

```
Requirement already satisfied: pandas in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (2.2.2)
Requirement already satisfied: matplotlib in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (3.9.2)
Requirement already satisfied: openpyxl in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (3.1.5)
Requirement already satisfied: numpy>=1.23.2 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from pandas) (2.0.1)
Requirement already satisfied: python-dateutil>=2.8.2 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from pandas) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from pandas) (2024.1)
Requirement already satisfied: tzdata>=2022.7 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from pandas) (2024.1)
Requirement already satisfied: contourpy>=1.0.1 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from matplotlib) (1.3.0)
Requirement already satisfied: cycler>=0.10 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from matplotlib) (4.54.1)
Requirement already satisfied: kiwisolver>=1.3.1 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from matplotlib) (1.4.7)
Requirement already satisfied: packaging>=20.0 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from matplotlib) (24.1)
Requirement already satisfied: pillow>=8 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from matplotlib) (10.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from matplotlib) (3.1.4)
Requirement already satisfied: et-xmlfile in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from openpyxl) (2.0.0)
Requirement already satisfied: six>=1.5 in C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages (from python-dateutil>=2.8.2->pandas) (1.16.0)
```

```
WARNING: Ignoring invalid distribution ~orch (C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages)
```

```
WARNING: Ignoring invalid distribution ~orch (C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages)
```

```
WARNING: Ignoring invalid distribution ~orch (C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages)
```

```
WARNING: Ignoring invalid distribution ~orch (C:\Users\gabri\AppData\Local\ Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages)
```

```
Collecting nbformat
```

```
  Using cached nbformat-5.10.4-py3-none-any.whl.metadata (3.6 kB)
```

```
Collecting nbconvert
```

```
  Using cached nbconvert-7.17.0-py3-none-any.whl.metadata (8.4 kB)
```

```
Collecting jupyter
```

```
  Using cached jupyter-1.1.1-py2.py3-none-any.whl.metadata (2.0 kB)
```

```
WARNING: Ignoring invalid distribution ~orch (C:\Users\gabri\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages)
WARNING: Ignoring invalid distribution ~orch (C:\Users\gabri\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-packages)
ERROR: Could not find a version that satisfies the requirement nbconvert-tex-templates (from versions: none)
ERROR: No matching distribution found for nbconvert-tex-templates
```

```
C:\Users\gabri\AppData\Local\Microsoft\WindowsApps\PythonSoftwareFoundation.Python.3.11_qbz5n2kfra8p0\python.exe
```

```
Out[172... ['analisefbase.ipynb',
 'br_seeg_emissoes_brasil.csv',
 'br_seeg_emissoes_brasil.xlsx']
```

Célula 2.1 — Guia de Leitura do Notebook (MD)

## Guia de Leitura do Notebook

Este notebook está estruturado em blocos analíticos progressivos, permitindo leitura sequencial ou direcionada.

### Estrutura geral:

- **Células 0–2:** Preparação do ambiente
- **Células 3–6:** Carga e compreensão dos dados
- **Células 7–8:** Engenharia temporal
- **Células 9.x:** Análises por gás individual (visão técnica)
- **Células 10.x:** Análises por grupos de gases (visão executiva)
- **Células 11+:** Visualizações e comunicação de resultados

	ano	nivel_1	nivel_2	nivel_3	nivel_4	nivel_5	nivel_6	tipo_emissao	gas	atividade_econom
0	1970	Agropecuária	Cultivo do Arroz	Diretas	Outros	Vegetal	Arroz	Emissão	CH4 (t)	N
1	1971	Agropecuária	Cultivo do Arroz	Diretas	Outros	Vegetal	Arroz	Emissão	CH4 (t)	N
2	1972	Agropecuária	Cultivo do Arroz	Diretas	Outros	Vegetal	Arroz	Emissão	CH4 (t)	N
3	1973	Agropecuária	Cultivo do Arroz	Diretas	Outros	Vegetal	Arroz	Emissão	CH4 (t)	N
4	1974	Agropecuária	Cultivo do Arroz	Diretas	Outros	Vegetal	Arroz	Emissão	CH4 (t)	N



Out[174...]

	<b>ano</b>	<b>gas</b>	<b>emissao</b>
<b>0</b>	1970	CH4 (t)	23046217.0
<b>1</b>	1971	CH4 (t)	2260163.0
<b>2</b>	1972	CH4 (t)	2201012.0
<b>3</b>	1973	CH4 (t)	21419556.0
<b>4</b>	1974	CH4 (t)	18686284.0

Out[175...]

	<b>ano</b>	<b>gas</b>	<b>emissao</b>
<b>0</b>	1970	C2F6 (t)	1.395662e+06
<b>1</b>	1970	CF4 (t)	2.134453e+07
<b>2</b>	1970	CH4 (t)	4.998021e+09
<b>3</b>	1970	CO (t)	4.356296e+09
<b>4</b>	1970	CO2 (t)	3.151364e+09

Out[176...]

<b>gas</b>	<b>C2F6 (t)</b>	<b>CF4 (t)</b>	<b>CH4 (t)</b>	<b>CO (t)</b>	<b>CO2 (t)</b>	<b>CO2e (t) GTP-AR2</b>	<b>CO2e (t) GTP-AR4</b>
<b>ano</b>							
<b>1970</b>	1395662.0	21344527.0	4.998021e+09	4.356296e+09	3.151364e+09	8.446847e+09	8.446847e+09
<b>1971</b>	20076635.0	30704159.0	5.664296e+09	4.495005e+09	3.538648e+09	8.614891e+09	8.614891e+09
<b>1972</b>	24281036.0	3713415.0	4.857771e+09	4.719047e+09	3.588300e+09	8.482554e+09	8.482554e+09
<b>1973</b>	2778885.0	42498817.0	5.615892e+09	4.302412e+09	3.725942e+09	8.946097e+09	8.946097e+09
<b>1974</b>	28261534.0	43221715.0	5.674398e+09	5.142865e+09	3.940045e+09	9.203126e+09	9.203126e+09

5 rows × 22 columns



## Célula 6.1 — Unidade da Variável Emissão

A variável **emissao** representa o volume de emissões de gases de efeito estufa expresso em:

**Milhões de toneladas (Mt)**

Todas as agregações e gráficos mantêm essa unidade de forma consistente.

Out[177...]

	ano	gas	emissao	periodo_5_anos	periodo_10_anos	periodo_30_anos
0	1970	C2F6 (t)	1.395662e+06	1970	1970	1950
1	1970	CF4 (t)	2.134453e+07	1970	1970	1950
2	1970	CH4 (t)	4.998021e+09	1970	1970	1950
3	1970	CO (t)	4.356296e+09	1970	1970	1950
4	1970	CO2 (t)	3.151364e+09	1970	1970	1950

Out[178...]

	ano	periodo_5_anos
0	1970	1970–1974
1	1971	1970–1974
2	1972	1970–1974
3	1973	1970–1974
4	1974	1970–1974
5	1975	1975–1979
6	1976	1975–1979
7	1977	1975–1979
8	1978	1975–1979
9	1979	1975–1979

Out[179...]

	ano	periodo_10_anos
0	1970	1970–1979
1	1971	1970–1979
2	1972	1970–1979
3	1973	1970–1979
4	1974	1970–1979
5	1975	1970–1979
6	1976	1970–1979
7	1977	1970–1979
8	1978	1970–1979
9	1979	1970–1979

Out[180...]

