



Scaling Elcogen Business Case Study

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Hydrogen Now: Accelerating Investments and Applications

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Elcogen at a glance



Estonian-Finnish scale-up company headquartered in Tallinn



20+ years solid oxide development experience



150+ customers in 30 countries



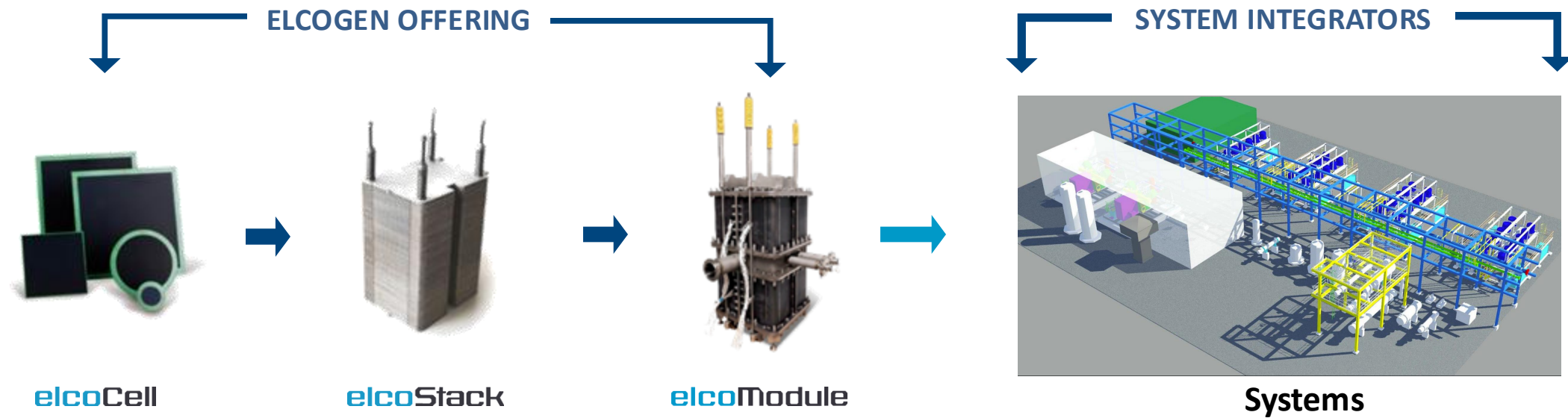
140+ people and growing fast!

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Elcogen offering– system core components

Elcogen offers core components for hydrogen generation and emission-free power production



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ELCO-1: The New Factory

Current setup



Capacity expansion to 30/90 MW/a SOFC



- **elcoCell**® development and manufacturing in Estonia
- **elcoStack**® development and manufacturing in Finland
- Capacity increased to ~3 MW/Yr. for 2023

ELCO-1

- Elcogen capacity expansion to 30 MW / 90 MW
 - ~ 1.2M to 3.6M **elcoCell**®
 - ~ 7000 to 17.000 **elcoStack**®

