

Modernizing Brazil's Isolated Power Systems

A portfolio of reforms to lower supply costs, cut diesel dependence, strengthen energy security and pilot new regulatory tools

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Executive summary¹

Brazil's isolated systems (*Sistemas Isolados*, SISOL), as shown in the figure below,² account for a small share of national electricity demand and are historically responsible for delivering power to consumers who are not connected to the national grid. In doing so, however, these systems impose a high and disproportionate cost. Diesel supplies more than 90% of installed capacity, funded by the Fuel Consumption Account (*Conta de Consumo de Combustíveis*, CCC),³ a cross-subsidy paid by every electricity consumer in the country. The financial burden is substantial and affects the affordability of electricity. In 2024, the CCC subsidy cost customers around R\$12.5 billion (about US\$2.4 billion), equal to an estimated 3.6% in additional charges to average residential tariffs nationwide. Moreover, the fuel dependence leaves these systems exposed to logistics and reliability risks.

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² Yellow dots are the isolated systems, and the lines are transmission lines at different voltage levels in the National Interconnected Transmission System. Source: Energy Research Office (Empresa de Pesquisa Energética, EPE). *Web map*. <https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/webmap-epe>

³ Chamber of Commercialization of Electric Energy (Câmara de Comercialização de Energia Elétrica, CCEE). (n.d.) Fuel Consumption Account [*Conta de Consumo de Combustíveis*]. <https://www.ccee.org.br/mercado/contas-setoriais/conta-consumo-de-combustiveis-ccc>

Figure 1. Map of Brazil's isolated systems

Source: Energy Research Office (Empresa de Pesquisa Energética, EPE). (n.d.). *Interactive map of the Brazilian energy system*

After connecting Roraima's Boa Vista system in 2025, what remains is the harder, costlier core, where diesel is most entrenched and each avoided liter delivers the greatest cost saving.⁴

A portfolio of reforms that improve the institutional, regulatory and economic framework of isolated systems can enable cleaner, cheaper options to compete and scale. Reform has already begun. The September 2025 SISOL auction, which contracted a large solar-plus-storage-plus-diesel hybrid at a steep discount and priced avoided emissions for the first time, shows how new approaches can deliver better outcomes with wider application. Drawing on this result, this brief outlines five actions to help modernize Brazil's isolated power systems. We recommend using these systems as testing grounds for tariff and metering tools before a wider rollout.

⁴ Energy Research Office (Empresa de Pesquisa Energética, EPE). (2026). *Sistemas Isolados* [in Portuguese]. <https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/sistemas-isolados>

Priority actions to consider

- A. Cut inefficient demand before buying supply.** The regulator (Agência Nacional de Energia Elétrica, ANEEL) can require utilities to quantify efficiency and loss-reduction potential in every isolated system plan before contracting new diesel.
- B. Adjust the product the auctions buy.** The Ministry of Mines and Energy (Ministério de Minas e Energia, MME) and ANEEL can set contract terms to better match the asset life of clean resources and can auction energy separately from capacity, so cheaper renewables displace diesel output.
- C. Pay for displaced diesel at what it is worth.** ANEEL can price net billing in isolated systems against the full cost of the diesel fuel it displaces, and test time-of-use rates so prices reflect when diesel is and is not used.
- D. Spur utilities to search for alternatives.** ANEEL can amend distribution planning rules to require utilities to assess solar, storage, microgrids, efficiency and loss reduction alongside conventional diesel expansion.
- E. Prioritize the projects nationally.** MME and the planning agency (Empresa de Pesquisa Energética, EPE) can use CGPAL⁵ and the SISOL planning cycle to publish a ranked project list scored on subsidy reduction, reliability, emissions and local capacity.

Why action is needed now

Two pressures make reform urgent. The first is the size of the subsidy and who pays it.

In 2024, isolated systems comprised roughly 175 systems, 1,255 MW of installed capacity and about 2.5 million people. The associated cross-subsidy burden reached roughly R\$12.5 billion (about US\$2.4 billion) and added an estimated 3.6% to average residential tariffs nationwide.^{6 7} The interconnection with Boa Vista in Roraima, the largest isolated load, has since lowered that burden. What remains is smaller but harder to serve, where diesel is most entrenched, and each avoided liter yields the most benefit. These systems run predominantly on diesel, so every operational improvement that cuts diesel burn lowers bills for all consumers, who fund the CCC, and lowers emissions.

