



Titanium prospects

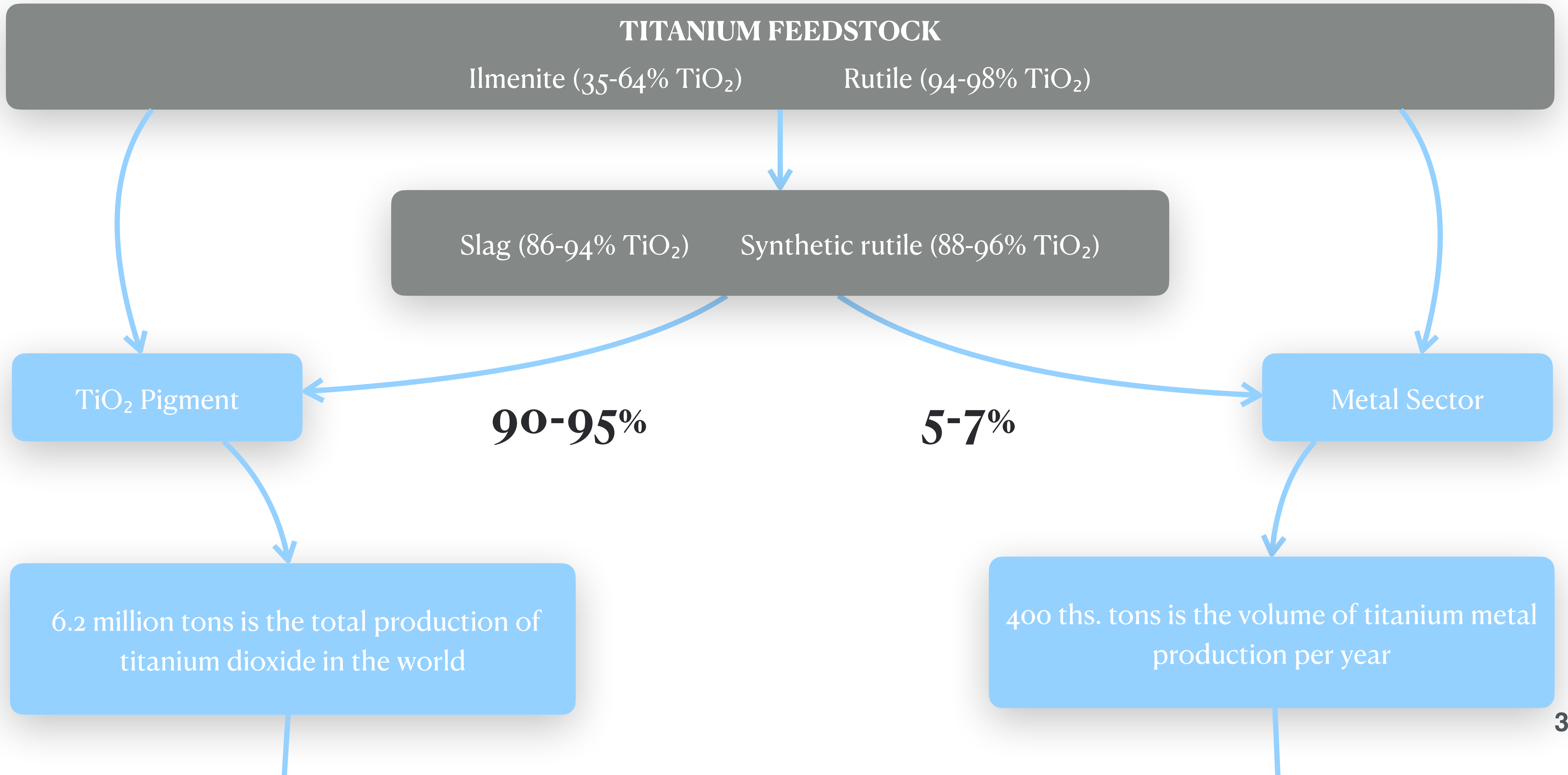
Prepared by Eastern Europe Security Institute in cooperation with the Foundation for Defense of Democracies



Titanium in figures

- 0.6% Titanium is present in the Earth's
- 4th most common construction metal after aluminum, iron and magnesium
- 784 from 801 types of igneous rocks analyzed by the United States Geological Survey (USGS) contained titanium.
- The most important mineral sources are ilmenite (FeTiO_3) and rutile (TiO_2)

Industrial upstream



TiO₂ Pigment

\$20.9 billion is the size of the global titanium dioxide market in 2021 and is projected to reach \$27.9 billion by 2026 at an annual average growth of 5.9%

