1025 2019

The Industrial Revolutions and Energy

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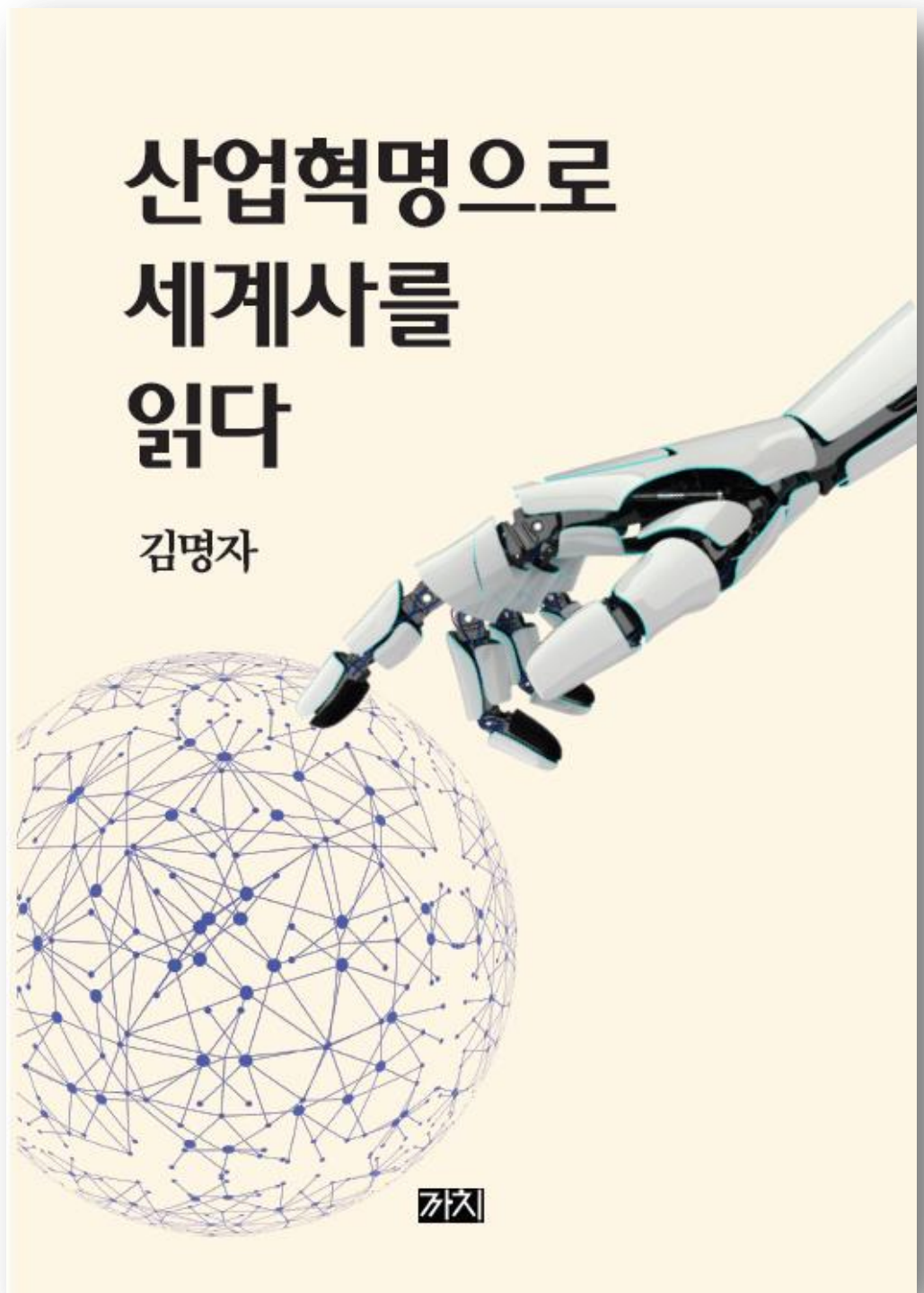
International Advisory Panel, Asian Infrastructure Investment Bank(2018-)
Visiting Distinguished Professor, KAIST (2008-2016)
National Assembly Member (2004-2008)
Minister of Environment (1999-2003)

KOFST



4차 산업혁명의 파도에 부딪히면서 누군가 18세기 이후의 산업혁명의 역사를 쉽게 설명해주기를 바랐는데, 역시 한국과총의 김명자 회장이 한 권의 재미있고 중요한 책을 선물해주었다. 역사로부터 배우지 못하는 나라나 민족은 자멸의 길로 들어선다는 것이 산업혁명의 교훈이다. 그러나 3차 산업혁명과 시장의 세계화가 가져온 발전과 번영에도 불구하고, 최근 강대국 사이에서 '제국으로의 향수'가 되살아나는 듯한 어두운 징조가 나타나고 있다. 과학기술의 발전과 인류공동체의 문명을 슬기롭게 조화시켜 나가는 것이 시대적 과제인 오늘의 시점에서, 이 책과 함께 역사에서 배우고 밝은 미래를 열어가는 지혜를 모을 수 있기를 기대한다.

—이홍구 전 국무총리, 서울대학교 명예교수

호모 데우스 시대, 4차 산업혁명이 여는 미래는 어떤 모습이며, 우리는 그 흐름에 어떻게 대처해야 할까? 『산업혁명으로 세계사를 읽다』는 이 큰 질문의 해답을 역사에서 찾는다. 김명자 전 장관은 디지털 혁명에서 인류사회가 직면하고 있는 도전을 산업혁명의 창을 통해서 내다보는 방식을 택했다. 학계, 관계, 정계를 거친 과학자의 눈으로 산업혁명이 정치, 경제, 사회, 문화적으로 어떻게 상호작용했는지를 들여다보고 있으니, 우선 그 통합적인 관점이 돋보인다. 특히 젊은이들이 근대 산업문명을 돌아보며 지구별의 미래를 내다보는 기회를 가지게 되기를 희망한다. 단언컨대 이 책보다 산업혁명의 통사를 더 잘 집약한 책은 없다.

—이어령 전 문화부 장관, 이화여자대학교 명예석좌교수

The Industrial Revolutions and the History of Modern World

1600s
17thC Mercantilism, Emergence of large scale international trade (United East India Co. 1602)

1st IR 1760

'Free Market System': '*The Wealth of Nations' (1776)* by Adam Smith
Industrial Capitalism, Economic Liberalism, Laissez-faire, Entrepreneurship
Gap between the rich and poor

1830

Communist Manifesto, K. Marx's 'Das Kapital', Dialectical Materialism, Socialism, Colonialism, Imperialism

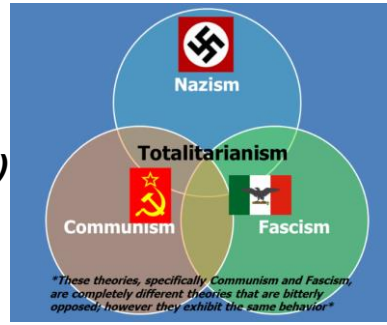
- Brougeois & Proletarian
- Opposition of Capital and Labour
- Labour organization

2nd IR 1870

Taylorism, Fordism, Unionism, Social Darwinism
Marketing and the Consumer Culture
Financial/Debt Crisis ('Buy Now, Pay Later')

WW1
1930 The Great Depression Keynesian Economics,
'The General Theory of Employment, Interest and Money(1936)

WW2 Communism, Nazism, Fascism, Totalitarianism(1930-45)
The Cold War



3rd IR 1970

Market for Corporate Control, 70's Stagflation, Oil shock,
1970's Hayek's Neoliberalism,
Deregulation, Flexibilization, Outsourcing, Offshoring
Digital Globalization, Finance Capitalism, Financial Crisis
Increased Social Inequality, Decline of Social Trust and Cohesion

2010

Globalized Economy, Informational Capitalism,
Digital Capitalism, Cyber Capitalism
Surveillance Capitalism (Shoshana Zuboff),
Rentier Capitalism (Guy Standing), Platform Capitalism

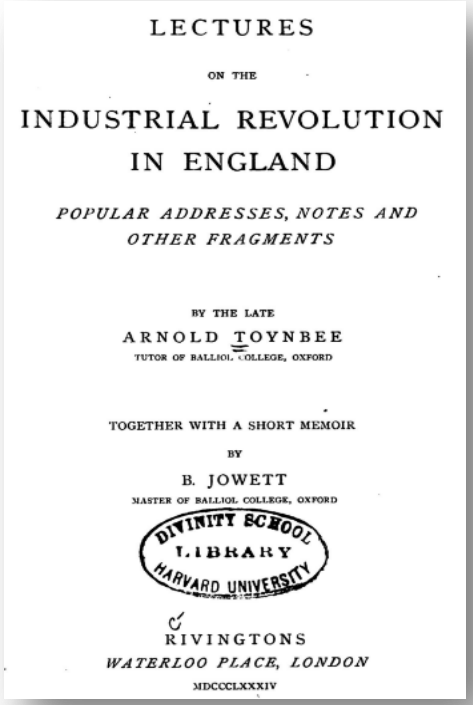
4th IR

"Lectures On the Industrial Revolution In England", London, 1884

1852-83

- Term **"Industrial Revolution"** coined by Oxford economic historian
- **Arnold Toynbee**, in reference to period 1760-1830:

  "It was in this period that modern Political Economy took its rise"



LECTURES

ON THE

INDUSTRIAL REVOLUTION IN ENGLAND

POPULAR ADDRESSES, NOTES AND OTHER FRAGMENTS

BY THE LATE

ARNOLD TOYNBEE

TUTOR OF BALLIOL COLLEGE, OXFORD

TOGETHER WITH A SHORT MEMOIR

BY

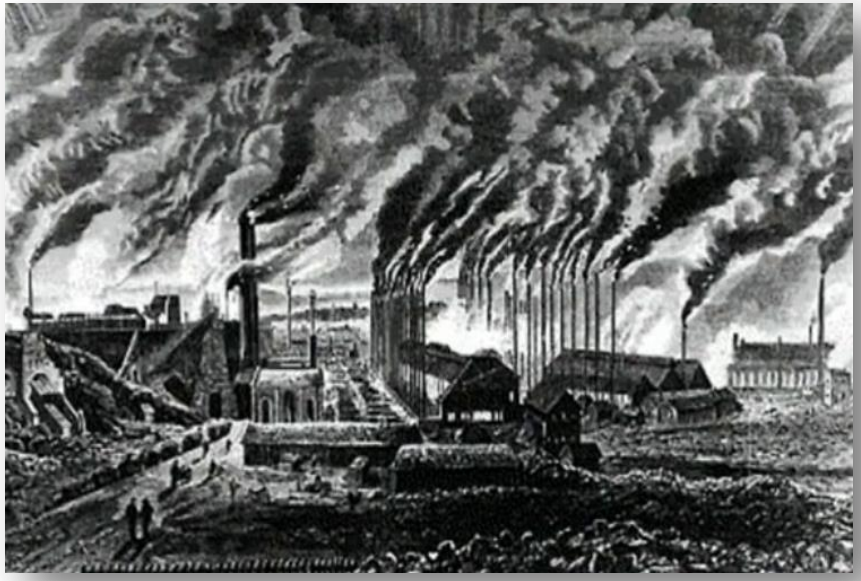
B. JOWETT

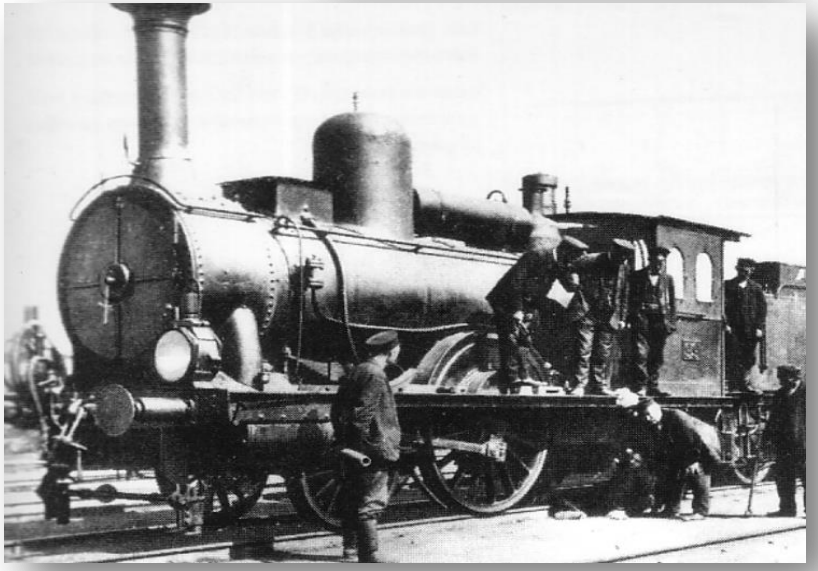
MASTER OF BALLIOL COLLEGE, OXFORD

RIVINGTONS

WATERLOO PLACE, LONDON

MDCCCLXXXIV



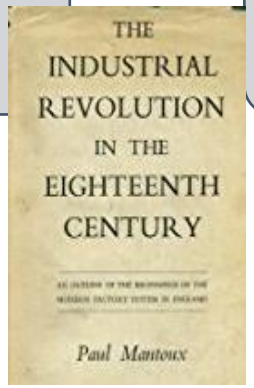


Industrial Revolutions in Historical Perspective

- The first two revolutions were named as such *ex post*, while the recent two revolutions were named amid ongoing transformations.

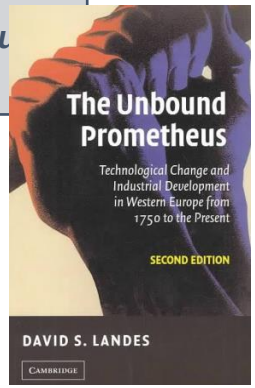
1st

- Arnold Tonybee (1884)
- Paul Mantoux, *The Industrial Revolution in the 18th Century* (1906)



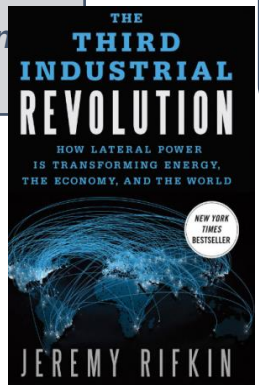
2nd

- Patrick Geddes, *Cities in Evolution* (1915)
- David Landes, *The Unbound Prometheu* (1969)



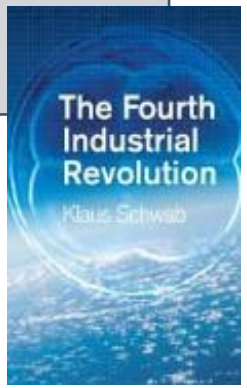
3rd

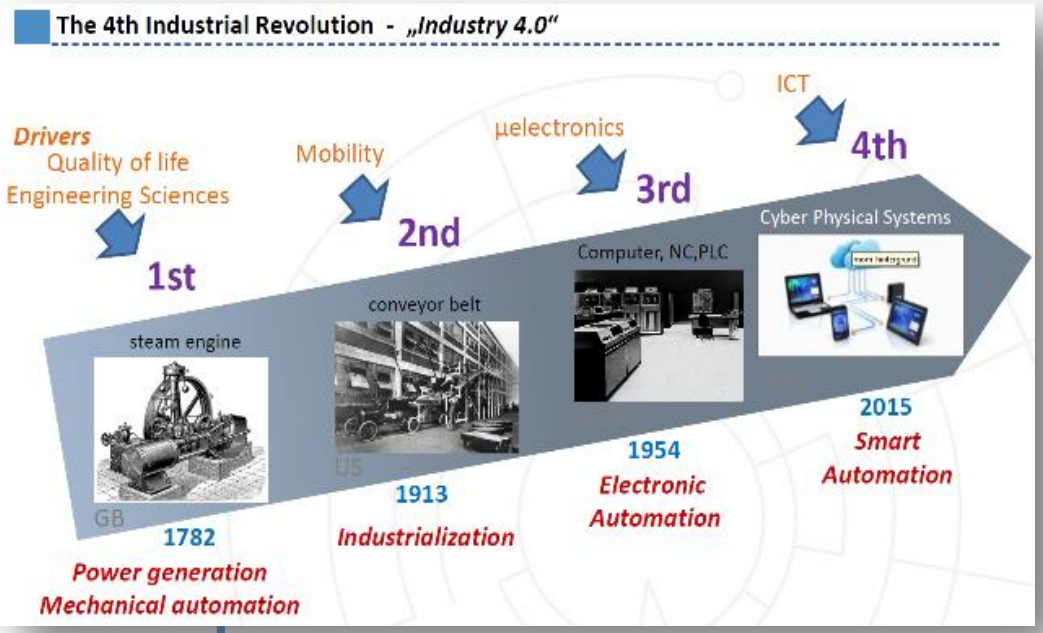
- Daniel Bell, 'The Coming of the Post-Industrial Society(1973)
- Jeremy Rifkin, *Third Industrial Revolution* (2011)



4th

- Klaus Schwab, *Fourth Industrial Revolution* (2016)





Industrial Revolutions

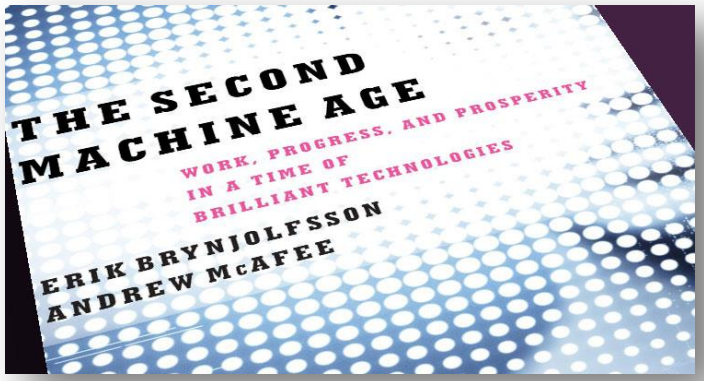
4차 산업혁명 : 사이버-물리적-바이오 시스템, AI, IoE, Drone, VR, 3D Nano....

3차 산업혁명 : 컴퓨터, 인터넷, 셀폰, 디지털 자동화, Maker Space

2차 산업혁명 : 화학염료,전기, 통신,정유,자동차 등 대량생산 체제; Science-based tech, Fordism, Taylorism,

1차 산업혁명 : 증기기관, 방적기(수력) 면직물 공업, 기계적 생산시설, 기업가정신

1750-1830 1870-1930 1960- 2015-



Pumping Water and James Watt

http://www.geography.hunter.cuny.edu/tbw/wc.notes/13.air.pollution/london.air.pollution.1200s.html

Gathering Sea Coal

- Large deposits of "sea-coal" off the northeast coast provided a cheap alternative
- It was 3 times more powerful than wood for fuel.

A Newcomen steam-engine being used in about 1780.

Boulton and Watt Steam Engine(1785~1786) -the oldest rotative steam engine in the world

It embodies the four innovations that, together with **extended patent protection, Matthew Boulton's capital and entrepreneurship, and James Watt's engineering skill and prudent management**, made the rotative engines **the first commercially successful stationary power plants that were independent of wind, water and muscle.**

By entering into partnership with the Birmingham magnate Boulton in 1774, J. Watt was able to channel the vast resource of Boulton's Soho Foundry

As B&W engines were prime movers in the Industrial Revolution, this engine represents not just invention and entrepreneurship, but also wealth creation, mass consumerism, great changes in working life, a massive shift in the use of resources, and consequent damage to the natural environment.

https://www.nms.ac.uk/explore-our-collections/stories/science-and-technology/boulton-and-watt-engine/

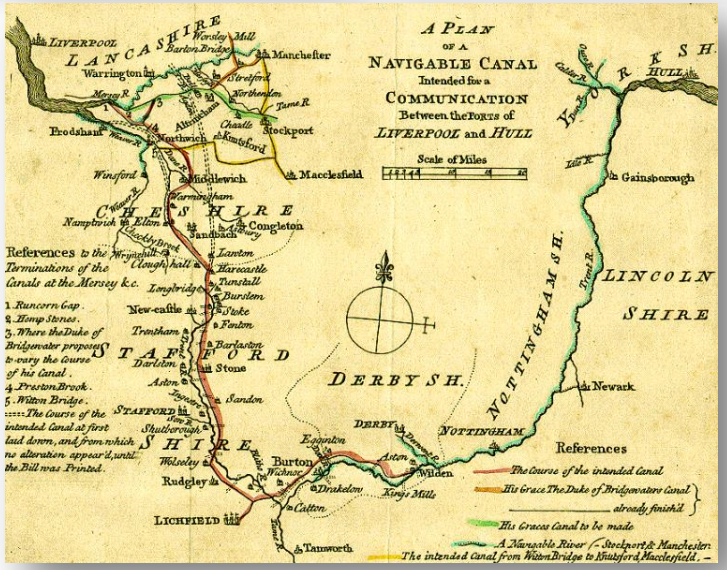
https://collection.maas.museum/object/7177

J. Wedgwood
Power of Marketing & Consumer Revolution
(1730~1795)

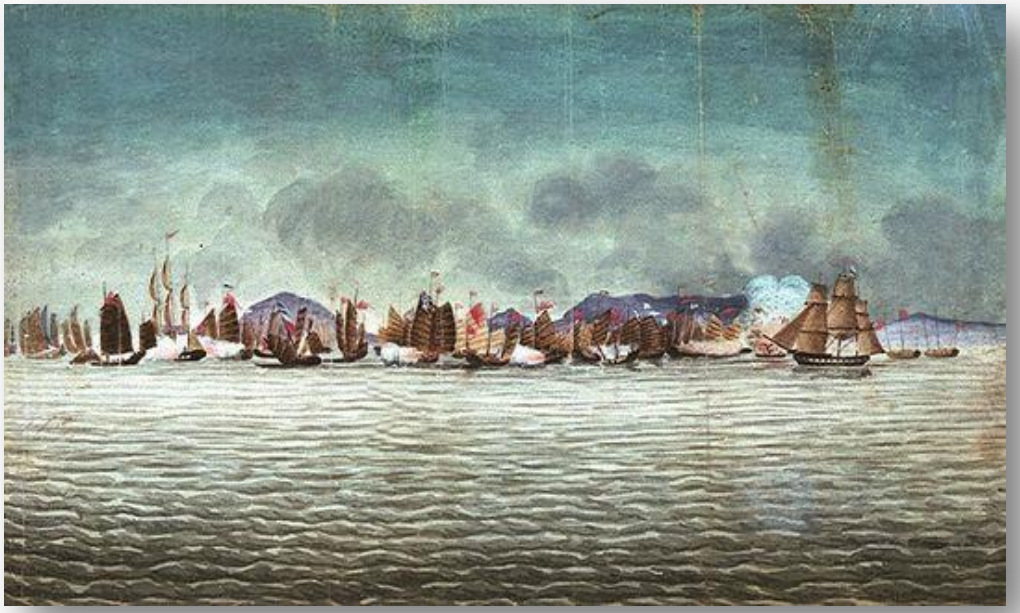
In the 1770s canals linked the country, carrying goods cheaply and efficiently. Without them it is hard to see how the IR could have happened.

1765, wedgwood tea and coffee service

A teapot in Wedgwood's famed jasperware (1785-90)



https://ichemeblog.org/2014/09/27/josiah-wedgwood-the-first-ceramics-engineer-day-116/



Engagement between British and Chinese ships in the First Battle of the Opium War in 1839

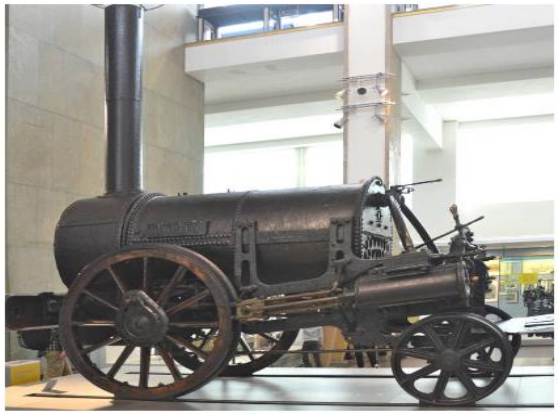
Steam Locomotives and industrial revolution

the Railway across Chat Moss, 1831

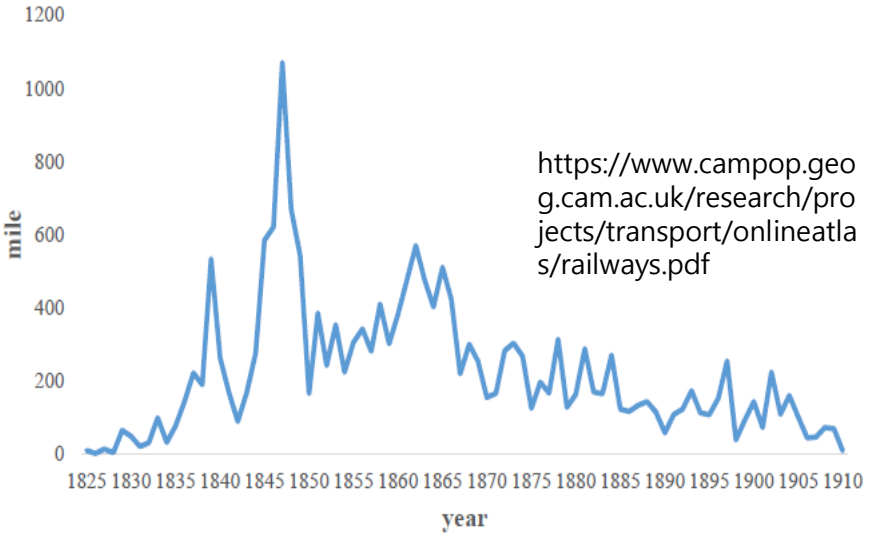
Steam locomotives began being built after the introduction of high-pressure steam engines after the expiration of the Boulton and Watt patent in 1800.

The first full scale steam locomotive was built in Britain by British engineer Richard Trevithick in 1804. However, adhesion was a problem.

