UCL

Synergies and complementarities between climate and circular economy policies

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UCL Institute for Sustainable Resources

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CircularMetal

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Context

A pathway towards 1.5°C requires substantial economic, societal and technological transformations (IPCC 2018).

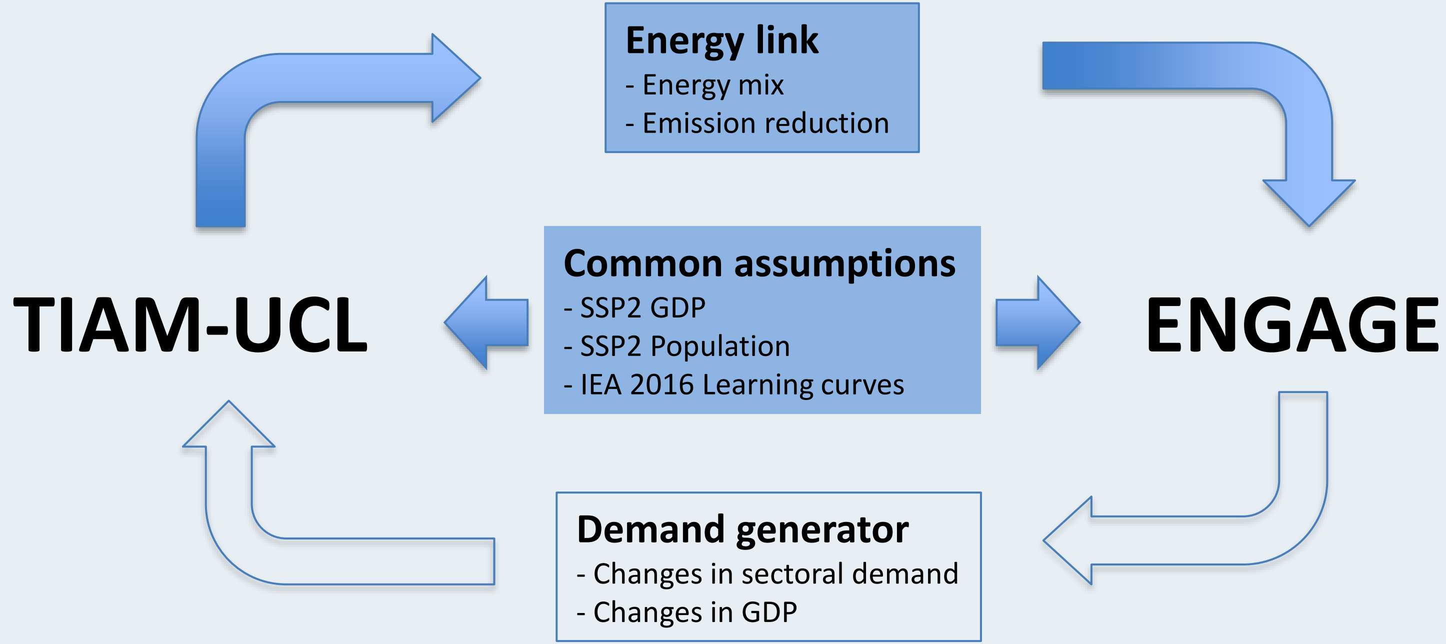
Technological breakthroughs and policy measures targeting energy efficiency and clean energy alone will not suffice to deliver Paris Agreement.

All sectors require deep and immediate emissions reductions. Heavy industry (steel, cement and chemicals) and heavy-duty transport (trucking, shipping and aviation) are responsible for around one-third of global CO2 emissions (ETC 2018).

The decarbonisation potential of these sectors might lie in transforming linear economic models into closed-loop industrial ecosystems and in shifting lifestyle patterns towards this direction.

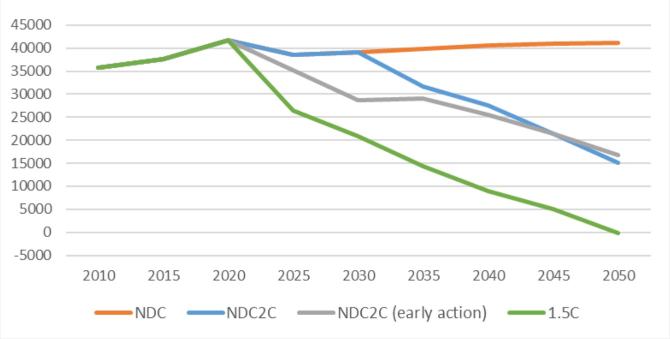
The current literature and research communities are fragmented. It needs an integrated assessment of circularity, decarbonisation, and sustainable development.