Paints, plastics, paper,
inks, ceramics

MAIN PLAYERS
Chemours, Venator, Tronox, Kronos

Metal Sector

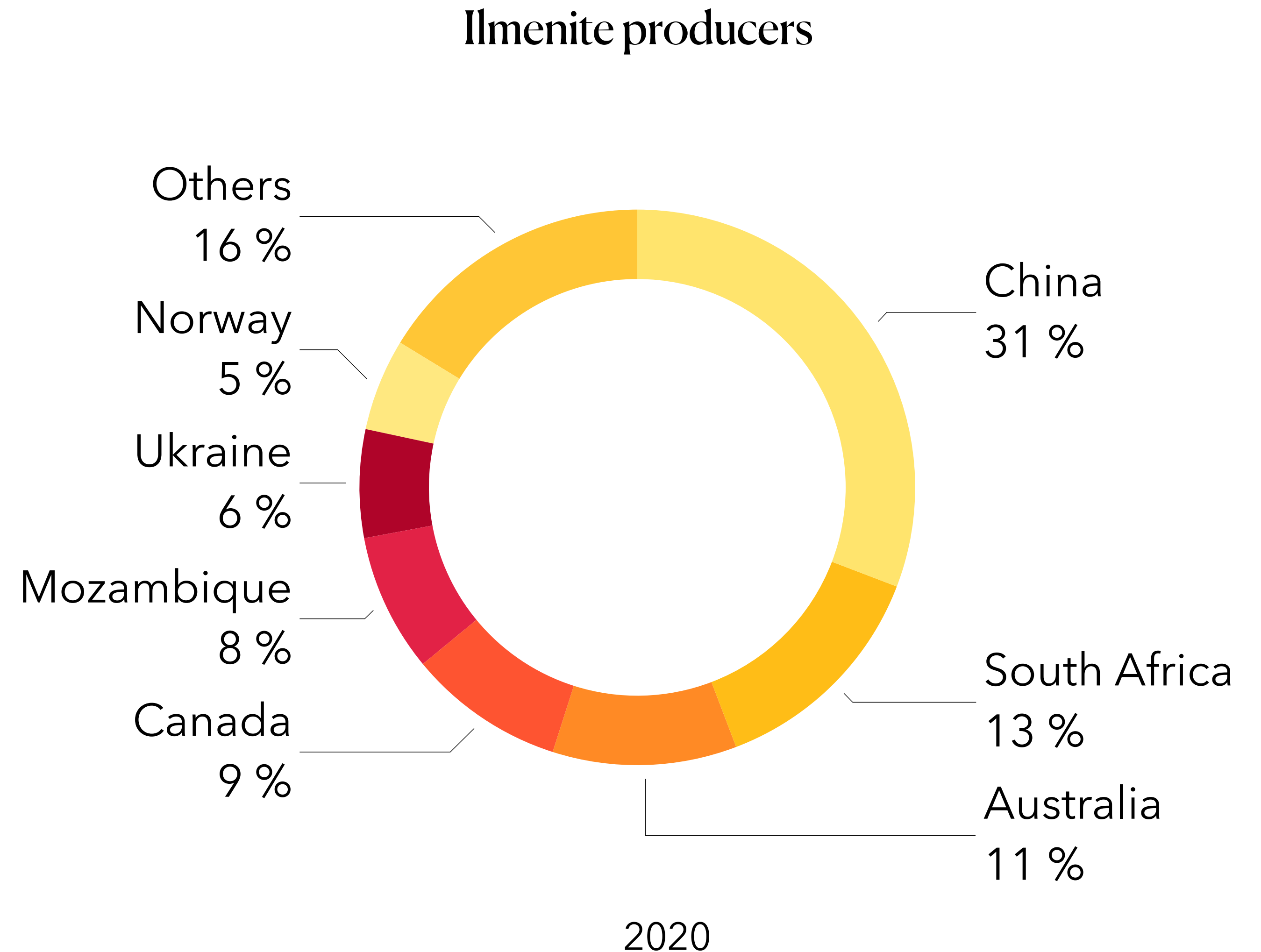
The global titanium market is forecast to grow from \$24.7 billion in 2021 to \$33.5 billion by 2026 at an annual average growth of 6.3%

Aerospace, military industry, welding,
electrodes, fluxes

MAIN PLAYERS
VSMPO Avisma, Osaka Titanium,
Toho Titanium, Timet, ATI, ZTMC

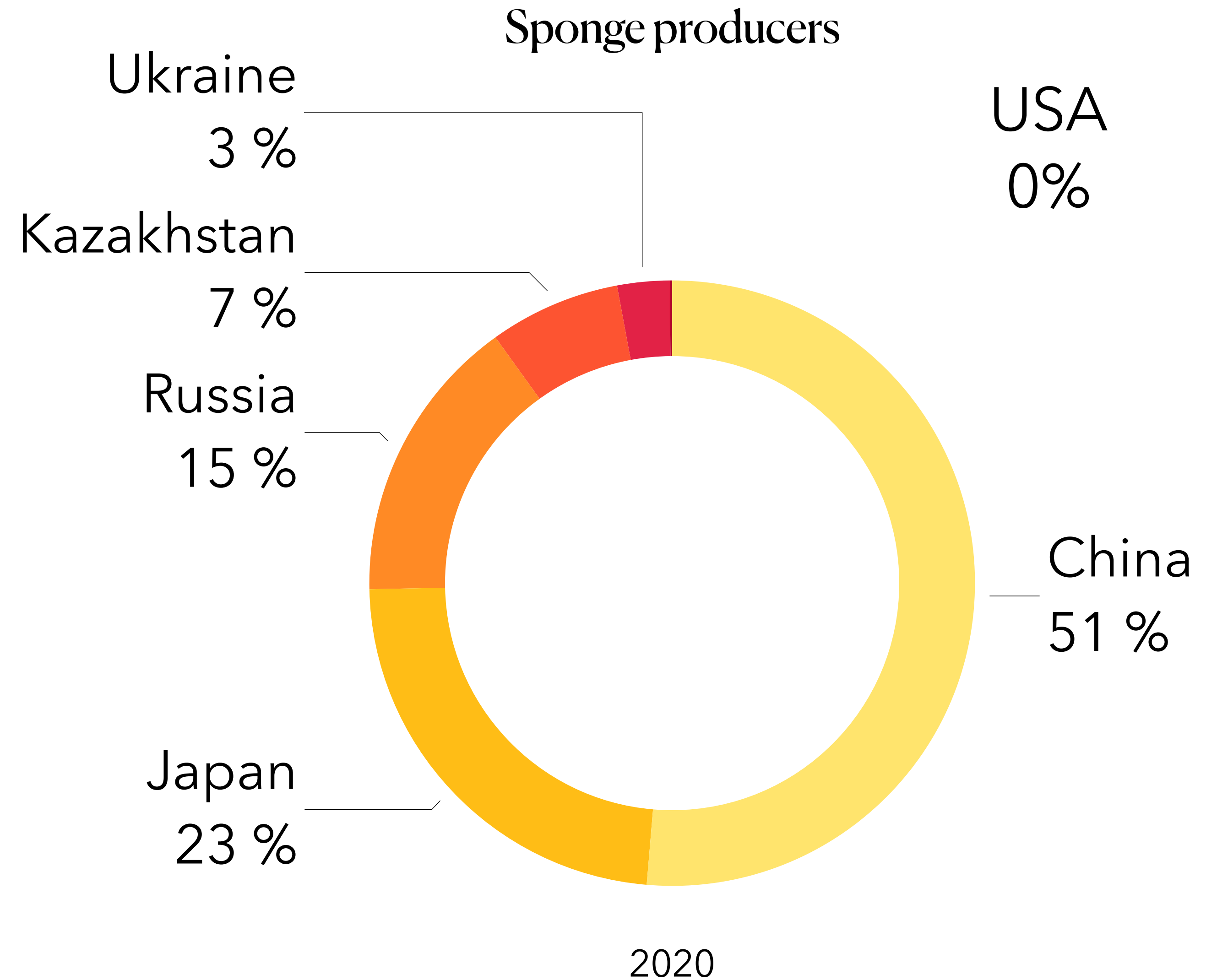
Titanium feedstock

- **\$24.7 billion** is the estimated volume of the world titanium products
- **\$33.5 billion** market growth by 2026 with an average annual growth rate of **6.3%**
- **7.465 million tons** of ilmenite and **478 ths. tons** of rutile were mined in the world in 2020.
- **700 million tons** of ilmenite, **46 million tons** of rutile are available resources of titanium minerals by country



