Cost and Environmental Impact Estimators for Well Completion utilising hot or superhot geo-resources

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Introduction

- In the COMPASS project, parametric Cost and cradle-to-gate Life Cycle Assessment (LCA) models for well completion have been developed, comprising mainly the casing and cementing components.
- Cost and Environmental impact estimators for well completion have been constructed based on these models.
- The cost estimator for well completion calculates the total estimated well completion cost per m of drilling activities considering the total costs of casing, laser cladding and cementing materials including freight, casing and cementing services' costs.
- The environmental impact estimator for well completion evaluates the environmental performance in terms of 1 m of drilling activities using user-inputted and default data populated in the COMPASS DBMS.

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Methods

Parametric Cost Model for Well Completion

- The costs of casing and cementing materials at different intervals of the drilled depth of a well are estimated using the deduced parametric costing equations for casing, laser cladding and cementing materials.

- Using the total costs of the materials, freight, casing and cementing services, the total cost of the well completion can be determined in units of €.

- The total cost of the well completion per unit length of drilling activities (€ / m) is determined by calculating

➢ the casing cost per unit length of drilling activities (€ / m),
➢ the cementing cost per unit length of drilling activities (€ / m) and
➢ the laser cladding cost per unit length of drilling activities (€ / m)

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Methods

Cradle-to-gate LCA Modelling for Well Completion

- Environmental Impact Estimator for well completion is constructed based on parametric LCA modelling, comprising mainly the casing and cementing components.
- The data of key modelling parameters of casing and cementing materials are being used to estimate the resource consumption at different sections of the drilled depth of the well.
- The functional unit of this cradle-to-gate LCA study is 1 m of drilling activities.
- For evaluating the environmental impacts of 1 m of drilling activities for the well completion, the functional flows of casing and cementing materials are calculated using the parametric equations deduced.
- Using these inventoried functional flows data, LCA tool SimaPro 9.5.0.0 (link with the Environmental Impact Estimator through API) evaluates the environmental footprints of 1 m of drilling activities for the well completion, considering the life cycle impact assessment (LCIA) methodology IMPACT 2002+ v2.15.

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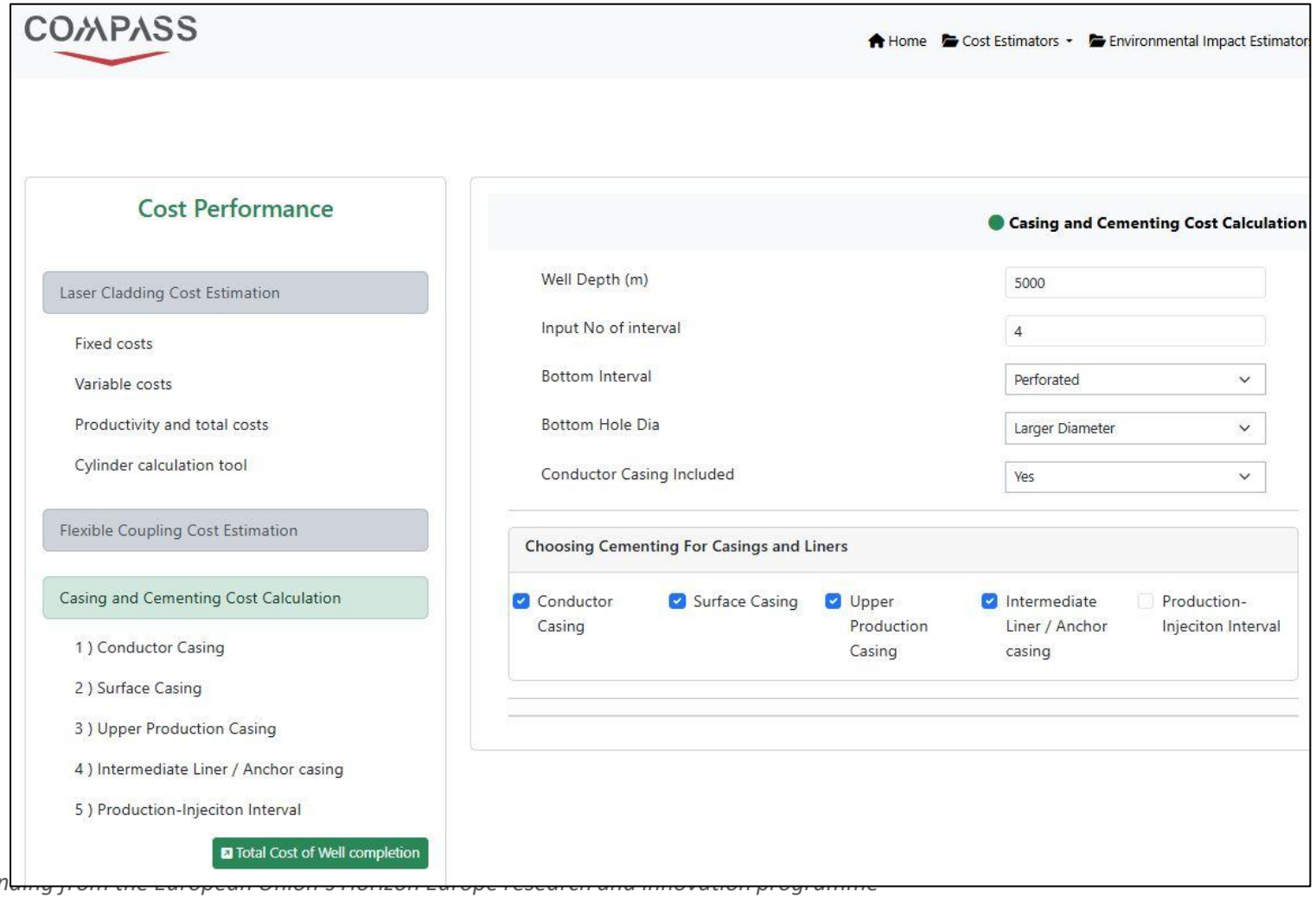
Cost Estimator for Well Completion

Link to the **COMPASS Cost Estimator for Well Completion:** https://compass.technovativesolutions.co.uk/well-completion/cost-performance

- **Casing and Cementing cost estimation**
  - ➢ User can give input data of well depth, number of interval stages, bottom interval, bottom hole diameter, and conductor casing included or not
  - ➢ User can choose number of cementing stages



