Tech & Environmental Collapse

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March 7, 2019

French labels everywhere

Sorry!

I'll translate the necessary parts though :)

Talk plan

Introduction

IPCC: 1.5 °C by 2100

Updated climate trajectories

Impact of technology

Conclusion

Slides & references

https://github.com/m09/talk-tech-collapse

Introduction

Goal

- Broad overview of environmental collapse & technology issues
- Spike your interest

We'll go fast :)

Environmental collapse

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- Worst part getting closer (children, grandchildren)

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- Global warming

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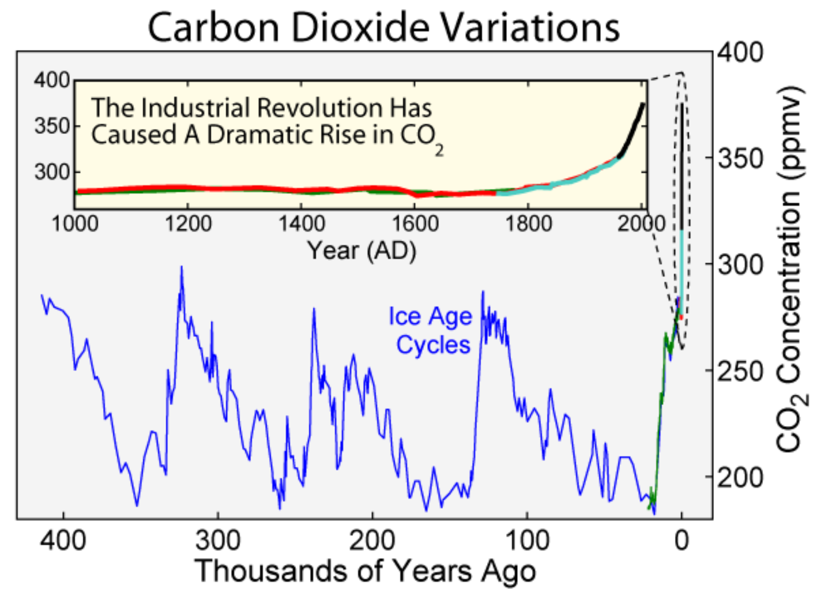
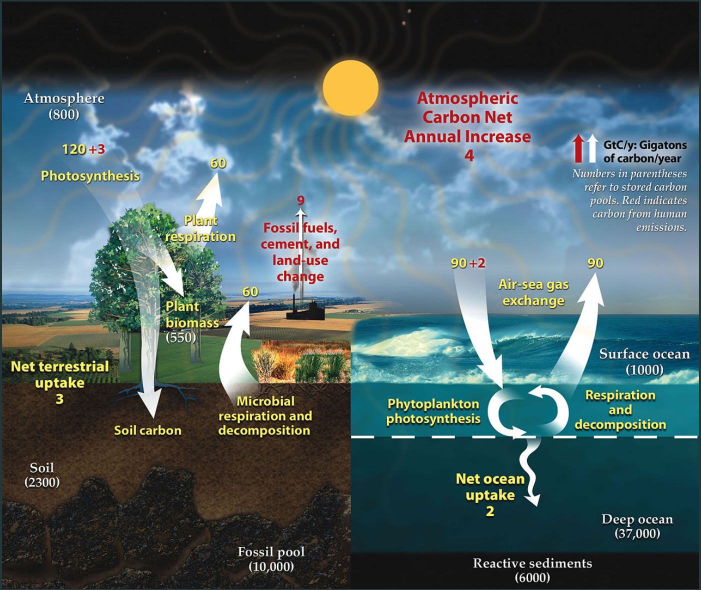
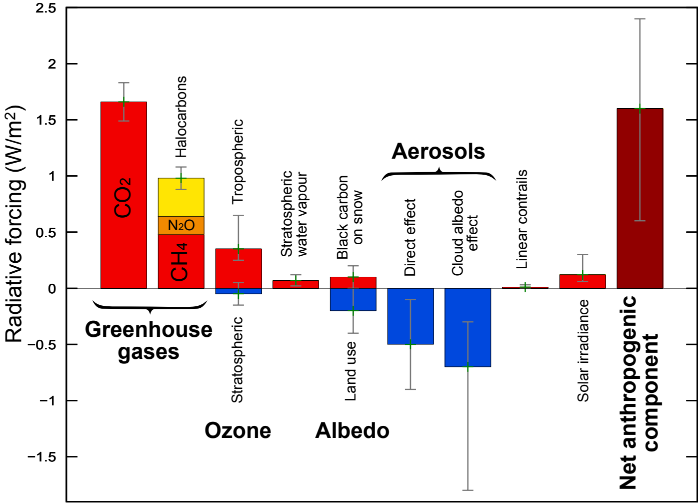
Tonight: focus on climate change



Disruption of the carbon cycle



Radiative-forcing components



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Technology & Environmental collapse

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Let's see!