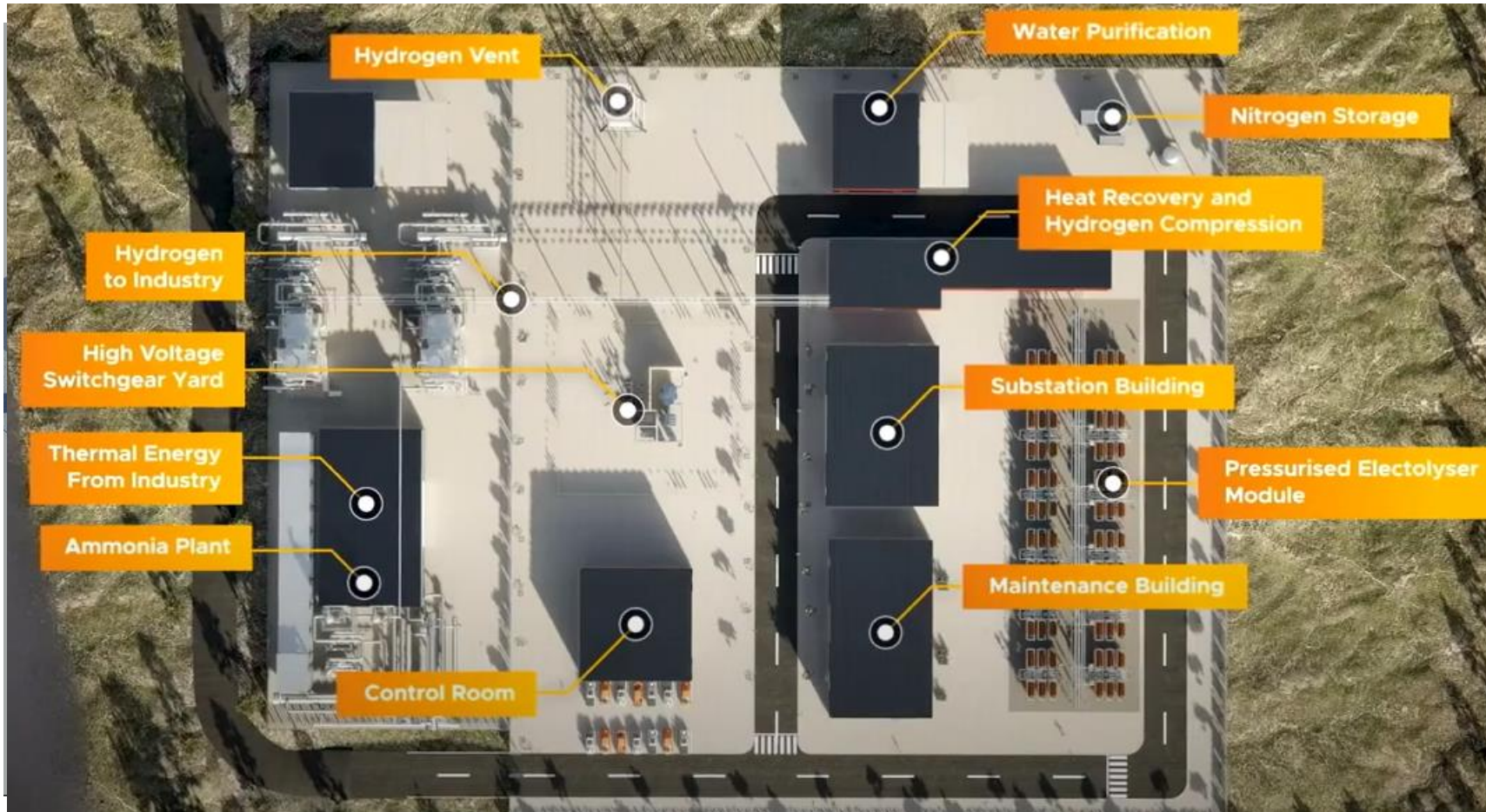
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Elcogen getting a piece of the cake Knowing the cost structure of LCOH



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Proposal for plant lay-outs



Cost of producing hydrogen

Capital cost of production facility

Operating cost

Fixed operating cost

Lease, salaries, Insurances,...

Cost of capital

Maintenance cost

Variable operating cost

Feedstock

Utilities

Energy



Plant ISBL cost: 100MW SOEC

E 101	Feed water preheater no.1	1	3.2	82000	82.000	2,98	240.000
E 102	EI heater	1		700.000	700.000	1,715	1.200.000
E 103	Syngas boiler	1		36.000	36.000	2,21	80.000
E 105	Product cooler	1	4.3	47.000	47.000	2,98	140.000
E 121	Off gas boiler	1		48.000	48.000	2,21	110.000
E 122	Off gas cooler	1	6.2	210.000	210.000	2,98	630.000
E 130	Interstage cooler for H2 compressor						
E 130 B	Hydrogen product after cooler no. 1	1	3.3	72.000	72.000	2,21	160.000
E 130C	Hydrogen product after cooler no. 2	1	1.2	21.000	21.000	2,98	63.000
K 130	Hydrogen product compressor	1	54,1	3.300.000	3.300.000	1,99	6.600.000
P 101 AB	Process condensate pump	2	0.3	31.000	62.000	3,2	200.000
V 101	Steam drum	1	2.0	31.000	31.000	2,21	
V 102	Inert vent gas separator	1	1.1	22.000	22.000	3,07	
V 130C	Makeup gas separator	1	1.4	24.000	24.000	3,07	
X 110	SOE stacks	1		51.000.000	51.000.000	1,7	87.000.000
E 111	FIE syngas exchanger						
E 112	Syngas EI heater						

