Received: 26 July 2021 | Revised: 1 December 2021 | Accepted: 15 December 2021

DOI: 10.1002/sd.2288

REVIEW ARTICLE

Sustainable Development

WILEY

Unveiling the shades of partnerships for the energy transition and sustainable development: Connecting public–private partnerships and emerging hybrid schemes

Giovanna Andrea Pinilla-De La Cruz[1] | Rodrigo Rabetino[2] | Jussi Kantola[3]

[1]VEBIC, University of Vaasa, Vaasa, Finland

[2]School of Management, University of Vaasa, Vaasa, Finland

[3]Faculty of Technology, University of Turku, Turku, Finland

Correspondence
Giovanna Andrea Pinilla-De La Cruz, VEBIC, University of Vaasa, Wolffintie 34, 65200 Vaasa, Finland.
Email: giovanna.pinilla.de.la.cruz@uwasa.fi

Funding information
Jenny ja Antti Wihurin Rahasto

Abstract

The transition to cleaner energy technologies and sustainable development requires the commitment and collaboration of the public and private sectors. Among such collaborations, public–private partnership (PPP) refers to the convergence and complementarity between public and private actors and represents an organizational arrangement for addressing strategic sustainability challenges such as reducing carbon emissions and plays a relevant role in transforming the sector after energy reforms. The rigidity of PPP schemes introduces certain limitations in adapting to the energy transition and sustainability needs. As a result, several hybrid schemes have emerged from PPPs, which are focal points in this paper. This article aims to contrast PPPs with emerging hybrid PPPs to facilitate their understanding. It contributes to the academic dialog on recognizing the relevance of emerging forms of collaboration in tackling contemporary issues. The review's primary outcome is a framework of PPPs and hybrid PPPs and the critical challenges for advancing the energy transition and sustainable development. The contributions from this study may help policymakers to design suitable tools for incorporating hybrid PPPs in climate change policies and institutional frameworks. The findings suggest developing mechanisms through which PPPs and hybrid PPPs foster cleaner technologies, thus improving energy efficiency and access and strengthening energy security strategies. Further work is needed to address key research issues related to (i) mechanisms for the institutional alignment of hybrid PPPs, (ii) assuring reciprocity and commitment, (iii) knowledge management, and (iv) capacity-building.

KEYWORDS
energy transition, environmental policy, hybrid, innovation, public–private collaboration, public–private partnership, public–private partnership, stakeholder engagement, sustainable development

1 | INTRODUCTION

Climate change requires urgent actions, including the transition toward cleaner technologies and sustainable development (Fleta-Asín & Muñoz, 2021). Current challenges involve technological, environmental, social, and economic disruptions (Sovacool, 2016; Wang & Ma, 2021). Forging alliances and cooperation networks is essential in pursuing this goal (Cruz & Sarmento, 2017; Pinilla-De La

Cruz et al., 2020). Accordingly, public–private partnerships (PPPs) are the point of convergence and complementarity between public and private actors (Jumbe & Mkondiwa, 2013; Morse & McNamara, 2009; Shahbaz et al., 2020). In particular, scientific research on the role of PPPs in energy has attracted attention with the advent of global reforms in the energy sector (Pinilla-De La Cruz et al., 2021; Sovacool, 2013). Thus, the private sector's involvement in the energy domain has been propelled since the economic recession of 1970 (Fleta-Asín & Muñoz, 2021; Sovacool, 2013), wherein PPPs became widely used as part of electricity reform process strategies around the world (Araquistain Portela, 2020; Gao & Zhao, 2020; Southard, 2010).

The energy transition and evolution of related energy systems have significantly broadened the role and scope of PPPs to support the transition toward cleaner technologies and sustainable development (Chen et al., 2019; De Carvalho, 2018). Per Thomas et al. (2018), the energy transition requires "scalar lenses" to comprehend and connect the different contexts in which it occurs (Broto & Baker, 2018; Harrison & Popke, 2018; Smith & High, 2017; Thomas et al., 2018, p. 184). Recognizing the multidimensionality of the energy transition is critical for understanding the needed transformation in cooperation between actors due to technical reconfigurations and the social and economic implications of this phenomenon (Smith & High, 2017; Thomas et al., 2018). It involves the transition toward creating more sustainable systems for the access and use of energy resources (Sanderink, 2020; Thomas et al., 2018; Turner et al., 2003) including the exploration of the circular economy, industrial ecology, ecological economy and political ecology (Bettencourt & Kaur, 2011; Seager, 2008; Thomas et al., 2018). Consequently, it is imperative to identify the current limitations of traditional systems to incorporate alternative responses where cooperation in pursuit of the transition is effective (Broto & Baker, 2018; Thomas et al., 2018).

Although the relevance of PPPs for reducing carbon emissions is shown (Raza et al., 2021), and they can play a determining role as a shortcut for the transformation of the energy sector (Somma & Rubino, 2016), it would seem that the current PPP schemes have certain limitations in their formats for the energy transitions. In this sense, Chaurey et al. (2012) and colleagues argue about the limitations against the incorporation of innovative technological and institutional solutions for access to energy aligned to the sustainable development goals (SDGs) given by the absence of sustainable partnerships adapted to the new scenarios (Chaurey et al., 2012). In their study on electric vehicle charging infrastructure, Wang and Ke (2018) highlight that PPPs require specific adaptations to the new contexts proposed by the energy transition, which differ from the experiences of infrastructure sectors. Cruz and Sarmento (2017) indicate that PPP models based on deterministic planning models on costs, risks, and revenues have proven unsuitable for uncertainty scenarios. Additionally, typical contract-based models appear incompatible with incorporating radical innovations and the interaction of different social actors (Cruz & Sarmento, 2017; Gunawansa, 2011).

Moreover, these authors further expose the need for reforming PPPs to provide them with greater flexibility in facing smart infrastructure challenges in the transport, water, energy, and information, communication and technology (ICT) sectors (Cruz & Sarmento, 2017). Likewise, Klijn and Koppenjan (2016) have studied the influence of contract length and flexibility on innovativeness in projects. Notably, from the need of developing innovation, a new field within the PPP umbrella is under construction and is of great interest as it provides opportunities to develop and adopt innovative solutions through collaboration (Weihe et al., 2011). These hybrid schemes are emerging in the Nordic countries as public–private innovation partnerships (PPIs) (Brogaard, 2015, 2017, 2019; Weihe et al., 2011). PPIs encompass a broad assemblage of formal alliances and collaboration based on networks between public and private organizations to innovate technologies, processes, and services (Brogaard, 2015).

An ongoing discussion is needed regarding the adequacy of PPP schemes to face the energy transition challenges and sustainable development. Indeed, relevant international forums have emphasized the need to align PPPs with SDGs to improve their broad implementation in projects for access to clean energy, new energy infrastructure, and energy innovation (Hancock et al., 2018). SGDs offer a broad vision that requires the collaborative participation of all social actors. For instance, Goal 17 seeks to promote new effective forms of collaboration and recognizes partnerships as vehicles to mobilize and share resources and knowledge to achieve the SDGs (Hassan et al., 2019; Oliveira-Duarte et al., 2021; Tremblay et al., 2020). Inexorably, the complex nature of sustainability requires additional efforts by governments, industry, and communities in aligning collaboration to achieve higher impacts (Owusu-Manu et al., 2020).

In the same vein, the energy transition and sustainability require systemic approaches beyond the traditional bilateral collaboration since it is not a confined or linear problem but interconnects multiple actors in multiple layers with a global impact (Svendsen & Laberge, 2005). As Heldeweg et al. (2015) point out, this change process includes "gray areas" that have not yet been regulated and of which there is no total clarity at the institutional level, in addition to the overlapping and competing roles among public and private actors. It is necessary to identify what exists and works for specific contexts and their limitations. Further, in specific and complex scenarios, such as the energy sector, alternative PPP schemes have emerged for the energy transition but do not seem to be entirely recognized as such in the previous literature. This group includes many new forms of collaboration typically referred to as "hybrid PPPs," which do not have a clear space within the framework of PPPs (Nel, 2018; Ungureanu et al., 2018; Vikkelsø et al., 2021; Zhu & Sun, 2020). Indeed, new forms of collaboration can generate social value in the form of innovative solutions, development, and transfer of new knowledge, building trust and mutual commitment (LaBerge & Svendsen, 2000; Svendsen & Laberge, 2005). It is appropriate to expose this phenomenon to speed up the energy transition and safeguard the principles in which energy governance is framed when incorporating alternative models of collaboration within PPPs (Heldeweg et al., 2015).

Against this backdrop, this article aims to contrast PPPs with emerging hybrid PPPs in the literature to understand emerging forms of collaboration and their key challenges. In doing so, this article does not intend to take a normative stand to determine what should or should not be included within the scope of PPPs. Instead, it aims to understand, based on a conceptual literature review, what kind of schemes have been classified as PPPs in the existing papers concerning the

energy sector, as well as the fundamental features of and differences between these schemes and the critical challenges for advancing the energy transition and sustainable development. Thus, following the methodology for conceptual reviews proposed by Hulland (2020), the present study addresses the following research question: *How do public-private partnerships and hybrid schemes differ in addressing the challenging transition toward cleaner and more sustainable energy systems?* The primary outcome of the study is a framework for understanding PPPs and hybrid PPP schemes. Thus, this paper contributes to the academic dialog on recognizing the relevance of emerging forms of collaboration in tackling contemporary issues by exploring the role of PPPs and emerging hybrid PPPs as well as key challenges of the transition toward cleaner and more sustainable energy systems.

2 | RESEARCH METHODS

The value of conceptual review papers derives from their ability to sense the voids requiring urgent recognition and updating current frameworks. As Hulland (2020, p. 31) states, "Conceptual reviews are most effective when they synthesize existing findings, identify gaps and generate new insights, and propose novel ways of thinking about a phenomenon." Accordingly, this review take this reference for the design of the research work.

Figure 1 shows the research outline for conducting this conceptual review following a five-stage process proposed by Hulland (2020, p. 28), that is, (i) defining the focal domain and scope, (ii) capturing and synthesizing current knowledge, (iii) identifying and resolving contradictory explanations, (iv) identifying gaps, and (v) setting research agenda, further explained in the text below (Sections 2.1–2.3).

2.1 | Data collection

A systematic search was conducted in Web of Science and Elsevier's Scopus databases to locate scholarly articles in English, using a search string that includes "ppps" OR "public private partnership" OR "public-private partnership" AND "energy." Since the acronyms PPP and PPPs are widely used in other disciplines, we included exclusions to the search string such as "pentose phosphate pathway," "purchasing power parity," "Poisson point process," among others. We retrieved 853 records (as of February 8, 2021), resulting in 676 unique items after eliminating duplications. By performing a screening process, we first assessed the connection between abstracts with PPPs in energy. After disregarding irrelevant articles by screening the abstract, the full texts of the remaining articles were analyzed applying two criteria: (1) focus on the energy sector, (2) centrality in partnerships reflected in the whole structure of the article. At the end of the screening process, 101 articles had become part of the final sample (see systematic search and screening process in Figure A1).

