

# 2021 SWITCH-Asia Leadership Academy on Technology for A Circular Economy



**ELLEN MACARTHUR  
FOUNDATION**

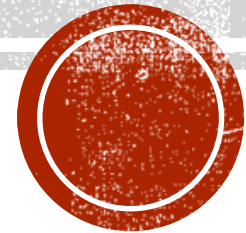
## Introduction to Circular Economy

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Tongji University

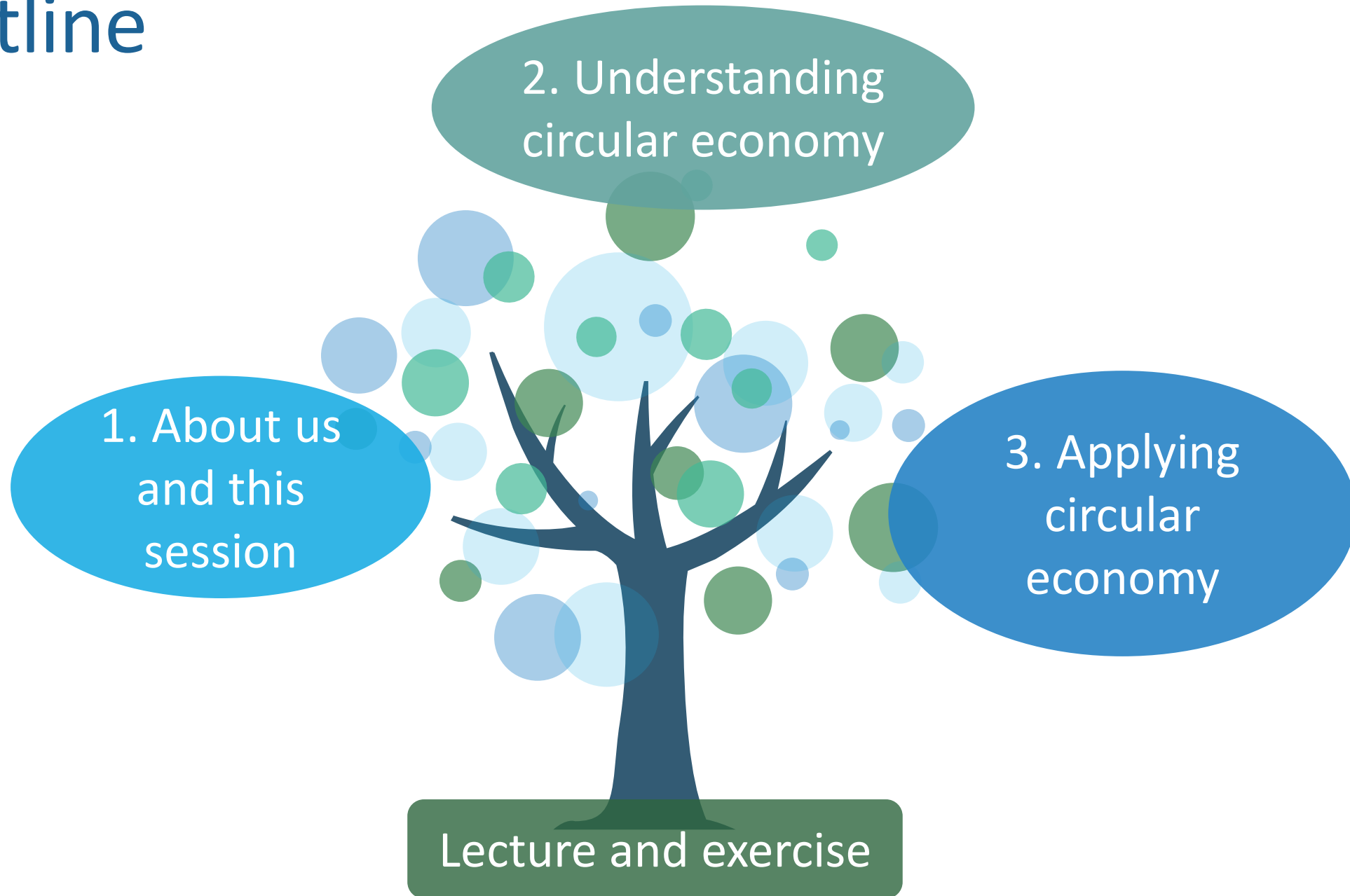
Chuan Fan

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6 September 2021

# Outline



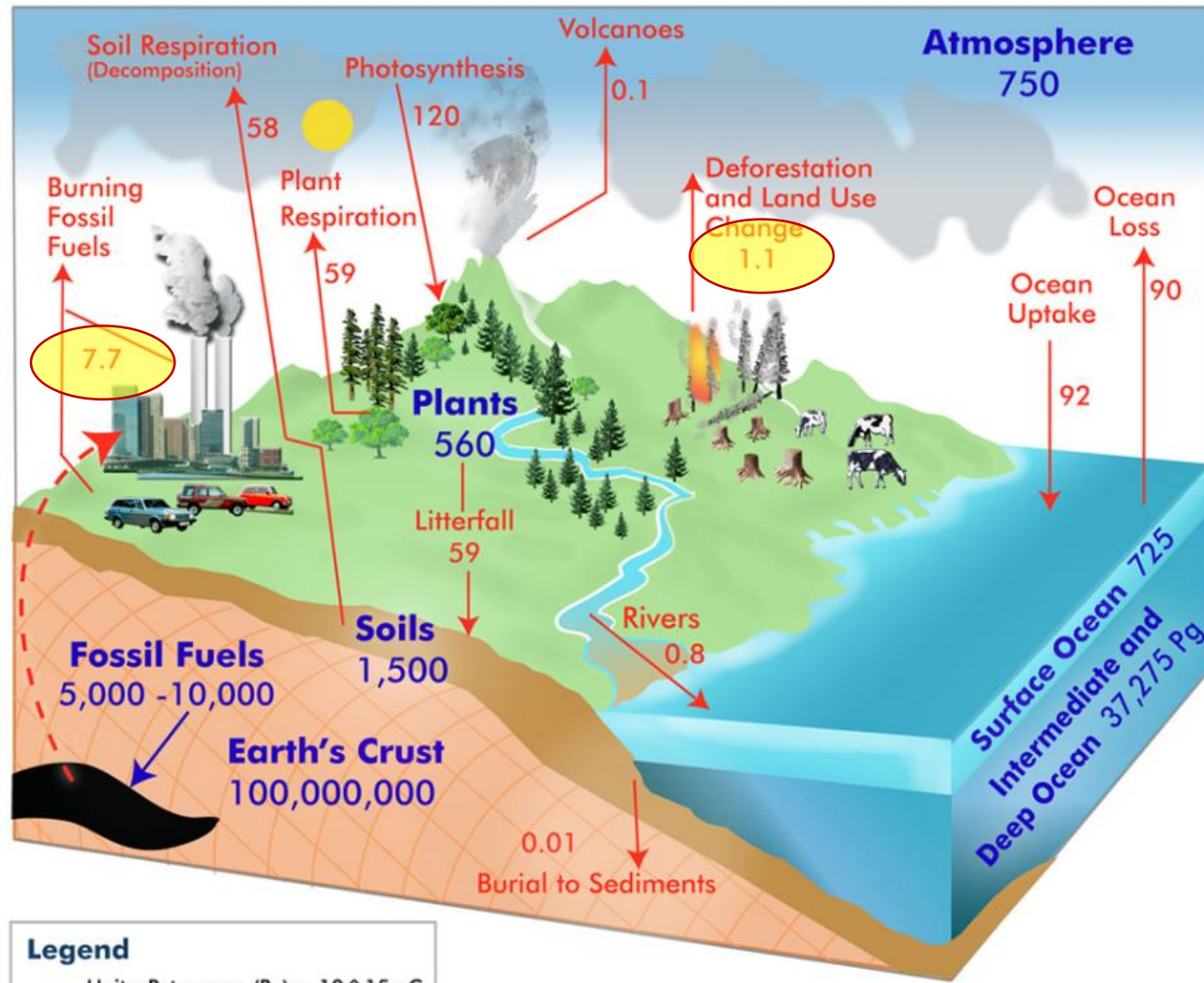
We are living in a  
**Material Cycling**  
world!