Modelling framework

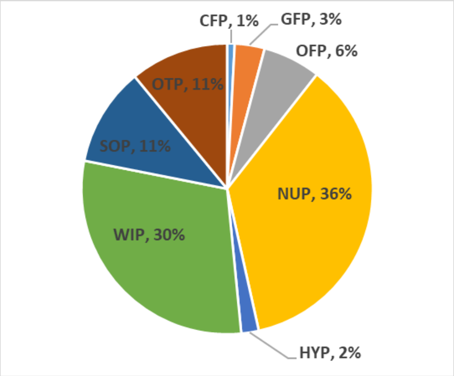


Decarbonisation modelling

TIAM-UCL CO2 emissions (MtCO2)
(energy and process emissions)

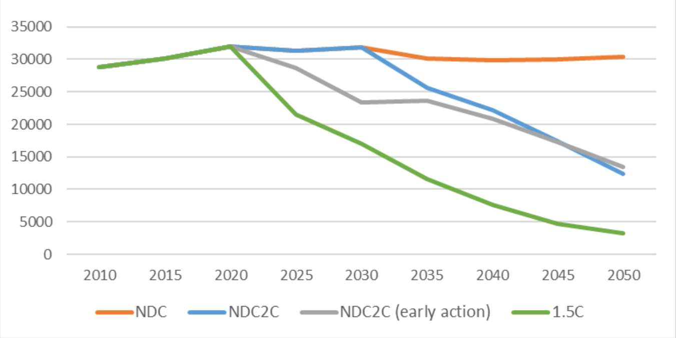


TIAM-UCL USA power mix

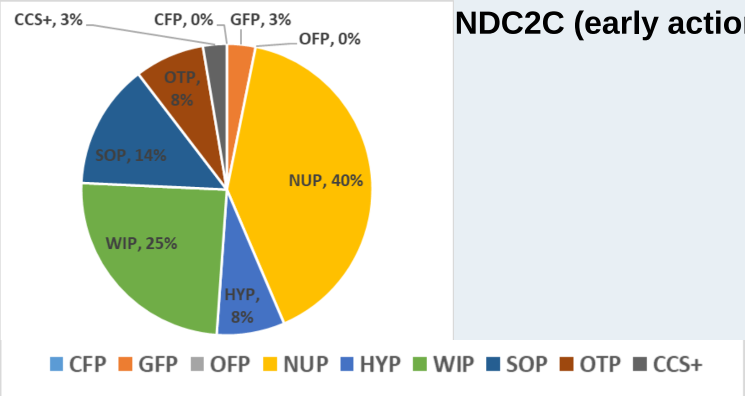


NDC2C (early action)

ENGAGE CO2 emissions (MtCO2)
(energy emissions)



ENGAGE USA power mix



NDC2C (early action)

ENGAGE-Materials model

Environmental Global Applied General Equilibrium (ENGAGE) model

Global CGE model

Recursive dynamic

Based in GTAP9-Power 2011

Steel in a circular economy context

Int Econ Econ Policy (2017) 14:383–407
DOI 10.1007/s10368-017-0385-3

ORIGINAL PAPER

Towards a circular economy: insights based on the development of the global ENGAGE-materials model and evidence for the iron and steel industry

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Published online: 5 July 2017

Abstract A number of recent economic modelling studies have attempted to analyse resource efficiency and the circular economy. However, modelling analysis in this area is relatively underdeveloped. In particular, many CGE models are unable to provide significant insight given their aggregated sectoral coverage. Here we describe the development of the Environmental Global Applied General Equilibrium (ENGAGE-materials) model created to consider the economic and sectoral effects of potential policies on a circular economy and resource efficiency, which affect materials and

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Steel in a circular economy: Global implications of a green shift in China

