

## Elements at risk Collapse or not collapse?

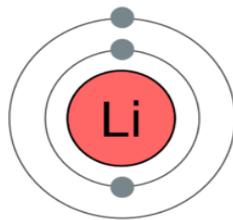
In this course, and following the previous chapter with Indium and Tantalum scarcity, we are now going to discover the actual situation of other chemical elements at risk, such as Lithium and Helium.

### 1. LITHIUM: THE NEW TREASURE

#### 1.1 WHAT DO YOU KNOW ABOUT LITHIUM?

3: Lithium

2,1



. 1 - Greg Robson, CC BY-SA 2.0 UK

Lithium is one of the smallest chemical elements, with only 3 protons and 3 electrons, but it has attracted growing interest. Why?

Watch the following video, then you will be prepare to answer the Refresh quiz

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Name:  
**Lithium**

Atomic number: **3**      Symbol: **Li**

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THE PERIODIC TABLE OF VIDEOS  The University of Nottingham  
By Brady Haran © 2010

Fig.2 - <https://www.youtube.com/watch?v=wY0afMI4Jgc&t=159s>

## 1.2 REFRESH YOUR KNOWLEDGE ABOUT LITHIUM

### REFRESH YOUR KNOWLEDGE ABOUT LITHIUM

By listening the following podcast

Click here: [LITHIUM \( Interactive activity: refresh-your-knowledge-about-lithium-206.h5p\)](#)

<https://www.rsc.org/periodic-table/podcast/3/Lithium>

Lithium is .....

- a transition metal
- a metal
- a noble gas
- a non metal

Lithium has.....

- 7 neutrons
- 4 neutrons
- 3 neutrons
- 4 protons

Lithium has ....

- an oxidation number of 3
- an atomic mass of 3
- an atomic number of 3
- an oxidation number of -3

Lithium is a member of .....

- the alkali earth group
- the halogens group
- the chalcogens group
- the alkali group

At room temperature Lithium is ....

- plasma
- liquid
- solid
- gas

Lithium is ....

- the denser element used in electronics
- denser than water
- the lightest of the solid elements
- the most dense of the solid elements

Lithium reacts with ....

- water and nitrogen
- with carbon dioxide
- with nitrogen and carbon dioxide

Lithium is used to treat

- Covid illness
- headaches
- bipolar disorders
- Alzheimer illness

Due to its high reactivity with water, ....

- ionic lithium never occurs freely in nature
- lithium chloride never occurs freely in nature
- atomic lithium never occurs freely in nature
- lithium carbonate never occurs freely in nature

Lithium can ....

- act as an electrical insulator
- act as an electrical conductor
- act as an electrical conductor and insulator

Lithium and lithium-ion batteries are ...

- both rechargeable
- the same

- rechargeable and non-rechargeable, respectively
- non-rechargeable and rechargeable, respectively

## 2. LITHIUM: SCARCITY OR NOT SCARCITY

### HOW CAN THIS SMALL ELEMENT BE SO IMPORTANT?

After reading a few articles in chronological order you will decide if the future of lithium is, as many other chemical elements, scarcity.

You will also learn how lithium is priced in the current market, its applications and if there is or not environmental impact.

(Interactive activity: lithium-scarcity-or-not-scarcity-207.h5p)

### 2011 - THE FUTURE OF LITHIUM

The Lithium future—resources, recycling, and the environment by Thomas Cherico Wanger

The demand for Lithium-ion batteries as a major power source in portable electronic devices and vehicles is rapidly increasing. I use cumulative data of vehicle, mobile phone, laptop, and digital camera production to show that demand will overshoot the available global Lithium resources before 2025. Even if 100% of all Lithium-ion batteries were recycled today, recycling could not prevent this resource depletion in time. **As the increasing Lithium scarcity will increase the price**, it will be feasible to mine diluted resources with a strong environmental impact. I highlight these impacts in Lithium-rich Bolivia, the potential new “Saudi Arabia of Lithium.” Lithium extraction is likely to cause substantial water pollution, and—through impacts on native diversity—facilitate human health impacts from cyanobacteria that are normally kept at bay by native flamingos.

