Integration of sustainability across the entire life cycle of Public-Private Partnerships in Infrastructure Projects

Master Thesis

Construction and Real Estate Management

Joint Study Program of Metropolia Helsinki and HTW Berlin

from

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Topic: **Integration of sustainability across the entire life cycle of Public-Private Partnerships in Infrastructure Projects**

Background

PPPs are one of the most common forms of contracts for the execution of infrastructure projects, as well as one of the longest in time, which could make them promising for the implementation of sustainability goals in the field. Infrastructure procurement by PPPs has the capacity to deliver on sustainable development if, among other things, sustainability values are continuously incorporated into contracts (Coverson and Perera, 2011). According to the report of Brauch regarding Contracts for Sustainable Infrastructure, different guidances (like the 2017 edition of the World Bank Group, *Guidance on PPP Contractual Provisions*) provide guidelines about the contract language to be adopted by governments for PPPs. Nevertheless, there is a gap of models and there are no concrete directions about how infrastructure projects can contribute to sustainable development (Brauch, 2017).

Objectives and expected results of the study

This thesis aims to study the nature of PPPs in infrastructure, the different opportunities they offer to the sector as well as the challenges they face. Sustainability is one of these challenges, that if integrated across the entire life cycle of Public-Private Partnerships, it can turn into an opportunity. The study aims to fill the existing gap of information and strategies by going through the different aspects of PPPs, from the first phases of inception and contracting, to implementation, final hand-over of the project, and maintenance. The final result will be a model or list of strategies about how sustainability practices can be incorporated in PPP projects in infrastructure.
Considering the vast nature of infrastructure, the study will be concentrated in specific fields like energy generation, transportation, and public education buildings, with case studies of actual projects executed in Europe (for example Albania and Finland). Quantitative data provided by these case studies will be used to analyse the qualitative data provided by literature review and previous academic studies. Another source of information that may be used are questionaries and statistical data.

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Research Questions

1. How and why Public-Private Partnerships are used in infrastructure projects?
2. What are the current practices of implementation of sustainability in infrastructure?
3. What are the existing gaps, deficiencies, and risks, related to sustainability in PPPs in infrastructure?
4. What policies must be adopted to mitigate the existing challenges and integrate sustainability into the entire life-cycle of PPPs in infrastructure projects?
5. What would be the best practice to implement sustainability into PPPs in infrastructure projects?

Signature of the Supervisor

1 Abstract

The need for more and better infrastructure is increasing with the world's population. In the meantime, the governmental financial resources are decreasing. PPPs are used as mitigating tools to the financial gap, but not only. One of the main aims of this thesis is to study the different ways in which PPPs can help infrastructure development, besides funds provision. Considering the long duration of PPPs, one of their contributions is the provision of sustainable infrastructure. The UN has already suggested Public-Private Partnerships as a mechanism towards the Sustainable Development Goals (Wang and Ma, 2020). However, there is a lack of models and clear guidelines about how infrastructure projects may support and integrate sustainable development (Brauch, 2017). This research seeks to close the existing gap by exploring PPPs from the initial stages of conception and contracting through construction, operation, and maintenance. For this purpose, two case studies belonging to economic and social infrastructure were used. The information about the case studies was provided through official documents published in official tendering platforms, websites of the contracting authorities and the developers, web-conferences, as well as third party assessors of the sustainability of the projects. The objective is to analyze the projects' implementation progress up to date, and the way sustainability principles have been implemented into them, as good practices to be followed. Finally, the practices are summarized in a list of recommendations which is structured based on the pillars of sustainable development: environment, society, economy, and governance. Besides the case studies, the research makes use of available literature like guidelines from the World Bank and the UN, books, and journals about the three main topics, infrastructure, PPPs, and sustainability.

Keywords: Infrastructure, PPPs, Sustainability, Sustainable Infrastructure, Sustainable Practices

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5 List of Abbreviations

ASCE	American Society of Civil Engineers
BIRN	Balkan Investigative Reporting Network
BOOT	Build, Own, Operate, Transfer
BOT	Build, Operate, Transfer
BRIC	Brazil, Russia, India and China
BTO	Build, Transfer, Operate
CBA	Cost Benefit Analysis
COP21	Conference of the Parties, 2015
COP26	Conference of the Parties, 2021
COVID-19	Coronavirus disease
CSP	Concentrated Solar Power
DBOT	Design, Build, Operate, Transfer
DHP	Devoll Hydropower
DSO	Distribution System Operators
ESG	Environmental, Social, Governance
ESIA	Environmental and Social Impact Assessment
EU	European Union
EUR	Euros
FIDIC	International Federation of Consulting Engineers
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HPP	Hydropower Plant
IDB	Inter-American Development Bank
IEA	International Energy Agency
IHA	International Hydropower Association
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IT	Information Technology
KESH	Korporata Elektroenergjitike Shqiptare-Albanian Power Corporation
NDC	Nationally Determined Contributions

NGO	Non-Governmental Organization
OECD	Organization for Economic Co-operation and Development
PEER	Performance Excellence in Energy Renewal
PFI	Private Finance Initiatives
PPP	Public Private Partnership
PV	Photovoltaics
RES	Renewable Energy Sources
RFP	Request for Proposals
RFQ	Request for Qualifications
RTS	Finnish Environmental Classification Tool
SD	Sustainable Development
SDG	Sustainable Development Goal
SPV	Special Purpose Vehicle
TSO	Transmission System Operators
UK	United Kingdom
UN	United Nations
US/USA	United States of America
USD	United States Dollar
VAT	Value Added Tax
WCED	World Commission on Environment and Development
WMO	World Meteorological Organization
WWF	Worldwide Fund for Nature

1. Introduction

Public infrastructure is vital to societies, and the needs for better public services and assets are increasing exponentially with the world population. The United Nations has suggested Public-Private Partnerships (PPP) as a mechanism towards the Sustainable Development Goals (Wang and Ma, 2020). The World Bank Group's Guidance on PPP Contractual Provisions, which was updated in 2017, is one of the guidance documents that offers recommendations on the contract language that governments should use for PPPs, according to the Brauch study on Contracts for Sustainable Infrastructure. However, there is a lack of models and clear guidelines about how infrastructure projects may support and integrate sustainable development (Brauch, 2017).

By exploring the many PPP aspects—from the initial stages of conception and contracting through construction, operation, and maintenance—this research seeks to close the knowledge and strategy gap that currently exists. The study is developed and structured over the three main concepts, infrastructure, PPPs in infrastructure, and sustainability.

The first chapter contains an explanation of the infrastructure concept, an analysis of its main sectors, its economic value, and investment trends. Electricity generation and educational infrastructure are the two main sectors that are analyzed and explained more in detail, considering their crucial role in the development progress of countries nowadays. Furthermore, the two of them together represent the two different areas of infrastructure, economic and social.

The second chapter analyses PPPs as long-term contracts that help in overcoming financial challenges faced by the public sector in infrastructure investment. The different contract types and their characteristics are identified and analyzed, together with the phases that PPPs go through during their lifecycle. One section of this chapter is also answering to the research question of how PPPs can help in overcoming infrastructure challenges.

Sustainability and sustainable development are analyzed on the third chapter of the study, starting with a brief history and some of the main events and regulations that have defined the future of sustainable development in our planet. Some of the most important sustainable development goals of the 2030 Agenda related to infrastructure

are identified and analyzed. The concept of sustainable infrastructure providing economic, social, institutional, and environmental benefits was developed together with the various ESG risks faced, especially by the electricity and educational infrastructure sectors.

Two actual projects are used as case studies, one in the hydroelectric generation field, and the other in the educational field, both coming from some of the best PPP practices ever followed in their respective countries. The analysis is based on quantitative and qualitative data of the two projects, gathered through official sources from their respective SPVs, as well as information and official documentation published by the contracting authorities, or third parties like independent certification institutions. Based on the analysis of the case studies, a list of recommended practices to integrate sustainability into PPPs is generated at the end of study. The recommendations are structured based on the four pillars of sustainability: environment, society, economy, and governance.

2. Infrastructure

The term ‘infrastructure’ was used for the first time in the military, referring to assets like airbases and camps. Afterwards, national authorities, academics, dictionaries, and the financial community have presented a wide range of definitions, and as a result, today infrastructure may have different meanings. Jochimsen, who focused on infrastructure's function in the evolution of a market economy, has given one of the most holistic definitions for it, taking into account social aspects in addition to economic and technical ones. He defined infrastructure as:

“The sum of all material, institutional and personal assets, facilities, and conditions available to an economy based on the division of labor and its individual economic units that contribute to realizing the assimilation of factor remuneration, given an expedient allocation of resources. The term material infrastructure stands for the sum of all physical assets, equipment and facilities and the term institutional infrastructure points to the norms and rules, which develop and are set in a society over time; in addition, the term personal infrastructure is used to encompass the number and qualities of people in a market economy.” (Jochimsen, 1966)

Later, in 1978, Frey pointed out that the term “infrastructure” in the modern language use of the time referred to material infrastructure, such as roads, ports, utilities, and other similar physical assets (Frey, 1978).

Fulmer proposes a simple description that incorporates the recurring themes of systems, material assets, and social needs: the physical elements of interconnected systems delivering goods and services required to enable, support, or improve society living circumstances (Fulmer, 2009).

A broad definition about civil infrastructure is given by the American Society of Civil Engineers (ASCE):

“Civil infrastructure systems enable thriving societies and healthy ecosystems. Civil infrastructure systems support transportation; energy production and distribution; water resources management; waste management; civic facilities in urban and rural communities; communications; sustainable resources development; and environmental protection. These physical, social, ecological, economic, and technological systems are complex and interrelated.” (ASCE, 2015)

In a concentrated overview, Weber et al. give the following definition:

“Infrastructure generally describes all physical assets, equipment and facilities of interrelated systems and the necessary service providers, together with its underlying structures, organizations, business models and rules and regulations, offering related sector-specific commodities and services to individual economic entities or the wider public with the aim to enable, sustain or enhance social living conditions.” (Weber et al., 2016)

Thus, the concept of infrastructure is quite broad and encompasses many elements, from the vital services provided for public use, to the assets needed to provide such services, and the institutions and rules directing the process. This chapter aims to analyze public infrastructure and some of its main sectors, in order to better understand its significance to societies, especially nowadays, when the world population and the needs for infrastructure services are increasing exponentially.

3.1 General characteristics of infrastructure

Infrastructure assets provide critical public needs in everyday life, such as transportation, electric energy, water, telecommunications, education, and healthcare, and are thus an essential component of economic growth and well-being. Each one of the infrastructure sectors has its own features but in general, all of them are characterized by these common attributes:

- **Non-flexible demand.** Infrastructure services are in high demand because of their vital outcomes, which make them essentially independent of industrial fluctuations and economic health. The need for them remains steady and foreseeable even when prices rise due to inflation or other factors affecting the market.

- **Strong entry barriers and almost-monopoly environment.** Because of the large start-up expenses of building utility networks, infrastructure assets are difficult to replicate. Following completion, the cost of delivering each additional service or product is quite cheap. Because of this mix of conditions, market entry barriers are considerable. As a result, there is little or no competition for these types of assets.

- **State influence and regulation.** Regulatory agencies can take over and adjust the market in cases when there is little or no competition. They may take measures like fixing prices, guaranteeing minimum payments, as well as guaranteeing and protecting the rights and interests of the citizens.

- **Long life expectancy.** Infrastructure assets can have a service life of up to 100 years (Roman aqueducts for example, had even longer lifespans). Besides the asset's physical and technical life, its economic life is also important, as it may vary among different assets. In healthcare facilities, for example, it might be as short as five years. Thus, it is important for the amortization time of the asset to correspond to its economic life.

- **Protection against inflation.** The income from infrastructure projects is typically associated with measures for inflation accountability and contractual guarantees, making infrastructure assets serve as good barriers against inflation. Furthermore, revenue from user charges, like toll roads, or public utilities, is frequently related to GDP or Consumer Price Index, rather than availability payments.

- **Cash flows that are consistent and predictable.** Well-managed infrastructure projects often generate steady, predictable, and long-term income, that can endure economic downturns and variations after accounting for inflation, while also supporting a considerable credit load.

3.2 Infrastructure Sectors

The physical assets that facilitate human life on our day-to-day basis are structured in two main groups, economic infrastructure, and social infrastructure. Economic infrastructure contributes to the economic development of a country, and it is made up of five main sectors: transport, energy, water, waste, and communication. Social infrastructure, on the other hand, contributes to the social development and its main sectors are health, education & culture, sport, public administration, and security. Going further, each one of the sectors has its own subsectors, as shown in Table 1 below.

Economic infrastructure				Social infrastructure
Transport	**Energy**	**Water**	**Communication**	
Land – Roads – Rail networks – Public local transport **Water** – Inland waterways – Sea – Canals (e.g. Suez) – Ports **Air** – Airport services – Airline services – Air traffic control **Multimodal** – Inland terminals (road/rail-freight) – Cruise terminals	**Generation Conventional** – Coal – Oil/gas – Nuclear **Renewable** – Solar – Wind – Water – Biomass – Geothermal **Transmission/Distribution** – Electricity – Gas – Oil/fuels **Storage** – Electricity – Gas – Oil/fuels **District Heating**	**Supply** – Domestic – Industrial **Sewerage** – Rain water – Domestic wastewater – Industrial wastewater **Waste** – Domestic waste – Industrial waste	**Telecommunication** – Fixed networks – Mobile networks – High-speed internet – Towers (cell & broadcast) **Space** – Satellite network – Observation **Other services**	**Health** – Diagnostic – Therapy/treatment – Care – Rehabilitation – Elderly housing **Education/Culture** – Schools – Student housing (campus) – Libraries – Theatres – Museums **Sport** – Recreational – Professional **Public administration** – Offices – E-government **Security** – Prisons – Police – Defence

Table 1: Infrastructure sectors and subsectors (Weber et al., 2016)

Some of the main drivers of economy and society among the different sectors are energy and education infrastructure. Each of them is analyzed more in detail in the following sections.

Electric Energy Infrastructure

One of Governments' principal supply duties is delivering energy goods and services to citizens, from electricity, to heating services, and fuels (like oil and natural gas). From energy generation to final customers' consumption, a variety of infrastructures, technologies, standards, laws, and deliverables need to be engaged for each of these services.

Figure 1 below shows the distribution of final energy consumption for different sectors in the top five countries with the highest consumption rate. It's obvious that industry is the biggest consumer, followed by transport and residential buildings.

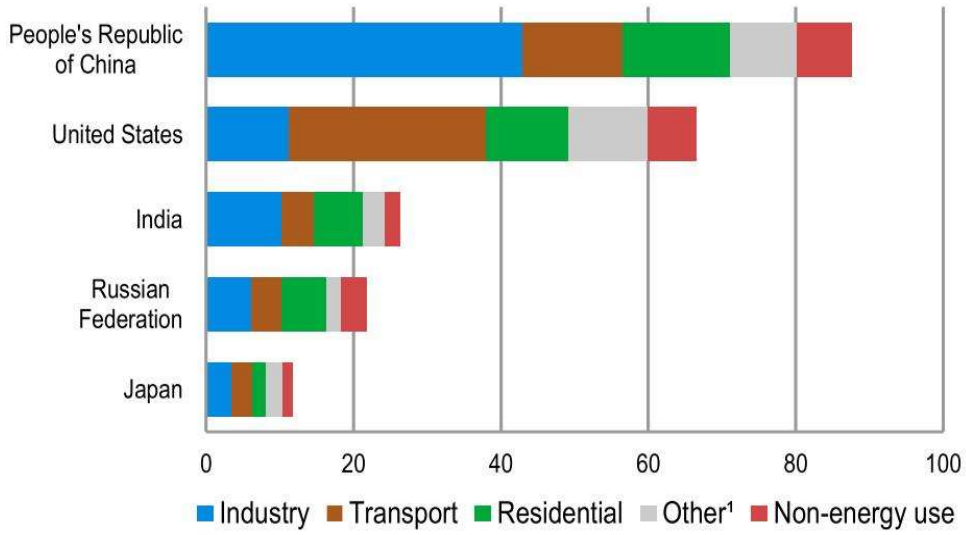

Figure 1: Top five countries by total final consumption by sector for 2019, in EJ (IEA, 2021)

Among the different forms of energy, electricity represented almost 20% of the world's total final consumption of energy in 2019 (see figure 2).

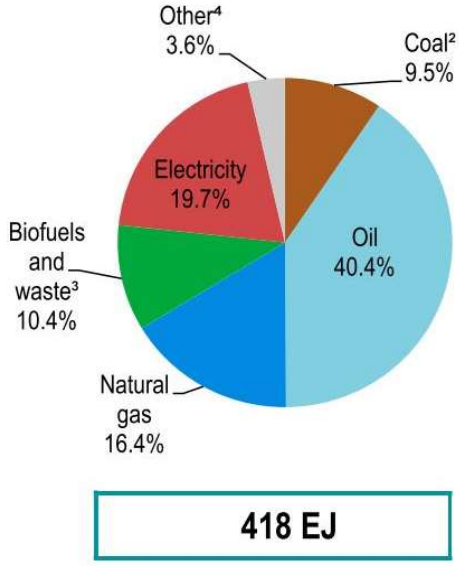

Figure 2: Share of world total final consumption of energy by source, for 2019 (IEA, 2021)

The structure of the electricity sector is made up of three main pillars: generation, transmission and distribution (T&D), and storage.

Figure 3 below shows the transition of electricity through the three stages, generation, transmission, and final consumption. At first, the various energy sources are converted into electricity. The generated electricity of high voltage is then carried by Transmission System Operators (TSOs) through a long-distance transmission network towards the distributors. Finally, Distribution System Operators (DSOs) make sure to distribute it to

the market and final end-users. DSOs are the ones that typically handle all client relationships. Depending on the generation mode and storage capacity, electricity can also be stored if needed, before going through the transmission line.

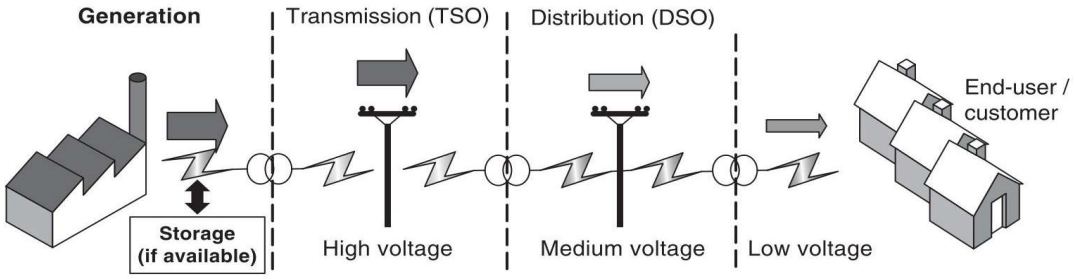

Figure 3: Framework of the electricity industry (Weber et al., 2016)

Generation of electricity is still highly dependent on centralized power plants, while T&D systems are quite independent, and the energy storage possibilities rather minimal. Nevertheless, the advancements in renewable energy production (solar, wind, water, biomass), and the adoption of new energy storage technologies are expected to change the situation. The limited capacity and the high entrance barriers give the three networks of different voltages the attributes of pure monopolies. Hence, across most countries, the supply of these services is regulated by national authorities to provide open access to market players.

According to the data provided by the International Energy Agency for 2019, almost 64% of electricity is generated by fossil fuels (coal, oil, natural gas), 10% by nuclear power, and 26% by renewable sources, as shown in figure 4 below. (IEA, 2021).

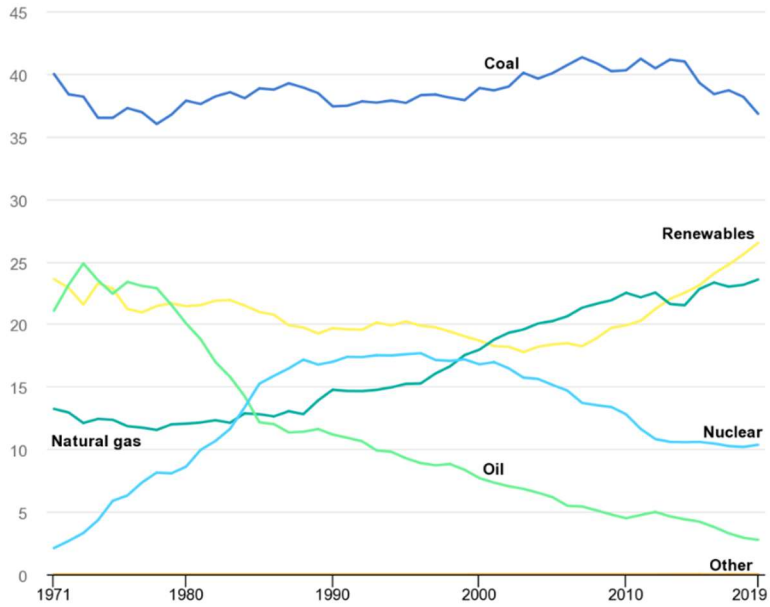

Figure 4: World electricity generation mix by fuel in %, 1971-2019 (IEA, 2021)

According to the report of REN21, renewable energy sources (RES) generated almost 17000 TWh, or 29% of the global electricity in 2020 (see Figure 5).

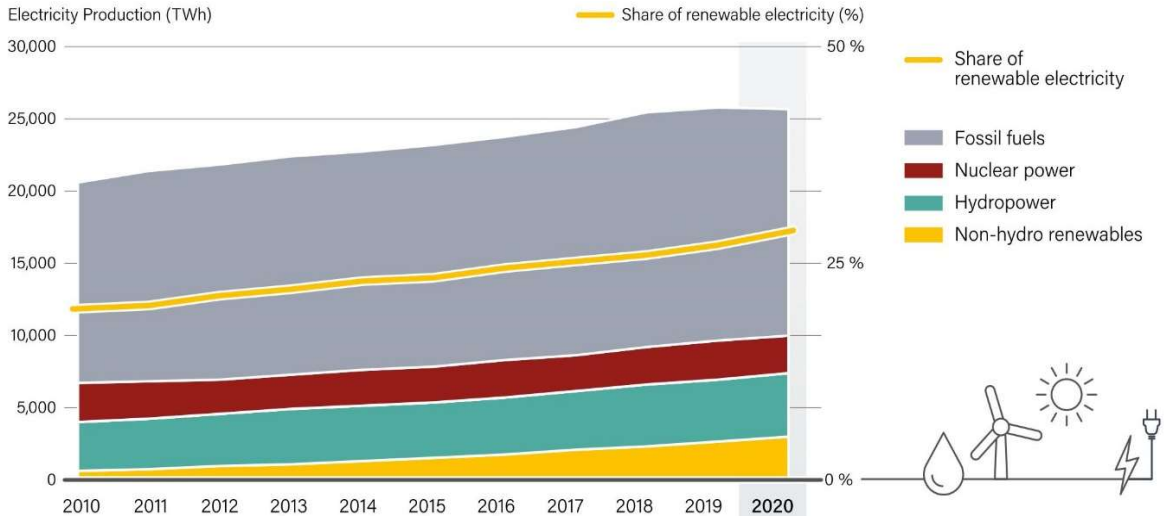

Figure 5: Global electricity production by source, and share of renewables, 2010-2020 (REN21, 2021)

According to other studies, the potential for RES to contribute to the global electricity demand can reach up to 50-90%. In countries that traditionally rely on hydropower, like Iceland and Brazil, renewables already account for 85% (Brazil) and 100% (Iceland) of total electricity generation (Weber et al., 2016).

Hydropower, ocean power (wave and tidal), solar photovoltaic (PV), concentrated solar power (CSP), wind (onshore and offshore), geothermal, and biopower (electricity generated from biomass) are just a few of the renewable energy sources currently contributing to the market, as shown in figure 6 below.

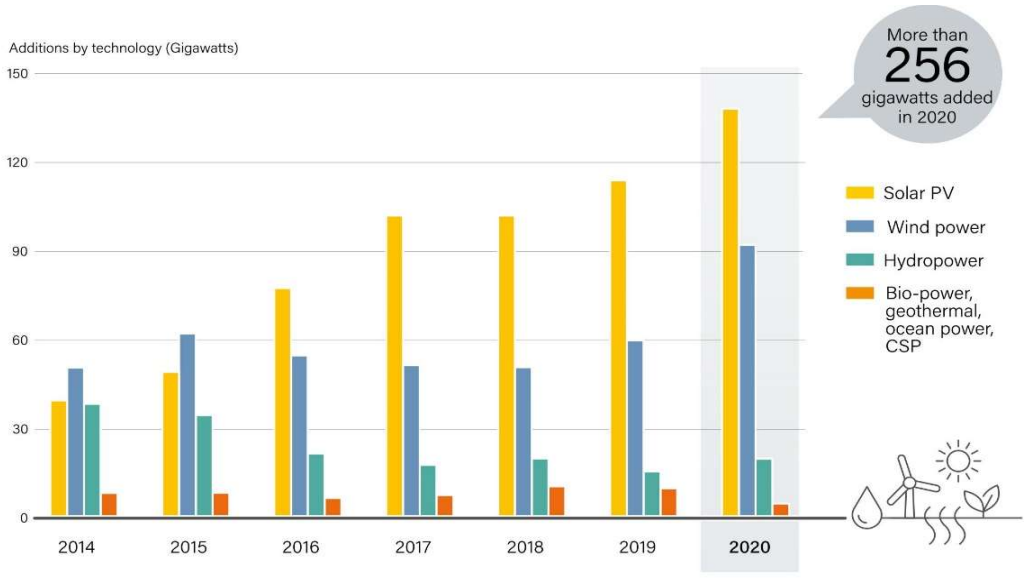

Figure 6: Yearly additions of renewable power capacity, by technology and total, 2014-2020 (REN21, 2021)

Hydroelectric energy

The hydroelectric sector is the biggest renewable energy producer in the world, making up almost 16% of the world's electricity generation, as shown in figure 7 below.

