

Vattenfall and the HYBRIT project

2018-09-13

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Fossil free within one generation



Sweden - a good place to start

98

...% fossil free
power
generation

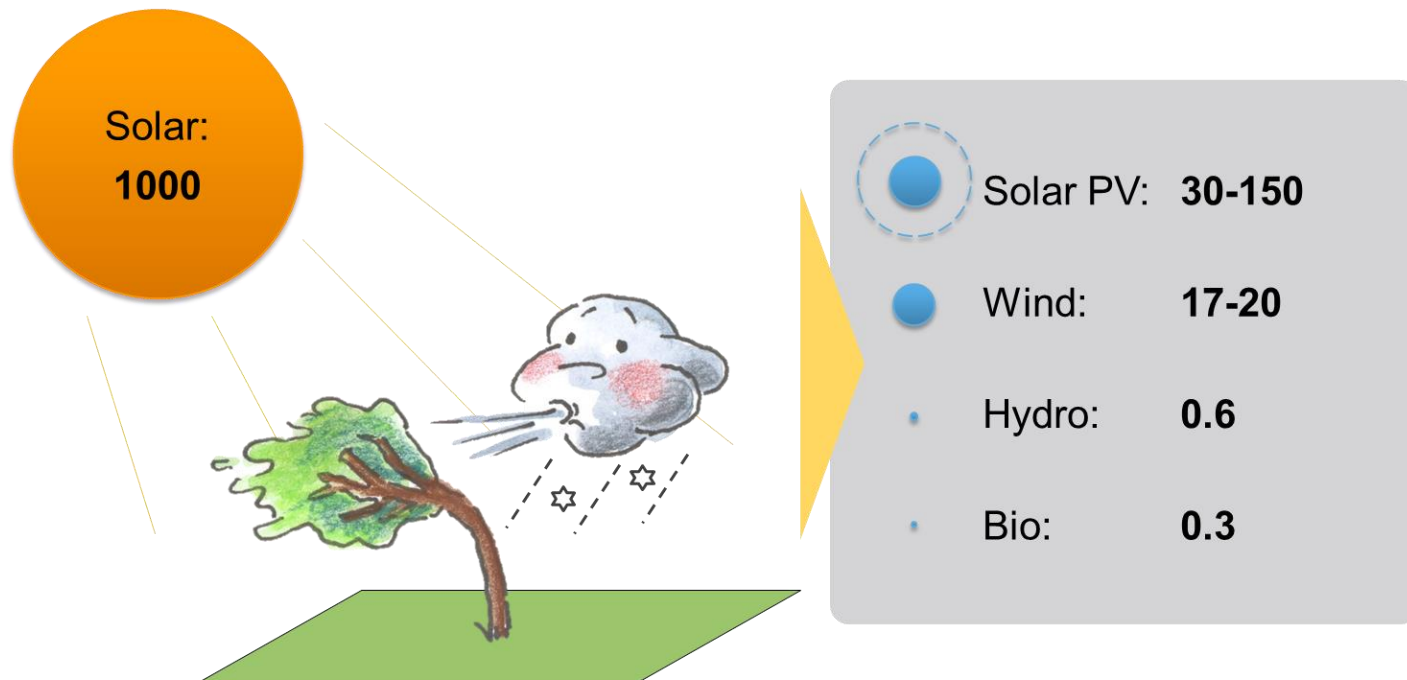
31

...€/MWh
average spot
price in 2017

16

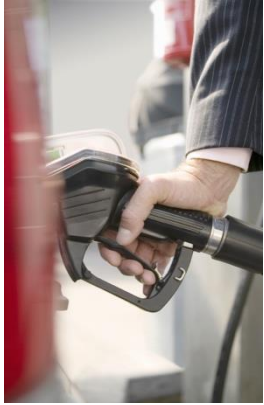
...TWh/yr
electricity
exported
2013-2017

If you want to replace fossil fuels – it matters what you can squeeze out of a piece of land



