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# False solutions: How do fossil fuel companies reproduce their power through the energy transition

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## ABSTRACT

In response to mounting political and social pressure to transform their business models, the fossil fuel industry is attempting to portray itself as “part of the solution” to the climate crisis by emphasising its investments into renewable energy, biofuels, green hydrogen, carbon capture and storage, and carbon offsets. However, environmental justice organisations have labelled these technologies as “false solutions” that do not address the root causes of the climate crisis and entrench environmental injustice and fossil fuel companies’ power. In this paper, we formalise and operationalise a definition of false solutions by engaging with Gramsci’s conception of hegemony and incumbent strategies, in particular the concept of transformismo. We extend neogramscian theory by proposing a model of reproduction and reinforcement of power within and between three power domains: ideas, infrastructure, and institutions. Empirically, we explore the environmental conflicts that arise around the deployment of false solutions through a global analysis of 48 case studies in the EJAtlas and a coding methodology that identifies processes of power reproduction and reinforcement. We show that false solutions comprise an array of technologies that prolong fossil fuel hegemony and neutralise socio-political pressures for systemic transformation, thereby sustaining current extractive economic models that reproduce environmental conflicts and injustices.

## 1. Introduction

Limiting the worst impacts of climate change and halting harmful impacts to human and environmental health requires an immediate and managed phase-out of global fossil fuel production and the early retirement of currently operational infrastructures [1–4]. The necessity of these production cuts, and the transformations required to existing modes of fossil fuel production and company operations across the upstream, midstream and downstream segments of the industry, present an existential threat to the fossil fuel industry, its profits, and its power. While many fossil fuel companies have publicly conceded to the need to decarbonise [5,6], none are pivoting their operations at the speed and scale that climate science now demands [7]. Indeed, many fossil fuel companies are resisting the systemic, financial and operational transformations required through a multitude of strategies, such as sowing doubt on climate science [8], promoting skewed economic science [9] and lobbying governments for favourable policy outcomes [10–12]. As a

result, fossil fuel incumbents are increasingly being targeted by direct action, legal challenges, government and institutional policy, the contestation of sponsorship agreements across cultural sectors, and loudening calls for the regulation of fossil fuel production.

In the face of these pressures, incumbent fossil fuel companies are positioning themselves as “part of the solution” to the climate crisis, the energy transition and the social and environmental challenges that these processes give rise to. Incumbents amplify their green credentials by emphasising their investments into renewable energy and other, more speculative or immature technologies, such as carbon capture and storage (CCS) and green hydrogen [13,14]. These incumbent strategies are not aimed at resisting decarbonisation claims per se [15], but rather at accommodating such calls without changing their core business model, therefore maintaining their political and social license to steer global climate and energy fora, while neutralising demands for a transformation in energy and economic systems. For more than two decades, environmental justice organisations (EJOs) have decried these

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strategies and criticised fossil fuel industry “false solutions” that do not address the root causes of the climate crisis, and the injustices that are entrenched by specific low-carbon technologies [16,17]. As a concept, false solutions incorporate a variety of intersecting concerns from EJOs over the corporate strategies of the fossil fuel industry to delay climate action and the social and environmental impacts of these technological pathways, particularly in relation to frontline communities and Indigenous Peoples. EJOs have used the concept of false solutions to describe (1) the fossil fuel industry discourses that legitimise further expansion of fossil fuel infrastructure on the premise of future emissions abatements [18]; (2) the projects that extend the lifetime of fossil fuel infrastructure and increase emissions under the promise of later compensation through negative emissions reductions [19]; and (3) the initiatives and projects with doubtful climate mitigation potential effectiveness [20]. EJOs further denounce false solutions on the grounds of receiving generous amounts of public subsidies from governments [21–23] and legitimised by public institutions captured by corporate interests [24]. It should be stressed that the concerns over the impacts of these technological pathways go beyond emissions mitigation and touch upon the systemic and structural issues of justice, dispossession, environmental degradation and the distributional impacts of specific technologies. In other words, the technologies favoured by incumbents fail to address the social, environmental, racial, economic and intergenerational root causes and ramifications of the climate crisis, further entrenching forms of social and environmental oppression. EJOs reject false solutions as they “continue consolidating a system of over-consumption, utilisation of fossil fuels, destruction of nature and hoarding of wealth” [25] and do not challenge the “economies of greed and hoarding; endless growth; corporate enclosure of land; erosion of biodiversity and the exploitation of life” that are the root cause of the multiple and intersecting environmental, climate and social crises [17: 3]. Instead, many EJOs find ‘true’ solutions to the root causes of environmental injustice in economic, political, social and cultural transformations that challenge the hegemony of fossil fuel corporations and their enablers [26].

However, the concept of false solutions has received little attention within academic literature, despite extensive scholarship exploring fossil fuel incumbents’ corporate behaviours, strategies of resistance and delay, the niche technological developments favoured by fossil fuel incumbents, and emergent forms of green extractivism [27]. While established analytical concepts like climate delay [14,28] and green extractivism [29,30] capture specific dimensions of incumbent resistance and strategies, we argue that false solutions encapsulate a broader critique that connects technological functions with both institutional and discursive framings. This albeit broader, functionalist framing goes beyond economic or political dimensions to capture technological, ideological and discursive functions, which are central to understanding how these technologies operate in practice and across diverse contexts. What’s more, the widespread and persistent use by EJOs justifies a more formal engagement with the concept in order to bridge the gap between academic, activist and policy debates [31,32]. We do this through a global comparative analysis of 48 case studies of environmental conflicts sparked by fossil fuel companies’ so-called low-carbon projects that further develops neoGramscian theories of hegemony and trasformismo. Our case studies span several technologies, including biofuels, green hydrogen, green ammonia, direct air capture, CCS, carbon offsetting through Reducing Emissions from Deforestation and forest Degradation in Developing countries (REDD+), and other afforestation projects, as well as wind, solar, geothermal and hydroelectric power plants owned by fossil fuel incumbents. In particular, we ask whether and how these projects reinforce extraction and reproduce the power of the incumbent fossil fuel companies within the energy system?

We contribute to the literature by formalising and operationalising a definition of false solutions that captures both the specific technologies that are portrayed as means of reducing emissions, as well as their function in reproducing the power of incumbents across three interlocking power domains: ideologies, institutions and infrastructure. We

argue that the pursuit of false solutions by fossil fuel companies is a form of ‘trasformismo’, whereby incumbents deploy low carbon technologies and narratives to accommodate pressures, reproduce and reinforce their hegemony, entrenching rather than addressing the root causes of the climate crisis. Such a conceptualisation lends itself to understanding the *what*, the *how*, the *who* and the *why* of false solutions: the specific technologies that can be deemed a false solution and how they function to neutralise socio-political pressures to consolidate the dominance of incumbent powers in the light of the necessity of a rapid and managed phase-out of fossil fuel production. By systematically analysing instances of trasformismo from incumbents, we add to understandings of preferred strategies of reproducing incumbent power and, by extension, potential routes to disrupting that power amidst an energy transition that is messy and multiscalar, unfurling in different ways and at divergent paces depending on context and structural factors. As such, our paper adds to action-oriented scholarship that seeks to learn from and through action [33,34].

## 2. Theoretical framework: Reproducing and reinforcing power through ideas, institutions and infrastructure

Processes of decarbonisation and transformation within global and national energy systems create winners and losers [35], spark resistance from incumbent actors [36,37], fuel new geopolitical rivalries [38], and often take place within contexts of uneven power relations [39,40]. As such, the analysis of power dynamics is fundamental to explaining the shape and speed of energy transitions and the social conflicts that they generate. Here, Antonio Gramsci’s theorisation of power and social transformations is a crucial and much-used tool. Many scholars have deployed Gramscian and neoGramscian theory to foster a better understanding of how power dynamics accelerate and hinder transitions, and how reconfigurations of power dynamics map across different contexts, industries, and terrains [12,15,41–47]. Of particular interest to understanding false solutions proposed by the fossil fuel industry is the theorisation of incumbent strategies to reproduce their power and fend off, or co-opt, external demands to transform the energy system to mitigate climate and socioecological damages.

Incumbent strategies differ according to context and are not solely about resisting change [15]. Indeed, the process of change - or at least the act of claiming that change is already underway or about to begin - could be deemed an incumbent strategy of fossil fuel firms at the current juncture in the energy transition. This strategy is captured in Gramsci’s notion of trasformismo, which has been deployed by scholars to explore how incumbents (re)produce favourable social and economic structures [15,42,43,48], and is particularly relevant to a theorisation of false solutions. Conceptualisations vary across the literature. Newell [42] describes trasformismo as the incumbents’ capacity to accommodate demands for transformative changes through strategies that reinforce the material, institutional and discourse power of incumbents, which ensures that any reconfigurations that take place do not disrupt social relations or the distributions of power (see Table 1 for key concept definitions). Others, such as Szabo [48] and Ford and Newell [43], describe trasformismo as a process whereby incumbents accommodate pressure to change and neutralise counter-hegemonic interventions by subsuming them into hegemonic frameworks through a process described as “fossilising renewable energy” [49–51]. As Tilsted et al. [15] point out, the process of trasformismo goes beyond efforts to impede change by also focusing on absorption and adaptation to align counter-hegemonic ideas and activities within the hegemonic framework. Through strategies of trasformismo, the very process of change can align with incumbent interests and even reinforce them.