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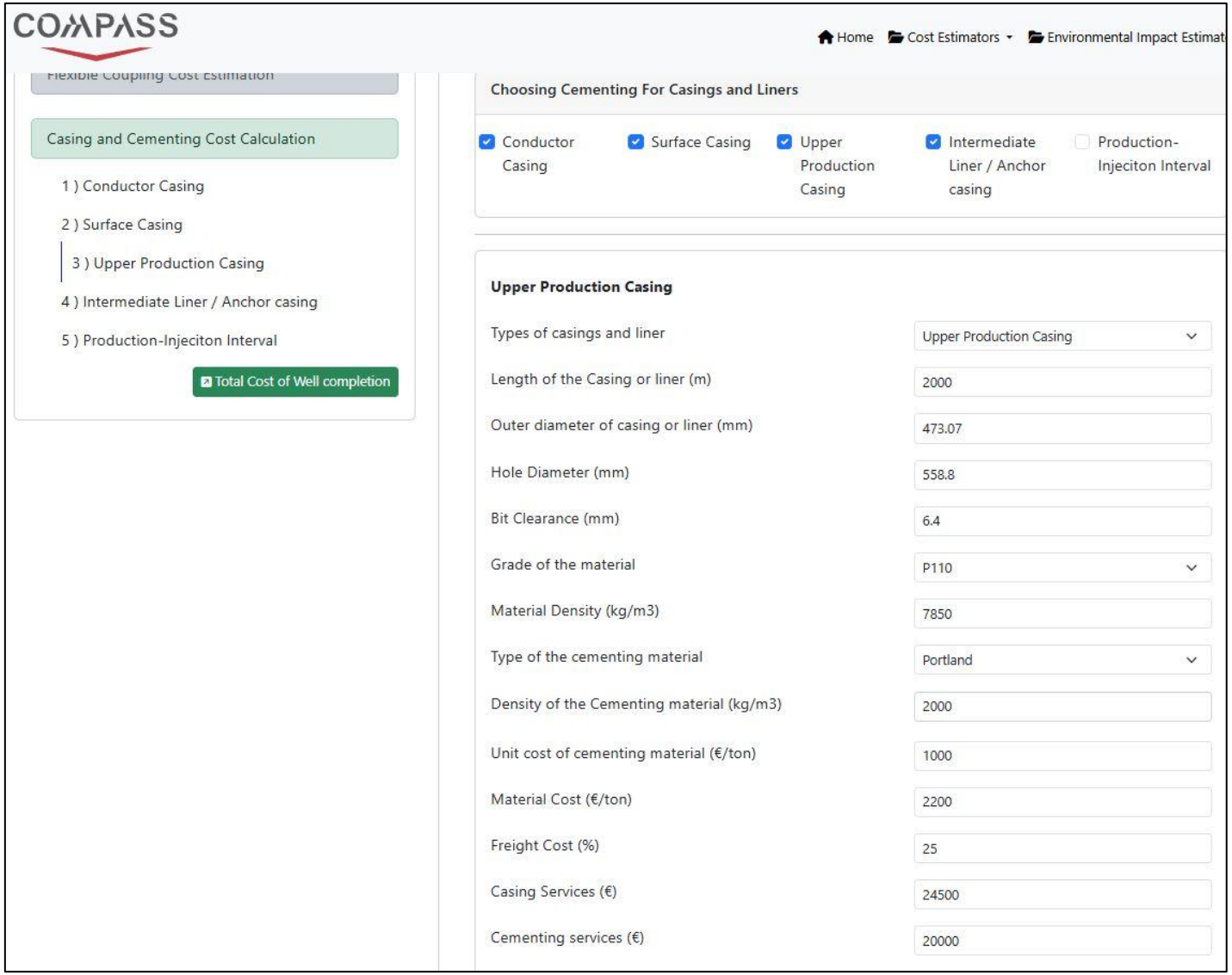
Cost Estimator for Well Completion

- **Casing and Cementing cost estimation**

➢ Then select the casing stages one after another for getting the default data of various parameters from COMPASS DBMS (database management system) or user can provide their data in the respective parameters.



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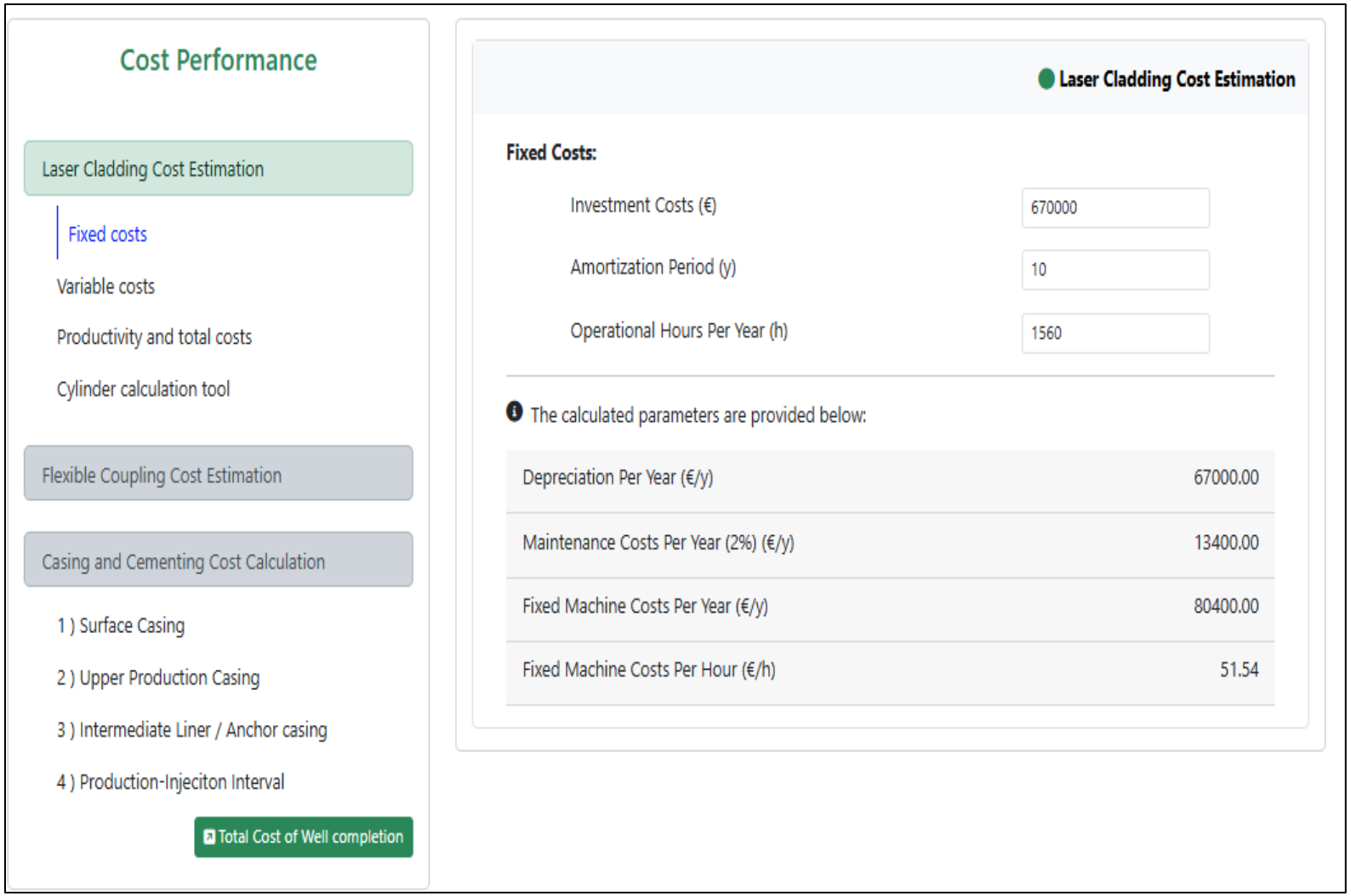
Cost Estimator for Well Completion

