

**Disciplina: PEN5002 – Recursos e oferta de energia**

# Usinas geotérmicas em operação/potencias (mundial, ALC e Brasil)

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**Docente:** Célio Bermann

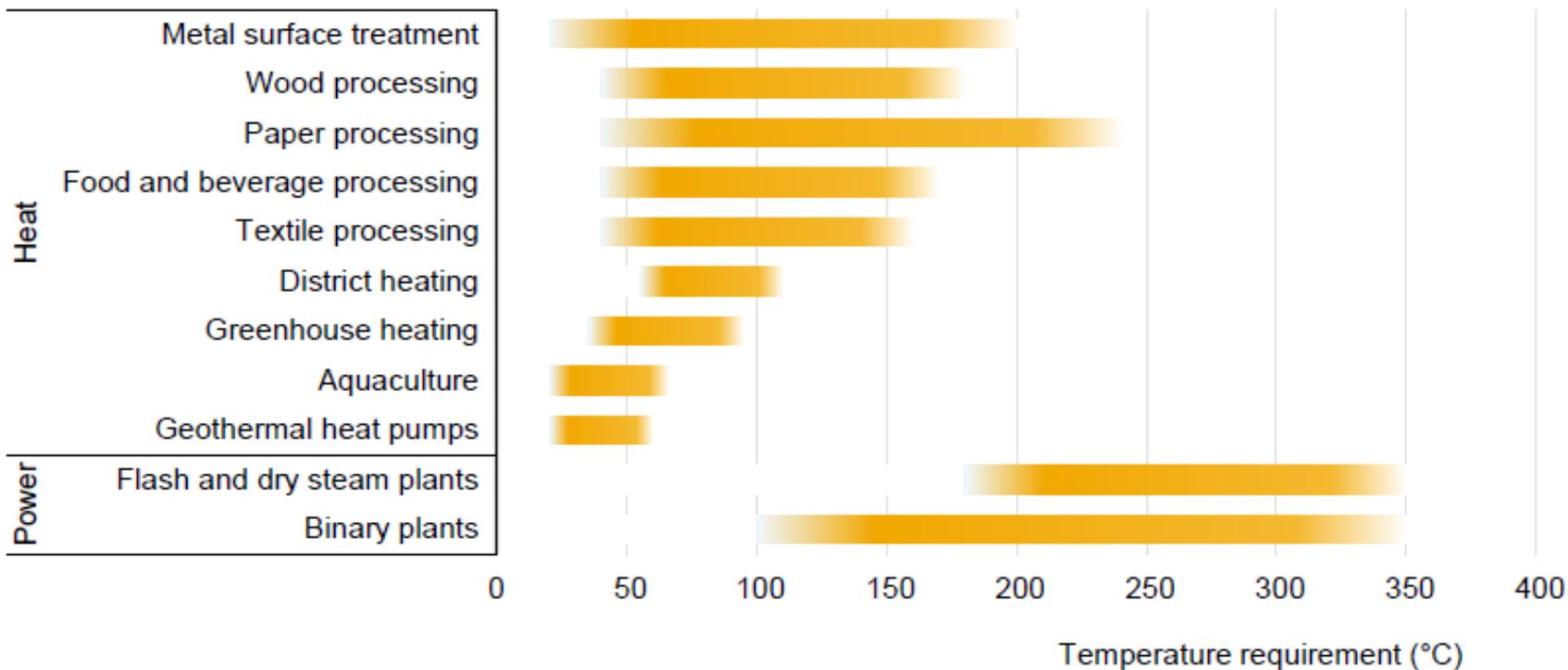
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## SUMÁRIO

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- Mundial
  - América Latina e Caribe
  - Brasil
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## REQUISITOS DE TEMPERATURA PARA POSSÍVEIS APLICAÇÕES DE ENERGIA GEOTÉRMICA



IEA. CC BY 4.0.

Sources: IEA analysis based on data from Arpagaus, C. et al. (2018), [High Temperature Heat Pumps](#); US DOE (2019), [GeoVision](#).

Fonte: IEA (2024).

Geothermal energy  
Énergie géothermique  
Energía geotérmica

CAP (MW)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
<b>World</b>	<b>11 843</b>	<b>12 169</b>	<b>12 754</b>	<b>13 196</b>	<b>13 824</b>	<b>14 165</b>	<b>14 451</b>	<b>14 696</b>	<b>15 092</b>	<b>15 412</b>
<b>Africa</b>	<b>626</b>	<b>660</b>	<b>680</b>	<b>691</b>	<b>691</b>	<b>870</b>	<b>870</b>	<b>957</b>	<b>992</b>	<b>947</b>
Ethiopia	7	7	7	7 e	7 o	7	7	7 o	7	7 e
Kenya	619 o	653 o	673 o	684 o	684 o	863 o	863 o	950 o	985 o	940 o
<b>Asia</b>	<b>3 896</b>	<b>4 001</b>	<b>4 222</b>	<b>4 376</b>	<b>4 566</b>	<b>4 572</b>	<b>4 732</b>	<b>4 760</b>	<b>5 039</b>	<b>5 113</b>
China	26	26	26	26	26 e					
Chinese Taipei				0 o	0 o	0 o	5 o	5 o	7 o	7 o
Indonesia	1 438 o	1 533 o	1 808 o	1 948 o	2 131 o	2 131 o	2 286 o	2 360 o	2 598 o	2 639 o
Japan	516	526	471	473	481	487	487	437	456	489 o
Philippines	1 916 o	1 916 o	1 916 o	1 928 o	1 928 o	1 928 o	1 928 o	1 932 o	1 952 o	1 952 o
Thailand	0	0	0	0 e	0 o	0 o	0 e	0 e	0 e	0 o
<b>C America + Carib</b>	<b>640</b>	<b>630</b>	<b>665</b>	<b>665</b>	<b>721</b>	<b>722</b>	<b>719</b>	<b>735</b>	<b>740</b>	<b>740</b>
Costa Rica	217 o	207	207	207 o	262 o	262 o	259 o	263 o	263	263 o
El Salvador	204 o	209 o	209 o							
Guadeloupe	15	15 o	15 u	15 o	15 e	15 e				
Guatemala	49	49	49	49 o	52 o	49 e				
Honduras			35 o	35 o	35 o	39				
Nicaragua	155	155	155	155 o	153 o	153 o	153 e	165 o	165 e	165 e
<b>Eurasia</b>	<b>698</b>	<b>895</b>	<b>1 138</b>	<b>1 357</b>	<b>1 596</b>	<b>1 695</b>	<b>1 758</b>	<b>1 773</b>	<b>1 773</b>	<b>1 816</b>
Russian Fed	74 e	74 e	74	74	81	81 e				
Türkiye	624	821	1 064 o	1 283	1 515	1 613 o	1 676	1 691	1 691 o	1 734 o
<b>Europe</b>	<b>1 503</b>	<b>1 507</b>	<b>1 558</b>	<b>1 617</b>	<b>1 622</b>	<b>1 627</b>	<b>1 633</b>	<b>1 640</b>	<b>1 670</b>	<b>1 662</b>
Austria	1	1	1	1	1 e	1 o	0	0	0 o	0 o
Croatia				10	10	10	10	10	10 o	10 o
France	15	16	16	16	16	16	16	16	16 e	16 e
Germany	29	33	32	35	40	40 e	46	52	52	44 o
Hungary			3	3	3	3	3	3	3 o	3 o
Iceland	665	665	710	756	756	756	756	758	788	788 e
Italy	768	767	767	767 e	767	772	772	772	772	772 o
Portugal	25	25	29	29	29	29	29	29 o	29 o	29 o
Romania	0 o	0 o	0	0	0	0	0	0	0	0
<b>European Union</b>	<b>838</b>	<b>842</b>	<b>848</b>	<b>861</b>	<b>866</b>	<b>871</b>	<b>876</b>	<b>882</b>	<b>882</b>	<b>874</b>
<b>N America</b>	<b>3 440</b>	<b>3 441</b>	<b>3 432</b>	<b>3 393</b>	<b>3 529</b>	<b>3 545</b>	<b>3 595</b>	<b>3 647</b>	<b>3 694</b>	<b>3 724</b>
Mexico	898 o	924 o	949 o	949 o	974 o	974 o	999 o	999 o	999 e	999 e
USA	2 542	2 517	2 483 o	2 444 o	2 555 o	2 572 o	2 597 o	2 649 o	2 696	2 725 o
<b>Oceania</b>	<b>1 040</b>	<b>1 035</b>	<b>1 035</b>	<b>1 059</b>	<b>1 059</b>	<b>1 093</b>	<b>1 093</b>	<b>1 100</b>	<b>1 100</b>	<b>1 327</b>
Australia	0	0	0 e	0	0	0	0	0 e	0 e	0 e
New Zealand	990	985	985	1 009	1 009	1 043	1 043	1 050	1 050 e	1 275 u
Papua N Guin	50 e	51 u								
<b>S America</b>			<b>24</b>	<b>40</b>	<b>40</b>	<b>40</b>	<b>51</b>	<b>83</b>	<b>84</b>	<b>84</b>
Chile			24 o	40	40 o	40 o	51	83	84	84 o



**CAPACIDADE INSTALADA (MW)  
POR REGIÃO E PAÍS.**

Fonte: IRENA (2025).

