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IKI International Climate Initiative

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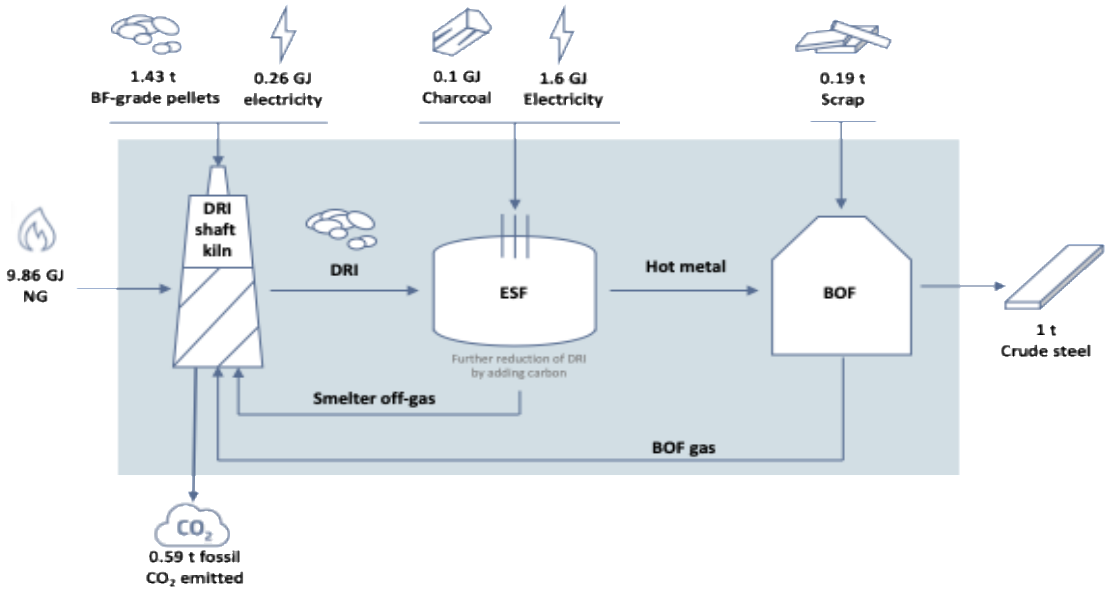
Steel

Direct reduction of iron with natural gas and steelmaking in the basic oxygen furnace (NG_DRI-ESF-BOF)

Description | Iron ore is reduced in a vertical shaft furnace using natural gas[1] as reducing agent at temperatures below the melting point of iron. The resulting direct reduced iron (DRI) is smelted and further reduced in an electric smelting furnace (ESF) and processed into crude steel in a basic oxygen furnace (BOF)[2]. The BOF is charged with fixed shares of DRI and scrap.



Process inputs and outputs per t of crude steel[3]

	Unit	Value
Electricity demand	GJ	1.86
Natural gas	GJ	9.86
Charcoal	GJ	0.1
Low-grade pellets	t	1.43
Scrap	t	0.19
CO_2 emissions (scope-1)	t CO_2	0.59
CO_2 emissions (scope-2)*	t CO_2	0.27
CO_2 captured	t CO_2	-

*Assumed emission intensity of electricity: 516 g CO_2/ kWh_{el}

Key characteristics:[4]

- Replacement of conv. plants (except BOF)
- CO_2 emission reduction (scope-1) compared to conventional BF-BOF: 67%
- Cost increase of steel production compared to BF-BOF (w/o CO_2 costs): 50%–55%
- CO_2 avoidance costs: 165–183 $/t CO_2

Key requirements:

- Access to natural gas grid

Applicability to the Kazakh context:

- Applicable in KZ "sweet spots" that have access to NG-grid and are close to iron ore mining, such as Rudny
- Most cost-effective option for significant near-term (before 2035) CO_2 reduction
- For achieving near-zero steel production in the longer term a "second step" is required (H_2-DRI or NG_DRI+CCS)

[1] Besides natural gas further reducing gases can be used: hydrogen, coal-derived syngas, bio-based syngas
[2] Another route processes the DRI in an electric arc furnace
[3] The system boundary for the shown values is iron and steel production up to crude steel
[4] More information and assumptions are provided in the final report of the DeKaMe project (https://epub.wupperinst.org/frontdoor/index/index/docId/8779)

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