Through the concept of trasformismo we can illustrate how Gramscian politics of contention are not only reflected in the academic literature, but are also expressed by EJOs (see Table 1). EJOs coined the concept of false solutions to characterise a process of trasformismo, whereby fossil fuel companies and states promote technologies and

**Table 1**

**Key Concepts and definitions.** The main concepts discussed in this article are described in the second column either through novel conceptualisation or through citations from earlier publications. The third column provides examples of environmental justice organisations discourses that implicitly deploy each theoretical principle.

Concept	Definition (authors' own and drawn from academic literature)	Environmental Justice Organisations' discourse examples
False solutions	False solutions comprise an array of adjacent technologies at differing stages in their development and deployment, used at different points in the fossil fuel industry's value chain to prolong the fossil fuel economy and neutralise socio-political pressures and demands for a systemic transformation of social, political and economic norms	"The fossil fuel industry and other polluting corporations have a lot invested in the infrastructure already in place, and they'll do anything to make sure they squeeze out every last cent of profit they can — including hyping up false solutions to make the public feel better about practices we know we need to change" [63].
Domains of power	Each of the three sociopolitical arenas (ideas, institutions, and infrastructure) where hegemonic incumbents can reproduce its position of domination by exerting power. The complex interlocking interactions between domains stabilises the hegemony of any coalition dominating all three of the domains.	"Indigenous Peoples' resistance to destructive industrial projects – from stopping oil and gas pipelines to blocking mega-dams, has been on the rise world-wide [infrastructure]. Young people have mobilized against the inaction of governments and farmers have rallied to stop policies that favour polluting corporations [institutions]. More than ever before, the center-of-gravity of the climate movements have shifted to a climate justice narrative – where we do not distinguish between the global war on biodiversity waged by corporate greed and the wars waged against the cultures, cosmologies, communities and bodies of oppressed peoples worldwide [ideas]" [17].
Hegemony	"Hegemony projects carried out by different actors [...] tied together by common interests and characterised by a variety of different strategies and tactics which attempt to universalize particular interests." [64:68].	"The United Nations Framework Convention on Climate Change (UNFCCC) has itself allowed and enabled the proliferation of false solutions, giving the world's biggest and wealthiest polluters multilateral cover and legitimacy" [24].
Trasformismo	"Petro-hegemony, which draws together the discursive, economic, and political strategies that fossil fuel companies leverage to shape and maintain favourable relations of consent, compliance, and coercion to advance their interests" [65:2]. The incumbent's capacity "to accommodate pressures for more radical and disruptive change and to employ combinations of material, institutional and discursive power to ensure that shifts which do occur in sociotechnical configurations do not disrupt prevailing social relations and distributions of political power" [42: 28]. A process where "potentially counter-hegemonic ideas and activities are neutralised by being brought within hegemonic frameworks" [43: 3].	"A tsunami of new carbon capture projects are underway, undermining the imperative to justly and urgently phase out fossil fuels. This new wave is only made possible with hundreds of billions of dollars of public money offered by governments through policies announced since 2020" [22]. "We call false solutions any initiative, project or proposal that claims to support the protection of the planet and its inhabitants, with formulas that include deception, technical flaws, alleged technological innovation and a discourse that claims to confront climate change, but rather continues consolidating a system of over-consumption, utilization of fossil fuels, destruction of nature and hoarding of wealth, as we know it" [25].
Conflicts	Social conflicts explicitly unearth the contradictions of the hegemonic regime, they reveal the correlation of forces, and identify the composition and strategies of historical blocs [47,64].	"The world is facing a persistent conflict between capitalist accumulation and sustainability that affects how we organise ourselves as a society" [66]. "[REDD+] has created conflict and increased corporate control over Indigenous land and land cultivated by forest peoples and peasant communities" [67].

policies that accommodate growing demands to phase-out fossil fuel production and pivot operations away from extractivism, while avoiding the required systemic transformations [17,52,53]. Through this process, false solutions neutralise external pressures, legitimise fossil fuel incumbents and their enablers, and, as a result, form the basis of claims that fossil fuel companies are "part of the solution" to the climate crisis [13,14].

In addition, false solutions refer to technologies deemed to do little to combat the climate crisis and, in some cases, inflict novel socio-ecological impacts on already marginalised communities [17,52,53]. Such technologies can be found across the global fossil fuel industry, including 'plug-and-play' technologies such as carbon capture and storage (CCS) and green hydrogen, which complement existing production methods and infrastructures and reinforce the structural power of incumbents. The concept also includes the use of renewable energy technologies to decarbonise fossil fuel production and specific extraction infrastructures, such as offshore oil rigs, as well as the use of so-called "nature-based solutions" to remove carbon emissions from the atmosphere after combustion has occurred. As a concept, false solutions pull together an array of adjacent technologies at differing stages in their development and deployment, used at different points in the fossil fuel industry's value chain. Yet what threads these technologies together conceptually is their function: false solutions prolong the fossil fuel economy and neutralise socio-political pressures and demands for a systemic transformation of social, political and economic norms, thereby maintaining incumbent power and sustaining current modes of extractivism.

This interpretation of false solutions encompasses ideological, institutional and technological dimensions, which in turn, allows us to extend neoGramscian theory on social forces, conflict and power relations. Departing from Newell [42], Ford & Newell [43] and Kalt [47],

we argue that false solutions exercise and reproduce incumbent power across three domains: ideas, institutions and infrastructures (See Fig. 1). This approach also draws on the work of Robert Cox, which moves beyond a state-centric approach to social transformations, highlighting the constant interplay of material conditions, social institutions and ideas [54,55]. We posit that the decisions and actions that take place within each of these domains are determined by the existing distribution of power and determine the resulting relationship of forces in a historic process that reproduces hegemony [43,56,57]. This reproduction of power leads to a historical inertia that stabilises hegemonic coalitions' control of a power domain for a sustained period of time. The stabilisation of power also operates at a higher scale as a position of domination in one of the domains reinforces hegemony in the other two domains in an interlocking network. For Gramsci, material conditions and ideas cannot be analysed in isolation [42,58], and institutions are both the mediators between the material and the ideological and the product of that mediation [54]. Trasformismo is precisely the process of reproduction and reinforcement of hegemony in each of the power domains through the accommodation of socio-technological changes.

When a coalition comes to dominate each of the three power domains, the mutual reinforcement between ideas, institutions and infrastructures locks-in a balanced power regime that can sustain itself for prolonged historical periods [41,43]. The interlocking and reproducing logics of power mean that high magnitude perturbations are required to unsettle the hegemony of established coalitions. These stable hegemonic regimes are termed "historical blocs" by Gramsci [58], and this concept has already been used to describe the alliance of powers built around fossil fuel companies [36,46]. The constitution of the currently hegemonic fossil fuel historical bloc includes state actors and economic powers coalesced around the provision of cheap, secure and discretionary energy supply by the fossil fuel industry [59]. In turn,

“institutional power is conferred [to the fossil fuel industry] because of this material power” [43:4]. The mutual dependence of fossil fuel companies and political, economic and social actors creates a historical bloc that mutually reinforces one another in a stable regime by combining the forms of power across each of the three power domains.

However, “hegemony is rarely complete” [43:5] and power regimes are constantly in an evolving and unstable equilibrium that can be disrupted by counter-hegemonic forces [54,58]. As such, the architecture of power across the three mutually reinforcing and reproducing domains not only serves as a model for hegemony, it also serves as a theory of change (Fig. 1). External disruptions or internal rearrangements can unsettle the reproduction of hegemony in one of the domains, at which point the supremacy in the other domains is also shaken. The virtue of mutual reinforcement between power domains also gives rise to the vulnerability of mutual dependencies and a precarious equilibrium that amplifies disturbances and can precipitate hegemonic changes when only one of the domains is initially disrupted. A destabilisation of the regime can come from internal fractures in the historical bloc [43] or from external challengers or landscape pressures [60,61]. When structural tensions break the power balance of the incumbent regime, an “organic crisis” arises, creating the conditions for a “struggle for hegemony” [58: 404, as cited in 47]. The struggle unfolds until a new coalition regains a stable hegemony in each of the power domains. The mutual reinforcement between the power of ideas, institutions, and infrastructure stabilises the hegemony of the winning coalition. Although there are no direct allusions to Gramsci or Cox, this theory of change is implicitly reflected in EJO strategies as they try to disrupt the reproduction of power in the ideological domain by identifying the low-carbon transition narrative of the fossil fuel industry as false solutions.