# Spaceship Earth

- K.E. Boulding (1966). *The Economics of the Coming Spaceship Earth*
- Transition from the **open unlimited 'cowboy' economy** to the 'spaceman' economy
- The closed economy of the future might similarly be called the **'spaceman' economy**, in which the Earth has become a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution, and in which, therefore, man must find his place in a **cyclical ecological system**



# Biogeochemical cycle for Element Carbon

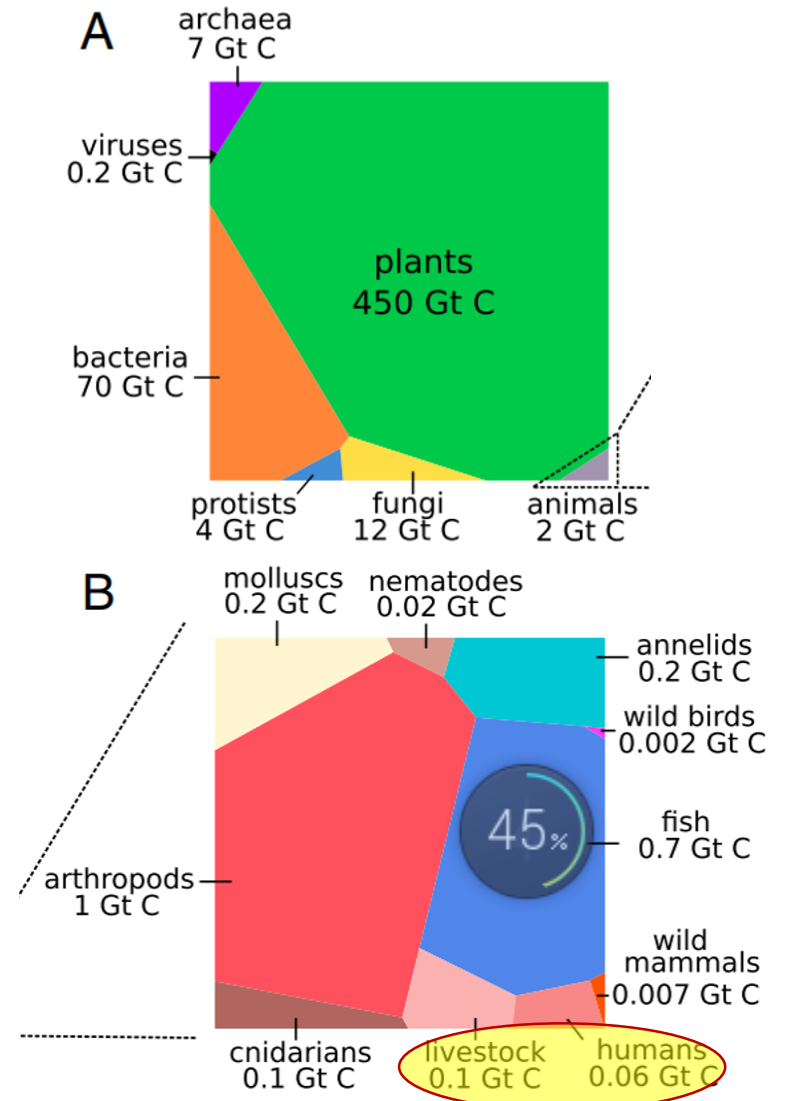


**Legend**

Units: Petagrams (Pg) =  $10^{15}$  gC

- Pools: Pg
- Fluxes: Pg/year

Source: NASA, 2010



Source: Bar-On et al., 2018



# “Circular Economy” term created

D.W. Pearce and R.K. Turner (1989). *Economics of Natural Resources and the Environment*. Johns Hopkins University Press