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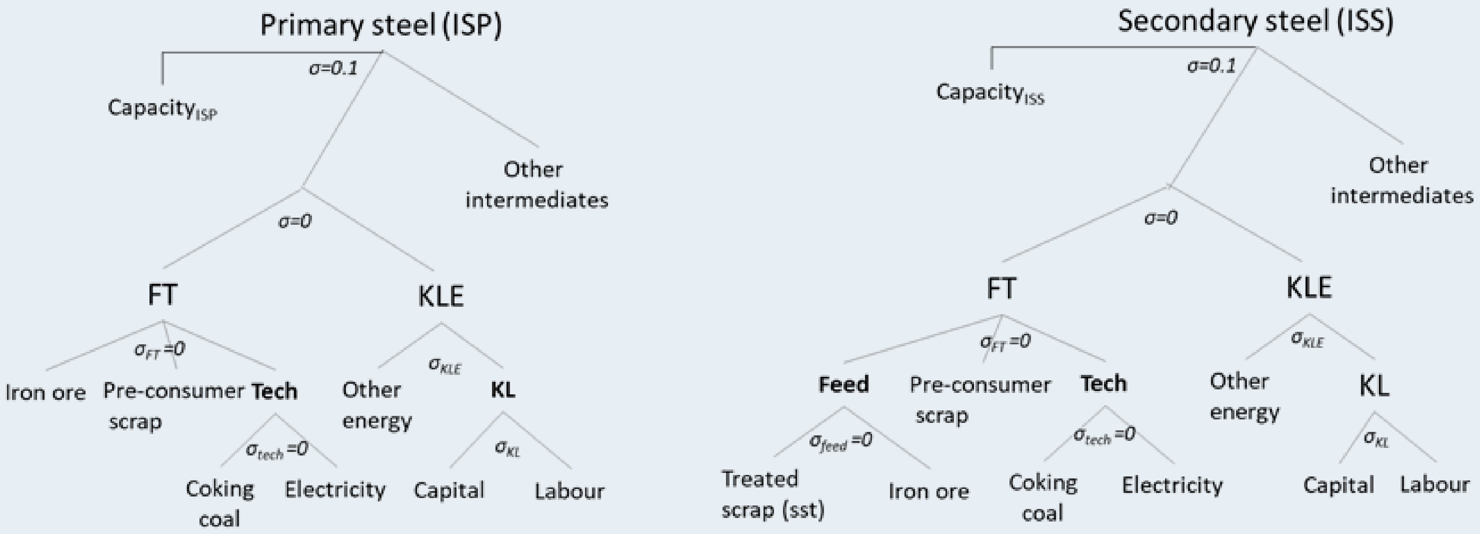
ABSTRACT

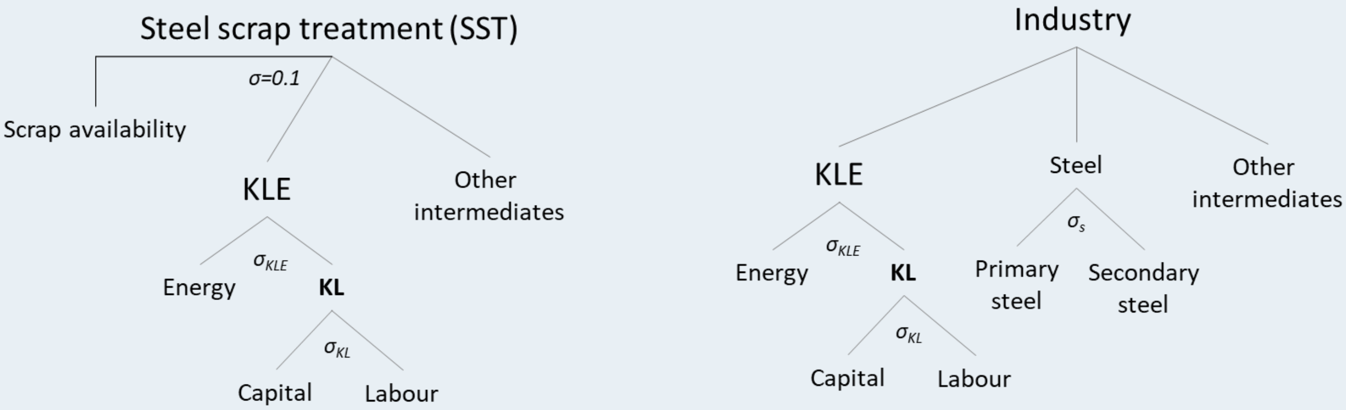
China is increasingly known for its ambitions towards an 'ecological civilisation' and a circular economy. Our article assesses the implications of an accelerated shift towards steel recycling in China. Given the relevance of steel for development worldwide as well as its environmental intensity, any such shift is likely to have implications for competitiveness in China and beyond. Recent findings suggest that China could take advantage of an increasing availability of obsolete steel scrap in the coming decades, moving towards more circular, and potentially greener, steel production. We assess such industrial restructuring from an economic perspective and address the competitiveness of China relative to other developing and industrialised regions. The analysis uses a novel global economy-wide modelling framework (ENGAGE-materials) to assess the aggregate and sector-level impacts of different scrap use options in China in the 2019–2030 time frame. The results show moderate GDP gains for China of cumulated USD 589 billion in GDP gains by 2030 despite a replacement of primary steel capacity. A more comprehensive industrial policy mix aimed at improved recycling practices and more adaptive downstream sectors could increase gains to USD 819 billion. The international implications are mixed, with losses for iron ore producers (Australia, Brazil and India) and gains for most developing countries benefiting from lower steel prices. Another result is an increasing demand for coal in electricity production if such a shift wouldn't be aligned with an accelerated energy transition towards low carbon pathways. We discuss policy implications of such alignment, potential co-benefits, and a need for green international partnerships.

