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CRISIS-INDUCED DECARBONIZATION: HOW INFRASTRUCTURE BREAKDOWN AND CHEAP SOLAR ARE DRIVING ENERGY TRANSITIONS IN THE ABSENCE OF POLICY

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EXECUTIVE SUMMARY

While global climate politics appear stalled, renewable energy deployment is accelerating rapidly in crisis-affected countries where electricity grids are failing, and fuel has become unaffordable.

Falling prices for Chinese solar technology have turned off-grid photovoltaic systems into the most viable solution for energy security in countries such as Lebanon, Pakistan, Nigeria, Syria, and Yemen.

Where fuel subsidies have been removed, solar adoption has surged especially fast; in conflict zones, decentralized systems spread because they are less vulnerable than centralized infrastructure.

What has emerged is a form of policy-free decarbonization, driven by necessity rather than climate strategy or international coordination.

These dynamics point to a future in which energy transitions may advance fastest in contexts of crisis and state fragility, raising new challenges (and opportunities) for energy governance and politics.

KEYWORDS:
Crisis-induced decarbonization, off-grid solar, energy insecurity, policy-free transitions, energy inequality

ZUSAMMENFASSUNG

Während die internationale Klimapolitik ins Stocken gerät, schreitet die Energiewende in krisenbetroffenen Ländern besonders rasant voran—dort, wo Stromnetze zusammenbrechen und Treibstoffe unerschwinglich geworden sind.

Sinkende Preise für chinesische Solartechnologie haben netzunabhängige Solarsysteme (Inselanlagen) in Ländern wie dem Libanon, Pakistan, Nigeria, Syrien und dem Jemen zur günstigsten Option für Energiesicherheit gemacht.

Diese Dynamik ist besonders ausgeprägt, wenn Subventionen für fossile Treibstoffe abgebaut werden. Auch in Konfliktkontexten setzen sich dezentrale Systeme durch, da sie weniger anfällig sind als zentrale Infrastrukturen.

Die Folge ist eine Form politikfreier Dekarbonisierung: nicht Klimastrategien oder internationale Koordination treiben den Wechsel von fossilen zu erneuerbaren Energieträgern voran, sondern dysfunktionale Infrastruktur und ökonomischer Zwang.

Diese Dynamiken eröffnen neue Chancen für die internationale Energiepolitik, stellen sie zugleich jedoch vor die Herausforderung, krisengetriebene Energiewenden zu begleiten, ohne Energiearmut und Ungleichheit weiter zu verschärfen.

KEYWORDS:
Krisenbedingte Dekarbonisierung, netzunabhängige Solarenergie, Energieunsicherheit, politikfreie Übergänge, Energieungleichheit

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THE TREND: POLICY-FREE DECARBONIZATION IN CRISIS CONTEXTS

Across a growing number of crisis-affected countries, economic collapse, fuel price shocks, and the breakdown of state electricity systems are accelerating a form of policy-free decarbonization. While global climate politics appear stalled (the 2025 COP in Belem failed to secure a commitment to phase out fossil fuels), Western governments are retreating from ambitious climate agendas, green financing is declining, and public attention is shifting (Greta Thunberg is increasingly known for her criticism of Israel's war on Gaza rather than her climate activism), renewable energy deployment is rising sharply in places least expected: in Yemen some 70 percent of households rely on some form of off-grid solar, in rural Lebanon 90 percent of households have solar panels on their roofs, in Pakistan citizens installed roughly half of the national grid's capacity in off-grid solar systems. Similarly, Syria and Nigeria are seeing unprecedented growth in off-grid solar energy adoption (Aklan & Al-Eryani, 2025; Mangi, 2024; Onu & Sguazzin, 2026; Stubenberg & Lawrie, 2024).

> *Households and businesses adopt decentralized solar not out of concern for climate change, but as a response to infrastructural failure, energy insecurity, and unaffordable fossil fuels*

In these contexts, high-quality Chinese solar components have become so affordable and accessible that off-grid photovoltaic systems now offer the most reliable and economical source of electricity. What decades of aid- and policy-driven electrification programs failed to achieve has unfolded within just a few years, driven by the combined pressures of dysfunctional grids and rising fuel costs.

This trend, which can be described as crisis-induced decarbonization pathways, differs fundamentally from mainstream narratives of energy transition. Here, households and businesses adopt decentralized solar not out of concern for climate change, but as a response to infrastructural failure, energy insecurity, and unaffordable fossil fuels. Importantly, these solar energy “revolutions” often go unnoticed since small scale private installations do not show up in national and international statistics (McKibben, 2024).

