

Redefining earthworks: tracker-level grading for buildable PV plants

Your speaker today

Natalia Opie Customer Success Lead

Currently leading a global team that supports customers in designing better solar projects with greater speed and confidence. She is an Energy Engineer specialized in renewable energy in electrical systems, and brings a strong mix of technical expertise, customer insight, and product knowledge to the intersection of engineering and software.

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01. Why Earthworks still break PV projects
02. Simplified Grading Approaches
03. Tracker-Level Grading
04. How the Piling Earthworks Engine Works
05. Practical Impact on PV Development
06. RatedPower Future Evolution
07. Q&A

01. Why Earthworks still break PV projects

Early-stage PV design often optimizes

- Installed Capacity
- DC/AC ratio
- Land usage
- Energy yield
- Electrical layout

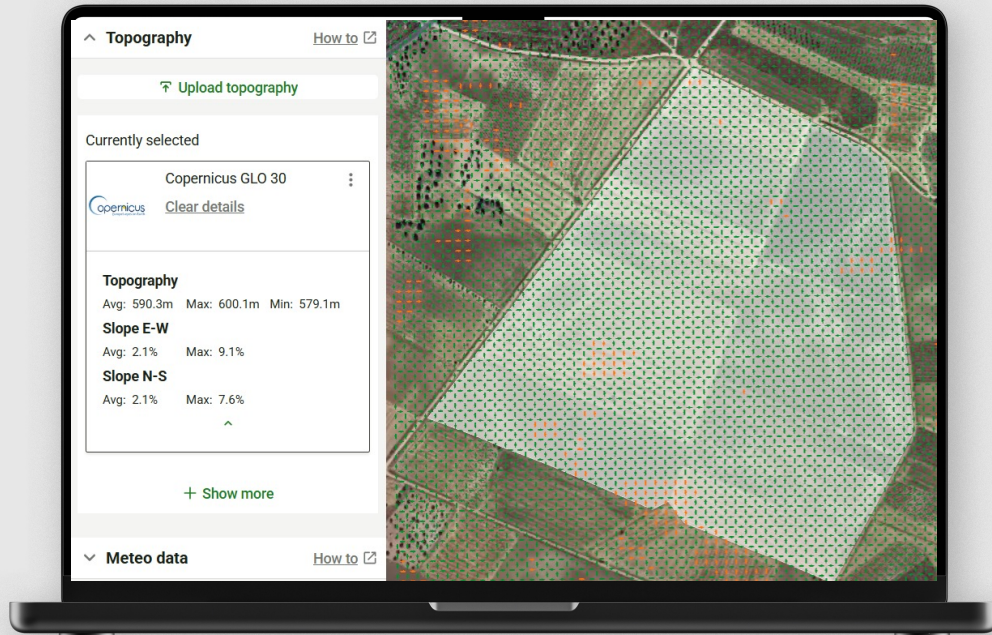
But terrain complexity impacts

- **Constructability**
- **CAPEX**
- **Structure choice**
- **Financial feasibility**
- **Schedule**

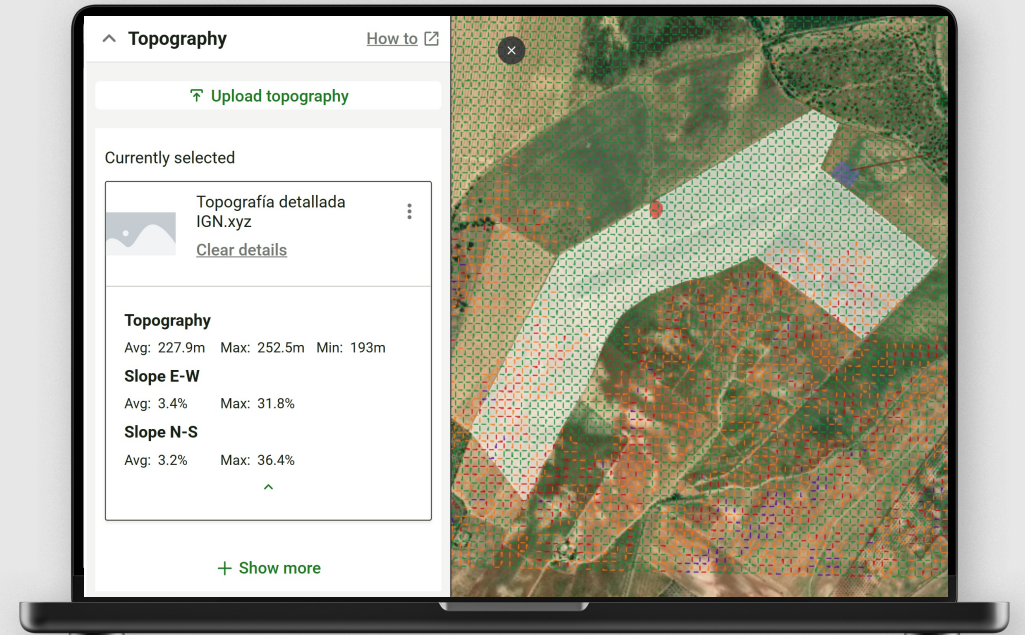
“Can we fit a PV plant on this site?”



“Can we build it realistically, economically, and at scale?”