Titanium sponge & metal

- **The 1st world's largest producer** of metal titanium is China. Its production has increased **22 times since 2000**. Over the same period, the US capacities dropped to zero.
- **The 2nd largest producer** is Japan - the main supplier of metal titanium to the US.
- **The 3rd largest producer** is Russia. But China and Russia could turn over the global supply chain by thwarting Japan's position. As tensions between the USA, China and Russia are rising, the probability that this will happen is becoming more and more likely.



China's critical materials

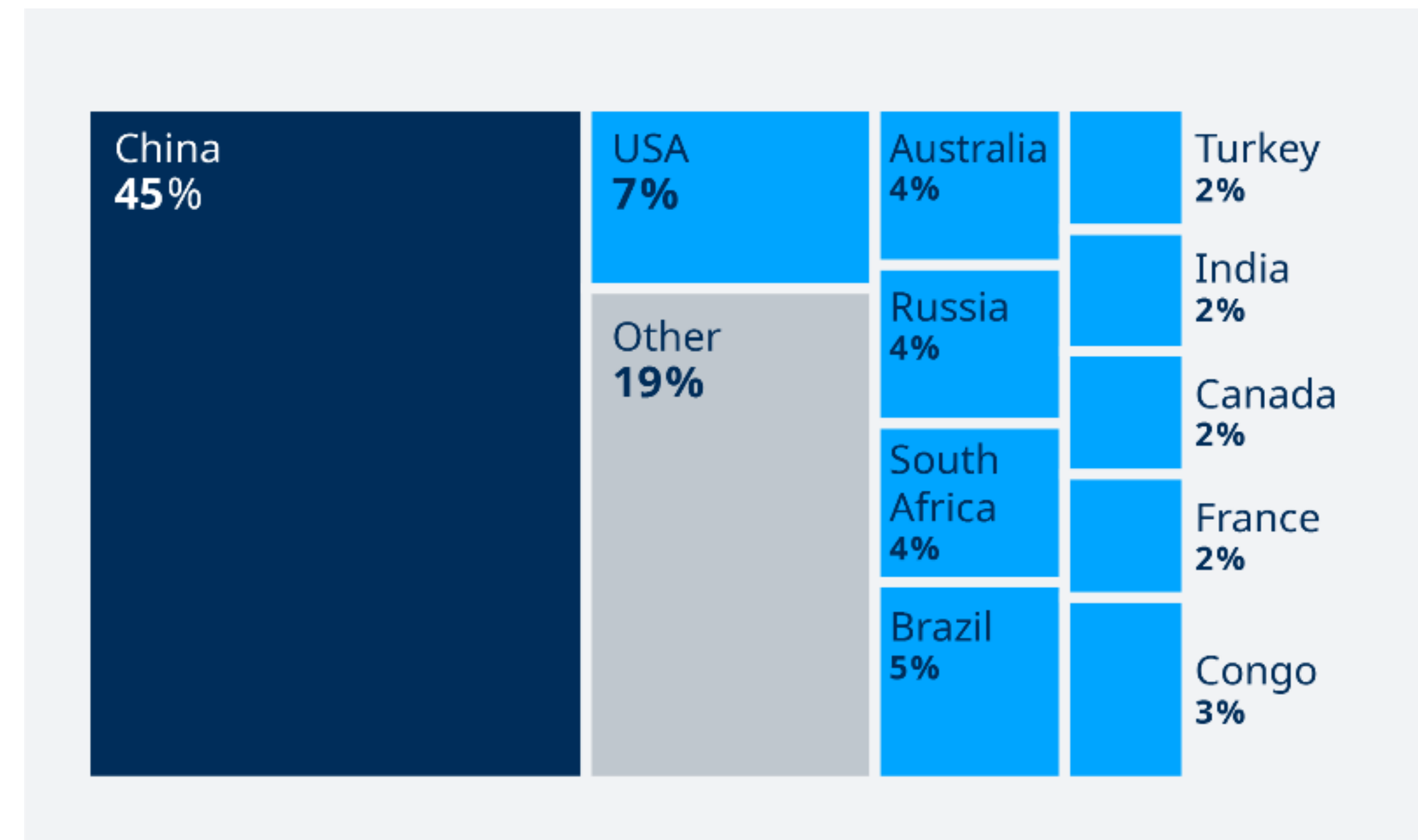
China's import of rare earths

98%
