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A Framework for Integration of Smart and Sustainable Energy Systems in Urban Planning Processes of Low-Income Developing Countries: Afghanistan Case

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Abstract: Population growth and city expansion in developing countries require traditional urban planning practices to be transformed in order to tackle climate change and follow Sustainable Development Goals (SDGs) agendas. Almost every expert in the urban sector believes that future cities should be sustainable, smart, and environmentally friendly, where energy is one of the most critical factors to achieve these goals. They also agree that smart and sustainable energy provision for cities requires a comprehensive and responsive legal and policy framework to be in place at the national level. However, this research's findings reveal a lack of such frameworks for this group of countries. Considering the challenges and unique nature of Low-Income-Developing (LID) countries, there should be a framework based on the realities in these countries. In this research, key challenges of urban and energy sectors of LID countries, specifically Afghanistan, are identified, and a framework for the integration of sustainable and smart energy in the urban planning processes for LID countries is proposed. To make it easily replicable and adaptable for LID countries, the proposed framework is studied and analyzed around Afghanistan's urban and energy sectors. This is one of the few frameworks of its kind for LID economies to the best of the authors' knowledge. This framework lays a solid foundation for sustainable and smart energy integration in the urban planning process of developing countries. This study highlights that sustainable and smart energy systems could ensure climate change mitigation and economic growth enhancement but require close cross-sectoral coordination and policy maker's commitments and involvement. This research will help many existing and emerging cities in the LID countries' worldwide use and benefit from the proposed framework in their urban planning processes. It also enables policymakers, urban planners and designers, municipalities leadership, and other stakeholders of the urban, energy, and environment sectors to work together and make smart and rational decisions for the future of their cities and lead them towards smart and sustainable cities.

Keywords: urban planning framework; sustainable energy integration; smart-sustainable city; low-income developing countries; sustainable development goals; environment

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1. Introduction

Cities are the consumers of 75% of the all-natural resources, 60–80% emitters of greenhouse gas (GHG), and hosting 55% of the world population in 2018 expected to increase to 68% by 2050 [1,2]. Most of the cities in the developing world are suffering from many social, environmental, and economic problems, such as excessive Greenhouse

Gas (GHG) emission, unclean, and unsustainable use of energy, air, and water pollution, poor planning and design, inefficient transportation, traffic congestion, outdated (old and traditional) infrastructure, and many others to name [3], significantly contributing to the climate change. There are three scenarios anticipated by the Energy Technology Perspective 2017 portraying climate change by the end of this century. The Reference Technology Scenario (RTS), also called the baseline scenario, is based on existing energy and climate-related commitments. Under this scenario, the global final energy demand will continue to grow by 50% in the period to 2060, with cumulative energy sector CO_2 emissions increased by over 1750 GT. The 2 °C Scenario (2DS) and the Beyond 2 °C Scenario (B2DS) limit future temperature increases to 2 and 1.75 °C by 2100, respectively. Therefore, the topic of transforming cities to sustainable and smart ones has been at the top of global discourses and debates in the last few decades. In 2015, world leaders worldwide agreed to achieve 17 sustainability goals by 2030. Goals seven, eight, nine, and eleven of Sustainable Development Goals (SDGs) targeting the provision of affordable and clean energy, decent work and economic growth, the industry, innovation and infrastructure, and sustainable cities communities, respectively. However, they highlighted that it would be unlikely to achieve these goals unless innovative and ambitious planning by city leaders are undertaken [4]. At the first round of SDG 7 progress review at the UN high-level political forum in 2018, it was realized that the key challenges towards transforming cities into sustainable ones as SDGs expects are the result of market barriers, inappropriate policy frameworks, financing gaps, poor capacity for design, planning, and implementation, and lack of affordability and reliability of energy [5].

Many green movements, including Smart and Smart-Sustainable cities, emerged in the last three decades to fight the climate change phenomenon and ensure sustainability. There are several definitions for smart and sustainable cities. International Telecommunication Union (ITU) defines smart-sustainable cities as: "*A smart-sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, the efficiency of urban operation and services and competitiveness while ensuring that it meets the needs of present and future generations concerning economic, social, environmental, as well as cultural aspects. (City competitiveness refers to policies, institutions, strategies, and processes that determine the city's sustainable productivity)*" [6]. On the other hand, smart cities utilize ICTs for enhanced livability, workability, and sustainability. Information and data are collected through sensors, communicated by IT networks, and eventually analyzed for instant and future use [7]. Smart cities are built with a high degree of environmental compatibility to provide security and comfort for the people in every way. Furthermore, the efficiency of these cities is much higher because all infrastructures are built based on new technologies, supported by sensors and computer systems [8]. Issues such as sustainable development and sustainable energy delivery in cities have become one of the key concerns of smart cities [9]. Although the smart city objective is not always sustainability, smartness helps to achieve sustainability and sustainable energy targets [10] The action fields of smart cities are focusing on these six areas: 1. Smart Governance, 2. Smart Economy, 3. Smart Mobility, 4. Smart Environment, 5. Smart People, and 6. Smart Living [11].

ICTs are some of the core components of smart sustainable urban planning [3], and have the potential to accelerate the achievement of all four SDGs goals discussed above and mitigate climate change. Cities that rely on ICTs could mitigate climate change and ensure sustainability by providing enhanced energy efficiency, increased utilization of renewable energy, improved waste management, traffic flow and safety, water, and health. Moreover, smart energy systems are automated algorithms used to analyze historical data consumption profiles and the current status of some variables in the demand side to optimize, predict, and plan to manage the energy system [12].

Smart grids, mini/micro-grids, renewable energy, and energy management are all interrelated. Smart grids are considered the future of power networks for managing generation, transmission, and distribution by using ICT, artificial intelligence (AI), and IoT. Mini/micro-grids are a potential solution for future systems relying on distributed genera-

tion and the emerging renewable energy resources integration. They could significantly improve demand and supply side management and energy efficiency in different layers of energy systems [11].

Here comes that ICT, Internet of Things (IoT), and energy systems meet sustainability goals and facilitate the transition to sustainable and smart energy systems and cities.

This manuscript justifies that integrating energy in urban development processes is critical for having smart and sustainable cities. Thus, it should result in climate change mitigation broadly and paves the way to achieve SDGs. Although it is not critical for developed countries, the main findings of this study reveal that energy, especially smart and sustainable energy topics, are overlooked in urban, transportation, environmental, and economic planning processes in most of the LID countries. It is also discovered that there is a lack of a standard and widely accepted mechanism or framework to be followed by urban leaders to solve the energy integration puzzle in the urban context of LID countries. Therefore, such a framework would have strong and positive economic, environmental, and social implications for most of the poor and LID countries around the globe. Hence, in this research, key challenges of urban and energy sectors of LID countries, specifically Afghanistan, are identified, and a framework for the integration of sustainable and smart energy in the urban planning processes is proposed. Specific recommendations are also provided for stakeholders and policymakers of the energy sector of these countries and Afghanistan. The highlights of this research could be listed as:

1. Integrating sustainable and smart energy in urban planning proceses is critical for smart and sustainable cities.
2. No frameworks exist for low–income developing countries to have sustainable and smart energy systems.
3. Sustainable Urban energy requires policy maker commitments and considerations.
4. Urban planning practices need to be upgraded for achieving SDGs.