Laser Cladding cost estimation

Fixed Costs calculations

- Firstly, select fixed costs where user can modify the values of different parameters, otherwise default values retrieved from COMPASS DBMS

- Then the estimator calculate different parameters such as fixed machine cost, maintenance cost, depreciation using the fixed cost parameters' data



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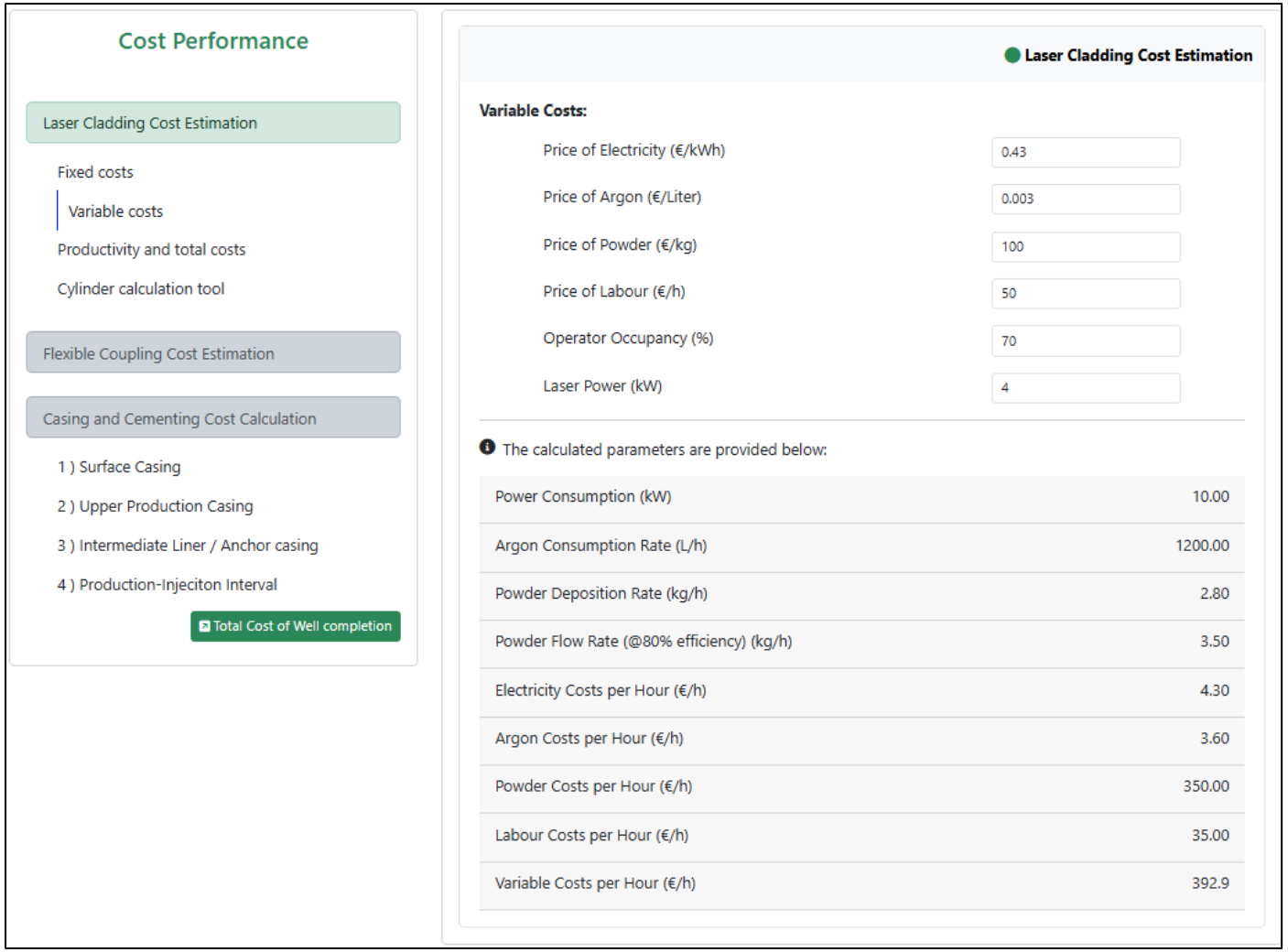
Cost Estimator for Well Completion

Laser Cladding cost estimation

Variable Costs calculations

- Variable costs of various parameters such as labour, electricity and materials' costs have been selected from the DBMS or users can give their inputs.
- Based on the default values or user-inputted values, hourly costs of labour, electricity and materials have been calculated.



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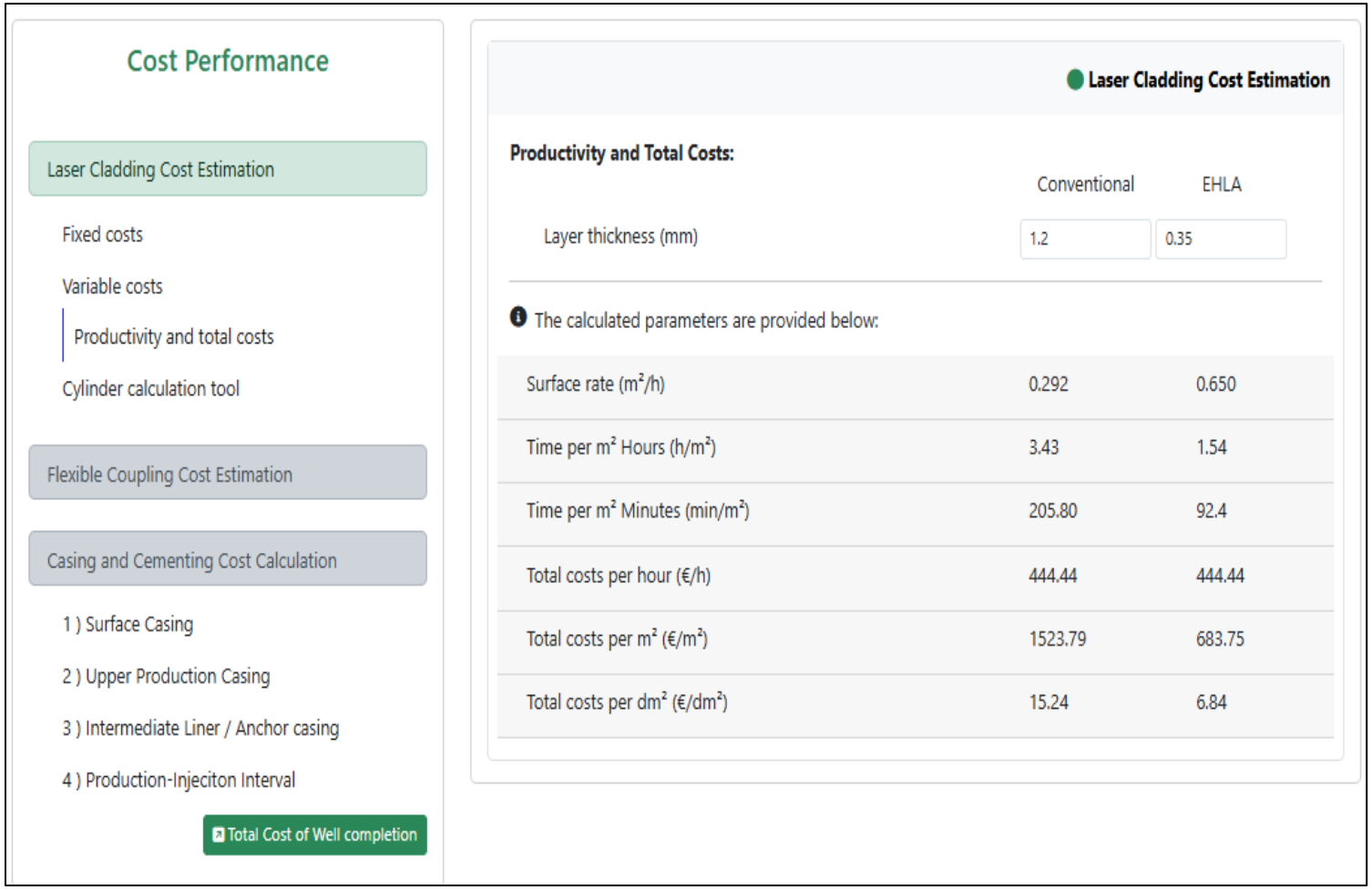
Cost Estimator for Well Completion