In 1814, the first successful steam engine locomotive was built by the British Engineer George Stephenson called Blücher. In 1825, Stephenson also created the first public railway for steam locomotives.

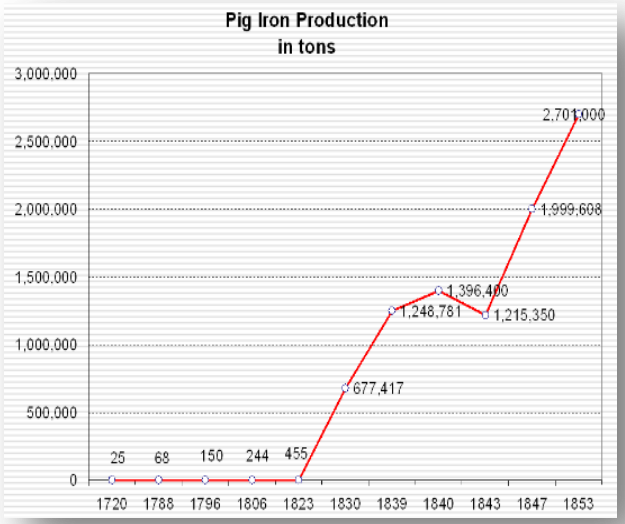


Rocket designed by Robert Stephenson. 1829.



https://www.campop.geog.cam.ac.uk/research/projects/transport/onlineatlas/railways.pdf

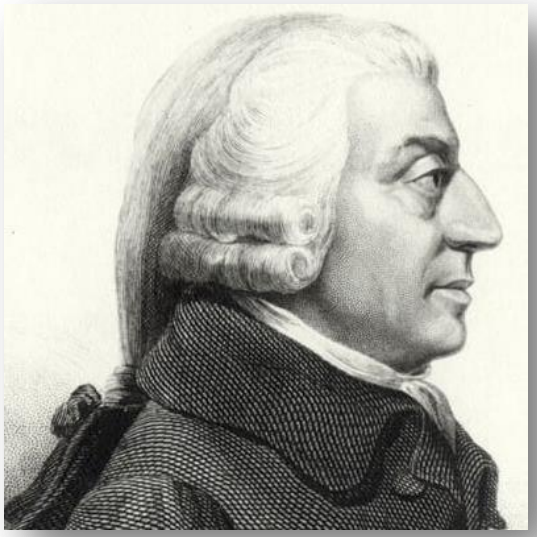
The annual growth of railway mileage in Britain, 1825-1911



Rocket marks one of history's key advances in technology -the first modern steam locomotive.

http://www.victorianweb.org/technology/railways/locomotives/22.html

Adam Smith: Father of Capitalism/modern economics



Economist, Educator, Journalist, Political Scientist (1723–1790)

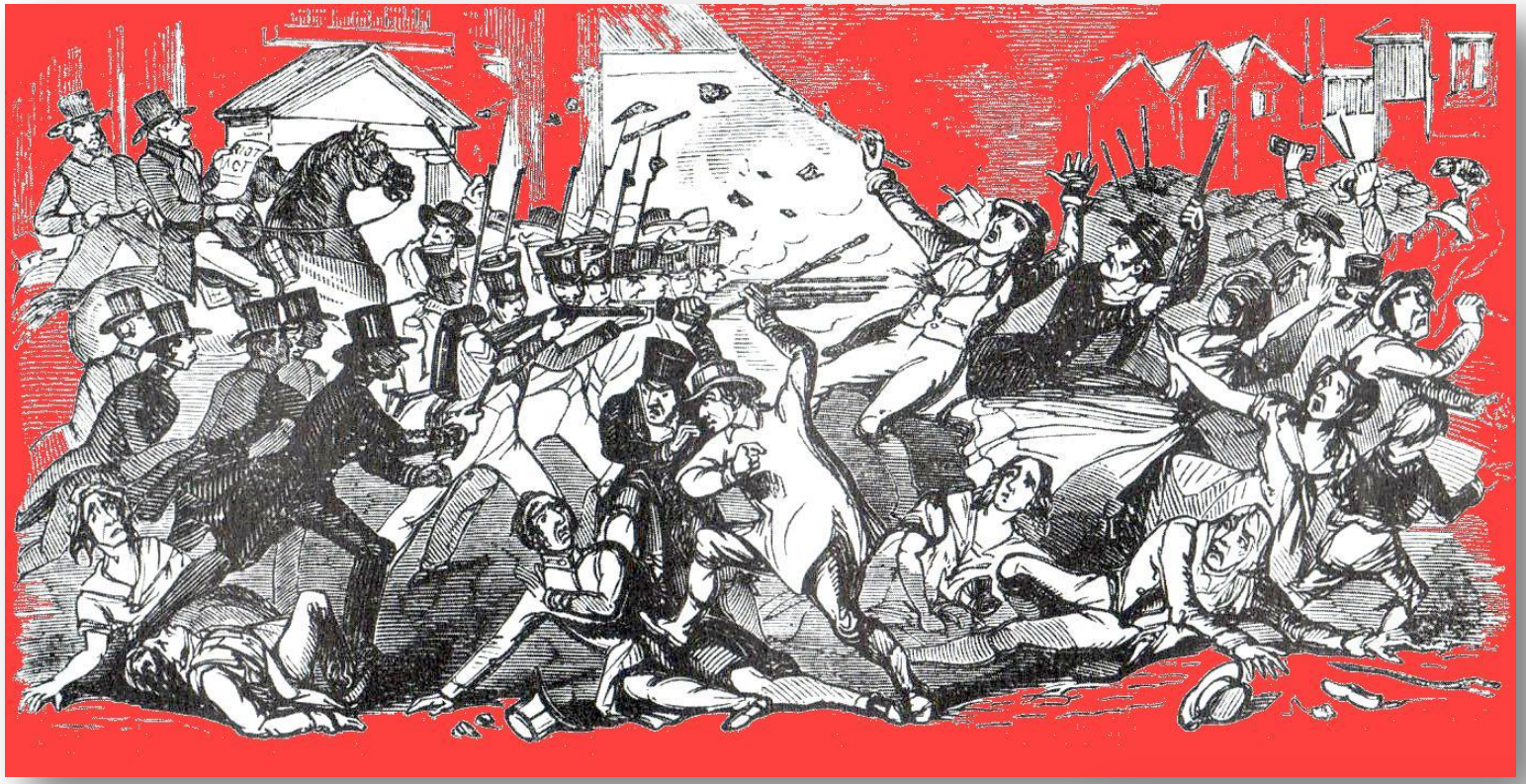
Adam Smith (1723-1790), Professor of Moral Philosophy at **Glasgow University**

'Theory of Moral Sentiments'(1759)
'An Inquiry into the Nature and Causes of the Wealth of Nations' (1776), "bible of capitalism"

- But he never mentioned Capitalism, once mentioned **'the invisible hand'** = System of Free Market
- **Personal profit + Free market + the frame of the common good of society**

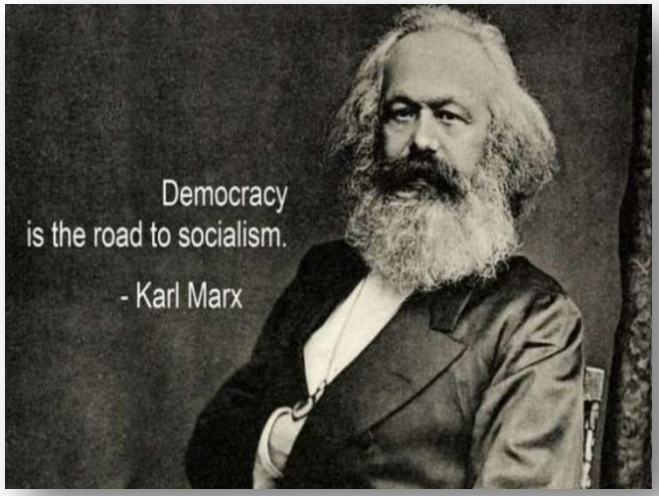
Smith proposed that a nation's wealth should be judged by **the total of its production and commerce(GDP) and** explored **theories of the division of labor** through which specialization would lead to a qualitative increase in productivity.

Smith's ideas are a reflection on economics in light of the beginning of the Industrial Revolution.
He states that free-market economies are the most productive and beneficial to their societies, based on individual self-interest led by an "invisible hand," in the frame of the greatest good for all.



1811- 13 Luddite(Ned Ludd) Movement

https://undergroundhistories.wordpress.com/the-luddite-legacy/



K. Marx (1818- 1883): 'Das Kapital I', 1867, Dialectical Materialism

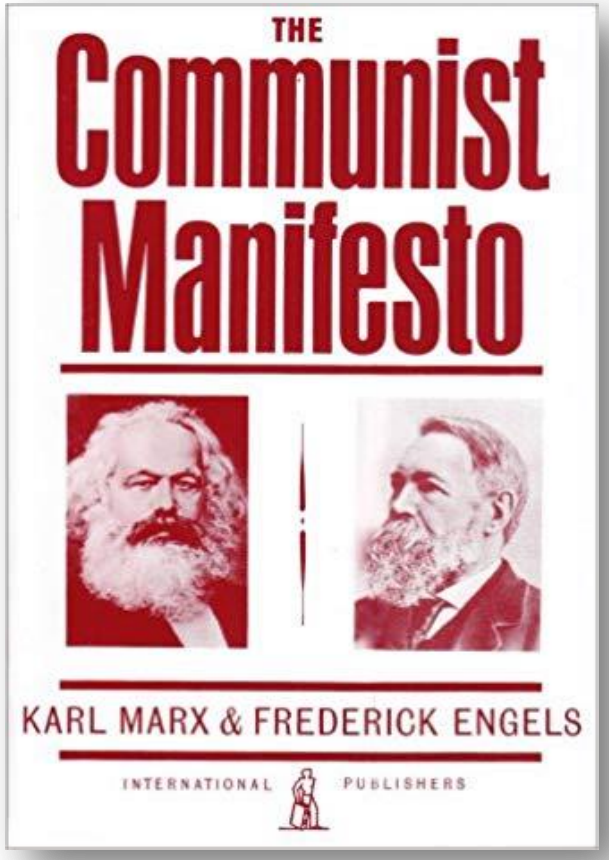
- **Marx's study of the condition of workers in English factories at the height of the industrial revolution. It is part history, part economics and part sociology.**

Marxism is based on three influences: Hegel's dialectics, French utopian socialism and English economics.

Marx's theories about society, economics and politics hold that human societies develop through class struggle. In capitalism, this manifests itself in the conflict between the ruling classes (the bourgeoisie) that control the means of production and the working classes (the proletariat) that enable these means by selling their labour power in return for wages.

"Capitalism misunderstood Adam Smith, and Communism misunderstood Karl Marx."

1848 London



1865 England, The Locomotive Red Flag Act

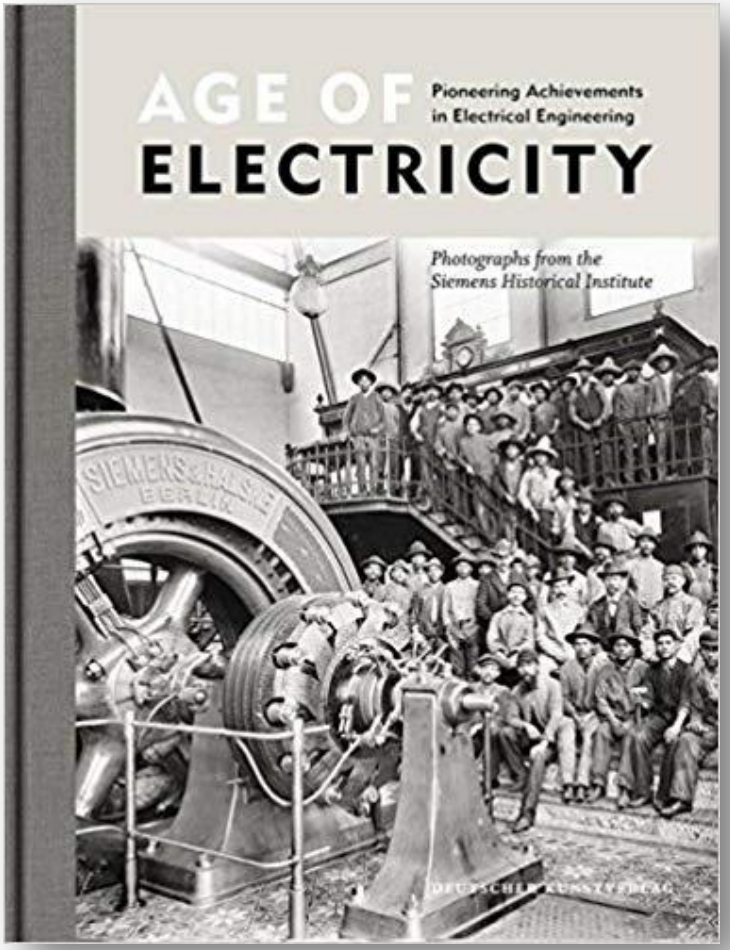
- For protection rail and horse carriage industries
- Max 3.2km/hr in cities, & Required: driver + stoker + flag

2nd IR in the US : The Rise of Modern Industrial Society

Chemical dye industry of Germany

Oil drilling in Beaumont, Texas in 1901

https://www.google.co.kr/searchrefinery



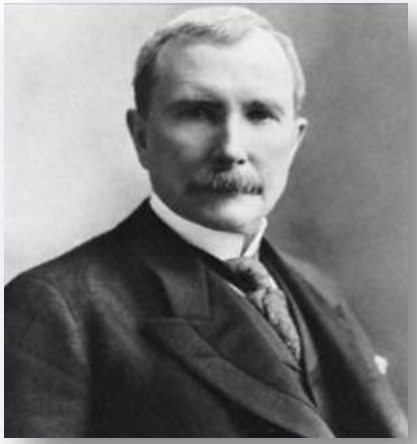
Battle between DC and AC; T. Edison + J. P. Morgan vs N. Tesla + G. Westinghouse

Fordism, Model T 1908 vs Unionism in 1920's Taylorism; Scientific Management

Captains of Industry

They were able to build great fortunes during the gilded era of the US.

Source: https://slideplayer.com/slide/6832259/

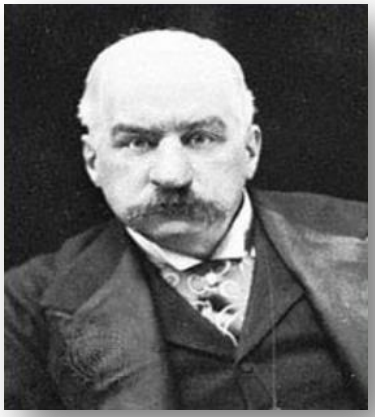


▶ **John D. Rockefeller (1839~1937, *97*)**

- Standard Oil (refinery)
- Implemented vertical integration & horizontal integration
- By 1875-refined $^1/_2$ of US oil

▶ **Andrew Carnegie (1835~1919, *84*)**

- Carnegie Steel Company
- By 1899, dominated US steel industry
- Sold to JP Morgan in 1901

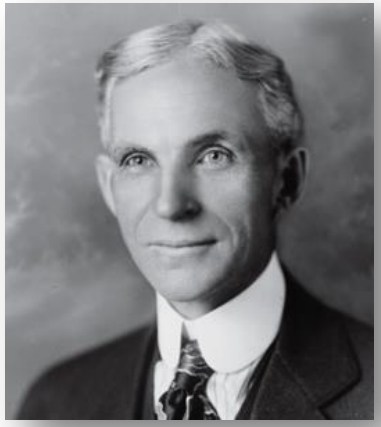


▶ **John Piermont Morgan (1837~1913, *76*)**

- Private banking
- Financed many industrial consolidations
- Railroads, Steel, Electricity

▶ **Cornelius Vanderbilt (1794~1877, *83*)**

- Began in shipping
- Invested in railroads during Civil War
- Controlled most railroads in eastern US



▶ **Henry Ford (1863~1947, *84*)**

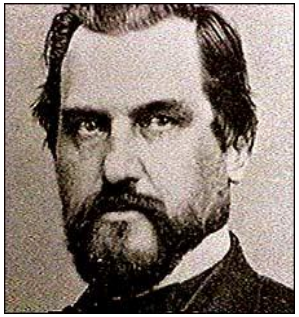
- 2nd generation builder of Am.
- Created the Ford Model T
- Automobile assembly line, Mass production

Linking a nation, The Trans-continental Railroad

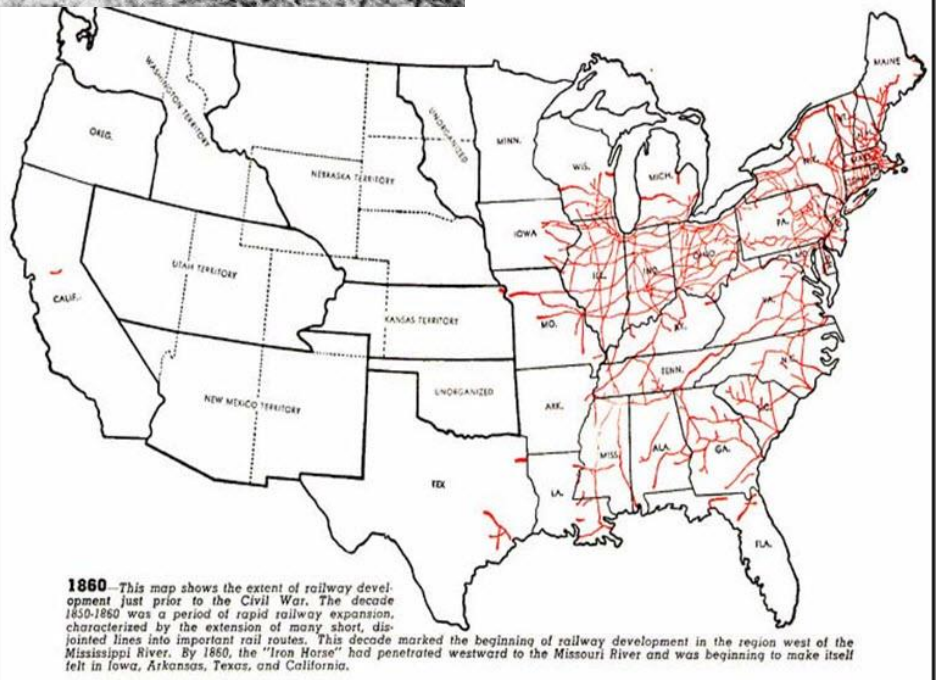
Puck Magazine (September 7, 1904)

US Railroad Map 1860

Railroads ruled the land in the mid and late 1800s and on into the 1900s. Thousands of miles of track linked the Atlantic and Pacific Oceans by using the iron horse.



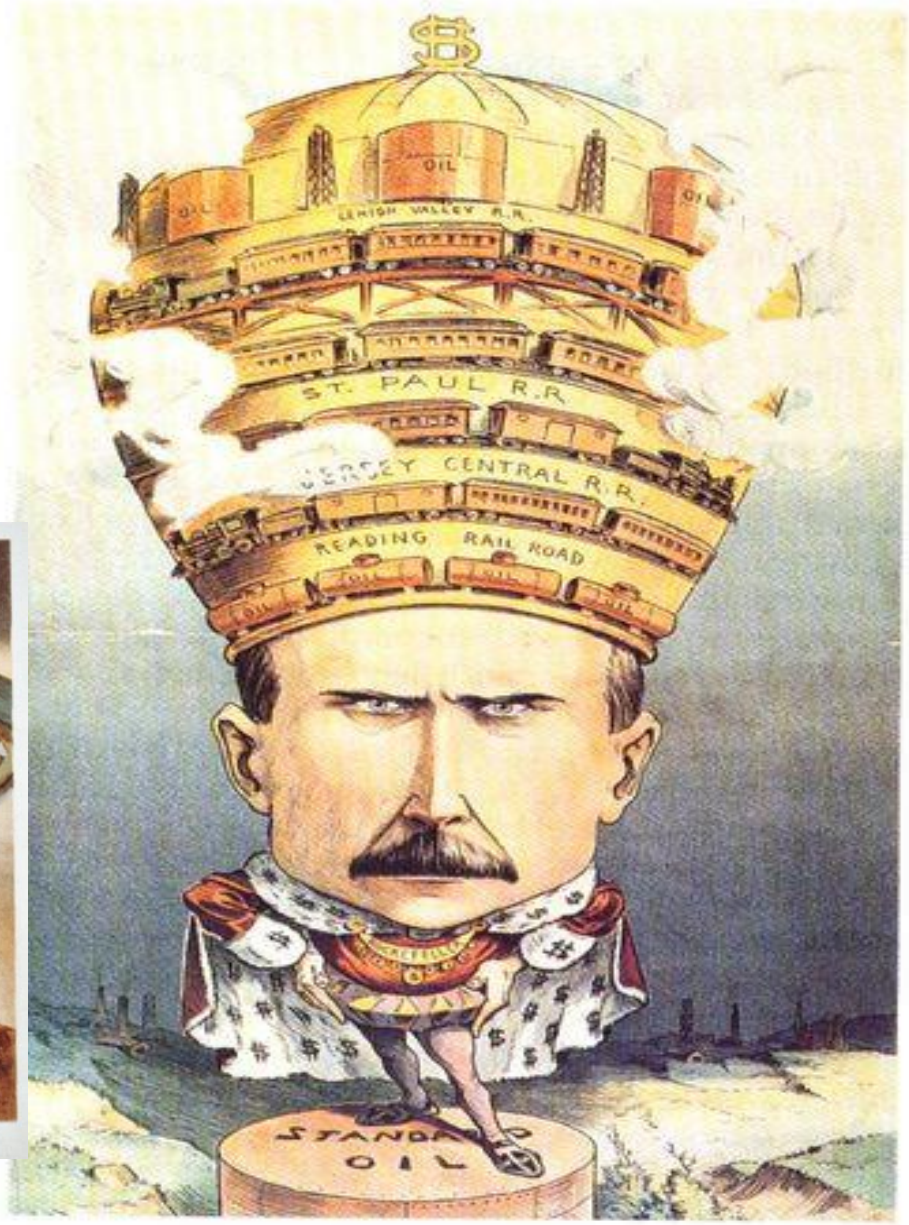
The Leland Stanford Junior University was founded in 1885 by California Senator Leland Stanford and his wife, Jane, in memory of their only child, Leland Jr., who died of typhoid fever at 15. (Opened in 1891)



1860—*This map shows the extent of railway development just prior to the Civil War. The decade 1850-1860 was a period of rapid railway expansion, characterized by the extension of many short, disjointed lines into important rail routes. This decade marked the beginning of railway development in the region west of the Mississippi River. By 1860, the "Iron Horse" had penetrated westward to the Missouri River and was beginning to make itself felt in Iowa, Arkansas, Texas, and California.*

John Davison Rockefeller exemplified the capitalist spirit of the day.
His Standard Oil Company dominated the oil industry.
The business practices of vertical and horizontal integration were used to almost wholly monopolize the oil industry.

In 1911, Standard Oil was disintegrated by the Sherman Antitrust law into 34 companies.



John D. Rockefeller, satirized in a 1901 Puck cartoon, is enthroned

THE TALE OF AN EARLY TECH RIVALRY

DC
Direct Current

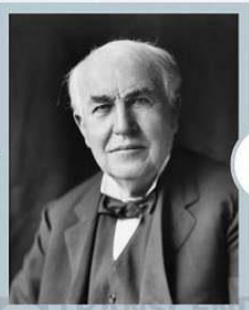
The flow of electricity is in one direction only. The system operates at the same voltage level throughout and is not a efficient for high-voltage, long distance transmission.

Direct current runs through

Battery Powered Devices

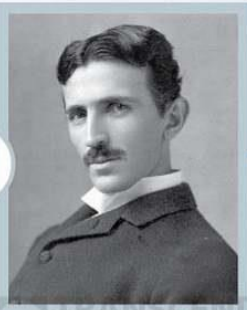
Fuel and Solar Cells

Light Emitting Diodes



THOMAS EDISON

VS



NIKOLA TESLA

AC
Alternating Current

Electric charge periodically reverses direction and is transmitted to customers by a transformer that could handle much higher voltages.

Alternating Current runs through

Car Motors

Radio Signals

Appliances

You would have never found two geniuses so spiteful of each other beyond turn-of-the-century inventors Nikola Tesla and Thomas Edison. They worked together- and hated each other. Lets compare their life, achievements and embittered battles.

1847	BORN	1858
Milan, Ohio	BIRTHPLACE	Smiljan, Croatia
Wizard of Menio Park	NICKNAME	Wizard of the West
Home-schooled and self-taught	EDUCATION	Studied math, physics and mechanics at The Polytechnic Institute at Gratz
Mass Communication and business	FORTE	Electromagnetism and electromechanical engineering
"Genius is one percent inspiration and ninety nine percent perspiration." Thomas Edison	METHOD	Trial and Error Getting Inspired and seeing the invention in his mind in detail before fully constructing it
DC (Direct Current)	WAR OF CURRENTS: ELECTRICAL TRANSMISSION IDEA	AC (Alternating Current)
Incandescent light bulb; phonograph; cement making technology; motion picture camera; DC motors and electric power	NOTABLE INVENTIONS	Tesla Coil - resonant transformer circuit; radio transmitter; fluorescent light; AC motors and electric power generation system
1093	NUMBER OF US PATENTS	112
0	NUMBER OF NOBEL PRIZES WON	0
1931 - Passed away peacefully in his New Jersey home, surrounded by friends and family	DEATH	1943 - Died lonely and in debt in Room 3327 at the New Yorker Hotel

"[Tesla's] ideas are splendid, but they are utterly impractical."
- Thomas Edison

"If edison had a needle to find in a haystack, he would proceed at once.... Until he found the object of his search. I was a sorry witness of such doings, knowing that a little theory and calculation would have saved him 90% of his labor."
- Nikola Tesla

Falling out

Edison promised Tesla a generous reward if he could smooth out his direct current system. The young engineer took on the assignment and ended up saving Edison more than $100,000(millions of dollars by today's standards). When TESLA asked for his rightful compensation, Edison declined to pay him. Tesla resigned shortly after, and the elder invertors spent the rest of his life campaigning to discredit his counterpart.