In this paper, we argue that *trasformismo* is a useful tool for theorising false solutions as one of many incumbent strategies deployed by the fossil fuel industry. We conceptualise false solutions as both a capacity of incumbents and an ongoing process of accommodation whereby counter-hegemonic interventions are subsumed into the dominant, or hegemonic, regime [43]. This research thus addresses the calls for “further empirical work on unsettling incumbency” [42: 19]. In particular, we focus on the socioecological conflicts generated by the deployment of novel energy and carbon management technologies as the arena where hegemony is contested and where the opportunities of social transformation emerge [47]. Change is brought about by “conflicts, power struggles, contestations, lobbying, coalition building and

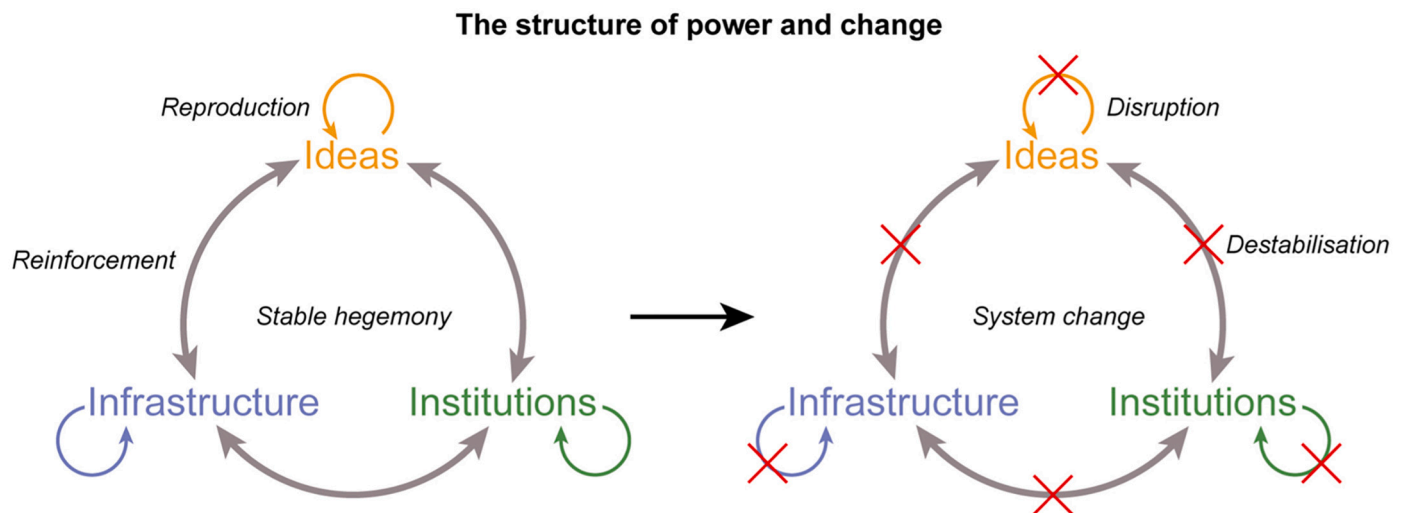
bargaining” between actors [62:415]. We have chosen to empirically focus on environmental conflicts documented in the EJAtlas to strengthen our theoretical contribution and illustrate how it can be deployed to further the study of environmental justice struggles around the world and bridge the gap between academia and activism.

### 3. Methodology

Environmental conflicts are sociopolitical phenomena where discourses, institutions and material conditions are contested between incumbent and counter-hegemonic powers. In this vein, conflicts are the frontiers where hegemony is disputed, and where its nature and vulnerabilities are revealed. We look through this unique window by comparatively analysing 48 environmental conflicts over false solutions from around the world (Table S1). The evidence provided seeks to support, illustrate and operationalise our theoretical contributions on false solutions as a form of *trasformismo* that enables the reproduction and reinforcement of power across each of the ideas, institutions and infrastructure power domains.

All of the empirical material for this study has been documented in and collected from the Global Atlas of Environmental Justice (EJAtlas.org), the world’s largest environmental conflict database with more than 4350 cases recorded [68–70]. The EJAtlas documents environmental conflicts based on a standardised data entry form that combines free text descriptions with coded categories across hundreds of data fields. The combination of description and coding enables the EJAtlas data to bridge the local and global scales in comparative multicase studies [71–77]. This allows us to explore global patterns in the deployment of false solutions by fossil fuel companies and the resistance by EJOs, as well as the geographic and technological specificities of the power dynamics in each case study.

The analysis focuses on 48 environmental conflicts involving fossil fuel companies and any of the following technologies: wind, solar, hydroelectric and geothermal power, biofuels, green hydrogen, green ammonia, direct air capture, carbon capture and storage, and carbon offsetting through REDD+, and afforestation (see Table S1). Fossil fuel companies are defined by a business model substantially dependent on the extraction and/or transportation of coal, oil, and/or gas. The selection of technologies has been based on the review of numerous EJO reports denouncing false solutions. For the particular case of solar and wind, some EJO reports classify them as false solutions, while others



**Fig. 1. Conceptual map linking the three domains of power: ideas, institutions and infrastructure.** Incumbent power in each power domain offers a platform to reproduce and sustain power in that domain through time (coloured loops). Hegemony in each of the domains reinforces the domination of relationships in the other two domains (grey lines). The framework can be used as a theory of change when the reproduction of power is disrupted in any of the domains, and/or when the interlocking dynamics between power domains are disrupted, potentially leading to an “organic crisis” and a reorganisation of hegemonic blocs.

argue they are fair solutions to climate change if implemented correctly and accompanied by forms of community ownership, for instance. In this case, we have taken EJOs' view that renewable technologies are not a credible climate solution unless they displace fossil fuels within energy systems, while acknowledging that renewable technologies can also drive land disputes and socio-environmental impacts akin to fossil fuel projects. Additionally, our investigation particularly focuses on wind and solar power plants owned by fossil fuel companies, which are often used to power fossil fuel infrastructures.

### 3.1. Conflict documentation

Of all conflicts analysed, 11 were already recorded in the EJAtlas, while 37 have been documented by the authors of this investigation between August 2022 and August 2024 (all conflicts are listed in Table S1). To identify conflicts for documentation, we screened oil and gas companies' green energy advertising, web pages, press releases and annual reports to identify low-carbon projects, which were subsequently investigated to identify organised resistance. Google searches combining the name of a project plus keywords highlighting conflict or impact elements such as *opposition, protest, conflict, fight, controversy, scandal, STOP, SOS, mobilisation, save, concerns, impacts, hazards, residents, neighbours, local community, displacement, and livelihoods* were used to identify news reporting opposition to a given project. We also relied on our own activist and research networks, discussing the campaigns they have worked on or case studies they have investigated in relation to false solutions. Information about conflicts was sourced from academic literature, local newspapers, specialised outlets, EJOs' websites, corporate documents, and other databases, such as Global Energy Monitor.

Documenting conflicts in the EJAtlas database allowed us to systematise them, exploring their shared themes through quantifying and qualifying data into categories. Some of these categories included the specific characteristics of the project, arguments or green credentials in favour of the projects, companies, institutions and actors who fund or are in favour of the project, alongside those resisting the project and their strategies of resistance. Each conflict case also explores key events, impacts and the outcomes of each instance of environmental injustice, as well as the current status of a project at the time of writing.

### 3.2. Conflict coding

After all cases were documented in the EJAtlas, we systematically identified, organised and analysed key mechanisms of reproduction and reinforcement of power across the power domains through a coding protocol. Following our theoretical model, six codes were designed, three of them to illustrate particular examples of power reproduction mechanisms within each of the infrastructure, institutions and ideas power domains (respectively, *Fossil fuel infrastructure lock-in, Collaboration with other economic sectors*, and *Colonial narratives*), and three more codes to illustrate the reinforcement dynamics between domains (*Public subsidies, Fossil fuel solutionism, Ecomodernism*) (Fig. 2). This coding design allowed us to integrate our theoretical and empirical contributions, providing illustrative examples of the power dynamics defined in our theoretical framework while highlighting the applicability of our theory to explain and understand the actors, strategies and motives behind power struggles in the energy transition.

In Table 2 we present the six codes together with a theoretical rationale justifying the power reproduction or reinforcement mechanism linked to our conceptual framework. To facilitate integration of theory and empirical observation, an example of a case study is briefly explained as an empirical illustration of the coded mechanism alongside its theoretical rationale. Each of the codes was subsequently assigned to a given conflict based on the theoretical definitions by two of the co-authors. The coding process was not mutually exclusive, with cases being coded into several mechanisms if necessary. This enabled a deeper understanding of the overlapping themes and commonalities between

cases, and the interrelations between different power reproduction and reinforcement mechanisms.

To enable a systematic analysis, this coding exercise was a necessary simplification of the mechanisms that occur in an inherently messy, complex and contingent power system. Indeed, we could also argue that public subsidies, for instance, are not only a reinforcement mechanism between institutions and infrastructure, but they are also indirectly a mechanism of reinforcement between institutions and ideas, as the pretext of providing public support to fossil fuel companies buttresses the narrative that they are indeed valid and honest partners in the decarbonisation of the energy system. Although these power interconnections are inherent in a complex power system, we consider that our coded mechanisms represent most clearly and directly the power reproduction and reinforcement processes in (or between) the domain(s) they are assigned to.