Conservation Letters 4(2011) 202–206

[https://www.researchgate.net/publication/229940500\\_The\\_Lithium\\_future-resources\\_recycling\\_and\\_the\\_environment](https://www.researchgate.net/publication/229940500_The_Lithium_future-resources_recycling_and_the_environment)

Search and note a few of the environmental impacts due to lithium extraction?

### 2021- LITHIUM OUTLOOK

At this [document](#) from Government of Western Australia Department of Mines, Industry Regulation and Safety (2021), take a look at Table 15.1, in which you can see the forecast for lithium production and stocks up to 2023.

What does “stockpiles run down” mean?

## What happens with lithium stocks from 2020 up to 2023?

<https://publications.industry.gov.au/publications/resourcesandenergyquarterlyjune2021/documents/Resources-and-Energy-Quarterly-June-2021-Lithium.pdf>

Table 15.1: Lithium Outlook

World	Unit	2020	2021 <sup>f</sup>	2022 <sup>f</sup>	2023 <sup>f</sup>	Annual percentage change		
						2021 <sup>f</sup>	2022 <sup>f</sup>	2023 <sup>f</sup>
Lithium production <sup>a</sup>	kt	464	441	538	679	-4.9	22	26
Demand <sup>b</sup>	kt	305	452	561	675	48	24	20
Stocks <sup>c</sup>	kt	122	76	21	-48	-37	-72	-326
- weeks of consumption		20.7	8.8	2.0	-3.7	-58	-78	-288
Spodumene price								
- nominal	US\$/t	437	670	768	736	53	15	-4.2
- real <sup>d</sup>	US\$/t	448	670	750	698	50	12	-6.9
Lithium hydroxide price								
- nominal	US\$/t	9,892	12,088	13,960	14,288	22	15	2.3
- real <sup>d</sup>	US\$/t	10,124	12,088	13,633	13,555	19	13	-0.6
<b>Australia</b>	<b>Unit</b>	<b>2019–20</b>	<b>2020–21<sup>a</sup></b>	<b>2021–22<sup>f</sup></b>	<b>2022–23<sup>f</sup></b>	<b>2020–21<sup>a</sup></b>	<b>2021–22<sup>f</sup></b>	<b>2022–23<sup>f</sup></b>
Mine production <sup>a</sup>	kt	233	213	289	327	-8.4	35	13
Spodumene export volume <sup>e</sup>	kt	1,503	1,440	1,951	2,209	-4.2	35	13
Export value								
- nominal value <sup>g</sup>	A\$m	1,093	928	1,975	2,472	-15	113	25
- real value <sup>h</sup>	A\$m	1,103	928	1,942	2,389	-16	109	23

Notes: a Lithium Carbonate Equivalent: This is a measure of the quantity of refined product; b Demand is ahead of consumption by approximately 12 months due to the lead time required in battery manufacturing; c Stockpile estimates difficult to estimate, calculated after losses from refining and allowing for lead time in battery manufacturing; d In 2021 US dollars; e Spodumene concentrates: mostly 6 per cent Li<sub>2</sub>O concentrate, stockpiles run down in 2019–20; f Forecast; g revenue from spodumene concentrate as well as lithium hydroxide; h In 2020–21 Australian dollars; s Estimate.  
Source: Company reports; Department of Industry, Science, Energy and Resources (2021); Roskill (2021); Government of Western Australia Department of Mines, Industry Regulation and Safety (2021)

## 2021 – THE ENVIRONMENTAL IMPACT OF LITHIUM-ION BATTERIES

In 2016, protestors drew attention to a toxic chemical leak at the Ganzizhou Rongda Lithium mine that had destroyed the local ecosystem, resulting in dead fish floating in the Liqi river. Eyewitnesses reported dead cows and yak also flowing downstream from the mine following the third incident in seven years. After the second incident in 2013, the mine had been closed, only to be reopened in 2016 due to increased demand for batteries for smartphones and electric cars. Shortly after reopening, locals noticed the fish had begun dying again.

