VOLVO

VCG Paintshop

Primer oven replacements

VOLVO

Issue: Paint shop primer oven replacement Type: Status report
Responsible: Stefaan Berlanger
Item to be handled in decision forum: PMT 21W14

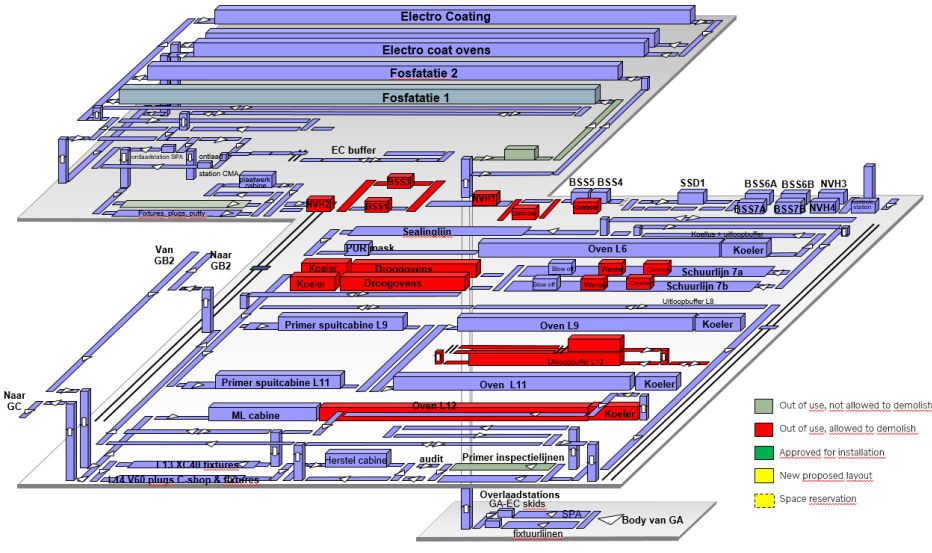
Purpose:
- To decide on concept for primer ovens (gas/electrical)
- Strategic direction for vision layout sealing/primer area
- Strategic direction for sustainability roadmap / CO2

Recommendation:
- To decide on concept of electrical oven (versus gas oven)
- Proceed vision layout (step 1) for primer ovens replacement

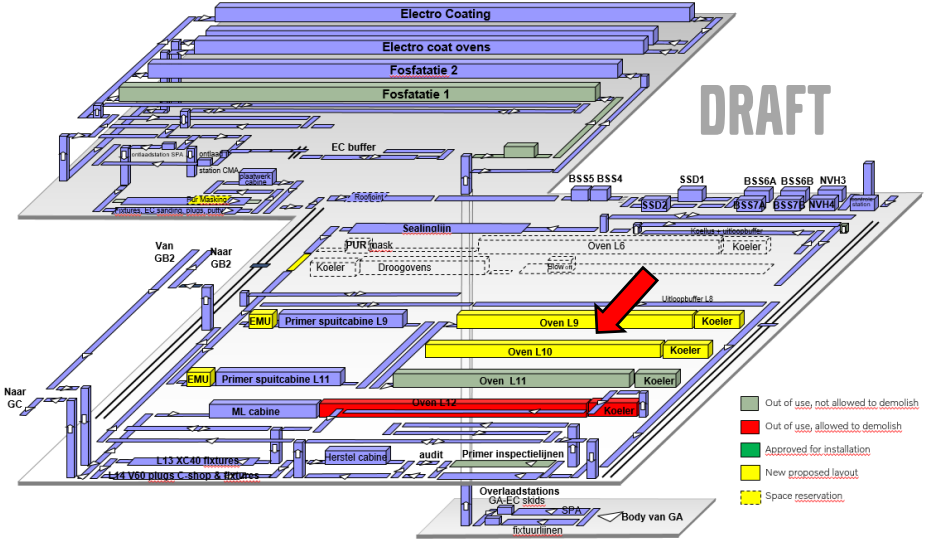
Background:
- Renewal primer ovens needed due to end of live & non-conformities (1989)
- Important is non-conformity on environmental legislation 2024 (NOx) / opportunity for CO2 roadmap
- Primer ovens are also crucial step in ‘sealing oven out’ which gives huge contribution to lean process KPI
- Primer ovens eventually to be delayed to SSD 2023/2024

Consequences & results:
- Gas or electrical oven concept gives different CO2 contribution / strategy
- Process overview
- Business case
- Summary

PRIMER OVENS - FIRST STEP



ONGOING STUDY



DRAFT

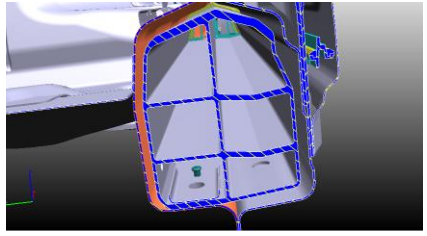
MAIN DRIVERS:

1. Important step in Vision layout / lower running cost
2. Equipment End Of Life situation + Non conformities
3. Environmental legislation / emission / CO2 neutral
4. Improved cooling to avoid heat problems

Risks

Product (Steel/Alu content) & materials
Combined sealing & primer curing
Alternative for blow off / feathering

PRIMER OVENS



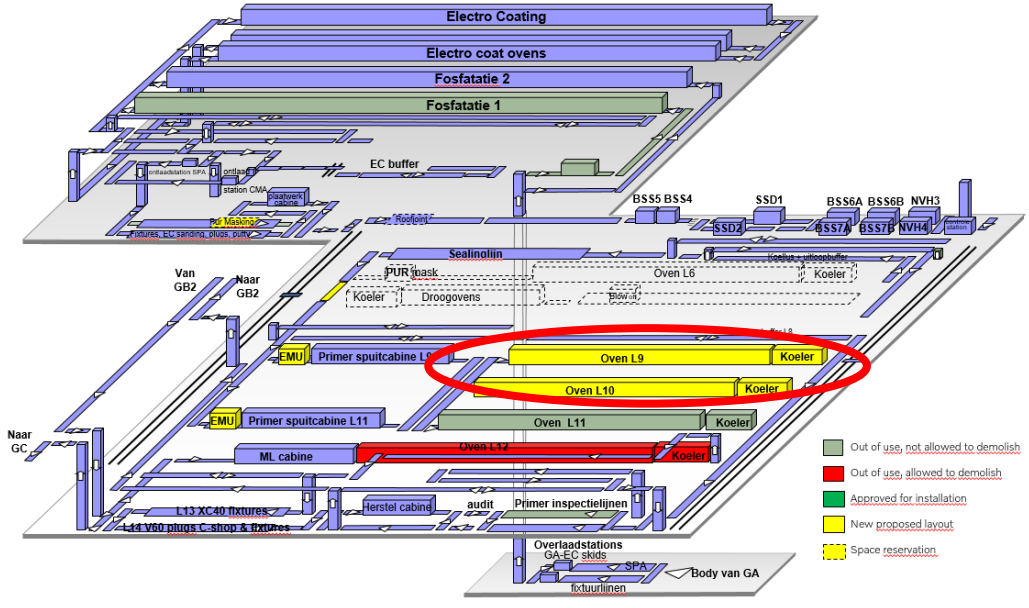
Prerequisites
Capacity 60 JpH netto C-shop
Product XC40 BEV ref; GPA unclear (test Chengdu)
Combined Sealer/Primer (specific oven design)
Legal: Compliance with EU legislation 2024 (NOx)

Location alternatives:
2 ovens on actual location L9/L10 (critical in lenght)
~~1 oven on old washing line L7B~~
~~2 ovens L9/L10/L12~~

Concept alternatives (study ongoing)
Gas ovens
- CO2 emission tax (cheaper but not CO2 neutral)
- CO2 green certificates (claim CO2 neutrality)
- CO2 capture (unclear / m²)

