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PARADIGMS FOR THE FORMATION OF EFFECTIVE MECHANISMS OF PUBLIC-PRIVATE PARTNERSHIP AND THE ROLE OF BUSINESS STRUCTURES IN THE RENEWABLE ENERGY SECTOR

Abstract. The article shows how public-private partnerships (PPPs) in renewable energy provide a chance for the public and private sectors to combine resources and share risks in order to finish utility-scale projects that would not otherwise be possible. PPPs are not fully utilized in Ukraine, although being documented in other nations. The relevance of this study is determined by the need to expand renewable energy technologies as a foundation for sustainable economic development. This article analyzes the role of public-private partnerships (PPPs) in the development of renewable energy and focuses on the interaction of public and private efforts to accelerate the transition to sustainable energy. Using narrative review methodology, it is shown that improving public-private partnership (PPP) mechanisms can stimulate the development of entrepreneurial structures in the renewable energy sector by combining public and private resources to implement projects, sharing risks, and accelerating their implementation. The main results of the study are the deterministic features of the development of PPP projects in the field of renewable energy sources, the systematization of the main models and mechanisms for the implementation of PPP in the field of renewable energy. The study also shows how factors like profitability, risk reduction, and advantageous policy frameworks motivate private sector involvement. Low-carbon, climate-resilient partnerships use more innovative strategies, include more stakeholders, exhibit different risk allocations, and focus more on social acceptance than more conventional PPP models. Based on agency theory paradigm, the article presents multi-stage risk allocation framework for PPPs, which is recommended for application, in particular, in Ukraine under the conditions of war-related critical damages of infrastructure.

Keywords: *Green Energy, Agency Theory, Public-Private Partnership, Entrepreneurship, Renewable Energy, Innovation, Stakeholders.*

JEL Classification: L5; O2; Q2; Q4.

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Introduction. A continuous funding gap that indicates a global misallocation of resources is revealed by the slow progress in matching financial flows with the uptake of clean technology. In order to overcome this obstacle, strong policies and political leadership are required to combat the fears that prevent financial flows from being redirected. Active development of public-private partnerships (PPPs) is one of the most important policies because it allows governments to draw private sector investment in public infrastructure services, either supplementing public resources or freeing them up for other public purposes. Additionally, they enable governments to provide public services that have historically been provided by the public sector by leveraging the effectiveness and knowledge of the private sector. PPPs are being used more and more globally to provide low-carbon, climate-resilient (LCCR) infrastructure and other climate mitigation and adaptation activities. Public-private partnerships are now regarded as a crucial tool for diversifying the world's energy supplies while guaranteeing safe, economical, and sustainable energy access (Casady et al., 2024).

The capacity to combine resources and knowledge is PPPs' main benefit. Private businesses contribute finance, creativity, and technology, while governments offer land access, legislative incentives, and regulatory support. When they work together, they can get over the logistical and financial obstacles that frequently prevent large-scale renewable energy projects from being developed.

PPPs can be an alternative source of funding for infrastructure projects for local governments, and they can give the public sector a way to use the knowledge, creativity, and funding of the private sector to develop and run renewable energy projects. However, not all governments have PPPs directly integrated into policymaking. PPPs can lead to a more effective use of the government's budget and lessen the financial strain on the public sector.

Due to their lengthy payback periods and high initial investment costs, renewable energy projects frequently carry substantial financial risks. PPPs reduce financial costs for both the public and private sectors by enabling risk-sharing. While the public sector partner maintains ownership of the assets and offers specific services like land acquisition, regulatory oversight, and/or performance guarantees, among other things, the private sector partner is usually in charge of the risks associated with designing,

building, financing, operating, and/or maintaining the project. PPPs can assist guarantee the project's successful completion by dividing the project's risks between the public and private sectors. Innovation and state-of-the-art technologies are brought into PPPs by the private sector. When it comes to technological developments in renewable energy, the private sector frequently leads the way (Mundonde & Makoni, 2025). This technology can be transferred and used in large-scale projects thanks to partnerships through PPPs. By generating employment opportunities, assisting regional businesses, and enhancing infrastructure in the areas where renewable energy projects are carried out, PPPs can help promote local economic growth. The combined resources and dedication of the parties involved in PPPs can guarantee the viability and continuation of renewable energy projects beyond short-term objectives, since these projects usually have long-term effects on the environment and the economy.

Overall, PPPs in the field of renewable energy help achieve a number of Sustainable Development Goals (SDGs): SDG 7 (Assure access to affordable, dependable, sustainable, and modern energy); SDG 9 (Build resilient infrastructure, promote sustainable industrialization, and foster innovation); SDG 11 (Make cities inclusive, safe, resilient, and sustainable); SDG 13 (Take urgent action to combat climate change and its effects); and SDG 17 (Revitalize the global partnership for sustainable development).

For war-affected countries, effective PPP in renewable energy sector is especially important. In particular, the scale of the destruction of the energy sector in Ukraine during the Russian-Ukrainian war, including renewable energy, requires a comprehensive approach to the restoration of energy infrastructure. The priority tasks are to attract international financial and technical assistance, introduce innovative technologies, modernize the energy system and create sustainable infrastructure solutions that will meet modern energy security requirements. The renewable energy sector in Ukraine is characterized by high potential for further development. The country has a significant number of qualified specialists who have deep knowledge and competence in the relevant field. In addition, the geographical features of Ukraine provide favorable conditions for the large-scale implementation and effective use of renewable energy sources, which helps to maximize their benefits. Therefore, the search for effective models of organization

and implementation of relevant projects, in particular on the basis of PPP, is one of the priority tasks of today. Within this task, the article aims to summarize, outline, and conceptualize the contemporary patterns of entrepreneurial structures' role and functions in PPP within renewable energy sector. This aim, in particular, implies deep analysis of risk sharing and innovation acceleration in such PPP. The object of study is PPP in the sector of renewable energy in the international perspectives. The subject of study is the landscape of business' role and implications.