EU

80%
USA

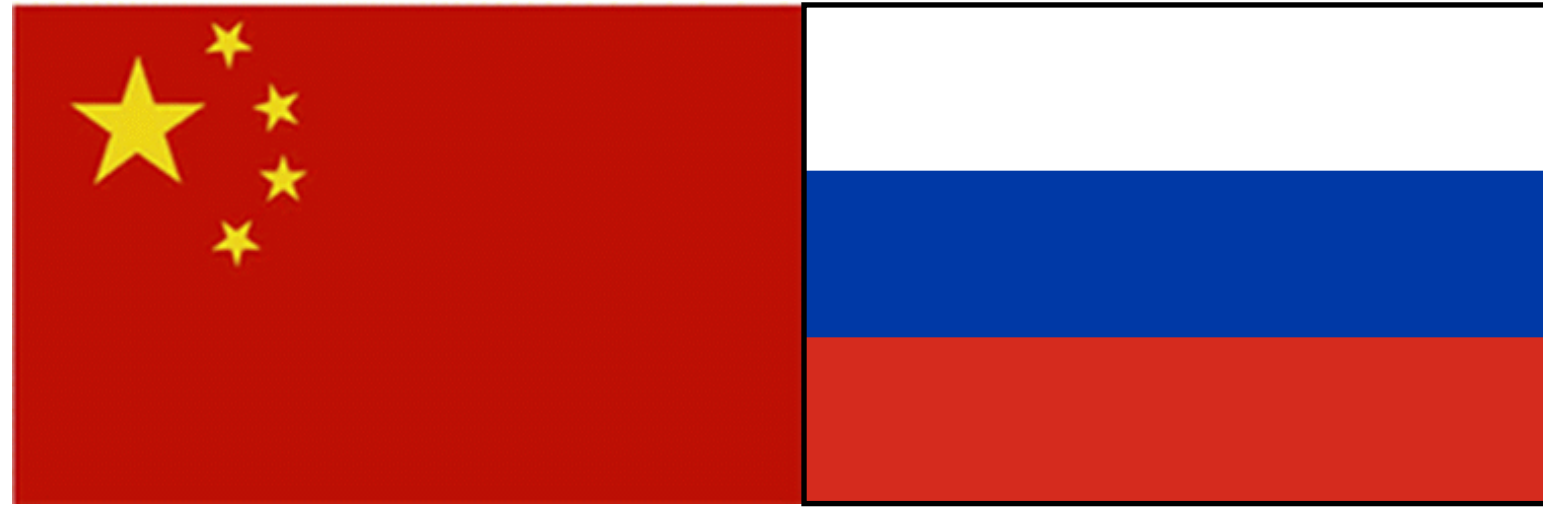
China is one of the three largest suppliers of many elements, well ahead of the United States and Russia. This dominance is partly due to the presence of deposits in China itself, but it is also due to deliberate planning.

China dominates the critical raw materials market

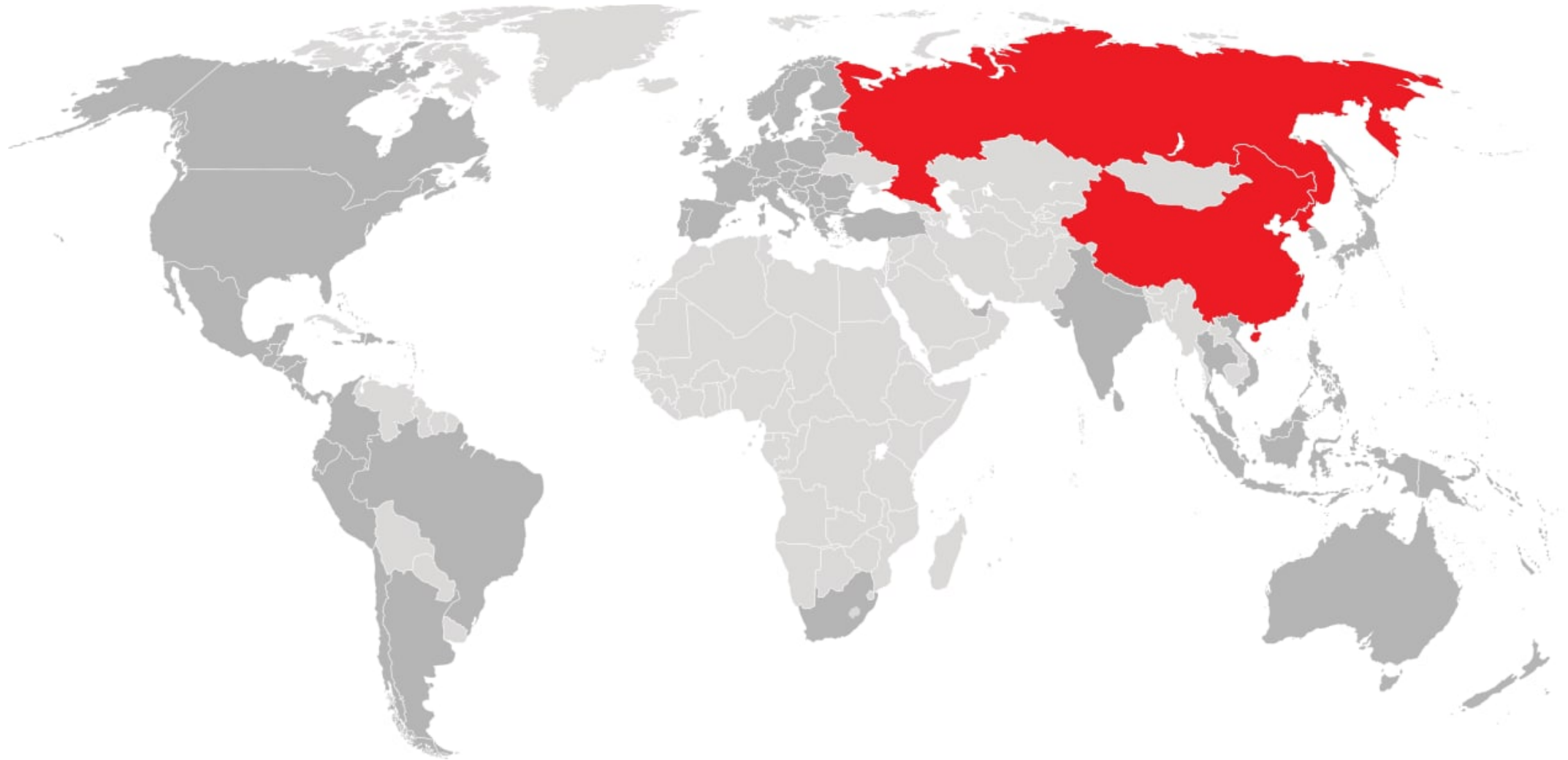


Supplier's market share of critical materials

Ti Geopolitical game



China and Russia dominate in:

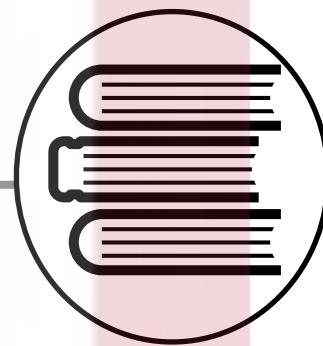


- **resources**
- **mining volumes**
- **production of titanium dioxide**
- **supplies of metal titanium to the American and European markets**

