İklim Değişikliği Ekonomisi Çalıştayı

Malzeme Kullanımı ve Sürdürülebilirlik

Prof.Dr. Etem Karakaya
ESOGU, İİBF,İKTİSAT

Eskişehir, 14 Eylül 2023

Bu ÇALIŞTAY "**Malzeme Talebi ve Malzeme Verimliliğinin Sürdürülebilirlik Açısından Analizi: Ülkeler Arası Karşılaştırmalı bir Analiz ve Türkiye için Değerlendirmeler**" başlıklı 221K082 numaralı TÜBİTAK projesi kapsamında hazırlanmıştır ve **TÜBİTAK tarafından desteklenmektedir.**

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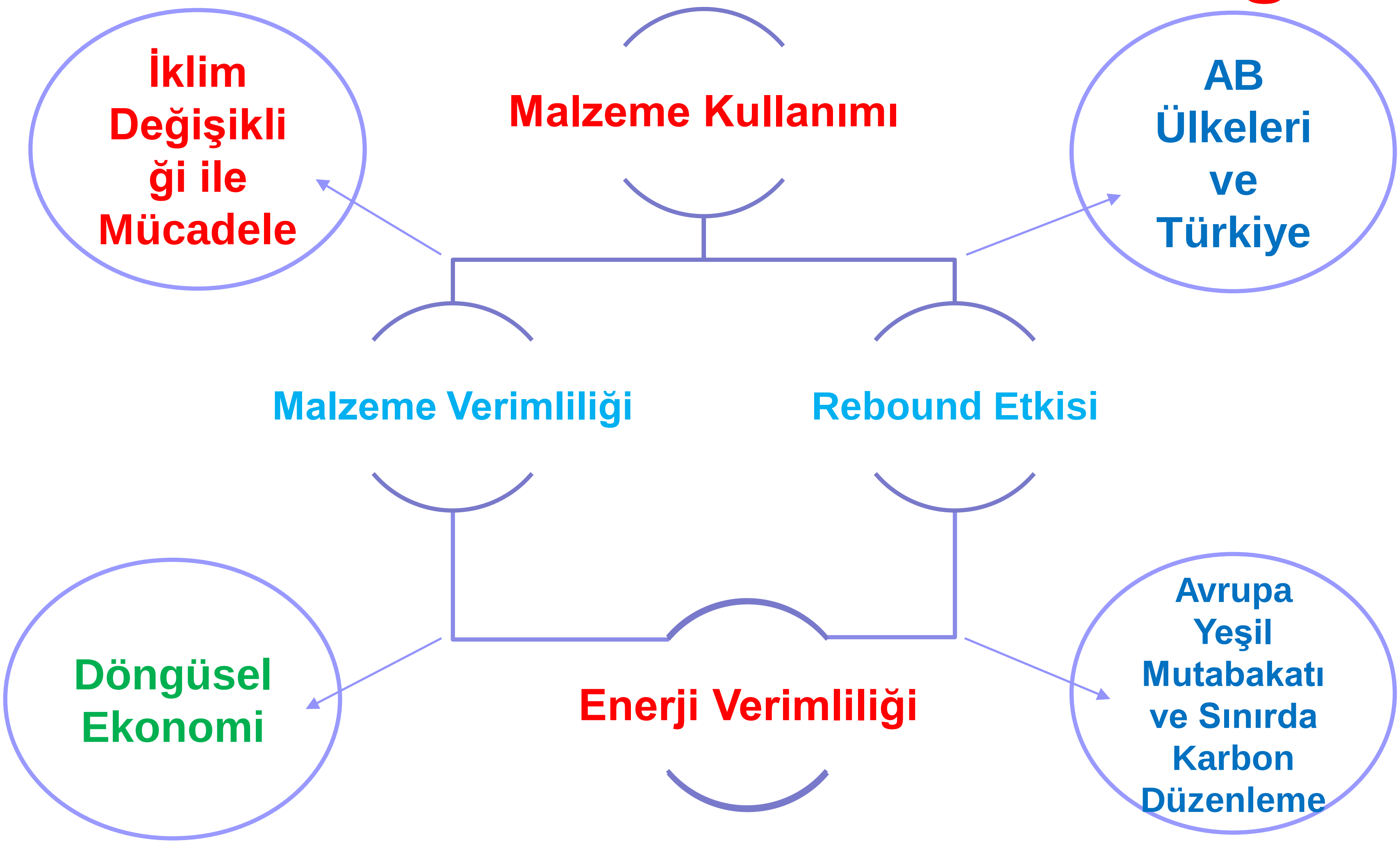

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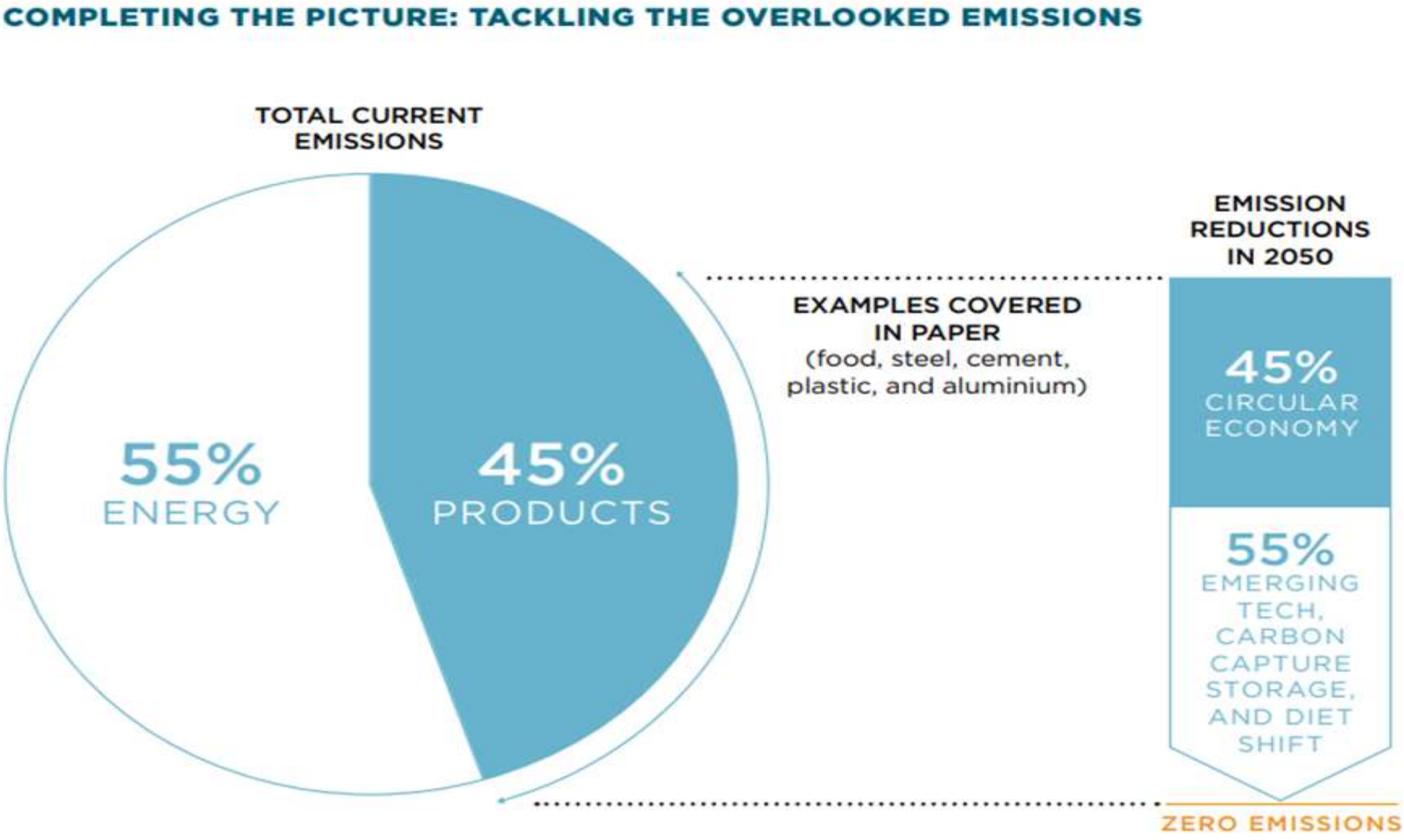
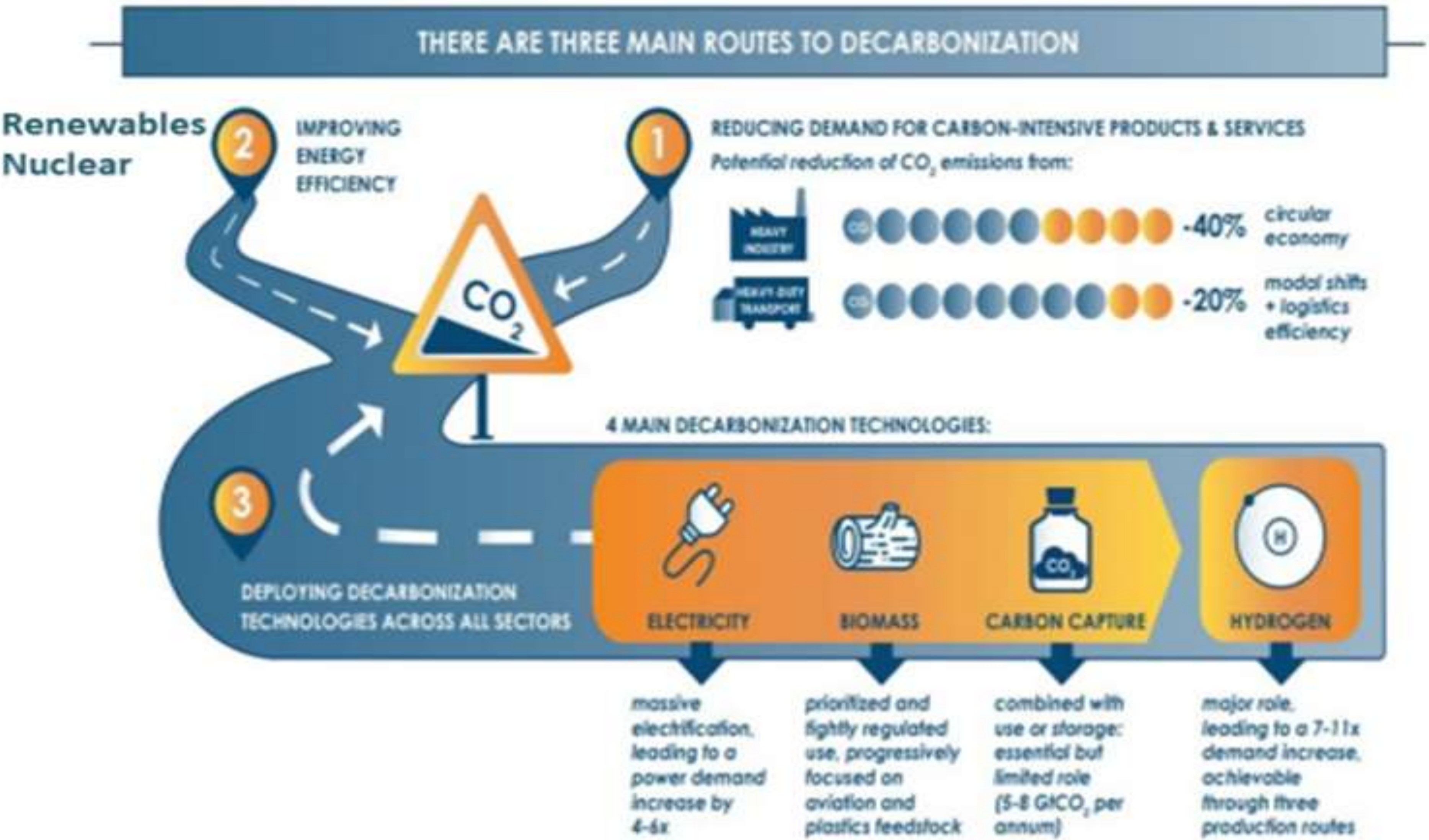
NET-SIFIR İÇİN SADECE ENERJİ'YE ODAKLANMAK YETERLİ DEĞİL !!!