The second pressure is the need for resilience. The 2020 Amapá blackout and the instability and supply risks observed in Amazonas during 2024 and 2025 show that neither interconnection

⁵ CGPAL is the management committee of Pro-Amazonia Legal Program.

⁶ Energy Research Office (Empresa de Pesquisa Energética, EPE). (n.d.). *Monitoring and Information Portal for Standalone Systems (PASI)* [Portal de Acompanhamento e Informações dos Sistemas Isolados]. <https://pasi.epe.gov.br>

⁷ National Electric Energy Agency (Agência Nacional de Energia Elétrica, ANEEL). (2026). *Subsidimeter Panel*. [Painel Subsidiômetro]. <https://portalrelatorios.aneel.gov.br/uznatarifa/subsidiometro>

nor diesel logistics offer one single sufficient resilience strategy. Remote systems need locally installed security, not just more wires. Distributed solutions, including battery storage paired with renewables and the use of diesel as a last-resort backup, can now provide firm local supply, without the need for extensive, risky supply channels. Yet the current auction design does not fully reward that capability.

Why the system keeps buying diesel

Brazil's isolated system framework has become more structured over time. Law 12,111/2009⁸ and Decree 7,246/2010⁹ define the regime for isolated systems. Ordinance 59/2022¹⁰ modernized the planning and auction framework by introducing a ten-year planning horizon, the Free Proposal Initiative (Livre Proposta Iniciativa, LPI) mechanism,¹¹ and the PASI information portal. Subsequent programs such as *Pro-Amazônia Legal*¹² and *Energias da Amazônia*¹³ frame isolated systems more explicitly in terms of subsidy reductions and the clean energy transition. Despite these improvements, the framework still carries three linked deficiencies.

- **The CCC socializes the cost of diesel.** Fuel costs are not fully passed through to consumers in isolated systems, which dampens incentives to invest in efforts to reduce them. Neither distributors nor generators see benefits if they take actions to improve energy efficiency or increase clean energy generation.
- **Utility distribution planning is too narrow.** The regulatory baseline still favors conventional expansion to the power system and, as a result, does not consistently require utilities to assess non-wires alternatives (NWAs) such as distributed energy resources, storage, microgrids, efficiency and loss reduction.
- **National planning inherits that narrowness.** It draws on the data and project proposals utilities submit and is only as broad as the options they evaluate; planning and auctions then reinforce conventional solutions.

In essence, the CCC limits the exposure of consumers to the cost of fuel burned in thermal generation, utilities are financially neutral to diesel, and the incentive to reduce fuel use through efficiency, demand-side measures, distributed energy resources or storage is correspondingly weak. Planning rules do not require utilities to study anything beyond more generation and

⁸ Presidency of the Republic, Civil House, Deputy Chief of Legal Affairs (Presidência da República, Casa Civil, Subchefia para Assuntos Jurídicos). (2009, 9 December). *Isolated System Act* [Lei dos Sistemas isolados]. https://www.planalto.gov.br/ccivil_03/ato2007-2010/2009/lei/l12111.htm

⁹ Presidency of the Republic, Civil House, Deputy Chief of Legal Affairs (Presidência da República, Casa Civil, Subchefia para Assuntos Jurídicos). (2010, 28 July). *Isolated Systems Decree* [Decreto Sistemas Isolados]. https://www.planalto.gov.br/ccivil_03/ato2007-2010/2010/decreto/d7246.htm

¹⁰ Ministry of Mines and Energy, Legal Advisory Services (Ministério de Minas e Energia Consultoria Jurídica). (2022, 26 December). *Auction rules for the Isolated Systems* [Portaria normativa modalidade de Leilão]. <https://www.gov.br/mme/pt-br/acesso-a-informacao/legislacao/portarias/2022/portaria-normativa-n-59-gm-mme-2022.pdf>

¹¹ The LPI is a standing channel for developers to propose lower-cost supply solutions that reduce the CCC, which EPE evaluates for inclusion in future auctions.

