



1 February 2024

# Towards net-zero emission of T&D grids



The logo features a stylized graphic consisting of two white, curved lines that arch over the word 'Movares'. The top line is a simple, smooth curve, while the bottom line is slightly more complex, with a small gap or notch at its peak.

**Movares**  
adviseurs & ingenieurs





# Knowledge is power: LCA's to optimize designs and procurement of T&D grids

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1 February 2024

Arnhem

**Mieke van Eerten-Jansen**





# Mieke van Eerten-Jansen PhD

Senior Advisor Sustainability & Circularity

- All-round engineer passionate about sustainability
- Movares: 2019 – present
  - Program Manager Sustainability
  - Senior Advisor

*“I make sustainability specific and quantifiable, thereby making it something that can be objectively decided upon.”*





# Content

- Sustainability at Movares
- LCA-software DuboCalc
- LCA's for designing stations
- LCA's for designing tower foundations
- Outlook

# Lowest CO<sub>2</sub>-footprint of engineering firms

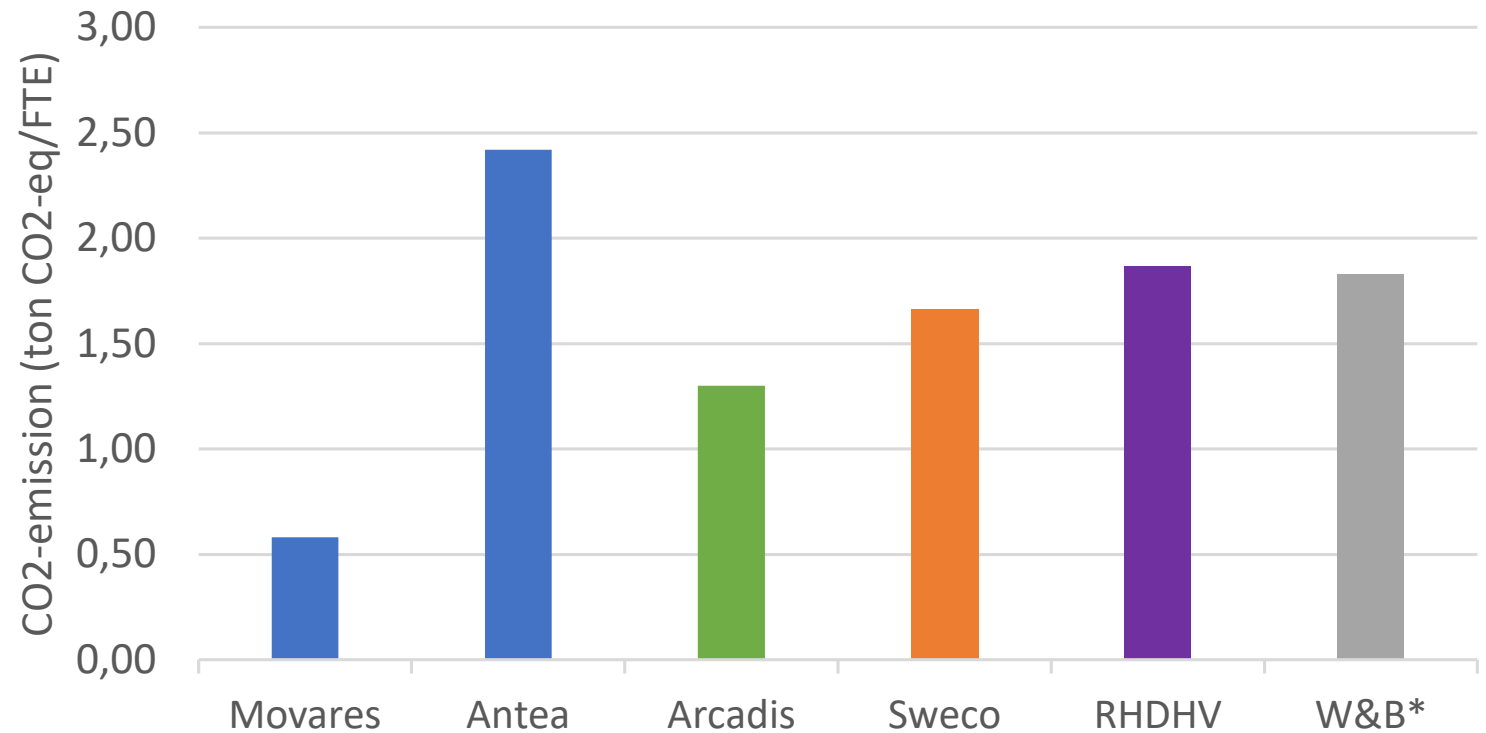
But most impact we make in projects with partners



