

# Niobium as a strategic metal for Brazil

Carlos C. Peiter

Centro de Tecnologia Mineral-CETEM

Brazil



RESOURCE MANAGEMENT WEEK 2021

ENABLING SUSTAINABILITY PRINCIPLES IN RESOURCE MANAGEMENT



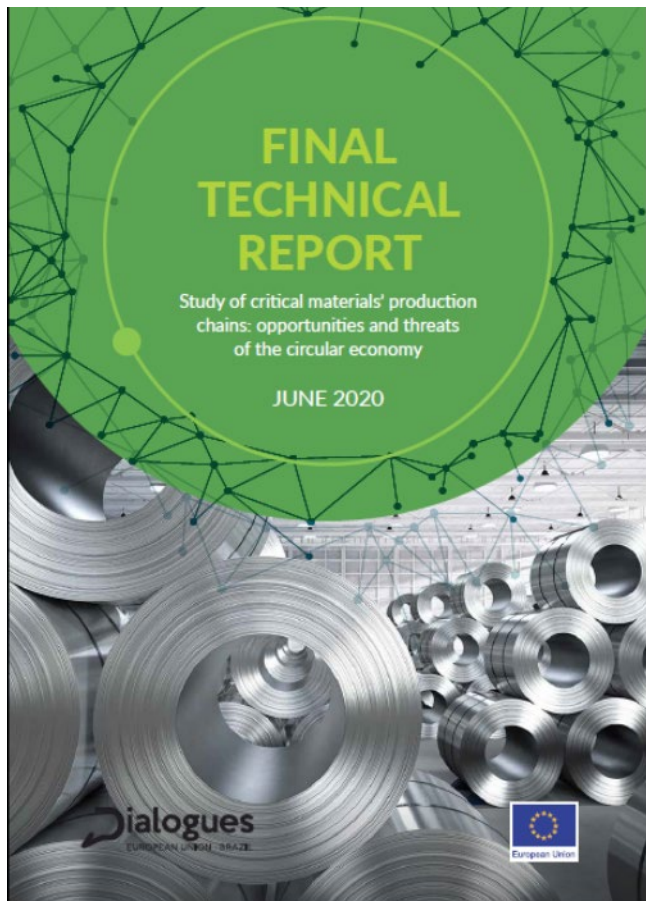
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# Recent report to EU Brazil Sectoral Dialogues Program

## Study on critical materials production chains: opportunities and threats of the circular economy



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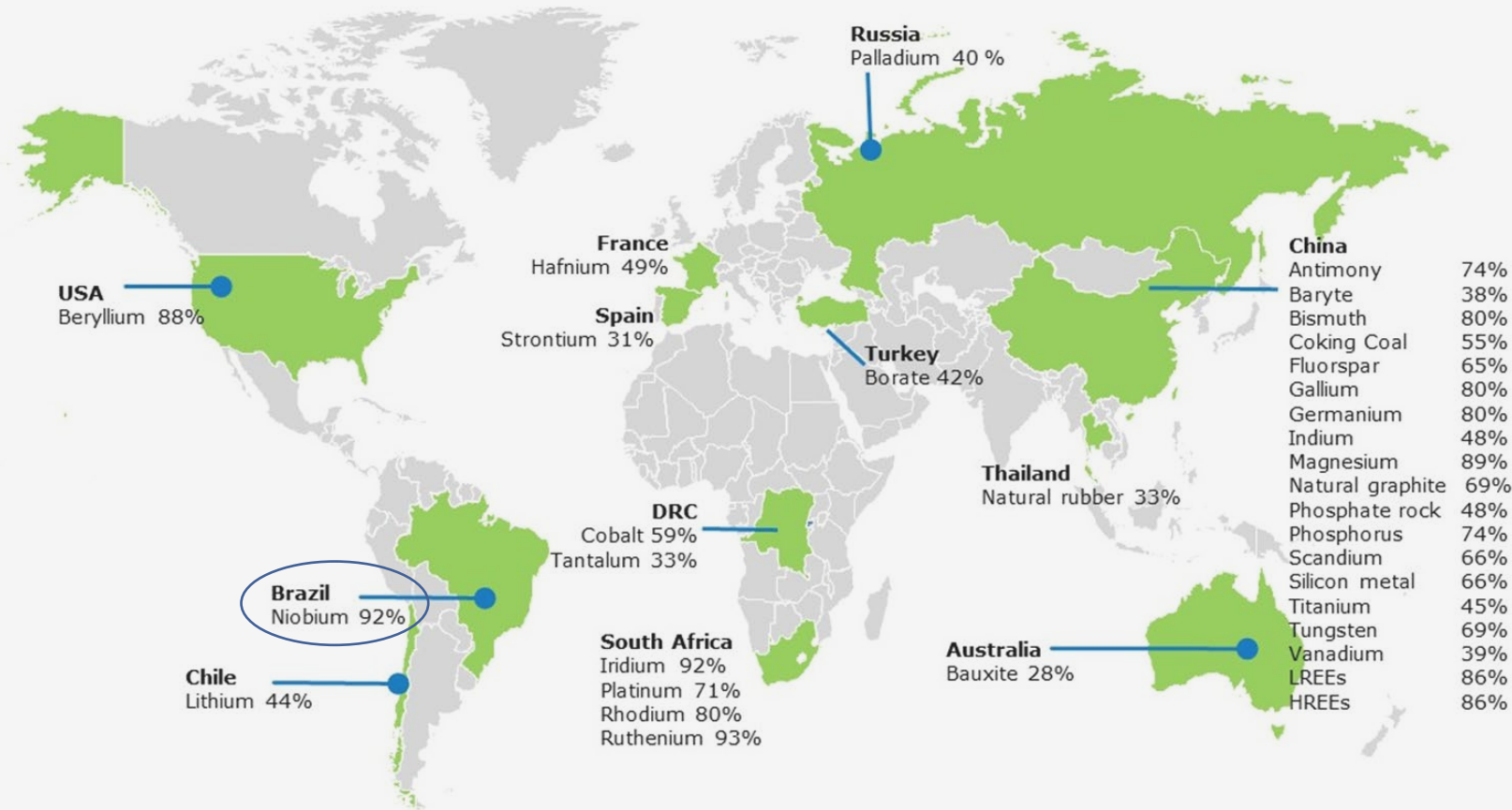