By [Sarah Moore](#); <https://www.azom.com/article.aspx?ArticleID=20551>

Where is placed Ganzizhou Rongda?

Is there any conflict in this area?

[https://www.washingtonpost.com/world/asia\\_pacific/tibetans-in-anguish-as-chinese-mines-pollute-their-sacred-grasslands/2016/12/25/bb6aad06-63bc-11e6-b4d8-33e931b5a26d\\_story.html](https://www.washingtonpost.com/world/asia_pacific/tibetans-in-anguish-as-chinese-mines-pollute-their-sacred-grasslands/2016/12/25/bb6aad06-63bc-11e6-b4d8-33e931b5a26d_story.html)

## 2022 - TRADING AND PRICING

Trading Economics provides Lithium pricing based on spot prices for Lithium Carbonate, 99.5% Li<sub>2</sub>CO<sub>3</sub> min, battery grade, traded in China. Lithium is a silver-white light metal. Lithium hydroxide is used in batteries for electrical vehicles and mobile phones. Lithium hydroxide is produced from a chemical reaction between lithium carbonate and calcium hydroxide. The biggest lithium producers are Chile, China, Australia and Argentina. The largest lithium importers are China, Japan, South Korea and the United States.

Lithium carbonate prices in China were at 377,500 yuan/tonne in beginning of February, amid high global demand and difficulty of securing supplies. Prices have surged over 25% this year from continuously increasing demand from lithium battery manufacturers, especially for electric vehicles. Global electric vehicle sales are estimated to have increased by 160% during 2021, while deliveries in China are expected to double in 2022 to over 5 million sales. Meanwhile, battery manufacturers race to secure long-term supply contracts due to mineral scarcity and environmental concerns with mining. On January 20th, the Serbian government revoked mining giant Rio Tinto's exploration licenses following extensive protests of environmental concerns. The now-defunct project would have been worth USD 2.4 billion and was estimated to produce enough lithium for 1 million electric vehicle batteries.

	Price	Day	Month	Year	Date
<a href="#">Gold</a>	1805.3	-0.06%	-0.56%	0.68%	21:40
<a href="#">Copper</a>	44.660	-0.67%	-0.03%	25.91%	21:40
<a href="#">Steel</a>	4,778.00	0.89%	4.90%	14.01%	Jan/28
<a href="#">Iron Ore</a>	143.50	0%	23.71%	-3.37%	feb-02
<a href="#">Lithium</a>	377,500.00	2.72%	36.04%	476.34%	feb-03

<https://tradingeconomics.com/commodity/lithium> (03/02/2022)

Which chemical element has largely increased its demand?

Why do you think?

## Lithium scarcity task

Once you finish the reading of previous articles, you will need to answer the following questions and submit them in an attached file:

Search and note a few of the environmental impacts due to lithium extraction?

What does “stockpiles run down” mean?

What happens with lithium stocks from 2020 up to 2023?

*Where is placed Ganzizhou Rongda?*

*Is there any conflict in this area?*

*Has lithium largely increased its demand compared to other commodities or metals? Why do you think?*

### 3. HELIUM: ROLE AND RESOURCES

HELIUM: MUCH MORE THAN BALLOONS AND SQUAEKY VOICES



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<https://commons.wikimedia.org/wiki/File:Balloons-aj.svg>

### 3.1 HELIUM: ROLE AND RESOURCES

Here you have a few articles posted, from which you will catch an idea of how important helium is. (Interactive activity: helium-role-and-resources-213.h5p)

Pay attention to all the questions after the articles! Click & Collect them



The Helium Boom Is About to Take Off in 2021 - Global Investment Daily, by Alex Kimani

3.1.1 Helium is about much more than balloons and squeaky voices. Its uses in medicine and military applications are vital but Europe risks finding itself between a rock and a hard place in securing a regular supply, writes Lukas Trakimavičius.