Movares first engineering firm to achieve:

- Level 5 CO<sub>2</sub>-certification (highest) and **lowest CO<sub>2</sub>-footprint**
- **CO<sub>2</sub>-neutral** since 2010
- **First** in obtaining **Zero Waste** certificate

CO<sub>2</sub>-emission/FTE: scope 1, 2 en 3 - year 2022



# Most sustainable Dutch engineering firm in 2025

All our advise makes the world markedly better



## SDG-ambitions to strengthen our claim



- Ambition: in 2030 all our projects are energy neutral on a yearly basis



- Ambition: in 2030 we use <50% primary material



- Ambition: under development (Clean Air Pact – NOx and PM & noise)



- Ambition: in 2030 all our projects are climate robust compared to 2050-High-scenario for drought, water (rain and flooding) and heat



- Ambition: in 2025 every project applies extra biodiversity measures on top of legal requirements



- Ambition: under development

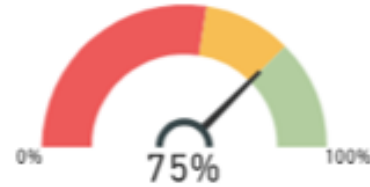


## 7 BETAALBARE EN DUURZAME ENERGIE

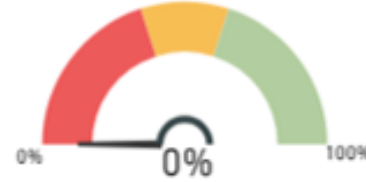


Ambitie: in 2030 zijn al onze projecten jaarrond energieneutraal

% jaarrond energieneutraal



% potentie tot Zero Emissie uitvoering

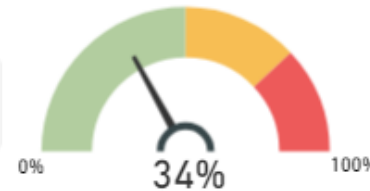


## 9 INDUSTRIE, INNOVATIE EN INFRASTRUCTUUR



Ambitie: in 2030 gebruiken we <50% primair materiaal

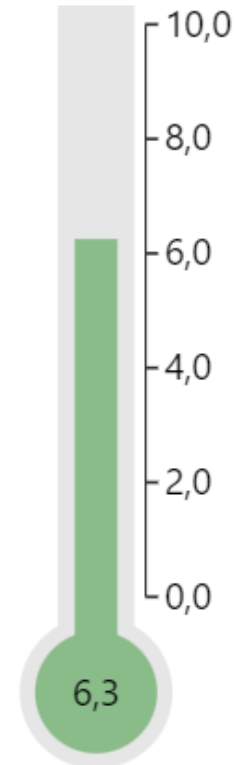
% primair materiaalgebruik



CO2  
1000ton

MKI  
€ 123.456

## Totaalscore duurzaamheidsimpact



- 0-5
- 5-6
- 6-8
- 8-10

## 11 DUURZAME STEDEN EN GEMEENSCHAPPEN



Ambitie: dit doel wordt projectspecifiek ingevuld



## 15 LEVEN OP HET LAND



Ambitie: in 2025 passen we altijd bovenwettelijke maatregelen biodiversiteit toe

Score bovenwettelijke maatregelen



Score klimaatactie

Ambitie: in 2030 zijn al onze ontwerpen klimaatrobust t.o.v. 2050-Hoog-scenario voor droogte, wateroverlast, overstroming en hitte