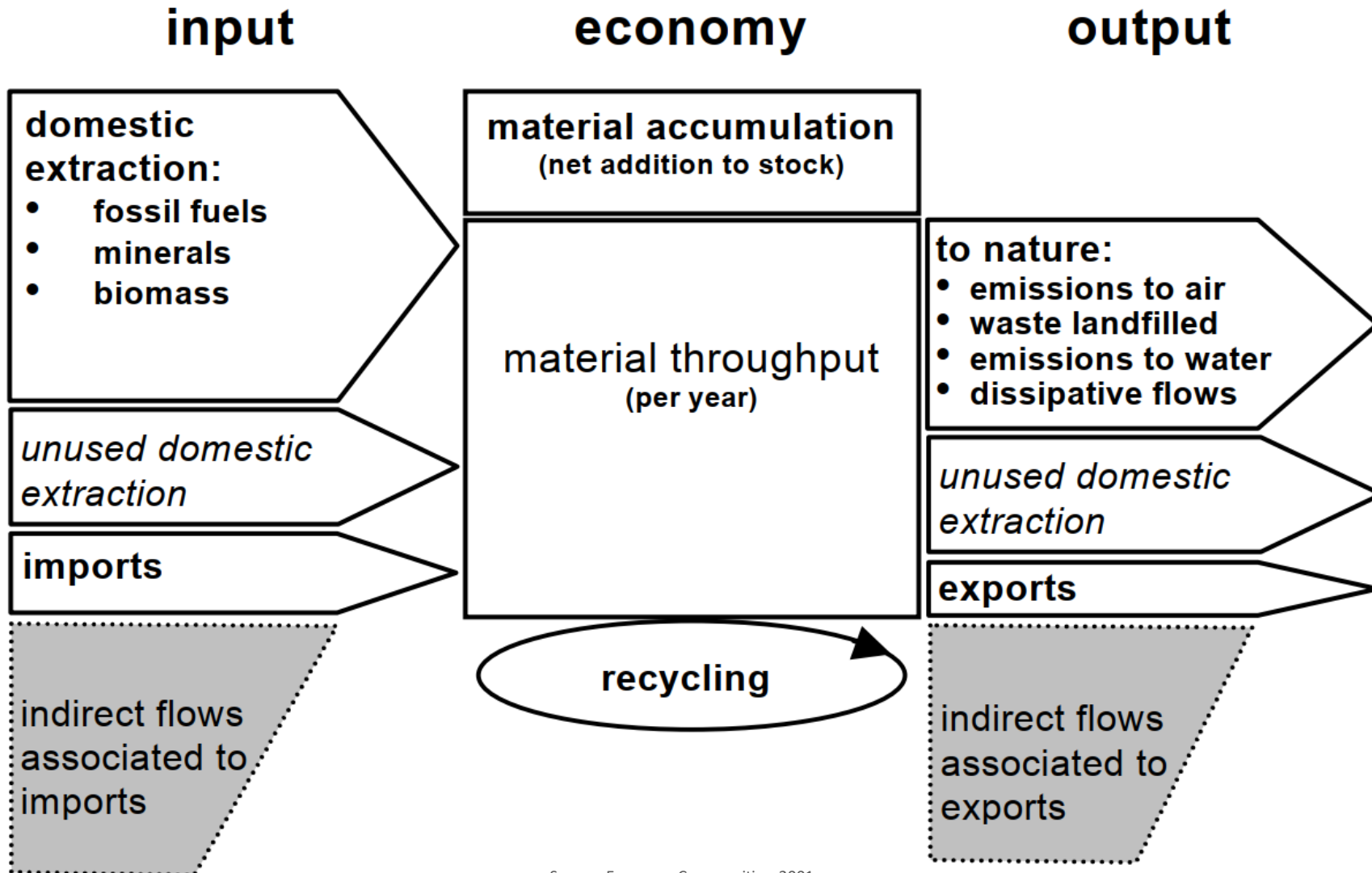


Preface and Acknowledgements	xi
PART I: ECONOMY AND ENVIRONMENT	
<b>Chapter 1 The Historical Development of Environmental Economics</b>	<b>3</b>
1.1 Introduction	3
1.2 Early Economic Paradigms and the Environment	4
1.3 Post-War Economics and the Rise of Environmentalism	12
1.4 Institutional Economics Paradigm	15
1.5 The Market Model of Environmental Management	16
1.6 Policy Analysis: Fixed Standard versus Cost-Benefit Framework	20
1.7 Economic and Environmental Values	21
1.8 Sustainable Economic Growth and Development	23
1.9 Ecological and Co-evolutionary Economic Paradigm	25
1.10 Conclusions	26
<b>Chapter 2 The Circular Economy</b>	<b>29</b>
2.1 Narrow and Holistic Views of Economies and Environments	29
2.2 The Environment-Economy Interaction	31
2.3 The Circular Economy	35
2.4 Existence Theorems	41
<b>Chapter 3 The Sustainable Economy</b>	<b>43</b>
3.1 Rules for Sustaining Closed Economies	43
3.2 Complementarity and Trade-Offs	44
3.3 Maintaining the Natural Capital Stock	48
3.4 The Meaning of Constant Capital Stock	52
3.5 Existing and Optimal Capital Stocks	53

# What is circular economy?

- Circular economy is an economic system aimed at minimizing waste and maintaining the value of products, materials and resources for as long as possible (*IRP and UNEP, 2019*)
- Circular economy is a **revolution** to today's **linear economy** that vastly extracts and uses natural resources and vastly discharges wastes

# Our economy today is largely linear





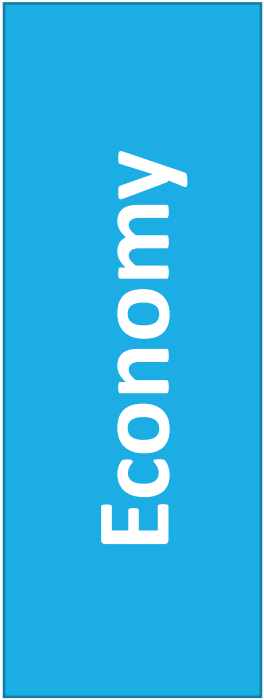
# Case: the Chinese economy

Water	<b>602</b>
Biomass	<b>4.2</b>
Fossil energy	<b>4.8</b>
Metal minerals	<b>3.6</b>
Nonmetal minerals	<b>22.6</b>

**Input**



Unit: Gt/a, ca. 2019



Carbon dioxide	<b>9.9</b>
Municipal waste	<b>0.24</b>
Industrial waste	<b>3.9</b>
C&D waste	<b>~1.8</b>
Agricultural waste	<b>~3.0</b>