Literature Review. The function and breadth of PPPs to assist the shift toward cleaner technologies and sustainable development have been greatly expanded by the energy transition and the expansion of linked energy systems, according to numerous academics (Chen et al., 2019; De Carvalho, 2018). Understanding the energy transition's multifaceted nature is essential to comprehending the social and economic ramifications of this phenomenon as well as the necessary shift in actor collaboration brought about by technical reconfigurations (Smith & High, 2017; Thomas et al., 2018). It entails the shift to more sustainable energy resource access and utilization systems (Sanderink, 2020), including the investigation of the circular economy, industrial ecology, ecological economy, and political ecology (Di Liddo et al., 2019).

Fleta-Asin and Munoz (2021) examine PPPs for renewable energy in developing nations in relation to the factors that influence private investment. Examine a large sample of 1,371 PPPs from 63 developing nations between 1997 and 2016. The results, which were obtained using a Tobit estimate technique, demonstrate a higher level of private investor participation in PPPs that are smaller, younger, where the private partner has more responsibility, and where the primary revenue source is the payments made by energy customers. Additionally, the appeal of private investment is substantially impacted by improved institutional and economic settings. The engagement of private investors in renewable energy PPPs is positively impacted by the backing of multilateral development banks (MDBs), and this effect becomes more significant when the institutional and economic frameworks are weaker, according to other intriguing findings.

The importance of PPPs in developing sustainable energy infrastructure in Nigeria

and the United States is examined by Ugwu et al. (2024). The results show that PPPs, which are joint ventures between public and private organizations, have played a significant role in the advancement of renewable energy projects in the United States, including wind farms and solar installations. These collaborations take advantage of government incentives, such grants and tax credits, to draw in private capital and promote the development of renewable energy technologies. Furthermore, PPPs in the US frequently entail long-term agreements that give private investors security and certainty, making it easier to finance and carry out big projects. PPPs present a viable way to meet Nigeria's expanding energy needs while switching to greener sources, where energy access is still a major obstacle. In order to raise private funds and expertise for the construction of renewable energy infrastructure, the Nigerian government has been aggressively pushing PPPs in the energy sector. These collaborations seek to increase energy access in marginalized and rural areas, diversify Nigeria's energy mix, and lessen reliance on fossil fuels. The government aims to remove institutional and financial obstacles that have historically impeded the development of clean energy infrastructure by collaborating with private investors. PPPs in both nations confront a number of difficulties despite their potential advantages, such as complicated regulations, political concerns, and problems with project funding. In the US, investor confidence and project feasibility may be impacted by ambiguities around laws and regulations. Similar to this, in Nigeria, PPP implementation may be hampered by elements like bureaucracy, corruption, and weak legal frameworks. The authors stress that in order to address these issues and establish a conducive environment for sustainable investments in clean energy, governments, business sector stakeholders, and civil society must work together.

Analyzing the role of business in renewable energy PPPs, the findings presented in literature can be summarized as follows (see Table 1).

According to Hossin et al. (2024), a persistent funding gap is revealed by the slow progress in matching financial flows with the adoption of clean technology, indicating a global misallocation of resources. In order to overcome this obstacle, strong policies and political leadership are required to combat the fears that prevent financial flows from being redirected. The study examines how macroenvironmental factors and

Table 1. Key roles of the private sector in renewable energy PPPs

Role	Details
Investment and finance	Businesses supply the initial funding and investment required for initiatives, which is frequently more than governments can afford
Innovation and technology	Private businesses provide state-of-the-art technology and creative solutions for the effective development and management of renewable energy projects
Project execution	Projects are designed, built, operated, and maintained by the private sector, which uses its experience to guarantee their successful completion
Mitigation of risks	PPPs make large-scale infrastructure projects more financially feasible by allowing private businesses to share the risks with the government
Operational efficiency	Private businesses can boost project operational effectiveness and spur industry innovation
Market creation	Businesses can contribute to the development of a stable market for renewable energy through programs like corporate power purchase agreements, which stimulate additional investment

Source: compiled by the authors based on Chunling et al. (2021), Adebayo (2022)

energy-related public-private partnership investments (PPPIE) affect the achievement of Sustainable Development Goal 7 (SDG7) in member nations of the Association of Southeast Asian Nations (ASEAN) between 1999 and 2021. The findings show that, although not statistically significant, a ten-year exogenous shock to the GDP growth rate initially results in a brief drop in both GDP and PPPIE. Over time, though, the shock becomes statistically significant and is associated with a drop in the GDP growth rate. This highlights the detrimental effects of outside variables, like as the COVID-19 epidemic, on the economic expansion of ASEAN member nations. In particular, the GDP growth rate decreases by 8.3% with every percentage increase in PPPIE, indicating a negative and unsustainable effect on the economy. This shows that energy investments are largely unsustainable and have a negative effect on economic growth in the ASEAN region. Furthermore, the region's progress toward achieving SDG7's clean energy targets by 2030 has been significantly hampered by these energy investments, which have contributed to a notable 52.6% increase in greenhouse gas emissions. This implies that the region's aims for sustainable clean energy are not in line with the current situation of PPPIE. In order to improve sustainable clean energy, Hossin et al. (2024) suggest diversifying energy sources and investment tactics. In order to better connect frameworks for private sector involvement with long-term economic sustainability goals, policymakers and researchers should also review the terms and circumstances of PPPIE.