Edison fries an elephant

In Order to prove the dangers of Tesla's alternating current, THomas Edison

War of current officially settled

In 2007, Con Edison ended 125 years of direct current electricity service that began when Thoms Edison opened his power station in 1882. It changes to only provide alternating current.

Nobel prize controversy

In 1915, both Edison and Tesla were to receive Nobel Prizes for their strides in

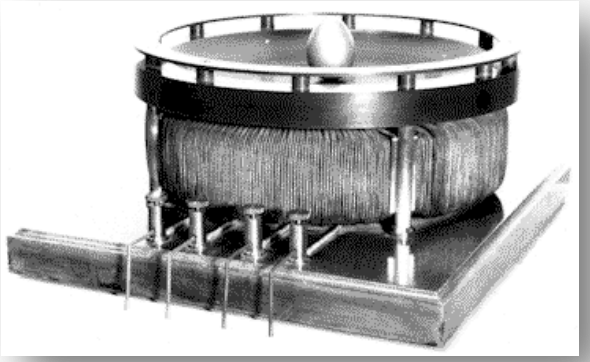
A visionary genius-the master of lightning, Nikola Tesla

A modern Prometheus who changed the world with electricity

War of the currents 1893

Edison(GE) DC vs. Westinghouse AC
The wonders of AC current electricity in 1893 Chicago Expo, which became the standard power in the 20th century

Tesla designed the AC electric system, which is still the predominant electrical system used across the world today



Nikola Tesla's "Egg of Columbus"

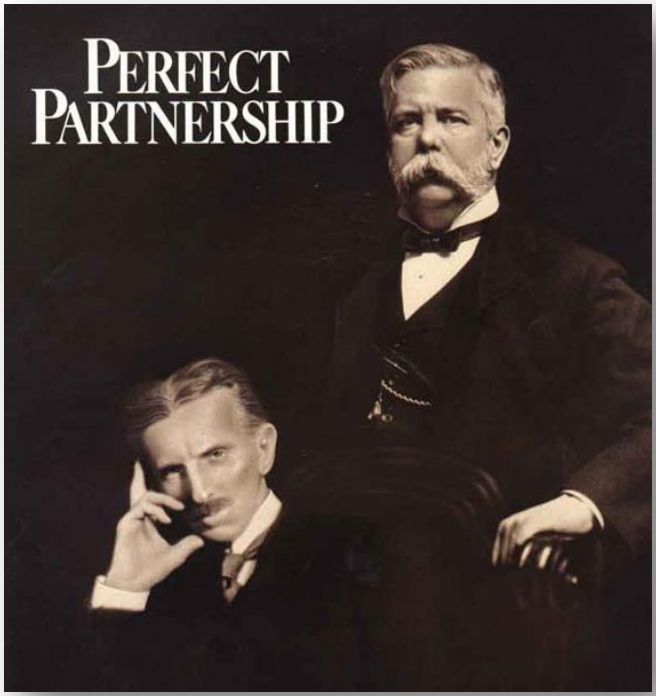
Niagara Falls power 1896 the electrical age began
- In 1889, the first long distance transmission of AC electricity

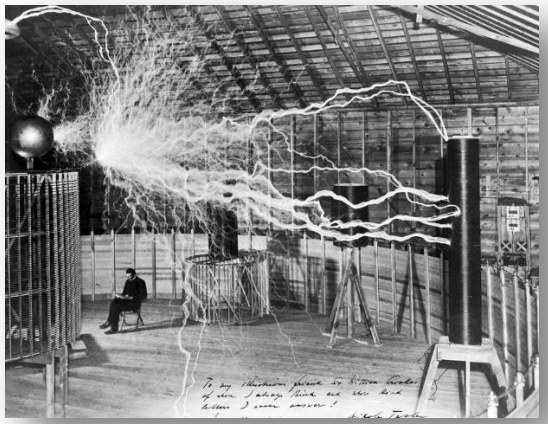
Nikola Tesla and George Westinghouse

"George Westinghouse was, in my opinion, the only man on this globe who could take my alternating-current system under the circumstances then existing and win the battle against prejudice and money power. He was one of the world's true noblemen, of whom America may well be proud and to whom humanity owes an immense debt of gratitude."

Edison and Nikola Tesla grew to be fierce competitors, but in the end, Edison had the upper hand during their lifetime

'Tesla' coil' : high frequency and wireless radio technology





Colorado Springs Laboratory (1899-1900)

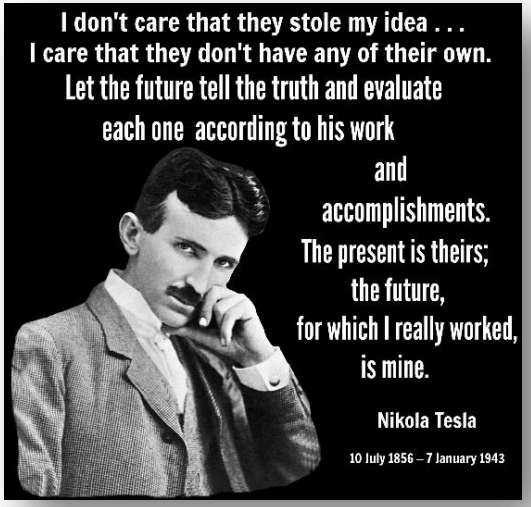
Tesla dedicated most part of his research to develop the right design of a wireless power transmission system to be able to energize the whole planet without wires and to send signals or messages instantly and non-transferable. He was inspired by the lightning.

Tower of Dreams

"When wireless is fully applied the earth will be converted into a huge brain, capable of response in every one of its parts," Tesla told Morgan.

When J.P. Morgan refused Tesla's plea, "It is not a dream," he protested. "It is a simple feat of scientific electrical engineering, only expensive... blind, faint-hearted, doubting world."

The Wardenclyffe Lab. & the world wireless system(1901-1906)



Modern society owes a lot to Nikola Tesla.

Over the course of his life, Tesla registered some 300 patents under his name, and traces of his inventions can be found in many modern-day devices including radio, which is as known that Marconi invented.

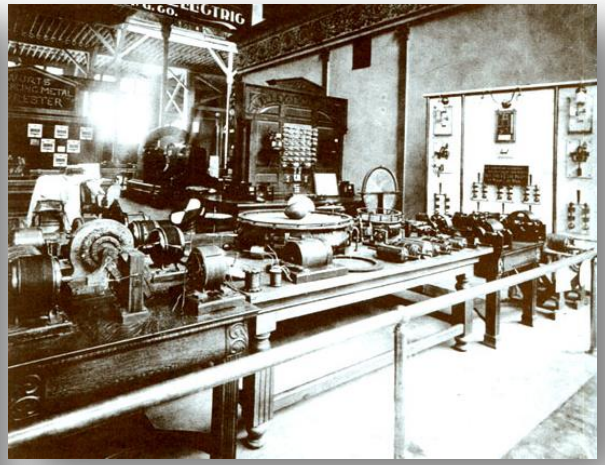
The scientific man does not aim at an immediate result. He does not expect that his advanced ideas will be readily taken all. His work is like that of the plant for the future, his duty is to lay the foundation for those who are to come and point the way.

War of Currents

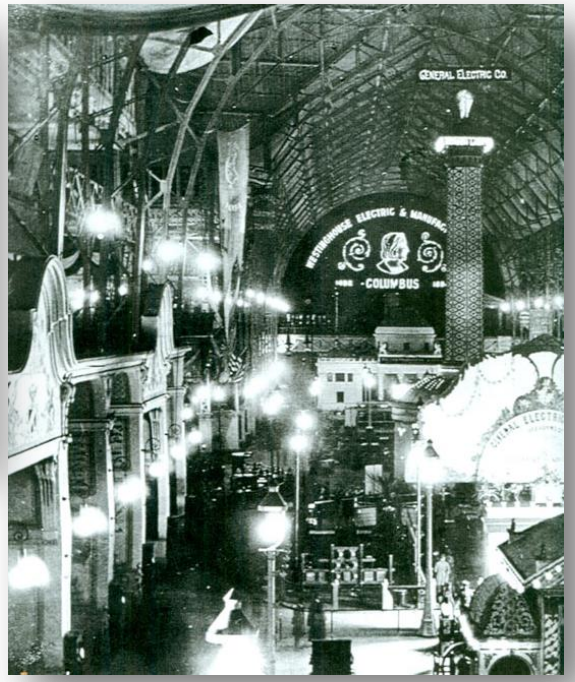
The Columbian Exposition of 1893 introduced electricity to the public

"Court of Honor" at the Columbian Exposition in Chicago, 1893. The age of light that Tesla did so much to bring about was exemplified in this scene. At nightfall, "stopper" (or Sawyer-Man) lamps by Westinghouse provided the most spectacular lighting display the world had ever seen.

This was the final great victory of Tesla/Westinghouse's Polyphase Alternating Current system electricity over Edison's Direct Current (DC)



Nikola Tesla's personal exhibit at the World Fair in Chicago, 1893. The Egg of Columbus centered in this photograph.



The Tesla/Westinghouse display at Electricity Hall. Tesla Polyphase Alternating Current System.

George Westinghouse and Nikola Tesla. Seeking to make long distance electric power transmission a reality, they combined their skills, their genius and their belief in a new technology ... alternating current. Together they started a revolution that electrified the world. A Perfect Partnership.

Fordism

Ford Motor Company at Detroit in 1903.

- **A Pioneer of standardization, mass production and the assembly line. Produced reliable and low cost cars.**
- **Higher salary to supply sustained financial expansion. 'The $5 Day'**

The Fordism production system has 4 key elements;

- **The separation of different work tasks between different groups of workers.**
- **Parts and components of the motor vehicles are highly standardized.**
- **The machines are arranged in the right order to manufacture the product.**
- **Workers are working on an assembly line.**

- **Standardization, Repeat operation, Moving assembly lines;**

  Rigorous supervision, Mechanized pacing of output,

  Capability of dealing with high volumes

  The main goal of Fordism is to lower the manufacturing cost of the automobile.

Tear gas fills the air as Dearborn Police and Ford Motor Company Servicemen attack demonstrators outside of the Rouge Plant during the 1932 Ford Hunger March.

A bird's-eye view of crowd of people, some carrying signs, as they march in the funeral procession and demonstration for four of the victims of the Ford Hunger March.

Great Depression

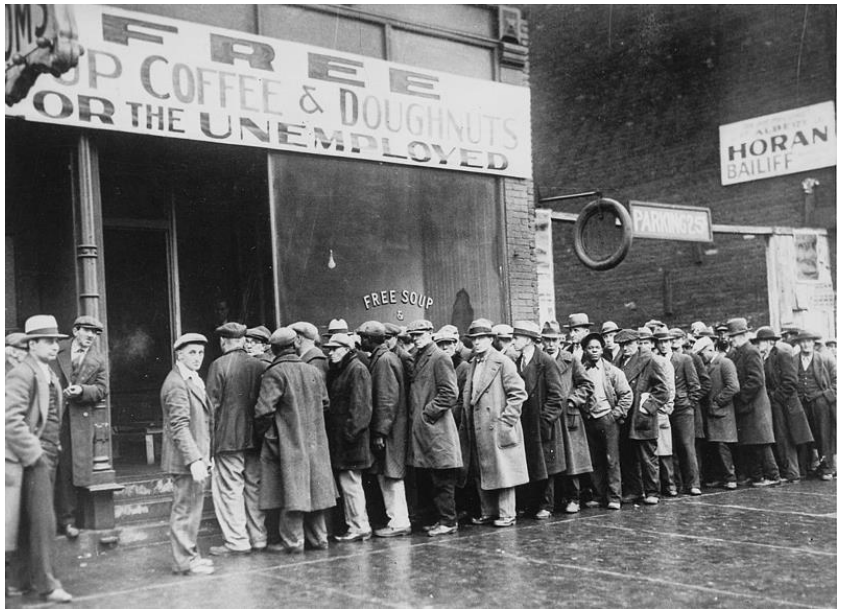
President Herbert Hoover, underestimating the seriousness of the crisis, called it "a passing incident in our national lives," and assured Americans that it would be over in 60 days. A strong believer in rugged individualism, Hoover did not think the federal government should offer relief to the poverty-stricken population.

Focusing on a trickle-down economic program to help finance businesses and banks, Hoover met with resistance from business executives who preferred to lay off workers. Blamed by many for the Great Depression, Hoover was widely ridiculed: an empty pocket turned inside out was called a "Hoover flag;" the decrepit shantytowns springing up around the country were called "Hoovervilles."

F.D.R. in 1932 took quick action to attack the Depression, declaring a four-day bank holiday, during which Congress passed the Emergency Banking Relief Act to stabilize the banking system. During the first 100 days of his administration, Roosevelt laid the groundwork for his New Deal remedies that would rescue the country from the depths of despair.

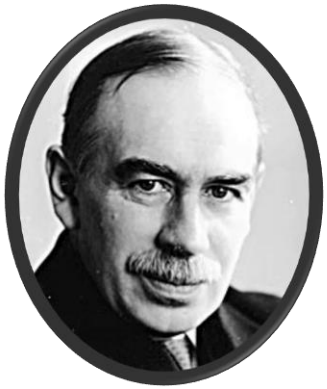
https://sites.google.com/site/bwimperialamerica12/home/the-great-depression

https://www.pbs.org/wgbh/americanexperience/features/dustbowl-great-depression/



https://www.pbs.org/wgbh/americanexperience/features/dustbowl-great-depression/

J. M. Keynes vs F. Hayek



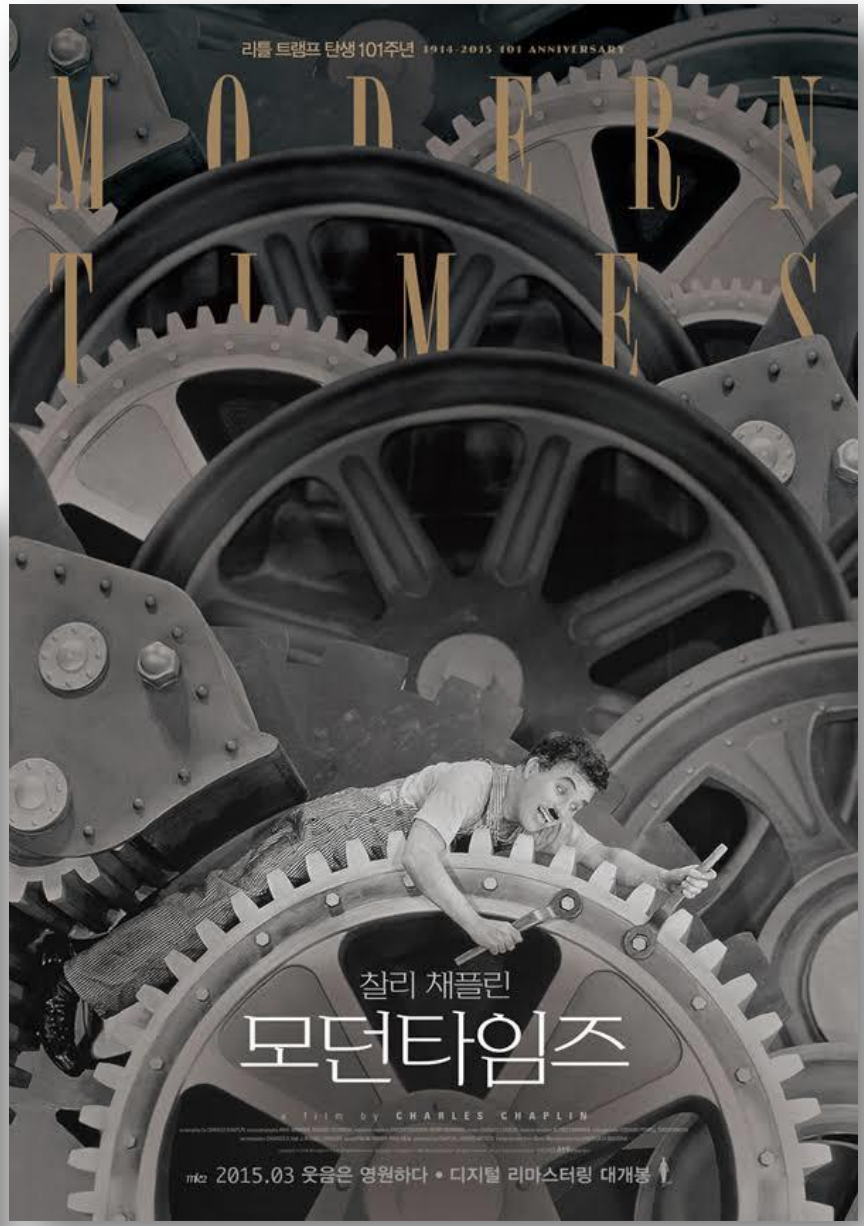
J. M. Keynes (1883-1946) : Father of **Macroeconomics**
'The General Theory of Employment, Interest, and Money' (1936)
'The End of Laissez-Faire: The Economic Consequences of the Peace' (1918)
FDR's New Deal; Focusing on the aggregate changes in the economy such as unemployment, growth rate, gross domestic product and inflation, stressing the role of Government.

F. Hayek (1899-1992) : **Neoliberalism,** 1974 Nobel Prize for Economics
'The Road to Serfdom' (1944), Thatcherism; After the British depression of the 1920s, he promoted the idea that private investment, rather than government spending, would promote sustainable growth, and warned of the danger of government *control* of *economic* decision-making through central planning."

Milton Friedman, ***'Free to choose' (1980s)***

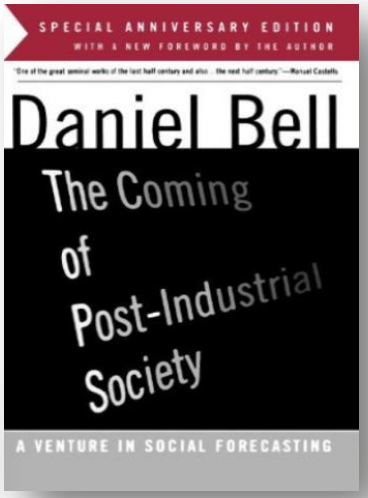
Critic to the machine age:
Charlie Chaplin's 'Modern Times'
1936

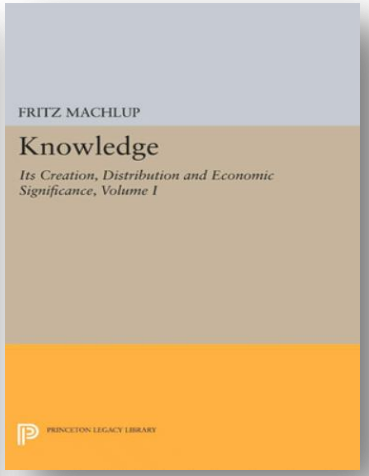
The LittleTramp working on the giant machine in the Modern Times' most famous scene

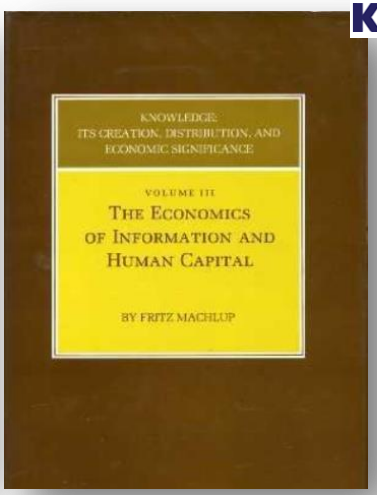


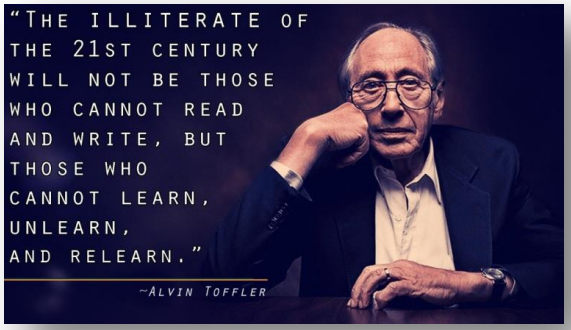
1960's

Post-Industrial Society Forecast, 'Information Society', 'Knowledge Industry'





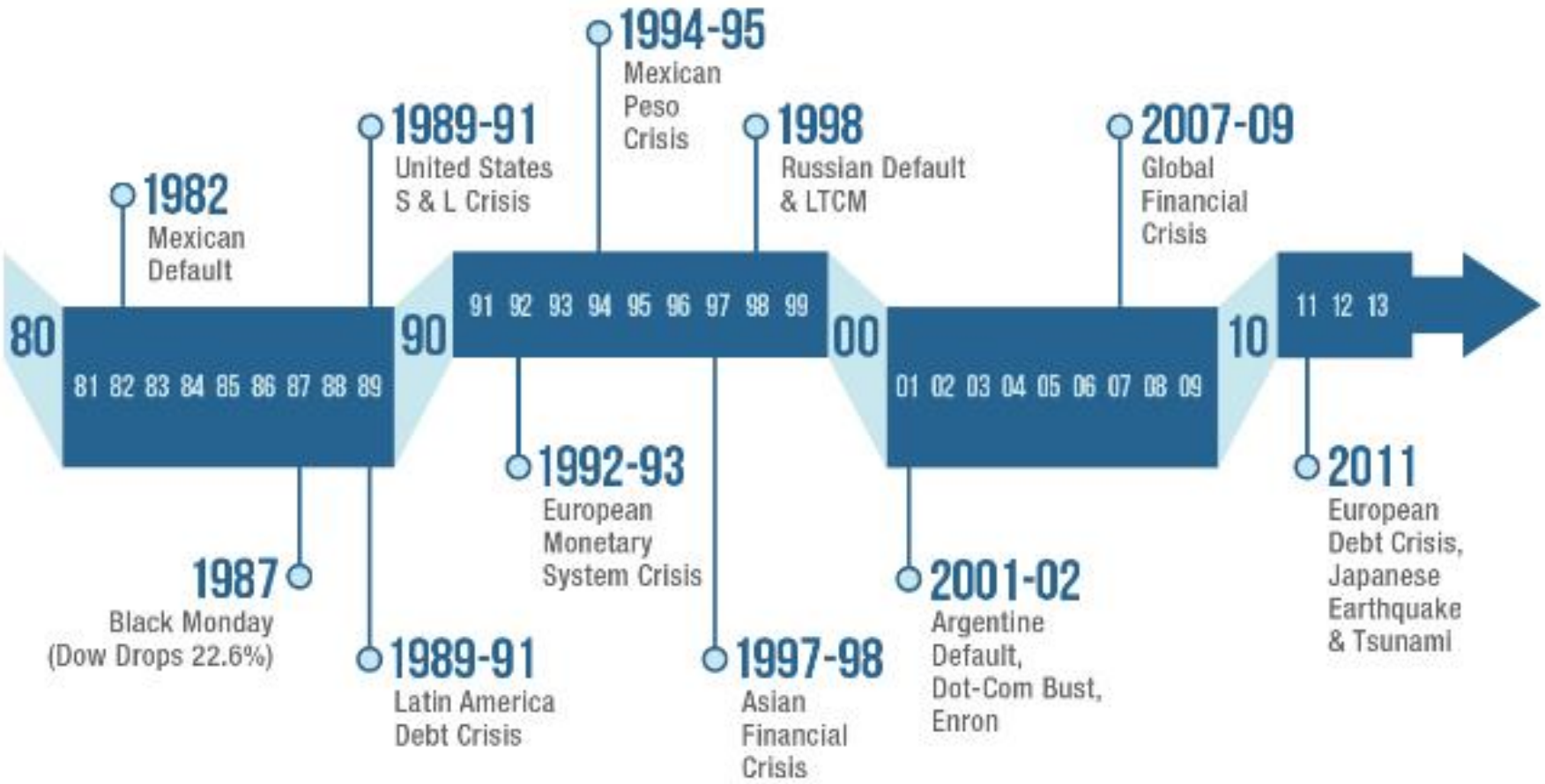




Theoretical Foundations

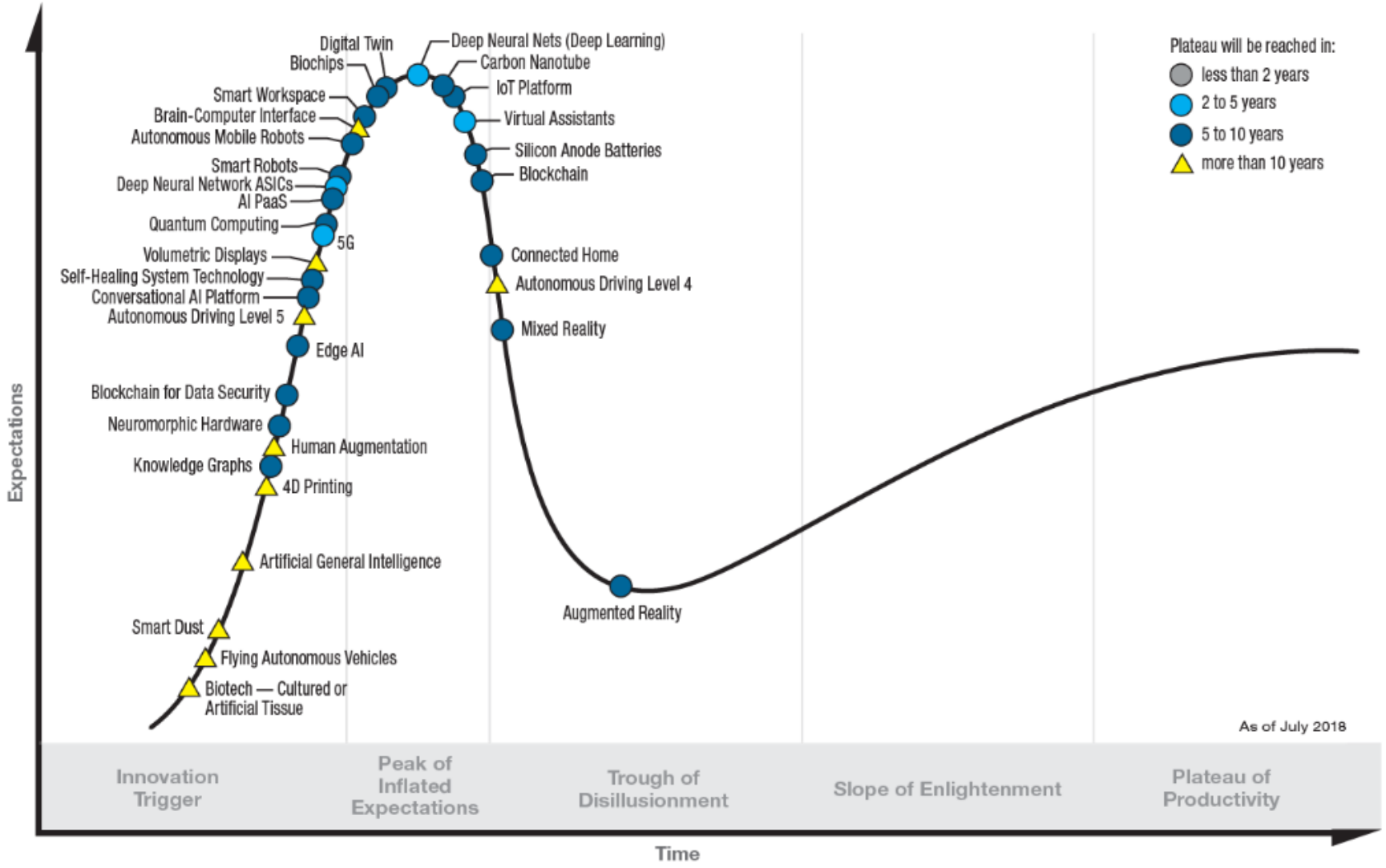
- Genealogy of the information society concept is usually traced to a term **"post-industrial society**- a term first used by sociologist Daniel Bell (1973). *Refer to Frank Webster, Chapter 3 on elaboration of the post-industrial society.*
- Another source of the information society concept is attributed to debates on the **"information economy"** developed by American economists Fritz Machlup (1962) and Marc Porat (1977).