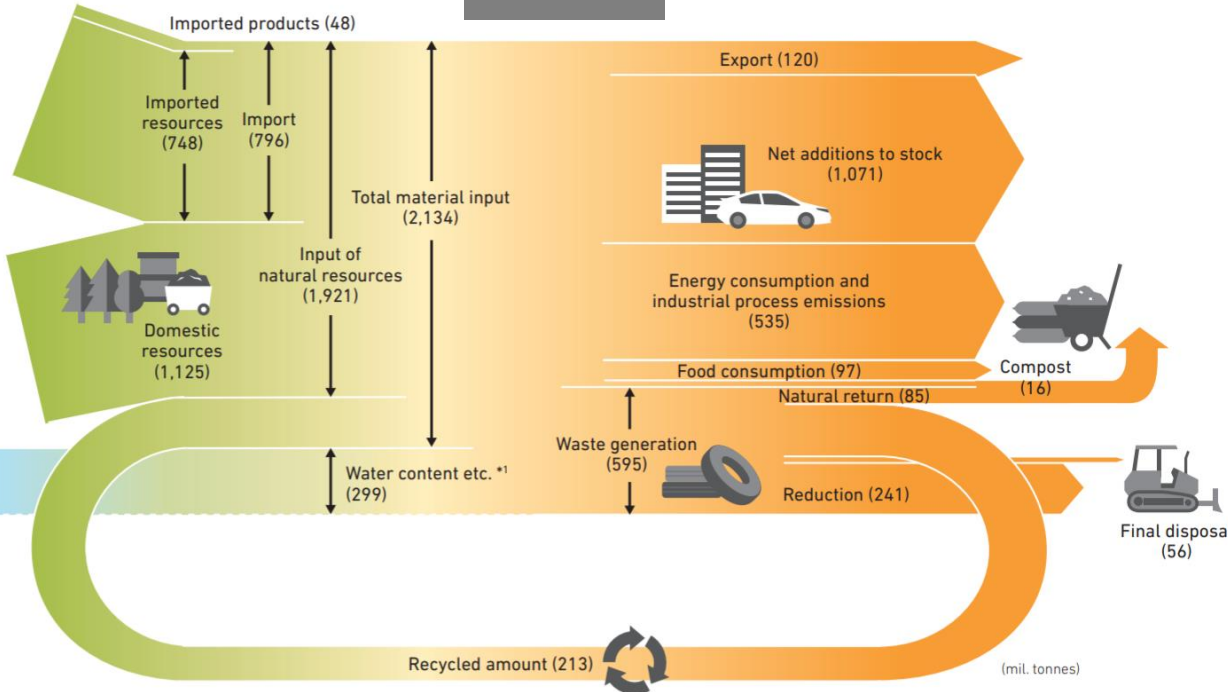


**Output**

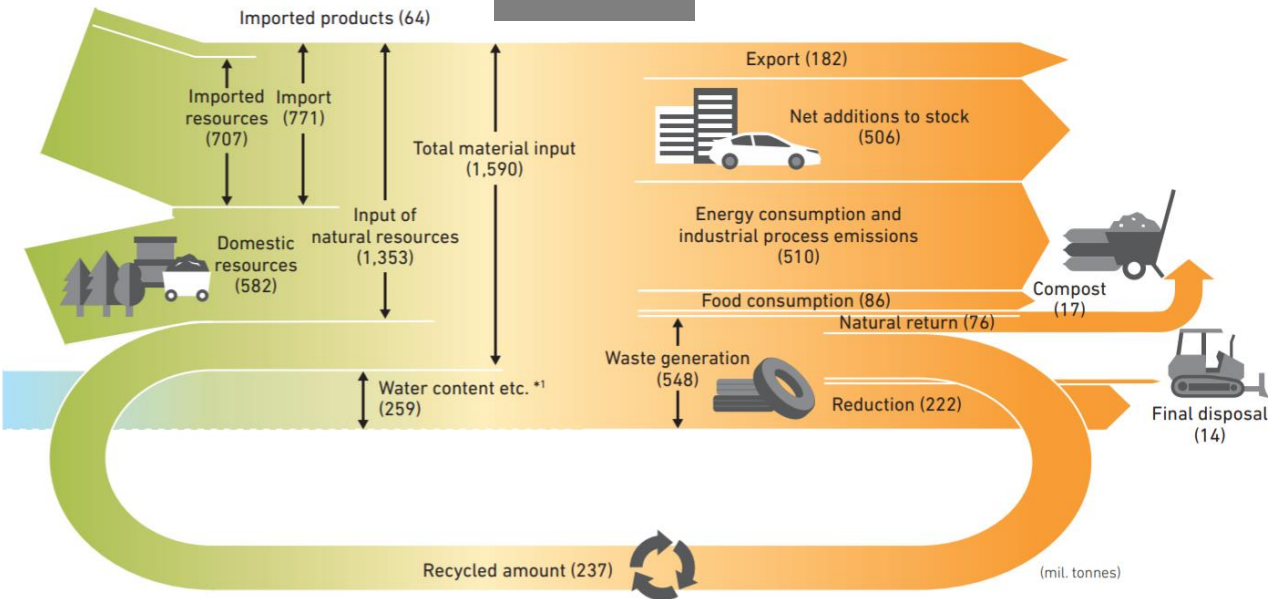
Metals	<b>0.25</b>
Paper	<b>0.052</b>
Plastics	<b>0.020</b>
Glass	<b>0.010</b>

# Case: the Japanese economy

**FY2000**



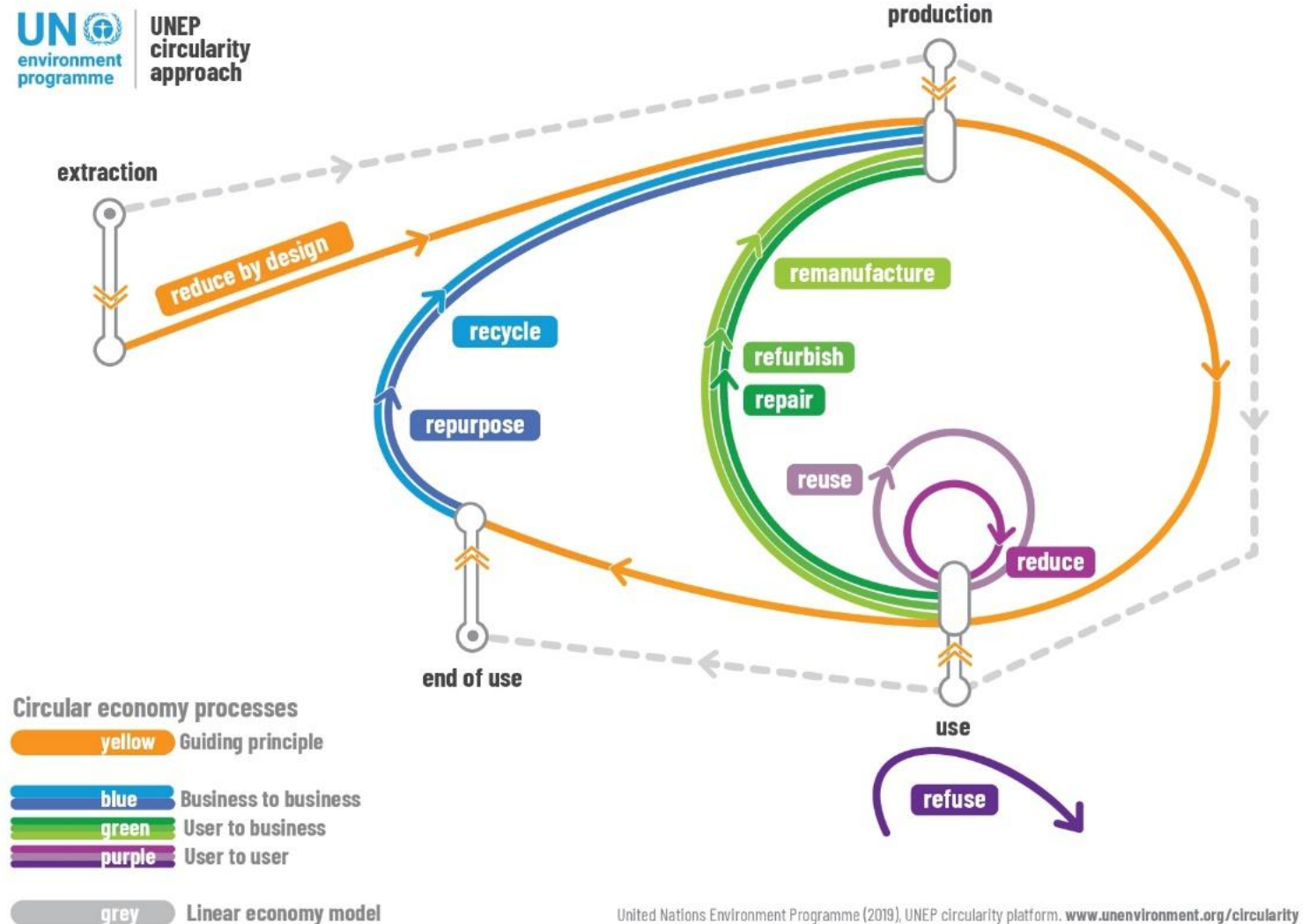
**FY2017**



Source: Ministry of the Environment

# CE approach: From 3R to 9R

- System: Reduce by design
- User2user: Refuse, Reduce, Reuse
- User2business: Repair, Refurbish, Remanufacture
- B2B: Repurpose, Recycle