## 13 KLIMAATACTIE



### Hitte

Blijft gelijk



### Overstroming

Neemt toe



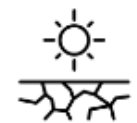
### Wateroverlast

Neemt af



### Droogte

Onbekend



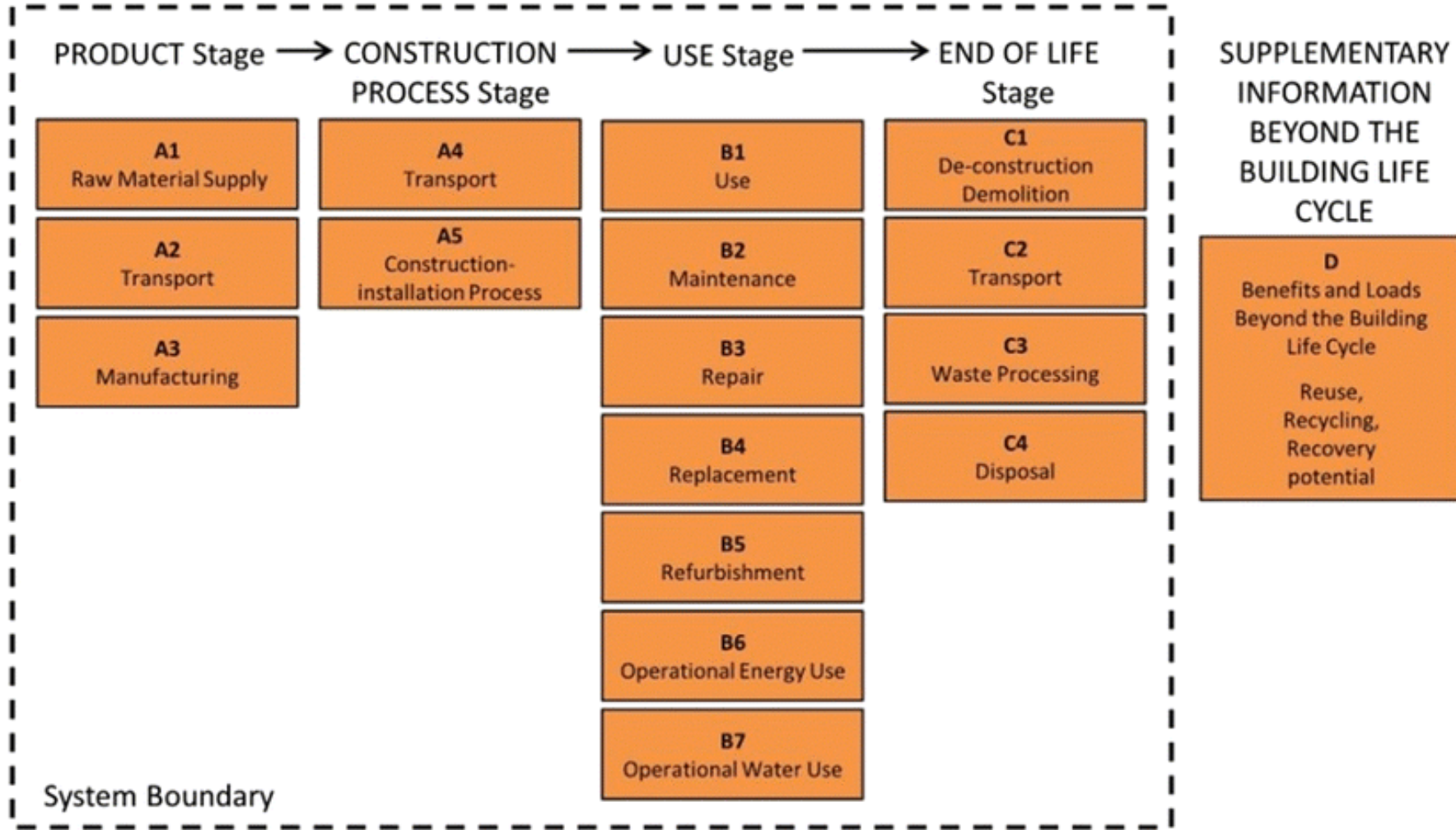




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# Life Cycle Analysis: life cycle stages