Global financial crisis



https://blog.realinstitutoelcano.org/en/financial-crises-flushing-toilets/

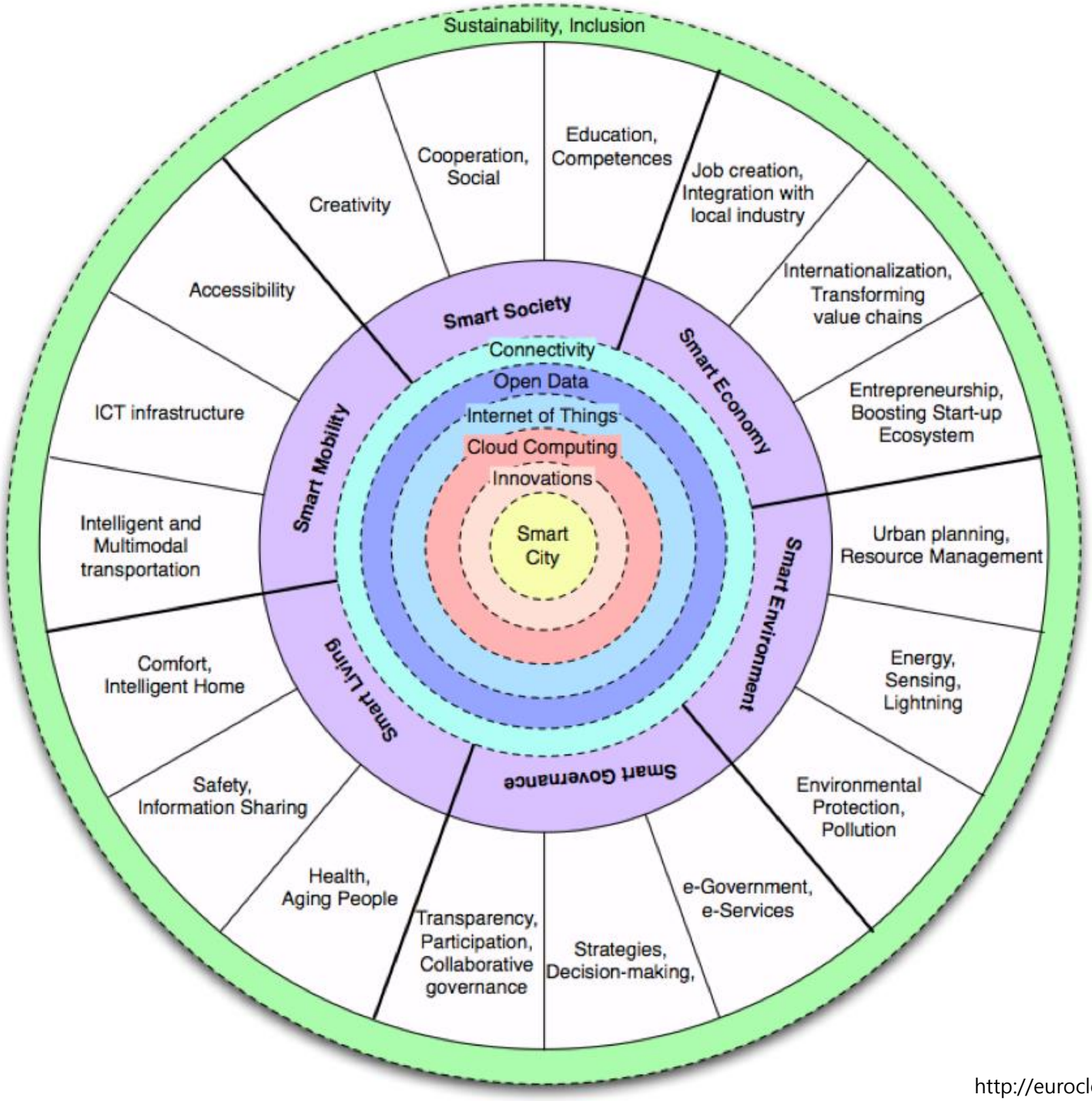
Hype Cycle for Emerging Technologies, 2018



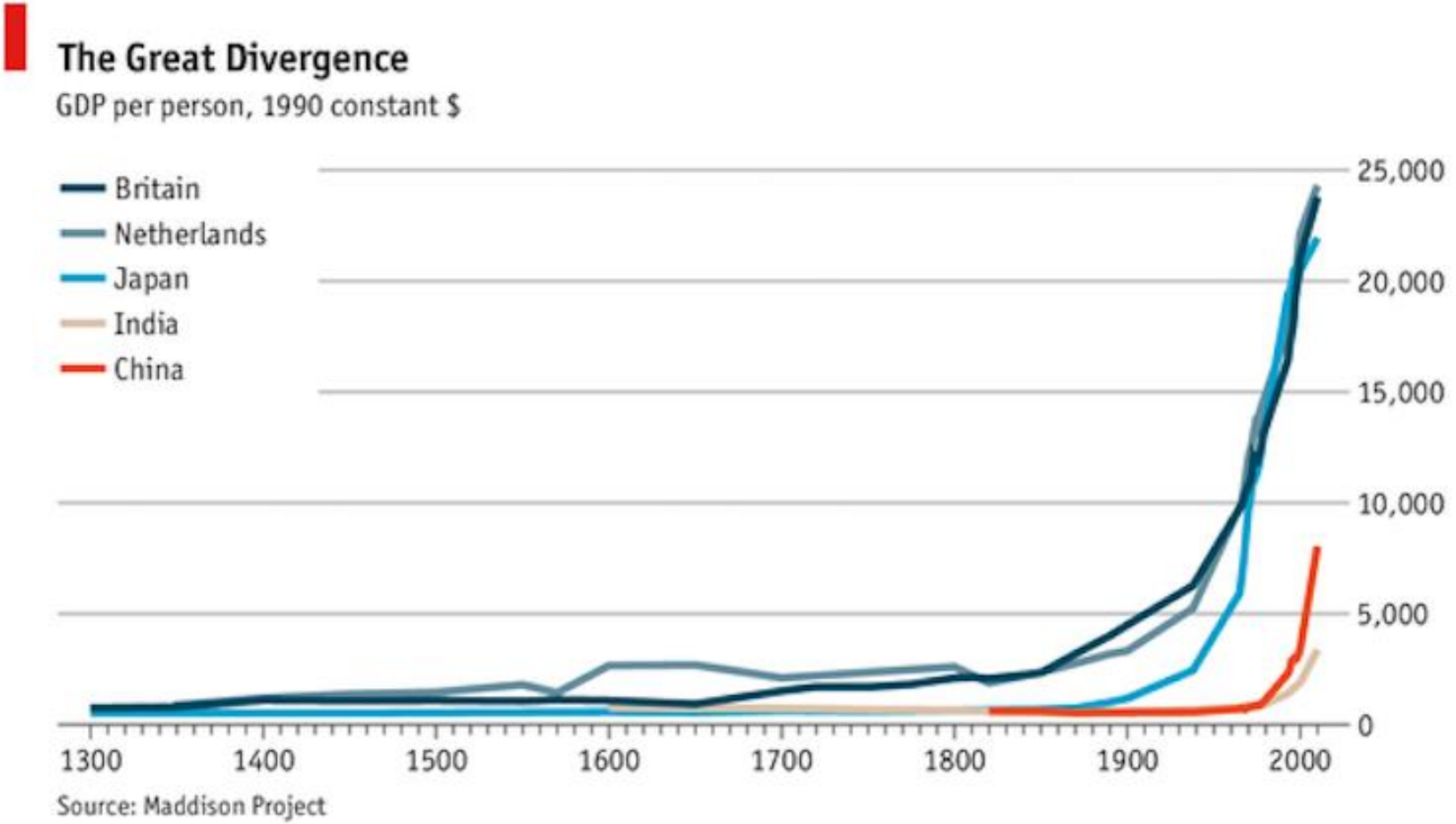
gartner.com/SmarterWithGartner

Source: Gartner (August 2018)

Gartner



http://eurocloud.si/lang/sl/2015/05/



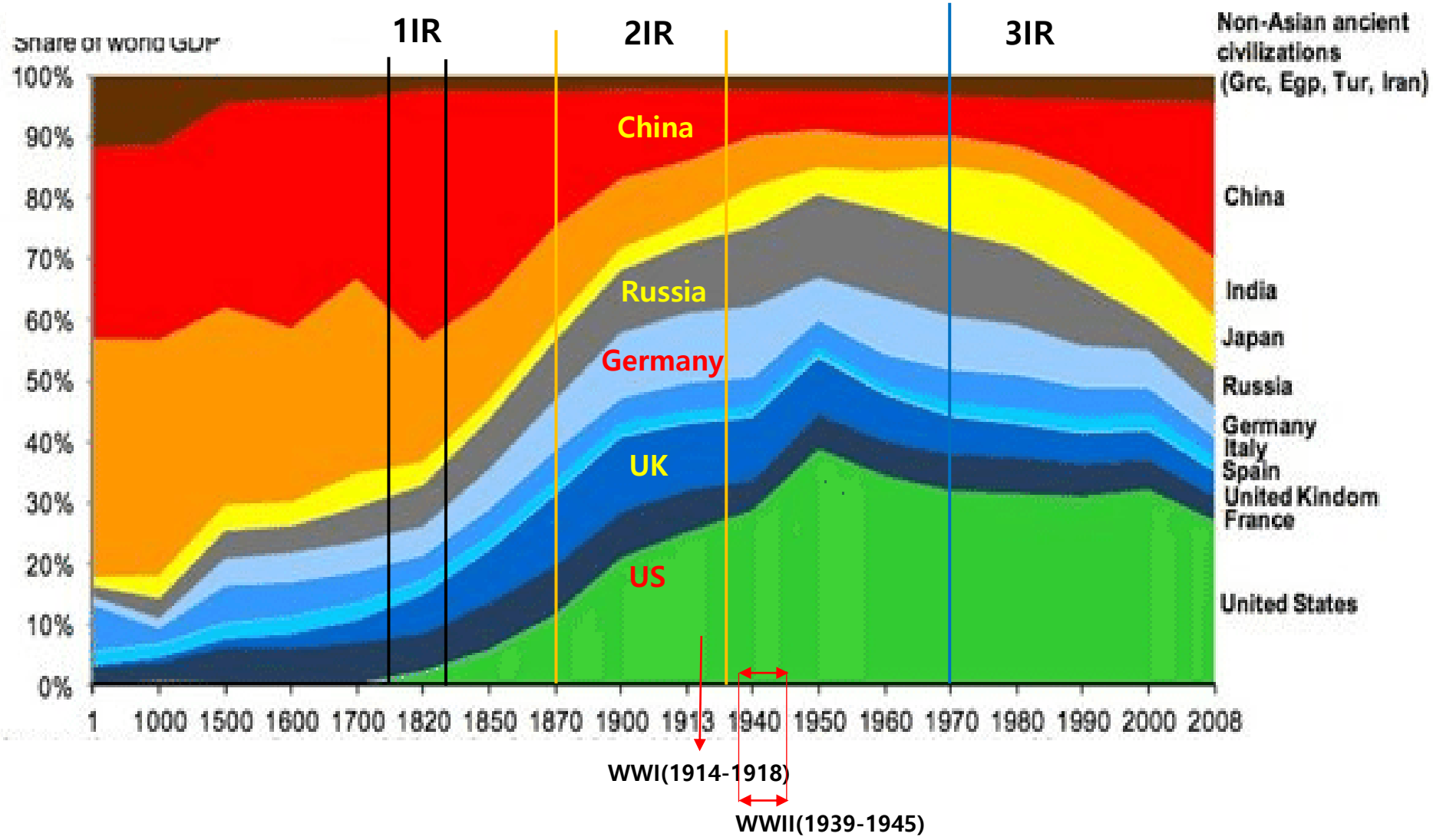
https://www.ripple.com/insights/welcome-to-the-fourth-industrial-revolution/

We've seen this chart before near the end of the 18th C and the beginning of the 1IR.

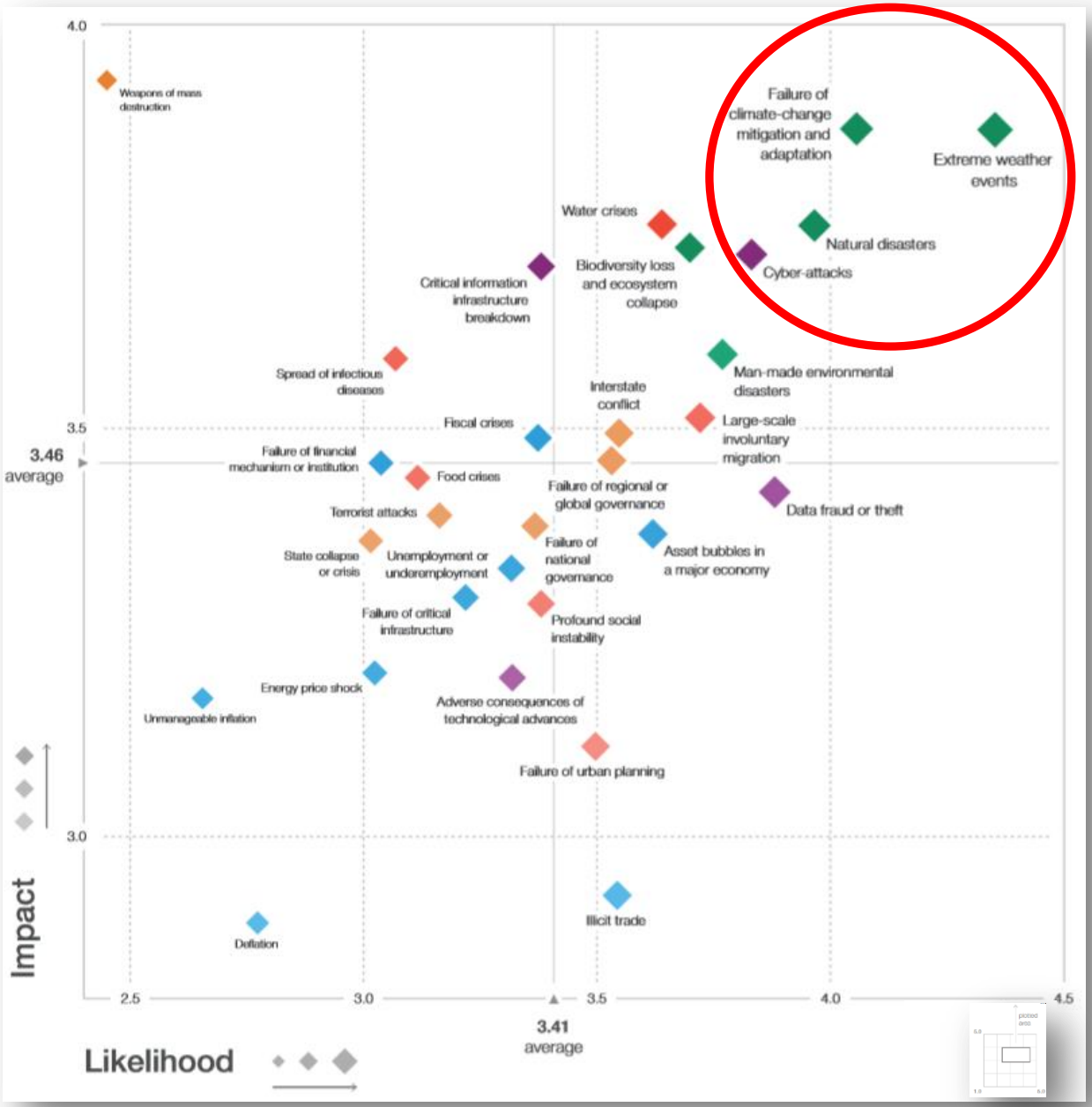
During this Great Divergence, the per capita income of Western Europe and parts of North America skyrocketed.

The Great Divergence was the result of many existing technologies reaching maturity at the same time. By the 1800s, we would witness the rise of the factory system accompanied with ever-expanding rail and telegraph networks catalyzing an unprecedented movement in people, goods and ideas. The maturation of existing technologies and ecosystems, invented' some 20 or 30 years ago boosts in computing power (Moore's law) and the reduction in cost.

Share of World GDP among 10 Major Economies through the Industrial Revolutions



The Global Risks Landscape 2019: World Economic Forum



Top 10 risks in terms of
Likelihood

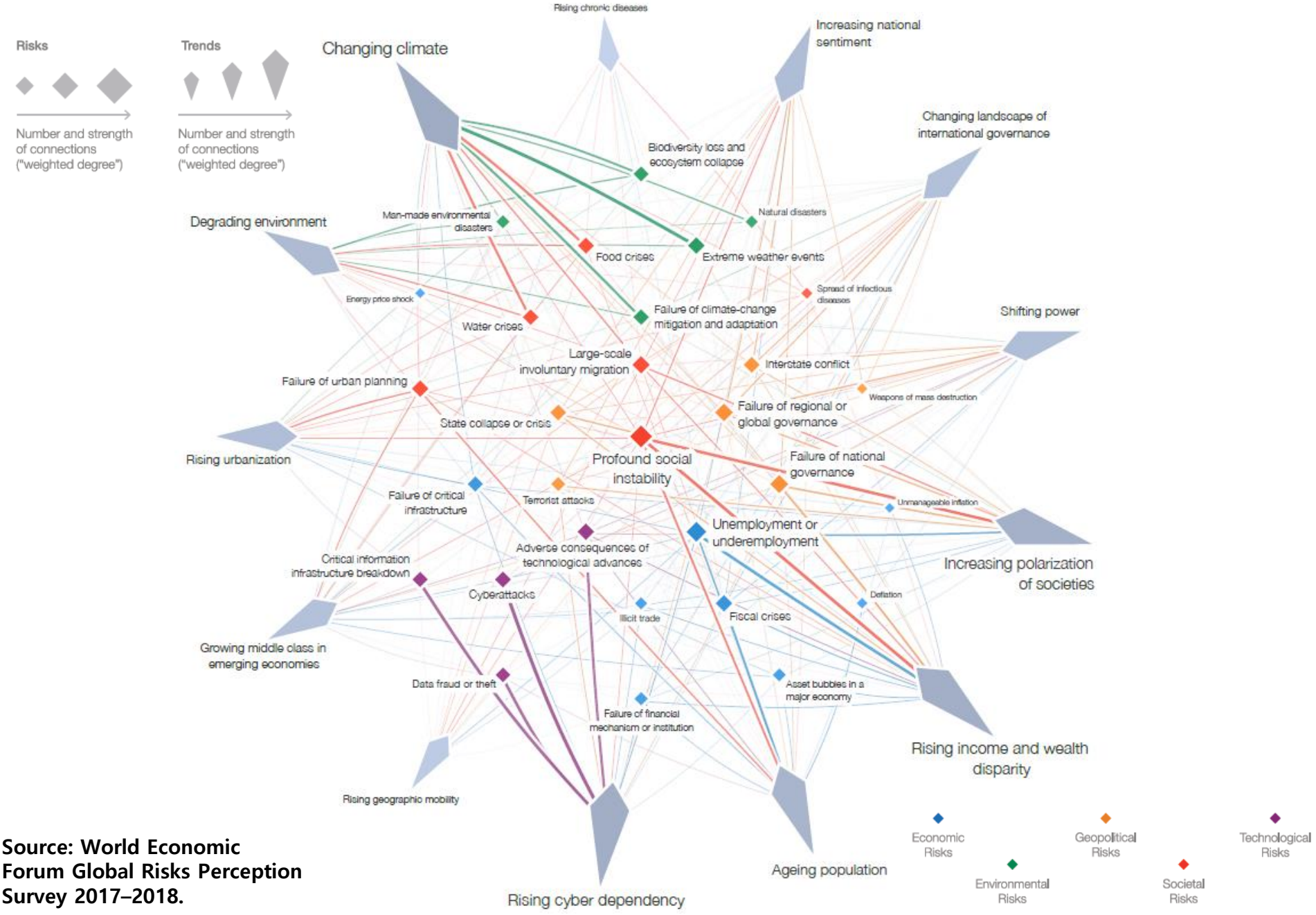
1. Extreme weather events
2. Failure of climate-change mitigation and adaptation
3. Natural disasters
4. Data fraud or theft
5. Cyber-attacks
6. Man-made environmental disasters
7. Large-scale involuntary migration
8. Biodiversity loss and ecosystem collapse
9. Water crises
10. Asset bubbles in a major economy

Top 10 risks in terms of
Impact

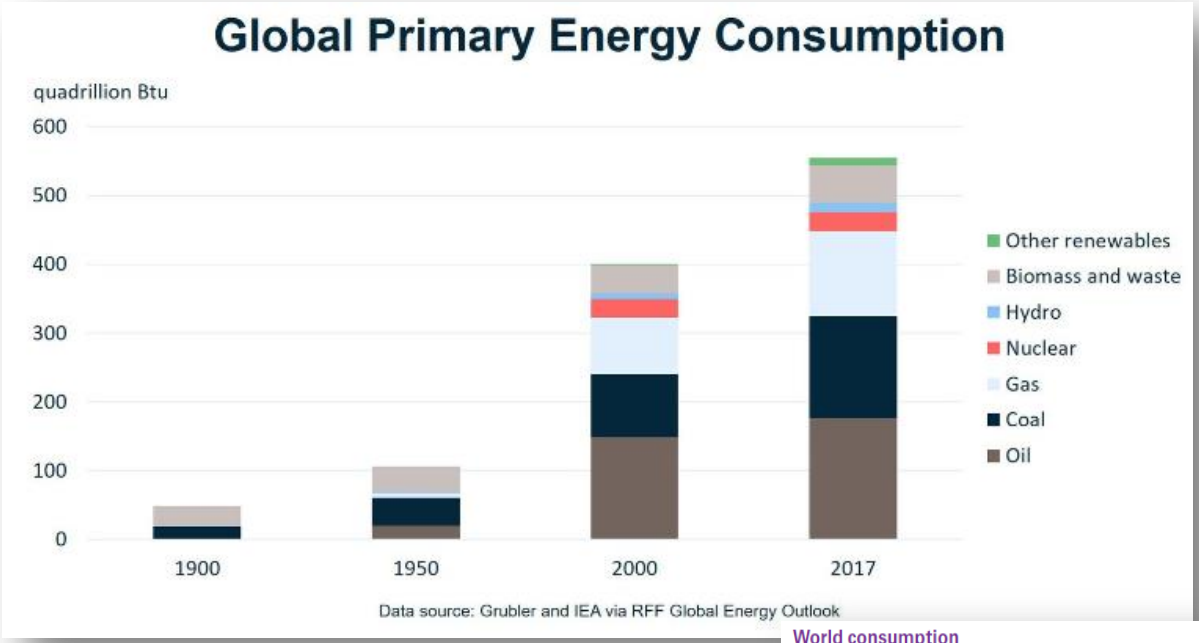
1. Weapons of mass destruction
2. Failure of climate-change mitigation and adaptation
3. Extreme weather events
4. Water crises
5. Natural disasters
6. Biodiversity loss and ecosystem collapse
7. Cyber-attacks
8. Critical information infrastructure breakdown
9. Man-made environmental disasters
10. Spread of infectious diseases

Economic | Environmental | Geopolitical | Societal | Technological

The Risks-Trends Interconnections Map 2018



Source: World Economic Forum Global Risks Perception Survey 2017–2018.