**ano periodo\_30\_anos**

<b>0</b>	1970	1950–1979
<b>1</b>	1971	1950–1979
<b>2</b>	1972	1950–1979
<b>3</b>	1973	1950–1979
<b>4</b>	1974	1950–1979
<b>5</b>	1975	1950–1979
<b>6</b>	1976	1950–1979
<b>7</b>	1977	1950–1979
<b>8</b>	1978	1950–1979
<b>9</b>	1979	1950–1979

Out[182...]

gas	C2F6 (t)	CF4 (t)	CH4 (t)	CO (t)	CO2 (t)	CO2e (t) GTP-AR2
-----	----------	---------	---------	--------	---------	---------------------

**periodo\_5\_anos**

<b>1970–1974</b>	76793752.0	141482633.0	2.681038e+10	2.301562e+10	1.794430e+10	4.369351e+10	4
<b>1975–1979</b>	179425910.0	274404627.0	3.040979e+10	2.766947e+10	2.453556e+10	5.117312e+10	5
<b>1980–1984</b>	426197118.0	361821242.0	3.873608e+10	3.316761e+10	3.270048e+10	6.177736e+10	6
<b>1985–1989</b>	408206070.0	172450164.0	4.247015e+10	3.841416e+10	3.353496e+10	6.205227e+10	6
<b>1990–1994</b>	470820560.0	165736484.0	3.976869e+10	3.806136e+10	4.176056e+10	7.106317e+10	7

5 rows × 22 columns



Out[183...]

gas	C2F6 (t)	CF4 (t)	CH4 (t)	CO (t)	CO2 (t)	CO2e (t) GTP-AR2
-----	----------	---------	---------	--------	---------	---------------------

**periodo\_10\_anos**

<b>1970–1979</b>	256219662.0	4.158873e+08	5.722017e+10	5.068510e+10	4.247986e+10	9.486664e+10
<b>1980–1989</b>	834403188.0	5.342714e+08	8.120622e+10	7.158177e+10	6.623544e+10	1.238296e+11
<b>1990–1999</b>	833462734.0	5.433699e+08	7.847599e+10	7.438898e+10	8.614018e+10	1.462134e+11
<b>2000–2009</b>	916422796.0	1.115858e+09	8.597986e+10	7.640134e+10	8.880178e+10	1.508789e+11
<b>2010–2019</b>	731445755.0	8.138590e+08	9.777839e+10	8.310586e+10	8.042540e+10	1.531326e+11

5 rows × 22 columns



Out[184...]

	gas	C2F6 (t)	CF4 (t)	CH4 (t)	CO (t)	CO2 (t)	CO2e (t) GTP-AR2
<b>periodo_30_anos</b>							
<b>1950–1979</b>	2.562197e+08	4.158873e+08	5.722017e+10	5.068510e+10	4.247986e+10	9.486664e+10	
<b>1980–2009</b>	2.584289e+09	2.193500e+09	2.456621e+11	2.223721e+11	2.411774e+11	4.209219e+11	
<b>2010–2039</b>	7.314458e+08	8.138590e+08	9.777839e+10	8.310586e+10	8.042540e+10	1.531326e+11	

3 rows × 22 columns



## Célula 10.0 — Transição da Análise Técnica para Executiva

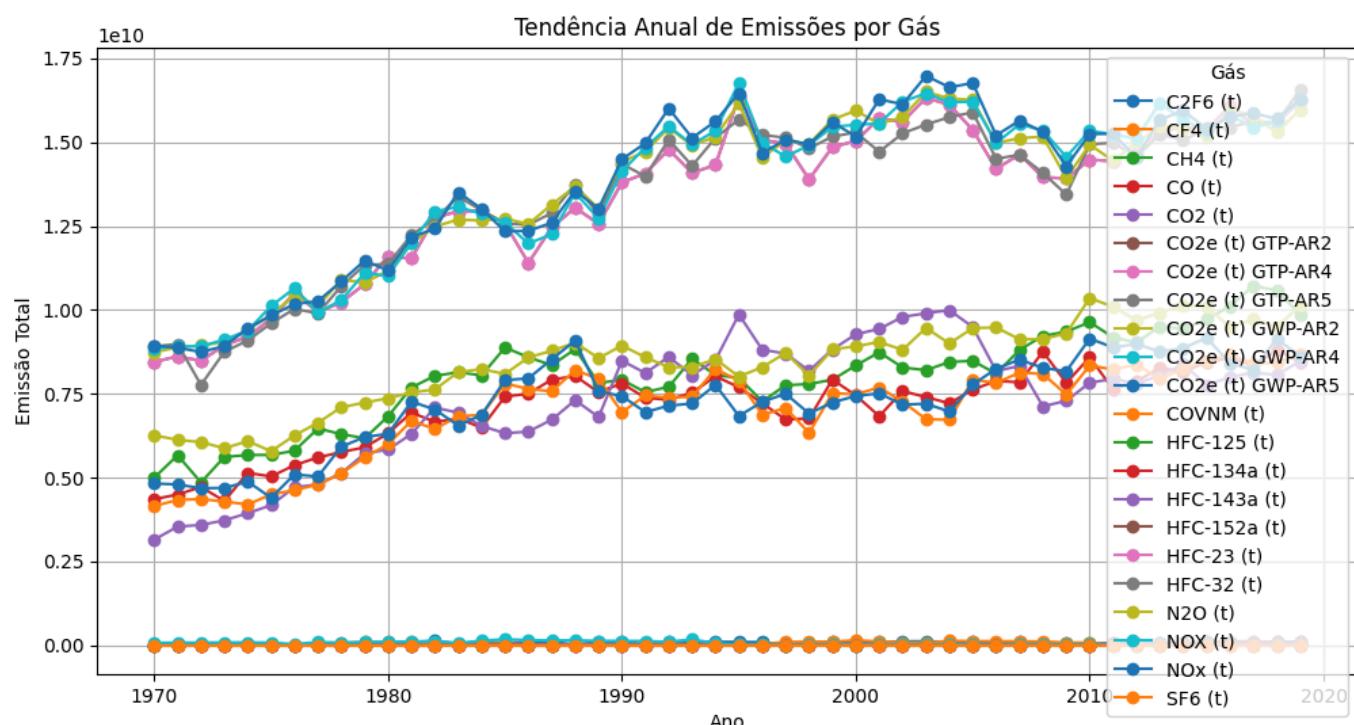
Até este ponto, as análises foram conduzidas considerando os **gases de efeito estufa individualmente**, preservando a granularidade técnica do dataset.

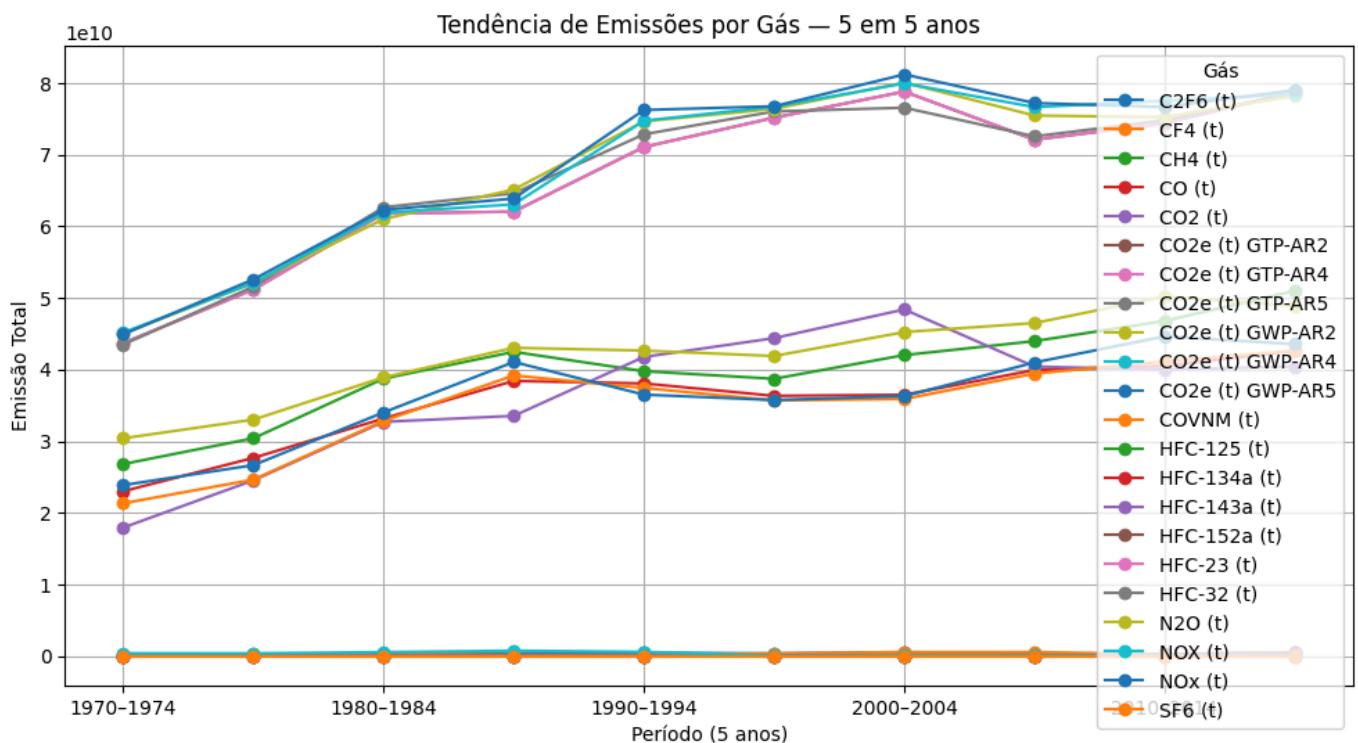
A partir da próxima célula, os gases serão **agrupados em categorias estratégicas** amplamente utilizadas em:

- Relatórios executivos
- Inventários ambientais (SEEG, IPCC)
- Comunicação com públicos não técnicos

### Objetivo da transição:

- Reduzir complexidade visual
- Facilitar comunicação de resultados
- Manter consistência com padrões institucionais





Out[187...]

	gas	grupo_gas
<b>14150</b>	CO2 (t)	CO2 / CO2e
<b>50</b>	CO2e (t) GTP-AR2	CO2 / CO2e
<b>100</b>	CO2e (t) GTP-AR4	CO2 / CO2e
<b>150</b>	CO2e (t) GTP-AR5	CO2 / CO2e
<b>200</b>	CO2e (t) GWP-AR2	CO2 / CO2e
<b>250</b>	CO2e (t) GWP-AR4	CO2 / CO2e
<b>300</b>	CO2e (t) GWP-AR5	CO2 / CO2e
<b>430800</b>	HFC-32 (t)	HFC
<b>430750</b>	HFC-23 (t)	HFC
<b>430700</b>	HFC-152a (t)	HFC
<b>430650</b>	HFC-143a (t)	HFC
<b>430600</b>	HFC-134a (t)	HFC
<b>430550</b>	HFC-125 (t)	HFC
<b>439200</b>	C2F6 (t)	Outros
<b>0</b>	CH4 (t)	Outros
<b>34850</b>	COVNM (t)	Outros
<b>439250</b>	CF4 (t)	Outros
<b>7650</b>	NOX (t)	Outros
<b>7250</b>	CO (t)	Outros
<b>4200</b>	N2O (t)	Outros
<b>34950</b>	NOx (t)	Outros
<b>445700</b>	SF6 (t)	SF6

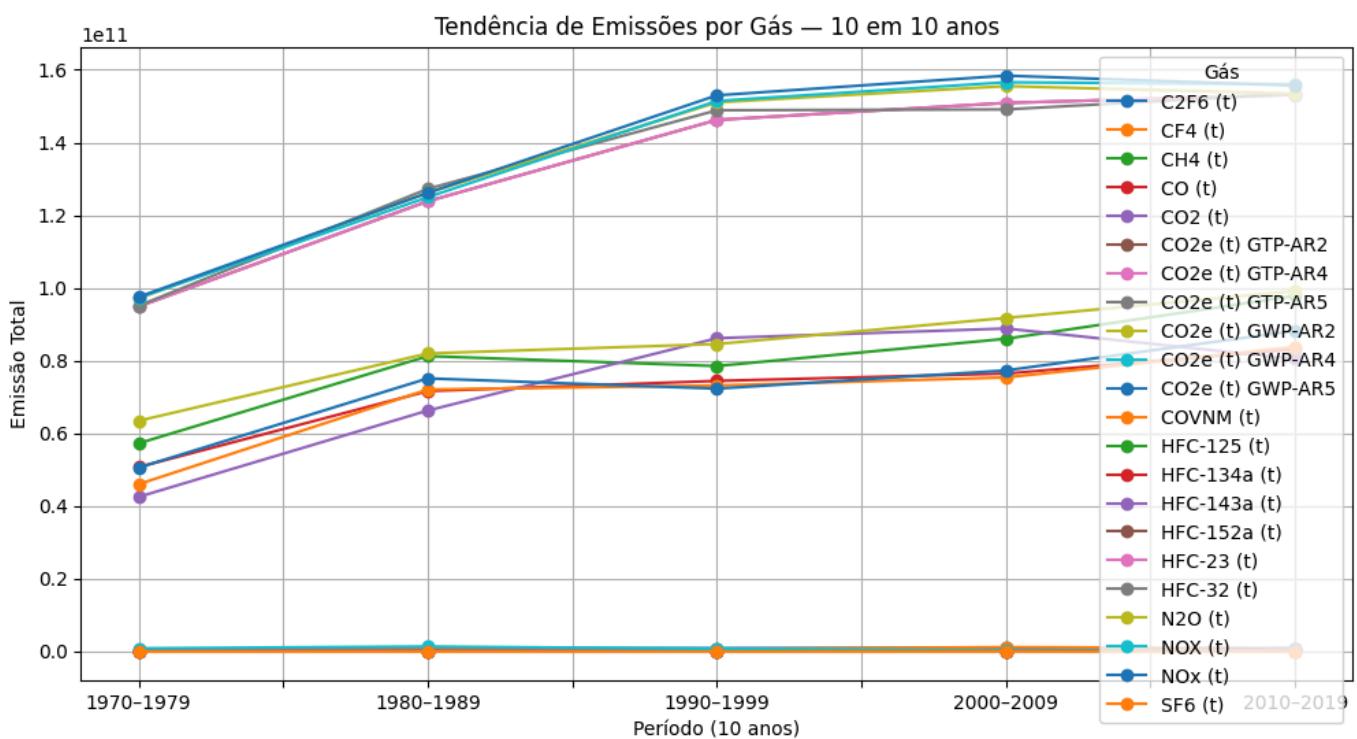
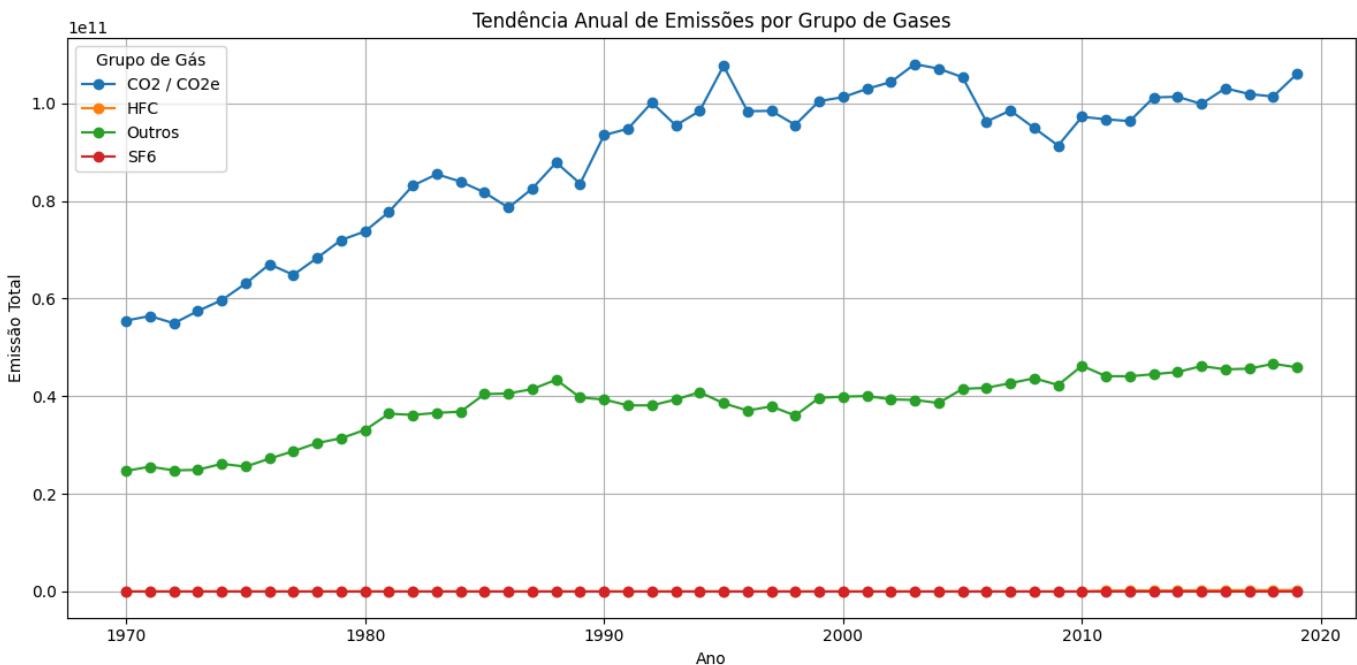
Out[188...]