2.2 | Data analysis

The data analysis started with an overview of the literature in PPPs in energy as a first approach to observing the sample's connection with the energy transition. Subsequently, for *capturing and synthesizing current knowledge*, we proceeded to identify the explicit definitions of "public-private partnership" or "PPP" in the literature based on the premise that definitions are the central pivot of any discipline (Ronda-Pupo & Guerras-Martín, 2012). We identified the key characteristics of PPPs by carrying out a qualitative analysis of the articles in the

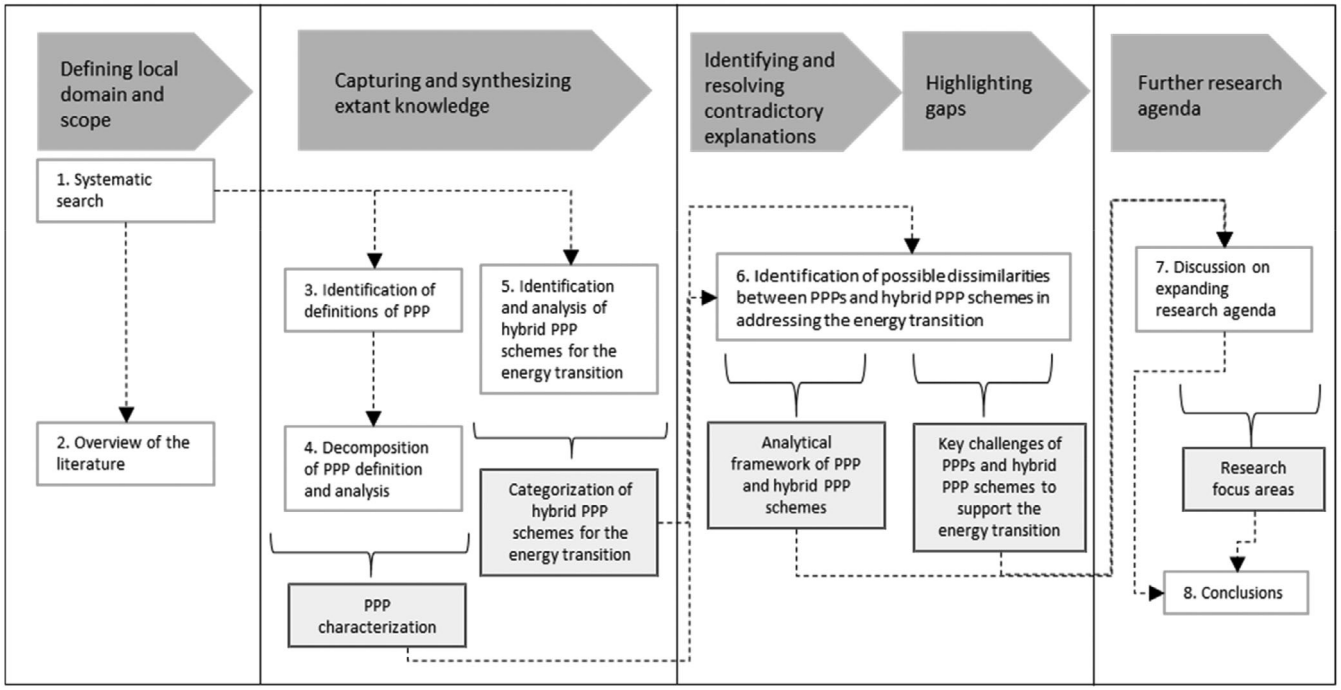


FIGURE 1 Research outline

sample using the NVivo 12 software package. This process included identifying constructs that shared commonalities or patterns in the texts, denoted as codes (see Table B1 and Figure C1) and later combined in higher-order categories. The systematic literature review by Kohtamäki et al. (2018), the Gioia et al. (2013) methodology was used as a reference for the analysis. The first outcome of the study at this instance was the characterization of the concept of PPPs. We described different categories of hybrid PPPs in the literature via content analysis. Later, based on the characterization of PPPs and identification of hybrid PPPs, we analyzed the current limitations of PPPs and hybrid PPPs to advance the energy transition. We obtained three outcomes in identifying and resolving contradictory explanations and identifying gaps as (1) a categorization of hybrid PPPs for the energy transition, (2) an analytical framework of PPPs and hybrid PPPs, and (3) a summary of key challenges of PPPs and hybrid PPPs to support the energy transition. In the final step, we suggested some future avenues for further research.

2.3 | Quality assessment

The study follows the premises to promote rigor proposed by Sovacool et al. (2018). It also adheres to the four alternative principles, that is, transparent, inclusive, explanatory, and heuristic, to produce systematic reviews, as described by Denyer and Tranfield (2009) and used as quality criteria by scholars (Rojon et al., 2021). First, transparency is ensured with the open presentation of the research process. In so doing, we described the research design, including the process of data collection and data analysis. Therefore, readers can relate the data, findings, and conclusions. Second, we used as data sources two of the electronic databases with the highest spectrum of academic journals (Scopus Elsevier and Web of Science) to guarantee the inclusiveness of the relevant literature for the study.

Additionally, the search string was designed to capture studies focused on the topic of interest. Based on the exclusion criteria, a screening process was used to obtain the final sample for analysis. Third, the explanatory principle is presented by contrasting and juxtaposing the literature and transparent ways of analyzing data, for example, the decomposition of PPP definitions and subsequent analysis of hybrid PPPs. Finally, the heuristic principle is adhered to by presenting the connection with the context when describing different hybrid PPPs for the energy transition.

3 | RESEARCH FINDINGS

3.1 | Overview of the literature in public–private partnerships in energy

The literature on PPPs in energy has its antecedents in the economic recessions of the 1970s and the following growth in public debt (Sovacool, 2013). These events led to the transformation of contracting models in the energy sector. Over the next two decades, the former natural monopolies progressively gave way to new actors and competitive forces. In the 1990s, a global reform process was consolidated, and at least 60 countries have included PPPs in their governance schemes (Komendantova et al., 2012; Sovacool, 2013). After that, and in connection with the growing concern about climate change and sustainable development (Faulkner, 1995; Zhang & Maruyama, 2001), the scientific literature compiled this transformation phenomenon and prepared the ground for the development of a new stream of research separate from those on the application of PPPs in other infrastructure sectors. From 2015 onward, the volume of scientific production in PPPs in energy has intensified in energy efficiency and agro-energy applications in Europe and waste-to-energy and electric vehicle charging infrastructure in China (Manos et al., 2014; Xu et al., 2015; Yang et al., 2016). A key aspect in the literature is the persistence of sustainability (Arbulú et al., 2017; Bougrain, 2012; Sheng et al., 2020), clean energy (Atmo & Duffield, 2014; Feng et al., 2021; Raza et al., 2021), and the energy transition (De Carvalho, 2018; Koengkan, 2020) as the motivation for research.

An interesting aspect of the literature is how the concept of PPP has been used over time. It should be noted that the current approaches differ from the studies published in early 2000. In the early studies, PPP appears to strengthen the electricity supply and facilitate energy access. Over time, several studies focused on identifying critical success factors (CSF), while others discussed the role of PPPs within new energy efficiency schemes. The latest studies show PPPs as a mechanism for developing emerging technologies such as hydrogen applications, and a substantial change occurred in discourse toward a discussion on the explicit role of PPPs in reducing CO_2 emissions and climate change. It reveals how PPP plays a relevant role in moving toward sustainable development.

3.2 | Analysis of definitions of public–private partnerships

Scholars have highlighted the lack of consensus in the literature on a universal definition of PPPs (Ahmad & Raza, 2020; Araquistain Portela, 2020; Di Liddo et al., 2019; Rossi et al., 2019; Shahbaz et al., 2020). According to Heldeweg et al. (2015, p. 3), based on Bloomfield (2006), some ambiguities emerge from what is known as the "container concept" attributed to PPPs. However, analysis of the previous definitions brings a better understanding of the central characteristics of PPPs. We identified 65 explicit definitions of PPPs in the literature (see studies in Table D1). A significant number of them are derived from the definitions proposed by international organizations such as the World Bank, European Commission, the Asian Development Bank, United Nations, and the Organization for Economic Co-operation and Development (OECD). Our analysis indicates the presence of six elements in the definition: (i) form, (ii) purpose, (iii) timeframe, (iv) stakeholders, (v) risk, reward, resource and responsibility-sharing, and (vi) critical success factors (Figure 2).

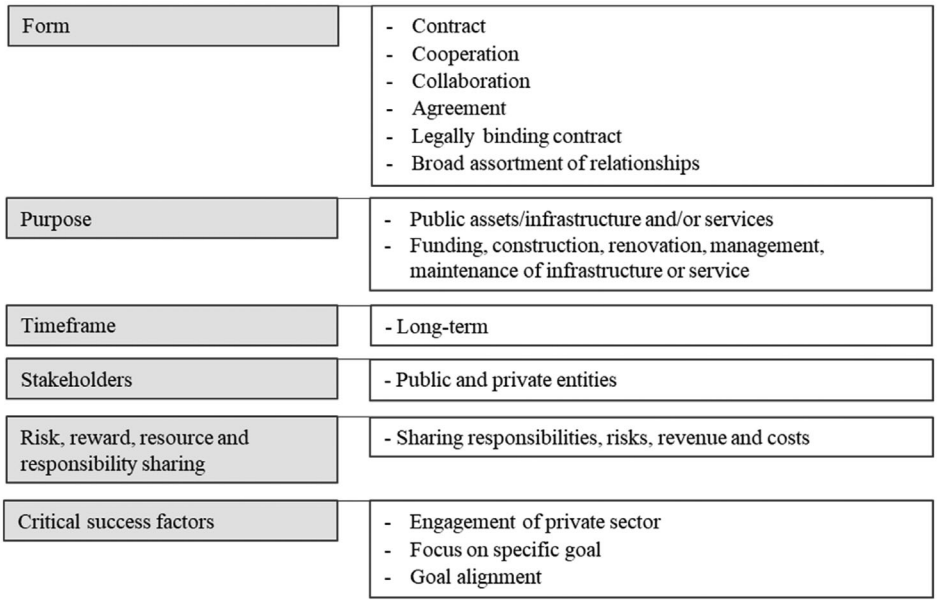


FIGURE 2 Characteristics of public–private partnerships from the definitions. *Source*: See sources in Appendix D

Each of the six elements in Figure 2 encompasses the key characteristics of PPPs. From this analysis, it is possible to observe how the "form" of PPPs is mainly described as a "contractual," "cooperative"; further, several authors refer to a PPP as an "agreement," "collaboration," and "broad assortment of relationships". There are also other "forms" identified in the analysis, such as "hybrid" (one time) (Nel, 2018) and "voluntary effort" (one time) (Fecondo & Moca, 2015), mainly originated from authors approaching hybrid PPPs. On the other hand, in terms of the "purpose," the finding indicates that PPPs are oriented to provide public assets, infrastructure and/or services, and activities related to financing, construction, renovation, management, and maintenance infrastructure or service. Concerning the timeframe, PPPs lean substantially toward long-term relationships. In terms of "stakeholders," there is consistency in the convergence of public and private actors. Regarding the "risk, reward, resource and responsibility-sharing" in PPPs, most agree that the relationship involves sharing responsibilities, risks, revenue, and costs. Only some definitions refer to "critical success factors," where scholars highlighted the relevance of private sector's engagement, focusing on a specific goal, and goal alignment.