Laser Cladding cost estimation

Productivity and total costs calculations for conventional and EHLA applications

- Calculating the time and total laser cladding cost per unit area for conventional and Extreme High-speed Laser Application (EHLA) applications using the fixed and variable costs.



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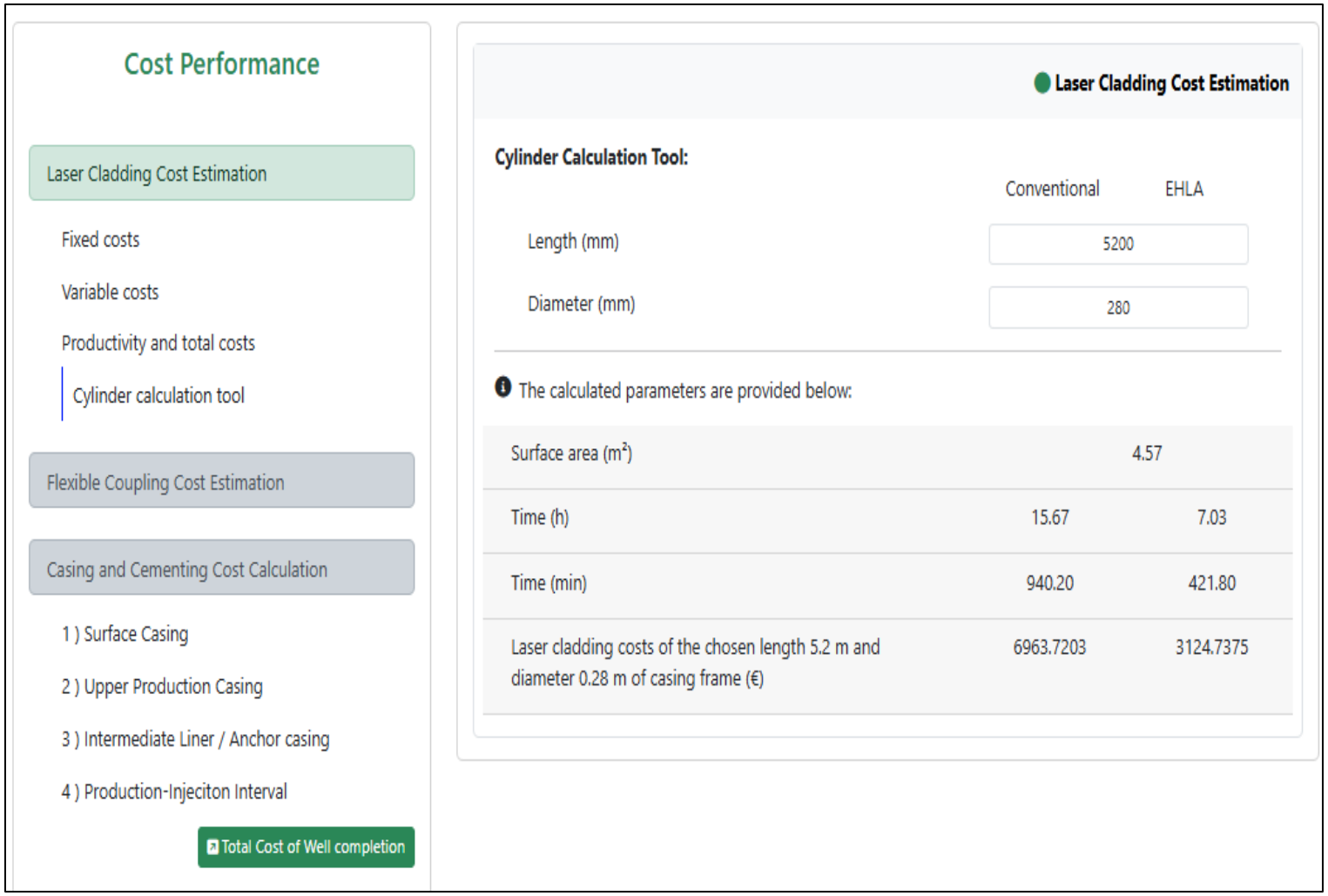
Cost Estimator for Well Completion

Laser Cladding cost estimation

Cylindrical calculation tool

- Cylindrical calculation page showed the total costs of laser cladding using conventional and EHLA methods for a chosen length and diameter of the casing frame.