The USA actions

on Dec. 20, 2017

President Trump issued *Executive Order 13817* (EO 13817) *Federal Strategy for the Safe and Reliable Supply of Critical Minerals* defining steps to reduce national import dependency, leadership maintenance in technological innovations, job creation support, and national security and trade balance enhancement.



on November 29, 2019

President the U.S. Department of Commerce, Bureau of Industry and Security, carried out an investigation about **Titanium Sponge Imports Impact on the National Security: an investigation carried out according to Section 232 of the Trade Expansion Act of 1962 with amendments** followed by publication in July 2021 implying:



on May 18, 2018

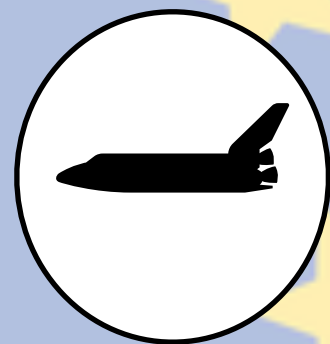
The US Ministry of the Interior published the *"Final List of Critical Minerals"* (83 Fed. Reg. 23295) consisting of *35 items*, including *titanium*.

- The US imports **68% of titanium sponge** to meet domestic demand (mostly coming from Japan and smaller - from Kazakhstan and Ukraine)
- The report notes "growing capacities" for titanium sponge production in China: between 2004 and 2018, **China's titanium sponge production capacity increased by approximately 1050%**.
- Titanium sponge is essential for **the production and maintenance of the USA defense systems**.
- Congress implicitly recognized that **titanium sponge was critical to national security** by including titanium as a strategic material in the clause about the special metals (10 U.S.C. §2533b).
- Titanium sponge is also vital to critical infrastructure and **supports 15 of 16 critical infrastructure sectors** identified by the Department of Homeland Security.

The European Commission

on September 3, 2020

European Union Critical Minerals List Investigation, consisting of 30 items, including titanium, implying:



- Titanium is a **critical material** in the following **areas**:

○ production of lithium-ion batteries,

○ fuel cells,

○ robotics and drones,

○ as well as in additive manufacturing and electrical engineering

- Thus it covers **the main 3 sectors of the EU** - renewable energy, latest technologies, aerospace and defense.

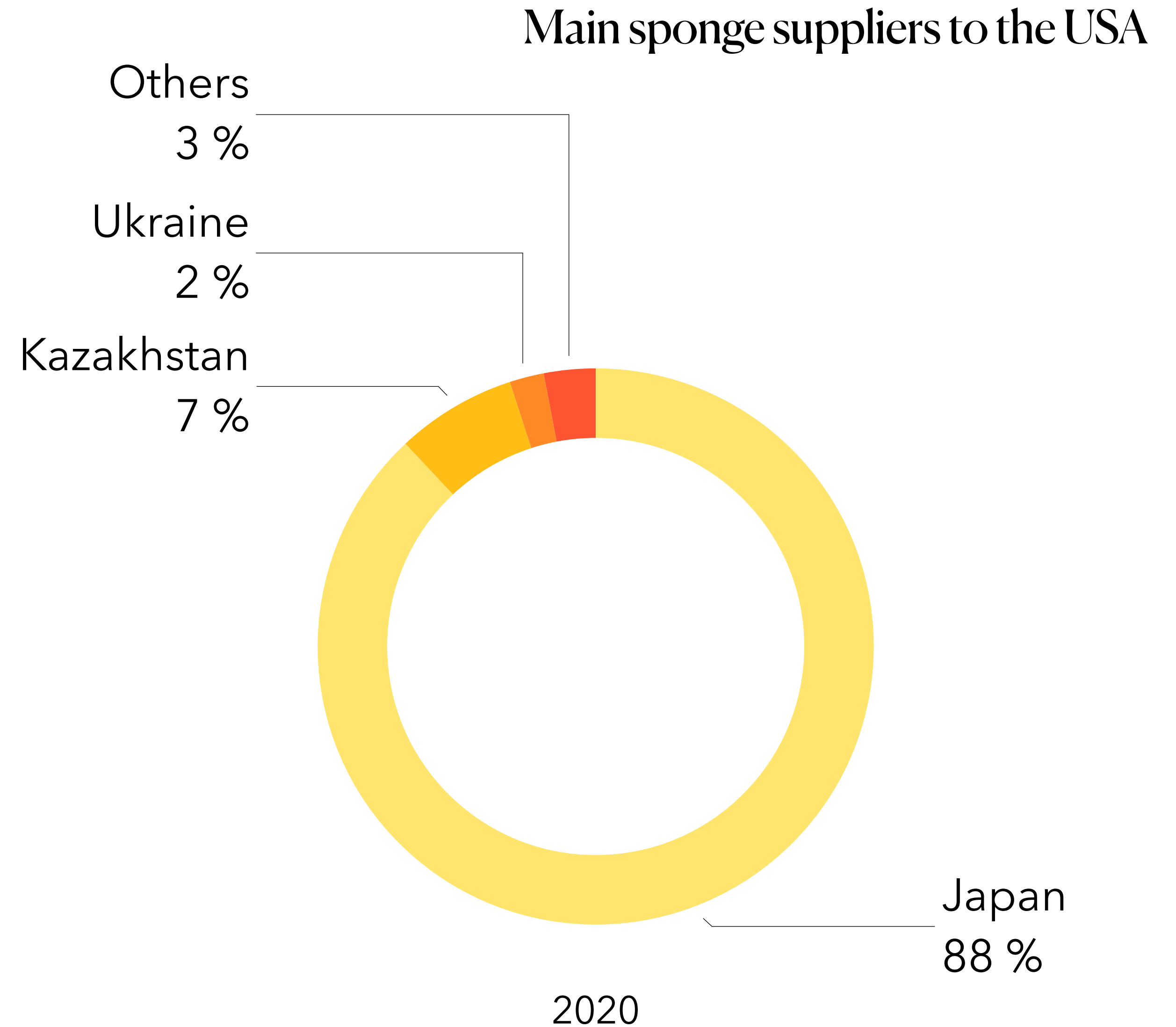
- **Demand** for titanium is confirmed for more than **10 years ahead**, while confirmation of **supply** exists **not more than 5 years**.