KARBONSUZLAŞMA YOL HARİTASI



Malzeme Tüketimi Neden Önemli?

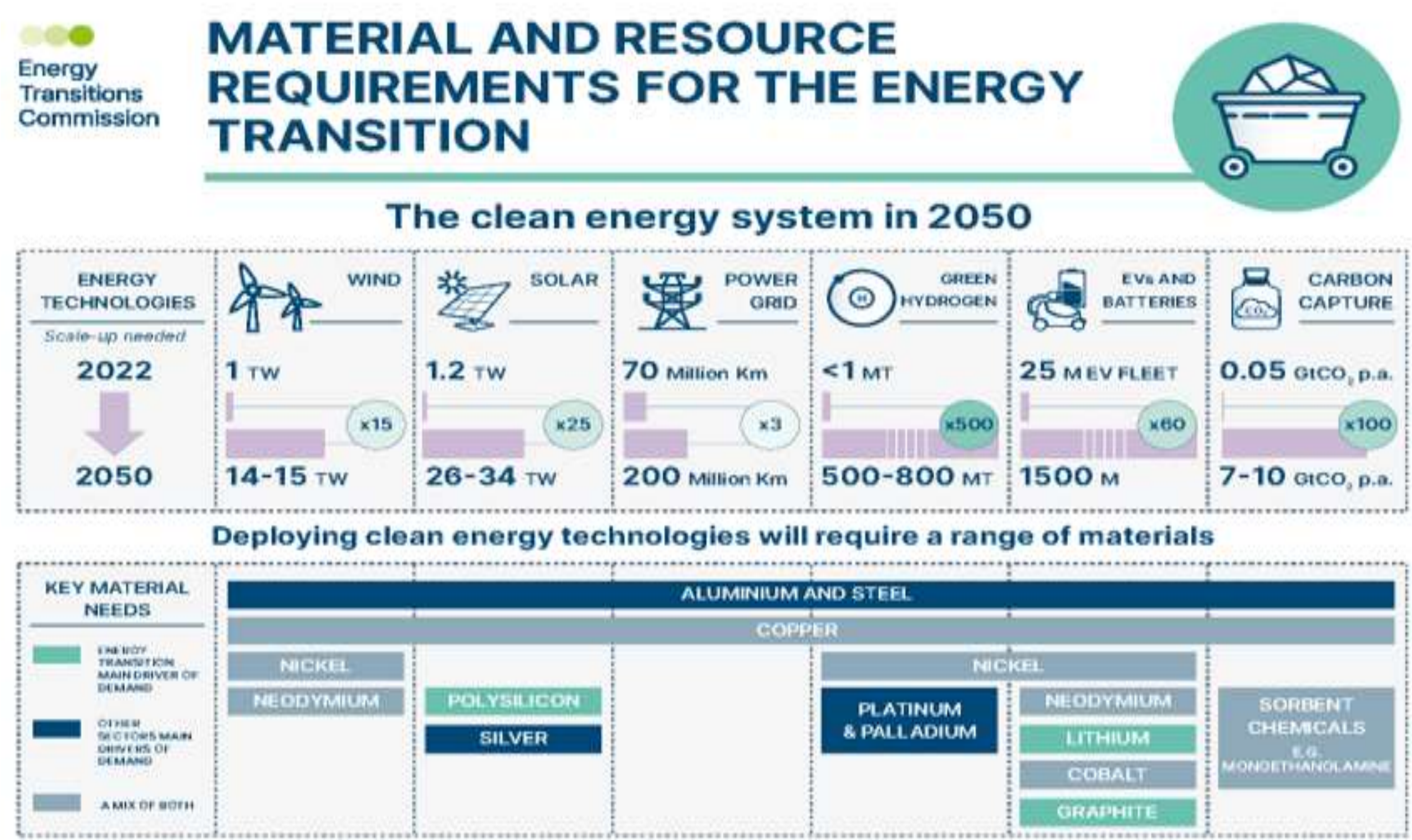
-OECD, küresel malzeme tüketiminin 2011 yılına kıyasla 2060 yılında iki katına çıkacağını tahmin ediyor. 20. yüzyılın enerji hedefi petrol ve gaza erişimle ilgiliyse, 21. yüzyıl da malzemelere erişimle ilgili olacak.

-Klasik ve kritik malzeme talebi artışı ciddi bir hızda artıyor.

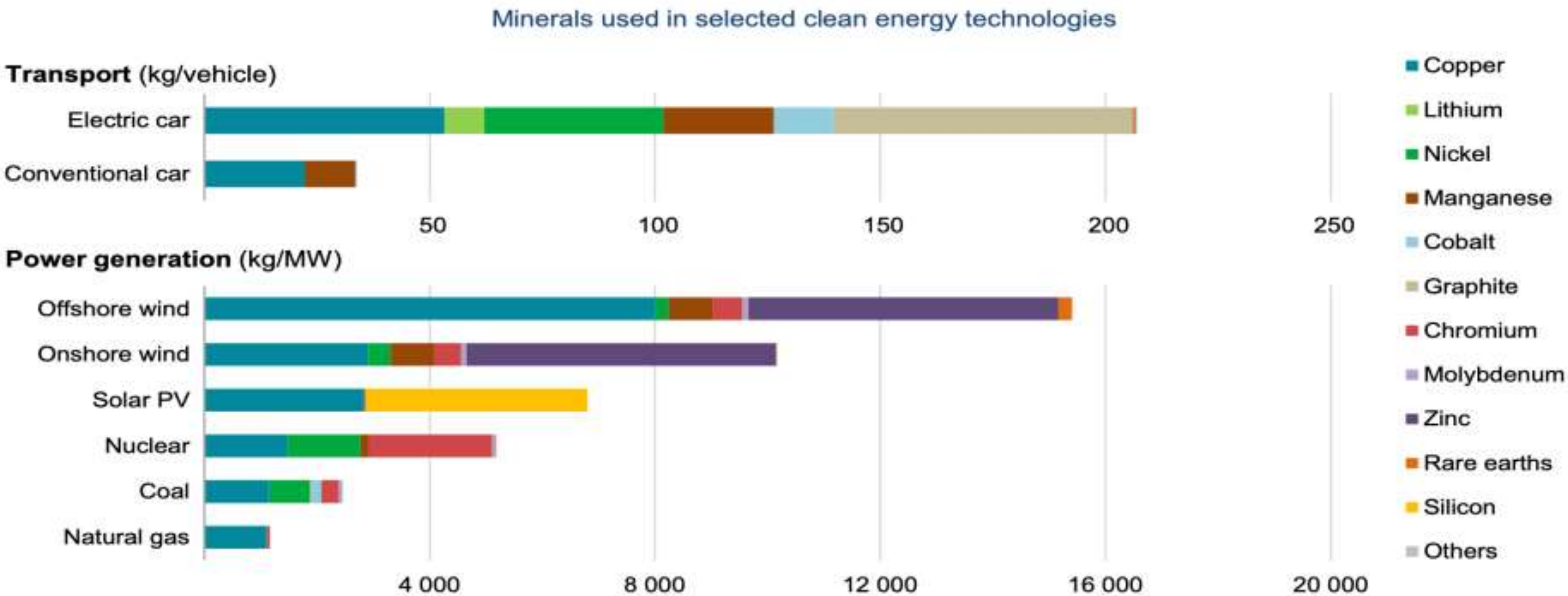
-Hammadde arzı bu artan talebe hızlı bir şekilde cevap veremeyebilir ve bu da temiz enerjiye geçişi yavaşlatabilir.

-Malzeme çıkarımı, üretimi, kullanımı yoğun karbon içermektedir.