18 Regions		33 Sectors	
AFR	Africa	AGR	Agriculture and food
AUS	Australia	I_M	Iron mining
CAN	Canada	O_M	Other minerals mining
CHI	China	WOP	Wood products
CSA	Central and South America	PPP	Paper products publishing
EEU	Eastern Europe	CRP	Chemical rubberplastic prods
FSU	Former Soviet Union	ISP	Primary steel
IND	India	ISS	Secondary steel
JPN	Japan	SST	Steel scrap treatment
MEA	Middle-east	NFM	Non-ferrous metals
MEX	Mexico	NMM	Non-metallic minerals
ODA	Other Developing Asia	MTP	Metal products
SKO	South Korea	MVT	Motor vehicles and transport equipment
USA	USA	ELE	Electronic equipment
WEU	Western Europe	MAE	Machinery and other equipment
RUS	Russia	OMA	Other manufacture
IDN	Indonesia	COA	Coal
BRA	Brazil	OIL	Crude oil
		GAS	Gas
4 Endowments		P_C	Petroleum & Coke
LND	Land	TnD	Transmission and distribution
LAB	Labor	NUP	Nuclear power
CAP	Capital	CFP	Coal-fired power
RES	Natural Resources	GFP	Gas-fired power
		WIP	Wind power
		HYP	Hydroelectric power
		OFP	Oil-fired power
		OTP	Other power
		SOP	Solar power
		RCY	Recycling
		CNS	Construction
		TRA	Transport
		SER	Service