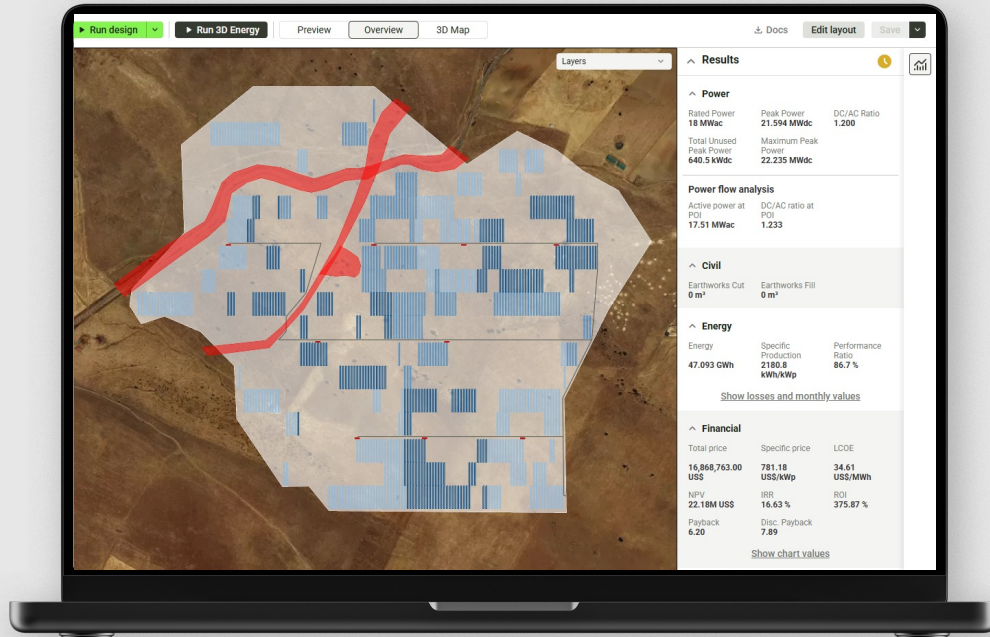


Avg. slope: 2.1%
Max. slope: 9.1%

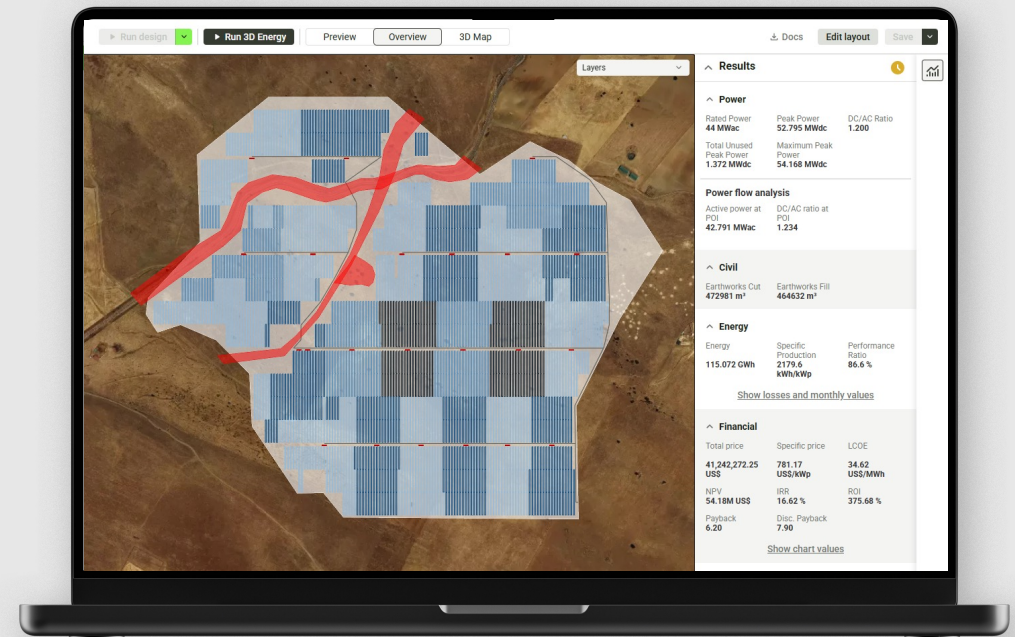


Avg. slope: 3.3%
Max. slope: 36.4%

The hidden risk in PV feasibility



Peak power: 21.6 MWdc
Cut/Fill: 0 m³

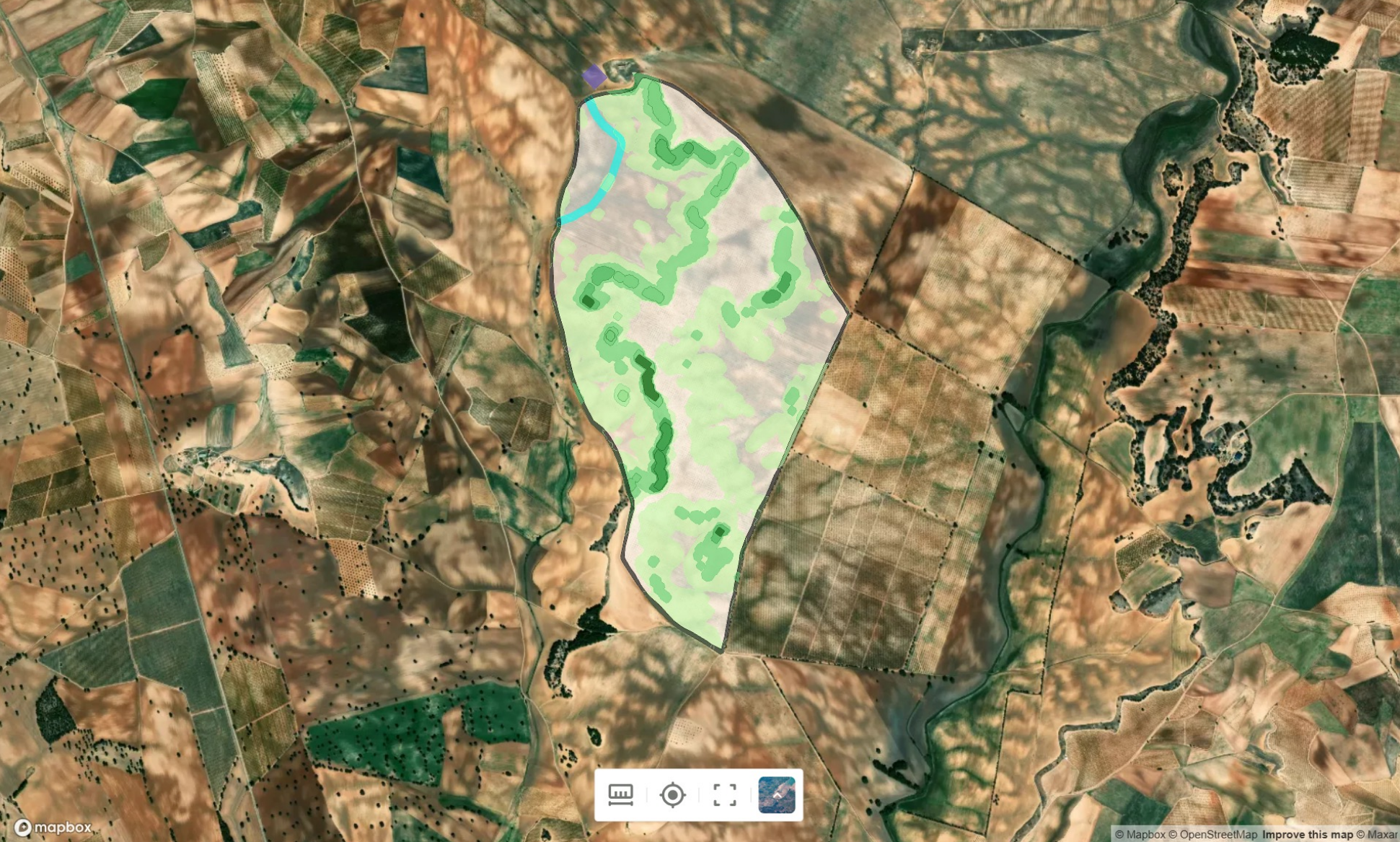


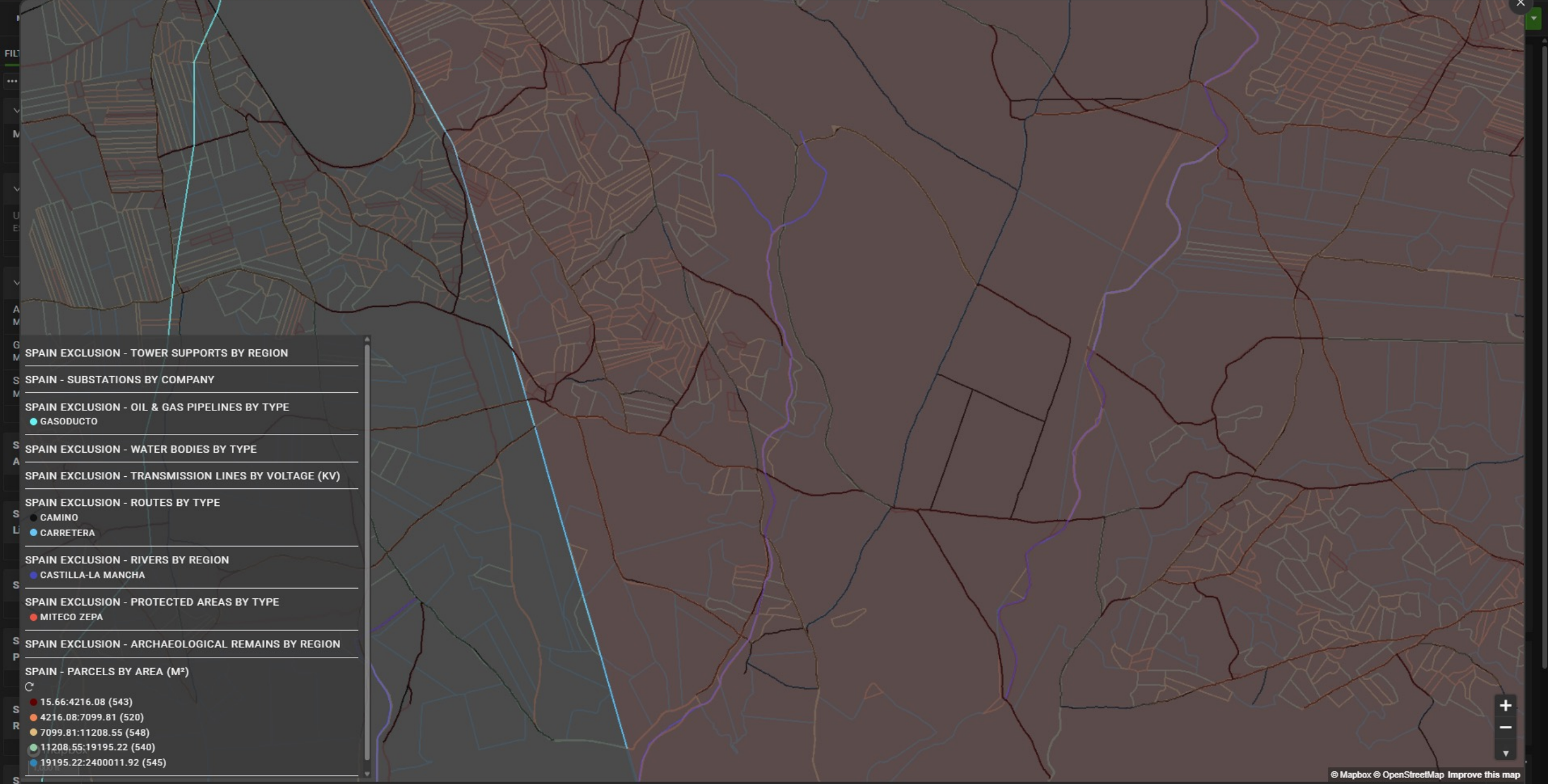
Peak power: 52.8 MWdc
Cut/Fill: 473/474.6 km³

*Earthworks is not just a cost output,
it is a design decision*

02. Simplified Grading Approaches

Terrain filtering

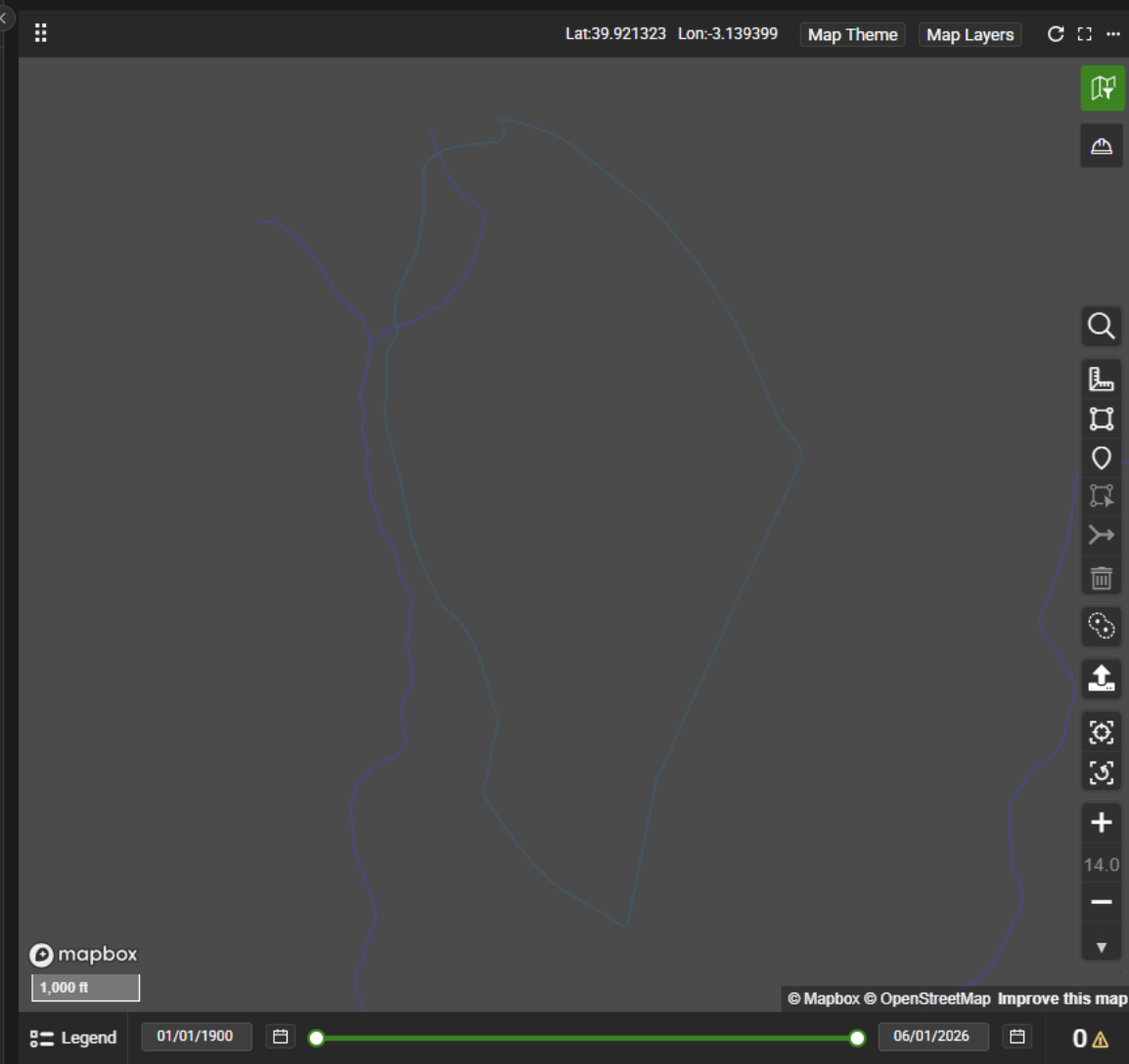




- SPAIN EXCLUSION - TOWER SUPPORTS BY REGION
- SPAIN - SUBSTATIONS BY COMPANY
- SPAIN EXCLUSION - OIL & GAS PIPELINES BY TYPE
 - GASODUCTO
- SPAIN EXCLUSION - WATER BODIES BY TYPE
- SPAIN EXCLUSION - TRANSMISSION LINES BY VOLTAGE (KV)
- SPAIN EXCLUSION - ROUTES BY TYPE
 - CAMINO
 - CARRETERA
- SPAIN EXCLUSION - RIVERS BY REGION
 - CASTILLA-LA MANCHA
- SPAIN EXCLUSION - PROTECTED AREAS BY TYPE
 - MITECO ZEPA
- SPAIN EXCLUSION - ARCHAEOLOGICAL REMAINS BY REGION
- SPAIN - PARCELS BY AREA (M²)
 - 15.66:4216.08 (543)
 - 4216.08:7099.81 (520)
 - 7099.81:11208.55 (548)
 - 11208.55:19195.22 (540)
 - 19195.22:2400011.92 (545)