IPCC: 1.5 °C by 2100

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- 3 working groups

IPCC Report on 1.5°C Climate Change by 2100

Special report. 4 sections:

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1. Understanding global warming of 1.5°C

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Focus on 1. and 2.

- Current climate = pre-industrial climate +1°C (± 0.2°C)

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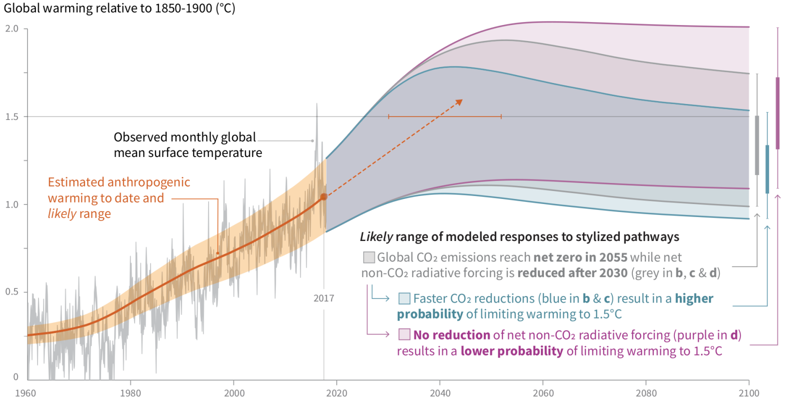
- Up to 3°C in specific regions (Arctic)


Global warming relative to 1850-1900 (°C)
2.0
1.5
1.0
0.5
0
1960
1980
2000
2020
2040
2060
2080
2100
2017
Observed monthly global mean surface temperature
Estimated anthropogenic warming to date and *likely* range
Likely range of modeled responses to stylized pathways
Global CO_2 emissions reach **net zero in 2055** while net non-CO_2 radiative forcing is **reduced after 2030** (grey in **b**, **c** & **d**)
Faster CO_2 reductions (blue in **b** & **c**) result in a **higher probability** of limiting warming to 1.5°C
No reduction of net non-CO_2 radiative forcing (purple in **d**) results in a **lower probability** of limiting warming to 1.5°C

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- could stabilize without new emissions
- could diverge due to feedbacks

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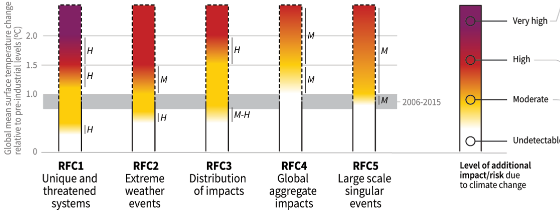
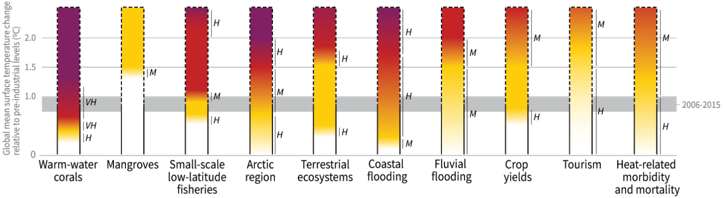
- ...

Impacts and risks associated with the Reasons for Concern (RFCs)



Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.
Red indicates severe and widespread impacts/risks.
Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.
White indicates that no impacts are detectable and attributable to climate change.

