



EU-SCORES
European Scalable Offshore Renewable Energy Sources

European Scalable Offshore Renewable Energy Source (EU-SCORES)

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EU-SCORES Project Overview

The €45 million marine energy project - European Scalable Offshore Renewable Energy Sources (EU-SCORES) - will pave the way for bankable hybrid offshore parks across Europe by 2025. Under the project lead of the Dutch Marine Energy Centre (DMEC), EU-SCORES will unlock the large-scale potential of wind, wave and offshore solar systems.

The current global annual electricity consumption is about 21,000 TWh and is predicted to double by 2050, with a growing population and GDP. Efficient and effective use of offshore renewables is pivotal in the EU's transition towards an economy with net-zero greenhouse gas emissions by 2050. To accomplish this, the EU set clear targets to reach 230-440GW and 40GW installed capacity of offshore wind and ocean energy by 2050, respectively.

Kicking off in September 2021, the project partners will jointly build on two highly comprehensive and impactful demonstrations: (1) A 3MW offshore solar PV system by Oceans of Energy off the Belgian coast co-located with a bottom fixed windfarm and; (2) A 1.2MW wave energy array by CorPower Ocean in Portugal co-located with a floating wind farm.

The demonstrations in EU-SCORES aim to showcase the benefits of continuous power output by harnessing complementary power sources including wind, sun and waves. This hybrid approach will create a more resilient and stable power system, higher capacity factors and a lower total cost per MWh. Major project developers and utility companies will further strengthen demonstration efforts, paving the way for future large-scale commercialisation of these innovative parks.

The full-scale demonstrations are intended to prove how the increased power output and capacity installed per km² will reduce the amount of marine space needed, thereby leaving more space for aquaculture, fisheries, shipping routes and environmentally protected zones. Additional benefits achieved by co-using critical electrical infrastructures and exploring advanced operation and maintenance methodologies supported by innovative autonomous systems should lower the costs per MWh. Moreover, the project demonstrations will support the stability and resilience of the European energy system, while considering sustainability, local stakeholders and existing ecosystems.

1. Introduction to Exceedence

Exceedence Finance is a cloud based standardised techno-financial software tool that allows the user to quickly and intuitively build, analyse and optimise any number of renewable energy projects and then presents them in a sophisticated analysis and comparison dashboard. It allows the user to focus on analytics and to identify and reduce risks early on. One of the main appeals of this software is its sensitivity analysis features, which allows the user to quickly assess “what if” questions among other things.

KPIs

- **Overview**
 - All key inputs
- **Financial**
 - LCOE, IRR, NPV, NPV/MW, ROI, Payback Period, Discounted Payback, Equivalent Annualised Charge
 - Full lifetime cashflow sheets
- **Technical**
 - AEP, ADE, Capacity Factor

Analytics

- **What if and Optimisation**
 - Parametric Sensitivity
 - Goal Seek
 - Tornado View
 - Multi project Comparison
- **Reporting**
 - View
 - Export

The Software has been calibrated against a number of existing financial tools including case studies with one of the big four accounting firms. To date, it has been used for prospecting, project development, product development, tariff analysis, test site development, and investment decisions. It has also been used in consulting projects

and tenders for cost benefit analysis of materials, components lifetimes, blade types and locations. Exceedence Finance has an intuitive work flow, illustrated by the flow chart in Figure 1. The technical aspects of the model consist of location/resource and device selection. The financial aspect of the model requires capital expenses (CAPEX), operational expenses (OPEX) and other financial inputs. The software then calculates the final results of LCOE, Internal Rate of Return (IRR) and Net Present Value (NPV). At this stage, the analysis module can be used to ask the all-important “what if” questions by conducting a ‘goal seek’ or examining parametric sensitivities.