## 4. Results and discussion

The 48 environmental conflicts documented and analysed in this study cover a wide range of technologies and geographical regions (Fig. 3). The selection of cases allows us to illustrate and locally ground the power reproduction and reinforcement dynamics we have theoretically proposed with particular examples of community struggles against the impacts of false solutions in different locations and against various technologies. We analyse and discuss the case studies in three subsections following three distinctive stages along the fossil fuel value chain: energy extraction, energy vectors and transport, and carbon management [79]. Throughout the text we relate the evidence to the theory, explicitly providing each of the six codes in brackets in relation to particular examples of power reproduction and reinforcement in our sample. At the end of the section, a global overview discusses the main trends behind false solutions across different technologies and looks at the interaction between different power reproduction and reinforcement mechanisms (Fig. 4).

### 4.1. Energy extraction

Rather than accelerating the phase-out of fossil fuels within energy systems, solar and wind projects can perpetuate the fossil fuel industry's dominance [80], serving purposes like electrifying fossil fuel extraction. Our case studies reveal that contested offshore wind projects in Norway (Case 1 and 2) are built to power existing oil extraction operations, thus effectively delaying decarbonisation by locking-in fossil extraction infrastructures (#Fossil Fuel Lock-In). Similarly in Scotland, licences for oil and gas exploration are being granted to Shell, Equinor, BP and TotalEnergies on areas of seabed that have been simultaneously demarcated for offshore wind provisioning (Case 3), in large part due to Shell and BP noting the potential for decarbonising fossil fuel extraction in the North Sea with offshore wind energy (#Fossil fuel solutionism). Likewise, BP, Chevron, ExxonMobil, and Shell have all been found to

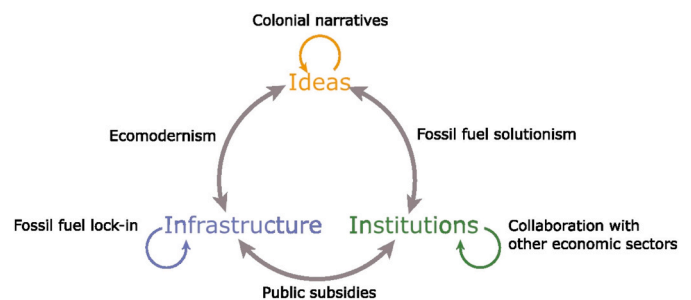


Fig. 2. Representation of codes and their association with the processes of reproduction and reinforcement of power. Full definitions are provided in Table 2.

Table 2

**Theoretical rationale and empirical examples for each of the six codes that systematise the analysis of environmental conflicts.** The second column provides the domain(s) of power and mechanism of reproduction/reinforcement that is most aligned with each code (see Fig. 1).

Code	Mechanism	Theoretical rationale	Empirical example
Fossil fuel infrastructure lock-in	Infrastructure Reproduction	False solutions can reinforce ongoing fossil fuel extraction by sustaining existing oil and gas facilities, re- or dual-purposing fossil fuel infrastructures, and keeping infrastructures operational through continued reliance and use, therefore entrenching the dependency on fossil fuels and complicating their phase-out while accommodating pressures for more rapid and effective decarbonisation.	In Norway, the Trollvind offshore wind farm has been partly motivated as a way to decarbonise the power supply to the Troll and Oseberg oil and gas fields (Case 1). In Japan, there are plans to co-fire coal with up to 20 % green ammonia in thermal plants as a way to extend the life of the power plants (Case 24).
Collaboration with other economic sectors	Institutions Reproduction	False solutions projects can foster partnerships and integrate the operations of fossil fuel companies with other major industrial sectors - such as Big Tech, industrial agriculture, aviation, automotive, or fertiliser industries. Such collaboration amplifies profits, maximises rents and mutually reinforces the dominance and influence of these highly polluting, extractive sectors within global power structures. What's more, these projects help keep together and expand a historical bloc that reproduces sociotechnical configurations as well as unequal social relations and distributions of power.	In the US, fossil fuel companies are acquiring and developing ventures that team up with the dairy industry to turn manure into gas using anaerobic digesters. The gas is marketed by the fossil fuel industry as "Renewable Natural Gas", while the alleged carbon emissions reductions are being sold as credits in cap and trade carbon markets. The profits accrue for both the fossil fuel and the dairy industry, and the technology incentivises ever larger, more industrialised dairy farms, locking-in the alliance and dependence between the sectors (Case 23).
Colonial Narratives	Ideas reproduction	The proponents of false solutions can use justifications or discourses that reflect or perpetuate colonial ideologies, practices, and/or power dynamics. Elements of these projects' design and/or implementation echo historical patterns of misrepresentation, exclusion, discrimination, exploitation, inequality and domination, particularly in relation to marginalised communities, Indigenous Peoples, or nations in the Global South. This strategy seeks to impose an epistemic hierarchy that subordinates indigenous and traditional values under the hegemony of market, technoscientific, and quantifiable valuation.	In a proposed tree plantation in the Republic of Congo, TotalEnergies has promised to provide "employment opportunities, [and] health, nutritional and educational initiatives to benefit neighbouring villages". This promise forecloses the possibility that the villages currently have their own means of sustaining their health, nutrition and education based on their existing local institutions and traditions. In fact, local residents have denounced that they have been prevented from accessing their customary agricultural land, which is the source of their intake and income, and the traditional basis of their nutrition, health, and the education of their children (Case 38).
Public subsidies	Institutions - Infrastructure Reinforcement	Fossil fuel companies hold significant influence over public institutions thanks to their intense lobbying activities and the centrality of their operations in national and global economic systems. In turn, this influence over public institutions can translate into public subsidies (both direct and indirect) that are essential for deploying and maintaining false solutions and reinforcing the hegemony of incumbents in energy infrastructure. This support can come in the form of monetary support or preferential treatment from publicly funded bodies or multilateral institutions such as national governments, EU institutions, the UN, regional development banks, the World Bank and IMF.	Immature technologies, such as green hydrogen, for which there does not exist production or demand at scale, require significant public subsidies to derisk private investment to create a market. In the case of the H2Med hydrogen pipeline, it was specifically designed and politically negotiated to be eligible for EU funding as a Project of Common Interest (IPCEI), which enables its fossil fuel developers to access funding sources such as the "Connecting Europe" facility which can cover up to 50 % of the project's eligible costs (Case 33).
Fossil fuel solutionism	Ideas - Institutions Reinforcement	False solutions projects can be used by fossil fuel companies to portray themselves as "part of the solution" to the climate crisis. Such narratives obscure that incumbent fossil fuel companies are in fact not transitioning away from fossil fuels, while claiming that they play an essential role in the decarbonisation of the economy [14]. Fossil fuel incumbents' control over the narrative grants them a social and political license to influence institutions and public opinion on the constructed notion that they are a good-faith partner in the energy transition.	Occidental Petroleum claims that enhanced oil recovery through the underground injection of captured CO <sub>2</sub> can produce "net zero oil", making the company part of the "climate solution". These narratives are essential to gain the trust, favour and support of public institutions for fossil fuel companies' projects, in this case in the form of \$1.2 billion in public subsidies from the Biden administration for CO <sub>2</sub> direct air capture facilities co-developed by fossil fuel companies (Case 23).
Ecomodernism	Ideas - Infrastructure Reinforcement	Discourses that place technology and innovation as the main drivers to decouple human development from environmental degradation and climate warming justify the deployment of specific false solutions infrastructure, leaving other sociopolitical conditions unchanged. Such projects often exhibit a degree of carbon-centricity whereby the sole focus is on mitigating emissions through technological solutions, rather than redistributing environmental burdens, benefits, and power by an economic, social, and political transformation of energy systems.	Supporters of ammonia-coal co-firing defend that it can reduce the emissions of coal power plants, while ignoring that thermal plants will continue polluting the air of surrounding communities, and discarding alternative proposals to substitute coal power with distributed renewable energies and energy conservation measures (Case 27). Similarly, local communities in Texas criticise that CCS projects prolong rather than mitigate the impacts of local petrochemical industry on air pollution, community health and socioeconomic segregation (Case 31).

invest in renewable projects at locations in proximity to their oil extraction activities, using this cheaper, "greener" energy to support extraction and profits [81]. Energy generated at these renewable energy facilities supports extractive activities, enabling oil giants to mask fossil fuel infrastructures under the guise of "climate-friendly energy" (#Fossil fuel solutionism) [82]. Additionally, utility-scale solar and wind projects often rely on oil and gas to power their deployment, further entangling the fates of fossil fuels and emerging low-carbon sources of energy (#Fossil Fuel Lock-In) [50,83]. These findings suggest that renewable energy projects built by the oil and gas industry could potentially entrench fossil fuel infrastructure rather than rupture industrial economies' lock-in with fossil energy systems [80,84]. Although the dynamics

of rent extraction differ across modes of generation, fossil fuel companies have incentives to invest in and profit from oil and gas, as well as renewable energies, in a non-mutually exclusive way.