*Lukas Trakimavičius is an intern in the Energy Security Section of NATO's Emerging Security Challenges Division. The views expressed in this article are the author's own and are contributed in a purely personal capacity.*

Last June, the diplomatic spat between Qatar and the rest of the Gulf countries sparked fears across the globe that it could affect Doha's capacity to satisfy the world's natural gas demand.

But angst over natural gas supplies overshadowed the fact that almost overnight nearly 32% of the world's helium supplies went offline. Although helium exports were resumed one month later and any significant damage to the consumers was averted, it highlighted the precariousness of the global helium market.

This is of great concern because the shifting supply and demand dynamics of the global helium market can in the near future undermine the resource security of Europe.

Big, brightly coloured balloons and squeaky voices at birthday parties is probably what most people associate helium with. But there is much more than that to this noble gas.

Due to its unique chemical properties, helium is widely used in medicine, welding, cryogenics, high-tech manufacturing and laboratory experiments.

More importantly, the element is very important for the military industry because it is essential for rocketry and the production of advanced military equipment. Unsurprisingly, the United States military accounts for around one fifth of the country's entire helium demand.

Although at current consumption rates there are enough helium supplies in the world to last for over a hundred years, its production is concentrated only in a handful of countries.

The US is by far the largest producer of helium as it accounts for 55% of the world's supply, Qatar and Algeria for 32 and 6%, respectively, and the rest of the world accounts for around 7%.

At the same time, the US is also the world's largest consumer of helium, constituting around 42% of the world's demand, followed by the Europe with around 20%.

However, unlike the US, Europe is almost entirely reliant on imports from abroad. For instance, in 2016, the European Union imported 32% of its helium from the US and Qatar, 21% from Algeria and the remaining 15% from other countries, including the United Arab Emirates and Russia.

While superficially these statistics do not raise any immediate red flags, a more in-depth look suggests that if there won't be any major changes to the current supply and demand dynamics, in the near future, Europe might end up between a rock and a hard place.

<https://www.euractiv.com/section/energy/opinion/how-helium-shortages-might-burst-europes-security/> 23/08/2017

Which could be the meaning of “Europe might end up between a rock and a hard place”?

Which is the unique property of helium making it widely used in medicine, welding, cryogenics, high-tech manufacturing and laboratory experiments?

From all the uses of Helium, which is for you the most important to preserve? (Personal answer)

### 3.1.2 THE HELIUM BOOM IS ABOUT TO TAKE OFF IN 2021

As the second most abundant element in the Universe behind only hydrogen, it's ironic—and somewhat maddening—that helium is also one of the rarest elements on earth. In our atmosphere, helium occupies just 5.2 parts per million (ppm), earning the designation of a 'rare' gas thanks to one of its most treasured qualities—being much lighter than air.

Helium is an inert gas that's so rare on our planet, partly due to the fact that it's 7x lighter than air and can, therefore, readily leak into space and eventually get torn away by solar winds but also because not much is generated by earth's natural processes.

Unfortunately, the vast majority leaks off into space, and whatever little that is trapped comes nowhere close to meeting our global demand of 32,000 tons of helium per year (about 6.2 billion cubic feet measured at 70°F and under earth's normal atmosphere). The vast majority of our helium reserves come from millions of years of gradual accumulation especially in shale formations.

Helium is, therefore, regarded as a finite, non-renewable resource.

This presents a big conundrum as we try to feed our growing helium habit.

Helium's unique properties make it an essential component in cryogenic shielding, leak detection, heat transfer, and analytical and lifting applications. At a melting point of -261.1°C (-429°F), helium has the lowest melting point of any element, meaning there's no substitute for the gas where ultra-low temperatures are required. This makes helium indispensable in the field of superconductors. Helium is also a critical component in the manufacturing process, such as MRIs and semiconductor chip manufacturing.

Explosive growth in the semiconductor and healthcare industries as well as space and quantum computing has been driving global demand in helium.