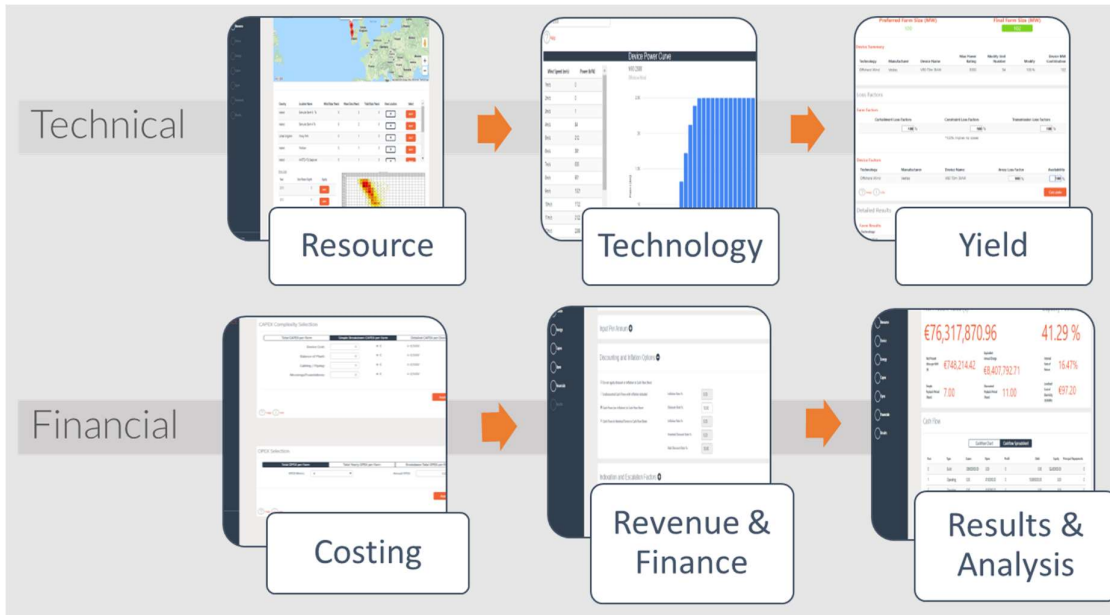


Figure 1: Flow schematic of Exceedence Finance, a techno-financial modelling software.

Exceedence Finance contains a database of renewable locations together with technical information on typical devices. The user can add to these databases by uploading their own location or device information. Exceedence Finance uses this information to calculate 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. By combining the financial information with the energy output data Exceedence Finance produces a cash flow sheet for the entire duration of a project. It returns financial indicators such as NPV, LCOE, IRR, and Payback Period. With this information, users can explore which devices and locations are the most promising in terms of future marine renewable deployments. A screen shot of the Project Dashboard in Exceedence Finance is shown in Figure 2.

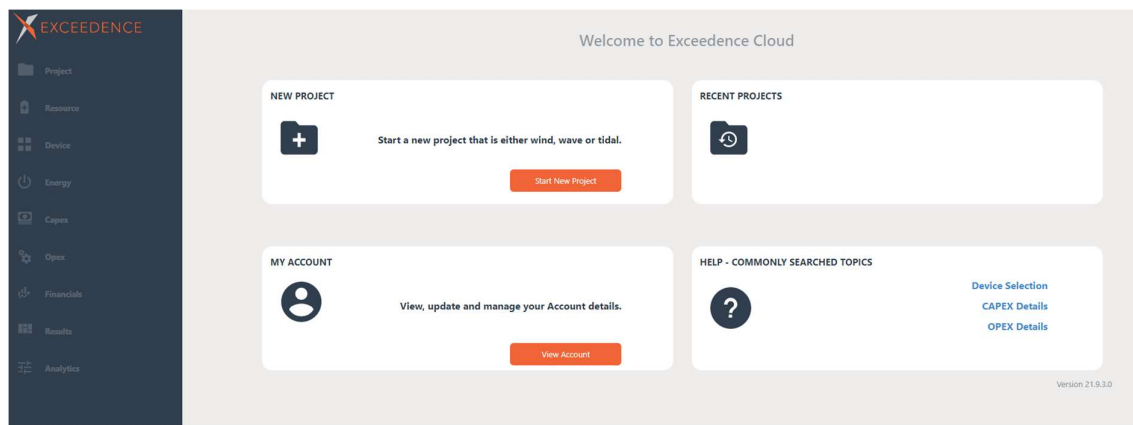


Figure 2: Screenshot of the Exceedence Finance dashboard.

Currently Exceedence Finance allows for four different types of project configurations: **off-shore/on-shore wind farms, tidal farm, wave farm, or a combination of any of the first three technologies.** The user needs to input certain project data such as, the desired farm size, the currency, operating years, specify any predevelopment years, and decommissioning years. Next the model requires both resource data (hourly or annual summary) as well as device data. Exceedence Finance contains a database for both resource data in addition to a database of leading wind, wave and tidal devices. The user also has the option to add their own databases. Based on the initial input data Exceedence Finance calculates the energy output of the project. Changes to the final farm size can be made now in addition to accounting for loss factors such as availability and transmission losses.

