A2 – Power Transformers & Reactors

PS2 – Beyond the mineral oil-immersed Transformers and Reactors

10130

A Proposal to Reduce Greenhouse Gas Emission in the Electrical Power Transmission Sector in Brazil: A Calculation Method Based on the Use of Natural Ester in Power Transformers

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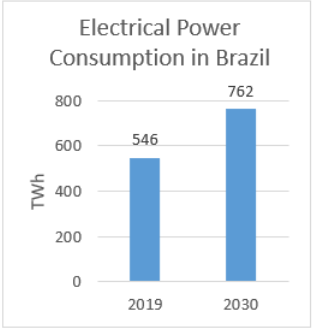
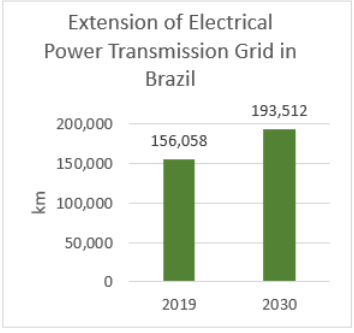
Introduction

- Between 2019 and 2030, Brazil will have a growth in electricity demand around 40% and more than 37,000 km of new transmission lines will added to the transmission grid
- Potential reduction of GHG considering, hypothetically that all transformers planned for the expansion of electrical power transmission could be filled with natural ester
- The proposal to reduce GHG emissions could contribute to the Brazilian commitment signed under the Paris Agreement to mitigate its emissions

The Expansion of Electrical Power Transmission in Brazil

- Total electricity consumption in Brazil will increase 39.6%
- Transmission lines extension will grow 24%
- The foreseen investment for substations alone is US$ 4.9 billion





Efficiency in the power transformers of Brazilian electrical power transmission grid

- Improvement of electrical efficiency can contribute with 32 TWh in 2030
- Total electricity generated (2005) 14% was wasted by global losses in T&D, and 30% of these technical losses were concentrated in transformer cores
- New ABNT NBR 5356-20 - Power Transformers - Energy Efficiency

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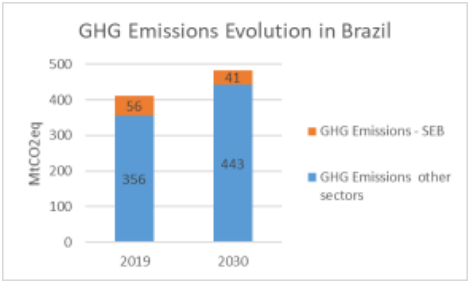
Greenhouse gas emissions in the Brazilian electricity sector

- The total CO_2 emissions associated with the Brazilian energy matrix was 412 $MtCO_2eq$ in 2019. The electricity sector was responsible for 13% of these emissions with 56 $MtCO_2eq$
- By 2030, total CO_2 emissions from energy matrix will be 484 $MtCO_2eq$, growth of 17.5%. The electricity sector will be responsible for 41 $MtCO_2eq$, with a reduction of 26.8%, representing only 8.5% of total emissions in 2030



Calculation of GHG Emissions for Natural Ester Filled Power Transformers

- 590 power transformers planned between 69 kV and 525 kV

Item	High Voltage (kV)	Number of Units	Subtotal	
Shunt-Reactor	230	2	72	
	500	37		3,573 MVAr
	525	33		
Autotransformer	230	184	339	
	345	18		
	440	3		52,666 MVA
	500	89		
	525	45		
Power Transformer	69	1	179	
	138	2		
	230	127		19,064 MVA
	345	33		
	440	13		
	500	3		
		590		

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- Carbon dioxide emissions (in gCO_2 equivalent / unit) for each macro stage of the life cycle for the 2 different types of insulating liquids
- "unit" means a 1,000 kVA transformer filled with 500 gallons of insulating liquid during 30 years of operation

	gCO_2eq / unit	
Stage	**Mineral Oil**	**Natural Ester**
Raw Material	1,048,184	-381,590
Manufacture	544,363	160,212
Transport	122,478	71,498
Use	154,124	153,450
Waste Management	30,825	30,690
Total	1,899,973	34,260

	Mineral Oil	**Natural Ester**
Emission of $kgCO_2eq$ per liter	1.005	0.018
Total volume of insulating liquid in liters	18,271,400	
Total emissions in tCO_2eq	18,368	329

HV Natural Ester immersed Power Transformers in Service in Brazil

- Largest natural ester filled transformers in Latin America. 2x 200 MVA, 34.5/230 kV wind farm collectors
- Power transmission company has +20 natural ester filled units between 69 and 245 kV. Some in operation for more than 13 years

Conclusions

- Benefits of using natural ester over mineral oil could allow for more sustainable power transformers and substations, as it could mitigates GHG emissions.
- The proposal makes possible to avoid emitting +18 tCO_2eq, helping Brazil to fulfill the goals established for the Paris Agreement