Moreover, the diffuse nature of solar and wind energy sources means their extraction generally impacts larger territories than equivalent fossil fuel projects [85,86]. This leads to an intensification of conflicts with particular impacts and disputes over land, ocean and landscape [87] (see Cases 4–6). Pressures, such as political access to land, intersecting with resource availability and technological development, significantly determine the geographical expansion of the solar and wind extraction frontier, as it does with fossil fuel infrastructures [73]. Indeed, solar and wind projects can often reproduce neocolonial

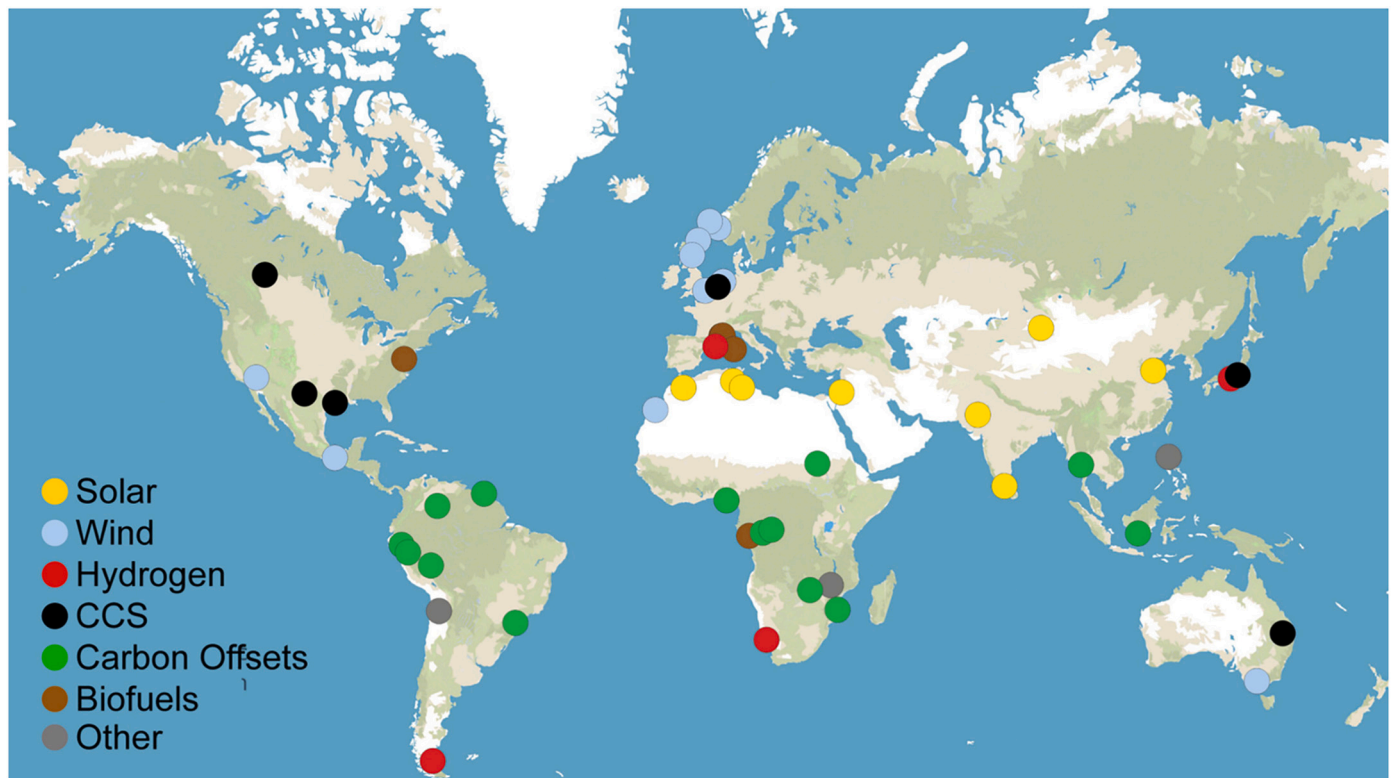


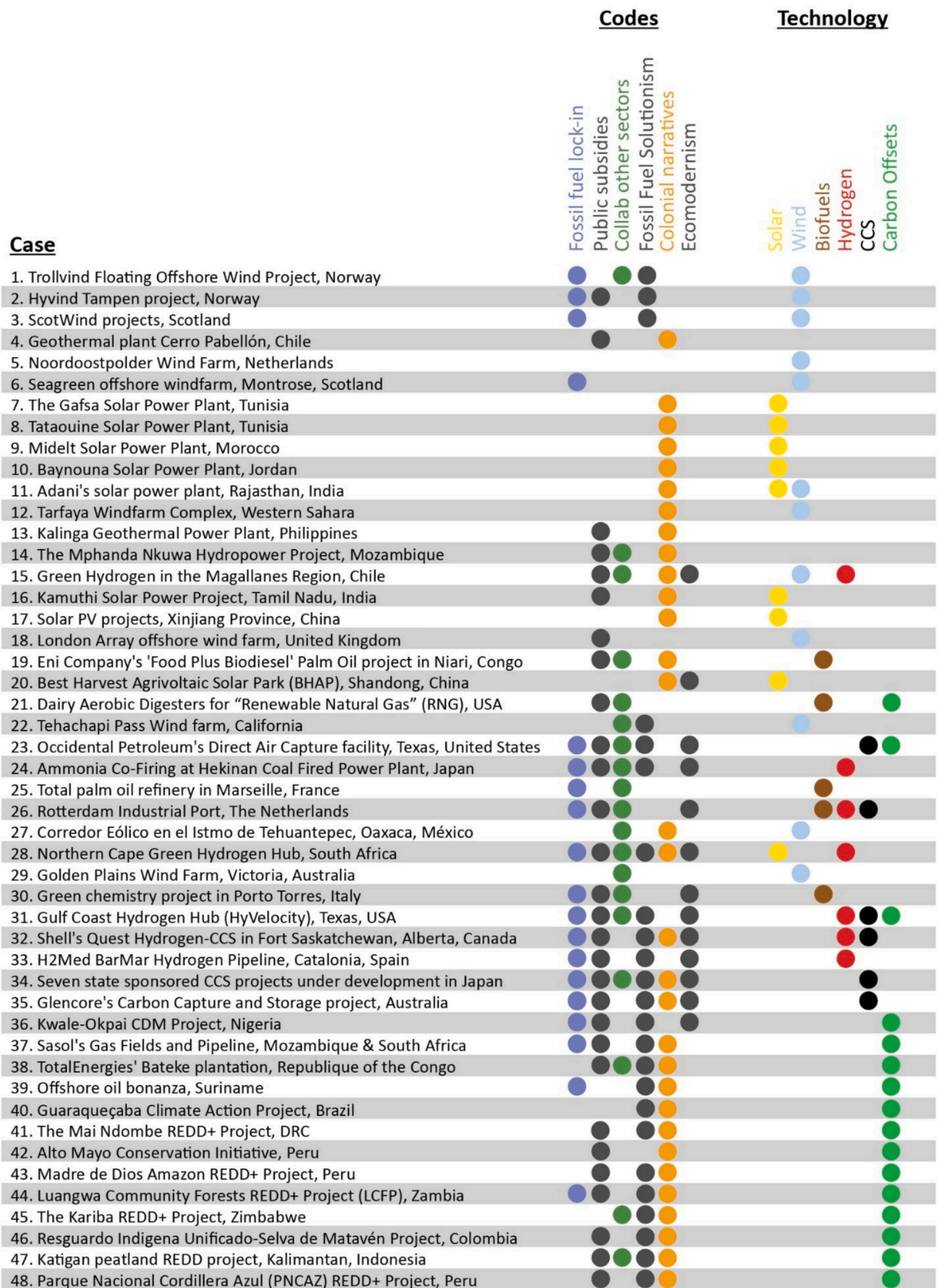
Fig. 3. Global distribution of 48 environmental conflicts of fossil fuel companies in the energy transition documented in the EJAtlas. The points are coloured by technology including conflicts on solar power plants (yellow), wind power plants (blue), hydrogen (red), carbon capture and storage (CCS; black), carbon offsetting projects (green), biofuels (brown), geothermal and hydropower (grey). Some conflicts involve more than one technology (See Fig. 4). A full list of conflicts can be found in Table S1. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

representations already used by fossil fuel incumbents in their core business activities to impose renewable projects on marginalised communities disproportionately in the Global South [51,88,89]. We document resistances to solar projects in Tunisia (Cases 7 and 8), Morocco (9), Jordan (10), India (11) and wind projects in Western Sahara (12), demonstrating how the systematic portrayal of desert landscapes as extensive, barren and (agriculturally) unproductive helps to reproduce the extractivist ideas of fossil fuel incumbents by effectively erasing the local relations with landscape (#Colonial narratives) [90]. Such projects are often promoted by oil and gas companies in alignment with authoritarian regimes and international institutions (EU, World Bank, IMF). Thus, extractivist wind and solar projects also perpetuate the hegemonic coalitions and the colonial narratives to advance control of land in the pursuit of energy resources, fossil or renewable [91].<sup>1</sup> In all these conflicts, as well as with geothermal (Case 13) and hydropower (Case 14) projects, the energy is not extracted to meet local needs, but to be exported to large consumption centres. Simultaneously, oil and gas incumbents instrumentalise these purportedly low-carbon projects in order to accommodate demands for decarbonisation and deflect attention from the calls demanding curbs in their fossil fuel extraction in a clear example of Gramscian transformismo.