### Partnerships:

- Brazilian research institutions CETEM, IBICT, EESC-USP
- European research/academic institutions: JRC/EC (Ispra, IT) and INAB/ Aachen University (GER)
- Brazilian Company CBMM (cooperation agreement) and Ministry for S, T & I Brazil (additional funds)
- <http://sectordialogues.org/projetos/estudo-das-cadeias-produtivas-dos-materiais-criticos-oportunidades-e-ameacas-da-economia-circular>

# Critical raw materials origin or market leadership

## EU's critical raw materials list 2020

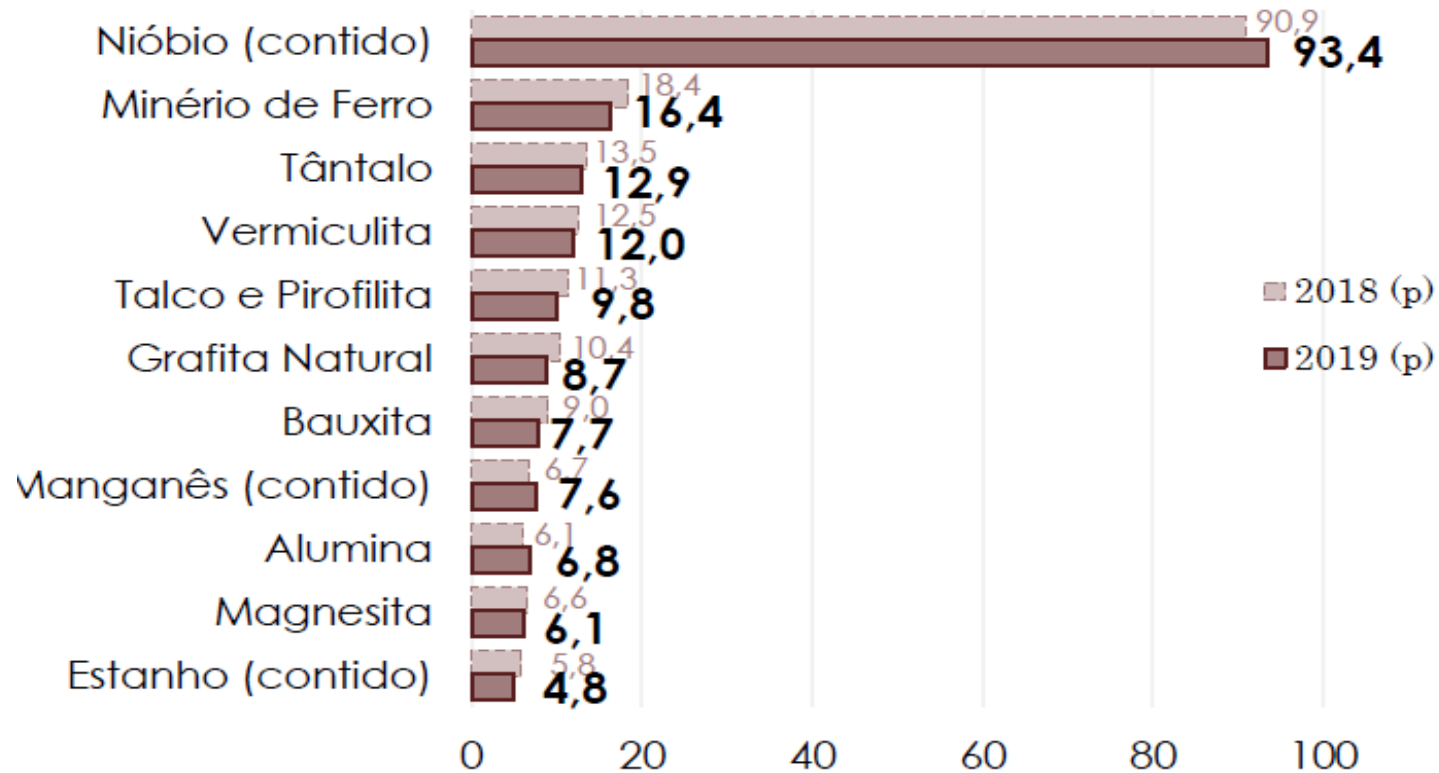


Source: Study on EU's list of critical raw materials 2020, JRC/EC