1-Enerji Dönüşümü-Malzeme Yoğun



Yeşil Dönüşüm Malzeme yoğun



China leads world in production of minerals needed for clean energy

Share of top three countries for extraction and processing of key minerals and fossil fuels

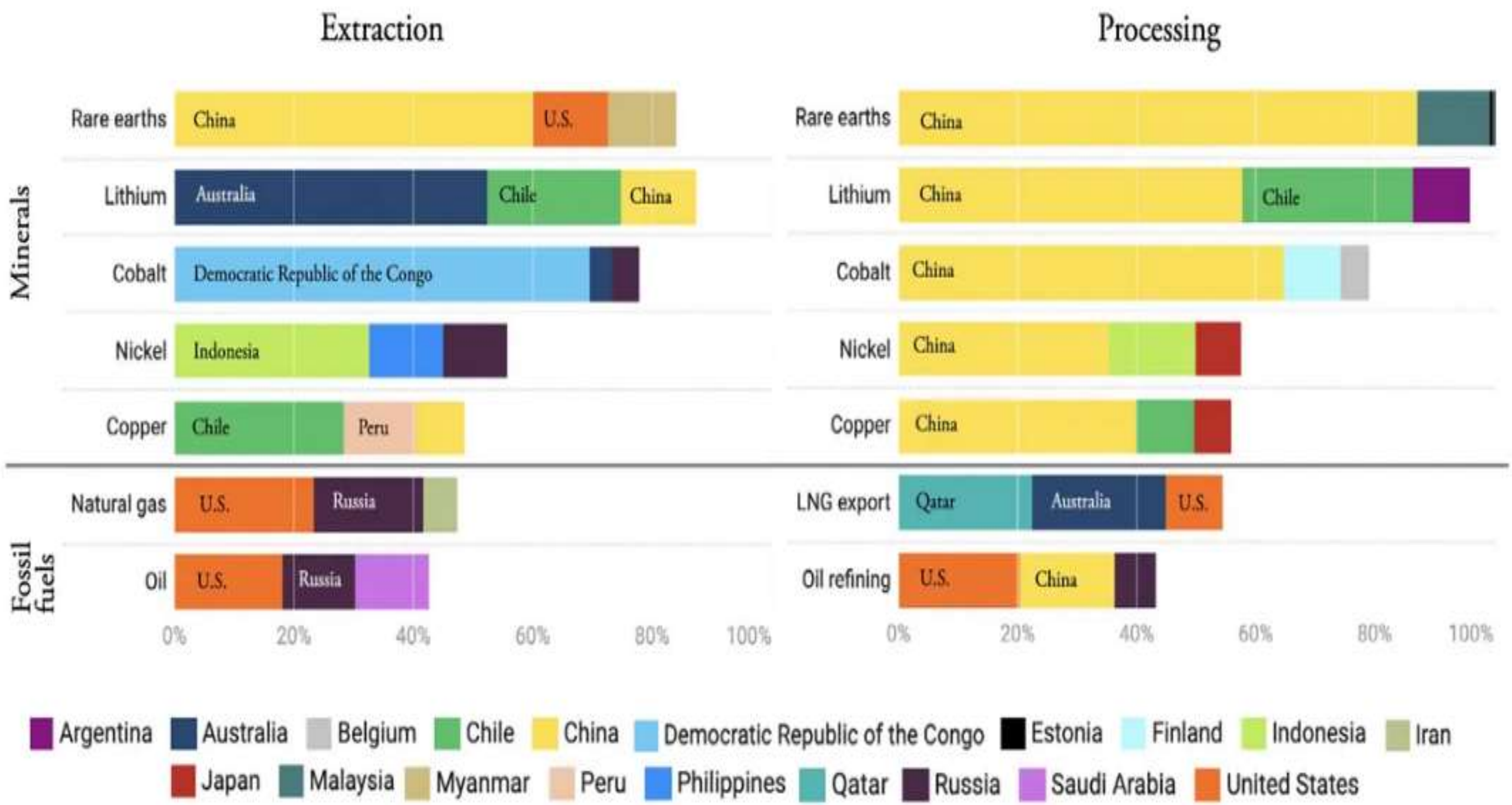


Chart: Canary Media • Source: IEA, The Role of Critical Minerals in Clean Energy Transitions

YAYIN: Enerji Dönüşümünde Kritik Mineraller: Yatırım stratejileri ve Arz riski Kitap bölümü, Palgrave Macmillan, 2023

Critical Raw Materials in the Clean Energy Transition: Evaluating Circular Economy and Investment Strategies for Mitigating Supply Risk

Book Chapter *"Sustainable Energy Development: Technology and Investment"* by Palgrave Macmillan 2023.

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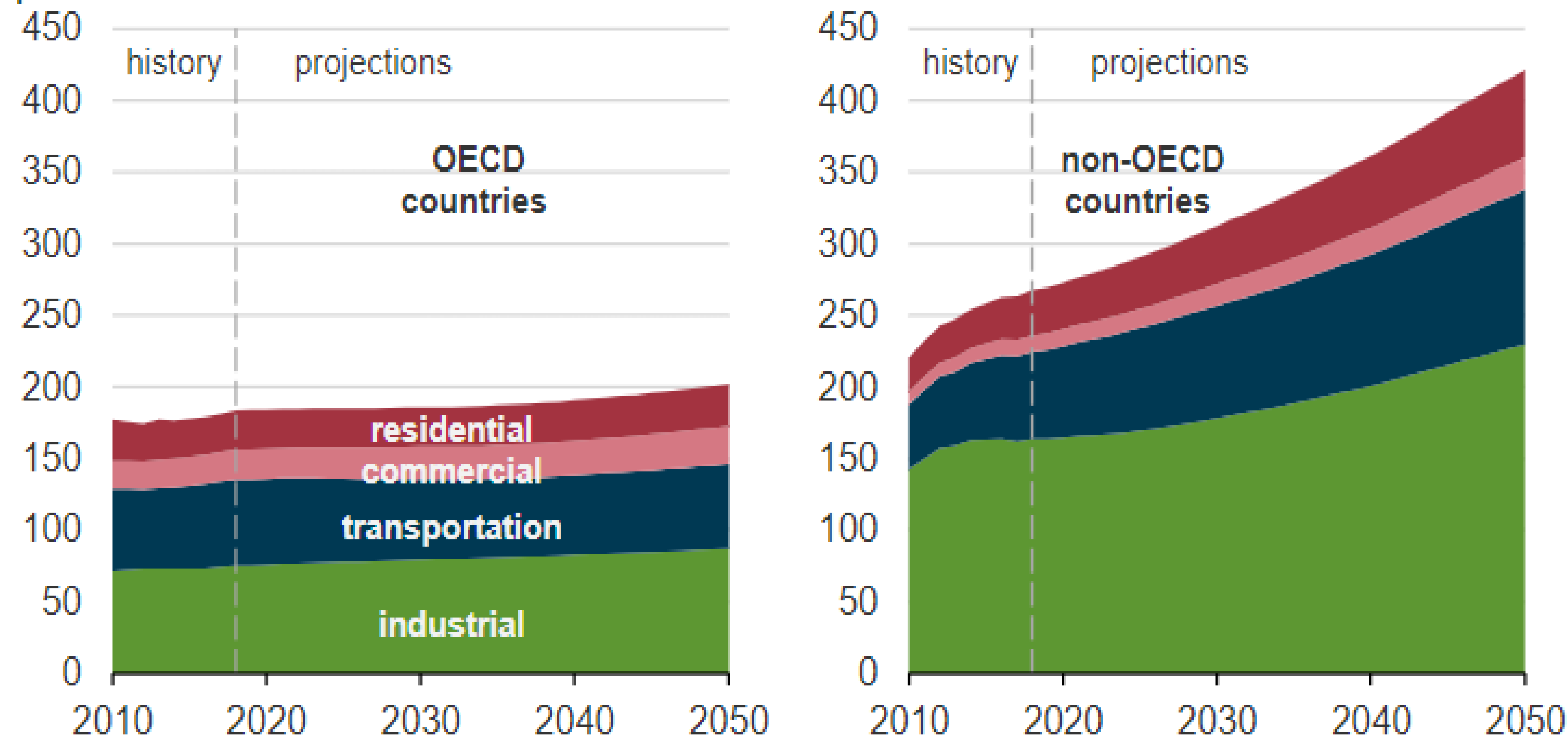
Abstract

As many countries set out net-zero emission targets after the Glasgow Climate Meeting (COP26), green energy transition become more viable. However, such an ambitious energy transition will require an enormous amount of materials that have a supply risk. Therefore, Critical Raw Materials (CRMs) have emerged as one of the most highlighted topics in academic research and environmental policy decision-making over the last decade. As countries continue to demand more of such critical materials, this topic

2-Azaltımı zor Sektör: Sanayi

ENERJİ KULLANIMI-OECD vs NON-OECD
NON- OECD çok yüksek
SANAYİ çok Yüksek

Global energy consumption by sector (2010-2050)
quadrillion British thermal units



Source: U.S. Energy Information Administration, *International Energy Outlook 2019* Reference case

YAYIN: Sanayide Karbonsuzlaşma ve Malzeme Etkinliğinin Rolü, ÇŞİ Dergisi, 2023

RESEARCH ARTICLE TR

PDF BibTex RIS Cite

SANAYİDE KARBONSUZLAŞMA: MALZEME ETKİNLİĞİ STRATEJİLERİNİN ROLÜ

Year 2022, Volume: 1 Issue: 2, 81 - 118, 12.08.2022

Burcu HİÇYILMAZ * Sedat ALATAŞ Etem KARAKAYA

Abstract

Sanayi emisyonlarının azaltımı net sıfır emisyon hedefinin başarılması için kritik öneme sahiptir. Bununla birlikte, bu sektörün karbon yoğun bir üretim sürecinin parçası olması, malzeme üretimi ve kullanımı sonucu ortaya çıkan emisyon azaltımını zorlaştırmaktadır. Bu çalışmanın amacı, sanayide karbonsuzlaşma için malzeme etkinliğinin önemine vurgu yapmak ve bu yönde uygulanabilecek stratejileri tartışmaktır. Bu yüzden, ilk olarak, sanayi sektörünün neden "azaltım yapılması zor" sektör olduğunu, sanayi sektörü azaltım seçeneklerini ve malzeme etkinliğinin azaltım politikası bağlamındaki kritik rolünü ele almaktadır. İkinci olarak, malzeme etkinliğini sağlayacak stratejileri ve bu stratejilerin hangi ürün yaşam döngüsü aşamalarında gerçekleştirilebileceğini tartışmaktadır. Tüm bu tartışmalar, literatürdeki çalışmalardan elde edilen bulgulara ve önemli kurum ve kuruluşların yayınladığı raporlara dayanmaktadır. Bulgular, sanayide karbonsuzlaşma için büyük bir potansiyel olduğunu ve ürünün tasarım aşamasından kullanım ömrü sonuna kadar geçirdiği süreçte, malzemenin etkin kullanımının sürdürülebilirlik ve döngüsel ekonomi açısından önemli katkılar sunabileceğini göstermektedir. Dahası, emisyon azaltım potansiyeli en yüksek olan aşamaların, tasarım ve kullanım aşamaları olduğu tespit edilmiştir. Bu çalışma, diğer çalışmalardan farklı olarak, malzeme etkinliği konusunu sanayi sektörü özelinde tartışmakta, ve malzeme etkinliğini sağlayacak stratejileri ve bu stratejilerin gerçekleştirilebileceği aşamaları tartışmaktadır. Bu bağlamda, literatüre önemli katkı sağlayacağı düşünülmektedir.