Next, the user will be prompted to enter the financial data into Exceedence Finance including CAPEX, OPEX, Salvage, Decommissioning, Revenue, Discounting Inflation, Indexation and Escalation Factors, Debt/Equity, Tax, and Depreciation. Exceedence Finance allows the user to enter both CAPEX and OPEX at three different levels of detail: Total CAPEX per farm, Simple breakdown of Total CAPEX per farm, or a Detailed breakdown of CAPEX per device, Total OPEX per farm, TOTAL yearly OPEX per farm, or Breakdown total OPEX per farm. A screenshot of the CAPEX entered for an example device can be found in Figure 3.

CAPEX Inputs Project: Project Example

Total CAPEX
Simple Breakdown CAPEX
Detailed CAPEX

Metric: Fixed Variable
-- Select a Metric
Currency: Fixed Variable
US Dollar

Select	Description	Metric	Currency	Cost
<input type="checkbox"/>	Development & Project Manager	Cost per MW	US Dollar	200000
<input type="checkbox"/>	Turbine/Device	Cost per Device	US Dollar	187500
<input type="checkbox"/>	Mooring/Foundation	Total Project Cost	US Dollar	11200000
<input type="checkbox"/>	Transmission & Balance of Plant	Cost per MW	US Dollar	350000
<input type="checkbox"/>	Installation & Commissioning	Cost per Device	US Dollar	43750

Capex Spend Profile
+

Apply

Figure 3: Screenshot of CAPEX for an example device entered into Exceedence Finance.

Exceedence Finance provides both energy results and project results. Energy results are provided as Device Capacity Factors, Farm annual Production, Farm Actual Energy Capture, and Farm Annual Delivery Energy. Project results are provided as NPV and NPV per MW, IRR, LCOE, Simple Payback Period, Discounted Payback Period, and Equivalent Annual Charge. A screenshot of an example project calculated using Exceedence Finance can be found in Figure 4.

The results can be viewed graphically from the Resource, Device, CAPEX, and OPEX modules. Another function is that all results can be exported to EXCEL, which can in turn be used to build bank ready financial spreadsheets.

Once Exceedence Finance has calculated the results using the preferred project and financial data, the user can conduct sensitivity analysis on the project's input parameters. This is a function that allows users to assess the impact of change on the project results. The user can either fine tune the project results by adjusting each input to establish the project configuration that produces the best return, or perform a Goal Seek on the necessary value of inputs required to achieve target results. A screenshot of the fine-tuning analysis can be found in Figure 5.