Geothermal energy  
Énergie géothermique  
Energía geotérmica

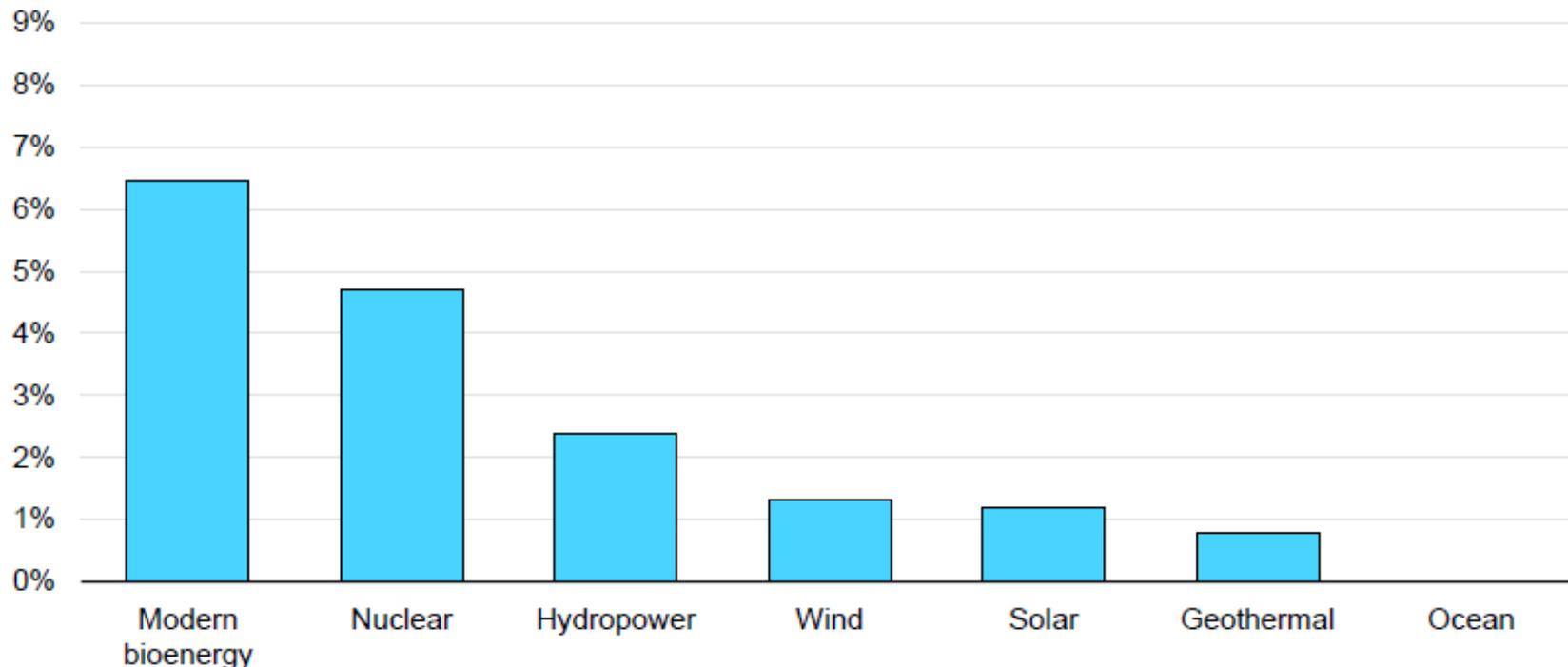
PROD (GWh)	2015	2016	2017	2018	2019	2020	2021	2022	2023
<b>World</b>	<b>81 229</b>	<b>83 241</b>	<b>86 705</b>	<b>89 465</b>	<b>92 002</b>	<b>95 453</b>	<b>94 618</b>	<b>97 277</b>	<b>98 159</b>
<b>Africa</b>	<b>4 481</b>	<b>4 689</b>	<b>4 870</b>	<b>5 168</b>	<b>5 384</b>	<b>5 385</b>	<b>5 183</b>	<b>5 727</b>	<b>6 086</b>
Ethiopia								29	
Kenya	4 481 o	4 689 o	4 870 e	5 168 e	5 384 e	5 385	5 183 e	5 698 e	6 086
<b>Asia</b>	<b>23 832</b>	<b>24 372</b>	<b>25 636</b>	<b>27 123</b>	<b>27 783</b>	<b>29 458</b>	<b>29 077</b>	<b>30 252</b>	<b>31 234</b>
China	144	144	144	144	144 e	144 e	144 e	144 e	144
Chinese Taipei				0 o	1 o	2 o	9 o	25 o	23
Indonesia	10 048 o	10 656 o	12 764 o	14 019 o	14 100 o	15 563 o	15 899 o	16 677 o	16 936
Japan	2 595	2 501	2 457	2 524	2 847	2 992	3 008	2 980	3 400
Philippines	11 044	11 070 o	10 270 o	10 435 o	10 691 o	10 757 o	10 016 o	10 425 o	10 730
Thailand	1 o	1 o	2 o	1 o	1 o	1 o	1 o	1 o	1
<b>C. America + Carib</b>	<b>3 927</b>	<b>3 994</b>	<b>3 896</b>	<b>3 969</b>	<b>4 432</b>	<b>4 709</b>	<b>4 592</b>	<b>4 603</b>	<b>4 513</b>
Costa Rica	1 376 o	1 340 o	1 118 o	969	1 513	1 689 o	1 602 o	1 619 o	1 479
El Salvador	1 540	1 576	1 569 o	1 545	1 474	1 557 o	1 559 o	1 581	1 595
Guadeloupe	83	84 o	112 o	107 o	109 o	115	84 o	96 o	111
Guatemala	252 o	289 o	253 o	262	274 o	265 o	265 o	282 o	285
Honduras			93	297	296	307	348 o	337 o	291
Nicaragua	678 o	706 o	751 o	801 o	778 o	767 o	734 o	687 o	751
<b>Eurasia</b>	<b>3 882</b>	<b>5 264</b>	<b>6 562</b>	<b>7 857</b>	<b>9 384</b>	<b>10 449</b>	<b>11 223</b>	<b>11 568</b>	<b>11 551</b>
Russian Fed	457 e	446 e	435 e	426 e	433 e	421 e	430 e	449 e	449
Türkiye	3 425	4 819	6 127	7 431	8 952	10 028	10 793	11 119 o	11 102
<b>Europe</b>	<b>11 617</b>	<b>11 800</b>	<b>11 885</b>	<b>12 665</b>	<b>12 744</b>	<b>12 678</b>	<b>12 340</b>	<b>12 344</b>	<b>12 266</b>
Austria	0	0	0	0	0	0	0	0	0
Croatia				2	92	94	90	73	21
France	92	98	133	127	128	133	100	114	129
Germany	133	175	163	178	197	231	244	206	195
Hungary			1	12	18	16	12	4	16
Iceland	5 003	5 067	5 170	6 010	6 018	5 961	5 802	5 916	6 006
Italy	6 185	6 289	6 201	6 105	6 075	6 026	5 914	5 837	5 692
Portugal	204	172	217	230	215	217	179	195	208
Romania	0	0							
<b>European Union</b>	<b>6 614</b>	<b>6 733</b>	<b>6 715</b>	<b>6 655</b>	<b>6 726</b>	<b>6 717</b>	<b>6 538</b>	<b>6 428</b>	<b>6 260</b>
<b>N America</b>	<b>25 058</b>	<b>24 732</b>	<b>25 388</b>	<b>24 149</b>	<b>23 716</b>	<b>24 158</b>	<b>23 337</b>	<b>23 678</b>	<b>23 821</b>
Mexico	6 331	6 148	6 662 o	5 375 o	5 352 o	5 327 o	4 260 o	4 536 o	4 321
<b>USA</b>	<b>18 727</b>	<b>18 584</b>	<b>18 726</b>	<b>18 774</b>	<b>18 364</b>	<b>18 831</b>	<b>19 077</b>	<b>19 142</b>	<b>19 500</b>
<b>Oceania</b>	<b>8 433</b>	<b>8 389</b>	<b>8 404</b>	<b>8 319</b>	<b>8 357</b>	<b>8 400</b>	<b>8 542</b>	<b>8 640</b>	<b>8 320</b>
Australia	1		1						
New Zealand	8 214	8 202	8 246	8 193	8 261	8 304	8 446	8 544	8 224
Papua N Guin	218 e	187 e	157 e	126 e	96 u	96 e	96 e	96 o	96
<b>S America</b>			<b>64</b>	<b>214</b>	<b>202</b>	<b>216</b>	<b>324</b>	<b>467</b>	<b>368</b>
Chile			64	214	202	216 o	324 o	467	368