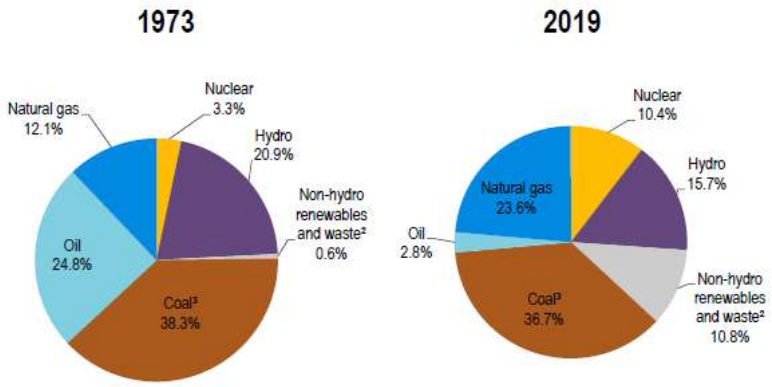

Figure 7: Share of world electricity production by source, 1973 and 2019 (IEA, 2021)

Before 2050, it is predicted that hydropower generation will increase twice, with projects in developing nations accounting for the majority of the expansion. The biggest producers of the moment are China, Brazil, and Canada, as shown in figure 8 below. (IEA, 2021)

Producers	TWh	% of world total
People's Rep. of China	1 304	30.1
Brazil	398	9.2
Canada	380	8.8
United States	311	7.2
Russian Federation	197	4.5
India	172	4.0
Norway	126	2.9
Turkey	89	2.1
Japan	87	2.0
Viet Nam	66	1.5
Rest of the world	1 199	27.7
World	**4 329**	**100.0**

2019 data

Net installed capacity	GW
People's Rep. of China	356
Brazil	110
United States	103
Canada	81
Russian Federation	54
Japan	50
India	49
Norway	33
Turkey	29
France	26
Rest of the world	417
World	**1 308**

2019 data
Sources:
IEA, Renewable Energy Market Update;
United Nations Statistics Division.

Country (top-ten producers)	% of hydro in total domestic electricity generation
Norway	93.4
Brazil	63.5
Canada	58.8
Turkey	29.2
Viet Nam	27.8
Russian Federation	17.5
People's Rep. of China	17.4
India	10.6
Japan	8.4
United States	7.1
Rest of the world²	14.2
World	**16.0**

Figure 8: Largest producers of hydroelectricity, 2019 (IEA, 2021)

Although a hydroelectric project needs a considerable initial investment, ongoing expenses are minimal since water is free and renewable, and dams can be functional up to centuries. However, many hydroelectric plants worldwide will need infrastructure upgrades to be undertaken till 2050, including modernization of facilities and equipment and expanding their capacities to accommodate increases in consumption (Weber et al., 2016).

When the lengthy lifespans of civil infrastructure are combined with the uncertainties caused by climate change, continually shifting energy mixes, and unpredictable energy markets, the need for modernization creates a variety of difficulties and possibilities. Because of its strategic significance and significant social effect, hydropower is subject to strict regulation. A governmental or private organisation assumes complete responsibility for planning, constructing, and running the plant in the majority of hydroelectric projects that are established under a concessionary arrangement. The public initiator often retains ownership, particularly when the projects contain huge plants. Because the costs of maintenance are very low, and there is no need for fuels, the hydropower sector can easily rival the other electricity sources. Among their various benefits, hydropower electricity provides stable and comparatively foreseeable cash flows in the long term, low and foreseeable operation and maintenance costs, and no additional or fluctuating expenses for their basic source which is water. However, the precedence given to other renewable sources like solar and wind may force HPPs to reduce their production and profit recently.

Some hydroelectric projects, particularly major ones, are funded and administered by public entities because they are deemed vital for their countries. Despite this, there are enough other, non-strategic, smaller HPPs, that are invested and managed by the private sector. There are no expectations for big developments in the sector in developed countries, besides the small HPPs and the possibility of privatisation of the bigger ones in the future. According to the IEA, Asia, South America and Africa have the greatest growth prospects (IEA, 2021).

Solar Energy

With a global average of 170 W/m^2, solar electricity production has the highest power density of all renewable energy. According to the International Energy Agency, the sun

delivered around 7000 times more power than it was used by mankind in 2012. Solar energy thus has a great chance of becoming the main source of energy for the whole world. Nevertheless, market rivalry, with traditional energy supplies, as well as technical limitations such as absence of extensive storage, are expected to restrict its market share in the future. (Weber et al., 2016)

While solar energy is plentiful and consistent across the world, its intensity, the total quantity of energy collected on a certain surface during a given period, differs locally, as well as on a daily and yearly basis. PV cells may be deployed on a variety of surfaces, like land, water, or existing structures. Furthermore, they can be assembled to provide various energy powers, from 1kW to 1000 MW) that is utilized in different forms, from local consumption to feed in the grid. Today, the most widely employed technologies are crystalline silicon and thin films. Crystalline silicon technology makes up 85% of the market, providing high return but also high costs. Thin films on the other hand, make up 15% of the market, have low costs but also provide low returns.

Although initial investment costs are high in both cases, operational expenses are cheap, and no one has to pay for the principal source of energy, the sun. It's necessary to remember that the life longevity of cells is maximum 25 years, and their output may fall in time depending on their quality. Figure 9 below shows the regional share of solar PV electricity production in 2005 and 2019, indicating a significant growth of this electricity sector in other countries besides the OECD.

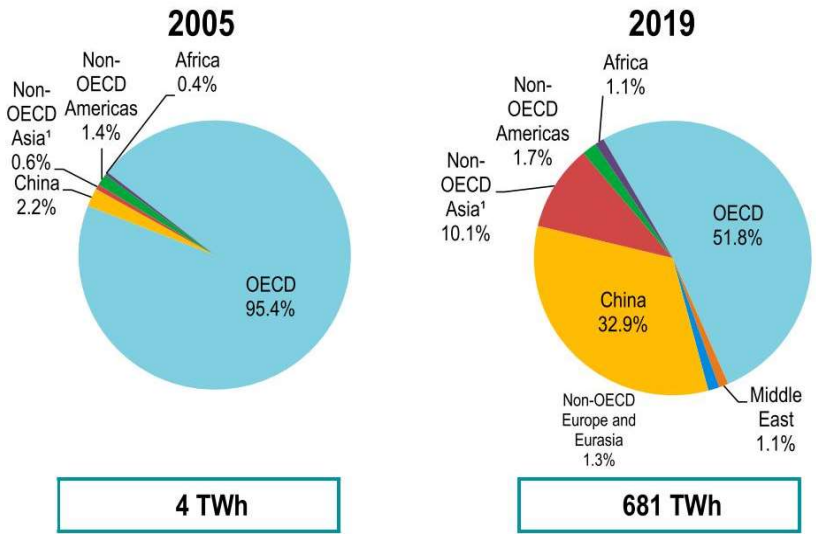

Figure 9: Share of world solar PV electricity production by region, 2005 and 2019 (IEA, 2021)

The tables below in figure 10 show the top producers of solar PV electricity in the world for 2019. It's obvious that China and the US lead the production and net installed capacity, while the percentage of solar PV in total domestic electricity generation is highest in Italy and Germany.

Producers	TWh	% of world total
People's Rep. of China	224	32.9
United States	94	13.8
Japan	69	10.1
India	51	7.4
Germany	46	6.8
Italy	24	3.5
Australia	15	2.2
Korea	13	1.9
United Kingdom	13	1.9
France	12	1.8
Rest of the world	120	17.7
World	**681**	**100.0**

2019 data

Net installed capacity	GW
People's Rep. of China	205.2
United States	75.7
Japan	63.1
Germany	49.2
India	37.6
Italy	20.9
Australia	15.9
United Kingdom	13.6
Korea	11.2
France	10.5
Rest of the world	99.7
World	**602.6**

2019 data

Country (top-ten producers)	% of solar PV in total domestic electricity generation
Italy	8.1
Germany	7.6
Japan	6.6
Australia	5.6
United Kingdom	4.0
India	3.1
People's Rep. of China	3.0
Korea	2.2
United States	2.1
France	2.1
Rest of the world[1]	1.3
World	**2.5**

2019 data

Figure 10: Producers of Solar PV electricity (IEA, 2021)

Another form of utilization of solar energy is CSP (Centralized Solar Power). In principle, CSP devices concentrate solar energy to heat a recipient to extreme temperatures. Turbines or other engines transform this heat into mechanical energy before finally turning it into electricity. The United States and Spain are the top two countries in terms of development of CSP which and is being considered for its storing energy capacities.

Wind Energy

Wind is another major renewable source of electricity. Wind electrical energy can be generated both onshore, through wind farms built over land surface, or offshore, through installation of wind turbines in the sea. Figure 11 below shows the significant growth in expansion and capacity of the wind electricity sector.

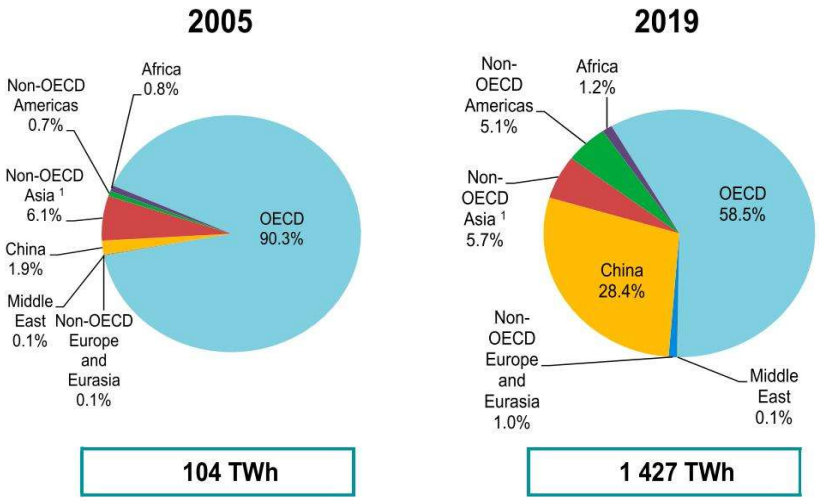

Figure 11: Share of world wind electricity production by region, 2005 and 2019 (IEA, 2021)

The tables below in figure 12 show the top producers of wind electricity in the world for 2019. It's obvious that China and the US lead the production and net installed capacity, while the percentage of solar PV in total domestic electricity generation is highest in Germany and Spain.

Producers	TWh	% of world total
People's Rep. of China	406	28.4
United States	298	20.9
Germany	126	8.8
India	70	4.9
United Kingdom	64	4.5
Brazil	56	3.9
Spain	56	3.9
France	35	2.4
Canada	33	2.3
Turkey	22	1.5
Rest of the world	262	18.5
World	**1 427**	**100.0**

2019 data

Net installed capacity	GW
People's Rep. of China	210.3
United States	103.7
Germany	60.9
India	37.7
Spain	25.5
United Kingdom	24.0
France	16.3
Brazil	15.4
Canada	13.4
Italy	10.7
Rest of the world	105.1
World	**622.9**

2019 data

Country (top-ten producers)	% of wind in total domestic electricity generation
Germany	20.7
Spain	20.4
United Kingdom	19.9
Brazil	8.9
Turkey	7.2
United States	6.8
France	6.1
People's Rep. of China	5.4
Canada	5.1
India	4.3
Rest of the world[1]	3.0
World	**5.3**

2019 data

Figure 12: Largest producers of wind electricity, 2019 (IEA, 2021)

The technology over which onshore wind electricity production is based has proven to be cheaper than traditional power generation, thus, there aren't expected any huge technical shifts on this sector. Profit growth is primarily determined by the production

cost, which on its side depends on the accessibility of the site. Other factors that determine the profitability are the location, intensity of winds, the expected energy prices and the regulatory assistance mechanisms if there are any. Onshore wind electricity is efficiently competing with other technologies of electricity generation. The competition for lands with high winds intensity is high and the sector is generally regulated through supporting mechanisms. Furthermore, the building and operation of the plants require permits regarding environmental impacts, recycling of turbines, and conformity to national or international laws.

Offshore wind generation on the other hand is younger and it only accounts for 2% of the total installed wind power capacity (Weber et al., 2016). The power generated through offshore wind farms is much higher due to stronger and more stable winds compared to onshore, their building and operation is much more expensive and riskier. Their life-long exposure to aggressive environments with salt water and strong winds makes the maintenance of offshore plants much harder. That is also reflected on the high maintenance and operation costs due to the necessity of utilization of special equipment, like helicopters and boats. The offshore turbines need to be connected to the land transmission grid through underwater cables of lengths of up to 200 km. All these issues make of the offshore wind sector a challenging sector from the logistical, economic, technical, and administrative perspective.

Electricity Storage

Electricity storage is one of the main issues related to the electrical energy sector. Storage assets are in general owned and managed by public or private entities. Nevertheless, with the developments in new storage technologies, the ownership models are expected to change. Table 2 below shows the different electricity storage technologies used nowadays.

Technology	Description	Maturity	Advantages	Drawbacks
Pumped hydro (PSH), existing	Water is pumped from lower to higher reserve where it can be used to generate hydropower	Mature	Commercial, large-scale, efficient	Limited locations, low energy density[23]
Compressed air (CAES)	Air is compressed and stored in enclosed volumes and later run through gas turbines to improve efficiency by almost 300%	Demo to mature	Large-scale, low-cost, flexible sizing	Limited locations, low energy density, requires gas to heat air at release
Flywheels (FES)	Energy stored and recovered via massive, fast-spinning rotors connected to a motor-generator	Demo to mature	High power density, efficient, scalable	High cost, low energy density
Lead acid batteries	Conventional electrochemical storage (excludes vehicle batteries)	Demo to mature	Flexible sizing, low cost	Low energy density vs. other batteries, performance degrades above 25°C
Lithium-ion batteries (Li-ion)	High energy density electrochemical storage (excludes electric vehicles)	Demo to mature	Efficient, high energy and power density	High cost, safety (overheating, fire)
Flow batteries	Electrochemical storage using external tanks to store electrolyte material	Develop to deploy	Scalable	High cost (more complex than other batteries)
Sodium–sulfur batteries (NaS)	High temperature electrochemical storage	Demo to deploy	Efficient, high energy and power density	Safety issues, must be kept hot
Hydrogen	Chemical storage via the production of hydrogen (separated from water)	Demo	High energy density	Lower efficiency, high cost, safety
Synthetic natural gas (SNG)	Chemical storage via the production of methane	Demo	High energy density, leverage existing gas infrastructure	Lower efficiency, high cost
Capacitors and superconducting magnetic storage (SMES)	Electromagnetic stored in an electric field between two plates or in a coil (SMES)	Develop to demo	Efficient, high power density, quick response	Lower energy density, higher cost

Table 2: Most common electrical energy storage technologies (Weber et al., 2016)

The need for electrical energy changes in foreseeable, changing in periodic ways throughout the day or year. Even though they have varying full-load times and variable prices, traditional plants using coal, nuclear, gas, or oil resources can provide electricity at any time. On the other hand, Renewable Energy Sources, except for hydropower, have no built-in energy storage capabilities. They can only supply electricity if the

renewable resources they use are available in real time. As a result, the output provided by solar and wind-powered generation is less consistent than the other traditional methods. Despite their significant storage restrictions, decentralized RES are granted preferential access in several of the world's most sophisticated power markets to encourage investment in this sector. However, this successful environmental advocacy has a number of detrimental consequences. First, an increasing instability of power capacity delivered into the grid has resulted from the growing percentage of wind and PV energy output. Second, rather of feeding into the high-voltage transmission grid, decentralized RES plants supply the medium-voltage grids of distribution directly. This limits the voltage control function performed by the operators. To address these constraints and unwanted side effects, such as RES volatility, it is needed to provide additional large storage infrastructure.

Social and Educational Infrastructure

Social infrastructure is often referred to as “public real estate” and considered as different from the other sectors of infrastructure because of its output that is not so much directed towards economic growth than social development. Assets of social infrastructure projects are more flexible in their usage, as they can be adapted into different forms during their lifecycle without major structural changes. Another specific feature for the social sector is its continuous exposure to social and market changes that lead to a forever changing demand for the social infrastructure assets. Such influencing factors can be the demographic changes affecting especially the healthcare, elderly housing, and education sector; innovation and technology affecting the quality demand and costs of the assets or services; or the changes in laws and regulations that may affect the usage of different sectors, like educational regulations. Among the different subsectors, education, healthcare, and administrative facilities are the most developed and standardized ones, as well as the most attractive ones for private investors. (Weber et al., 2016)

Table 3 below gives a summary of the different sectors of social infrastructure. For the purpose of this study, only the educational infrastructure sector will be explained more in detail in this section.

	Privatisation model	Partnership model	Business model	Contract model	Financing model
Health facilities	**Material** (formal, functional)	**Vertical** (horizontal)/ management of infrastructure **assets** and **tasks and services**	**All tasks and services at own risk** in case of full material privatisation/PSP: PPP owner model, purchase model, lease model, tenant model (= asset based approach in a vertical partnership)	**Design, Build, Operate, Own, Finance** (Transfer, Lease, Rent)	**Corporate finance**, project finance (forfeiting model)/healthcare **service fees** (user fees)
Elderly housing	**Material** (formal, functional)	**Vertical** (horizontal)/ management of infrastructure **assets** and **tasks and services**	**All tasks and services at own risk** in case of full material privatisation/PSP: PPP owner model, purchase model, lease model, tenant model (= asset based approach in a vertical partnership)	**Design, Build, Operate, Own, Finance** (Transfer, Lease, Rent)	**Corporate finance**, project finance (forfeiting model)/senior citizen **service fees** (user fees)
Education facilities	**Functional** (material in case of private education facilities)	**Vertical** (horizontal)/ management of infrastructure **assets** (and Facility management services)	PSP: **PPP owner model, purchase model, lease model, tenant model (= asset based approach** in a vertical partnership)/asset provision and tasks and services at own risk in case of private education facilities	**Design, Build, Operate, Finance, Lease, Rent** (Transfer, Own)	**Project finance, forfeiting model/public budget** (user fees and public subsidies in case of material privatisation)
Administrative facilities	**Material, functional** (formal)	**Vertical, horizontal/** management of **assets** (and Facility management services)	**Asset provision at own risk** in case of full material privatisation/PSP: **PPP owner model, purchase model, lease model, tenant model** (= asset based approach in a vertical partnership)	**Design, Build, Operate, Own, Finance, Transfer, Lease, Rent**	**Project finance, forfeiting model** (corporate finance in case of full material privatisation)**/public budget** (rent and service charge)
Sport and leisure facilities	**Material, formal, functional**	**Vertical** (horizontal)/ **urban development** and management of **assets** (and partially tasks and services)	**All tasks and services at own risk** in case of full material privatisation/PSP: PPP owner model, purchase model, lease model, tenant model (= asset based approach in a vertical partnership)	**Design, Build, Operate, Own, Finance, Transfer, Lease, Rent**	**Corporate finance**, project finance (forfeiting model)**/public budget** (subsidies) and **service fees** (user fees)
Cultural centres	**Material, formal, functional**	**Vertical** (horizontal)/ **urban development** and management of **assets** (and partially tasks and services)	**All tasks and services at own risk** in case of full material privatisation/PSP: PPP owner model, purchase model, lease model, tenant model (= asset based approach in a vertical partnership)	**Design, Build, Operate, Own, Finance, Transfer, Lease, Rent**	**Corporate finance**, project finance (forfeiting model)**/public budget** (subsidies) and **service fees** (user fees)
Security facilities	**Functional**	**Vertical, horizontal/**management of **assets**	PSP: **PPP owner model, purchase model, lease model, tenant model** (= **asset based approach** in a vertical partnership)	**Design, Build, Operate, Finance, Lease, Rent** (Transfer, Own)	**Project finance, forfeiting model/public budget**

Table 3: Overview of the social infrastructure sectors (Weber et al., 2016)

The education sector is considered as a sovereign function of the public authorities. They own and operate a large part of education facilities, as well as influence the private ones through accreditation of their programs. As mentioned before, the sector is highly affected by social changes. Demographic movements of the young generations from rural areas towards the big cities result in aged population in these areas. As a result of the reduced numbers of students enrolled in rural schools, education there becomes less cost-efficient. In densely populated metropolitan regions, where a high degree of capacity demand necessitates the construction of new schools, the opposite tendency is seen. However, because of the low birth rates, especially in developed nations, this tendency in urban areas is less noticeable. Political policies may highly impact service provision in the education sector also. Policy shifts often result in difficult reconsiderations of existing contracts or in re-accreditation problems if they are private educational institutions.

The majority of educational institutions are funded by the government. This is true for both assets and service delivery. OECD nations spend around 6.1 percent of their GDP on education each year while the amount varies in different countries. It is estimated that the Nordic Countries are the ones who spend much more than the southern European countries, as well as have more independence in managing their finances in the sector. Given that public schools have higher attendance rates and that most private schools are also subsidized by the government, investment in private education is negligible. In general, the involvement of the private investors in the sector is either by full material privatization or by functional privatization, where public authorities reach out to private investors to build and operate their facilities. Usually, the partnership contracts comprise numerous schools inside a municipality in order to make the investment more attractive to private parties. (Weber et al., 2016)

3.3 Economic importance and investments in infrastructure

The ability of the economy to function and flourish is largely influenced by the state of roads, energy supply, schools, waste and water treatment plants, and other infrastructure assets. To collect raw materials, as well as provide goods for consumers, industry necessitates well-maintained highways, trains, airports, and ports. Many sorts of public infrastructure improvements increase business efficiency by lowering expenses. Water and sewer systems that are in good working order are essential for the health and

wellbeing of developing communities. Future generations will benefit from public schools that are free of overcrowding and safety problems. Efficient public transportation and road networks can optimize the everyday commute of employees to their workplaces, no matter how far they are. Targeted actions to maintain and develop public infrastructure strengthen a state's long-term productivity, resulting in increased economic growth and higher-paying jobs. When the circumstances are appropriate, public infrastructure can become a source of decent job opportunities.

In 2008, economists in the US generated a variety of evaluations of the impact of infrastructure investment on GDP growth. It resulted that an extra dollar invested would bring 1.50 USD to 2.5 USD in GDP growth. (McNichol, 2019)

Nevertheless, actual investments are getting lower. According to Weber et al., during the last forty to fifty years, all countries that are members of the OECD have reduced their investments in infrastructure, especially due to the global financial crisis and the implications of infrastructure with climate change. According to the “Infrastructure to 2030” OECD study, investments of up to 60 trillion USD, or 3.5% of global GDP per year will be needed from 2013 to 2030 in order to meet infrastructure needs. The investment demand and spending in each sector from 2000 to 2030 are given in figure 11 below. (Weber et al., 2016)

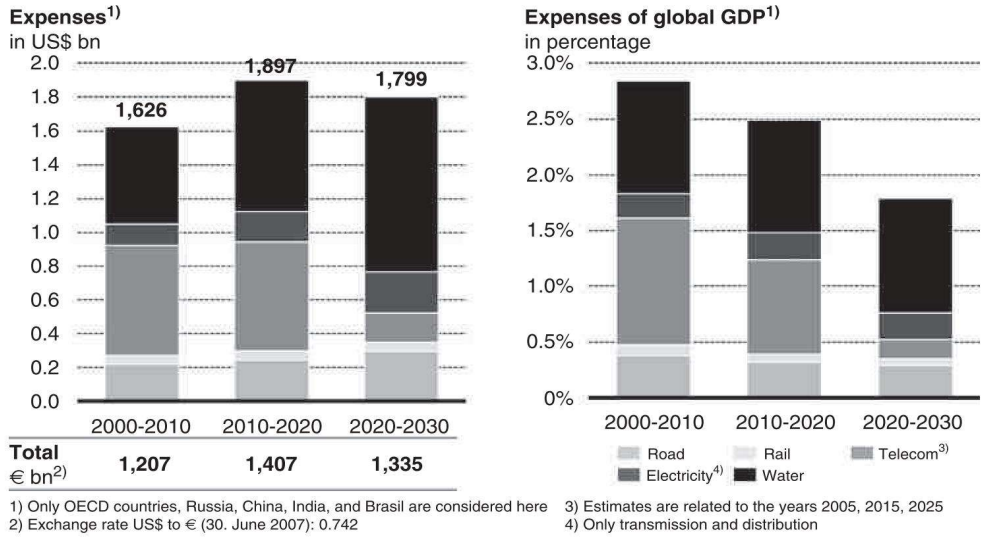

Figure 13: Yearly expenditures on new and repaired infrastructure in OECD and BRIC nations from 2000 to 2030 (Weber et al., 2016)

Furthermore, the study states that between 2005 and 2030, the annual infrastructure costs for OECD member nations should exceed 600 billion USD in highways, railways,

water, and electricity infrastructure. Infrastructure upgrades in the energy industry alone are expected to cost roughly 4 trillion USD. The cost of upgrading and developing water, energy, and transportation infrastructure in cities across Western Europe, the United States, and Canada is estimated to be around 16 trillion USD (Weber et al., 2016). To fulfil increased demand, industrialized nations will also need to entirely replace current infrastructure and make substantial new expenditures.