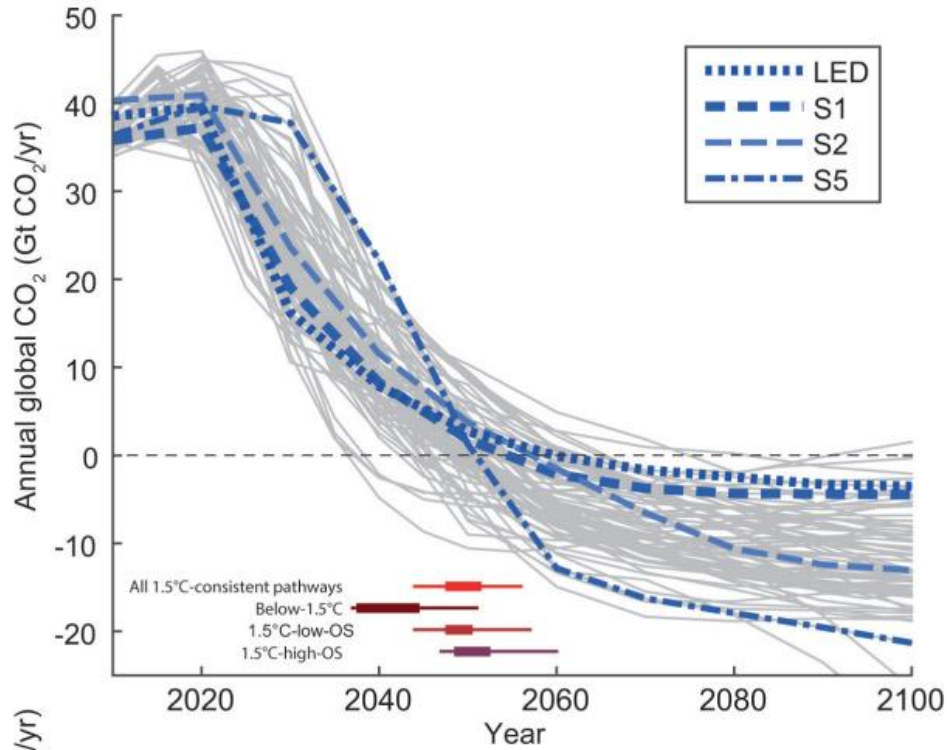


# SDGs: CE can help

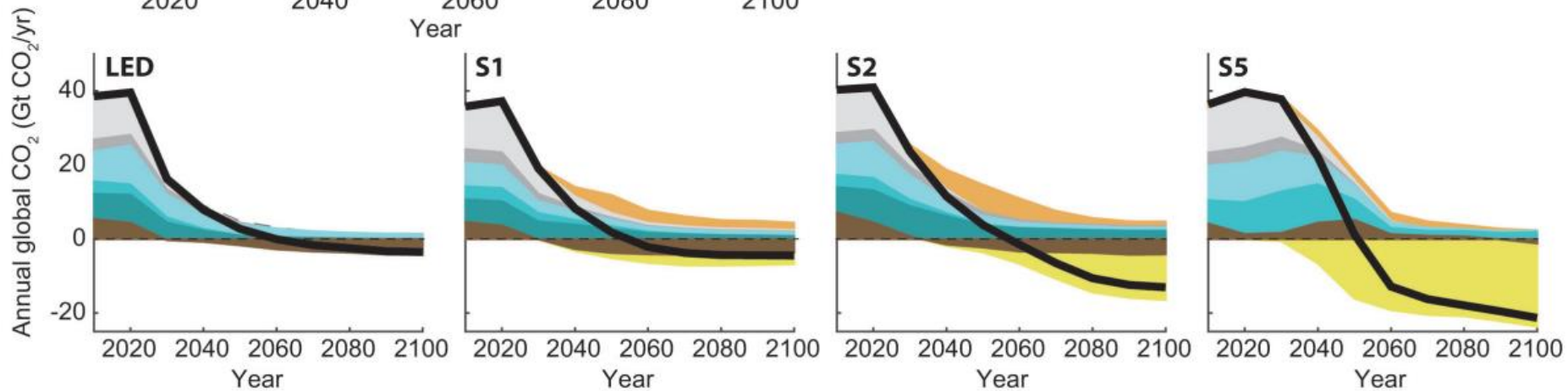
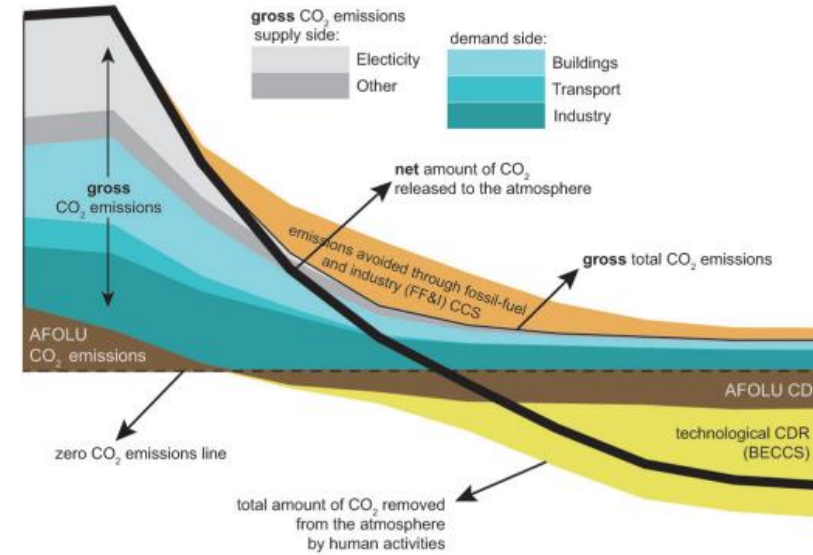


- **17** Sustainable Development **Goals** (SDGs), cover a broad range of development issues, in total **169 targets and 232 indicators**
- Heart of the *2030 Agenda for Sustainable Development* adopted by all UN members in 2015
- CE **directly relevant to many SDGs, including Goal 13** – Climate Action

# 1.5° C climate action



## LEGEND: EMISSION CONTRIBUTIONS

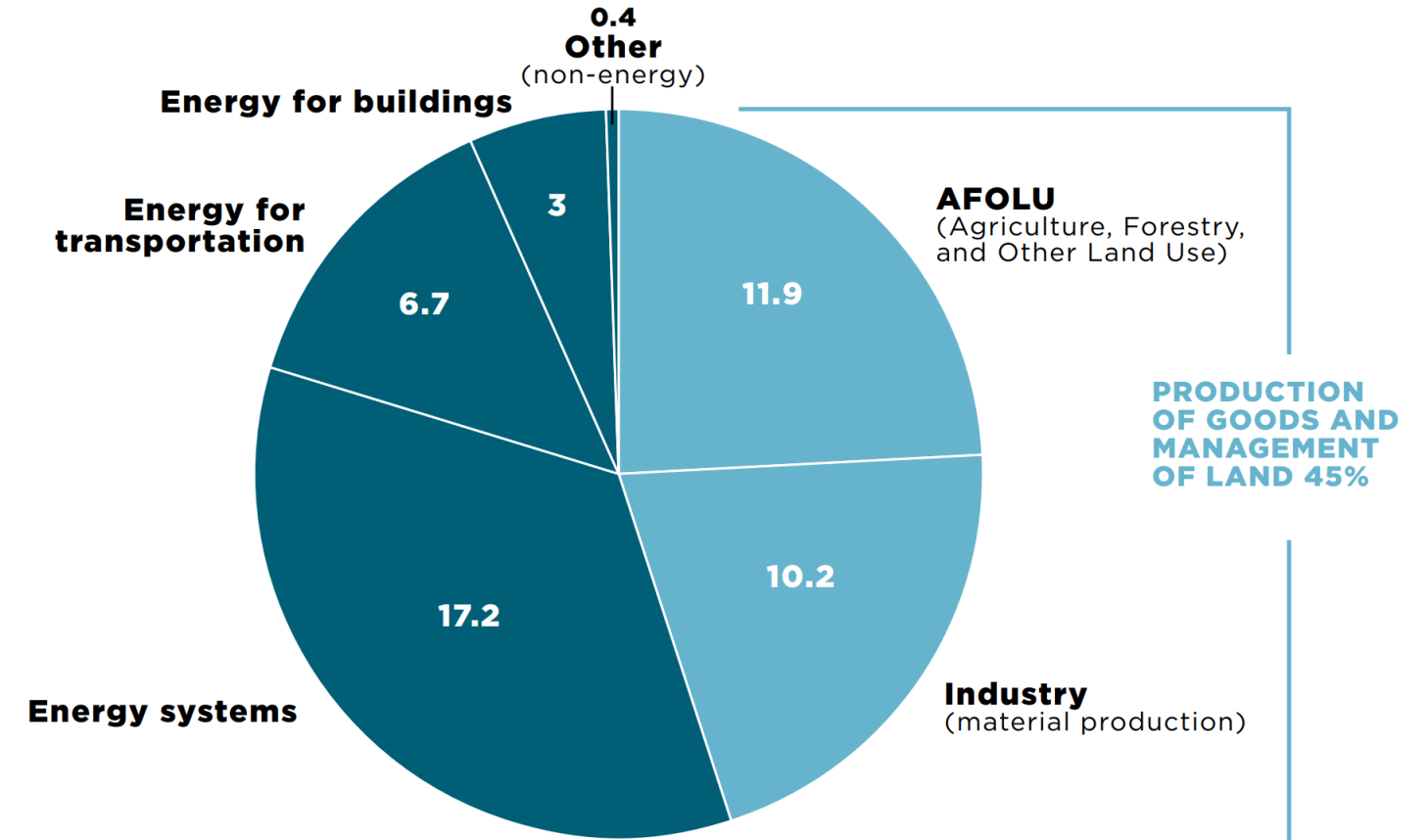


# CE contributes to climate action

- **45%** GHG emissions from the products cycle where CE can work
- Renewable energy transition also needs **critical materials** (Si, Li, Cu, RE, ...)