Modelling framework



Modelling framework

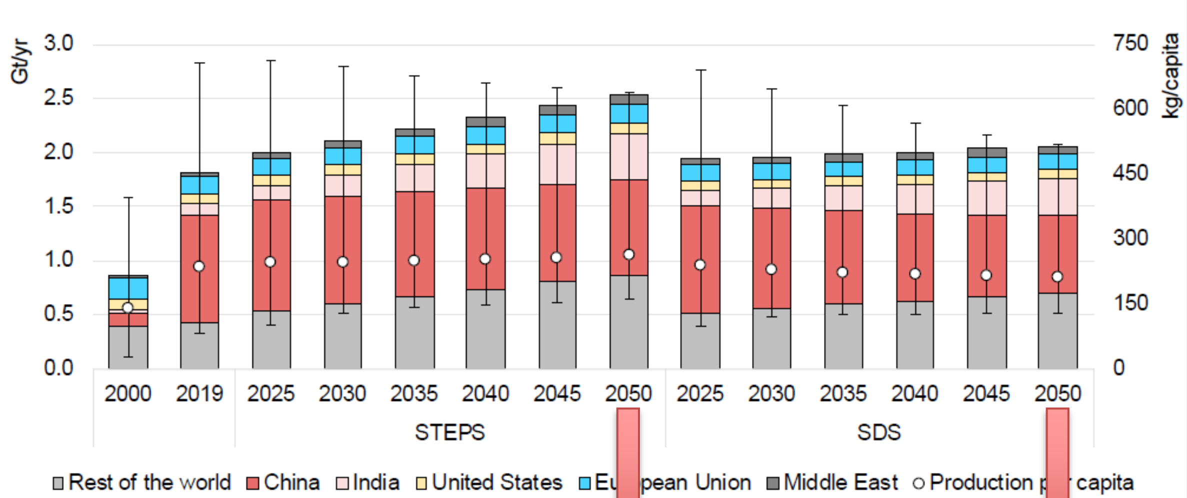


Iron and Steel Technology Roadmap, IEA (2022)

STEPS: Stated Policies Scenario

SDS: Sustainable Development Scenario

Figure 2.4 Regional steel production and production per capita by scenario



Source: IEA (2020

Scrap availability

Home scrap	178	124
Prompt scrap	326	198
End-of-life scarp	977	918
Iron ore and steel scrap	**1,480**	**1,240**

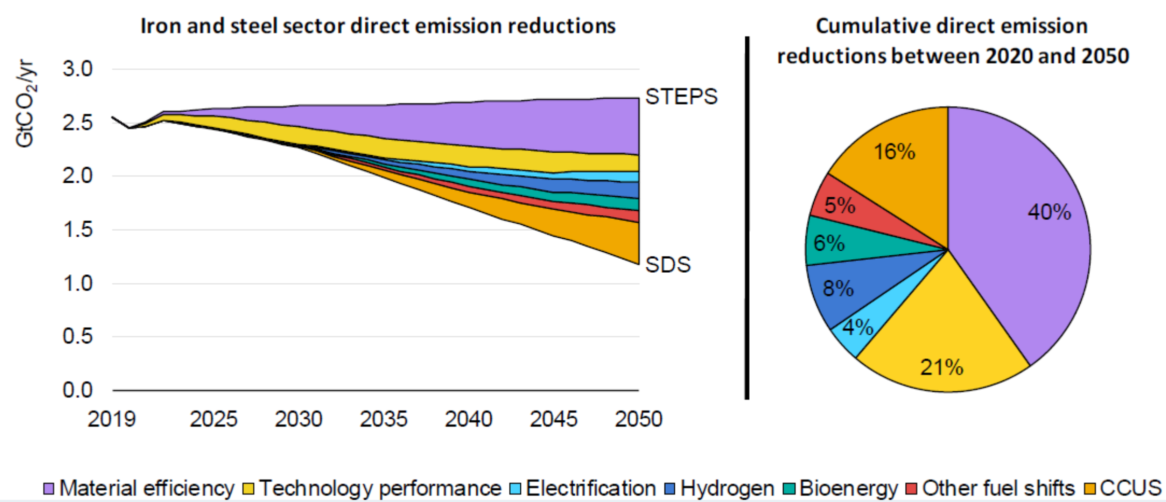
Iron and steel pathways

Iron and Steel Technology Roadmap, IEA (2022)

STEPS: Stated Policies Scenario

SDS: Sustainable Development Scenario

Figure 2.6 Iron and steel sector direct CO_2 emission reductions in the Sustainable Development Scenario by mitigation strategy