~~Hydrogen oven~~
Electrical oven

Planning: delayed to 2023 oven L10 / 2024 oven L9

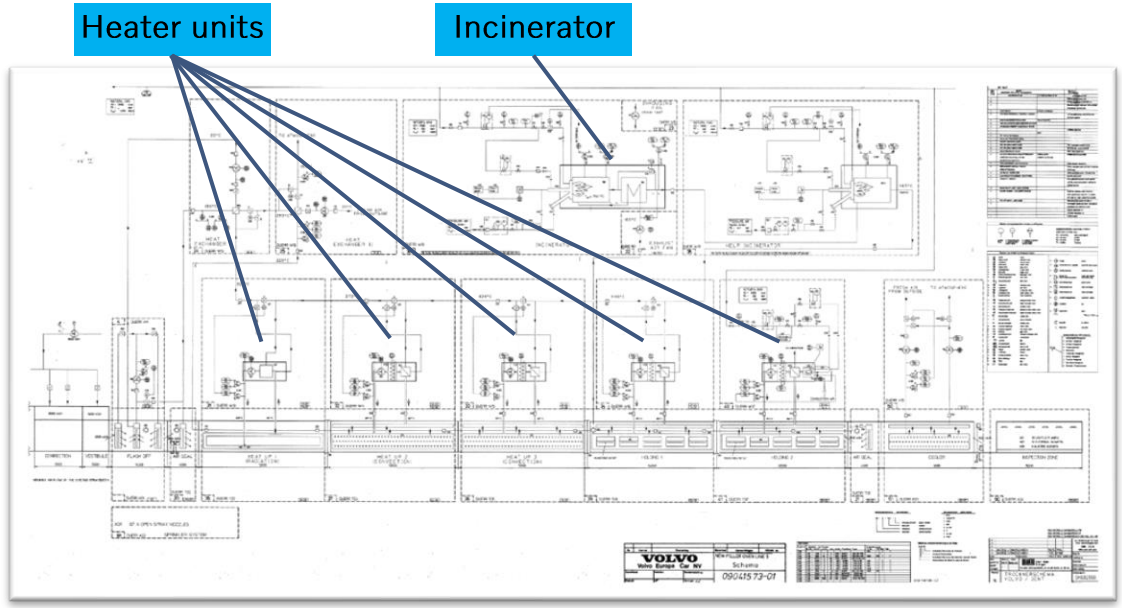


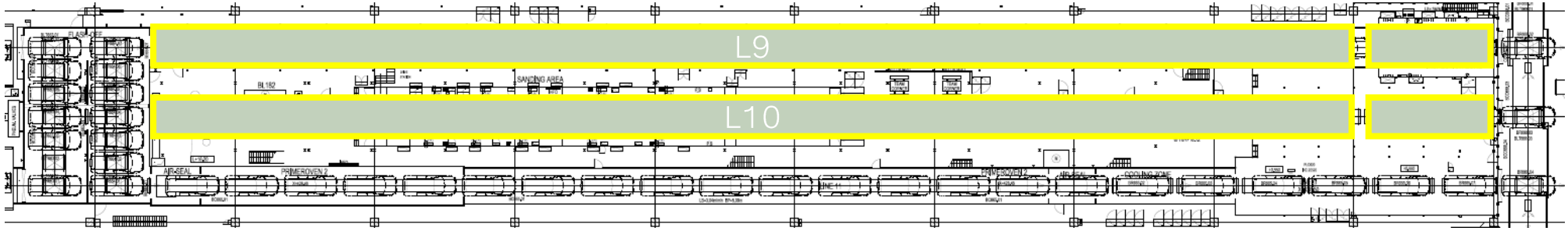
1/ ALT. GAS OVENS

Pro
Known concepts
Energy saving LCVA
Incinerator after-treatment
Existing gas supply piping
Low energy cost

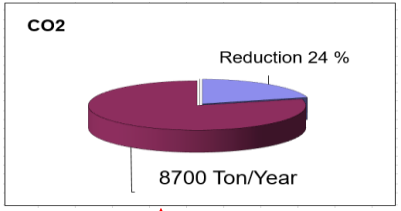
Con
Increased CO2 emission cost (ref. base 2030)

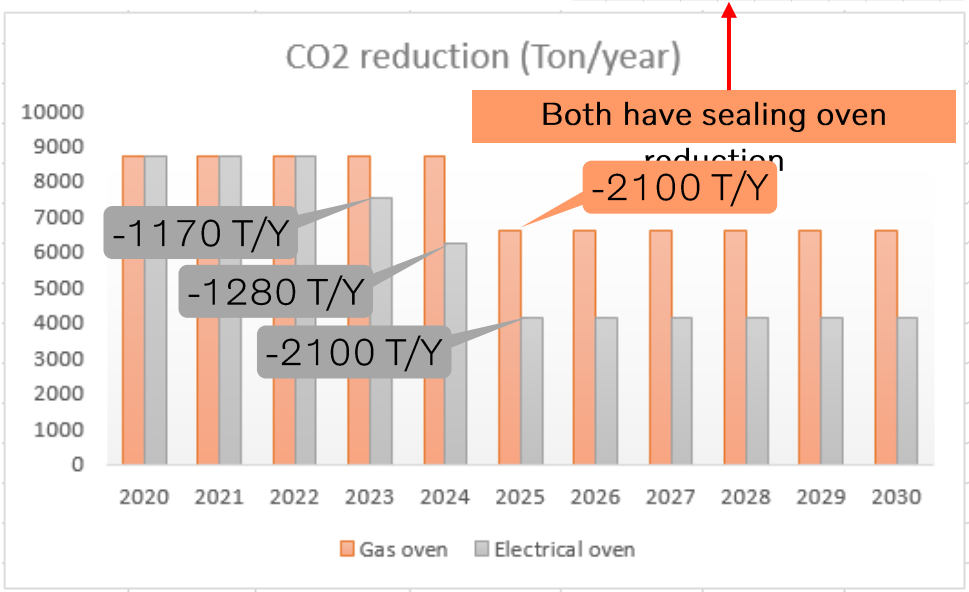
GAS					**1.821.850**	
Hot water	1,2	(GWh/Y)	31.000	(€/GWh)	**37.200**	(€/year)
Electricity	3,5	(GWh/Y)	90.700	(€/GWh)	**317.450**	(€/year)
Gas	13,1	(GWh/Y)	32.000	(€/GWh)	**419.200**	(€/year)
Certificates	13,1	(GWh/Y)	80.000	(€/GWh)	**1.048.000**	(€/year)