¹² Ministry of Mines and Energy (Ministério de Minas e Energia). (n.d.). *CGPAL - Pro-Legal Amazon Steering Committee* [CGPAL - Comitê Gestor do Pró-Amazônia Legal]. <https://www.gov.br/mme/pt-br/assuntos/conselhos-e-comites/cgpal-1>

¹³ Ministry of Mines and Energy (Ministério de Minas e Energia). (n.d.). *Amazon Energy Program* [Programa Energias da Amazônia]. <https://www.gov.br/mme/pt-br/assuntos/secretarias/sntep/programa-energias-da-amazonia>

more wires. Auctions then buy what those plans propose. These deficiencies lock the system into conventional solutions, supported by the supply and transport arrangements around them. Fixing these deficiencies would lower the CCC bill paid by every Brazilian consumer, make remote supply more secure and cut both diesel burn and emissions. The five actions below show how.

A. Cut inefficient demand before buying supply

The cheapest diesel is the diesel never burned. Data from the Monitoring and Information Portal for Standalone Systems (*Portal de Acompanhamento e Informações dos Sistemas Isolados*, PASI) shows that, in the 2025 planning cycle, only 16% of isolated localities had an energy-efficiency project and 2.5% had a loss-reduction initiative. Both fell from the previous cycle, when the figures were 20% and 7%, respectively.¹⁴ Part of the diesel now under contract is therefore serving unnecessary demand.

Elevating efficiency and loss reduction from programmatic afterthoughts to core planning resources, and combining them with solar, storage and local implementation can rapidly reduce diesel consumption while improving service quality. Prioritizing the Amazon region would target the largest concentration of isolated systems and the greatest gap in efficiency coverage.

In addition, delivery can move faster with better project identification and cost data, a public tracking dashboard, and more funding for efficiency projects. Promising instruments include on-bill financing, climate finance schemes and coordinating energy efficiency funds to expand delivery capacity. One obstacle, however, sits upstream. Utilities do not report efficiency and loss-reduction potential in a standard form, so nobody can assess the opportunity nationally. Action E returns to this.

Key recommendation: ANEEL can require utilities to quantify efficiency and loss-reduction potential in every isolated-system plan before contracting new diesel capacity. MME can direct the first packages in the Amazonas.

B. Adjust the product the auctions buy

Another lever to modernize Brazil's isolated systems is procurement design. Isolated system auctions have largely followed the standard Brazilian auction design, even though these grids already have more than enough diesel-based capacity. What they lack is cheaper energy.

The 2025 SISOL auction shows how design changes help unlock cleaner solutions. It built on earlier rounds that already captured the diesel-subsidy cost in their ranking and added a carbon-adjusted scoring system to prioritize cleaner portfolios¹⁵ as well as a minimum renewable-share threshold to overcome the incumbency advantage that favors diesel solutions. Alongside steady

¹⁴ The 2024 planning cycle showed 34 of 175 localities with an energy-efficiency project, 12 of 175 with a loss-reduction initiative. The 2025 cycle dropped to 25 of 160 localities for energy efficiency and 4 of 160 for loss reduction.

¹⁵ Carbon is not directly priced in Brazil.

cost declines in storage and renewables, these changes were enough to tip the result in Jacareacanga, Pará, to a hybrid approach pairing diesel, solar and 30 MW of battery storage. It cleared at R\$1,593.16/MWh, at nearly half of the R\$3,000/MWh ceiling.

One feature merits note. While the average total generation cost in April 2026 was around R\$2,100/MWh, Jacareacanga came in roughly 25% below that.¹⁶ The 2025 design did not pay a premium for cleaner power. It bought cheaper power that happened to be cleaner.

Further design changes could make even more room for clean solutions. Aligning contract tenors with assets, which in practice means longer terms better matching the operating life of assets such as solar PV, would improve competition and reduce the structural penalty on renewables and storage. Another idea to consider is to run separate auctions for capacity and introduce regular energy auctions, which could allow cheap renewables to dynamically displace energy production from diesel. These changes might be enabled through centralized procurement.

Key recommendation: MME and ANEEL can redesign isolated system auctions better to capture shadow carbon impacts,¹⁷ accommodate the asset life of renewables, and allow renewables to displace diesel production through periodic energy auctions separate from capacity. This approach also allows the MME to buy clean equipment on their own timeline rather than inside the supply contract, with rules for transferring it to the concessionaire.