Among Ukrainian authors, the scientific and theoretical foundations of public-private

partnership in the renewable energy sector are considered, in particular, by Mammedov (2025). The author analyzes the advantages of public-private partnership, which will allow Ukraine to reduce the burden on the economy and at the same time create healthy competition for the renewable energy sector, represented by renewable energy sources (RES). Such cooperation is beneficial for both parties, as it will allow the private partner to enter those sectors of infrastructure and other services where the state previously dominated.

Another Ukrainian researcher, H. Kryshstal (2025), notes that Ukraine has great potential for attracting private investment in energy projects through joint ventures, public-private partnerships, and consortia. The author claims that PPP model allows reducing risks by providing financing and support from both the state and private investors. In addition, it is important to introduce new financial instruments for risk management, in particular, through insurance of energy projects against force majeure circumstances, such as changes in legislation or natural disasters, as well as hedging currency risks for the stability of financial flows.

Also, Vovk (2024) in her article highlights the main principles of PPP design for the implementation of projects in the field of energy efficiency and waste-free production. The author presented the developed mechanism for PPP realization in the field of implementing waste-free technologies for biofuel production in Ukraine, and also systematized the factors that are necessary to ensure the successful implementation of these projects. The article also suggests mechanisms for state

stimulation of PPP development in the field of implementing waste-free technologies for biofuel production.

Meanwhile, the discourse of PPP in renewable energy sector is quite scattered and predominantly implies case-base approach, to the detriment of fundamentality and theoretical reasoning.

Research Methodology. The research is based on narrative review methodology. The choice of research tool is based on the fact that narrative reviews align with subjectivist and interpretivist paradigms. These worldviews emphasize that reality is subjective and dynamic, which is namely the case for today renewable (green) energy sector. Narrative reviews are useful in particular for domains that require a meaningful synthesis of research evidence which may be complex or broad, implying detailed, nuanced description and interpretation (Sukhera, 2022).

The search for entries to be included in the sample of literature sources for review was carried out in scientometric databases (libraries) ResearchGate, ScienceDirect, MDPI, Tandfonline, as well as through direct searching in Google search platform. Overall procedure of sampling was organized based on standard PRISMA protocol (see Fig. 1).

Main results

PPPs as drivers of renewable energy

development

The shift to renewable energy sources has become a global concern as the globe struggles to reach lofty environmental objectives and deals with the effects of climate change. The large-scale deployment of renewable energy infrastructure, technologies, and innovation has been made possible by public-private partnerships, which have emerged as a crucial driver in this transition. PPPs have the potential to significantly accelerate the transition to greener energy while tackling issues like financing, technology uptake, and regulatory frameworks by utilizing the assets of both sectors.

The theoretical studies and practice outline how PPPs drive renewable energy development (Carbonara & Pellegrino, 2020; Endo et al., 2022):

1. Financing and Risk Sharing: The initial expense of constructing infrastructure is one of the biggest obstacles to the development of renewable energy. Before they can start making money, solar farms, wind turbines, and other renewable energy projects need a sizable initial investment. Governments and private businesses can split the financial risks and benefits through PPPs. While private businesses contribute investment cash and management experience for large-scale energy projects, governments may

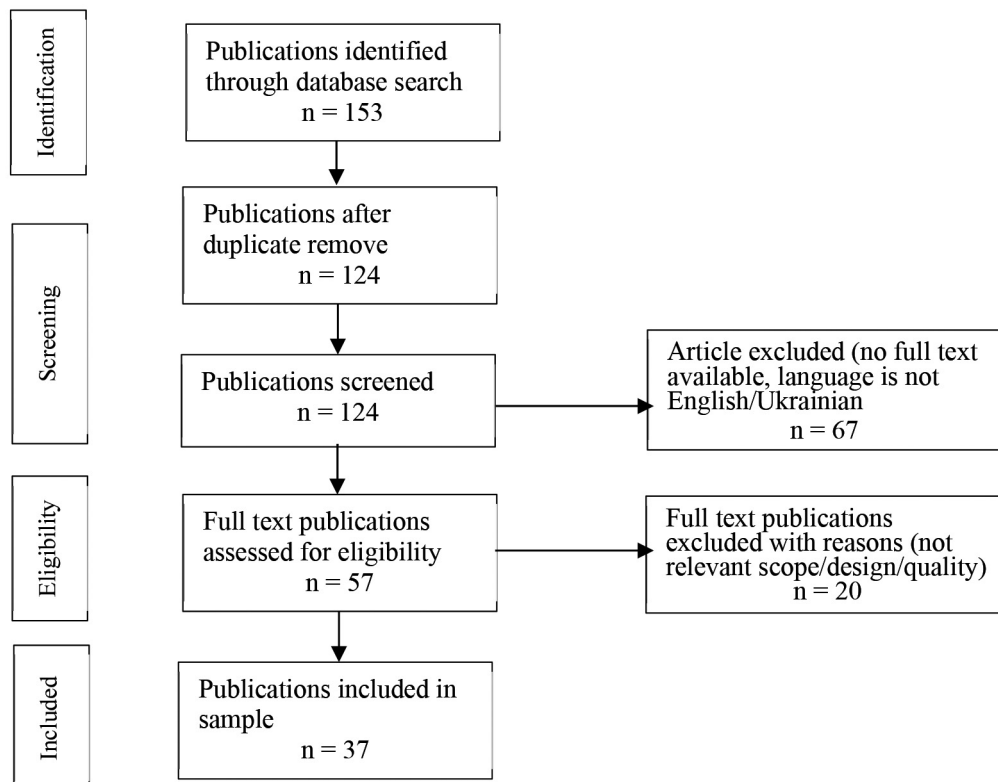


Fig. 1. PRISMA Flow Diagram for the Study

Table 2. Hybrid public–private partnerships for the energy transition (Owojori & Erasmus, 2025)