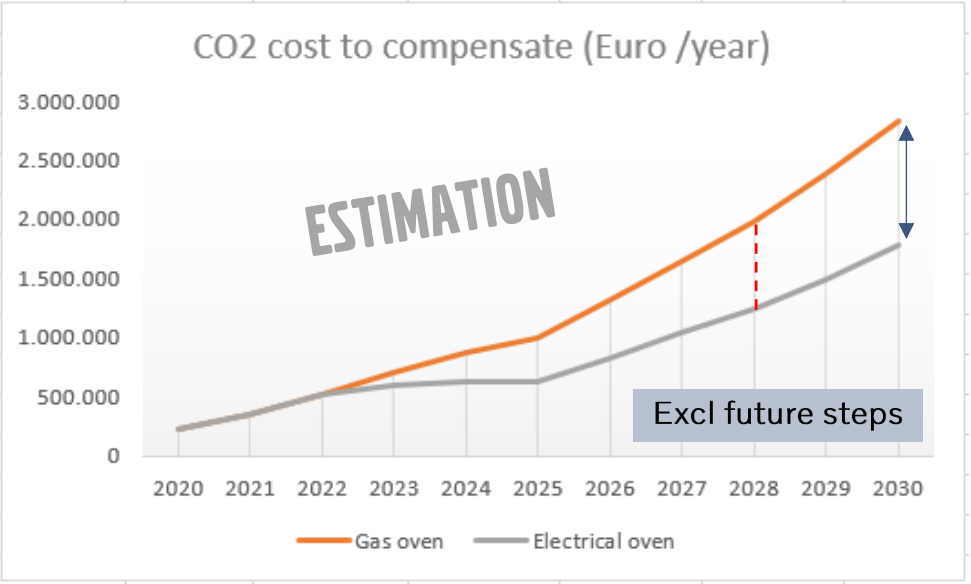




CO2 ROADMAP GB







	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
delta CO2	0	0	0	1170	2450	2450	2450	2450	2450	2450	2450
delta cost cert.	0	0	0	93.600	245.000	367.500	490.000	612.500	735.000	882.000	1.048.600

2/ ALT. ELECT. OVENS

Con

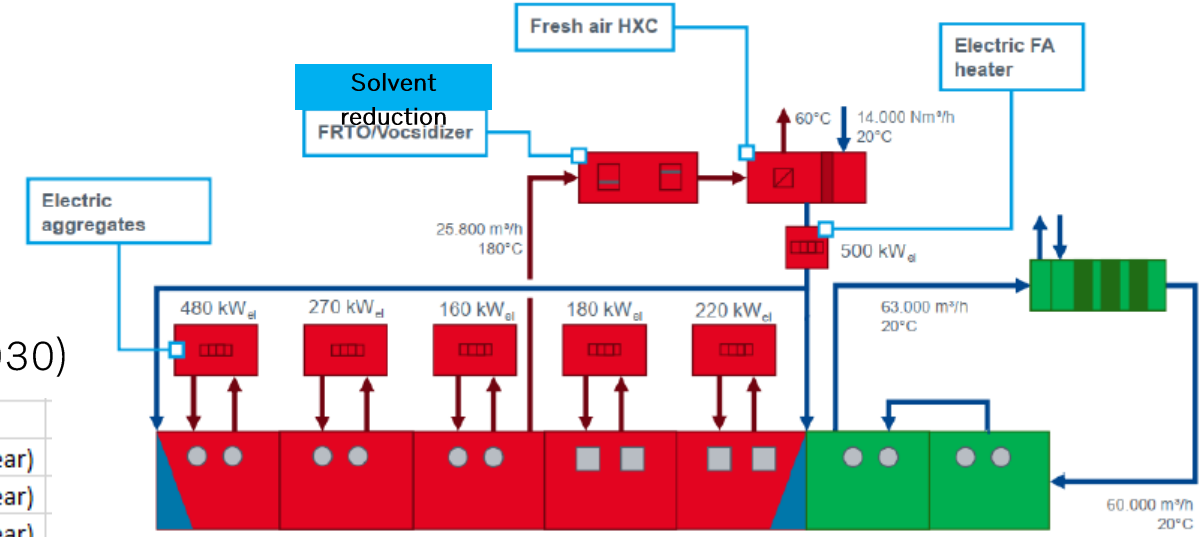
New concepts in study
Vocsidizer aftertreatment (location/energy)
Additional electrical grid works
Higher energy cost (50%)