Impacts and risks for selected natural, managed and human systems



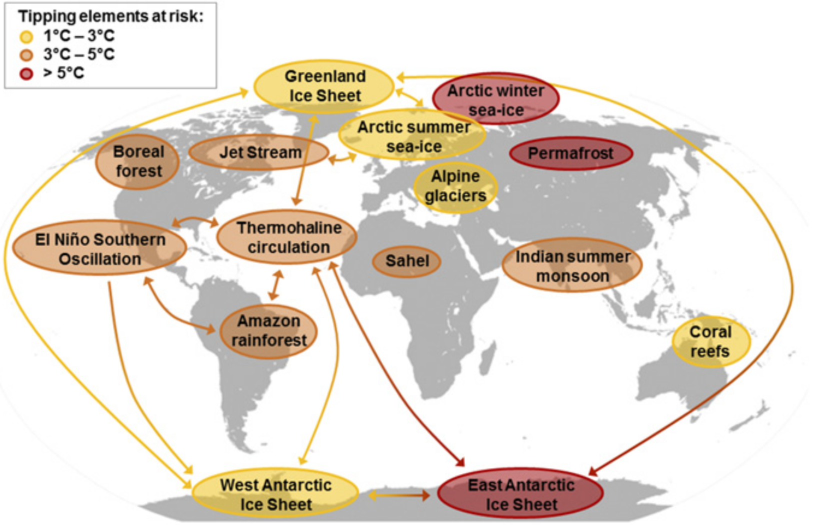
Confidence level for transition: *L*=Low, *M*=Medium, *H*=High and *VH*=Very high

Harder to forecast.

Updated climate trajectories

Latest developments (August 2018)

Paper in PNAS. Re-evaluates the importance of feedbacks.

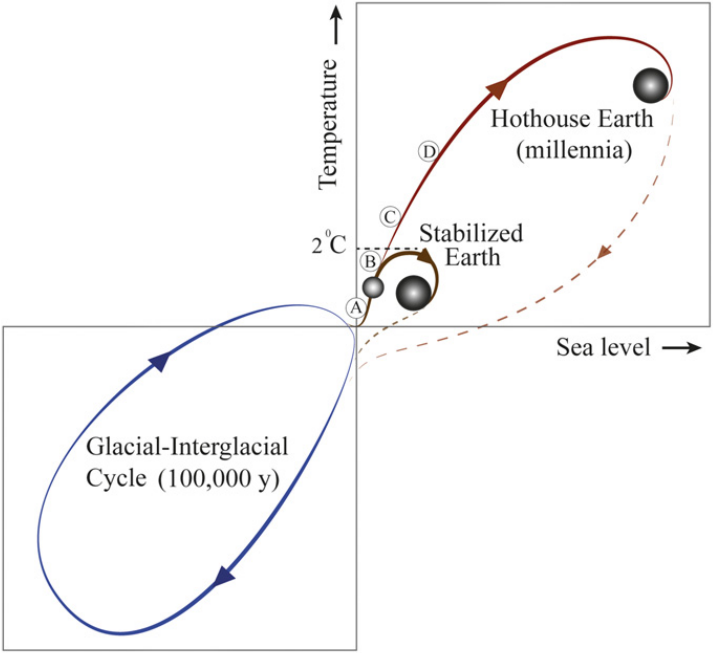

Tipping elements at risk:
1°C – 3°C
3°C – 5°C
> 5°C
Greenland Ice Sheet
Arctic winter sea-ice
Arctic summer sea-ice
Boreal forest
Jet Stream
Permafrost
Alpine glaciers
El Niño Southern Oscillation
Thermohaline circulation
Sahel
Indian summer monsoon
Amazon rainforest
Coral reefs
West Antarctic Ice Sheet
East Antarctic Ice Sheet

References from the past

Period	Time	CO_2 ppm	°C	Sea	Stabilization
Current	0	400	>1.0	NA	No
A. Mid-Holocene	~6-7 ka	260	~0.6-0.9	NA	No
B. Eemian	~125 ka	280-300	1.0-1.5	6-9	No
C. Mid-Pliocene	~3-4 Ma	400-450	2-3	10-22	Paris
D. Mid-Miocene	~15-17 Ma	300-500	4-5	10-60	Current

Feedbacks

Feedback	Threshold °C	Force °C	Speed
Permafrost thawing	~2.0°C	0.09	by 2100
Weakening of C sinks	~2.0°C	0.25	by 2100
Oceanic bacterial respiration	~2.0°C	0.02	by 2100
Amazon forest dieback	~2.0°C	0.05	by 2100
Boreal forest dieback	~2.0°C	0.06	by 2100
Reduct of Northern snow	scales	North x2	by 2100
Arctic summer sea-ice loss	~1.0°C	North x2	by 2050
Antarctic summer sea-ice loss	~1.0°C	Smaller	30%by 2100