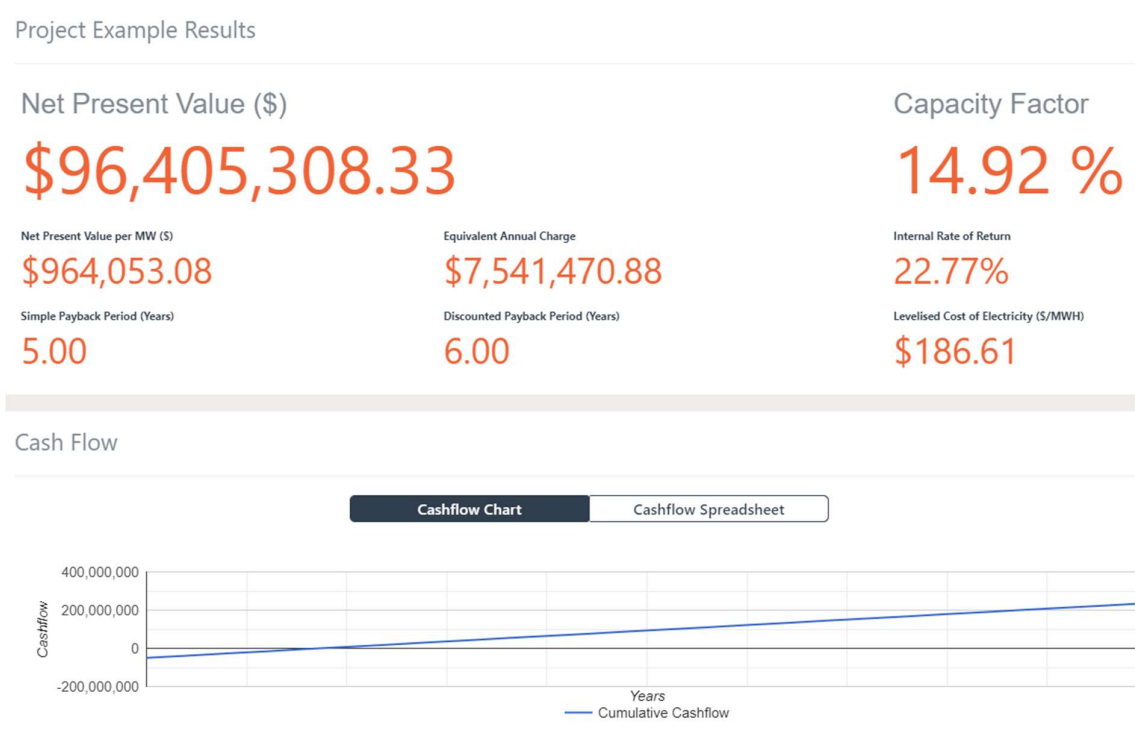


Figure 4: Screenshot of the project results page.



Figure 5: Screenshot of the fine-tuning analysis tool in Exceedence Finance.

2. How Cloud software is developed

Exceedence use Microsoft Azure to host our cloud software. We use industry standard DevOps tools to manage the release pipeline.

We have a number of environments where the software is live

1. Development – This is where our developers work and this is not released
2. QA: (Quality Analysis) – Once a block of developments has been completed it moves to QA area. This version is accessible only by the the testing team, using sample data. It does not get released until tested and bugs are fixed.
3. Staging – Once testing is complete and the product is ready for release it is copied to a pre-release area for final performance, data and security testing This is accessible to anyone that we grant access to and can be seen as a Beta. It does not get released until tested and any issues raised have been addressed.
4. Production – This is the live, tested and stable customer version of the software and the one which is supported.

Throughout the development cycles of software, a new feature or version goes through a release from development, to testing(QA), staging and then to production. In the case of the major release for wind and floating wind, this release was done on the 29th June 2021.

Agile Process – Going from Idea to Product

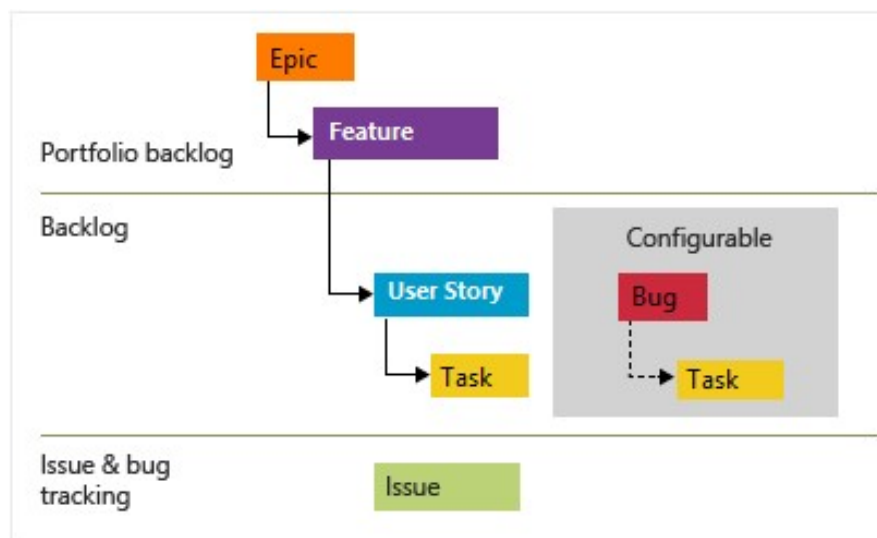
We use a combination of the Agile development process and DevOps delivery techniques to convert software requirements into deployed features.