<https://globalinvestmentdaily.com/the-helium-boom-is-about-to-take-off-in-2021/>

Why does the second article say “Helium is, therefore, regarded as a finite, non-renewable resource”?

Which property makes Helium an essential component?

In which fields is need Helium nowadays?

### 3.1.3 Metz-based 45-8 ENERGY lands €1.3 million to bring helium production to Europe.

Founded in Metz in 2017, 45-8 ENERGY is all about a strategic resource: helium. Helium is a rare and highly sought after resource, due to its physico-chemical properties (lightweight, non-flammable, non-toxic, volatile, poorly soluble, etc.), being environmentally friendly, and non-replicable. “It is respectful of the environment because it does not participate in the greenhouse effect”, adds Camille Sigu, manager at 45-8 Energy .

So far helium is not produced equally across the world, meaning that often it has to be imported at high energy costs. Helium is currently essential for many industries (medical, electronic, aeronautical and space), making its local production crucial. Helium is one of the first 'helium exploration' companies in Europe, and is bringing this resource a lot closer to home.

By [Charlotte Tucker](#) - June 18, 2020

<https://www.eu-startups.com/2020/06/metz-based-45-8-energy-lands-e1-3-million-to-bring-high-demand-helium-production-to-europe/>

Do you think Europe is already prepared to produce our own helium needs?

#### 3.1.4 At the Fourth list of CRMs (Critical Raw Materials)

**At the Fourth list of CRMs (Critical Raw Materials)** - in 2020, the European Commission has published in its [communication on critical raw materials](#)

The 2020 EU list contains 30 materials as compared to 14 materials in 2011, 20 materials in 2014 and 27 materials in 2017. 26 materials stay on the list. Bauxite, lithium, titanium and strontium are added to the list for the first time. Helium remains a concern as far as supply concentration is concerned, but is removed from the 2020 critical list due to a decline in its economic importance. The Commission will continue to monitor helium closely, in view of its relevance for a range of emerging digital applications. It will also monitor nickel closely, in view of developments relating to growth in demand for battery raw materials.

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0474>

Do you think Europe is concerned with scarcity materials? Why?

From the last list of CRMs of European Commission, can we conclude that there are not more problems on helium supply?

#### 3.1.5 Global helium production by country 2020

The United States and Qatar are the largest helium producers worldwide. In 2020, the production of helium in the U.S. stood at approximately 74 million cubic meters, whereas Qatar followed with 45 million cubic meters. Helium is one of the six naturally occurring noble gases. It is an odorless, colorless, tasteless monoatomic gas that presents a very low chemical reactivity. Helium in the U.S. In 2020, global sales of helium produced in the United States amounted to 75 million cubic meters, whereas domestic helium consumption reached 40 million cubic meters. Apart from being the world's main producer and one of the largest helium consumers, the U.S holds the most

extensive helium reserves worldwide. As of 2020, the country's helium reserves stood at 3.9 billion cubic meters, surpassing the reserves of runners-up Algeria and Russia combined. Uses of helium Helium's major application is in the healthcare sector, mostly as a cooling gas in magnetic resonance imaging (MRI) and nuclear magnetic resonance (NMR) spectrometers. It is also widely used in semiconductor and fiber optic cable manufacturing, an application that has seen a steep growth in recent years. As of 2021, a 32-percent share of the global helium consumption was attributable to its use in MRI scanners, while the semiconductor and fiber market was responsible for 18 percent.

Published by [Lucía Fernández](#), Nov 22, 2021

<https://www.statista.com/statistics/925214/helium-production-worldwide-by-country/>

Why is helium used as a cooling gas?

### 3.2 The Click&Collect questions

## **SUBMIT THE ANSWERS INTO AN ATTACHED FILE:**

Which could be the meaning of “Europe might end up between a rock and a hard place”?

Which is the unique property of helium making it widely used in medicine, welding, cryogenics, high-tech manufacturing and laboratory experiments?

From all the uses of Helium, which is for you the most important to preserve? (Personal answer)

Why does the second article say “Helium is, therefore, regarded as a finite, non-renewable resource”?