4 Public-Private Partnerships

Due to the gap in public funds resources, many governments have attempted to develop new methods of funding infrastructure projects. Collaboration with the private sector has been a good alternative in almost all of the countries concerned, with the goal of maintaining ongoing internal economic productivity despite expanding populations and insufficient public finances. Worldwide, a large portion of infrastructure assets are already owned by the private sector. This is notably apparent in the telecommunications industry, with electricity production, transmission, and storage coming in second, and water, waste, transportation, and social infrastructure coming in third. Because governments lack the financial power to fund and maintain public infrastructure, private capital is projected to continue to be invested into these sectors. Simultaneously, private investors are always interested into long-term and low-risk investments in a context of persistently low interest rates in the market. Thus, the majority of Western nations, as well as a number of growing economies in Eastern Europe and the Mid-East have enacted many laws to allow private infrastructure investment. The amount of private capital invested in infrastructure is likely to grow significantly in the future, as it will be necessary to close the aforementioned funding gap for the public sector and assure continued economic growth. This is especially true for rising economies. Across most regions, the volume of private infrastructure investments has increased in recent years. There are many ways of how the private sector can invest in infrastructure projects, from complete privatization, to outsourcing and partnerships. Among them, one of the earliest and still standing models are Public-Private Partnerships. PPPs offer not only a solution to the depleting public funds, but they are also a mechanism for optimizing project development, planning, and management, with an approach similar to LEAN methodology in construction. This chapter describes what PPPs are, their different forms, and how they can help public infrastructure overcome some of its hardest challenges.

4.1 What are PPPs?

According to the World Bank's reference guide of 2017, PPPs are defined as:

"A long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and

management responsibility, and remuneration is linked to performance.” (World Bank Group, 2017)

Some authors describe PPPs as:

“…commercial transactions between a public and a private party wherein the private party:

• provides a service for a substantial period of time (that is usually delivered by the public sector);

• takes on risks—construction, operational and commercial; and

• gets paid, either directly by the public authority, or through user fees, or a combination of both.” (Pratap & Chakrabarti, 2017)

Another source defines them as:

“… a procurement approach where the public and private sector join forces to deliver a public service or facility. In this arrangement normally both the public and private sector will contribute their expertise and resources to the project and share the risks involved.” (Chan & Cheung, 2014)

There is a variety of definitions and opinions about PPPs in the professional and academic world, but in all of them there are the following common elements:

- The presence of two main parties, public and private, which are independent from each other
- A long-term agreement that benefits both parties, to deliver goods or services to the public
- Optimized risk allocation to the party that is more able to bear it
- Performance based payment mechanisms

In most cases, the contractual terms of PPPs last from 20 to 30 years and in fewer cases they can have a shorter or longer duration (World Bank Group, 2017). The duration should be sufficient for the private entity to be encouraged to invest in project design-phase service delivery costs. Additionally, while determining the partnership's duration, maintenance aspects must be included in order to minimize the original investment and future operating and maintenance expenses. The key to the efficiency of service delivery by PPPs stands exactly on this whole-life approach, that accounts for long term costs and benefits for both parties. The availability of funding and its terms

are crucial factors affecting the project's duration. Other factors that influence the length of the partnership are the project type and policy concerns. Policymakers have to be sure that demand for the provided assets is sustained during the lifetime of the contract, while the private entity must be able to embrace responsibility for the delivery of such assets and services during that time.

4.2 PPP contract types

PPP contract types are classified based on three main parameters:

- Types of assets involved
- Payment method
- Functions for which the private party is accountable

Each parameter is further explained below.

Types of assets

If the assets involved are new, it is assumed that the parties agree on a greenfield project. On the other hand, if the partnership implies the upgrading and management of existing assets by the private sector, it is considered a brownfield project. In both cases, the assets and services provided are defined in relation to the outcomes, not inputs, i.e., the output, not how it will be delivered.

Payment method

The method of payment is another defining characteristic. There are three ways a private investor can get renumeration for his work in a PPP contract: by collecting it from users of the asset or service, by getting it directly from the government, or as a combination of these two methods.

In the case of user-pays PPPs, the private company offers a service to customers and makes money from the fees they are charged. Usually, these fees are extended by government subsidies also (e.g., when the services are provided to low-income customers, or incentives to the investment upon end of the construction or achievement of certain milestones). Such payments are contingent on the quality level of the service/asset, also taking into consideration that the ones benefiting from such contracts are not only the users of the asset/service, but a much broader population. For example, when a new highway is constructed based on a PPP agreement and the private

investor is gaining payment through toll roads, such an asset can increase the value of the real estate near it and influence the economy of the whole country.

In the case of government-pays PPPs, the government is the only one to pay. Such payments are contingent on the quality or volumes of the services/assets provided by the private party.

In general, the payment method should be constructed in a way that the private party's net compensation matches its performance. An effective motivation for the private party to supply services at the standards defined by the procurement authority is a recurring payment when the requisite performance is met. On the other hand, repeated large deviations from the expected performance should result in cancellation of the contract and termination costs tailored to make abandoning the project a difficult option for the private entity.

Project functions

A distinctive feature of PPP contracts is that they make together many functions of the project. Depending on the type of asset or service to be provided, the functions assigned to the private entity may vary. Such functions can be:

- **Design:** This function entails taking the project from its initial concept and developing it further to its building-ready design standards.
- **Build or rehabilitate:** Especially in cases of infrastructure assets, the private party is often required to build the asset (greenfield project). In other cases, when the asset is already existing, the private only has to rehabilitate or upgrade it to a functional state (brownfield project).
- **Finance:** Especially in greenfield projects, the private party is usually supposed to finance a part or all the capital necessary to build the asset.
- **Maintain:** During the life of the contract, PPPs delegate the task of maintaining the infrastructure asset to an agreed quality to the private party.
- **Operate:** The private party's operational duties in a PPP may vary significantly depending on the type of facility and the related service. He may be in charge of technical operation of the asset as well as provide a service to a public entity or to the users directly. In other cases, the private sector can be responsible for providing support services while leaving the delivery of public services to the government agency.

A researcher on the PPPs field, J. Keci, has identified some types of infrastructure contracts based on how the functions and project phases are agreed to be undertaken as shown in table 4. The World Bank has also published a list of the different types as shown in table 5 below.

Typically, the services are offered via a Special Purpose Vehicle (SPV). The private party creates the SPV as an independent company to allow for the separation of all income and expenses associated with the supply of services.

It is important to remind that the ownership concept does not always refer to the possession of the asset itself but to the economic rights to exploit that asset also. In this context, BOT and BTO contracts do not differ significantly, as the private party may have the right to use the asset as a guarantee or use the proceeds from its operation even after the transfer. Speaking about ownership of the asset may be considered inappropriate during the duration of the contract, as the owner of the asset is really defined after the expiration of the contract.

Type/Model	Description of the model
Design-Build (DB)	The government contracts a private partner to design and build a facility in accordance with requirements it sets out. After completing the facility, the government assumes responsibility for operating and maintaining the facility. This method of procurement is also referred to as Build-Transfer (BT)
Design-Build-Maintain (DBM)	This model is similar to Design-Build, except that the private sector also maintains the facility. The public sector retains responsibility for operations
Design-Build-Operate (DBO)	With this model, the private sector designs and builds the facility. Once it is completed, the title for the new facility is transferred to the public sector, but the private sector operates the facility for a specified period. This procurement model is also referred to as Build-Transfer-Operate (BTO).
Design-Build-Operate- Maintain (DBOM)	This model combines the responsibilities of design-build procurements with the operations and maintenance of a facility for a specified period by a private sector partner. At the end of that period, the operation of the facility is transferred back to the public sector. This method of procurement is also referred to as Build-Operate-Transfer (BOT)
Build Operate Transfer (BOT)	PSO enters concession contract to design, build, finance, and operate a public sector facility over an agreed period. PVSO recovers investment over the contract period under the pre negotiated contract terms. The concession period is usually significantly shorter than the operating life of the facility.
Build-Own-Operate- Transfer (BOOT)	The government grants a franchise to a private partner to finance, design, build and operate a facility over a specific period of time. Ownership of the facility is transferred back to the public sector at the end of that period.
Build-Own-Operate (BOO)	The government grants the right to finance, design, build, operate and maintain a project to a private entity, which then retains ownership of the project. The private entity is not required to transfer the facility back to the government
Buy-Build-Operate (BBO)	Transfer of a public asset to a private or quasi-public entity usually under contract that the assets are to be upgraded and operated for a specified period of time. Public control is exercised through the contract at the time of transfer.
Design-Build- Finance-Operate/Maintain (DBFO, DBFM or DBFO/M)	Under this model, the private sector designs, builds, finances, operates and/or maintains a new facility under a long-term lease. At the end of the lease term, the facility is transferred to the public sector. In some countries, DBFO/M covers both BOO and BOOT.
Operate and Maintain (O&M)	Private sector organization (PSO) enters contract to operate a public sector facility on behalf of a public sector organization over an agreed period of time.
Build Lease Transfer (BLT)	Similar to D&B except that the public sector organization pays for the project over a long term lease; Transfer of title is made on completion of payment of lease
Build-Lease-Operate-Transfer (BLOT)	A private entity receives a franchise to finance, design, build and operate a leased facility (and to charge user fees) for the lease period, against payment of a rent.
Finance Only	A private entity, usually a financial services company, funds a project directly or uses various mechanisms such as a long-term lease or bond issue.
Operation License	A private operator receives a license or rights to operate a public service, usually for a specified term. This is often used in IT projects.

Table 4: Models of Public-Private Partnerships (Keci, 2015)

Contract Nomenclature	Overview Description and Reference	Type of Asset	Functions Transferred	Payment Source
Design-Build-Finance-Operate-Maintain **(DBFOM)**; Design-Build-Finance-Operate **(DBFO)**; Design-Construct-Manage-Finance **(DCMF)**	Under this nomenclature, the range of PPP contract types is described by the functions transferred to the private sector. The maintain function may be left out of the description (so instead of **DBFOM**, a contract transferring all those functions may simply be described as **DBFO**, with responsibility for maintenance implied as part of operations). An alternative description along similar lines is Design-Construct-Manage-Finance (**DCMF**), which is equivalent to a DBFOM contract.	New infrastructure	As captured by contract name	Can be either government or user pays
Build-Operate-Transfer **(BOT)**, Build-Own-Operate-Transfer **(BOOT)**, Build-Transfer-Operate **(BTO)**	This approach to describing PPPs for new assets captures legal ownership and control of the project assets. Under a **BOT** project, the private company owns the project assets until they are transferred at the end of the contract. **BOOT** is often used interchangeably with BOT, as Yescombe (Yescombe 2007) describes. In contrast, a Build-Transfer-Operate (**BTO**) contract, asset ownership is transferred once construction is complete. As Delmon (Delmon 2015, 20–21) describes, ownership rights mainly affect how handover of assets is managed at the end of the contract.	New infrastructure	Typically, design, build, finance, maintain, and some or all operations. Under some definitions, BOT or BTO may not include private finance, whereas BOOT always includes private finance	Can be either government or user pays
Rehabilitate-Operate-Transfer **(ROT)**	In either of the naming conventions described above, Rehabilitate may take the place of Build where the private party is responsible for rehabilitating, upgrading, or extending existing assets.	Existing infrastructure	As above, but rehabilitate instead of build	Can be either government or user pays
Concession	Concession is used for a range of types of contract, as described in Delmon (Delmon 2010, Box 1 on page 9). In some jurisdictions, concession may imply a specific type of contract; while in others it is used more widely. In the PPP context, a concession is mostly used to describe a user-pays PPP. For example, in Brazil, the Concession Law applies only to user-pays contracts; a distinct PPP Law regulates contracts that require some payment from government. On the other hand, concession is sometimes used as a catch-all term to describe a wide range of PPP types—for example, all recent PPPs in Chile have been implemented under the Concession Law, including fully government-pays contracts.	New or existing infrastructure	Design, rehabilitate, extend or build, finance, maintain, and operate—typically providing services to users	Usually user pays— in some countries, depending on the financial viability of the concession, the private party might pay a fee to government or might receive a subsidy
Private Finance Initiative **(PFI)**	The United Kingdom was one of the first countries to introduce the PPP concept under the term Private Finance Initiative, or PFI. It is typically used to describe a PPP as a way to finance, build and manage new infrastructure.	New infrastructure	Design, build, finance, maintain— may include some operations, but often not providing services directly to users	Government pays
Operations and Maintenance **(O&M)**	O&M contracts for existing assets may come under the definition of PPP where these are performance-based, long-term, and involve significant private investment (sometimes also called performancebased maintenance contracts).	Existing infrastructure	Operations and maintenance	Government pays
Affermage (leasing, from French)	An affermage contract is similar to a concession, but with the government typically remaining responsible for capital expenditures. Affermage in particular may have a specific meaning in some jurisdictions. The World Bank's explanatory notes on water regulation (Groom et al. 2006, 36–42) describe lease contracts, as well as concessions. Such contracts may or may not come under the definition of PPP, depending on the duration of the contract.	Existing	Maintain and operate, providing services to users	User pays—private party typically remits part of user fees to government to cover capital expenditures
Management Contract	The state retains asset ownership, and capital expenditure is the responsibility of the public sector, whereas operation and maintenance is the handled by the private sector. These types of contracts are 3-5 years in duration.	Existing	Operations and maintenance	Management fees extended to the contractor
Franchise	Franchise is sometimes used to describe an arrangement similar to either a concession or a lease or affermage contract, as described in Yescombe (Yescombe 2007).	Existing or new	May include design, build, and finance, or may be limited to maintaining and operating an asset	User or government pays

Table 5: PPP Infrastructure contracts, types, and nomenclature (World Bank Group, 2017)

The three above-mentioned characteristics are the main parameters for classifying PPP contracts, while other parameters can be used for a more detailed and specific classification. Such criteria may be the degree of private funding involved, the type of the private company's service delivery duties (either wholesale or retail), the range of structures, and so on. Nevertheless, the main criteria accepted by all authors, countries, or jurisdictions, are the ones analyzed above.

In some countries, like Brazil and France, only government-pay contracts are considered PPPs, while the user-pay ones are referred to as concessions. In Chile, all PPP contracts are called concessions. In the UK, green-field government-pay PPPs are considered as Private Finance Initiatives (PFI), while PPPs for brown-field projects are considered franchises. Thus, while the main classification criteria are the same, the terminology may vary in different countries and jurisdictions. (World Bank Group, 2017)

Moreover, the PPP experience varies in different countries when it comes to the sectors and services they provide, as the public services concept also differs. The World Bank has identified several types of assets and services that PPPs can provide for different infrastructure sectors, as shown in table 6 below.

Sector	Project Types
Transport	Roads, tunnels, and bridges Rail Mass transit systems Ports Airports
Water and waste	Bulk water treatment Water distribution and sewerage systems Solid waste management services
Power	Generation assets Distribution systems
Social and government infrastructure	Education—school facilities and services Health—hospitals and other health facilities and services Prisons Urban regeneration and social housing projects

Table 6: PPPs by sector (World Bank Group, 2017)

Some governments may decide to use PPPs only in specific sectors, aiming to focus on the country's priorities or improve service delivery in those sectors. Other countries identify certain sectors as core services, an exclusivity of the government that cannot be provided by any private party. Such services can include the health-care sector, education, and so on.

The boundaries between PPPs and other forms of participation of private entities in public infrastructure are quite narrow, and sometimes they even get confounded with privatization, outsourcing, or other forms of public infrastructure contracts. Therefore, explaining what PPPs are not could be helpful in better understanding their concept and clarifying their position.

4.3 What PPPs are not

The real position of PPPs is mid-way between public and privatized ownership, as shown in figure 14 below.

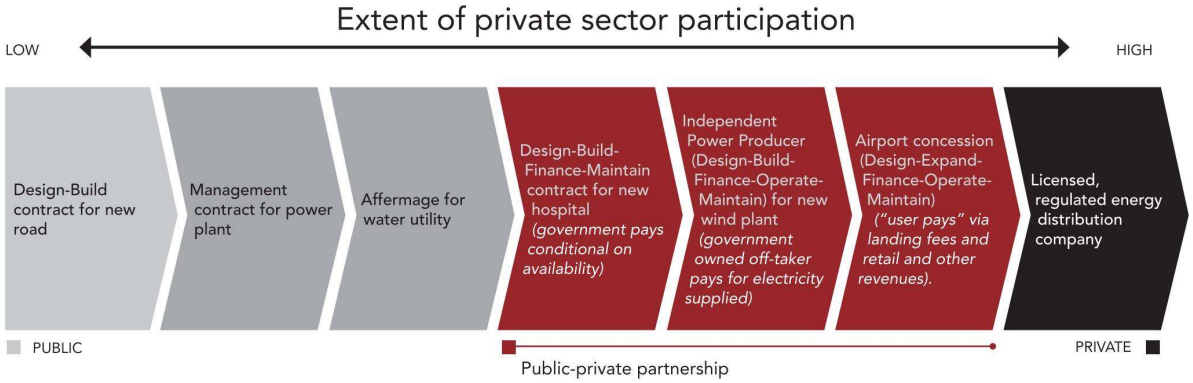

Figure 14: PPPs, midway between public and private (World Bank Group, 2017)

In the case of PPPs, the government remains the owner of the provided asset and the private entity has no ownership or transfer rights over it, while in privatization the state completely withdraws from its ownership rights.

In a PPP, the government is always present during the lifetime of the infrastructure asset. Either as the purchaser of the services from the private entity, or as the ultimate service provider when the private leaves the project or when the partnership contract ends, the state is always engaged. In contrast, when the asset is privatized, the government's engagement ends right after.

Furthermore, under the PPPs, the public sector remains accountable for the provision of the service to the citizens. The government regulates its responsibility towards citizens through a contract agreement that helps the public authorities to maintain control and supervision over the performance of the private investor.

Another attribute of PPPs that make them differ from Privatizations is their duration. PPP contracts are for a limited duration of 15-30 years or more, while privatizations are for an indefinite period from the moment the property is transferred to the private.

Furthermore, PPPs are tightly associated with public planning, considering their final outcome, while in Privatizations, such an association is quite seldom.

Compared to outsourcing, PPPs assume much more risk overtaking by the private entity. The private is paid to provide goods and services according to specific requirements, as well as all the administrative, technological, and financial sources necessary to meet these requirements. PPP agreements do not imply one-off engagements of the private as outsourcing contracts, but long-term relationships based on strict performance regimes.

Moving on, it is important to clarify the difference between PPPs and other forms of contracts that provide public assets and services, like Design-Build or Turnkey contracts, Management contracts, Affermage contracts, or Financial Lease ones.

Design-build or Turnkey contracts are also performance-based and include specific requirements like PPPs, but differently from them, their duration is much shorter, and they do not include operation or maintenance. As such, their performance requirements are not as strict as in PPPs. Due to the short involvement of the private company, these types of contracts are not appropriate for complex infrastructure projects. They may lead to unsuitable design which allows contractors to take shortcuts that result in increased maintenance and operation expenses.

Like PPPs, Management Contracts are performance-based contracts and as such the private party accepts to bear risks that are not beard by the government. Nevertheless, they don’t involve the same high private investment and the same long-term duration as PPPs.

Affermage contracts are typically used when the government is able to invest on its own on the assets and only delegates the management of the public services to the

private in exchange of a specific fee. In contrast to PPPs, in such contracts, the private company doesn't have to make any infrastructure investment.

Finally, Financial Lease contracts are contracts between public and private entities for the provision of public assets. Similarly to PPPs, they are also long-term, but unlike them, the role of the government in bearing risk here is much higher. The management and performance risk delegated to the private party is much smaller as they are not projected to result in major improvements in service quality or cost reductions.

4.4 How can PPPs help to overcome infrastructure challenges?

PPPs were born as a solution to the challenges and needs of public infrastructure. Besides the lack of financing sources already mentioned, infrastructure is facing several other challenges, from inadequate project selection and planning to inefficient delivery and inappropriate maintenance.

These challenges are directly reflected on society and its wellbeing, besides the economy of a country. According to the World Bank, in 2016 there were more than 2.4 billion people that didn't have access to appropriate sanitation. Over 1 billion people had no electric power in their homes, and at least 663 million could not get clean drinking water. (World Bank Group, 2017)

Many of the challenges that infrastructure is facing derive from problems in public agencies. These issues rise due to the large amounts of money involved in infrastructure projects, that make them more sensitive to fraud and corruption. Politicians may use promises for new infrastructure projects during elections to buy votes. They are the ones responsible for planning and selecting these projects and they may use them for personal interests, while the consequences are paid by the taxpayers. Such problems with governing agencies are one of the main reasons why infrastructure projects fail.

Another issue is the quality of infrastructure assets and services provided. Even existing assets are frequently neglected and not well-maintained, resulting in increased expenses and diminished returns. Figure 15 below illustrates schematically the challenges and how PPPs may help to overcome them. Each challenge and the solutions offered by PPPs will be addressed in the following sections.

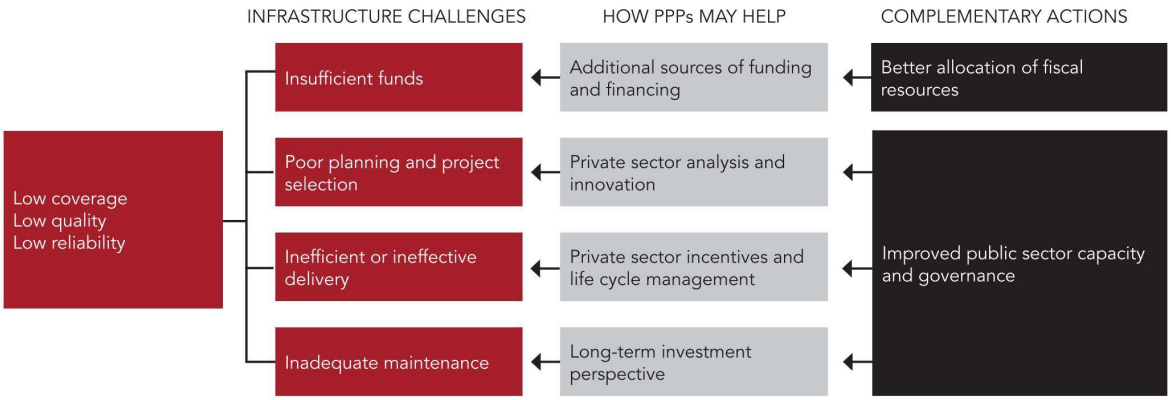

Figure 15: The challenges of infrastructure and how PPPs can help (World Bank Group, 2017)

Insufficient funds

The consequences of lack of funds in public infrastructure are already tackled in the previous chapter. PPPs are considered as a good solution to mitigate this challenge in the context of increasing needs for infrastructure assets and services, through the fiscal space they offer. The extent of this space depends on the type of project. User-pays contracts offer long-term fiscal flexibility, while those that include government payments provide that space just in the near term.

Recent research indicates that nowadays it is more reasonable to discuss a funding deficit rather than a financing deficit (World Bank Group, 2017). Governments may ask private entities to finance the projects and many of them may be able to do it, but none of them will show up if the projects don't offer a sufficient return on investment. That's why public authorities have to increase fundings through measures like modelling user fees or sale of existing assets. PPPs, in the meantime, can help increase the available fundings by improving the user-fee administration, eliminating leakages in fees collection, or implementing targeted user-fees.

Alternative uses of the infrastructure assets are another way of increasing revenues. Initiatives like development of commercial areas within them (e.g. inside an airport or train station) have demonstrated to be successful. On this aspect, private parties are more able to recognize the potential and develop assets to increase profitability, compared to public ones.

PPPs can also help governments in alleviating their borrowing limitations. Governments are frequently restricted from borrowing due to contractual arrangements with international institutions or due to their own financial management policies. Such barriers can turn into obstacles even for the development of totally user-pays public infrastructure projects by the public sector. Because projects under PPPs are financed by the private party, they can help governments to overcome this barrier, especially when they are user-pays projects.

Increasing cost recovery through optimization of assets/services delivered to the users is another possibility that PPPs offer. The private partner has the opportunity to improve the project and offer additional, better services to the users, prompting them to contribute towards the increase of funds, instead of waiting to be subsidized by the government.

Of course, the abovementioned initiatives can also be taken by governments, but according to studies, it is harder for them to charge customers a fee for publicly offered services, compared to private companies (World Bank Group, 2017).

Furthermore, even though a PPP is expected to generate more resources by charging the users, governments often have to incur some project risks. They may offer guaranties on risks such as currency rates, specific prices, demand variations. In PPP contracts, such guaranties are translated into compensation clauses in the event of contract cancellation. Sometimes, these guaranties may cost more than expected due to decreased demand or low revenues.

Even without these kinds of guaranties from the government, every PPP contract contains liabilities originating from the necessity to save the project (e.g., in the event of the private entity’s bankruptcy). In these cases, the state is under pressure to help out in an effort to minimize service interruptions to its citizens.

Thus, despite the many solutions that PPPs may offer for public infrastructure financing, the choice to go with a partnership instead of another implementation model is not based on these advantages. Such decisions are based primarily on cost/benefit analysis and value-for-money assessments. Nevertheless, it is absolutely necessary to calculate the cost of risk transferring to the private entity, as well as the value that such a decision may bring to society.

Poor planning and project selection

Limited resources wasted on ill-chosen projects which are not proportional to their costs is another issue of public infrastructure. Such projects, characterized by underutilized assets and inadequate service delivery are generated from poor planning and lack of coordination between sectors and subsectors. Without effective planning and cross-sector cooperation, relevant agencies will not have a complete picture of which are the feasible projects that may be done, or the best order of implementation to get the most value for money. Good planning and coordination on the other side, can save up to $1 trillion expenses per year in infrastructure (World Bank Group, 2017).

Incorrect analysis is another challenge that characterizes the selection of infrastructure projects. Poor analysis based on optimism bias results in projects that are only theoretically cost-benefit reasonable. Benefits are frequently overstated, while costs are undervalued, and the complexity or size of the project is much higher than the demand for the services it provides.

According to a survey of 258 transportation projects, real costs were 28% higher than budgeted costs, and for projects outside of Europe and North America they exceeded by 65%. Moreover, in a survey of 25 rail projects, traffic was shown to be significantly exaggerated, with average traffic being more than double that of actual traffic (World Bank Group, 2017).

Another significant factor influencing project selection is politics and its high corruption levels. In countries with high levels of corruption, politicians may interfere by implementing projects whose size and complexity don’t justify their purpose, or projects that lack in quality.

All these elements can also interact with one another. For example, projects favored for political or personal profit are often backed up by poor analysis and planning that misrepresent their real costs and benefits.