- Titanium has a **very high economic importance factor** for the EU among all critical elements, which is growing every year.

- The main definition of titanium as a critical material is also a **very low number of suppliers** of metal stage products (processing stage - titanium sponge)

The USA titanium sponge consumption

- **15 of 16** critical infrastructure sectors are supported by titanium sponge as identified by the US Department of Homeland Security
- **69%** of the USA consumed titanium sponge are imported
- **35 ths. tons** is the amount of consumed titanium sponge in 2020 with **24 ths. tons (\$206 million)** imported
- **6 ths. tons** were the US design capacity till the titanium sponge production has been stopped since the end of **2020**. Respectively, the significant increase in imports of titanium sponge in **2021** and subsequent years can be expected



The USA titanium sponge consumption

Titanium sponge is essential for the production and maintenance of the US defense systems

Titanium is used in many military components



Aircraft cases

Jet and helicopter engines

Ships

Ground equipment

Satellites

Submarines

VSMPO-AVISMA

- **4.72 ths. tons** per year - billets export of Russia (VSMPO-AVISMA) to the USA
- The holding is controlled by the team of Colonel-General **Sergei Chemezov** (close to Vladimir Putin), General Director of the State Corporation ROSTECH (Russian Technologies), a member of the supreme council of the “United Russia” party
- **100 % dependence** of the Russian titanium sector on imports of titanium feedstock with 83% of it is of Ukrainian origin

Titanium billets - the role of Russia

Weapons:

- 4th and 5th generation fighters
- Strategic airlift
- Helicopters
- Different types of missiles
- Different types of submarines

Also in multiple launch rocket systems, armor and nodal components of various armored wheeled and tracked vehicles

Aerospace

Before the crisis, VSMPO-Avisma covered:

- **up to 35% of all Boeing titanium needs**
- **65% of Airbus Group's demand**
- **100% - Embraer titanium needs**

The global titanium market as well as the USA market are **highly vulnerable due to such players as China and Russia.** And they will only continue their aggressive geopolitical game.

50%

25%

China

holds World
Titanium Sponge
Production

Russia

holds World
Titanium
Market

What are the prospects?

Negative scenario for the USA

As the result:

- China will **monopolize** the market of raw materials, production of titanium pigment and sponge
- Russia will **monopolize** the finished products market for aerospace
- **Control** over titanium ore **deposits** in Africa and Europe (including Ukraine)
- The supply of products at the market **can be limited** by creating shortages and the risk of uncontrolled price increases
- Titanium becomes the **instrument in the geopolitical struggle with the USA**



What are the prospects?

Optimal scenario for the USA

Effective use of the available resources and opportunities will decrease the market share of China and Russia and increase own share:

- **100% provision** of the necessary resources for the **next 15-20 years**. Monitor the existing resource base in the world (including available deposits that can be absorbed)
- **Concentrate** the controlled production of titanium products for the American industry. **Provide** support to the USA companies regarding absorption of commodity companies and production assets. **Monitor** titanium sponge & powder manufacturing companies that can be absorbed or controlled
- **Control over modern technologies**, increasing the technological gap between the US and Russia. Monitor new technologies of titanium production, project development stages, assess the potential. Support the USA companies in gaining control over technologies and their use for the benefit of the US economy and security.

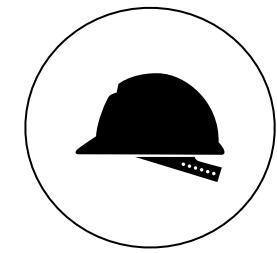
These steps will help to **reduce** dependence on uncontrolled imports **more than twice**

New technology status:

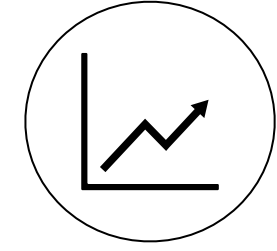
- The new technology of titanium production from ilmenite is being developed in Ukraine, the USA and South Korea;
- It reduces the final product and have zero waste and emissions;
- The construction of a pilot production has already begun in Ukraine;
- Ukranian technology transfer to the US can prevent industrial espionage by Russia or China.

Technology is solution

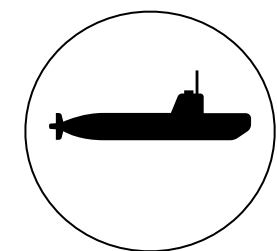
US benefits:



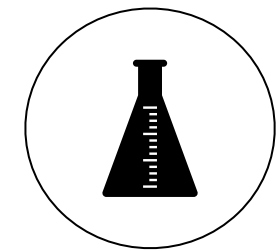
Controlled deposits of titanium feedstock and their exploitation will secure the market



Cover the needs of the US market in metal titanium



Zero risks of metal titanium shortage for the military and the aerospace industries



Tech advantage that limits China and Russia access to the new technologies



Market advantage over Russia and China in the global titanium metal market due to the use of cheaper and controlled technology

Ukraine

- 26 deposits of titanium have been explored, and another 48 deposits are out of balance
- The proven reserves of titanium feedstock in Ukraine at current production volumes will meet the needs for 199 years, and the explored reserves - for 430 years
- The annual production of titanium concentrate in Ukraine is about 700 ths. tons. About 80% of it is exported (540 ths. tons in 2020 in the amount of \$138 million, including 100 ths. tons in the USA)

Ukraine

UMCC-Titanium

Owner: government

Assets: Vilnohirsk Mining and Metallurgical Plant (VMMP) and Irshansk Mining and Processing Plant (IMPP)

Reserves:
ilmenite - 4.4 mln tons
rutile - 0.27 mln tons
zircon - 0.14 mln tons

Velta LLC

Owner: private company controlled by Ukrainian businessman Andriy Brodsky

Assets: Birzulivske MPP - 220 ths. tons of ilmenite per year. Likarivske mine - under development. Currently, the technology has 2 patents in Ukraine and 3 patent applications in the USA, the examination of the technology by the Zaporizhian Titanium Institute is being completed and the first industrial line is being built.

