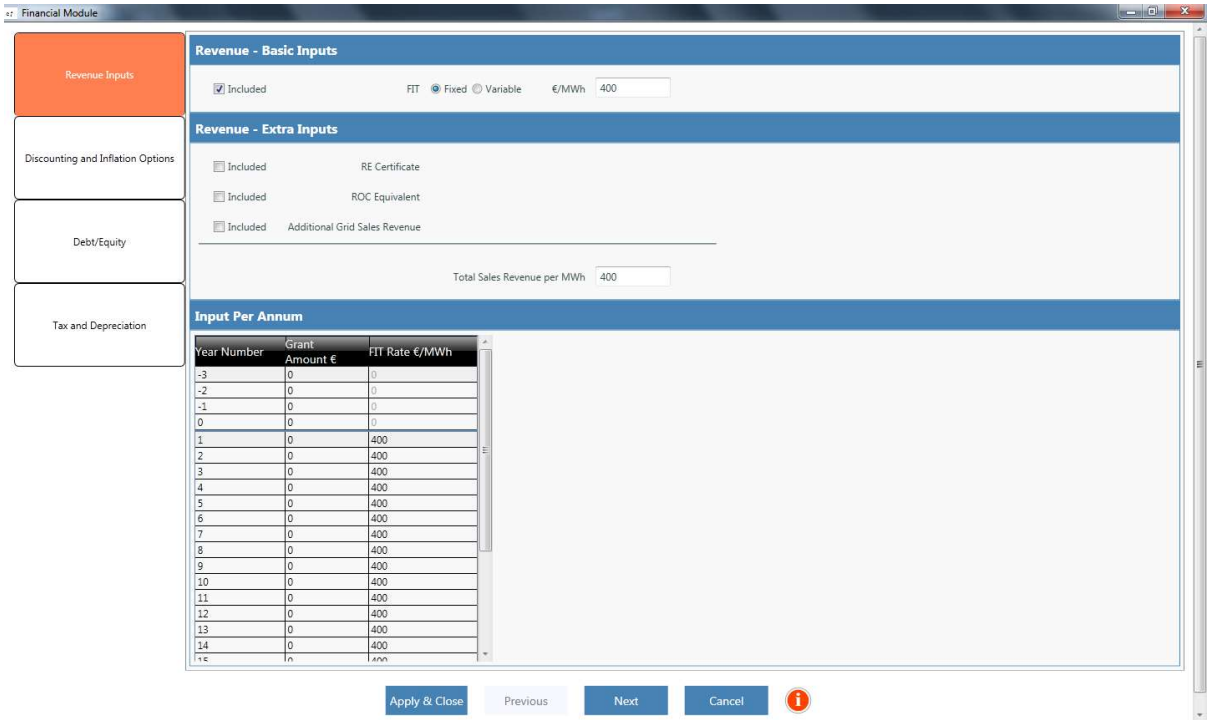

Figure 28: Case Study 2: Revenue.

Click 'Next' to progress onto the 'Discounting and Inflation Options' tab. Here select the fourth option 'Apply Cash Flows in Nominal Terms' and enter a Nominal Discount Rate of 6% and an Inflation Rate 2%.

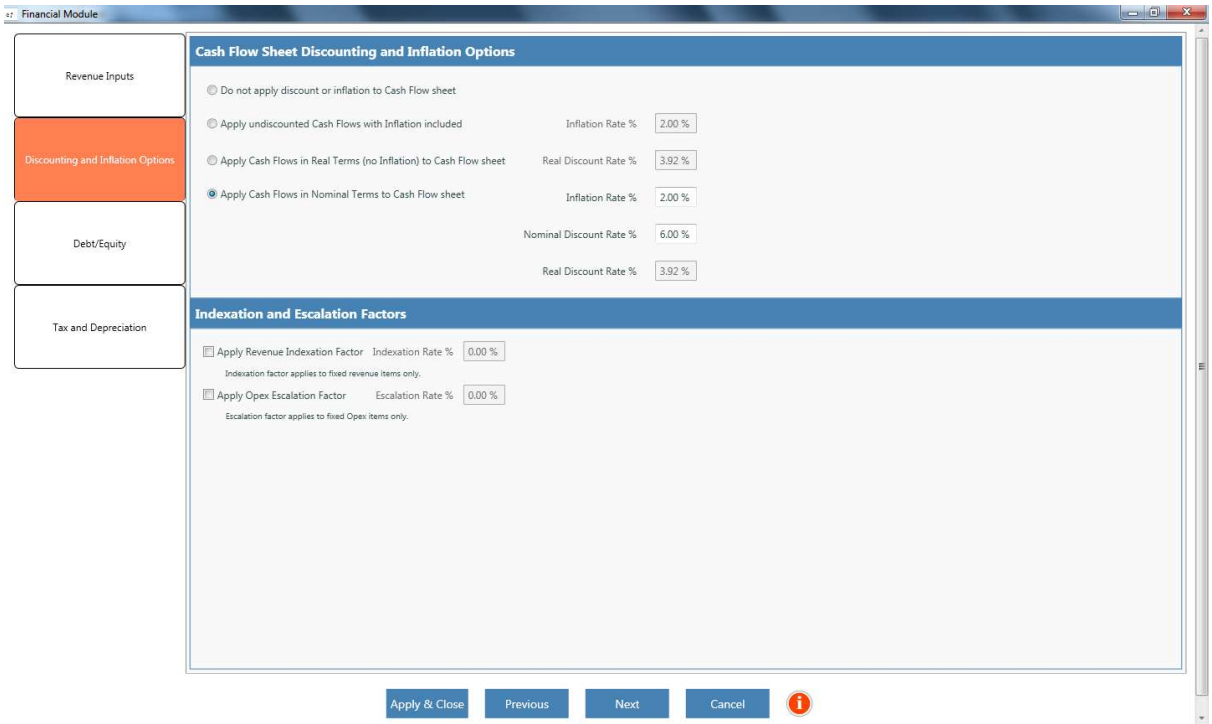

Figure 29: Case Study 2: Discounting.

The completed discounting tab is shown in Figure 29. Click 'Next' to progress onto the 'Debt/Equity' tab. The following should be entered.

- Assign a 40% Debt/60%Equity ratio.
- Enter a 12 year Debt term
- Enter a 3% Borrowing Rate
- Choose Monthly Loan Repayments
- Begin repayments Year 0.

The completed Debt/Equity tab is shown in Figure 30.

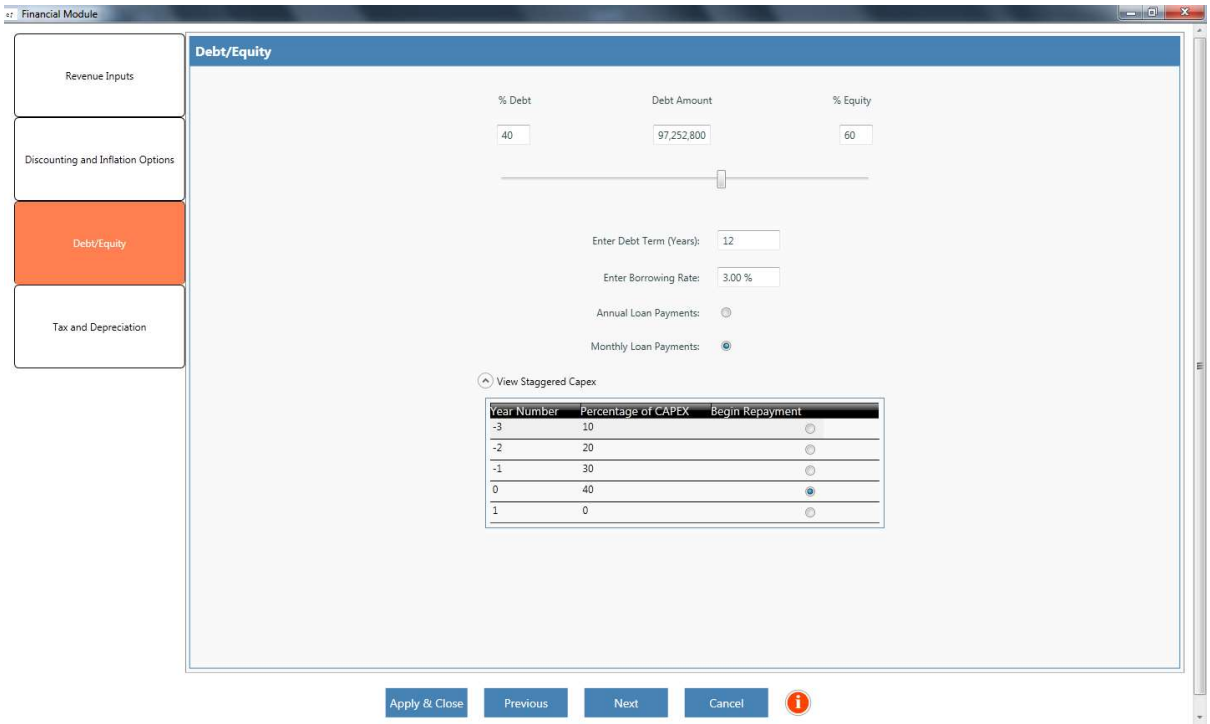

Figure 30: Case Study 2: Debt/Equity.

Click 'Next' to progress on to the 'Tax and Depreciation Module'
First enter a 5% Tax Rate. This should open the depreciation table. In the table enter the following.

- Enter a 'Device Cost' depreciation amount of 100% with 'Straight Line' depreciation over 15 years.
- Enter a 'Cabling and Piping' depreciation amount of 100% with 'Variable' depreciation. In the table on the right hand side enter 40% in Year 1, 30% in Year 2, 20% in Year 3, 10% in Year 4.
- Enter a 'Moorings and Foundations' depreciation amount of 100% depreciation with 'Single year' depreciation.

The completed tax & depreciation tab is shown in Figure 31.

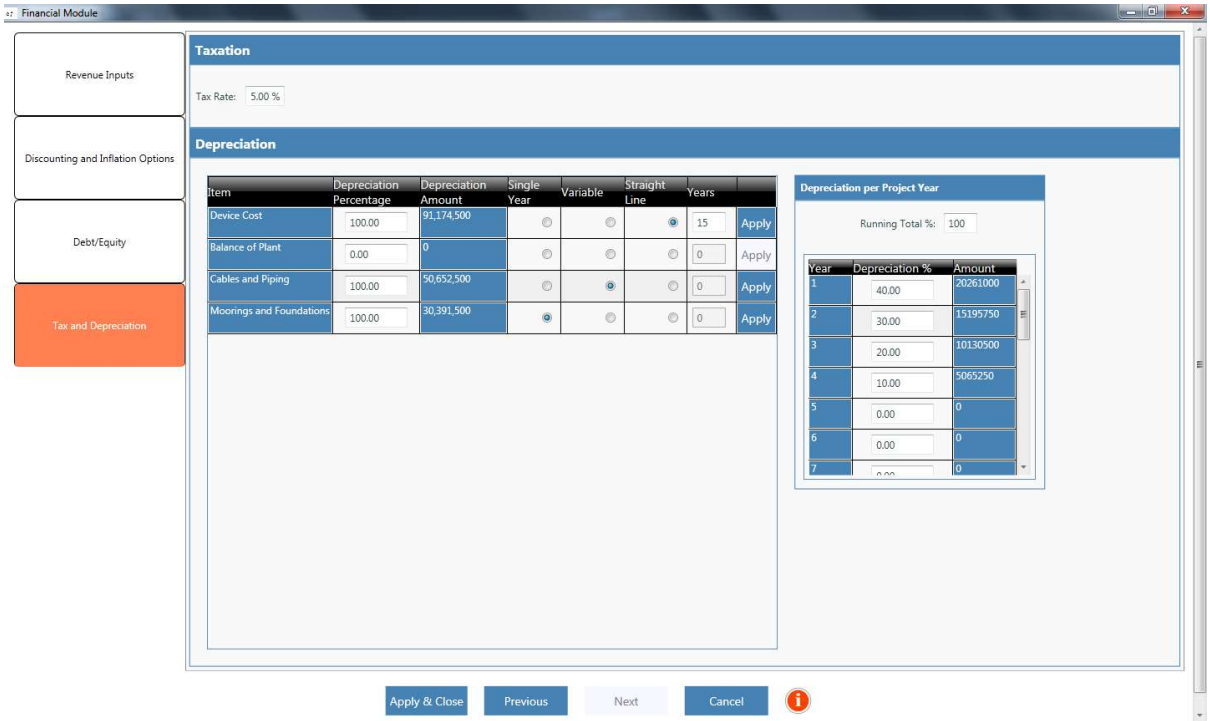

Figure 31: Case Study 2: Tax & Depreciation.

This completes the inputting of the project details. To calculate the project results click 'Apply & Close' in the Financial Module. This will calculate the final results and return the user to the project dashboard where the output modules Advanced Results, Sensitivity, Graphical Results and Excel Export are unlocked.

The project results that should be returned are shown in Table 6.

Net Present Value (NPV) £	£55,350,369
Levelised Cost of Electricity (LCOE) £/MWh	£457.79/MWh
Internal Rate of Return %	9.39%

Table 6: Case Study 2: Project Results.

2.5 Case Study 3: Advanced Project

The third case study involves building a project with the following parameters shown in Table 7.

Farm Technology	Combination Wave and Offshore Wind
Farm Size	300 MW
Currency	US Dollars
Operating Duration	20 Years

Location and Year	EMEC 2005
Devices	Generic F-3OF & Vestas V90
Capex	Detailed Capex
Opex	Detailed Opex
Revenue Rates	Mixture of Fixed Rate and Grant
Nominal Discount Rate	6%
Inflation Rate	3%
Debt/Equity Ratio	50/50

Table 7: Case Study 3: Project Details.

Note that the values used in this case study are purely for the purposes of showing the functionality and are not intended to be representative of real projects or the devices used in the case study.

2.5.1 Main Project Details

To build a farm the user must first select 'New Project' on the main menu. This will open a blank Project Dashboard. The project dashboard is where all the modules required to build a project are accessed from. It guides the user through the project building process by sequentially unlocking modules as the user enters the required details in each. The inputs entered in each module are then summarised on the project dashboard as well as the final results when the project is complete.

The main project details are located on the left hand side and must be entered before the first module 'Select Resource' can be accessed.

For this case study enter the following in the main project details

- From the Farm Technology dropdown select Combo: Wave & Offshore Wind.
- From the Currency dropdown select USD-US Dollars
- For Farm Size enter 300 MW
- In Operating Years enter 20 Years

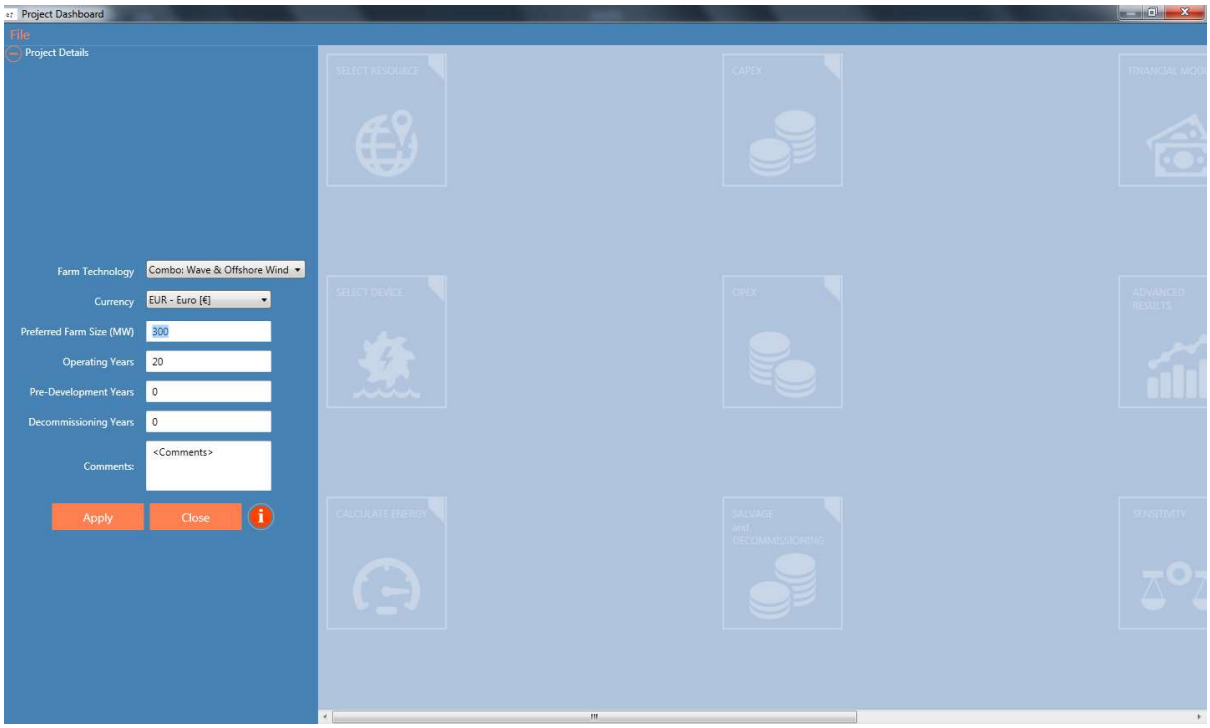

Figure 32: Case Study 3: Main Project Details.