**PRODUÇÃO (GWh) POR REGIÃO E PAÍS**

## PARTICIPAÇÃO DAS TECNOLOGIAS DE BAIXO CARBONO NA DEMANDA TOTAL DE ENERGIA – 2023

### CONTRIBUIÇÃO DE 17% DO TOTAL MUNDIAL



IEA. CC BY 4.0.

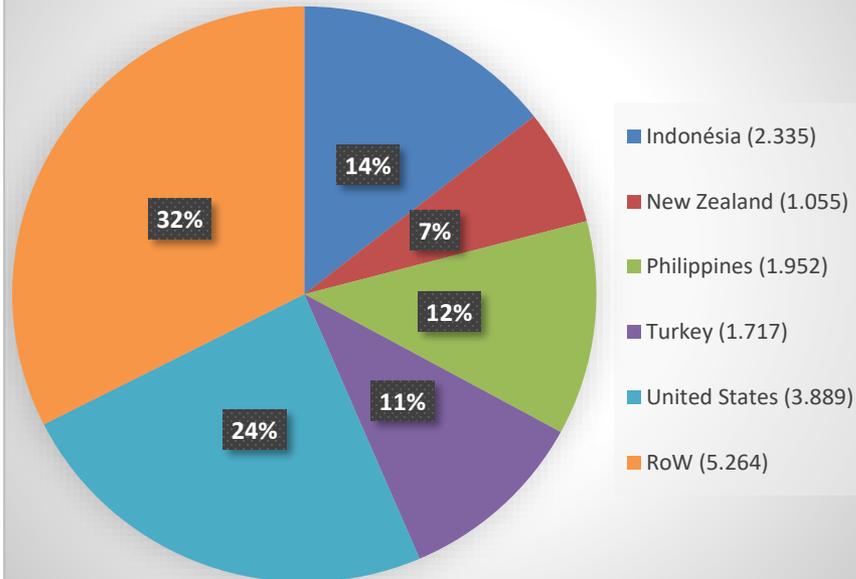
Notes: Values exclude geothermal heat harnessed by ground-source heat pumps, which is not included in official IEA statistics. However, estimates of geothermal heat from ground-source heat pumps derived from modelling are included in the heat discussion below, as well as in the outlook section. “Modern bioenergy” includes all bioenergy in the form of liquids (ethanol, biodiesel and biojet fuel), gases (biogas and biomethane) and solids, excluding the traditional use of solid bioenergy such as a three-stone fire or basic improved cook stoves (ISO tier < 3), often with no or poorly operating chimneys.

Source: IEA (2024), [World Energy Balances](#).

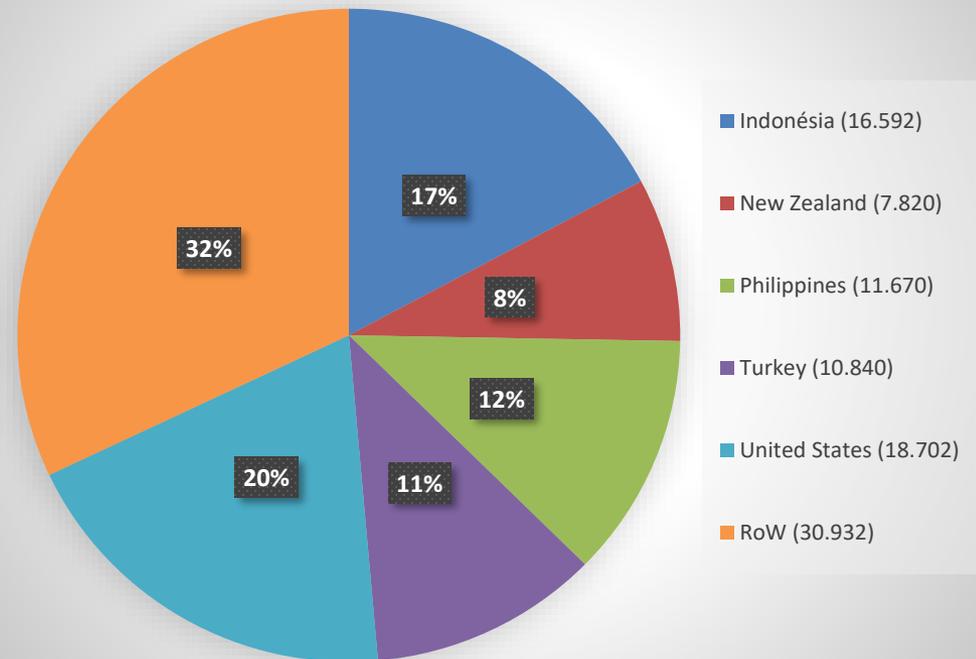
Fonte: IEA (2024).

## IGA Power Data – International Geothermal Institute

**Capacidade Instalada (16.211 MW)**



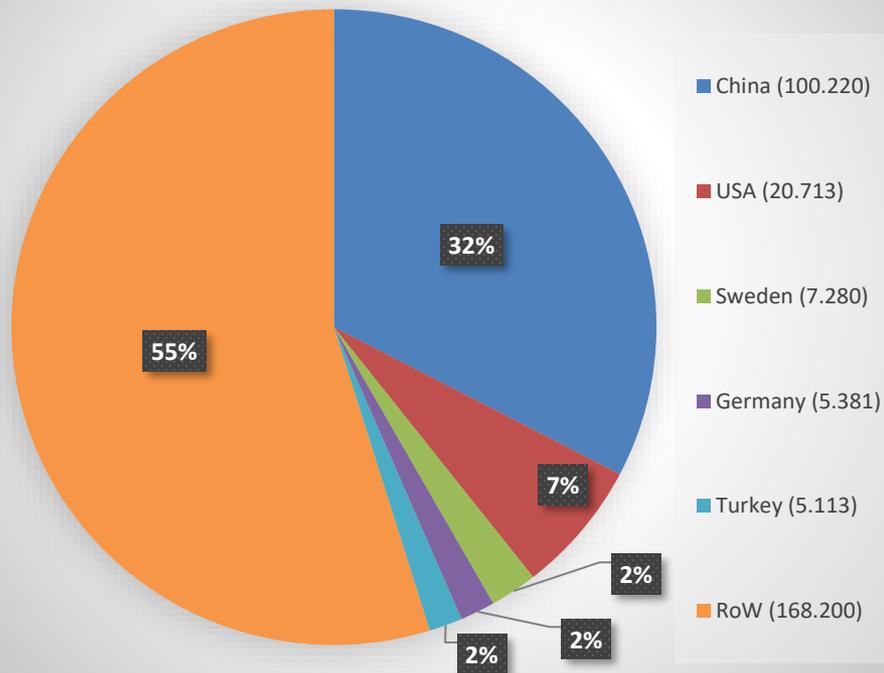
**Geração Elétrica (96.556 GW/h)**



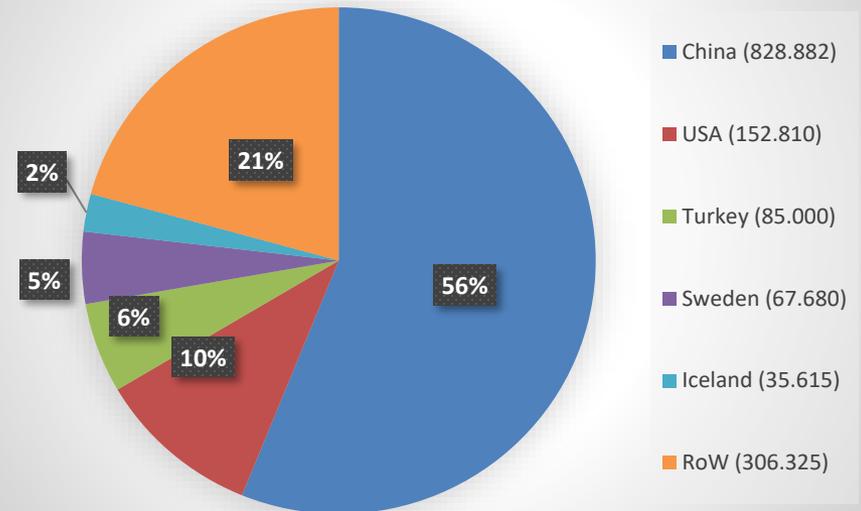
Fonte: IGA (2025).