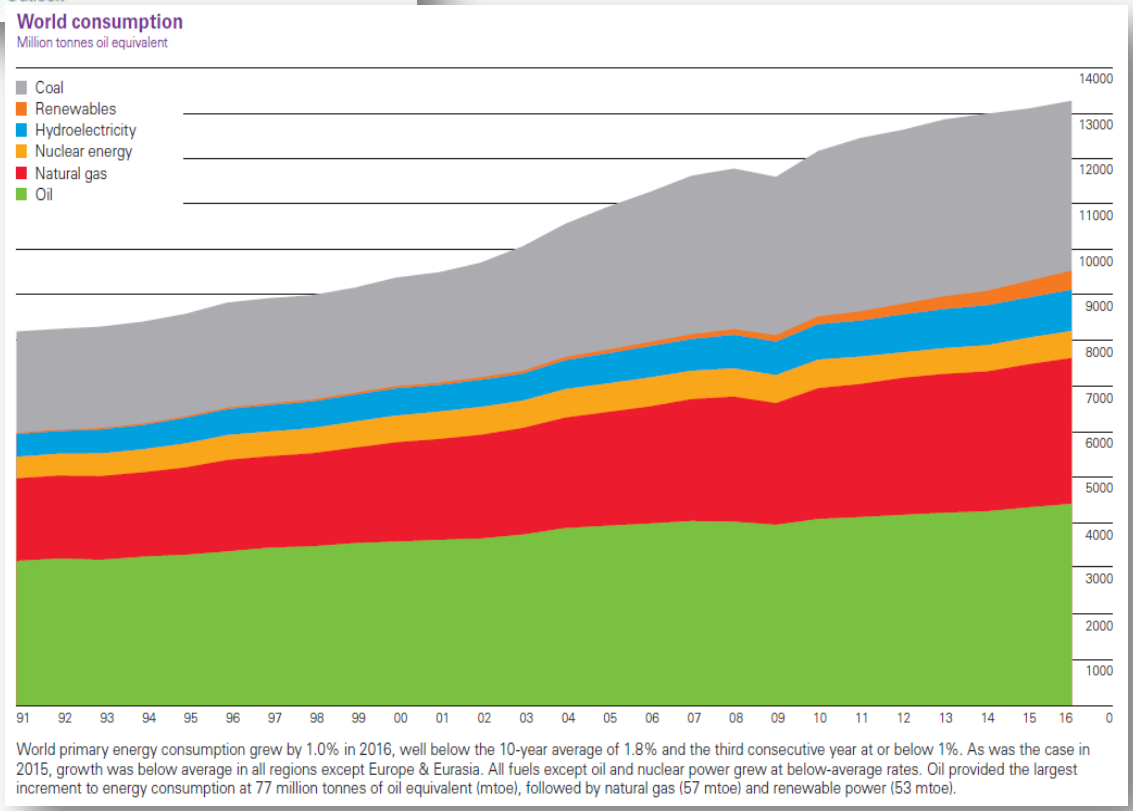


https://www.resourcesmag.org/common-resources/sea-changes-facing-global-energy-industry/

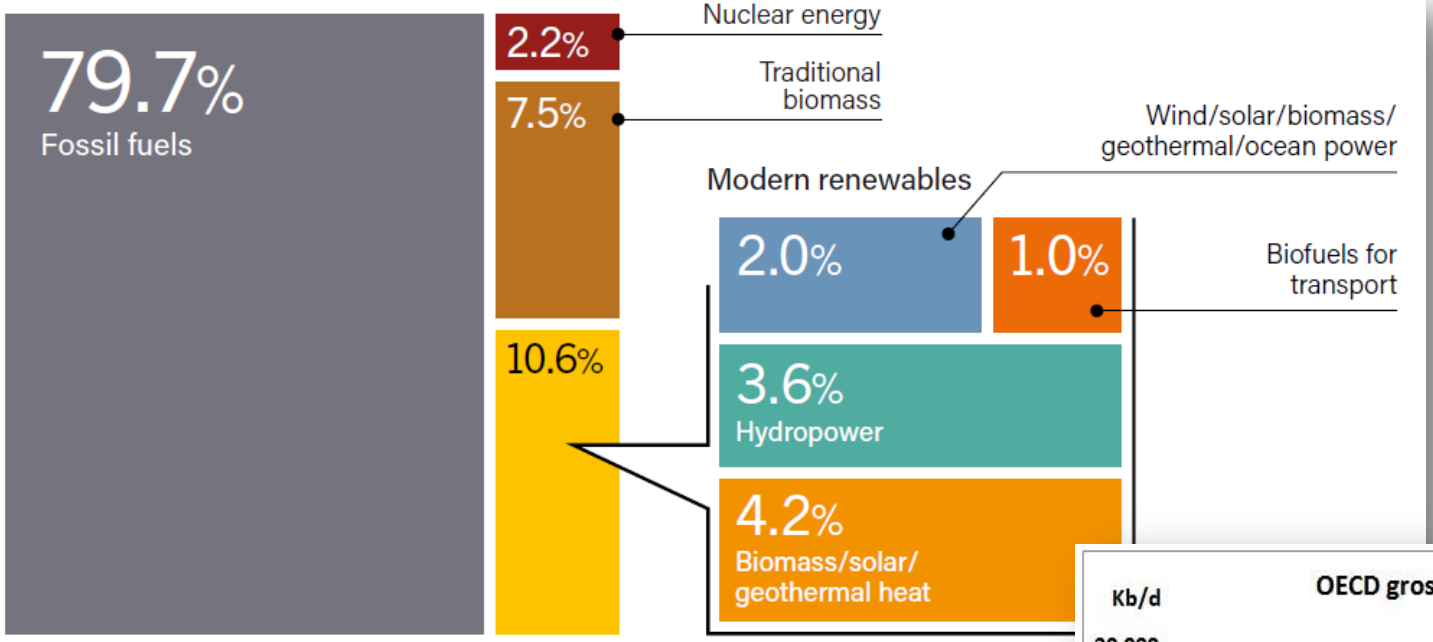
Global Energy Supply by Fuel, 2017

Source: BP Statistical Review of World Energy, 2017

http://www.hellenicshippingnews.com/iea-data-shows-global-energy-production-and-consumption-continue-to-rise/



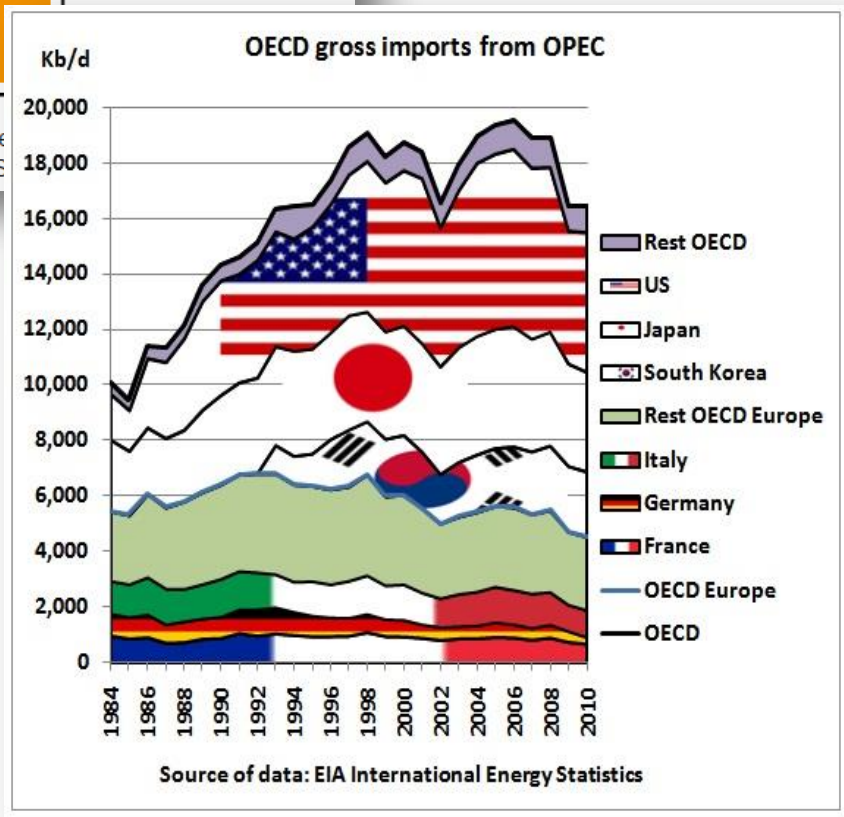
Estimated Renewable Share of Total Final Energy Consumption, 2017



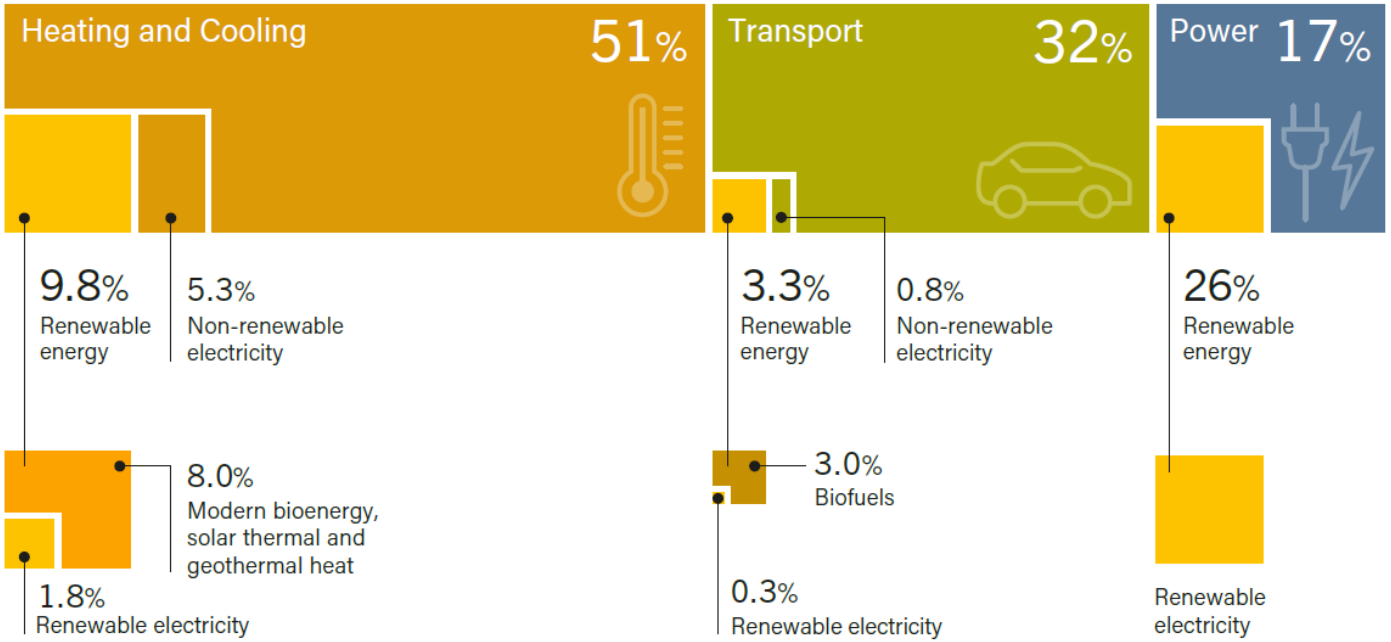
Note: Data should not be compared with previous years because of revisions due to improved or adjusted data or methodology. Totals may not add up due to rounding.

Source: Base

https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf



Renewable Energy in Total Final Energy Consumption, by Sector, 2016



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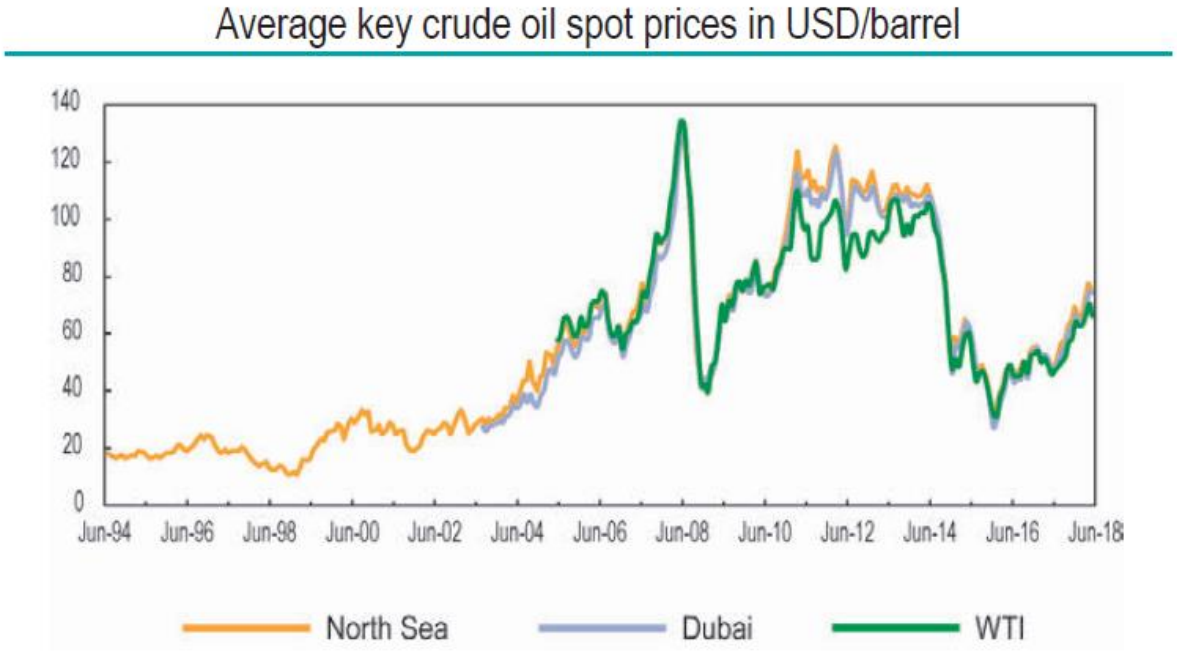
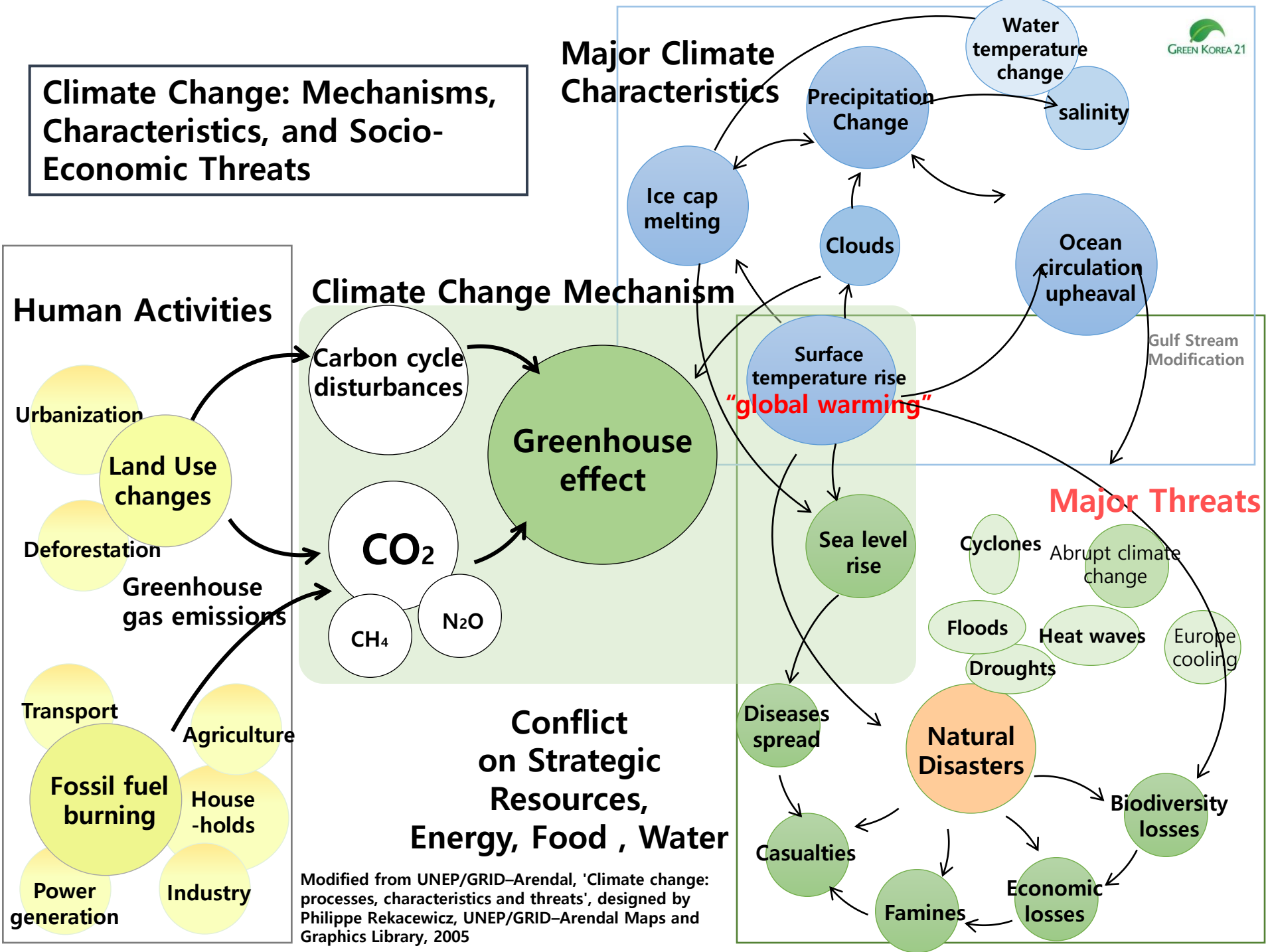
Note: Data should not be compared with previous years because of revisions due to improved or adjusted methodology.

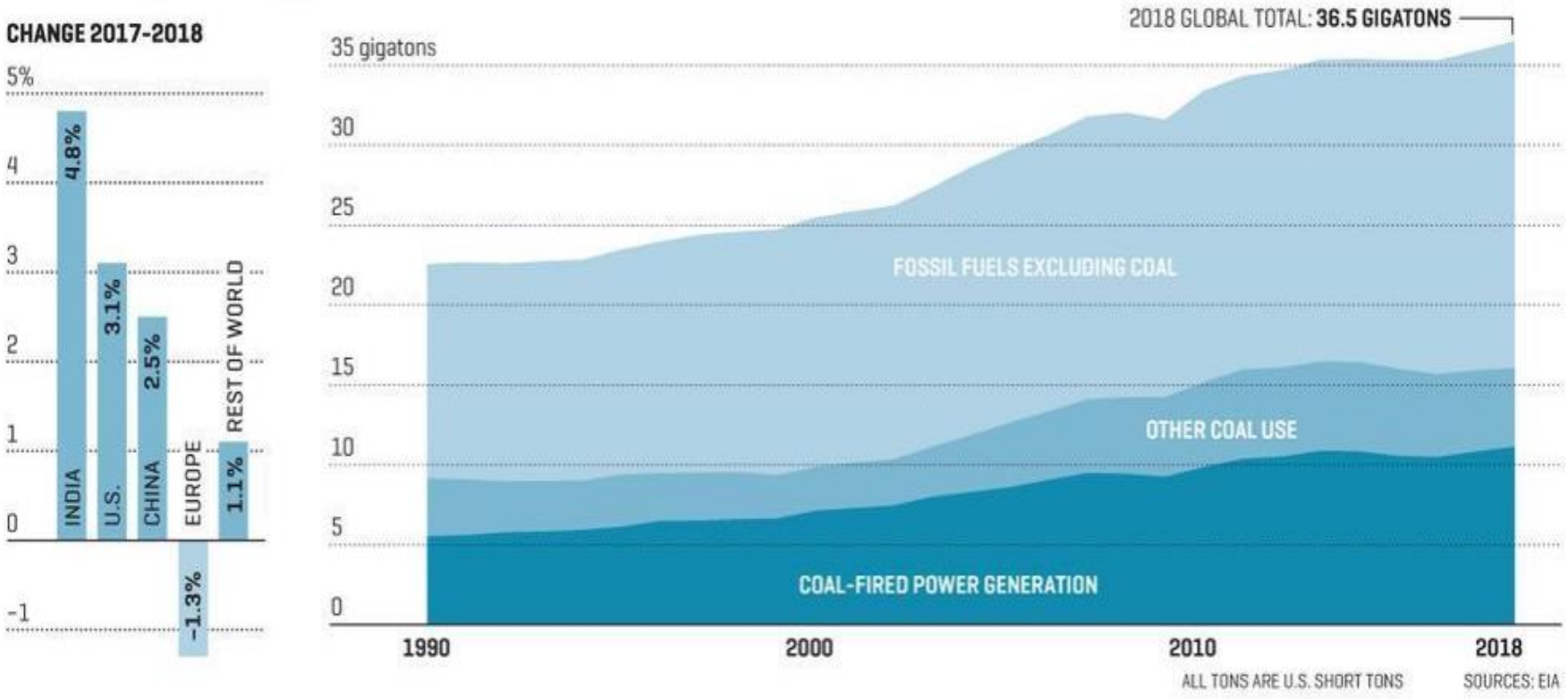


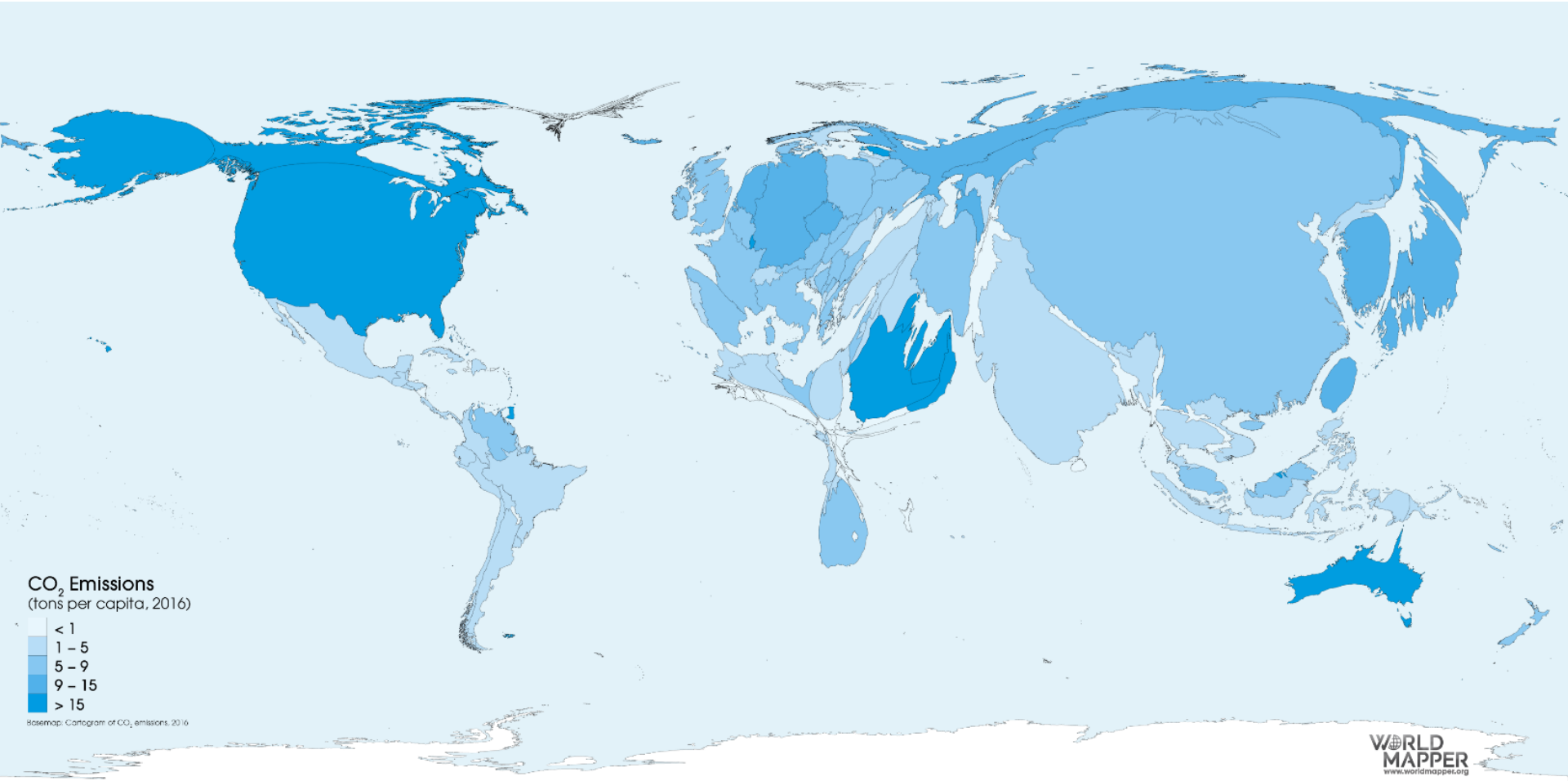
Climate Change: Mechanisms, Characteristics, and Socio-Economic Threats