Total ISBL Cost*: ~125 m€

Professional services**: ~20 m€

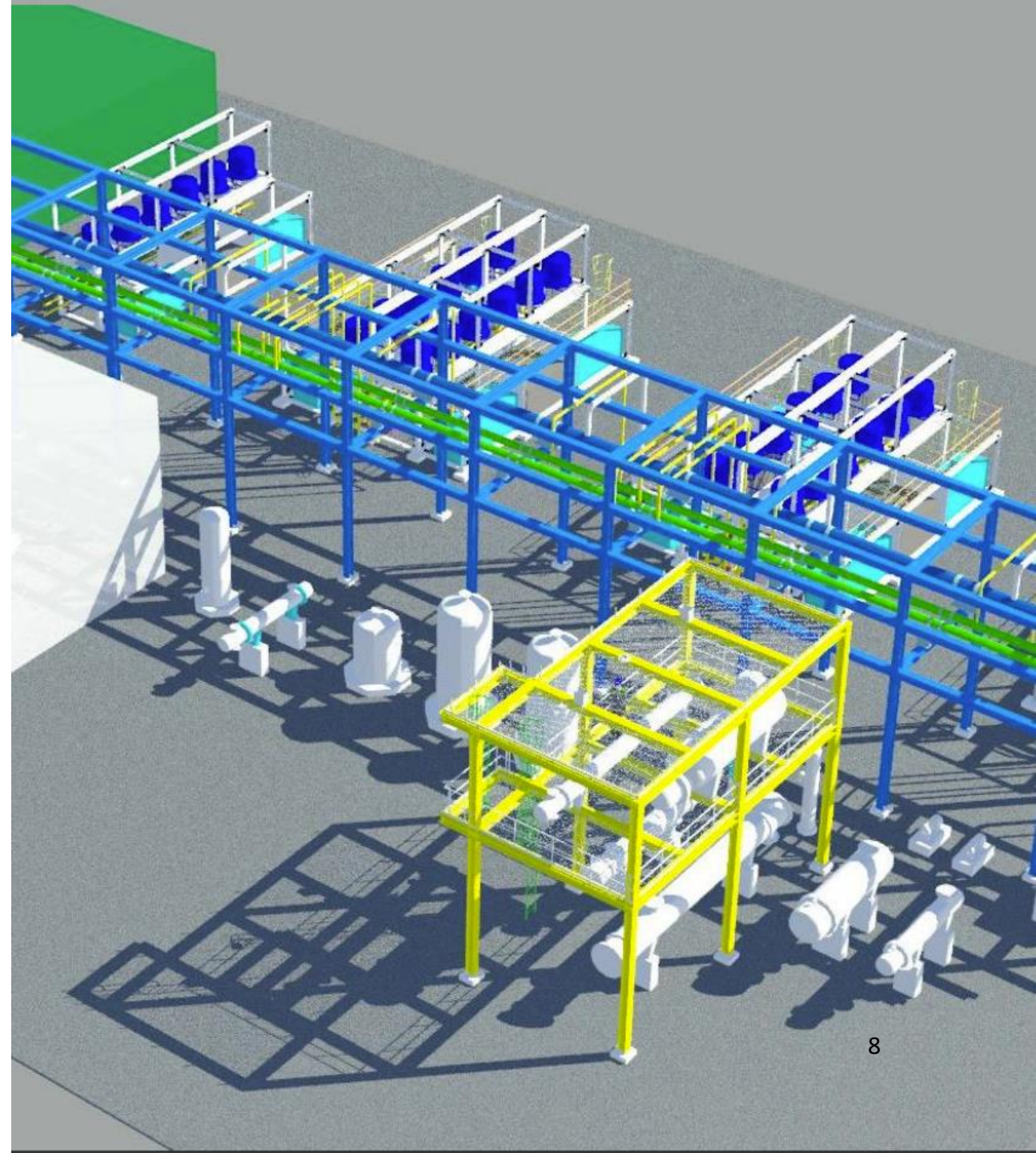
Contingency and contractor margin (15%): ~20 m€