## Global GHG emissions

Billion tonnes of CO<sub>2</sub>e per year, 2010

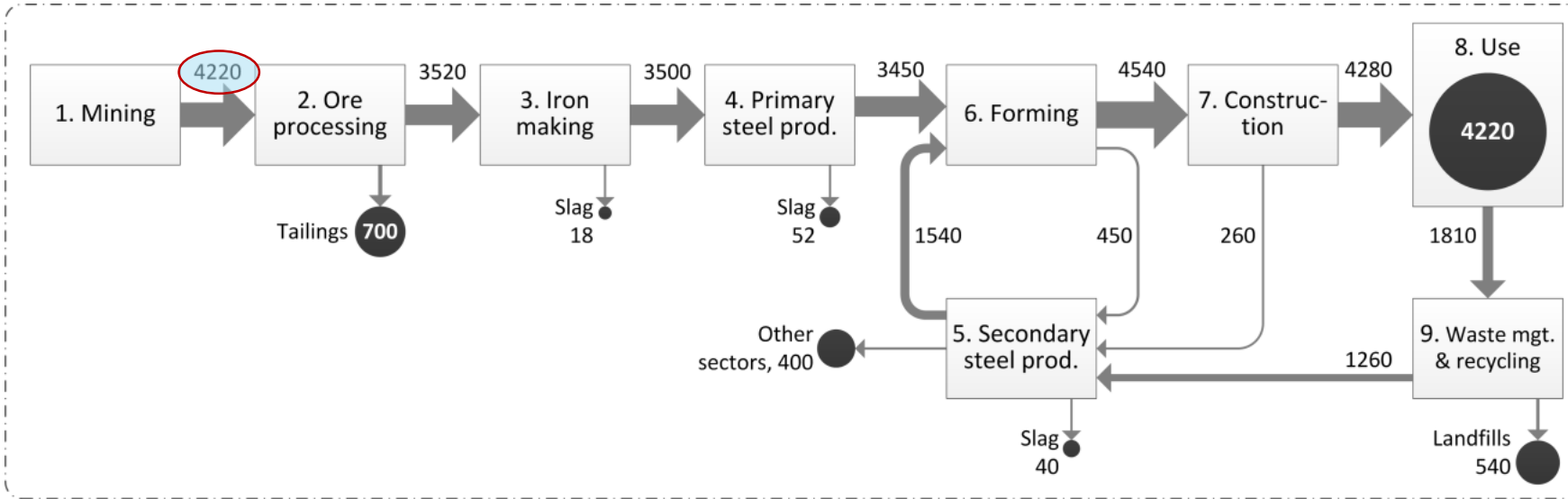


Source: Ellen Macarthur Foundation, 2019



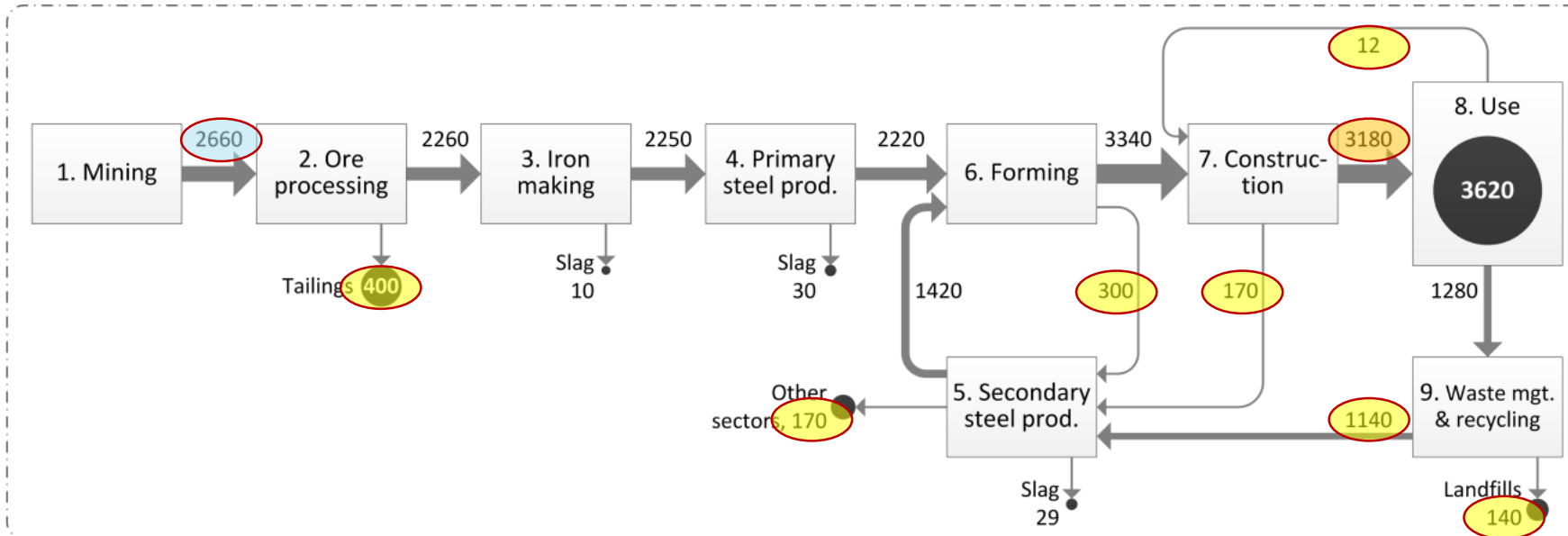
# CE for building steel in China

Base scenario



System boundary: Steel cycle associated with buildings in China, 2013–2050, base scenario