While these dynamics often overlap, crisis-induced decarbonization unfolds through at least two distinct pathways. The most rapid and disruptive transitions occur where infrastructural breakdown coincides with sudden fuel price shocks following the removal of subsidies, as in Lebanon, Pakistan, and Nigeria. In conflict-affected settings such as Syria, Yemen, and to some extent Ukraine, decentralized solar adoption follows a related but distinct logic. Here, off-grid systems proliferate not only because of price shocks, but also because they are less vulnerable to attacks on centralized infrastructure. Together, these pathways form a broader pattern of crisis-driven energy transitions.

WEAK GRIDS, LOAD SHEDDING, AND THE GENERATOR REGIME

Electricity grids across much of the Global South, and increasingly beyond, are struggling with a combination of rising demand, climate stress, chronic underinvestment, and armed conflict (IEA, 2020). Extreme heat drives surging air-conditioning demand, storms and floods damage infrastructure, while fiscal crises and war limit maintenance and expansion.

In such settings, utilities must resort to load shedding—the planned interruption of electricity supply in parts of the grid when demand exceeds available generation—in order to protect overall grid stability. These rolling “blackouts” have become a normalized feature of everyday life.

The standard societal response to recurring blackouts has long been private backup generators. These machines have shaped the soundscape, air quality, and political economy of cities with weak or absent electricity grids. Technically, however, generators are an extremely inefficient way of producing electricity: roughly 90 percent of energy is lost in small portable gasoline generators, and around 60 percent even in large commercial diesel generators, with most energy dissipated as heat and noise. Despite these inefficiencies, generators have remained viable for decades because their operating costs were artificially suppressed.

Taken together, these dynamics created an energy landscape defined not by a single system, but by constant switching between overlapping and unequally accessible sources of power. Grid electricity, private generators, and, later, other decentralized solutions did not replace one another sequentially. Instead, they coexisted and had to be actively managed in everyday life. Households, businesses, and institutions became accustomed to navigating outages, coordinating generator subscriptions, timing energy-intensive activities, and paying multiple electricity bills in parallel. In this sense, electricity scarcity was not only a technical failure but a materialized political economy, one that redistributed costs, noise, pollution, and risk across society.

FUEL SUBSIDIES AS THE FRAGILE STABILIZER

What made this solution of backup generators economically, and thus politically, tolerable were fuel subsidies. Much like bread subsidies, cheap fuel functioned as a form of compensation for broader state failures, inequality, and unreliable public services (McCulloch, 2023).

Yet these subsidies impose enormous fiscal burdens. Until 2014, Yemen reportedly spent around 20 percent of its national budget on fuel subsidies. In Iraq, fuel subsidies cost the government some USD 8 billion in 2022. Similar dynamics existed in Lebanon, Pakistan, and Nigeria. Fuel subsidies thus acted as a stabilizing mechanism for fragile energy systems, masking inefficiency and deferring infrastructural reform.

At the same time, subsidy regimes were uneven and increasingly fragile. In conflict settings such as Syria and Yemen, prolonged war fractured both centralized infrastructure and the institutional capacity to sustain coherent subsidy systems, shifting the dynamics of energy insecurity away from affordability alone and toward physical destruction and territorial fragmentation.

SHOCK: SUBSIDY COLLAPSE, INFRASTRUCTURE DESTRUCTION, AND CHEAP SOLAR

Over the past decade, a combination of political and economic crises has challenged fuel subsidy regimes. Yemen sharply reduced subsidies in 2014 following an IMF-linked reform package. Lebanon phased out fuel subsidies in 2021 after two years of financial collapse. Pakistan's 2022 balance-of-payments crisis resulted in sharp fuel price increases, and Nigeria formally ended petrol subsidies in 2023, triggering price hikes of 100 to 200 percent. In Syria, the civil war fractured both subsidy practices and centralized energy governance from 2011 onwards.

While subsidy removal reduced fiscal pressure on governments, it produced a profound short-term shock. Societies that had become increasingly dependent on electricity faced continuing blackouts from national grids and suddenly unaffordable generator power.

At the same moment, the cost of Chinese solar panels, batteries, and inverters fell by roughly 90 percent over the past decade, making off-grid solar the cheapest and most reliable alternative (Ritchie, 2024). In the 21st century, electricity is no longer a luxury but a prerequisite for a dignified life in digitally connected societies (Human Rights Watch, 2023). The result was a rapid and largely unplanned deployment of off-grid solar home systems, driven not by policy design but by necessity.

Once operating diesel generators became prohibitively expensive, decentralized solar quickly emerged as the default mechanism for securing electricity. Across crisis-affected countries, households and businesses installed rooftop panels, batteries, and inverters at unprecedented speed.

OUTCOMES: SOLAR AS THE NEW DEFAULT ENERGY FIX

Once operating diesel generators became prohibitively expensive, decentralized solar quickly emerged as the default mechanism for securing electricity. Across crisis-affected countries, households and businesses installed rooftop panels, batteries, and inverters at unprecedented speed. In rural Lebanon, some 90 percent of households now have a solar system. In Pakistan's remote regions, some 70 percent of households have gone solar. In Yemen and Syria, where years of civil war have made blackouts and fuel shortages the norm, solar panels are a fixture of the landscape.