Pattern	Example	Essence
Energy security	IPP independent power producer	Infrastructure initiatives of the next generation are its main focus. Although IPP is the name given to private energy producers, it is also acknowledged as a hybrid partnership program. The public authority does not have direct or indirect control over the private company in this hybrid form, and IPPs do not offer services on behalf of the public authority
	PPA power purchase agreements	It is a contractual arrangement between the private IPP and the state electrical companies that is often focused on a long-term partnership
	Environmental partnerships	The primary objective is to ensure environmental quality while also serving as a supplementary energy supply method, such as waste-to-energy initiatives
	Private–private partnerships	Type of cooperation in locations where the energy transition has not yet resulted in complete regulation. Private businesses like biogas suppliers, energy firms, and network operators in the Netherlands are one example. They may initially seem like private partnerships, but after a thorough examination of official documents, they should be classified as “hybrids” or a “particular type of PPP” since they adhere to the principles of energy governance and are regulated by the laws governing the provision of public services
Energy efficiency	ESCO Energy Service Company, ESPC Energy Saving Performance Contract, EPC Energy Performance Contract	Energy efficiency initiatives, such as energy audits, energy savings, and technology upgrade projects, are frequently implemented in the European market using the EPC. In essence, this plan seeks a long-term partnership. A private business, usually an energy services company (ESCO), organizes EPCs. One kind of structure utilized in PPP projects pertaining to energy efficiency, renovation, or upgrading is the energy-saving performance contract (ESPC).
	TES thermal energy services	In this case, public energy service providers collaborate with an organization or business to enhance heating systems by acting as energy suppliers. For instance, British Columbia school districts own a large number of TES in infrastructures
	PPP-BR green renovations	PPP-BR seeks to rebuild current building infrastructure in order to meet green standards and quality, including enhanced energy savings and decreased emissions and waste
	City-level partnerships	Partnerships at the city level concentrate on projects pertaining to sustainable technologies and energy efficienc.
	VA Voluntary agreements	VA seeks to attain energy efficiency in a flexible and economical manner. VAs are usually bottom-up strategies that mobilize potential energy savings that would be challenging to accomplish with conventional command-and-control strategies. In order to establish specific energy-saving goals, the government and private businesses or trade associations negotiate. By signing a “non-mandatory type of VA”, the parties enter into a relationship.
Energy access	5Ps pro-poor PPPs	The goal of 5Ps is to give distant populations access to electricity. Communities, including government agencies, private businesses, multilateral development banks, microfinance institutions, service providers, energy companies, non-profits, academic institutions, research, and members of civil society, are not only beneficiaries in this situation but also stakeholders. These initiatives include creative and sustainable business ideas to promote the adoption of clean technologies, even though they are mostly reliant on public or private subsidies
Energy technology development	Technology development partnerships	Partnerships between academic institutions, government agencies, and private businesses to do technical research on energy efficiency, financial models, intellectual property, and all elements of implementing technology in a particular setting
	Voluntary technology development	Through cooperation amongst organizations engaged in the same subject, these programs aim to achieve technological innovation, such as the development of clean technology. Decentralized decision-making techniques are frequently used in these cooperative projects
Promoting and supporting energy initiatives	Deliberative partnerships	Civil, commercial, and governmental stakeholders collaborate on issues pertaining to regional needs, like implementing cleaner energy technology
Type II partnerships	Multi-stakeholders partnerships	The magnitude, functions, context, structure, funding, and efficacy of this plan might all differ. The renewable energy and energy-efficiency partnership (REEEP) is one of the best examples. This program was established in 2002 to support energy-efficiency and sustainable energy initiatives created by small and medium-sized businesses in developing nations and emerging markets. Over 300 representatives from public and private organizations participate in REEEP (Sanderink, 2020). The finance system for initiatives backed by private donors is supported by national governments and donations
	Global partnerships	voluntary efforts to address issues like energy and sustainability objectives. The United Nations Environment Program (UNEP) partnerships are used by Otsuka and Cheng (2020) as an illustration of international collaborations

provide tax breaks, grants, or subsidies.

This partnership lessens the financial strain on both industries and increases investor interest in renewable energy projects. Additionally, it makes it possible for initiatives to obtain steady, long-term funding, guaranteeing their long-term viability.

2. Legislative and Regulatory Support: Governments are crucial in establishing the legal and legislative frameworks that direct the advancement of renewable energy. By enacting policies that encourage the deployment of renewable energy, such as feed-in tariffs, renewable portfolio standards, or carbon pricing systems, governments can use PPPs to establish advantageous conditions for private sector participation.

Together, the public and private sectors can make sure that market realities are reflected in regulatory frameworks, which would expedite approval procedures and lower bureaucratic obstacles. This cooperation guarantees that renewable projects can go more effectively from conception to implementation.

3. Technology and Innovation: When it comes to technological innovation, especially in renewable energy technologies, the private sector frequently leads the way. Private businesses propel the technological developments that increase the efficiency and affordability of renewable energy sources, from sophisticated solar photovoltaic cells to innovative wind turbine designs.

By supplying the required infrastructure, such as transmission lines and grid integration solutions, governments can aid in the development of these technologies through PPPs. In exchange, the private sector provides the innovation required to optimize renewable energy systems' output. More sophisticated, scalable, and sustainable energy solutions that can be duplicated in different locations are the result of this partnership.

4. Job Creation and Economic Growth: PPPs for renewable energy development help to boost the economy by producing jobs in construction, engineering, and technology. As large-scale renewable energy projects gain traction, they create job opportunities in local areas, promoting economic development and contributing to national sustainability goals.

PPPs also allow for the transfer of skills and expertise from the private to the public sectors, which improves governments' overall ability to manage renewable energy infrastructure. This has long-term implications, particularly in emerging nations where the development of local renewable energy knowledge can increase economic stability.