# Brazilian share in some ores/metals world production



## Brazilian share in world 10 important ores or metals production



Source: Boletim do setor mineral 2020, MME; Brazil



# Why is Niobium important ?

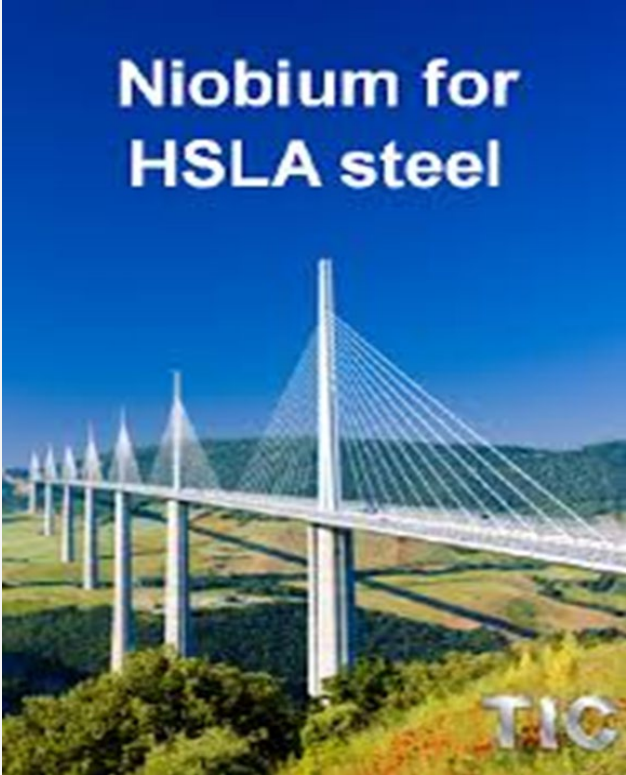
Steels for pipelines, structural steels, superalloys , superconductors



Steel for pipelines



Superalloys



Photos available at internet sites



Superconductors (e.g. CERN Particle accelerator Large Hadron Collider , 27 Km long)

# Why is Niobium important ?



Under development Nb/ Ti oxides anodes for lithium ion batteries

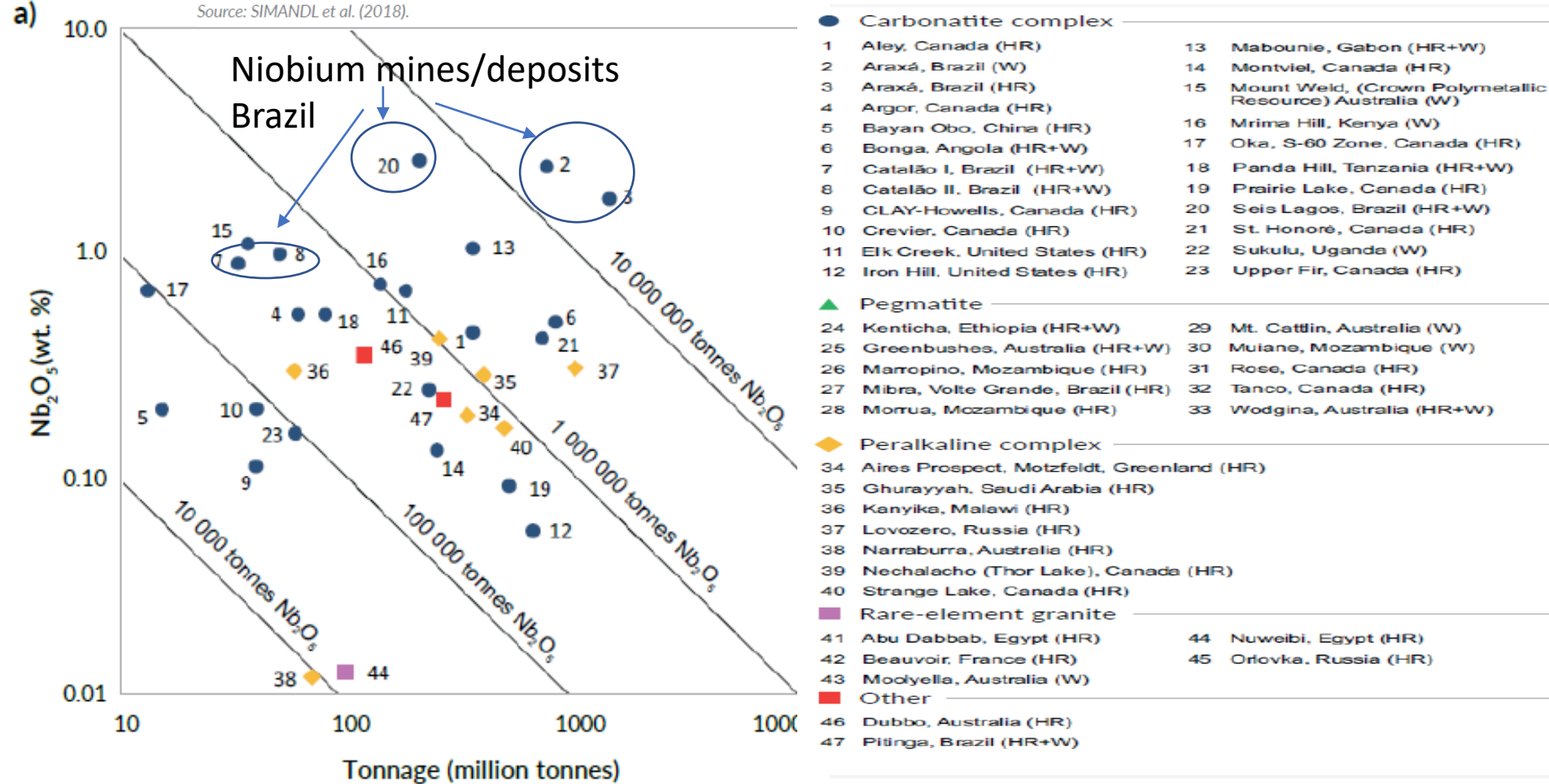
# Is Niobium a rare metal ?