On this aspect, PPPs come to help by mitigating the factors that lead to poor planning and project selection. Private investors are directly interested in increasing their revenue. Financial return is directly dependent on accurate cost and revenue estimates; thus, they are directly interested in leveraging the analysis and selection of projects. In most cases, they make their own research based on their own expertise and profit-driven interests. On this aspect, non-feasible projects are directly rejected by

contractors since the tender phase of a PPP. Furthermore, big contractors, with a long experience and level of expertise can also come up with their own ideas of new projects that they propose to the public authorities in the form of unsolicited bids. Such proposals can provide valuable insight into project selection.

Despite their positive impact in project selection, PPPs may not be so helpful regarding planning. For example, if a project is tendered by the government and it is found not viable by the private entity, they may avoid it and all the planning work done by the public institutions is gone to waste. In other cases, their project ideas may not be in line with the government's investment priorities. Also, being a long-term commitment, they are more expensive than traditional public procurement forms when changes are required to be made. Furthermore, they can also fall into optimism bias and exaggerate numbers in their demand analysis, although their assumptions are more realistic than those of the public sector. In the end, if the risk they have to bear is not high on a certain field, their motivation for thorough study is also diminished.

In conclusion, PPPs must go through the same scrutiny and rigorous procurement competition as other big public investments so that their effectiveness in mitigating project selection and planning can be fully exploited.

Weak management

Studies have shown that when it comes to managing infrastructure building projects and service delivery after the assets are built, the private sector is more efficient and effective than the public one. Limited capacity and insufficient managerial incentives frequently hinder the quality of infrastructure services by government bodies. According to the World Bank, it is often more difficult to train, retain, and lead qualified employees in the public sector. (World Bank Group, 2017)

However, the government's role in organizing, tendering, and implementing a PPP is crucial to obtain the benefits they offer. They can even be jeopardized by poor government or private capacities, like weakly managed tendering processes, poorly conceived contracts, or recurring negotiations.

PPPs have shown to benefit the construction of new infrastructure assets by reducing their implementation time and cost overruns. According to the World Bank, when compared to traditionally tendered infrastructure projects, the number of overbudget or delayed PPPs is much lower. In a study done in Australia, it resulted that both PPPs and

traditionally procured projects had delays but in different phases of the project. In PPPs the delays are experienced in the early stages, due to the complex contracting procedures, but once contracted, they are implemented on time. In publicly tendered projects, the contracting process is quite fast, but implementation takes more time. Cost estimates, on the other hand, have shown to be more accurate in PPPs than in traditionally procured projects, due to a greater discipline imposed in them. Such discipline is due to the more detailed analysis of project's specifications as well as the inflexibility of PPP contracts when it comes to changes in costs. In contrast to traditional contracts, the return of PPP projects depends entirely on their completion on time and on budget. (World Bank Group, 2017)

Furthermore, according to another study of the World Bank, regarding the influence of private sector participation in public services delivery, there were found efficiency benefits when private parties participated, either through concessions or full privatizations of utilities. Such benefits in water and electricity utilities included better service delivery, like expanded coverage and service hours per day, as well as less water losses and improved staff efficiency. (World Bank Group, 2017)

Nevertheless, like in the previous paragraphs, benefitting from these PPPs improvements depends a lot on governments' efficiency of organizing, acquiring, and administering the PPP project throughout its life cycle. The government's influence on this aspect is to increase competition, provide better risk transfer, and make sure that improvements are actually made in reality. Even in nations with a lengthy history of PPP adoption, ensuring fair competition in procurement procedures may be difficult. First of all, the government must come with a well-organized project that is subjected to a competitive bidding procedure. If not, the bidders may either not participate in the tender, or make offers that are intentionally low, with the goal of addressing ambiguities through post-bid dialogue. According to Guasch's study of 1000 concessions in Latin America during 1985 and 2000, it resulted that 55% of transportation contracts, 10% of electric energy contracts, and 75% of water contracts were restructured almost 2 years after their initiation (Guasch, 2004). These results can be explained by weaknesses in the procurement process and regulations, as well as opportunistic behavior that favored the operator, like raised fees and decreased or postponed investment commitments.

Inadequate maintenance

Infrastructure projects are usually characterized by poor maintenance and a greater allocation of funds to the construction of new assets over maintenance. Lack of maintenance increases costs of operation. According to a study of the World Bank, preventive maintenance of roads in Africa could save up to USD2.6 billion per year. Furthermore, the cost of preventive maintenance of roads increased up to six times when delayed by three years, and up to eighteen times when delayed by five years. (World Bank Group, 2017)

In most of the cases, users also have to pay a price for poor maintenance of infrastructure assets. It is estimated that the costs of repairs and operation for American drivers reach up to USD67 billion per year due to poor road maintenance (World Bank Group, 2017). Therefore, major infrastructure projects need a whole life cycle cost analysis that includes their operation and maintenance.

PPPs can serve as good incentives for either the private or public sector to prioritize maintenance of infrastructure assets. Because construction and maintenance are combined in a single contract, encouraging the private entity to construct with high standards from the start, and decreasing the need for maintenance later. This is true either for user-pays or government-pays contracts. In the first case, the private company has a high motivation to ensure that the asset fulfils performance standards that satisfy the customers. In government-pays contracts, it is the government that commits in advance to provide sufficient funds for the asset's maintenance.

Private parties in PPP contracts have not only the motivations to provide adequate maintenance service, but they also have better means and equipment to achieve that. Government agencies depend on budgetary allocations, while private contractors are encouraged to present investment strategies that include maintenance funds through a life-cycle plan.

In user-pays contracts, the abilities of PPPs to improve maintenance of infrastructure assets can be limited due to the state of monopoly provider of the private company. The same can happen in government-pays contracts due to vague specification of the quality requirements in the contract and lack of inspection. Moreover, when the contractor has little ownership or revenue on the project, he will prefer to walk away from it instead of spending on expensive upkeep. Finally, near the conclusion of the

contract, when the contractor realizes he will not enjoy the benefits of additional maintenance spending, he may neglect it. Therefore, the final stage of completion has to be backed up by specific contract terms dealing with the handover of the project, so that the private contractor keeps the same commitment regarding maintenance until the end. Thus, a good contract design and a fair competitive procurement process are essential to benefit from PPP advantages.

4.5 Lifecycle of PPP contracts

PPP contracts are generally assumed to go through six main phases, from their conceptualization to their hand back. The APMG Public-Private Partnerships Certification Program has summarized the tasks executed in each phase in the table 7 below.

This cycle is typical for cases when the project identification and selection is done on a project-by-project basis, and not through a program approach. In that case, the first phases, such as the project identification, selection, and screening as possible PPPs are done as part of the program that the public authorities have decided to develop. It is also important to emphasise that this sequence of phases is mostly used for projects that are preferred to be implemented as PPPs in the first place, instead of any other traditional type of contract. That is typical of projects that lack funding, and their immediate implementation is crucial to the infrastructure development of a country. Thus, the investment decision is linked to the procurement decision. This way, the government saves money on appraisal if the project may not be feasible as a PPP. Furthermore, in this structure, the tasks of each phase can further develop through the next phases and depend on them. Thus, it is not uncommon going back to previous tasks as the process moves forward. Finally, the tasks on each phase are also defined by the local legal framework and policies.

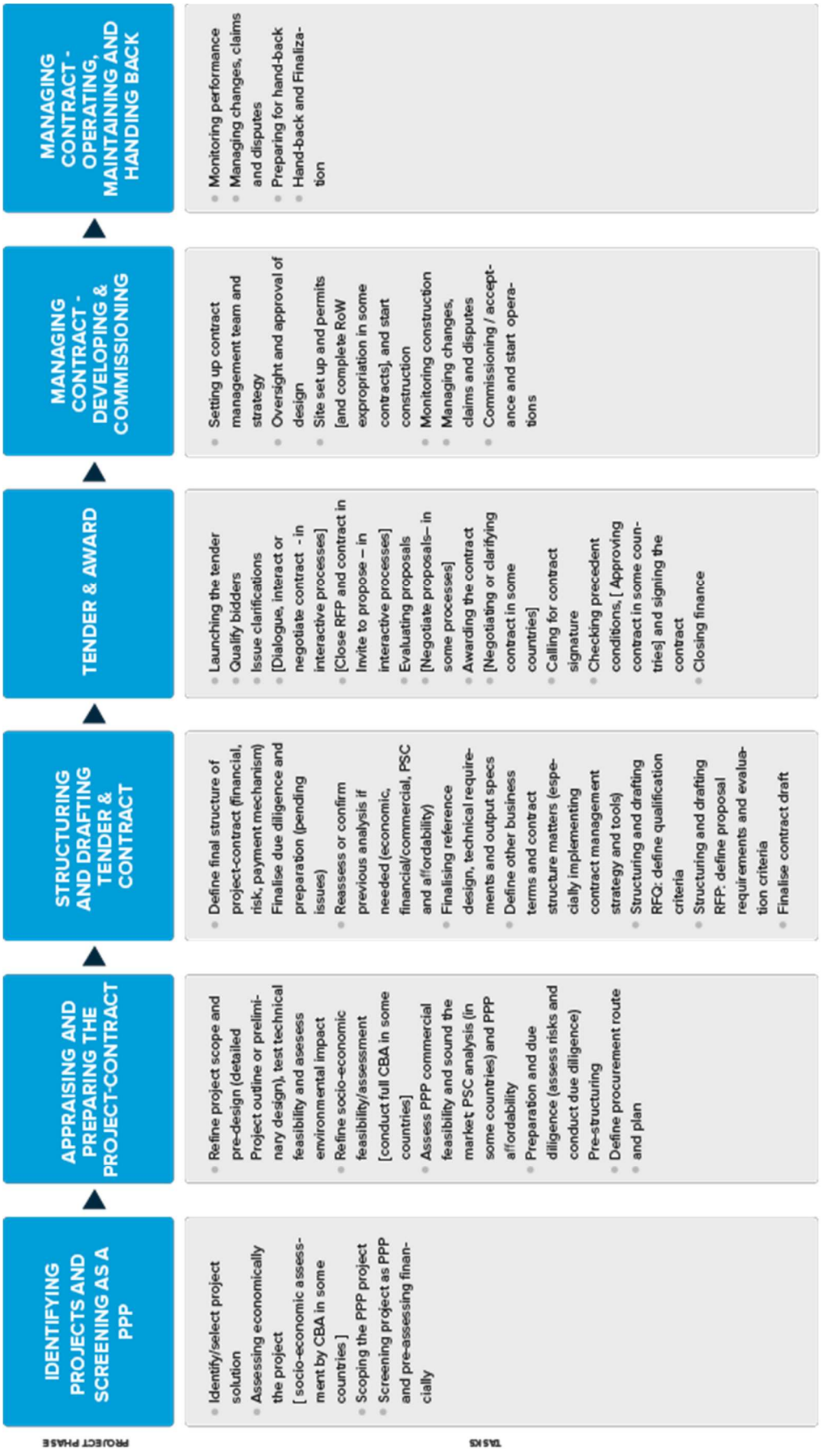

Table 7: PPP process cycle (The APMG PPP Certification Program, 2022)

Project's identification and screening for PPP procurement

A PPP project must be built over an adequate technical solution. The aim of the first phase is exactly the identification of such a solution and the pre-assessment of the viability of the project as a PPP. By screening it beforehand, the government saves resources on unnecessary studies and procedures which are quite expensive in the case of PPP contracts. The tasks to be completed in this phase are as follows:

- Identification and selection of project solution among different options
- Determining the scope of the project
- Economic evaluation of the project and, if necessary, prioritizing the most valuable projects
- Screening the project as a prospective PPP
- Develop a project management strategy and define the project team as part of the project governance during the preparation of the tender

The identification of prospective projects is a process that is typical of infrastructure planning, despite the procurement method. It is not strictly related to the PPP cycle as in most countries such projects are already identified as part of the infrastructure development plans. Nevertheless, it is a crucial task in the PPP life cycle and has to stand by project screening and appraisal. Before deciding on the form of procurement, it is necessary to decide what is the best technical and strategical solution to an infrastructure need or problem. For example, if a city is facing traffic congestion problems, there are three possible solutions: an investment on light rail transport system, a metro system, or an improvement of the existing road network. Besides them, there is always another option to be considered: doing nothing. The optional solutions will be compared and analyzed through different analysis methods. Methods like CBA, cost-effectiveness, or multi-criteria analysis help to identify the most suitable solution in general terms, as the cost estimates are only preliminary. The project scope defined in this phase is also in the form of an overview that will be further developed later. In some countries, the analysis executed on this phase are considered as pre-feasibility exercises.

After the identification, the project is screened as a potential PPP contract. To do that, besides defining the contract scope, it is also necessary to conduct preliminary tests that establish whether it is appropriate to use the PPP procurement method. The

screening report includes a project management plan and schedule also. Based on the results of the PPP screening report, it is then possible to proceed with a full appraisal of the project and the contract as a PPP.

Project's evaluation and contract preparation

The goal of this phase is to assess the feasibility of the project and the PPP contract in order to avoid the risk of failure during the tender process or throughout the project's contract life. The following is a typical list of tasks to be completed during this stage:

- Expand the pre-design and scope of the project, as well as evaluate technical feasibility and analyze its environmental impact
- Examine the economic viability of PPPs (including their bankability)
- Fine tune the socioeconomic feasibility analysis, or conduct it thoroughly from the start
- Other financial evaluations, including Value for Money (VfM), analysis of the affordability of the PPP contract, as well as the impact on national accounting in some countries
- Risk assessment and due diligence tasks
- PPP preliminary structuring
- Create a procurement strategy and plan

The process of appraisal and feasibility studies is mandatory for all projects, especially the public infrastructure ones, despite their procurement method. Nevertheless, PPP projects are characterized by specific tasks and features. First, the preparation of the tendering phase for PPPs is more demanding, and as such, longer than traditional forms of procurement. The feasibility study for these projects is expanding in two phases. At first, it is assessed if the project is the right solution to the presented needs, which is done in the identification phase. Then, the second phase is concentrated on analyzing the risk level of the project. A thorough CBA determines if the project is worth the money to the society in this regard. Besides the economic viability, the feasibility study must be conducted for technical, social, environmental, and legal aspects. Afterwards, the PPP option is compared with other conventional procurement methods to determine if it is the best option that can deliver additional benefits to the project.

The approach towards the project's appraisal can vary among different countries based on the government's financial position. In countries where the financial

resources are limited, governments are interested in using PPPs as an alternative to public finance. In this case the investment decision is done together with the procurement decision. In contrast, in more developed economies, the main reason for implementing PPPs is to increase productivity and efficiency. These governments are able to make the investment decision before assessing the possible procurement methods. They first consider if the project should continue based on socio-economic analysis, and then determine if the PPP method of procurement would provide higher value for money than other methods. In this case, the initial step is the development of a strategic business case that identifies the problem to be solved, the possible strategic responses, and the benefits derived from them. Based on the analysis of the strategic business case, it is then decided whether to continue with a more thorough full business case. The full business case includes full CBA that can be done even for more than one project solution. The different solutions are compared and the best one is identified, developed, and analyzed more thoroughly. Finally, the full business case contains a comparative analysis of the different procurement strategies and identifies the most appropriate one for the selected project. This process is backed by the detailed CBA analysis and other appraisals done previously, thus a good understanding of the project that helps in identifying the best procurement option.

Nevertheless, the feasibility study is not finished here. In many cases, issues related to commercial and financial feasibility or affordability, that are specific to the PPP method, are developed on the next phase. Preparation on the other hand, refers to activities undertaken before tendering, like due diligence of risks that may threaten the project's success. These activities may continue on the next phase, but they should end before the project is tendered.

The outcomes of this phase include the feasibility assessment, a procurement plan, as well as a preliminary PPP structure of the project. The procurement plan is influenced by the local legal framework and common practice. In general, there are five main forms of tendering: open tender with one stage, open tender with a pre-qualification stage, restricted procedure with shortlisting, negotiated process that implies shortlisting with negotiations, and the dialogue process. The finalization of the procurement plan opens the green light to the next phase which is the structuring of the contract.

Structuring and drafting of tender and contract

The aim of this phase is to define and construct a tender process and a PPP contract that protects and maximizes the value for money of the project. As shown in table 7, the following tasks are completed in this phase:

- Establish the final structure of the contract, including risk allocation and structuring, specification of payment method and other financial arrangements
- Complete the due diligence and preparation initiated in the appraisal phase
- If necessary, re-evaluate or confirm earlier studies (economic, financial, and commercial), maybe incorporating fresh market testing, as well as upgrading the affordability study
- Complete the reference design and the technical specifications
- Further development of contract management strategy
- Establish the qualifying requirements, design and draft the Request for Qualifications (RFQ)
- Design and prepare the Request for Proposals (RFP) by establishing proposal requirements and assessment specifications
- Complete the draft of the contract that will be published together with the RFP

There are two outcomes to this phase: the structured and drafted project contract, and the structured procurement package of documents that includes the RFQ and the RFP.

The project contract is developed over the preliminary draft from the previous phase. Risk analysis and allocation are developed in further detail, together with the payment mechanism and other business terms that need to be made clear.

Structuring of the tender documents and procedures include the specification of the bar for qualification criteria, specific assessment requirements, submission time, the bid bond requirements, and so on. All the contents and terms of the tender package are drafted on this phase, including the RFQ and the RFP. The aim is to prepare a tailor-made tendering process that fits to the specifics of the project. The duration of the documents drafting varies depending on the type of tender process. In open tender procedures, there is only one single package of documents that must include everything. Documents like qualification requirements, evaluation criteria, and the contract rules are part of the whole package of the RFP. In contrast, in two-phase processes, the RFP and the RFQ do not have to be finalized at the same time. The RFP can be refined and finalized during the qualification process.

The documents are closed and submitted for internal approvals after all evaluations have been completed in line with contract structure revisions, to get the green light to begin the tender process.

Tendering & Award

The main objective of this stage is to select the offer of the most optimal value in a just and competing environment. The tasks completed during the tendering and award phase are as follows:

- Opening the tender
- Qualifying bidders or shortlisting them in some cases
- Clarify any issues of the bidders
- Communication and contract negotiation in case of interaction tendering methods
- Launch the invitation for proposals in case of interaction tendering methods
- Assessing the proposals
- Negotiate offers in certain cases
- Awarding the contract
- Signing the contract
- Commercial close

The administration of the tender process as it was planned and regulated via the RFQ and RFP is the most important activity during this phase. The general objectives of the tender process are the same as any other procurement, but PPP processes are more complex, and their details require more attention from the tendering authorities. In general, the tender process goes through four main phases:

- Pre-qualification in open tenders, or shortlisting in pre-selection procurements
- Period from bid launching to bid submission in open tenders without pre-qualification, or from invitation to bid submission and negotiation in others
- Bid qualifications, evaluation, and award
- Contract signature and financial closure

The details of each phase vary depending on the type of tendering procedure. One-phase open tender processes usually go through launching and bid submission, qualification and evaluation, and finally award and signature. In some cases, there are

negotiations between the bidder and the tendering agency before the award of the contract.

The award stage itself may vary in different jurisdictions. In some cases, it is necessary to obtain a ratification by the legislative authorities like the parliament. In other cases, it may be divided into two sub-stages, the provisional award and the definitive one.

In open tenders with negotiation the process starts with the request for qualification to continue with the selection of the shortlist of qualified bidders. Afterwards, the shortlisted bidders can negotiate with the procuring authority on the terms of the contract. The offers may be submitted as a series or as a final bid. Finally, negotiations can be done even on the final stage of the award and signature. Besides the interaction part, the other procedures and challenges are similar to the other methods.

Finally, it is essential for the winner of the contract to achieve financial close, which means he has to possess the necessary finance for the development of the project. In some cases financial close is reached directly after signing the contract, and in others the awardee may ask for some time to achieve it. Afterwards, the construction phase starts.

Contract management-Construction phase

The main objective of this phase is to limit or avoid risks related with modifications, claims and conflicts by managing the contract in a proactive way and in compliance with building rules. The main tasks of this phase are:

- Creating a governance structure and a contract management team
- Defining and carrying out contract administration, as well as creating the manual of contract management for the construction phase
- Managing the site transfer, design and permits
- Managing delays
- Inspecting performance
- Managing stakeholders and collaboration
- Managing variations, claims, and conflicts
- Managing risk allocation and changes in the contract
- Managing payments in case of government-pays or co-financed contracts
- Commissioning or accepting the asset

- Preparing for the operation phase

The basis of the contract management strategy is already provided in the contract in the form of instruments such as:

- The financial structure and documentation
- Instruments for correcting errors and poor performance like fines, reductions, liquidated damages, or even premature termination
- The essential mechanisms for dealing with risks, variations, claims, and disputes

Nevertheless, besides the strategy, it is considered good practice to create a contract management manual. The manual should not be used as a reference document in place of the contract, but rather to assist the management team in tasks like clarifying inconsistencies or further development of the management procedures included in the contract.

Some of the activities undertaken in this phase are ongoing during construction, while others are episodic and undertaken only when risks arise. Such activities can be related to variation orders in contract service requirements, disputes, or compensation claims.

The commissioning of the assets and the authorization to continue with the operation or service, are the final steps that conclude the construction phase.

Contract management- Operation & hand-back phase

Similarly to the construction phase, the main objective of this phase is to limit or avoid risks related with variations, disputes, and claims, by managing the contract in a proactive way. On this aspect, some of the main tasks on this phase are as follows:

- Managing variations, disputes, and claims
- Monitoring progress
- Getting ready for hand-back
- Completion and hand-back

The basics of contract management on this phase are similar to those of the construction phase, with some specific elements related to the operation of the asset. The contract management manual also includes specific sections dedicated to the operation phase.

Considering that the objective of PPPs is to provide a service at a defined level, this is the phase when the correct monitoring of the performance, as well as the management of payment mechanisms starts. Therefore, the tendering authority must deal with issues like:

- Poor performance or non-compliance of the private contractor in delivering the contract specifications
- Share transfers or variations in ownership
- Changes in financial planning (refinancing)
- Monitoring of renovation plans, investments, and funds

The contract completion and asset handover to the purchasing authority are also included in this phase. The contract must include specific requirements for the handover process as well as technical requirements related to the quality of the infrastructure at this point. On this aspect, before handing over the asset to the authorities, the private company may need to make significant investments to fulfil these criteria.

5 Sustainability and Sustainable Development

The main purpose of infrastructure development is to meet and fulfill the needs of society. According to the last report of the United Nations, the current world population of 7.6 billion will reach up to 8.6 billion in 2030, and 9.8 billion in 2050 (UN, 2021). These numbers are indicators of increasing demand for new and upgraded social, energy, transportation, and water infrastructure.

Moreover, according to the Organization for Economic Cooperation and Development, it is expected that the water consumption will increase by 55% and the energy demand by up to 85% if the “business-like” approach towards infrastructure remains the same. This may result in a worldwide water supply breakdown and threatening climate-related events, like severe floods, sea-level rises, severe storms, and extreme heatwaves. (OECD, 2012)

Such events have already been rising during the last decades, as shown in figure 16 below:

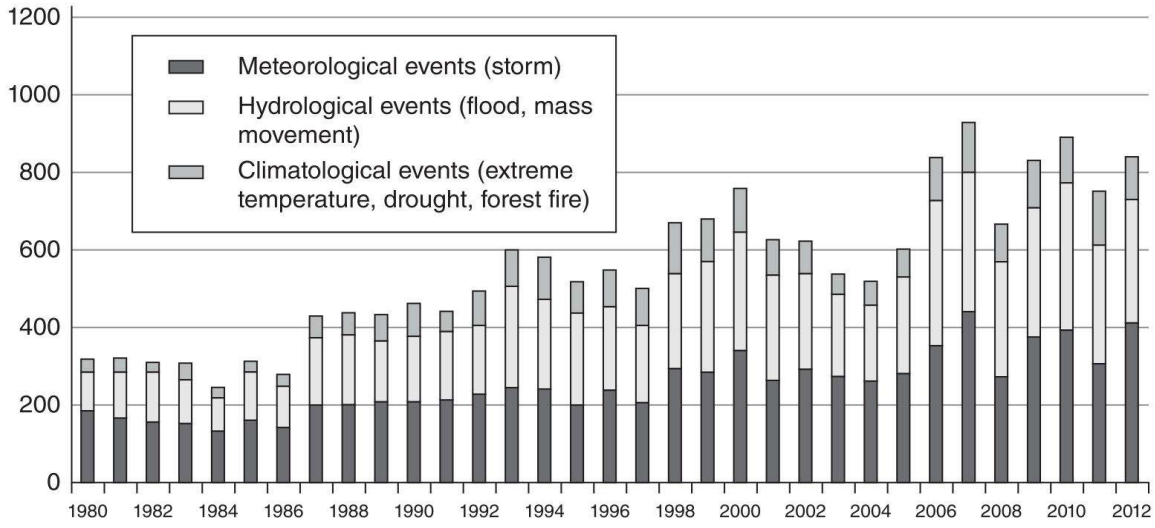

Figure 16: Weather-related catastrophes worldwide 1980–2012 (Weber et al., 2016)

According to the World Meteorological Organization (WMO), over the last 50 years, there has been one disaster related to climate, water, or weather hazards, happening every day. These events have left behind 202 million USD of losses and 115 deaths daily. (World Meteorological Organization, 2021)

Infrastructure shares the same main goal with sustainability, which is, as mentioned before, to meet the present and long-term needs of societies. They are strongly interrelated to each other. Future effects of infrastructure systems on the environment

and community will be greatly influenced by how we select, build, and manage them now. In exchange, this will have an impact on how vulnerable infrastructure assets are to hazards from the environment, society, and governance issues. Environmental risks are related to damages on the physical integrity of the assets due to ecological disasters such as floods, storms, wildfires, or even pollution and degradation in time. Social risks related to health and safety, human and consumer rights violations, unfair competition, and violation of indigenous peoples' rights, are all factors that might influence an infrastructure project. Finally, governance risks can derive from missing rules and laws, misconduct (like corruption), or inappropriate management structures that generate conflict of interest between the stakeholders in an infrastructure project.