FILTERS | KEY INSIGHTS

- + Add a Filter**
- Areas of Interest**
 - Map Extent Filter
- Spain - Parcels**
 - Unique ID
ES.SDGC.CP.45157A04300603
- Spain - Substations**
 - Available Capacity (MW)
Min 0
 - Generation requests - Available Capacity...
Min 0
 - Storage requests - Available Capacity fo...
Min 0
- Spain Exclusion - Rivers**



CBA Model Beta

Total Parcels: 1 Total Area (ha): 156

1 Step 1 Configure Analysis 2 Step 2 Choose Layers

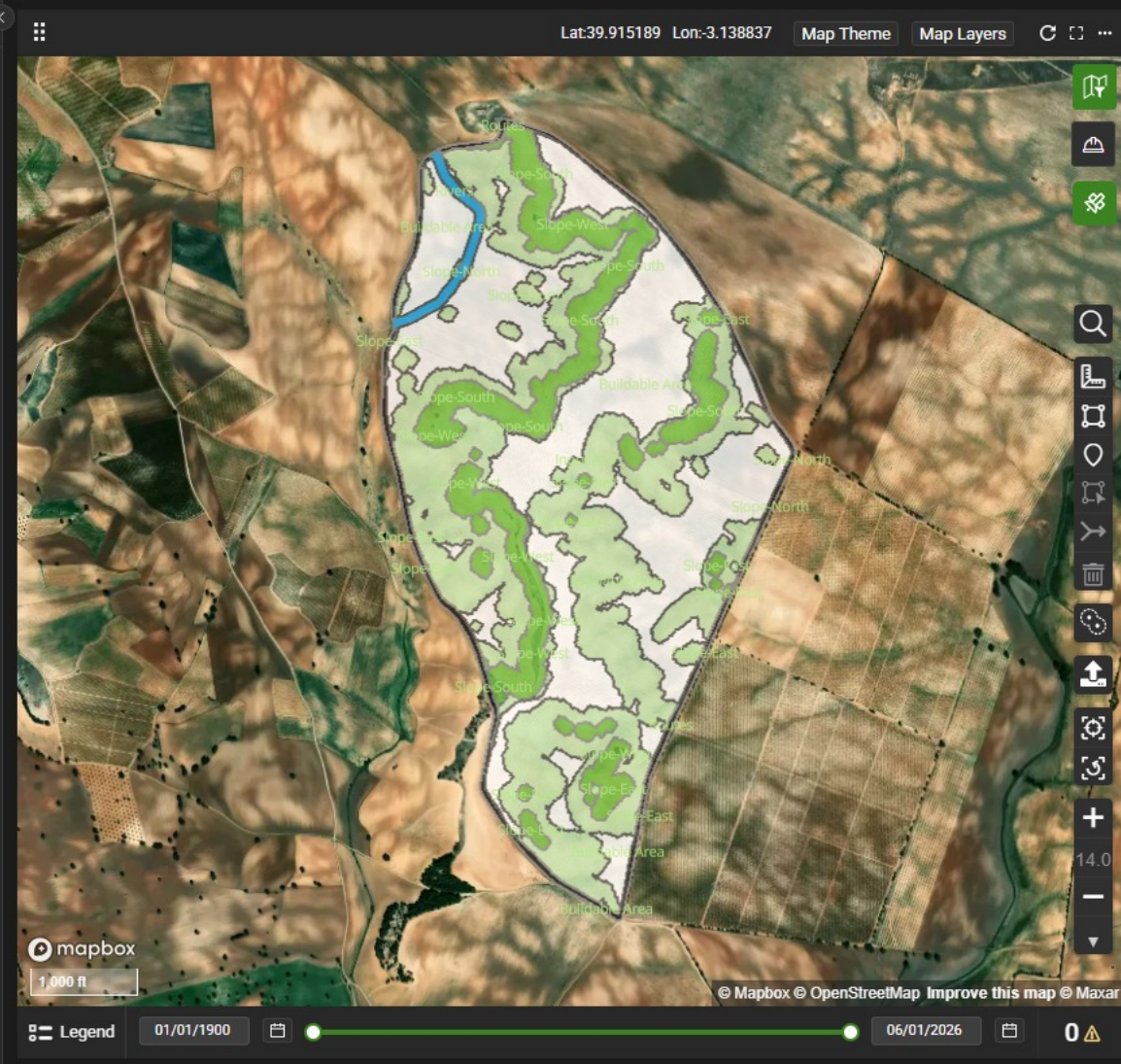
- Minimum Buildable Area acres
- Default Setback m
- Boundary Setback m
- Run Model on Custom Boundary
- Show Additional Details
- Include Input Area of Interest Boundary
- Split Unbuildable Area by Parcel

Next

FILTERS KEY INSIGHTS

[+ Add a Filter](#)

- Areas of Interest**
 - Map Extent Filter
- Spain - Parcels**
 - Unique ID: ES.SDGC.CP.45157A04300603
- Spain - Substations**
 - Available Capacity (MW): Min 0
 - Generation requests - Available Capacity...: Min 0
 - Storage requests - Available Capacity fo...: Min 0
- Corral**



CBA Model Beta

Total Parcels: 1 | **Total Area (ha):** 156

Step 1 Configure Analysis | **Step 2** Choose Layers

- Environmental** Select All
 - Slope** 20 % 5.00 m
 - By Aspect
 - Biosphere Reserves** 5.00 m
 - Protected Areas** 5.00 m
 - Rivers** 5.00 m
 - Water Bodies** 5.00 m
- Infrastructure** Select All
 - Archeological Remains** 5.00 m
 - Pipelines** 5.00 m
 - Routes** 5.00 m
 - Support Towers** 5.00 m
 - Transmission** 5.00 m

Results Data Source

Corral Exclusions

[Previous](#) [Run Model](#)