As the required details necessary to build a project have been entered the 'Apply' button should now be enabled, as shown in Figure 32. Click 'Apply' to store the details and unlock the next module 'Select Resource'

2.5.2 Resource Selection

When the 'Select Resource' is clicked on the project dashboard the resource screen is opened. The locations which contain wind and wave data are listed.
Select 'United Kingdom' and 'EMEC' as Location and 2005 as the data year for both. The selection is made by clicking the row in each table after which the selected location/data year is highlighted in blue. The resource selection is shown in Figure 33.

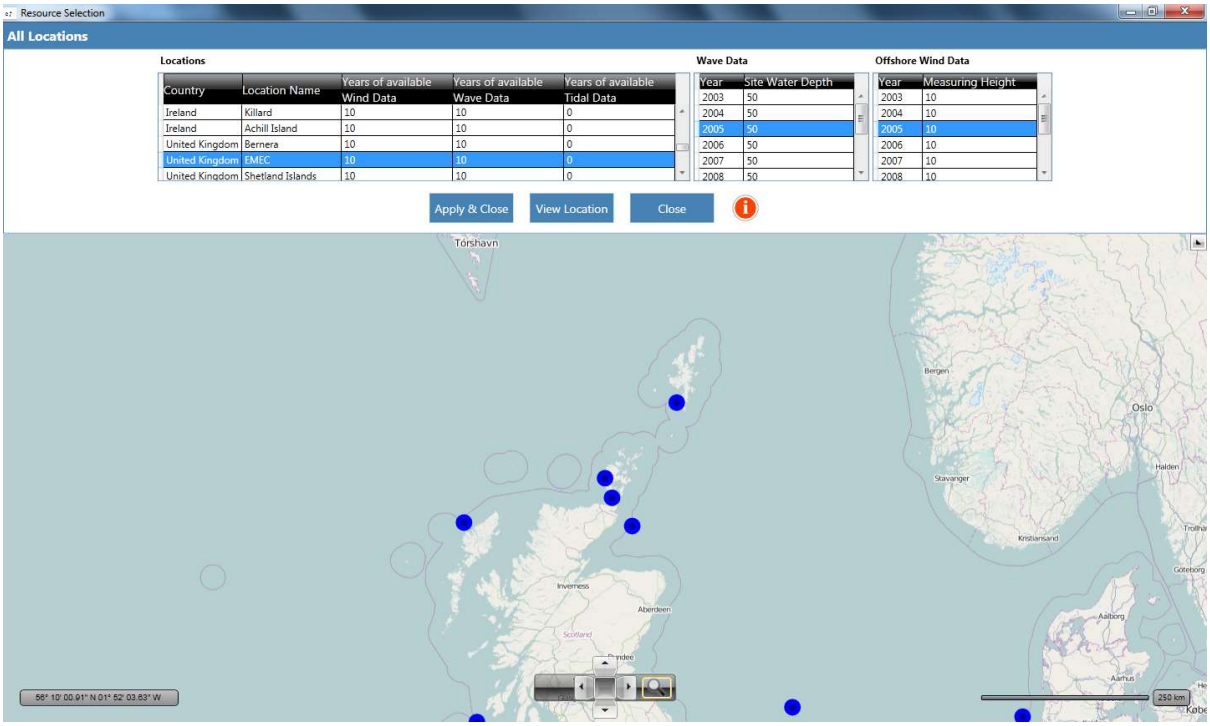

Figure 33: Case Study 3: Resource Selection.

After the location and data year are selected click 'Apply & Close' to store the selection made. The user will be brought back to the project dashboard and the next module 'Select Device' will be unlocked.

2.5.3 Device Selection

When the 'Select Device' icon is clicked the device module opens and all the wave and wind devices in the database are listed.

Select both the 'Generic F-3OF' 1665kW and the 'Vestas V90-3.0MW' 3000kW devices from the list. The selection is made by clicking the row which lists the device after which the selected device is highlighted in blue. The user must then click 'Add to Selected Devices' which moves the device from the 'Available Devices' list to the 'Selected Devices' list. More than one device can be selected in this way. The completed device selection is shown in Figure 34.

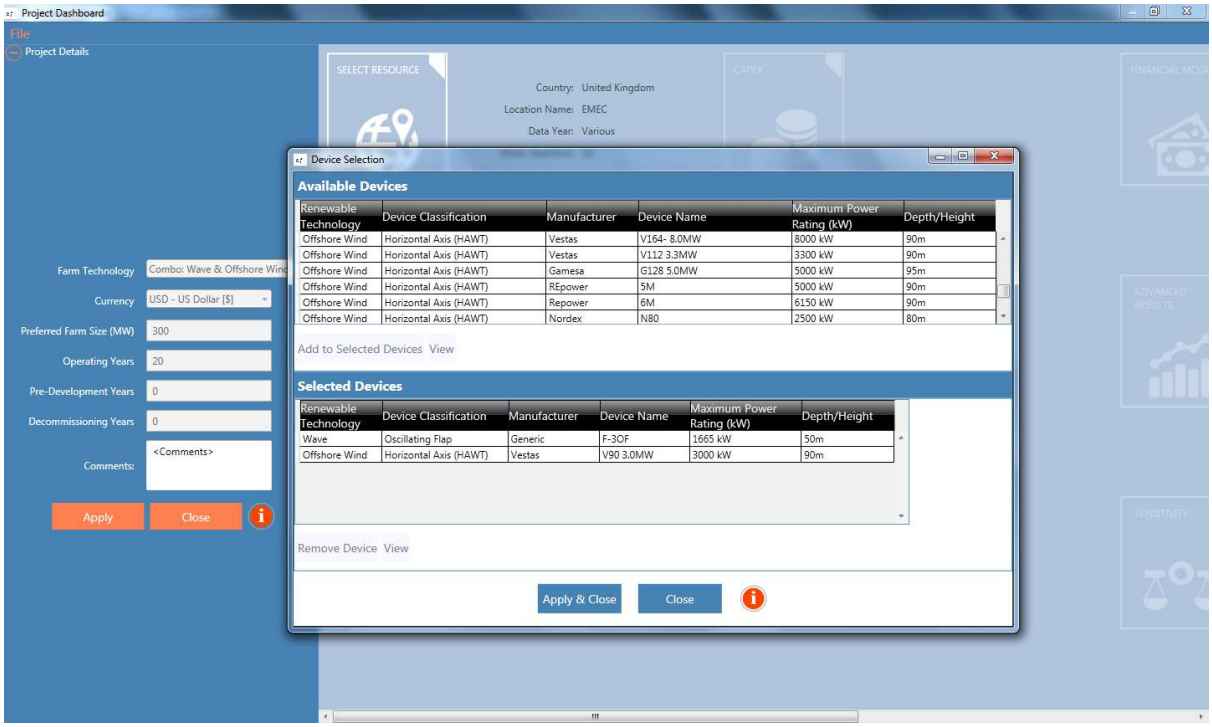

Figure 34: Case Study 3: Device Selection.

When the desired devices has been selected and added to the 'Selected Devices' list, click 'Apply & Close' to store the device selection. This will take the user back to the project dashboard and the next module 'Calculate Energy' will be unlocked.

2.5.4 Energy Calculation

When the 'Calculate Energy' icon is clicked the Energy Calculation module opens. This contains three tabs. The first allows the user to set the final farm size by adjusting the number of units of each device. The second allows to user to enter factors to account for possible losses in the energy calculation process and the third lists the energy output results once the calculation has taken place.

In this case study there are no farm size adjustments or loss factors applied therefore the energy calculation process can be initiated by clicking 'Calculate'.
Note: A message will appear for the wave device notifying the user that Exceedence Finance will perform the energy calculation using the converted scatterplot and not the original. Click OK to the message.
Next the offshore wind height adjustment window will open. This highlights that the wind resource data has been measured at a different height than the wind turbines hub height and must be adjusted.
In this case select 'Power Law' and enter a 'Power Law Exponent' of 0.142. This is shown in Figure 35.

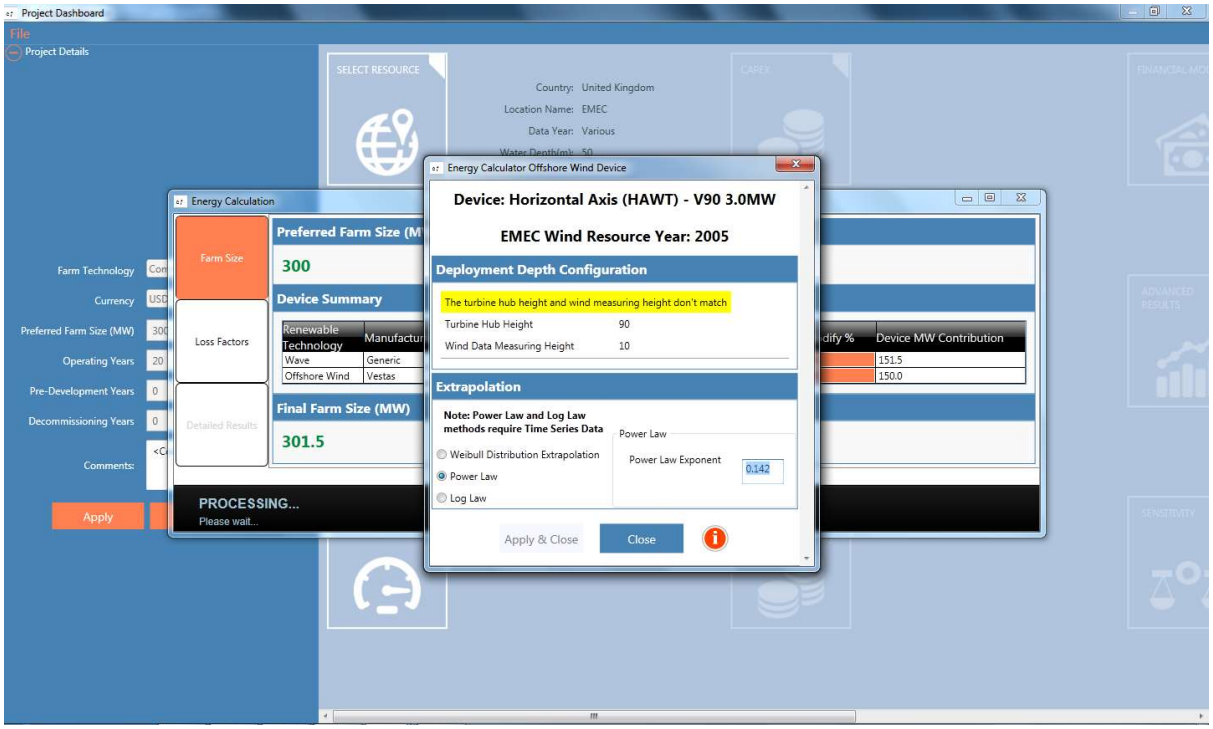

Figure 35: Energy Calculation. Power Law Adjustment.

Click 'Apply & Close' to conclude the energy calculation process. This should open the 'Detailed Results' tab as shown in Figure 36.

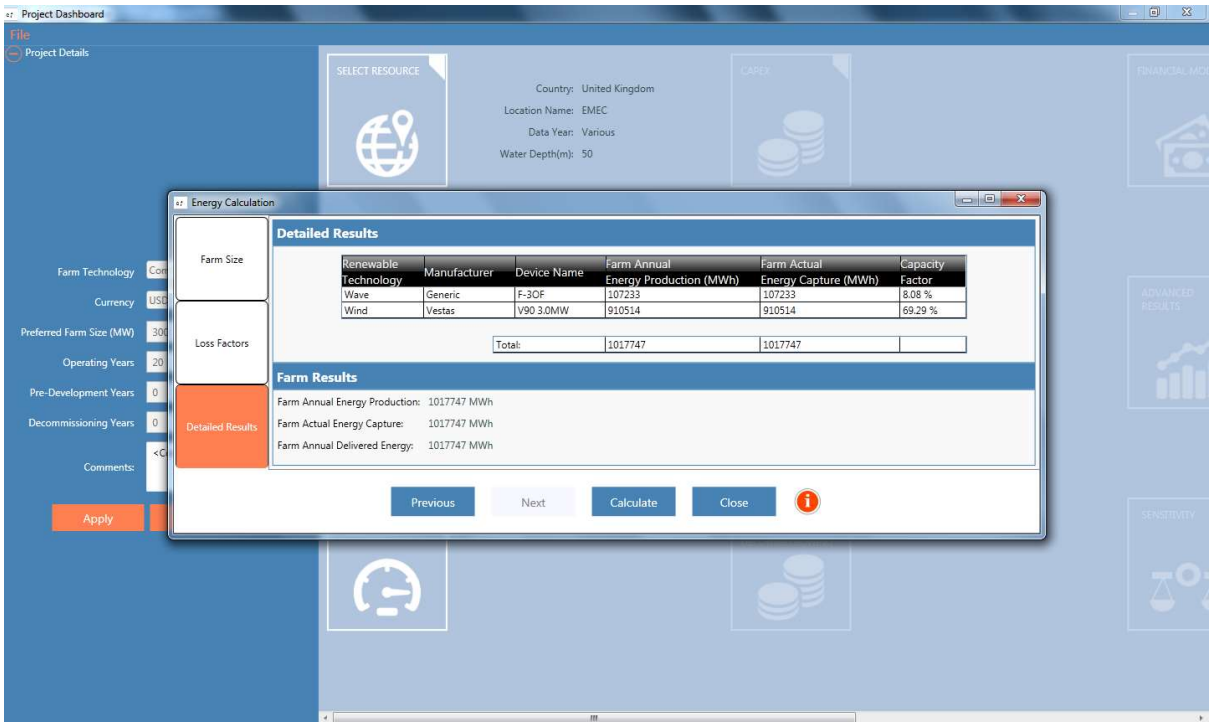

Figure 36: Case Study 3: Energy Results.

The energy results that should be outputted are listed in Table 8.

Generic F-3OF Capacity Factor	8.08%
Vestas V90-3.0MW Capacity Factor	69.29%
Farm Annual Energy Production	1017747MWh
Farm Actual Energy Capture	1017747MWh
Farm Annual Delivered Energy	1017747MWh

Table 8: Case Study 3: Energy Results.

Click 'Close' to store these results after which the user will be returned to the project dashboard and the next module 'Capex' will be unlocked.

2.5.5 CAPEX

When the Capex icon is clicked the user is presented with three options for entering Capex. The first 'Total Capex per farm' is the simplest method and is one number covering the entire project's Capex. The second 'Simple Breakdown of Capex per Farm' is a breakdown of the farm's Capex into four areas. The third option 'Detailed Capex per Device' is the most detailed and allows the user to enter individual Capex costs for each device and project component.
For this case study select 'Detailed Capex per Device' and click 'Apply & Close.
As this is a combination project with both offshore wind and wave devices the user must answer some questions regarding the project infrastructure sharing.
The first of these is what cabling infrastructure sharing is to be modelled. There are two options available 'Farm Shares Export and Interarray Cabling' or 'Farm Shares Export Cabling only'.
In this case choose the first option 'Farm Shares Export and Interarray Cabling/Piping'.
The next question is whether the power exported in this project will be electricity though cabling or hydro using piping. In this case choose 'Electrical Cabling'.
Finally the user must state whether each device uses moorings or foundation for its station keeping. For the 'Generic F-3OF' wave device choose 'Moorings' and for the 'Vestas V90 3.0MW' offshore wind turbine choose 'Foundations'.
This brings the user onto the Main Detailed Capex page shown in Figure 37. From here the user selects 'Input Cost' and then details the cost for that device.