All these risk factors are asking for a change of approach in infrastructure development, from "usual business" towards sustainable development, presenting new challenges and opportunities in the field. Sustainable requirements have been more urgent lately, but they have been present throughout the world history for a long time. The history of sustainability, its definition and importance, can help to understand its evolution, current state, and expectations for the future.

5.1 Sustainability and sustainable development – definition and history

The first concept of sustainability dates back to the beginning of the 18th century. In Saxony, the intense deforestation for timber in the mining industry was bringing to extreme scarcity of wood and threatening the wellbeing of thousands of inhabitants. To prevent further degradation, the mining administrator of the region, Hans Carl von Carlowitz, devised a new regulation that restricted the quantity of cut wood to the number of trees projected to grow again (Weber et al., 2016).

This was the first stated notion of sustainability that recognized the interdependency of human well-being, economic development, and management of natural resources.

The concept of sustainable development was born later, by the end of the 20th century. The first official definition was given in the Bruntland Report of 1987, for the World Commission on Environment and Development (WCED), as follows:

"Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987).

The difference between sustainability and sustainable development is that sustainability itself is the long-term goal of the many processes that make up sustainable development, and that aim to achieve that goal. The challenge of sustainable development is figuring out how to balance the three pillars of sustainability: Environment, Economy, and Society needs.

During the last years, there have been many meetings, agreements, and ratified regulations aiming to accelerate the integration of sustainable development principles.

The starting point was the Earth Summit held in 1992, in Rio de Janeiro, where the UN introduced two frameworks: the Convention on Biological Diversity, and the non-binding sustainable development action plan named Agenda 21.

Afterwards, in 1997, the Kyoto Protocol set binding objectives for developed countries to cut CO_2 emissions by 5% by 2012 in comparison to the levels of 1990.

The United Nations introduced the Global Compact program in 1999, which included guides for environmental preservation, human rights, labor, as well as a framework of sustainable business practices.

The Millennium Declaration was established by the United Nations in 2000. It is a set of sustainable development goals, aiming to guarantee the well-being of coming generations.

All countries, including China and USA, pledged to limit global warming to 2 degrees Celsius over pre-industrial levels and to take further steps against climate change during the Climate Change Conferences of 2009 and 2010.

The problem of climate change was presented as an urgent threat to be dealt with in the Intergovernmental Panel on Climate Change (IPCC) in 2014. It was concluded that in order to avoid the threat, the emissions needed to be significantly reduced during the following decades, while the CO2 and other GHGs needed to cut near zero by the end of the century.

The Agenda 2030 presented in 2015 in the UN Headquarters in New York, was adopted by all UN Member States. The Agenda contains 17 sustainable development goals, and sets up a 15-year plan to reach these goals, as well as indicators to measure the level of achievement.

The Paris Agreement of 2015 marked a breakthrough in the UN Climate Change Conference (COP21) in Paris. The agreement states long-term objectives for all countries, like reducing the GHGs in order to keep the century's temperature rise to 2 degrees Celsius and aim further to 1.5 degrees. Each country was free to adopt and select the approach towards these goals. It also includes the commitment to finance developing nations in their efforts to prevent or adapt to climate change, as well as reviewing the commitment of every country each five years. Its highest importance stands in the fact that it is a legally enforceable agreement. It went into effect on November 2016 and has now 193 parties (192 nations plus the European Union). (United Nations, 2021)

Finally, one of the most important recent events was the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow, on October – November 2021. The aim of the COP26 summit was to speed up the progress towards the goals of the UN framework Convention on Climate Change and the Paris Agreement. COP26 was held after the 5 year due period when each country should bring forward their updated national plans known as Nationally Determined Contributions. There were 197 parties participating in the summit (196 countries and EU). (COP26, 2021)

Some of the successful outcomes were the investment funds in net-zero economies, transparency requirements for the private sector besides governments, and the decisions to hold more frequent meetings in order to pressure countries into accelerating their pace towards achieving the Paris Agreement goals. Nevertheless, many of the goals were still not reached. According to The Law Society, the summit failed to meet the 1.5 degrees target, by only decreasing the amounts of coal or fossil fuels, instead of phasing them out. There is progress compared to COP21 when the commitments could limit the temperatures only by 3 to 4 degrees. Nevertheless, according to data from Climate Action Tracker and International Energy Agency, the commitments of COP26 may help in reaching only 1.8 to 2.4 degrees Celsius. (Law Society, 2021)

It is important to explain the reasons behind the limitation of global warming to 1.5 degrees Celsius. A rise of 2 degrees would bring devastating effects on people and nature in the years to come. Almost a third of the earth's population would live under extreme heat on a daily basis, causing health concerns and an increase in heat-related mortality. The impact on nature is also expected to be severe. It is expected that at least once every ten years the Arctic Sea ice would melt completely wreaking havoc on the species and communities they sustain, as well as causing many meters of sea

level rise. The effects would be strong but less devastating at 1.5°C. There would be fewer species at risk of extinction, fewer food and water shortages, and less threats to economic progress. Air pollution, malnutrition, sickness, and exposure to excessive temperatures would all pose less of a threat to human health. That is why even a tenth of a degree of warming counts. (COP26, 2021)

5.2 Sustainable development goals

The 2030 Agenda of 2015 marked one of the most important events in the history of Sustainable Development as it provided a framework for the future of sustainability. The framework consisted of 17 Sustainable Development Goals (SDGs), acknowledged by all UN Member States, as an urgent call to action for all nations. Figure 17 below shows a graphic representation of the goals. The following paragraphs will give a short description of the progress of some of the goals that are mostly related to infrastructure.

Figure 17: Graphic representation of the Sustainable Development Goals (United Nations, 2022)

Goal 3: Good health and well-being – ensure healthy lives and promote well-being for all at all ages

As a result of the pandemic, the progress in health services has halted and the life expectancy is shortened. COVID-19 runs the danger of undoing ten years of progress

in mother and child health. While 90% of all nations continue to report interruptions to basic health services, evaluating the true effect of COVID-19 is disrupted by missing data. There is a short supply of health workers that have been stretched to their limits by the pandemic. It is estimated that there are 150 nurses and midwives per 10 000 people in North America, 40 in Europe, and only 10 in the Sub-Saharan Africa. Increasing investment in universal health coverage is considered essential. (United Nations, 2021b)

Goal 4: Quality education – ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

According to the UN report for 2021, the pandemic has wiped out 20 years of education achievements, with an additional 101 million or 9% of children in grades 1 to 8 that fell below the minimum reading proficiency levels in 2020. During the pandemic, many of the children were entirely reliant on caregivers at home. School completion rate has also experienced a fall and expected to get worse, despite the slight progress between 2010 and 2019. Generally, many nations lack the necessary educational infrastructure. It is estimated that only 56% of schools with basic infrastructure in less developed countries have drinking water, 40% handwashing facilities, and only 33% have electricity. (United Nations, 2021b)

Goal 6: Clean water and sanitation – ensure availability and sustainable management of water and sanitation for all

In 2020 it was estimated that there were 2 billion people (26% of world population) lacking access to safe drinking water, 3.6 billion (46% of global population) with no access to safely administered sanitation, and 2.3 billion (29% of global population) lacking access to basic hygiene. These numbers are alarming considering the importance of such an access to COVID-19 recovery. 2.3 billion people are counted living in water-stressed countries, while between 1970 and 2015 natural wetlands shrank by 35%. The progress towards the 2030 targets needs to double while 129 nations will not have water resources that are sustainably administered by 2030. (United Nations, 2021b)

Goal 7: Affordable and clean energy – ensure access to affordable, reliable, sustainable, and modern energy for all

According to the report of 2021, 759 million people lack access to electricity, with 3 out of 4 of them living in Sub-Saharan Africa. One third of the global population use

dangerous and inefficient cooking systems and energy efficiency improvement rate needs to accelerate and reach 3% until 2030, compared to 2% that it was until 2018. Moreover, modern renewable energy needs accelerated action, especially in heating and transport sectors. According to the report, renewable energy made up only 25.4% in the electricity sector, 9.2% in the heating sector and 3.4% in transport. (United Nations, 2021b)

Moreover, energy prices and insecurity are increasing significantly due to the war in Ukraine. While some European countries plan to respond the crisis by accelerating the transition towards renewable sources, others plan a coal comeback, jeopardizing the green transition goals. (United Nations, 2022)

Goal 8: Decent work and economic growth – promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all

Due to the pandemic, the equivalent of 255million full-time jobs were lost, which makes up around four times the losses due to the financial crisis of 2009. Almost 1.6 billion workers belonging to informal economy who lacked social safety, were severely affected by the pandemic. While the global economy is recovering and the real GDP per person is rising considerably compared to 2020, several nations' economies are not likely to reach their before-pandemic growth rates until 2023. The number of tourists has also significantly decreased, from 1.5 billion foreign visitors in 2019 to 381 million in 2020. It is not anticipated that tourism will return to 2019 levels for up to four years. The pandemic is expected to lead to an increase in youth being unemployed, or not in school or in a training, with 31% of them being women and 14% being young men. (United Nations, 2021b)

In the meantime, the war in Ukraine has disrupted supply chains and distressed the financial markets, besides skyrocketing prices of food, fertilizers, and fuel. The refugee crisis is expected to be followed by a worldwide food crisis. Russia and Ukraine provided more than 50% of sunflower oil and around 30% of the world’s need for wheat. Despite the slight rise of the global output at the beginning of 2021, the rising inflation, the disruption of the supply chains, political risks, and the growing debt in developing nations, led to another slow down by the end of 2021. World economic growth is expected to decrease by 0.9% points in 2022. (United Nations, 2022)

Goal 9: Industry, innovation, and infrastructure – build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

The SDG Report of the UN for 2021 states that the global manufacturing production plummeted by 6.8% in 2020 due to the COVID-19 crisis. The production of middle and high-tech goods, which saw a 4% gain over the same period in 2019, fueled economic recovery in the meantime. Demand for air travel decreased by 60% between 2019 and 2020, from 4.5 billion passengers to 1.8 billion. Rural road connectivity is significant to reduce poverty, while in 25 nations, about 300 million of the 520 million rural residents have no reliable access to roads. Finally, increased spending in research and development was essential to develop solutions for the COVID-19 crisis. About 2.2 trillion USD were invested globally in research and development, while there were estimated to be around 1235 researchers per million inhabitants. (United Nations, 2021b)

The manufacturing industry marked a recovery compared to 2021, but nevertheless, the rise is not full and even between countries, especially least developed countries. Except for automobiles and other transportation equipment, most medium- and high-tech sectors have approached pre-pandemic levels. Nevertheless, the car manufacturing industry is encountering greater problems due to the disturbances in the supply chain of resources and intermediate materials. (United Nations, 2022)

Goal 11: Sustainable cities and communities – make cities and human settlements inclusive, safe, resilient, and sustainable

The difficulties of slum dwellers in the cities have worsened due to the pandemic. The majority of the more than 1 billion slum dwellers are concentrated in three regions, Eastern and South-Eastern Asia, Sub-Saharan Africa, and Central and Southern Asia. The average global share of urban area allocated to streets and open public spaces is estimated at 16%, which is lower than the desired percentage of 30% roadways and 10% to 15% open public areas. While 156 countries have developed national urban policies, only half of them are implementing them. Convenient access to public transportation, which is living in 500m walking distance to a bus stop and 1000m to a railway or ferry terminal, is granted only to half of the world's urban population. (United Nations, 2021b)

The UN draft-report of 2022 states that by the end of 2021, local governments in 98 countries have indicated establishing catastrophe risk reduction policies, up from 51 nations in 2015. (United Nations, 2022)

Goal 13: Climate action – take urgent action to combat climate change and its impacts

Unfortunately, the UN SDG Report of 2021 states that the climate crisis continues, with no interruption. While the 2020 global average temperature was estimated as 1.2 degrees Celsius above the pre-industrial baseline, it is still off track to stay at or below the 1.5 degrees Celsius required in the Paris Agreement. The rising GHG emissions require shifting economies towards carbon neutrality. In the meantime, from 2015 to 2018, climate finance rose by 10%, totaling an average of 48.7 billion USD per year. There are 125 out of 154 developing countries that are formulating and implementing national climate adaptation plans in the highest priority areas like the main economic sectors and services, health, food security and production, land and water ecosystems, and freshwater resources. (United Nations, 2021b)

On April 2022, 193 partners (192 nations and the EU) have submitted their first nationally determined contributions (NDCs) to the United Nations Framework Convention on Climate Change, and 13 others submitted their second NDCs. The NDCs show that governments are developing more quantifiable adaptation objectives and indicators. Scientists suggest that global emissions must be decreased by 45% by 2030 compared to 2010 levels in order to keep global warming below 1.5 degrees Celsius. However, based on existing national promises, global emissions are expected to rise by over 14% over the next decade. (United Nations, 2022)

In general, in the latest draft-report of 2022, the UN considers the current situation a critical point, from which the world will either fail to reach its commitments or step up its efforts towards the 2030 goals. (United Nations, 2022)

5.3 Sustainable infrastructure – definition and benefits

Infrastructure itself is one of the sustainable development goals and an essential tool towards the achievement of other SD goals. Infrastructure's limitations hinder productivity and restrict access to employment, education, healthcare, and markets, whereas good infrastructure boosts socio-economic growth and well-being. The IDB Group defines sustainable infrastructure projects as follows:

“infrastructure projects that are planned, designed, constructed, operated, and decommissioned in a manner to ensure economic and financial, social, environmental (including climate resilience), and institutional sustainability over the entire life cycle of the project” (Inter-American Development Bank, 2018)

The Sustainable Infrastructure Tools Organization defines sustainable infrastructure as follows:

“Sustainable Infrastructure includes built or natural systems that provide a range of services in a manner that ensures economic, financial, social, environmental, and institutional sustainability – both in line with the Sustainable Development Goals and over the entire infrastructure lifecycle – from strategic planning all the way to decommissioning & repurposing.” (sustainable-infrastructure-tools.org, 2022)

Referring to the three-pillar concept of sustainability, according to Brauch:

“the term sustainable infrastructure refers to infrastructure projects that are economically, socially and environmentally sustainable” (Brauch, 2017)

In this regard, sustainability should be incorporated into all stages of the infrastructure project, from design, to development, operation, and maintenance. Despite the fact that sustainability features vary among the different types of projects, sustainable infrastructure is typically intended to provide economic, social, institutional, and environmental benefits. Figure 18 below shows a diagram of the different dimensions of sustainable infrastructure.

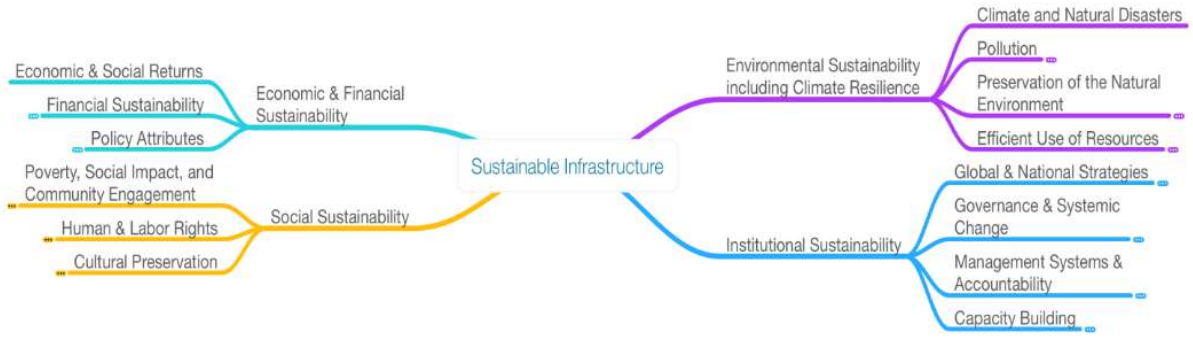

Figure 18: The four dimensions of sustainable infrastructure (Inter-American Development Bank, 2018)

An economically sustainable infrastructure is meant to maximize the value for money across the economy for governments or investors as well as taxpayers and users. Vast land use change and urbanization have put such a pressure on nature that one in every five nations is at danger of ecological collapse – which is concerning considering that

over half of the world's GDP relies somehow over biodiversity. It is estimated that investing in sustainable infrastructure generates a net benefit of 4.2 trillion USD, with 4 USD in benefits for every 1 USD invested, compared to "business-as-usual" infrastructure that only yields 1.5 USD for every 1 USD spent. (www.sustainable-infrastructure-tools.org, 2022)

Sustainable infrastructure is expected to create jobs for people of all skill levels and wage levels. It also assists in the building of basic infrastructure required by diverse economic sectors to promote green economic growth. It assures investors of appropriate profits over the project's duration, and enhances the capabilities of local suppliers and developers, as well as provides chances for them. Furthermore, it encourages local and international value chains to collaborate on research and development, as well as technical innovation, particularly in green technology. It can attract domestic investors as well as foreign direct investment. Finally, sustainable infrastructure can increase the efficiency of both labor and capital and rise the value of real estate in the local area.

Besides the economic benefits, sustainable infrastructure counts several social benefits also. The revenue generated through new job opportunities can be significant especially for low-income families. As a result, it assists in the alleviation of poverty and social disparities. Besides employment opportunities, it can also help in creating new green-related specializations and developing skills in this area. Furthermore, such sustainable infrastructure projects are expected to comply with or even surpass labor norms and human rights, providing better conditions at work. They have to be inexpensive, accessible, and inclusive to people from all walks of life in both urban and rural locations. All stakeholders impacted by the project, either favorably or negatively, are involved in the decision-making process, including low-income families and vulnerable communities. This is achieved through prior, free, and informed consent, as well as conflict resolution systems that are open and reachable by all impacted parties. Sustainable infrastructure is expected to ensure that there are protections in place to prevent corruption and bribery, as well as encourages private firms to be transparent and accountable. It provides easier access to basic services for the low-income families and improves public health services. It provides gender equality in the infrastructure construction and accessibility, as well as boosts investment in professional qualifications and education. It is estimated that adopting a gender perspective to

infrastructure projects would boost overall GDP by 2.5% by 2050 in the OECD countries (www.sustainable-infrastructure-tools.org, 2022).

Environmentally sustainable infrastructure can help in reducing air, soil, and water pollution, as well as provide management and protection for the ecosystems. It can encourage the usage of environment-friendly technologies as well as contribute to the conservation and efficient use of natural resources. Regarding climate change goals, sustainable infrastructure can contribute to reducing GHG emissions in line with the Paris Agreement's goals, as well as assist in the transition towards a renewable energy economy. Furthermore, it can make use of and promote high energy-saving standards. It is expected to resist to severe weather conditions and catastrophes. Besides that, through taking climate change concerns into account during all the phases of the project, it can help in safeguarding against climate change risks.

Finally, sustainable infrastructure is built on transparent and consistent governance processes throughout the project cycle and is associated with national and international obligations, along with the Paris Agreement. Institutional sustainability is enabled by strong institutional capability and well-defined project planning, tendering, and operation. To improve sustainability local capacity development is essential. This includes channels for transferring knowledge, encouragement of innovative solutions, and project management. By establishing technical and engineering capabilities, as well as data collecting, surveillance, and assessment systems, sustainable infrastructure is able to quantify its impacts and provide empirical evidence.

5.4 Environmental, social, and governance (ESG) risks in infrastructure

Environmental, social, and governance risks are considered general risks to be assessed and analyzed in every type of development. Nevertheless, their importance becomes higher in infrastructure projects as directly related to the wellbeing of the community in micro and macro levels. Even though they are considered as externalized risks that do not affect the project directly in financial terms, their importance is still significant, especially nowadays. Besides the financial damage, they risk the project and its stakeholders in reputational terms as well. Table 8 below shows some of these risks related to infrastructure projects.

Environmental	Social	Governance
Climate change (physical and policy risks)	Human rights, labour rights	Corruption related to government approvals, licensing
Resource scarcity (e.g. water and other natural resources)	Safety and health risks	Public and corporate governance structures
Environmental degradation	Consumer protection	Executive compensation, incentive systems
Pollution (e.g. hazardous waste, contamination)	Public resistance of local communities and/or indigenous populations to projects	Local rule of law Government and stakeholder relations

Table 8: ESG risks in infrastructure projects (Weber et al., 2016)

The three risks, environmental, social, and governance are interrelated to each other and as such, the three of them need to be assessed together. For example, a project that triggers environmental risks, can also face objections from activists and community, thus facing social risks at the same time. In the context of such risks, governance risks like corruption may also rise, as infrastructure projects always need to be approved by public authorities. Such problems are especially relevant in countries with weak legal systems.

In the light of depleting natural resources and irreversibly damaged ecosystems, environmental risk has become very important nowadays as it is limiting the ability of infrastructure to meet the needs and demands of population. Environmental risks can be either risks coming from the environment to infrastructure assets or deriving from the infrastructure itself towards the environment. Some examples of environmental risks may be:

- Risk of physical integrity due to climate change
- Regulations risks due to changed environmental policies
- Use of limited resources in an unsustainable manner
- Risk of climate change due to GHG emissions
- Risk of harming natural ecosystems that control nutrient cycles, food production, and diseases
- Risk of damaging biodiversity systems
- Adverse effect on surface water, forests, wetlands, and primary ecosystems
- Contamination of water
- Pollution of the air due to gas emissions

- Dangerous waste, including chemicals and other substances
- Lack of compliance with environmental legislation

Among them, climate change needs special attention as infrastructure assets are exposed either to the physical risks or the policy risks connected with climate change like subsidies, carbon tax, etc. By definition, climate change risk is “the exposure and vulnerability of infrastructure assets to climate hazards such as droughts, floods, hurricanes, changes in sea level, and so on”. The location of the asset in an area that is prone to climate hazards is related to the exposure level, while vulnerability is related to the ability of the asset to withstand such hazards or adopt to them in order to minimize their impact. Physical risk from extreme weather conditions is a major global concern affecting all sectors and all kinds of infrastructure assets nowadays, either new or existing. A reflection of the growing effect of extreme weather conditions are the increasing insurance rates for the assets. Besides the physical impact, climate change is affecting infrastructure projects through its impact on the environmental laws and policies. Governments and authorities are adapting their regulations to the current situation by changing their targets on GHGs, inducing carbon taxes, or by subsiding specific sectors that are deemed as environment friendly.

The cost for adapting infrastructure to climate changes has been predicted to add up to 1–2% to the entire initial investment (Weber et al., 2016). Such costs may seem high at the initiation of the project due to the uncertainty of the long-term effect of climate change, but it is quite small compared to all the factors that may affect the life cycle costs of the project in the long term. Considering that environmental risk is multidimensional, it is generally shared between the public and the private parties, based on the scale it can be minimized by each of them. In general, environmental approvals are managed by the public authorities.

As mentioned before, ESG risks are interrelated to each other. Environmental failures can trigger large social reactions, presenting social risk to the project. Governance risk related to poor management is often the cause of social risks like poor working conditions. The most frequent social hazards in infrastructure projects are those related to human and labor rights, as well as issues with workers' and local residents' health and safety. They are reflected in reputational risk of unwanted media exposure, as well as public and non-governmental organization opposition. Some forms of social risks can be as follows:

- Safety issues related to large-scale projects
- Exposure to toxic materials either by the workers or by the locals
- Forced labor on children
- Indigenous people and cultural heritage places suffering negative consequences

Social risks may vary between different infrastructure sectors and sizes of projects. Large projects built in more ecologically or socially aware areas are more prone to such risk compared to smaller projects.

Finally, governance risks are related to all government interactions, including approvals, concessions, and permits. Some forms of governance risks may be:

- Corruption in business practices from both parties
- Incorrect payments to contractors
- Inability to get the necessary licenses and certificates
- Structures of public or private governance in poor shape
- Unachieved necessary degree of stakeholder participation

Like social and environmental risks, governance risks vary among the different sizes, types, and locations of infrastructure projects.

ESG considerations in social infrastructure

Environmental concerns related to buildings, as well as social and governance aspects, mostly connected to population changes and urban development, stakeholder management, and laws and policies, are the most important ESG issues for investors in social infrastructure assets.

Regarding environmental risks, as mentioned before, climate change can have a significant impact on the sector. Natural hazards like floods or wildfires can directly damage the physical assets, while long and extreme heatwaves risk the comfort and well-being of their users, thus affecting the operation of the facilities and the services provided. Taking into account the crucial functions of some of them, like hospitals or emergency rooms, it is absolutely necessary to provide defending measures in case of natural disasters caused by climate change. On the other hand, buildings themselves can intensify climate change. According to the UN’s Energy Program, buildings use around

40% of the world energy and 25% of global water reserves. Furthermore, they account for almost 30% of worldwide CO_2 emissions (UNEP, 2015). Therefore, the EU has developed regulations like the Energy Performance of Buildings Directive and the Energy Efficiency Directive, which aim at minimizing the building energy usage. According to them, by 2020, all public infrastructure buildings must have already became nearly zero energy buildings, meaning that they should combine energy-efficient measures like HVAS systems, for example, with self-generation of energy through PVs or geothermic heat-pump technology. Besides energy efficiency, efficiency of resources like water, or even wastewater discharge and air pollution are also important aspects to be considered by public facilities developers. Government-owned buildings are subject to harsher criteria than private ones in several states since the public sector acts as a role model for the private. Even though it is still challenging to convince public or private parties to invest on such measures, their short-term costs can very well be compensated by the decreased risk of vacancy and the lower costs of the resources themselves.