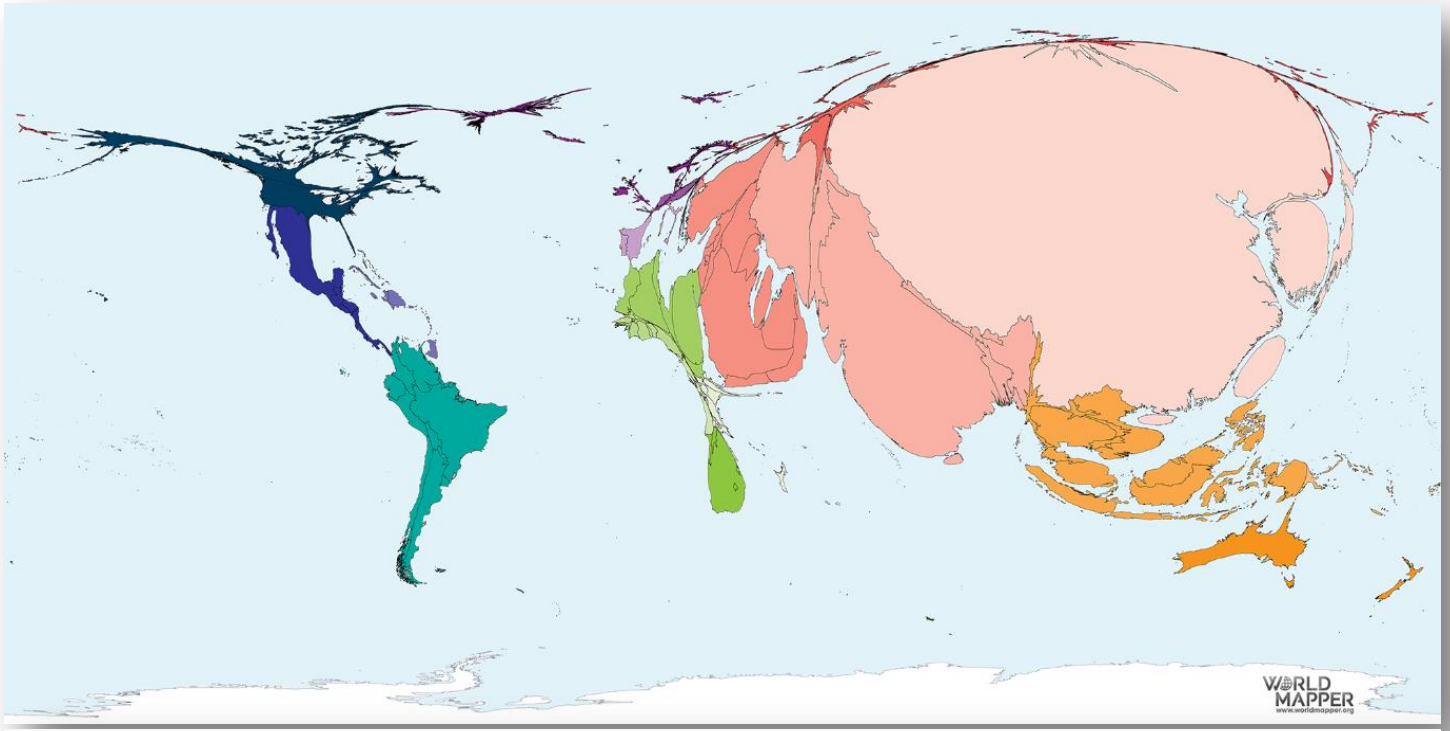
Modified from UNEP/GRID–Arendal, 'Climate change: processes, characteristics and threats', designed by Philippe Rekacewicz, UNEP/GRID–Arendal Maps and Graphics Library, 2005

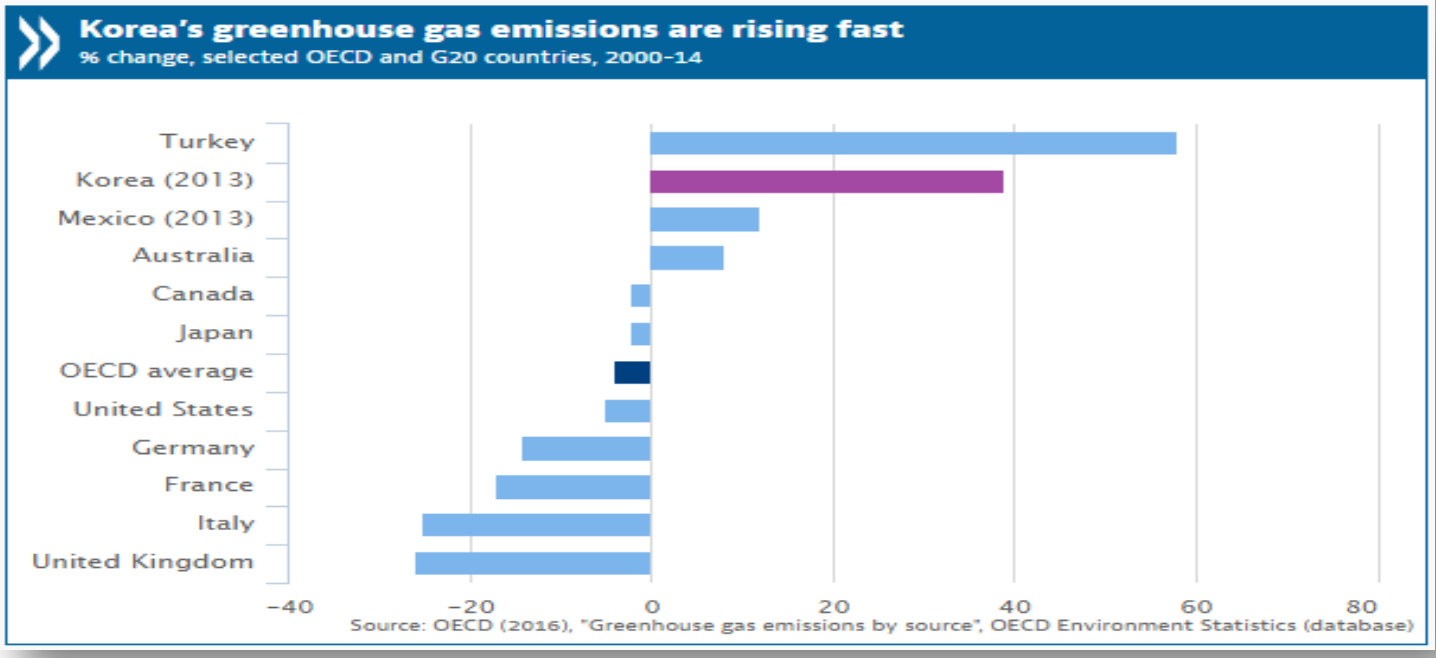
ENERGY-RELATED CO_2 EMISSIONS FROM FUEL COMBUSTION




CO_2 Emissions
(tons per capita, 2016)
< 1
1 – 5
5 – 9
9 – 15
> 15
Basemap: Cartogram of CO_2 emissions, 2016
WORLD MAPPER
www.worldmapper.org

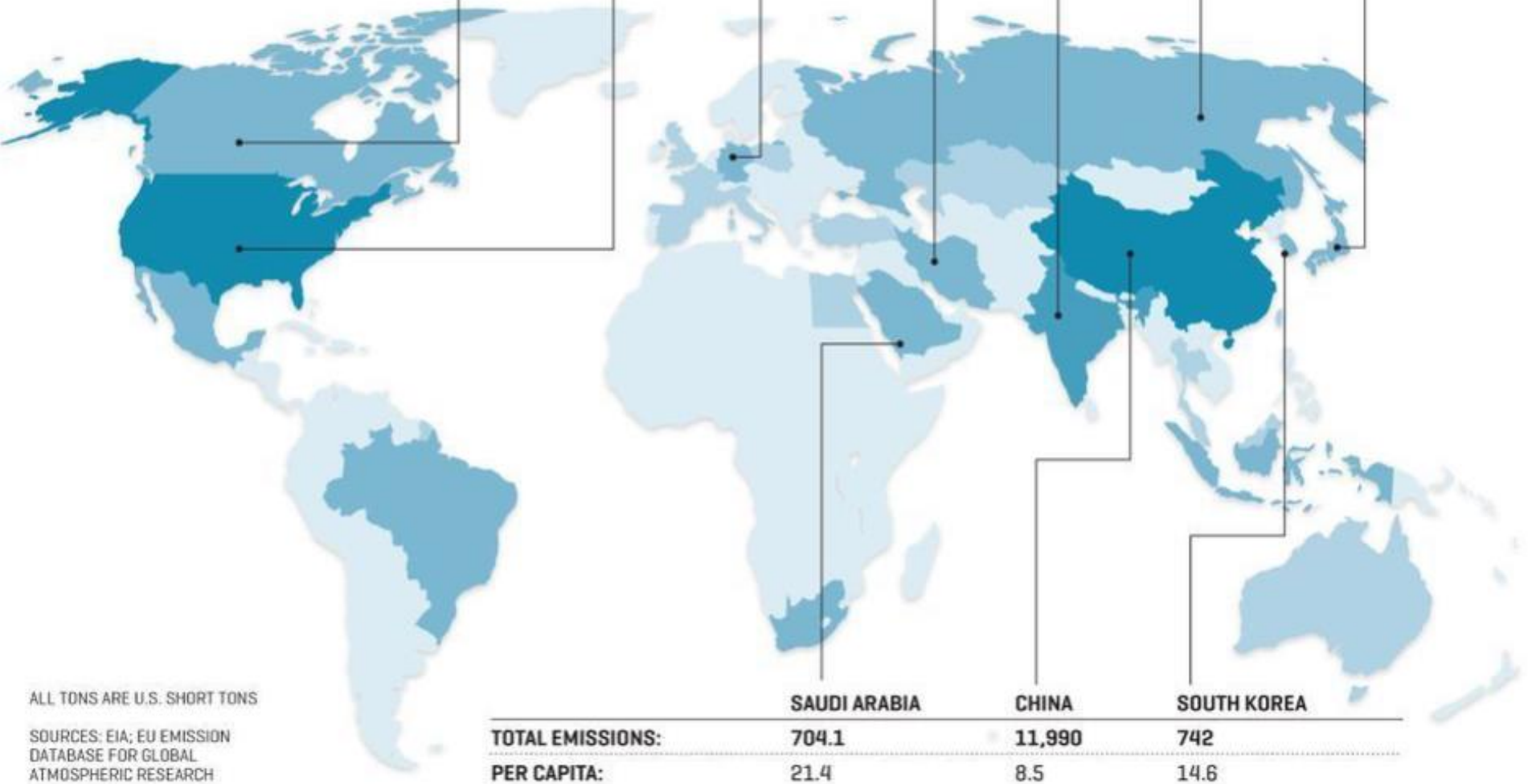
Carbon Dioxide Emissions Increase 1990-2015





ANNUAL CO_2 EMISSIONS PER COUNTRY (MILLIONS OF TONS OF CO_2, 2017)

0–250 MILLIONS TONS | 250.1–500 | 500.1–2,500 | 2,500.1–5,000 | 5,000.1–12,000



10 LARGEST-EMITTING COUNTRIES

	CANADA	U.S.	GERMANY	IRAN	INDIA	RUSSIA	JAPAN
TOTAL EMISSIONS:	680	5,630	878	740	2,706	1,945	1,456
PER CAPITA:	18.6	17.4	10.7	9.1	2.0	13.5	11.4

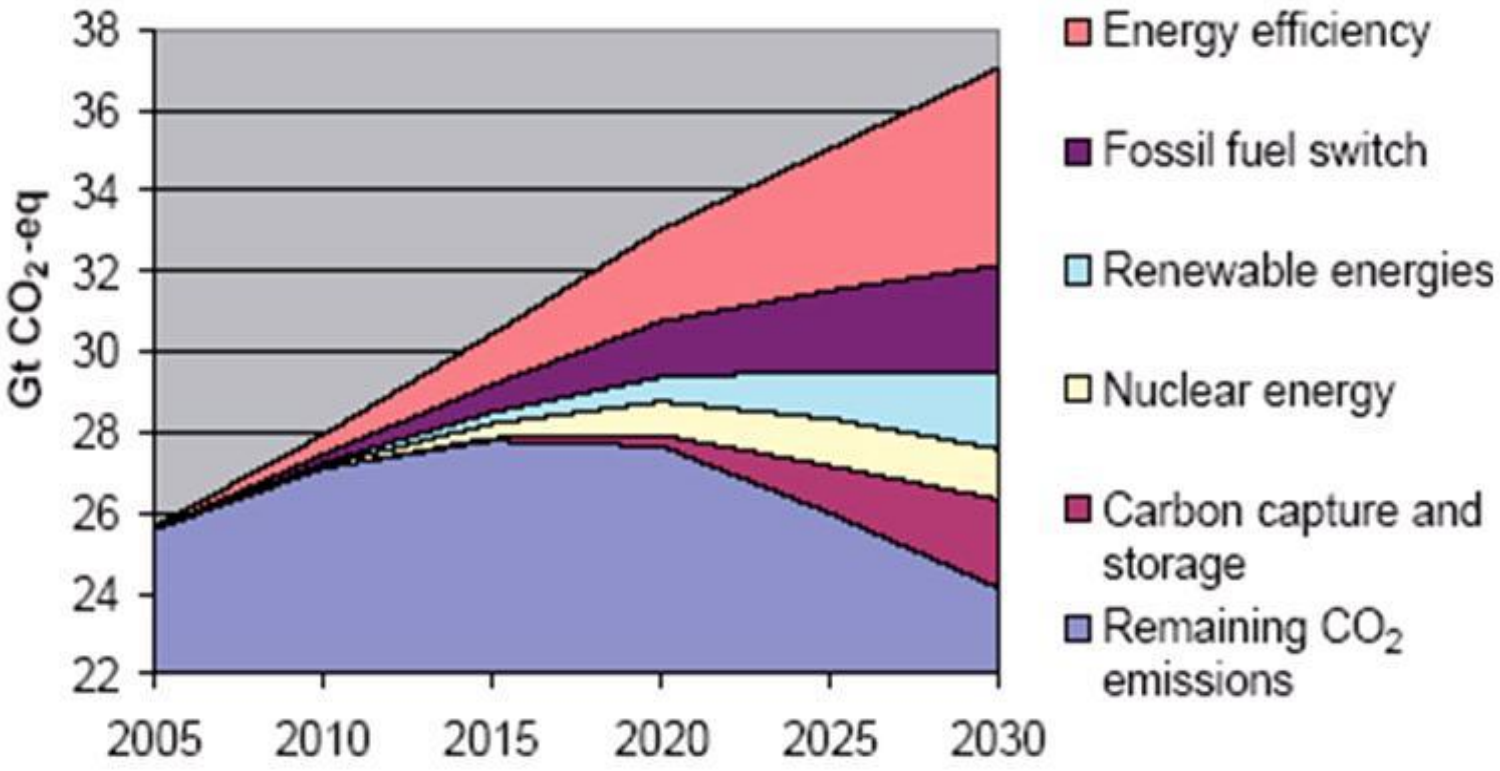
	SAUDI ARABIA	CHINA	SOUTH KOREA
TOTAL EMISSIONS:	704.1	11,990	742
PER CAPITA:	21.4	8.5	14.6

ALL TONS ARE U.S. SHORT TONS

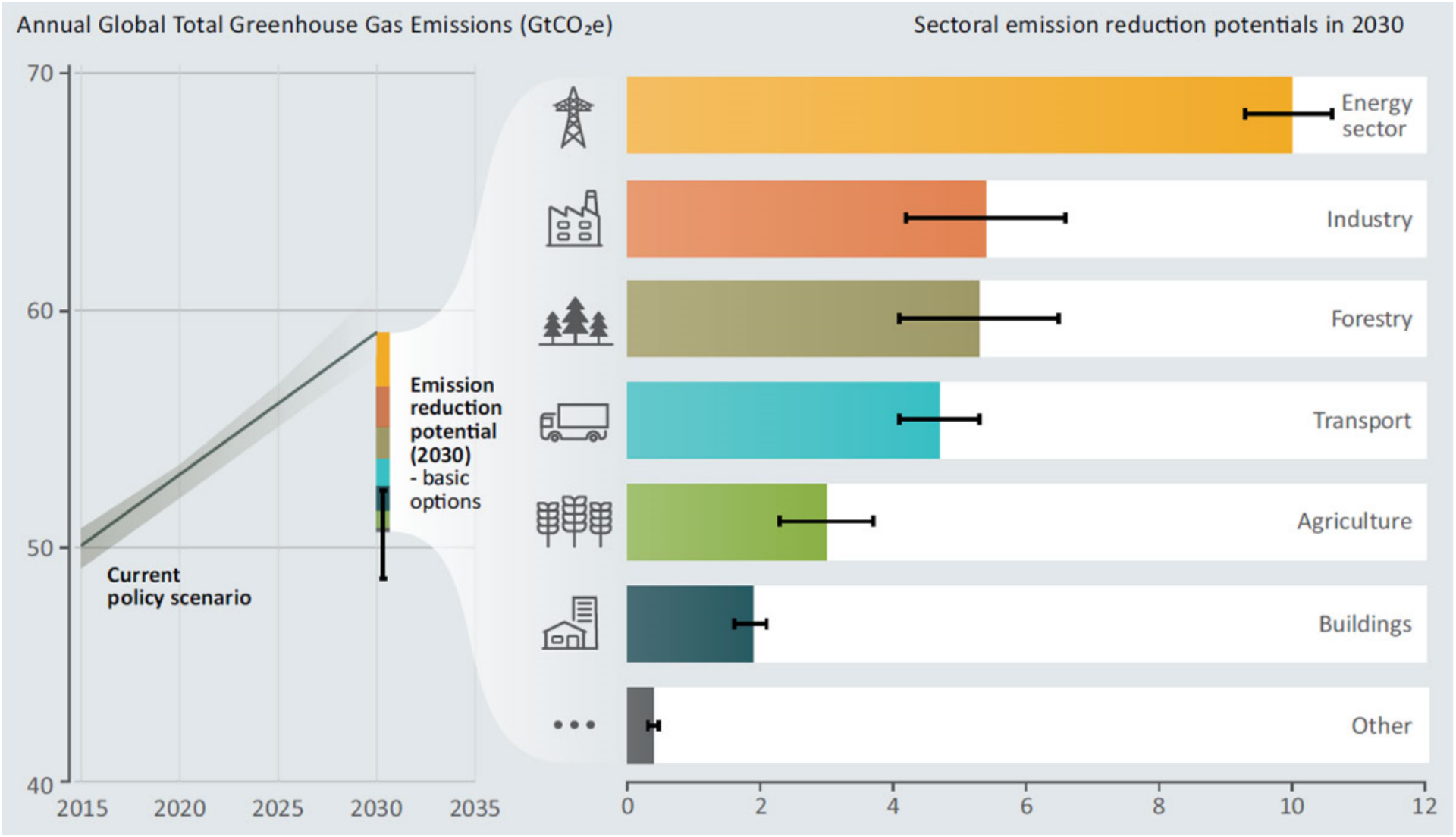
SOURCES: EIA; EU EMISSION DATABASE FOR GLOBAL ATMOSPHERIC RESEARCH

How to Reduce GHG Emission

Energy Resource Efficiency is the key issue to achieve Green Growth : Measures to reduce global CO_2 emissions from energy combustion

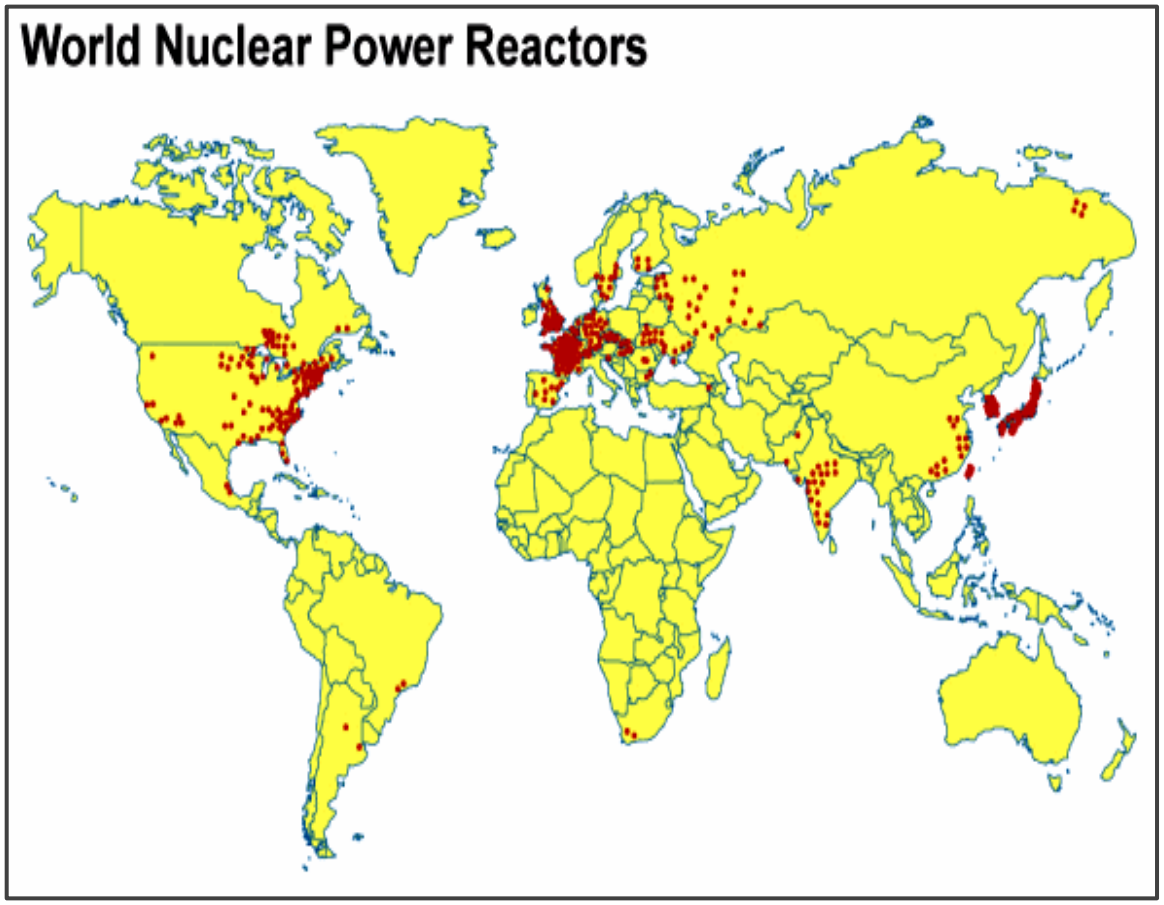


< Source: European Commission, 2008, EU action against climate change-Leading global action to 2020 and beyond



https://unicwash.org/emissions-report/10-31-unep-emissions-rpt-infogrphics/

Reactors around the world : 2019. 8



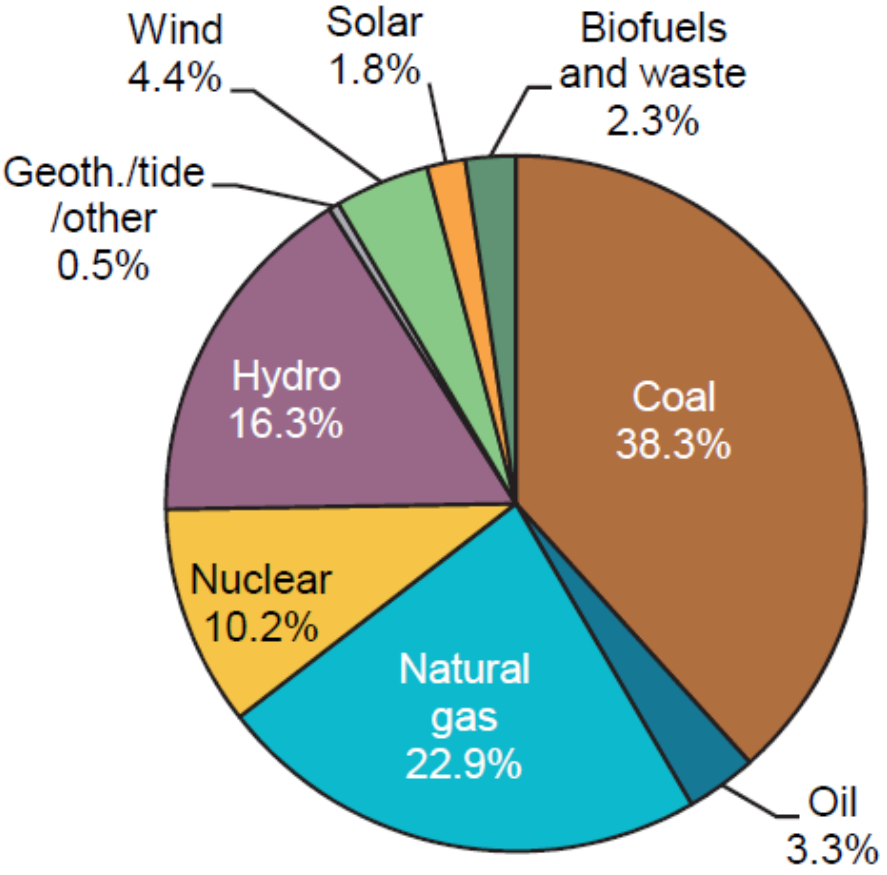
국가	현재	건설 중	계획	제안	2019년 기준 설비용량 [MWe]
미국	97	4	3	18	98,699
프랑스	58	1	0	0	63,130
일본	33	2	1	8	31,679
러시아	36	6	24	22	29,139
대한민국	24	4	0	2	23,231
인도	22	7	14	28	6,219
중국	47	11	43	170	45,688
캐나다	19	0	0	2	13,553
영국	15	1	3	6	8,883
우크라이나	15	0	2	2	13,107

444 Reactors in Operation / **54** Under Construction /

111 Ordered or Planned / **330** Proposed

출처 : WNA 2019. 8

Global Electricity production and Nuclear Power : 2017



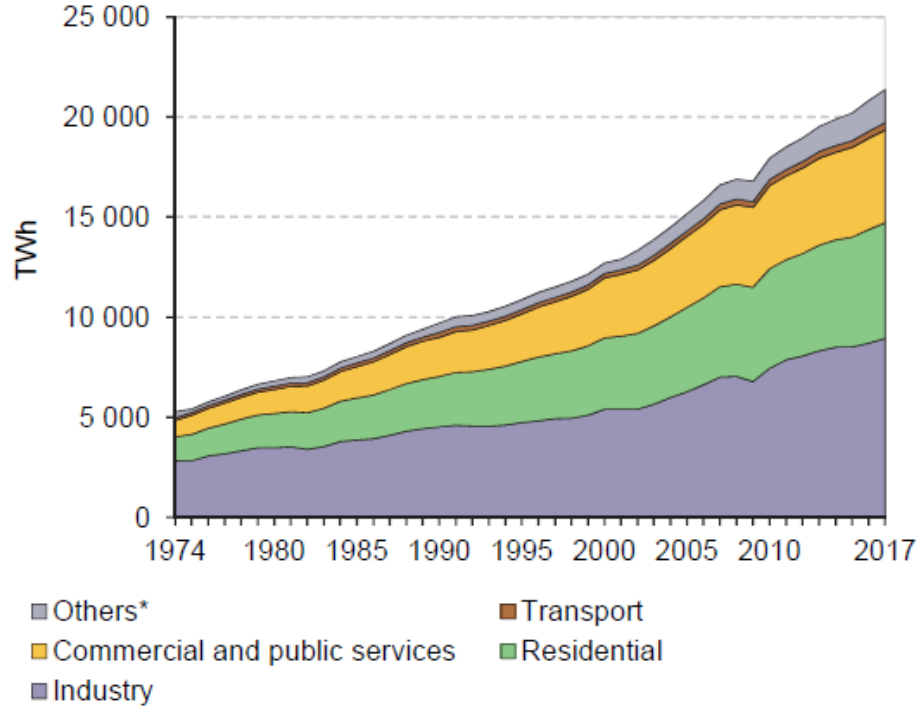
	1973 (%)	2017 (%)
Coal and Peat	38.3	41.3
Oil	24.6	4.8
Natural gas	12.2	21.9
Nuclear	3.3	11.7
Hydro	21.0	15.8
Other	0.6	4.5