grupo\_g

CO2 / CO2e HFC

## **Outros SF6**

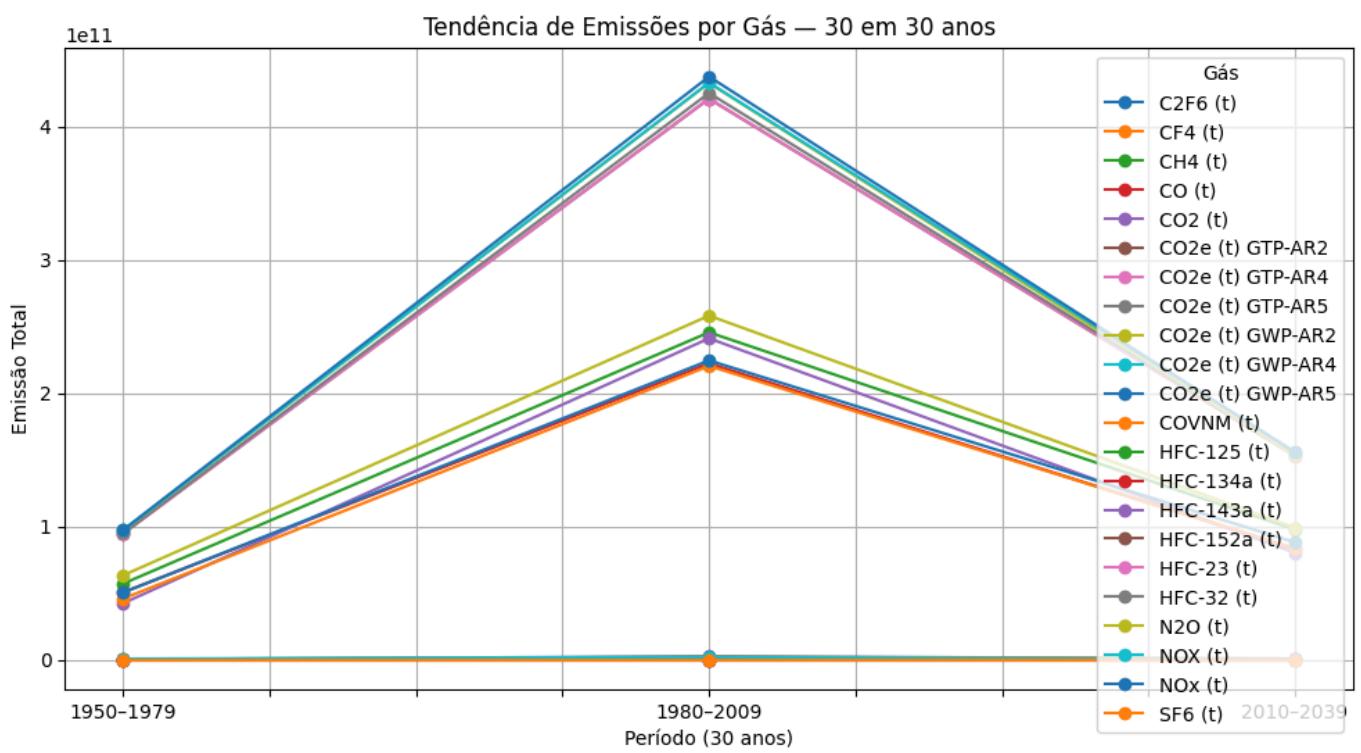
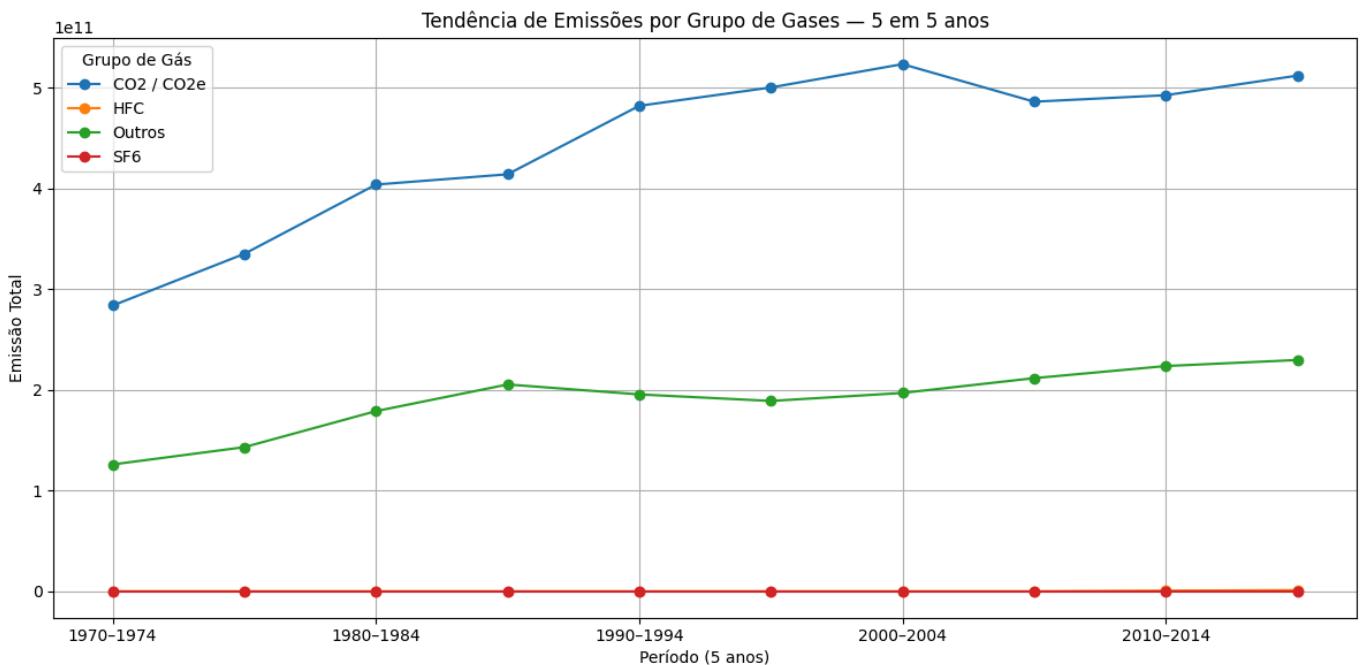
<b>ano</b>				
<b>1970</b>	5.548073e+10	0.0	2.468583e+10	0.0
<b>1971</b>	5.641745e+10	0.0	2.554148e+10	0.0
<b>1972</b>	5.491845e+10	0.0	2.478522e+10	0.0
<b>1973</b>	5.744273e+10	0.0	2.490051e+10	0.0
<b>1974</b>	5.966347e+10	0.0	2.613586e+10	0.0



grupo_gas	CO2 / CO2e	HFC	Outros	SF6
-----------	------------	-----	--------	-----

**periodo\_5\_anos**

<b>1970–1974</b>	2.839228e+11	0.0	1.260489e+11	0.0
<b>1975–1979</b>	3.352636e+11	0.0	1.432301e+11	0.0
<b>1980–1984</b>	4.040778e+11	0.0	1.790153e+11	0.0
<b>1985–1989</b>	4.142889e+11	0.0	2.054856e+11	0.0
<b>1990–1994</b>	4.823137e+11	47846.0	1.956275e+11	418.0