C. Pay for displaced diesel at what it is worth

A household in an isolated system pays a regulated tariff. Supplying it costs several times that, and the CCC covers the gap. So, a household that installs a solar panel or a business that shifts its load off the evening peak is compensated at the retail tariff – a fraction of the value created. The savings land in the CCC, where the person who produced them never benefits. As a result, consumers have no incentive to support system efficiency because prices do not signal the value of doing so.

Brazil compensates injected energy in kilowatt-hours; these are returned as credits that cannot be priced or sold.¹⁸ This is net metering, and it works where the energy displaced costs roughly what the tariff says it costs. Isolated systems would benefit from net billing, where the price more accurately reflects the value of the energy fed back to the grid.

¹⁶ Brazilian Chamber of Electric Energy Commercialization (Câmara de Comercialização de Energia Elétrica, CCEE). (n.d.). *Fuel Consumption Report – ccc* [Conta de consumo de combustíveis – ccc]. <https://www.ccee.org.br/en/boletim-infoccc>

¹⁷ A shadow carbon price is a hypothetical monetary value assigned to each ton of greenhouse gas emissions. No actual money linked to carbon costs changes hands. Rather, the shadow price can inform the selection of auction winners.

¹⁸ Presidency of the Republic, General Secretariat, Deputy Chief of Legal Affairs (Presidência da República, Secretaria-Geral, Subchefia para Assuntos Jurídicos). (2022). <https://www.normasbrasil.com.br/norma/?id=447271>. Law No. 14,300 of 6 January 2022, Establishes the legal framework for micro and mini distributed generation [Institui o marco legal da microgeração e minigeração distribuída]. Diário Oficial da União [Official Gazette of the Union]. https://www.planalto.gov.br/ccivil_03/_ato2019-2022/2022/lei/114300.htm; National Electric Energy Agency (Agência Nacional de Energia Elétrica, ANEEL). (2023). Normative Resolution No. 1,059 of 7 February 2023 [Resolução Normativa nº 1.059, de 7 de fevereiro de 2023]. Improves the rules for the connection and billing of microgeneration and distributed minigeneration plants in electricity distribution systems and more. <https://www2.aneel.gov.br/cedoc/ren20231059.html>

Price formation here merits attention. The benchmark is not the auction price, because the fifteen-year supply contracts pay a fixed revenue whether the plant runs or not.¹⁹ What a kilowatt-hour of local generation actually saves is the full cost of the fuel not burned, plus the operating and maintenance costs that vary with running hours. Both are already measured for CCC reimbursement.

Time-of-use pricing can more closely align prices with actual system costs, shifting the question from whether to when. Two things currently block a general rollout here. The metering standard for low-voltage generators only requires separate measurement for consumed energy and injected energy. In contrast, low-income and prepaid consumers, who make up the majority in these localities, are excluded from the hourly tariff by rule. Bounded pilots can work around both, with hourly rates set against what diesel costs in each hour and by ensuring social tariff protections remain intact.

With these two steps, compensation would be based on hourly rates and reflect local costs. As consumers respond to these more efficiently formed price signals, this will lessen the subsidy cost. Service quality obligations continue to apply to the utility to drive performance.

Key recommendation. MME can set the directive that local generation in isolated systems is compensated according to the avoided cost of diesel, meaning fuel and variable operating costs rather than the contract price. Furthermore, ANEEL can write the rules and test time-of-use rates on the same basis in bounded pilots.

D. Spur utilities to search for alternatives

Utilities are where the next gains lie. Distribution planning still defaults to the conventional expansion of power system infrastructure. Optimal siting of renewables, storage, microgrids and NWAs all remain outside the core regulatory requirement. Without better utility planning, the national system will continue to favor auctions and interconnection over more granular options, missing out on the benefits of integrated resource planning.

Hosting-capacity maps make investment decisions responsive to network realities. Publishing granular information on system limits helps developers see where solar and storage can connect without undermining reliability and helps planners judge where distributed options are genuinely feasible. A regulatory roadmap for distributed energy resources, storage, NWAs, energy efficiency as a resource, and microgrids would complement that visibility by removing barriers and filling the gaps in commercial and operational rules.