Total ISBL Lump sum: 165 m€

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* Stackcost ~35%

**Detailed eng., Procurement & Expediting, PM, Site supervision etc.



Plant OSBL cost: 100MW SOEC

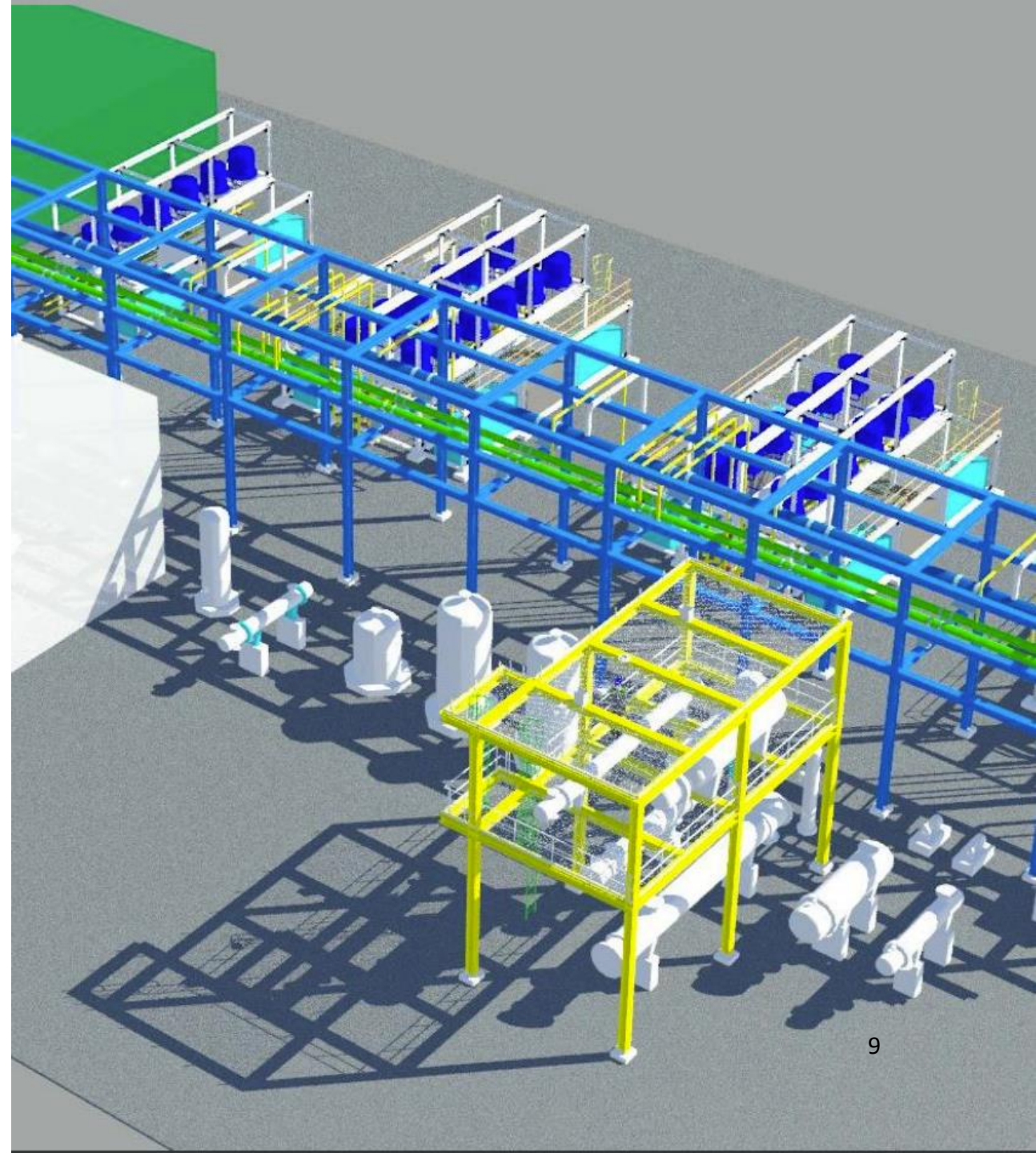
DMW unit, 9.2 ton/h			1,000,000	2.5
Waste water treatment				
N2 & Instrument air unit			2,000,000	2.0
Flare system			250,000	2.0
Control system HW & software Ind UPS			1,400,000	2.0
Control & sanitary building			400,000	2.0
Substation building & Interrel's				