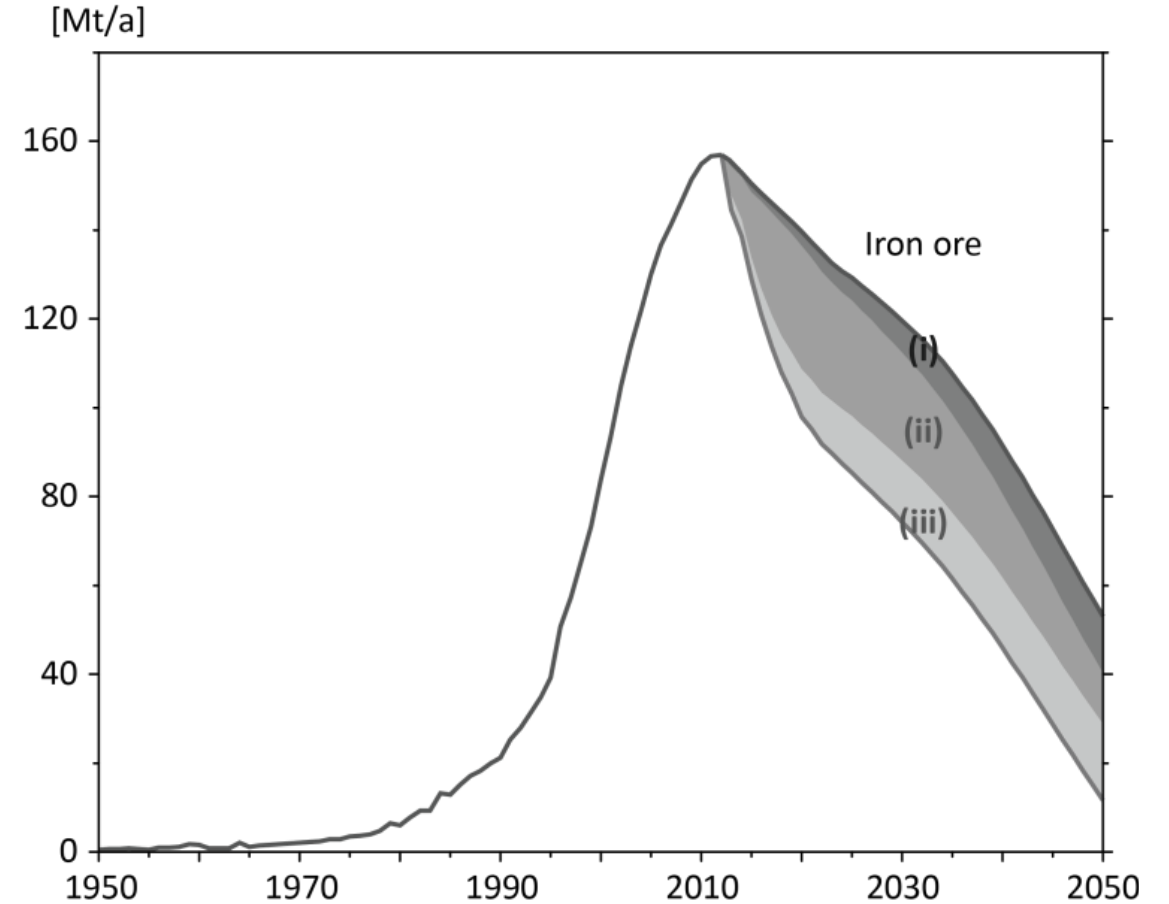
CE scenario



System boundary: Steel cycle associated with buildings in China, 2013–2050, conservation scenario

# CE for building steel in China

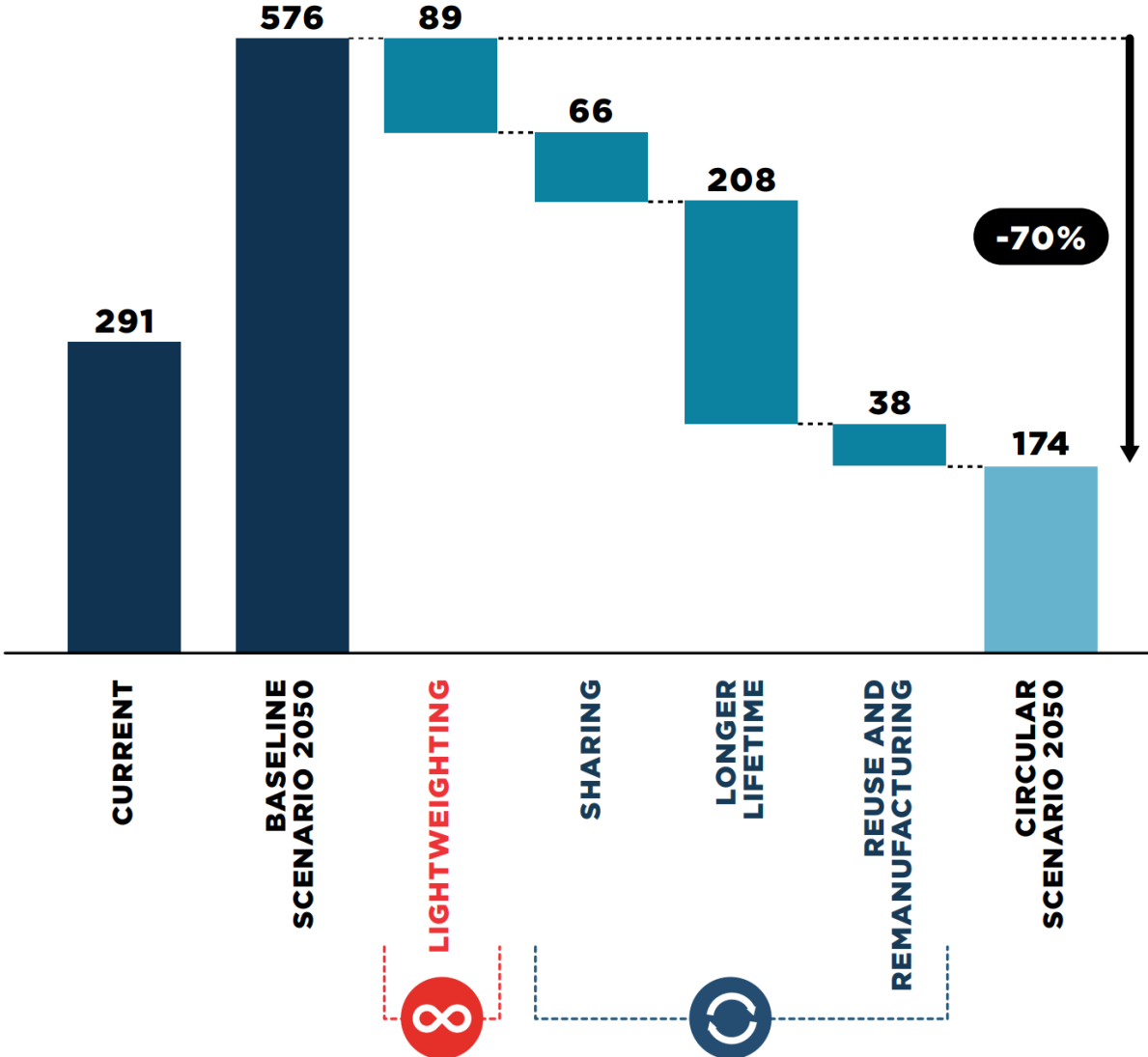
- 37% saving of iron ore via (i) longer building lifetime (7%), (ii) stronger but less steel use in buildings (18%), (iii) higher material efficiency in the steel cycle (12%)
- 27% reduction of GHG emissions from the steel