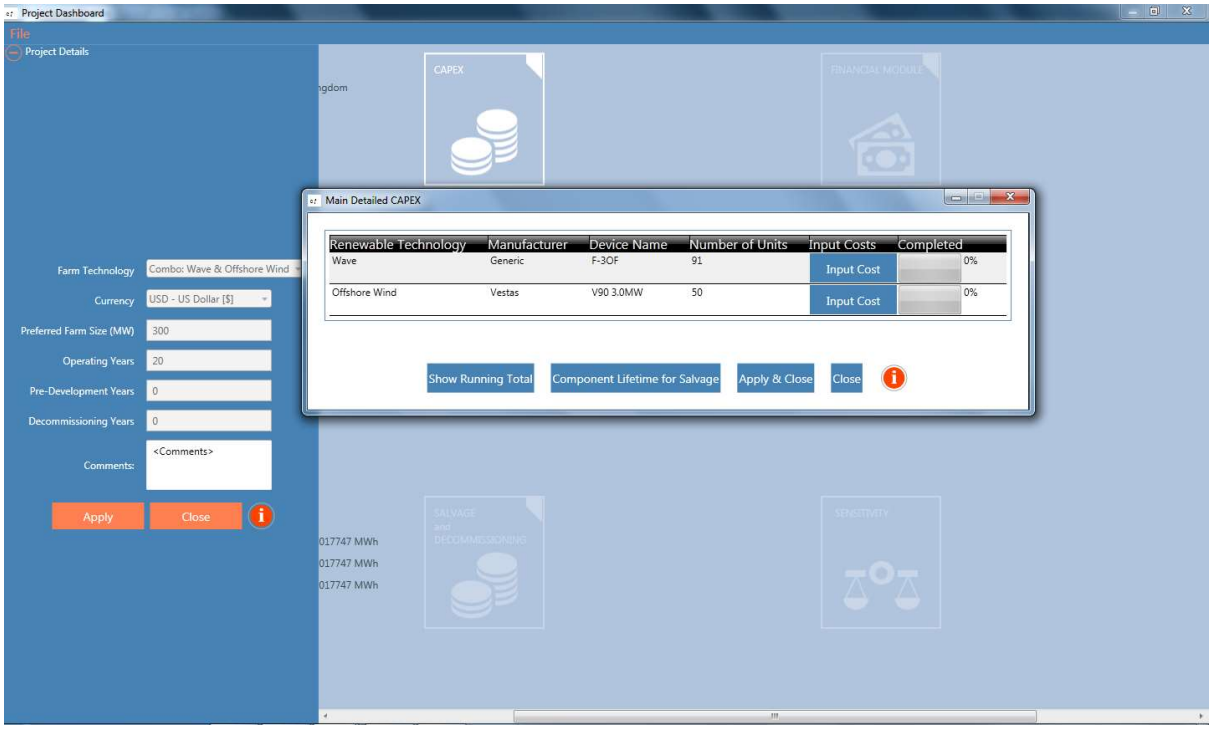

Figure 37: Main Detailed Capex.

First choose 'Input Cost' for the Generic F3OF wave device. This shows the user the four main breakdown Capex areas for this device as shown in Figure 38.

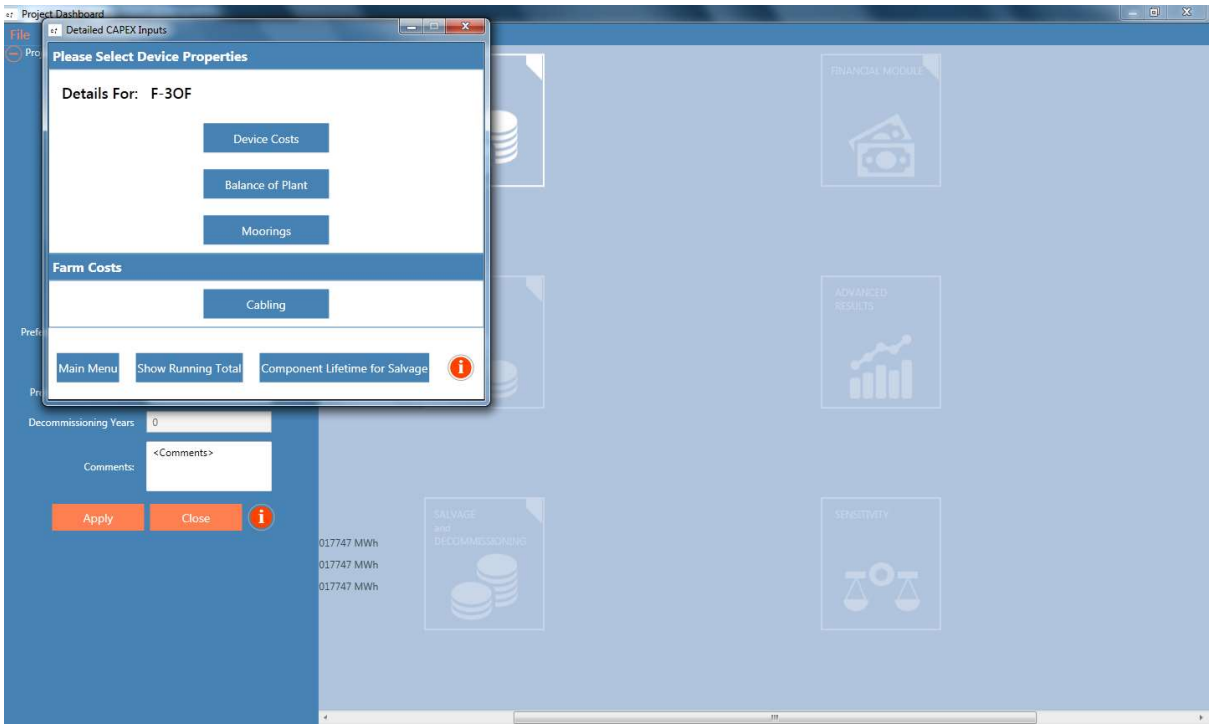

Figure 38: Detailed Capex Inputs.

The user selects each area and then enters the detailed costs for each. Note that the 'Cabling costs' filled in apply for the whole farm (both devices) as the project shares this infrastructure.
First select 'Device Costs'. This presents the user with an initial list of device components. The user can edit this initial list by user the 'Create/Delete' function below the list.
To include item in the project, and subsequently enter costs for these items, the items must be selected. To do so click on the item, this should highlight it in blue. Then click the arrows pointing to the right. This moves the items from the 'Initial Items' list to the 'Selected Items' list and includes them in the project.

For this device select

- Hull
- PTO
- Control System
- Miscellaneous

The completed device costs item selection is shown in Figure 39.

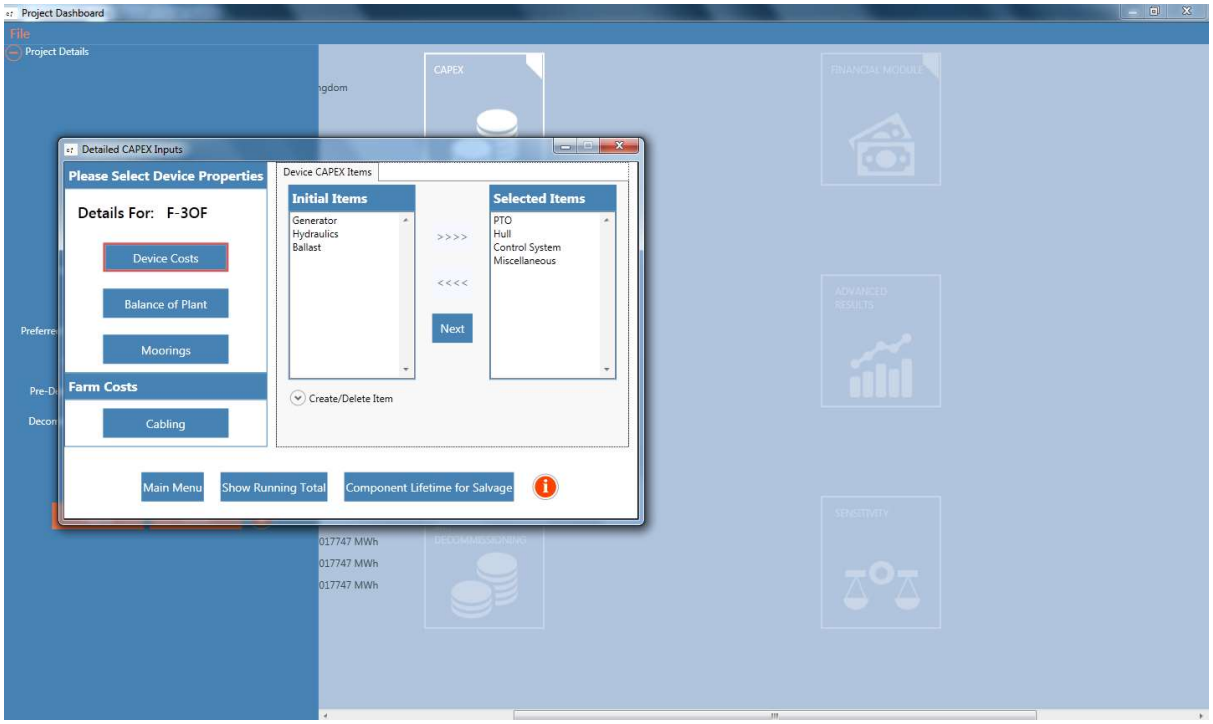

Figure 39: Detailed Capex Item Selection.

Click 'Next' to move onto the 'Device Capex Inputs' screen. Here the user enters the costs for each item. In this case enter the following costs

- For the 'Hull' enter $850,000
- For the 'PTO' $1,000,000
- For the 'Control System' $350,000
- For 'Miscellaneous' $750,000

After the costs are entered click 'Calculate & Apply' to apply these costs. The resulting applied costs are shown in Figure 40.

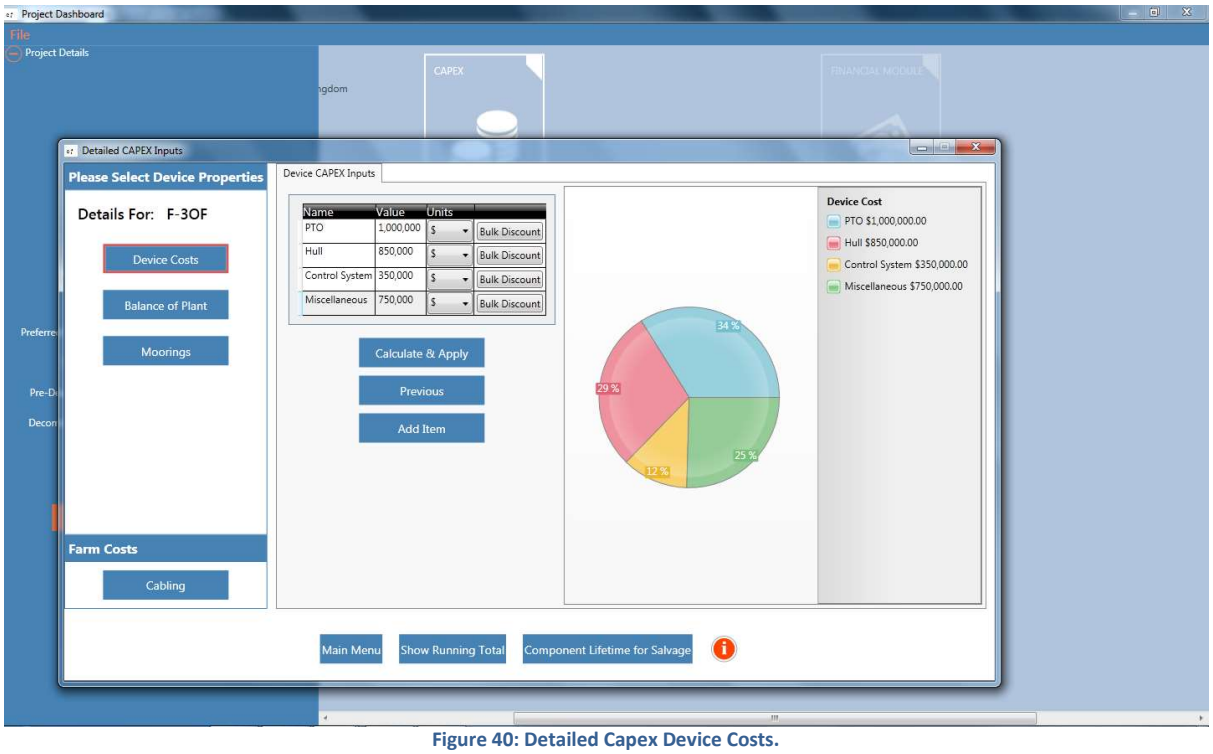

Figure 40: Detailed Capex Device Costs.

Next click 'Balance of Plant' on the left hand side. Using the same process as shown for the 'Device Costs' enter the following for 'Balance of Plant'

- Balance of System $1,000,000

After this cost is entered click 'Calculate & Apply' to apply the cost. The resulting applied costs are shown in Figure 41.

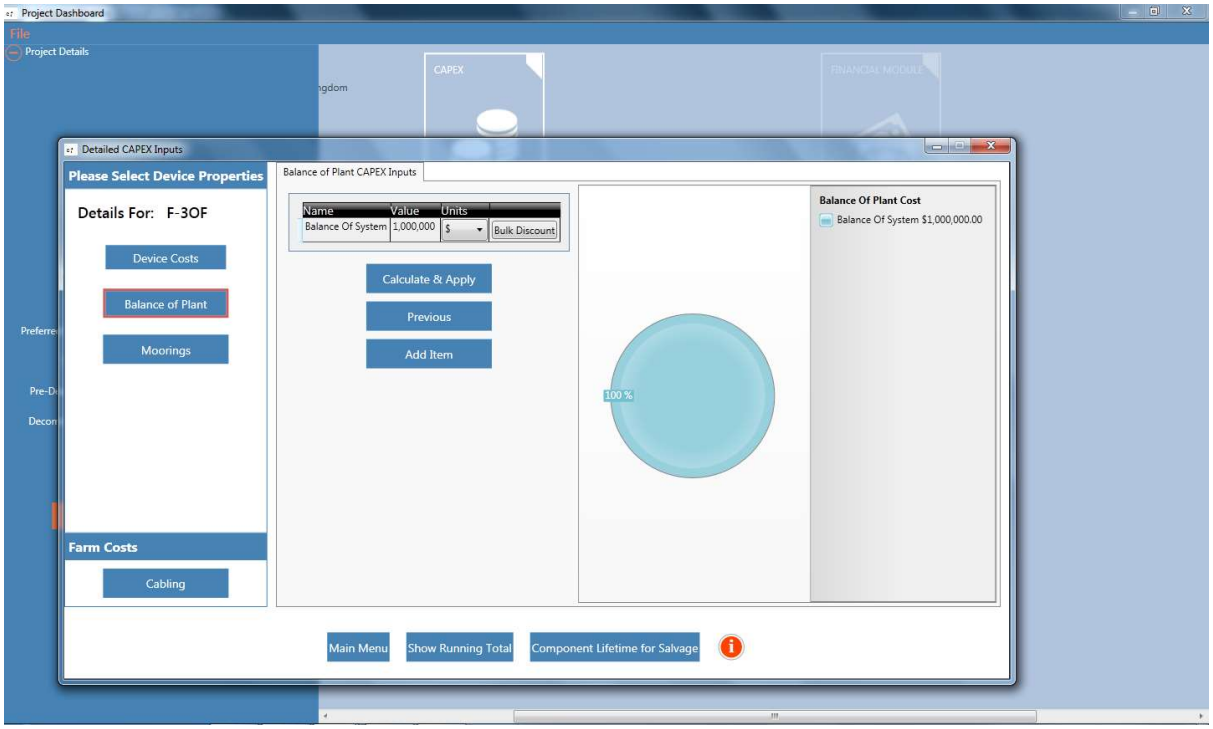

Figure 41: Detailed Capex Balance of Plant Costs.

Next click 'Moorings' on the left hand side. Using the same process as shown for the 'Device Costs' enter the following for 'Moorings'

- Moorings
  - Mooring Line $250,000
  - Anchor $150,000
  - Deployment $350,000

After the costs are entered click 'Calculate & Apply' to apply these costs. The resulting applied costs are shown in Figure 42.