Keywords

Sanayide Karbonsuzlaşma, Malzeme Etkinliği, Malzeme Etkinliği Stratejileri, Döngüsel Ekonomi

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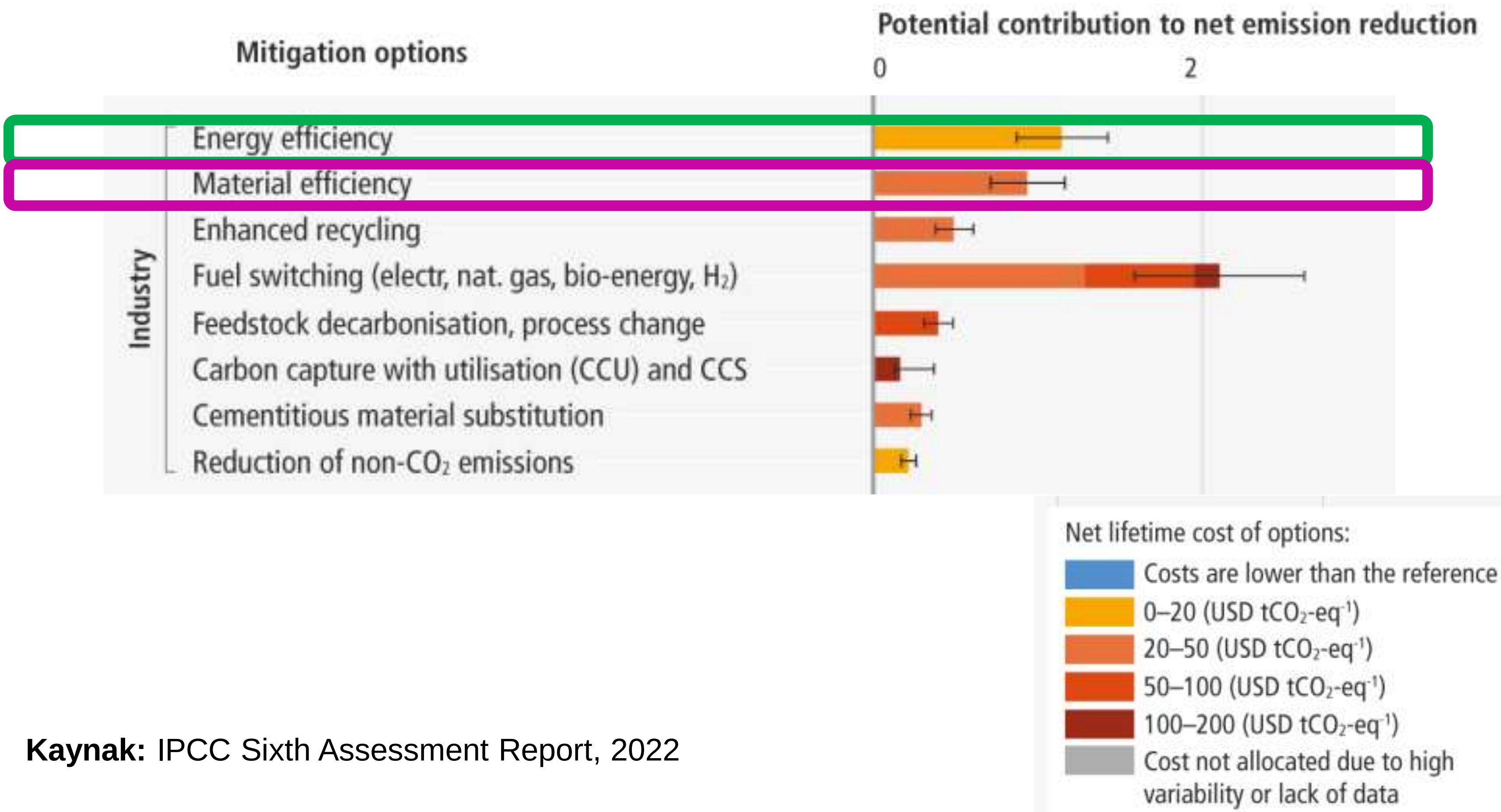
RESOURCE EFFICIENCY vs MATERIAL EFFICIENCY

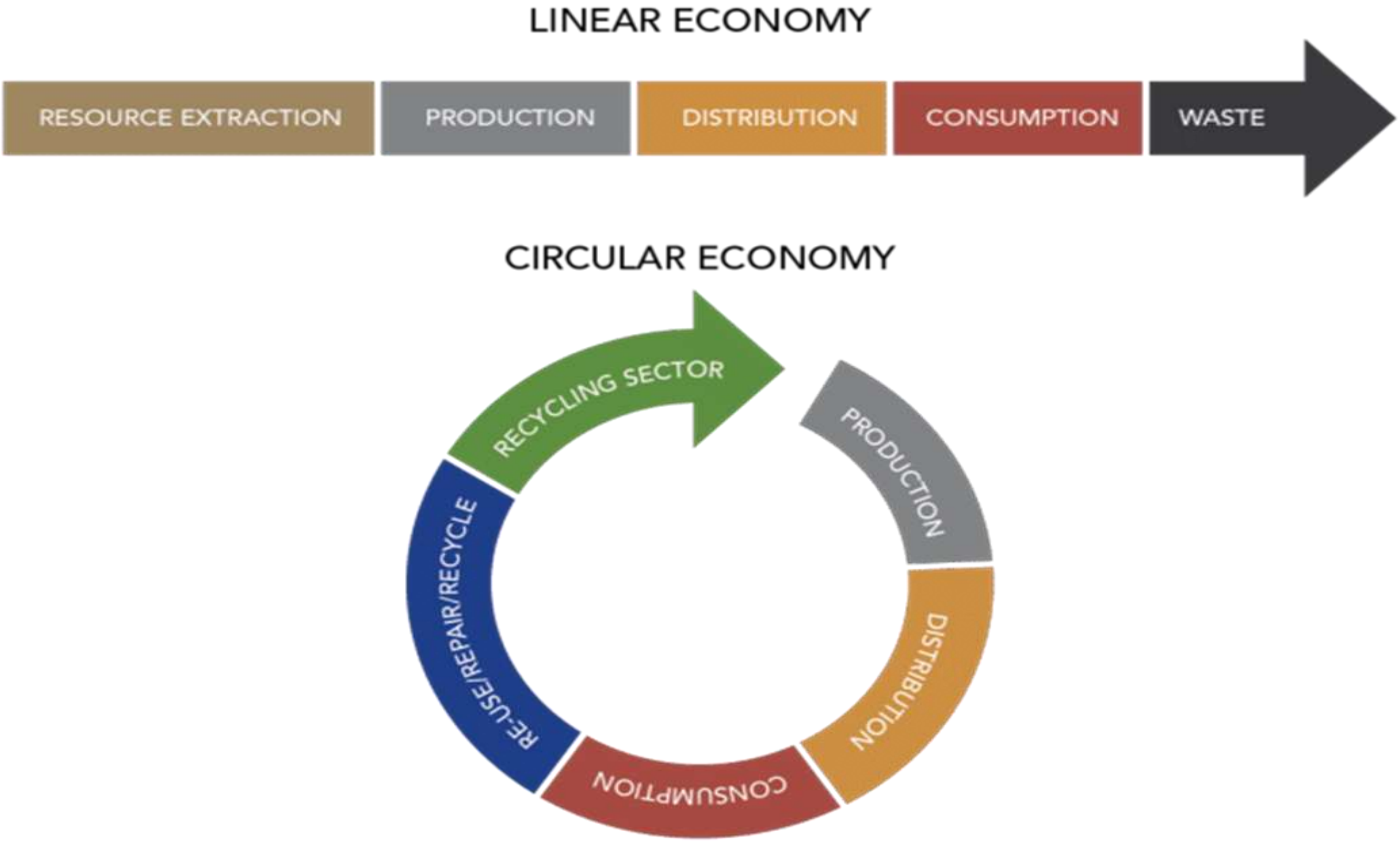
Malzeme verimliliği:
Hazır, Ucuz, Etkin

Sanayi- Azaltım Seçenekleri



Kaynak: IPCC Sixth Assessment Report, 2022

Çözüm: Sürdürülebilir Üretim ve Tüketim



YAYIN: Enerji ve Malzeme Kullanımı Belirleyicileri ve Decoupling Analizi, ESPR, 2023

Environmental Science and Pollution Research (2023) 30:80863–80883
https://doi.org/10.1007/s11356-023-28020-y

RESEARCH ARTICLE

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Understanding material and energy use in the processes of decoupling CO_2 emissions from economic growth

Tuğba Akdoğan[1] · Elif Erkara[1] · Betül Mert[1] · Burcu Hiçyılmaz[2] · Sedat Alataş[3] · Etem Karakaya[4]

Received: 9 March 2023 / Accepted: 27 May 2023 / Published online: 13 June 2023

Abstract
The share of emissions from materials has dramatically increased over the last decades and is projected to rise in the coming years. Therefore, understanding the environmental effect of materials becomes highly crucial, especially from the climate mitigation perspective. However, its effect on emissions is often overlooked and more attention is heavily paid to the energy-related policies. In this study, to address this shortcoming, we investigate the role of materials on the decoupling of carbon-dioxide emissions (CO_2) from economic growth and compare it with the role of energy use in the world's top-19 emitting countries for the 1990–2019 period. Methodologically, using the logarithmic mean divisia index (LMDI) approach, we first decompose CO_2 emissions into four effects based on the two different model specifications (materials and energy models). We secondly determine the impact decoupling status and efforts of countries with two different approaches: Tapio-based decoupling elasticity (TAPIO) and decoupling effort index (DEI). Our LMDI and TAPIO results show that material and energy-related efficiency effects have an inhibitory factor. However, the carbon intensity of materials has not contributed to CO_2 emissions reduction and impact decoupling as much as the carbon intensity of energy has. DEI results indicate that while developed countries make relatively good progress towards decoupling, particularly after the Paris Agreement, developing countries need to further improve their mitigation efforts. Designing and implementing some policies only centering energy/material intensity or carbon intensity of energy might not be sufficient to achieve the decoupling. Both energy- and material-related strategies should be considered in harmony.

