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4 Abstract

5 Introduction: There are times when crises provide more eloquent warnings about unattended
6 problems than all discourses and learned studies. The crisis detonated almost 15 years ago by
7 the gas supply cutoff from Argentina, awakened Chile to its perilous vulnerability resulting
8 from its growing (and excessive) dependence on a single source of energy supply. This
9 situation also triggered the opportunity to start addressing emerging issues, particularly
10 environmental concerns. To this end, a simple ?benchmarking? exercise was undertaken to
11 enable Chilean power sector stakeholders to learn from what other countries have done in
12 their energy programs in terms of their: (i) impact or results; (ii) all-in costs; and (iii)
13 required institutional arrangements for implementation. The results were eye-opening.
14 Whereas countries like Germany embarked on an ambitious recasting of their energy matrix,
15 others followed a more gradualist and organic approach to increase their share of renewables.
16 The former approach, required a solid top-down and disciplined investment effort, resulting in
17 a significant change in the energy matrix, though at a major cost and increased energy risks,
18 which became evident early on the Ukrainian war, when gas supplies were significantly
19 curtailed, triggering an important energy crisis. There were others that acted more gradually,
20 and hedging through some degree of diversification the risks of misjudging energy demand
21 forecasts.

22

23 *Index terms—*

24 1 Energy Transition in Unsettled Times

25 2 Miguel Schloss

26 A Front Row View of What Chile Learned from the World, and the World Can Learn from Chile

27 3 I. Summary and Introduction

28 Seeing through the fog in front of us . To this end, a simple "benchmarking" exercise was undertaken to enable
29 Chilean power sector stakeholders to learn from what other countries have done in their energy programs in terms
30 of their: (i) impact or results; (ii) all-in costs; and (iii) required institutional arrangements for implementation.

31 The results were eye-opening. Whereas countries like Germany embarked on an ambitious recasting of their
32 energy matrix, others followed a more gradualist and organic approach to increase their share of renewables. The
33 former approach, required a solid top-down and disciplined investment effort, resulting in a significant change
34 in the energy matrix, though at a major cost and increased energy risks, which became evident early on the
35 Ukrainian war, when gas supplies were significantly curtailed, triggering an important energy crisis. There were
36 others that acted more gradually, and hedging through some degree of diversification the risks of misjudging
37 energy demand forecasts.

38 When discussing these outcomes with Chilean civil society organizations, environmental NGOs, utilities, most
39 stakeholders particularly final consumers centered their concerns on affordability (fancy programs being OK, but
40 "not with my money"), energy security and compatibility with the institutional capabilities in the country. In
41 contrast with the top-down framework implied in international meetings, the approach chosen in Chile centered on
42 "crowding in" the private sector for investments, rather than stretching an already overextended (and consequently
43 slow) public sector for such task. This approach in effect encouraged the Authorities to center their attention
44 on creating business conditions through pricing, taxation and other conditions that could be instrumental in

6 III. MOVING FROM EXHORTATION TO ACTIONS AND OUTCOMES

45 attracting financial and human resources from the private sector to finance and manage investments that otherwise
46 would be difficult to handle, given the institutional limitations and fiscal constraints.

47 The progress (as described in section V, below) speaks for itself. It does not, however provide for longerterm
48 assurance of continued enhancement, since the very success "crowds in" new players and solutions. This generates
49 potential new sources of competition and other conditions that require further adjustment in the enabling and
50 regulatory environment, which becomes difficult to accommodate when vested interests and inertia constrain
51 adaptation of governance arrangements defended by incumbents.

52 In all, though, Chile has been ranked among the five best performing countries in terms of the increases
53 attained of renewables in overall energy supply, leaving however a steep and more complex road ahead.

54 4 II. Taking Stock

55 5 Seeking Collaboration through Institutional Compulsions. 56 Alignment of Interests

57 Much of international discourse hinges on the premise that issues stemming from global warming are of such
58 magnitude and complexity that they require collective and collaborative efforts to address them in a meaningful
59 way. 1 Not surprisingly:

60 ? International debates tend to be steered by government institutions, international and multilateral
61 organizations (UNFP, IEA, and various multilaterals), which for the most part have a public sector focus for
62 problem solving. here are times when crises provide more eloquent warnings about unattended problems than
63 all discourses and learned studies. The crisis detonated almost 15 years ago by the gas supply cutoff from
64 Argentina, awakened Chile to its perilous vulnerability resulting from its growing (and excessive) dependence
65 on a single source of energy supply. This situation also triggered the opportunity to start addressing emerging
66 issues, particularly environmental concerns.