3.3 | Hybrid public–private partnership schemes: Developing a categorization

Although there is no clear border between PPPs and hybrid PPPs, we searched for hybrid schemes in the literature. Surprisingly, almost 30% of the literature reviewed refers directly or indirectly to variants of PPPs, although our search string does not include any explicit keyword concerning the hybrid schemes. Those hybrid PPPs appear with different labels and descriptions; however, they pursue the ultimate goal of the energy transition from diverse approaches. Based on the findings, we gathered those examples of hybrid PPPs and classified them according to their approach or purpose (Table 1).

In Table 1, we described 15 examples of hybrid schemes classified into five categories. These hybrid PPPs correspond to specific approaches contributing to the energy transition. Those categories are energy security (Arbulú et al., 2017; Heldeweg et al., 2015; Nel, 2018), energy efficiency (Bougrain, 2012; Martiniello et al., 2020; Zhang et al., 2018), energy technology development (De Carvalho, 2018; Foley et al., 2011; Hancock et al., 2018; White, 2004), energy access, and promoting and supporting energy initiatives (small-scale and bottom-up; Otsuka & Cheng, 2020; Sanderink & Nasiritousi, 2020; Figure 3).

Figure 3 illustrates how the five categories of hybrid PPPs can be articulated to achieving energy transition goals. There are different motivations for hybrid PPPs to emerge; for example, the so-called Type II partnerships have originated from international events such as the Johannesburg Conference in 2002 as an instrument to fulfill Agenda 21 (Abbott, 2012, p. 548). Type II partnerships are transnational partnerships providing financial or regulatory support for initiatives oriented toward sustainable development and energy transition (Abbott, 2012; Sanderink & Nasiritousi, 2020).

3.4 | Public–private partnerships and hybrid schemes: How do they differ in addressing the challenges of the energy transition and sustainable development?

As mentioned above, we found that most of the studies in our sample are related to the transition toward cleaner and more sustainable energy systems. However, since partnerships can have different origins, some could be derived from government strategies closely aligned with infrastructure practices, others can be bottom-up initiatives or a combination of both. As a result, there may be variations between how PPPs and hybrid PPPs respond to the energy transition. Based on the characterization of PPPs and the identified categories of

TABLE 1 Hybrid public–private partnerships for the energy transition

	Example	
Energy security	IPP—independent power producer	It focuses on new generation infrastructure projects. IPP is the label of the private energy producer, but it is also recognized as such as a hybrid scheme of collaboration (Nel, 2018). The significant distinctions of IPP is that they do not provide a service on behalf of the public authority, and the public authority does not have direct or indirect control over the private entity in this hybrid form (Nel, 2018, p. 42).
	PPA—power purchase agreements	It is a contractual figure between the state electricity companies and the private IPP, which is generally oriented toward a long-term relationship (Baylis, 2000; Lesser, 2008; Salci & Jenkins, 2018; Tobey & McGinnis, 2018; Weiss & Sarro, 2013; Weisser, 2004; Wiser, 1998).
	Environmental partnerships	The main goal is to guarantee environmental quality and, at the same time, can be a complementary strategy of energy supply—for example, waste-to-energy projects (Arbulú et al., 2017, p. 917).
	Private–private partnerships	Form of collaboration in areas that are not fully regulated yet due to the energy transition. One example is private companies such as biogas suppliers, energy companies, and network operators in the Netherlands (Heldeweg et al., 2015). At first glance, they may appear to be private partnerships; however, after an exhaustive analysis of official documents, they should be labeled as "hybrids" or a "particular type of PPP" (Heldeweg et al., 2015, p. 11) because they are governed by the rules for the provision of public services and comply with the principles of energy governance.
Energy efficiency	ESCO—Energy Service Company, ESPC—Energy Saving Performance Contract, EPC—Energy Performance Contract	The EPC is widely used in the European market to carry out energy efficiency programs, including energy savings, energy audits, and technology modernization projects. This scheme pursues a long-term relationship in essence (Martiniello et al., 2020). EPCs are organized by a private company, generally an energy services company (ESCO) (Martiniello et al., 2020). The energy-saving performance contract (ESPC) is a type of structure used in PPP projects related to energy efficiency, refurbishment or upgrades (Tobey & McGinnis, 2018). Although several authors state that these schemes can be classified as PPP, this notion is not totally shared in the academic arena (Burger & Hawkesworth, 2011; Dastig, 2009; Martiniello et al., 2020, p. 2).
	TES—thermal energy services	Here, public energy service companies act as energy providers to partner with an institution or company to improve heating systems. For example, many TES in infrastructures belong to British Columbia school districts (Jensen & Dowlatabadi, 2018).
	PPP-BR green renovations	PPP-BR aims to reconstruct existing building infrastructure to achieve green quality and green standards, including improved energy savings and reduced emissions and waste (Yang et al., 2019).
	City-level partnerships	City-level partnerships focus on initiatives related to energy efficiency and clean technologies (Andonova et al., 2009; Galli & Fisher, 2016; Jänicke & Jörgens, 2009).
	VA—Voluntary agreements	VA aims to achieve energy efficiency flexibly and cost-effectively (Zhang et al., 2018). VAs are typically bottom-up approaches mobilizing potential energy savings that would be difficult to achieve with traditional command-and-control approaches. The operating mechanism is based on a negotiation between the government and individual private companies or industry associations to determine individual energy-saving targets (Zhang et al., 2018). The parties join in a relationship by signing a "non-mandatory type of VA" (Zhang et al., 2018, p. 282).
Energy access	5Ps—pro-poor PPPs	5Ps aim at providing energy access to remote communities (Chaurey et al., 2012; Sovacool, 2013; Wentworth & Makokera, 2015). Here, communities not only receive benefits but are also stakeholders involved (Chaurey et al., 2012), such as public entities, private companies, multilateral development banks, microfinance institutions, service companies, energy companies, non-profit organizations, research, and academic institutions and members of civil society (Chaurey et al., 2012; Sovacool, 2013; Wentworth & Makokera, 2015). Although these programs are fundamentally based on public or private subsidies, they also include innovative and sustainable business concepts to advance the diffusion of clean technologies (Kouassi & Pineau, 2011; Sovacool, 2013).

TABLE 1 (Continued)

	Example	
Energy technology development	Technology development partnerships	Collaborations between universities, public institutions and private companies to develop research on energy efficiency at a technical level and financial models, intellectual property, and all aspects for adopting technologies in a specific context (Foley et al., 2011).
	Voluntary technology development	These schemes seek to achieve technological innovation, for example, the development of clean technologies through collaboration among those organizations interested in the same issue (White, 2004). These collaborative initiatives often use decentralized decision-making models.
Promoting and supporting energy initiatives Type II partnerships	Deliberative partnerships	Stakeholders, such as civil, market, and government work on problems related to a local need, such as adopting cleaner energy technologies (Forsyth, 2005).
	Multi-stakeholders partnerships	This scheme can vary in terms of scale, functions, setting, structure, funding and effectiveness (Andonova & Levi, 2003; Hale & Mauzerall, 2004; Pattberg et al., 2012; Sanderink & Nasiritousi, 2020; Sovacool & Van de Graaf, 2018; Szulecki et al., 2011). One of the most successful examples is the renewable energy and energy-efficiency partnership (REEEP). This scheme started in 2002 to finance clean energy and energy-efficiency projects developed by small to medium companies in emerging markets and developing countries (Sanderink & Nasiritousi, 2020). In REEEP, more than 300 members of public and private entities intervene (Sanderink & Nasiritousi, 2020). Country governments and donations back the financing mechanism for supported projects from private contributors (Sanderink & Nasiritousi, 2020).
	Global partnerships	Voluntary initiatives to respond to challenges such as energy and sustainability goals (Otsuka & Cheng, 2020). Otsuka and Cheng (2020) show the United Nations Environment Program (UNEP) partnerships as an example of global partnerships.