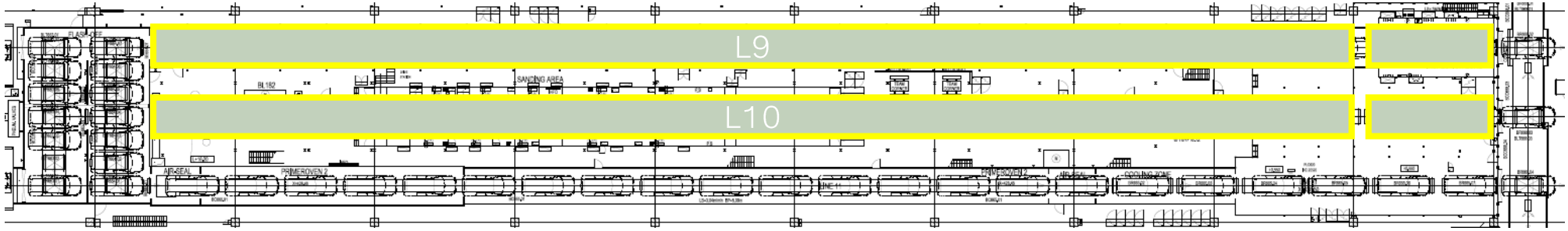
Pro

No CO2 emission / no cert. cost (ref. base 2030)

ELI					**1.571.040**	
Hot water	1,2	(GWh/Y)	31.000	(€/GWh)	**37.200**	(€/year)
Electricity	16,6	(GWh/Y)	90.700	(€/GWh)	**1.505.620**	(€/year)
Gas	0	(GWh/Y)	32.000	(€/GWh)	**0**	(€/year)
Certificates	16,6	(GWh/Y)	1.700	(€/GWh)	**28.220**	(€/year)

Process example





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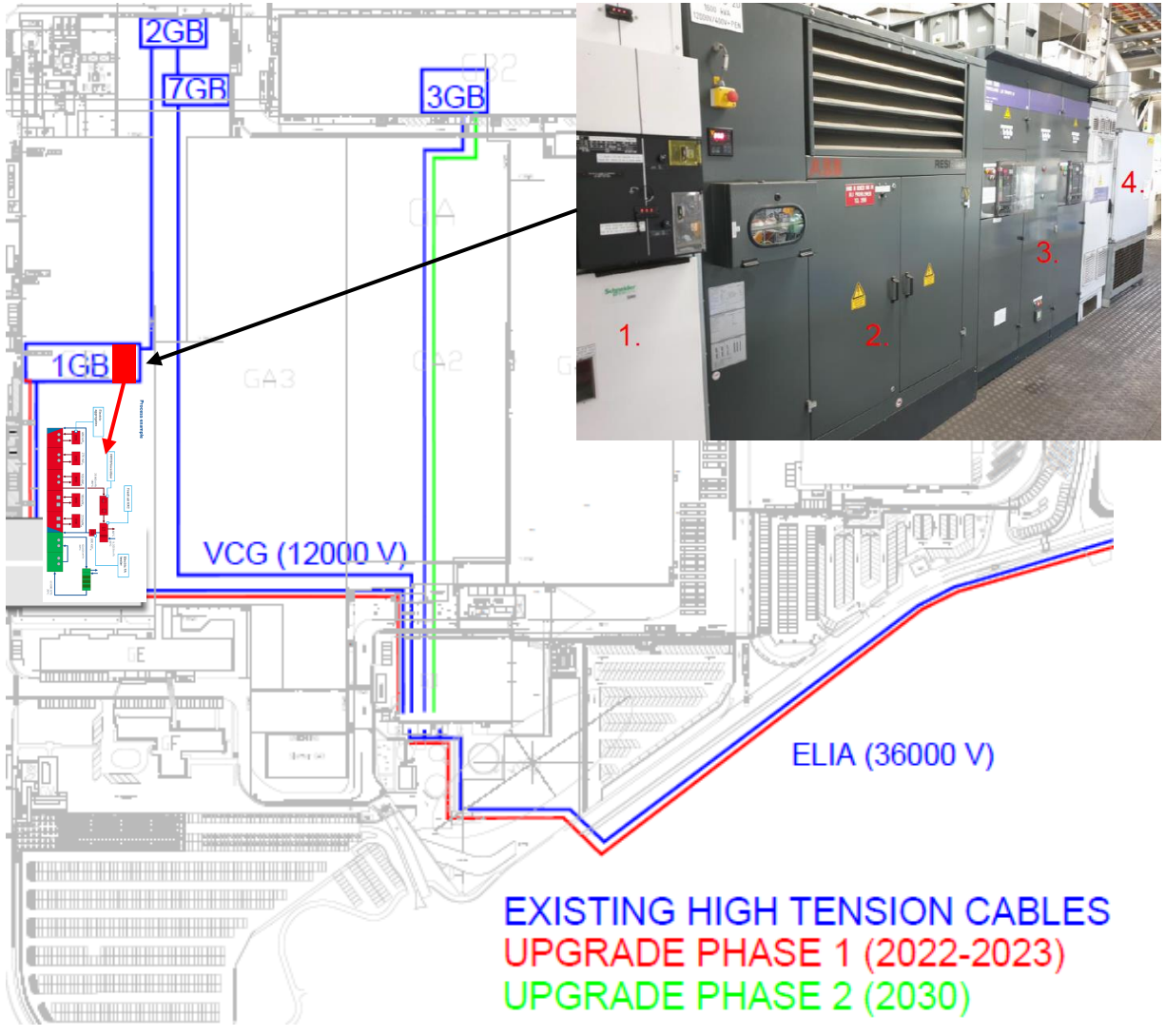
ELECTRICAL GRID