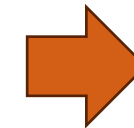




# LCA-software DuboCalc: environmental effects into €

Unique system in Netherlands to monetize environmental effects

	Eenheid	Onder	Centraal	Boven
Klimaatverandering	€/kg CO <sub>2</sub> -eq.	€ 0,05	€ 0,13	€ 0,16
Ozonlaagaantasting	€/kg CFC-11-eq.	€ 15,2	€ 29,1	€ 69,6
Straling	€/kBq Co-60-eq.	€ 0,00275	€ 0,00422	€ 0,00594
Smogvorming, menselijke gezondheid	€/kg NO <sub>x</sub> -eq.	€ 0,99	€ 1,70	€ 2,21
Smogvorming, ecosystemen land	€/kg NO <sub>x</sub> -eq.	€ 0,043	€ 0,043	€ 0,153
Fijnstofvorming	€/kg PM <sub>2,5</sub> -eq.	€ 101,2	€ 168,0	€ 235,0
Verzuring	€/kg SO <sub>2</sub> -eq.	€ 3,38	€ 6,46	€ 10,72
Vermesting, zoetwater	€/kg P-eq.	€ 2,56	€ 5,53	€ 10,13
Vermesting, zoutwater	€/kg N-eq.	€ 7,64	€ 14,25	€ 27,60
Ecotoxiciteit, land	€/kg 1,4-DCB-eq.	€ 0,00067	€ 0,00095	€ 0,00123
Ecotoxiciteit, zoetwater	€/kg 1,4-DCB-eq.	€ 0,0218	€ 0,0309	€ 0,0400
Ecotoxiciteit, zoutwater	€/kg 1,4-DCB-eq.	€ 0,0033	€ 0,0047	€ 0,0060
Humane toxiciteit, kankergerelateerd	€/kg 1,4-DCB-eq.	€ 3,55	€ 5,25	€ 7,91
Humane toxiciteit, niet-kankergerelateerd	€/kg 1,4-DCB-eq.	€ 0,066	€ 0,097	€ 0,146
Landgebruik	€/m <sup>2</sup> a crop-eq.	€ 0,103	€ 0,146	€ 0,189
Uitputting, mineraal	€/kg Cu-eq.	€ 0,0000	€ 0,0140	€ 0,0826
Uitputting, fossiel	€/kg olie-eq.	€ 0,000	€ 0,028	€ 0,163
Waterverbruik	€/m <sup>3</sup>	€ 0,000	€ 0,137	€ 0,181
NO <sub>2</sub> -mortaliteit*	€/kg NO <sub>x</sub> -eq.	€ 6,30	€ 9,32	€ 14,08



DuboCalc

\* De NO<sub>2</sub>-mortaliteit is een additionele berekeningsstap die additioneel aan de LCA-analyse kan worden uitgevoerd om de mortaliteit van NO<sub>2</sub> goed in de externe kostenschattingen te brengen.



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# Hollandse Kust Noord

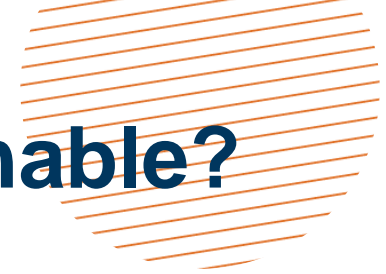
High voltage substation designed using BIM



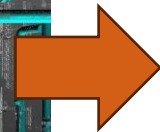
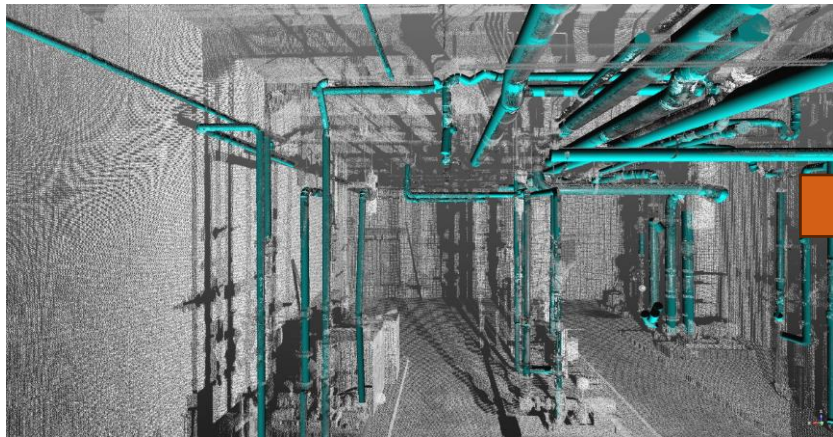