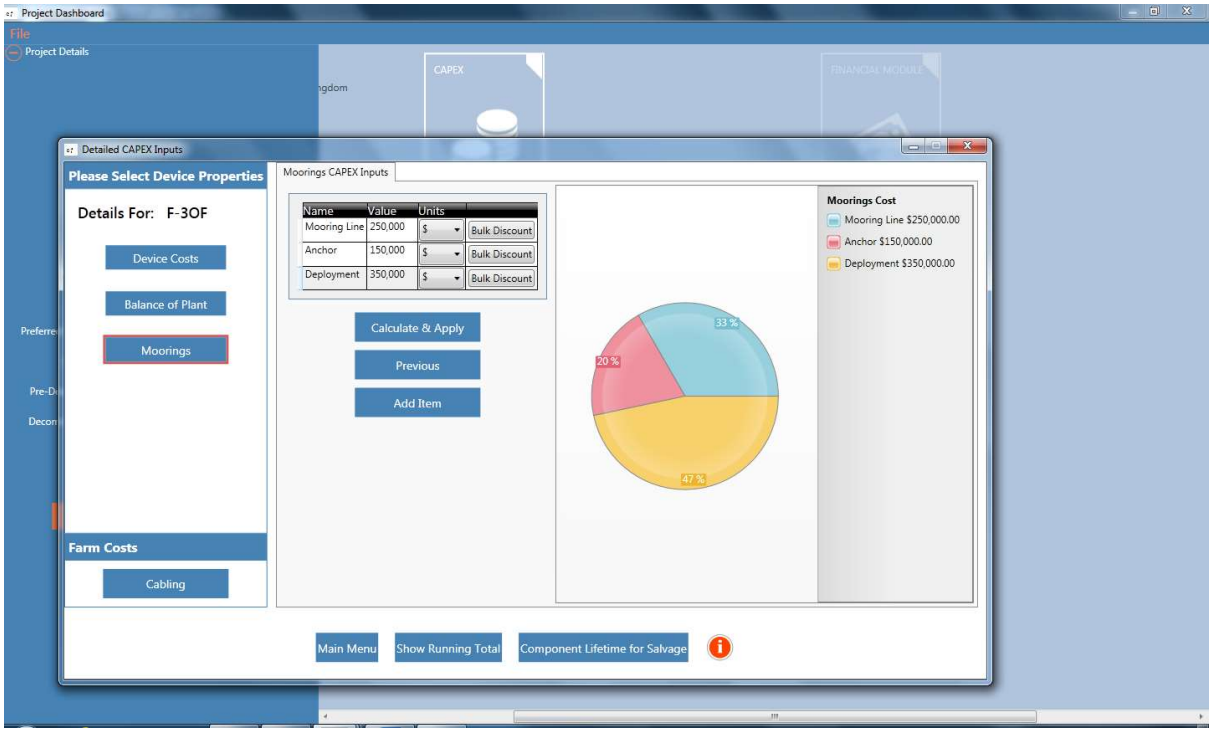

Figure 42: Detailed Capex Moorings Costs.

Next click 'Cabling' on the left hand side. Using the same process as shown for the 'Device Costs' enter the following for 'Cabling'. Note these values apply to the whole farm.

- Cabling (Whole Farm)
  - Export $15m
  - Substation $25m
  - Onshore $20m
  - Interarray $10m

After the costs are entered click 'Calculate & Apply' to apply these costs. The resulting applied costs are shown in Figure 43.

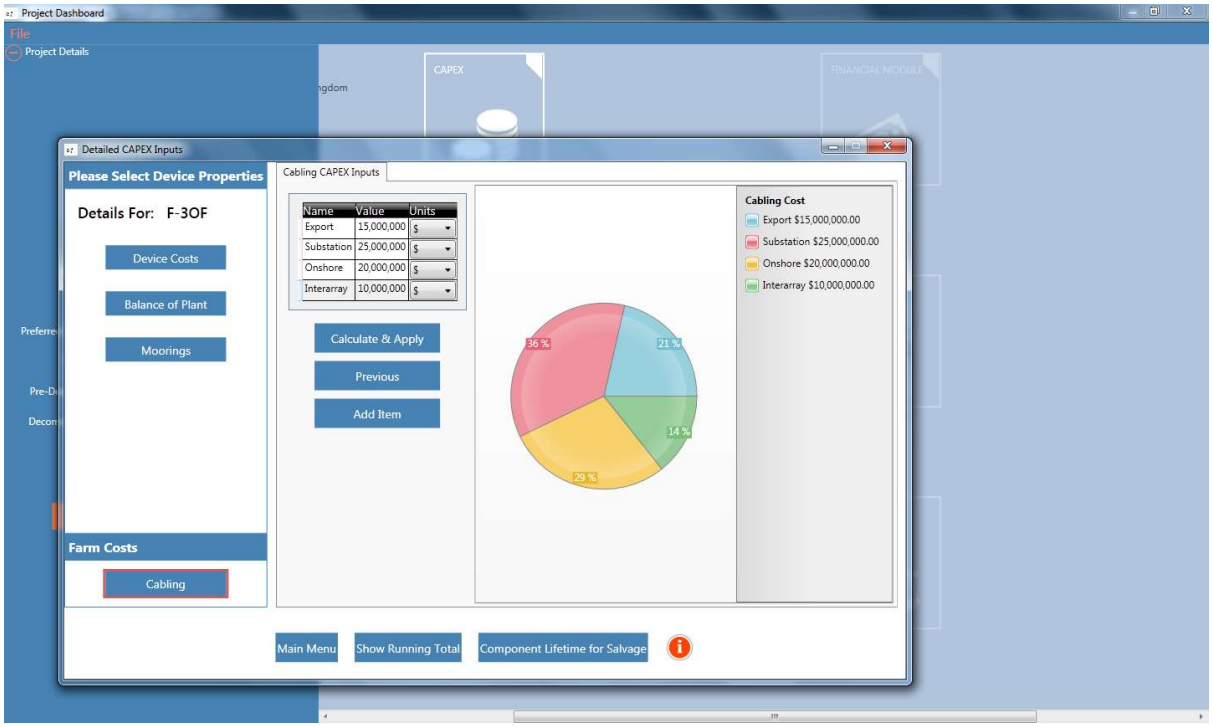

Figure 43: Detailed Capex Cabling Costs.

This completes the costs for the Generic F-3OF device. Click 'Main Menu' to return to the Main Capex menu. Then click 'Input Cost' for the Vestas V90 offshore wind turbine.

Using the same process as shown for the Generic F-3OFdevice, enter the following for Vestas V90.

- Device Costs
  - Turbine $255,000
  - Tower $250,000
  - Blades:$550,000
  - Transition Piece $550,000
- Balance of Plant
  - Balance of System $500,000
- Foundation
  - Material $100,000
  - Fabrication $100,000
  - Transport $100,000

After each series of costs are entered click 'Calculate & Apply' to apply these costs. Cabling costs do not have to be entered as they were already entered for the farm under the Generic F-3OF device.

This completes the costs for the Vestas V90 device. Click 'Main Menu' to return to the Main Capex menu. Now all the required Capex costs for both devices have been entered. Both should be listed as 100% complete in the table as shown in Figure 44.

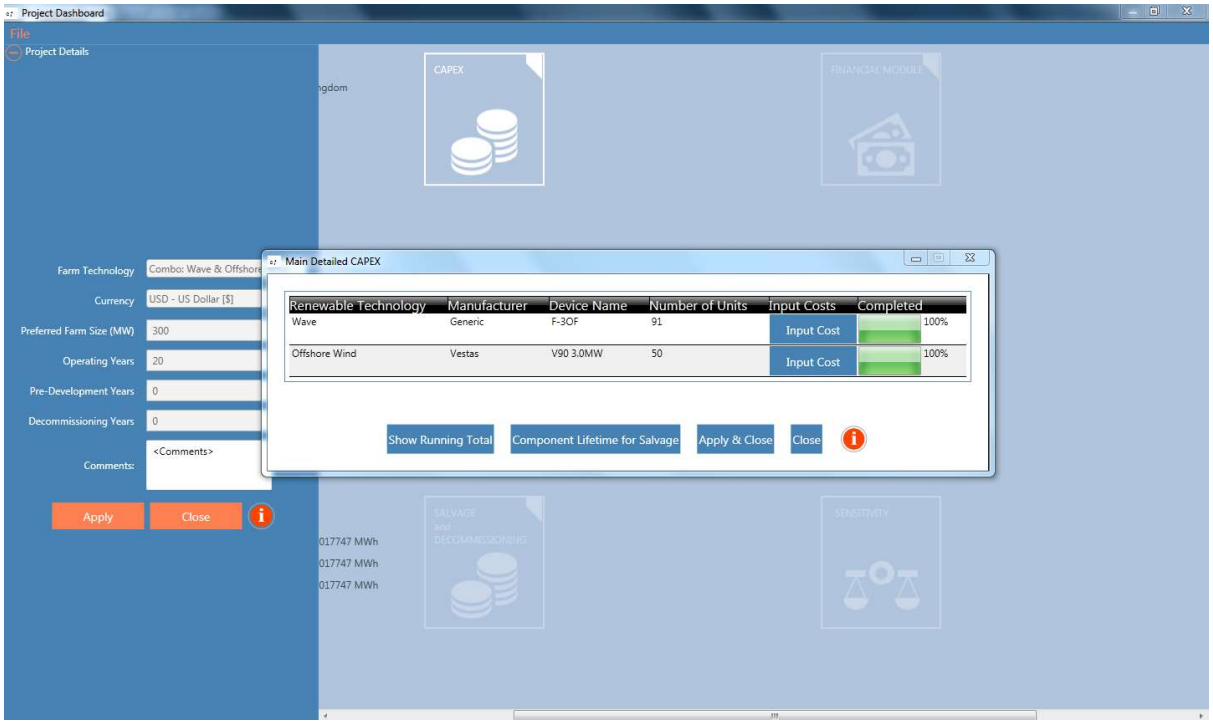

Figure 44: Completed Main Detailed Capex.

Click 'Apply & Close' to store the values entered. This will return the user to the project Dashboard where the next module 'Opex' is unlocked.

2.5.6 OPEX

When the Opex icon is clicked the user is presented with three options for entering Opex. The first 'Total Opex per farm' is the simplest method and is one number covering the entire project's annual Opex. The second 'Total Yearly Opex per Farm' is a where the user can enter a single Opex number for each individual year of the project. The third option 'Breakdown Total Opex per Farm' is the most detailed and allows the user to enter individual Opex costs for each device and projects components. For this case study select 'Breakdown Total Opex per Farm' and select 'Apply & Close'. This presents the user with an initial list of Opex items. The user can edit this initial list by user the 'Create/Delete Item' function below the list.

To include an item in the project, and subsequently enter costs for these items, the item must be selected. To do so click on the item, this should highlight it in blue. Then click the arrows pointing to the right. This moves the items from the 'Initial Items' list to the 'Selected Items' list and includes them in the project.

For this case study enter the following

- Select 'Planned O&M' (if this is not on the list it can be added using the create/delete functionality). Assign this as 'Fixed' and enter a value of $20m per year.
- Select 'Unplanned O&M' and assign this as variable. The costs for this are entered on the next page.

- Select ‘Spare parts’ and assign as Fixed. Enter a value of $15/MWh.

The opex configuration should look like that shown in Figure 45.

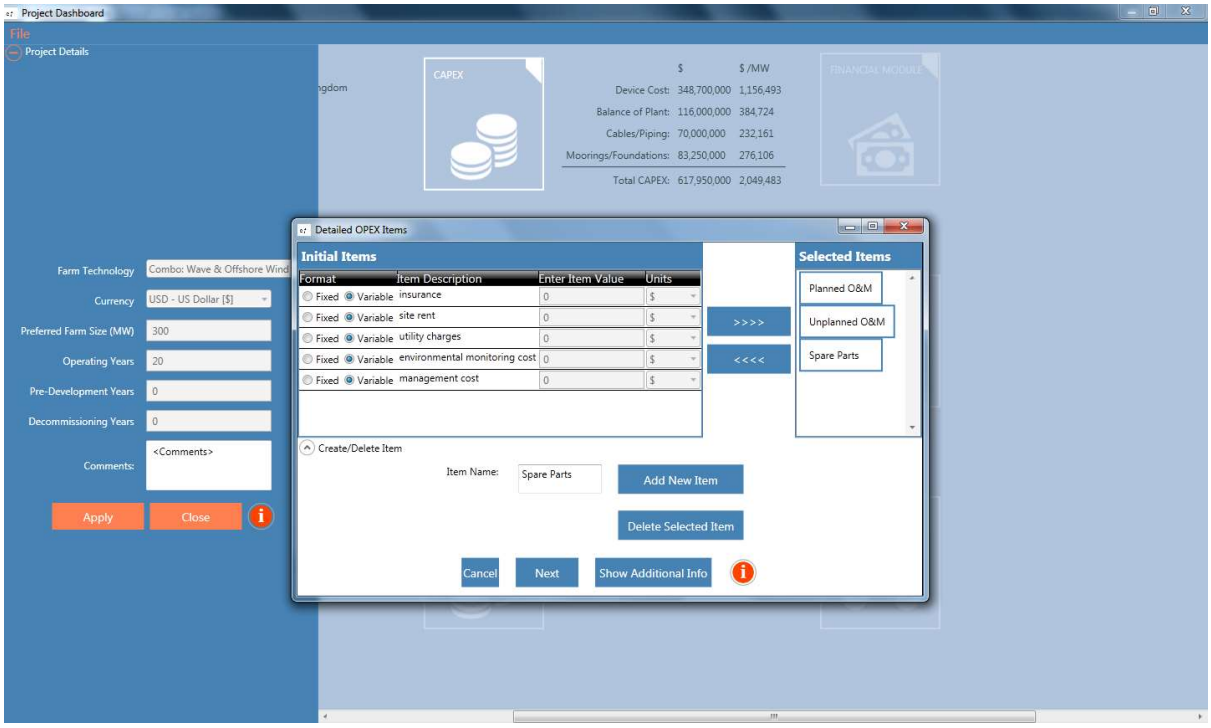

Figure 45: Detailed Opex Item Selection.

Once the items are selected and the costs for the fixed items have been entered click ‘Next’. This brings the user onto the ‘Detailed Opex Inputs’ page. Here the opex costs for each year can be seen and the variable Opex costs can be entered for each year.
For ‘Unplanned O&M’ enter $10m every year except for Years 5, 10, 15 & 20 which have a value of $20m. The completed table is shown in Figure 46.

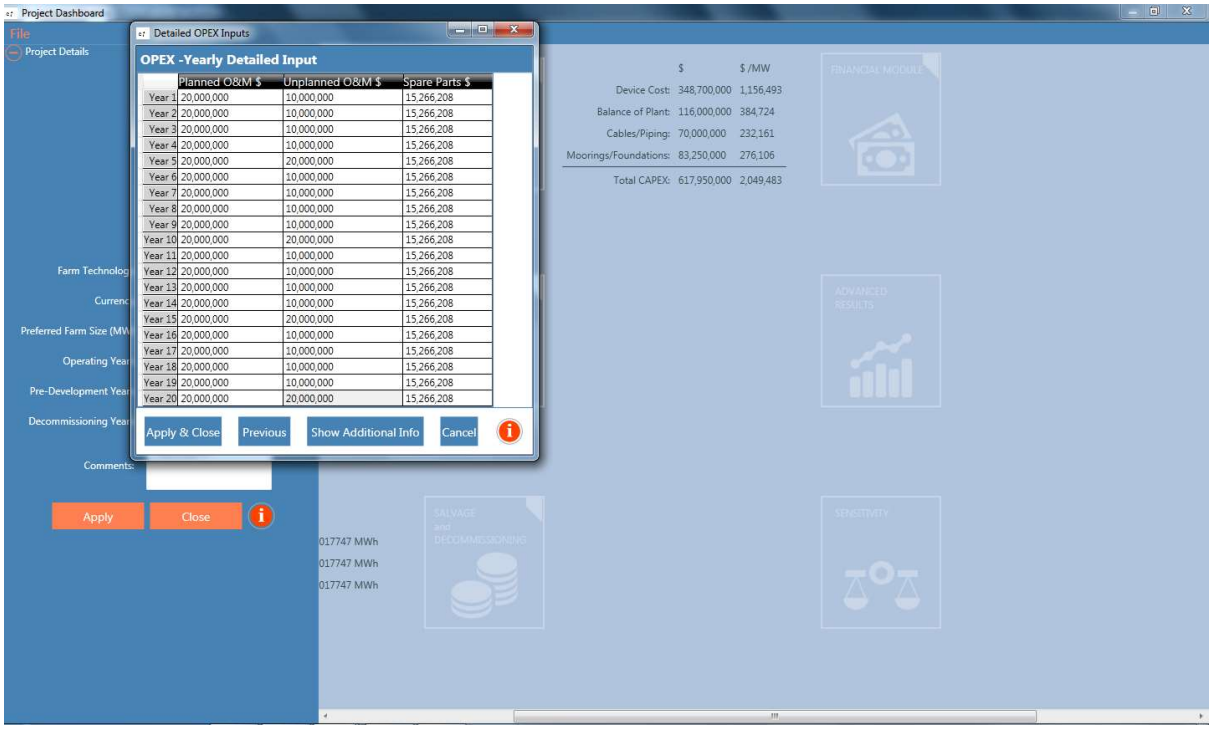

Figure 46: Detailed Opex Table.