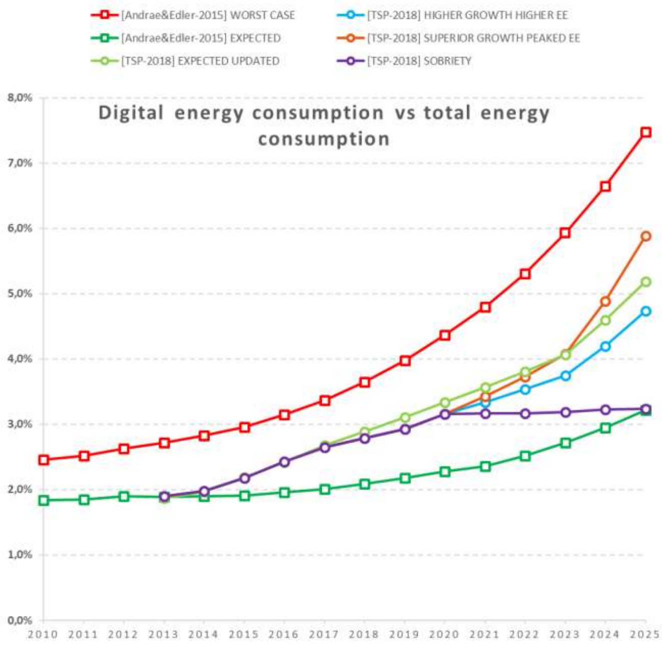

Temperature
Sea level
Hothouse Earth
(millennia)
Stabilized
Earth
2°C
A
B
C
D
Glacial-Interglacial
Cycle (100,000 y)

Impact of technology

Vocabulary

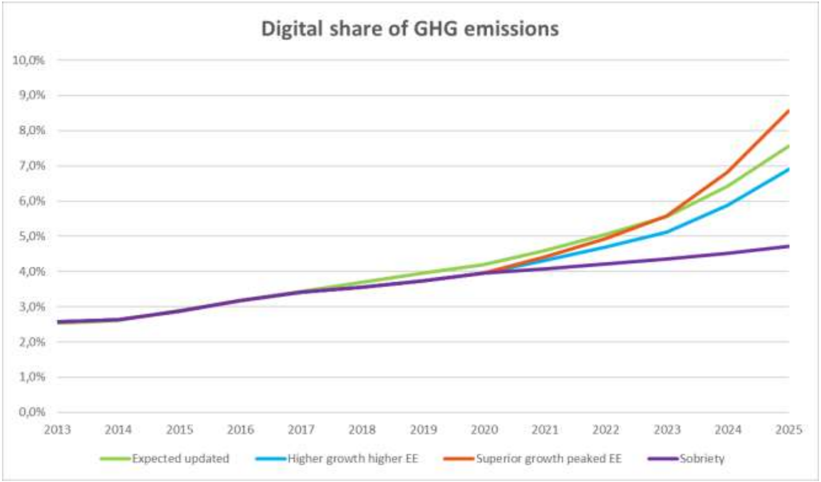
Technology = Information Technology in the next slides.

- 10% Cumulative Annual Growth Rate
- 2% total budget in 2010
- (domestic flights are 2%, cars 8%)

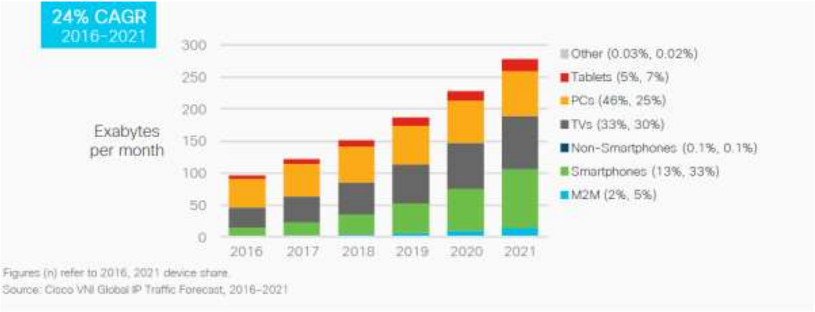

[Andrae&Edler-2015] WORST CASE
[Andrae&Edler-2015] EXPECTED
[TSP-2018] EXPECTED UPDATED
[TSP-2018] HIGHER GROWTH HIGHER EE
[TSP-2018] SUPERIOR GROWTH PEAKED EE
[TSP-2018] SOBRIETY
Digital energy consumption vs total energy consumption
8,0%
7,0%
6,0%
5,0%
4,0%
3,0%
2,0%
1,0%
0,0%
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025