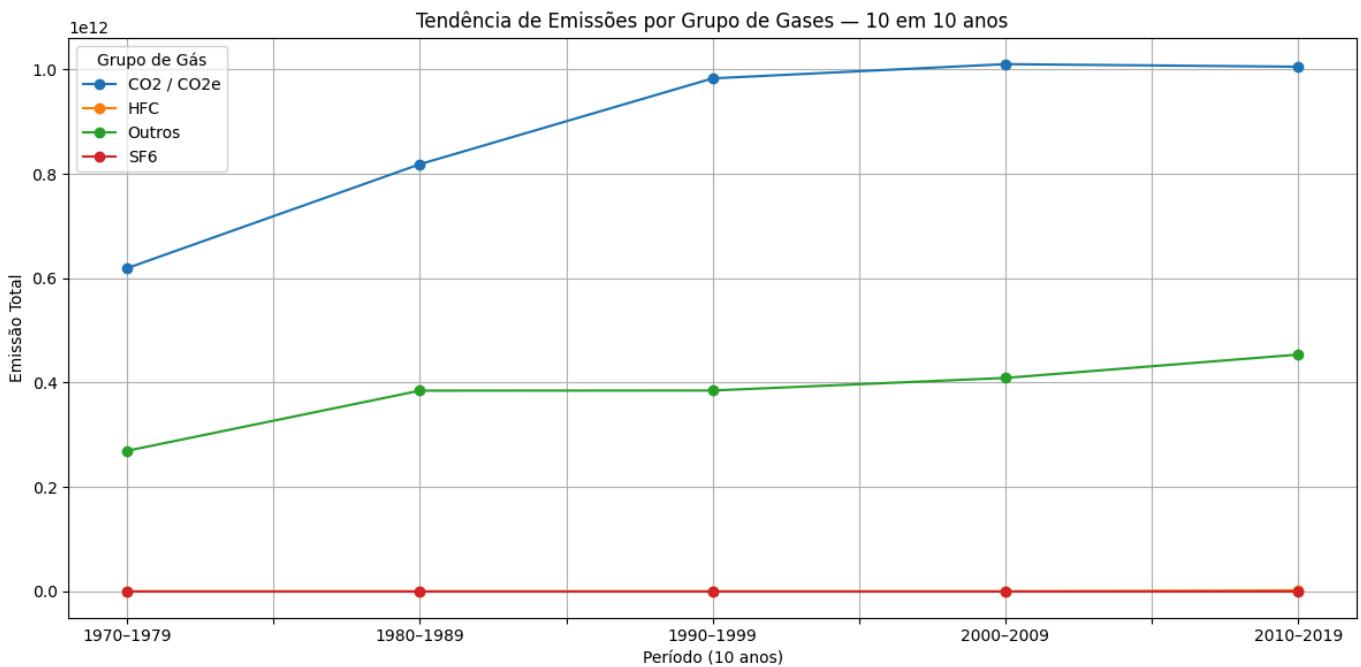


Out[194...]

grupo_gas	CO2 / CO2e	HFC	Outros	SF6
-----------	------------	-----	--------	-----

**periodo\_10\_anos**

<b>1970–1979</b>	6.191865e+11	0.000000e+00	2.692790e+11	0.0
<b>1980–1989</b>	8.183668e+11	0.000000e+00	3.845009e+11	0.0
<b>1990–1999</b>	9.828534e+11	1.542440e+05	3.847686e+11	1162.0
<b>2000–2009</b>	1.010124e+12	3.517470e+05	4.088443e+11	3172.0
<b>2010–2019</b>	1.005183e+12	1.846420e+09	4.536035e+11	7202.0

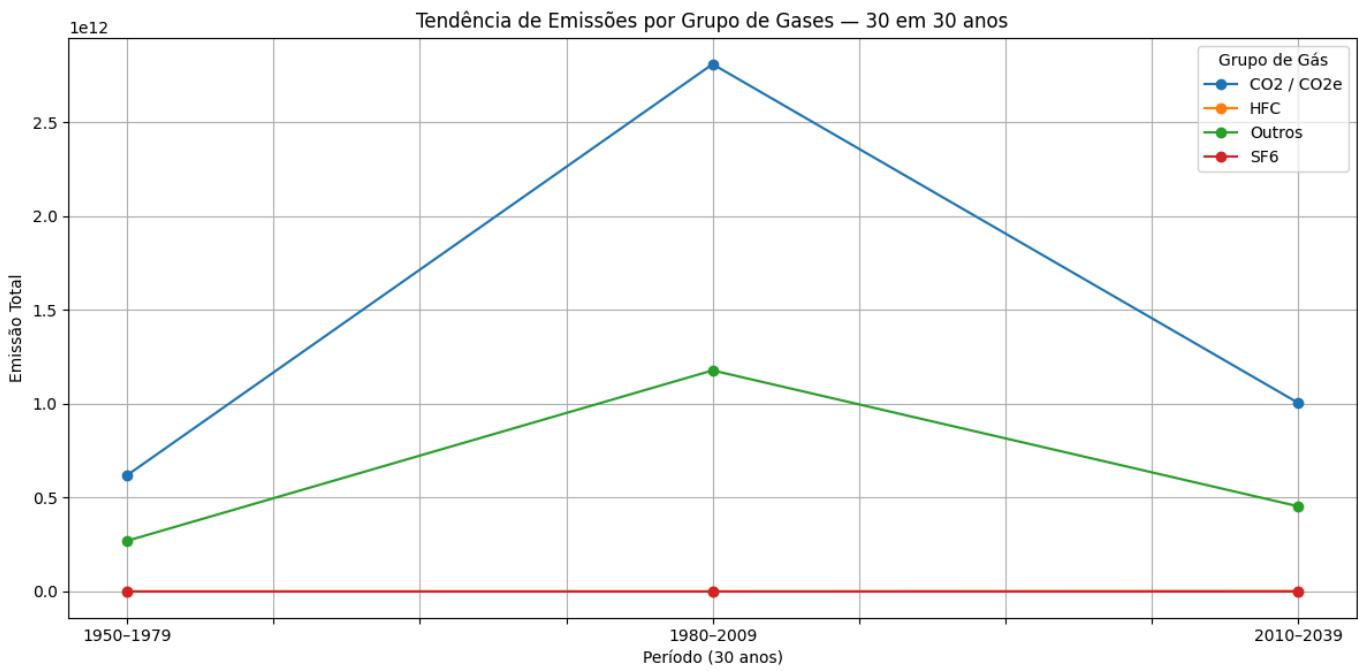


Out[196...]

grupo_gas	CO2 / CO2e	HFC	Outros	SF6
-----------	------------	-----	--------	-----