<sup>1</sup> Such colonial practices echo the ‘Maroc utile-Maroc inutile’ (“useful Morocco-useless Morocco”, the term was coined by Hubert Lyautey, the first Resident-General of the French Protectorate) rhetoric of French administrators in the early 1900s by which only places amenable to resource extraction received investment in infrastructures to integrate them with the colonial economic system, while other regions were left behind (Bogaert, 2015) This phrase came to symbolise the French political project of the 20th century in Morocco, which classified and prioritised regions within the country by their utility value and strategic importance to France’s pursuits.

Market-oriented, colonial ideals reinforce institutional arrangements that aid the enclosure of land for energy through simplifying land-use change permissions. We document solar projects in India, where land regulations were altered to make way for utility-scale solar power plants on land considered sacred by local communities (Cases 11 and 16). Elsewhere, land expropriation by state-led companies in China (Case 17) also advances mass solar projects in the occupied territory of Xinjiang, formerly East Turkestan, where persecuted Uyghur Muslims in the region are subject to highly exploitative labour practices linked to all stages of the solar panel manufacturing chain [92,93]. This solar project, along with cases studied in Morocco (Case 9) and Jordan (10), demonstrates how the institutional power of the historical bloc built around fossil fuel companies and authoritarian state regimes reinforces domination in the infrastructural domain. Where previously they united in the energy sphere for oil extraction, fossil fuel incumbents now repurpose their hegemonic alliance through the process of transformismo, leveraging the institutional power sourced from their agreements with authoritarian regimes to secure land access that, in turn, reinforces infrastructural power to build solar and wind megaprojects. These examples show in practice the interlocking power between ideologies, the institutions that sponsor them and the infrastructural projects they legitimise to reinforce a system of “decarbonisation by dispossession” in the pursuit of new energy resources [27,79,94]. These dynamics are visible in Jordan (Case 10), where an agreement to trade water-for-sunlight with Israel demonstrates how private firms rely on public subsidies, organised through public-private-partnership (PPP) deals, to establish a utility-solar project (#Public subsidies). This project not only inflicts land rights violations, but also creates a country-wide dependence on Israel that Jordanians have condemned [95].

Additionally, public subsidies from governments and multilateral organisations can catalyse investments into false solutions by reducing both the cost of capital and the risk profile of new extraction frontiers



(caption on next page)

**Fig. 4. List of conflicts and summary of codes.** A list of the 48 conflicts analysed in this study is provided alongside the different coded processes identified, and the type of technologies involved. The codes are colour-coded to show alignment with the reproduction of power in the infrastructure (blue), institutions (green) and ideologies (orange) power domains, or the reinforcement of power between them (grey). For more details see Table S1. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

and speculative technologies. In the DRC, local and international EJOs have challenged Italian oil-giant Eni's crop to biofuel project, denouncing that the appropriation of land and natural capital diverts resources away from domestic food production towards energy exports that drive environmental destruction (Case 19). Ironically, this project is facilitated through collaborations with large agri-food companies, and funding from multilateral agencies, such as the Food and Agricultural Organization (FAO) (#Collab. Other Sectors; #Public Subsidies). Another example of the connection between the fossil fuel and industrial food production sectors, enabled through public funding, can be found in the USA. There, public subsidies bolster so-called "renewable natural gas" projects, deepening carbon lock-in through collaborations with industrial-scale dairy farms (Case 21). Such schemes have been condemned by national and international EJOs, who found that they encourage the amalgamation of small-scale farms and the expansion of industrial-scale farming and concentrated feeding operations (#Collab. Other Sectors) [63,96]. In these biofuel cases, we can observe a process of *trasformismo* whereby incumbent coalitions can neutralise counter hegemonic ideas, such as territorial preservation against fossil fuel extraction, by highlighting their investments into false solutions. As such, incumbent actors can dilute public discontent over land acquisition, legitimise land use change and accommodate resistance strategies by promoting biofuels as a climate solution.

In addition to the agri-food industry, we have found instances of Big Tech (Cases 1, 22 and 23), the fertiliser industry (Case 24), the aviation industry (Cases 25 and 26), mining and smelting corporations (Case 14, 15, 27, and 28), other energy-intensive industries (steel, cement, chemical, mining, petrochemicals, paper, glass in Case 27; [51]), and the banking sector (Cases 9 and 29) collaborating with fossil fuel incumbents in false solutions projects (#Collab. Other Sectors). Rather than breaking hegemonic institutional alliances, false solutions prove to be a process of *trasformismo*, reproducing and expanding the coalitions around "Fossil Capital" [97] in the form of "Green Capital" [98,99]. In sum, the energy *transition* may better be described as the energy *addition* [80], as renewable energy is extracted by the same oil and gas incumbents through the same means, to the same ends, without substituting fossil fuels. That is a "rearrangement" of the fossil fuel historical bloc, rather than a new hegemonic arrangement that disrupts and destabilises incumbent regimes [42].

#### 4.2. Energy vectors and transport

Oil and gas companies play a central role in organising the world's energy flows. It is through the industry's operations that energy extraction and its associated impacts are left in peripheral regions, while consumption is concentrated in economic cores [73]. The oil and gas incumbents play a hegemonic role in the distribution of energy given the unique biophysical properties of oil and gas, whose high density and fluid nature allow for efficient transport and storage. In the light of the decarbonisation imperative and the role of false solutions, several questions arise: Which low-carbon energy vectors is the fossil fuel industry betting on? Can they support the dominant position of the fossil fuel industry? How do consumer states support investment in low-carbon energy vectors? Which environmental justice issues are related to these vectors?

One of the frontrunner low-carbon vectors has been biofuels, now also rebranded as Sustainable Aviation Fuels (SAF) in collaboration with the aviation industry (#Collab. Other Sectors). Biofuels have biophysical properties nearly identical to fossil fuel products, so modes of production, infrastructures and the forms of consumption do not require

wholesale transformation. Likewise, biofuels enable energy to be extracted in the world's peripheries, shifting the socioecological costs of energy provision to marginalised territories. A clear example is the already mentioned Eni's crop-to-biofuels project in DRC, which produced palm oil to feed its biorefineries in Italy (Case 19). This is not the only example, as we also see the TotalEnergies biorefinery in Marseille (France) being fed with palm oil cultivated in Indonesia (Case 24). Moreover, biofuel projects are particularly useful in reproducing the industry's dominance in the infrastructure domain, as refineries can be turned into biorefineries with only a few technical adaptations (#Fossil fuel lock-in). And indeed, what we observe is that these conversions are generally subsidised by public "just transition" funds, like in the case of Eni's refinery in Porto Torres, Italy (#Public subsidies) (Case 30). A clear example of infrastructural transformismo reinforced by public subsidies from the institutional domain.

Energy vectors are particularly well suited for this interplay between institutional capture and infrastructural transformismo. Green hydrogen (made through water electrolysis powered by renewable energy) is a particularly attractive vector because it locks-in gas infrastructure [100]. Indeed, over 99 % of hydrogen is currently made from fossil gas [101], and the industry is proposing to bridge the gap through the production of green hydrogen, with interim solutions such as blue hydrogen (hydrogen made from natural gas, capturing the CO<sub>2</sub> through CCS) (#Fossil Fuel Lock-In) (Cases 31 and 32). Another infrastructural lock-in process is the retrofit of fossil gas infrastructure to accommodate hydrogen. Fossil fuel companies spent at least over half a billion euros in 2022 to lobby institutions in the EU, where gas infrastructure is proposed to be repurposed for green hydrogen [102]. Much of this infrastructure is not yet built, meaning new conventional gas pipelines will be constructed and later repurposed, challenging the viability of net-zero targets and assuming a questionable level of sustained demand for green hydrogen [102,103]. This becomes clear from the H2Med's BarMar pipeline between France and Spain that has been labelled a "gas pipeline in disguise", as it is ready to transport fossil gas, which Spain mostly imports from Algeria, towards other European countries [104] (#Fossil fuel lock-in) (Case 33). Under the pretext of energy security following the invasion of Ukraine, the project was revived as an undersea pipeline between Barcelona and Marseille in 2022 by the Spanish, Portuguese, French and German governments to reduce dependencies on Russian gas and with the promise to pivot to green hydrogen in the future as part of Spain's push to become a green hydrogen hub (Case 33). Beyond gas pipelines, gas incumbents are also justifying the expansion of liquefied natural gas terminals with proposals to retrofit them to support green hydrogen and ammonia transport [105] (#Fossil fuel lock-in). Fossil fuel companies are leading investors in green hydrogen projects around the world (Cases 15, 24, 26, 28, 31, 32, and 33) [101], the example of H2Med shows that through a process of *transformismo* the fossil fuel industry prioritises green hydrogen to justify gas infrastructure in disguise and continue sourcing energy from extraction frontiers, and concentrating it in Northern Europe consumption cores, using Southern Europe as a transportation hub.