Total OSBL Cost: ~11 m€

Contractor margin (100%): ~11 m€

Total OSBL Lump sum: 22 m€

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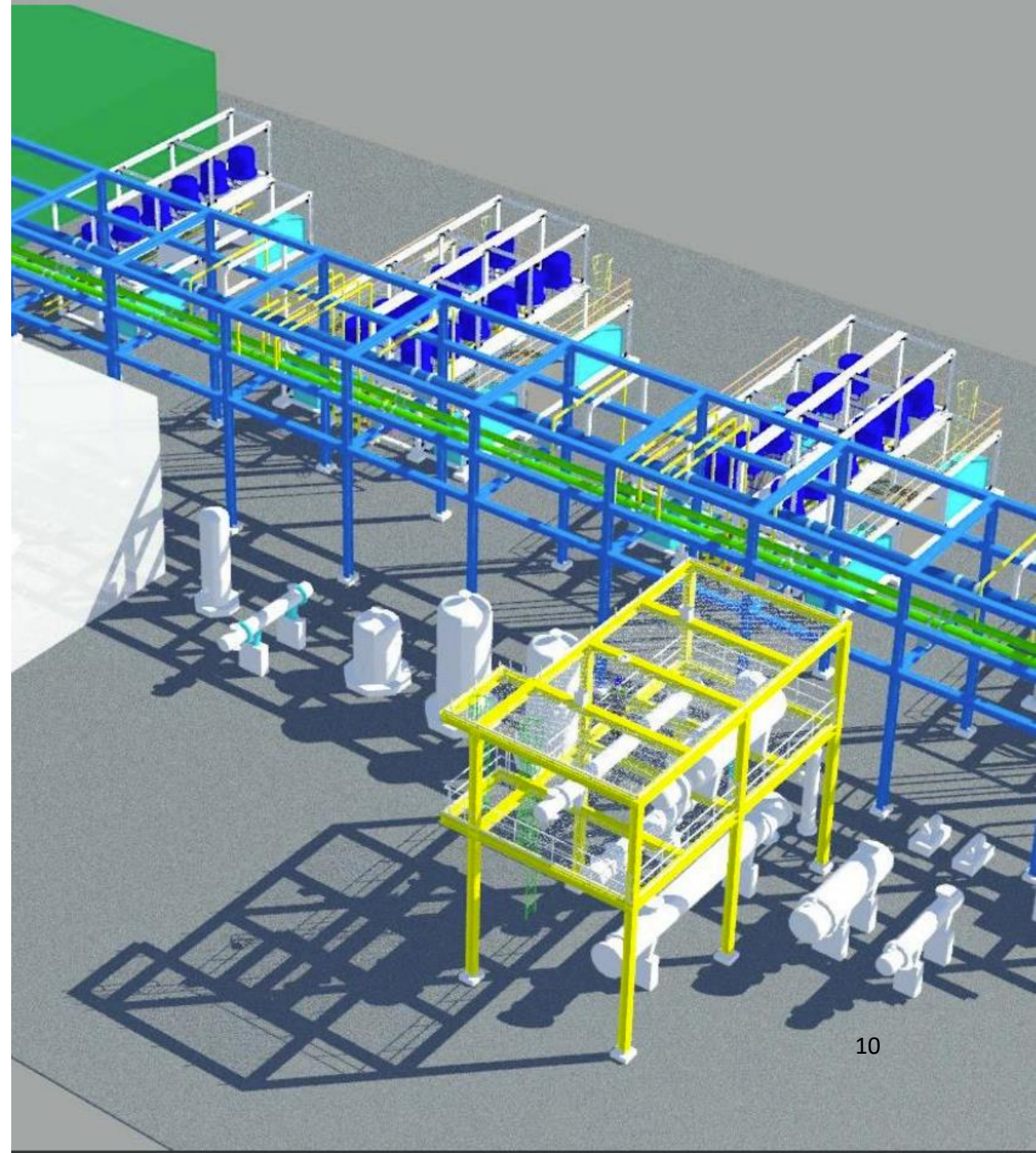
Plant Owner's cost: 100MW SOEC

- Owners: Preoperations cost, technology/feasibility studies, permits, cost of land (8%)
- Owners: PMC consultants, project coordination, management, supervision, procurement (7%)
- Operator training (0,3%)
- Start-up consumables, feedstock, fuels, utilities (1%)
- Taxes, levies & duties (0,5%)
- Insurance cost and losses not covered by insurances (15% - high new technology)
- Forward escalations to date of expense (5%)