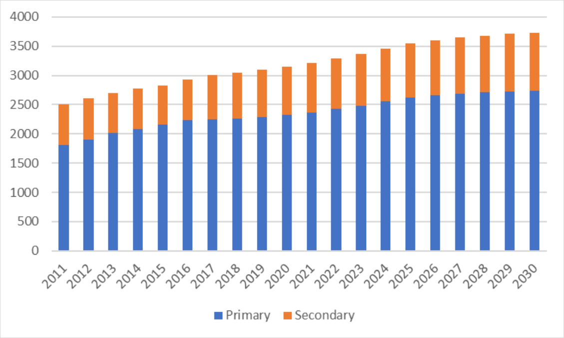
Source: IEA (2020

Climate and circular economy scenarios

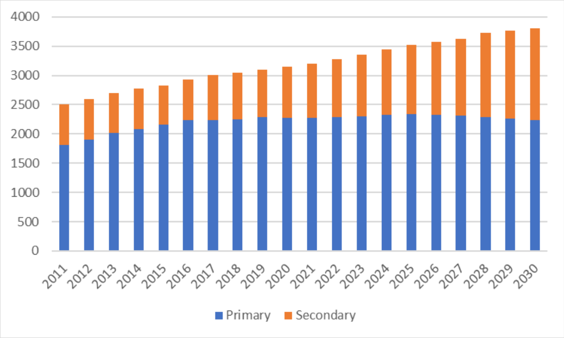
Scenario	Climate action	Circular steel action
BAU	NDC	STEPS (Baseline primary/secondary share)
SUSplus	NDC	SDS (Lower primary/secondary share) + downstream sectors
1p5	1.5C	STEPS (Baseline primary/secondary share)
SUSplus1p5	1.5C	SDS (Lower primary/secondary share) + downstream sectors

Results

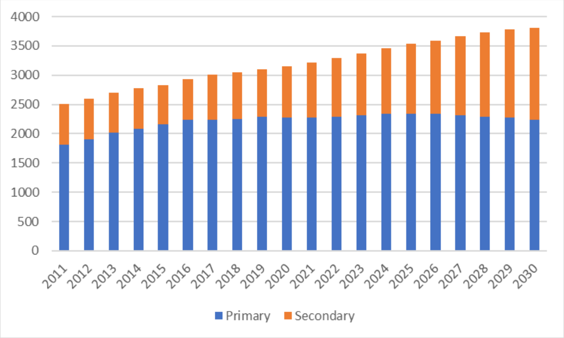
BAU – Steel production (million USD)



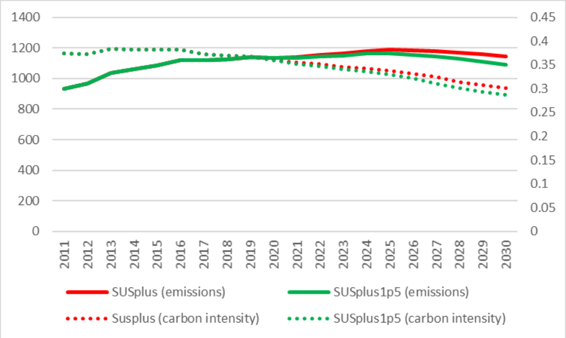
SUSplus – Steel production (million USD)



SUSplus1p5 – Steel production (million USD)

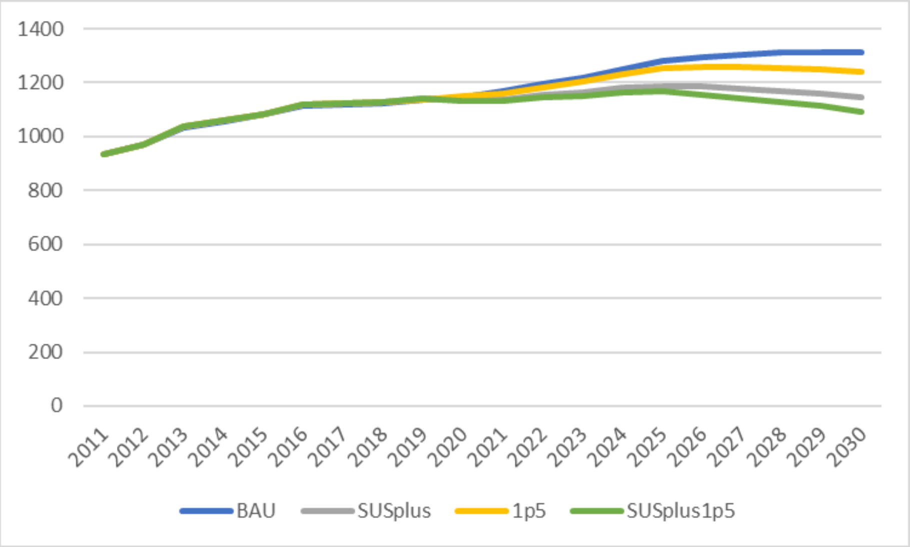


Emissions (MtCO2) and **Carbon intensity**



Results

Steel Emissions (Primary and Secondary) (MtCO2)