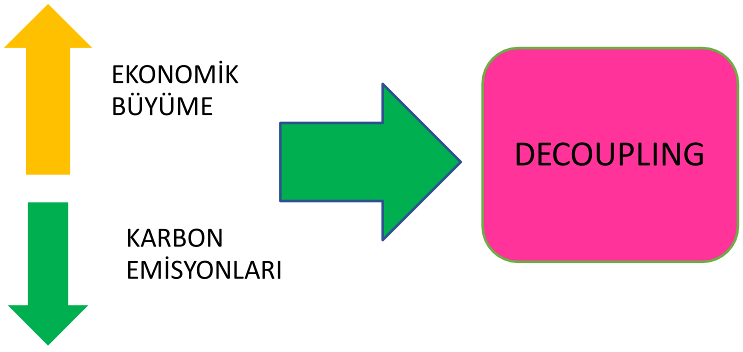
Keywords CO_2 Emissions · Materials · Energy · Decoupling · Decomposition · Decoupling Effort Index · Tapio · LMDI

JEL codes Q56 · O13 · C33

Çalışmanın Amacı

CO_2 emisyonları ile ekonomik büyüme (GDP) arasındaki ilişkiyi ayrışma(decoupling) yöntemine dayalı olarak analiz etmek

enerji tüketiminin yanı sıra malzeme tüketimini de dikkate alarak, ayrışma durumunu etkileyen faktörleri ortaya koymaktır.



MODELLER ve LİTERATÜR

BULGULAR: Mutlak decoupling sayısı enerjide artıyor. Malzeme az!

	No Decoupling Effort $\delta < 0$	Weak Decoupling Effort $0 < \delta < 1$	Absolute Decoupling Effort $\delta > 1$
1990-1995	KOR (-0.28) CAN (-1.07) IDN (-0.45) TUR (-1.18) JPN (-0.58) IRN (-2.46) IND (-0.68) BRA (-2.67) AUS (-0.91) SAU (-4.17)	ITA (0.63) CHN (0.49) USA (0.19)	DEU (2.78) GBR (1.94) POL (1.93)
1995-2000	MEX (-0.00) CAN (-1.71) ZAF (-0.02) IRN (-2.32) IND (-0.07) BRA (-5.02) TUR (-0.97)	GBR (0.92) KOR (0.33) CHN (0.73) JPN (0.20) ITA (0.50) AUS (0.06) USA (0.39)	RUS (2.18) POL (1.49) DEU (1.46)
2000-2005	ZAF (-0.01) ITA (-1.87) BRA (-0.11) SAU (-2.82) CHN (-0.38) MEX (-89.59) IDN (-0.42) IRN (-0.68)	RUS (0.97) TUR (0.47) POL (0.84) KOR (0.42) GBR (0.79) AUS (0.22) USA (0.72) JPN (0.05) CAN (0.67) IND (0.03)	DEU (2.42)
2005-2010	BRA (-0.13) IRN (-0.50) IND (-0.19) TUR (-1.22) IDN (-0.24) MEX (-756.66) ZAF (-0.39)	RUS (0.90) KOR (0.09) POL (0.78) CHN (0.43) AUS (0.24)	JPN (31.00) DEU (1.80) CAN (1.25)
2010-2015	IND (-0.04) SAU (-1.14) BRA (-12.85)	RUS (0.87) MEX (0.43) JPN (0.81) IDN (0.40) AUS (0.77) CAN (0.38) CHN (0.64) TUR (0.19) KOR (0.51)	GBR (3.97) ZAF (2.39) USA (1.90) POL (1.67) DEU (1.42)
2015-2019	IDN (-0.49) TUR (-0.54)	POL (0.83) RUS (0.51) KOR (0.79) IND (0.33) CHN (0.72) CAN (0.65)	GBR (4.75) USA (1.47) DEU (3.16) ITA (1.30) JPN (2.86) AUS (1.04) MEX (2.36)
Whole	IND (-0.08) ZAF (-0.96) TUR (-0.30) BRA (-1.33) IDN (-0.60) IRN (-2.46) MEX (-0.88) SAU (-7.37)	USA (0.99) KOR (0.18) JPN (0.87) AUS (0.16) CHN (0.40) CAN (0.27)	RUS (2.51) POL (1.20) ITA (2.34) GBR (2.08) DEU (2.03)

Yayın: AB Ülkeleri için Malzeme Talebi ve Malzeme verimliliğinin Hesaplanması: SFA Analizi, Sustainable Development, 2023

Received: 7 April 2023 | Revised: 6 June 2023 | Accepted: 16 June 2023
DOI: 10.1002/sd.2648

RESEARCH ARTICLE

Sustainable Development
WILEY

Material demand and material efficiency for sustainable development in the European Union countries: A stochastic frontier analysis

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Abstract

Materials are of great importance as they are fundamentally integrated into many different critical topics, including green transition, technological progress, industrial emissions, and supply chains. Therefore, the amount of materials we demand and employ in the production process or how efficiently we use them become highly crucial. In this paper, we study the emerging role of materials with a special focus on the key role of material efficiency (ME) in climate mitigation. To this end, we empirically investigate the main determinant of material demand and evaluate the ME performance in the European Union (EU) countries over the period of 1995–2019 based on a four-component Stochastic Frontier Analysis (SFA) panel data approach that separates unobserved country effects from persistent and transient inefficiency. We obtain the following outcomes. First, material demand function estimates reveal that economic growth and energy consumption are the main drivers of domestic material consumption, highlighting the need for promoting sustainable energy and economic growth. Second, although the SFA-based ME scores significantly vary across countries, transient inefficiency is the main source of overall inefficiency for most coun-

BULGULAR:

Malzeme Talebinin Belirleyicileri

TABLE 2 Drivers of material demand frontier.

Variables	Coefficient	Standard errors
lnGDP	0.9063***	0.0602
lnPOP	−0.6677***	0.0938
lnAREA	0.1158	0.0837
lnEC	0.2676***	0.0815
lnMP	0.0004	0.0142
lnISH	0.0621	0.1180
lnSSH	−0.7867***	0.2446
lnTO	−0.5079***	0.0635
UMDT	0.0197***	0.0042
$UMDT^2$	−0.0009***	0.0001
Constant	9.8965***	1.9115
Observations	650	
Number of countries	26	
R-squared	0.7980	

Note: The dependent variable is the log of domestic material consumption.
*, ** and *** denotes significance at 10%, 5% and 1%, respectively.

Bulgular: AB ülkelerinin Malzeme verimliliği performansı

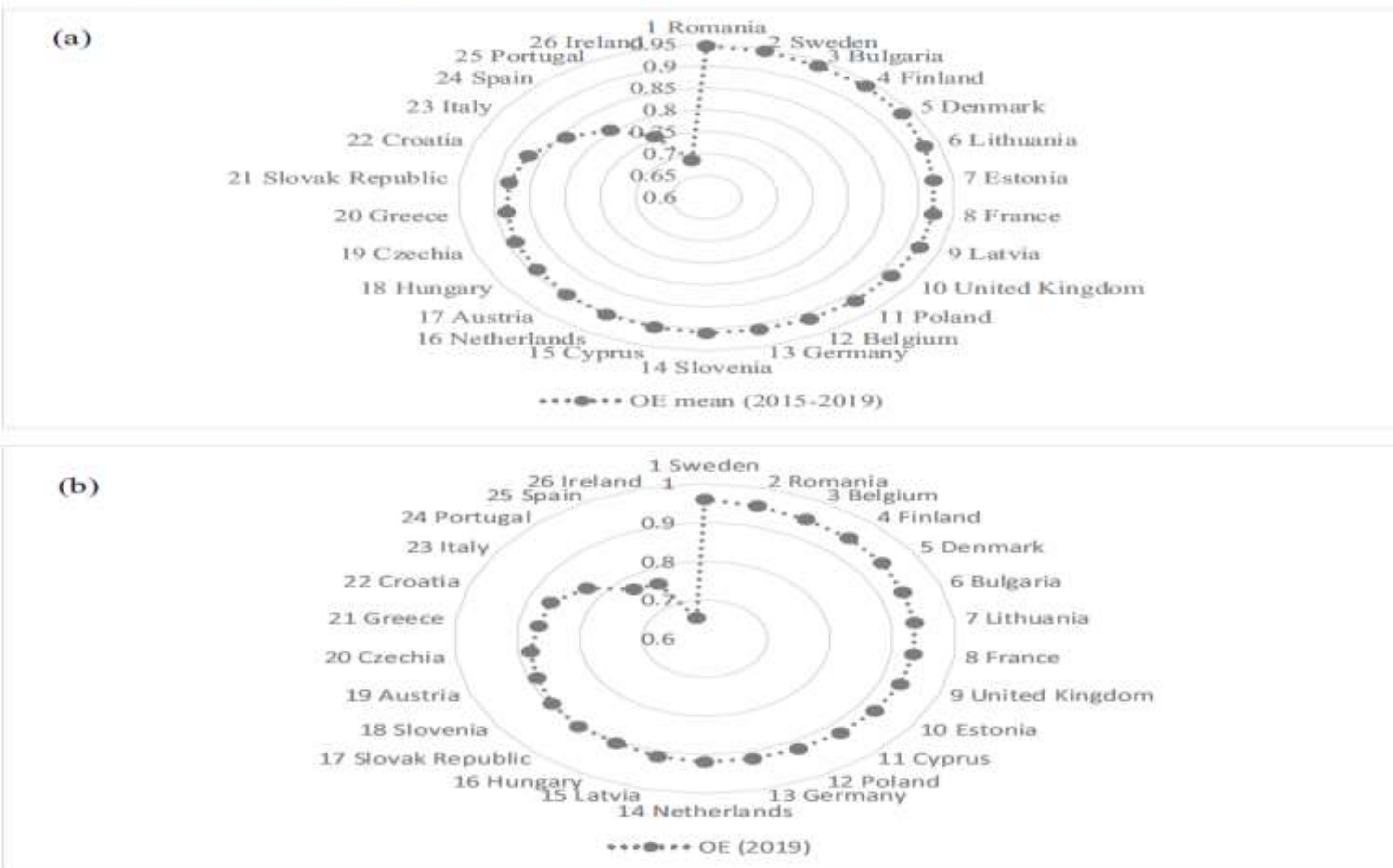


FIGURE 3 OE scores and rankings for mean 2015–2019 period (a) and 2019 (b). The numbers next to the countries represent the ranking from 1 to 26, from the best countries to the worst in the material efficiency ranking.

Bulgular: AB Ülkelerinin Geçici ve Kalıcı malzeme verimliliği performansı

FIGURE 4 Development of material efficiency performances within the European Union over the period of 1995–2019.