Click 'Apply & Close' to store the Opex value entered. This will return the user to the project Dashboard where the next set or modules 'Salvage & Decommissioning' and 'Financial Module' are unlocked. In this case study we will skip the Salvage and Decommissioning modules.

2.5.7 Financial Module

On the project dashboard click 'Financial Module'. This has four tabs covering Revenue, Discounting & Inflation, Debt/Equity and Tax & Depreciation.

In the revenue tab under 'Revenue-Basic Inputs' select 'Included' next to FIT to include this factor in the project. Change the default selection from 'Variable' to 'Fixed'. This should open the FIT Input box where a value of $100/MWh should be entered.

Also enter a Grant amount. This can be directly entered into the table. Enter a Grant of $10m in each of the first 5 operating years of the project. The completed revenue tab is shown in Figure 47.

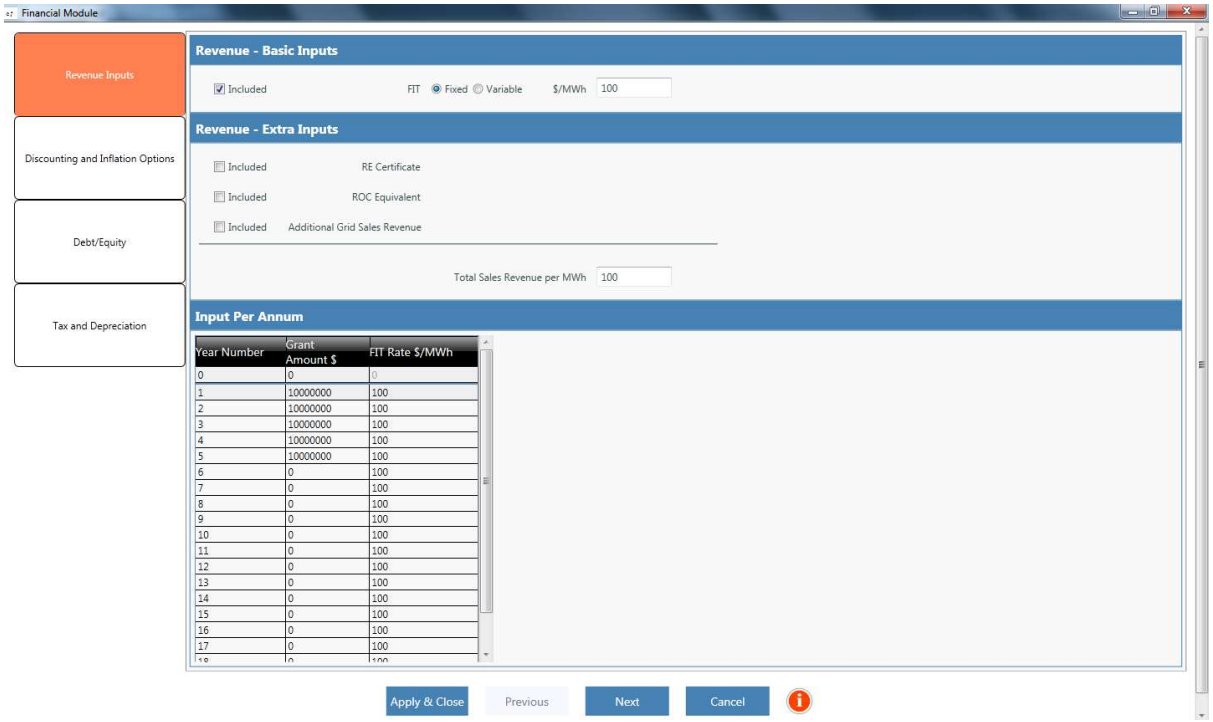

Figure 47: Case Study 3: Revenue.

Click 'Next' to progress onto the 'Discounting and Inflation Options' tab. Here select the fourth option 'Apply Cash Flows in Nominal Terms' and enter a Nominal Discount Rate of 6% and an Inflation Rate 3%. The completed discounting tab is shown in Figure 48.

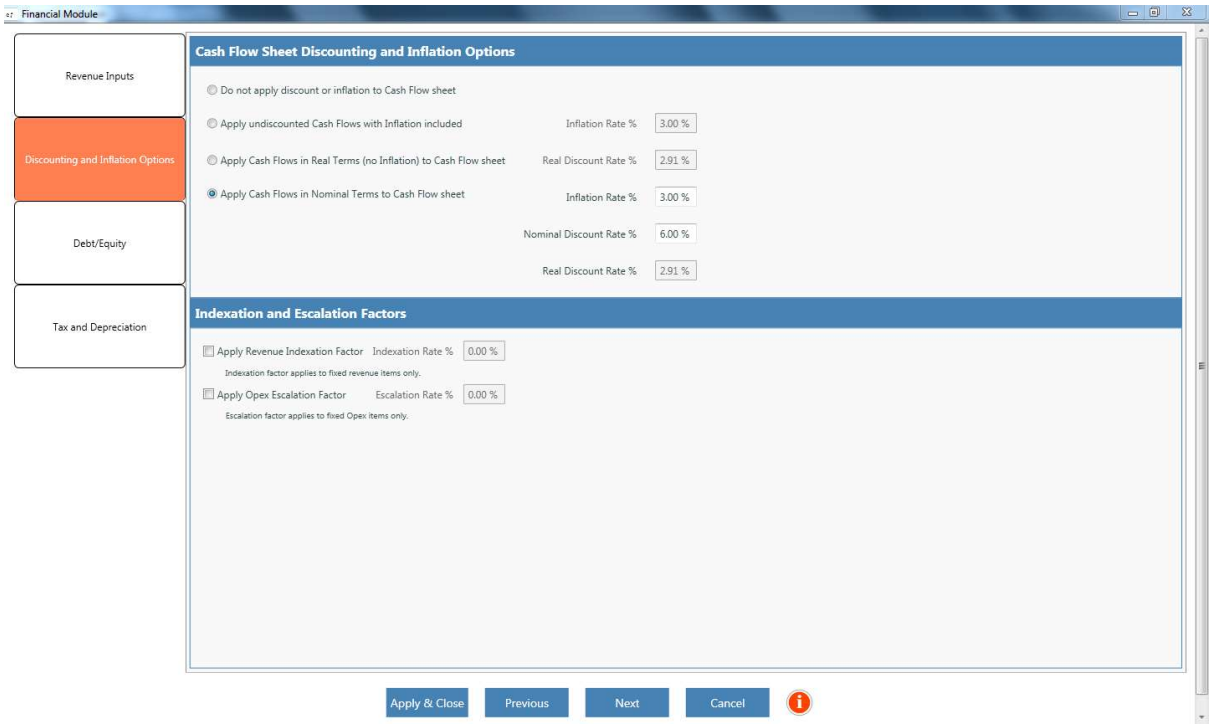

Figure 48: Case Study 3: Discounting.

Click 'Next' to progress onto the 'Debt/Equity' tab. The following should be entered.

- Assign a 50% Debt/50%Equity ratio.
- Enter a 20 year Debt term
- Enter a 2% Borrowing Rate
- Choose Annual Repayments

The completed debt/equity tab is shown in Figure 49.

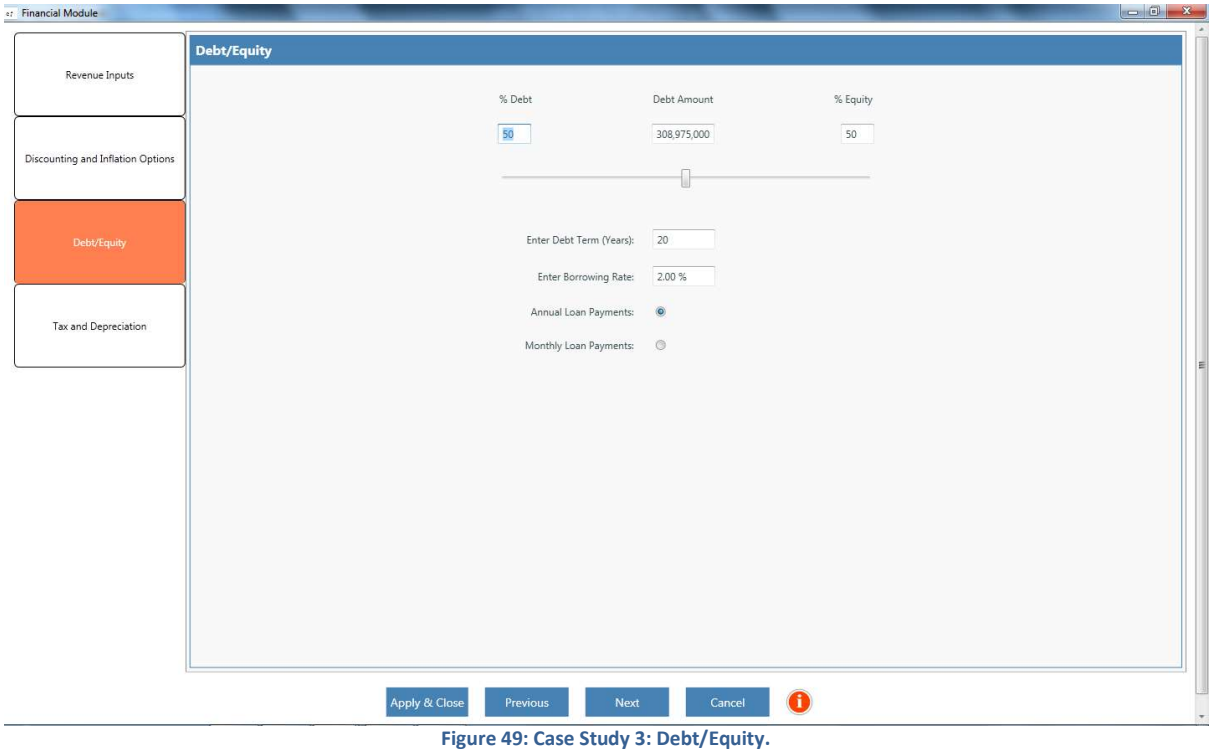

Figure 49: Case Study 3: Debt/Equity.

This completes the inputting of the project details. To calculate the projects results click 'Apply & Close' in the Financial Module. This will calculate the final results and return the user to the project dashboard where the output modules Advanced Results, Sensitivity, Graphical Results and Excel Export are now unlocked.

The project results that should be returned are shown in Table 9.

Net Present Value (NPV) £	$339,438,662
Levelised Cost of Electricity (LCOE) £/MWh	$105.62/MWh
Internal Rate of Return %	16.54%

Table 9: Case Study 3: Project Results.

3 Theory Overview

3.1 Locations

Exceedence Finance has a location database. This contains the marine renewable locations. Within each location the resource data for offshore wind, wave and tidal for that location are stored.

The user can add their own location by entering detail about the country, distance to shore, water depth etc. They can also enter coordinates for the location which allows for the location to be displayed on the location map.

Within each location the user can enter offshore wind, wave and tidal data for each year in either summary form or time series data.

3.2 Tidal Resource summary import

Exceedence Finance allows for Tidal summary data to be entered by the user in the form of an annual frequency histogram. This is the annual number of hours of occurrence within bins of current speeds. Exceedence Finance uses IEC standard bin sizes for its tidal histograms. The tidal speeds are binned every 0.1m/s with the label stating the upper-point of each bin. The current speeds are binned up to a maximum of 5.0m/s. Any current speed values above 5.0m/s are recorded in the upper most bin.

Data can be entered in percentage or hours. For percentage the sum of the entered values must equal 100%. For hours the sum of the entered values must equal the sum of the hours in the specified data year (8760 hrs in a normal year or 8784 hrs in a leap year).

The measured depth of the data must be specified by the user. This is not the overall water depth at the site but the depth at which the tidal current speeds were measured at (A site may have a depth of 30m but you may have tidal current speed for 10m depth). Depth in this case is distance from surface.

3.3 Tidal resource time series import

Exceedence Finance allows for Tidal data to be entered by the user in time series format. Time series data is entered by importing a file of hourly tidal data for each year.

Exceedance Finance can import Excel files or CSV files containing the time series data. Note that Exceedance Finance does not import pre-2007 excel files. If a user has pre-2007 excel files these can be saved as CSV files and imported.

The tidal current data can be in knots or m/s. If data is in knots, it will be converted upon import to m/s as all tidal and wind data displayed in Exceedance Finance are in m/s.

The measured depth of the data must be specified by the user. This is not the overall water depth at the site but the depth at which the tidal current speeds were measured at (A site may have a depth

of 30m but you may have tidal current speed for 10m depth). Depth in this case is distance from surface. The data year must also be specified by the user.

Note that any inconsistencies between the supporting information provided and the information in the import files will result in the import failing. The importation will also fail if the import file type is not in the correct format or the data set contains any gaps or errors. Data must be hourly data. Sample Excel & CSV files are provided for the user to check that their data is in the correct format and uses the correct time stamp.

The successful importation will result in Exceedence Finance producing summary histograms from the time series data.

3.4 Wind resource summary import

Exceedence Finance allows for Wind summary data to be entered by the user in the form of an annual frequency histogram. This is the annual number of hours of occurrence within bins of wind speed. Exceedence Finance uses IEC standard bin sizes for its wind histograms. The wind speeds are binned every 1m/s with the label stating the upper-point of each bin. The wind speeds are binned up to a maximum of 30m/s. Any wind speed values above 30m/s are recorded in the upper most bin.

Data can be entered in percentage or hours. For percentage the sum of the entered values must equal 100%. For hours the sum of the entered values must equal the sum of the hours in the specified data year (8760 hrs in a normal year or 8784 hrs in a leap year).

The measured height of the data must be specified by the user. This is the height in meters above ground level that the wind data was measured at.

3.5 Wind resource time series import

Exceedence Finance allows for Wind data to be entered by the user in time series format. Time series data is entered by importing a file of hourly wind data for each year.

Exceedance Finance can import Excel files or CSV files containing the time series data. Note that Exceedance Finance does not import pre-2007 excel files. If a user has pre-2007 excel files these can be saved as CSV files and imported.

The wind data can be in knots or m/s. If data is in knots, it will be converted upon import to m/s as all tidal and wind data displayed in Exceedance Finance are in m/s.

The measured height of the data must be specified by the user This is the height in meters above ground level that the time series wind data was measured at. The data year must also be specified by the user.

Note that any inconsistencies between the supporting information provided and the information in the import files will result in the import failing. The importation will also fail if the import file type is not in the correct format or the data set contains any gaps or errors. Data must be hourly data.

Sample Excel & CSV files are provided for the user to check that their data is in the correct format and uses the correct time stamp.

The successful importation will result in Exceedence Finance producing summary histograms from the time series data.

3.6 Wave resource summary import (period adjustment)

Exceedence Finance allows for wave summary data to be entered by the user in the form of an annual scatterplot. This is the annual number of hours of occurrence within bins of significant wave height and wave period. Exceedence Finance uses IEC standard bin sizes for its wave scatterplots. The significant wave heights are binned every 0.5m with the label stating the mid-point of each bin. The wave periods are binned every second with the label stating the mid-point of each bin. Significant wave heights are binned to a maximum wave height of 15m with wave period binned to a maximum of 25 seconds. Any values above these are recorded in the upper most bin.

Data can be entered in percentage or hours. For percentage the sum of the entered values must equal 100%. For hours the sum of the entered values must equal the sum of the hours in the specified data year (8760 hrs in a normal year or 8784 hrs in a leap year).

When entering a wave scatterplot the user must define which one of the following wave period types the scatterplot is based on.

- Zero Up Crossing Period (Tz) is the average time between successive crossings of the mean water level in the upward direction.
- Peak Period (Tp) is the period of the component within the wave spectrum which has the highest energy content or the point of highest spectral density.
- Energy Period (Te) is the period of a simple sinusoidal wave that would carry the same energy as the sea state.

In order to calculate the energy output using power matrices whose period types are different from the original period type of the data set, Exceedance Finance also produces two 'Converted' scatterplots for each data set.
In order to do this the user must enter conversion factors to convert the original period type values into the two other period types. When data is in summary scatterplot form, all that is known about the wave period is the number of occurrences within each wave period bin, this value is an integer. How they are distributed within each bin is not known. Exceedance finance assumes that the wave period occurrences within each bin are normally distributed and uses this to assign decimal values to the wave period summary occurrences. This allows for an even distribution of values when the wave periods are multiplied by the conversion factors as if the integer values only were converted they would all be converted to the same value.

3.7 Wave resource time series import

Exceedence Finance allows for Wave data to be entered by the user in time series format. Time series data is entered by importing a file of hourly wave data for each year.

Exceedance Finance can import Excel files or CSV files containing the time series data. Note that Exceedance Finance does not import pre-2007 excel files. If a user has pre-2007 excel files these can be saved as CSV files and imported.