48 Nb minerals mines/deposits/occurrences in all continents but strategic for Brazil that operates the higher Nb content mines



Figure 9. Mines, deposits and niobium minerals occurrences throughout the world.

Source: SIMANDL et al. (2018).



# Main niobium producing companies



Table 9. Major companies producing niobium in the world (semi-manufactured).

|   |  |
|---|--|
| <br>Companhia Brasileira de Metalurgia e Mineração | Ferroniobium<br>Vacuum Grade FeNb and NiNb<br>Oxides: high purity, optical grade, niobic acid (HY-340) and ammonium niobium oxalate (ANO)<br>Niobium metal: reactor-grade, commercial-grade, RRR superconductor grade, and niobium zirconium |
| <br>NIOBRAS  | Ferroniobium   |
| <br>UNE COMPAGNE DE MAGRIS RESOURCES               | Ferroniobium   |
|    | Ferrotantalum & Ferroniobium   |

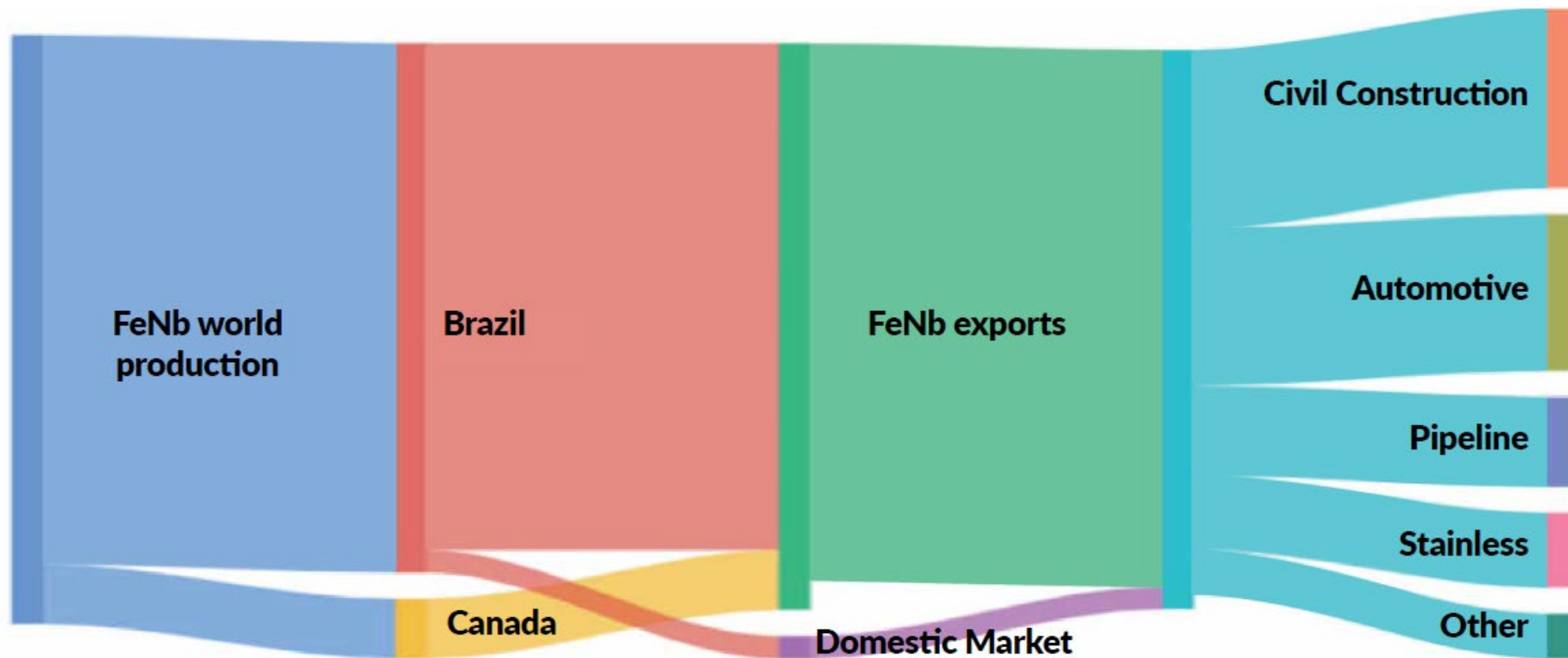
Source: Elaborated in-house.