## IGA Power Data – International Geothermal Institute – 2023

**Total Instalado (306.907 MWt)**



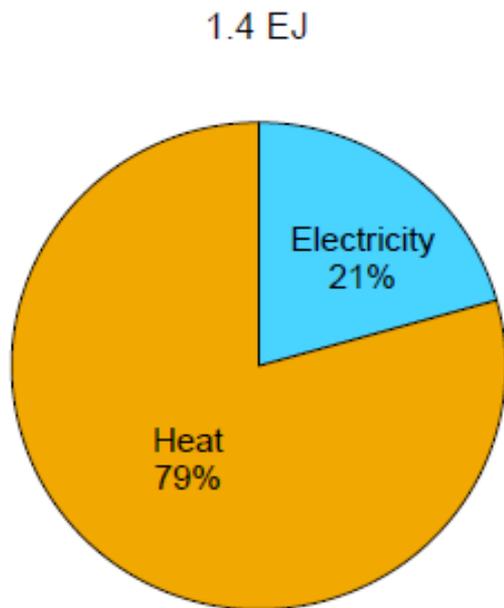
**Total Produzido (1.476.312 TJ/y)**



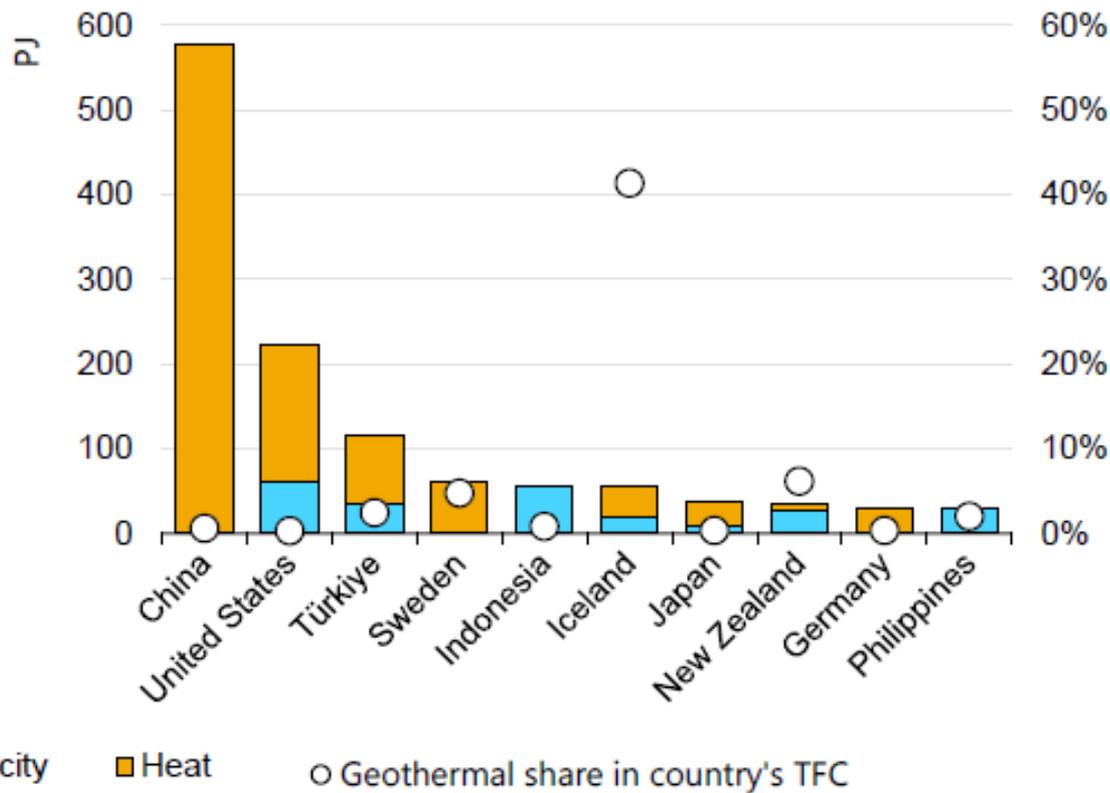
Fonte: IGA (2025).

# CONSUMO TOTAL DE ENERGIA POR APLICAÇÃO (TFEC)

## Mundial



## 10 Maiores Consumidores



IEA. CC BY 4.0.

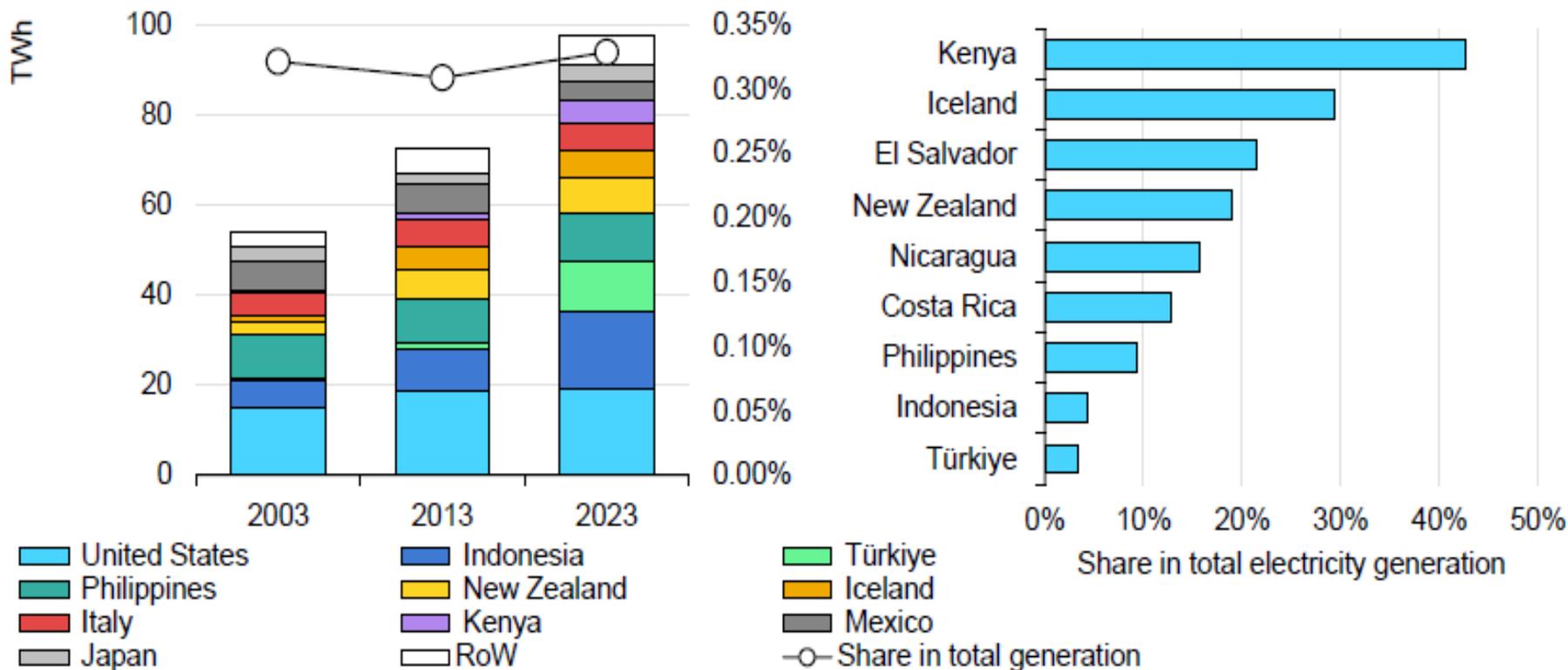
Notes: TFEC = total final energy consumption. EJ = exajoule. PJ = petajoule. Heat consumption includes an estimate for ground-source heat pumps that is not included in IEA direct heat consumption statistics.