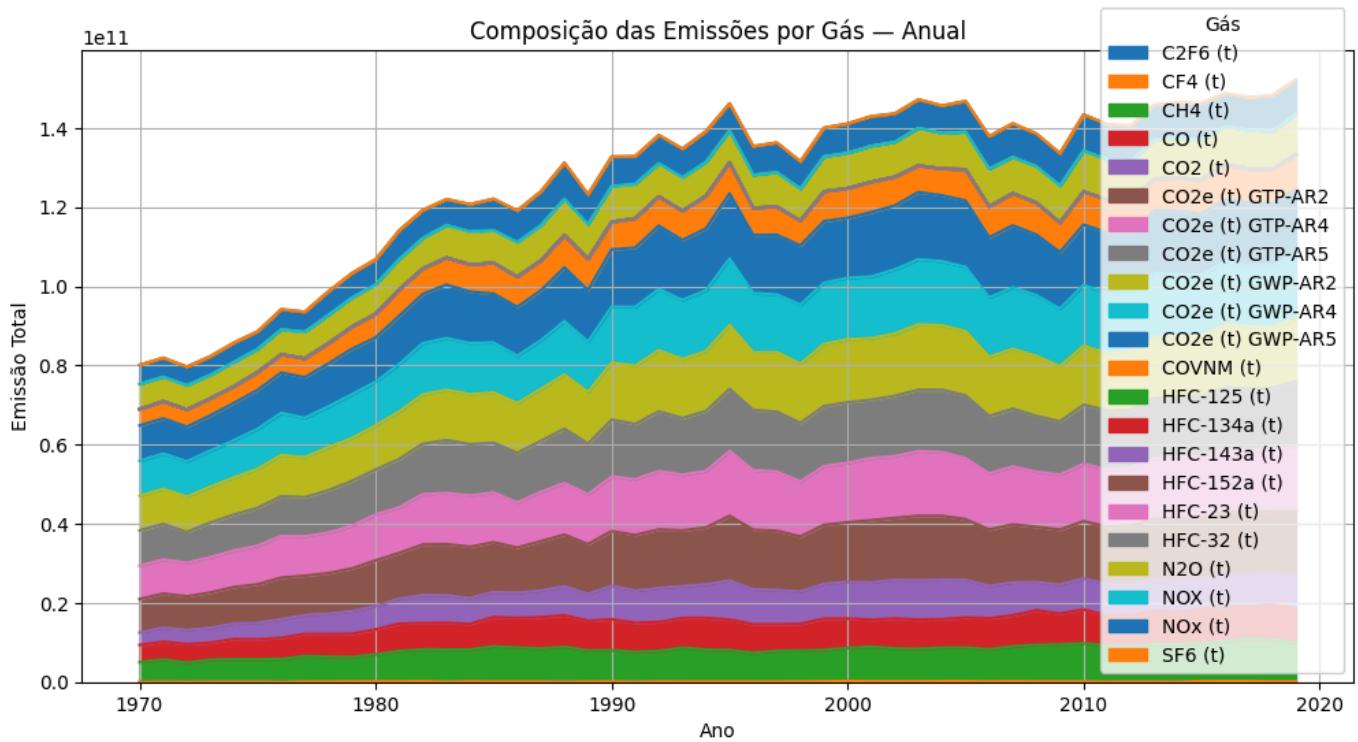
**periodo\_30\_anos**

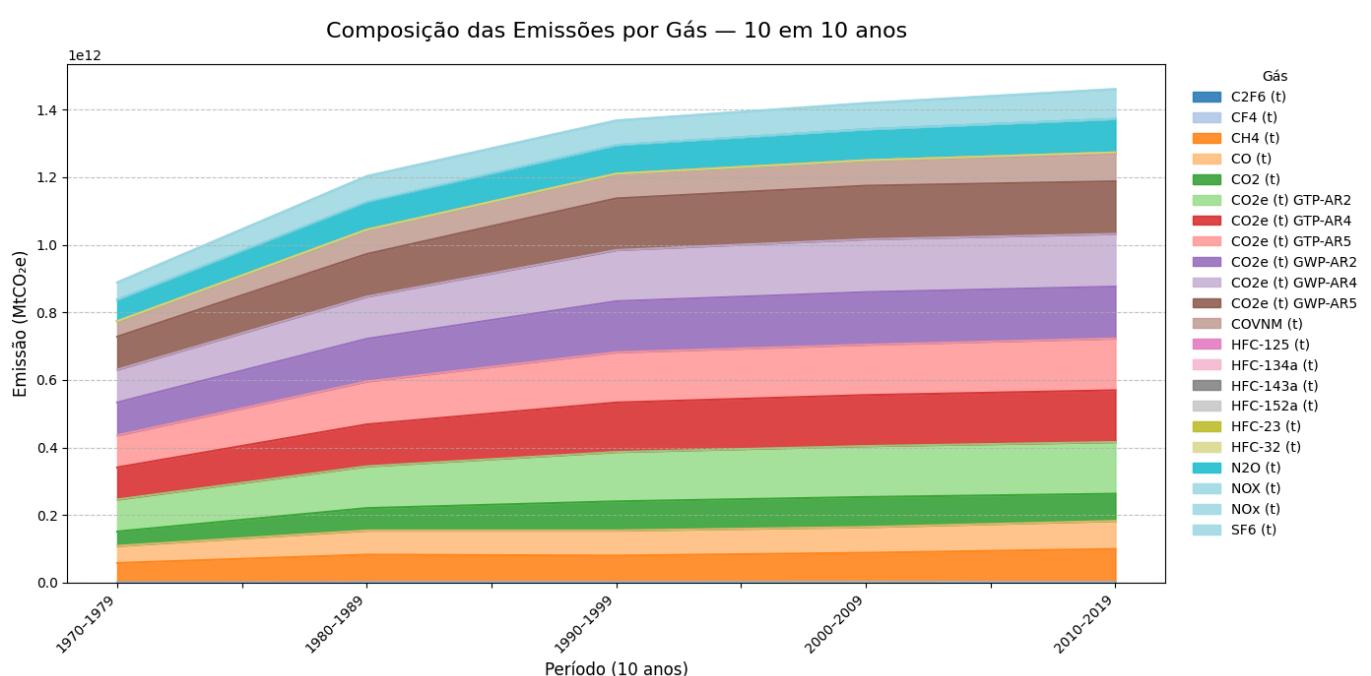
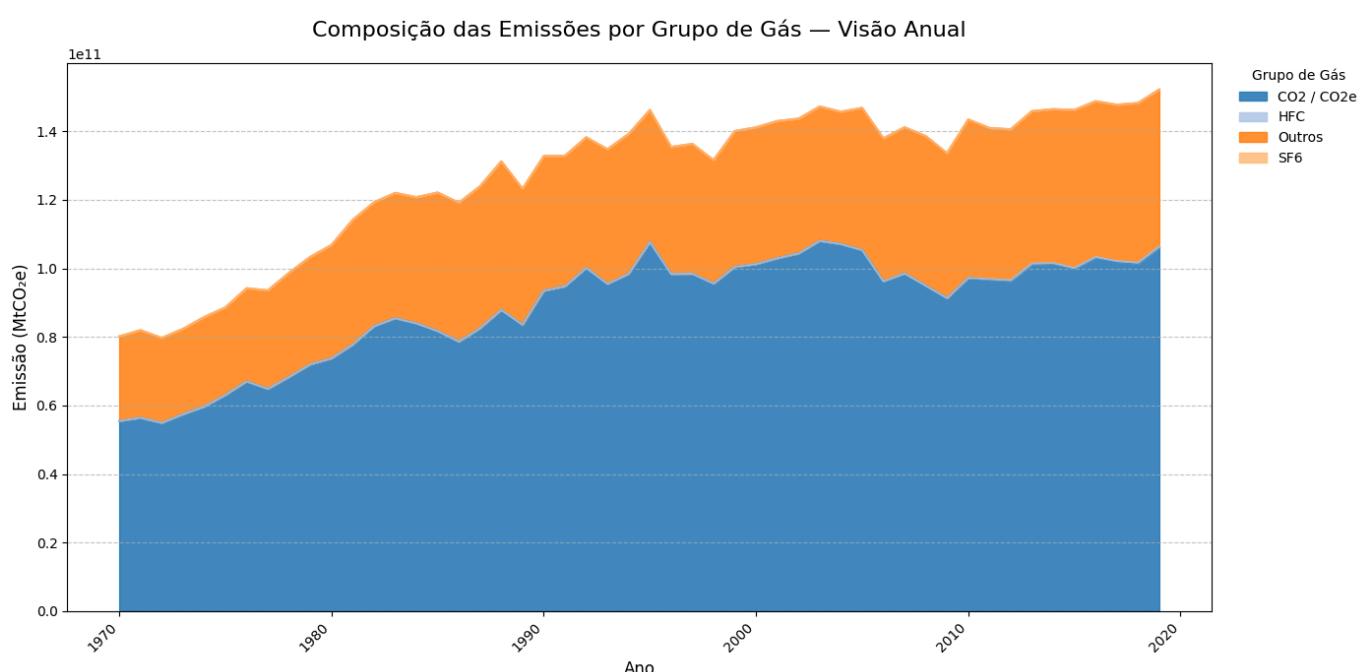
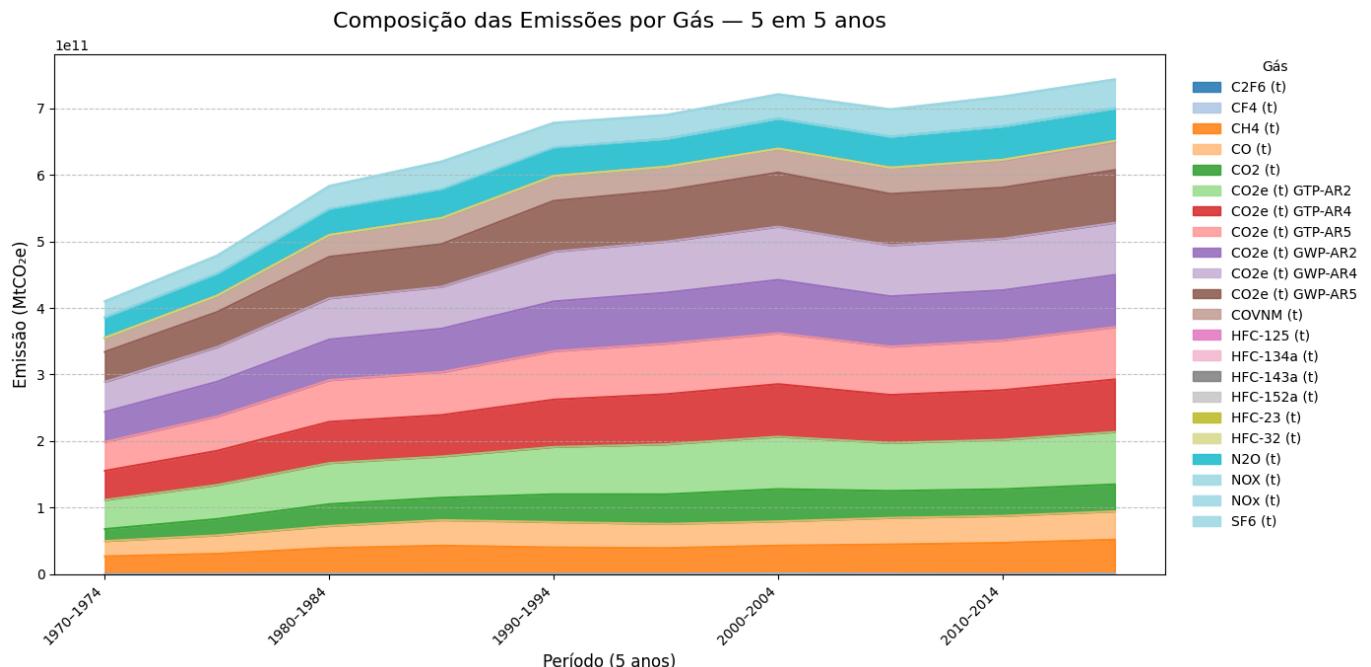
<b>1950–1979</b>	6.191865e+11	0.000000e+00	2.692790e+11	0.0
<b>1980–2009</b>	2.811344e+12	5.059910e+05	1.178114e+12	4334.0
<b>2010–2039</b>	1.005183e+12	1.846420e+09	4.536035e+11	7202.0