The significant wave heights must be in meters and the wave periods must be in seconds.

In Exceedance Finance when entering time series wave data, the user must define which one of the following wave period types the data is based on.

- Zero Up Crossing Period (Tz) is the average time between successive crossings of the mean water level in the upward direction.
- Peak Period (Tp) is the period of the component within the wave spectrum which has the highest energy content or the point of highest spectral density.
- Energy Period (Te) is the period of a simple sinusoidal wave that would carry the same energy as the sea state.

This is the 'Original' period type for that data set. In order to calculate the energy output using a power matrix whose period type is different from the original period type of the data set, Exceedance Finance also produces two 'Converted' scatterplots for each data set.

In order to do this the user must enter conversion factors to convert the original period type values into the two other period types. The period conversion factors are multiplied against each individual wave period value in the time series to produce hourly values for the two 'converted' period values. These are then used to create the converted scatterplots.

Note that any inconsistencies between the supporting information provided and the information in the import files will result in the import failing. The importation will also fail if the import file type is not in the correct format or the data set contains any gaps or errors. Data must be hourly data. Sample Excel & CSV files are provided for the user to check that their data is in the correct format and uses the correct time stamp.

The successful importation will result in Exceedence Finance producing summary scatterplots from the time series data.

3.8 Preloaded Resource Data

The following resource data comes pre-loaded with Exceedance Finance

- 10 years of modelled tidal resource data for Arklow bank in the Irish Sea. This was based on ADCP measurements from 2000. Site details were taken from the following PHD thesis which described the measuring process (MELVILLE, G. T., 2008. Hydrodynamic and economic modelling of tidal current energy conversion systems. https://openair.rgu.ac.uk/bitstream/10059/695/1/Guy%20Melville%20PhD.pdf). The tidal measuring depth of the data was not listed therefore it is assumed to be 5m.
- 10 years of Wind and Wave data for 21 locations around Europe. This is modelled data and with the model described in (Neill, S.P. & Hashemi, M.R. (2013) Wave power variability over the northwest European shelf seas. Appl. Energy. 106, 31-46.) It should be noted that Exceedance did not carry out any validation of this data and therefore

cannot guarantee its accuracy or how representative it is of real measured data at any of the sites.

- 16 years of modelled data for the AMETS test site off the West Coast of Ireland. Data is provided for depths of 30m and 50m to cater for nearshore and offshore devices. Details of the SWAN model are contained in (A Fifteen Year Model Based Wave Climatology of Belmullet, Ireland," Report prepared on behalf of the Sustainable Energy Authority of Ireland (SEAI) 2011.)

3.9 Device importation (IEC)

In order to import a device into the Exceedance Finance device database the user must provide details about the device

- Renewable Technology: This defines the marine renewable device in the database as Wave, Tidal or Offshore Wind.
- Device Classification: This is where the classification of the device is entered. The classification contains more information about the devices station keeping mechanism, PTO system and principle power capture motion. The default list of device classifications in Exceedance Finance can be edited using 'Admin: Manage Lists' on the homepage.
- Manufacturer: The company that manufactures the device or device developer for early stage technologies.
- Device Lifetime: This is the expected operational lifetime of the device in years.
- Period type: This applies to wave devices only. In Exceedance Finance when entering a wave device, the user must define which period types the power matrix is based on Tz, Tp or Te.
    - Zero Up Crossing Period (Tz) is the average time between successive crossings of the mean water level in the upward direction.
    - Peak Period (Tp) is the period of the component within the wave spectrum which has the highest energy content or the point of highest spectral density.
    - Energy Period (Te) is the period of a simple sinusoidal wave that would carry the same energy as the sea state.
- Maximum Power Rating (kW): The default setting in Exceedance Finance is that Power Rating is defined as the maximum power value in the Power Matrix or Power Curve. The Power Rating would be expected to closely match a devices peak power capture. However, in the absence of a rating standard, with respect to aggregation and smoothing, power rating may currently be inconsistently defined across marine renewable technologies.
- Deployment Depth: This is the depth or range of depths at which the tidal or wave device can be deployed at. Deployment depth is in units of meters with depths measured relative to the surface.
- Hub Depth: This is the depth of the tidal turbine hub. Hub depth is in units of meters with depths measured relative to the surface. The hub depth must be lower than the shallower range of deployment depth limit.
- Hub Height: This is the height above ground level of the wind turbine hub in meters.

Once the supporting information has been provided the user enters the devices power performance values.

3.9.1 Wave Device Power Matrix

The user can enter or paste in the power matrix values. The power matrix contains the power performance characteristics of the wave energy device. It shows the power outputted in kW by the device for each sea state. Exceedance Finance uses IEC standard bin sizes for its Power Matrices. The significant wave heights are binned every 0.5m with the label stating the mid-point of each bin. The wave periods are binned every 1 sec with the label stating the mid-point of each bin.

3.9.2 Tidal Turbine Power Curve

The user can enter or paste in the tidal power curve values. The tidal power curve contains the power performance characteristics of the tidal current turbine. It shows the power outputted in kW by the device for each tidal current speed. Exceedance Finance uses IEC standard bin sizes for its Power Curves. The current speeds are binned every 0.1m/s with the label stating the upper-point of each bin.

3.9.3 Offshore Wind Turbine Power Curve

The user can enter of paste in the wind power curve values. The wind power curve contains the power performance characteristics of the offshore wind turbine. It shows the power outputted in kW by the device for each wind speed. Exceedance Finance uses IEC standard bin sizes for its Power Curves. The wind speeds are binned every 1m/s with the label stating the upper-point of each bin.

3.10 Preloaded Devices

The following devices come pre-loaded in Exceedence Finance

Technology	Name	Source	Comment
Offshore Wind	Siemens SWT-2.3-93	http://www.energy.siemens.com/hq/pool/hq/power-generation/wind-power/E50001-W310-A102-V6-4A00_WS_SWT-2.3-93_US.pdf	Device lifetime is assumed.
Offshore Wind	Siemens SWT-3.6-107	http://www.energy.siemens.com/hq/pool/hq/power-generation/renewables/wind-power/wind%20turbines/E50001-W310-A103-V6-4A00_WS_SWT_3_6_107_US.pdf	Device lifetime is assumed.
Offshore Wind	Siemens SWT-3.6-120	http://www.energy.siemens.com/hq/pool/hq/power-generation/wind-power/E50001-W310-A169-X-4A00_WS_SWT_3-6_120_US.pdf	Device lifetime is assumed.
Offshore Wind	Darwind XD115	http://www.darwind.nl/Wind-turbines/XD115-5MW	Device lifetime is assumed.
Offshore Wind	Areva M5000	http://india.areva.com/home/liblocal/docs/India%20Offer/Renewable/Wind/AREVA%20M5000%20Technical%20Data	Hub Height is assumed.

		.pdf	
Offshore Wind	Vestas 8MW	http://pdf.directindustry.com/pdf/vestas/offshore-v164-80-mw-v112-33-mw/20680-310439.html	Hub Height is assumed.
Offshore Wind	Vestas V90 3.0MW	http://www.vestas.com/Files/Filer/EN/Brochures/Vestas_V_90-3MW-11-2009-EN.pdf	Device Lifetime is assumed.
Offshore Wind	Vestas V112 3.3MW	http://nozebra.ipapercms.dk/Vestas/Communication/Productbrochure/3MWbrochure/3MWProductBrochure/	Device Lifetime and Hub Height as assumed.
Offshore Wind	Gamesa G128 5.0MW	http://www.gamesacorp.com/recursos/doc/productos-servicios/aerogeneradores/catalogo-g10x-45mw-eng.pdf	Device Lifetime is assumed.
Offshore Wind	Repower 5M	http://www.gl-group.com/pdf/100506-HOW-REpower6M-JG-Hand-out.pdf	Device Lifetime is assumed.
Offshore Wind	Repower 6M	http://www.gl-group.com/pdf/100506-HOW-REpower6M-JG-Hand-out.pdf	Device Lifetime is assumed.
Offshore Wind	Nordex 2500	http://www.nordex-online.com/fileadmin/MEDIA/Produktinfos/EN/Nordex_N90_2300_GB.pdf	Device Lifetime is assumed.
Offshore Wind	RePower 3XM	https://sam.nrel.gov/	Device Lifetime and Hub Height as assumed.
Offshore Wind	Bard 5.0	https://sam.nrel.gov/	Device Lifetime and Hub Height as assumed.
Offshore Wind	NREL 5MW	https://sam.nrel.gov/	Device Lifetime and Hub Height as assumed.
Wave	Generic B-HBA	Babarit, A., et al. (2012). "Numerical benchmarking study of a selection of wave energy converters." Renewable Energy 41: 44-63.	Device Lifetime is assumed.
Wave	Generic B-OF	Babarit, A., et al. (2012). "Numerical benchmarking study of a selection of wave energy converters." Renewable Energy 41: 44-63.	Device Lifetime is assumed.
Wave	Generic Bref-HB	Babarit, A., et al. (2012). "Numerical benchmarking study of a selection of wave energy converters." Renewable Energy 41: 44-63.	Device Lifetime is assumed.
Wave	Generic Bref SHB	Babarit, A., et al. (2012). "Numerical benchmarking study of a selection of wave energy converters." Renewable Energy 41: 44-63.	Device Lifetime is assumed.
Wave	Generic F-2HB	Babarit, A., et al. (2012). "Numerical benchmarking study of a selection of wave energy converters." Renewable Energy 41: 44-63.	Device Lifetime is assumed. Deployment depth of 50m+

			assumed.
Wave	Generic F-3OF	Babarit, A., et al. (2012). "Numerical benchmarking study of a selection of wave energy converters." Renewable Energy 41: 44-63.	Device Lifetime is assumed. Deployment depth of 50m+ assumed.
Wave	Generic F-HBA	Babarit, A., et al. (2012). "Numerical benchmarking study of a selection of wave energy converters." Renewable Energy 41: 44-63.	Device Lifetime is assumed. Deployment depth of 50m+ assumed.
Wave	Generic F-OWC	Babarit, A., et al. (2012). "Numerical benchmarking study of a selection of wave energy converters." Renewable Energy 41: 44-63.	Device Lifetime is assumed. Deployment depth of 50m+ assumed.
Wave	Wavestar C6	Laurent Marquis Wavestar. lma@wavestarenergy.com	Full details provided by Wavestar
Wave	Wavestar C6S	Laurent Marquis Wavestar. lma@wavestarenergy.com	Full details provided by Wavestar
Tidal	Atlantis AR1000	http://www.vegvesen.no/_attachment/328174/binary/575806?fast_title=Technology+survey+for+renewable+energy+integrated+to+bridge+constructions%3A+Wave+and+tidal+energy.pdf	Hub Depth is assumed.
Tidal	Hammerfest HS1000	http://asiacleanenergyforum.org/acef2013/images/stories/2013pdf/Day-3/Session-18/Peter-Gnos-%28Final%29.pdf	Hub Depth is assumed.
Tidal	Siemens MCT	http://www.marineturbines.com/3/news/article/38/dnv_confirms_seagen_s_powerful_performance_	Hub Depth and lower deployment depth assumed.
Tidal	Oceanflow Energy	http://www.vegvesen.no/_attachment/328174/binary/575806?fast_title=Technology+survey+for+renewable+energy+integrated+to+bridge+constructions%3A+Wave+and+tidal+energy.pdf	Hub Depth and upper deployment depth range assumed.
Tidal	Tidal Sails	http://www.vegvesen.no/_attachment/328174/binary/575806?fast_title=Technology+survey+for+renewable+energy+integrated+to+bridge+constructions%3A+Wave+and+tidal+energy.pdf	Hub Depth is assumed.
Tidal	Tocardo HT4	http://www.vegvesen.no/_attachment/328174/binary/575806?fast_title=Technology+survey+for+renewable+energy+integrated+to+bridge+constructions%3A+Wave+and+tidal+energy.pdf	Hub Depth is assumed and some power curve values interpolated.
Tidal	Verdant	http://www.vegvesen.no/_attachment/328174/binary/575	Hub Depth is

		806?fast_title=Technology+survey+for+renewable+energy+integrated+to+bridge+constructions%3A+Wave+and+tidal+energy.pdf	assumed.
Tidal	Voith	http://www.vegvesen.no/_attachment/328174/binary/575806?fast_title=Technology+survey+for+renewable+energy+integrated+to+bridge+constructions%3A+Wave+and+tidal+energy.pdf	Hub Depth is assumed.
Tidal	OpenHydro	http://oceanenergy.epri.com/attachments/streamenergy/reports/004tisecdevicereportfinal111005.pdf	Device lifetime, hub depth and deployment depth range assumed.
Tidal	Lunar Energy	http://oceanenergy.epri.com/attachments/streamenergy/reports/004tisecdevicereportfinal111005.pdf	Hub Depth and lower deployment depth assumed.

4 Main project details (currency, farm size, operating, de-com and pre-dev years)

When modelling a project in Exceedence Finance the user must first specify the main project details. These include

4.1.1.1 Farm Technology

This defines the type of farm that the user wishes to model. Exceedance Finance allows for four different project configuration types

5. An Offshore Wind farm
6. A Tidal Farm
7. A Wave Farm
8. Co-location farms made up of any mixture of the above three technologies.

4.1.1.2 Currency

The user selects the currency that they wish the project financial results to be calculated in. The following is the list of currencies available for selection

Country	Currency

United States	US Dollar- USD
Canada	Canadian Dollar – CAD
Mexico	Mexican Peso - MXN
Chile	Chilean Peso - CLP
Argentina	Argentine Peso - ARS
South Africa	South African Rand - ZAR
India	Indian Rupee - INR
Singapore	Singapore Dollar - SGD
Australia	Australian Dollar - AUD
New Zealand	New Zealand Dollar - NZD
EU	Euro - EUR
United Kingdom	British Pound - GBP
Denmark	Danish Krone - DKK
Norway	Norwegian Krone - NOK
Sweden	Swedish Krona - SEK
Russia	Russian Ruble - RUB
Japan	Japanese Yen - JPY
China	Chinese Yuan - CNY
Brazil	Brazilian Real - BRL
Taiwan	Taiwan Dollar - TWD

4.1.1.3 Preferred Farm Size

This is the farm size in MW that the user wishes to model. Subsequently when the user selects devices for the farm, Exceedance Finance will adjust this preferred farm size based on the nearest whole number of devices in order to achieve a farm size of at least that sought by the user (i.e. a preferred farm size of 100MW with a device of 6MW will results in 17 devices of 6MW and a farm size of 102MW). The number of devices can be adjusted in the 'Calculate Energy' module to set the Final Farm Size prior to the calculation of energy output.

4.1.1.4 Operating Years

The operating years in Exceedance Finance refers to the number of years of power generation from the farm. In Exceedance Finance Year 0 will be when the farm is built with generation commencing in Year 1 for whatever period the user specifies.

4.1.1.5 Pre-Development Years

This specifies any pre-development years in a project. In Exceedance Finance the default is to have no-predevelopment years and for the farm to be built and commissioned in Year 0 with generation commencing in Year 1. The CAPEX is therefore all charged to Year 0.

Pre-Development years allow the CAPEX to be staggered over a longer period to more accurately reflect real life projects. Any pre-development years will be counted as prior to year 0 (i.e. year -1, year -2, year -3 etc).

4.1.1.6 Decommissioning Years

This specifies any extra decommissioning years in a project. In Exceedance Finance the default is for the project to be decommissioned in the final operating year. Extra decommissioning years can be added to account for situations where the decommissioning of the infrastructure may take many years. Decommissioning years will be counted in Exceedance Finance as additional to the operational (generation) years (i.e. year +1, year +2, year +3 etc). Any revenues achieved from salvaging or reselling equipment or any costs incurred for decommissioning equipment can be staggered over the decommissioning years.

4.1.1.7 Comments

The comments box enables the user to record any additional information about the project that they may have.

Once the user has entered the required main project details, clicking 'Apply' will set these parameters and unlock the first module in the project modelling process.

4.2 Resource and device selection include depth, height and period compatibility and assumptions

4.2.1 Select Resource

The user selects the location and resource data for the project. The resource data is filtered to only show data that is available and that matches the project farm technology.

The country, location name and years of available data are shown. In a separate table the years of available data, including averages are listed. The user selects the year they want the project to be modelled on by highlighting the desired year in the table.

4.2.2 Select Device

The user selects the device(s) for the project. The available devices are filtered to only show devices that match the project farm technology.

4.2.2.1 Wave Device Period Message

If the user has selected a wave device whose period type is different from the original period type of the location data then a message will appear notifying the user that the converted scatterplot data will be used in the energy calculation. (This message appears when the energy calculation process is initiated).