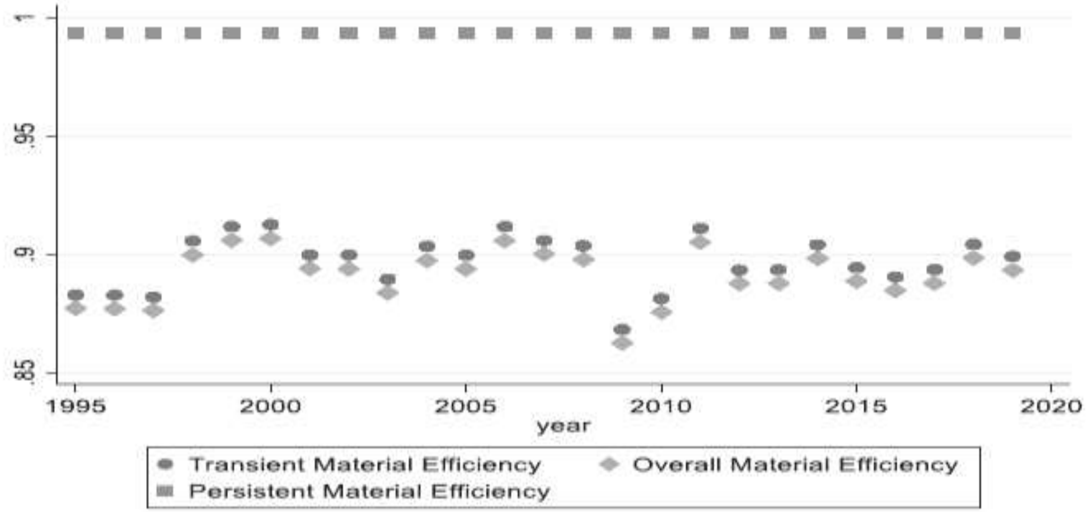
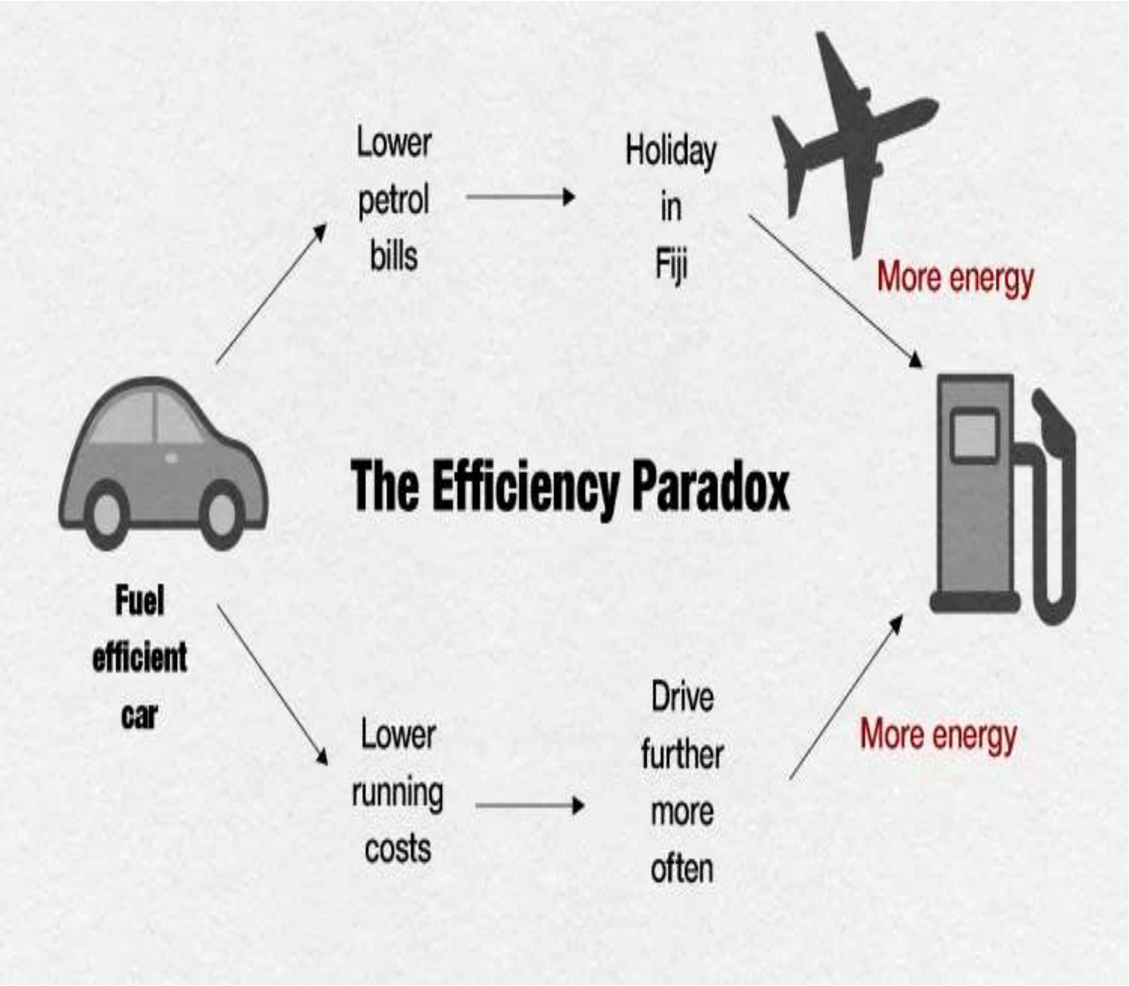


TABLE 4 Transient efficiency (TE) scores and ranking for the 2015–2019 period and year 2019.

Country	TE mean (2015–2019)	Ranking	Country	TE (2019)
Romania	0.9508	1	Sweden	0.9653
Sweden	0.9492	2	Romania	0.9581
Bulgaria	0.9443	3	Belgium	0.9528
Finland	0.9441	4	Finland	0.9524
Denmark	0.9409	5	Denmark	0.9492
Lithuania	0.9339	6	Bulgaria	0.9434
Estonia	0.9279	7	Lithuania	0.9426
France	0.9273	8	France	0.9405
Latvia	0.9268	9	United Kingdom	0.9388
United Kingdom	0.9217	10	Estonia	0.9346
Poland	0.9216	11	Cyprus	0.9315
Belgium	0.9191	12	Poland	0.9272
Germany	0.9163	13	Germany	0.9248

REBOUND (GERİ TEPME) ETKİSİ



Kaynak verimliliği maliyetleri düşürür

Sonuç: Geri-tepme etkisi

- Daha fazla kullanım
- Başka malları kullanım
- Daha fazla emisyon

Yayın: AB Ülkeleri ve Ticari Partnerlerinin Enerji/Malzeme verimliliğinin ve Rebound etkisinin Hesaplanması: SFA Analizi, preprint, in Submission, 2023

The Rebound Effect of Material and Energy Efficiency and Their Determinants: Insights from the Stochastic Frontier Analysis for the EU and its Major Trading Partners

31 Pages • Posted: 20 Jul 2023

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Aydın Adnan Menderes University

Malzeme ve Enerji verimliliği belirleyicileri ve rebound etkisi

Table 2 Drivers of material and energy demand frontier and rebound effects

(a) Drivers of material demand frontier and rebound effect			(b) Drivers of energy demand frontier and rebound effect		
Variables	**Coefficient**	**Std. err.**	**Variables**	**Coefficient**	**Std. err.**
Frontier					
lnGDP	1.1814***	0.0999	lnGDP	1.1266***	0.0483
lnPOP	-0.6922***	0.1133	lnPOP	-0.1457***	0.0464
lnAREA	0.3440***	0.0426	lnAREA	0.1806***	0.0329
lnISH	-0.3495***	0.1127	lnISH	-0.2596***	0.0766
lnSSH	-0.5146***	0.1985	lnSSH	0.0266	0.0708
lnMP	0.1277***	0.0299	lnEP	-0.0616***	0.0166
lnEC	-0.0724	0.0735	lnDMC	-0.0031	0.0122
lnTO	-0.1863***	0.0429	lnTO	-0.0252	0.0177
UMDT	0.0027	0.0034	UEDT	-0.0219***	0.0016
Constant	-3.0965*	1.8316	Constant	-29.0039***	0.8977
Rebound Effect					
lnGDPP	-0.0948	0.0632	lnGDPP	0.1968***	0.0189
lnMP	0.1852***	0.0436	lnEP	-0.0481***	0.012
lnCOGDP	-0.7763***	0.1783	lnCOGDP	-0.4773***	0.0664
lnISH	-0.3946***	0.0922	lnISH	-0.1664***	0.0579
UMDT	0.0086**	0.0043	UEDT	-0.0166***	0.0022
σ_u	1.1039**	0.4318	σ_u	3.0007***	0.4169
σ_v	-4.0628***	0.0493	σ_v	-5.9613***	0.0493

Note: *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Malzeme verimliliği politikalarının Avantajı

Figure 2 The trend of material efficiency and rebound effect over the years 1995-2019

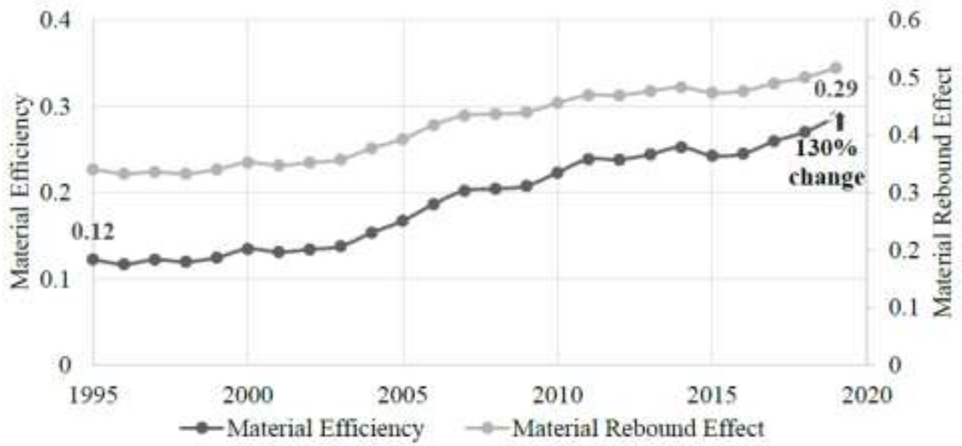
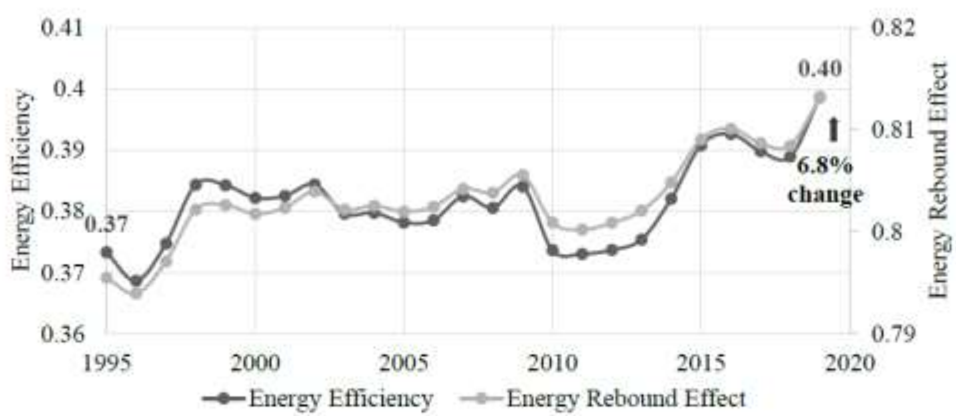