Global electricity generation

25,721 TWh(2016) vs. 6,131 TWh(1973)

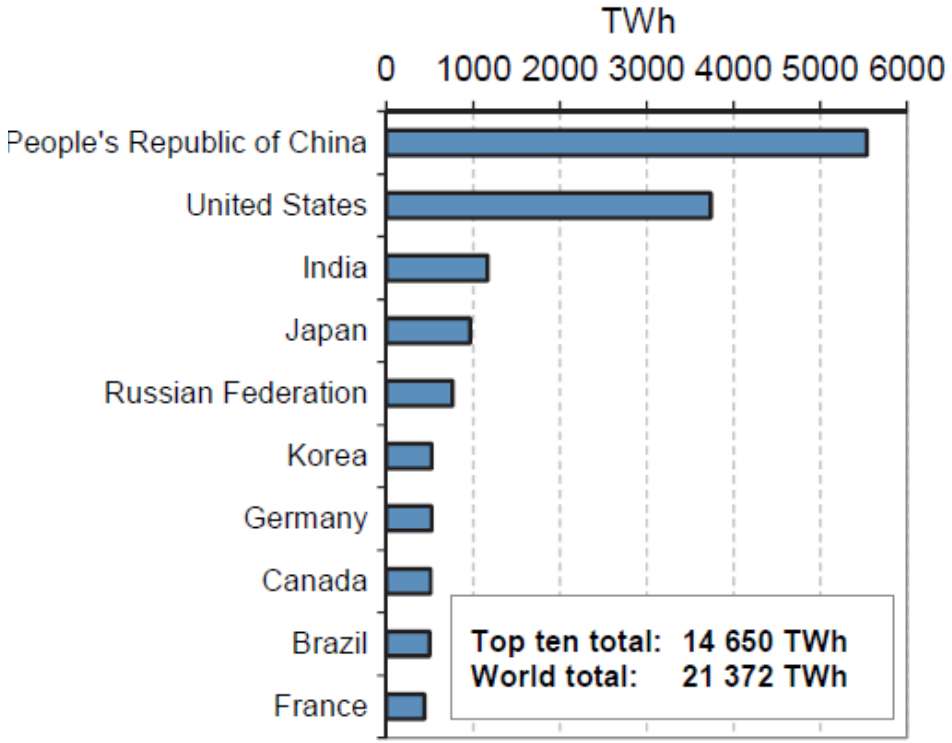
source : IEA (2019), "Electricity information: overview"

World electricity final consumption by sector



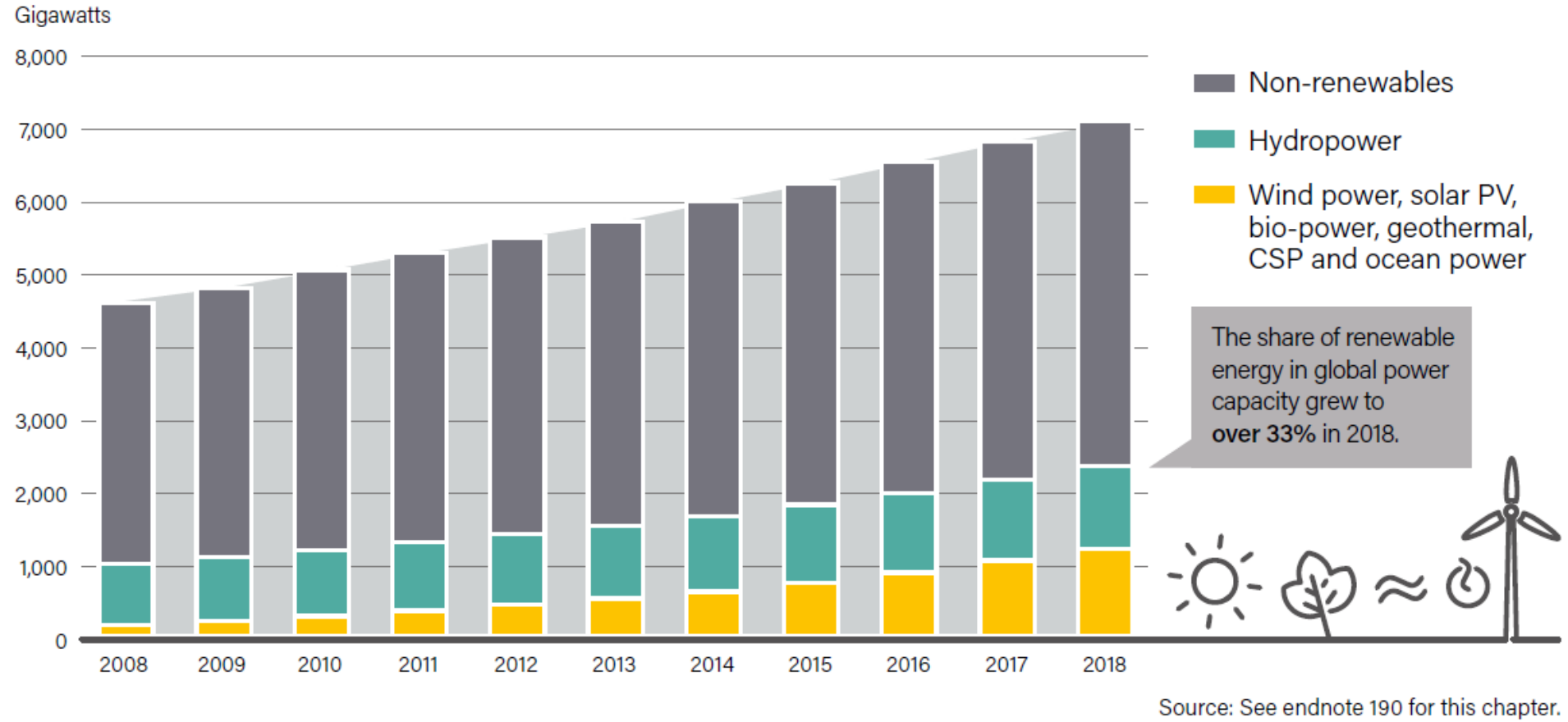
* includes agriculture and forestry, fishing, and other non-specified.

Top ten electricity consuming countries, 2017



Source: Electricity information: overview, iea 2019

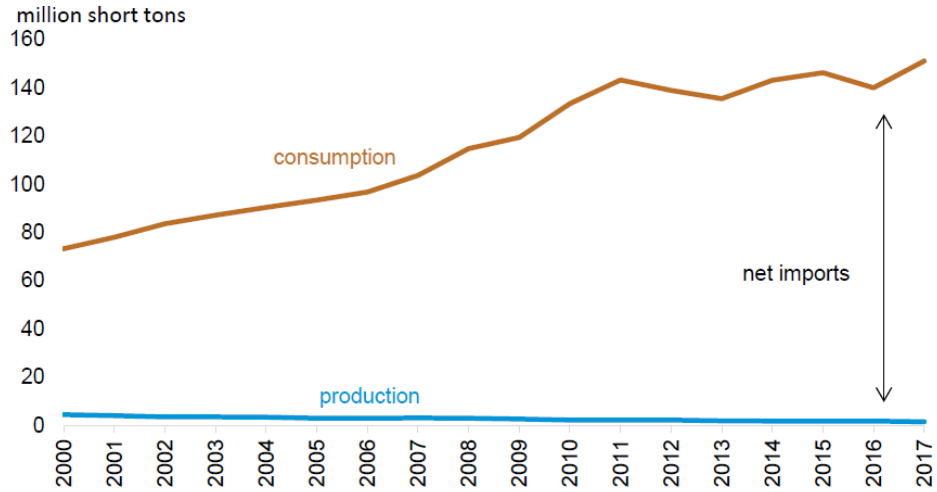
Global Power Generating Capacity, by Source, 2008-2018



Source: See endnote 190 for this chapter.

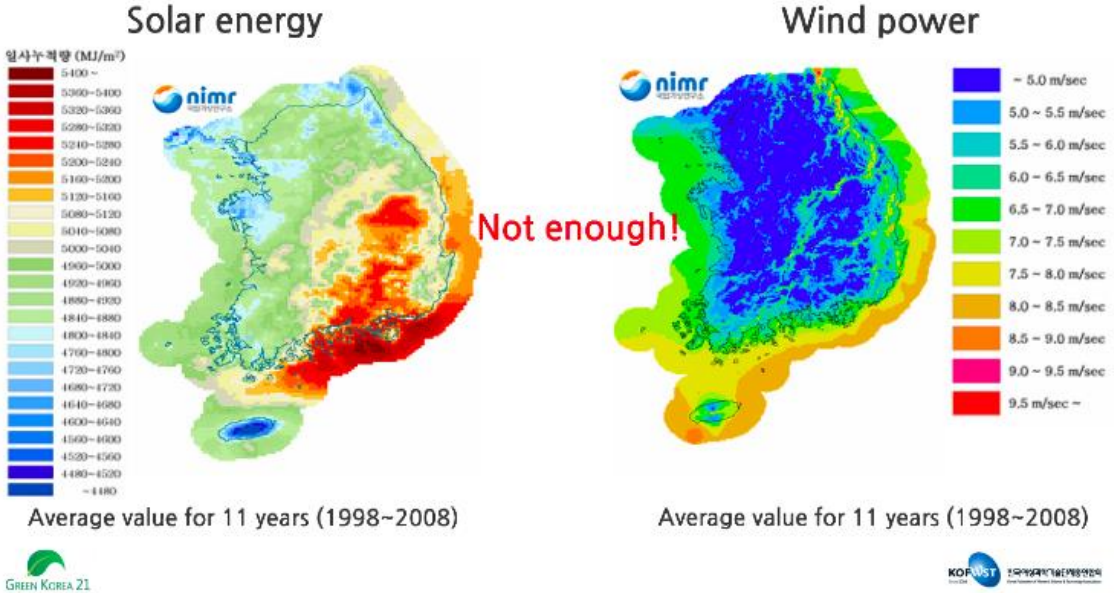
https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf

Figure 9. South Korea's coal production and consumption, 2000-17



eia Source: U.S. Energy Information Administration,

Renewable energy resource maps of korea



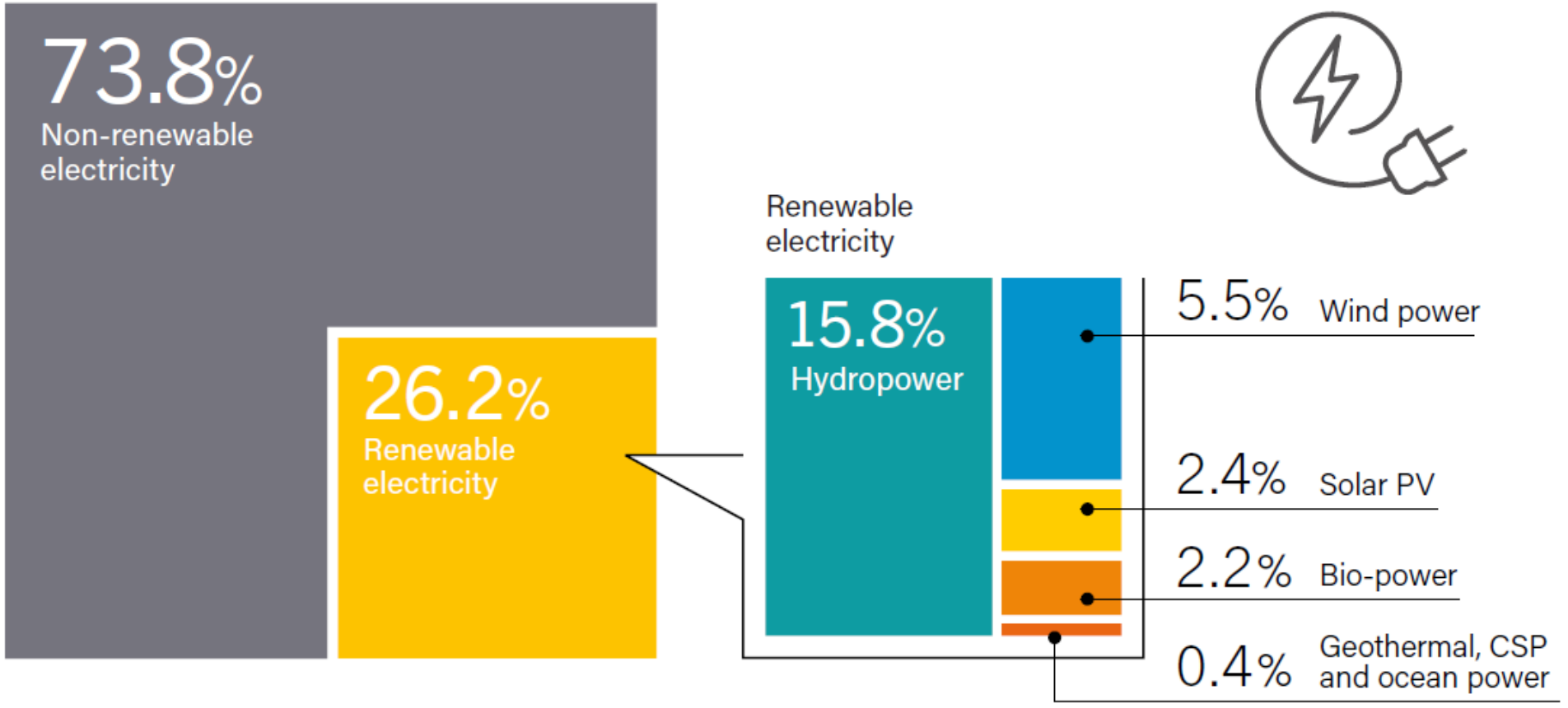
Average value for 11 years (1998~2008)

Average value for 11 years (1998~2008)

GREEN KOREA 21

KOFST

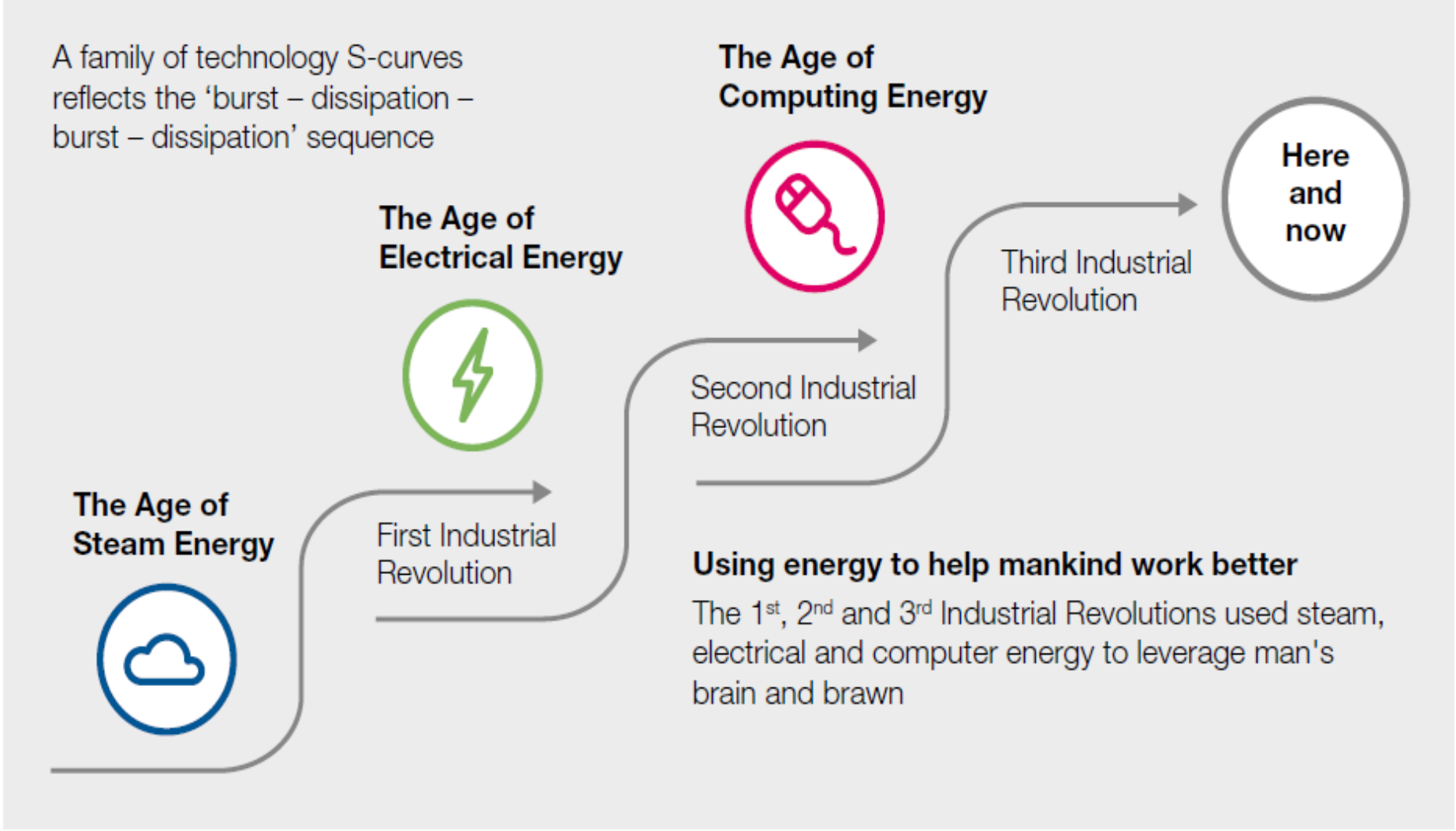
Estimated Renewable Energy Share of Global Electricity Production, End-2018



Note: Data should not be compared with previous versions of this figure due to revisions in data and methodology.

Source: See endnote 192 for this chapter.

https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf



https://dynasty.co.za/4th-industrial-rev-renewable-energy/
Figure1 : The global economy evolves thermodynamically

Energy drives industrial revolutions

The 4IR is not centred on robotics and artificial intelligence as significant as these advances are. Rather, as with all previous such revolutions, it will be driven by the release of a new form of energy into humanity's ecosystem. The global economy has always evolved thermodynamically : bursts of energy followed by dissipation followed by a new burst then dissipation and so on.

Figure 1. **Average annual global primary energy demand growth by fuel, 2010-18**

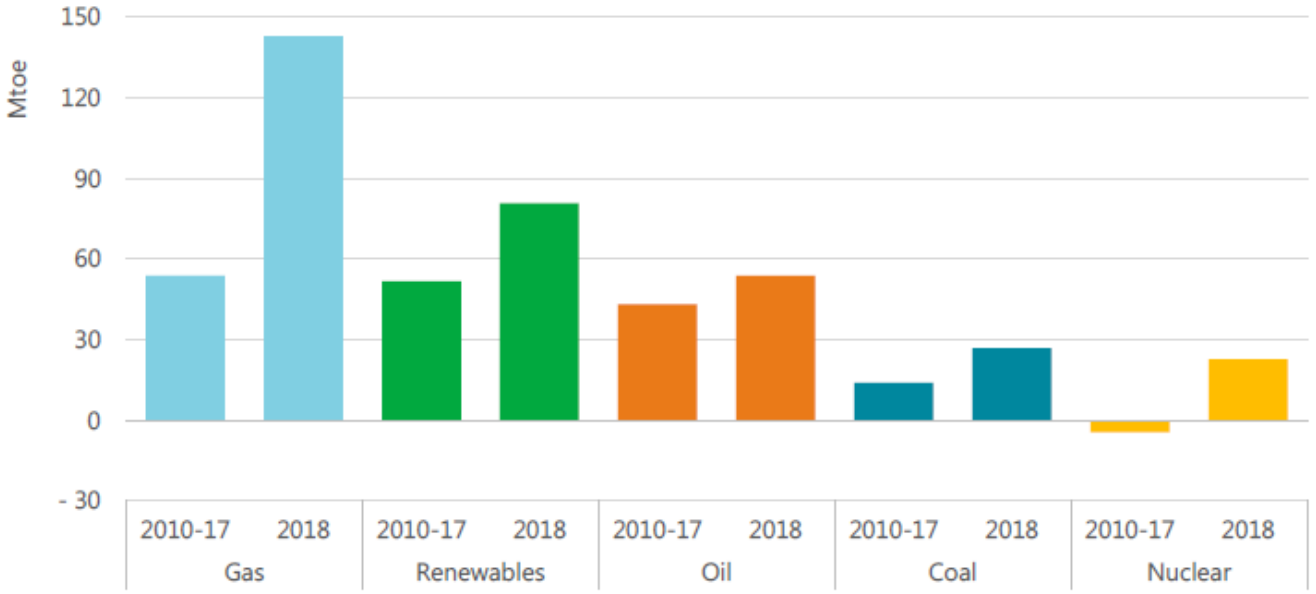
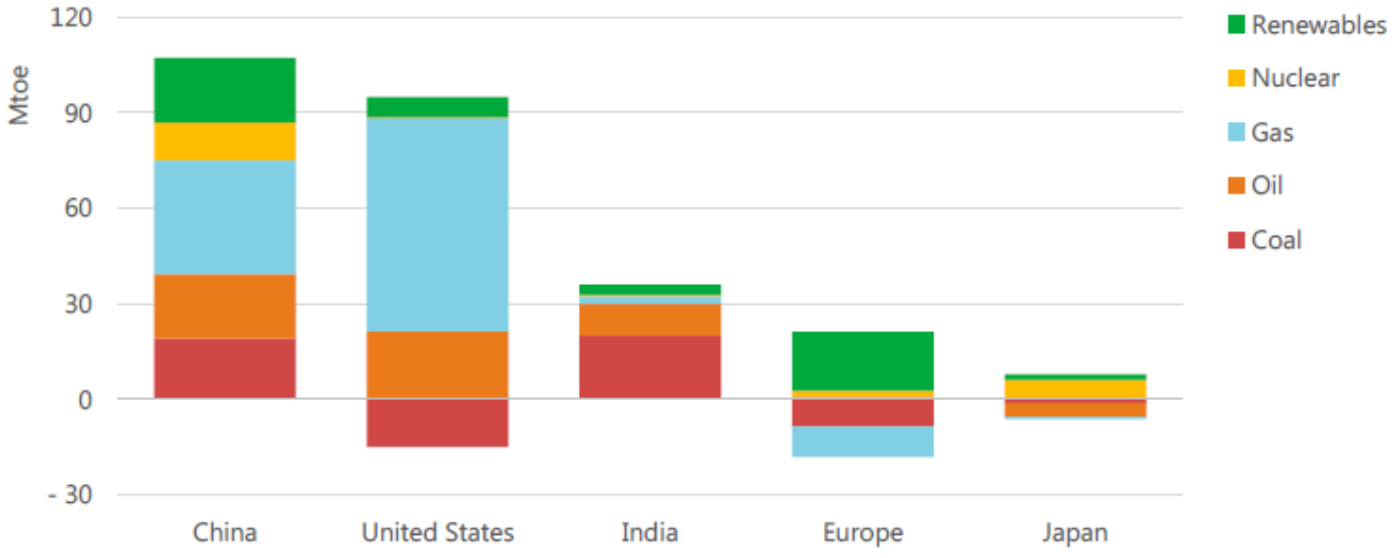
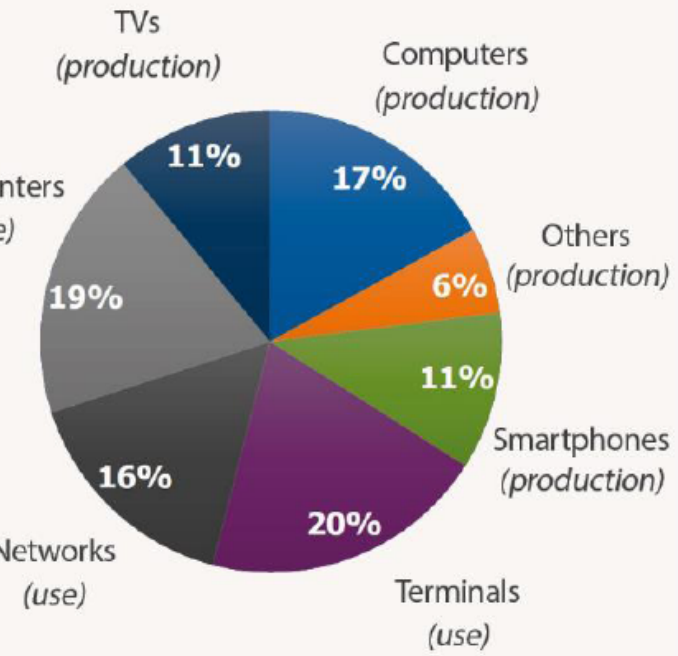


Figure 3. **Primary energy demand growth by fuel in major energy markets, 2017-18**