Group DF

Owner: Dmitry Firtash, an Ukrainian oligarch

Assets: Mezhdurechensky MPP - **110** ths. tons of ilmenite per year

Motronovsky MPP - planned capacity of ilmenite - **120** ths. tons, zircon - **14** ths. tons, rutile - **20** ths. tons

Demurinsky MPP

Controlled: PJSC VSMPO-AVISMA Corporation

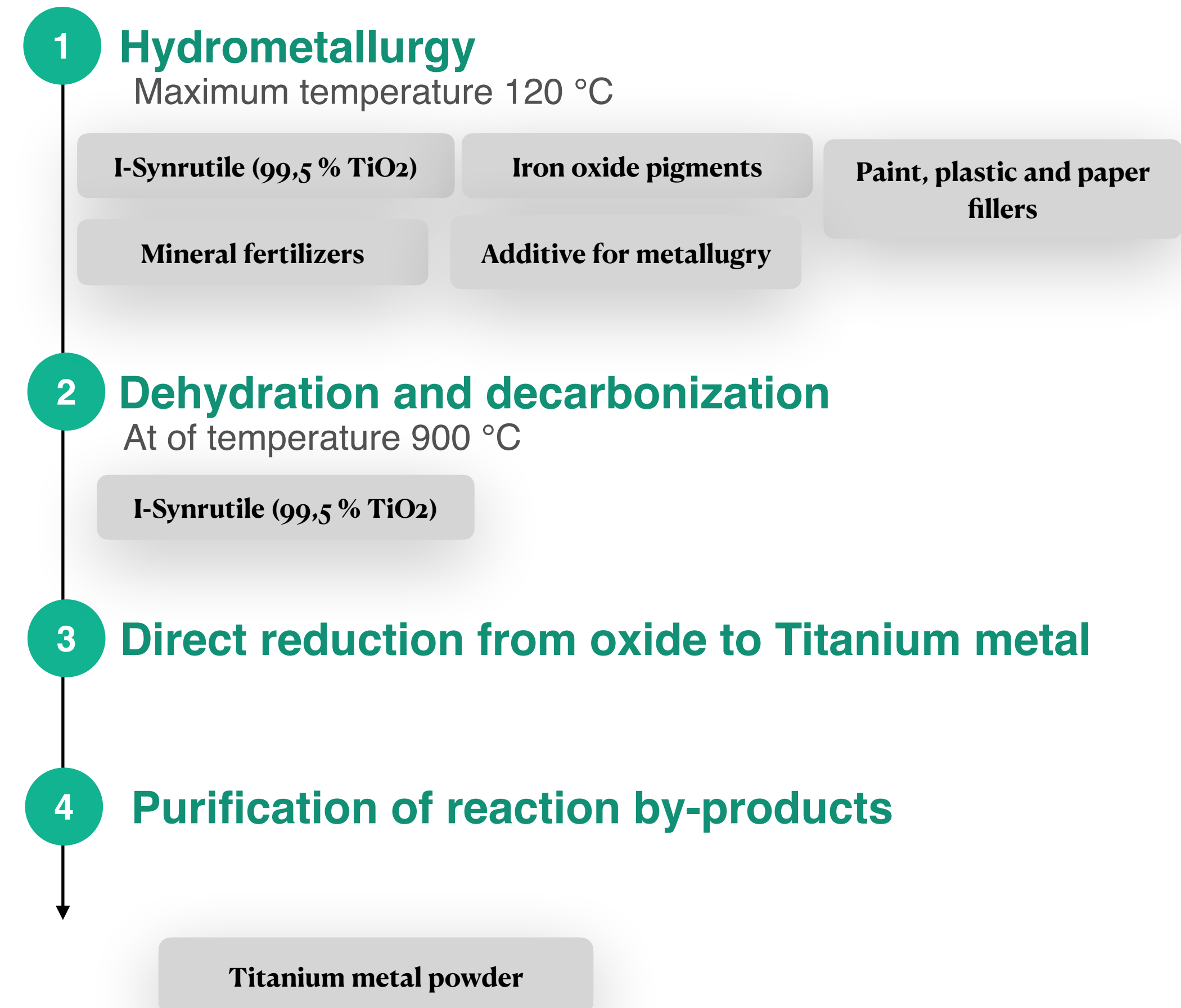
Demurinsky MPP - **15** ths. tons of ilmenite per year.

Technology is solution

- Full range of titanium alloys
- Reduce carbon footprint
- High value-added by-products
- No solid or liquid waste
- Air emission limitation
- No Cl_2

Velta TiProcess

Ilmenite (56% TiO_2)





Feedstock

Ukraine's titanium potential

- The current Ukrainian capacity is not enough to cover the US needs.
- Investments are required to develop new deposits and capacities - increased production by at least 1.5 times.
- Min \$60 million of investment is required for a mining and processing plant with a capacity of 100 ths. tons of concentrate per year
- Min 700 ths. tons mined are required to fully satisfy the USA titanium imports with Ukrainian feedstock
- \$150 million is the preliminary cost of the purchase of a company producing titanium concentrate with a capacity of 200 ths. tons per year
- Min \$400 million investment (not counting the cost of purchasing licenses) is required to develop new deposits with the capacity of more than 500 ths. tons per year