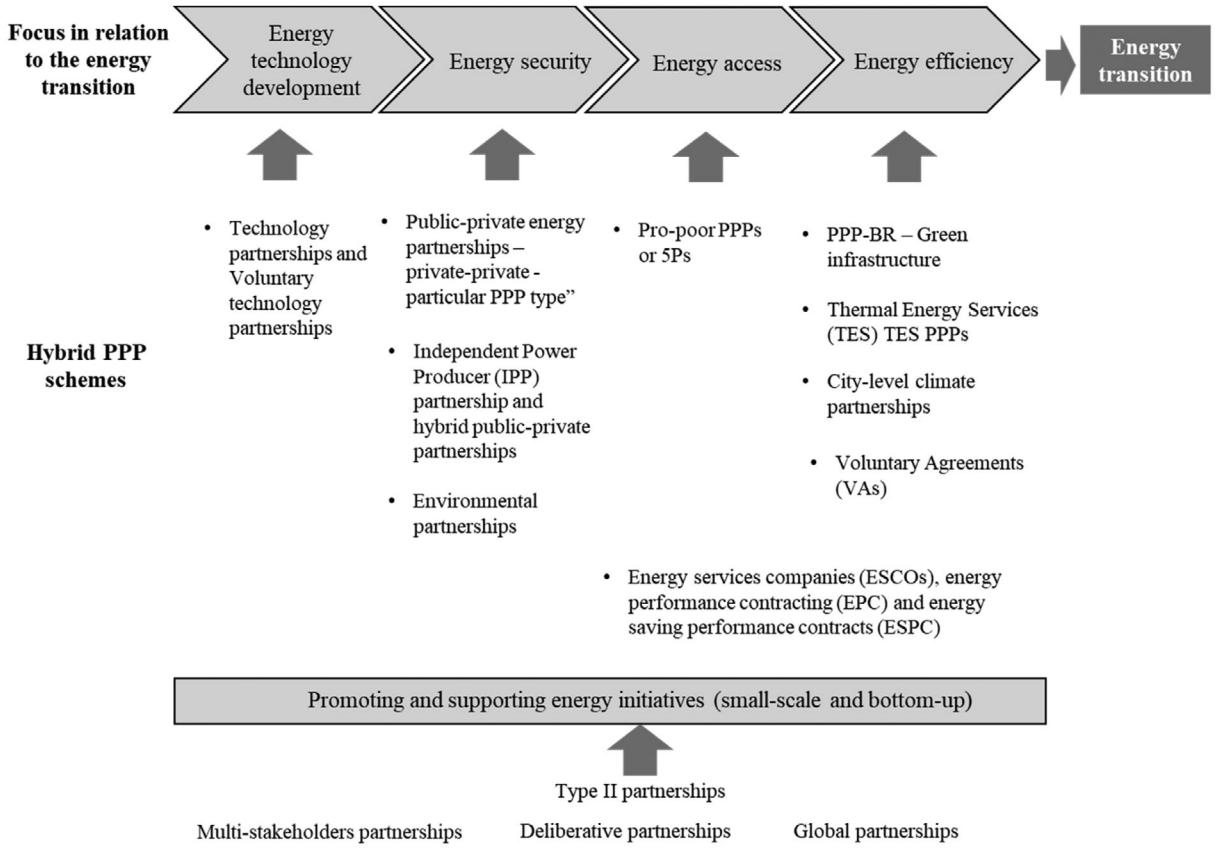
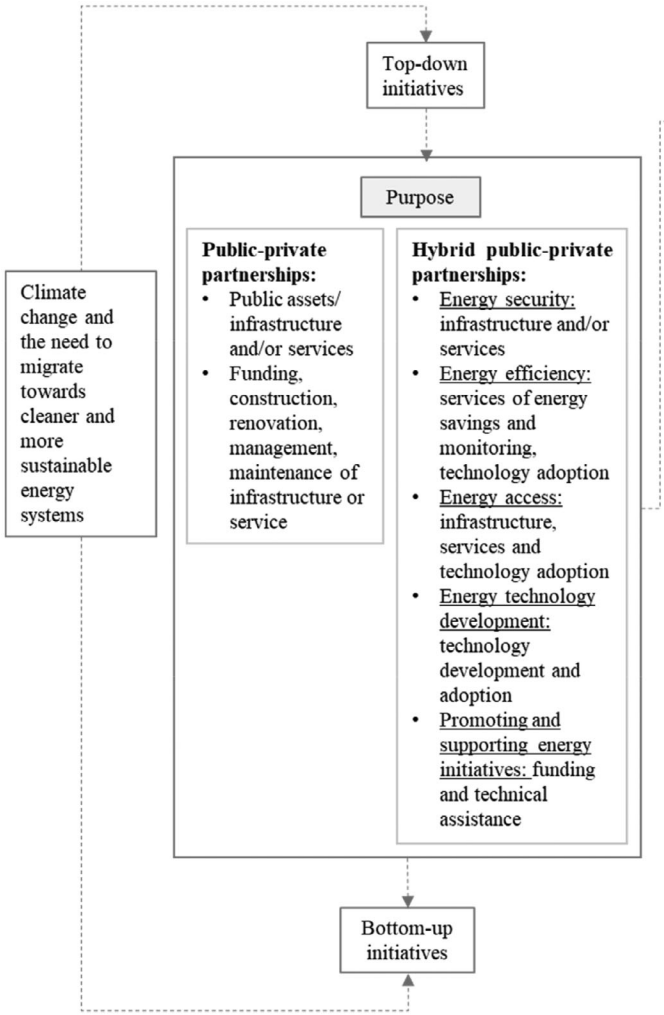


FIGURE 3 Articulation of hybrid public–private partnerships to achieve the energy transition



Characteristic	Public/private partnerships	Hybrid public-private partnerships
Form	- contract - cooperation - collaboration - agreement - legally binding contract - broad assortment of relationships	broad assortment of relationships: - contractual - voluntary agreements - hybrids: combining with sector-specific contractual figures for different purposes (power purchasing, energy savings, etc.)
Timeframe	long-term	long-term in essence but not restricted
Stakeholders	public and private entities	- public and private entities - different social actors - cross boundaries and multi-level
Risk, reward, resource, responsibility sharing	sharing responsibilities, risks, revenue and costs	new dynamics of sharing risk, revenue and costs
Critical success factors	- engagement of private sector - focus on a specific goal - goal alignment	- appropriate risk management - trust building (particularly relevant in voluntary partnerships) - accountability

FIGURE 4 Framework for analyzing public–private partnerships and hybrids public–private partnerships

hybrid PPPs, we created a framework showing these two parallel approaches (Figure 4).

This framework in Figure 4 does not intend to arrange hybrid PPPs as a homogeneous group but make some relevant aspects from the literature visible and pave the way to identify their current challenges. In doing so, the six characteristics presented are discussed below (Sections 3.4.1–3.4.6) based on the commonalities and differences identified in the literature between PPPs and hybrid PPPs.

3.4.1 | Form

Scholars argue that PPP contracts are not flexible in incorporating changes during a project's life cycle, which leads to costly renegotiations and could be an obstacle against innovations (Bougrain, 2012). However, the energy transition is opening an avenue for enhancing community participation in energy markets; further, new energy scenarios include the implementation of both top-down and bottom-up initiatives (Dinica, 2008a; Grotenbreg & van Buuren, 2017). In contrast, hybrid schemes rely more on negotiated forms or even voluntary forms, based on the premise of building a solution from collective efforts (Galli & Fisher, 2016). Zhang et al. (2018) and White (2004) refer to these new PPPs as voluntary agreements. Nevertheless, inexorably, a PPP formed to support the energy transition will face challenges relating to the implications of voluntary and bottom-up approaches, particularly in the risk of lack of reciprocity and commitment of parties involved (Heldeweg et al., 2015). Therefore, PPP depends on a solid institutional foundation; otherwise, the legitimacy of the relationship can be undermined.

3.4.2 | Purpose

The response to the challenges of sustainability and the particularities of the energy sector have led to creating customized partnerships for these purposes. Hancock et al. (2018) stated the relevance of aligning PPPs with SDGs. In particular, new forms of PPPs can be crucial to achieving Goal 7 related to promoting access to energy and new energy solutions, as well as Goal 9, in terms of ensuring energy security through building resilient, inclusive and innovative systems

(Hancock et al., 2018). While there are guidelines for implementing PPPs in infrastructure, these new forms of collaboration in the energy sector also require knowledge management for satisfactory implementations.

3.4.3 | Timeframe

PPPs, per se, have a prominent orientation toward long-term relationships. Indeed, PPPs have durability for several reasons: (i) the private actor is expected to carry out activities on behalf of the public authority during the project's life cycle (Martins et al., 2011; Yang et al., 2019); (ii) large-scale projects are characterized by slow payback; and (iii) a long-term relationship guarantees energy-purchasing conditions to reduce the uncertainty of renewable-energy projects. Overall, hybrid PPPs are also aimed at building relationships that last over the long term. However, in some hybrid PPPs, financial sources pose difficulties in ensuring lasting relationships, for example, schemes depending on subsidies, grants, or donors.

3.4.4 | Stakeholders

Unlike PPPs, hybrid schemes tend to be more decentralized, participatory and inclusive (Forsyth, 2005). Different social actors will inevitably enter the energy arena during the transition toward cleaner and more sustainable systems, such as small private enterprises, citizen organizations, research institutions, academia, non-profit organizations and consumers (Forsyth, 2005). As Grotenbreg and van Buuren (2017) note, the energy sector is a rapid technological evolution scene featuring bottom-up initiatives, leading to building partnerships. In particular, public authorities assume facilitating roles and transfer leadership positions to actors outside the public sphere (Grotenbreg & van Buuren, 2017). The distinction between public and private actors is blurred since their roles intersect and overlap. In this context, public entities without a statutory power mandate and even private actors can perform as functional public authorities (depending on the specific case and regulation; Heldeweg et al., 2015). One of the most significant challenges in encouraging the participation of new stakeholders is to clarify who can exercise public authority and how new actors are institutionalized within PPPs.

3.4.5 | Risk, reward, resource, and responsibility-sharing

Innovation is the central axis of the energy transition, as the development and adoption of new technologies can provide growth opportunities (Phang, 2020). However, overcoming technical and commercial barriers requires flexibility and adaptation. Although technological risk takes on major significance in these contexts, the literature on PPPs shows that new risk management approaches involving different levels of innovation incorporations seem scarce. As Phang (2020) highlights, innovation in the energy transition context requires recognizing technological risks and adopting new business models, and hybrid PPPs, particularly schemes where the source of funding includes grants or donations, present challenges to ensuring the sustainability of partnerships over time, given the significant financial risk (Chaurey et al., 2012).

3.4.6 | Critical success factors

For hybrid PPPs, in addition to the CSFs mentioned in Section 3.2, other factors are also crucial for successful implementations. For example, in EPC, ESPC, and ESCOs, an adequate accounting framework and institutional capacity for risk allocation purposes

TABLE 2 Key challenges of public–private partnerships and hybrid public–private partnerships for the energy transition

Characteristic	Key challenges to support the energy transition
Form	There is no complete alignment of PPPs and hybrid PPPs. Legitimacy and institutional alignment are key challenges. In hybrid PPPs, the key challenge is guaranteeing reciprocity and commitment, particularly in voluntary schemes.
Purpose	There is no clear space in PPPs not strictly related to infrastructure and associated services. A strategy for structuring the information related to sector-specific practices in PPPs and hybrid PPPs is relevant for further successful implementations
Timeframe	The durability of hybrid PPPs is a challenge considering the financial constraints of new business models in hybrid PPPs.
Stakeholders	There is no clear space for the participation of different social actors in PPPs. Defining the representative authority in hybrid PPPs when activities are not fully regulated is a key challenge.
Risk, reward, resource, and responsibility-sharing	PPPs' risk management approaches could be limiting when dealing with technological innovations and/or multiple PPPs stakeholders. In hybrid PPPs, a key challenge is to achieve a well-balanced risk allocation when meeting current institutional frameworks.
Critical success factors	Building trust in hybrid PPPs is a challenge, particularly in voluntary schemes.

Abbreviation: PPPs, public–private partnership.