More recently, Nigeria has been experiencing a solar boom, with imports increasing by 60 percent in 2025 (Adeoye & Mooney, 2025; Raven, 2021; Shah, 2025).

> *Crisis-induced decarbonization instead points to a more unsettling but revealing possibility: that renewable energy may spread fastest where states and infrastructures are weakest, driven by necessity rather than design.*

The outcome has been a massive diffusion of renewable energy technologies, transforming everyday energy practices and reshaping expectations of electricity provision. Decarbonization, in this context, is not the product of coordinated transition strategies but a by-product of system breakdown. Across both fiscal-crisis and conflict-driven contexts, decentralized solar has gained traction precisely because it bypasses centralized points of failure, whether these are unaffordable fuels, bankrupt utilities, or physically targeted infrastructure.

Whether this shift represents a temporary interregnum or a durable restructuring of energy systems depends on several key drivers: global fuel prices, Chinese export policies, the recovery of national grids, and the political capacity of states to reassert centralized energy governance.

SCENARIOS: WHERE THE TREND COULD GO

A) REVERSAL

A reversal would require either a dramatic collapse in fuel prices or a sharp rise in solar equipment costs. Given global oil market structures and ongoing geopolitical tensions, such a scenario appears unlikely.

B) SLOWDOWN

The trend may slow once the "natural frontier" of crisis-affected adopters is reached. Off-grid electricity remains costly, limited in scale, and socially demanding as it exacerbates energy inequality. In this scenario, crisis-induced solar expansion represents a transitional phase until centralized grids recover. This second scenario seems more likely as the electrification of transport and heavy industry will require quantities of electricity that necessitate utility-scale solutions.

C) STABILIZATION

Decentralized solar may stabilize and consolidate, producing permanently hybrid energy systems. Utilities would be forced to adapt technically and institutionally to a landscape in which centralized supply coexists with widespread private generation. This third scenario, too, seems somewhat likely.

D) ACCELERATION

In an acceleration scenario, driven by deeper crises, higher fuel prices, or further grid deterioration, countries may experience widespread grid defection. As customers disconnect, utilities lose revenue, raise tariffs, and lose more users, triggering a utility death spiral that ultimately undermines electricity as a collective service. While it appears unlikely that such an acceleration happens on a global scale, solar "rushes" like those of Lebanon or Pakistan might well play out in fragile countries with unsustainable fuel subsidies.

OUTLOOK: WHERE CRISIS-INDUCED SOLARIZATION IS LIKELY HEADED NEXT

The cases examined—Pakistan, Lebanon, Nigeria, Syria, and Yemen—share a condition of weak electricity utilities and long familiarity with private energy provision. Where fuel subsidies have been reduced or removed, solar adoption has accelerated rapidly. Where war and political fragmentation dominate, decentralized solar has spread as a resilient alternative to vulnerable centralized infrastructure.

Countries combining political fragility with high energy subsidies, such as Iraq, Libya, Sudan, Venezuela, and to a lesser extent Egypt and Algeria, are strong candidates for similar dynamics. Armed conflict further reinforces this trend, as centralized infrastructure becomes a strategic target. Even Ukraine, despite less favorable solar irradiation, is witnessing rapid growth in decentralized solar and battery installations (Krynytskyi, 2025; Mundy, 2025).

These developments challenge a core assumption of global climate governance: that decarbonization flows primarily from policy leadership, institutional capacity, and formal planning. Crisis-induced decarbonization instead points to a more unsettling but revealing possibility: that renewable energy may spread fastest where states and infrastructures are weakest, driven by necessity rather than design. Crucially, this form of transition unfolds largely outside the categories through which energy systems are typically monitored and governed.

As a result, crisis-induced solarization follows a pathway fundamentally different from policy-led energy transitions in the EU or many non-crisis middle-income countries. It is rapid, decentralized, and often statistically invisible, as existing energy data and international reporting frameworks prioritize utility-scale projects and regulated grid systems. Governments and international institutions therefore risk underestimating how profoundly energy landscapes and everyday energy practices are changing. At the same time, this form of decarbonization reveals both promise and risk. Like subsistence farming, life off the grid is often marked by recurring energy poverty and deepened inequalities. Yet crisis-induced decarbonization also highlights an underappreciated potential: the transformative power of now-affordable renewable technologies combined with people's capacity to adapt, experiment, and innovate under constraint. Recognizing, measuring, and engaging this trend offers an opportunity for smarter energy and climate policy, one that builds on its speed and resilience while mitigating inequality, insecurity, and exclusion.

Governments and international institutions therefore risk underestimating how profoundly energy landscapes and everyday energy practices are changing.

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