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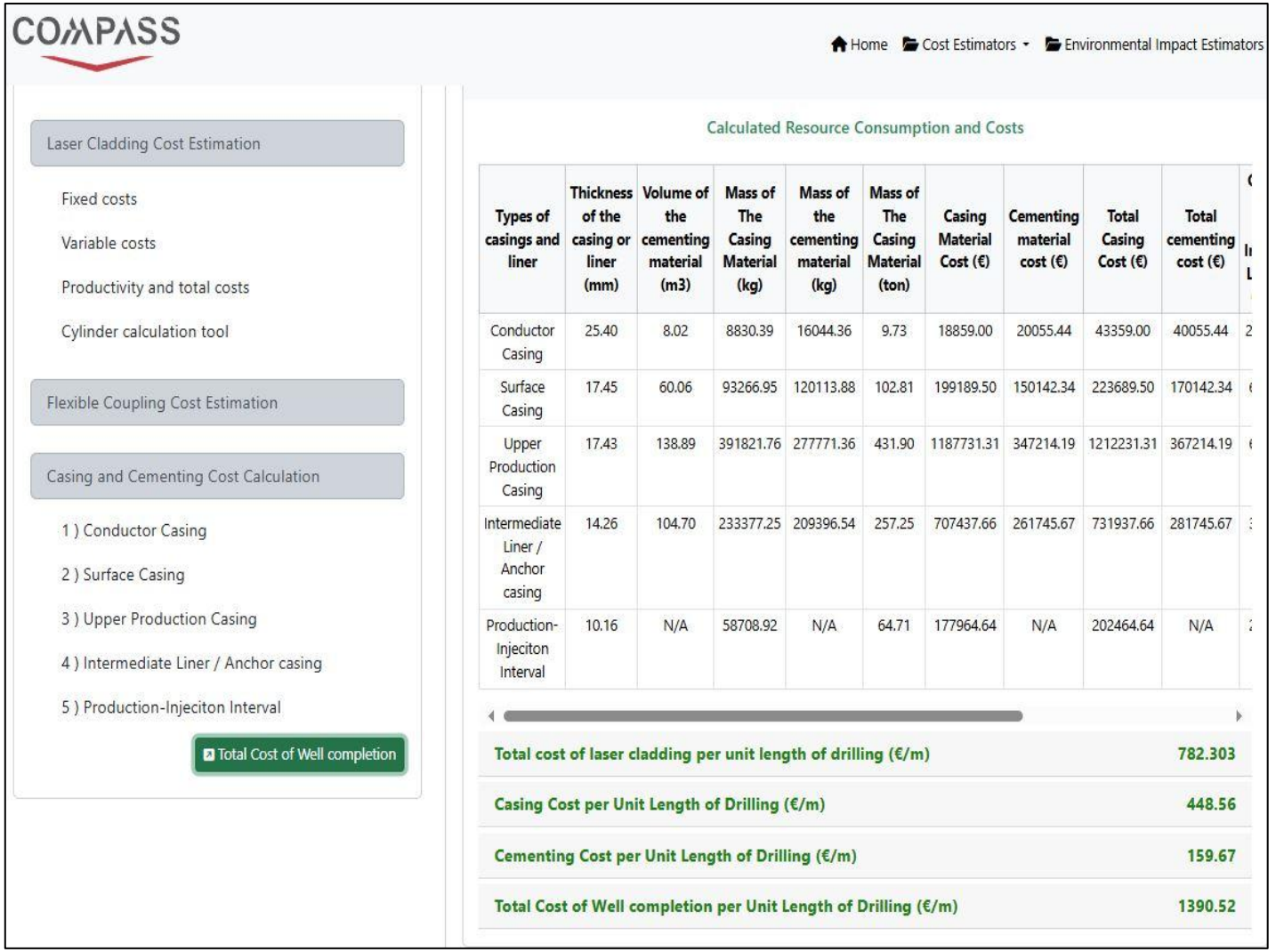
Cost Estimator for Well Completion

Cost estimation for well completion

- This page demonstrates
  - ➢ the total cost of well completion
  - ➢ Casing costs
  - ➢ Cementing costs
  - ➢ Laser cladding cost

per unit length of drilling activities.



Types of casings and liner	Thickness of the casing or liner (mm)	Volume of the cementing material (m3)	Mass of The Casing Material (kg)	Mass of the cementing material (kg)	Mass of The Casing Material (ton)	Casing Material Cost (€)	Cementing material cost (€)	Total Casing Cost (€)	Total cementing cost (€)
Conductor Casing	25.40	8.02	8830.39	16044.36	9.73	18859.00	20055.44	43359.00	40055.44
Surface Casing	17.45	60.06	93266.95	120113.88	102.81	199189.50	150142.34	223689.50	170142.34
Upper Production Casing	17.43	138.89	391821.76	277771.36	431.90	1187731.31	347214.19	1212231.31	367214.19
Intermediate Liner / Anchor casing	14.26	104.70	233377.25	209396.54	257.25	707437.66	261745.67	731937.66	281745.67
Production-Injeciton Interval	10.16	N/A	58708.92	N/A	64.71	177964.64	N/A	202464.64	N/A

Total cost of laser cladding per unit length of drilling (€/m)	782.303
Casing Cost per Unit Length of Drilling (€/m)	448.56
Cementing Cost per Unit Length of Drilling (€/m)	159.67
Total Cost of Well completion per Unit Length of Drilling (€/m)	1390.52

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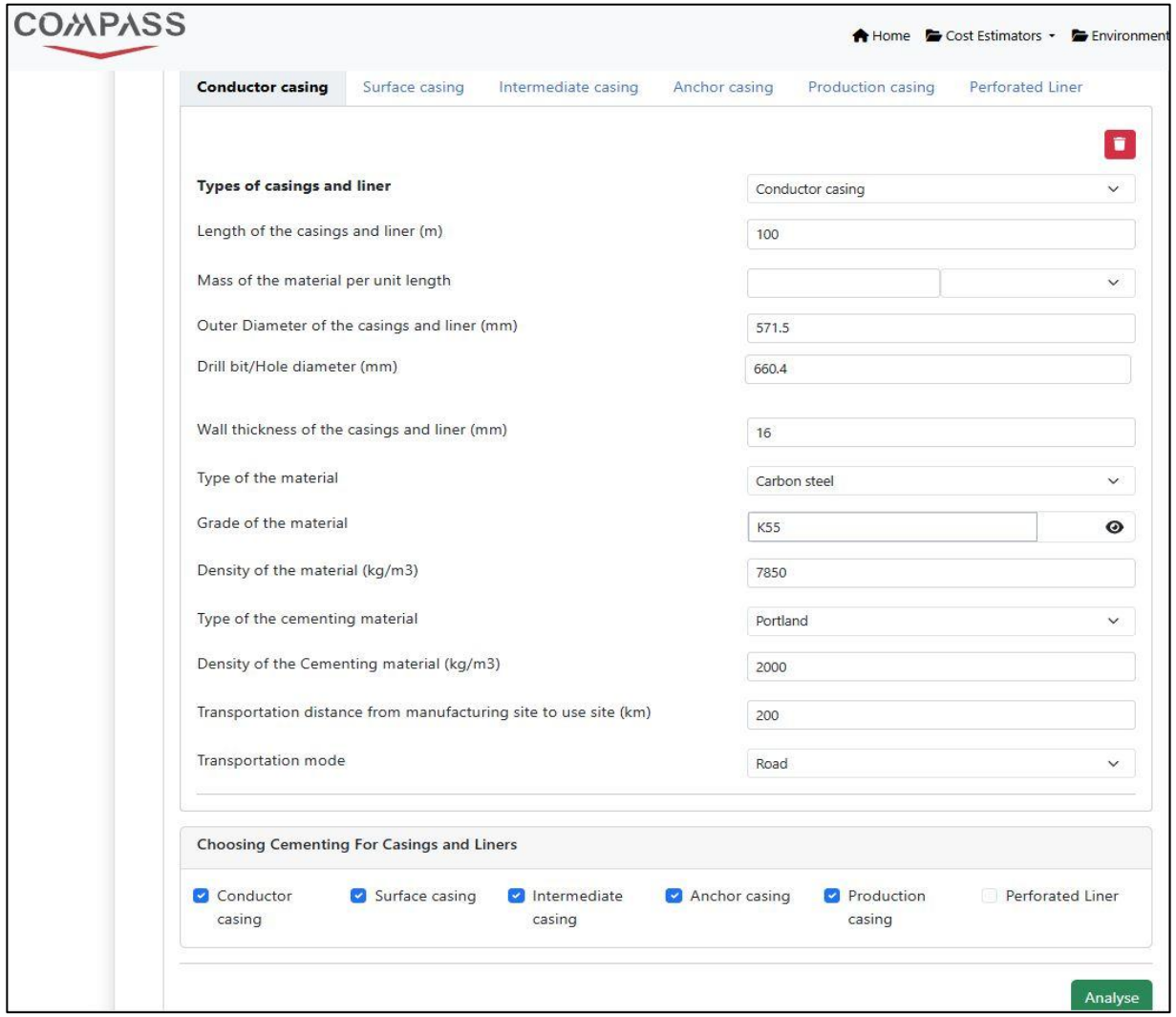
Environmental Impact Estimator for Well Completion

https://compass.technovativesolutions.co.uk/well-completion/environmental-performance/resource-consumption