4.2.2.2 Wave Device Depth Message

If the location's site water depth lies outside of the specified range of deployment depths of the wave device a message will appear notifying the user of this. They are given the choice of selecting a

different device or continuing with the energy calculation process and using 'Attenuation' or 'Amplification' factors to adjust the energy output. (This message appears in the device selection module).

4.2.2.3 Tidal Device Depth message

If the location's site water depth lies outside of the specified range of deployment depths of the tidal device a message will appear notifying the user of this. The user is given the option of reselecting a more appropriate device for the location or continuing with the energy calculation process. The energy results will be for indicative purposes only as no power law or energy adjustment can be applied.

4.3 Energy calculation (farm size, losses, result terms)

Based on the selected Resource and Devices, Exceedance Finance calculates the energy output of the project. Prior to the energy calculation the user can set the final farm size by adjusting the number of devices. They can also account for loss factors such as availability and transmission losses. After the energy is calculated a breakdown of the energy output results can be viewed.

The user can account for potential losses during the energy production process by applying loss factors. These are split between 'Farm Factors' which account for energy losses that apply to the whole farm and 'Device Factors' which account for losses associated with each device.

Farm factors include

- Curtailment Factor: This is a loss factor to account for potential dispatch-down of electricity exported due to system wide grid reasons. This factor will be multiplied by the initial energy output figure therefore 100% Curtailment Factor equates to no impact or no loss in energy output.
- Constraint Factor: This is a loss factor to account for potential dispatch-down of electricity exported due to local distribution grid capacity reasons. This factor will be multiplied by the initial energy output figure therefore 100% Constraints Factor equates to no impact or no loss in energy output.
- Transmission Loss Factor: This factor accounts for electrical losses suffered when the energy captured by the farm at sea is transmitted ashore via the export cable. This factor will be multiplied by the initial energy output figure therefore 100% Transmission Loss Factor equates to no impact or no loss in energy output.

Device Factors include

- Array Loss Factor: This factor accounts for potential array losses or wake losses. A 100% array loss factor would imply no array losses.
- Availability Factor: This factor accounts for reductions in energy output of a farm due it being not available to produce power. This can be due to issues such as downtime for

maintenance or device failure etc. A 100% availability loss factor would imply no availability losses.

4.3.1 Wave Energy Calculation

The wave energy calculation involves multiplying the annual scatterplot of hours of the selected location and year with the power matrix of the device selected. Subsequently any loss factors specified are applied. If the resource and device data inputted has been produced to IEC standards then the energy output results generated will be and IEC standard result.

In the case where there is a depth difference between the sites water depth and the devices range of deployment depths the user can choose to apply the following

4.3.1.1 Nearshore Attenuation Factor

Where the wave data has been measured at a depth deeper than the device deployment depth, the user can opt to enter a 'Nearshore Attenuation Factor' to account for the fact the resource at the shallower deployment site may not be as high as the deeper measurement location and hence the energy output may be lower. The attenuation factor will reduce the energy output figure (90% attenuation factor will reduce the energy output by 10%). This topic is discussed in more detail in[1].

4.3.1.2 Offshore Amplification Factor

Where the wave data has been measured at a depth shallower than the device deployment depth, the user can opt to enter an 'Offshore Amplification Factor' to account for the fact the resource at the deeper deployment site may be higher than the deeper measurement location and hence the energy output may be higher. The amplification factor will increase the energy output figure (110% amplification factor will increase the energy output by 10%).

4.3.2 Tidal Energy Calculation

The tidal energy calculation involves multiplying the annual frequency histogram of the selected location and year with the power curve of the device selected. Subsequently any loss factors specified are applied. If the resource and device data inputted has been produced to IEC standards then the energy output results generated will be and IEC standard result.

Where the location's site water depth lies outside the range of deployment depths of the tidal turbine the using has the option of calculating the energy output for indicative purposes only.

Where the location's site water depth lies within the range of deployment depths of the device but the measured depth of the data is different from the depth of the tidal turbine hub the user can apply the following adjustment factors.

4.3.2.1 Tidal summary adjustment

In the event that there is a difference between the measuring depth of the tidal data and the hub depth of the turbine, the user must choose which method to adjust the measured data to match the depth of the turbine hub depth.

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[1] Folley, M. and T. J. T. Whittaker (2009). "Analysis of the nearshore wave energy resource." Renewable Energy **34**: 1709-1715

Where the original data entered is a summary frequency histogram, the only option available to the user is the Frequency Histogram Power Law method. The time series power law is only available where the original data entered is time series data. The user can also choose to apply the Frequency Histogram Power Law method to time series derived histograms if they wish.

4.3.2.2 Frequency Histogram Power Law

This method adjusts the tidal frequency histogram from the measured data depth to the turbine hub depth by applying the power law to the current speed bins of the frequency histogram based on the method described in [2].

After the bins have been adjusted and the frequency histogram is representative of the turbine hub depth, a weibull curve is fitted to the power law-adjusted frequency histogram and a new frequency histogram is generated using the weibull parameters for the standard bin sizes that Exceedance Finance uses.

This results in a frequency histogram adjusted to the tidal turbine hub depth which has the same bin sizes as the tidal turbine power curves.

4.3.2.3 Time Series Power Law

The power law can be used to adjust tidal current speeds at the measured depth to current speeds at the turbine hub depth. The power law used for tidal is as follows:

$$V_2 = V_1 \left(\frac{d_2}{d_1}\right)^{\alpha} \text{ [3]}$$

d_1 = Measured depth (m) (For this formula all depths measured relative to bottom, i.e. 7m depth from surface in 20m of water would give a d_1 of 13m)

d_2 = Turbine hub depth (m)

v_1 = current speed at measured depth (m/s)

v_2 = current speed at turbine hub depth (m/s)

α = Power law exponent

The user must specify the Power law exponent to be used for the power law extrapolation.

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[2] Hagerman, G., et al. (2006). Methodology for Estimating Tidal Current Energy Resources and Power Production by Tidal In-Stream Energy Conversion (TISEC) Devices, EPR

[3] Hagerman, G., et al. (2006). Methodology for Estimating Tidal Current Energy Resources and Power Production by Tidal In-Stream Energy Conversion (TISEC) Devices, EPR

4.3.3 Wind Energy Calculation

The wind energy calculation involves multiplying the annual frequency histogram of the selected location and year with the power curve of the device selected. Subsequently any loss factors specified are applied. If the resource and device data inputted has been produced to IEC standards then the energy output results generated will be and IEC standard result.

In the event that there is a difference between the measuring height of the wind data and the hub height of the wind turbine, the user must choose which method to adjust the measured data to match the height of the turbine hub height.

4.3.3.1 Weibull Distribution Extrapolation

This adjusts the wind speeds at the measured height to the wind speeds at the turbine hub height by adjusting the frequency distribution of wind speeds using the weibull distribution extrapolation method. The Weibull curve fitting is done using the Modified Maximum Likelihood Method[4] . The height adjustment of the weibull curve is done using the Weibull Wind Speed Distribution Method[5] .

4.3.3.2 Power Law & Power Law Exponent

The power law can be used to adjust wind speeds at the measured height to wind speeds at the turbine height. This method is only used on wind where hourly time-series data is available. The Power law formula is as follows:

$$V_2 = V_1 \left(\frac{h_2}{h_1}\right)^{\alpha}$$

h_1 = Wind data measuring height (m)

h_2 = Turbine hub height (m)

v_1 = Wind speed at measured height (m/s)

v_2 = Wind speed at turbine hub height (m/s)

α = Power Law Exponent

The user must specify the Power law exponent

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[4] Seguro, J. V. and T. W. Lambert (2000). "Modern estimation of the parameters of the Weibull wind speed distribution for wind energy analysis." Journal of Wind Engineering and Industrial Aerodynamics **85**(1): 75-84

[5] Gualtieri, G. and S. Secci (2012). "Methods to extrapolate wind resource to the turbine hub height based on power law: A 1-h wind speed vs. Weibull distribution extrapolation comparison." Renewable Energy.

4.3.3.3 Log Law & Surface Roughness Length

The Log law can be used to adjust wind speeds at the measured height to wind speeds at the turbine height. As with the power law, this method is only available if wind data is in the form of hourly time series. The log law formula is as follows

$$V_2 = V_1 \left(\frac{ln\left(\frac{h_2}{Z_0}\right)}{ln\left(\frac{h_1}{Z_0}\right)} \right)$$

h_1 = Wind data measuring height (m)

h_2 = Turbine hub height (m)

v_1 = Wind speed at measured height (m/s)

v_2 = Wind speed at turbine hub height (m/s)

Z_0 = Roughness Length (m)

The user must specify the roughness length Z_0.

4.3.4 Energy Results

After the calculation process has concluded and all adjustments have been accounted for Exceedence Finance produces the following Energy results

- Capacity Factor: This is listed for each device. Capacity Factor is the ratio of the actual energy produced to the maximum energy that could theoretically be produced by that device if it ran continuously at maximum rated power. In Exceedance Finance, capacity factor is based on the Actual Energy Capture of each set of devices, this is inclusive of any array or availability losses but not inclusive of any electrical transmissions losses.
- Farm Annual Energy Production: This is the estimate of total energy production at the point of power capture of the devices. It is meant only to represent device technology performance and subsequently does not include either array losses, availability or transmission losses.
- Farm Actual Energy Capture: When Annual Energy Production is modified by Availability and Array losses of the farm it becomes Actual Energy Capture.
- Farm Annual Delivered Energy: When Actual Energy Capture is further modified by the inclusion of electrical transmission losses to the point of grid interconnection (i.e. power output to delivered power), as well as any constraints or curtailment adjustments, it becomes Annual Delivered Energy

4.4 CAPEX

The Capex is where the user accounts for the projects Capital Expenses. Exceedence Finance allows for Capex to be entered in one of three ways:

- Total Capex per farm
- Simple Breakdown of Total Capex per farm
- Detailed Capex per device: This is the most detailed Capex input option. There are four main breakdown headings of Device Costs, Mooring/Foundation Costs, Cabling/Piping Costs and Balance of Plant costs. Under each of these headings there is a list of components that make up each section. This list is editable to allow the user to create a list that matches the cost items they have. Costs for each item in the list can be entered as either € or €/MW or percentage of device costs.

4.4.1 Total Capex per farm

This is the simplest Capex input option. It is a single value covering the whole Capex cost of the entire farm. This value can be entered either in € or in €/MW.

4.4.2 Simple Breakdown of Total Capex per farm

This is the middle level of Capex complexity. It is the whole Capex cost of the farm broken down into four main areas. Device Costs, Mooring/Foundation Costs, Cabling/Piping Costs and Balance of Plant costs. Costs for these four breakdown areas can be entered as € or €/MW. In Exceedance Finance Balance of plant refers to all non-device, station keeping or electrical costs.

4.4.3 Detailed Capex per device

This is the most detailed Capex input option. There are four main breakdown headings of Device Costs, Mooring/Foundation Costs, Cabling/Piping Costs and Balance of Plant costs. Under each of these headings there is a list of components that make up each section. This list is editable to allow the user to create a list that matches the cost items they have. Costs for each item in the list can be entered as either € or €/MW or percentage of device costs.

4.4.3.1 Device Costs

This will take the user to the list of device items. Here the user can customise and finalise the list of items that make up the device costs and enter costs for each item. Any costs entered for an item will be per device costs (these will be multiplied by the number of units of the device to get the farm costs).

4.4.3.2 Balance of Plant

This will take the user to the list of balance of plant items. Here the user can customise and finalise the list of items that make up the balance of plant costs and enter costs for each item. Any costs entered for an item will be per device costs (these will be multiplied by the number of units of the device to get the farm costs).

4.4.3.3 Moorings/Foundations

This will take the user to the list of mooring/foundation items. Exceedance Finance will provide either a list of mooring items or foundation items depending on the station keeping specified for each device. Here the user can customise and finalise the list of items that make up the costs and enter costs for each item. Any costs entered for an item will be per device costs (these will be multiplied by the number of units of the device to get the farm costs).

4.4.3.4 Cables/Piping

This will take the user to the list of cabling/piping items. Exceedance Finance will provide either a list of cabling items or piping items depending on the power export type specified for the farm. Here the user can customise and finalise the list of items that make up the device costs and enter costs for each item. Any costs entered for an item will be per farm costs. For a project containing multiply devices or a combo project, there will be only one Cabling/Piping detailed cost list for the farm as these costs typically apply at a farm level.

4.4.4 Component Lifetime for Salvage

This allows the user enter details about the operational lifetime of the projects components. This information is used in the Salvage module. The user enters the operational lifetime of the Cabling/Piping and Moorings/Foundations. Details about the device lifetime will have been entered in the device module.

4.4.5 BDR (Bulk Discount Rate)

This allows the user to account for the effect of discounts that may be achieved through the bulk purchase of Capex items.

In order to accurately account for bulk discounts and ensure that the correct value inclusive of any bulk discounts is applied correctly in Exceedance Finance, the following is the process laid out in the Bulk Discount module.

1. The user is asked to enter the cost quote they have for the Capex item.
2. The user is asked to enter the number of devices that the cost quote entered in (1) is based on.
3. Exceedance Finance returns the Equivalent Single Item Cost based on the user values entered in (1) & (2).
4. Here the number of devices in the project is listed. The user is asked to enter how many of the Capex items are in one device.
5. The user is asked to enter the percentage bulk discount available for the purchase of the total number of Capex items required for the project.
6. Exceedance Finance lists the single item cost including the bulk discount entered.
7. Exceedance Finance lists the PER DEVICE cost of the Capex items including the bulk discount entered. This is the figure that should be entered for the item in the Capex Module.

When the user clicks 'Apply' this will enter the Per Device item cost into the Capex input cell for that item. The user can also manually enter the cost.

4.4.6 Detailed Capex Selections

When the user opts for the Detailed Capex option they must answer some preliminary questions about the project in order for the appropriate components lists to be displayed.

4.4.6.1 Power Export Type

Exceedance Finance allows for wave energy devices to be modelled as electricity generation devices or as Hydro pump devices which pump water ashore to onshore generation stations. The Power Export prompts the user to assign one of these options to their device. The choice of either Electrical (Cables) or Hydro (Piping) will dictate the list of components that will be populated in the detailed Capex section.

4.4.6.2 Station Keeping Type

The user defines the mode of station keeping for the selected device. This can be either fixed using foundations or floating using moorings. The choice of either Fixed (Foundations) or Floating (Moorings) will dictate the list of components that will be populated in the detailed Capex section.

4.4.6.3 Co- Location and Infrastructure Sharing

This prompts the user to assign one of the following farm infrastructure sharing options to the combination project.

- Farm Shares Export and Interarray Cabling/Piping
- Farm Shares Export Cabling/Piping Only.

The choice will dictate the list of components that will be populated in the detailed Capex section.

4.4.7 Staggered Capex

In Exceedance Finance the default is for the farm to be built and commissioned in Year 0 with generation commencing in Year 1. The Capex is therefore all charged to Year 0.

Staggered Capex allows the user to spread the Capex over a longer period to more accurately reflect real life projects. This is only available where 'Pre-Development' years has been entered in the main project details. Also if pre-development years are specified a portion of the Capex must be allocated to the first pre-development year. The save button will not enable unless the total percentage is 100%.

4.5 OPEX

The Opex is where the user accounts for the projects annual operational expenses. Exceedence Finance allows for Opex to be entered in one of three ways:

- Total Opex per farm

- Total yearly Opex per farm
- Breakdown total Opex per farm

4.5.1 Total Opex per farm

This is the simplest Opex option. It is one figure which will be the annual running costs of the farm. Exceedence Finance treats the Opex entered with this option as fixed. Total Opex per farm can be entered in one of the following four

- €
- €/MW: This metric is calculated based on the projects final farm size
- €/MWh: This metric is calculated based on the annual delivered energy of the farm.
- % Total Capex: This is the percentage of the farms total Capex figure.

4.5.2 Total yearly Opex per farm

This is the mid-level Opex complexity option. It allows the user to enter a single annual running cost for the farm for each individual year of the project. Total yearly Opex per farm can be entered in either €, €/MW or €/MWh. Exceedence Finance treats Opex entered with this option as variable which are not subject to Opex Escalation.

4.5.3 Breakdown total Opex per farm

This is the most detailed and complex Opex input method. The user is provided with an initial list of Opex cost items. From this list, the user can create the final list of Opex items which match the Opex costs for their project. For each of the items selected, the user can assign an Opex cost as either 'Fixed' or 'Variable'. Fixed items will be the same for each year in the project whereas variable items can have different values in each year of the project.

4.5.4 Show Additional info

This lists any project equipment or infrastructure that may require replacing during the operational years of the project. This information is based on the device lifetime (from the device details in the database) and any component lifetimes entered in the Capex module. If any of the lifetimes of these components are less than the operating lifetime of the project, the year(s) that they will need to be replaced will be displayed.