Sources: IEA (2024), [World Energy Balances](#); IEA (2024), [World Energy Outlook 2024](#).

Fonte: IEA (2024).

## GERAÇÃO ELÉTRICA GEOTERMICA – 2003-2023

## PARTICIPAÇÃO GEOTERMICA SUPRIMENTO ELÉTRICO – 2023



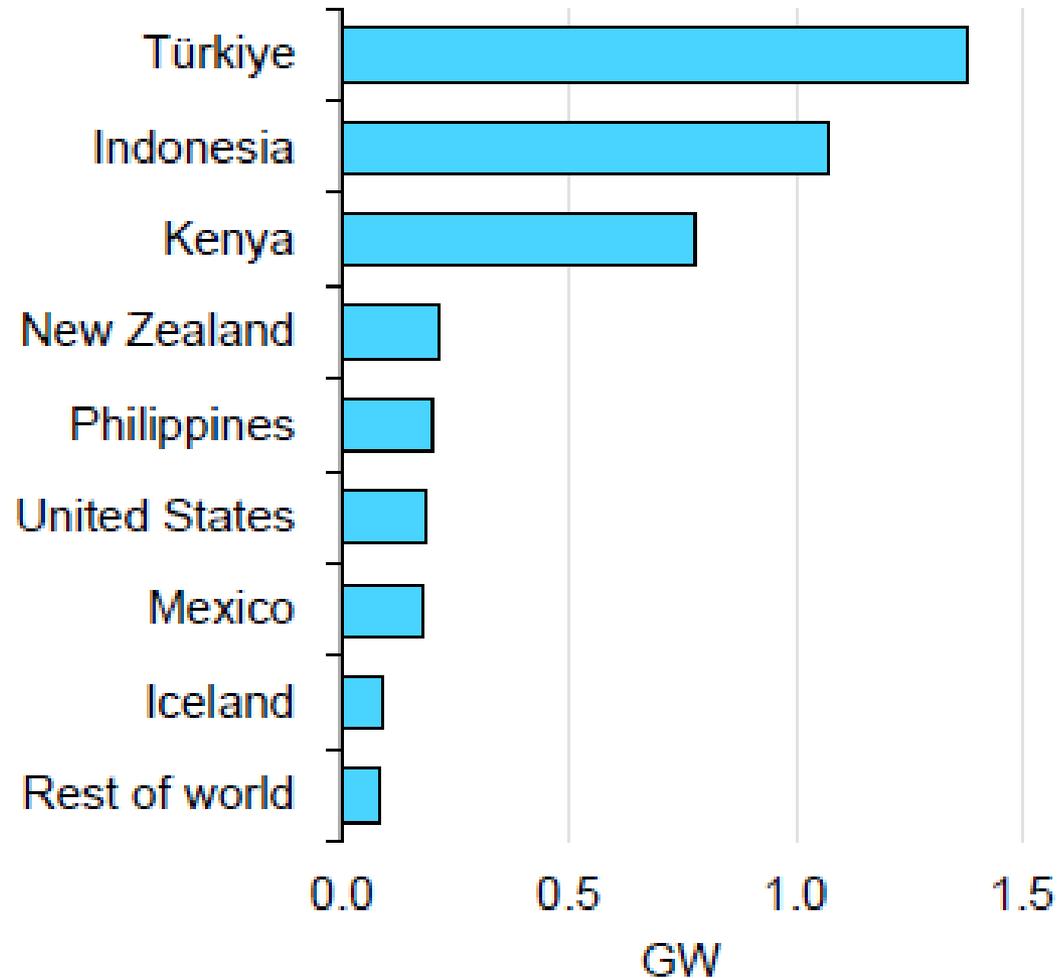
IEA. CC BY 4.0.

Note: RoW = rest of world.

Source: IEA (2024), [World Energy Balances](#).

Fonte: IEA (2024).

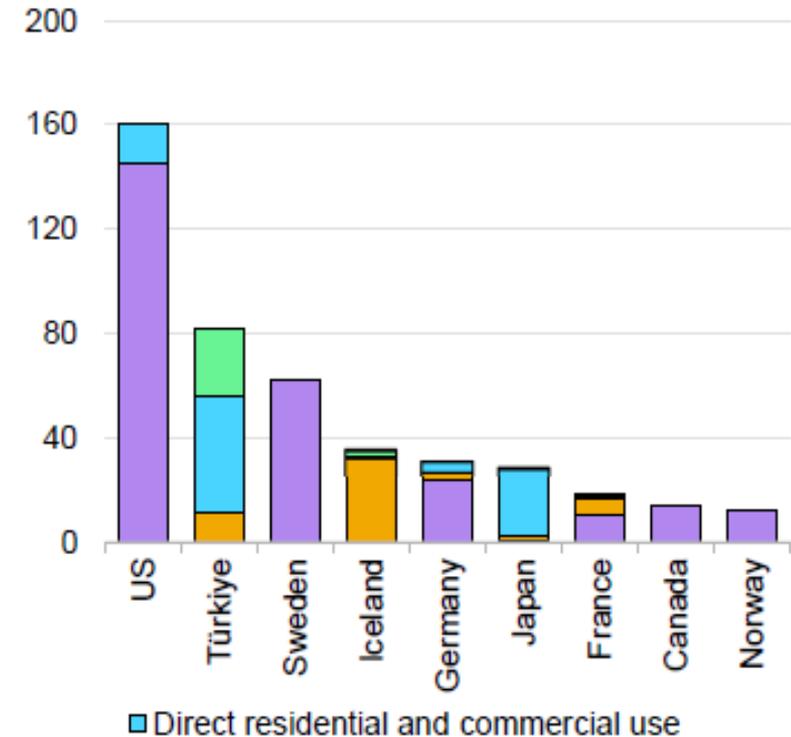
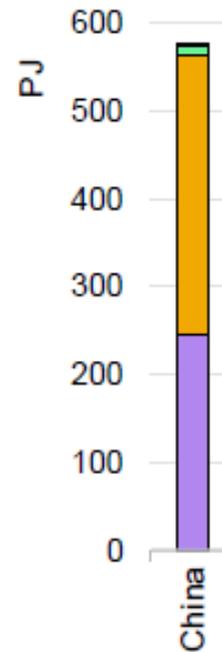
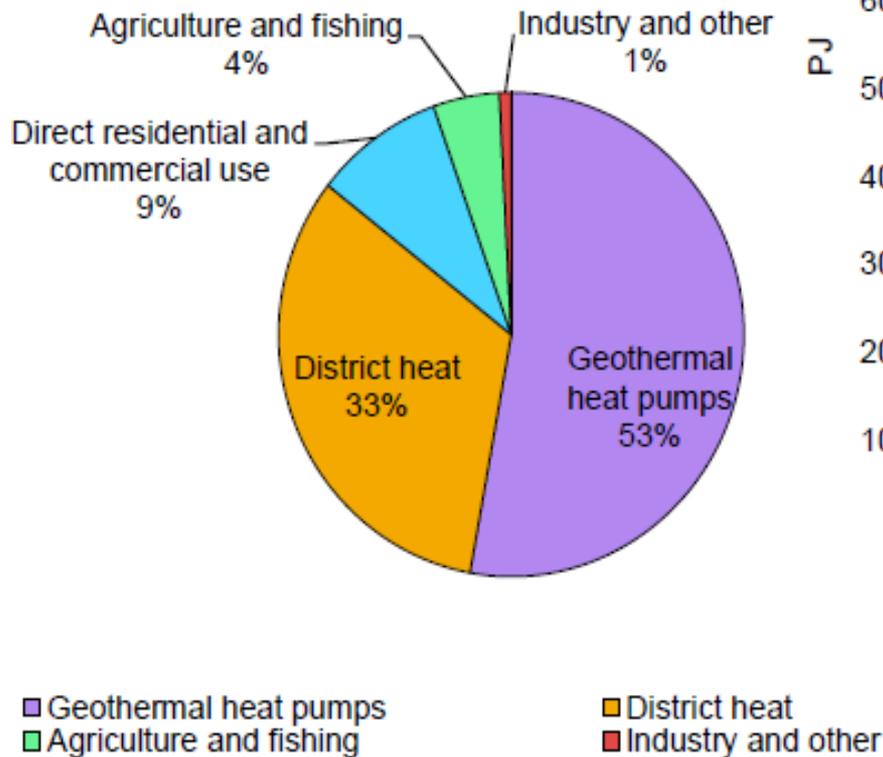
## AUMENTO DA CAPACIDADE DE ENERGIA GEOTÉRMICA LÍQUIDA NOS PRINCIPAIS PAÍSES 2013-2023



Fonte: IEA (2024).