67 T projects, set standards to be achieved, and resources required to be committed.

68 In the absence of institutions with genuine implementation experience and responsibilities, it has become
69 almost inevitable that projections endorsed by global institutions tend to rely on aggressive assumptions and
70 "tortured" modelling to meet desirable lower emission goals. Feasibility seems to take secondary importance.

71 It shouldn't thus be surprising to see significant shortfalls from agreed targets. The tendency to seek stretch
72 goals (with limited attention to implementation requirements or feasibility), tends to focus debates on the need
73 for pushing harder to mobilize more financial resources, that others not present in the meetings are unable (or
74 unwilling) to defray.

75 However, with considerable resource requirements for meeting identified needs, and competing claims for major
76 pent-up adjustments requirements (like economic reactivation following Covid shut-downs) no county or entity
77 seems to be in a position to effectively respond. Under the circumstances, pledges are easy to make, but difficult
78 to deliver, thereby contributing to a gaping difference between goals and reality.

79 In all, the scale of global financing required to meet mitigation and adaptation needs is vast, and current
80 financing availabilities fall well below desirable levels. For example, according to a November 2022 report from
81 the Rockefeller Foundation and Boston Consulting Group (BCG), "To achieve net zero, public and private sector
82 entities across the globe will need approximately \$3.8 trillion in annual investment flows (equivalent to 3.8 percent
83 of global GDP) through 2025. But only a fraction of this capital is currently being deployed. Even when viewed
84 with a wider lens that considers funding such as transition finance, expected needs still outweigh flows by 66%".
85 2 Energy transition projects alone will need a substantial amount of climate finance. While estimates for this
86 component vary as well, it has been estimated that up to several trillion dollars annually in new investments is
87 needed for this purpose through 2030. be needed to achieve a major uptake of investments for energy transition.

88 6 III. Moving from Exhortation to Actions and Outcomes

89 Impossible Takes a Bit Longer Aside from this, here are some broader comments beyond Chile:

90 ? Most UN organizations and multilaterals (including much of the environmentalist community) having
91 limited first-hand experience and responsibility in implementation, tend to focus more on exhortation and global
92 concerns, rather than analysis and attention to issues standing in the way for effective progress. This has resulted
93 in debates centered on processes, overall goal setting, rather than substance and focus on results, thereby rendering
94 the proceedings largely immune to learning from empirical evidence. This enabled leaders to hide behind facile
95 statements on the risks of global warming and exhortations, rather than the hard choices and trade-offs to be
96 made, the experiences and results of different approaches being undertaken, and lessons to be drawn to achieve
97 tangible results. ? As elsewhere, the evidence suggests that in the absence of adequate financial incentives, one
98 cannot expect real action and ensuing results.

99 Where polluters pay for the costs they generate, one can see mitigation arrangements and associated
100 investments. This can be seen glaringly in the progress Chile has made in its energy matrix towards increased
101 renewables though proper energy pricing. Something similar occurred in the virtual elimination of sulfur emissions
102 through a cap-and-trade system to price sulfur emissions, which ultimately led to sharp reductions in acid rain cast
103 by SO2 emission. 3 ? There are, of course, various market approaches to pricing externalities to reflect emissions,

104 but the default model on environmental management in much of the world has tended to rely on regulation
105 and top-down goal setting, which are institutionally intensive and therefore difficult to manage, particularly in
106 institutionally-weak countries. One shouldn't thus be surprised that the results have been at best mixed, if not
107 downright poor, costly and overly dependent on the discretion of public officials. Almost inevitably, this has
108 exposed investment projects to increasing and costly delays, opportunities for corruption and often changing
109 (and contradictory or idiosyncratic) criteria for investments. Given the resulting public debates stemming from
110 implementation shortfalls, and the rather removed role of the private sector in such proceedings, attention should
111 seriously shift towards resource mobilization and mainstreaming the private sector into the proceedings. This
112 requires sharper attention on building the business case to attract such resources, and a consequent recasting of
113 the approach to energy transition.

114 Similarly, the role of multilateral banks, particularly the World Bank and IFC to enhance their capabilities,
115 risk mitigation arrangements, and support for policy development towards enabling conditions will instruments
116 to help finance particular projects. This may be a valid, though limited, approach to circumvent constraints by
117 earmarking resources and ring-fencing projects, not much different from what the World Bank did in the early
118 days of industrial and mining financing. Such approaches generated generally solid, but enclave initiatives that
119 didn't sustain themselves more broadly in the absence of such special efforts, or sustained financing for further
120 expansions to meet growing needs. Given the magnitude of resources needed to finance a meaningful program, a
121 significantly upscaled effort will be needed to mobilize resources even in the absence of Multilateral Development
122 Banks intervention.