# Client: how can we make the design more sustainable?

LCA's for hotspot analysis and sustainability advice



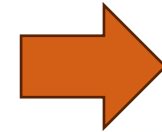
## BIM design



X1 = Exterior walls

## List of materials

Components	Types	Materials
	Wood stud 1	Wood stud + plywood sheathing + alum. Veneer
	Wood stud 2	Wood stud + plywood sheathing + steel veneer
	Wood stud 3	Wood stud+ plywood sheathing + brick veneer
	Wood stud 4	Wood stud + plywood sheathing +stone veneer
	Masonry 1	Brick blocks + plywood sheathing+ alum. Veneer
	Masonry 2	Brick blocks + plywood sheathing+ steel veneer
	Masonry 3	Brick blocks + plywood sheathing+ brick veneer
	Masonry 4	Brick blocks + plywood sheathing+ stone veneer
	Masonry 5	CMU blocks + plywood sheathing+ alum. Veneer
	Masonry 6	CMU blocks + plywood sheathing+ steel veneer
	Masonry 7	CMU blocks + plywood sheathing+ brick veneer
	Masonry 8	CMU blocks + plywood sheathing+ stone veneer
	Metal stud 1	Metal stud + plywood + alum. Veneer
	Metal stud 2	Metal stud + plywood + steel veneer
	Metal stud 3	Metal stud + plywood + brick veneer
	Metal stud 4	Metal stud + plywood + stone veneer
	Precast panels	
	Cast in place 1	Concrete + ply wood sheathing + alum. Veneer
	Cast in place 2	Concrete + ply wood sheathing + steel veneer
	Cast in place 3	Concrete + ply wood sheathing + brick veneer



## LCA



DuboCalc

Uittrekstaat BIM	MKI totaal	MKI Bouwfase	CO <sub>2</sub> (kg CO <sub>2</sub> -eq)	% MKI
Uittrekstaat TER kantopsluiting	€ 107.391,43	€ 44.527,52	1143	10%
Uittrekstaat TER bestrating	€ 150.572,02	€ 55.067,46	1416	14%
Uittrekstaat TER bliksempieken	€ 242.041,24	€ 189.326,97	2349	22%
Uittrekstaat TER hekwerken	€ 8.403,92	€ 21.622,58	64	1%
Uittrekstaat TER kabelgoten	€ 27.147,10	€ 20.595,34	262	2%
Uittrekstaat TER kabelgoten 001	€ 7.552,70	€ 5.729,91	73	1%
TER fundering -001	€ 228.892,81	€ 173.651,15	2209	21%
TER fundering -002	€ 12.414,56	€ 9.456,81	120	1%
Uittrekstaat IAG wanden	€ 48.259,02	€ 50.669,89	468	4%
Uittrekstaat IAG staa	€ 12.416,81	€ 16.575,39	136	1%
Uittrekstaat AIS kolommen	€ 37.192,20	€ 49.589,60	409	3%
Uittrekstaat TER aardnet	€ 140.783,17	€ 83.282,73	1277	13%
Uittrekstaat IAG aardringlei001	€ 7.369,59	€ 2.876,78	68	1%
Uittrekstaat IAG vloeren	€ 81.885,59	€ 40.512,20	830	7%
Uittrekstaat IAG daken	€ -	€ -	0	0%
Uittrekstaat IAG structural 001	€ 559,89	€ 424,76	5	0%
Uittrekstaat TRA aardringlei003	€ -	€ -	0	0%
Uittrekstaat TRA aardringlei004	€ -	€ -	0	0%
Uittrekstaat TRA aardringlei005	€ -	€ -	0	0%
Uittrekstaat TRA aardringlei006	€ -	€ -	0	0%

Pavement

Lightning rods

Prefab concrete foundations

Technical buildings

Earth loop not in DuboCalc



Voor de uittrekstaten IAG daken, IAG aardringlei003/004/005/006 konden geen gelijkende items in DuboCalc worden gevonden.