Figure 3 The trend of energy efficiency and rebound effect over the years 1995-2019



Malzeme verimliliği geri-tepme= %40

Enerji verimliliği geri-tepme= %80

Table 4 Ranking based on material efficiency scores and rebound effect (1995-2019)

Country	Material Efficiency Scores	Ranking	Country	Material Rebound Effect
Luxembourg	0.9815	1	Switzerland	0.6622
Switzerland	0.8471	2	Sweden	0.5972
Sweden	0.5997	3	Norway	0.5694
Norway	0.4690	4	France	0.5640
Denmark	0.3905	5	Denmark	0.5333
Finland	0.3765	6	Luxembourg	0.5312
France	0.3053	7	UK	0.5263
Austria	0.2749	8	Italy	0.4925
UK	0.2624	9	Austria	0.4903
Ireland	0.2219	10	Netherlands	0.4767
Italy	0.2175	11	Ireland	0.4731
Latvia	0.1999	12	Portugal	0.4705
Netherlands	0.1915	13	Spain	0.4629
Belgium	0.1540	14	Belgium	0.4579
US	0.1438	15	Cyprus	0.4391
Spain	0.1428	16	Latvia	0.4377
Portugal	0.1329	17	Finland	0.4347
Greece	0.1224	18	Germany	0.4335
Croatia	0.1126	19	Greece	0.4241
Lithuania	0.1086	20	Turkey	0.4175
Germany	0.1085	21	Croatia	0.4111
Slovenia	0.0980	22	Japan	0.4093
Cyprus	0.0944	23	US	0.4009
Japan	0.0935	24	Lithuania	0.3992
Slovak Rep.	0.0442	25	Slovenia	0.3723
Hungary	0.0391	26	Hungary	0.3667
Turkey	0.0343	27	Romania	0.3285
Estonia	0.0294	28	Slovak Rep.	0.3268
Romania	0.0233	29	South Korea	0.3249
South Korea	0.0167	30	India	0.2782
Czechia	0.0121	31	Czechia	0.2612
Poland	0.0053	32	Estonia	0.2602
Bulgaria	0.0050	33	Bulgaria	0.2598
Russia	0.0029	34	Poland	0.2590
India	0.0001	35	China	0.2111
China	0.0001	36	Russia	0.2076

PROJE KAPSAMINDAKİ DİĞER FAALİYETLERİMİZ

lessmaterial.ogu.edu.tr

- 5 İngilizce, 11 Türkçe Blog yazısı
- Uluslararası ve ulusal etkinliklerde 7 sunum
- Bursiyerler için 1 yüz yüze, 1 online eğitim
- 1 röportaj
- İklim haberde projemiz ile ilgili bir yazı
- 10 adet İNFOGRAFİK
- İKLİM DEĞİŞİKLİĞİ EKONOMİSİ ÇALIŞTAYI

KALAN SÜREDE YAPACAKLARIMIZ

BURSİYERLERİMİZE 1 ONLINE EĞİTİM

ÜZERİNDE ÇALIŞTIĞIMIZ 1 ARAŞTIRMA MAKALESİ

TEŞEKKÜRLER

ETEM KARAKAYA

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MATERIALS=MALZEME
ADDITIONAL SLIDES

Policy Tools and Instruments for Resource Efficiency and the 3Rs

Resource extraction

- Material stewardship
- Mineral resource extraction charge
- Tax on raw materials
- Aggregates(stone, rocks and gravel) levy
- Natural resource taxation

Product design Production

- EPR
- Material stewardship
- Training / consultancy on Lean manufacturing (KAIZEN) / Resource efficient process
- Eco-label/Eco-Design /EPEAT/Certification /Standards/ top-runner
- EMS(EMAS/ISO14001)
- R&D support
- Voluntary agreement
- Awareness / Awards

Consumption Usage

For citizens

- EPR / Deposit-refund, Take-back
- Eco-label / Certification
- Differenciated VAT
- Awareness campaigns

For companies

- Eco-label / Certification
- Green Procurement

Waste management

For citizens

- Plastic bag tax
- Pay as you throw (PAYT)
- Municipal waste charge / Pay for MSW collection bag
- Awareness campaigns / training / trainer