Source: Study of critical materials' production chains: opportunities and threats of the circular economy



# Niobium a strategic metal for Brazil

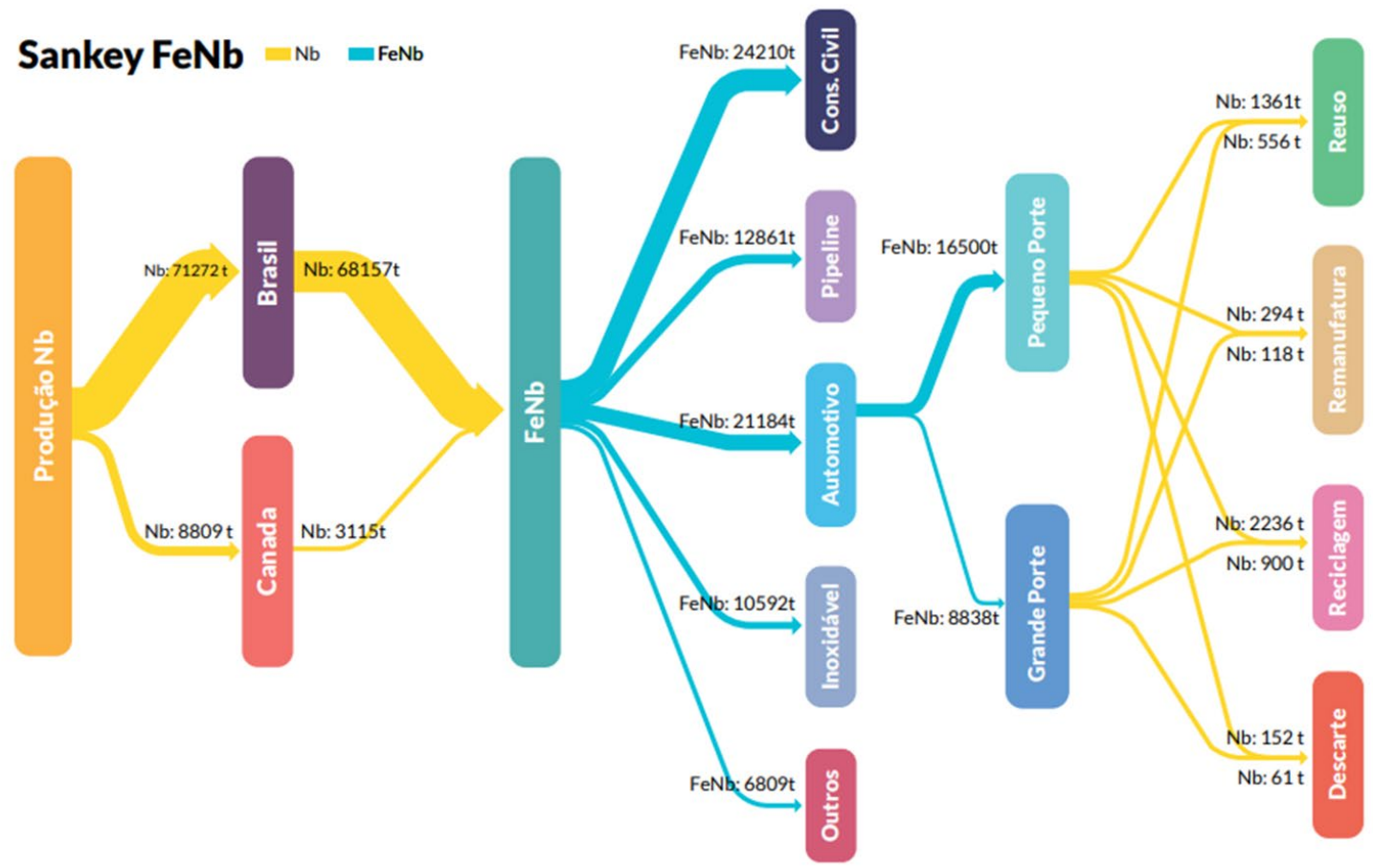
MFA for FeNb



Source: Study of critical materials' production chains: opportunities and threats of the circular economy