2. Literature Review

2.1. Sustainable and Smart Energy Integration in Urban Planning—Needs and Progress

Since the early 1990s, urban planning and development practitioners from different disciplines have been promoting the concept of sustainability for the future of cities [3]. According to the UN general assembly dated 25 September 2015, world leaders from 193 nations agreed to a plan of action for people, planet, and prosperity under 17 goals and 169 indicators, called the Sustainable Development Goals or SDGs [13]. Among these 17 goals, goals 7, 9, 11, and 13 are directly linked to sustainable and smart energy systems and cities. Goal 7 focuses on universal access to affordable, reliable, and modern energy, a considerable increase in the share of renewable energy in the world energy mix, a 2-fold increase in the global energy efficiency, enhanced international support in facilitating access to clean energy research and investment in clean energy technologies, and particular attention on the sustainable energy systems infrastructure upgrade in developing, small islands, and landlocked states. Goal 9 focuses more on developing and least developed (LD) countries. Sustainable industrialization and the building of resilient infrastructure for the economic development of these countries by providing financial means, technical support, research and innovation, and universal and affordable access to internet and ICT technologies being pondered by this goal. Goal 11 is particular to sustainable, safe, and resilient cities. Adequate, safe, and affordable housing, sustainable, accessible, safe, and an affordable transport system reduced environmental impacts of cities by special attention to air quality and waste management as well as creating a positive economic, social, and environmental link between cities and rural areas for the residents of cities are part of the key agenda of this goal. Goal 13 warns city leaders, especially the LD countries, to integrate climate change measures into national policies, strategies, and planning, support them to raise their capacities for effective climate change-related planning and management, and provide the funds for meaningful and transparent climate change mitigation actions [13]. The ratification of the Paris agreement and SDGs has shown a strong global consensus and

support for promoting sustainability and addressing climate change concerns. Key tools and enablers for responding to these concerns are the expansion of the electrification of the end-use in urban sectors, especially buildings, transportation, and industrial sectors, increased share of the renewable energy in the electric energy generation, and increased share of electricity in the overall energy demand [14]. It tells us that future urban planning should be based on an integrative application of urban planning, sustainable development, and ICT [3].

In this epoch, realizing urban sustainability goals requires transdisciplinary knowledge of the sustainability concepts, complicated and big data computation and analysis, and the application of smart and innovative planning methodologies. For having a sustainable energy future, integrated approaches are fundamental [14–16]. Integrated approaches are the only method to make sure decisions are made based on the right assumptions. Therefore, contemporary urban scale energy modeling requires the presence of optimization models of all urban sub-sectors such as the urban environment, buildings energy, and supply, transportation, and energy [17,18].

The key requirements for integrating energy in the urban planning processes are national targets for sustainability and smartness, legal frameworks, energy, and urban planning strategies, defined roles of actors and stakeholders, and necessary urban-related data [19]. For target setting, assessing target performance, management, and decision-making, urban leaders need specific indicators. Expert knowledge is required to choose the most suitable indicators [20]. Currently, there are six international city indicator standards and the UN SDGs, relevant to smart and sustainable cities evaluation and reporting. They focus on the performance of city services and quality of life (ISO 37120), smart cities (ISO 37122), sustainable digital multiservice cities (ETSI), use of ICT sustainability impacts (ITU 4901), assessing the SDGs (ITU 4903), and plan of action for people, planet, and prosperity (UN-SDGs). The natural environment, built environment, water and waste, transport, energy, economy, culture and science, health and safety, governance and city management, and ICT sectors are covered by these standards [20].

2.2. About Afghanistan

2.2.1. General Information

Afghanistan is a landlocked country in South Asia, with a 37.1 million population (31.7 according to Afghanistan Central Statistical Office [21]), among 47 countries classified as least-developed countries (The IMF classifies Afghanistan among Emerging Market and Developing Economies ([22]. The UNDP classifies Afghanistan as a Developing country [23]. WDI puts Afghanistan in the low income category, with HCI 0.39 [24]. The Afghanistan HDI score is 0.496 and ranked 170th among 189 nations [23].) in the world [25,26] with the GDP per capita of 579$ [27]. Afghanistan is ranked 170th in the human development index perspective among world nations. The mortality rate attributed to household and ambient air pollution is 211 per 100,000 population [23]. Around 80% of the Afghanistan economy and livelihoods are directly or indirectly linked to Agriculture [28]. Afghanistan's total available electric power capacity is 1.5 GW, where 60% of this power is imported from Uzbekistan, Tajikistan, Turkmenistan, and Iran. The highest domestic electricity generation capacity is from hydro, which constitutes 44% of the total, followed by thermal, 41%, and diesel, 15%. In 2016, up to 30% of the total population of Afghanistan had access to electricity. In addition, 77% of the Afghan population lived in rural areas, where only 11% had access to the national grid, which is 90% in large urban areas. However, Afghanistan had 178 kWh per capita of electricity consumption, which is the lowest globally [29].

Integrating climate change considerations into the national planning processes is highlighted by the government of Afghanistan [30]. To realize Afghanistan's Intended Nationally Determined Contributions (INDC), the WBG (World Bank Group (WBG)) climate policy team has suggested several mitigation actions and policies. These policies are mainly focusing on energy efficiency in the building and transportation sector (Increased share of efficient vehicles if public transport, and fleet), creating financial incentives for

the deployment of renewable energy technologies (solar PV, Solar thermal, biomass, energy waste), shifting fuel to clean fuel and gas, clean and efficient heating and cooking, development of codes and standards for demand-side appliances and equipment (Building codes, standards on appliances and equipment, market mechanisms), identify energy efficiency measures (households, transport, industry, services, mining, agriculture), shift to environmentally friendly and smart agriculture (biomass recovery measures for energy, national herd, and manure management, and reduced fertilizer application), and methane recovery from landfills. Many of these policies and plans need to be incorporated into the urban planning processes. However, it requires a strong political will, public support, and follow up [31,32].

2.2.2. Afghanistan's Existing Legal and Regulatory Framework Relevant to Energy Systems

Key stakeholders of the energy sector of Afghanistan and their mandates and role are described in Table 1.

Table 1. Mandates for each key stakeholder of the urban energy-related stakeholders. Source: Author.

No.	Name of Entity	Mandates	Source
1	**Ministry of Urban Development and Land** (High Council of Urban Development is chaired by the president. The main purpose of this council is the coordination of the urban sector. Key Members are minister of finance, minister of transport, minister of economy, minister of urban development and land, minister of energy and water, municipalities affairs deputy of IDLG, head of CRIDA, head of NEPA, Kabul Mayor, Head of DABS, and Head of Afghanistan Urban Water Supply and Sewerage Corporation,)	Development of policies, plans, and master plans for cities, housing, land (land information, distribution, lease, and regulations)	[33] (Ministry of Urban Development and Land (MUDL))
2	**Ministry of Energy and Water (MEW)**	Development of legal framework (Law, policies, plans, regulations), conducting feasibility studies, and surveys for the Energy Sector (focusing on Water and Electricity)	[34] (Afghanistan National Development Strategy (ANDS))
3	**Kabul Municipality**	Plan, design, and construction of roads, the drainage system, and parks, solid waste management, property and business tax collection, and public awareness, urban sanitation control, development of regulations for townships, traffic control, improvement of the urban economy	[35] (Ministry of Justice (MoJ))
4	**Da Afghanistan Brishna Sherkat (DABS), The National Electricity Utility Company)**	Provision of reliable electricity, generation, transmission, distribution, building, and O&M of the power plant, and power trade (Purchase and sell) of electric energy all over Afghanistan	[36]

Table 1. *Cont.*

No.	Name of Entity	Mandates	Source
5	**Ministry of Mines (MoM)**	Development of legal framework (Law, policies, plans, regulations), conducting feasibility studies, surveys, regulating and facilitating mining contracts and activities for the Energy Sector (focusing on Oil, Gas, Coal)	[34]
6	**Ministry of Commerce (MoC)**	Development of legal framework (Law, policies, plans, regulations) and regulating liquid oil and gas trade	[34]
7	**Ministry of Communication and Information, Technology**	Development of policy and strategies for the ICT sector, e-governance promotion, improvement of the postal services	[37] (Ministry of Communication and Information Technology (MCIT))
8	**Afghanistan National Standards Agency (ANSA)**	Establishing quality basis and infrastructure, quality improvement of goods set regulations for consumable, Ensure the safety and health of consumers	[38]
9	**National Environmental Protection Agency**	National Policy, strategy, and action plans development and implementation, monitor the implementation of the Environmental law, prepare the state of the Environment report, coordination, and awareness	[39]
10	**Ministry of Transport**	Create policies, plans, and frameworks for a safe, accessible, clean and reliable transportation system for the country.	[40]

Several policies and legal documents ratified by the government of Afghanistan have implications on climate change, CO_2 emissions, environment, energy, and economic development (For detailed classifications and information, refer to the Tables A1–A6, Appendix A). Table 2 summarizes these documents.

Table 2. Legal and policy documents ratified by the government of Afghanistan have implications on climate change, CO_2 emissions, environment, energy, and economic development. Source: Author.