Which property makes Helium an essential component?

In which fields is need Helium nowadays?

Do you think Europe is already prepared to produce our own helium needs?

Do you think Europe is concerned with scarcity materials? Why?

From the last list of CRMs of European Commission, can we conclude that there are not more problems on helium supply?

Why is helium used as a cooling gas?

## **4. THE LIMITS TO GROWTH**

IS THERE OR IS NOT THERE A LIMIT TO GROWTH?

That could be a good question to treat in philosophy classes:

IF WE DON'T KNOW THE LIMITS OF THE UNIVERSE, HOW CAN WE TALK ABOUT LIMITS TO GROWTH?

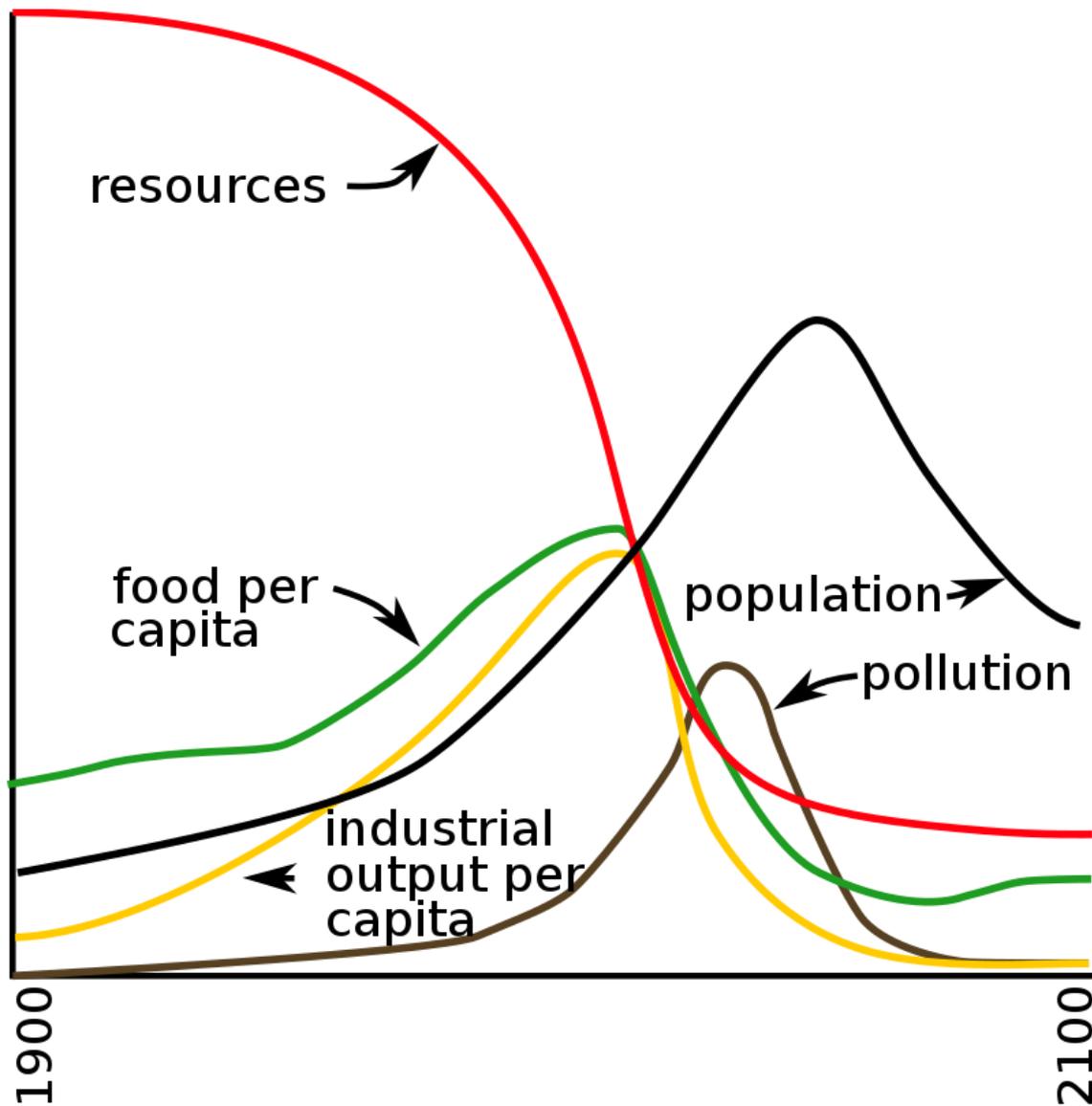
The fact is our planet is finite at the pace we consume its resources.