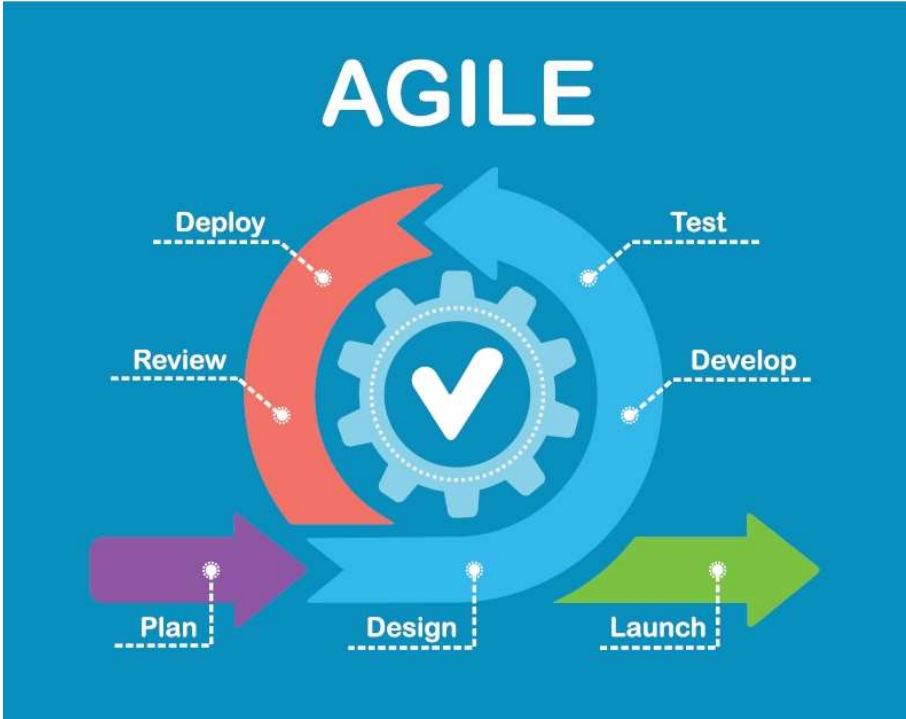
User Stories are created based on requirements received from customers and other stakeholders. These Stories are grouped into Features and Epics to help us organise new functionality.

Stories are prioritised according to business need, then broken into related Tasks. These items are brought into a **Sprint**, which is a period of time in which prioritised work is undertaken then deployed at the end. Exceedence utilises fortnightly Sprints, which ensures regular and consistent deployments from the Development to Testing environment. Once code has been deployed, the system is tested by QA testers and any bugs are fixed.

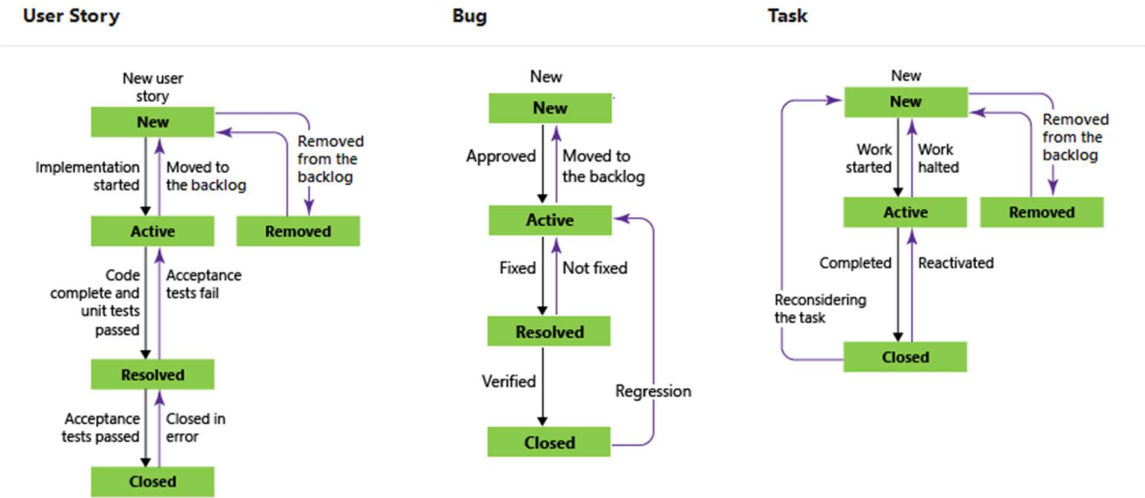
After the system has been thoroughly tested, we release the new version and monitor its performance.

During the process our code is managed by Microsoft's DevOps infrastructure. Code versioning and automated releases to QA help to minimise conflicts in code and versions. The final release is done manually following approvals by senior management team.





The diagram overleaf shows the main progression and regression states of the user story, bug, and task Work Item Types (WITs).