¹⁹ There are legal references that may support this action. Law 9,648/1998 and Decree 7,246/2010 regulate CCC subrogation, which has paid the difference between the variable cost of the thermal generation they displace and their own cost to projects. Also, Law 14,300 instructs ANEEL to regulate the payment for ancillary services to distributed generators, expressly to reduce thermal dispatch in isolated systems and, in turn, reduce the use of CCC resources. Presidency of the Republic, Civil House, Deputy Chief for Legal Affairs ((Presidência da República, Casa Civil, Subchefia para Assuntos Jurídicos) (27 May 1998) https://www.planalto.gov.br/ccivil_03/leis/19648cons.htm; Presidency of the Republic, Civil House, Deputy Chief of Legal Affairs, 2010. Presidency of the Republic, General Secretariat, Deputy Chief of Legal Affairs, 2022.

Some utilities already plan better than others, so tighter obligations are ideally accompanied by a task force to raise planning quality to a minimum standard across states and concession areas. Better rules and better templates move together.

At the same time, it is important for utilities and local supply chains to address capability gaps. The analytical requirement above assumes granular network data and staff able to use it. Neither is uniformly present today, so it's important to phase in the obligation with the capability to support it. MME can support implementation with task forces that improve planning capability and help local utility groups to deliver efficiency and loss-reduction projects, and with finance that supports structural projects, not only those at pilot-scale. Two existing instruments can carry part of this load rather than requiring new ones. The regulatory sandbox can host the first standardized planning exercises under supervision, and strategic research and development calls can fund the data collection, hosting-capacity assessment and methods that utilities are being asked to produce.

Key recommendation: ANEEL can reform distribution-planning requirements for isolated system concession areas to obligate utilities to analyze distributed energy resources, storage, NWAs, microgrids, efficiency and loss reduction alongside conventional expansion. In doing so, it's important to ensure proper sequencing, so that the requirement arrives with the templates and data support needed to meet it. EPE can require more detailed and standardized inputs, especially on losses, efficiency potential and network hosting capacity to improve the quality of national planning. End-of-life removal and disposal of storage and generation equipment should be included in the same plans.

E. Prioritize projects nationally

Prioritization leads to better resource allocation. Brazil has many policies touching isolated systems but little visibility into which projects – such as interconnection, efficiency improvements and hybrid approaches – deliver the greatest combined benefit across subsidy reduction, emissions, reliability and community values. The latter might include local development, social issues and the like.

Ranking projects requires four things: better data from utilities; a working prioritization framework, which can draw on the CGPAL²⁰ pathway and the ten-year planning cycle; tighter coordination between regional utility plans and national planning; and stronger multicriteria methods. Together, these enable decision-makers to rank projects and direct public attention accordingly.

The payoff from the prioritization process is tailored solutions. Some localities justify interconnection, some need hybrid supply, and others could deliver quicker value through efficiency, loss reduction or distributed resources. A tighter planning interface between utilities

²⁰ CGPAL is the management committee of Pro-Amazonia Legal Program.

and national institutions would also ease the "garbage in, garbage out" problem, in which weak utility data travels upward and narrows national choices.

Key recommendation: MME and EPE can use CGPAL and the planning cycle to publish and update a priority project list that ranks projects by subsidy reduction impact, reliability value, emissions reductions and local implementation potential.

COMPLEMENTARY RECOMMENDATION: Isolated systems can serve as a pilot environment for power sector modernization

Isolated systems are bounded, observable and expensive. Those three properties make them unusually good places to test regulatory tools that are hard to trial at scale in the interconnected system. Effects on cost, reliability, emissions and consumers show up quickly and can be measured against a clear counterfactual. The cost of getting something wrong is also contained.

Net billing (Action C) presents a preliminary promising pilot. Three others stand out: (i) smarter metering and interval data, to make consumption patterns visible; (ii) storage treated as a system resource with its own operating and procurement protocols; and (iii) active distribution practices, including locational planning, where the cost of planning error is high enough to justify the effort.

Design determines the extent of usable knowledge yielded by the pilot. Demonstration projects need a limited scope, adequate operational and consumer data, consumer protection measures and transparent performance metrics that cover service quality as well as diesel displacement, with an ex-post review before anything is replicated.

Key recommendation: MME and ANEEL can treat isolated systems as a circumscribed testing environment for modern regulatory tools, with defined evaluation criteria, consumer safeguards and a stated pathway for scaling what works.