User-inputted or default data of casings and cementing materials

- First retrieve the default data from the DBMS or user-inputted data of various parameters of conductor casing.
- Then select other casing materials and perforated liner for either retrieving the default data or user-inputted data at different stages of drilled depth.
- Next, choose the cementing stages at different stages of drilled depth
- After selecting the data of all the casings and liner stages and cementing stages of the drilled depth, click the 'analyse' button to estimate the resource consumption of casing, liner and cementing materials.



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Environmental Impact Estimator for Well Completion

Calculations of Resource consumption

- Based on the data provided for different casing and cementing stages, functional flows of casing and cementing materials have been calculated in terms of functional unit of 1 m of drilling activities.
- Estimated functional flows data of casing and cementing materials are directly connected to LCA software tool SimaPro 9.5.0.0 through API and considering the impact assessment methodology 'IMPACT 2002+ v2.15.
- Then click the button 'Environmental performance' to evaluate the environmental impacts of 1 m of drilling activities for a particular well completion.

Types of casings and liner	Volume of the casings and liner (m3)	Cementing volume (m3)	Mass of the casings and liner (kg)	Mass of the cementing material (kg)	Functional mass flow of the casings and liner (kg/m)	Functional mass flow of cementing material (kg/m)	Weighted length factor	Weighted functional mass flow of the casings and liner (kg/m)	Weighted functional mass flow of cementing material (kg/m)	Weighted functional transportation flow of the casings and liner (tkm/m)	Weighted functional transportation flow of cementing material (tkm / m)
Conductor casing	2.79	8.60	21908.03	17194.00	219.08	171.94	0.02	4.38	3.44	0.88	0.69
Surface casing	4.04	9.54	53586.93	19086.98	158.39	95.43	0.04	6.34	3.82	1.27	0.76
Intermediate casing	7.16	32.25	109788.49	64501.23	112.40	129.00	0.10	11.24	12.90	2.25	2.58
Anchor casing	9.71	29.75	185996.42	59492.12	76.21	59.49	0.20	15.24	11.90	3.05	2.38
Production casing	10.54	23.55	268718.47	47099.91	41.36	23.55	0.40	16.54	9.42	3.31	1.88
Perforated Liner	6.32	N/A	318351.69	N/A	41.36	N/A	0.24	9.93	N/A	1.99	N/A

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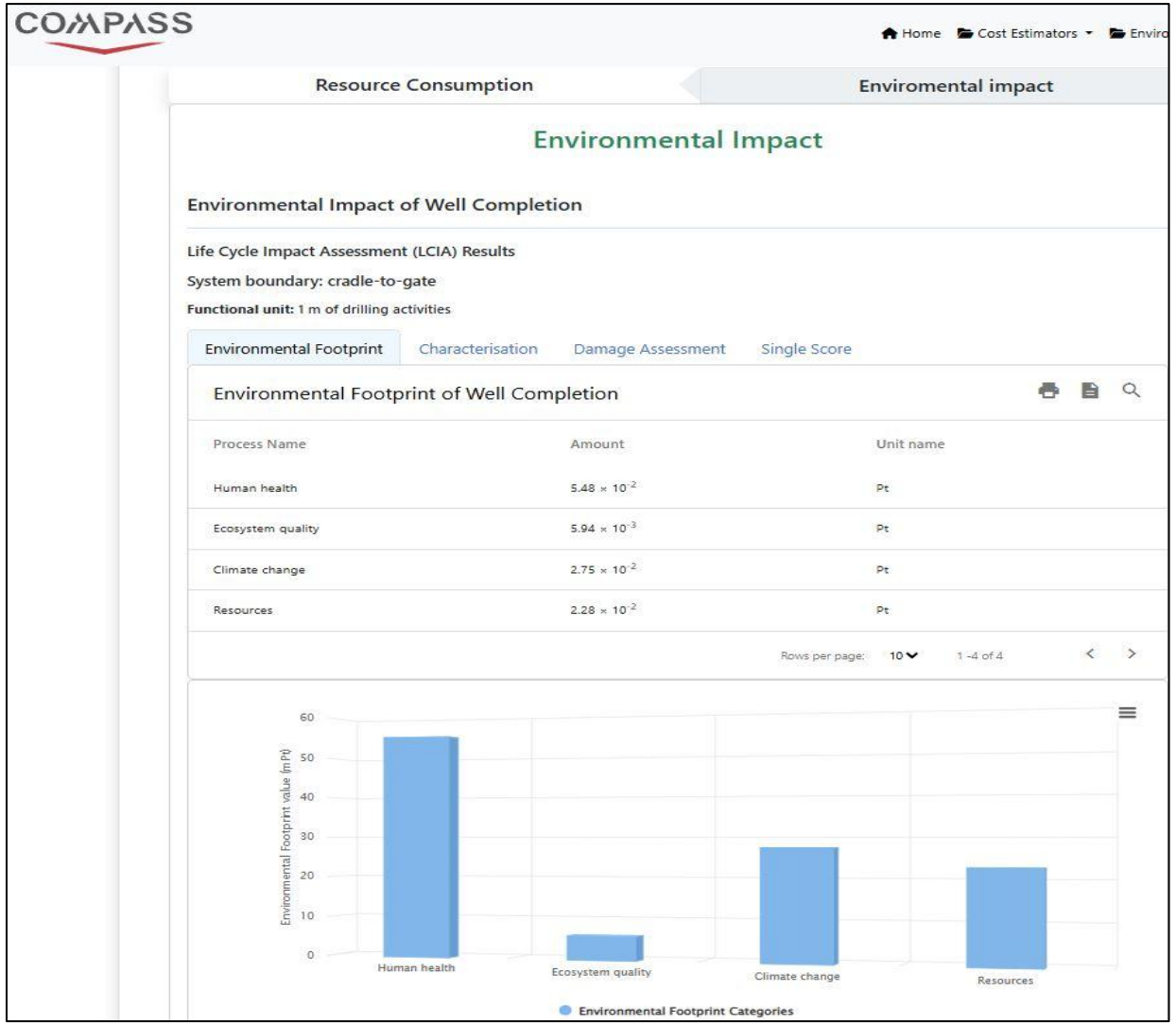
Environmental Impact Estimator for Well Completion

Results of Environmental impacts of 1 m of drilling activities of Well completion

Environmental Footprint Results

- Four environmental footprints of 1 m of drilling activities for well completion, expressed in a common scale of measurements called eco-point (Pt).