Category	Document Name	Level
Law	Power Services Regulation Act (2015)	National
	Environment Law (2007)	National
	Nuclear Energy Law (2015)	National
Regulation	Regulation for Electricity Regulatory Authority of Afghanistan (2019)	Ministry/National
	Fuel Consumption Regulations (2010)	National
	Afghanistan Energy Efficiency Code for Building (2015)	National
Plan	Afghanistan National Peace and Development Framework (2017)	National
	Renewable Energy Roadmap (Draft)	Ministry
	Energy Sector Strategy (2007–2011)	Sector
	Kabul Urban Design Framework (KUDF) 2018	City
	Power Sector Master plan (2013)	Sector
	Afghanistan Green Urban Transport Strategy (2014)	Ministry/City
Policy	Renewable Energy Policy (2015)	National
	National Housing Policy (2019)	Ministry
	Afghanistan INDC (2015)	National
	National Energy Policy (draft)	National

The only document discussing most urban sectors in an integrative manner is KUDF (Kabul Urban Design Framework). KUDF is the urban development design framework/vision prepared for the next 10–15 years of Kabul City. Sustainable infrastructure, housing for the next 2 million populations, urban mobility (reducing pollution, bicycle lanes, Mobility + Accessibility, Walkability, Biking, Public Transit, and Universal Accessibility), and economic empowerment are key drivers of this framework. The approach to energy planning for the long-term vision is based on these key design concepts and principles: local distributed renewables, energy efficiency, low-carbon sustainable development, and 100% access of the urban population to grid electricity the smart meters. This framework is only a planning tool, which requires strong coordination with related governmental departments and involved stakeholders, local community involvement in the planning process, and collection of actual data from the mentioned sites. KUDF proposes three phases to realize the main goals identified for Kabul City: 1–5 years' phase focuses on enabling legislation, mobility planning, quick impact projects, and some pilot projects and programs. In addition, the 5–10 years' phase is for the future planning initiatives, expansion of projects, programs, and policies. Finally, the 10+ phase focuses more on large-scale projects and planning and organizational changes. According to DABS, the peak demand of Kabul for the next ten years will increase to around 2200 MW. KUDF is pointing to the importance of sustainable energy systems as the key to Kabul's long-term growth. Mentioning energy security as the basis for a sustainable energy plan, KUDF introduces the economic feasibility, environmental protection, and practical implementation of the plans for the energy sector. However, not many details are provided for these sectors. KUDF also argues that the legal and policy framework for the energy sector in Kabul is well established and proposes very few recommendations for the national power utility, DABS, for providing incentives for customers to reduce electric energy consumption during peak hours and the installation of smart meters [41]. The key suggestions and design framework for the Kabul City energy being quoted below from KUDF:

> *"A sustainable energy system is the key to Kabul's long-term growth. While energy security is the basis of a sustainable energy plan, improving energy efficiency and*

encouraging low-carbon design will accelerate the development of Kabul City. Principles of sustainability, economic feasibility, environmental protection, and practical implement ability are at the core of the approach to planning for the energy" [41].

2.2.3. Afghanistan and Its Capital, Energy, and Environment Related Problems

Afghanistan, especially its urban areas are suffering vastly from environmental pollution. Water, air and soil pollution, scarcity of clean water, and solid waste management are major environmental issues. In addition, almost 70% of the energy is consumed in urban areas, contributing to 50% of CO_2 emissions in the country. The main sources of these gases in urban areas are electricity generation, transportation, and biomass combustion for heating. Afghanistan's greenhouse gas emissions composition in 2013 is detailed in Table 3 [28].

Table 3. National Greenhouse Gas Inventory, GHG Emissions for six sectors in Afghanistan for 2013 (in Gg) Source: [28].

Ghg Source and Sink Categories	CO_2		CH_4	N_2O	N_xO	CO	NMVOC	CO_2e
	Emissions	Removals						
Total Emissions and Removals	20,395		519	73	70	541	45	**60,237**
1. Energy *	9639		3	0	61	235	45	**9747**
2. Industrial Processes	210		0	0	0	0	0	**210**
3. Solvent and Other Product Use	NE	NE	NE	NE	NE	NE	NE	**NE**
4. Agriculture			489	72	4	110		**38,762**
5. Land-Use Change & Forestry **	10,546		22	0	6	197		**11,338**
6. Waste			5	0				**180**

* Including fugitive emissions. ** Net emissions comprising both emissions and removals.

For Afghanistan, lack of access to finance, very low technical and engineering knowledge, corruption, security, and lack of a functional regulatory are listed as key challenges of the energy sector by BSW [29], which are directly linked to the slow transition of the energy sector to a sustainable and smart one. Although INDC proposes the use of renewable energy and energy efficiency improvement in building, transport, industrial, and power sectors, there are some key challenges outlined by the World Bank Group, Climate Policy team [31]. This team outlines the lack of political decision of adaptation by the head of state, ministries, and parliament levels, no consideration of these goals in the planning process, and lack of technical support.

Kabul, the capital of Afghanistan, has been growing very fast and expanding widely to its outskirts since 2001. Its population has dramatically increased from 0.8 million to 4.9 million [21] since 2001, and is expected to grow to 5.7 million by 2030 [1]. A city built for 0.8 million should host this population and provide them with a quality and livable environment and living facilities. It has never been easy anywhere in the world to transform a city from an ordinary living style to a modern and technology-based one.

Kabul City has been transforming vertically and horizontally in the last two decades, and a lot of money is spent on installing infrastructures for transportation, water, energy, and ICT without aligning them to urban smart and sustainable agendas. There are nearly 2 million imported vehicles consuming diesel and petrol (few runs by LPG), operating on the roads of Afghanistan [28], from which 0.6 million are in Kabul [42]. Kabul City transport fully relies on fossil fuels. No hybrid or electric vehicle is not yet available in the city, and no regulations exist for integrating low emission or electric vehicles in the city mobility system. According to [43], at a minimum, 50% of male adults in Kabul City drive or use a passenger car and enjoy a lifestyle built around the use of the car. As a result, the combined effects of the gradual increase of traffic in populated cities of Afghanistan, especially Kabul, are starting to create grave economic, environmental, and social problems [43]. There is no official number of deaths due to air pollution. However, according to the State of Global air research group, around 26,000 lives are lost due to air pollution in 2017, which is proportionally much higher

than the number of civilians killed, 3483, in the war in the same year. This group claims that at least 19,400 of these deaths are attributable to household pollution [44].

3. Methodology

This research is undertaken to investigate solutions for upgrading energy systems of LID countries to more sustainable and smart ones, and to meet the requirements of this millennium detailed in SDGs.

Initially, a qualitative review of the existing literature on sustainability concepts, sustainable and smart cities, sustainable and smart energy systems, and a linkage between smart-sustainable cities and energy systems is undertaken. Keywords such as Smart-Sustainable cities, sustainable energy integration in urban planning processes, urban challenges in low-income developing countries, and frameworks for sustainable and smart energy integration in urban planning processes are used to identify the reports and research paper. The selection of reports and research papers to be used in this paper was based on their relevance to the research questions. As a result of the review, the global sustainable energy trends, existing approaches and frameworks for sustainable energy integration, and challenges towards transforming traditional energy systems to more sustainable and smart ones, have been investigated and specified. Secondly, Afghanistan's energy and urban issues are investigated by reviewing its legal and policy frameworks, the status of the energy and urban sectors, and existing challenges to upgrade its energy systems to smart and sustainable ones. Specifically, Afghanistan energy and urban sector-related legal, policy, and regulatory documents are reviewed and analyzed. In addition to this literature, the key stakeholders for sustainable and smart energy system for Afghanistan have been explored and specified. Based on the findings and analysis of the studied literature, the authors' main results are presented in two parts; 1. Key challenges of the urban and energy sectors in LID countries, and 2. Proposed framework for the integration of sustainable and smart energy in urban planning processes of LID countries. The framework is proposed considering political, social, technical and financial, and institutional parameters and facts in LID countries.

To make it easily replicable and adaptable for LID countries, the proposed framework is adapted and analyzed around Afghanistan's urban and energy sectors. Lastly, general sets of recommendations for effective application of the proposed framework are presented for LID countries' key stakeholders of the urban and energy sector. Moreover, specific recommendations for urban and energy sectors authorities of Afghanistan are provided. Figure 1 illustrates the methodology in completing this research.