All numbers in kWh/m²/year

That's why...we want to electrify everything



THE TRANSPORT SECTOR



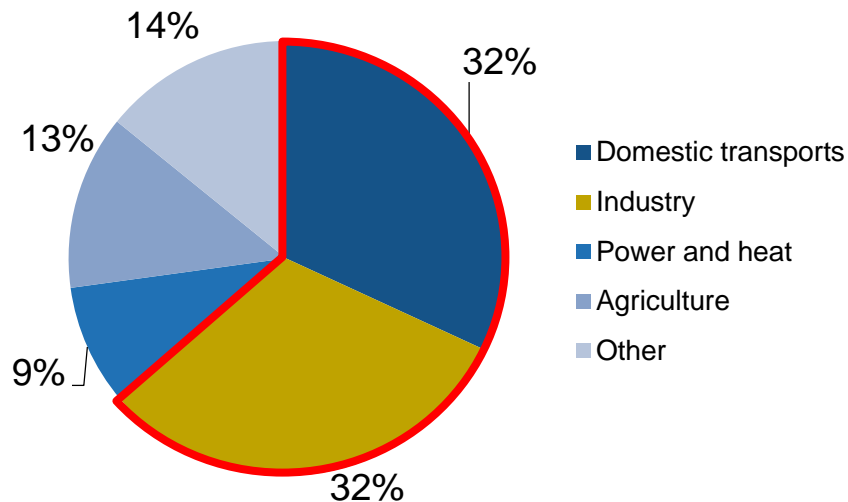
HEATING



THE INDUSTRY

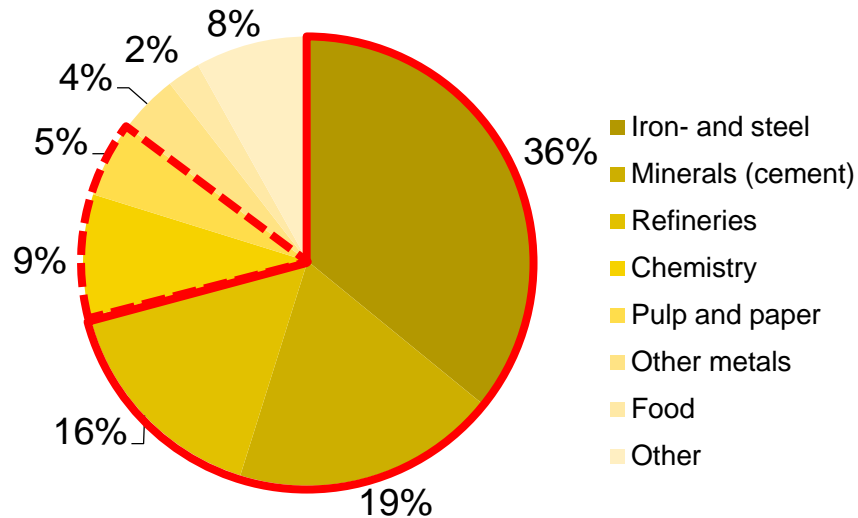
To live up to the Paris Agreement, Swedish industry and transports need to be handled