TABLE 3 Overview of the research work

Stage	Outcome	Key aspects
Defining local domain and scope	Literature on PPPs in energy	
Capturing and synthesizing extant knowledge	PPP characterization	Characteristics of public–private partnerships PPPs from definitions: • Form: contractual relationship • Purpose: providing public infrastructure and/or services • Timeframe: long-term • Stakeholders: public and private entities • Risk, reward, resource and responsibility sharing: sharing responsibilities, risks, revenue and costs • Critical success factors: engagement of private sector, focus on specific goal and goal alignment
	Categorization of hybrid PPP schemes for the energy transition	• Energy security • Energy efficiency • Energy access • Energy technology development • Promoting and supporting energy initiatives
Identifying and resolving contradictory explanations	Analytical framework of PPP and hybrid PPP schemes	Hybrid PPPs emerge as top-down and bottom-up initiatives as a result of the need to migrate toward cleaner and more sustainable energy systems. • Broad assortment of relationships including voluntary agreements, hybrids and contractual. • Multiple social actors participate in these arrangements. • New approaches for risk sharing and business models. • Critical success factors are appropriate risk management, trust building and accountability.
Highlighting gaps	Key challenges of PPPs and hybrid PPP schemes to support the energy transition	• Lack of flexibility in PPPs as well as a lack of clear space for other purposes not strictly related to infrastructure and associated services, for example technology development, and the participation of different social actors. • Lack of alignment of PPPs and emerging hybrid PPPs.
Further research agenda	Research focus areas	• Mechanisms for the institutional alignment of hybrid PPPs. • Mechanisms for assuring reciprocity and commitment. • Knowledge management • Capacity building

Abbreviation: PPPs, public–private partnership.

are critical for achieving win-win conditions (Carbonara & Pellegrino, 2018). Moreover, in environmental partnerships, a solid institutional framework and strategic vision are crucial to reducing risk significance (Arbulú et al., 2017). Regarding bottom-up initiatives and voluntary agreements, it is essential to guarantee accountability and transparency (Muleya et al., 2019) and high levels of trust to facilitate the decision-making process (Zhang et al., 2018).

4 | DISCUSSION ON EXPANDING RESEARCH AGENDA

How do public-private partnerships and hybrid schemes differ in addressing the challenges of the transition toward cleaner and more sustainable energy systems? This study highlights the neglected role of PPPs and emerging variants of PPPs, so-called by scholars as "hybrid

PPPs" in the energy transition context. As noted in the literature, existing divergences on the scope of PPPs have profound effects on how collaborations occur, and propose relevant challenges when facing cross-cutting changes in energy systems toward sustainable development (Table 2). However, to the extent that this phenomenon becomes visible, research efforts can be oriented to explore it. Notably, the dissimilarities in the partnership's form (e.g., contractual vs. voluntary) reflect how, alongside the top-down initiatives formalized in contractual PPPs, there are also bottom-up initiatives from multiple social actors. Furthermore, some partnerships emerge in incomplete institutional frameworks, posing ambivalences related to their adherence to PPP schemes, even when they comply with energy governance principles. Hence, PPPs and hybrid schemes are highly dependent on the specific context where they are applied.

As described in Table 2, the first challenge of PPPs and hybrid PPPs is recognizing hybrid forms and their institutional alignment. This aspect can significantly influence the risk aversion in projects. Since emerging hybrid PPPs do not present visible incorporation into institutional frameworks and current PPP guidelines, there is a call for research on developing adequate mechanisms to address this issue and strategies that guarantee reciprocity and commitment. Such a study would require the participation of practitioners, policymakers, multilateral organizations, civilians, and the scientific community in reconciling ideas and conceptions about how PPPs is adapted to current collaboration needs. Research efforts should also focus on developing strategies for knowledge management of PPPs and hybrid PPPs in the energy sector, providing project-implementation guides according to the particularities of this sector. Since the energy transition is oriented toward increasingly decentralized and participatory systems, it is necessary to find paths for different social actors to collaborate in the energy transition. One of the critical aspects is to clarify the representativeness of public and private stakeholders in PPPs and hybrid PPPs.

Regarding the operationalization of risk-sharing principles, it is necessary to reconcile hybrid PPPs with the institutional frameworks in accounting forms to achieve a win-win relationship that encourages private actors' participation. Simultaneously, the development of alternative approaches to risk management is required for high technological, market, and regulatory risks in the energy transition context. Finally, a fundamental aspect in PPPs and hybrid PPPs is how to build trust for decision-making, taking into account that technological progress, as well as changes in the market and regulations, require agile adaptation, stakeholders' alignment and, above all, a high level of trust. In summary, the research agenda should include the following:

- *Mechanisms for the institutional alignment of hybrid PPPs*: Alignment of bottom-up initiatives with institutional frameworks, accounting approaches and public repressiveness of social actors.
- *Mechanisms for assuring reciprocity and commitment*: Development of frameworks for assuring legitimacy in hybrid PPPs.
- *Knowledge management*: Developing a knowledge management strategy for PPPs and hybrid PPPs in sector-specific features as well as new risk management approaches, sustainable business models and CSFs.
- *Capacity building*: Capacity building in achieving goal alignment, trust-building, accountability, stakeholders´ engagement and value creation.

5 | CONCLUSIONS

This article attempts to unveil an overlooked phenomenon in the literature, such as the existing differences between PPPs and hybrid PPPs in addressing the energy transition. Our analysis examines the definitions of PPPs used by the authors. In this analysis, six conceptual elements emerged in the definitions: PPP form, purpose, timeframe, stakeholders, risk, reward, revenue and responsibility-sharing, and CSFs. Alongside the decomposition of the definitions, several examples of hybrid PPPs were also identified in the literature targeting various purposes related to the energy transition, such as energy technology development, energy access, energy security, and energy efficiency. The definitions of PPP and hybrid PPPs were used to develop an analytical framework to contrast similarities and differences. Overall, we found the need for research on the institutional alignment of PPPs and hybrid PPPs, mechanisms for assuring reciprocity and commitment in hybrid schemes, and developing a strategy for knowledge management and capacity building public–private collaboration in energy. Table 3 provides an overview of the research work regarding the primary outcomes and key aspects of the five-stages process approached in this conceptual review paper.

5.1 | Conceptual contributions and policy recommendations

The value of this paper is threefold. First, it clarifies the concept of PPP and offers a guide for understanding the differences between the various related concepts used in the literature. Second, it exposes the challenges to advancing the energy transition from existing ambivalences between PPPs and hybrid PPPs. Third, it shows the increasingly innovative responses from various social sectors to join forces to face energy transition and sustainability challenges. This paper is the first study that directly approaches this phenomenon from the literature of PPPs in energy to the best of our knowledge. Several scholars have made other efforts along the way in exploring hybrid PPPs based on empirical evidence (Heldeweg et al., 2015; Nel, 2018). Additionally, this article points out the critical research areas to focus on advancing the energy transition from collaboration schemes.

The present study is not limited to summarizing the extant literature. It also identifies, analyzes, and presents a relevant research gap with a potentially significant impact on contemporary social issues such as the energy transition. Furthermore, this research work provides several research outcomes that may be useful for future research, for example, (i) characterization of PPPs; (ii) classification of hybrid PPPs; (iii) analytical framework of PPPs and hybrid PPPs; (iv) synopsis of the key challenges for the energy transition; and (v) identification of research focus areas.

Besides, this study points to several implications for managers and policymakers. Concerning the managerial implications, the study summarizes how various hybrid PPP schemes have emerged to face challenges such as expanding access to energy, energy technology, energy efficiency, transnational cooperation, and initiatives on a smaller scale. In this study, practitioners can directly connect PPP and hybrid PPP as collaboration schemes with energy sector experiences. Similarly, the six criteria derived from the PPP definitions can characterize control items for new PPP energy projects.

As in every study, this article has inherent limitations. First, the data capture and synthesis process have inherent limitations arising from the systematic search. Second, although two of the most comprehensive databases for bibliometric studies were used, a few articles that can only be found in other databases may have been missed. Therefore, other databases were reviewed to identify missed studies, but no relevant articles were found. Finally, although the data selection and analysis were exhaustive, some data may have been omitted.

Regarding the implications for policymakers, first, the study provides an avenue to design appropriate mechanisms for the formal alignment of hybrid PPPs in climate change policies and institutional frameworks. Second, a clear picture of PPPs and hybrid PPPs helps one understand opportunities from bottom-up initiatives. Third, the findings could lead to new mechanisms for PPPs to foster emerging technologies and business opportunities in the energy transition context. Last, this article's contributions could help policymakers facilitate access to funding schemes and broader collaborations.

ORCID

Giovanna Andrea Pinilla-De La Cruz https://orcid.org/0000-0001-7157-4413
Rodrigo Rabetino https://orcid.org/0000-0001-8567-2559
Jussi Kantola https://orcid.org/0000-0001-8660-9068

REFERENCES

Abbott, K. W. (2012). Engaging the public and the private in global sustainability governance. *International Affairs*, *88*(3), 543–564.

Ahmad, M., & Raza, M. Y. (2020). Role of public-private partnerships investment in energy and technological innovations in driving climate change: Evidence from Brazil. *Environmental Science and Pollution Research*, *27*(24), 30638–30648. https://doi.org/10.1007/s11356-020-09307-w

Akcay, E. C., Dikmen, I., Birgonul, M. T., & Arditi, D. (2017). Estimating the profitability of hydropower investments with a case study from Turkey. *Journal of Civil Engineering and Management*, *23*(8), 1002–1012.

Andonova, L. B., Betsill, M. M., & Bulkeley, H. (2009). Transnational climate governance. *Global Environmental Politics*, *9*(2), 52–73. https://doi.org/10.1162/glep.2009.9.2.52

Andonova, L. B., & Levi, M. A. (2003). Franchising global governance: Making sense of the johannesburg type II partnerships. In O. S. Stokke & O. B. Thommessen (Eds.), *Yearb. Int. co-operation environ. Dev. 2003/2004* (pp. 19–31). Earthscan Publications.

Araquistain Portela, C. (2020). Urban utilities and opportunities for the private sector in local energy services in Switzerland. *Competition and Regulation in Network Industries*, *21*(2), 193–218. https://doi.org/10.1177/1783591720916347

Arbulú, I., Lozano, J., & Rey-maquieira, J. (2017). The challenges of tourism to waste-to-energy public-private partnerships. *Renewable and Sustainable Energy Reviews*, *72*, 916–921.

Atmo, G., & Duffield, C. (2014). Improving investment sustainability for PPP power projects in emerging economies: Value for money framework. *Built Environment Project and Asset Management.*, *4*(4), 335–351.

Bai, W., & Zhang, L. (2020). How to finance for establishing hydrogen refueling stations in China? An analysis based on fuzzy AHP and PROMETHEE. *International Journal of Hydrogen Energy*, *45*(59), 34354–34370. https://doi.org/10.1016/j.ijhydene.2019.12.198

Baylis, K. (2000). *Independent power producers: A review of issues*. University of Greenwich.

Benkovic, S., Makojevic, N., & Jednak, S. (2013). Possibilities for development of the electric power industry of Serbia through private source financing of small hydropower plants. *Renewable Energy*, *50*, 1053–1059.

Bettencourt, L. M. A., & Kaur, J. (2011). The evolution and structure of sustainability science. *Proceedings of the National Academy of Sciences of the United States of America*, *108*(49), 19540–19545.

Bloomfield, P. (2006). The challenging business of long-term public–private partnerships: Reflections on local experience. *Public Administration Review*, *66*(3), 400–411.

Bougrain, F. (2012). Energy performance and public private partnership. *Built Environment Project and Asset Management.*, *2*(1), 41–55. https://doi.org/10.1108/20441241211235044

Brogaard, L. (2015). *What drives innovation in public-private innovative partnerships?*. Paper presented at Dansk Selskab for Statskundskab, Kolding, Denmark.