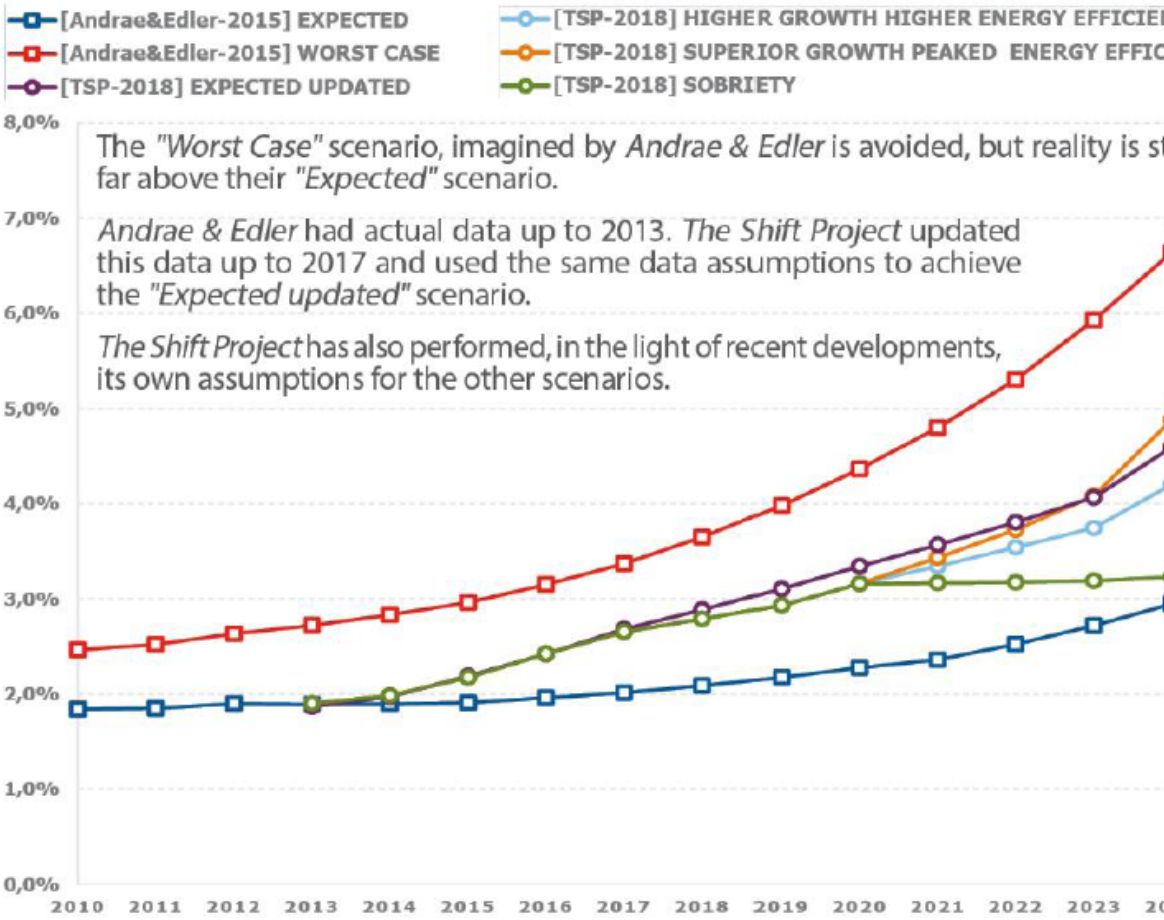
https://www.eenews.net/assets/2019/03/26/document_cw_01.pdf

SCENARIOS FOR 2025



**bution of energy consumption per digital
kstation for production and use in 2017.**

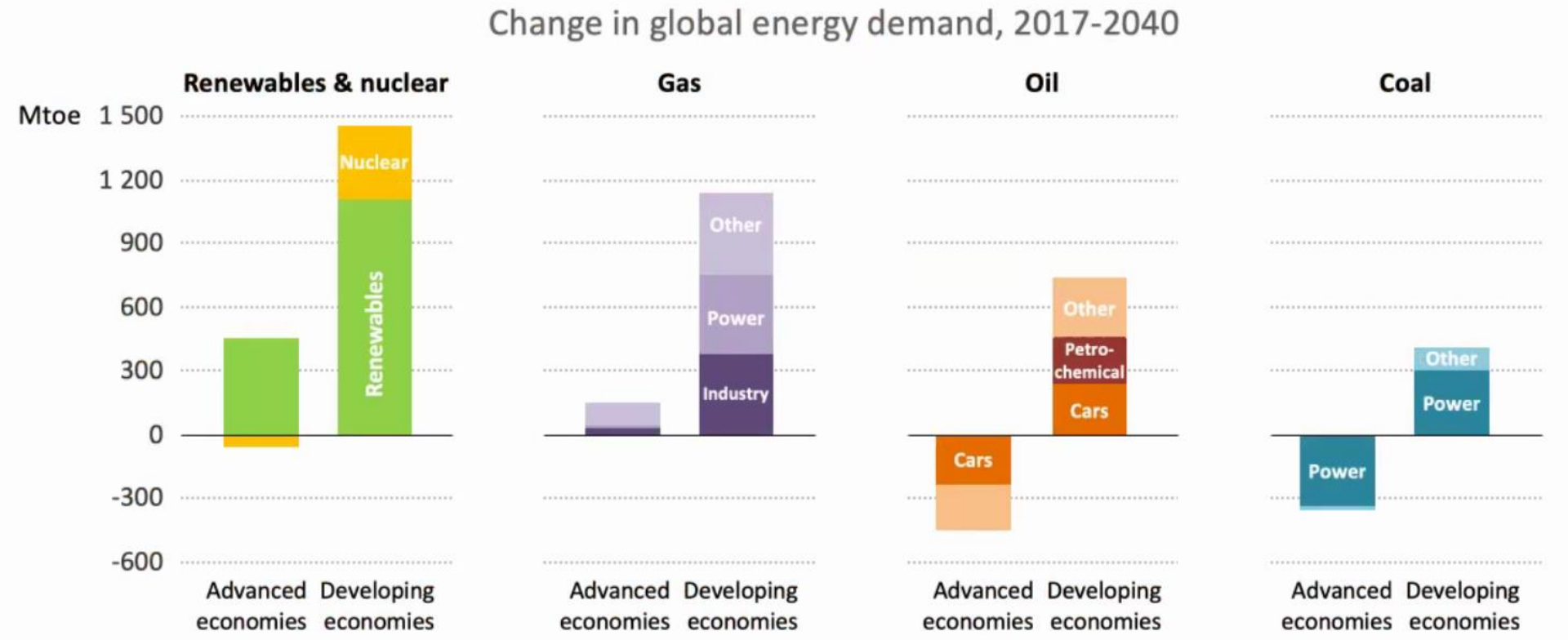
: *The Shift Project* 2018, as of Andrae & Edler 2015]



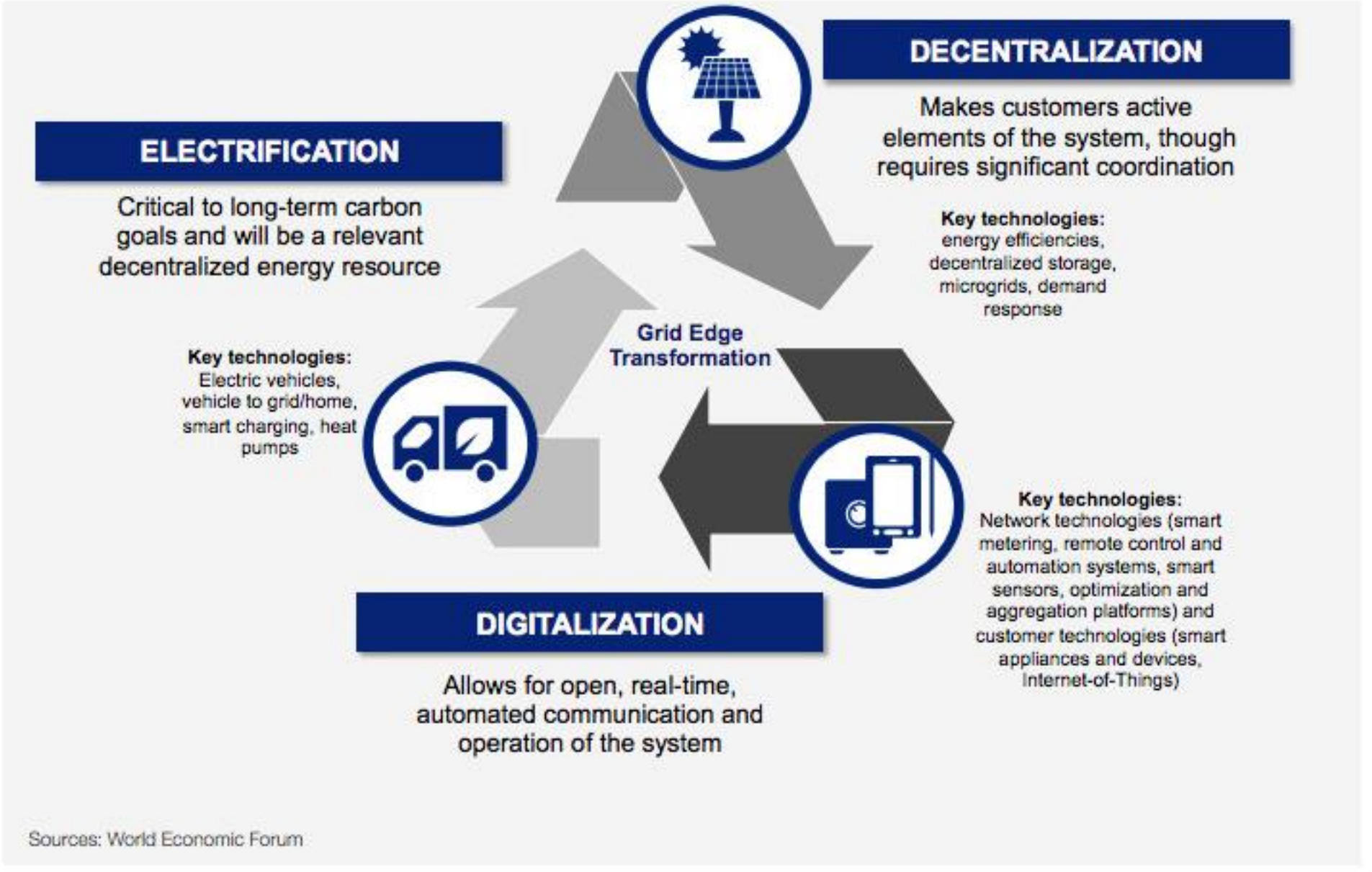
**Evolution of global energy consumption of digital between 2010 and 202
proportion of total world energy consumption**

[Source: *The Shift Project 2018*, as of Andrae & Edler 2015]

https://theshiftproject.org/wp-content/uploads/2019/03/Lean-ICT-Report_The-Shift-Project_2019.pdf



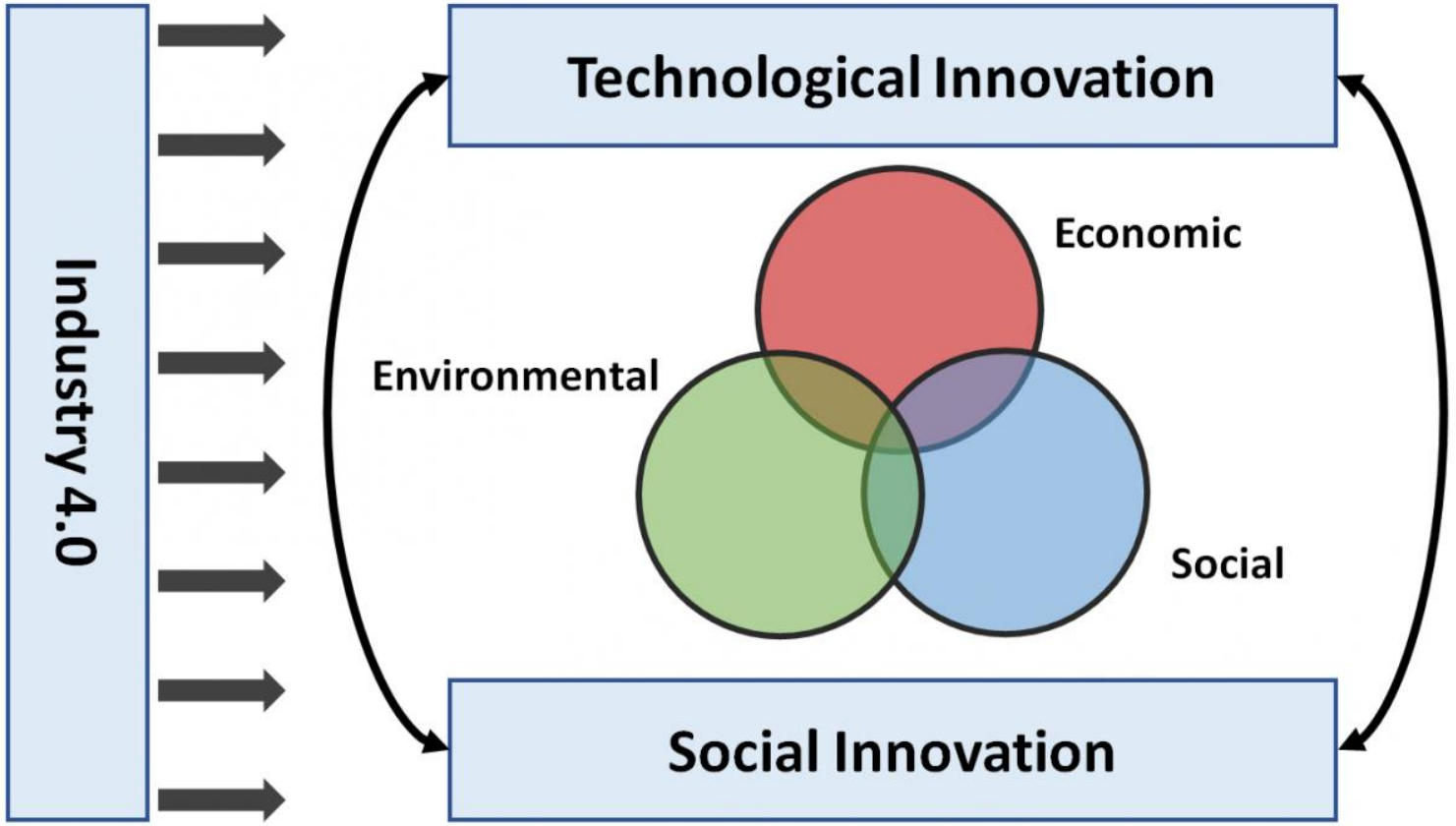
https://www.carbonbrief.org/global-coal-use-may-have-peaked-iea-world-enery-outlook/screen-shot-2018-11-12-at-14-19-34



https://www.autonomousvehicletech.com/articles/1139-the-4th-industrial-revolution-investing-in-connected-mobility-and-sustainable-impact-in-transportation

Three trends–electrification, decentralization, and digitalization–act in a virtuous cycle, enabling, amplifying, and reinforcing developments beyond their individual contributions. (World Economic Forum and Bain & Company

* The 4th Industrial Revolutions : Investing in connected mobility and sustainable impact in transportation



https://timreview.ca/article/1117

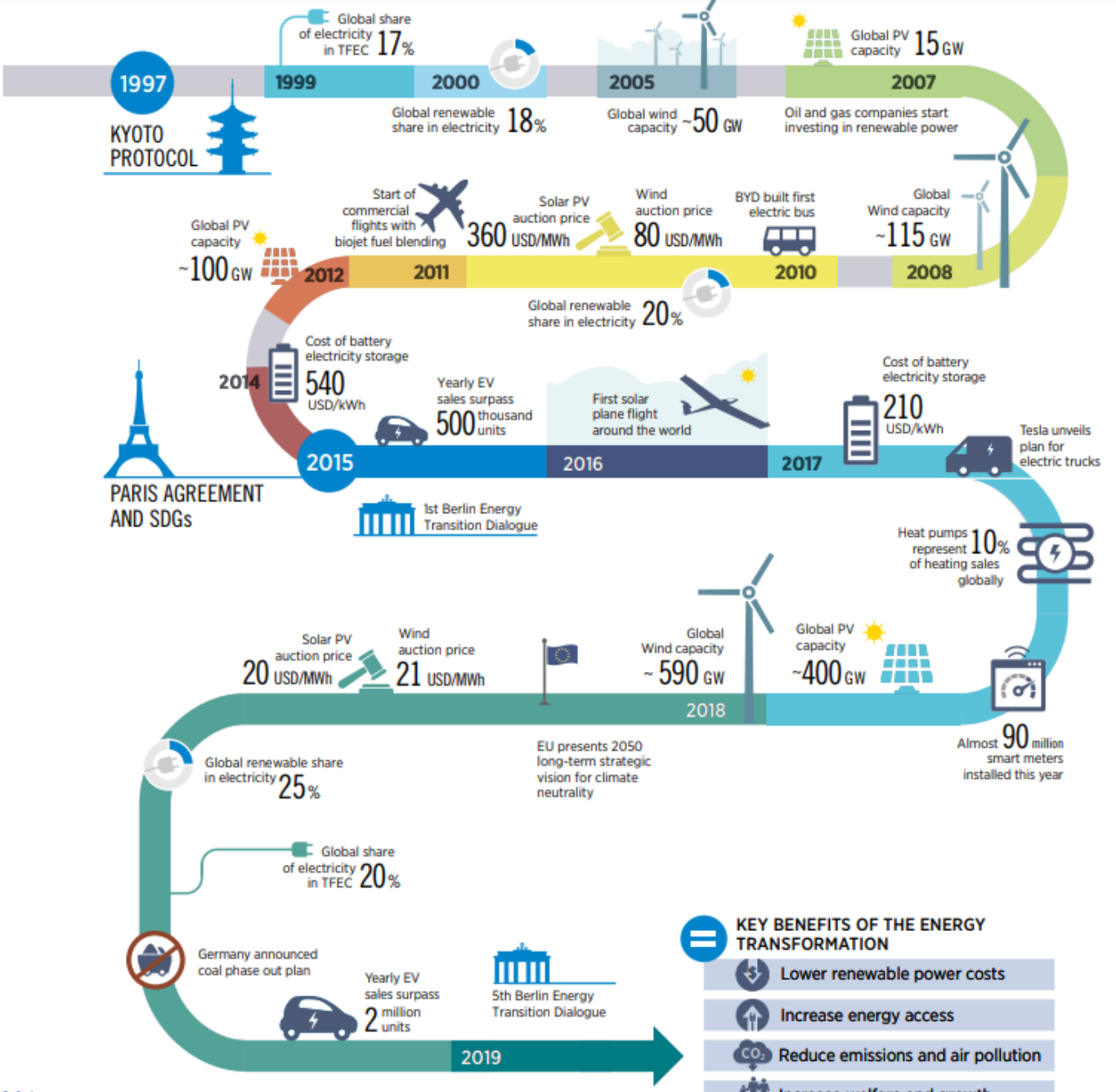
A Framework for a Sustainable Industry 4.0

The impact of technology has increasingly made an impact beyond industrial and economic perspectives, and it could play a critical role in speeding up the realization of a paradigm shift.

The challenges that are caused by the technological innovations need to be addressed by complementary and innovative approaches to provide innovative solutions for future emerging technologies and their impact.

A useful base to start with is using the sustainability concept, considering three key pillars – economic, social, and environmental aspects of development. Technological and social innovation are key drivers in providing sustainable solutions that meet the three key criteria of sustainability and can act as an assessment mechanism to any related developments of Industry 4.0, as shown in graph.

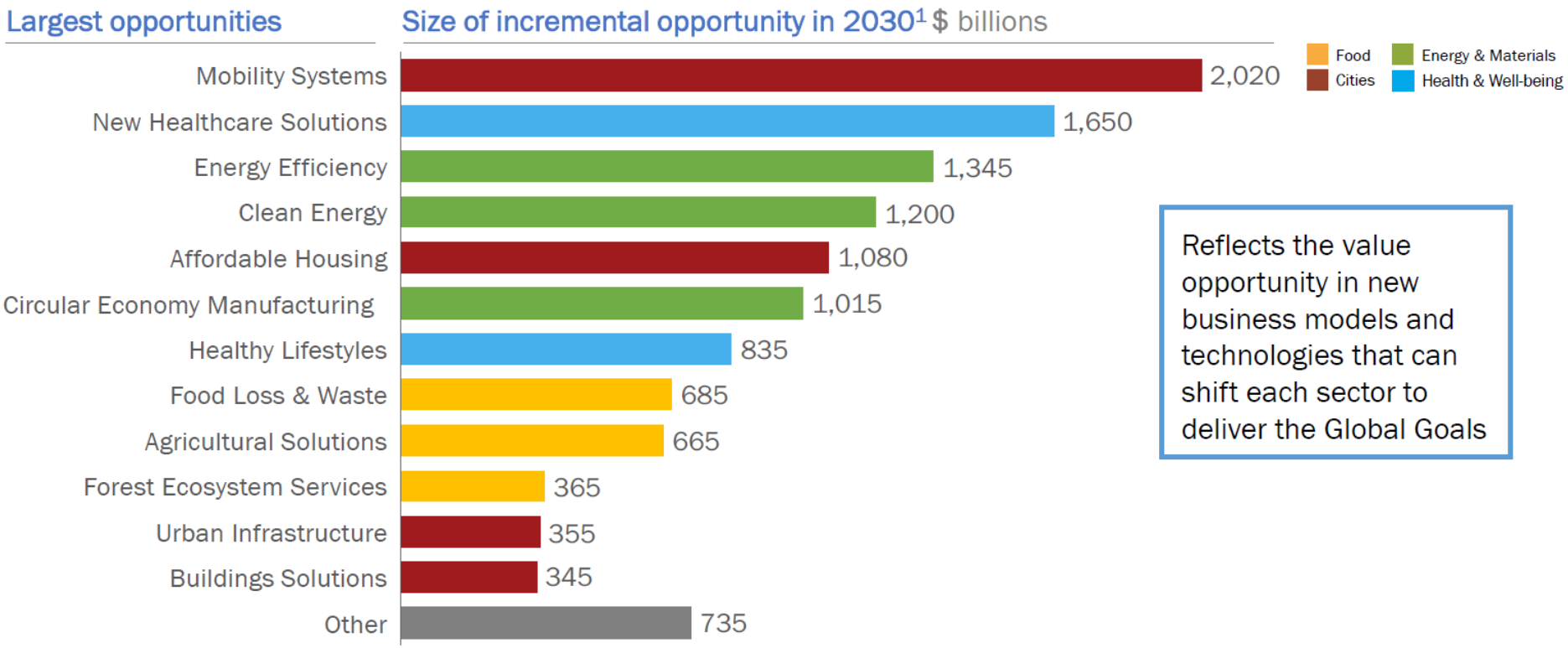
Recent progress of the energy transformation
- Key milestones over the past 20 years in renewables and digitalisation



Sources: (IEA, 2018c); (IRENA, 2018f); (GWEC, 2015); (Reuters, 2007); (IRENA, 2018d); (INSIDEEVs, 2019b); (IEA-PVPS, 2018); (EV Volumes, 2019); (Solar Impulse, 2019); (IRENA, 2017c); (Electrek, 2017); (IEA, 2019); (GlobalData, 2018); (EC, 2018a); (GWEC, 2019); (CleanTechnica, 2018); (IATA, 2018); (BNEF, 2018).

https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Apr/IRENA_Global_Energy_Transformation_2019.pdf

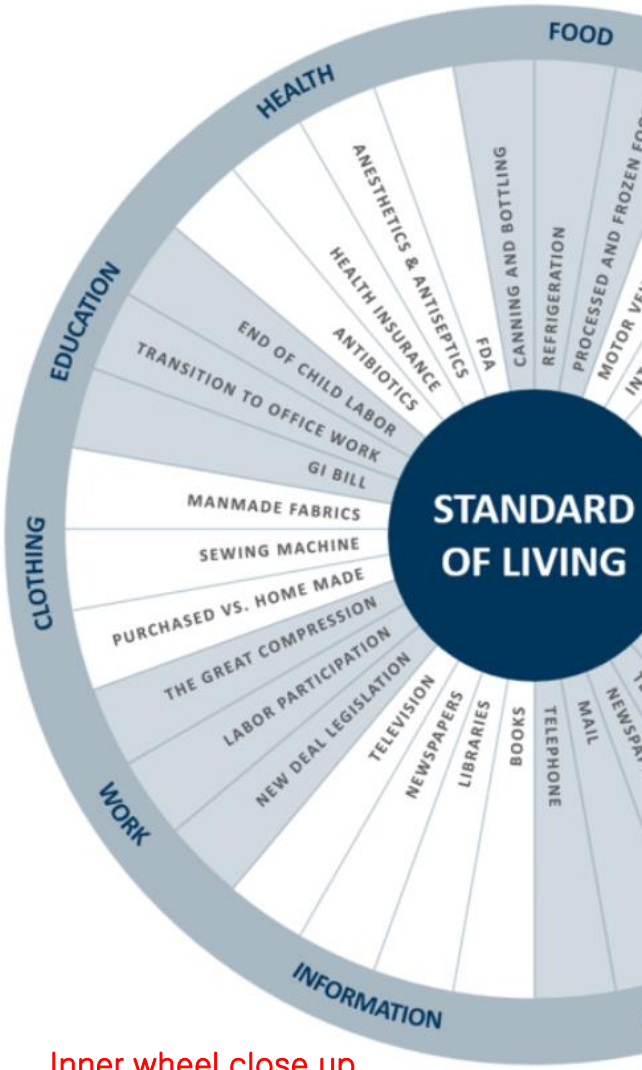
12 market opportunities can generate up to $12 trillion worth of business value



Reflects the value opportunity in new business models and technologies that can shift each sector to deliver the Global Goals

Source: Business & Sustainable Development Commission

Revolution and the Innovation wheel



Inner wheel close up

https://frankdiana.net/2016/10/31/revolution-and-the-innovation-wheel/

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