# ENERGIA GEOTERMICA DIRETA E INDIRETA CONSUMIDA PARA AQUECIMENTO E REFRIGERAÇÃO (MUNDIAL)

## 10 MAIORES CONSUMIDORES



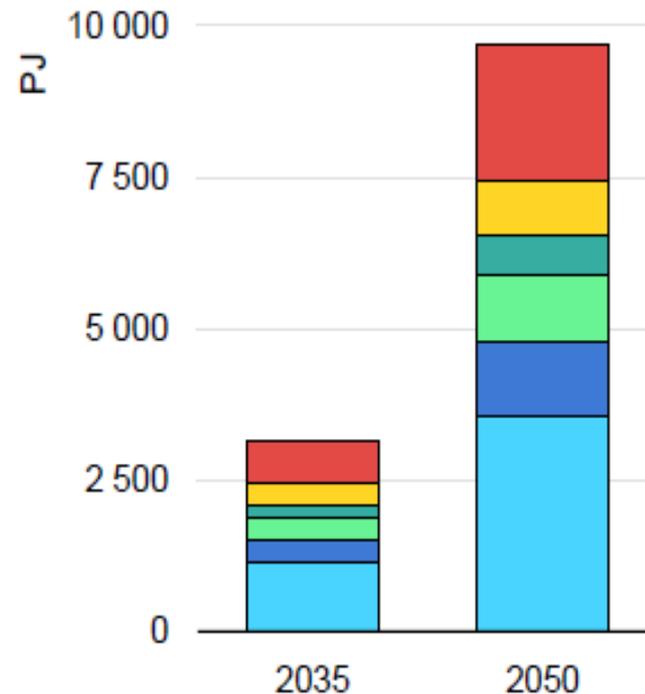
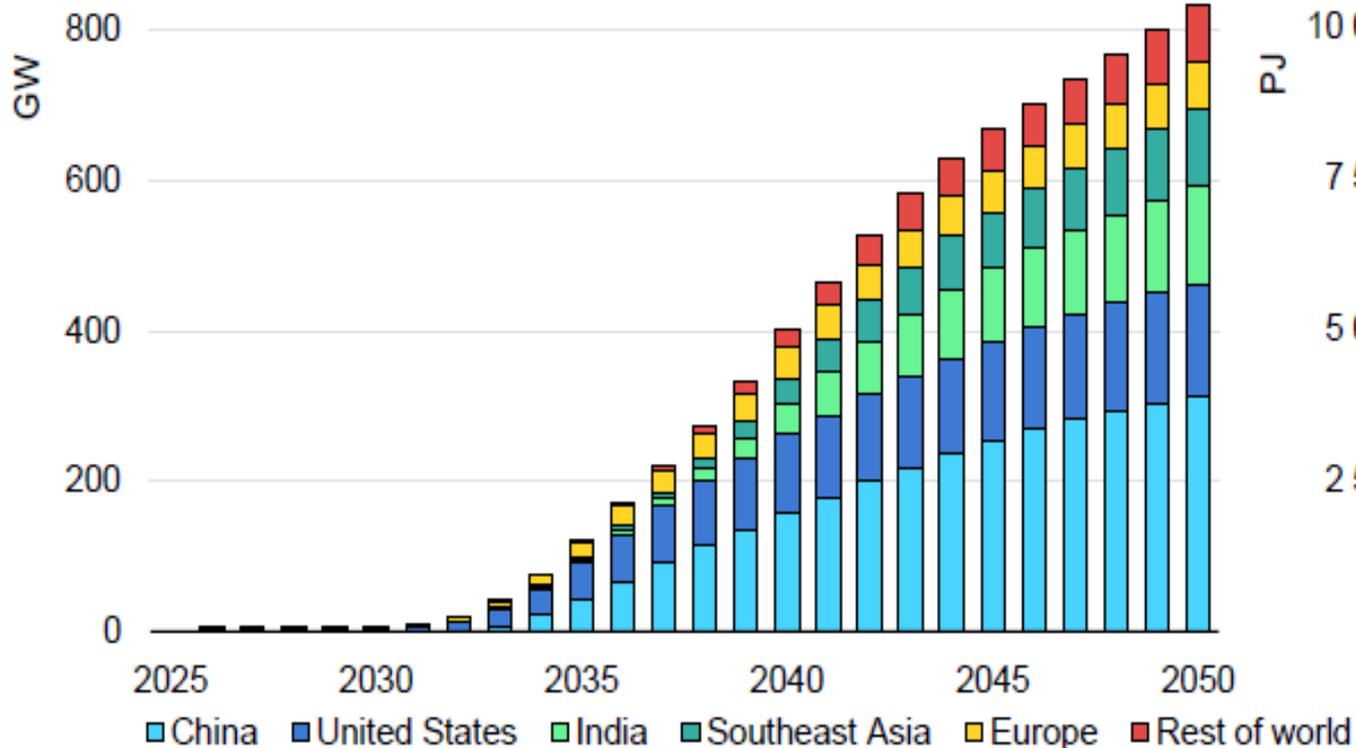
2023

IEA. CC BY 4.0.

Note: "Direct residential and commercial use" includes space and water heating, bathing and swimming, and snow-melting.