- Figure depicted the contributions of these four categories of environmental footprints and indicated that Human Health environmental footprint showed the most impacts as compared with other environmental footprints.



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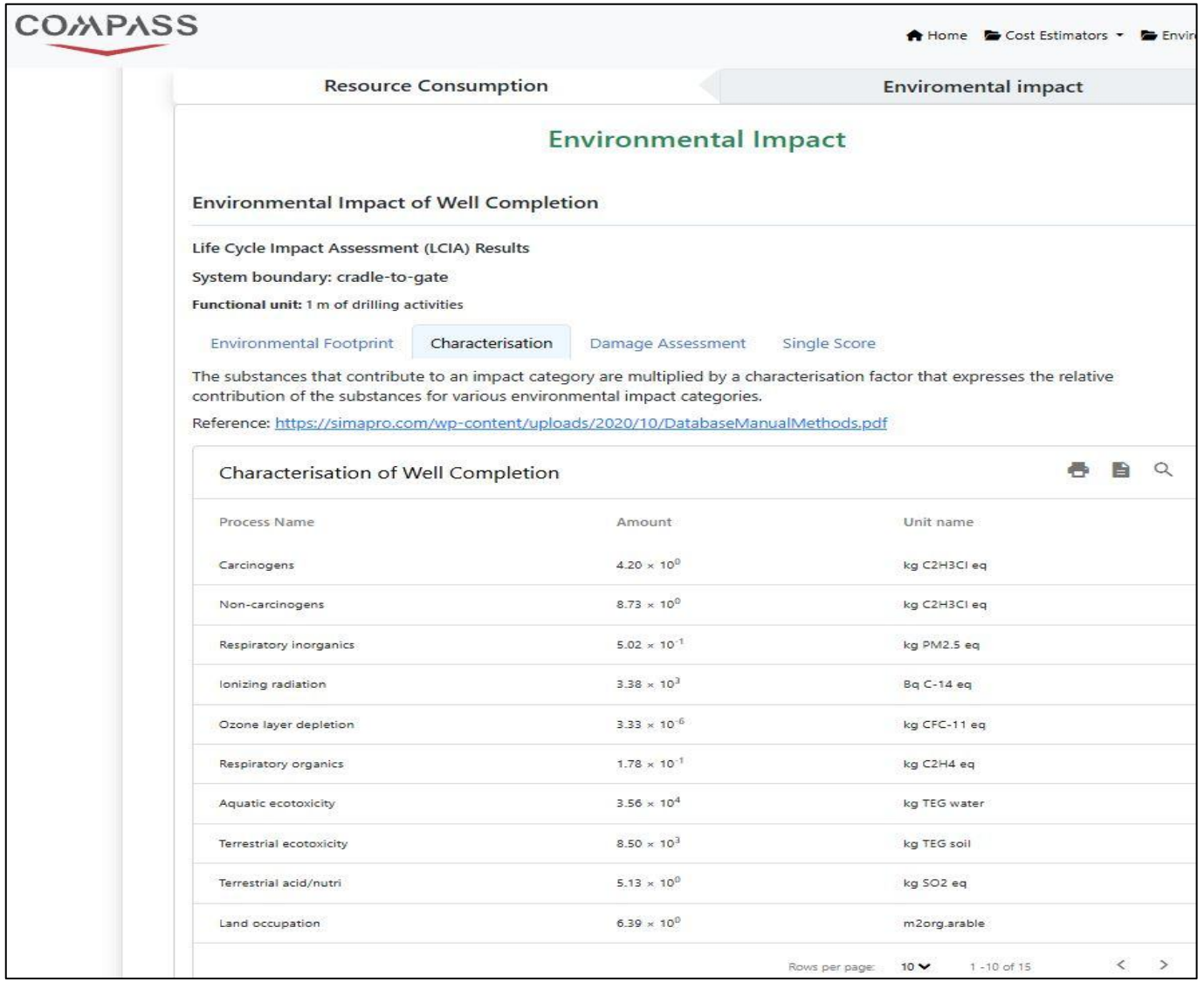
Environmental Impact Estimator for Well Completion

Results of Environmental impacts of 1 m of drilling activities of Well completion

Characterisation (midpoint damage categories) Results

- The quantification results of 15 midpoint impact categories (characterisation) of 1 m of drilling activities for well completion, expressed in their respective units.



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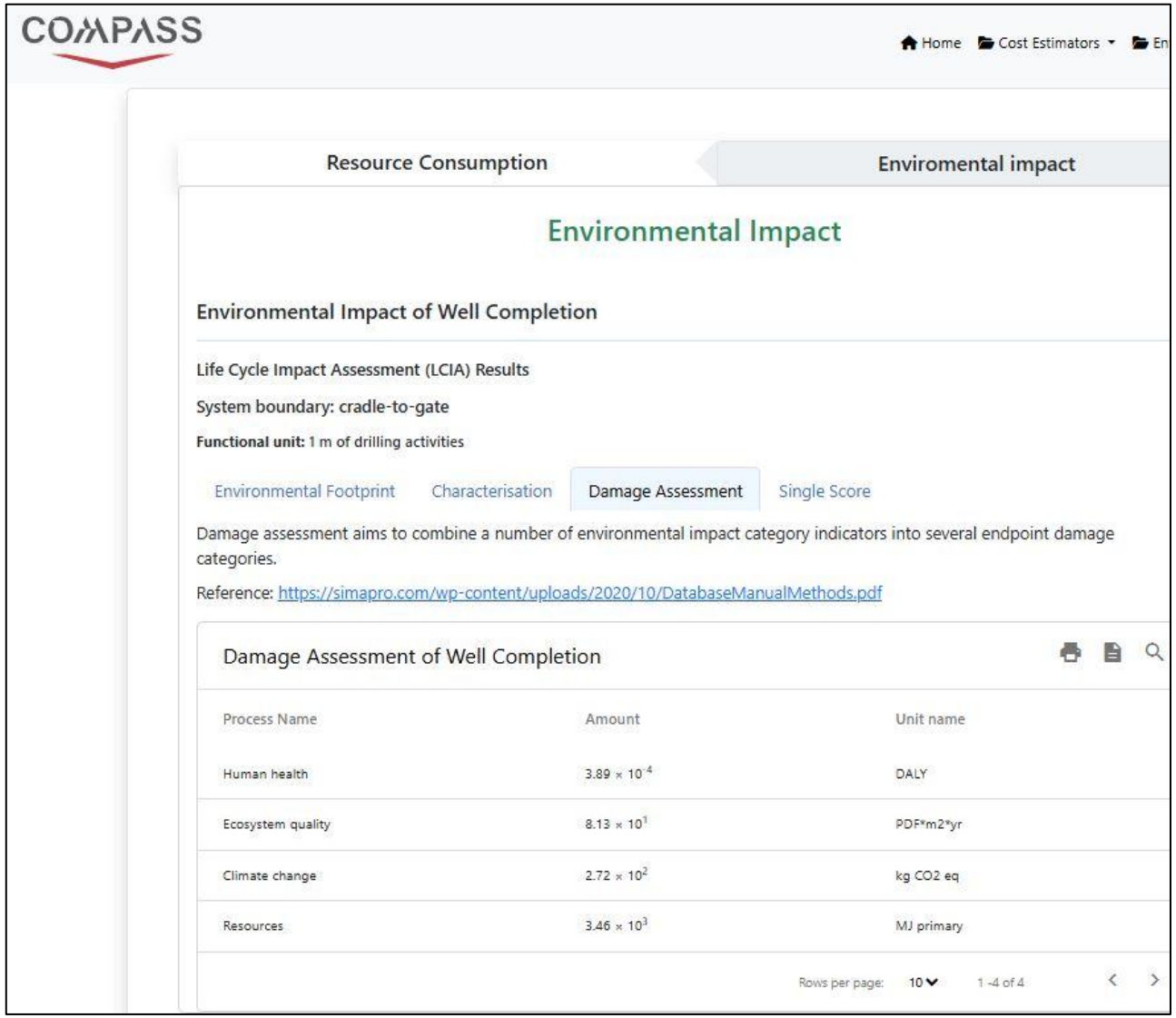
Environmental Impact Estimator for Well Completion