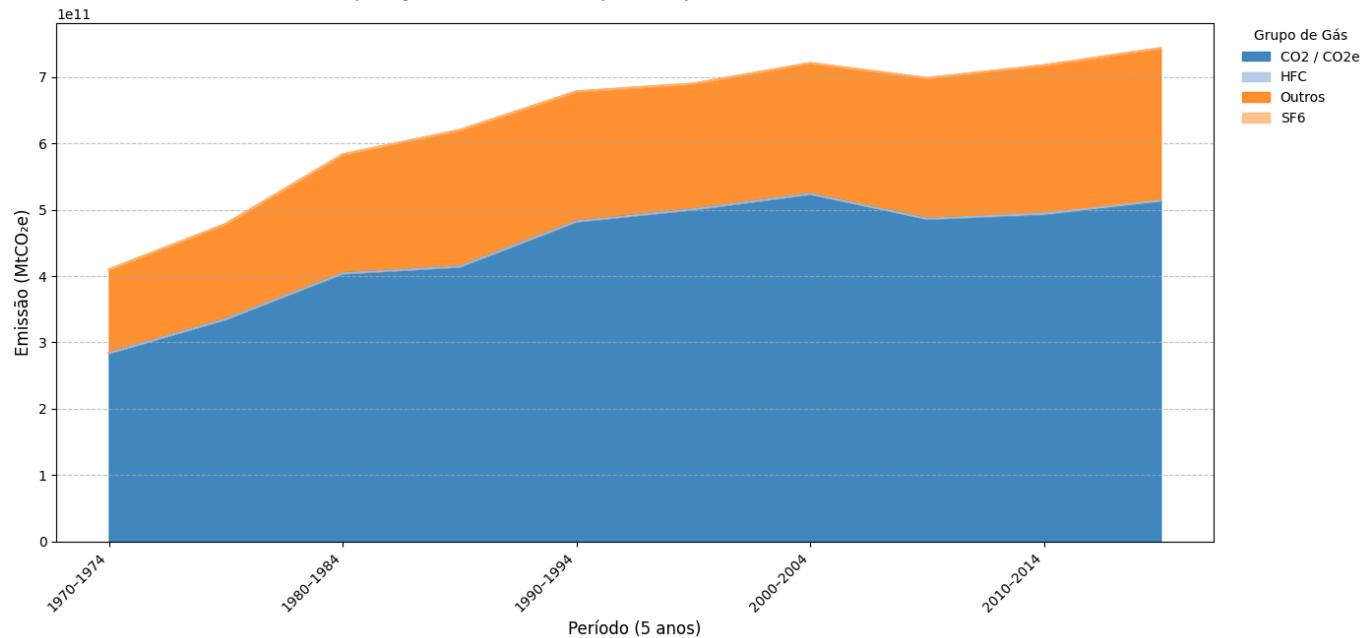
**TODO:**

ajeitar toda a organização do processo do 11 (11.1. et cetera)

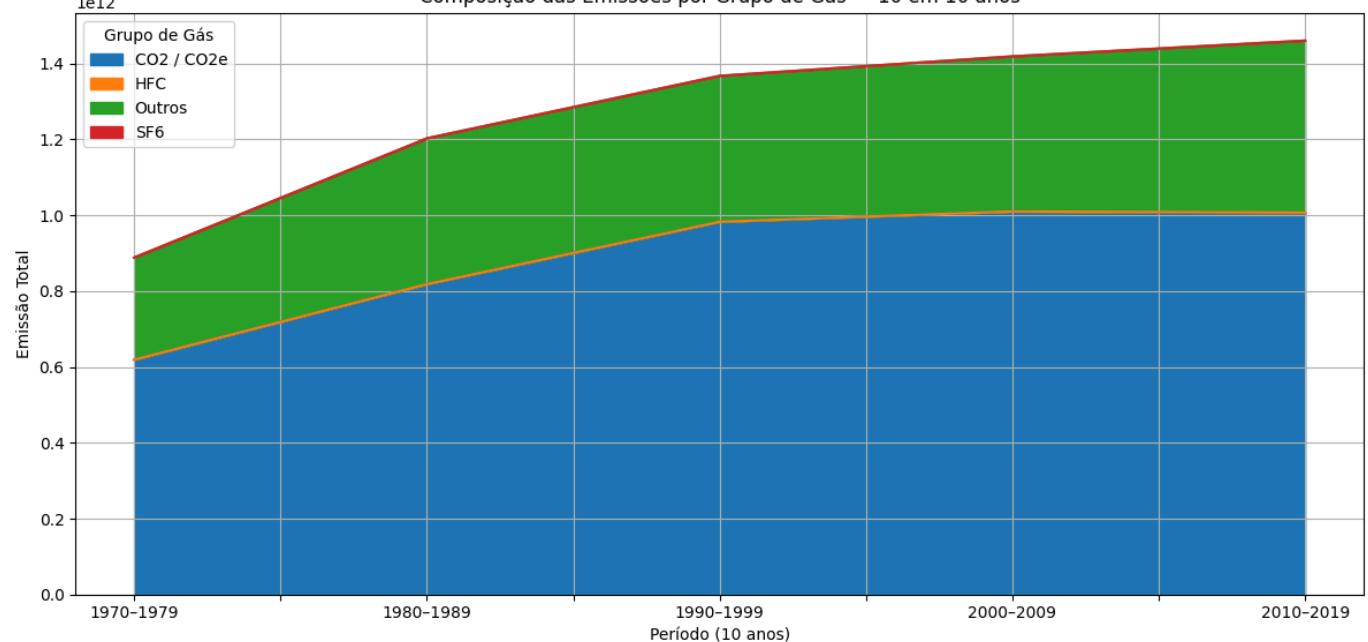




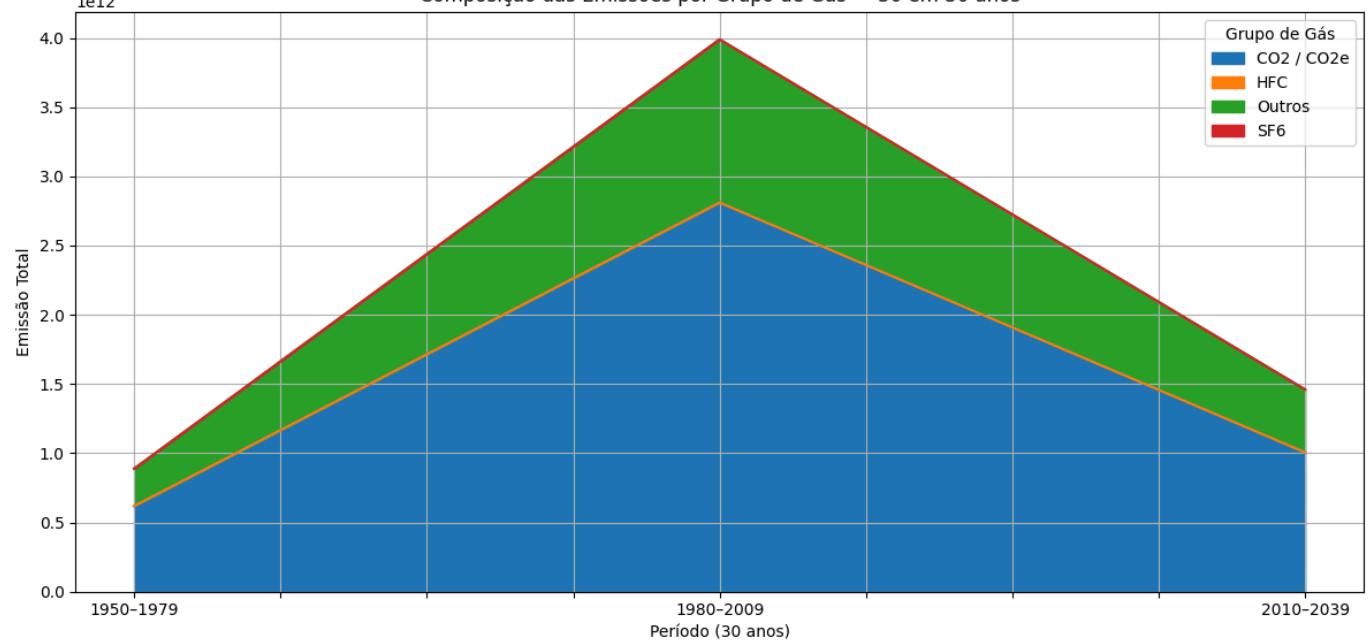
### Composição das Emissões por Grupo de Gás — 5 em 5 anos