As already mentioned, demographic changes like aging or increased populations can directly impact social infrastructure. Thus, flexible construction designs, guaranteeing that space in buildings may be modified according to the fluctuating future demands, need to be implemented. In many western countries with aging populations, it is required for education buildings to be designed as multifunctional facilities that can be utilized by different members of the society during their lifecycle. Furthermore, the social developments can increase the quality levels required for the design, construction, and operation of these facilities. A well-managed social infrastructure attracts additional residents and businesses, hence increasing the tax base needed to fund future community investment. Because social infrastructure facilities are often utilized by the general public, they are vulnerable to the financial and reputational effects of issues caused by disease or accidents. Asset owners must provide a secure space for individuals who use the property. Furthermore, social infrastructure can provide favorable opportunities for local employment, as health and safety risks in the sector are quite low, with the exception of health care facilities or prisons. PPP contracts for social infrastructure usually assign the demographic risk to the owner of the facility, which is usually the public. The private party that provides the service is usually responsible for risks related to employment or health and safety.

As for the governance aspect, one of the main issues that needs to be carefully addressed in social infrastructure is the stakeholder management, as good relations between them are preconditions for well-managed social facilities. Furthermore, for long-term infrastructure investment, public policy issues are important. For example, investors must consider the changes in the value of their healthcare investments if governments or people could no longer afford to pay for the healthcare needs of an ageing population. Finally, ethical issues related to social infrastructure need to be addressed during the development of such assets, as some investors may give priority to ethics besides the ESG aspects, like in the case of religious pension funds.

ESG considerations in electricity infrastructure

Electricity generation is largely affected by the environment and climate changes. The hydroelectric energy sector is especially affected by temperature fluctuations and precipitations levels causing either long periods of droughts or floods. Hydropower projects themselves can also affect the environment on a large scale, due to the necessity of land flooding for building water reservoirs. This can impact the region's fragile flora and fauna, as well as modify water supply for local farmers. Furthermore, the necessity for transmission networks may imply installing them across wilderness regions. Some of the measures to mitigate the negative impacts may include diversion of upstream sources, construction of resilient dams, and construction of extra reservoirs. Reforestation of upstream land can also be undertaken to mitigate the dangers of slides, erosion, floods, and sedimentation runoffs. The negative environmental impact is especially large in big projects involving the construction of large dams, as they may affect the downstream flow, while in smaller projects this is not a concern. Solar energy is also influenced by climate change as PV panels are directly affected by temperature fluctuations, wind, and clouds. The energy outcome is reduced by cloud coverage by 40-80%, and 12% by high temperatures, while strong winds may cover the panels with dust layers that reduce their generation capacity (Weber et al., 2016). On this aspect, the location selection for the PV farms is crucial. The impacts are also directed from these infrastructures towards the environment. Solar PVs may not need fuel to generate energy and they do not release GHGs, but a lot of energy and fossil fuels are spent to produce them. Furthermore, their recycling after disposal is quite problematic, especially in countries that lack the infrastructure for waste disposal. Nevertheless,

sustainable technical solutions are being developed to minimize these issues and harvest the benefits of solar power generation with less environmental damage.

Regarding transmission systems, they are considered as environmentally clean systems that do not generate GHGs and do not require large amounts of energy. These systems, especially overhead lines, can be highly affected by climate change and natural disasters, thus, there is an increasing trend to replace them with underground lines.

The impact of energy storage technologies over the environment may vary significantly. Some technologies, like batteries made of non-renewable raw materials have a large impact not only during their production but also related to toxic waste disposal. Other technologies, like those used by hydropower storage units, are more ecological in terms of GHG emissions, and their negative effects are related only to the large land areas required for the reservoirs. In general, energy storage can contribute to fighting climate change and increasing the development of renewable energy sources.

On the social aspect, the impacts of hydropower energy generation are mostly related to expropriation and relocation issues. Such initiatives may disrupt the traditional cultures of indigenous communities living in the area. Furthermore, communities located on the downstream of the project may be affected by water supply scarcity issues. Solar panels' impact is mostly related to the visual impairment due to their reflective surfaces. Besides the locals, it may cause problems to the air traffic also. People working on the operation and management of these facilities are often exposed to very high temperatures, while the magnetic fields created from them may impair the quality of life of the locals. The production of PV panels can also expose workers to toxic materials like acids and solvents, risking their health and safety at work. Wind turbines in wind farms are usually a source of noise pollution disturbing the nearby communities. Social issues caused by transmission systems are mainly related to electromagnetic emissions causing health risks on the areas near the overhead or underground lines. The negative impact of storage systems is mostly related to the battery storage technology, as the people working on their production are highly exposed to health risks caused by toxic materials.

State and local regulatory framework, legal system, and business practices are all common governance concerns in electricity generating and transmission projects.

Especially in the case of concessions from the government, these projects are risked by corruption and bribe exposure. Political instability can also be a reason why many big investors hesitate to develop such projects in developing countries where the legal frameworks are missing, depriving these countries from economic and social growth opportunities. Governance risks in transmission systems are mostly related to the monopolistic nature of their operators, risking generating unjust competition, price manipulation, or even corruption. Such problems need to be addressed from the very first phases of the project, especially in developing countries that miss out on regulatory preparedness and laws.

6 Case studies

The case studies used for this thesis were chosen from two different fields, electricity, belonging to the economic infrastructure, and education, belonging to social infrastructure. Electricity was chosen for its crucial role in the world's economy nowadays, taking into account the global energy crisis and the urgency of renewable energy resources. Education facilities built and operated through a PPP form have been developed only recently and still haven't found place in many of the developing countries. A combination of the two may help in creating a broader view of PPP projects in infrastructure and the ways of integrating sustainability into them.

6.1 Case Study 1 - Hydropower Plants over Devoll River in Albania

Albania is a mountainous country with lots of water resources, and hydropower is the main source of electric energy. The electricity generation capacity has increased in line with the increasing needs and development of the country, reaching 2204 MW in 2018. The Albanian Power Corporation (KESH) owns most of the installed capacity (1448 MW), while private producers generate around a third of the total capacity (755 MW). (IRENA, 2021)

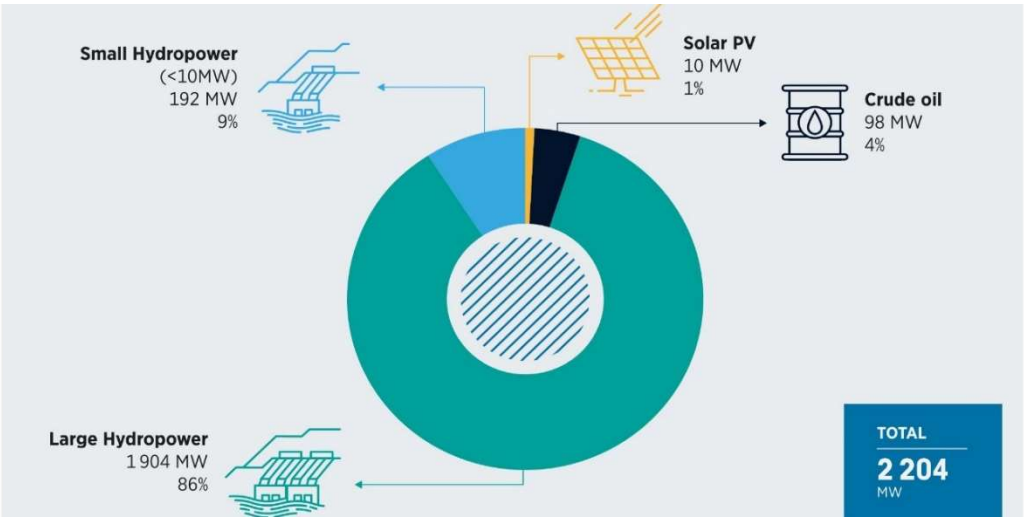

Figure 19: Installed power capacity in 2018 in MW (IRENA, 2021)

As shown in figure 19, hydropower dominates the electricity generation sector, making up to 95% of the total capacity, or 2096 MW in total for 2018. Large hydro power plants of more than 10MW capacity make up 86% and small ones 9%. Nevertheless, it is estimated that the installed capacity of hydropower makes up only 47% of the total

hydropower potential of the rivers of Albania, estimated at 4500 MW. However, these potentials are more and more endangered by climate change and droughts that are affecting Albania's climate significantly in the last years. Based on the development trends of the past, the National Energy Sector Strategy 2030 indicates that the annual energy consumption in Albania is likely to rise by 77% in 2030 compared to 2018 levels, as shown in figure 20 below. (IRENA, 2021)

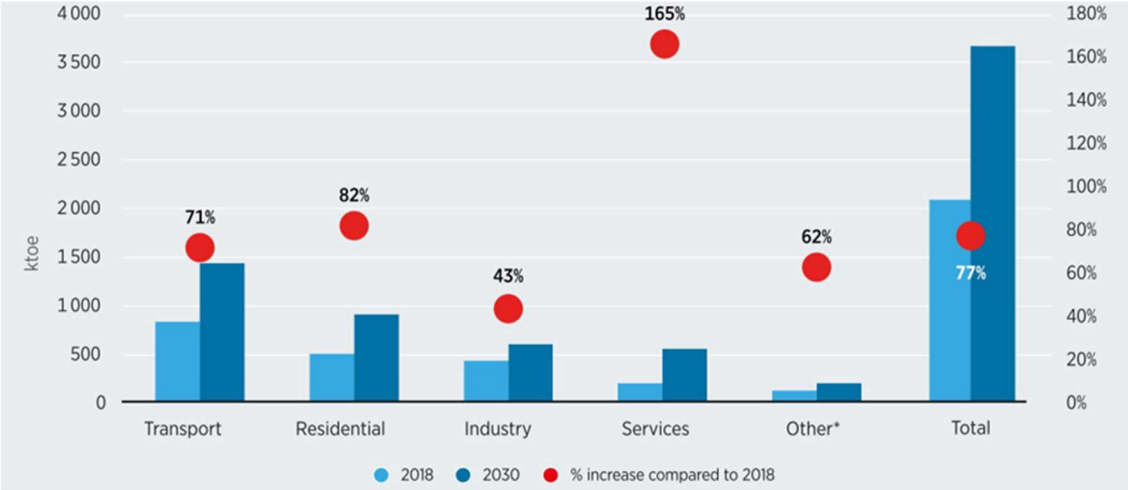

Figure 20: Projection for energy demand increase between 2018 and 2030 (IRENA, 2021)

Based on the increasing demand trends and the high potential of natural water resources, the government of Albania has signed a significant number of PPP contract agreements with private entities, most of them hydropower plants.

The PPP contract for the construction of the two Devolli Hydropower Plants is currently the largest PPP project ever implemented in Albania in all sectors, not only energy. The following table gives some basic data about the project.

Table 9: Basic data about the Devoll Hydropower project (BIRN Albania, 2020)

Case Study no. 1: Hydropower Plants over Devoll River in Albania	
Contract date	19.12.2008
Type of contract	Concession Agreement, BOOT
Procurement procedure	Proposals solicited from a contracting authority
Contracting authority	Ministry of Economy, Trade and Energy
Private authority	Devoll Hydropower s.a, 100% owned by Statkraft Markets B.V
Cost of investment	1 046 698 873 €
Source of funding	Clients
Concession duration	35 years

The Agreement with the Albanian government is based on the BOOT model. The SPV, “Devoll Hydropower” s.a., is responsible for developing, planning, and building the two hydropower plants, Banja and Moglica. Afterwards, it has the full ownership and is responsible for the maintenance and operation. The power facilities will be delivered to the Republic of Albania after the Concession Agreement responsibilities have been completed. On December 19, 2008, the Concession was signed with the government and afterwards confirmed by the Albanian Parliament. (Statkraft AS, 2009)

The project is located in south-eastern Albania, as shown in the map in figure 21 below. The HPPs were built over the Devoll River, whose source is near the Greek border on the south. The river continues flowing towards the north and west until it joins the Seman river and they both discharge in the Adriatic Sea. Banja HPP is a brownfield project as it was constructed over an existing abandoned dam, while Moglica is completely greenfield.

The two HPPs have an installed capacity of 269 MW and the planned power is around 700 GWh/year, increasing Albania’s generating capacity by 13%. After the concession agreement was approved by the Albanian Parliament in 2009, the project began its pre-construction phase operations on site. The building of Banja HPP (figure 22) began in 2013, and it was completed and put into service in 2016. Construction on the Moglica HPP (figure 23) began in 2015 and it was put into service in 2020. Among the two, Moglica is the biggest one, with an installed capacity of 197 MW. The 167 m high dam is one of the highest asphalt-core rock-filled dams in the world. Its reservoir has a full area of 7.2km² and can hold over 380 million m³ of water. Banja dam is approximately 80m high and it has an impervious clay core. The reservoir has a storing capacity of 400 million m³ of water and a full area of around 14 km². International and national contractors were engaged in the construction process of the two HPPs and they were both finished on time. (Statkraft AS, 2009)

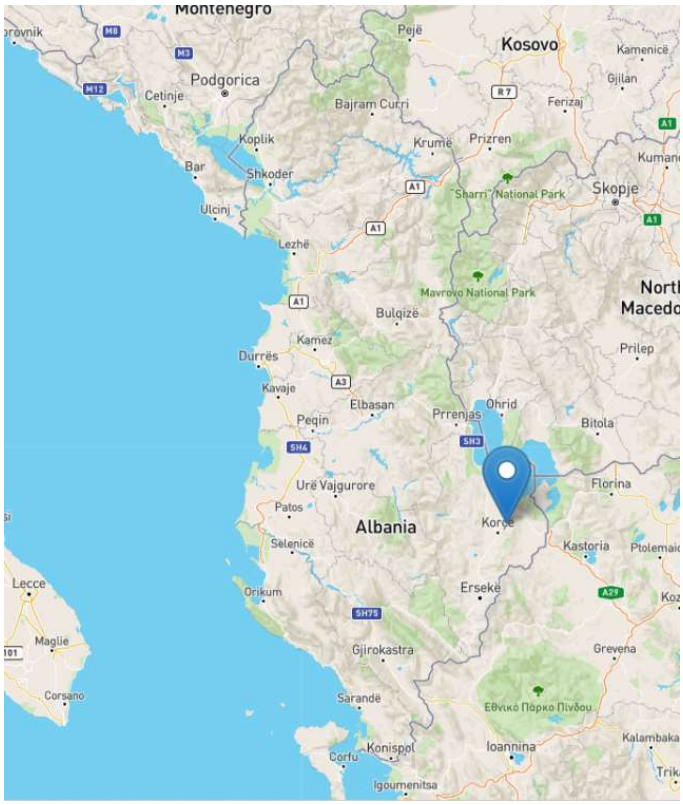

Figure 21: Location of the project (BIRN Albania, 2020)

Figure 22: Banja Hydropower Plant (Statkraft AS, 2016)

Figure 23: Moglica Hydropower Plant (Statkraft AS, 2020)

Sustainability considerations in the project

The following information regarding the Devolli Hydropower Project was collected from the Sustainable Hydropower in the Western Balkans Webinar organized by the International Hydropower Association (IHA) in March 2021. The concessionary company presented the ways in which sustainability was integrated in the different phases of the project. Afterword, IHA presented their sustainability assessment of the project.

During the pre-construction phase (2009-2013), the company conducted a detailed feasibility study that included sustainability aspects and requirements. Statkraft is part of the UN Global Compact and has pledged adherence to the 10 principles of sustainable development, including human rights, work standards, environment, anti-corruption, and so on. The study identified and planned the impact on the environment, climate, and society, and elaborated detailed and extensive programs for following up health, safety, human rights, and compliance requirements. A strategic Environmental and Social Impact Assessment and Plan (figures 24, 25), with participation of all stakeholders, from community participants to local and central authorities, as well as NGOs, was also developed as part of the pre-construction studies. (Gegprifti, 2021)

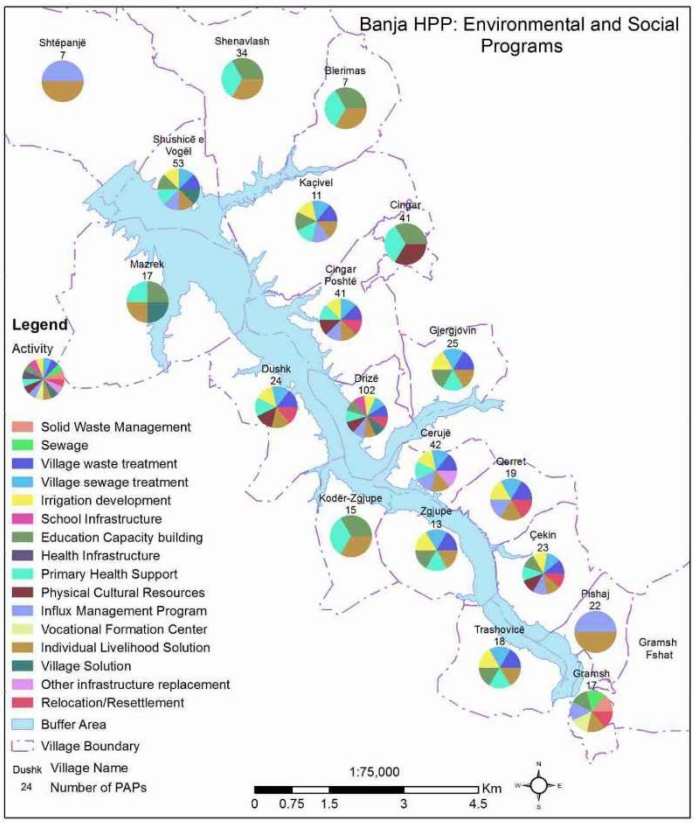

Figure 24: Environmental and Social plan for Banja HPP (DHP, 2013)

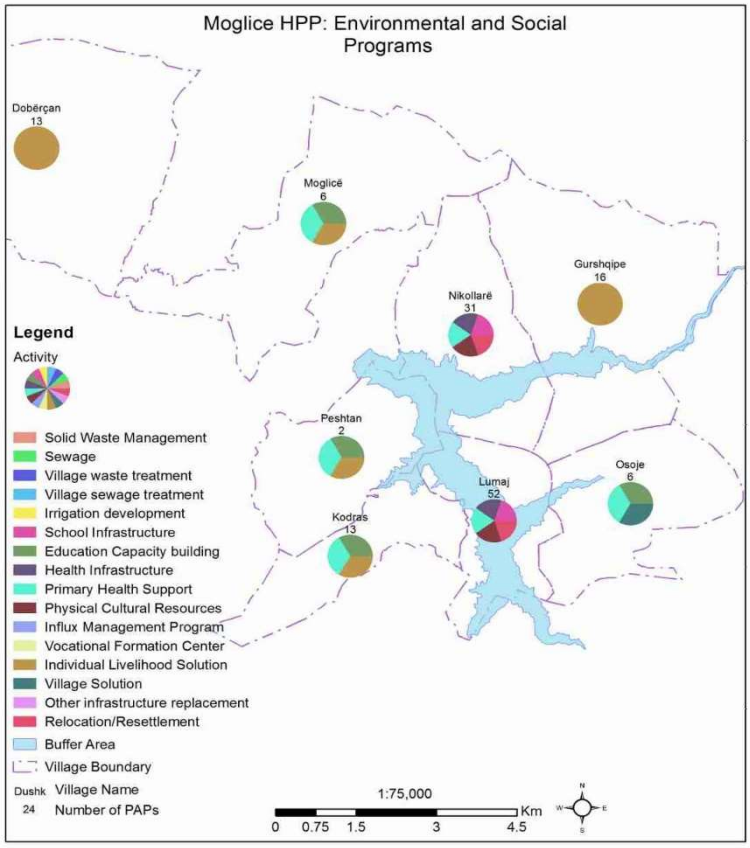

Figure 25: Environmental and Social plan for Moglica HPP (DHP, 2013)

During the construction phase (2013-2020), international and national contractors under FIDIC conditions of contract were engaged in the construction works for the two HPPs. According to the representative of the company, construction works were challenging due to the overlapping activities of the two plants, Banja in operation and Moglica in construction. Nevertheless, they were finished successfully, as all main contracts, either for civil works or electromechanical works with contractors and subcontractors were prepared including relevant sustainability aspects as mandatory requirements. The construction activities themselves followed a detailed Environmental and Social Management Program that was also integrated and part of the contractors' and subcontractors' performance, with systematic monitoring and management by the project administration team. (Gegprifti, 2021)

Besides the construction of the power plants, the project included also the necessary connecting infrastructure. New roads, upgrading of the existing ones, water supply systems, wastewater treatment plant for the town of Gramsh nearby, were all based on the sustainability principles. Social supporting programs were undertaken towards the community, families, and households that were impacted by the project, in order to mitigate, compensate, and minimize these impacts. On the environmental aspect, an extensive environmental program with considerable forestation activities, water quality monitoring, and monitoring of the environmental infrastructure in place was implemented. In 2017, when Banja was in operation and Moglica in construction, the International Hydropower Association (IHA) was asked for an assessment of the sustainability implemented throughout all the stages. (Gegprifti, 2021)

The operation phase, started in 2016 and it marked the beginning of the trading activities domestically and regionally. According to the representative of the company, sustainability is on the core of the activities and operation is done by carefully balancing the various societal needs and integrating such considerations in the business processes. The Environmental and Social Programs started on the pre-construction phase, continue with the same scope as an Environmental and Social Action Plan during the operation phase. Aquatic biodiversity monitoring and water quality monitoring is continued regularly during the operation phase on a monthly basis, through water sampling and analysis. (Gegprifti, 2021)

Below there are some facts and figures of the different activities undertaken by the concessionary company, with many of them aiming to increase the sustainability of the project:

- Construction of 100 km of roads (replacement roads and community roads), including 15 briges, with an investment amount of more than 90mil EUR. This provided connectivity possibilities for 50 000 inhabitants that live in the area as well as accessibility and identification of new sectors that can further contribute to the society and economy in the region.
- Construction of 60km transmission lines (220 kV and 110kV) with an investment of more than 10 mil EUR.
- Construction of more than 50 resettlement houses with an investment of 2mil EUR. The accommodation of 30 families in Banja area and 20 in Moglica area is completed while 28 new apartments are in construction.
- Implementation of social supporting programs in the project area especially for training programs in schools.
- Implementation of forestation programs covering up to 900ha, with an investment of 4mil EUR. Further monitoring activities for the survival rate of the parcels are done on a regular basis.
- Transfer of technology expertise and know-how to the Albanian community of experts as one of the first ambitions of the internal stakeholders of the project. Job trainings have prepared a new generation of experts in Albania, considered as the new ambassadors of sustainable development in the country, considering the lack of expertise on the field.
- Public information center established in 2010 provides support, advice, and transparency of information for good neighborhood to the local community. (Statkraft, 2022)

Some of these undertaken initiatives are shown in the following figures.

Figure 26: Bridge over the Banja reservoir (Statkraft AS, 2020)

Figure 27: Water quality monitoring and forestation (Statkraft AS, 2021)

Figure 28: Resettlement houses and social initiatives (Statkraft AS, 2021)

Sustainability assessment of the project

The sustainability assessment of the project is based on the assessment made by IHA in 2016. IHA is a large association of more than 100 members with the mission of advancing sustainable hydropower. The members include organizations and governments of more than 120 countries, like the German government, Swiss government, World Bank, and the Worldwide Fund for Nature (WWF). (IHA, 2021)

The assessment is based on the Hydropower Sustainability Standard developed by IHA. Four main sustainability topics are considered: Social, Environmental, Technical, and Economic, as well as cross cutting issues between the four different topics. Each topic is made of different sustainability aspects, as shown in figure 29 below:

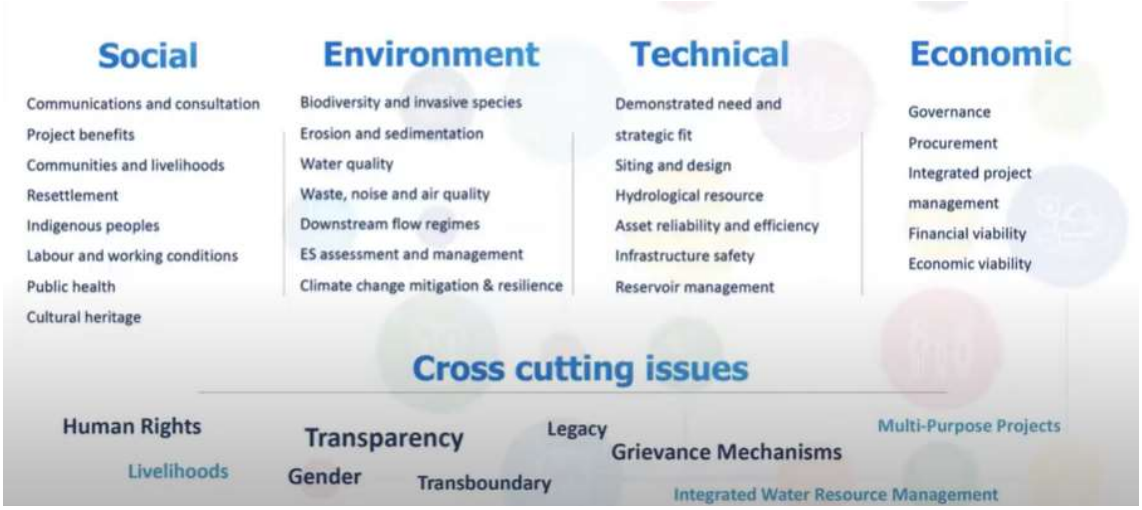

Figure 29: Sustainability aspects used for the assessment of the Devolli HPPs (IHA, 2021)

Table 10 below shows the scoring of the project based on the forementioned criteria of sustainability. The data is picked from the Sustainability Assessment Report of the IHA and based on the following scoring system:

5 Meets basic good practice and proven best practice

4 Meets basic good practice with one significant gap against proven best practice

3 Meets basic good practice with more than one significant gap against proven best practice

2 One significant gap against basic good practice

1 More than one significant gap against basic good practice

Table 10: Sustainability assessment score of Devolli Hydropower project (Author, with data from IHA, 2022)

Nr	Criteria	Score
1	Communications and consultation	4
2	Governance	4
3	Environmental and social issues management	4
4	Integrated Project Management	5
5	Infrastructure safety	5
6	Financial viability	4
7	Project benefits	4
8	Procurement	4
9	Project-affected communities and livelihoods	3
10	Resettlement	2
11	Indigenous people	not relevant
12	Labour and working conditions	3
13	Cultural heritage	5
14	Public health	5
15	Biodiversity and invasive species	3
16	Erosion and sedimentation	4
17	Water quality	4
18	Waste, noise, and air quality	2
19	Reservoir preparation and filling	4
20	Downstream flow regimes	2

It is obvious that the project meets basic good practice and proven best practice regarding infrastructure safety, integrated project management, culture heritage, and public health. There was found one significant gap into the resettlement, waste, noise, and air quality, and downstream flow regimes criteria. The households who took part in the resettlement programs had a considerable increase in living conditions and a high chance of improving their livelihoods. However, preparations for relocation and involvement in one village fell through, barring most of its households from livelihood aid. The low score of the waste, noise and air quality is related to the absence of waste management facilities during the construction phase. The approach towards mitigating such problems was mostly in the form of inspections, nevertheless, the company is working to move from that approach towards capacity-building. The issues with the downstream flow regimes criteria are related to the absence of an assessment of the social and environmental impact of altered flows. In general, it can be said that the

reasons why the project does not fulfil the fundamental good practice standards on these areas usually revolve on contractor management and performance such as waste management, or the challenges of economic and physical relocation. (IHA, 2017)

On 16 of the 19 issues considered in the evaluation, Devoll HPP meets or surpasses all fundamental good practice requirements. A major part of them has a scoring of 3 to 4. This score is related to the necessity to anticipate risks in areas like biodiversity, water quality, sedimentation, and livelihood recovery, in a more proactive way. The lack of plans for responding to opportunities that may give beneficial impacts unassociated with the project is another issue that hinders the sustainability performance of the project. (IHA, 2017)

One holistic way of assessing the sustainability performance of the project would be by measuring the achievement of the Sustainable Development Goals, as shown in table 11 below:

Nr.	Goals	High Impact	Moderate Impact
1	No poverty		
2	Zero hunger		
3	Good health & well-being		X
4	Quality education		X
5	Gender equality		
6	Clean water & sanitation	X	
7	Affordable & clean energy	X	
8	Decent work & economic growth	X	
9	Industry innovation & infrastructure	X	
10	Reduced inequalities		
11	Sustainable cities & communities		
12	Responsible consumption & production		X
13	Climate action		
14	Life below water	X	
15	Life on land	X	
16	Peace, justice & strong institutions		
17	Partnership for the goals	X	

Table 11: SD Goals achieved/targeted by the Devolli Hydropower Project (Prepared by the author)

Devoll Hydropower is the biggest PPP project ever implemented in Albania in terms of money and sustainability considerations. From the assessment, it's obvious that there is still space for improvement, especially regarding waste management, relocation, and risk and opportunities anticipation. Some of these issues, like waste management or relocation are related to gaps in the general infrastructure of the country or poor management by the central government. Waste management is an issue in all Albania, as the country misses waste management facilities in most of the regions, while expropriations prices assigned by the government are often considered very low by the locals.