Total GHG emissions 2016



52.9 Mton

Industrial GHG emissions 2016



16.9 Mton

Fossil free steel with SSAB/LKAB



HYBRIT
▶▶▶ FOSSIL-FREE STEEL



+



=



+



Iron ore pellets

Hydrogen

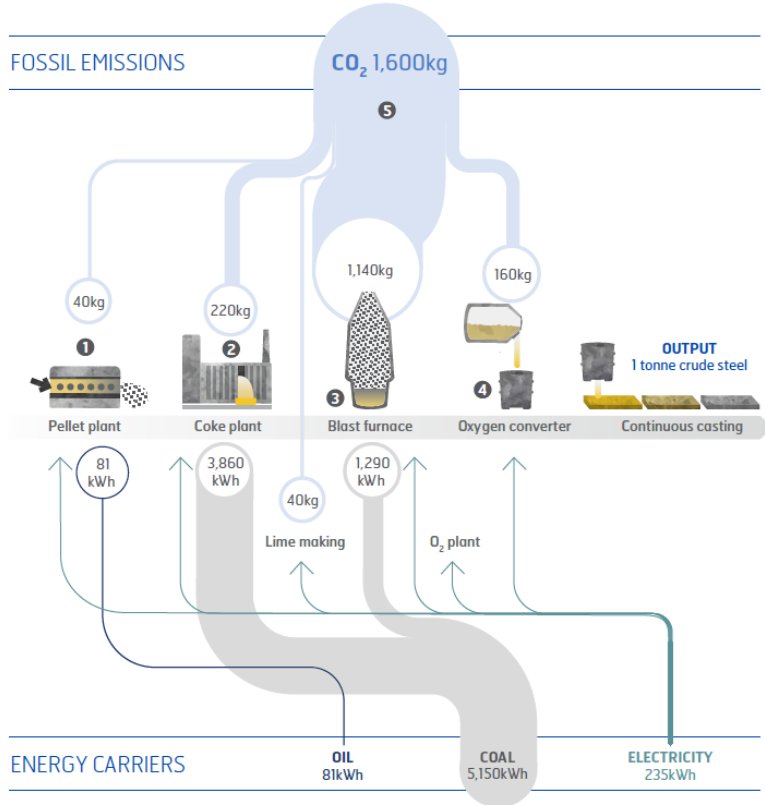
Sponge iron

Water

Close to complete elimination of CO₂

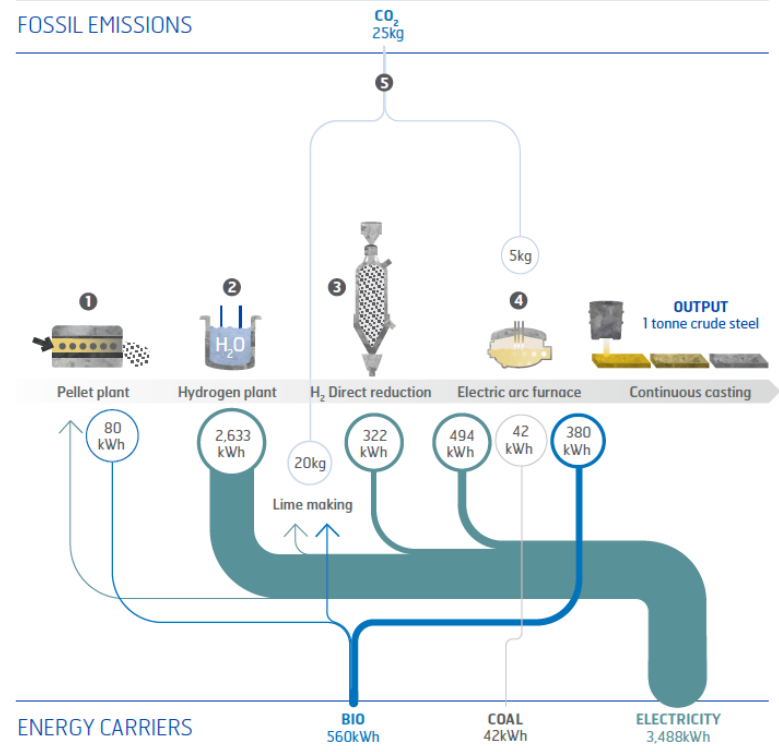
SWEDISH REFERENCE

FOSSIL EMISSIONS

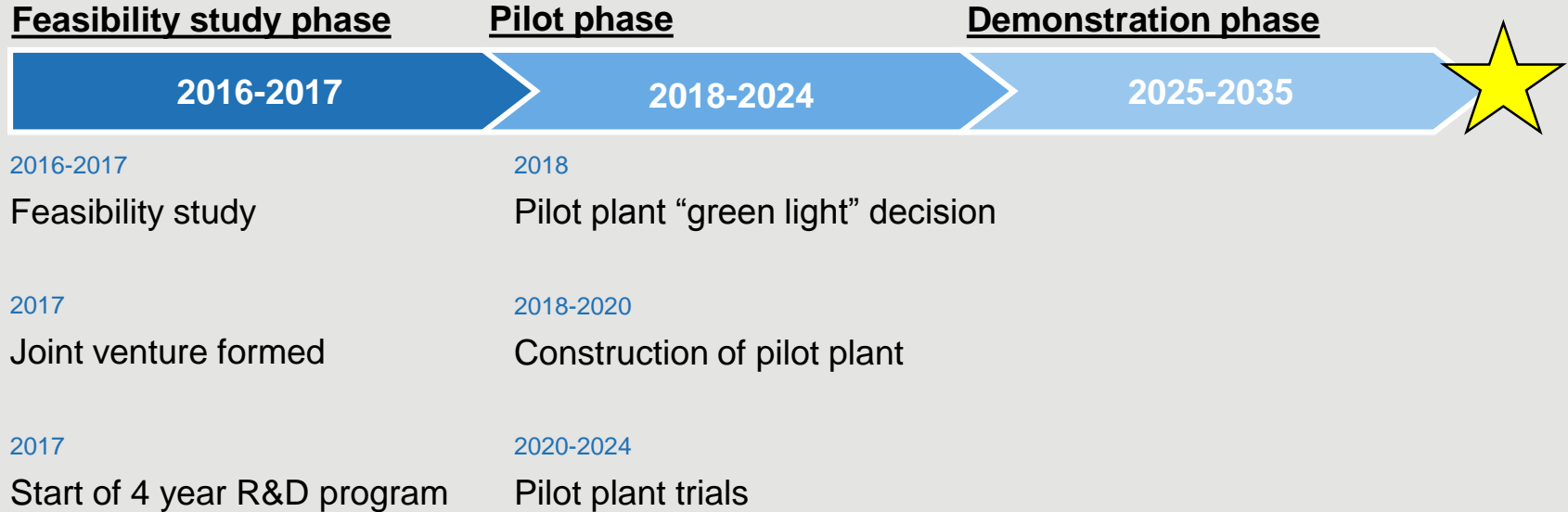


HYBRIT

FOSSIL EMISSIONS



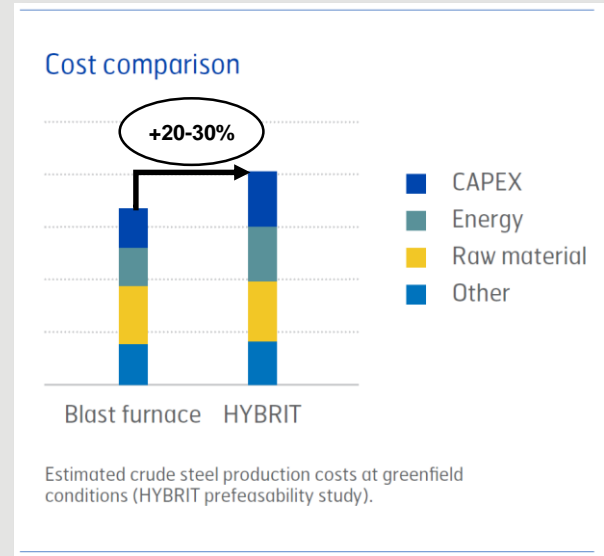
HYBRIT roadmap



HYBRIT – prefeasibility conclusions