Total Owners cost ~37% of ISBL+OSBL: 70 m€

Grand total (-40/+60%): 260.000.000 €

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SOEC Economics

100MW / $\sim 29.000 \text{Nm}^3/\text{hr H}_2$

CAPEX cost (260m€, 7%WACC, 10 years payback):	$\sim 37.000 \text{ k€}/\text{year}$
Fixed OPEX (4% of CAPEX):	$\sim 10.500 \text{ k€}/\text{year}$
Variable OPEX (5500 hrs/year, 50€/MWh _e)	
Electricity:	$\sim 27.000 - 32.000 \text{ k€}/\text{year}$
Water:	$\sim 200 \text{ k€}/\text{year}$
Stack replacement (3 years lifetime):	$\sim 10.000 \text{ k€}/\text{year}$
Sum:	<u>$\sim 90.000 \text{ k€}/\text{year}$</u>
Stack cost fraction:	($\sim 16.000 \text{ k€}/\text{year}$)
LCOH:	<u>$\sim 6 - 6,5 \text{ €}/\text{kg}$</u>
Stack cost fraction:	($\sim 1 \text{ €}/\text{kg}$)

Elcogen LCOH

- Tool to estimate LCOH considering:
 - Plant size
 - Installation year
 - With or without heat integration
 - Payback time, WACC
 - Onstream time
 - Electricity cost
 - Direct comparison to cost structure and LCOH for alkaline and PEM
- Output:
 - LCOH
 - CAPEX/OPEX
 - ISBL cost
 - Total investment cost



		2030				
Year	2029	PEM	SOEC	SOEC		
Plant "Capacity"	100	100	85	74	MW	
Installed stack capacity	93	93	67		MW	
Heat integrated	-	-	No	Yes		
Hydrogen production	21.552				Nm ³ /hr	
Plant efficiency	4.64	4.64	3.95	3.45	kWh/Nm ³ H ₂	
Stack efficiency	4.30	4.30	3.10	3.10	kWh/Nm ³ H ₂	
CAPEX	143.018	125.398	169.020	169.020	k€	
Payback time	15				Years	
Rate	7.0%					
CAPEX	15.703	13.768	18.557	18.557	k€/year	
Capex (-40%)	9.422	8.261	11.134	11.134	k€/year	
Capex (+70%)	26.694	23.406	31.548	31.548	k€/year	
Fixed OPEX % of CAPEX	4%					
Fixed OPEX	5.721	5.016	6.761	6.761	k€/year	
Fixed OPEX [Capex (-40%)]	3.432	3.010	4.056	4.056	k€/year	
Fixed OPEX [Capex (+70%)]	9.725	8.527	11.493	11.493	k€/year	
Annual operation	7.000				hours	
Cost of electricity	50				€/MWh	
Variable OPEX electricity	35.000	35.000	29.795	26.024	k€/Year	
Water consumption	9,7	9,7	9,7	9,7	kg _{H2O} /kg _{H2}	
Cost of water	1,5				€/ton	
Variable OPEX water	196	196	196	196	€/Year	
Variable OPEX Stacks	820	4.514	6.307	6.307	k€/year	
Sum of variable OPEX	36.016	39.710	36.298	32.526	k€/Year	
LCOH	0,38	0,39	0,41	0,38	€/Nm ³ H ₂	
	11,207				Nm ³ H ₂ per kg H ₂	
LCOH	4,27	4,35	4,58	4,30	€/kg H ₂	
LCOH [Capex (-40%)]	3,63	3,79	3,82	3,54	€/kg H ₂	
LCOH [Capex (+70%)]	5,38	5,32	5,89	5,61	€/kg H ₂	
ISBL plant cost	552	440	842	964	€/kW	
ISBL plant cost /w adders	823	694	1.190	1.362	€/kW	
ISBL plant cost	2.559	2.040	3.325		€/Nm ³ H ₂	
ISBL plant cost /w adders	3,82	4,25	4,70		€/Nm ³ H ₂	
Grand total plant cost	1.430	1.254	1.985	2.273	€/kW	
Grand total plant cost	6.636	5.818	7.843		€/Nm ³ H ₂	

Take aways

Investment cost into electrolyzers are more than stack cost and often underestimated

Stack cost are significant and influential on grand total investments

Operation cost is more than electricity cost

Cost of capital is often underestimated

LCOH cost are challenging

Depending on stack cost and lifetime stack cost influence on can range between 15 and 40%