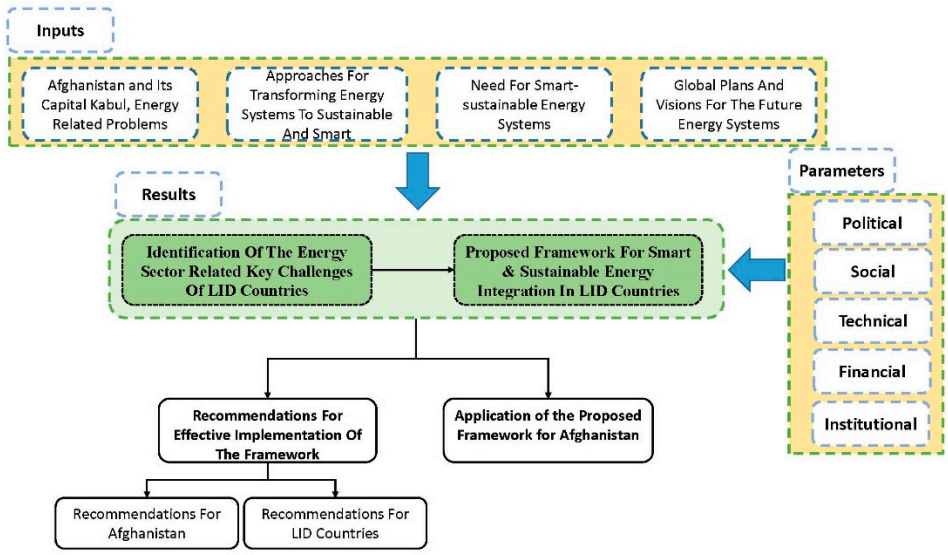

Figure 1. Methodology of the research. Source: Author.

4. Results

4.1. Key Challenges of the Urban and Energy Sectors in LID Countries

LID countries/economies are distinguished by their less than 1025 $ per capita gross national income (GNI), weak human asset index (HAI), and low Economic Vulnerability Index (EVI) [45] still follow the brown agenda, looking at the green agenda as something luxurious and for the future generation [46]; therefore, their cities are unhealthier, poor, and energy-intensive compared to the developing and developed cities. In addition, most of the population growth and city expansion will be in the developing and LD countries as the developed countries have already reached a stable condition [15]. Therefore, LID countries strongly need to transition their energy systems to sustainable and smart ones, something the new world requires.

The energy systems of developing countries, especially LD countries, are characterized by their poor performance of the power sectors (Insufficient operational and maintenance performance, high level of technical and non-technical losses, the rapid growth of electricity demand, low reliable electricity supply, organizational issues, limitation of capital for investment, dependence on imported power, and low consumer prices), low rate of access to electricity, low tariffs usually below long-term marginal cost, poor revenue collection, electricity theft, transitional economies (from traditional to modern), structural deficiencies, weak planning practices resulting in inadequate investment decisions, improper use of subsidy, market regulations, increased energy intensity, poor energy efficiency, and increasing reliance on energy imports [45,47,48]. Sharifi and Yamagata provide an exhaustive study on the resilience of the urban energy systems, identifying climate change, cyber-attacks, terrorism, technical deficiencies, and market volatility as significant threats to urban energy supply [49], with LID countries highly vulnerable to these threats [50].

Moreover, there are many other challenges for urban planners and urban policymakers when discussing moving towards smart sustainable cities. One of the key challenges that stand at the top is the lack of a high-level and responsive framework for integrating sustainability theories and goals into the complex urban planning processes and discourse [51]. A lack of integrated models for having sustainable and smart energy systems has been identified as another key challenge in the urban planning context [52], mainly due to the complexities, uncertainties, lack of reliable and quality data availability, and a lack of ability to handle a wide variety of different data and information.

Based on the LID countries' profiles, key challenges and obstacles towards having sustainable and smart energy systems in LID urban systems are classified into five main areas and explained in Table 4:

Table 4. Key challenges and problems towards sustainable energy systems in LID countries' urban systems. Source: Author.

Barriers Type	Challenges	Description
Political	**Security**	Physical security, energy security, water security, and cybersecurity are some of the main issues to be addressed in cities. Cybersecurity for a smart city is very crucial. Personnel information security is also a concern in a smart urban context as big data management requires strong database support and security.
	Political instability	Most low-income states have fragile states with several institutional and security challenges [53]. Timely and proper decision-making is not always possible in a divided and unstable political environment.
	Corruption	Most of the low-income developing countries are suffering from corruption at different political levels compared to developed countries [54,55] including Afghanistan [56]. Individuals and group benefits are guaranteed in the existence of corruption. Thus, there will be many spoilers and resistors to the process of reforms in the urban sector.
Legislative	**Lack of strong and independent regulatory bodies**	Lack of regulatory entities will result in weak monitoring and control of the national targets' progress. On the other hand, independent and strong regulatory bodies will foster achieving the governments' goals and targets. For Afghanistan, it is mentioned in multiple documents that the lack of a strong and independent regulatory body for the energy sector is one of the main challenges towards the improvement of the energy sector in this country [29,56,57]
	Outdated laws and policies	Outdated laws and policies slow down the integration of sustainable and smart urban agendas. Update of laws and national policies is not always easy and quick.
Institutional	**Lack of a technically capable and authoritative urban planning entity**	When the urban planning leading entity does not have the strong technical capability and authoritative role over key urban stakeholders, it will not be easy to prepare and agree on smart sustainable urban energy agendas and set unified and agreed-upon targets for cities.
	Overlap of mandates and responsibilities	In an environment where institutional roles and responsibilities are conflicting and unclear, initiating sustainable and smart agendas for energy and urban sectors seems a big challenge.
	Weak stakeholders coordination and engagement	Poor stakeholder coordination and participation is a major issue in different management and leadership levels in poor countries. Lack of coordination is mainly caused by the lack of a clear national vision for a smart and sustainable energy future, not only for cities but for the states.
	Lack of a high level, independent and systematic monitoring and supervision entity	Lack of a systematic and independent monitoring and control entity for urban issues could be damaging to the process of urban target implementation.
	Weak private sector involvement in the urban sectors	The private sector needs to be involved, active, and capable of delivering the plans. LID countries have not been able to provide an enabling environment for the involvement of the private sector.
Technical	**Low interdisciplinary knowledge of policymakers**	National goals, energy security, interdisciplinary approaches, and sustainable development are the key dimensions of strategic urban energy planning [58]. Not all policymakers and politicians know about smart sustainable urban planning and some do not even believe in the climate change phenomena, even in developed countries. Lobbying and awareness could help remove this critical obstacle.
	Lack of human resource for high level and strategic planning	Local human resource capacity is not always appropriate to run the smart sustainable urban and energy agendas. There should be a deep capacity assessment and programs for government and private sector stakeholders.
	Lack of local industry for the support of the urban smart sustainable energy deployment	Smart sustainable cities will need strong technology and industry support. The technology and industry needed for smart sustainable urban and energy systems to be identified and the environment for investment in those sectors to be supported. Seeking international support for collaborative actions and technology transfer is highly suggested to the urban leaders.
	Inappropriate infrastructure	Smart grids and mini-grids are needed when generation sources are distributed and switched to renewable energy [59,60]. The power system infrastructure in LID countries is not appropriate for embracing smart and sustainable energy systems [1].
	The fast pace of low quality and low-efficiency building construction	Urban infrastructure expansion happens and could not be stopped. However, it will be difficult if the quality and efficiency of these structures are not controlled and regulated. LID countries are famous for low quality and efficient building sector.
Financial	**Financial limitations of the government**	Turning brown cities to green need financial resources. However, it is not always available. These funds need to be approved and be available by the financial institutions. Policies for financing and creating a market for investment in this sector are highly needed. Cities should plan to transition their economy and development activities from federal and donor agencies' reliance on self and private sectors centered economy.
	Dependence of the governments on external development finance (Aid Dependence)	For some years in the future, LID countries will remain depending on external development financ [61]. For a sustainable economic transformation, public investment and services are critical to achieving SDGs. For an aid-dependent economy, it could be time-consuming to encourage public investment.
	Lack of enabling environment for attracting investment and private sector support	LD/LID countries are faced with significant challenges in attracting investment. The ease of doing business is challenged in more than 90% of this group of countries. Low access to finance, high cost of energy, skills deficiency, and limited ICT support have been listed as the main barrier for the private sector [62].