Similar to biofuels, the proliferation of green and blue hydrogen projects is being subsidised by public institutions. The governments of the USA, the EU, Norway, Canada and the Netherlands combined account for 95 % of the \$30 billion of public money that is spent on carbon capture and hydrogen [22], with the UK just recently pledging to invest £22 billion [106]. This trend is illustrated by the \$100 billion HyVelocity project, subsidised through the USA's Inflation Reduction Act, which plans one of the largest CCS operations in the world to support the conversion of grey hydrogen to blue hydrogen operations in the US Gulf

Coast, many of them owned by oil and gas companies (#Public subsidies) (Case 33). This interdependence between state institutions and fossil fuel incumbents results in the mutual reinforcement between ideas, institutions and infrastructures that partially insulates the fossil fuel hegemonic alliance against the turbulences of decarbonisation [36,43]. The reproduction of the current historical bloc also becomes visible in the PPPs, as seen in strategies like the German initiative H2Global [107]. Mechanisms such as these are aimed at resolving the international investment dilemma of large-scale green hydrogen production facilities in, for example, South Africa (Case 28) and Namibia (EJAtlas Conflict id 6762, not part of this study). Here, H2Global is used as an international tool that creates a green hydrogen auction for (northwestern) European states that need to secure their green hydrogen supply from suppliers in the Global South, with a prominent role for fossil fuel incumbents. In July 2024, the first deal under H2Global was awarded to ADNOC (Abu Dhabi National Oil Company) to produce and sell green ammonia from Ain Sokhna in Egypt to Europe [108]. Such PPP mechanisms require governments to take on a significant public debt in case expectations fail to be met (Case 15) and draw resources away from a genuine just transition, as voiced by opponents (#Public subsidies) [109]. Under the guise of sustainable development, public money is used to put private capital in control, allowing powerful investors and Global North countries to write new 'green' rules, redefining a policy space for public service provision, risking further entrenchment of financial and technological dependencies as well as societal inequalities [101,110].

Green hydrogen production is expensive, and fossil fuel incumbents seek to cut prices through scale. To produce sufficient green hydrogen to meet the outsized energy needs of industrial societies, large amounts of land are needed. Neocolonial representations of "undeveloped" territories, together with asymmetrical geopolitical configurations and jurisdictional access to land, mean that these enormous projects are usually proposed in the Global South. In Boegoebaai, South Africa, Sasol is planning to produce and export green hydrogen and other critical mineral commodities with the promise of developing the region, bringing jobs and investment. However, such export-led development justification relegates the impacts of land acquisition conflicts, port constructions, and desalination on traditional farming and fishing livelihoods (#Colonial narratives)(Case 28). Sasol is even proposing to replicate the formula of building a brand new town to house the workers of the project, as it did with their fossil fuel operations in Sasolburg and Secunda during Apartheid [111]. By boasting that it "recognises and embraces its responsibility as a leader of the energy transition in South Africa", Sasol portrays itself as the most suitable private partner for the national and provincial governments to develop the project (#Fossil fuel solutionism) (Case 28). In turn, the provincial government's official communications go beyond raw export-oriented justifications, promoting the idea that green hydrogen can replace fossil fuels and help address climate change (#Ecomodernism), which particularly buoys Sasol's public sustainability claims at a time when it actually does not show evidence of replacing fossil fuel operations.

We find a very similar example of raw export-oriented development narratives in Chile where the local population critiques a green hydrogen project co-owned by a consortium which include Total-Energies (France), Enel Green Power (Italy), ExxonMobil (USA), RWE (Germany) and Empresa Nacional del Petróleo (Chile), as a false solution that will produce seven times as much energy as Chile's current electricity production and could contribute 13 % to the world's green hydrogen production (Case 15). Our analysis indicates that through a process of transformismo biofuels and green hydrogen enable the reproduction of fossil fuel companies' systemic function, facilitating the appropriation of energy resources in the Global South to meet the energy demands of the Global North, at the cost of the local livelihoods and environments.

#### 4.3. Carbon management

Oil and gas companies' decarbonisation plans rely upon extending fossil fuel extraction while managing carbon removal through carbon offsets and various forms of carbon capture and storage (CCS) [112]. Fossil fuel companies use these projects to create a narrative of being part of the "climate solution" while producing "net zero oil" through the deployment of Direct Air Capture (DAC) technology (Case 23) or delivering "carbon-neutral liquified natural gas" claimed to be offset by REDD+ projects (#Fossil fuel solutionism) (Cases 44, 45, 47 and 48). The promise of solving the climate crisis by technological innovation or carbon accounting, rather than slashing fossil fuel emissions, permits companies to justify expanding oil and gas extraction (#Ecomodernism). However, considering that technical and economic failure of large-scale CCS pilot projects has led to 78 % being cancelled or postponed over a 30-year period, fossil fuel incumbents are creating unrealistic emissions reduction strategies heavily reliant on this unproven technology to maintain infrastructure and current rates of extraction [113].

CCS has been necessarily linked to fossil energy extraction, refining and consumption in order to concentrate CO<sub>2</sub> directly from high-emitting sources. In all five CCS case studies, carbon dioxide is collected from multiple industrial point sources, including existing fossil fuel infrastructure, locking-in the infrastructure of the incumbent industry while collaborating with other high-emissions economic sectors (#Fossil fuel lock-in). Globally, over 82.5 % of CCS projects are used for enhanced oil recovery (EOR), a clear example of infrastructural power entrenchment, and the fossil fuel industry is involved in 90 % of the total CCS projects around the world [114,115]. In addition, the rollout of CCS infrastructure relies on institutional stabilisation in the form of government subsidies, regulatory schemes, carbon crediting mechanisms and tax incentives for economic viability [113]. This is very evident in the case of the Japanese government's plans to become a "CCS powerhouse" [116] by investing up to ¥150 trillion over the coming decades into infrastructure, tax incentives and subsidies (#Public Subsidies) (Case 34). The Renewable Energy Institute, along with five other policy think tanks, criticised the Japanese government's plans saying that they will "lock-in Asian countries' dependence on fossil fuels" [117]. We have also observed that major CCS projects in the Netherlands (Case 26), the USA (31), Canada (32), and Australia (35) rely heavily on state funding and carbon credit regulations.

Meanwhile, EJOs denounce that CCS projects in the Netherlands (Case 26), USA (33), and Canada (34) do nothing to address carcinogenic pollution threatening neighbouring communities. CCS thus entrenches environmental racism and disproportionately locates polluting sites around racialised and minority communities in the Global North [118,119]. In addition, local communities and EJOs also condemn the threats geological storage poses to health, livelihoods and biodiversity. For instance, we documented Glencore's "unprecedented" plan to inject CO<sub>2</sub> into a freshwater aquifer in Queensland, Australia. The local community argued that the project threatens a vital water resource that is used for human and agricultural consumption and generates \$13 billion for the Australian economy (Case 35).

CCS not only entrenches racial and socioeconomic injustice, it also threatens to reproduce colonial patterns of pollution displacement. In Japan, the government has proposed multilateral treaties with Australia, Indonesia and Malaysia to transport and store liquified carbon dioxide. EJOs have condemned the ploy as "waste dumping" and "carbon colonialism" (#Colonial narratives) (Case 34). These examples show how the reproduction of infrastructural dominance by the fossil fuel industry is inseparable from the perpetuation of environmental injustice across colonial, racial and socioeconomic lines, as well as the narratives that justify it.

Similar to CCS, carbon offsets are used to justify extending and expanding fossil fuel infrastructures while exacerbating global environmental injustices. In two cases, Shell and Sasol received economic benefits under the UNFCCC Clean Development Mechanism for reducing

the emissions of their fossil fuel projects that have been denounced for not complying with environmental regulations and negatively affecting the health of neighbouring populations while providing no benefits to local communities (#Public subsidies) (cases 36 and 37). In addition, we document carbon offset deals to protect and plant forests in the Republic of Congo (Case 38) and Suriname (39) brokered by TotalEnergies and national institutions, while the company simultaneously acquired oil exploration licences from the same governments, which threaten local ecosystems and livelihoods. Furthermore, fossil fuel companies' net-zero roadmaps retain much of their current oil and gas infrastructure, relying on large-scale retirement of carbon credits (#Fossil-fuel lock in) [112]. In fact, multiple companies, including TotalEnergies, Eni and Shell, are already investing hundreds of millions of dollars in forest conservation projects.

Carbon offset projects linked to forest conservation hinge on colonial narratives that falsely blame indigenous and territorial communities for deforestation to justify the additionality of the project's climate contribution. These projects and narratives entrench colonial patterns of exclusion by forcing communities living within conserved areas to abandon their land and traditional livelihoods while threatening local food sovereignty, autonomy, and Indigenous cosmologies and knowledge. In Brazil (Case 40), Congo (41), Peru (42, 48), Zambia (44) and Zimbabwe (45), project managers prohibited communities' subsistence practices (farming, fishing, hunting, etc.) within project boundaries (#Colonial narratives). And yet, the material and ideological reproduction of fossil fuel dominance through carbon offsets requires a third support point in the form of institutions that guarantee the public's confidence in the carbon market. This is provided both by the UNFCCC REDD+ programme and by a network of carbon credit certifiers, among which Verra is the most prominent actor. However, recent investigations prove that 94 % of Verra's - the world's leading carbon credit certifier - REDD+ offsets are "worthless" [120]. Other studies found no significant deforestation reduction from the implementation of most REDD+ projects [121]. Indeed, in several of our cases covering Peru (Cases 42, 43, 48), Colombia (46), Zambia (44), and Zimbabwe (45), the claimed emissions reductions are overestimated. A ratings agency's remote sensing scientist stated that "the Kariba REDD+ project in Zimbabwe could be generating 30 times as many offsets as it should" (Case 45). In response to the studies and campaigns challenging the climate efficacy of REDD+ offsets, the carbon market based on forest and land use sinks has declined by 69 % in 2023, reflecting a loss of public confidence [122]. In turn, this has forced some fossil fuel companies to distance themselves from carbon offset projects or even suspend their investments [123]. This chain of events illustrates how our theoretical framework can be mobilized as a theory of change and how hegemony can be destabilised. When the legitimacy of institutions is put in question, public trust in the ideas they sustain erodes, which consequently forces material changes in the operations of fossil fuel companies and curtails the capacity of incumbents to pursue processes of transformismo.