123 Focusing on enabling conditions, including carbon trading and pricing vehicles 4 ? Finally, as Global
124 Greenhouse Emissions and the attendant climate change are global factors, the current focus on county-and
125 project-level approach has its limitations. The large increase of PV installations is, for instance, grounded
126 on CO2 emission reductions estimates in IPCC models, rather than primary (and verified) data from actual
127 producers. As a result, China, where according to some studies may actually generate much larger emission
128 footprints in the manufacturing of PV facilities -more comparable to natural gas power generation, given the
129 country's large dependence on coal-based power generation-may serve as a better estimate for the material of its
130 exported PV installations.

131 should avoid having to be exposed to eternal negotiations, the whims of changing political and/or other
132 idiosyncratic conditions, and corruption associated with excessive discretionary powers of regulatory Authorities.

133 7 5

134 8 IV. 'Voices with Energy' Debate in Chile

135 Conversely, the country or project focus tends to miss the emerging role of international supply chains in emission
136 reduction of commodities like copper, lithium, graphite and nickel, whose role in emerging technologies to
137 decarbonize productive sectors, needs to be explicitly considered as part of program evaluations of the mining as
138 much as in the downstream power sector investments. The evaluations, and investment or policy actions must
139 address the whole supply chain to achieve the intended goals.

140 9 I'm not looking for those who think like me. I look for those 141 who, like me, think

142 The Chilean electricity sector was the first in Latin America and one of the first in the world to deregulate (1981)
143 and privatize (1986-88) its generation sector, forcing generators to compete with each other. As such, the sector
144 is efficient, transparent and sophisticated, with tariffs equal to the marginal cost of production plus a market
145 rate of return, reflecting relative scarcity and all-in costs. Chilean electricity can be sold via regulated tariffs
146 to captive clients, and via freemarket contracts with large industrial clients. In addition, generators with excess
147 capacity can sell the electricity surplus to generators with energy deficits via spot market transactions.

148 The country was at the forefront of electricity deregulation and has provided a transparent, predictable and
149 rational means of delivering appropriate riskadjusted returns. Chile has delivered reasonably priced electricity;
150 capital flows have not been impeded into the sector and energy efficiency is good by international standards.
151 The energy efficiency seems particularly good considering that Chile's main export goods are energy intensive
152 (mining) and the topography of the country could have led to high costs. Thus, any further developments should
153 be set within the context of building upon what has been, by and large, a successful strategy for over two decades.

154 The country's greatest advantage is in effect having succeeded in moving towards a streamlined regulatory
155 system (where duplication, offsetting incentives etc. are avoided) that constitutes a solid asset to build on.
156 The country can thus afford to minimize the rules, use pricing where at all possible, and avoid choosing energy
157 development paths that become costly and complicated, and difficult to change when vested interests become
158 dependent on special institutions or different forms of privileged access to resources.

159 As a result, Chile is in a strong position to deal with new threats to energy supply in a cost-effective manner.
160 In many regards, Chile pioneered de-regulation in the sector, has achieved reasonable levels of energy efficiency
161 (although more can be done) and has a strong record of bringing private finance into the sector. It has done so
162 through a judicious mixture of solid and adaptable policy and a stable and predictable pricing framework.

12 CONCERNS AND CRITIQUES OF CIVIL SOCIETY ORGANIZATIONS REPRESENTING POWER SECTOR CONSUMERS:

163 With newly emerged challenges of dealing with security concerns and the environment, Chile will need to
164 turn to the same innovation and policy adjustments, as it has done in the past. In doing so, it will be able
165 to continue on its solid track record while integrating these new issues, embarking on a new energy chapter as
166 it fully adjusts to its membership of the OECD. ?? While, as noted above, the existing system has been the
167 outgrowth of discussions with the various stakeholders of the sector, and periodic debates with various interest
168 groups, the following summarizes the assessment of the latest (October 2023) debate on "Voices with Energy" of
169 stakeholders on the ongoing transition that essentially:

170 ? Reassured that the direction of Chilean energy and decarbonization policy continues to be solidly grounded,
171 unambiguously defended, and highly

172 10 Energy Transition in Unsettled Times

173 11 Global Journal of Science Frontier Research (H) XXIII 174 Issue VI Version I Year 2023

175 performing, despite populistic inclinations and pressures of the current public administration that need to be
176 overcome; ? Suggested that civil society organizations are becoming increasingly solid and prepared to call into
177 account private enterprises utilities and public Authorities on their commitments; ? Reinforced a broad unease
178 on the grasp of UN and associated organizations have to provide tangible and effective advice in support of
179 decarbonization efforts.