GHG SHARE OF TECHNOLOGY

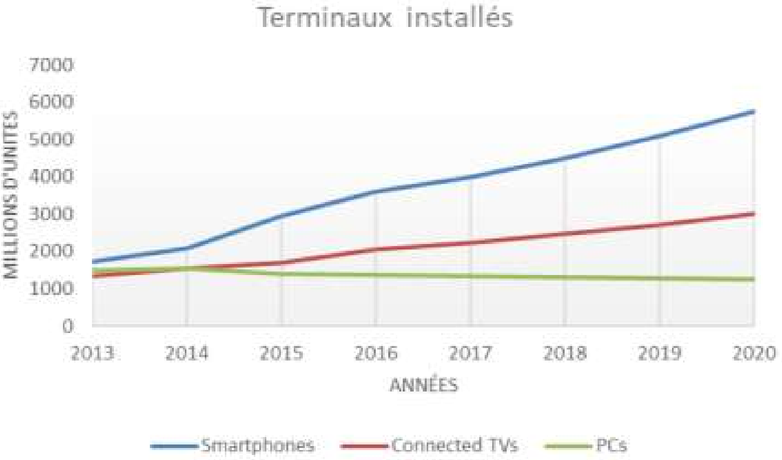
Same than energy.


Digital share of GHG emissions
10,0%
9,0%
8,0%
7,0%
6,0%
5,0%
4,0%
3,0%
2,0%
1,0%
0,0%
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Expected updated
Higher growth higher EE
Superior growth peaked EE
Sobriety

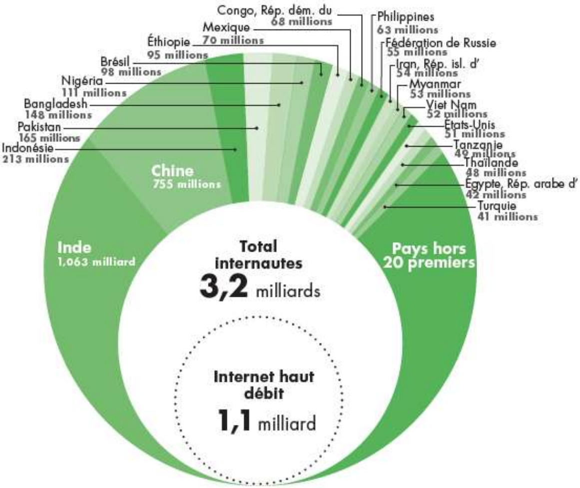
INTERNET


24% CAGR
2016–2021
Exabytes per month
300
250
200
150
100
50
0
2016
2017
2018
2019
2020
2021
Other (0.03%, 0.02%)
Tablets (5%, 7%)
PCs (46%, 25%)
TVs (33%, 30%)
Non-Smartphones (0.1%, 0.1%)
Smartphones (13%, 33%)
M2M (2%, 5%)
Figures (n) refer to 2016, 2021 device share.
Source: Cisco VNI Global IP Traffic Forecast, 2016-2021

Devices


Terminaux installés
7000
6000
5000
4000
3000
2000
1000
0
MILLIONS D'UNITES
2013
2014
2015
2016
2017
2018
2019
2020
ANNÉES
Smartphones
Connected TVs
PCs