#### 4.4. Global overview

Our analysis identifies six recurring strategies through which fossil fuel incumbents deploy 'false solutions' to reproduce power: infrastructural lock-in, collaboration with other economic sectors, colonial narratives, public subsidies, ecomodernist framing, and fossil fuel solutionism. These six codes reflect examples of strategies that act within and across three domains - infrastructures, institutions, and ideas - to reproduce incumbent hegemony and accommodate demands for rapid and deep decarbonisation. In this overview, we examine how power reproduction and reinforcement strategies interact and how they correlate with different false solutions technologies (Fig. 3).

Within the infrastructure domain, we observe that 19 out of the 48 low-carbon projects studied support the lock-in of fossil fuel infrastructure. This is particularly true of CCS projects (6/6) which are

coupled with fossil fuel extraction or combustion, and hydrogen projects (6/7) which generally involve dual use of fossil fuel infrastructure like pipelines, tankers, or refineries. It is also present in less obvious ways in the deployment of wind projects (4/12) that power offshore oil and gas extraction. The reproduction of power in the infrastructural domain seems to be less favoured by technologies, such as carbon offsets (6/16) and especially solar (1/9).

Within the institutional domain, fossil fuel companies future-proof their historical bloc by integrating their operations with dominant industrial sectors like aviation, automotive, agriculture, fertiliser and Big Tech. Instances of direct economic integration of projects with companies in other sectors are observed in 19 of the false solutions projects throughout our analysis. In particular, the integration of biofuels (5/5) with the agricultural sector, and cooperation in the development of hydrogen (5/7) with fertiliser companies to develop green ammonia production. Direct economic integration with other sectors is less prevalent in wind projects (5/12), and even less in solar projects (1/9).

Finally, in the ideological domain, in 31 of the cases we document how ideological hegemony is reproduced through colonial narratives in low-carbon projects, especially solar (9/9) and carbon offsetting projects (12/12) in the Global South. This is largely explained by the significant land consumption associated with solar and forestry projects [87], which exacerbates displacements and land grabs in the Global South. In turn, companies justify through a neocolonial narrative that such projects create value in otherwise unproductive lands, inherently neglecting the traditional and Indigenous activities, cultures and livelihoods that these landscapes currently support [124].

These three domain-based strategies are further reinforced across domains. For instance, in 29 out of 48 cases, the projects were supported by public subsidies. This highlights how the scale of the fossil fuel industry's influence over public institutions and policy design is central in reproducing its infrastructural hegemony. In turn, ecomodernist discourses present technocentric fixes like CCS (6/6) and hydrogen (7/7) as idealised and apolitical solutions without affecting cultural, social, political or economic norms, thus legitimising continued dependence on technologies that lock-in fossil fuel infrastructure. Finally, fossil fuel incumbents often position themselves as climate leaders by aligning with net zero or ESG narratives ('fossil fuel solutionism'), mostly in carbon offsetting projects (14/16) and CCS (5/6), to obscure their role in perpetuating extractivist infrastructures and reinforce their political license to influence institutions while accommodating growing demands for rapid decarbonisation [113].

Technologies like CCS and hydrogen appear most frequently to reproduce power in all three domains and are especially present in cases showing cross-domain reinforcement. For example, CCS projects lock in infrastructure while receiving state backing and are promoted using ecomodernist discourses. On the flip side, solar projects, while being well-suited to reproduce ideological hegemony (9/9), only appear to reproduce power in the infrastructural (1/9) and institutional (1/9) domains when combined with green hydrogen (Case 28). In addition, solar projects do not strongly support the reinforcement of power between domains.

Such power dynamics can be ultimately traced back to the material properties of oil and gas. The systemic function of fossil fuel companies is to extract and geographically concentrate energy and power [73]. This process is ideally facilitated by energy vectors that can be extracted in a geographically concentrated manner and transported at high energy densities. Despite being established mature technologies, unlike CCS and hydrogen, wind and photovoltaics are diffuse energies that produce electricity, which is inefficient and expensive to transport over long distances. Consequently, only a narrow range of speculative decarbonisation pathways - CCS, hydrogen, and large-scale carbon offsetting - allow for the continuity of fossil capital's systemic function within the hegemonic historical bloc by enabling new forms of energy and land concentration.

Thus, from a power reproduction perspective, we would anticipate

that investments in CCS and hydrogen will dominate the oil and gas industry's political and economic priorities going forward. This will be to the detriment of renewable energy technologies, especially solar (unless linked to green hydrogen), despite being less speculative decarbonisation technologies. In the last decade, a strategic chasm has pitted American oil and gas companies investing in CCS and hydrogen, versus European companies hedging investments between carbon management and renewable power [125]. In terms of market valuation, American companies have been the clear winners, systematically outperforming their European peers [126]. This divergence reflects a broader dynamic: fossil fuel companies that better reproduce hegemony - across infrastructure, institutions, and ideas - are those best positioned to financially thrive in the "energy addition" [80]. This is now manifesting in a withdrawal from renewables by major fossil players [127], confirming that under capitalist conditions hegemonic reproduction outweighs climate contributions as a predictor of company financial performance and operational strategy.

## 5. Conclusion

Our study reveals how fossil fuel incumbents seek to link oil and gas infrastructure with false solutions throughout the fossil fuel industry value chain. This strategy serves to build a cohesive block around its current business model that accommodates the pressures of decarbonisation and industrial transformation. In addition, we show how fossil fuel incumbents' false solutions are deployed in collaboration with key economic players like the aviation industry, industrial agriculture, and technological giants. This infrastructural integration tries to expand the global economic dependency on fossil fuels to a dependency on fossil fuel incumbents. When analysed in combination, the integration of key economic actors, with publicly-subsidised technologies and fossil fuel infrastructures, reveals a strategy to cement a coalition of economic and political powers to maintain the hegemony of fossil fuel companies in the energy system.

The scale and scope of false solutions being deployed by fossil fuel companies and their allies suggest that these form a significant element of incumbent strategies of resistance at the current juncture in the global energy system. However, the infrastructural hegemony of oil and gas companies rests on sustaining a hegemonic block at the institutional and ideological level. In this vein, the fossil fuel industry's "part of the solution" discourse is the cornerstone for the survival of oil and gas companies against the widespread pressure to decarbonise the energy system. On the premise that the fossil fuel industry is a force for good and an ally to reckon with, incumbents seal agreements and gain influence in key institutions, be it the UNFCCC, national governments, financial markets, or higher education. The fossil fuel industry's false solutions projects are, more than anything, an instrument to buttress a narrative that protects its socio-political license, accommodates pressures and avoids a transformation of the energy system that challenges their power and profits. The false solutions counter-narrative developed by EJOs reveals and exploits the tensions of this key vulnerability of fossil fuel companies' strategy by highlighting how the fossil fuel industry's false solutions reinforce continued oil and gas extraction rather than mitigating climate change. As such, Gramsci's concept of *trasformismo* has proved crucial for the formalisation of false solutions as an academic concept and the formulation of a theory of change based on the disruption of power reproduction and reinforcement processes.

Finally, our analysis opens up new avenues for research and asks important questions over the trajectory of false solutions as a process of *trasformismo*. For instance, it is unclear how false solutions will interact with dominant forms of neoliberal capitalism, whereby rent extraction determines capital flows and structures of ownership. While scholars have highlighted the dynamics of green capital accumulation and the rise of sustainability as a commodity in itself [128], it remains unclear how the more speculative or immature types of false solutions (CCS, green hydrogen, carbon offsets) will be treated by financial markets. In

addition, further research is required to gauge the role of false solutions in the rising tide of green extractivism, whereby colonial relations of power and production are reproduced through the imperative of global decarbonisation. Finally, ongoing research is required to examine how false solutions might evolve in response to increasing scrutiny and potential regulatory shifts. As governments and industries intensify decarbonisation efforts, there is a risk that false solutions may become further embedded within policy frameworks, making meaningful transformation harder to achieve and incumbents more difficult to disrupt.

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## CRedit authorship contribution statement

**Marcel Llaveró-Pasquina:** Writing – review & editing, Writing – original draft, Visualization, Investigation, Conceptualization. **Sarah Eckstein:** Writing – review & editing, Writing – original draft, Investigation. **Freddie Daley:** Writing – review & editing, Writing – original draft. **Nathaniel Rugh:** Writing – original draft, Investigation. **Judith Glimmerveen:** Writing – original draft, Investigation.

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## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Data availability

All data used for this study is publicly available at [ejatlas.org](http://ejatlas.org)

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