PRISM layers

PRISM preview

Region

Spain

Map layers Clear

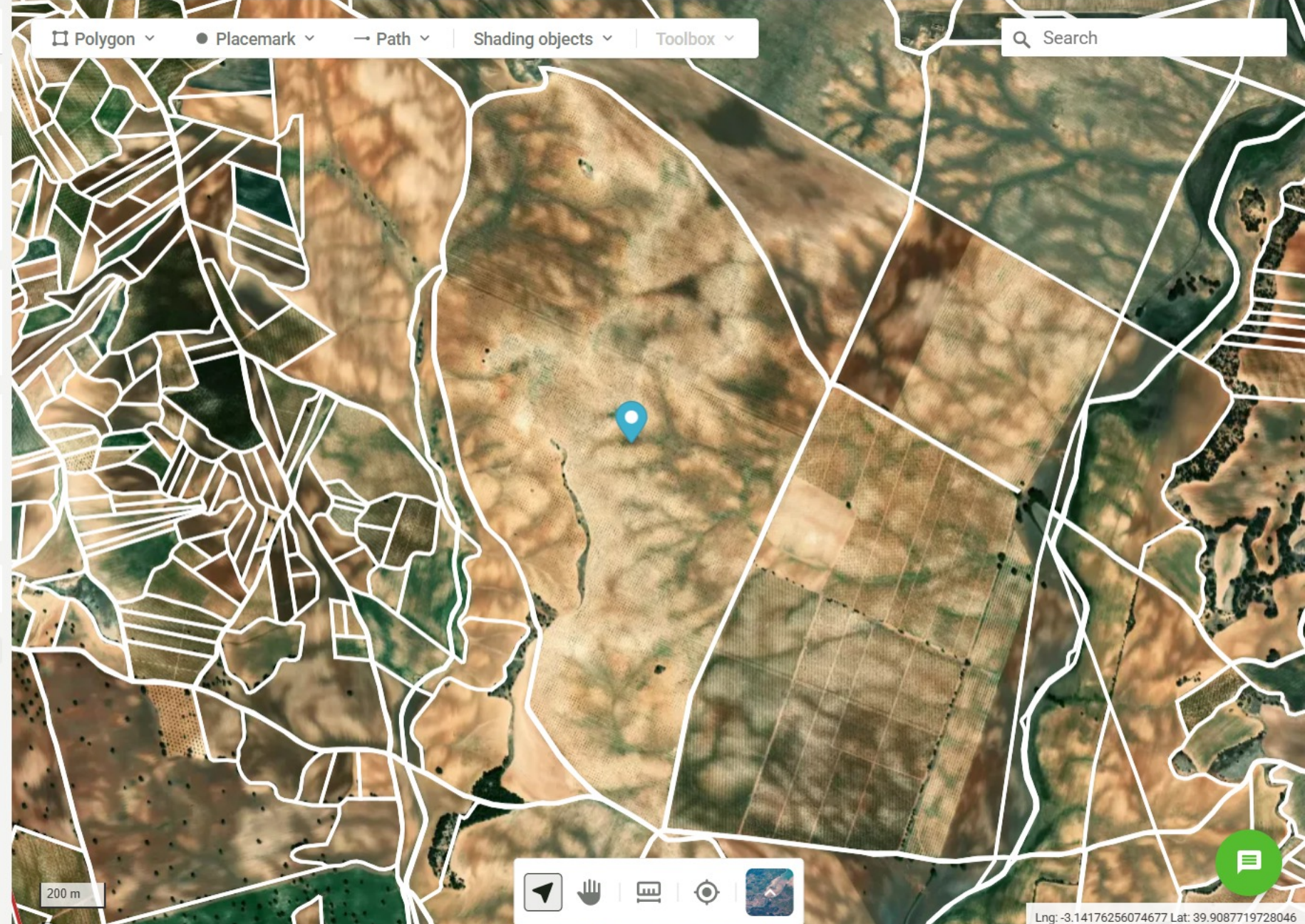
- Parcels

Exclusion layers

- Water bodies
- Protected areas

PRISM integration

Open shared CBA outputs



Advantages

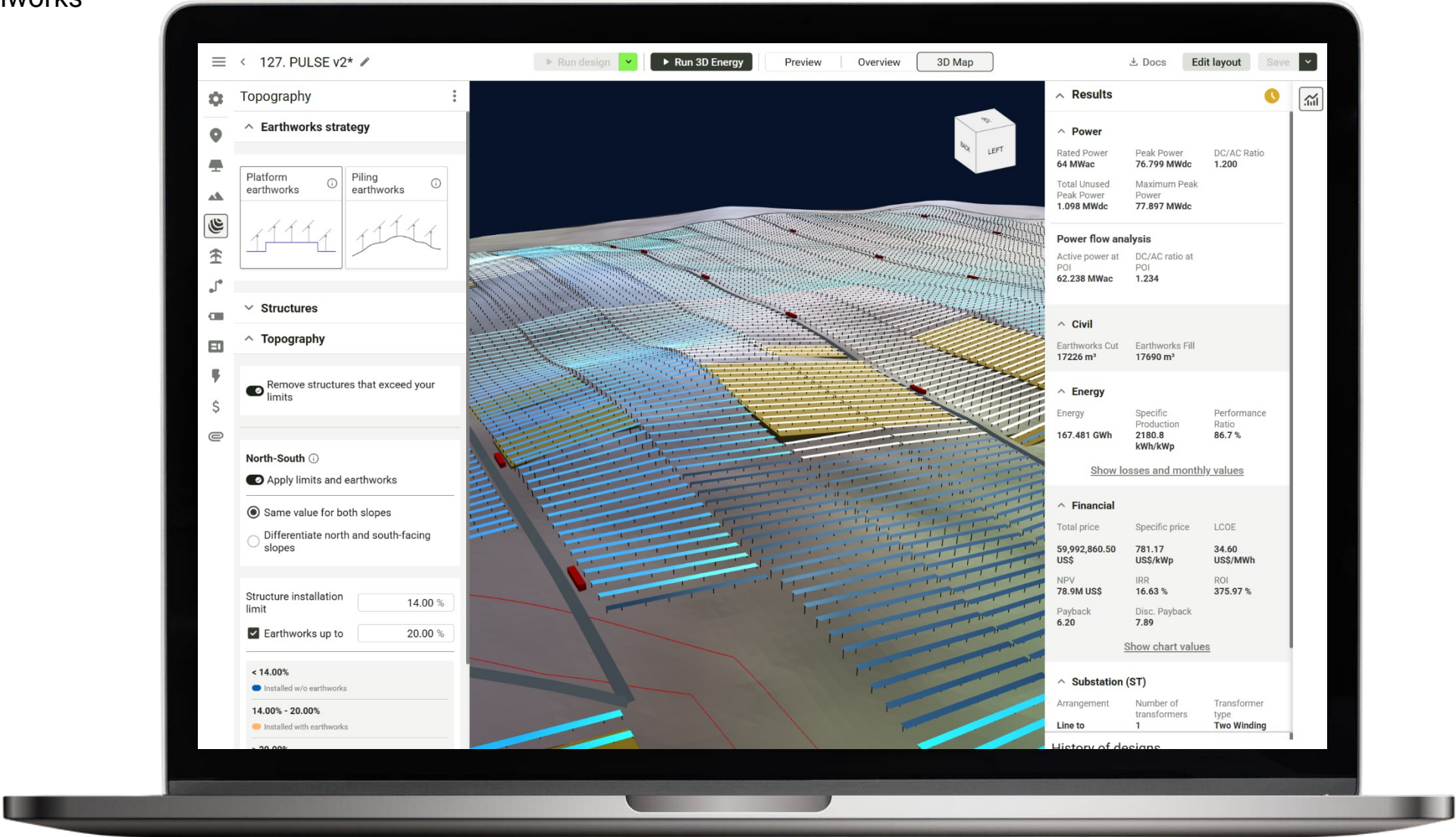
- Fast and simple screening methodology
- Effective for identifying clearly problematic terrain
- Useful during early-stage site selection

Limitations

- Terrain alone does not define constructability
- Potentially buildable areas may be discarded
- Local undulations are not fully understood
- Tracker adaptability is not evaluated directly

*Filtering terrain before understanding structure behavior
can lead to overly conservative decisions.*

Platform Earthworks



Results

Power		
Rated Power	Peak Power	DC/AC Ratio
64 MWac	76.799 MWdc	1.200
Total Unused Peak Power	Maximum Peak Power	
1.098 MWdc	77.897 MWdc	

Power flow analysis	
Active power at POI	DC/AC ratio at POI
62.238 MWac	1.234

Civil	
Earthworks Cut	Earthworks Fill
17226 m ³	17690 m ³

Energy		
Energy	Specific Production	Performance Ratio
167.481 GWh	2180.8 kWh/kWp	86.7 %

[Show losses and monthly values](#)

Financial		
Total price	Specific price	LCOE
59,992,860.50 US\$	781.17 US\$/kWp	34.60 US\$/MWh
NPV	IRR	ROI
78.9M US\$	16.63 %	375.97 %
Payback	Disc. Payback	
6.20	7.89	

[Show chart values](#)

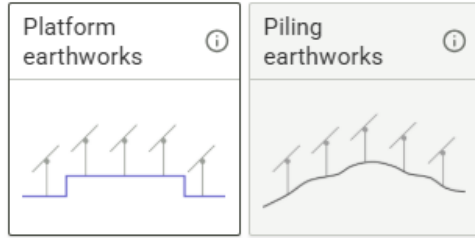
Substation (ST)		
Arrangement	Number of transformers	Transformer type
Line to	1	Two Winding

History of designs

Platform Earthworks

Topography

Earthworks strategy



Structures

Mounting System

	Ground clearance	Pile clearance
Minimum Ground Clearance ⓘ	<input type="text" value="0.55 m"/>	
Pile length ⓘ	<input type="text" value="3.5 m"/>	Min: 1.62 m
Pile clearance ⓘ		<input type="text" value="1.617 m"/>
Pile depth ⓘ		<input type="text" value="1.883 m"/>