Source: Wang et al., 2015

# CE for passenger cars in the world

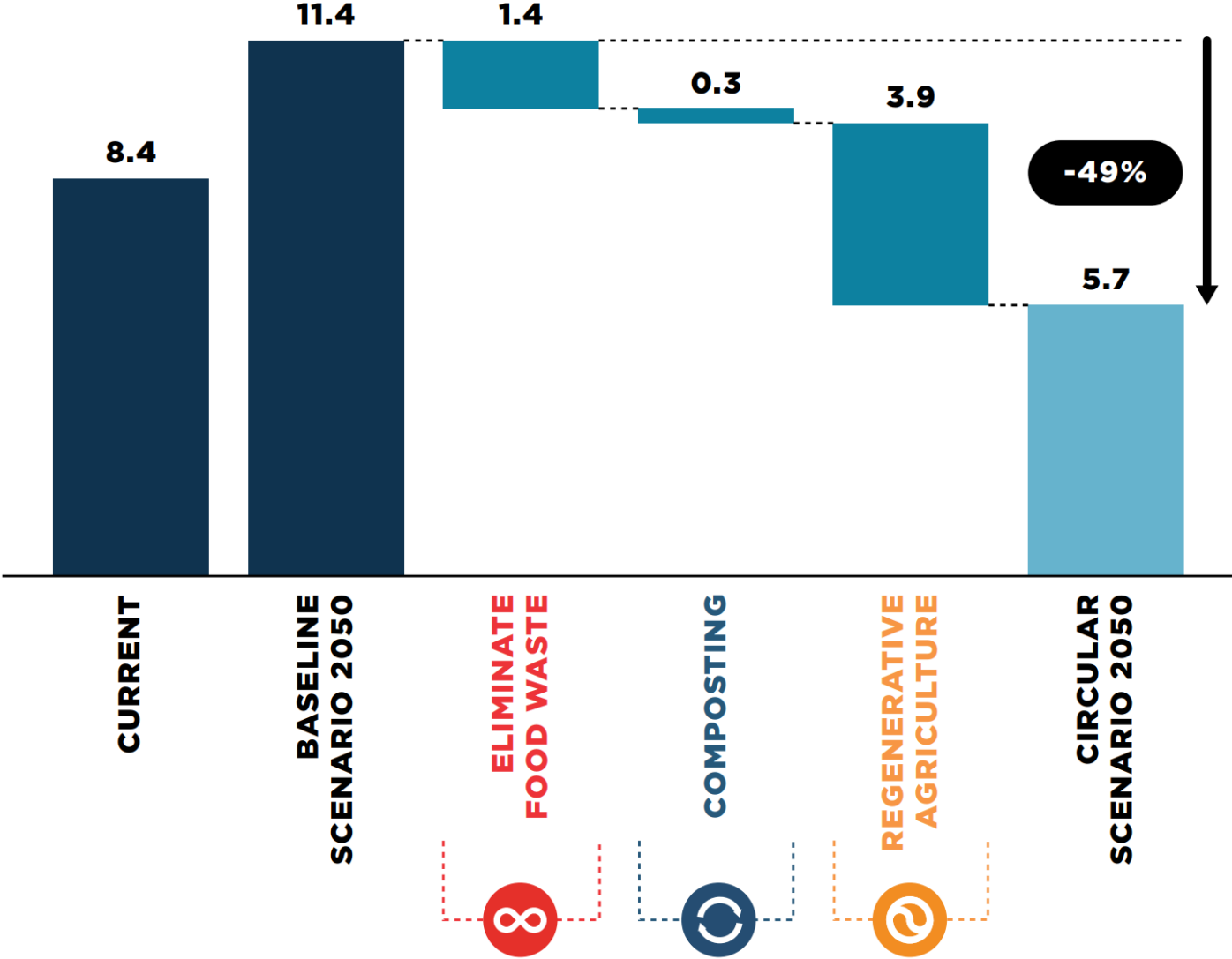
Emissions from all materials used in passenger cars  
Million tonnes of CO<sub>2</sub> per year, globally



Source: Ellen Macarthur Foundation, 2019

# CE for food system in the world

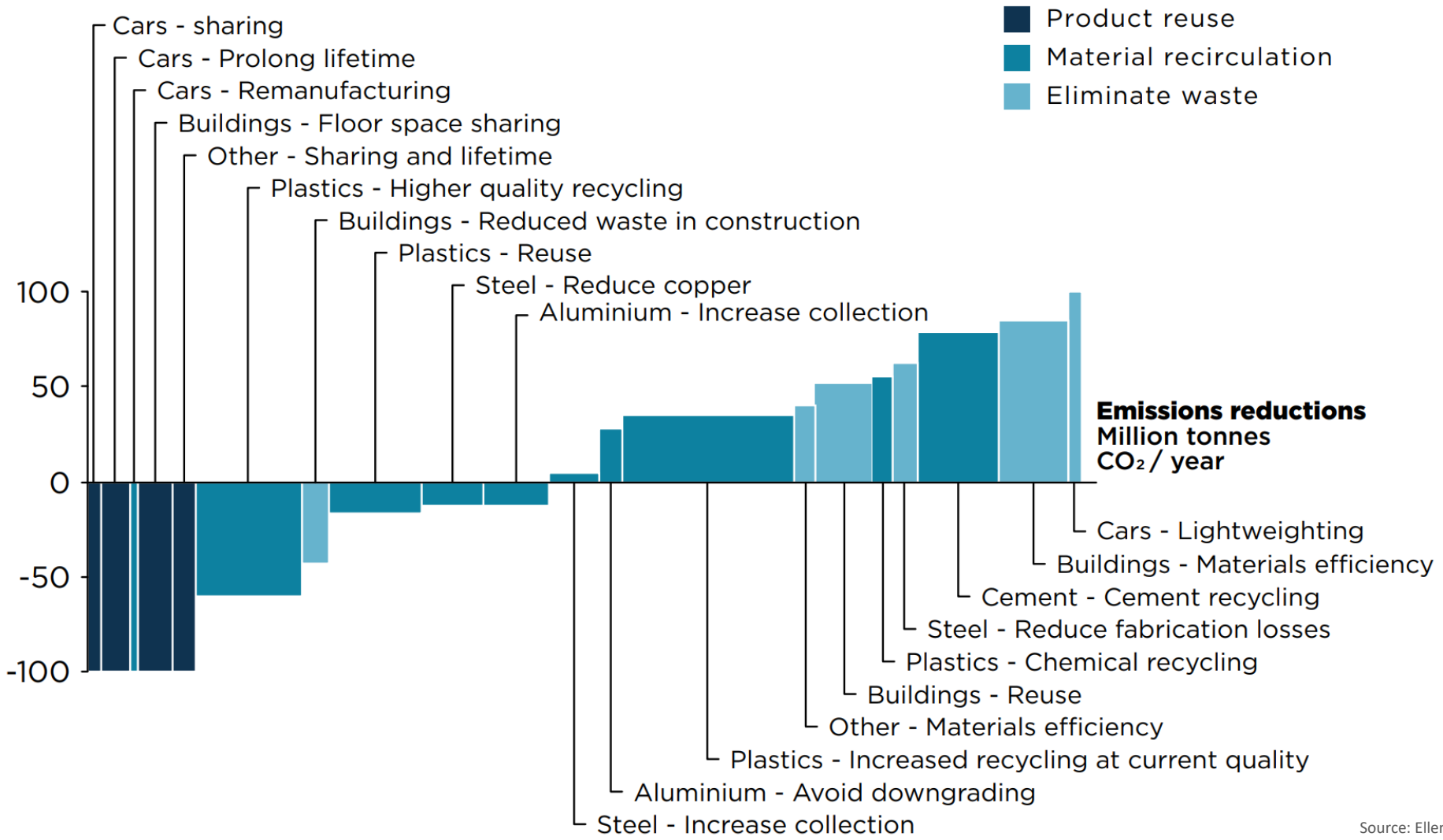
**Emissions from the global food system**  
Billion tonnes of CO<sub>2</sub>e per year



Source: Ellen Macarthur Foundation, 2019

# CE is cost-effective and business-raising

**Cost of emissions reductions**  
EUR / tonne CO<sub>2</sub>



Source: Ellen Macarthur Foundation, 2019

Tong Ji Da Xue

同 济 大 学

All in the same boat,  
help each other!

Thanks and  
see you again!

Xun Huan Jing Ji

循 环 经 济

Circularity



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