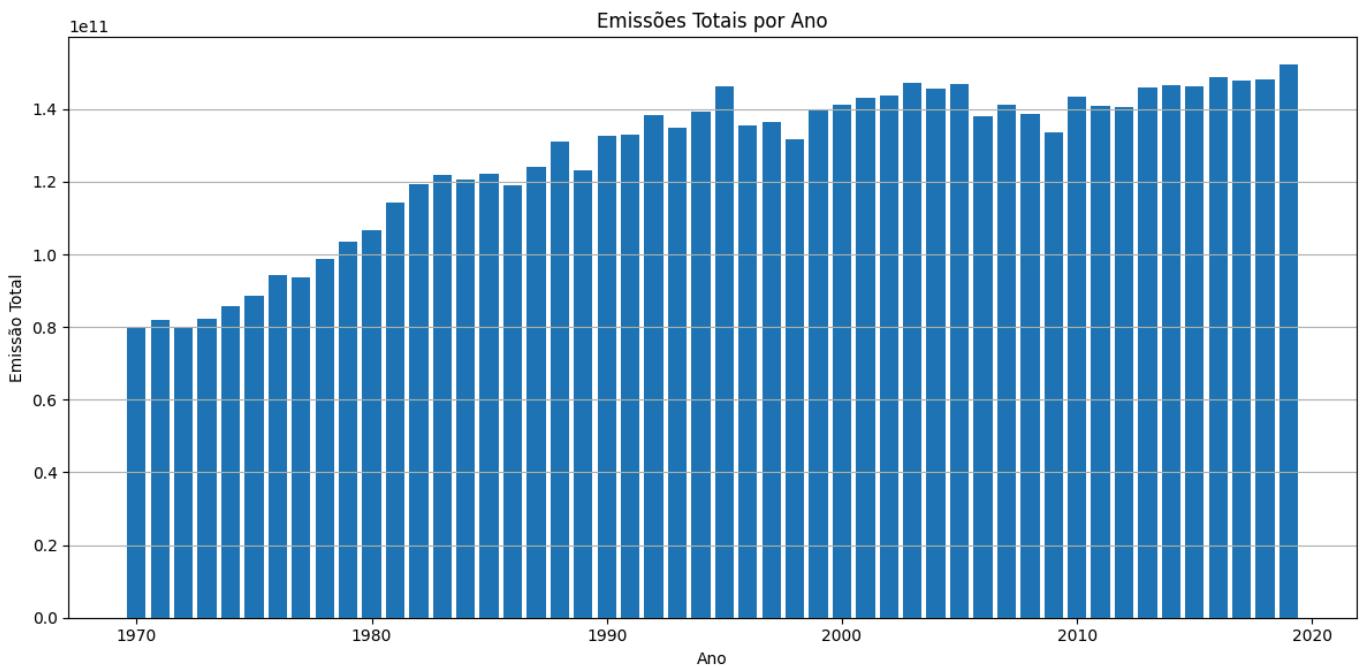


### Composição das Emissões por Grupo de Gás — 10 em 10 anos



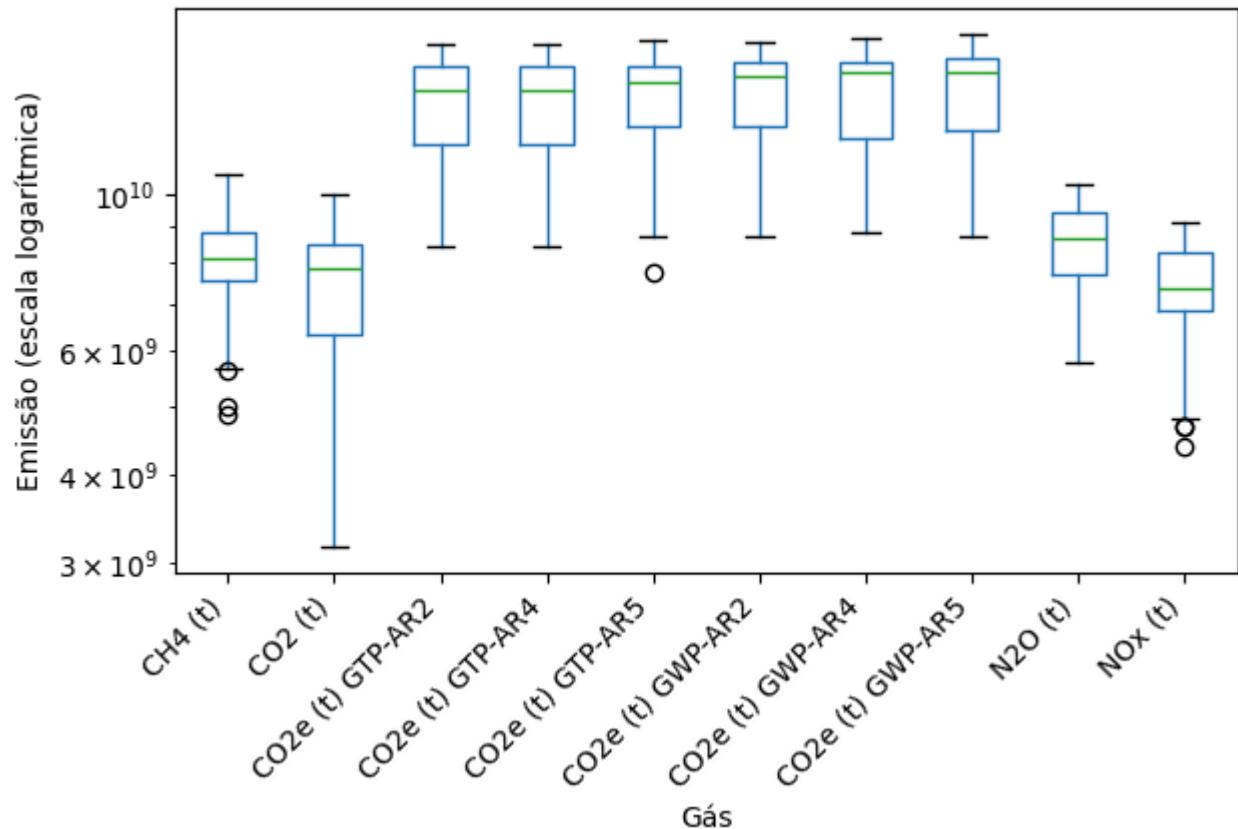
### Composição das Emissões por Grupo de Gás — 30 em 30 anos





<Figure size 1400x600 with 0 Axes>

Distribuição das Emissões por Gás (Top 10)



```
Out[226]: '\nTODO: Célula 14 – Exportação para PDF\nwith open("analisebase.ipynb", encoding="utf-8") as\nf:\n    nb = nbformat.read(f, as_version=4)\n    npdf_exporter = PDFExporter()\n    npdf_exporter.template_name = \'report\'\n    npdf_exporter.latex_engine = \'xelatex\' # essencial para acentos\n    body, resources = pdf_exporter.from_notebook_node(nb)\n    writer = FileSWriter()\n    writer.write\n    (body, resources, notebook_name="análise da base de dados emissões do brasil")\n'
```