Schematic diagram

Topography

Remove structures that exceed your limits

North-South ⓘ

Apply limits and earthworks

Same value for both slopes

Differentiate north and south-facing slopes

North facing

Structure installation limit

Earthworks up to

< 5.00%

Installed w/o earthworks

5.00% - 20.00%

Installed with earthworks

> 20.00%

Exceeding the installation limit

South facing

Structure installation limit

Earthworks up to

East-West ⓘ

Apply limits and earthworks

Structure installation limit

Earthworks up to

< 20.00%

Installed w/o earthworks

> 20.00%

Rejected due to installation limit

Terrain undulation

Undulation tolerance and earthworks

Undulation tolerance

Earthworks up to

< 100cm

Installed w/o earthworks

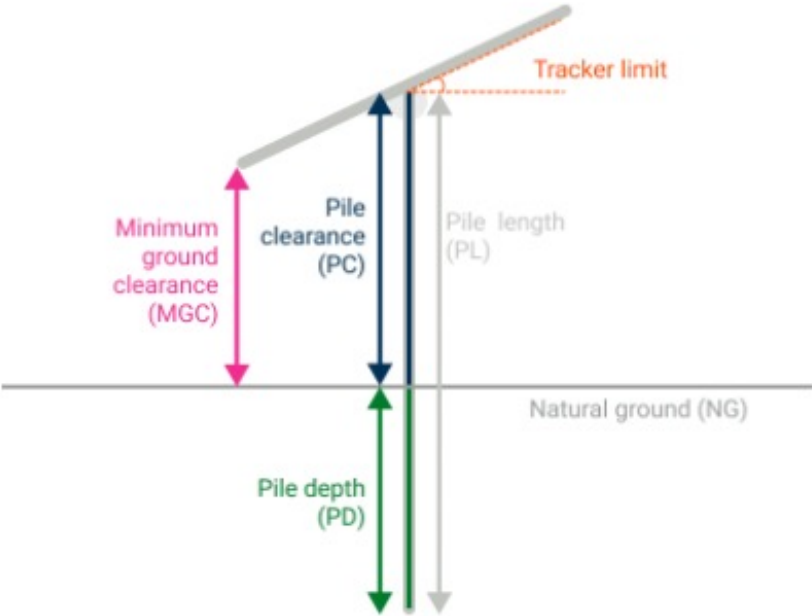
100cm - 200cm

Installed with earthworks

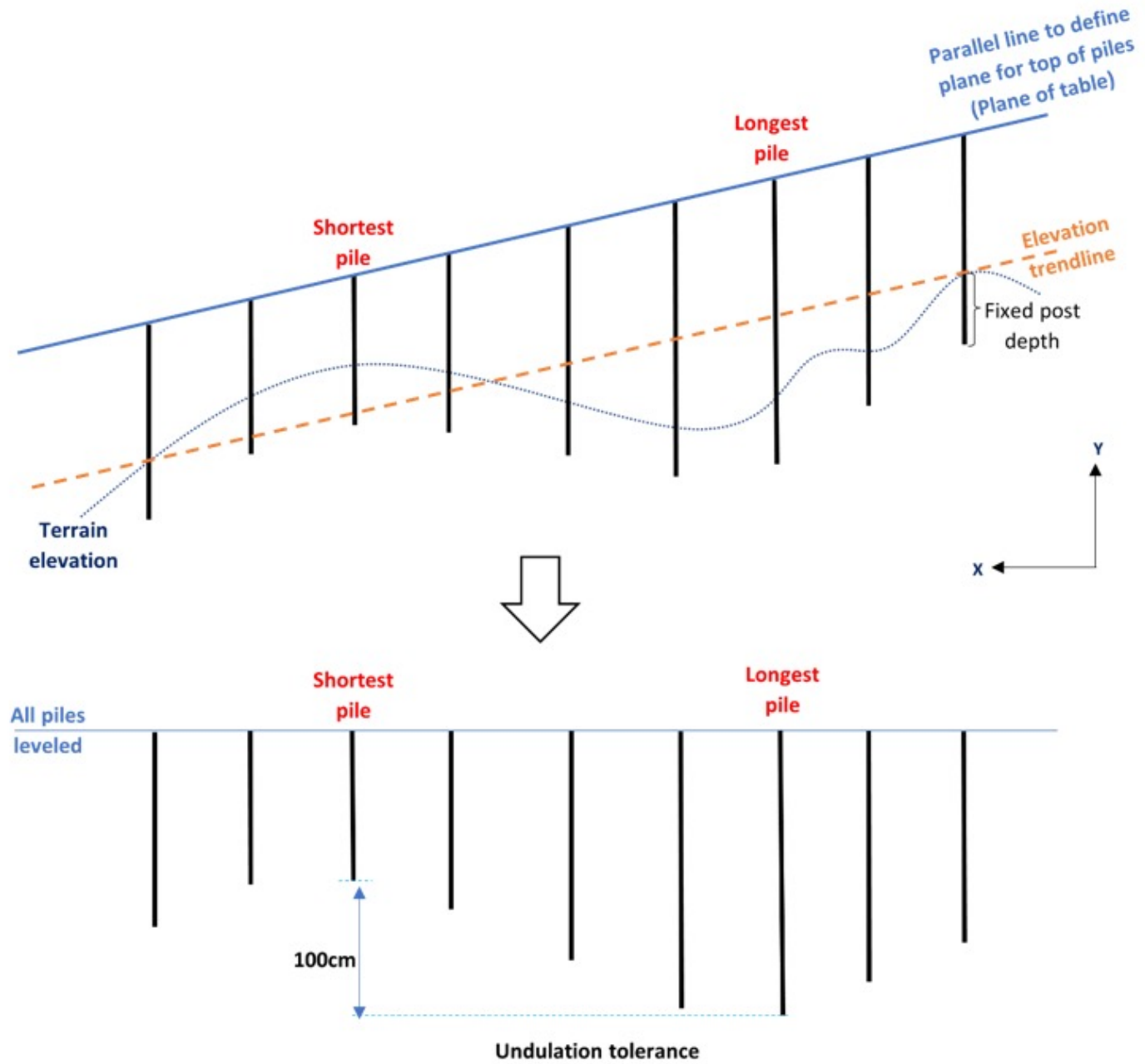
> 200cm

Exceeding the installation limit

Platform Earthworks



Platform Earthworks



Topography

15.00% - 20.00%
 Installed with earthworks

> 20.00%
 Exceeding the installation limit

East-West

Apply limits and earthworks

Structure installation limit: 20.00 %

Earthworks up to: - %

< 20.00%
 Installed w/o earthworks

> 20.00%
 Rejected due to installation limit

Terrain undulation

Undulation tolerance and earthworks

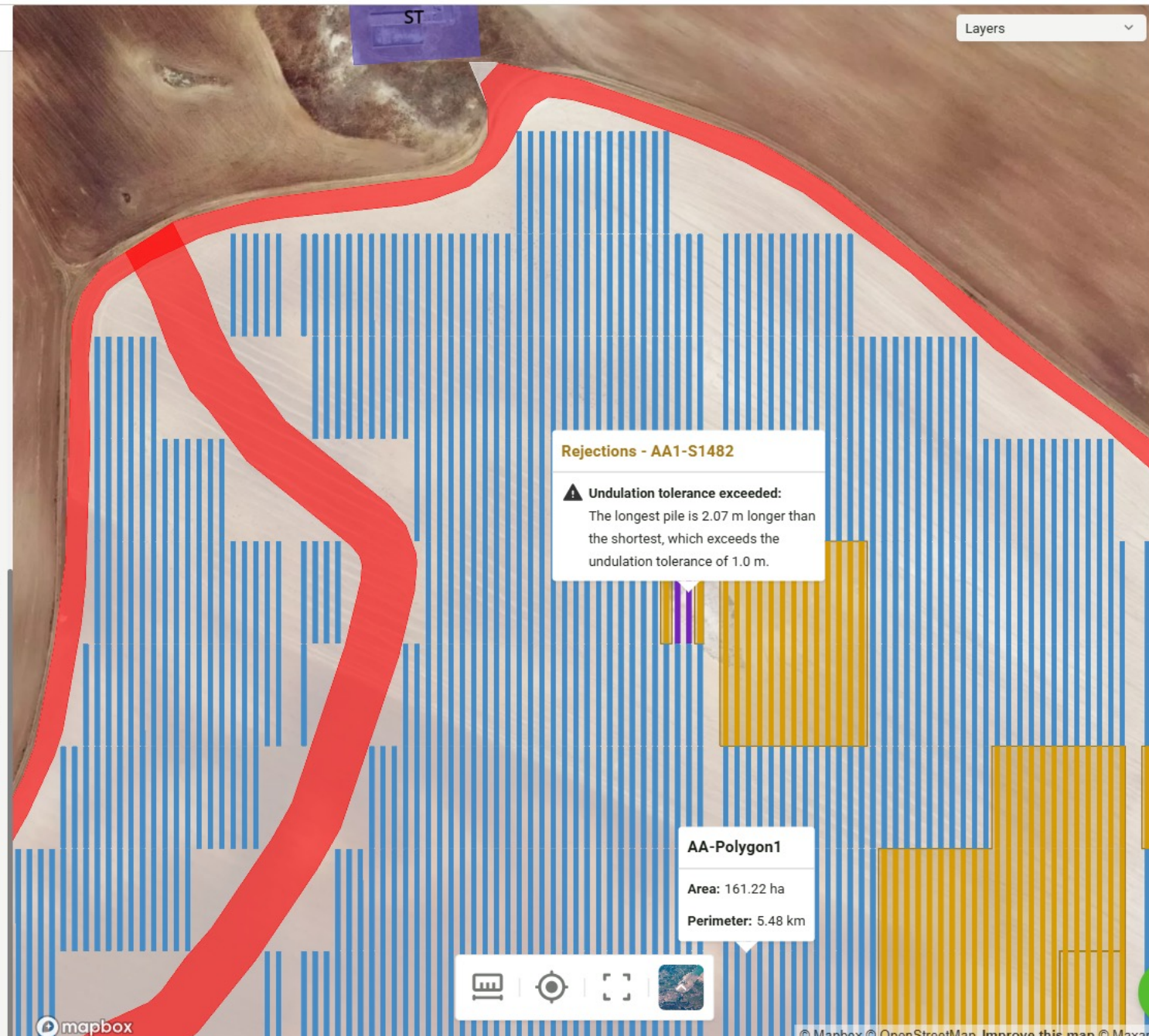
Undulation tolerance: 100 cm

Earthworks up to: 200 cm

< 100cm
 Installed w/o earthworks

100cm - 200cm
 Installed with earthworks

> 200cm
 Exceeding the installation limit



Results

Power

Rated Power	Peak Power	DC/AC Ratio
97.02 MWac	117.588 MWdc	1.212
Total Unused Peak Power	Maximum Peak Power	
0 Wdc	117.588 MWdc	

Power flow analysis

Active power at POI	DC/AC ratio at POI
94.71 MWac	1.242

Civil

Earthworks Cut	Earthworks Fill
48964 m³	46580 m³

Energy

Energy	Specific Production	Performance Ratio
246.383 GWh	2095.3 kWh/kWp	87.2 %

[Show losses and monthly values](#)

Financial

Total price	Specific price	LCOE
96,673,017.06 US\$	822.13 US\$/kWp	37.48 US\$/MWh
NPV	IRR	ROI
107.5M US\$	15.13 %	334.57 %
Payback	Disc. Payback	
6.78	8.82	

History of designs

Select all

16. Platform Earthworks *

Topography

15.00% - 20.00%
 Installed with earthworks

> 20.00%
 Exceeding the installation limit

East-West

Apply limits and earthworks

Structure installation limit: 20.00 %

Earthworks up to: - %

< 20.00%
 Installed w/o earthworks

> 20.00%
 Rejected due to installation limit

Terrain undulation

Undulation tolerance and earthworks

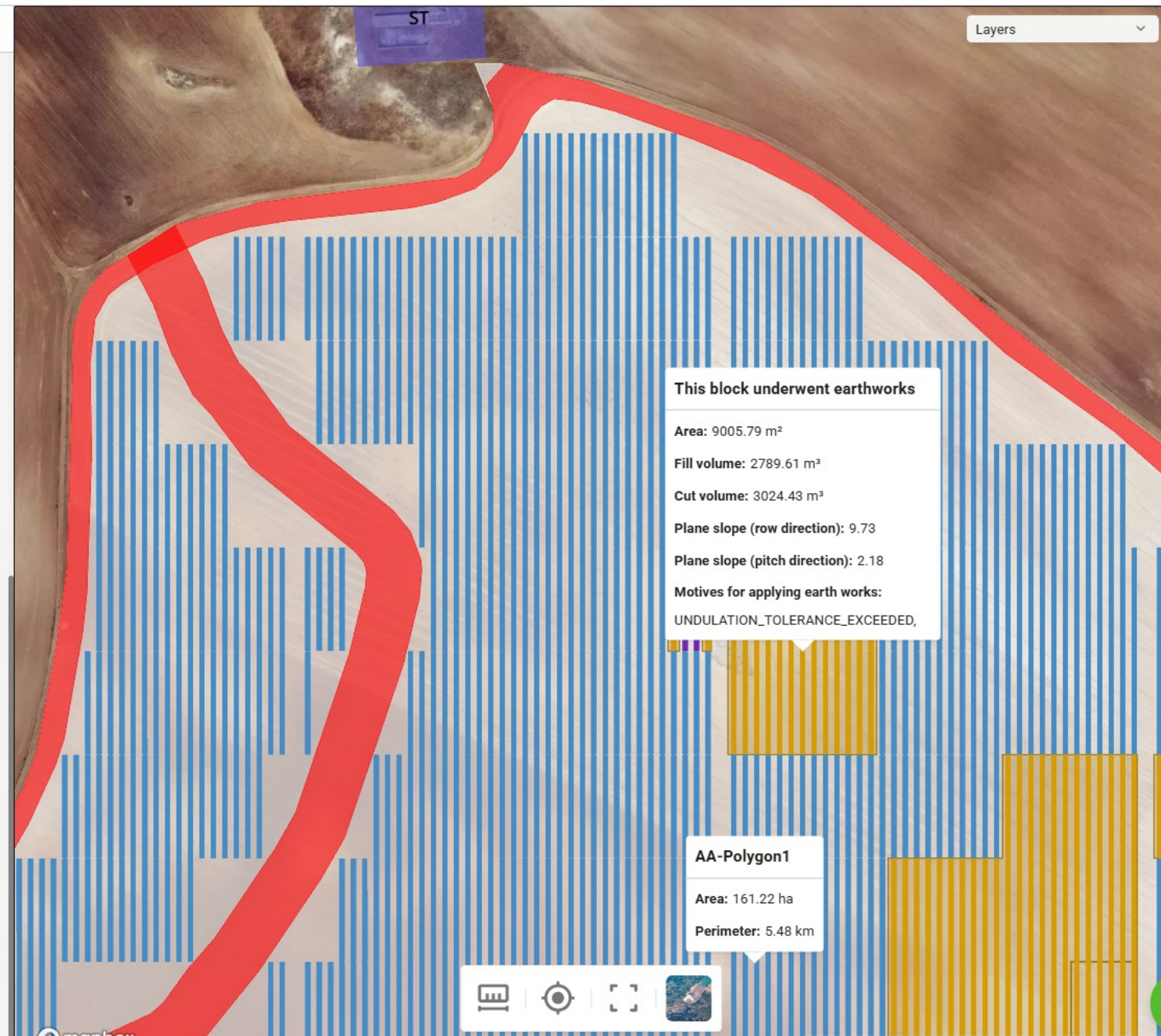
Undulation tolerance: 100 cm

Earthworks up to: 200 cm

< 100cm
 Installed w/o earthworks

100cm - 200cm
 Installed with earthworks

> 200cm
 Exceeding the installation limit



Results

Power

Rated Power	Peak Power	DC/AC Ratio
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48964 m ³	46580 m ³