4.2. Proposed Framework for the Integration of Sustainable and Smart Energy in Urban Planning Processes of LID Countries

City leaders and authorities are willing and working to make cities smart and sustainable, but they do not have sufficient authority and mandates to lead this endeavor independently. At the same time, energy cannot be discussed alone in the urban context. It has close links with other urban sectors such as transportation, environment, economy, ICT, water, buildings, and land use. It requires to be discussed at the national-multi-sectoral level [15]. Therefore, to integrate sustainable and smart energy in urban planning processes, there is a serious need for strong and clear legal and strategic frameworks. For example, Sharifi and Yamagata propose a conceptual framework for making the urban energy systems resilient and adaptive to any adverse event and incidents in the future. According to their framework, future energy systems should have the ability and full preparedness for Planning, Absorbing, Recovering from, and Adapting to such events. They further argue that the four sustainability pillars of energy systems (Availability, Accessibility, Affordability, and Acceptability) would be ensured by integrating these four abilities [49]. Then, they introduce some principles, such as Flexibility, Coordination Capacity, Collaboration, Oversight Capacity, and Efficiency as the required principles for resilient urban energy systems. Considering the Sharifi and Yamagata conceptual framework, South Korea's urban planning mechanism could be deemed as one of the successful urban planning practices of a developing country. In this country, the Ministry of Land, Infrastructure, and Transportation of South Korea is responsible for the development of the Comprehensive National Territorial Plan (CNTP), which is a high-level plan where the vision, long-term development strategies, population, and industries distribution, infrastructure supply, and environmental protection in the state level is defined. All other provincial, metropolitan, and city plans are required to follow CNTP [63].

As a result, the key solution to overcome multiple problems of the energy systems and cities is the structural transformation of the traditional urban planning practices [45]. These changes should require creation of a high-level and inclusive framework for managing urban issues at the state level. The proposed generic framework that could tailor the integration of sustainable and smart energy in urban planning processes of LID countries is shown in Figure 2.

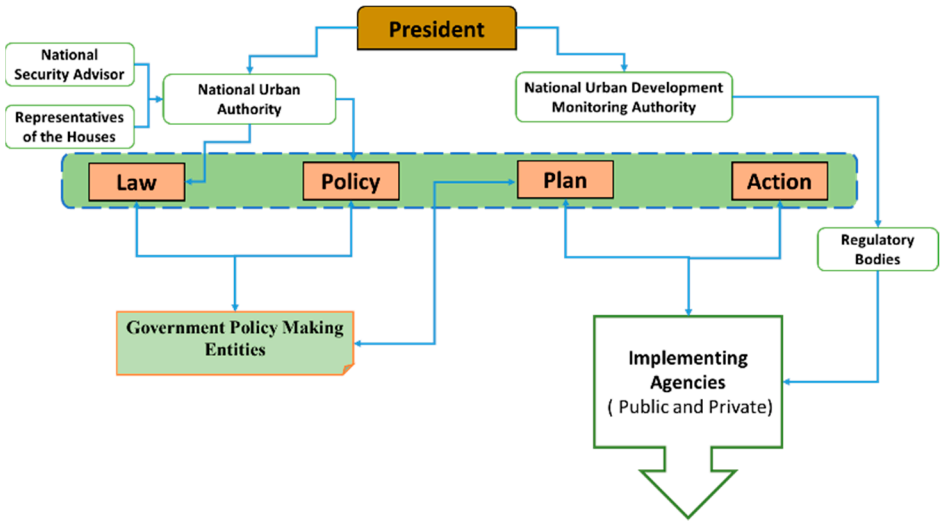

Figure 2. A generic proposed framework for integration of sustainable and smart energy in the urban planning process. Source: Author.

This framework is focusing on four key stages of action enforced from the top; 1. Development of laws and regulations, 2. Development of policies, 3. Preparation of relevant plans, and 4. The implementation stage. From now on, it will be called the APPL (Action-Plan-Policy-Law) framework. In the APPL framework, the head of the state should

be involved in coordinating the urban sector. The roles and responsibilities of the key players in this framework are detailed as follows:

Head of the State/President

Since the political power is mostly centralized in many low-income developing countries, strong political will and support are crucial for setting and implementing urban sustainable and smart agendas. Due to the involvement of many essential sectors in the urban issues, the head of the country or any high-ranking government figure is suggested to lead and coordinate this important structure. Without a strong political commitment and support, it will be very challenging and pricey to have a smart, sustainable, and resilient energy system [49]. It will help the decisions to be made quickly compared to other setups where high-level authorities are not involved.

National Urban Authority (NUA)

Due to the low technical capacity and lack of coordination capabilities of the urban sector entities in LID countries, there should be another supporting and more authoritative entity on the top of all urban stakeholders to develop laws, vision, and policies for the urban sector, specify the mandates of each, and facilitate and ensure coordination and communication between urban stakeholders. This authority shall work directly under the head of the state. NUA shall be the key authority for producing laws and policies with the technical support of its team members comprised of national and international experts and the support of the key sectoral entities. Development of the national urban vision, national urban targets, national codes, and standards will be the core responsibility of this entity. This entity shall identify the required plans, strategies, and implementation plans for the smooth and efficient implementation of the national urban vision and targets, to be developed by the line ministries and implementing agencies such as municipalities.

National Urban Development Monitoring Authority (NUDMA)

The main mandate of this authority is to track and report the progress of the national urban targets. An evaluation and measurement mechanism is also proposed to be developed to track the progress, identify checkpoints and bottlenecks, and prepare regular reporting of each entity. This authority will be in close coordination with the national regulatory bodies to oversee and report the progress to the government.

National Security Council (NSC)

Access to clean energy, water, air, energy security, water security, physical security, safe traffic, and transportation system has national security implications. Therefore, smart sustainable urban issues require NSC close involvement and endorsement. This entity in every country has the authority and responsibility to ensure citizens' security from different perspectives. This entity will play a supportive role in maintaining smooth communication and coordination between technical government bodies. This entity will also help track and monitor national targets and consider them while making decisions.

Representatives of the Legislative Chambers

Laws require the approval of the legislative chambers of countries. Thus, the representation of the legislative chambers of the country should be involved in this process. This will facilitate the approval of legal and policy documents by the houses.

Regulatory Bodies

For the regulation of urban services, regulatory bodies play a crucial role. Regulatory bodies will be able to provide data for the national urban developing monitoring authority about the quality of the services and the extent of the progress of the national targets.

Government Policy Making Entities

These entities are mainly the ministries and other independent national authorities. NUA and policy-making entities will work and develop laws, policies, targets, codes, and standards for each urban sector. These entities will also be involved in urban planning processes. However, they will have their operation plans.

Implementing Agency

Implementing agencies are all public and private organizations involved in the implementation of programs and projects.

4.3. Adapted Framework for Afghanistan

The GHG reduction, renewable energy-based generation, and energy efficiency improvement are discussed at different levels of the government of Afghanistan and its legal and policy documents. However, there is no clear framework with a specific strategic plan, where all stakeholders could follow [33]. Referring to the problems described in Section 2.2.3, Afghanistan's urban and energy sectors and systems are dealing with almost the same issues every other developing country does. Currently, all urban issues of Afghanistan are coordinated by the high urban development council. This council is chaired by the president of Afghanistan and organized by the ministry of urban development and land (MUDL). Members of this council are high-ranking authorities of MoF, MUDL, IDLG (Independent Directorate for Local Governments (IDLG)), KM (Kabul Municipality (KM)), MEW, DABS, MAIL (Ministry of Agriculture Irrigation and Livestock (MAIL)), CRIDA (Capital Region Development Authority (CRIDA)), KG (Kabul Governor (KG)), MoT (Ministry of Transport (MoT)), NEPA (National Environmental Protection Agency (NEPA)), CSO (Central Statistical Office (CSO)), MRRD (Ministry of Rural Rehabilitation Development (MRRD)), and AUWSSC (Afghanistan Urban Water Supply and Sewerage Corporation (AUWSSC)). Figure 3 shows the existing coordination setup of the Afghanistan urban sector. Previously, the coordination of the energy sector was done by the Ministry of Economy through the Inter-Ministerial Commission for Energy (ICE). ICE was comprised of a high-ranking representative of national and international stakeholders of the energy sector of Afghanistan [64]. This coordination structure is no longer active.