The user can account for replacing items by including the replacement cost in the year of replacement.

4.6 Salvage

This accounts for any salvage or resale value that may be achieved when project assets are scrapped or re-sold at the end of the project. (Salvage values entered are not costs and are treated as positive cash flows to the project)

The remaining lifetime of devices, mooring/foundation and cabling/piping infrastructure at the end of the operational life of the project is listed. These are based on any device lifetime, mooring/foundation and cabling/piping operational lifetime that the user has previously entered. The remaining lifetime assumes that any equipment whose lifetime is less than the project lifetime will have been replaced.
The remaining lifetimes are provided for information purposes to assist the user in assigning any salvage costs that may eventuate.

4.6.1 Device Salvage

The user enters any scrappage or resale value that may result from the devices at the project end. Scrappage value can be entered as €, €/MW or percentage of Device initial costs.

4.6.2 Other Salvage

The user enters any scrappage or resale value that may result from any other project infrastructure at the project end. Scrappage value can be entered as €, €/MW or percentage of Capex.

4.6.3 Cable/Piping Salvage

The user enters any scrappage or resale value that may result from the cabling/piping infrastructure at the project end. Scrappage value can be entered as €, €/MW or percentage of cabling/piping initial costs.

4.6.4 Mooring/Foundation Salvage

The user enters any scrappage or resale value that may result from the mooring/foundation infrastructure at the project end. Scrappage value can be entered as €, €/MW or percentage of mooring/foundation initial costs.

4.6.5 Staggered Salvage

This allows the user to spread any salvage value for the project over the last year of the project and any decommissioning years. The sum of the percentage of salvage entered must equal exactly 100%.

4.7 Decommissioning

This accounts for any decommissioning costs that may be required to decommission the project infrastructure at the end of the project. The user can enter decommissioning costs for the last operation year of the project together with any decommissioning years. Decommissioning costs can be entered in either €, €/MW or percentage of farm Capex.

4.8 Revenue

This is where the user inputs the revenue the project will generate. Revenue rates are entered in €/MWh and are calculated annually based on the annual delivered energy of the farm (MWh).

Any grant income received by the project can also be entered.

4.8.1.1 Revenue - Basic Inputs

This is a grid sales revenue or feed-in-tariff (FIT) figure which is entered in €/MWh. The user must choose whether this revenue figure is Fixed or Variable. Fixed figures are the same for each year of the project whereas variable figures can be different for different years. Revenue Indexation does not apply to variable revenue figures.

4.8.1.2 Revenue - Extra Inputs

In addition to basic revenue the user has the option to include any additional revenue the project may receive. These must all be entered in €/MWh. Additional revenue items are

- Re Certificate: This is a €/MWh figure to account for any revenue from Renewable Energy Certificates or equivalent.
- ROC Equivalent: This is a €/MWh figure to account for any revenue from Renewable Obligation Certificates or equivalent..
- Additional Grid Sales Revenue: This is a €/MWh figure to account for any revenue any additional sources that the user wishes to include.

If the user chooses to include any of these items, they must choose whether the item is Fixed or Variable. Fixed figures are the same for each year of the project whereas variable figures can be different for different years. Revenue Indexation does not apply to variable revenue figures

4.9 Discounting & Inflation

This accounts for any discounting or inflation factors that apply to the projects cash flows.

Exceedance Finance has four different Cash Flow Discounting options. Discounting adjusts anticipated future cash flows to their present values. The four methods are as follows

- Do not apply discounting or inflation options to Cash Flows

  This option will output the raw unadjusted cash flow sheets with no inflation or discounting accounted for. This raw output is available for users who wish to undertake the cash flow analysis on a separate spreadsheet or in their own model.

- Apply undiscounted Cash Flows with inflation included

  This applies no discounting of future cash flows but does include inflation. This output can be exported if a user wishes to undertake the remaining cash flow analysis on a separate spreadsheet or in their own model.

- Apply Cash Flows in Real Terms (no inflation) to Cash Flows

  This produces future cash flows in real terms and uses a Real Discount Rate. Cash flows in Real Terms do not account for inflation therefore no inflation is applied.

- Apply Cash Flows in Nominal Terms to Cash Flows

  This produces future cash flows in nominal terms and uses a nominal discount rate. Cash flows in nominal terms account for inflation in the analysis. Therefore with this option selected both the Opex and Revenue will be increased each year with inflation. With this option the inflation of Opex and Revenue will occur in addition to any escalation of indexation rate selected

The Nominal Discount Rate is calculated as follows:

$$Nominal\ Discount\ Rate = R + (R * I) + I$$

R = Real Discount Rate

I = Inflation Rate.

4.9.1.1 Inflation Rate

This is the annual rate at which all cash flows will increase over the lifetime of the project.

4.9.2 Indexation and Escalation Factors

These account for any non-inflation increase in Revenue or Opex rates over time.

4.9.2.1 Revenue Indexation Factor

The user can account for any non-inflation increases in Revenue rates over time by applying an 'Indexation Rate'. This will increase the Revenue rates annually at the rate entered. This will apply to fixed revenue items only.

4.9.2.2 Opex Escalation Factor

The user can account for any non-inflation increases in Opex costs over time by applying an 'Escalation Factor'. This will increase the Opex annually at the rate entered. This will apply to fixed Opex items only.

4.9.3 Application of Discount, Inflation, Indexation and Escalation Rates

The default in Exceedence Finance is for Year 0 (the current year) to be the build year and Year 1,2,3,4,5…….. to be the operating years.

- Discounting applies from Year 1 onwards i.e. cash flows from Year 1 onwards are discounted into present values (Year 0 the current year)
- Inflation also applies from Year 1 in the same way as discounting.
- Indexation and Escalation apply from Year 2. Indexation and Escalation account for non-inflation increases in Revenue or Opex costs. Exceedence Finance assumes that the value the user has entered is the value for that item in the first year it is charged to the project (Year1). Any escalation or indexation rates apply to that year 1 cost in the subsequent years.

4.10 Debt Equity

This allows the user to account for any debt raised in order to fund the project. The default in Exceedance Finance is for projects to be based on 100% equity and projects will be assessed on this basis if this module is skipped.

The Debt/Equity ratio can be specified by the user by entering a value into either the % Debt or % Equity cells. The percentage debt is the portion of the project's Capex that is to be raised from Debt. The percentage equity is the portion of the project's Capex that is to be raised from Equity. The user must specify the debt term (the user specifies the number of years over which the debt is to be repaid) and the borrowing rate (the interest rate to be charged on the borrowings).

The user must choose whether the repayments are to be modelled as either Annual or Monthly Loan Payments. Annual involves one repayment each year whereas Monthly involves one repayment every month. Monthly will result in a slightly lower cost due to lower interest payments.

4.10.1.1 Debt/Equity with Staggered CAPEX

This only applies to projects that have pre-development years assigned and displays the following.

- Year Number: This lists the pre-development years of the project along with the build year (Year 0) and the first operating year of the project (Year 1).
- Percentage of CAPEX: This displays the users previously specified CAPEX distributed over the pre-development years of the project. This is displayed to assist the user in selecting the appropriate year to begin debt repayments for their project.
- Begin Repayment: This is where the user selects which year to begin the debt repayments. The default in Exceedance Finance is for the Capex to be charged to the project in Year 0 and the debt repayments begin in Year 1. The Begin Repayment option here allows to user to specify a different year if the Capex has been staggered.

4.11 Tax and Depreciation

4.11.1 Tax

This is where the user can account for taxes. Note that Exceedence Finance only assesses Taxes on the projects profits. Also Exceedence Finance carries losses forward which can be applied against taxable profits in the following years.

The user must specify the Tax rate that is to be applied to the projects profits.

4.11.2 Depreciation

This allows the user to assign any depreciation, also known as Capital Allowances, which can be charged to the profit for tax purposes. Depreciation allocates the cost of an asset to the cash flow sheet over the economic life of the asset.

For each Capex item that the user wishes to assign a Depreciation amount, they first must specify how much of the original Capital Cost of that item is to be depreciated. The user then has the option to allocate the depreciation in three ways.

1. Single Year
   This will allocate 100% of the depreciation amount in the first year of the project.

2. Straight Line

This will spread the depreciation amount equally over a set number of years. This is the most common depreciation method with the number of years typically being the economic life of the asset.

3. Variable

This allows the user to customise the allocation of depreciation amounts over the lifetime of the project.

4.12 Advanced Results

This is where the user can view the results of the project. Exceedence Finance outputs the following project results

- Net Present Value
- Internal Rate of Return
- Levelised Cost of Electricity
- Simple Payback Period
- Discounted Payback Period
- Equivalent Annual Charge
- Net Present Value per MW

4.12.1 Net Present Value

The net present value (*NPV*) is the sum of all the cash flows discounted to the present using the time value of money. If the net present value is greater than zero, it is expected that value will be created for the investor. If it is less than zero, it is expected that value will be destroyed for the investor. The net present value is a method of quantifying the value that is to be created for the investor.

The net present value is calculated based on the following formula:

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$$

where CF_t is the cash flow at year t, n is the project lifetime and k is the discount rate[6] .

Thus, the net present value of the project is the present value of the anticipated cash flows generated by the project less the present value of the cash flows consumed by the project.

[6] Crundwell, F. (2008). Finance for engineers, Springer

4.12.2 Internal Rate of Return

The internal rate of return, which is also called the rate of return and the discounted cash flow rate of return (DCFROR), is the value of the discount rate at which the net present value is zero. The higher the IRR is above the discount rate used the more desirable it is to undertake the project.

4.12.3 Simple Payback Period

The simple payback period determines the point in the project at which the investor gets their investment back. In other words, the payback period is the period at which the cash flow generated by the investment is equal to the cash invested in the project . For projects with pre-development years, these years are included in the payback period.

4.12.4 Discounted Payback Period

The discounted payback period is the same as the simple payback period, except that the time value of money has been included. The simple payback period is the time taken for the cash in-flows from the project to be equal to the cash out-flows. At that point the investor has "got their money back." The discount payback period is the same concept, except that it incorporates the time value of money. This rectifies one of the main criticisms of the simple payback period as a decision criterion, that is, that it does not account for the time value of money. For projects with pre-development years, these years are included in the payback period.

4.12.5 Equivalent Annual Charge

The equivalent annual charge (*EAC*) distributes the present value of the project equally over the life of the project as if it were an annuity.

$$EAC = PV\left(\frac{k(1+k)^n}{(1+k)^n - 1}\right)$$

where *PV* is the present value or net present value of the project, *k* is the discount rate, and *n* is the project lifetime.

4.12.6 Levelised Cost of Electricity

Levelised Costs are defined as the ratio of total lifetime expenses versus total expected outputs expressed in terms of the present value equivalent[7] .

Exceedence Finance uses the 'Discounting' method of calculating Levelised Cost of Electricity (LCOE).

$$LCOE_D = \frac{PV(Costs)}{PV(Outputs)}$$

The 'Costs' include all costs CAPEX, OPEX, Decommissioning and Interest Payments.

[7] Allan, G., et al. (2011). "Levelised costs of Wave and Tidal energy in the UK: Cost competitiveness and the importance of "banded" Renewables Obligation Certificates." Energy Policy **39**(1): 23-39

In Exceedence Finance, we also consider Tax as a cost; however the level of Tax payable is dependent on the level of Revenue coming from grid sales. The PV (Costs) in the LCOE formula is calculated based on the cash flows of the costs only (no revenue from grid sales is included).

In order to account for an appropriate Tax cost in the LCOE, Exceedence Finance includes a tax cost that would be paid by a Grid Sales rate equal to the LCOE (i.e. If the LCOE result is €200/MWh this would include the tax cost that would be payable if the farm was being paid €200 for each MWh).

In simplified terms this would then mean that if the farm is paid more per MWh than the LCOE it makes money and if it is paid less per MWh than the LCOE it loses money. If the tax cost were not accounted for this may not be the case as you may get paid more per MWh than the LCOE figure shown but you may still lose money after tax is paid.

4.12.7 Net Present Value Per MW

This is simply the Net Present Value of the project divided by the final farm size of the project.

4.13 Sensitivity Analysis

4.13.1 Parametric Sensitivity

This allows the user to perform sensitivity analysis on the Discount Rate and Revenue inputs by viewing the project results using a range of values for each.

- The user first selects the Input parameter, either Fixed Revenue or Discount Rate.
- Next the user enters the range of values for the parameter that they wish to view results for. The original value of the input parameter that was used in the project is listed in the first input cell.
- The user selects the project result that they wish to view for the range of input values. Result parameters available are Levelised Cost of Electricity (LCOE), Net Present Value (NPV), Internal Rate of Return and Net Present Value per MW (NPV/MW). Note that IRR is not available with Discount Rate and LCOE is not available with Fixed Revenue.

The results for the project using the range of input values that the user has entered are displayed in tabular and graphical form.

Due to the complexity of calculation and the need to provide quick results, the parametric sensitivity results are for indicative purposes only as there may be some small discrepancies between these and the project results.

4.13.2 Fine Tuning Sensitivity

This allows the user to adjust a range of project inputs to establish the impact that each parameter has on the project results.

Once the input parameter has been selected a graph will display project results with the input parameter at its original value and also at its current slider value. By adjusting the slider value within the range selected, the user can visually see the impact of the changes on the project results.

The analysis can be performed on Levelised Cost of Electricity (LCOE), Internal Rate of Return , Net Present Value (NPV) and Net Present Value per MW (NPV/MW).

The results are also displayed in a table. For each input parameter selected it lists the original or base case results along with the results at the minimum, maximum and current slider value.

Due to the complexity of calculation and the need to provide quick results, the fine tuning sensitivity results are for indicative purposes only as there may be some small discrepancies between these and the project results.

4.13.3 Goal Seek Sensitivity

This allows the user to establish the value of input parameters that are required in order to meet target values of project results.

The user selects the output parameter that they want to set a target value for. The outputs available for selection are Levelised Cost of Electricity (LCOE), Internal Rate of Return , Net Present Value (NPV) and Net Present Value per MW (NPV/MW). The user specifies the target value for the output parameter they have selected.

The user selects the input parameter from the tree view window that the Goal Seek analysis will be performed on.

The results will calculate the value of the Input parameter that will be required in order for the project to reach the target value of the output parameter.

A value will only be outputted if a result can be calculated within the constraints of the current project and within the 'Inner Range' specified below. Any results not within 'Inner Range' but within the 'Outer Range' will also outputted but with the message 'Nearest Result Found'.

If no results are achieved within 'Outer Range' a 'No Result Found' message will appear. This will display the last result achieved and the input value for that last result.

Inner Range

- NPV €1m
- IRR 0.1%
- LCOE €1/MWh

Outer Range

- NPV €5m
- IRR 1%
- LCOE €3/MWh

Due to the complexity of calculation and the need to provide quick results, the goal seek sensitivity results are for indicative purposes only as there may be some small discrepancies between these and the project results.

5 Project Comparison

This allows the user to select projects existing from saved files to compare. Once 2 – 5 projects have been selected the following project parameters can be compared

- Final Farm Power (MW)
- Farm Annual Delivered Energy (MWh)
- Capital Expenditure (CAPEX)
- Operational Expenditure (OPEX)
- Net Present Value (NPV)
- Internal Rate of Return
- Levelised Cost of Electricity (LCOE)
- Simple Payback Period
- Discounted Payback Period
- Equivalent Annual Charge
- NPV/MW

5.1.1 Currency Conversion

Exceedence Finance allows for projects that were built in different currencies to be compared. This option only appears where projects being compared where built in different currencies. It allows for the results of one or more of the projects to be converted so a comparison can be made in one currency.

The currencies that the original projects were built in are listed. The user to assigns a currency from one of the projects as the base currency. Once a base currency is selected, the conversion factors entered for each project will convert the results of those projects into the base currency.

6 Project Saving & Reopening

When an Exceedence Finance project is saved it is saved to a file. This file can be emailed or sent to another PC where it can be opened in another copy of Exceedence Finance. The saved project files are designed to contain all the necessary information for the project to be opened and viewed in a separate version of Exceedence Finance.

Where a project being opened was originally created in another copy of Exceedence Finance, prior to opening the project the program will check if the location, resource and device data in the project already exists in the current user's database.

If they do not, they will be imported with the project and a new location, resource or device will be added to the database (Note for time series data these will be imported as summary data).

Issues may arise if the current database contains a location and resource data that is labelled the same as that in the project file but contains different underlying values. In this case rather that overriding the existing database the project will not open and no importation will take place.

Users should note that due to this if they send a project files to another user they are also sending the device and resource details with it.