# Ferroniobium MFA

## Flow details for FeNb ( steels) for transportation



Source: Study of critical materials' production chains: opportunities and threats of the circular economy

# Niobium circularity is low

## 0.14 for generic Nb and 0.11 for Nb in steels for transportation based on EU mass flow analysis (Deloitte, 2015)



AN APPROACH TO MEASURING CIRCULARITY

### Material Circularity Indicator Dynamic Modelling Tool

Drag the sliders to change input values and see how the MCI changes!



MCI = 000

|                      | Feedstock   | Destination after use            |
|----------------------|---|----------------------------------|
| Reused               | <input type="text" value="0%"/>                     | <input type="text" value="5%"/>  |
| Recycled             | <input type="text" value="3%"/>                     | <input type="text" value="0%"/>  |
| Recycling efficiency | <input type="text" value="50%"/>                    | <input type="text" value="50%"/> |
| Lifespan             | <input type="text" value="1,0 x industry average"/> |                                  |
| Functional units     | <input type="text" value="1,0 x industry average"/> |                                  |



Computation of the MCI:

|                |      |
|----------------|------|
| V              | 0,97 |
| W <sub>0</sub> | 0,95 |
| W <sub>F</sub> | 0,03 |
| W <sub>C</sub> | 0,00 |
| W              | 0,97 |
| X              | 1,00 |
| f(X)           | 0,90 |
| LFI            | 0,96 |
| MCI            | 0,14 |



AN APPROACH TO MEASURING CIRCULARITY

### Material Circularity Indicator Dynamic Modelling Tool

Drag the sliders to change input values and see how the MCI changes!



MCI = 000

|                      | Feedstock   | Destination after use            |
|----------------------|---|----------------------------------|
| Reused               | <input type="text" value="0%"/>                     | <input type="text" value="0%"/>  |
| Recycled             | <input type="text" value="0%"/>                     | <input type="text" value="33%"/> |
| Recycling efficiency | <input type="text" value="6%"/>                     | <input type="text" value="6%"/>  |
| Lifespan             | <input type="text" value="1,0 x industry average"/> |                                  |
| Functional units     | <input type="text" value="1,0 x industry average"/> |                                  |



Computation of the MCI:

|                |      |
|----------------|------|
| V              | 1,00 |
| W <sub>0</sub> | 0,67 |
| W <sub>F</sub> | 0,00 |
| W <sub>C</sub> | 0,31 |
| W              | 0,83 |
| X              | 1,00 |
| f(X)           | 0,90 |
| LFI            | 0,99 |
| MCI            | 0,11 |

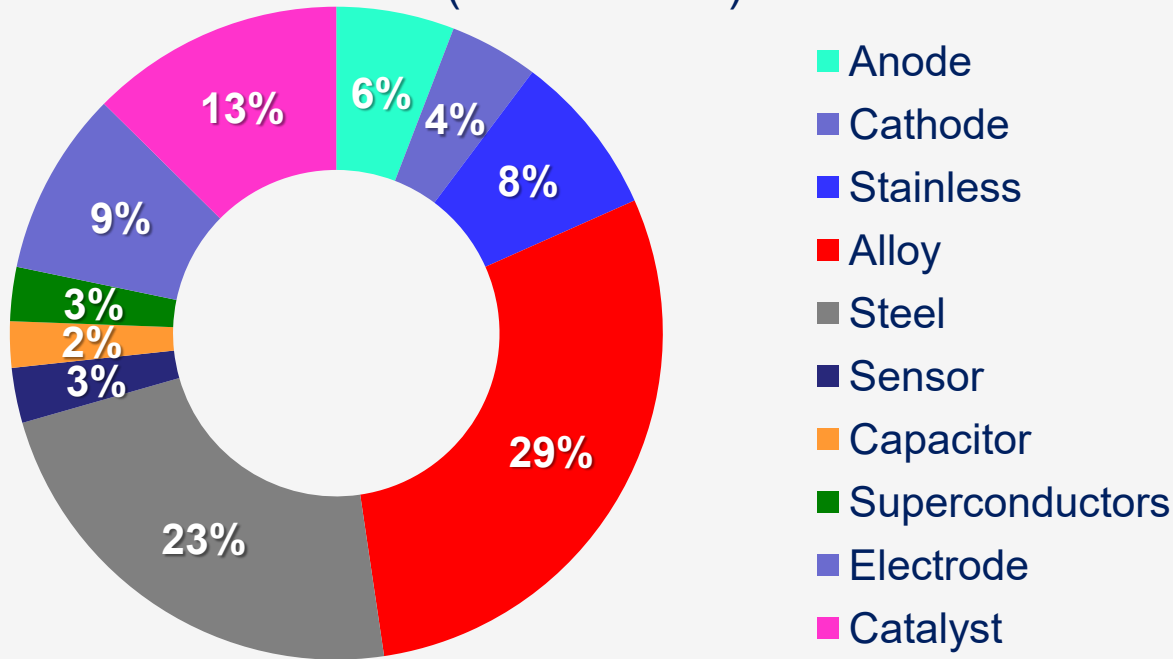
Source: Study of critical materials' production chains: opportunities and threats of the circular economy