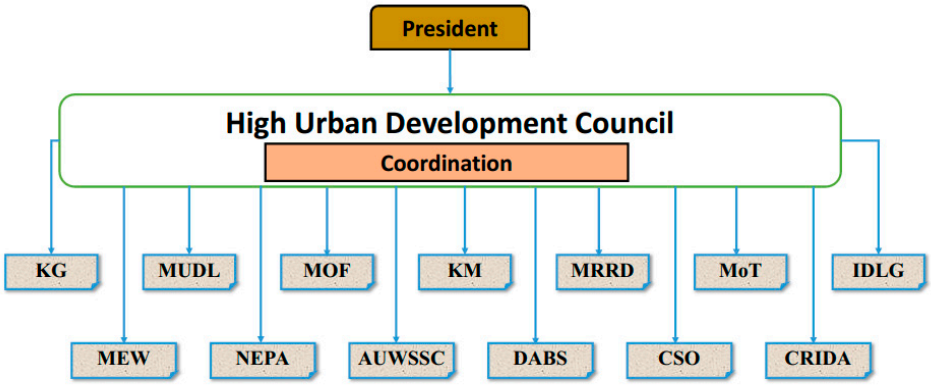

Figure 3. Existing coordination setup of the Afghanistan Urban Sector. Source: Author.

It is evident from Figure 3 that the current urban planning and management structure and setup of Afghanistan are only used for coordination purpose. The key functions that are legislation and policy-making are not part of these council mandates. After adopting the proposed generic framework for the Afghanistan context, the new framework for Afghanistan urban sector for integrating smart and sustainable energy in the urban planning processes would be transformed into one shown in Figure 4.

In the proposed adapted framework, the existing High Council of Urban planning will be transformed into NAU with the key responsibilities of law and policy-making and a permanent structure in the government. One of the appropriate entities NAU could work under could be the Administrative Office of the President structure or an independent-new entity.

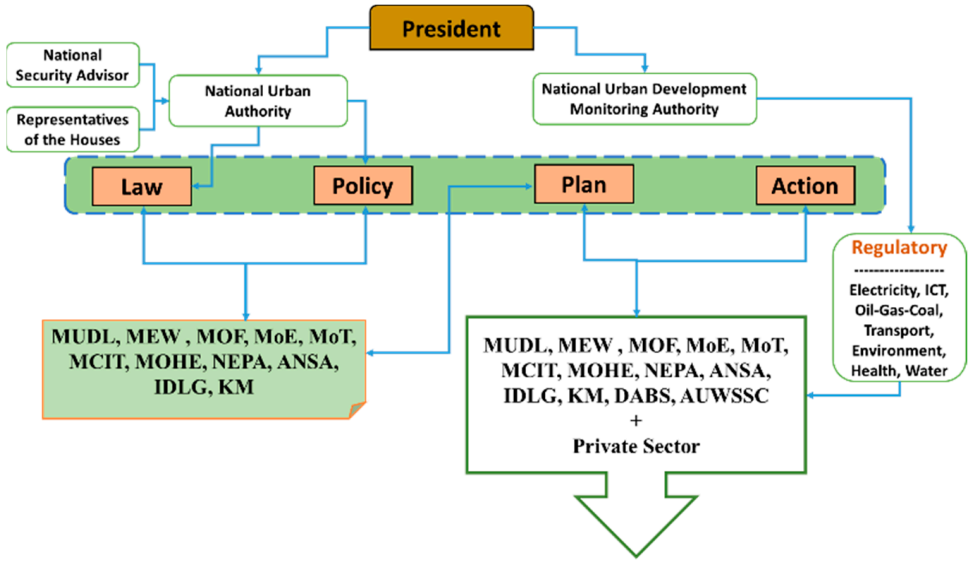

Figure 4. Adapted framework for the Afghanistan urban sector. Source: Author.

4.4. Adapted Framework for Kabul City

According to the APPL framework, the role and mandates of the implementing agencies, KM in the case of Afghanistan, shall be redefined. The KM role will be limited to planning and implementation. The existing design framework for Kabul City, the KUDF, should be revised by National Urban Authority (NUA) in line with the national urban vision, targets, standards, and codes (which are not yet existing). Following this, NUA will prepare the Kabul City master plan according to the revised KUDF. KM will be responsible for preparing its detailed plans, regulations, procedures, and implementation strategies for implementing the Kabul City master plan. Obviously, whatever needs to be produced by KM shall be in line with the national vision, targets, and standards for urban systems. NUDMA will monitor the progress, quality, and effectiveness of KM implementation plans through its resources and regulatory bodies. The proposed KM mandates and operations framework are described in Figure 5.

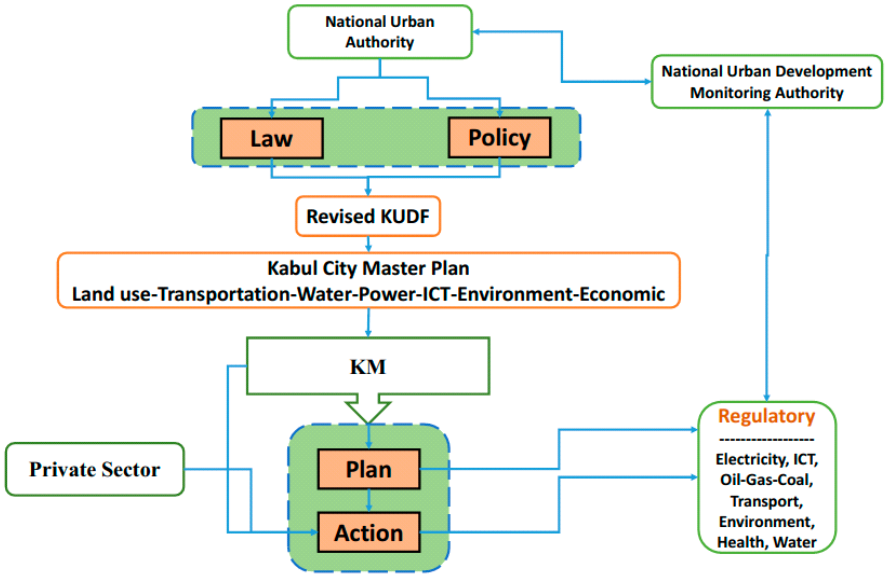

Figure 5. Adapted framework for Kabul Municipality Operations. Source: Author.

Currently, KM is responsible for the construction and maintenance of the transport infrastructure, traffic management, land-use, and land re-adjustment planning, detailed

urban plans development, buildings' design documents approval and construction permit issuance, solid waste management, greenery, some sanitation responsibilities around the city, and urban revenues collection. However, KM needs to be at the top of all urban infrastructure. Transportation, water supply and management, environment, energy, electricity, health and sanitation, ICT, and wastewater management shall be planned and implemented by KM in the lead. Figure 6 shows the diagrams of existing and proposed KM responsibility areas.

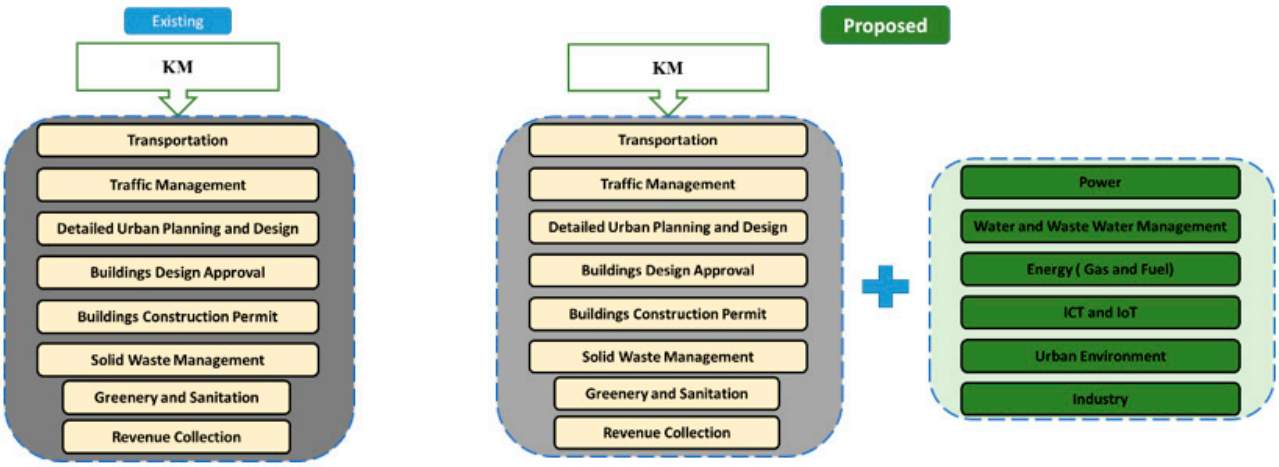

Figure 6. Kabul Municipality (KM) existing and proposed responsibility areas. Source: Author.