There is already a broad range of successful case studies of PPPs in renewable energy, some of them we present below.

Morocco's Ouarzazate Solar Power Station (Noor). The Noor project in Morocco, one of the world's largest solar power facilities, is an excellent example of a public-private partnership. The Moroccan government collaborated with private investors to build this gigantic solar energy complex, which is estimated to generate enough electricity to power more than one million people. The project got financial support from both the public and private sectors, including the World Bank and the African Development Bank, demonstrating how public-private partnerships can generate funds for large-scale renewables projects.

India's national solar mission. In India, the National Solar Mission has accelerated solar energy expansion through public-private partnerships. The government works with private solar enterprises to accomplish aggressive solar energy generation targets. This project provides legislative incentives, such as solar power purchase agreements, while the private sector builds and manages solar farms. As a result, India now has one of the world's largest solar markets, which will help the country meet its renewable energy ambitions.

United States Offshore Wind Projects. In the United States, multiple offshore wind projects have been constructed via PPPs. State governments, along with private energy corporations, have invested in wind farms around the East Coast. Public incentives, such as tax credits and subsidies, as well as private investment in technology and infrastructure, help to fund these projects. Offshore wind is a rising sector in the United States, adding to the country's renewable energy portfolio.

Core concerns and context of energy transition

One of the most significant impediments to financing renewable energy projects is market risk. This frequently results in either the project failing or a prolonged negotiating period until the government persuades the private sector to invest in the project (Li & Wang, 2023). Odhiambo et al. (2020) conducted a survey and interviews with Kenya Electricity Generating Company Limited (Kengen) staff to explore the impact of market risks on the performance of PPP renewable energy projects in Kenya. The survey examined the impact of price volatility, demand, monopoly, and government

subsidies on the performance of renewable energy PPP projects, and found a substantial association between market risks and project performance. However, price volatility has no substantial impact on performance because PPP projects are protected against price fluctuations. Furthermore, the findings show that demand risks have a detrimental impact on PPP projects, which are typically on-demand because the private sector prefers these types of projects. Thus, understanding of risk considerations by both the public and private sectors is a critical factor in the successful implementation of PPP projects. To guarantee the effective execution of PPP renewable energy projects, this study would need to be repeated in various nations in order to comprehend and measure the impact of the market risks in these particular markets, as the impact of market risk factors varies across nations (Othman & Khallaf, 2022).

The public and business sectors must be committed to and cooperate in the shift to cleaner energy technology and sustainable development. Public-private partnerships (PPPs) are one type of collaboration that refers to the convergence and complementarity between public and private actors. PPPs are an organizational arrangement for addressing strategic sustainability challenges, like lowering carbon emissions, and they have a significant impact on the sector's transformation following energy reforms. PPP systems' inflexibility makes it difficult to adjust to the demands of sustainability and the energy transition. Consequently, PPPs have given rise to a number of hybrid systems (La Cruz et al., 2022).

Despite the lack of a distinct distinction between PPPs and hybrid PPPs, current alternatives can nevertheless be summed up (see Table 2).

The five types of hybrid PPPs can be used to achieve energy transition objectives, as shown in Figure 2. Hybrid PPPs can arise for a variety of reasons. For instance, international gatherings like the Johannesburg Conference in 2002 gave rise to the so-called Type II partnerships as a means of achieving Agenda 21 (Fabre & Straub, 2021). Type II partnerships are international collaborations that offer financial or regulatory assistance for projects focused on energy transition and sustainable development (Sanderink, 2020).

Agency theory' view angle

Strong statistical data demonstrating a favorable correlation between PPP funding structure and the completion of geothermal

energy development projects in Kenya is presented by Olando et al. (2024). The results imply that the probability of a quicker project completion rises with PPP engagement. The study also shows that the completion of geothermal energy development projects is significantly impacted by a balanced PPP finance structure. The analysis shows that a hybrid PPP financing structure with suggested ratios of grants, commercial and concessional loans, hybrid finance, and private and government equity has a substantial impact on project completion results.

When it comes to green energy investment decisions, cooperation between private and public actors is often crucial because it allows the parties to share risk and compensate each other for their respective advantages. The public sector requires capital investment and management expertise, while the private sector needs guarantees to face the policy and financing risks entailed by the time gap between a project's planning phase and its actual implementation.

In the meantime, political unrest deters private sector investment in PPP projects and raises doubts about their viability. High political stability, on the other hand, results in less risks and a better climate to draw in the private sector; lastly, laws and regulations are crucial to the success of PPP projects including renewable energy.

Furthermore, since agency theory examines possible conflicts of interest between the public sector (principal) and the private sector (agent) as a result of variables like divergent objectives, information asymmetry, and risk aversion, some academics particularly stress the applicability of agency theory to green energy PPPs (Tipu & Yousaf, 2022). In order to reconcile the agent's self-interest with the principal's public interest objectives, agency theory proposes solutions like performance-based contracts, incentive systems, and more monitoring. However, these conflicts may result in less than ideal outcomes.