Electrical power
Actual VCG Electrical capacity 21 MW

Gas -> Electr. (primer ovens)= + 5 MW
Gas -> Electr. (all ovens)= + 10 MW

Scope ifo primer ovens (step 1)
Increase Elia grid 36.000 V (>2 years)
Increase Volvo grid 12.000 V
Transfo room
(1)Distribution 12.000 V
(2)Transformation 12.000 -> 400V
(3)Distribution 400V

Investment steps
First step ELIA -> 0,970 milj. € (in study)
Second step primer ovens -> 3,900 milj. €
Total scope for all ovens -> 10 milj. €



INVESTMENT/RUNNING COST

ESTIMATION

Oven alternatives	Gas oven		Electr. oven		Delta	
Equipment investment / demolition	15.375.000		18.175.000		2.800.000	
Energy piping / grid investment			3.900.000		3.900.000	
Carbon capture (Vito/Orbix)	6.770.000				-6.770.000	
Investment cost / 14,5 years	**22.145.000**	23,0	**22.075.000**	22,9	**-70.000**	-0,1
Investment cost / years	1.527.241	6,6	1.522.414	6,6	-4.828	0,0
Energy Cost - Hot Water	37.200		37.200			
Energy Cost - Electricity	317.450		1.505.620			
Energy Cost - Gas	419.200		0			
Carbon capture (Energy cost)	236.000					
Energy Cost - Emission/Certificates	5.950		28.220			
Running cost/year	**1.015.800**	4,4	**1.571.040**	6,8	**555.240**	2,4
Base is estimation for 2030	(€/year)		(€/year)			
Cost/car perspective (€/car)		27,4		29,7		2,3

CONCLUSIONS / RECOMMENDATION

Oven alternatives	Gas oven	€/car	Electr. oven	€/car
Known concept / technology			technical challenges	
Known VOC after-treatment			unclear (location/energy)	
Equipment investment			higher investment cost	
Grid investment (initial +5 MW & future +10 MW)		23	extra grid cost, critical planning	22,9
Running cost - Energy			higher energy cost (+ 50%)	
Running cost - Emission/Certificates	cost green certificates	4,4	no emisson cost	6,8
CO2 neutral strategy / real CO2 perspective	issues buying green certificates		CO2 reduction extra 2450 Ton/year	
option Hydrogen blending	H2 limited CO2 reduction (< 3%)		NA	
option carbon capture end-of-pipe CO2 reduction	CO2 capture technology uncertain		NA	
Business case perspective (pay back)			strategic decision	
Cost / car perspective		27,4	higher cost/car	29,7

Recommendation: Postpone installations with 1 year, go for electrical concept, optimize investment & running parameters

Next step: Final review & confirmation of strategic direction before 21W20.

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Back up slides

2022 — 2023 — 2024 — 2050

Purchase certified Biogas

(Approval Flemish regulator?)

W13 meeting with Flemish government Energy regulator and sector Organisations:

Proposal of Goteborg Energi

Will be analysed as a case

Can be implemented

If Flemish government approves

The Volvo case:

— Voluntary with V317 (after purchase procedure)

— Legal 1 January 2022 (EU-legislation)

Purchase Local produced H2-certificates

(Limited 25MWh/y And only the first 3years))

CCU

Carbon Capitation

Q to perform study (expected- W17) on:

— Conventional technique (disadvantage = area use)

— Pilot test modular technique

Utilization:

— In building materials (Revenue 10€/ton)

— Future public CO2-grid

— Commercialize via Airliquide (TBI)

Electrification ovens paint shop

(Electricity cost)