Brogaard, L. (2017). The impact of innovation training on successful outcomes in public–private partnerships. *Public Management Review*, *19*(8), 1184–1205. https://doi.org/10.1080/14719037.2016.1272710

Brogaard, L. (2019). Innovative outcomes in public-private innovation partnerships: A systematic review of empirical evidence and current challenges. *Public Management Review*, *1–23*, 135–157. https://doi.org/10.1080/14719037.2019.1668473

Broto, V. C., & Baker, L. (2018). Spatial adventures in energy studies: An introduction to the special issue. *Energy Research & Social Science*, *36*(1), 1–10 Retrieved from 10.1016/j.erss.2017.11.002

Burger, P., & Hawkesworth, I. (2011). How to attain value for money: Comparing PPP and traditional infrastructure public procurement. *OECD Journal on Budgeting*, *11*(1), 91–146.

Carbonara, N., & Pellegrino, R. (2018). Public-private partnerships for energy efficiency projects: A win-win model to choose the energy performance contracting structure. *Journal of Cleaner Production*, *170*, 1064–1075. https://doi.org/10.1016/j.jclepro.2017.09.151

Chaurey, A., Krithika, P. R., Palit, D., Rakesh, S., & Sovacool, B. K. (2012). New partnerships and business models for facilitating energy access. *Energy Policy*, *47*, 48–55.

Chen, C., Yu, Y., Osei-Kyei, R., Chan, A. P. C., & Xu, J. (2019). Developing a project sustainability index for sustainable development in transnational public–private partnership projects. *Sustainable Development*, *27*(6), 1034–1048. https://doi.org/10.1002/sd.1954

Copiello, S. (2015). Achieving affordable housing through energy efficiency strategy. *Energy Policy*, *85*, 288–298. https://doi.org/10.1016/j.enpol.2015.06.017

Cruz, C. O., & Sarmento, J. M. (2017). Reforming traditional PPP models to cope with the challenges of smart cities. *Competition and Regulation in Network Industries*, *18*(1–2), 94–114. https://doi.org/10.1177/1783591717734794

Cui, C., Sun, C., Liu, Y., Jiang, X., & Chen, Q. (2019). Determining critical risk factors affecting public-private partnership waste-to-energy incineration projects in China. *Energy Science & Engineering.*, *8*(4), 1181–1193. https://doi.org/10.1002/ese3.577

Dastig, M. (2009). How can EU-funds be used to finance public-private partnerships? *European Procurement & Public Private Partnership Law*, *4*, 158.

De Carvalho, L. (2018). Rethinking the continuum between public and private actors in electricity policy in the context of the UKenergy transition. *Czech Sociological Review.*, *54*(6), 881–906.

Denyer, D., & Tranfield, D. (2009). Producing a systematic review. In D. A. Buchanan, & A. Bryman (Eds.), *The Sage handbook of organizational research methods* (pp. 672–689). Sage Publications Ltd.

Di Liddo, G., Alessandro, L., & Ernesto, R. (2019). Determinants of PPP in infrastructure investments in MENA countries: A focus on energy. *Journal of Industrial and Business Economics.*, *46*(4), 523–580. https://doi.org/10.1007/s40812-019-00129-7

Dinica, V. (2008a). Greening electricity production: Success story of multilevel governance convergence and innovation. *Energy & Environment*, *19*(6), 787–801.

Dinica, V. (2008b). Initiating a sustained diffusion of wind power: The role of public–private partnerships in Spain. *Energy Policy*, *36*(9), 3562–3571. https://doi.org/10.1016/j.enpol.2008.06.008

Fang, Y., Wei, W., Liu, F., Mei, S., Chen, L., & Li, J. (2019). Improving solar power usage with electric vehicles: Analyzing a public-private partnership cooperation scheme based on evolutionary game theory. *Journal of Cleaner Production*, *233*, 1284–1297. https://doi.org/10.1016/j.jclepro.2019.06.001

Fantozzi, F., Bartocci, P., Alessandro, B. D., Arampatzis, S., & Manos, B. (2014). Public-private partnerships value in bioenergy projects: Economic feasibility analysis based on two case studies. *Biomass and Bioenergy*, *66*, 387–397.

Faulkner, H. J. H. (1995). Public-private partnerships in sustainable development. *Review of Eurpean Community and International Environmental Law*, *4*(2), 133–136.

Fecondo, P., & Moca, G. (2015). The ELENA Programme in the province of Chieti-a public private partnership best practice improving energy efficiency of buildings and public lighting systems. *Journal of Sustainable Development of Energy, Water Environment Systems.*, *3*(3), 230–244.

Feng, Z., He, Q. C., & Ma, G. (2021). Mitigating poverty through solar panels adoption in developing economies. *Decision Sciences*, 1–21. https://doi.org/10.1111/deci.12505

Fleta-Asín, J., & Muñoz, F. (2021). Renewable energy public–private partnerships in developing countries: Determinants of private investment. *Sustainable Development*, *29*(4), 653–670. https://doi.org/10.1002/sd.2165

Foley, H. C., Freihaut, J., Hallacher, P., & Knapp, C. (2011). The greater Philadelphia innovation cluster for energy-efficient buildings: A new model for public-private partnerships. *Research-Technology Management*, *54*(6), 42–48. https://doi.org/10.5437/08956308X5406014

Forsyth, T. (2005). Building deliberative public – Private partnerships for waste management in Asia. *Geoforum*, *36*(4), 429–439. https://doi.org/10.1016/j.geoforum.2004.07.007

Galli, A. M., & Fisher, D. R. (2016). Hybrid arrangements as a form of ecological modernization: The case of the US energy efficiency conservation block Grants. *Sustainability*, *8*(1), 88. https://doi.org/10.3390/su8010088

Gao, L., & Zhao, Z. (2018). System dynamics analysis of evolutionary game strategies between the government and investors based on new energy power construction public-private-partnership (PPP) project. *Sustainability*, *10*(7), 2533. https://doi.org/10.3390/su10072533

Gao, L., & Zhao, Z. Y. (2020). The evolutionary game of stakeholders' coordination mechanism of new energy power construction PPP project: A China case. *Sustainability*, *12*(3), 1045. https://doi.org/10.3390/su12031045

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, *16*(1), 15–31. https://doi.org/10.1177/1094428112452151

Grotenbreg, S., & van Buuren, A. (2017). Facilitation as a governance strategy: Unravelling governments' facilitation frames. *Sustainability*, *9*(1), 160. https://doi.org/10.3390/su9010160

Gunawansa, A. (2011). Contractual and policy challenges to developing ecocities. *Sustainable Development*, *19*(6), 382–390. https://doi.org/10.1002/sd.445

Hale, T. N., & Mauzerall, D. L. (2004). Thinking globally and acting locally: Can the johannesburg partnerships coordinate action on sustainable development? *Journal of Environment & Development*, *13*(3), 220–239. Retrieved from. https://doi.org/10.1177/1070496504268699

Hancock, L., Ralph, N., & Ali, S. H. (2018). Bolivia's lithium frontier: Can public private partnerships deliver a minerals boom for sustainable development? *Journal of Cleaner Production*, *178*, 551–560. https://doi.org/10.1016/j.jclepro.2017.12.264

Harrison, C., & Popke, J. (2018). Geographies of renewable energy transition in the Caribbean: Reshaping the Island energy metabolism. *Energy Research and Social Science*, *36*, 165–174. https://doi.org/10.1016/j.erss.2017.11.008

Hassan, M. M., Lee, K. E., & Mokhtar, M. (2019). Streamlining non-governmental organizations' programs towards achieving the sustainable development goals: A conceptual framework. *Sustainable Development*, *27*(3), 401–408. https://doi.org/10.1002/sd.1912

Heldeweg, M. A., Sanders, M., & Harmsen, M. (2015). Public-private or private-private energy partnerships? Toward good energy governance in regional and local green gas projects. *Energy. Sustain. Soc.*, *5*(1), 1–12. https://doi.org/10.1186/s13705-015-0038-8

Hulland, J. (2020). Conceptual review papers: Revisiting existing research to develop and refine theory. *AMS Review*, *10*(1), 27–35.

Jänicke, M., & Jörgens, H. (2009). New approaches to environmental governance. In A. P. J. Mol, D. A. Sonnenfeld, & G. Spaargaren (Eds.), *Ecol. Mod. Read* (pp. 157–187). Routledge.

Jensen, T., & Dowlatabadi, H. (2018). Challenges in financing public sector low-carbon initiatives: Lessons from private finance for a school district in British Columbia, Canada. *Climate Policy*, *18*(7), 878–888. https://doi.org/10.1080/14693062.2017.1387512

Jumbe, C. B. L., & Mkondiwa, M. (2013). Comparative analysis of biofuels policy development in Sub-Saharan Africa: The place of private and public sectors. *Renewable Energy*, *50*, 614–620.

Khan, Z., Ali, M., Kirikkaleli, D., Wahab, S., & Jiao, Z. (2020). The impact of technological innovation and public-private partnership investment on sustainable environment in China: Consumption-based carbon emissions analysis. *Sustainable Development*, *28*(5), 1317–1330. https://doi.org/10.1002/sd.2086

Klijn, E. H., & Koppenjan, J. (2016). The impact of contract characteristics on the performance of public–private partnerships: Results from a survey among PPP projects in The Netherlands. *Public Money & Management*, *36*(6), 455–462. https://doi.org/10.1080/09540962.2016.1206756

Koengkan, M. (2020). Capital stock development in Latin America and the Caribbean region and their effect on investment expansion in renewable energy. *Sustainable Finance and Investment.*, 1–18. https://doi.org/10.1080/20430795.2020.1796100

Kohtamäki, M., Rabetino, R., & Möller, K. (2018). Alliance capabilities: A systematic review and future research directions. *Industrial Marketing Management*, *68*, 188–201. https://doi.org/10.1016/j.indmarman.2017.10.014

Komendantova, N., Patt, A., Barras, L., & Battaglini, A. (2012). Perception of risks in renewable energy projects: The case of concentrated solar power in North Africa. *Energy Policy*, *40*, 103–109.

Kouassi, H., & Pineau, P. (2011). Financing challenges for electricity projects in sub-saharan africa: Reviewing old models and exploring new ones. *Journal of African Business*, *12*(3), 347–367. https://doi.org/10.1080/15228916.2011.621815

LaBerge, M., & Svendsen, A. (2000). New growth: Fostering collaborative business relationships. *Journal for Quality and Participation*, *23*(3), 48.

Lesser, J. A. (2008). Design of an economically efficient feed-in tariff structure for renewable energy development. *Energy Policy*, *36*(3), 981–990.

Liu, J., & Wei, Q. (2018). Risk evaluation of electric vehicle charging infrastructure public-private partnership projects in China using fuzzy

TOPSIS. *Journal of Cleaner Production*, *189*, 211–222. https://doi.org/10.1016/j.jclepro.2018.04.103

Lugaric, T. R., Dodig, D., & Bogovac, J. (2019). Effectiveness of blending alternative procurement models and EU funding mechanisms based on energy efficiency case study simulation. *Energies*, *12*(9), 1612.