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6.78	8.82	

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Select all

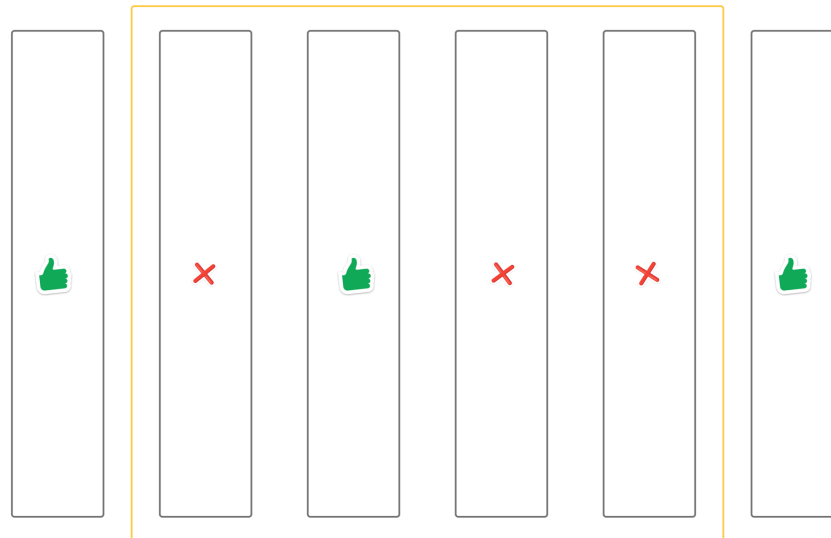
16. Platform Earthworks*

Advantages

- Effective for filtering out problematic structures
- Rough cut and fill estimates
- Rough extra steel estimates
- Platforms respect the pitch direction slope limit

Limitations

- Creates steps between platforms and surrounding terrain
- Calculates many different piles lengths
- Not aligned with real engineering practice



03. Tracker-Level Grading

Piling Earthworks

17. Piling Earthworks*

Run design | Run 3D Energy | Preview | Overview | 3D Map

Docs | Edit layout | Save

Topography

Earthworks strategy

Platform earthworks | Piling earthworks

Structures

Mounting System

Ground clearance | Pile clearance

Pile clearance: 1.6 m (Min: 1.07 m)

Pile depth: 1.9 m

Minimum Ground Clearance: 0.533 m

Pile length: 3.5 m

Schematic diagram

Topography

Remove structures that exceed your limits

North-South (Structural axis)

Apply limits and earthworks

Same value for both slopes

Differentiate north and south-facing slopes

North facing

Results

Power

Rated Power	Peak Power	DC/AC Ratio
97.02 MWac	117.618 MWdc	1.212
Total Unused Peak Power	Maximum Peak Power	
0 Wdc	117.618 MWdc	

Power flow analysis

Active power at POI	DC/AC ratio at POI
94.71 MWac	1.242

Civil

Earthworks Cut	Earthworks Fill
65576 m ³	64452 m ³

Energy

Energy Production	Specific Production	Performance Ratio
246.443 GWh	2095.3 kWh/kWp	87.2 %

Show losses and monthly values

Financial

Total price	Specific price	LCOE
96,697,089.03 US\$	822.13 US\$/kWp	37.48 US\$/MWh

History of designs

Design in progress

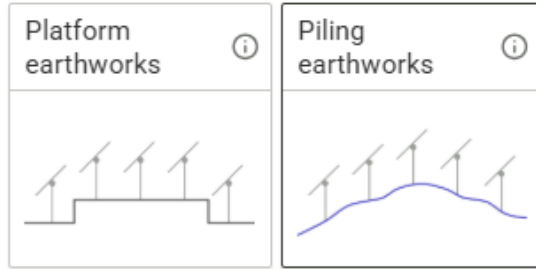
Select all

- 17. Piling Earthworks (PV)
 - Notes: Natalia Support RatedPower 23:42 19/05/2026
- 16. Platform Earthworks (PV)
 - Notes: Natalia Support RatedPower 22:53 19/05/2026
- 15. Corral -3*

Piling Earthworks

Topography

Earthworks strategy



Structures

Mounting System

Ground clearance

Pile clearance

Pile clearance ⓘ
Min: 1.07 m

Pile depth ⓘ

Minimum Ground Clearance ⓘ 0.533 m

Pile length ⓘ 3.5 m

[Schematic diagram](#)

Topography

Remove structures that exceed your limits

North-South (Structural axis) ⓘ

Apply limits and earthworks

Same value for both slopes

Differentiate north and south-facing slopes

North facing

Structure installation limit

Earthworks up to

< 5.00%
● Installed w/o earthworks
● Installed with earthworks due to pile limits

5.00% - 20.00%
● Installed with earthworks

> 20.00%
● Exceeding the installation limit

South facing

Structure installation limit

Earthworks up to

< 15.00%
● Installed w/o earthworks
● Installed with earthworks due to pile limits

15.00% - 20.00%
● Installed with earthworks

> 20.00%
● Exceeding the installation limit

East-West ⓘ

Apply limits

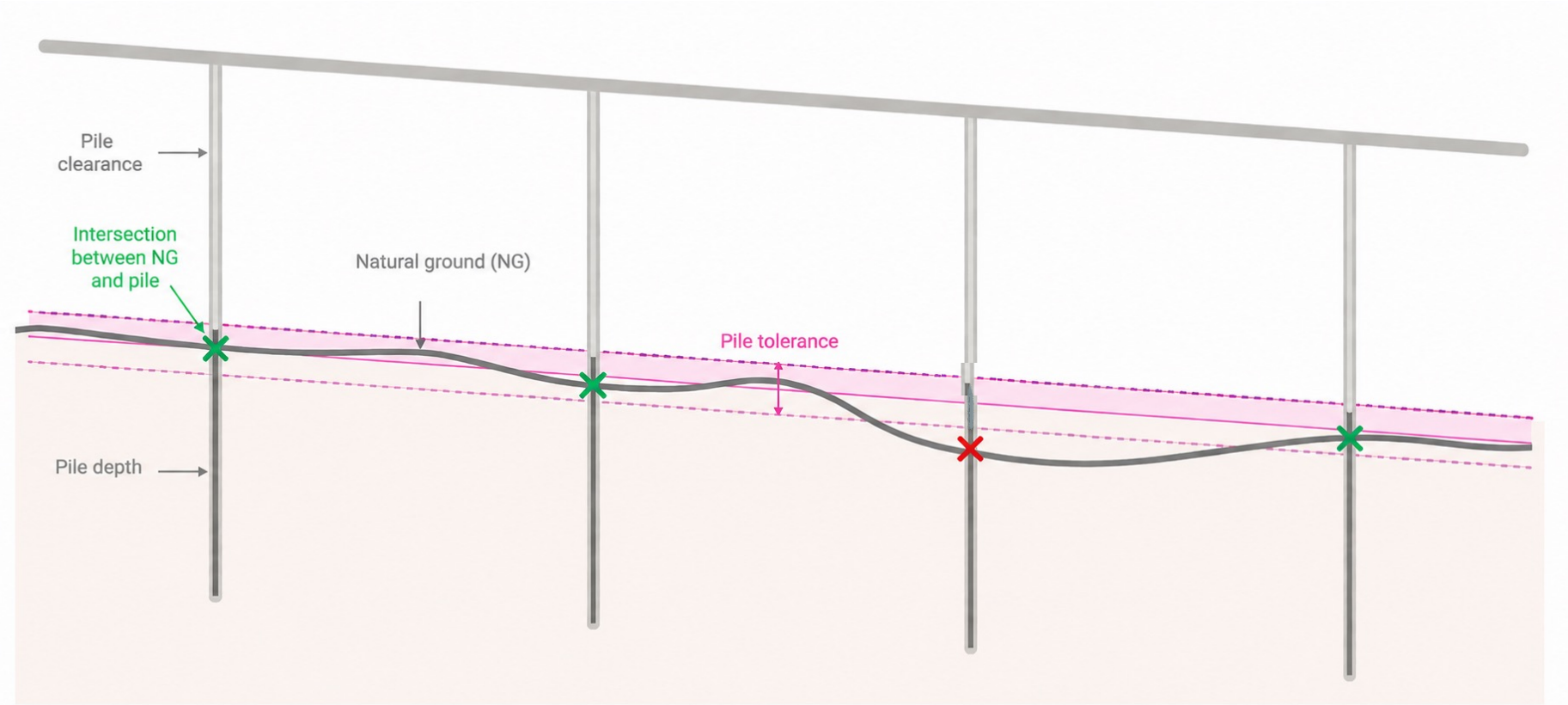
Target installation limit

Pile tolerance ⓘ

Cut/fill tolerance

[Schematic diagram](#)