## MERCADO POTENCIAL PARA CAPACIDADE DE ENERGIA GEOTÉRMICA PARA A PRÓXIMA GERAÇÃO

## CALOR NA INDÚSTRIA

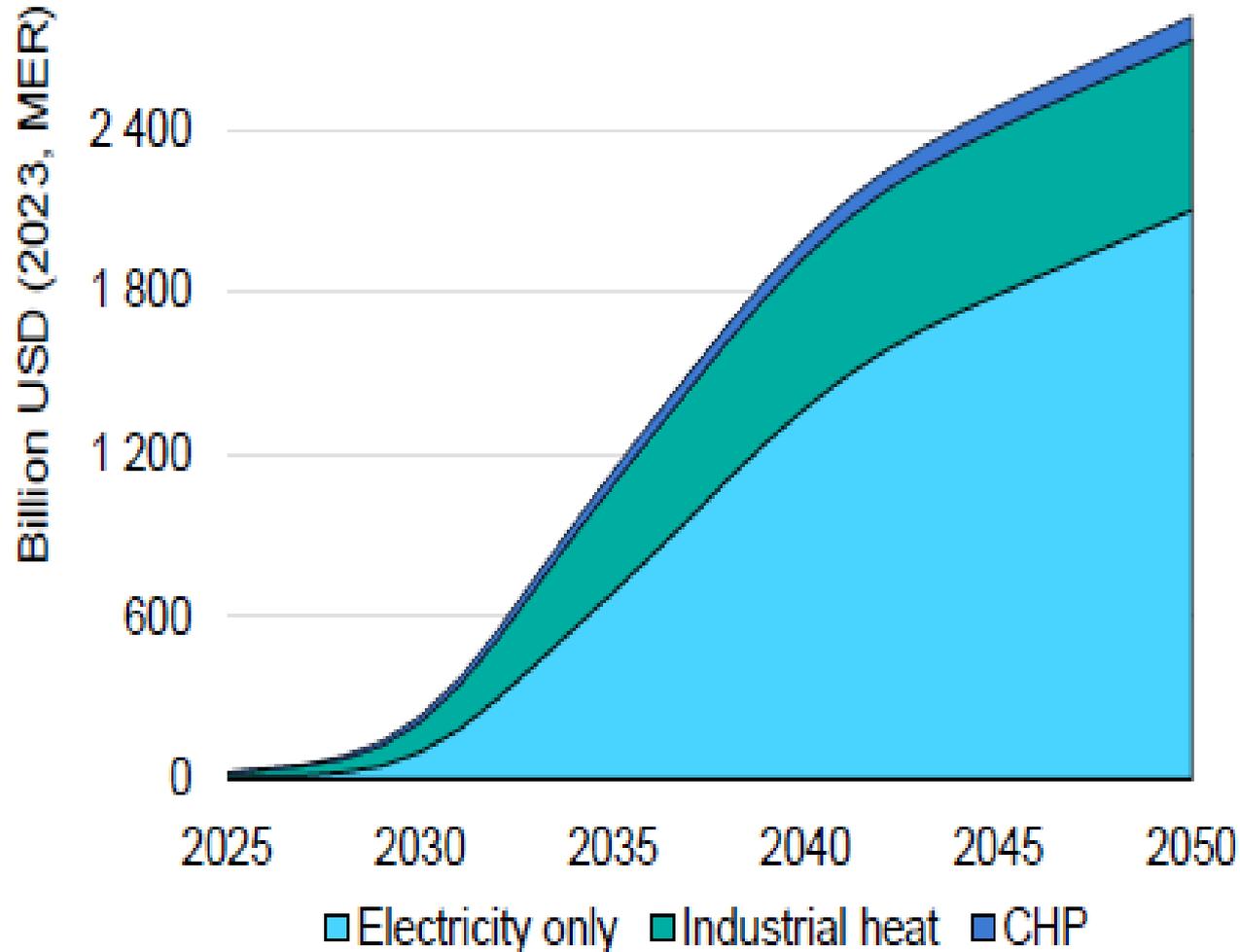


2025 - 2050

Fonte: IEA (2024).

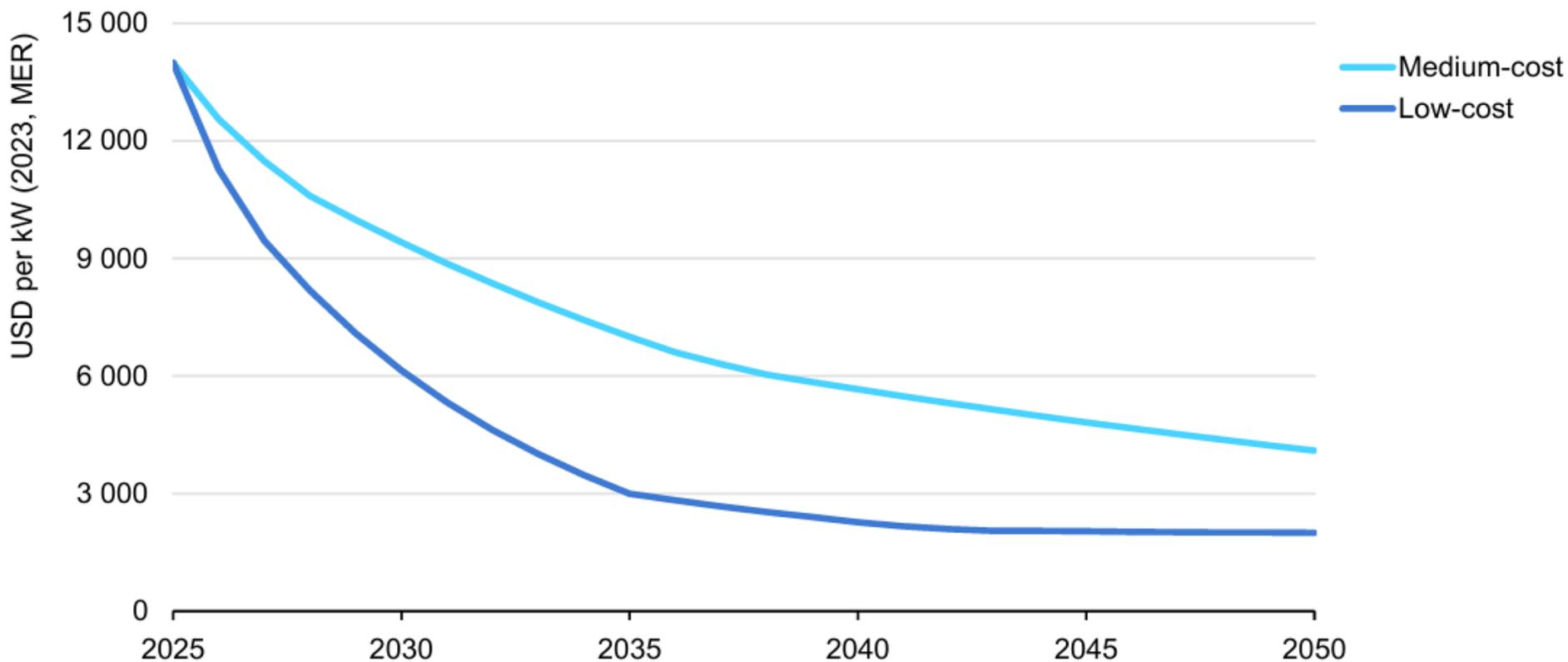
## MERCADO POTENCIAL GEOTÉRMICO PARA A PRÓXIMA GERAÇÃO, 2025-2050

### INVESTIMENTOS CUMULATIVOS



Fonte: IEA (2024).

## CUSTO MÉDIO DE INSTALAÇÃO GEOTÉRMICA, 2025-2050



IEA. CC BY 4.0.

Notes: MER = market exchange rate. Costs shown are for projects with an average size of 300 MW; depth of 3 km; temperature of 200°C in suitable conditions.

Fonte: IEA (2024).