5. Discussions

Significance of the Results

The proposed framework in this study provides a high-level coordination and collaboration structure for LID countries to discuss energy, environmental, and climate changes issues at the state and urban levels. Top-down approaches for setting national-level visions and targets for a sustainable future are critical for these countries. This research strongly proposes structural changes for urban planning practices in this group of countries. LID countries are encouraged to review their existing national and urban level visions, targets, strategies, regulations, and planning in light of the SDGs and integrate necessary environmental, energy, and climate change topics required into their national and urban planning and management processes and practices. Other developing countries may also benefit from the findings of this research since the global agenda for sustainability outreach requires all nations to work jointly and closely. The result urges the central government's endorsement and engagement to create an enabling environment for policymakers, experts, legislators, private sector, people representatives, and service providing entities to interact, debate, and agree on long-term national targets and plans.

Sustainable development is impossible without economic growth [65], and cities are the heart for both. Retiring LID countries from their existing economic level to more developed ones, sustainable energy, and sustainable growth are prerequisites. This study strongly recommends consideration of sustainable energy agenda as an integral component of the national agendas such as security, economic growth, and public well-being.

The importance of coordination, collaboration, high-level stakeholder engagement, collective target setting, planning, and overseeing urban energy issues are highlighted for state policy and decision-makers. Higher-level policies, strategies, plans, and targets would help the energy sectors and all other sectors understand their role and responsibilities in achieving national urban targets and goals.

Another key significance of this research is adapting and implementing the proposed framework over an LID country context. The framework is adapted for Afghanistan and its capital city, Kabul. This research presents a complete picture of Afghanistan and Kabul City urban planning processes, energy-related existing and planned legal and regulatory framework, key challenges of the urban and energy sectors, and how the

proposed framework for urban energy system would look like extensively presented and visualized. Therefore, it should help policymakers of LID countries' urban and energy sectors to see an example somehow similar to their context.

6. Recommendations

6.1. Recommendations for LID/LD Countries

It is clear that here there will be unprecedented changes in the urban planning practices, including sustainability considerations and the application of big data (ICT and IoT storm) [3]. It is unavoidable, and cities should not only prepare but willingly embrace them.

There is a serious need for strong and clear legal frameworks to integrate sustainable and smart energy in urban planning processes. The existence of laws, policies, and regulations such as energy transition or energy integration law or policy can ensure and facilitate such initiatives [19]. Outdated laws and policies hinder the implementation of sustainable and smart urban agendas and create blockages in different stages of the implementation. A thorough assessment of the laws and policies is needed to ensure they support urban sustainability goals. Developing suitable urban planning practices and policies, opportunities for reducing energy consumption, solar energy integration in the energy systems, and smart technologies integration in the urban context could be promoted and ensured [66]. Immediate actions by the urban leaders need to be taken for developing energy efficiency policies for the building, transport, and industrial sectors.

Clear policies and incentives are very important for the private sector engagement and empowerment in the LD countries [67], especially for the energy sector. Therefore, governments should focus on developing clear policies and incentives for private sector involvement and investment. At the same time, LID economies should own the charge of fighting corruption, improving governance, and reinforcing transparency and accountability, which are key enablers for appropriate business and investment environment and eventually achieving SDGs [53].

A comprehensive national urban development strategy needs to be developed. This strategy shall be based on contemporary global smart and sustainable urban agendas. Measures and indicators for the monitoring purpose of the set sustainability targets shall be developed. It requires big data collection, compilation, and analysis from all the sectors involved in cities. Therefore, complex and sophisticated ICT and GIS-based databases would be needed to monitor and visualize the progress and effects of targets on cities' economic, social, and environmental aspects.

Shifting to green and sustainable energy embodies many opportunities as well as risks. However, this needs to be balanced between political, regulatory, geographical, and socio-economical contexts [68]. Transitioning of the LID/LD countries to green economies can be easily compared to developed economies. Developed economies will need significant time and economic and social costs to shift from inefficient fossil fuel technologies to greener and efficient ones. However, LID/LD economies can easily adapt to existing sustainable approaches and practices [67], but access to finance is a key challenge in realizing sustainable energy targets in LID countries. UNICTAD suggests that the LD countries should focus on getting access to long-term and climate-related finance. The capacity of the policymakers needs to be built for development planning and financial analysis [45]. It also suggests using domestic public resources to reduce the financing gap for development purposes and facilitating private sector engagement in development activities.

Overlap of scope and mandates is a common issue in LID/LD countries. To avoid the overlap of responsibilities, improve government responsiveness, ensure public participation, and realize transparency, there should be independent and dedicated entities for developing policies, planning, monitoring and supervision, and regulation. With the emergence of smart and sustainable energy systems and city agendas, opportunities are created to specify and re-define the roles and scope of urban stakeholders. All levels/functions of institutions involved in urban energy issues shall be clearly defined (policy-making, planning and support level, legislative level, controlling and supervision level, regulating

level, implementing/service levels) [69], and close coordination and cooperation among stakeholders from different levels of the government, academia, private sector, and civil society organizations needs to be ensured [5].

Sustainable and smart urban energy systems require strong political endorsement and consensus. Therefore, for the successful and sustainable implementation of the smart sustainable urban and energy agendas, it is crucial that both ruling and opposition parties have a consensus on national visions for the urban sector. This requires a strong lobby of the urban leadership and authorities in different political and social layers. In other words, the sustainable urban and energy discourse shall be de-politicized and political changes and shifts should not affect national vision and targets extensively.

6.2. Recommendations for Afghanistan and Its Capital, Kabul

First and foremost, a national vision for futures cities of Afghanistan needs to be ratified by the government of Afghanistan and approved by legislators' chambers (the level of smartness and sustainability features need to be specified through a comprehensive study and consultation with stakeholders and expert's groups). For facilitating smart and sustainable energy integration in cities, legal and regulatory frameworks need to be in place. Independent and strong regulatory bodies need to be in place for the regulation of urban. Strong regulatory regimes could ensure the provision of technically feasible public infrastructures and other urban services [70]. Regulatory bodies are based on key principles of role clarity, objectives, autonomy, and legal accountability [71].

Involving citizens in the decision-making process is an international requirement for sound transparency. As one of the highly corrupt countries, Afghanistan needs to have entities to ensure citizens' participation in setting policies, plans, and monitoring the progress and implementation process of urban matters [72]. By transforming the urban planning and management structure as suggested in this research, Afghanistan will not only improve its urban and energy sectors, but it will strengthen civic engagement, increase public participation, reduce corruption, and incline public trust in government. Smart and sustainable urban infrastructures will be highly supportive for realizing transparency critical for attracting local and global investments, attracting aiding agencies for providing technical and financial support, and, more importantly, the citizens' satisfaction. Public awareness-raising campaigns by the government are critical to attracting public support and approval.

Another immediate step for Afghanistan to take is to amend the environment law to house more clarity on the sustainability of the environment and the inclusion of all affecting sectors and areas. In addition, national building codes and standards with specific mandatory articles on energy efficiency and clean energy usage need to be enacted. Finally, on top of all the key initial steps, a national fund to promote a sustainable energy industry, businesses, and innovations need to be created. Without a dedicated and long-term fund, lack of strong political commitment, and full reliance on international technical and financial supports for key national programs, the probability of failure of these national programs is very high.