Lukamba-Muhlya, J. M., & Uken, E. (2006). The electricity supply industry in The Democratic Republic of the Congo. *Journal of Energy in Southern Africa*, *17*(3), 21–28.

Manos, B., Partalidou, M., Fantozzi, F., Arampatzis, S., & Papadopoulou, O. (2014). Agro-energy districts contributing to environmental and social sustainability in rural areas: Evaluation of a local public–private partnership scheme in Greece. *Renewable and Sustainable Energy Reviews*, *29*, 85–95.

Martiniello, L., Morea, D., Paolone, F., & Tiscini, R. (2020). Energy performance contracting and public-private partnership: How to share risks and balance benefits. *Energies*, *13*(14), 1–16. https://doi.org/10.3390/en13143625

Martins, A. C., Cunha, R. C., & Cruz, C. O. (2011). Public–private partnerships for wind power generation: The Portuguese case. *Energy Policy*, *39*(1), 94–104. https://doi.org/10.1016/j.enpol.2010.09.017

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Academia and clinic annals of internal medicine preferred reporting items for systematic reviews and meta-analyses. *Annual Internal Medicine*, *151*(4), 264–269.

Morse, S., & McNamara, N. (2009). The universal common good: Faith-based partnerships and sustainable development. *Sustainable Development*, *17*(1), 30–48. https://doi.org/10.1002/sd.368

Muleya, F., Zulu, S., & Nanchengwa, P. C. (2019). Investigating the role of the public private partnership act on private sector participation in PPP projects: A case of Zambia. *International Journal of Construction Management*, *20*(6), 598–612. https://doi.org/10.1080/15623599.2019.1703088

Nel, D. (2018). An assessment of emerging hybrid public-private partnerships in the energy sector in South Africa. *International Journal of Economics and Finance Studies.*, *10*(1), 33–49.

Oliveira-Duarte, L., Reis, D. A., Fleury, A. L., Vasques, R. A., Fonseca Filho, H., Koria, M., & Baruque-Ramos, J. (2021). Innovation ecosystem framework directed to sustainable development goal #17 partnerships implementation. *Sustainable Development*, 1018–1036. https://doi.org/10.1002/sd.2191

Otsuka, K., & Cheng, F. T. (2020). Embryonic forms of private environmental governance in Northeast Asia. *The Pacific Review*, *35*(1), 1–31. https://doi.org/10.1080/09512748.2020.1811372

Owusu-Manu, D. G., Adjei, T. K., Sackey, D. M., Edwards, D. J., & Hosseini, R. M. (2020). Mainstreaming sustainable development goals in Ghana's energy sector within the framework of public–private partnerships: Challenges, opportunities and strategies. *Journal of Engineering Design Technology.*, *19*, 605–624. https://doi.org/10.1108/JEDT-06-2020-0255

Owusu-Manu, D.-G., Edwards, D. J., Kutin-Mensah, E. K., Kilby, A., Parn, E., & Love, P. E. (2017). The impact of socio-political and economic environments on private sector participation in energy infrastructure delivery in Ghana. *Journal of Engineering Design Technology.*, *15*(2), 166–180. https://doi.org/10.1108/JEDT-02-2016-0007

Panteli, C., Klumbytė, E., Apanavičienė, R., & Fokaides, P. A. (2020). An overview of the existing schemes and research trends in financing the energy upgrade of buildings in Europe. *Journal of Sustainable Architecture and Civil Engineering*, *27*(2), 53–62. https://doi.org/10.5755/j01.sace.27.2.25465

Pattberg, P. H., Biermann, F., Chan, S., & Mert, A. (2012). *Public-private partnerships for sustainable development: Emergence, influence and legitimacy*. Edward Elgar.

Phang, S.-Y. (2020). The convergence of water, electricity and gas industries: Implications for PPP design and regulation. *Competition and Regulation in Network Industries*, *21*(4), 380–395. https://doi.org/10.1177/1783591720970340

Pinilla-De La Cruz, G. A., Rabetino, R., & Kantola, J. (2020). Public-private partnerships (PPPs) in energy: Identifying the key dimensions from two different Bibliometric analyzes. In J. Kantola & S. Nazir (Eds.), *Advances in human factors, business management and leadership* (Vol. 1209, pp. 65–71). Springer.

Pinilla-De La Cruz, G. A., Rabetino, R., & Kantola, J. (2021). Public-private partnerships (PPPs) in energy: Co-citation analysis using network and cluster visualization. In D. Russo, T. Ahram, W. Karwowski, & G. Di Bucchianico (Eds.), *Intelligent human system integration* (Vol. 1322, pp. 460–465). Springer International Publishing. https://doi.org/10.1007/978-3-030-68017-6

Raza, S. A., Shah, S. H., & Yousufi, S. Q. (2021). The impact of public-private partnerships Investment in Energy on carbon emissions: Evidence from nonparametric causality-in-quantiles. *Environmental Science and Pollution Research*, *1–11*, 23182–23192. https://doi.org/10.1007/s11356-020-12306-6

Rehman, I. H., Sreekumar, A., Gill, B., & Worrell, E. (2017). Accelerating access to energy services: Way forward. *Advances in Climate Change Research*, *8*(1), 57–61. https://doi.org/10.1016/j.accre.2017.03.003

Rojon, C., Okupe, A., & McDowall, A. (2021). Utilization and development of systematic reviews in management research: What do we know and where do we go from here? *International Journal of Management Reviews*, *23*(2), 191–233. https://doi.org/10.1111/ijmr.12245

Ronda-Pupo, G. A., & Guerras-Martín, L. A. (2012). Dynamics of the evolution of the strategy concept 1962-2008: A co-word analysis. *Strategic Management Journal*, *33*(2), 162–188. https://doi.org/10.1002/smj

Rossi, M., Festa, G. G. A., & Gunardi, A. (2019). The evolution of public-private partnerships in a comparison between Europe and Italy: Some perspectives for the energy sector. *International Journal of Energy Economics and Policy*, *9*(3), 403–413.

Saadeh, D., Al-khatib, I. A., & Stamatia, K. (2019). Public–private partnership in solid waste management sector in the West Bank of Palestine. *Environmental Monitoring and Assessment*, *191*(4), 1–19.

Salci, S., & Jenkins, G. P. (2018). An economic analysis for the design of IPP contracts for grid-connected renewable energy projects. *Renewable and Sustainable Energy Reviews*, *81*, 2410–2420. https://doi.org/10.1016/j.rser.2017.06.047

Sanderink, L. (2020). Shattered frames in global energy governance: Exploring fragmented interpretations among renewable energy institutions. *Energy Research & Social Science*, *61*, 101355. https://doi.org/10.1016/j.erss.2019.101355

Sanderink, L., & Nasiritousi, N. (2020). How institutional interactions can strengthen effectiveness: The case of multi-stakeholder partnerships for renewable energy. *Energy Policy*, *141*, 111447. https://doi.org/10.1016/j.enpol.2020.111447

Seager, T. P. (2008). The sustainability spectrum and the sciences of sustainability. *Business Strategy and the Environment*, *17*(7), 444–453.

Shahbaz, M., Raghutla, C., Song, M., Zameer, H., & Jiao, Z. (2020). Public-private partnerships investment in energy as new determinant of CO2 emissions: The role of technological innovations in China. *Energy Economics*, *86*, 104664. https://doi.org/10.1016/j.eneco.2020.104664

Sheng, M., Sreenivasan, A. V., Sharp, B., Wilson, D., & Ranjitkar, P. (2020). Economic analysis of dynamic inductive power transfer roadway charging system under public-private partnership–evidence from New Zealand. *Technological Forecasting and Social Change*, *154*, 119958. https://doi.org/10.1016/j.techfore.2020.119958

Smith, J., & High, M. M. (2017). Exploring the anthropology of energy: Ethnography, energy and ethics. *Energy Research & Social Science*, *30*, 1–6. https://doi.org/10.1016/j.erss.2017.06.027

Somma, E., & Rubino, A. (2016). Public-private participation in energy infrastructure in Middle East and North African countries: The role of institutions for renewable energy sources diffusion. *International Journal of Energy Economics and Policy*, *6*(3), 621–629.

Southard, K. (2010). The first public-private partnerships? *Public Contract Law Journal*, *39*(2), 395–410.

Sovacool, B. K. (2013). Expanding renewable energy access with pro-poor public private partnerships in the developing world. *Energy Strategy Reviews*, *1*(3), 181–192.

Sovacool, B. K. (2016). How long will it take? Conceptualizing the temporal dynamics of energy transitions. *Energy Research and Social Science*, *13*, 202–215. https://doi.org/10.1016/j.erss.2015.12.020

Sovacool, B. K., Axsen, J., & Sorrell, S. (2018). Promoting novelty, rigor, and style in energy social science: Towards codes of practice for appropriate methods and research design. *Energy Research and Social Science*, *45*, 12–42. https://doi.org/10.1016/j.erss.2018.07.007

Sovacool, B. K., & Van de Graaf, T. (2018). Building or stumbling blocks? Assessing the performance of polycentric energy and climate governance networks. *Energy Policy*, *118*, 317–324. https://doi.org/10.1016/j.enpol.2018.03.047

Stritzke, S. (2015). 'Clean energy for all': The implementation of scaling solar in Zambia. *World Journal of Science, Technology and Sustainable Development*., *15*(3), 214–225. https://doi.org/10.1108/WJSTSD-11-2017-0042

Svendsen, A. C., & Laberge, M. (2005). Convening stakeholder networks. *JCC*, *2005*, 91–104.

Szulecki, K., Pattberg, P. H., & Biermann, F. (2011). Explaining variation in the effectiveness of transnational energy partnerships. *Governance*, *24*(4), 713–736.