Piling Earthworks

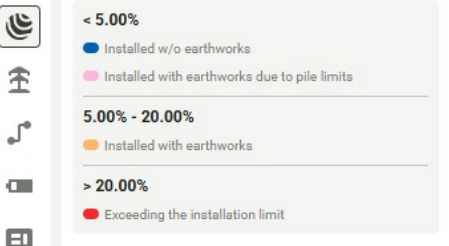


Topography

North facing

Structure installation limit

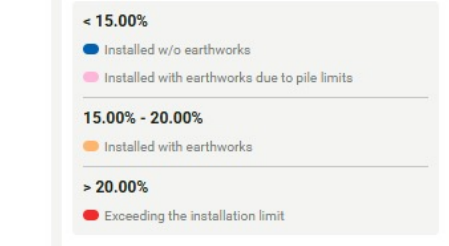
Earthworks up to



South facing

Structure installation limit

Earthworks up to



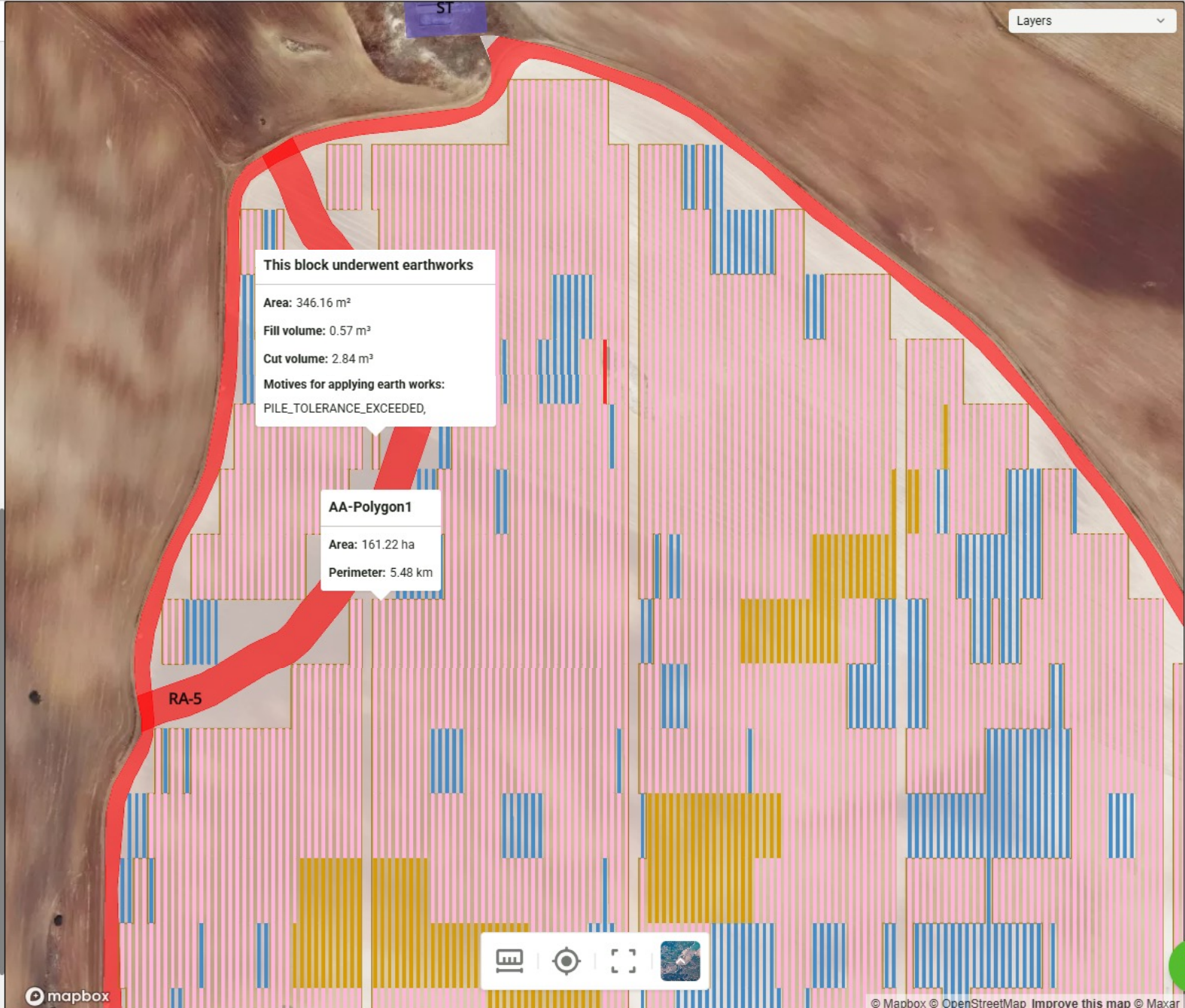
East-West

Apply limits

Target installation limit

Pile tolerance

Cut/fill tolerance



Results

Power

Rated Power	Peak Power	DC/AC Ratio
97.02 MWac	117.618 MWdc	1.212
Total Unused Peak Power	Maximum Peak Power	
0 Wdc	117.618 MWdc	

Power flow analysis

Active power at POI	DC/AC ratio at POI
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Civil

Earthworks Cut	Earthworks Fill
65576 m ³	64452 m ³

Energy

Energy	Specific Production	Performance Ratio
246.443 GWh	2095.3 kWh/kWp	87.2 %

Show losses and monthly values

Financial

Total price	Specific price	LCOE
96,697,089.03 US\$	822.13 US\$/kWp	37.48 US\$/MWh
NPV	IRR	ROI
107.5M US\$	15.13 %	334.58 %
Payback	Disc. Payback	
6.78	8.82	

Show chart values

Substation (ST)

Arrangement	Number of transformers	Transformer type
Single Busbar	2	Two Winding
Transformer's maximum capacity		
55 MW		

Topography

North facing

Structure installation limit: 5.00 %

Earthworks up to: 20.00 %

< 5.00%

- Installed w/o earthworks
- Installed with earthworks due to pile limits

5.00% - 20.00%

- Installed with earthworks

> 20.00%

- Exceeding the installation limit

South facing

Structure installation limit: 15.00 %

Earthworks up to: 20.00 %

< 15.00%

- Installed w/o earthworks
- Installed with earthworks due to pile limits

15.00% - 20.00%

- Installed with earthworks

> 20.00%

- Exceeding the installation limit

East-West

Apply limits

Target installation limit: 20.00 %

Pile tolerance

Cut/fill tolerance: 20 cm



Rejections - AA1-S1417

Maximum pitch slope exceeded:
The East-West pitch slope is 20.1%, which exceeds the limit of 20.0% (positive slopes represent west-facing terrain).

Pile tolerance exceeded:
At least one pile in the structure is too short. The pile length is 3.5 m, the default exposed length is 1.6 m, and the pile exposed length is 2.9 m. The maximum exposed length is 1.7 m.

AA-Polygon1

Area: 161.22 ha

Perimeter: 5.48 km

Results

Power

Rated Power	Peak Power	DC/AC Ratio
97.02 MWac	117.618 MWdc	1.212
Total Unused Peak Power	Maximum Peak Power	
0 Wdc	117.618 MWdc	

Power flow analysis

Active power at POI	DC/AC ratio at POI
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Earthworks Cut	Earthworks Fill
65576 m³	64452 m³

Energy

Energy	Specific Production	Performance Ratio
246.443 GWh	2095.3 kWh/kWp	87.2 %

[Show losses and monthly values](#)

Financial

Total price	Specific price	LCOE
96,697,089.03 US\$	822.13 US\$/kWp	37.48 US\$/MWh
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6.78	8.82	

[Show chart values](#)

Substation (ST)

Arrangement	Number of transformers	Transformer type
Single Busbar	2	Two Winding
Transformer's maximum capacity		
55 MW		

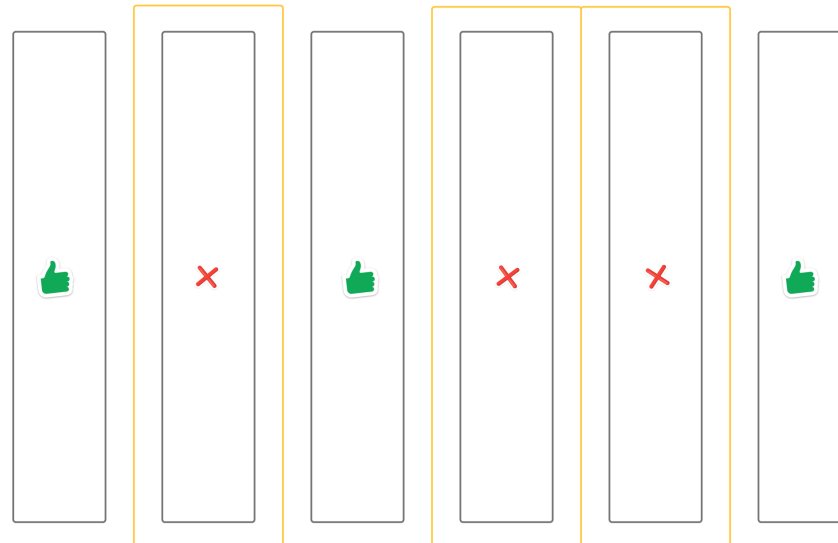
History of designs

Advantages

- Based on real engineering logic
- More reliable cut and fill volumes
- More realistic layouts
- Better constructability

Limitations

- No option to filter out structures exceeding the pile tolerance
- No pitch direction earthworks
- Not ready-to-build



04. How the Piling Earthworks Engine Works

How the Piling Earthworks Engine Works

Tracker	Position X	Position Y	Type	Tracker al Sur	Hincia Norte	Hincia Sur	Cota Hincia Norte	Cota Hincia Sur	Dif. Cota	Pendiente
T001	241.291.719	6.101.674.356	tracker_tpo2	T026	1001-7	1026-1	221.80	221.84	-0.04	-0.83%
T002	241.291.719	6.101.674.356	tracker_tpo2	T027	1002-7	1027-1	221.08	221.14	-0.06	-1.24%
T003	241.301.719	6.101.674.356	tracker_tpo2	T028	1003-7	1028-1	220.40	220.46	-0.06	-1.18%
T004	241.311.719	6.101.674.356	tracker_tpo2	T029	1004-7	1029-1	219.71	219.78	-0.07	-1.40%
T005	241.321.720	6.101.667.956	tracker_tpo2	T030	1005-7	1030-1	219.19	219.31	-0.12	-2.42%
T006	241.331.720	6.101.661.556	tracker_tpo2	T031	1006-7	1031-1	218.81	218.95	-0.14	-2.72%
T007	241.341.720	6.101.655.156	tracker_tpo2	T032	1007-5	1032-1	218.57	218.81	-0.24	-3.40%
T008	241.351.721	6.101.648.755	tracker_tpo2	T033	1008-5	1033-1	218.50	218.96	-0.37	-3.67%
T009	241.361.721	6.101.642.355	tracker_tpo2	T034	1009-5	1034-1	218.61	218.99	-0.38	-3.81%
T010	241.371.721	6.101.635.955	tracker_tpo2	T035	1010-5	1035-1	218.74	219.26	-0.51	-5.19%
T011	241.381.721	6.101.629.555	tracker_tpo2	T036	1011-5	1036-1	218.14	219.75	-0.62	-6.15%
T012	241.391.722	6.101.623.155	tracker_tpo2	T037	1012-5	1037-1	219.64	220.27	-0.63	-6.28%
T013	241.401.722	6.101.616.755	tracker_tpo2	T038	1013-5	1038-1	220.11	220.71	-0.60	-5.97%
T014	241.411.722	6.101.610.354	tracker_tpo2	T039	1014-5	1039-1	220.40	221.03	-0.54	-5.40%
T015	241.421.723	6.101.603.954	tracker_tpo2	T040	1015-5	1040-1	220.84	221.34	-0.50	-4.97%
T016	241.431.723	6.101.597.554	tracker_tpo2	T041	1016-5	1041-1	221.14	221.62	-0.48	-4.63%
T017	241.441.723	6.101.591.154	tracker_tpo2	T042	1017-5	1042-1	221.27	221.91	-0.54	-5.41%
T018	241.451.723	6.101.584.754	tracker_tpo2	T043	1018-5	1043-1	221.71	222.43	-0.71	-7.14%
T019	241.461.724	6.101.578.354	tracker_tpo2	T044	1019-5	1044-1	222.27	223.12	-0.75	-7.49%
T020	241.471.724	6.101.571.953	tracker_tpo2	T045	1020-5	1045-1	222.90	223.81	-0.82	-8.15%
T021	241.481.724	6.101.565.553	tracker_tpo2	T046	1021-5	1046-1	223.56	224.35	-0.79	-7.86%
T022	241.491.725	6.101.559.153	tracker_tpo2	T047	1022-5	1047-1	224.26	224.91	-0.75	-7.54%
T023	241.501.725	6.101.552.753	tracker_tpo2	T048	1023-7	1048-1	225.04	225.43	-0.40	-7.96%
T024	241.511.725	6.101.546.353	tracker_tpo2	T049	1024-7	1049-1	225.80	226.21	-0.41	-8.14%
T025	241.521.726	6.101.539.953	tracker_tpo2	T050	1025-7	1050-1	226.68	227.14	-0.46	-8.24%
T026	241.281.719	6.101.639.356	tracker_tpo2	N/A	1026-7	N/A	221.98	N/A	N/A	N/A
T027	241.291.719	6.101.633.356	tracker_tpo2	N/A	1027-7	N/A	221.44	N/A	N/A	N/A
T028	241.301.719	6.101.627.356	tracker_tpo2	N/A	1028-7	N/A	220.89	N/A	N/A	N/A
T029	241.311.719	6.101.621.356	tracker_tpo2	N/A	1029-7	N/A	220.35	N/A	N/A	N/A
T030	241.321.720	6.101.615.356	tracker_tpo2	N/A	1030-7	N/A	219.96	N/A	N/A	N/A
T031	241.331.720	6.101.609.356	tracker_tpo2	N/A	1031-7	N/A	219.80	N/A	N/A	N/A
T032	241.341.720	6.101.603.156	tracker_tpo2	N/A	1032-5	N/A	219.75	N/A	N/A	N/A
T033	241.351.721	6.101.613.755	tracker_tpo2	N/A	1033-5	N/A	219.80	N/A	N/A	N/A
T034	241.361.721	6.101.607.355	tracker_tpo2	N/A	1034-5	N/A	220.17	N/A	N/A	N/A