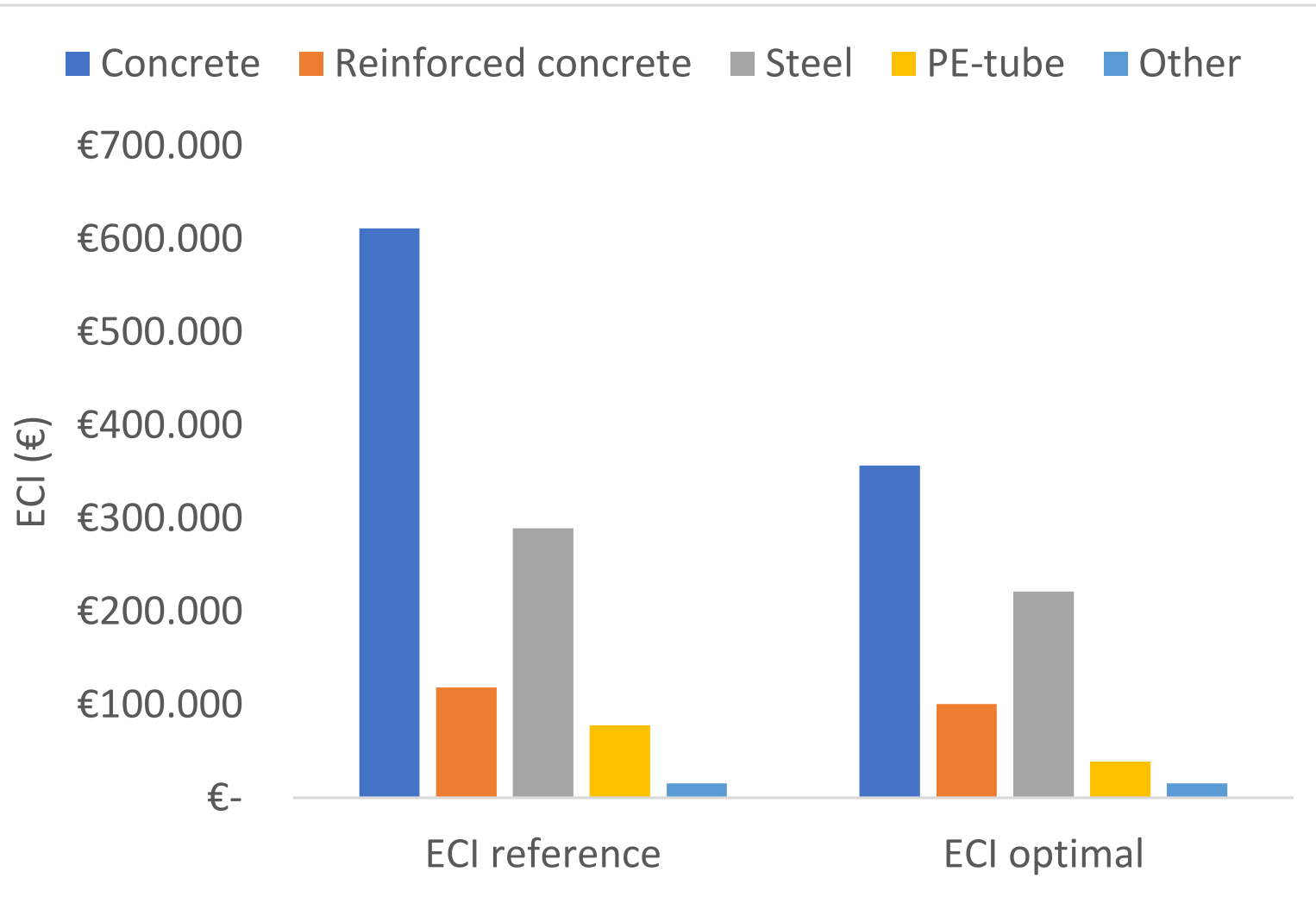
# Insight into which materials were dominant in LCA