b. La population mondiale non connectée

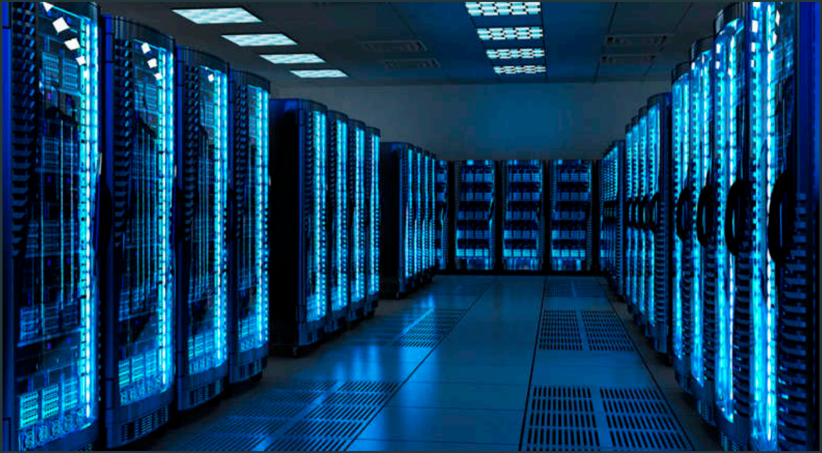


Aggravating factors

- YouTube effect
- Rebound effect
- Hidden construction cost
- Energy-resources tradeoff

YouTube effect — user view

Effet YouTube — datacenter view



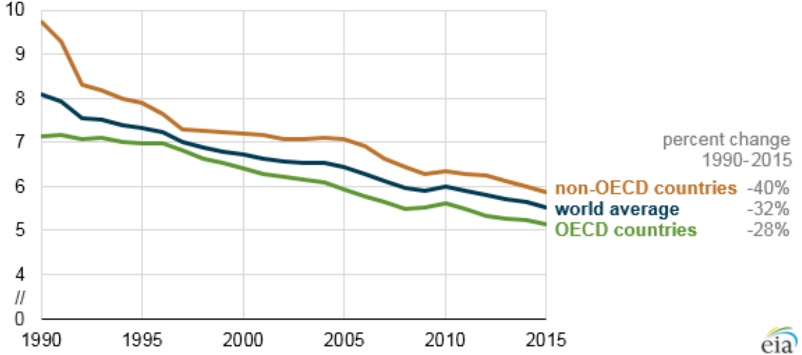
YouTube effect

Energy consumption of a video viewing: 1500 times higher than the smartphone consumption

Increasing the energy efficiency of an object increases the consumption related to its function.

World energy intensity, 1990-2015

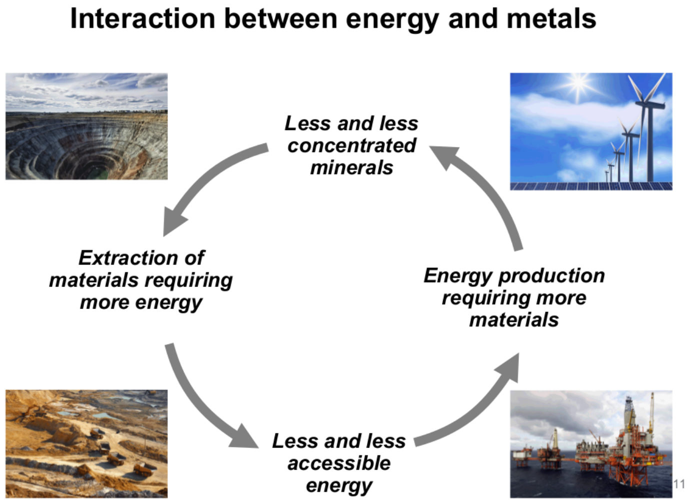
quadrillion British thermal units per trillion dollars gross domestic product