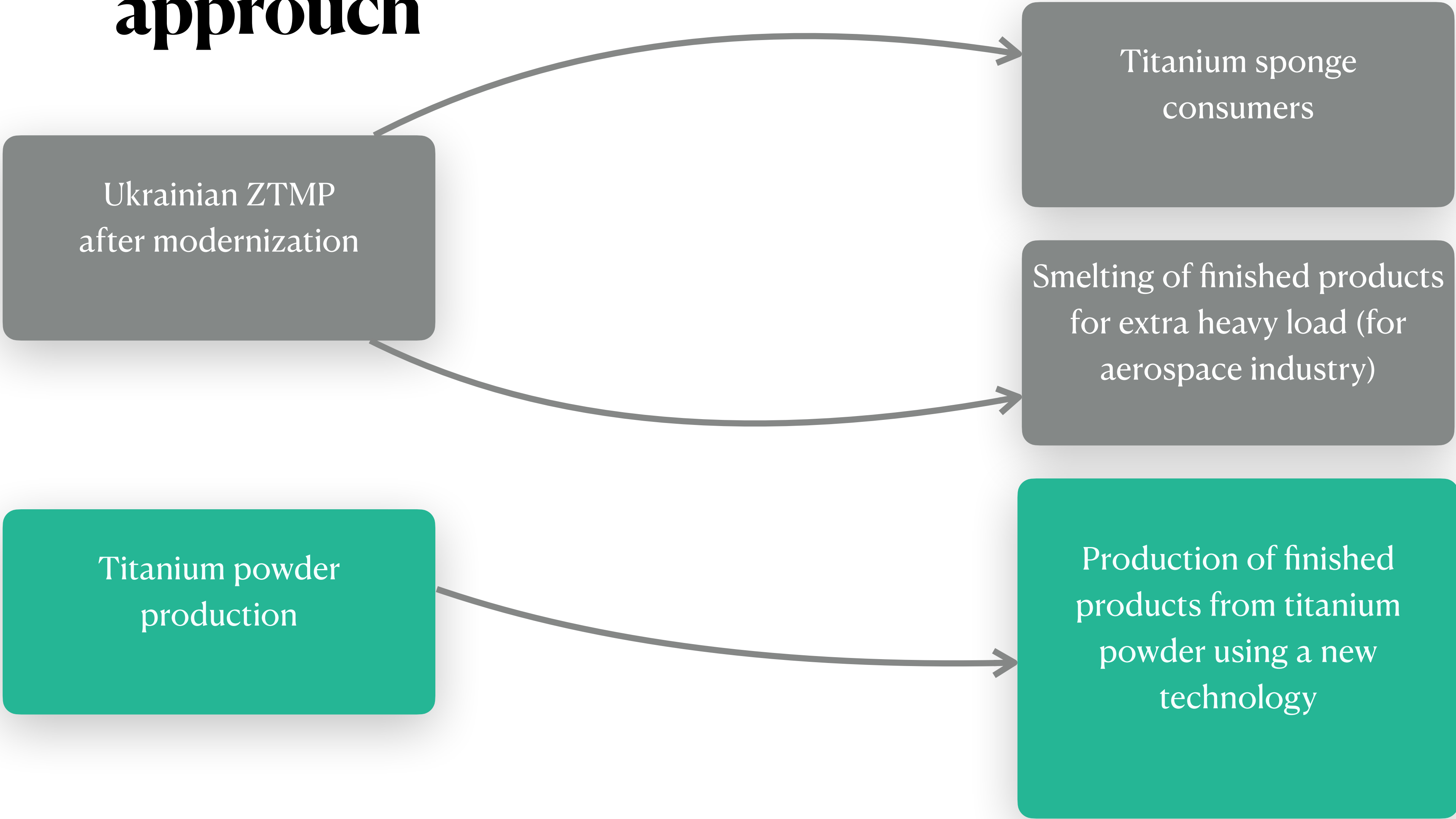


Titanium sponge

Ukraine's titanium potential

- Ukrainian ZTMP (Zaporizhian Titanium and Magnesium Plant) is the only manufacturer of titanium sponge in Europe.
- 20 ths. tons of titanium sponge per year - the design capacity of the plant and it is not enough to cover the USA titanium sponge demand
- 24 ths. tons is the US annual import amount
- Min 2-2.5 times capacity increase (taking into account the internal needs of Ukraine) can be achieved by the modernization of existing and development of new capacities

Classic and innovative approach



How Ukraine can replace Russia and China in the titanium supply chain?

Ukraine as an alternative source of titanium feedstock for the US - the following steps are necessary:

Step 1

to ensure the control over deposits (to participate in the privatization of existing state-owned companies (UMCC), invest in existing private companies and establish new companies to develop new deposits)

Step 2

to ensure, together with the government of Ukraine, the eradication of access of Russian and Chinese companies or companies affiliated with them to deposits and companies involved in the further processing of titanium

Step 3

to develop and implement the best option for Ukrainian-American cooperation (to develop a Roadmap for such cooperation with the participation of the interested American and Ukrainian companies - fix its key points in the Memorandum between the governments of the United States and Ukraine)

How Ukraine can replace Russia and China in the titanium supply chain?

Priority areas of cooperation

Section 1

mining of feedstock

Section 2

technological cycle of production of articles from chemical titanium

Section 3

technological cycle for the production of articles from metal titanium, which, in turn, is divided into:

- production of high-strength products from sponge produced according to the Kroll method
- production of high-quality titanium powder and products from it using new innovative technology

up to \$1.15 billion - the investment required to fully cover the US needs in titanium feedstock, sponge and products

The war in Ukraine - consequences

1. The following important enterprises were stopped for various reasons:
 - the Zaporozhye Titanium and Magnesium Combine
 - the Volnogosky GOK
 - the Demurinsky GOK
3. Nationalization of all Russian assets: a political decision has been made, specific decisions are being prepared on the nationalization of Demurinsky GOK, VSMPO TITAN UKRAINE LLC, and possibly enterprises that belong to the D. Firtash group.
4. Any industrial facilities on the territory of Ukraine are at the risk of being destroyed by Russian missile attack.

To minimize the risks

- The US government should help the government of Ukraine skillfully nationalize facilities that belong to Russian structures and oligarchs, and then can offer President Zelensky to buy out all the titanium assets owned by the state of Ukraine
- normal private Ukrainian companies operating in this area may be allowed to enter their capital. In particular, Velta LLC mentioned earlier and small private enterprises: SPC "Titan", LLC "Antares" and LLC "Fiko". This may be additional protection for resources and assets
- missile defense systems can be placed near the objects that will be US-owned or in its sphere of influence to protect them from Russian missiles
- the creation of a new high-tech production of titanium products based on the technology of direct processing of raw materials into titanium by a chemical method can and should be implemented in the United States, as well as the creation of an engineering center to improve this technology.



A possible current solution:

A government program to encourage the substitution of titanium raw materials and titanium products of Russian and Chinese origin by a significant increase in supplies from Ukraine, including the acquisition of Ukrainian enterprises and the construction of new production capabilities in cooperation with Ukrainian companies.