Opportuniteit to challenge the market to come up with sustainable alternatives

DuboCalc materialen	↕↑ MKI totaal	↕ MKI Bouwfase	↕ CO <sub>2</sub> (kg CO <sub>2</sub> -eq)
Beton, prefab, utiliteitsbouw; AB-FAB	€ 45.471,49	€ 47.882,86	445
Betonband groot	€ 107.391,43	€ 44.527,52	1143
Betongranulaat 300 mm	€ 302,45	€ 220,45	2
Betonmortel C30/37 (CEMIII)	€ 13.349,67	€ 9.410,75	123
Betonmortel C35/45 (CEMIII)	€ 342.904,90	€ 240.575,24	3160
Betonstaal	€ 159.593,81	€ 141.426,20	1695
Betonstraatstenen keiformaat	€ 143.824,27	€ 52.082,84	1368
Betontegels normaal	€ 3.992,48	€ 958,20	25
Doorgaand gewapend beton C35/45 CEM III	€ 3.615,84	€ 2.921,33	32
Draadmathekwerk (BID-301.05)	€ 8.403,92	€ 21.622,58	64
Kanaalplaat, prefab beton; AB-FAB	€ 9.249,94	€ 9.249,94	99
Keramische tegels; ongeglazuurd/gelijmd	€ 629,79	€ 629,13	5
Landzand (per as), 25 km	€ 2.452,82	€ 1.805,97	22
PE-buis klein	€ 77.808,98	€ 30.373,37	713
Prefab betonplaten	€ 60.045,76	€ 21.042,12	615
ROCKWOOL RockSono Base (Isolatielagen)	€ 4.100,97	€ 4.100,97	34
Staal zwaar constructiestaal o.a. balken, profiel	€ 59.514,00	€ 79.352,00	655
Stalen buis klein	€ 70.343,78	€ 55.786,15	631
Vuren, grenen, larix	€ 14,81	€ 39,39	-1

- Most dominant materials: concrete (in-situ and prefab), steel and pavement materials
- Procurement can challenge the market to come up with more sustainable alternatives

# Up to 34% reduction in Environmental Cost Indicator possible:



- Using more sustainable concrete (CEMIII instead of CEMI-concrete)
- Reuse of prefab materials (e.g. pavement, prefab concrete elements, etc.)
- Optimizing design

# LCA Results for sustainable station design

Improved insights into environmental impact; follow up:



- Unfortunately, due to miscommunication the LCA results were too late to be implemented in the design or procurement
- However, the insights made TenneT aware of sustainable opportunities:
  - In-depth research on sustainable materials for the technical buildings (and friction with design specifications)
  - Discussion on the need for pavement: why not having a 'green field'?
  - Integral sustainability studies: investigating to which extent the station design meets TenneT sustainability targets
- Many follow up studies followed to make the station design more sustainable...