Climate neutrality Within EU

CLIMATE NEUTRAL MANUFACTURING BY 2025

Energy prices and costs in Europe

REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS-Brussels, 9.1.2019

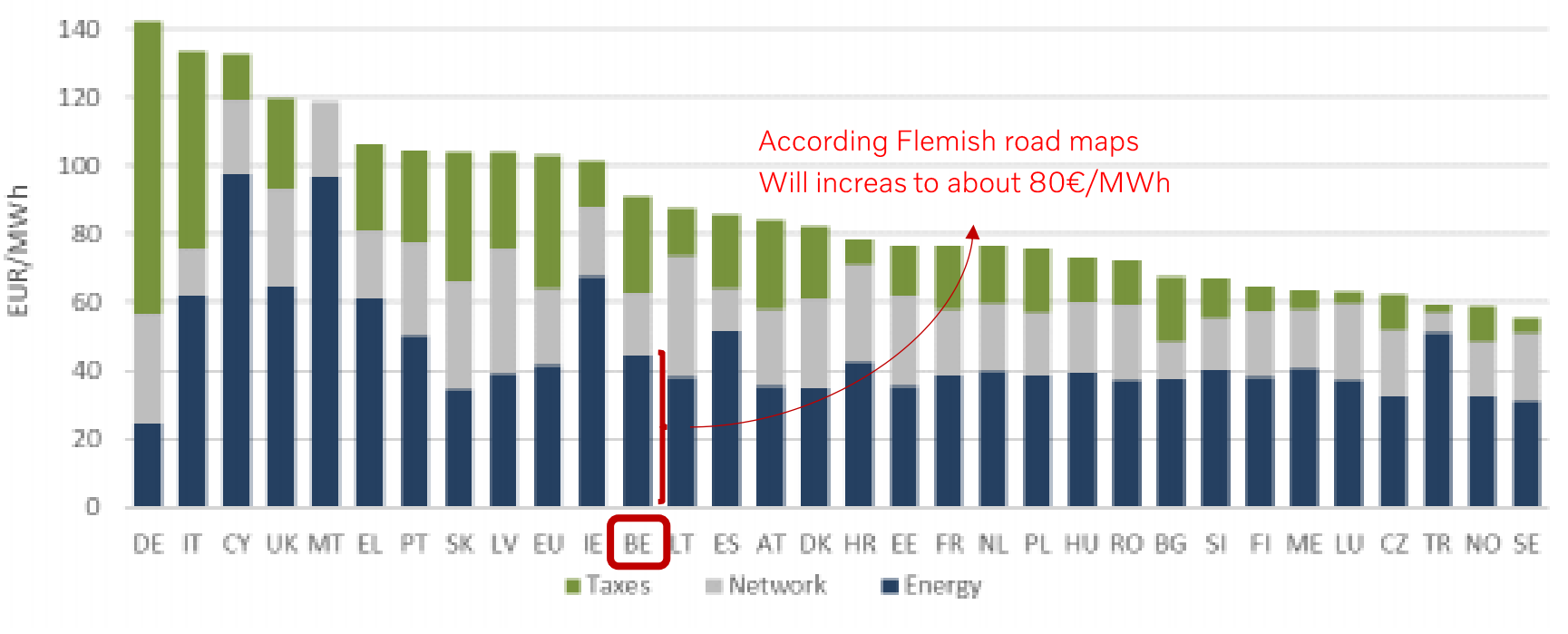


Figure 3 — Industrial electricity prices in 2017 — Source: DG ENER in-house data collection

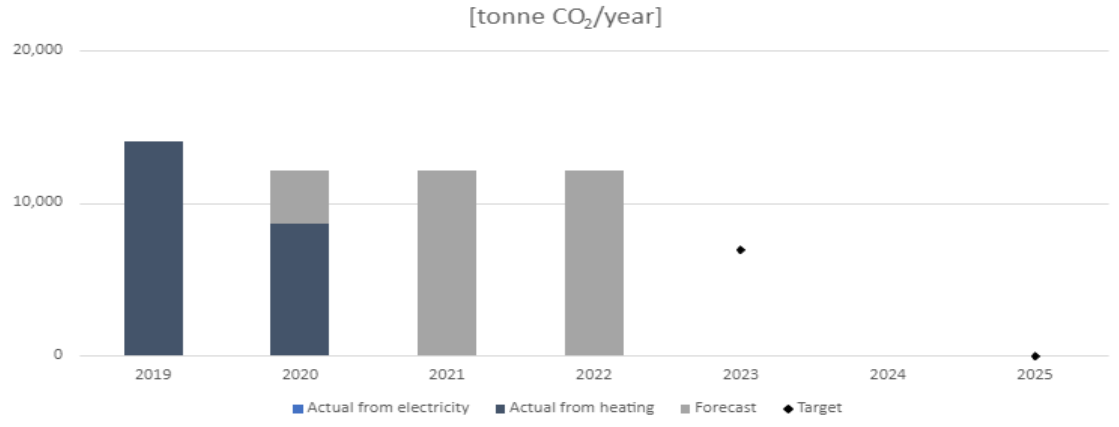
Roadmap Climate Neutrality - VCG

Share of climate neutral energy [% of MWh/year]
Electricity: 100 %
Heating: 50 %

On-site generation
Wind turbines: 6 MW (15 % of elec. use)
Solar panels: 3 MW (5 % of elec. use)