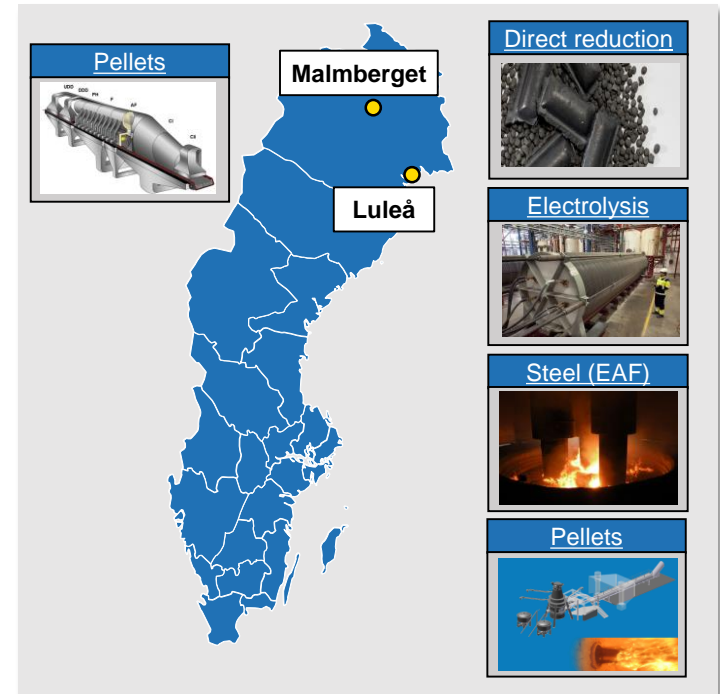
- No new major technical showstoppers identified
 - However, significant development efforts required to overcome main challenges
- 20-30% increase in crude steel production cost
 - Cost structure strongly dependent on prices of coking coal, electricity and CO₂ emission rights
 - Further optimisation possible
 - On the same level or better than competing alternatives
 - Anticipated shift in prices and market demands make fossil-free steel an attractive option
- Strengthened belief in the concept