Next steps

Brazil does not need to choose between addressing isolated systems issues and modernizing the power sector. Done well, it can do both at once. The same reforms that would make remote systems cleaner and less subsidy-intensive are also the ones that could help Brazil test a more modern regulatory toolkit in a controlled, decision-relevant environment.

The five actions above do not need to happen all at once. In fact, treating them as a single package may stall the ones that could start now.

Table 1. Sequencing of priority actions for modernizing Brazil's isolated systems

When	What	Who
Now , no rule change needed	Efficiency and loss-reduction packages; auction parameters for the next SISOL round	Ministry of Mines and Energy, utilities
Next planning cycle	Distribution-planning obligation, standardized utility reporting, hosting-capacity maps, ranked project list	ANEEL (regulator), EPE (planning agency), Ministry of Mines and Energy
Sandbox window	Net billing with avoided-cost pricing tested and evaluated; time-of-use pilots with targeted metering	ANEEL (regulator), via Energias da Floresta initiative

Nothing in the first tier requires a change in the rules. The second sits within the planning cycles. The third needs the sandbox and produces the evidence upon which pricing structures can later be established.

Sequenced this way, isolated systems stop being a fiscal and operational liability and become the place where Brazil tests the regulatory toolkit it will need everywhere else.

Annex: Overview of priority actions

Action	Problem addressed	How it works	Lead actor(s)	Expected effects	Implementation issue
A. Efficiency and loss reduction	Diesel is contracted to serve demand that could be avoided.	Treat end-use energy efficiency and loss reduction as system resources in planning; package with local solar and storage; add public tracking and dedicated financing.	ANEEL (regulator), Ministry of Mines and Energy, utilities, development finance.	Fast diesel displacement and lower CCC.	Delivery capacity and project screening, not technology.
B. Auction design	Localities have different capacity and energy needs, and contract terms are too short for solar and storage.	Amend contract life; separate energy and capacity products where justified and where system economics support this; and retain carbon-adjusted ranking and minimum thresholds for renewables.	Ministry of Mines and Energy, ANEEL (regulator), EPE (planning agency).	Better competition and stronger economics for hybrids.	Design complexity and managing bankability.
C. Tariff and subsidy	Anyone who displaces diesel is paid the subsidized tariff, a fraction of what the displacement saves.	Implement net billing and test compensation priced against avoided diesel cost in the sandbox; pilot time-of-use tariffs where metering allows.	ANEEL (regulator), Ministry of Mines and Energy, Chamber of Commercialization of Electric Energy, utilities.	Local generation and demand response bring value; long-run subsidy pressure falls.	Fixed-revenue supply contracts limit the displaceable saving; distributed generation currently cannot be curtailed; low-income and prepaid consumers are excluded from the hourly tariff by rule; rewards are measured per MWh served, so the incentive cannot be earned by supplying less.

Action	Problem addressed	How it works	Lead actor(s)	Expected effects	Implementation issue
D. Utility planning and grid visibility	Planning rules point at poles, wires and conventional generation.	Require assessment of solar, storage, microgrids, efficiency and loss reduction alongside conventional expansion; publish hosting-capacity maps; standardize reporting.	ANEEL (regulator), utilities, EPE (planning agency).	Better siting, better planning, more room for distributed resources and storage.	Utilities need capability, templates and regulatory enforcement.
E. National prioritization	No prioritization overview of which projects deliver the greatest combined benefit.	Use CGPAL (management committee of Pro-Amazonia Legal Program) and planning cycle with multicriteria methods to prioritize projects by subsidy reduction, reliability, emissions and local implementation capacity.	Ministry of Mines and Energy, EPE (planning agency), ANEEL (regulator), utilities.	Public money is directed to the highest-value projects; fewer one-size-fits-all decisions.	Success depends on the quality of the data supplied.
Pilot environment	Conventional solutions dominate and new approaches have no low-risk space to be tested.	Use the regulatory sandbox to test metering, storage protocols and active distribution practices, with defined metrics and ex-post review.	Ministry of Mines and Energy, ANEEL (regulator), EPE (planning agency), utilities, providers.	Learning and capabilities that transfer to the interconnected system.	Requires coordination, incentives and sustained commitment.



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