When asked about the vision for the future of sustainability in the project, the concessionary company responded that they will continue to contribute towards a sustainable future through the core businesses of the company, which is providing renewable energy. Considering the renewable potential of Albania, especially in solar energy, and the positive development observed in the market in Albania and the region, the company believes in a further optimization of its assets by integrating floating PV panel systems in the Banja HPP. (Gegprifti, 2021)

This would be an initiative that contributes to the diversification of renewable energy generation modes in Albania, where hydropower makes up 95% of the total. Nevertheless, the impact towards the flora and fauna residing under the floating panels need to be well assessed and mitigated.

6.2 Case Study 2 - The Myllypuro Campus of Helsinki's Vocational and Adult Education Center

Finland is well-known for the high level of its education system and social infrastructure. It was ranked as the 8th most educated country in the world for 2022 (World population review, 2020). Social infrastructure in the education field has seen significant growth in the last years, while public institutions are trying innovative ways to implement projects in this field. Particularly in the city of Helsinki, a number of public-private partnerships have been put into place that cover the whole life cycle of educational buildings, from design, to building, operation, and maintenance.

The Myllypuro Campus of Helsinki's Vocational and Adult Education Center is one of these projects. The following table gives basic data about the contract:

Case Study 2 - The Myllypuro Campus of Helsinki's Vocational and Adult Education Center	
Contract date	19.2.2021
Type of contract	DBOT
Procurement procedure	Competitive negotiation procedure
Contracting authority	City of Helsinki
Private authority	Fira & Caverion Suomi
Value of the contract	46 308 540 EUR (excluding VAT)
Contract duration	20 years

Table 12: Basic data about the Myllypuro Campus project (Tenders Electronic Daily, 2021)

The new facility, which will serve the vocational and adult college, will initially have space for roughly 1100 students and a total area of about 8300 m^2 over a plot of 10800 m^2. The contract covers work on the new building's design and construction, as well as separately specified maintenance and user services. The purpose is for the project developer to be accountable for the building's use and conditions over the next 20 years. The procurement of the contract was processed through a competitive negotiation procedure. The proposals of four companies participating in the tender were assessed based on price and quality criteria, where the proposed price had a weight of 55% and the offered quality had 45%. (Tenders Electronic Daily, 2021)

The school is part of Stadin AO, Helsinki's Vocational and Adult Education Center, a network of 14 schools all around the city, that provide basic vocational training, in-service training, as well as apprenticeship and joint training. Around 17000 students get vocational education in more than 50 professions and 30 different degrees. (STADIN AO, 2022)

The works for the construction of the campus began in June 2021 and they are expected to finish in 2023. A picture of the construction progress in June 2022 is given in figure 30 below:

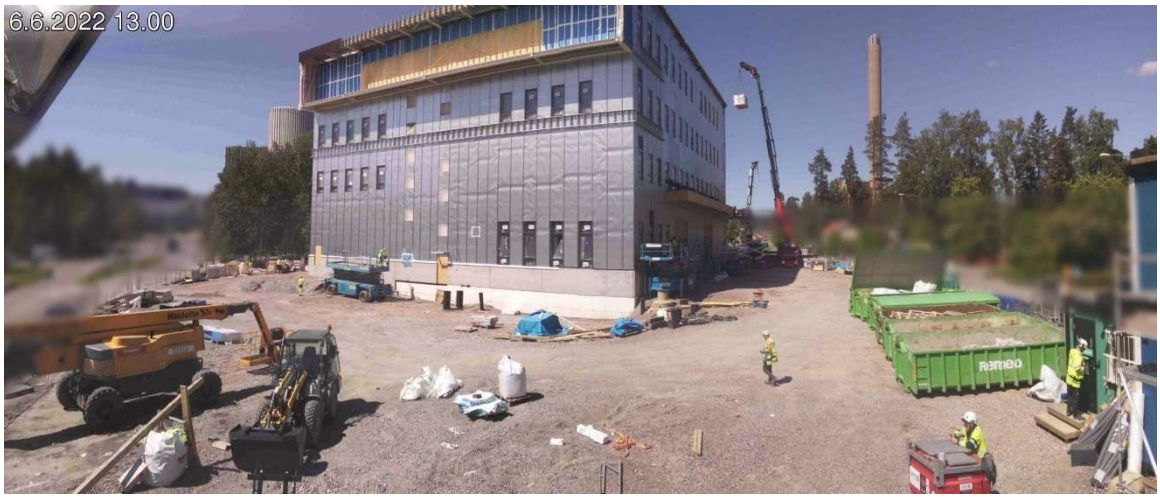

Figure 30: Progress of the works on site, June 2022 (Stadin AO, 2022)

The campus is located in the Myllypuro district of Helsinki. Out of three options for the site, it was decided that it would be constructed in close proximity to the Myllypuro campus of Metropolia University of Applied Sciences (in circle in the map, figure 31).

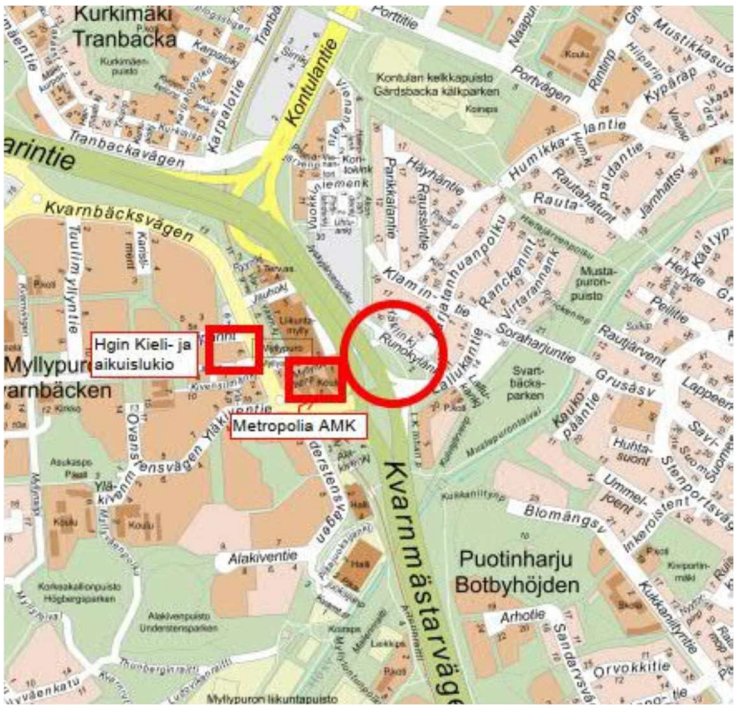

Figure 31: Location of the Myllypuro Vocational School, close to Metropolia (City of Helsinki, 2020)

The selection of this site was not casual, as the two institutions are expected to collaborate and share their premises with each other. According to the Project Plan of the City of Helsinki, Stad Vocational and Adult Education Center together with Metropolia University of Applied Sciences form a campus where students train as professionals in the field of building technology and construction in cooperation with each other and companies in the field. A laboratory for concrete and stone construction will not be built

on the Myllypuro campus of Stad Vocational and Adult Education Center, as the concrete laboratory facilities of Metropolia University of Applied Sciences will be utilized to teach these skills. Students of Metropolia University of Applied Sciences can use the wood construction facilities to be built on the premises of Stad Vocational and Technical College. With the help of the building information model, students receive access to the building and its technology systems that are also partly visible behind the glass walls, thus making the building part of the learning environment. (City of Helsinki, 2020)

Sustainability considerations in the project

According to the Project Plan of the City of Helsinki, various stakeholders have been actively involved in the input data of the project. In 2018, staff from pedagogy participated in the campus cooperation workshop between Stad Vocational and Adult Education Center and Metropolia, as well as in the workshop on the development of operations and facilities. The staff and students of Stad Vocational and Adult Education Center have also been involved in drawing up the pedagogical plan for the project and in preparing the space program and operational objectives. Furthermore, representatives of construction industry like the Finnish Construction Trade Union and the Confederation of Finnish Construction Industries have been involved in the project from the very beginning. (City of Helsinki, 2020)

The project is based on the Strategy of the City of Helsinki for 2017-2021, which states that Helsinki will continue to strive for a position as a European example of preventing segregation and enable the equality and well-being of neighborhoods. Quality education is considered as one of the best ways to reduce inequalities. The city ensures that its facilities are easy and safe to use for educational, civic, and cultural activities. Helsinki invests in physical learning environments that promote the learning of skills needed in working life and in the information society. Safe and healthy learning environments have to be provided for children and young generations. In addition to reducing life-cycle problems, promoting space efficiency, and making better use of vacant buildings are some of the main aims in improving the quality of the real estate portfolio of the city. The architecture and standard of construction must reflect the strong identity of the city. (City of Helsinki, 2020)

Project risks are transferred to the service provider. The service provider designs and implements solutions for the site to ensure that it is available in a cost-effective manner in accordance with the set goals. He is responsible for ensuring that the conditions and residual technical value of the site are in accordance with the service agreement during and after the 20-year service period. The responsibility covers the technical risks related to design, construction, and maintenance, including risks related to conditions such as indoor air problems caused by the property. The building has a usability guarantee. In addition, the exact condition in which the object will be handed over to the customer after the service period is already determined. The building is expected to be approximately 85% new due to the ongoing maintenance even after 20 years. Maintenance includes property management, outdoor area care, heating, cleaning, and so on. The maintenance cost paid by the lessee of the property to the service provider is covered by the maintenance rent charged to the user. (City of Helsinki, 2020)

The project represents a high-quality and ecologically sustainable building that reflects the activities that take place inside the building. The ground floor is a flexible space, and the functions of the spaces are visible from the outside. The façade materials are aesthetically durable and of high quality. Helsinki's climate goals are made clearly visible in the architecture. The use of low-carbon and recyclable building materials, as well as energy-efficient building technology solutions are part of the building's design solution. The project seeks a long-term, energy-efficient, and easy-to-maintain building. Structures, materials, furniture, and fittings are durable, refurbishable, and easy to clean. Special attention is paid to structural safety in the design of indoor and outdoor spaces. In addition to the day-to-day operations of the building, health and safety measures are taken into account in the space design. Particular attention is paid to indoor air quality, lighting, fire safety and sound insulation. The premises are equipped with the necessary technology and IT installations that take into account the requirements of learning environments of the future. The structural system, technical installations and spatial planning are intended to enable the subsequent reorganization of the rooms in the event of a change in operations. (City of Helsinki, 2020)

The plan of the project had already anticipated the expected indoor climate classes, ventilation system cleanliness class, and emission class for the building materials. Regarding the energy targets, they are set using the criteria of the Finnish RTS Environmental Classification System. The minimum level for this project is 4 stars. The building

will be designed and implemented in energy class A, and its e-value is set to less than 80 kWhE/ (m2 a). At least 15% of the site's total energy needs is produced at the site using renewable energy sources, like solar panels and heat pump technology. The service provider is responsible for ensuring that energy efficiency targets are met throughout the 20-year service period. (Stadin AO, 2021)

Figures 32 and 33 below show some images of the campus as it is expected to look like after completion

Figure 32: View of the façade of the Stadin Vocational School Project (Capex Advisors, 2021)

Figure 33: View of the interiors of the Stadin Vocational School Project (Capex Advisors, 2021)

The project will reserve facilities and collection facilities for the efficient sorting of waste (municipal waste: biowaste, cardboard, paper, glass, metal, plastic packaging, and mixed waste, as well as hazardous waste). Parking spaces are calculated based on the calculation guidelines and city guidelines that emphasize the use of public transport and commuting. The plot is in the immediate vicinity of Myllypuro metro station, and a cycling line also passes by, providing sustainable connection modes to the campus. (City of Helsinki, 2020)

Together with Metropolia, the Vocational School campus is expected to energize the whole eastern Helsinki area. When compared to the area's occupancy before the development of the campus, its surroundings are predicted to attract 7,000 additional individuals. The building, which will also function as a gathering spot, will offer a wealth of services and a vibrant urban culture to the Myllypuro, Kontula, and Itäkeskus areas. As the area's business operations increase and change, more employment will be created. With educational programs aimed at diverse language speakers and individuals from various cultural backgrounds, the campus will also serve the large number of foreign-born citizens in eastern Helsinki. (City of Helsinki, 2019)

Sustainability assessment of the project

According to the Finnish RTS Environmental Classification System, the campus is classified as a 4-star building in a scale from 1 to 5 stars. The RTS system classifies edifices based on a range of criteria related to environment and energy, health and wellbeing, processes, economy, and innovation, as shown in table 13.

The system has a five-level star grade that is directly dependent on the points earned on a range from 25 to 110 points. Table 14 below shows the minimum requirements of the classification levels.

The Vocational Campus has surpassed the minimum of 70 points and is classified as a high-quality project that fulfills all sustainability requirements related to energy efficiency, carbon footprint, local impacts, innovation, and site sustainability.

Main group		Groups		Criteria		
Process	23	Commissioning	8	P1.1	Design phase audit	3
				P1.2	HVAC Commissioning	3
				P1.3	User guide and training	2
		Moisture safety	10	P2.1	Moisture safe design	4
				P2.2	Moisture safe construction	6
		Site sustainability	5	P3.1	Sustainable construction	3
				P3.2	Site dust management	2
Economy	12	Life cycle costs	3	T1.1	Life cycle costs	3
		Maintenance	9	T2.1	Durability	3
				T2.2	Maintainability	4
				T2.3	Adaptability	2
Environment and Energy	35	Carbon footprint	12	Y1.1	Life cycle carbon footprint	7
				Y1.2	Material resource efficiency	4
		Energy	16	Y2.1	Energy efficiency	8
				Y2.2	Energy metering	3
				Y2.3	Consumption targets	3
				Y2.4	Core system efficiency	2
		Water	3	Y3.1	Water efficiency	3
		Local impacts	4	Y4.1	Ecological value	3
				Y4.2	Cyclist and strollers spaces	2
Health and Wellbeing	30	Indoor Air Quality	18	S1.1	Indoor temperature	6
				S1.2	Air quality	7
				S1.3	User controls	2
				S1.4	Material emissions	3
		Visual comfort	6	S2.1	Daylight	4
				S2.2	Lighting quality	2
		Acoustics	6	S3.1	Space acoustics	3
				S3.2	Sound insulation	3
Innovations	10	Innovation	10	I	Innovation	10

Table 13: Overview of the RTS assessment criteria (RTS, 2020)

Criterion	1 star	2 stars	3 stars	4 stars	5 stars
Points	25	40	55	70	85
P1.2 HVAC Commissioning			50%	50%	50%
P1.3 User guide and training				100%	100%
P2.1 Moisture safe design			75%	75%	75%
P2.2 Moisture safe construction		75%	75%	75%	75%
Y1.1 Life cycle carbon footprint			15%	30%	30%
Y2.1 Energy efficiency		20%	30%	40%	40%
S1.1 Indoor temperature			25%	50%	50%
S1.2 Air quality		50%	50%	50%	50%
S1.4 Material emissions			50%	50%	50%
In-use audit after 1or 2 years					YES

Table 14: The minimum requirements of classification levels in the RTS system (RTS, 2020)

The achievement or expected achievement of the Sustainable Development Goals for the project is estimated in table 15 below:

Nr.	Goals	High Impact	Moderate Impact
1	No poverty		
2	Zero hunger		
3	Good health & well-being		X
4	Quality education	X	
5	Gender equality		
6	Clean water & sanitation	X	
7	Affordable & clean energy	X	
8	Decent work & economic growth	X	
9	Industry innovation & infrastructure	X	
10	Reduced inequalities	X	
11	Sustainable cities & communities	X	
12	Responsible consumption & production	X	
13	Climate action		X
14	Life below water		
15	Life on land		
16	Peace, justice & strong institutions	X	
17	Partnership for the goals	X	

Table 15: SD Goals achieved/aimed by the Stadin Vocational School projects (Prepared by the author)

6.3 Practices and recommendations for the integration of sustainability in PPP infrastructure projects

The two selected case studies belong to different sectors of infrastructure, which makes it hard to do a comparative analysis between them. Nevertheless, it would be a good approach to make use of the different ways in which sustainability is integrated in the different sectors and come up with a common general view for all PPPs in infrastructure. In many cases, one PPP project may aim a specific primary sustainability goal and achieve other secondary ones at the same time, like in the case of the DHP project, that not only provides clean energy, but has also benefitted the health and education services of the community through its secondary initiatives. The integration of sustainability through the lifetime of PPP infrastructure projects is based over the

four pillars: social, environmental, governance, and economic. The following paragraphs will suggest some of the best practices towards sustainable PPPs based on the case studies and requirements from the SDGs and the United Nations.

Environmental sustainability

According to the Espoo Convention on Environmental Assessment, the duty of the parties to assess the environmental impact of the project should be fulfilled from the early planning phases. Environmentally sustainable projects must reduce greenhouse gas emissions and enhance energy efficiency. To achieve this, the annual GHGs expected to be emitted during the project's life cycle must be calculated beforehand, together with a plan of strategies to reduce these emissions. The project must take concrete steps towards reducing them under the baselines specified either by global regulations, or by the industry standards. Such measures may include forestation initiatives to capture CO_2 emissions (like in the case of the DHP project), implementing technologies or using materials that are able to absorb GHGs coming from the project itself, using more energy efficient processes and equipment, as well as substituting fossil fuels with renewable sources (like in the case of the Myllypuro Campus). The requirement for a certification after construction and during the operation phase would also be a good practice on this regard. The certification should be undertaken by a credible, widely recognized third party organization that verifies the project and certifies it based on a globally or industry accepted rating system.

Similarly to GHG emissions, energy efficiency can be improved by regular calculations of annual energy consumption rates and the development of plans and strategies to reduce consumption. Based on the national standards or the EU Energy Performance of Buildings Directive, the project must take steps to minimize energy usage per unit of service and improve the Energy Performance Index and the Energy Use Index.

Waste reduction is another important aspect of environmental sustainability that needs to be considered from the early stages of the project planning by adopting Circular Economy approaches. This means finding beneficial uses or reuses for the waste generated by the project itself or any excess resources like other projects implemented nearby. Such waste can be waste materials, heat or energy, gas emissions, or even waste of space capacity. On this regard, the potentials of utilizing this unwanted or

excess waste need to be investigated from the planning phases of the project, together with the potentials of reducing it and the identification of the right spots where the waste can be beneficially reused. An operational Waste Management Strategy that targets waste reduction including hazardous substances needs to be developed. That means, less solid waste creation and disposal on land, less particle and vaporized waste in the air, and less liquid waste in the sea. The amount of waste generated per unit of asset or service per year needs to be within the accepted national norms of industry. The location of the project also needs to be considered, if it is going to be built on already developed land, or on deserted ground. A sustainable approach would be to restore the deteriorated land inside the project's area towards a state that facilitates natural habitat or reclaim the brownfield sites through remedial work. The absence of plans and their negligence during implementation can spoil the environmental sustainability of the project, like in the case of the DHP project. It is important to analyze all factors that may fail the process, public or private, and find ways to mitigate them.

Another aspect of environmental sustainability is the water usage and wastewater discharge. The project must follow the mandatory wastewater discharge requirements after treatment and include strategies to reduce negative freshwater use consequences or wastewater discharge issues. It is important to assess beforehand if there is a net-zero effect on the amount and access to fresh surface and groundwater resources because of the project.

In order to protect biodiversity, projects need to be preceded by an Environmental and Social Impact Assessment that considers health and cultural impacts on the biodiversity of the area. Besides the ESIA, in order to guarantee that the project is developed in an ecologically responsible way, a detailed Environmental Management Plan must outline the mitigation strategies, the measuring and reporting requirements, protocols, and management practices.

Moreover, projects must include a strategy for risk assessment, reduction, and mitigation for disaster management. A response and recovery coordination structure must be established, together with a budget fund for any losses. Furthermore, a Community Driven Development Program which identifies preventive measures and preparatory steps before natural and human-caused catastrophes, emergency operations during disasters, and relief and strengthening efforts after disasters, needs to be developed.

Social Sustainability

Improving access to important public services for social prosperity and reduced poverty is a primary goal throughout the 17 SDGs, recognizing that depriving people of even one service may have negative consequences for their livelihoods and welfare. Furthermore, all citizens interested in the service, including the economically disadvantaged and those who are socially excluded must have equal and fair access to them.

From the early conceptualization phase, accessible and equitable PPP projects, defined as people-first projects, must be planned to provide basic services that consider the real necessities of the population regarding its social and economic conditions. On this aspect, the stakeholder engagement process from the early phases of the feasibility study is a determinant moment for the social sustainability of the project.

Public involvement refers to all stakeholders, including natural or legal persons who are interested in or may be interested in the project or its consequences. The list may include end users of the services; banks and equity holders; construction, operation, or maintenance contractors and subcontractors; local enterprises; NGOs; media; disadvantaged or vulnerable communities; indigenous communities; local community associations like neighborhood associations; and legal, financial, or technical consultants. People must react to the outcomes and benefits that the project provides. When people are engaged, they are more likely to react positively. As a result, best practice in stakeholder engagement and public involvement usually refers to how the government and private sector communicate with all stakeholders to make them feel included in the project. Stakeholder engagement entails establishing a framework of legislation, processes, and contractual requirements, as well as encouraging contracting authorities and the private entity to value effective and inclusive stakeholder engagement and public involvement. Engaging directly with the residents and communities impacted by the projects, and sometimes mobilizing them via a unified body, is a good practice of stakeholder engagement and public involvement that is much in line with socially sustainable PPPs. The unified bodies may serve as a bridge for the perspectives of impacted people on the project, which can subsequently be discussed in transparent talks by the public and private parties. A stakeholder engagement plan needs to be developed, that identifies all stakeholders, and considers the needs of each of them, together with metrics that measure the effectiveness of the plan. The plan must be

implemented during the whole lifetime of the project and the stakeholders feedback needs to be integrated into the project's design, plans and processes. The whole process needs to be overseen by an independent committee that supervises and assesses the success of the stakeholder engagement and public involvement processes, as well as the distribution and publishing of project information.

Frequent reports outlining the major outcomes of general stakeholder engagement sessions must be published and available to all stakeholders. The reports should contain metrics of the stakeholder engagement like the number of meetings participants each month, the number of representatives from marginalized communities or even women participating in decision-making, the number of surveys conducted and their responsive rate, satisfaction/complaint rates from stakeholders, and so on. Furthermore, a system to handle public grievances and customer input needs to be set up in a way that such feedback is protected by personal privacy laws.

The services provided through the PPP projects must be affordable and give universal access to their users. In concession projects, for example, it can be anticipated that the project's service will remain fairly inexpensive for users, including, if required, those who are most vulnerable and disadvantaged. In government-pay projects it is necessary to make sure that the services provided by the project can be handled by the available public sector budget. In both cases, there should be plans to control and manage the affordability measures by keeping the economic and financial balance in mind and making sure that the costs of providing the service through the PPP form are lower than other procurement forms.