# Science and Innovations

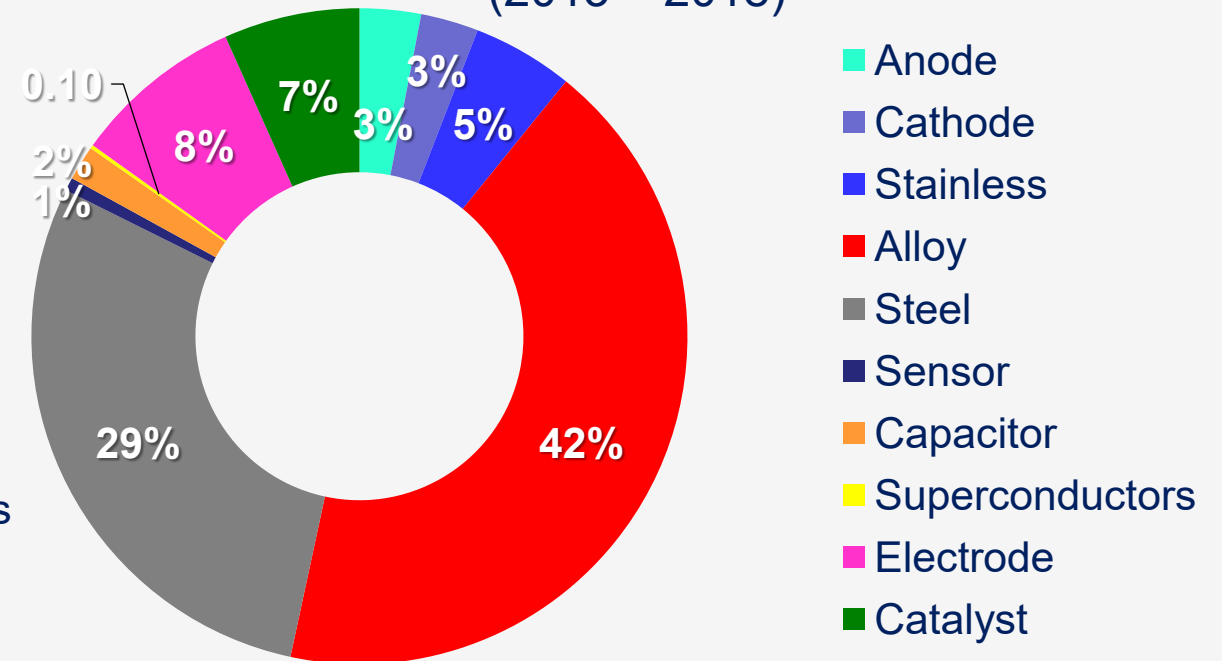
Results from 4.953 papers sample and from 3.092 patents sample collected 2013-19  
**Steel making and metallurgical use higher shares and energy applications growing**



Percentage of scientific papers by application  
(2013 – 2019)



Percentage of Patents per application  
(2013 – 2018)



Source: Study of critical materials' production chains: opportunities and threats of the circular economy

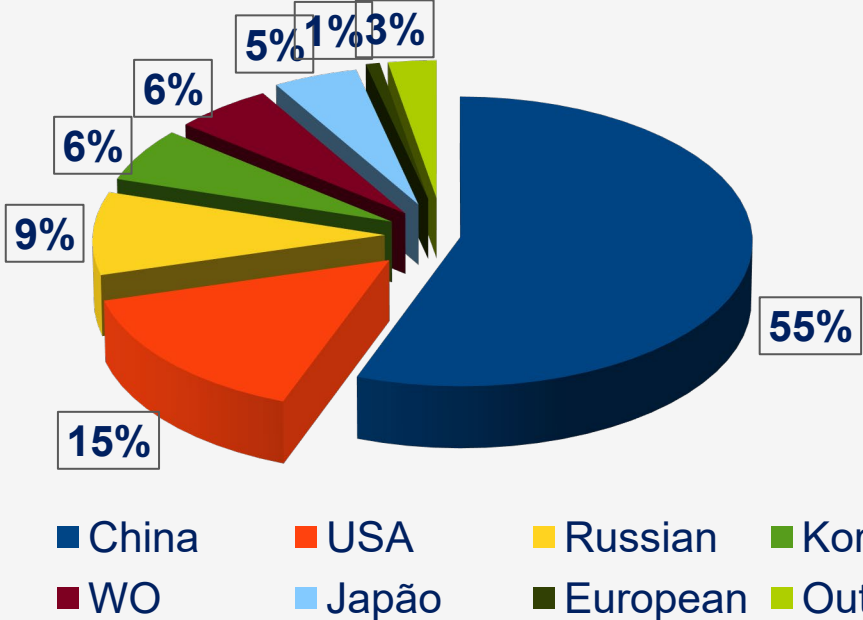


# Niobium Science and Innovations

## Patent applicants by countries' origin



Percentage of Patents by country  
(2013 - 2018)