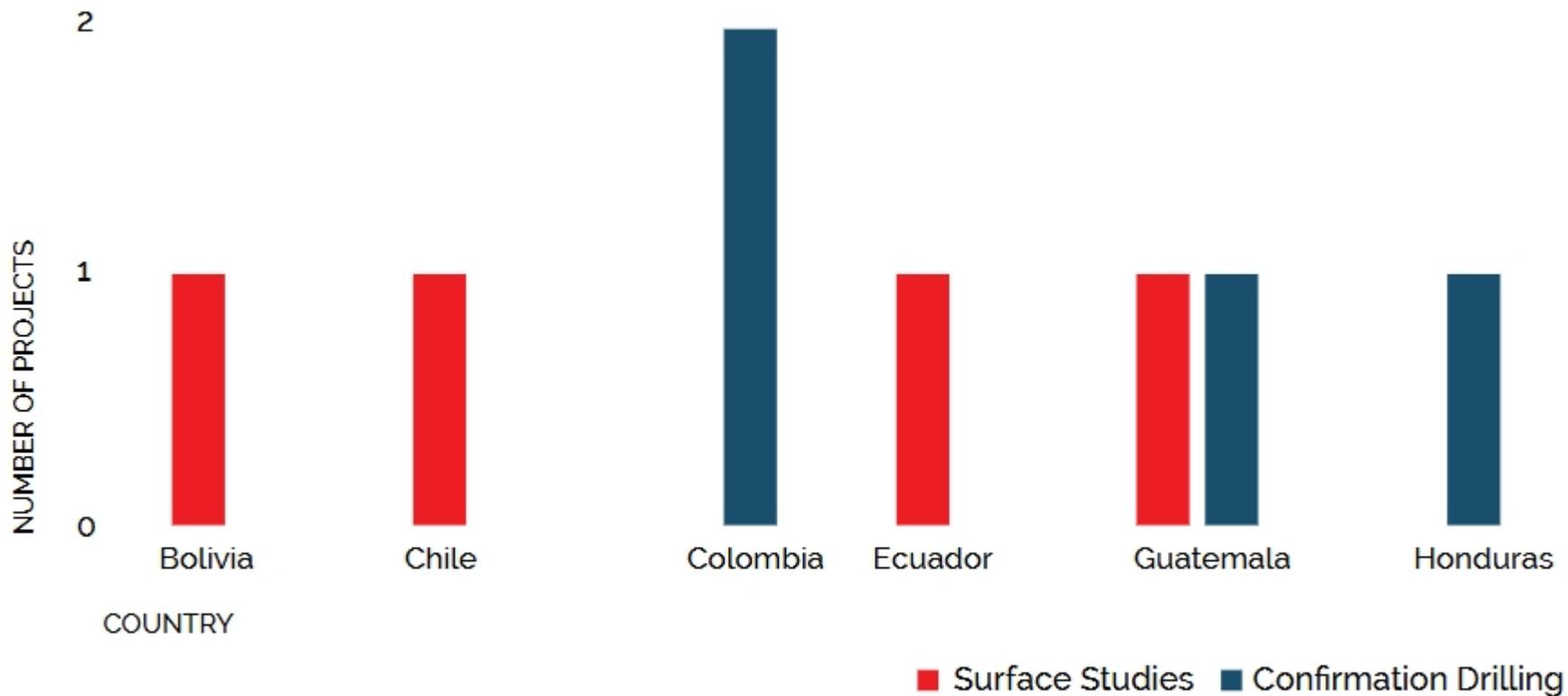
- **AMERICA LATINA E CARIBE**

# CAPACIDADE GEOTÉRMICA INSTALADA: AMERICA LATINA E CARIBE – Jun/2020



## NOVOS PROJETOS

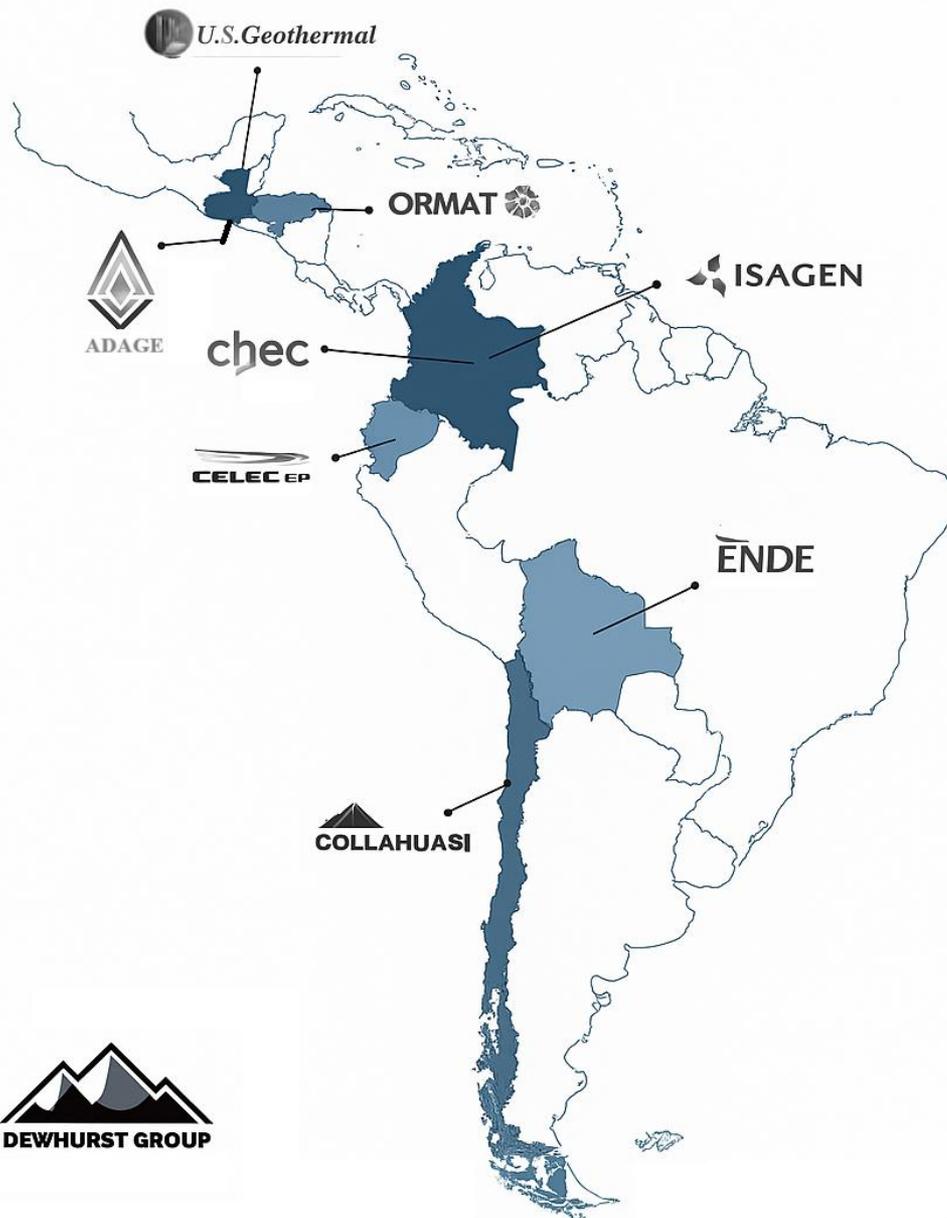
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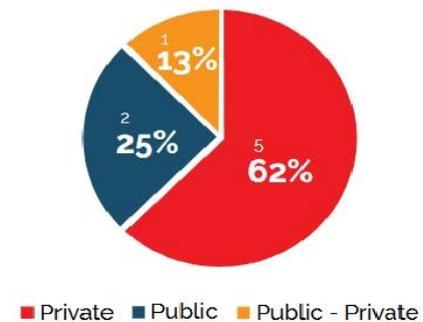
Fonte: IADB (2020).

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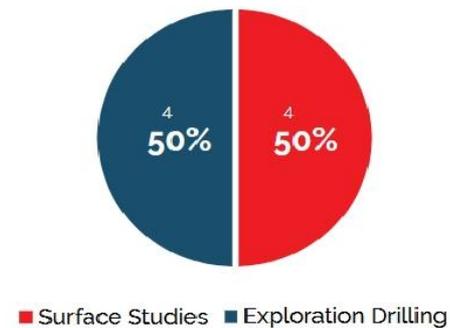
# PROGRAMAS DE FINANCIAMENTO



ORGANIZATION TYPE



GRANT TYPE



Fonte: IADB (2020).

## BRASIL

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- **Geração elétrica:** praticamente inexistente (não há usinas geotérmicas comerciais).
  - **Uso térmico direto:** ainda limitado (bombas de calor, balneários, agro)—sem dados consolidados.
  - **Potencial significativo:** identificado em bacias sedimentares, regiões de gradiente elevado, mas ainda pouco explorado.
-



## AQUECIMENTO E REFRIGERAÇÃO GEOTÉRMICA

Categoria	Instalado (MWt)	Produzido (TJ/ano)
Agricultura	1,00	20,00
Industria	4,20	77,00
Saúde	355,90	6.545,40
Aquecimento	2,35	40,30
Outros	0,00	0,00
Total	363,45	6.682,70

Sem dados disponíveis para Produção de Energia

Fonte: IGA (2025).

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State / Region	N <sub>R</sub>	Te (°C)	RBUA (10 <sup>9</sup> J)	RRUA (10 <sup>9</sup> J)
Santa Catarina	23	86.2	263.0	20.6
Goiás	14	96.1	286.3	18.9
Minas Gerais	60	71.7	231.6	18.1
Mato Grosso	24	70.3	235.1	17.4
Tocantins	31	70.2	225.9	14.4
Ceará	10	97.9	285.7	14.3
Mato Grosso do Sul	7	75.6	256.1	12.8
Bahia	25	50.9	183.1	12.7
Sergipe	11	86.2	255.0	12.8
Alagoas	9	78.9	233.5	11.7
Paraná	39	76.2	227.3	11.4
São Paulo	69	74.0	217.9	10.9
Rio Grande do Sul	15	75.4	211.4	10.6
Amazonas	72	69.1	205.4	10.6
Maranhão	25	70.1	203.1	10.2
Rio Grande do Norte	14	66.8	202.3	10.1
Pará	40	65.0	192.1	9.6
Rio de Janeiro	27	62.0	179.9	9.0
Piauí	4	56.1	165.2	8.3
Acre	4	49.3	114.8	7.2
Amapá	2	61.3	102.1	5.1
Pernambuco	1	42.5	42.5	2.1
Paraíba	5	25.4	26.7	1.3
Rondônia	7	26.6	26.6	1.3
Roraima	1	26.1	26.1	1.3
Espirito Santo	6	43.3	15.5	0.8
<b>Average</b>			<b>201</b>	<b>11.8</b>

- NR - Número de reservatórios identificados.
- Te (°C) - Temperatura média estimada da água/rocha (grau de aproveitamento térmico).
- RBUA (10<sup>9</sup> J) - Recursos Brutos Utilizáveis Anuais – potencial energético bruto disponível.
- RRUA (10<sup>9</sup> J) - Recursos Recuperáveis Utilizáveis Anuais – energia que efetivamente poderia ser aproveitada, considerando perdas e limitações técnicas.

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**Obrigado!**

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