Diverse scholars have examined agency theory from various angles in various principal-agent interaction settings. In this sense, a number of links have been proposed and confirmed in many fields (Rose, 2019). The use of agency theory in public-private partnership projects is contingent upon the type of relationship or coordination between partners, which is directly tied to the success of the project. The nature of the relationship between the principal and agents is described

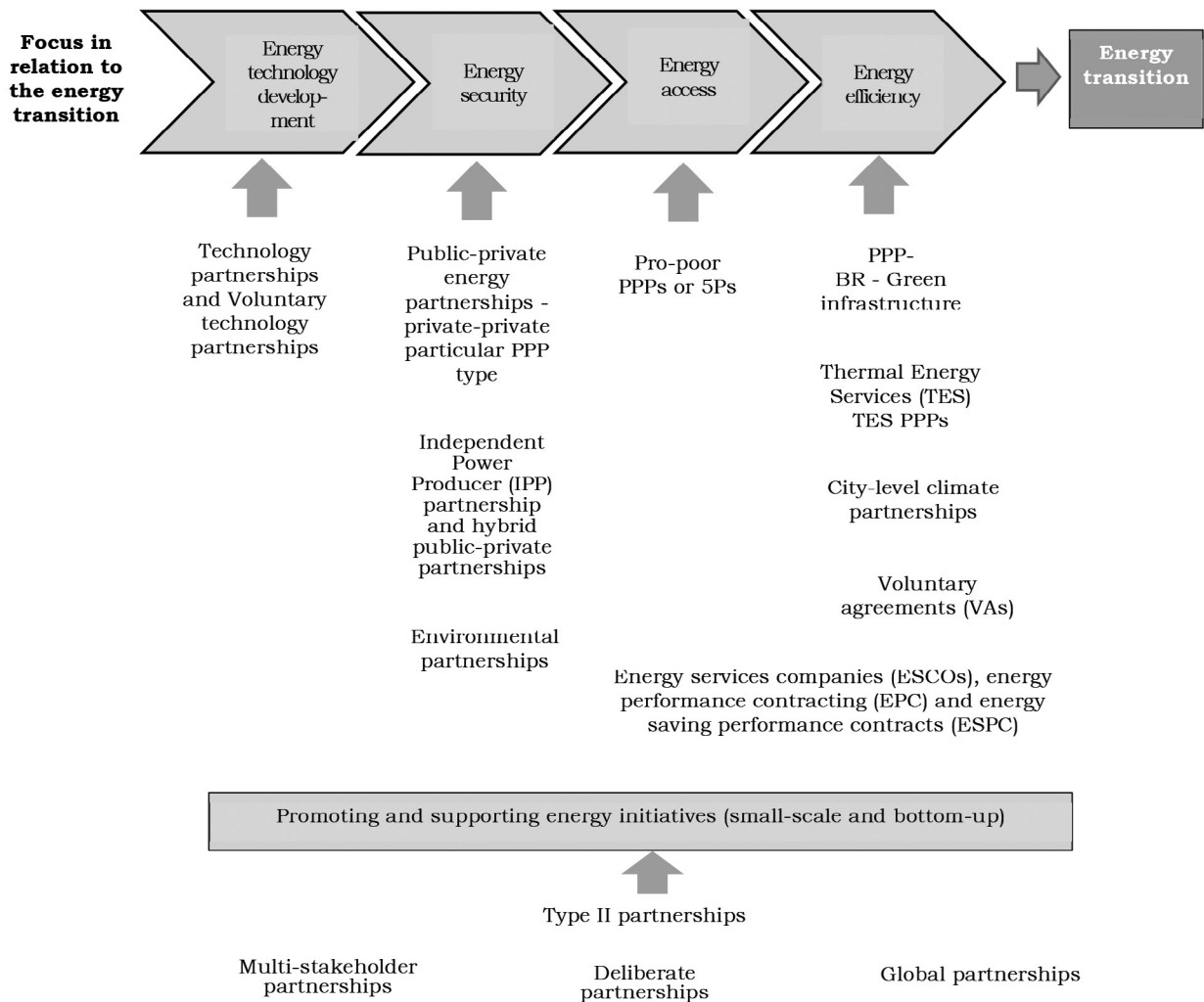


Fig. 2. Articulation of hybrid public-private partnerships to achieve the energy transition (La Cruz et al., 2022)

by the coordinating arrangements between partners (see Fig. 3).

Conflicting partner interests, the notion of rationality in taking specific actions, asymmetric information, uncertainty, and risk management are some of the assumptions that agency theory addresses in relation to agency difficulties. Because various collaborators have varied orientations and levels of understanding, achieving mutuality across partners is particularly challenging (Liu et al., 2015). A highly helpful framework for identifying problems that can have a big impact on relationships and revealing their consequences is provided by agency theory. The key elements include the project members' different risk attitudes about complexity and uncertainty, as well as the designation of goals for which they have developed a partnership. Therefore, by addressing uncertainty with appropriate risk management techniques, agency theory is utilized to address the questions that can promote a cooperative

connection among the parties. The agency issues in PPP relationships, particularly the uncertainty component, are rarely discussed (Smith et al., 2018). In order to propose a solution to the application problem while keeping in mind the agency theory, it is evident that the agency problem that is, uncertainty, asymmetric information, and risk management must be evaluated (Cheng et al., 2021).

Applying a stakeholder approach and allocating risks competently are two of the vectors in this situation. Specifically, a paradigm for risk allocation in public-private partnership (PPP) projects is proposed in the paper by Shrestha et al. (2019). As stated by the principal-agent theory (PAT), it contributes by identifying and incorporating risks brought forth by project stakeholders. The framework evaluates risks and directs them to the parties most qualified to lessen their influence on the project. A thirteen-step procedure makes this risk allocation easier. This study's practical

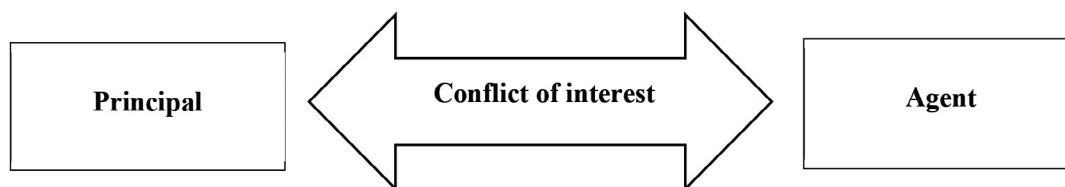


Fig. 3. Agency theory (Clark & Hakim, 2019)

usefulness is that it provides a clear, methodical approach to effectively assigning risk to the project's government and private industry stakeholders. By doing this, risk mitigation can be anticipated to improve project performance, maximize stakeholder objectives, and strengthen sustainability goals, such as increased social and community benefits and enhanced operational life-cycle efficiency.