Tang, B., Xu, J., Sun, Y., Zhou, N., Shen, B., Liao, S., & Liu, Y. (2019). Policy solution and game analysis for addressing the challenge of developing public–private partnership energy project. *Environmental Research Letters*, *14*(4), 044019. https://doi.org/10.1088/1748-9326/ab0217

Thomas, S., Richter, M., Lestari, W., Prabawaningtyas, S., Anggoro, Y., & Kuntoadji, I. (2018). Transdisciplinary research methods in community energy development and governance in Indonesia: Insights for sustainability science. *Energy Research and Social Science*, *45*(June), 184–194. https://doi.org/10.1016/j.erss.2018.06.021

Tobey, B., & McGinnis, S. (2018). P3s and the water–energy nexus: Opportunities for water sector energy projects. *Journal of American Water Works Association*, *110*(12), 44–49. https://doi.org/10.1002/awwa.1196

Tremblay, D., Fortier, F., Boucher, J. F., Riffon, O., & Villeneuve, C. (2020). Sustainable development goal interactions: An analysis based on the five pillars of the 2030 agenda. *Sustainable Development*, *28*(6), 1584–1596. https://doi.org/10.1002/sd.2107

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., & Christensen, L. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences of the United States of America*, *100*(14), 8074–8079. https://doi.org/10.1073/pnas.1231335100

Ungureanu, P., Bertolotti, F., & Macri, D. (2018). Brokers or platforms? A longitudinal study of how hybrid interorganizational partnerships for regional innovation deal with VUCA environments. *European Journal of Innovation Management*, *21*(4), 636–671. https://doi.org/10.1108/EJIM-01-2018-0015

Vikkelsø, S., Skaarup, M. S., & Sommerlund, J. (2021). Organizational hybridity and mission drift in innovation partnerships. *European Journal of Innovation Management*. https://doi.org/10.1108/EJIM-09-2020-0384

Wang, K., & Ke, Y. (2018). Public-private partnerships in the electric vehicle charging infrastructure in China: An illustrative case study. *Advances in Civil Engineering*., *2018*, 1–10.

Wang, L., & Zhang, X. (2018). Bayesian analytics for estimating risk probability in PPP waste-to-energy projects. *Journal of Management in Engineering*, *34*(6), 04018047. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000658

Wang, L., & Zhang, X. (2019). Determining the value of standby letter of credit in transfer stage of a PPP project to control concessionaire's opportunistic behavior. *Journal of Management in Engineering*, *35*(3), 04019003. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000682

Wang, N., & Ma, M. (2021). Public–private partnership as a tool for sustainable development – What literatures say? *Sustainable Development*, *29*(1), 243–258. https://doi.org/10.1002/sd.2127

Wang, Q., Dogot, T., Yang, Y., Jiao, J., Shi, B., & Yin, C. (2020). From "coal to gas" to "coal to biomass": The strategic choice of social Capital in China. *Energies*, *13*(16), 1–22.

Weihe, G., Højlund, S., Theresa Bouwhof Holljen, E., Helby Petersen, O., Vrangbæk, K., & Ladenburg, J. (2011). Strategic use of public-private cooperation in the Nordic region. Nordic Council of Minister; p. 75.

Weiss, J., & Sarro, M. (2013). *The importance of long-term contracting for facilitating renewable energy project development* Retrieved from http://www.brattle.co.uk/system/publications/pdfs/000/004/927/original/The_Importance_of_Long-Term_Contracting_for_Facilitating_Renewable_Energy_Project_Development_Weiss_Sarro_May_7_2013.pdf?1380317003

Weisser, D. (2004). Power sector reform in small Island developing states: What role for renewable energy technologies? *Renewable and Sustainable Energy Reviews*, *8*(2), 101–127.

Wentworth, L., & Makokera, C. G. (2015). Private sector participation in infrastructure for development. *South African Journal of International Affairs*, *22*(3), 325–341. https://doi.org/10.1080/10220461.2015.1081568

White, D. (2004). Government behind the wheel and backseat driving: Coordination and informational challenges of voluntary partnerships as programmes for stimulating sustainable technology. *Greener Management International*, *47*, 63–76.

Wiser, R. (1998). Financing investments in renewable energy: The impacts of policy design. *Renewable and Sustainable Energy Reviews*, *2*(4), 361–386.

Xu, Y., Chan, A. P. C. C., Xia, B., Qian, Q. K., Liu, Y., & Peng, Y. (2015). Critical risk factors affecting the implementation of PPP waste-to-energy projects in China. *Applied Energy*, *158*, 403–411. https://doi.org/10.1016/j.apenergy.2015.08.043

Yang, T., Long, R., Li, W., & Rehman, S. U. R. (2016). Innovative application of the public–private partnership model to the electric vehicle charging infrastructure in China. *Sustainability*, *8*(8), 738. https://doi.org/10.3390/su8080738

Yang, X., Zhang, J., Shen, G. Q., & Yan, Y. (2019). Incentives for green retrofits: An evolutionary game analysis on public-private-partnership reconstruction of buildings. *Journal of Cleaner Production*, *232*, 1076–1092. https://doi.org/10.1016/j.jclepro.2019.06.014

Zhang, M., Cui, Y., ter Avest, E., & van Dijk, M. P. (2018). Adoption of voluntary approach: Can voluntary approach generate collective impacts for China achieving ambitious energy efficiency targets? *Energy & Environment*, *29*(2), 281–299. https://doi.org/10.1177/0958305X17744491

Zhang, Z., & Maruyama, A. (2001). Towards a private–public synergy in financing climate change mitigation projects. *Energy Policy*, *29*(15), 1363–1378.

Zhu, R., & Sun, S. L. (2020). Fostering generative partnerships in an inclusive business model. *Sustainability (Switzerland)*, *12*(8), 1–20. https://doi.org/10.3390/SU12083230

How to cite this article: Pinilla-De La Cruz, G. A., Rabetino, R., & Kantola, J. (2022). Unveiling the shades of partnerships for the energy transition and sustainable development: Connecting public–private partnerships and emerging hybrid schemes. *Sustainable Development*, 1–17. https://doi.org/10.1002/sd.2288

APPENDIX A

SYSTEMATIC SEARCH AND SCREENING PROCESS

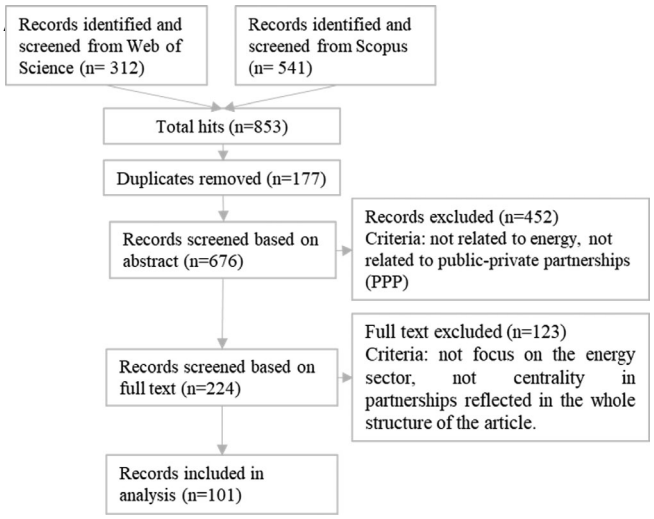


FIGURE A1 Systematic search and screening process. Adapted from Moher et al. (2009)

CODING PROCESS OF PUBLIC–PRIVATE PARTNERSHIP DEFINITIONS

TABLE B1 Example of coding process

Code	Text
Public assets-infrastructure and-or services	"delivering infrastructure or public services"
	"delivery of services or facilities for public use"
Legally binding contract	"Legally structured partnership"
	"Legally-binding contract"
Long-term	"long-term relationship"
	"long-term"

APPENDIX C

DATA STRUCTURE

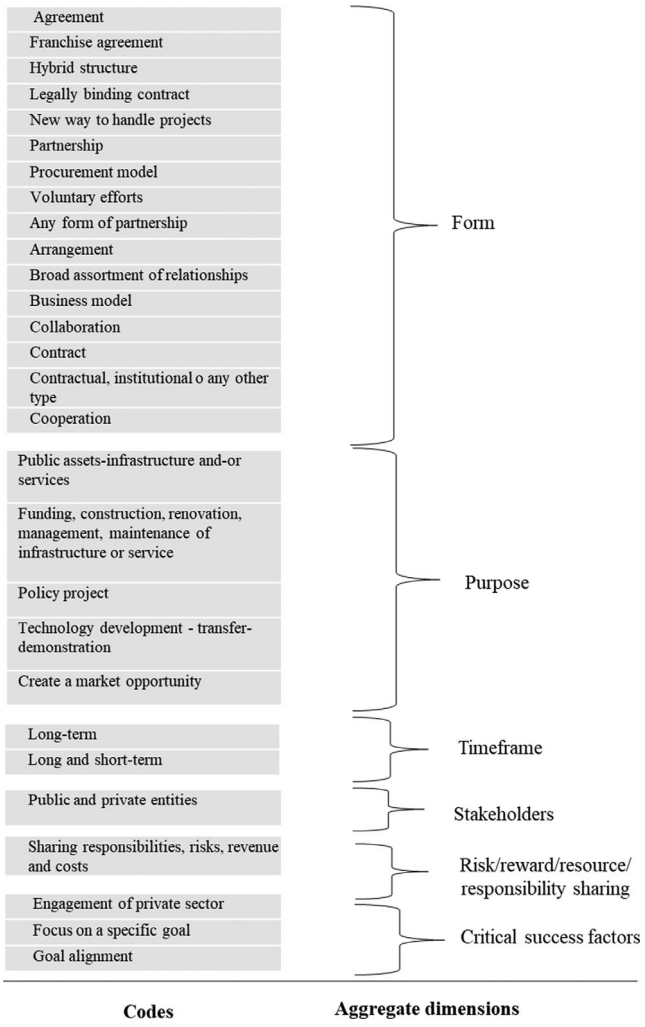


FIGURE C1 Data structure of public–private partnership definitions: From codes to aggregate dimensions

APPENDIX D

LIST OF STUDIES OF PUBLIC–PRIVATE PARTNERSHIP DEFINITIONS

TABLE D1 List of studies where public–private partnership definitions were identified

List of studies
Fleta-Asín and Muñoz (2021)
Raza et al. (2021)
Araquistain Portela (2020)
Sheng et al. (2020)
Panteli et al. (2020)
Bai and Zhang (2020)
Wang et al. (2020)
Ahmad and Raza (2020)
Koengkan (2020)
Martiniello et al. (2020)
Khan et al. (2020)
Shahbaz et al. (2020)
Gao and Zhao (2020)
Di Liddo et al. (2019)
Fang et al. (2019)
Wang and Zhang (2019)
Tang et al. (2019)
Saadeh et al. (2019)
Rossi et al. (2019)
Lugaric et al. (2019)
Cui et al. (2019)
Muleya et al. (2019)
Tobey and McGinnis (2018)
Wang and Zhang (2018)
Jensen and Dowlatabadi (2018)
Gao and Zhao (2018)
Liu and Wei (2018)
Carbonara and Pellegrino (2018)
Wang and Ke (2018)
Nel (2018)
Stritzke (2015)
Akcay et al. (2017)
Rehman et al. (2017)
Arbulú et al. (2017)
Owusu-Manu et al. (2017)
Somma and Rubino (2016)
Heldeweg et al. (2015)
Xu et al. (2015)
Fecondo and Moca (2015)
Copiello (2015)
Wentworth and Makokera (2015)
Fantozzi et al. (2014)
Sovacool (2013)
Jumbe and Mkondiwa (2013)
Benkovic et al. (2013)
Chaurey et al. (2012)
Martins et al. (2011)
Dinica (2008b)
Lukamba-Muhlya and Uken (2006)