3. EU-SCORES partner engagement

Overall tasks as per proposal

One of Exceedence's main tasks is to enhance its existing cloud software to capture better information and to enable better decisions in multi-use farms. Three main tasks were proposed in the original proposal:

- Data Security
- User Levels
- Combine projects

Exceedence has already put thought into what these three tasks may look like and have engage with the EU-SCORES partners over the past couple of months to allow their feedback to be reflected in this requirement specification document.

Engagement with partners

The engagement was initiated over a number of meetings, after which an info pack along with a questionnaire was sent out. This was followed by a demo and onboarding session of the software, where 11 of the partner organisations and 17 users were onboarded. This allowed the partners to have a chance to work through and use the software themselves, to compare it with how they normally do techno-financial modelling. Partners were encouraged to respond to the questionnaire and send them back to Exceedence. Some partners wished to have one-to-one sessions as well, which Exceedence accommodated for.

Feedback was received from 8 partners so far, that has fed into this requirement specification document. All partners have indicated a desire to stay up to date on progress as the software is enhanced and developed and will feed in their expertise where they can.

General feedback

- The partners within EU-SCORES cover a wide range of the industry segments. Exceedence received feedback from partners identifying as developers, government, corporates, utilities, consultants and research institutes.
- The types of roles carried out within these organisations that would use the software are analysts, influencers and decision makers.
- These organisations combined investigate a wide range of renewable assets: onshore, fixed offshore and floating offshore wind, onshore and floating PV, wave and tidal.

- The organisations use a range of different tools to produce techno-financial models such as in-house teams, external consultants, software tools, and custom excel.
- A range of different decision metrics are used such as cashflow, LCOE, IRR, NPV, Carbon offset, capacity factor and yield.
- Models are used for a varying number of purposes, such as investment decisions, technology roadmaps, project optimisation, funding applications, acquisitions, and consultancy.
- The main purpose of models is for technology assessment, front end design, pre-feasibility and feasibility, as well as M&A.

Specific feedback on how best to enhance the software with the three tasks in mind, is collated in the next chapter.

4. Requirements Specification

The original ideas proposed in the EU-SCORES project along with the engagement with partners has provided initial insight into what fits, what is missing and why, along with the relative importance to allow for prioritisation. Exceedence will continue to engage with the partners as it develops the software within the its existing framework.

The main ideas as per proposal were considered the most important by the EU-SCORES partners and these will be enhanced and developed throughout the EU-SCORES project:

Data security: The purpose of this task will be to facilitate and ensure secure management of sensitive commercial information among the project partners and consistent reporting and analysis.

All seemed happy enough with current functionality with some further improvement in clarifying server location and its data handling process and encryption. Current export functionality was also considered useful with some improvements suggested in also allowing for export of charts and graphs.

User levels: The purpose of this task will be to ensure that correct access is given to the correct users.

Some of the suggested improvements to current functionality was to allow for users to be able to edit and others to view only, as well as locking some screens.

Combination projects: The purpose of this task will be to facilitate combination models of wind/wave and wind/PV to be modelled.

This will require new functionality of catering for PV yield calculations, for which a number of options will be explored.

Other enhancements:

The feedback received also covered a range of the other functionality outside the scope of the EU-SCORES project. It is excellent for Exceedence to receive this feedback and it will be fed into the development roadmap however the priority will be given to the SCORES scope and as such these additional enhancements may fall outside the SCORES timeline.

Resource Data: All seemed happy enough with current functionality with some further improvement in import functionality, averaging resource data, and general user friendliness

Device Performance Data: All seemed happy enough with current functionality with some further improvements in import user friendliness, creating generic power curves, and splitting the turbine from the foundation/mooring

Yield calculation: All seemed happy enough with current functionality with some further improvements in allowing for staged release, and power down

CAPEX: All seemed happy enough with current functionality with some further improvements making more editable fields, to allow for uploading cost inputs from excel or csv, split on per device basis

OPEX: All seemed happy enough with current functionality with some further improvements making more editable fields, and also to add further cost breakdown

Decommissioning: All seemed happy enough with current functionality with some further improvements such as spreading it over a number of years, as well as introducing a repowering option

Financial information: All seemed happy enough with current functionality with some further improvements such as detailed WACC calculations and capture energy price variations

Results screen: All seemed happy enough with current functionality with some further improvements such export functions.

Analysis: Some suggestions were to introduce possibility for side-by-side comparison of main KPI's with other projects, fine tuning analysis with a discount rate option and an increase or reduction of resource availability option, cost reduction pathway plot, box and whisker charts.