Risk allocation framework

PPP contracts frequently leave risks to the party least equipped to manage them because they assign them to the party least able to refuse them. PPP success is still significantly hampered by this misallocation of risk (Lai et al., 2020). A number of studies looking at effective risk allocation techniques have been prompted by awareness of this issue. Thirteen models for risk allocation in PPPs are identified by Ameyaw and Chan (2016). In essence, these risk allocation models aim to strike a balance between the levels of success that PPP projects can provide for both the public and private sectors. Ameyaw and Chan (2016) describe "efficient risk allocation" as allocating risks to parties according to their capacity for risk management, drawing on contract theory. PPPs are a low-cost tool used by governments to maximize social welfare and advance economic growth (Yu et al., 2018). However, private companies will not prioritize these objectives. Instead, since they are driven by profit, it is reasonable to assume that they will prioritize efficiency over efficacy. They usually try to decrease expenditures, which can lead to compromised results (Fouad et al., 2021). The problem with PPP project procurement is that, although private involvement reduces the cost burdens on the procurer, it also gives the private partner considerable control over the project, encouraging actions that divert benefits to the project contractor at the expense of the procurer, whose interests they are meant to represent. Shrestha et al. (2019) suggested a suitable approach for risk distribution in light of this. The established framework is shown

in Figure 4 utilizing a methodical approach. It makes clear how effective risk allocation is determined. The framework directs the process of allocating risk to one party or dividing it among the parties. An effective distribution of project risk is the result.

The framework's first step lays out the standards for judging whether the private sector can affect the degree of risk. The person with the power to control a risk will also be able to stop or lessen its detrimental effects. Controlling the risk before it materializes is consistent with the party's capacity to lessen the danger's likelihood and intensity. This is especially true for endogenous risks. With these risks, the risk-bearing party can take preventative action before the risk materializes, either completely eliminating the risk or at least lowering its likelihood of happening. However, an audit of the risk bearer's capacity to take appropriate measures to lessen the risk impact is crucial to the assessment. Both endogenous and exogenous hazards can be reduced. This can be accomplished by having backup or contingency plans in addition to appropriate risk management strategy. For instance, mitigation solutions for external risks like inflation can involve fixed price contracting, indexing revenues to inflation, and other tactics that lessen the possible effects.

The framework's second step emphasizes information. Information is required for a party to understand the risks and create a successful risk management strategy. Effective risk management depends on estimating the likelihood of risks and projecting the harm they could cause. Information will also affect a party's capacity to manage risks. As a result, an evaluation is required to verify that the private sector possesses the required data. In this case, information sharing between the parties is necessary, and the government will have information relevant to the private party since it is the project's custodian. The government may really be better informed about certain endogenous risks, such as regulatory changes, procedures, permissions,

and land acquisition, even though the private sector's superiority in this regard is assumed. To help with a better risk assessment, prospective bidders may also be given more information about the project before it is put out to bid.

The framework outlines the requirements for rewards in steps three and four. This need to be a crucial factor in evaluating risk distribution. The private sector should only be given risks if they have the motivation to handle them. Therefore, Step 4 evaluates whether the government can offer the private sector incentives to manage risk, whereas Step 3 examines if the private sector has (and will continue to have) the motive to do so.

The framework's fifth step takes control into account and emphasizes the private sector's capacity to absorb the risk's effects. The project will probably struggle and the risks will be returned to the government when the private sector is unable to handle the consequences. This may be especially true for exogenous risks, when control rests on the private sector's capacity to withstand the effects of the risks without going bankrupt. Larger-scale PPP project failures create social 'hazards', thus governments need to choose a private business that can effectively manage those risks. This is a crucial step in reducing the issue of adverse selection. Better information signaling from bidders that assess the potential agents' capacity for risk management is made possible by good tendering procedures along with robust and open competition. According to Mazher et al. (2022), project businesses can distribute the expense of exogenous risk among a variety of projects and/or shareholders.

Step 6 looks into control once again by defining standards for the private sector's capacity to shift risks to third parties; these standards are closely related to Posner and Rosenfield's superior risk bearer theory and Abrahamson's concept. Therefore, an assessment is required to ascertain if the private sector can transfer these risks to third parties when it is clear that the private sector cannot bear the repercussions of a particular risk. Through closed contracts with contractors and operators for building and operation risks, the project business transfers a large number of endogenous risks to third parties (Fouad et al., 2021). Third-party insurance covers some external risks. Transferring both exogenous and endogenous risks to third parties is a crucial risk mitigation strategy for the private sector, and their capacity to do so depends on their

project experience as well as their familiarity with and comprehension of hazards. Once more, determining this capacity of the private sector may depend on ex-ante competition.

Step 7 focuses on the government's capacity to gather data about whether or not the private sector effectively manages the risks allocated to them throughout the project's ex-post phases. Because it focuses on minimizing information asymmetry, this stage is crucial. The government must get proof of the risks' management (or lack thereof) even in cases where all the aforementioned requirements are satisfied. If this isn't done, allocating risks to the private sector won't be effective.

Step 8 deals with private sector risk mitigation. The framework focuses on how the private sector reduces the risks that are assigned to it. At this point, it is established that the private sector is the superior risk bearer. According to the superior risk bearer theory, the private sector may effectively reduce risks by either shifting risk to third parties or lowering the likelihood or severity of the hazards. The best approach to reduce risks can change based on the project's circumstances and the private sector's preferred method. Choosing the best risk mitigation strategy requires weighing the implementation's costs and effort against its advantages. However, as a means of offering incentives, governments can mandate that the private sector reduce (certain) risks in a predetermined way. This can be accomplished by third-party transfer, such as requiring insurance on certain risk items, or risk reduction, such as putting in place mechanisms that let governments approve decisions (such as choosing third-party contractors).