180 On the Chilean achievements in energy transition (i.e., the progress/outcomes, risks and challenges), main
181 points highlighted were:

182 ? Power sector capacity is currently three times higher than energy demand; 63% share in renewables, and 75%
183 if hydro and geothermal are included ? Sector has added last 10 years 14,000 MW in installed capacity, evidencing
184 favorable investment climate to meet energy demand ? Another 7000 MW currently in execution that will enter
185 into service in the near term ? 12000 MW projects in preparation that are currently undergoing environmental
186 evaluation, suggesting favorable outlook and expectations for the longer term ? The country has the highest
187 share of renewables in the region, and among the five highest internationally, and given current projections, Chile
188 will meet, if not surpass its international pledges, suggesting a stronger policy framework compared with most
189 at the international level.

190 12 Concerns and critiques of civil society organizations repre- 191 senting power sector consumers:

192 ? The international "promise" of low cost solar and wind energy doesn't seem to be born out in Chile, where
193 energy costs have been consistently been increasing as the share of renewables have been incorporated into the
194 grid; ? At some point this may trigger issues of affordability, particularly for lower income population; ? There
195 are growing risks with the current system, where most renewable sources generate power at distances ranging
196 from 1,200 to 1,800 Kms away from main markets, which could be disrupted within such ranges.

197 Global approaches, particularly as seen from UNFCCC's (United Nations for Climate Change Convention)
198 vantage point:

199 ? The need to strengthen multilateral processes of the Paris Agreement, Kyoto Protocol and the Convention
200 through COP proceedings for goal setting, tracking and debating emerging issues on climate change programs
201 ? Clearer recognition of the various issues and sectors involved, indicating the actions need to be approached
202 differently among countries ? An emerging recognition of progress that Chile has achieved with liberal policies,
203 which are being replicated in some European countries and US states.

204 The implications as seen by local power utilities have been that:

205 ? There are no "silver bullets" to deal with the issue, and while costs have significantly decreased for renewables,
206 they have inevitable constraints, such as being location-specific -in the case of Chile in the distant North, far
207 away from main consuming centers, and being intermittent depending on weather conditions (i.e., when there
208 is sunshine and wind). ? There are also major excess and shortages of energy generation in early and late
209 parts of the day, producing excess and deficit of generation capabilities to respond to market demands for
210 which there are no easy technological responses. ? All this requires energy storage facilities, which for the
211 time being are costly, and major investments in transmission lines, which constitute integral parts the costs of
212 renewables. ? On the other hand, the regulatory framework needs some updating, to reflect new services that have
213 emerged from new players and technological developments that would permit trimming of government regulatory
214 interventions of natural monopolies that no longer exist, and thus create conditions for growing competition and
215 lowering costs. ? As Chile is a marginal player in terms of GHG emissions, even with the progress that has
216 been achieved, the country could tangibly contribute at an increasing scale internationally. This could be done
217 by reversing restrictive practices that have been instituted in recent years for new and/or expanding mining
218 activities, by lowering barriers to investments in projects such as copper, lithium, which constitute major inputs
219 for decarbonized energy production and storage, and where the country has major reserves and comparative
220 advantages. ? Chilean emissions have been reduced by 28% over the last five years (partly by limited growth of

221 economic activity), and the remaining third to achieve net zero goals will require more complex efforts, including
222 further technical innovation, and revisiting technologies where some estimate of the footprint of solar PV suggest
223 that they may be

224 **13 Energy Transition in Unsettled Times**

225 **14 Global Journal of Science Frontier Research (H) XXIII** 226 **Issue VI Version I Year 2023**

227 higher than models being used by the IPCC, given production practices in China.

228 In all, it has been acknowledged that progress has been impressive, but there are challenges that need to be
229 addressed in the steeper road ahead, and the need to take a broader view of regulatory practices if the country
230 is to make further progress and help achieve greater impact at the global level.

231 **15 V. The Record and the Lessons**

232 To dialogue: ask, first; then... listen; then act and track Chile's greatest advantage is having succeeded in
233 moving towards a streamlined regulatory system (where duplication, offsetting incentives etc. are avoided) that
234 constitutes a solid basis to build on.