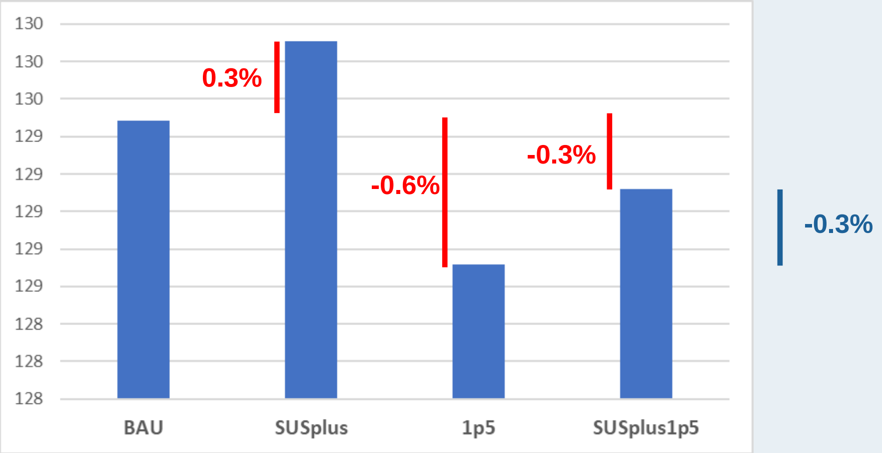
SUSplus1p5 - Steel Industry Emissions (MtCO2)

	2019	**2030**	**Change (%)**
Primary	1055	962	
Secondary	85	131	
Subtotal	**1139**	**1093**	**-4%**
Steel scrap	19	3	
Iron ore mining	62	16	
Total	**1220**	**1112**	**-9%**

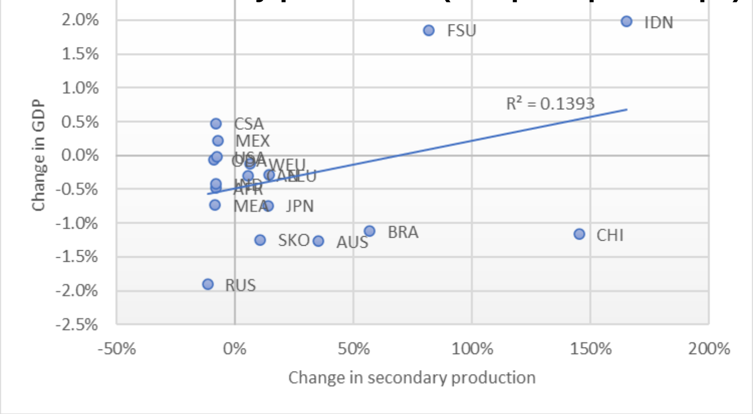
SUSplus1p5 - Steel Industry Emissions (MtCO2)

Results

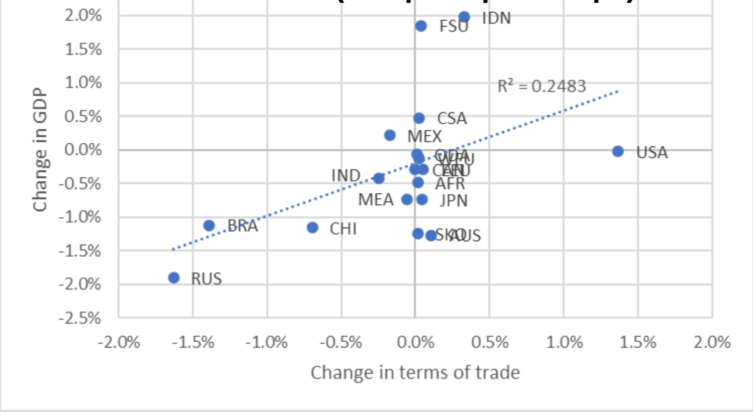
Global GDP (Trillion USD)



GDP vs Secondary production (SUSplus1p5 wrt 1p5)



GDP vs Terms of trade (SUSplus1p5 wrt 1p5)



Conclusions

There is a need to assess the role and potential of the circular economy for climate change mitigation

Circular economy industries facilitates emission reductions and lower the economic cost of the energy transition.

Climate policies penalising fossil fuels use and renewable power production facilitates an early transition towards a more circular steel industry, replacing coke/iron-based steel production with electricity/scrap-based steel production.

However, this type of steel decarbonisation is dependant on scrap availability. Long-term scenario need to asses the role of technological changes in the steel industry (e.g. Hydrogen, CCUS)