→ Proceed with pilot plant (decision Feb 2018)



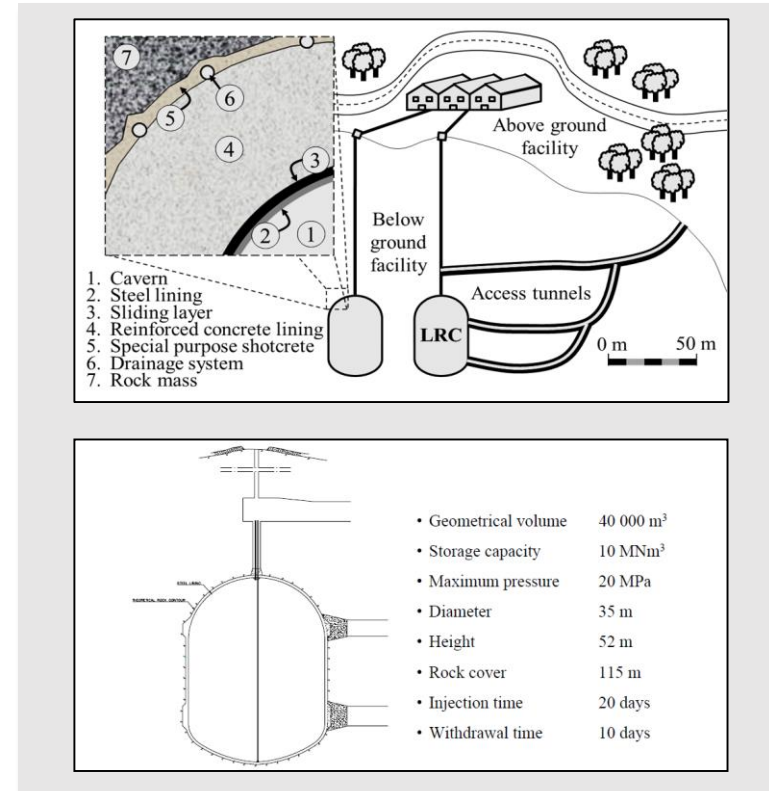
HYBRIT pilot plant - the next step

- Pre-engineering and design since January
- Location Luleå & Malmberget
 - Direct reduction: ~1 ton/h DRI
 - H₂: ~600-700 Nm³/h (~3-4 MW_e)
 - Steel (EAF): ~10 ton/batch
 - H₂ storage: TBD 2019
- Time schedule
 - Start groundwork summer 2018
 - Commissioning early 2020
 - Test campaigns 2020-2024
- Total cost 2018-2024 ~150 M€
 - Includes CAPEX + OPEX for whole test period
 - Co-funded by Swedish Energy Agency



H₂ storage – an important part of the HYBRIT concept

- Underground H₂ gas storage the most cost effective storage alternative
- Salt caverns not available in Sweden
- Lined Rock Cavern (LRC) storage promising alternative
- Natural gas LRC demo in operation in Sweden (Skallen) since early 2000
- Main challenges are 1) the liner material selection, and 2) rock mechanics at dynamic operation



HYBRIT pilot plant – ground breaking ceremony June 20th 2018



"The mind is like a parachute – it doesn't work if it's not open"
- Frank Zappa

Thank you

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