Schakeltuin

Dienstgebouw TenneT

Transformatoren en  
dienstgebouw Lander

Hoogspannings

**Knowledge is power: station design nowadays more sustainable (although many opportunities still possible)**



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# Sustainable foundation

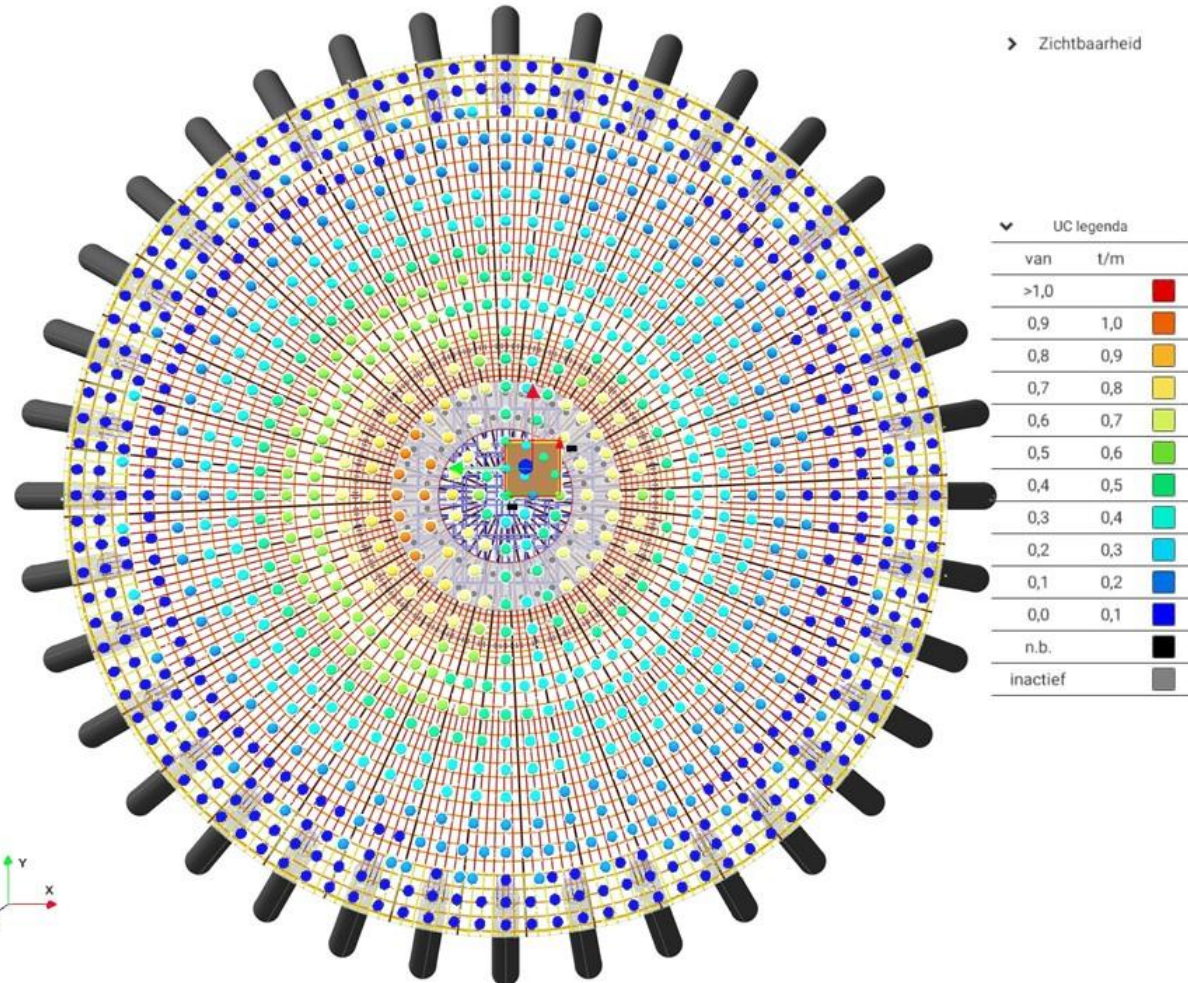
Question: how to design fast, constructively safe and with minimal materials?



# Movares UC1-Concrete tool: parametric design

Fast design for constructive safety with minimal materials

- Time was short since collaboration with contractor failed
- 235 foundations to be designed, high amount of repetition
- Dimensions of foundation were fixed, only steel could be optimized
- Parametric design for constructive safety with minimal materials
- LCA used to calculate environmental benefits



# Results: 18% CO<sub>2</sub>-reduction due to steel savings

More CO<sub>2</sub>-savings possible when also optimizing concrete

- Traditionally 175 kg steel needed per m<sup>3</sup> concrete foundation

**Due to parametric design reduced to 133-154 kg/m<sup>3</sup> (depends on location)  
– 18% reduction!**

- Environmental benefits LCA:
  - €274.000,- environmental costs savings
  - 2.911 ton CO<sub>2</sub>-eq. savings



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# “By quantifying sustainability it can be decided upon”

LCA's are a proven and validated method to quantify sustainability impacts

- But to successfully use LCA's for sustainable design and procurement:
  - Sustainability needs to be just as important as the technical specifications: “green” Customer Requirement Specification
  - Integrate LCA's in BIM-design, so sustainability is part of design decisions
  - Use LCA's for procurement: challenge and reward contractors to make the design even more sustainable

**At Movares we say: “Together it works”. So lets work together on these challenges!**



# Thank you for your attention



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