235 The country can thus afford to minimize the rules and avoid costly public sector regulatory intervention, use
236 pricing where at all possible, and avoid choosing energy development paths that become costly and complicated,
237 or difficult to change when vested interests become dependent on special institutions with privileged access to
238 resources. This enabled the country to move its energy matrix in a decisively renewable direction in an effective
239 manner, as can be seen below:

240 **16 Energy Transition in Unsettled Times**

241 **17 Global Journal of Science Frontier Research (H) XXIII** 242 **Issue VI Version I Year 2023**

243 Chile is now in a strong position to cost effectively deal with many new threats to energy supply. In many
244 regards, Chile having pioneered de-regulation in the sector, has achieved good levels of energy efficiency, and has
245 a strong record of bringing private finance into the sector. It has done so through a judicious mixture of solid
246 policy and a stable and predictable pricing framework.

247 With the newly emerged challenges of dealing with security concerns and the environment, the country will
248 need to turn to the same innovation and introduce policy adjustments as it has done in the past. In doing so, it
249 will be able to continue on its solid track record while integrating these new issues, embarking on a new energy
250 chapter by integrating the requirements stemming from its membership in OECD, and further the policy and
251 technical development for its decarbonization efforts.

252 While the thrust of concerns relates to growing public good externalities in the energy sector (for Chile and
253 most other countries) of environmental impacts and security of supply concerns, addressing those concerns should
254 still be possible within the current investment framework of the country. This can be achieved by ensuring that:

255 ? The playing field for investment remains level (any regulations are applied across the board) while still
256 ensuring that flexibility is built in to the system (to cope with pricing shifts and other shocks); ? Any legitimate
257 additional costs of compliance to environmental standards can be recouped through output prices; ? Consultation
258 between the public and private sectors would always precede any policy decisions.

259 VI. The Way Forward in an Uncertain World

260 **18 First things first, last things later**

261 Looking beyond the various issues mentioned above, if there is one broad lesson to be learned, it is the
262 need to recognize that major imbalances and associated adjustment policies can be extremely disruptive. In
263 fact, they are ultimately a sign of failurei.e., the inability to foresee structural changes and adapt to them
264 through deliberate changes in incentive structures and investment solutions, to adapt to emerging societal and
265 technological requirements. Meeting the challenge of the unpredictable seldom comes from "pushing harder"
266 or "changing faster", but from learning to recognize the need to redesign in a timely fashion. 7 The deeply
267 alluring command and control ways of forcing change can just as easily produce costly and misguided investment
268 decisions. A more open and flexible approach to constant and organic adaptation through open competition
269 and entrepreneurship might on the whole be a more effective way of mobilizing skills, innovation, funding and
270 technology to respond to emerging needs. If properly designed such changes could provide a framework of
271 certainty and stability that are crucial to promote the path of growth, without prejudice to the introduction of
272 some innovations, included much needed promotion of free competition and entrepreneurship for innovation in
273 productive activities.

274 In the end, much of the complexity of policy design in relation to energy stems from a multiplicity of objectives.
275 Ultimately, when designing policies experience suggests the following factors to merit special consideration to
276 untangle the conflicts that tend to arise from the various objectives normally being sought:

277 ? Efficient resource allocation, which requires that both producers and users of energy face prices that reflect
278 its scarcity value—which for nonrenewable resources stems not only from direct production costs but also the
279 opportunity cost of present consumption in terms of future consumption foregone—and any associated externalities.
280 When externalities spill across national borders, however, they create an important distinction between global and
281 national perspectives on efficiency: they matter for the former, but not the latter. ? Competitiveness concerns,
282 with a fear of disadvantaging domestic producers in world markets, have increasingly become important in
283 designing fiscal measures bearing on energy. ? Terms of trade considerations also arise in shaping fiscal policies
284 toward energy, particularly as hydrocarbons constitutes among the largest balance of payments in most countries.
285 Accounting for nearly 45 percent of global oil demand, for example, the G7 collectively is likely to have significant
286 power in the world market: measures to restrict demand may bring about a reduction in world oil prices that
287 raises their citizens' welfare, in effect transferring to them part of the resource rent that suppliers of oil would
288 otherwise enjoy. The converse of any such gain, however, is a corresponding loss to oil exporting countries. ?
289 Revenue concerns and interactions with the wider tax system, more generally, may affect both the choice of
290 instrument and the level at which it is set.