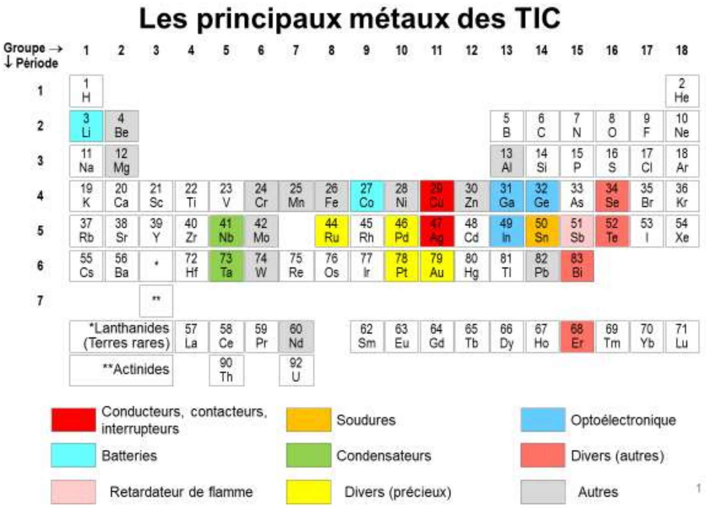


Hidden production cost

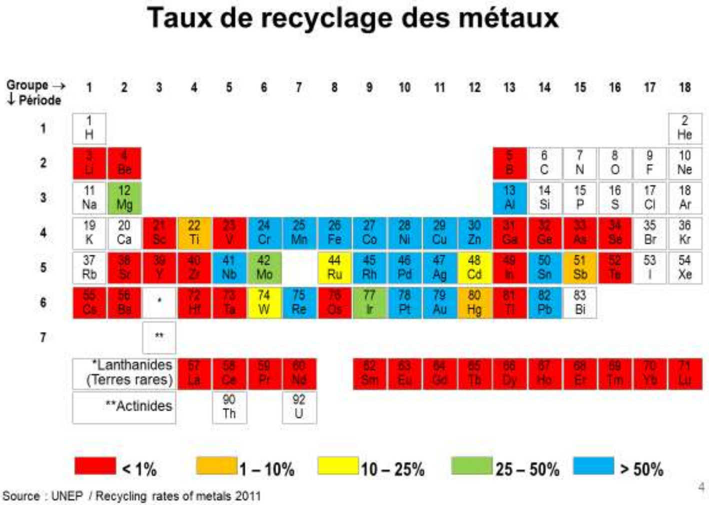
Smartphone: production energy cost = 33 $\times$ its annual consumption

ENERGY-RESOURCES TRADEOFF




Les principaux métaux des TIC
Groupe → 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
↓ Période
1 1 H 2 He
2 3 Li 4 Be 5 B 6 C 7 N 8 O 9 F 10 Ne
3 11 Na 12 Mg 13 Al 14 Si 15 P 16 S 17 Cl 18 Ar
4 19 K 20 Ca 21 Sc 22 Ti 23 V 24 Cr 25 Mn 26 Fe 27 Co 28 Ni 29 Cu 30 Zn 31 Ga 32 Ge 33 As 34 Se 35 Br 36 Kr
5 37 Rb 38 Sr 39 Y 40 Zr 41 Nb 42 Mo 44 Ru 45 Rh 46 Pd 47 Ag 48 Cd 49 In 50 Sn 51 Sb 52 Te 53 I 54 Xe
6 55 Cs 56 Ba * 72 Hf 73 Ta 74 W 75 Re 76 Os 77 Ir 78 Pt 79 Au 80 Hg 81 Tl 82 Pb 83 Bi
7 **
*Lanthanides (Terres rares) 57 La 58 Ce 59 Pr 60 Nd 62 Sm 63 Eu 64 Gd 65 Tb 66 Dy 67 Ho 68 Er 69 Tm 70 Yb 71 Lu
**Actinides 90 Th 92 U
Conducteurs, contacteurs, interrupteurs
Soudures
Optoélectronique
Batteries
Condensateurs
Divers (autres)
Retardateur de flamme
Divers (précieux)
Autres
1

RECYCLING RATE



Several stages of loss:

Recycling

Several stages of loss:

1. Dissipative usage

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2. Usage loss

Recycling

Several stages of loss:

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3. Downcycling

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2. Usage loss
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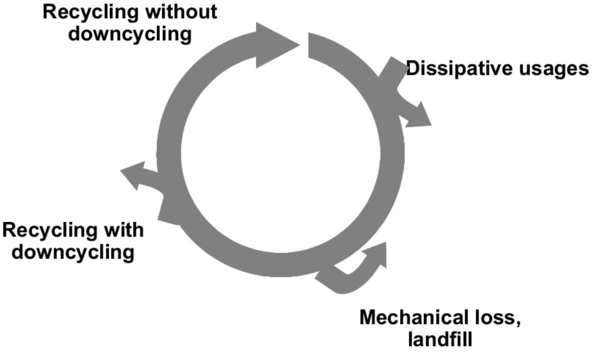
Only the rest can be recycled.

The « vertuous circle » of recycling



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- Known for a long time
- Main polluters = main deciders → inertia
- Technology and science are not the answer by themselves
- Limiting growth is more important

Thank you for your attention!

Questions/Discussion Time!