*The Limits to Growth (LTG)* is a 1972 report<sup>1</sup> on the exponential economic and population growth with a finite supply of resources, studied by computer simulation. The study, done by The Club of Rome, used the World3 computer model to simulate the consequence of interactions between the earth and human systems.

The report concludes that, without substantial changes in resource consumption, "the most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity"

The Limits to Growth - Wikipedia

Compare the estimated values for resources, population, food per capita, pollution and industrial output at 1900 and 2100.



800px-Limits-to-growth-figure-35.svg

YaguraStation ·  
July 2020

CC BY-SA 4.0 ·

File:Limits-to-growth-figure-35.svg ·

Created: 9

The Club of Rome has persisted after *The Limits of Growth* and has generally provided comprehensive updates to the book every five years. Let's read and follow the evolution of these updates.

#### 4.1 COLLAPSE OR NOT COLLAPSE??



### THE LAST UPDATES TO "THE LIMITS TO GROWTH"

In 2015, a calibration of the updated World3-03 model using historical data from 1995 to 2012 to better understand the dynamics of today's economic and resource system was undertaken. The results showed that human society has invested more to abate persistent pollution, to increase food productivity and have a more productive service sector however the broad trends within *Limits to Growth* still held true.

In 2016, a report published by the UK Parliament's 'All-Party Parliamentary Group on Limits to Growth' concluded that "there is unsettling evidence that society is still following the 'standard run' of the original study – in which overshoot leads to an eventual collapse of production and living standards". The report also points out that some issues not fully addressed in the original 1972 report, such as climate change, present additional challenges for human development.

In 2020, an analysis by Gaya Herrington (Sustainability and Dynamic System Analysis Lead at KPMG in the United States but in a personal capacity) was published in Yale's *Journal of Industrial Ecology*. The study assessed whether, given key data known in 2020 about factors important for the "Limits to Growth" report, the original report's conclusions are supported. In particular, the 2020 study examined updated quantitative information about ten factors, namely population, fertility rates, mortality rates, industrial output, food production, services, non-renewable resources, persistent pollution, human welfare, and ecological footprint, and concluded that the "Limits to Growth" prediction is essentially correct in that continued economic growth is unsustainable under a "business as usual" model. The study found that current empirical data is broadly consistent with the 1972 projections, and that if major changes to the consumption of resources are not undertaken, economic growth will peak and then rapidly decline by around 2040.

[https://en.wikipedia.org/wiki/The\\_Limits\\_to\\_Growth](https://en.wikipedia.org/wiki/The_Limits_to_Growth)

[https://simple.wikipedia.org/wiki/2052\\_-\\_A\\_Global\\_Forecast\\_for\\_the\\_Next\\_Forty\\_Years](https://simple.wikipedia.org/wiki/2052_-_A_Global_Forecast_for_the_Next_Forty_Years)

IN THIS FORUM YOU SHOULD POST YOUR OWN INDIVIDUAL THINKINGS/IDEAS REGARDING:

What is The Club of Roma?

What is the World3 model?

What does the word "OVERSHOOT" mean?

The last update in 2020, of "The limits to growth", forecasts that economic growth will peak and then rapidly decline by around 2040. How old you will be by then and what will you do in order to protect yourself of a possible COLLAPSE?