For Kabul City, it is highly recommended that the KM role be re-defined. Kabul municipality mandates should shift to planning and implementation, as proposed in the proposed framework in this paper. KUDF is a good attempt to solve Kabul urban challenges, but KM is not in the position and does not have the required technical capacity to prepare inter-disciplinary planning and designs, coordinate among different stakeholders, and operate large portfolios. Therefore, KUDF needs to be updated in light of high-level national legal and policy documents (e.g., national urban law, national urban targets, or . . .) before it is moved to the implementation stage. It is also worth mentioning that, before any master plan is prepared for Kabul City, it is important to specify a limit for the future population in Kabul City, not only by the historical increase of population but also on Kabul City's vision.

Renewable energy supply will help cities become clean and healthy and also boost the creation of green jobs [73]. For Kabul City, clean air and job creation are some of the urgent

needs. Unemployment of youth has contributed to insecurity and inclination of crime rates. Mortality due to polluted air (Major air pollution comes from burning fossil fuel, plastic products, and inefficient transportation [74]) has been way higher than the criminal and terroristic attacks. Thus, integrating renewable energy could create employment opportunities, offset fossil fuel consumption, improve citizens' air and health quality, save lives, and finally improve the city and state economy.

7. Conclusions

It is globally agreed that the provision of sustainable energy is one of the key factors for a livable and safe environment. It will largely help climate change mitigation. The new generation of urban planning revolves around the UN sustainable agendas and broadly and strongly suggests cities' sustainability, where sustainable energy is one of the main goals, linked with several other goals of SDGs. Efficiencies' optimization of the urban sectors has economic, environmental, and social benefits. Almost all of the urban sectors will soon rely on electric energy. On the other side, the ICT sector's quick pace introduces many smart solutions for urban sectors' efficiency and decarbonization. An integrated approach to urban planning is essential. Integration of sustainable energy in the urban planning processes requires close coordination and communication between key urban stakeholders and is no longer the energy sector's responsibility. It is a more complex issue and is a severe national responsibility and concern. Energy security, water security, environmental security, and cybersecurity all come together in the urban context and makes the urban issue a severe national security agenda. Thus, the state leaders should assign an entity that could bring all these players around a table, prepare a national vision for the country's urban areas, develop required laws and policies, and assign roles and responsibilities for each key urban sector. It is challenging to get a helpful result when there are ambiguities, overlaps, and a lack of role identification. The monitoring and supervision of the progress toward the national targets for urban areas need another strong entity at higher government levels. Governments should communicate their plans and actions on global targets with the international and local communities to gain internal and external support and attention and attract investments. As modern urban planning will bring about several business opportunities, private sector empowerment and involvement are crucial. Finally, all urban sectors should have a clear and joint vision for a carbon-free energy system and an authoritative unit for sustainable urban energy planning and management.

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Appendix A

As described, energy is closely linked to electricity, transport, industry, housing, and environment sectors. In this appendix, the key implications of each legal and policy document of the government of Afghanistan to each of these sectors are described:

Table A1. Key indicators outlined about the energy in legal and policy documents of Afghanistan.

Category	Document Name	Energy
Law	Nuclear Energy Law (2015)	Use of nuclear energy for peaceful purposes
Plan	Afghanistan National Peace and Development Framework (2017)	Reforms to energy regulation
	Renewable Energy Roadmap (Draft)	It only talks about power/electricity and 95% of electricity generated from renewable energy sources by 2032
	Energy Sector Strategy (2007–2011)	Provision of reliable and affordable energy access to drive economic e. Integration of renewable energy, clean cooking,
	Kabul Urban Design Framework (KUDF) 2018	sustainable energy system for Kabul's long-term growth and energy security locally distributed renewables
	Power Sector Master plan (2013)	feasibility, environmental protection,
	Afghanistan Green Urban Transport Strategy (2014)	Energy is considered as one the components
Policy	Afghanistan INDC (2015)	Technology transfer of renewable energy and sustainable energy
	National Energy Policy (draft)	Access to reliable and clean energy for all. Close coordination among stakeholders of the energy sector

Table A2. Key indicators outlined about the Buildings' energy in legal and policy documents of Afghanistan.

Category	Document Name	Buildings
Regulation	Afghanistan Energy Efficiency Code for Building (2015)	For saving energy in the building by applying minimum standards in lighting, air-conditioning, elevators, escalators, building envelop and the integration of photovoltaics in buildings
Plan	Renewable Energy Roadmap (Draft)	Rooftop and mini-grid projects
	Energy Sector Strategy (2007–2011)	Energy efficiency improvement in the production side and end-use
	Kabul Urban Design Framework (KUDF) 2018	Energy efficiency, renewable energy integration (Rooftop solar PV and solar hot water)
	Power Sector Master plan (2013)	Connection rate for households reach 100% in urban areas and 65% in rural areas by 2032
Policy	National Housing Policy (2019)	Environmental sustainability and energy efficiency is focused.
	Afghanistan INDC (2015)	Energy efficiency, clean cook stoves and fuels, and solar energy
	National Energy Policy (draft)	Improve energy efficiency and energy saving

Table A3. Key indicators outlined about the Transport energy in legal and policy documents of Afghanistan.

Category	Document Name	Transport
Regulation	Fuel Consumption Regulations (2010)	Standard fuel consumption of vehicles and generators (5–20 KW)
Plan	Renewable Energy Roadmap (Draft)	Only pointing to the greening of this sector
	Kabul Urban Design Framework (KUDF) 2018	Sustainable urban mobility (Public transport, biking, bicycle lane, walkability, universal accessibility, reduced pollution)
	Afghanistan Green Urban Transport Strategy (2014)	Affordable, clean, safe, accessible, and integrated
Policy	Afghanistan INDC (2015)	Energy efficiency
	National Energy Policy (draft)	To provide needed expert advice

Table A4. Key indicators outlined about the Industries energy in legal and policy documents of Afghanistan.

Category	Document Name	Industry
Law	Nuclear Energy Law (2015)	Use of nuclear energy for peaceful purpose
Plan	Renewable Energy Roadmap (Draft)	Only pointing to the greening to this sector
	Kabul Urban Design Framework (KUDF) 2018	Waste to energy for Industrial use,
	Power Sector Master plan (2013)	Industrial demand is calculated
Policy	Afghanistan INDC (2015)	Energy efficiency
	National Energy Policy (draft)	To provide needed expert advice

Table A5. Key indicators outlined about the electric energy in legal and policy documents of Afghanistan.

Category	Document Name	Electricity
Law	Power Services Regulation Act (2015)	Law for the generation, transmission, distribution and trade of electricity
Regulation	Regulation for Electricity Regulatory Authority of Afghanistan (2019)	Regulate electricity businesses, attract investment and develop relevant policies and standards
Plan	Afghanistan National Peace and Development Framework (2017)	Increase local energy generation by 2300 MW, expand the national grid, ensure regional energy projects CASA (Central Asia South Asia (CASA)-1000) and TAPI (Turkmenistan Afghanistan Pakistan India (TAPI))
	Renewable Energy Roadmap (Draft)	Increase electricity deployment from renewable energy resources to 5000 MW for 2032.
	Energy Sector Strategy (2007–2011)	The target of 65% electricity access to households and 90% non-residential urban areas set for 2010
	Kabul Urban Design Framework (KUDF) 2018	100% electricity access to the urban population
	Power Sector Master plan (2013)	Electricity demand and power system forecast for 2032 is done
Policy	Renewable Energy Policy (2015)	Set a target of producing 95% of electricity from renewable energy sources by 2032 (5000–6000 MW)
	Afghanistan INDC (2015)	Energy production (hydropower, solar systems, wind, and biomass) in commercial industry
	National Energy Policy (draft)	Increase the generation of electricity from local and renewable resources

Table A6. Key indicators outlined about the Environment and energy in legal and policy documents of Afghanistan.

Category	Document Name	Environment
Law	Environment Law (2007)	Develop and implement national environmental policies and strategies in (Water, Solid Waste, Pollution, Natural habitat)
Plan	Afghanistan National Peace and Development Framework (2017)	recognizes climate change as a serious threat to Afghanistan
	Energy Sector Strategy (2007–2011)	EIA considerations in energy-related policies
	Kabul Urban Design Framework (KUDF) 2018	Low carbon sustainable development
Policy	Afghanistan INDC (2015)	Behavioral change for provision and development of alternative and renewable energy sources to contribute to a reduction in the unsustainable usage of natural resources and decreasing the strong reliance on fossil fuels by rural communities.
	National Energy Policy (draft)	To provide needed expert advice

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