Accessibility, just like affordability, must be planned and monitored through indicators and targets for both nominal and actual results towards the inclusion of all users, including the most disadvantaged and vulnerable ones. An Environmental and Social Impact Assessment needs to be carried out in order to analyze and mitigate the project's spectrum of direct and indirect social impacts on the residents to provide inclusion and social justice.

Moreover, the project needs to be conceived, organized, implemented, managed, and contracted in a way that it remains possible to foresee and adapt to anticipated future demands in terms of cost, equality, and accessibility throughout its entire life cycle.

Another aspect that may affect the social sustainability of PPP infrastructure is the physical or economic displacement, as in the case of the DHP project. In such scenarios, it is first important to make sure that the chosen plot of land will be only for the project's inevitable and essential needs. Afterwards, it is essential that the relocation process follows the local regulations and the UN Basic Principles and Guidelines on Development-based Evictions and Displacement (2007).

Economic sustainability and governance

The highest influence of the government as a defender of the needs and interests of the citizens is during the initial phases, project definition, structuring, and procurement of PPP projects. These are critical phases that can be determinant to the sustainability of the project. During the project definition it is important for the public authority to identify his objectives related to sustainability, ascertain the objectives of other stakeholders, find out what are the available solutions offered by the market and at what cost. The structuring of the contract can also affect the level of sustainability of the project, whether it includes all the phases from design to transfer or only some of them.

Nevertheless, the moment when governments can have the strongest influence is the procurement process. In the pre-qualification phase, they can deliver sustainable requirements through selection criteria, exclusion criteria for companies that have violated environmental legislation, or obligations for prior experience of sustainable practices. Output specifications, as a way of specifying the criteria based on the final results instead of the means to achieve them, are a tool that allows bidders to create their own sustainable approaches. They establish the minimum sustainability criteria on the first phase of the tender. It is important for them to be measurable and enforceable in order not to lose their incentive value. This can be achieved by referring to international or local sustainability standards and tools.

On the second stage the bidders submit an offer that is assessed by the procurement authority based on the award criteria. These criteria are the ones that reflect the sustainability preferences of the public authority. In order to strengthen these requirements in confront to the price criteria, a good practice would be to set a minimum score for each of them. This way, the bidders cannot avoid the responsibility to fulfill them to some extent. In order to concentrate the bidding process on quality instead of price,

another strategy would be to work with a ceiling price. This incentivizes the interested companies to work more on the quality of the services they will provide, including the sustainability aspects. Finally, another motivating instrument would be to award bonuses for additional energy-efficiency initiatives.

An important aspect on this matter is also the prevention of corruption and procurement transparency. The projects need to be awarded through a competitive, open, and transparent tender process. In case of non-open procedures or unsolicited proposals, the process must follow the procurement laws of the country or, in case they are missing, international regulations like the UN's "Standard on a Zero Tolerance Approach to Corruption in PPP Procurement". A draft of a balanced contract resulting from a planned negotiation process, must be part of the tender documents.

The project's contribution to economic development and decent employment, as well as the reason for choosing a PPP procurement form over alternative contractual choices, define the economic and financial sustainability of the project. Other factors are the project's capacity to create a decent level of profitability from cheap tariffs and enable the government to manage its budget and debt in a sustainable manner.

In order to increase economic feasibility and financial sustainability, the project must produce value for people, that is, give both tangible and intangible value to society via higher-quality services. Moreover, the PPP must provide good value for money, meaning that compared to another contemporary public contracting approach, the costs of the chosen PPP procurement arrangement are lower. When comparing the amount of tax money necessary for the project to the economic advantages that would arise from its execution, the project's cost/benefit analysis must favor the public. In order to make sure of the financial sustainability of the project, the budgetary viability and the credibility of the public party need to be openly recorded in public accounts. Any costs of direct payments, the fiscal payback to the government, and any possible debt load from future obligations must be clearly revealed to the relevant stakeholders.

In order to increase the financial feasibility on the long run, the private party must own or have access to financial and technical resources to finance, implement, operate, and maintain the asset during the project's life cycle, and adapt to possibly changing demands. The revenue generated from the project must cover not only the invested capital and an agreed projected Internal Rate of Return, but also the expenses for

operation and maintenance based on the risk and payback profile of the project. For this purpose, the project's risks and benefits must be identified, managed, and assigned adequately in the contract or the relevant PPP regulation of the country. On this aspect, clear design requirements or a staged approach to development might help to reduce execution risks.

Finally, PPP projects are expected to increase job and economic potentials. They must generate employment opportunities and decent working conditions, in line with the labor rights and regulations, like non-discrimination rights, women's rights, equal payment, and harassment prevention. The project must identify shortages of skills or capacities in the local labor and develop training programs that will serve to the project and country's economy in the long term.

For all these initiatives to be widely implemented in PPP projects, it is necessary for them to be replicable, that is, to serve as a model for future projects. On this aspect, a good practice would be the standardization of the project preparation process by generating standard tender documents, frameworks, and contracts, as well as training of the public administration staff dealing with it. The private partner's training and the implementation of innovative technologies, processes, and methods is also an efficient practice that contributes to minimization of limitations and issues. Global and regional collaborations are also strengthened through training offered or coordinated by the private party, contributing to the replicability of the expertise for future projects in the region and beyond.

The above-mentioned practices and recommendations are summarized in the form of a list that is easy to check and verify, as follows in table 16 below. The practices may find place in the different phases of the project, but in all cases, to ensure their implementation, it is necessary for them to be integrated into the contract agreement between the two parties.

Environmental sustainability	Social sustainability	Economic sustainability and governance
Minimize GHGs and enhance energy efficiency	**Plan for and increase public involvement and stakeholder engagement**	**Integrate sustainability requirements from the procurement phase**
• Conduct an Environmental and Social Impact Assessment (ESIA) as part of the pre-construction phase • Develop and implement a strategic Environmental and Social Management Plan as part of the contractors' and subcontractors' obligations • Reduce GHG emissions in accordance with the Paris Agreement's aim of maintaining global average temperature increases to well below 2°C over pre-industrial levels • Plan and take measures to reduce emissions, through forestation, utilization of technologies and materials that reduce or absorb GHGs, substitute fossil fuels with renewable sources • Conduct regular measurements of the annual energy consumption rates • Minimize energy usage per unit of service/asset provided and make use of renewable energy resources to generate energy on site • Improve the Energy Performance Index and the Energy Use Index • Conduct regular sustainability assessments by a globally or industry recognized third-party organization	• Identify all stakeholders directly or indirectly affected by the project • Develop a stakeholder engagement plan that considers the needs of each of them • Mobilize the local community through a unified body that serves as a bridge for expressing their perspectives and needs • Organize open and transparent meetings and workshops with the interested parties • Establish a supervision committee that independently oversees the process • Establish stakeholder engagement metrics to measure the performance of the participation process and its outcomes • Regularly report the outcomes of the stakeholder engagement sessions and share transparent information about the project	• Deliver sustainable requirements through output specifications, exclusion criteria for companies that have violated environmental legislation, or obligations for prior experience of sustainable practices, in the pre-qualification phase • Reflect the sustainability preferences through award criteria in the evaluation phase of the tender • Strengthen the quality criteria in confront to the price through a mandatory minimum score (e.g. 45% weight to the quality criteria and 55% to the price) • Work with a ceiling price as an incentive to increase quality and sustainability • Award bonuses for additional sustainable initiatives

Table 16: Recommended practices for the integration of sustainability in PPP infrastructure projects (prepared by the author)

Recommended practices for the integration of sustainability in PPP infrastructure projects (cont'd)		
Environmental sustainability	**Social sustainability**	**Economic sustainability and governance**
Regulate water consumption and wastewater discharge	**Deliver essential infrastructure services according to actual needs**	**Provide a transparent and free of corruption procurement process**
• Identify and implement strategies to reduce freshwater consumption per unit of service • Provide net-zero impact over the availability and quality of surface and underground water supplies • Meet the wastewater discharge norms after treatment	• The project must consider the real needs of the community according to the stakeholder engagement results • Evaluate and provide concrete evidence of the project's impact on the well-being of the citizens • Contribute to the local community through secondary social supporting programs like trainings and skill development	• The projects must be awarded through a competitive, open, and transparent tender process • In case of non-open procedures or unsolicited proposals, the process must follow the local or international procurement laws • A draft of the contract must be an integral part of the tender documents • The sustainability criteria must be well stipulated in the contract as obligations to both parties
Minimize waste and rehabilitate degraded land	**Increase accessibility and affordability**	**Increase economic feasibility and sustainability**
• Develop an operational Waste Management Strategy • Limit and reduce pollution in the soil, water, and air • Reserve facilities and collection facilities for the efficient sorting of waste, including hazardous materials • Find beneficial uses or reuses for the unwanted or excess waste • Compensate degraded land within the project by restoring another equivalent plot within the area of impact of the project	• The Environmental and Social Impact Assessment must clearly identify all impacted groups and the level of impact • In concession projects, the services must remain inexpensive for users, especially the most vulnerable and disadvantaged • In government-pays projects, the costs of the services must be affordable by the available public sector budget • Develop plans for controlling and managing affordability measures	• The project must produce value for people, that is, give both tangible and intangible value to society • Produce good value for money, meaning the costs for PPP procurement form are lower than other forms • Cost Benefit Analysis of the project must favor the public • Open and transparent public budgetary viability must demonstrate the credibility of the public party • Any costs of direct payments, fiscal payback to the government, and any possible debt load from future obligations must be clearly revealed to the relevant stakeholders

Recommended practices for the integration of sustainability in PPP infrastructure projects (cont'd)		
Environmental sustainability	**Social sustainability**	**Economic sustainability and governance**
Preserve biodiversity	**Reduce or eliminate economic or physical relocations**	**Maximize financial feasibility in the long run**
• Plan and implement the management practices as per the Environmental Management Plan • Conduct regular aquatic biodiversity monitoring and water quality monitoring during the operation phase, through water sampling and analysis	• Aim towards a project solution that doesn't require relocation • If relocation is inevitable, make sure it is planned and executed according to the UN Basic Principles and Guidelines on Development-based Evictions and Displacement (2007)	• Make sure the private party owns or has access to financial and technical resources to finance, implement, operate, and maintain the asset during the project's life cycle, and adapt to possibly changing demands • The revenue generated from the project must cover the invested capital and the agreed Internal Rate of Return • The revenue must also cover expenses for operation and maintenance based on the risk and payback profile of the project • The project's risks and benefits must be identified, managed, and assigned adequately in the contract or the relevant PPP regulation of the country • Reduce execution risks by specifying clear design requirements or taking a phased approach towards the development of the project

Recommended practices for the integration of sustainability in PPP infrastructure projects (cont'd)		
Environmental sustainability	**Social sustainability**	**Economic sustainability and governance**
Plan for disaster management & determine risk levels	**Handle public grievances and user feedback**	**Increase employment rate and economic opportunities**
• Take climate change concerns into account when designing, maintaining, and operating the infrastructure assets • Develop a strategy for risk assessment, reduction, and mitigation for disaster management • Establish a response and recovery coordination structure and a budget fund for losses • Develop a community-driven Program for managing disasters before and after	• Set up a system and mechanisms for handling public grievances and customer feedback • Establish a public information centre from the beginning of the project, that will provide support, advice, transparency of information, and a good neighborhood to the local community • Make sure complaints and feedback are successfully addressed • Make sure they are subject to the law for the protection of personal data	• Generate employment opportunities and decent working conditions, in line with the labor rights and regulations, like non-discrimination rights, women's rights, equal payments, and harassment prevention • Include requirements for the protection of health and safety at work based on national and international regulations • Identify shortages of skills or capacities in the local labor market and develop training programs that will serve to the project and the country's economy in the long term • Transfer technology expertise and know-how to the local community, and increase the replication potential of the project in the future

7 Conclusion

The role of public infrastructure in social and economic development is vital, and the needs for more and better public services and assets are increasing in parallel with the world population. Infrastructure includes all physical and institutional assets and services that are essential for the society, from transport, energy, water, waste, and communication, to health, education, culture, sport, public administration, and security. Infrastructure projects have a stable demand that is independent of industrial and economic fluctuations. Infrastructure development is considered as an almost-monopoly environment due to the high initial costs, raising strong entry barriers in the market that can be adjusted by the state. Studies show that investment in infrastructure can double GDP growth. Nevertheless, current investments are getting lower due to financial crisis and the implications of infrastructure with climate change. In the meantime, demand for investments in greenfield and brownfield projects is expected to increase.

Public-Private Partnerships, as a form of collaboration between public and private sector, were born exactly out of the necessity to provide large infrastructure projects that bear high financial resources and long-term risk. Their most distinctive features are the long-term duration (20-30 years), the optimized risk allocation, and the performance-based payment mechanisms. There are different types of PPP agreements, depending on the types of assets involved, the payment method, and the functions for which the private party is accountable. They should not be confounded with any form of privatization even if they share many of their characteristics.

PPPs are chosen as procurement tools to fill the financial gap that many of the governments face to invest on big infrastructure. By improving the user-fee administration, eliminating leakages in fees collection, or implementing targeted user-fees, they can help in increasing the available fundings. PPPs can also help governments in alleviating their borrowing limitations and increase cost recovery through optimization of assets and services delivered. They can be used as mitigating tools for poor planning and project selection issues, from incorrect analysis, to bias in project selection, politics influence, and corruption. Private investors are directly interested on increasing their revenue through efficient analysis and by investing on really feasible projects. PPPs have shown to be an efficient tool in the management of infrastructure projects, as their return depends entirely on their completion on time, quality, and budget. Infrastructure

projects are usually characterized by poor maintenance. In PPPs, because construction and maintenance are combined in a single contract, the private party is encouraged to construct with high standards from the start and decrease the need for maintenance later. Nevertheless, benefitting from these advantages of the PPPs depends a lot on governments' efficiency in organizing, acquiring, and administering the project through its life cycle. The government's influence on this aspect is to increase competition, provide better risk transfer, and make sure that the citizens' needs are met.

PPPs go through various phases during their lifetime. They start with the project's identification and screening for PPP procurement, to continue with its evaluation and contract preparation, structuring and drafting of tender and contract, the tendering process, contract management during the construction and operation, and finally hand back. Some of the phases are like other contract types and others specifically related to PPPs, especially the initial ones before the signature of the contract.

The decision to go with a PPP instead of another procurement form is usually based on cost-benefit analysis and value-for-money assessments. Nevertheless, it is necessary to calculate the cost of risk transferring to the private entity, as well as the value that such a decision may bring to society. If shifted from the "business as usual" approach, PPPs can be a mechanism towards the Sustainable Development Goals. The concept of sustainable infrastructure is used for projects that provide economic, social, institutional, and environmental sustainability.

The two projects used as case studies for this thesis represent the two different fields of infrastructure, social and economic. Both projects were analyzed based on their sustainability performance. Devolli Hydropower project succeeded in the achievement of many of its primary and secondary SDGs, like provision of affordable and clean energy, industry innovation and infrastructure, clean water and sanitation, decent work and economic growth, good health and well-being, quality education, life below water and on land, as well as partnership for the goals. Nevertheless, it was still missing on other aspects, like waste management and resettlement. The waste management issues derive from the lack of a local waste management system. The resettlement issues are mostly related to the disagreement of the locals with expropriations prices assigned by the government. This is an indicator of public governance issues, still present especially in developing countries.

The second case study, the Myllypuro campus, has gone through its initial phases and is now on its way to the construction completion. The initial phases, from the conceptualization to the tender are characterized by very good social and governance sustainability practices. There has been a significant involvement of the public and groups of interest from the conceptualization to the design. The qualification of the bidders in the tender process was only 55% based on the price and 45% based on quality criteria. Besides the various requirements during the construction and operation phase, like the energy efficiency, waste management, accessibility, carbon footprint, and the flexibility of spaces, it is expected that the building must be approximately 85% new after 20 years when it will be handed over to the public authority.

Finally, the last chapter summarizes recommendations of good practices for sustainable PPPs based on the case studies and the SDG requirements. The recommendations are then summarized in a table that is structured based on the sustainability pillars: environment, society, economy, and governance. Some of the environmental practices like the ESIA and EMP belong to the planning phase, while most of them are concrete steps to be taken during the construction and operation phases. Social recommendations include practices for public involvement, accessibility and affordability of the services, relocation issues, and management of public grievances. Among the different practices, special attention must be paid to the procurement phase of PPPs. On this phase, output specifications, exclusion criteria, award requirements, and strengthening of the quality criteria in confront to the price, can determine the future of the sustainability of the project. Transparency during the tender is also crucial on this aspect. Other practices are related to the financial feasibility of the project, like a public favorable CBA, good value for money in comparison to other procurement forms, and transparent budgetary viability from the public authority. In the economic aspect, PPPs can increase employment opportunities in decent working conditions, as well as increase skill levels through training initiatives to the community.

The recommendations cover all phases of the Public Private Partnerships, and they are directed to both private and public authorities. Experience has shown that they are viable, but nevertheless, it is crucial for them to be supported by a strong PPP legal framework in the respective countries.

6 Declaration of Authorship

I hereby declare that the attached Master's thesis was completed independently and without the prohibited assistance of third parties, and that no sources or assistance were used other than those listed. All passages whose content or wording originates from another publication have been marked as such. Neither this thesis nor any variant of it has previously been submitted to an examining authority or published.

Berlin, 05.07.2022

Location, Date	Signature of the student

7 Consent of publishing the Master`s Thesis

This page of the Master`s Thesis is optional. If you agree to publish the Master`s Thesis at the HTW Berlin library after a successful Final Oral Examination, then you should also attach the relevant formula here.

8 List of Literature

American Society of Civil Engineers (2015) Journal of Infrastructure Systems. Available from: https://ascelibrary.org/page/jitse4/editorialboard.

BIRN Albania (2020). Construction of hydropower plant on the river Devoll : BIRN Albania - Concessions Database. [online] ppp.reporter.al. Available at: http://ppp.reporter.al/en/ppp/Construction-of-hydropower-plant-on-the-river-Devoll.

Brauch, M. (2017). Contracts for Sustainable Infrastructure: Ensuring the economic, social and environmental co-benefits of infrastructure investment projects IISD REPORT. [online] . Available at: https://www.iisd.org/system/files/publications/contracts-sustainable-infrastructure.pdf

Capex Advisors (2021). Agreements for the Myllypuro campus life cycle project were signed. [online] CAPEX ADVISORS. Available at: https://www.capexadvisors.fi/ajankohtaista/2021/02/24/myllypuron-kampusalueen-elinkaarihankkeen-sopimukset-allekirjoitettiin.

Chan, A.P.C. & Cheung, E. (2014) Public-private partnerships in international construction: Learning from case studies. Routledge Taylor & Francis Group: London, New York.

City of Helsinki (2019). Myllypuro to have a modern real-estate and construction-industry college campus. [online] Helsingin kaupunki. Available at: https://hel.fi/uutiset/en/kaupunginkanslia/myllypyro-to-have-a-modern-real-estat-and-construction-industry-college-campus.

City of Helsinki (2020). Kasvatus ja koulutus, Stadin ammatti-ja aikuisopisto Kaupunkiympäristö Helsingin toimitilat Koy Kaupunkiympäristö Hankesuunnitelma Stadin ammatti-ja aikuisopisto Myllypuron kampus Runokylänkatu 2, 00920 Helsinki Uudisrakennus, elinkaarihanke Hankenro 2821U20091. [online] Available at: https://dev.hel.fi/paatokset/media/att/ec/eccf3e3e3c04ddb950707b7ea81c9749518102bb.pdf.

COP26 (2021). COP26 EXPLAINED. [online] Available at: https://ukcop26.org/wp-content/uploads/2021/07/COP26-Explained.pdf.

Frey, R.L. (1978). Art. Infrastruktur, in Albers, W. et al. (eds.), Handwörterbuch der Wirtschaftswissenschaft, Stuttgart, Germany: Gustav Fischer (in German).

Fulmer, J.E. (2009). In Infrastructure Investor, July/August 2009, PEI Media.

Guasch, José Luis. 2004. Granting and Renegotiating Infrastructure Concessions: Doing it right. Washington, DC: World Bank.

IEA, International energy Agency (2021) Key World Energy Statistics 2021.

IEA, World electricity generation mix by fuel, 1971-2019, IEA, Paris https://www.iea.org/data-and-statistics/charts/world-electricity-generation-mix-by-fuel-1971-2019

IRENA (2021) Renewables Readiness Assessment: Albania.

Jochimsen, R. (1966). Theorie Der Infrastruktur, Grundlagen Der Marktwirtschaftlichen Entwicklung,

Julinda Keci (2015) Public Private Partnership for Infrastructure Projects: Mapping the Key Risks. World Academy of Science, Engineering and Technology, 9(9).

Law Society (2021). Reflecting on COP26: what were the key outcomes? [online] www.lawsociety.org.uk. Available at: https://www.lawsociety.org.uk/topics/climate-change/reflecting-on-cop26-what-were-the-key-outcomes.

Law Society (2021). Reflecting on COP26: what were the key outcomes? [online] www.lawsociety.org.uk. Available at: https://www.lawsociety.org.uk/topics/climate-change/reflecting-on-cop26-what-were-the-key-outcomes.

leverageedu.com (2022). Finland Education System. [online] Leverage Edu. Available at: https://leverageedu.com/blog/finland-education-system/#:~:text=Finland%20is%20the%208th%20most.

PPP Knowledge Lab (2022). PPP Knowledge Lab | PPP Reference Guide. [online] pppknowledgelab.org. Available at: https://pppknowledgelab.org/guide/sections/9-infrastructure-challenges-and-how-ppps-can-help.

Pratap, K.V. & Chakrabarti, R. (2017) Public-Private Partnerships in Infrastructure. Springer Singapore: Singapore.

Reiserer, A. (2021). EBRD supports KESH’s first floating solar photovoltaic plant in Albania. [online] www.ebrd.com. Available at: https://www.ebrd.com/news/2021/ebrd-supports-keshs-first-floating-solar-photovoltaic-plant-in-albania.html.

REN21 (2021) Renewables 2021, Global Status Report.

RTS (2020). Classification Criteria for new construction and overhaul of Office and Service Buildings 2018 Programme operator The Finnish Building Information Foundation RTS sr RTS -Environmental Classification v1.1. [online] Available at: https://cer.rts.fi/wp-content/uploads/rts-environmental-classification-for-office-and-service-buildings_eng_220920.pdf.

Stadin AO (2021). Myllypuron kampus. [online] StadinAO. Available at: https://stadinao.fi/tietoa-stadin-aosta/myllypuron-kampus/.

Stadin AO (2022). STAO Myllypuro (iframe). [online] enlapser.cloud. Available at: https://enlapser.cloud/53560329/fi/read/STAO_Myllypuro_iframe.

STADIN AO (2022). About Stadin AO. [online] StadinAO. Available at: https://stadinao.fi/tietoa-stadin-aosta/.

Statkraft AS (2009). Devoll Hydropower Sh.A. [online] www.statkraft.com. Available at: https://www.statkraft.com/en-al/about-statkraft/devoll-hydropower-sh.a/.

Sustainable Infrastructure Foundation (2020). SIF. [online] Sustainable Infrastructure Foundation. Available at: https://public.sif-source.org/.

sustainable-infrastructure-tools.org (2022). Get started. [online] Infrastructure Tool Navigator. Available at: https://sustainable-infrastructure-tools.org/get-started/

Tenders Electronic Daily (2021). Urakat - 104116-2021 - TED Tenders Electronic Daily. [online] ted.europa.eu. Available at: https://ted.europa.eu/udl?uri=TED:NOTICE:104116-2021:TEXT:FI:HTML.

The APMG Public-Private Partnerships Certification Program (2022). An Overview of the PPP Process Cycle: How to Prepare, Structure and Manage a PPP Contract [online] Available from: https://ppp-certification.com/ppp-certification-guide/10-overview-ppp-process-cycle-how-prepare-structure-and-manage-ppp-contract

UN (2021). World Population Projection. [online] www.un.org. Available at: https://www.un.org/en/development/desa/population/events/pdf/other/21/21June_FINAL%20PRESS%20RELEASE_WPP17.pdf.

UNEP (2015). District Energy in Cities: Unlocking the potential of energy efficiency and renewable energy, United Nations Energy Programme.

United Nations (2021a). The Paris Agreement. [online] United Nations. Available at: https://www.un.org/en/climatechange/paris-agreement.

United Nations (2021b). The Sustainable Development Goals Report. [online] Available at: https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf.

United Nations (2022). Progress towards the Sustainable Development Goals Report of the Secretary-General. [online] Available at: https://sustainabledevelopment.un.org/content/documents/29858SG_SDG_Progress_Report_2022.pdf.

Wang, N. and Ma, M. (2020). Public–private partnership as a tool for sustainable development – What literatures say? Sustainable Development. doi:10.1002/sd.2127.

WCED (1987). Brundtland Report: Our common future. The World Commission on Environment and Development (WCED). Oxford: Oxford University Press.

Weber B. & Staub-Bisang M. & Alfen H.W. (2016) Infrastructure as an asset class: investment strategy, sustainability, project finance and PPP, 2nd edition. Wiley.

World Bank Group (2017) Public-Private Partnerships Reference Guide: Version 3.

World Meteorological Organization (2021). Weather-related disasters increase over past 50 years, causing more damage but fewer deaths. [online] World Meteorological Organization. Available at: https://public.wmo.int/en/media/press-release/weather-related-disasters-increase-over-past-50-years-causing-more-damage-fewer.

World population review (2020). Most Educated Countries 2020. [online] worldpopulationreview.com. Available at: https://worldpopulationreview.com/country-rankings/most-educated-countries.

Worldometers.info. (2020). World Population Clock: 7.7 Billion People (2019) - Worldometers. [online] Available at: https://www.worldometers.info/world-population/.