Results of Environmental impacts of 1 m of drilling activities of Well completion

Damage Assessment (endpoint damage categories) Results

- The quantification results of 4 endpoint impact categories of 1 m of drilling activities for well completion, expressed in their respective units.
- The carbon footprint (climate change) of 1 m drilling activities is about 272 kg CO2 eq per m of drilling activities



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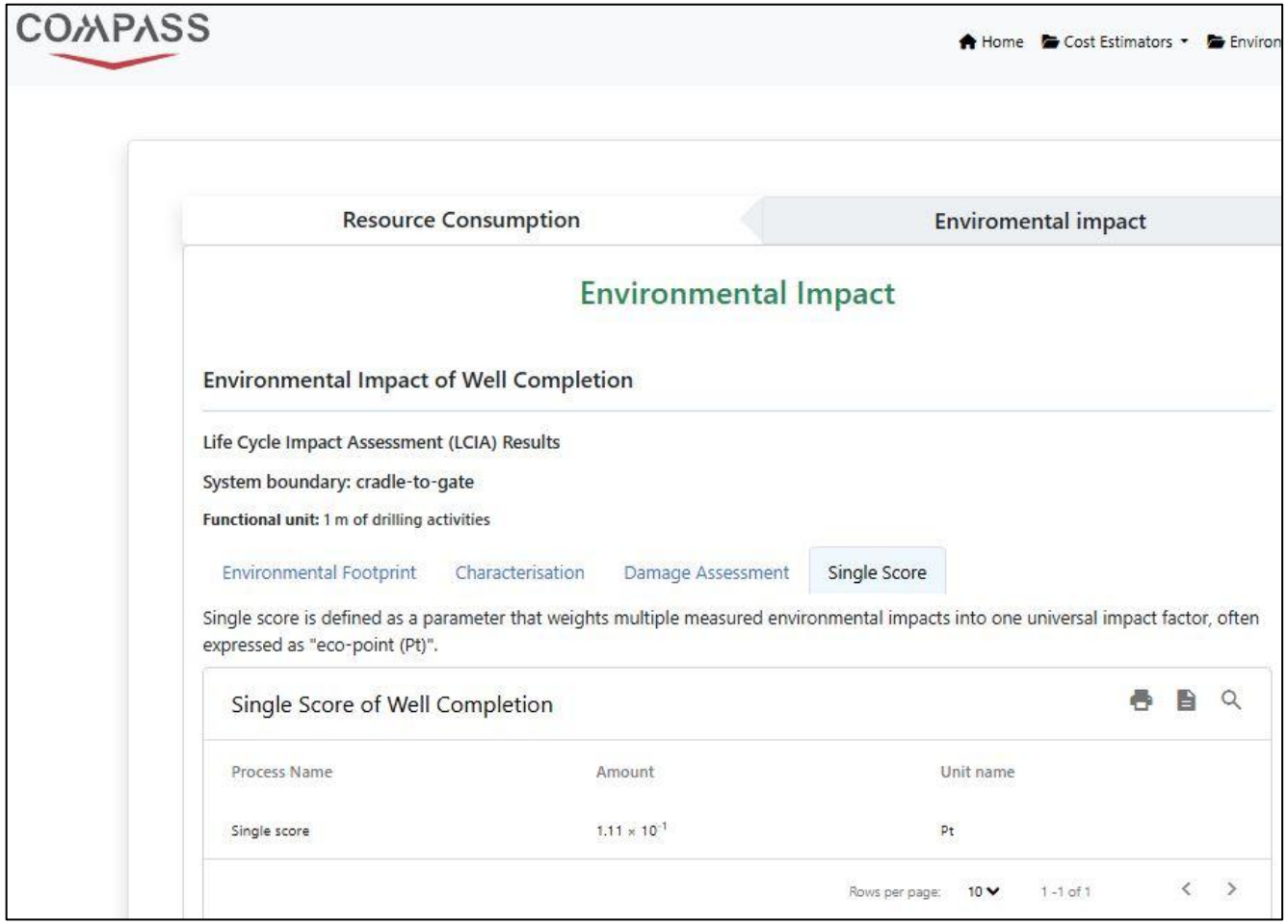
Environmental Impact Estimator for Well Completion

Results of Environmental impacts of 1 m of drilling activities of Well completion

Single score Results

- The quantification results of 4 endpoint impact categories of 1 m of drilling activities for well completion are shown in different scale of measurement and these results are converted to a common scale of measurements, called eco-point (Pt).
- The total environmental footprint, as 'single score' of 1 m drilling activities for well completion is about 111 mPt.



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Conclusions

Cost Estimator for Well Completion

- ❑ This Cost Estimator for Well Completion can calculate the laser cladding cost, casing and cementing cost per unit length of drilling activities.
- ❑ This Cost Estimator for Well Completion can calculate the total cost of well completion per unit length of drilling activities

Environmental Impact Estimator for Well Completion

- ❑ This estimator for well completion can calculate the environmental performances of 1 m drilling activities for well completion of the chosen drilled depth using the user-inputted data of laser cladding, casing and cementing materials.

- ❑ The user can compare the environmental footprint results of well completion using conventional casing and cementing materials with COMPASS technology components for extracting superhot geofluid.

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About the Organisation: TVS

Who are we?

https://technovativesolutions.co.uk/

Established in 2012, Technovative Solutions Ltd (TVS) specialises in digital innovation, solving global challenges through cutting-edge technologies.

Core Domains:

- Materials & Manufacturing
- Renewable Energy
- Digital Healthcare
- Climate & Disaster Resilience
- Digital Product Passport (DPP)
- Software Development

TVS at a glance

- **30+** EU&UKRI Projects
- **150+** Partners
- **20+** Tools
- **70+** experienced scientists, engineers, and developers
- **12+** years of experience
- **4** Spin-offs

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Questions???

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Thank you

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