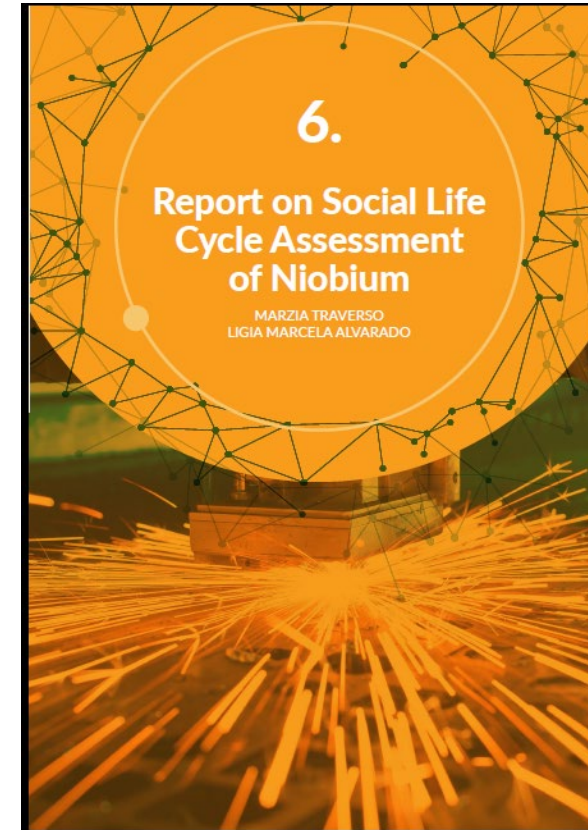
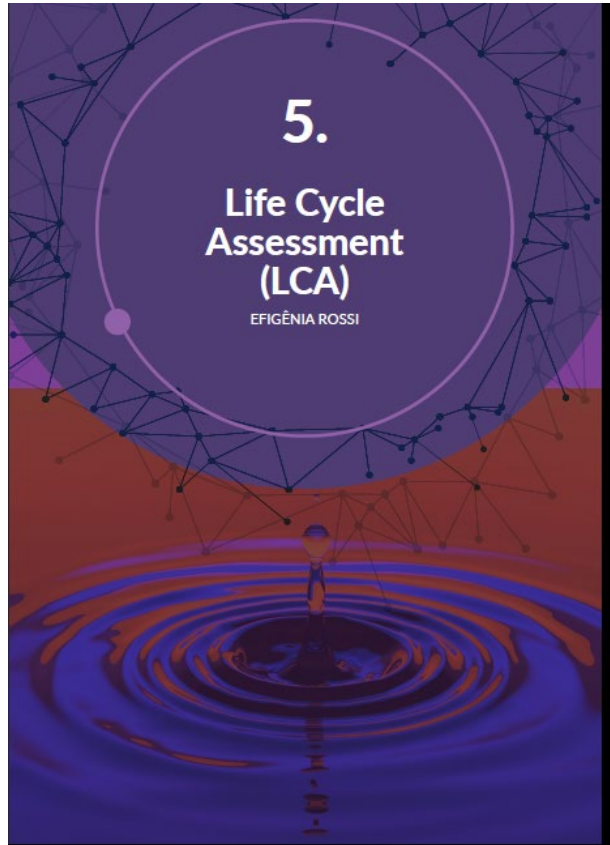


Brazilian R&D on Niobium is raising and more related to extractive metallurgy  
Federal Gov will stablish a new Research Lab . For Niobium and Grapehene materials

Source: Study of critical materials' production chains: opportunities and threats of the circular economy

# Niobium sustainability indicators

## FeNb LCA and S LCA results



Source: Study of critical materials' production chains: opportunities and threats of the circular economy

# Why is Niobium strategic for Brazil ?

## Some very good reasons



1. Very large amount of available minerals resources with high niobium content
2. National and international companies operating mines and metallurgical units in Brazil at high level production standards
3. A promising future due to innovations developed and under development in many countries (many with brazilian companies partnership)
4. Important contribution to sustainability improving energy and materials conservation (while planning on how to improve circularity)

Source: Study of critical materials' production chains: opportunities and threats of the circular economy

**Thank you!**

[cpeiter@cetem.gov.br](mailto:cpeiter@cetem.gov.br)



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