Main challenges to close remaining gap
Harmonised standards to be put in place for certified biogas, in order to enable cross border purchasing within EU or purchase local GoO on H2

Technical solutions (H2 – electrification-CCU)> 2030



	2020	2021	2022	2023	2024	2025
Actions and initiatives Status for action: **Decided** Planned action in BPL *To be investigated* *I: investment* *S: saving* *C: Cost* ** Most probable * Uncertain	*Purchase of certified biogas*** *Purchase GoO from H2*** *Technical solutions on:* — *H2 ** — *Electrification ** — *Carbon capitation and Utilisation to make bricks **	*Debate with our sector organisation to force the Flemish energy regulator getting the same level playing field within Europe**		*Purchase certified biogas*** C: about 80€/MWh gas or 5600k€/year *Purchase GoO on H2*** C: about 80€/MWh gas or 5600k€/year		*Carbon capitation and Utilisation to make bricks **

CCU-Capture

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— *UK Carbone Capture, Usage and storage, a strategy to support the development in the UK and internationally. A journey started 2011.*

— *Carbon Clean, an UK enterprise, has:*

  — *Expertise in process design and engineering that, when integrate with existing industrial plants or new plants, enables optimized carbon capture*

  — *38 facilities across the globe:*

CDRMax technology

  — *Conventional design*

  — *Capacities 40-500 ton per day CO2*

  — *CO2 recovery units*

  — *Mature technology*

  — *Next Gen technology:*

Next Generation technology

  — *100% modular and containerized*

  — *Capacities 5-500 ton per day CO2*

  — *Biomethane and CO2 recovery units*

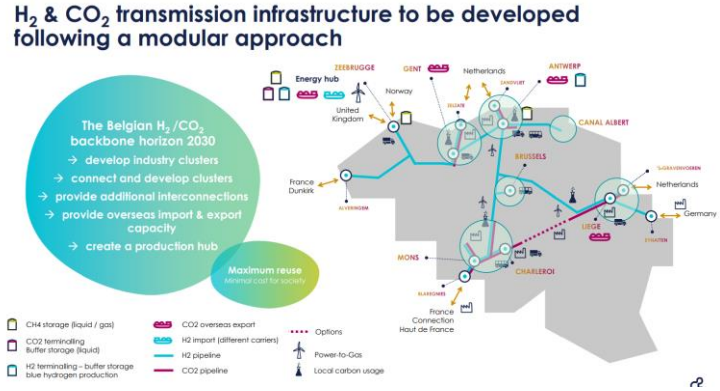
  — *10x size reduction vs conventional technology*

  — *Budgetary quote performed, It is requested to Carbon Clean to propose a FEED study for the design of the following scope:*

    — *Pipeline collection from the emission sources of CO2 (conventional technique)*
    — *Pilot testing campaign should also be offered with following content (next gen technology)*
    — *Volvo is open to innovative solutions and pilot plants which require more maturity for a commercial concept.*
    — *Delivery of the proposal to be by the 3rd week of April, Volvo will require around 3 months to decide after delivery of proposal.*

CCU -Utilization

1. Carbstone Innovation NV:
   - developed a patented process in which the fine residual product from the slag from slag production is converted into high-quality building materials by adding carbon dioxide.
   - This is done without adding expensive binders such as cement, which means considerable cost savings.
   - This revolutionary process has many environmental benefits in the treatment of EAF and BOF slag: production of high-quality building materials unique permanent storage of substantial amount of CO2 addition of cement is avoided final stabilization of alloy metals in slag, complete reuse of all fractions of the slag
   - This technology is contained in a patent. Carbstone Innovation NV can assist third parties in applying the carbonation technology in their process, thus giving part of their slag a higher added value, and in addition to capturing the CO2 from the furnaces.
   - In view of stricter environmental standards and the zero waste policy pursued by governments in the EU and the anticipated increase in CO2 emission rights, the Carbstone process offers considerable added value.
   - **Revenue Volvo 10€/ton CO2**
2. Public CO2-grid (Fluxys)



3. Commercialize via air liquid: TBI