The framework's steps nine and ten evaluate whether the government has or can obtain the data required to mitigate the risks. Compared to businesses in the private sector, governments are more likely to be less knowledgeable about hazards. One crucial requirement for governments to be able to take on risks is having knowledge about the hazards that could materialize. Furthermore, it is crucial to comprehend the relationships between hazards because they are interconnected and the occurrence of one risk may trigger another.

Step 11 assesses the government's ability to pay for the risks' potential outcomes. The government is often thought to have more control over exogenous hazards, even though the private sector might be better adapted to handle endogenous risks. In the meantime, sharing the risk is the best course of action

when neither party has enough ability to control the risk (usually in the case of exogenous risks). Therefore, it is necessary for the two parties to discuss and share risks through a risk-sharing system.

The framework's Step 12 establishes the standards for the government's willingness to assume the risk. For private sectors participating in PPPs, the government's credibility in handling their portion of the risks is frequently questioned and seen as a significant problem. Given the prevalence of government opportunism in PPPs, the contract should guarantee government commitment through transparent risk-sharing procedures, unambiguous price adjustment formulas, trustworthy dispute resolution procedures, and, in some situations, call and put options.

Lastly, Step 13 takes into account risk sharing between the two parties. Depending on the risk situation and the contract's form, this might be done in equal or different amounts. However, choosing risk-sharing arrangements may once more require talks, leading to an unsettled distribution. Notably, there may have been a change in the parties' bargaining strength if the private sector has already been chosen when this framework is used. As a result, it may be important at this point to assign risks based on the data (pertaining to effective risk allocation) evaluated during the framework's earlier stages.

Such an approach seems to be expedient for application in Ukraine, with its two critical needs the urgent necessity of quick deployment of renewable energy facilities to provide energy to all regions of the country, in particular those with significantly damaged

energy infrastructure, and, on the other hand, unstable safety landscape, lack of detailed legislative support of PPP, as well as social and political risks. Public-private partnerships are a key lever in diversifying energy resources while ensuring secure, affordable and sustainable access to energy, and can become the base of Ukraine's sustainable post-war reconstruction.

Conclusion. Globally, public-private partnerships are becoming more and more important in promoting the growth of renewable energy. PPPs can solve the technological, financial, and regulatory obstacles that frequently impede the switch to renewable energy by combining the advantages of the public and private sectors. PPPs can help create a more sustainable and energy-secure future through collaboration, shared risk, and innovation.

PPPs can provide a unique win-win situation for governments, corporations, and strategic energy goals. PPPs will be crucial in promoting the widespread use of renewable energy technology as we continue to transition to a low-carbon economy. This will allow nations to meet their climate targets and develop more resilient energy infrastructure.

In green energy public-private partnerships, business partners are vital because they offer funding, technological know-how, and creativity that governments might not have. Additionally, they share project risks with the public sector, which is crucial in today's volatile circumstances. Specifically, competent, transparent, clear, and effective risk management can serve as a solid basis for any renewable energy project carried out through PPP.

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ПАРАДИГМИ ФОРМУВАННЯ ЕФЕКТИВНИХ МЕХАНІЗМІВ ДЕРЖАВНО-ПРИВАТНОГО ПАРТНЕРСТВА ТА РОЛЬ ПІДПРИЄМНИЦЬКИХ СТРУКТУР У СЕКТОРІ ВІДНОВЛЮВАЛЬНОЇ ЕНЕРГЕТИКИ

У статті показано, як державно-приватне партнерство (ДПП) у сфері відновлюваних джерел енергії надає можливість державному та приватному секторам об'єднати ресурси та розділити ризики з метою реалізації проектів комунального масштабу, які в іншому випадку були б неможливими. ДПП не використовується в Україні в повній мірі, хоча в інших країнах про нього є документальні свідчення. Актуальність цього дослідження визначається необхідністю розширення технологій відновлюваних джерел енергії як основи сталого економічного розвитку. У цій статті аналізується роль державно-приватних партнерств (ДПП) у розвитку відновлюваної енергетики та зосереджується увага на взаємодії державних і приватних зусиль для прискорення переходу до сталого енергопостачання. За допомогою методології нарративного огляду показано, що вдосконалення механізмів державно-приватного партнерства (ДПП) може стимулювати розвиток підприємницьких структур у секторі відновлюваної енергетики шляхом об'єднання державних і приватних ресурсів для реалізації проектів, розподілу ризиків та прискорення їх реалізації. Основними результатами дослідження є визначення детермінованих особливостей розвитку проектів ДПП у сфері відновлюваних джерел енергії, систематизація основних моделей і механізмів реалізації ДПП у сфері відновлюваних джерел енергії. Дослідження також показує, як такі фактори, як прибутковість, зниження ризиків і вигідні політичні рамки, мотивують приватний сектор до участі. Низьковуглецеві, кліматично стійкі партнерства використовують більш інноваційні стратегії, залучають більше зацікавлених сторін, демонструють різні розподіли ризиків і більше зосереджуються

на соціальній прийнятності, ніж більш традиційні моделі ДПП. На основі парадигми теорії агентства в статті представлено багатоетапну систему розподілу ризиків для ДПП, яку рекомендується застосовувати, зокрема, в Україні в умовах критичних пошкоджень інфраструктури, пов'язаних з війною.

Ключові слова: зелена енергія; теорія агентських відносин, державно-приватне партнерство, підприємництво, відновлювальна енергетика, інновації, стейкхолдери.

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