291 **19 ? Minimizing costs of compliance and administration,**
292 to enterprises and governments respectively, is a standard principle of public policy design, though it has received
293 little distinct attention in relation to energy issues.

294 Finally, the issue of coherence across policies has become a major challenge in many countries. It is not
295 uncommon to find an array of subsidies, grants, tax

296 20 Energy Transition in Unsettled Times

297 21 Global Journal of Science Frontier Research (H) XXIII 298 Issue VI Version I Year 2023

299 interventions, etc. that are being applied with little attention to coherence, and often producing conflicting
300 signals. Indeed, concern over environmental effects has spawned many complex, distorting and conflicting policies.
301 Countries should avoid such tendencies. The directness, simplicity and market orientation of Chile's approach to
302 business and key sectors (as energy) stand it in good stead to avoid such pitfalls.

303 Above all, the environmental aspects need proper mainstreaming, as it is an issue that goes well beyond
304 the energy sector. 8 1) Make effective climate action –both adaptation and mitigation –part of core
305 development efforts (rather than reactive clearance arrangements for individual projects, which may be
306 contentious, timeconsuming and expensive);

307 Whatever the organizational set-up, a strategic framework on environmental and climate change for a country's
308 engagement may need to be developed to:

309 2) Address the ensuing incremental resource requirements through up-scaling of existing innovative instruments
310 for finance, beyond the prevailing project-by-project approach, which has had high transaction costs and
311 consequently limited application for widespread impact programs on a larger scale; 3) Develop market friendly
312 policies aiming at reflecting in prices and incentives externalities, and more broadly create an enabling
313 environment for leveraging private sector investment and finance; and 4) Set up policy research, scanning
314 international experiences, knowledge management and capacity building to facilitate development of policies
315 and adaptation of climate-friendly technologies to local environments.

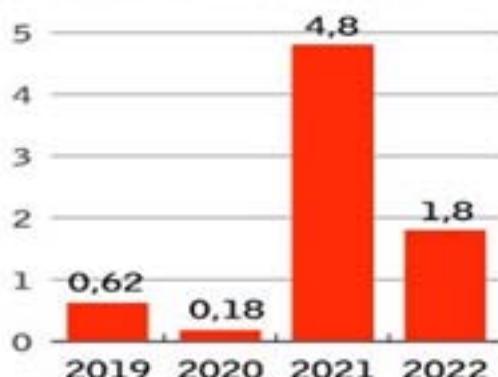
316 With a more structured approach to issues as suggested above, it should be possible to consider "over
317 the horizon" issues. This should enable countries focus on emerging issues and poise themselves in a timely
318 and systematic manner for emerging technologies, market and other disruptions to allow a coherent way of
319 anticipating, inevitable changes in a cost effective and manageable manner. ¹

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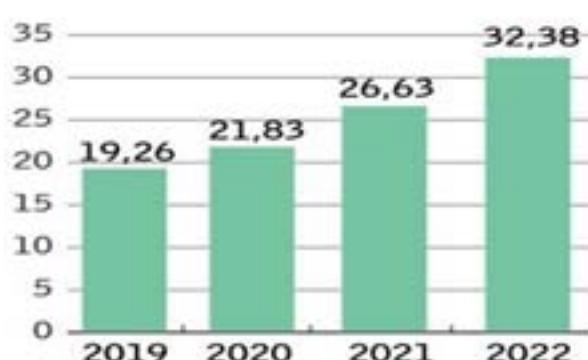


Figure 1: Energy

Crecimiento de la demanda



Participación anual ERNC



Generación por fuente total (en TWh)

	2022	2021	Var. %
Eólica	8,8	7,2	22,4
Geotérmica	0,5	0,3	43,8
Hidráulica	20,1	16,3	23,2
Solar	14,1	10,5	33,4
Térmica	38,9	46,5	-16,3

Generación renovable no convencional (en TWh)

	2022	2021	Var. %
Biomasa	1,51	1,63	-7,4
Eólica	8,75	7,15	22,4
Pasada (minihidro)	2,23	2,05	8,8
Solar	14,03	10,53	33,2

Generación térmica (en TWh)

	2022	2021	Var. %
Biomasa	1,65	1,86	-11,3
Carbón	19,03	27,47	-30,7
Diésel	1,48	1,81	-18,2
Gas Natural	15,84	14,48	9,4

*Cifras al 28 de diciembre de 2022

Fuente Coordinador Eléctrico Nacional

EL MERCURIO

Figure 2:

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