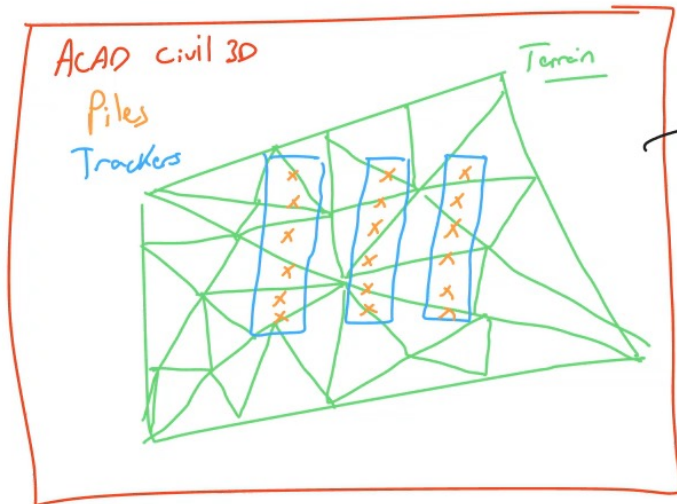



Juan Carlos Zamorano



Felix Perez Cicala

Process Manual



Extract CSV
 Piles X Y Z
 ↑
 ACAD 2D

Excel Step 1

Str	Pile			Slope (Ax:d)
	x	y	z	
1	-	-	10	1st → 13%
	-	-	11	
	-	-	12	
	-	-	11	
	-	-	11	Last →
-	-	20		
2	-	-	7	→ 5%
	-	-	7	
	-	-	6	
	-	-	9	

Calculated with excel formula

Step 2: Correction

Too High → Modify piles

How the Piling Earthworks Engine Works

Inputs

- RatedPower 2D Layout
- 3D Terrain Model
- Constraints

Filtering

- Find non-compliant structures.
- Discard structures exceeding earthworks limits.

Grading

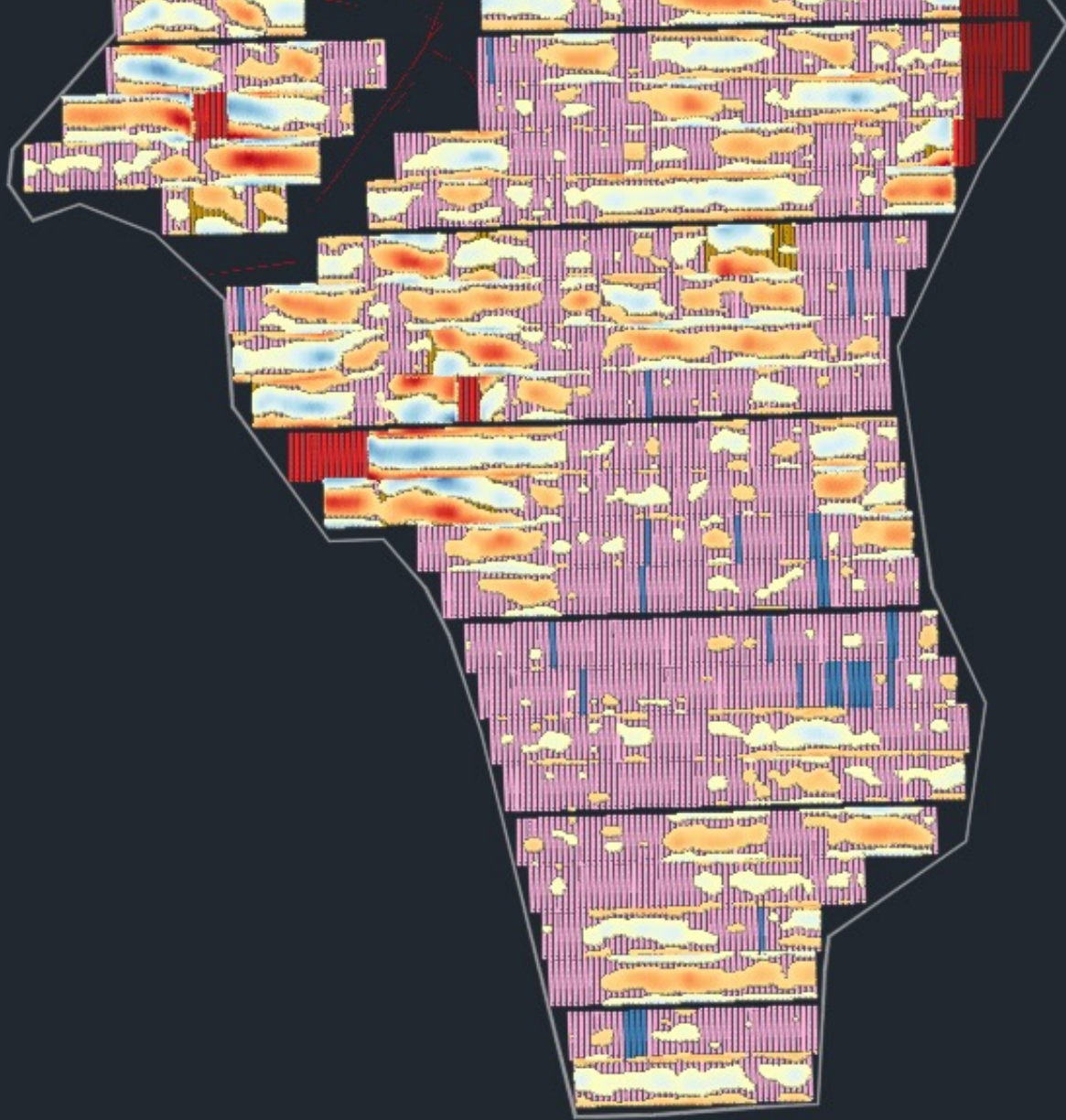
- Slope rectification per structure**
If the slope limit is surpassed, the new slope is the slope limit.
Cut and fill volumes are balanced by elevating or sinking the modified terrain versus the original.
- Pile tolerance**
If the slope limit is respected but the pile tolerance isn't, the structure is subject to earthworks.

Outputs

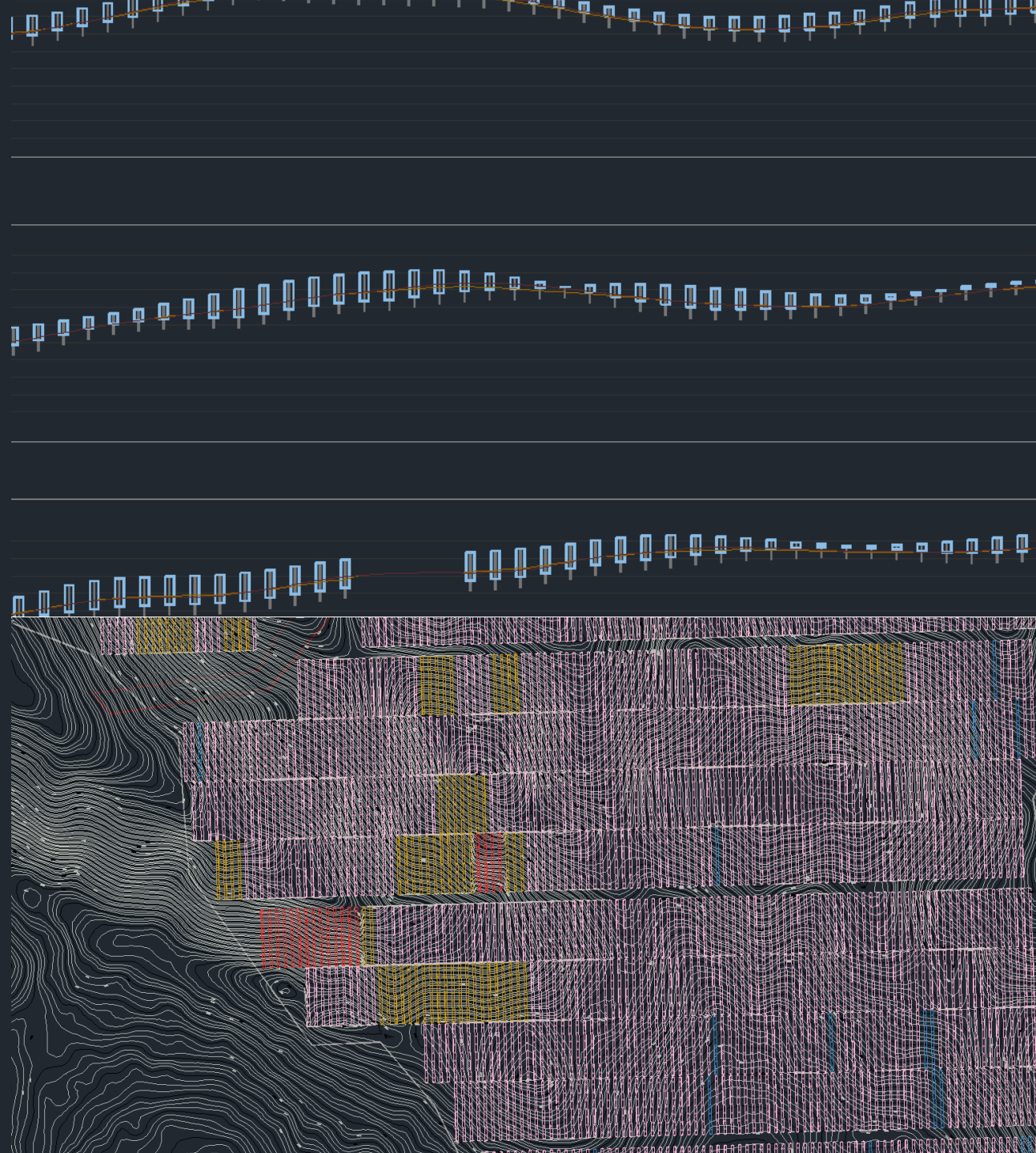
- New terrain*
- Contour lines
- Cut-and-fill
- Heat maps
- 3D layout
- Cross-sections
- Longitudinal sections

*The terrain output is rebuilt using the mesh created from the z-values under each pile.

05. Practical Impact on PV Development



Earthworks height [cm]





More confidence from day one

06. RatedPower Future Evolution

RatedPower Earthworks Improvements

- Smoother transitions between modified and natural terrain.
- Limit elevation differences between adjacent structures
- Custom cut-and-fill balance
- Earthworks for roads
- Earthworks for terrain-following trackers

Thank you!

Questions?

We're all ears! Drop yours in the question box!



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