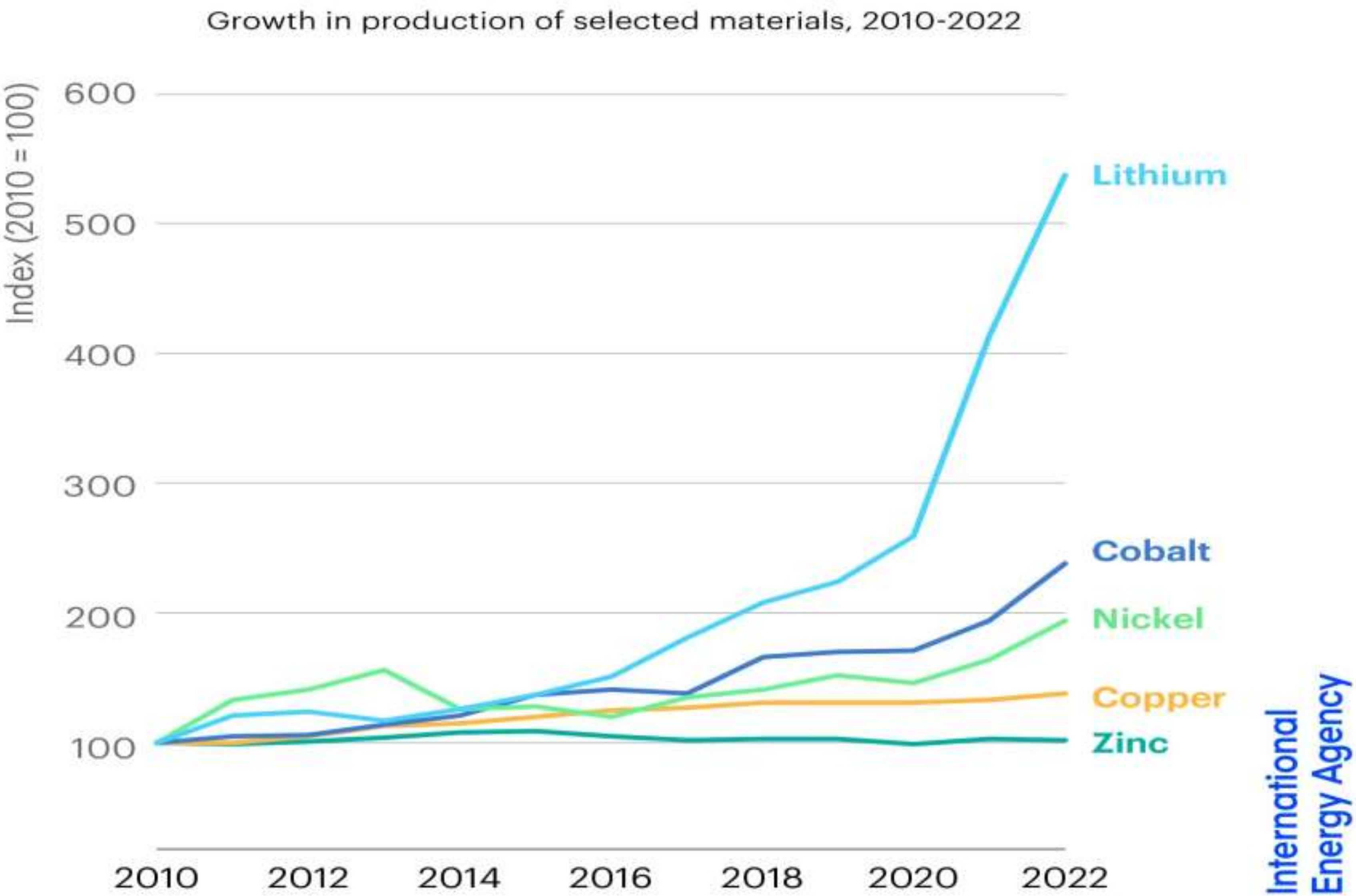
For companies

- Plastic bag tax
- Land fill tax
- Landfill allowance trade
- Incineration tax

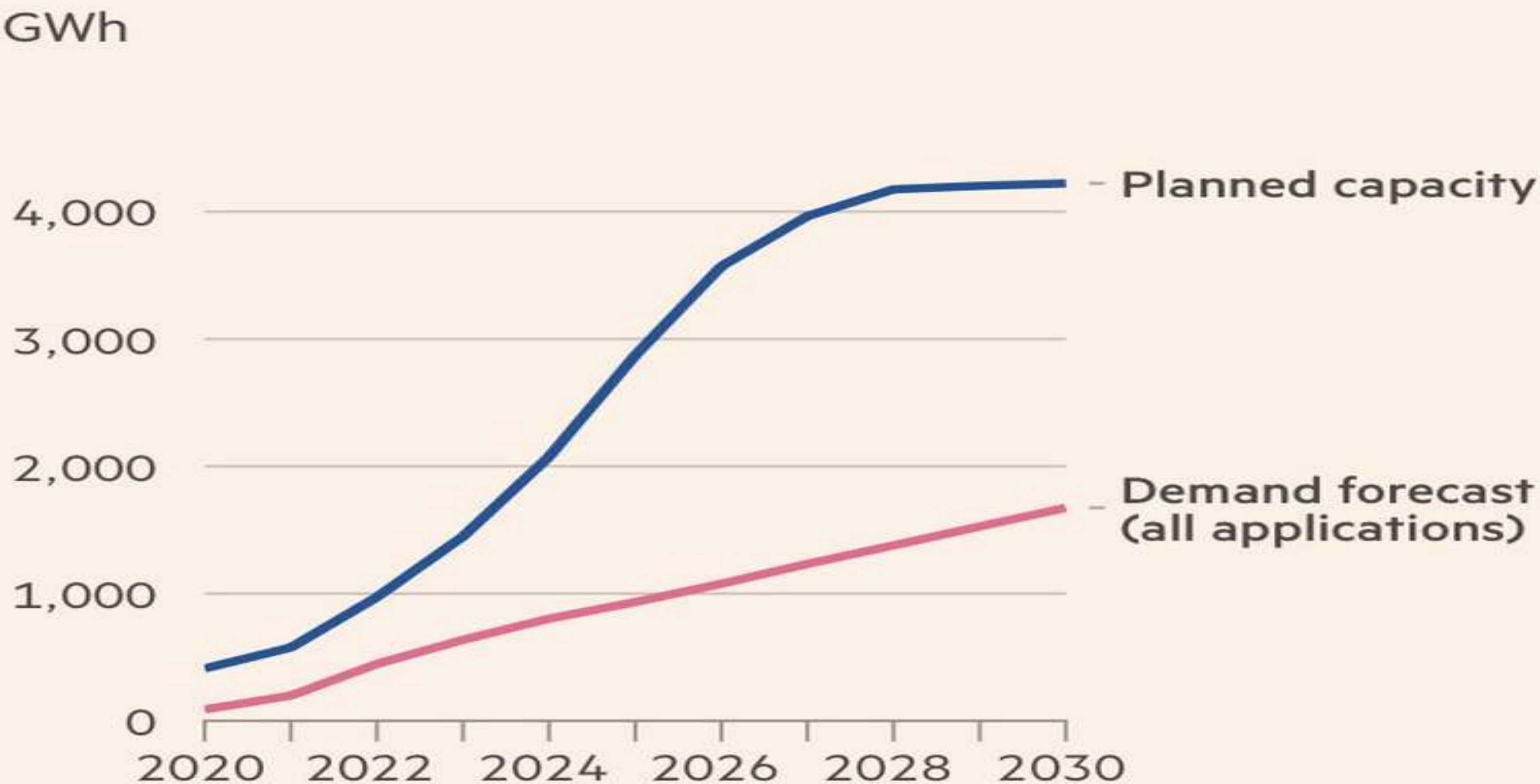
Material Resource Circulation

- Recycling Policy
- Remanufacturing
- Reuse, Repair, Refurbish

Clean energy is driving unprecedented growth for critical minerals



China is building battery plants far beyond its needs



FINANCIAL TIMES

Source: CRU Group

TÜKETİM TEMELLİ EMİSYON –GDP DECOUPLING I BİLE GERÇEK

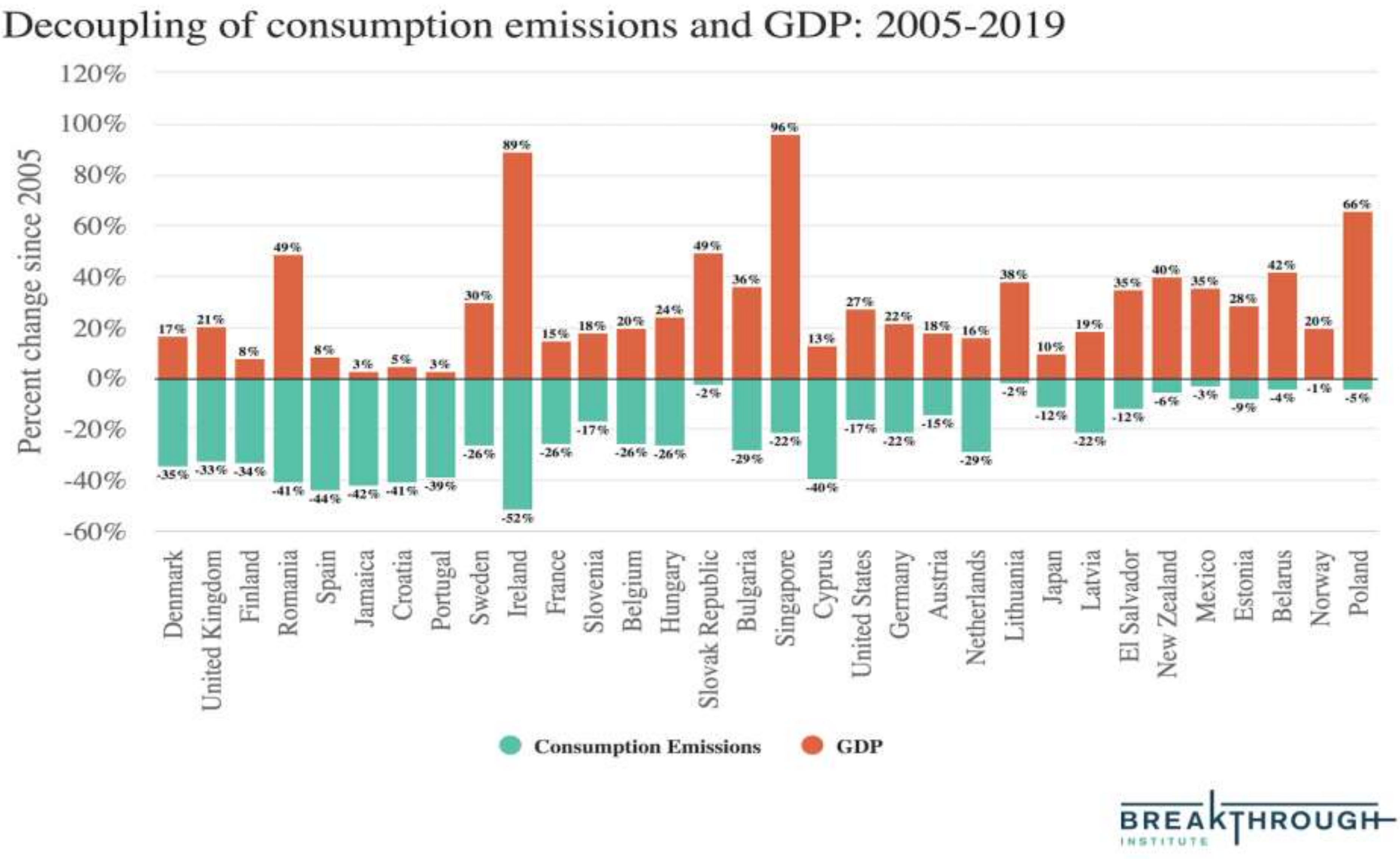
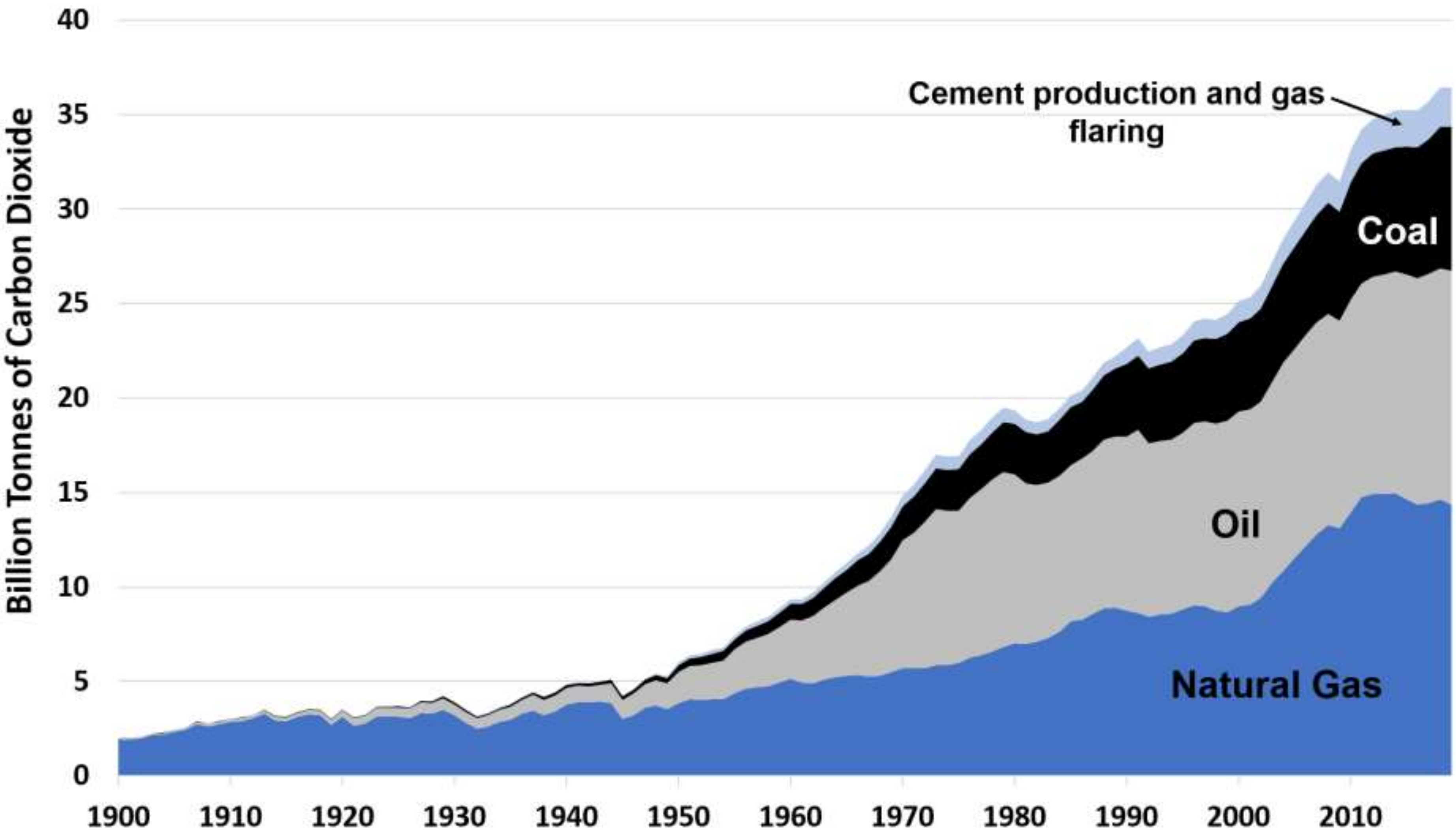


Figure 12.2 Global Carbon Dioxide Emissions from Fossil Fuel Consumption, 1900-2019



Source: Global Carbon Project, Global Carbon Budget 2020.