

**POLITICAL ECONOMY OF SOLAR ENERGY
MANAGEMENT IN URBAN CENTERS – AN
UNDERSTANDING TOWARDS SUSTAINABLE ECO-
ENERGY PLATFORMS AS A NEXT STEP FOR PAKISTAN**

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***Abstract:** Current writing attempts to dialog the search of conservational sustainability by being investigative; the inferences drawn are within the governmental settings for workable ingenuities and upholding the ecological municipalities. Masdar a top growth portrayed urban outfit as ‘the world’s first sustainable city’ has developed into a perfect housing outfit of Abu Dhabi’s new urban dream. Abu Dhabi administration proclaimed in 2006 its resolve to devote \$22 billion to shape Masdar, as a carbon-free, zero-landfill metropolis that would display excellence while ascending the ranking in sustainable urban enterprise. Amazingly significant experiential lessons worldly urban administrations may pursue to develop extra livable. Keeping Masdar as a role model, a comparison is drawn for the opportunity of renewable energy investors and developers where Pakistan is endowed with excellent natural conditions for the development and deployment of wind and solar. Fast growing economy and population, there exists robust demand for current and future electricity generation, an acute need for investments in scalable and quickly deployable power generating technologies in*

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solar generation capacity. Commitment of the Federal government to the continuing development of coherent, conducive political, legal and market framework for the power sector broadly, and the renewable sector specifically, suggest an increasingly attractive business environment for domestic and international investors and developers¹. It shall be interesting to draw an analytical insight as where we are as per the solar perspective in relation to the leading models in the politico economic realm and how best we may fair in this sector. This paper aims to propose a conceptual framework to guide cities being developed under sustainable development for use of alternate source of energy as sustainability is a major concern for the governments and citizens of the urban cities.

Introduction

Twelve types of metropolitan reformative maintainable metropolises exist and if we account, these *cities* are: ‘livable’, ‘low carbon’, ‘ubiquitous’, ‘resilient’, ‘sustainable’, ‘intelligent’, ‘information’, ‘knowledge’, ‘digital’, ‘green’, ‘eco’ and ‘smart’. Wherever designated urban groups are not substitutable, interrelationships among the twelve groups do figure out. The foundation of newer sets from more recognized groups with variable shades of intangible connection amongst the city groups are found. Six classes in cities category are reinforced by a explicit group of philosophies (‘sustainable’, ‘smart’, ‘eco’, ‘low carbon’, ‘resilient’ and ‘knowledge’). *Sustainable city* is the most often arising type and, in the plans the main and most consistent, complicatedly connected with ‘eco’ and ‘green’ city category. After taking into account the larger perspective and shaping of the cities which the world is housed in, let’s study the first and most common of the inhabited type of city i.e sustainable cities and in this class the role of *solar drive* in creating the lives contented and towns functional. Comparison shall be drawn and analyzed between Pakistan’s existing policy mechanism and Masdar City as an ambitious trial, an incubator of unpolluted electric generation know-hows that was to be motorized wholly by renewable energy while showing the highest standards of energy productivity.

¹Satterthwaite, David, “Adapting to climate change in urban areas: the possibilities and constraints in low- and middle-income nations,” *Vol. 1. Iied*, 2007:1-25.

Masdar City in Abu Dhabi has been often branded as an eco-city with an ambition for inexpensive, safe, suitable and thriftily varied accommodation. City has been pushed out to at least 2030 with candid discourse on sustainability². Possible paradigm for future sustainable cities show: compact groupings of highly efficient mid-rise buildings set amidst carefully planned green space, with on-site renewable power production and excellent transit connections (Satterthwaite, 2007)³. Pakistan's renewable sector has yet to take advantage of the natural resources and constitutes only a small percentage of installed capacity. Only about 4% of Pakistani households tap into solar power, though Pakistan targets at succeeding 5-6% of its over-all on-grid power from renewables (excluding large aquatic power) by 2030⁴. The energy bazaar in Pakistan orbits round a diversity of serious community, government and private investors, engaged in generation, transmission, distribution, pricing, regulation, consumption that are interlinked and dependent while operating independently, thus power sector remains relatively centralized.

Research Questions

To understand and probe study seeks to answer following questions:

- An over view of existing sustainable urban development concept of Masdar (UAE) with Pakistan as an affordable and sustainable development city, while using *solar* as an alternate source of energy.
- Identification of Policy Reforms and Integration challenges in Urban Affordable Sustainable Development for Pakistani mega cities; how ease of solar energy as an electric clean source is manageable and view the politico-economic strings associated?

²Cugurullo, Federico, "How to build a sandcastle: An analysis of the genesis and development of Masdar City," *Journal of Urban Technology* 20, no. 1 (2013): 23-37.

³Satterthwaite, David, "The transition to a predominantly urban world and its underpinnings," *No. 4.Iied*, 2007:7-21.

⁴ Mirza, Umar K., M. Mercedes Maroto-Valer, and Nasir Ahmad, "Status and outlook of solar energy use in Pakistan," *Renewable and Sustainable Energy Reviews* 7, No. 6 (2003): 501-514.

Theoretical Framework

Interaction among stakeholders is a critical factor in the policy-making of city sustainable process which can possibly change the relations and emerging sustainable city trends required to integrate the already existing systems in an efficient way with possible challenges including laws, costs, as well as the security and effectiveness of urban delivery. Combined method idea into city growth procedures, where cohesive built-up and enlargement strategy under urban philosophy⁵ is a concurrent and just thought for all issues to cartel with. United metropolitan growth program is a course that synchronizes grave, three-dimensional, sectoral and time-based matters. Actors outside the management and enabled residents played an energetic part in determining their living surroundings thus fashioning workable towns by harmonizing and taking care of interest groups. Dominated theoretical framework with architectural theory⁶, in the control and supervision vision for structure, boulevard and locality with environments created in shared household⁷. Cities if sustainable, 80% of international fortune is formed where folks discover openings for labor and socialization⁸. Sustainability as the skill to encounter the wants of the present populace without conceding the upcoming generations to encounter their personal desires i.e sufficient work, safety while youngsters voyage to university, adjacent community conveyance, air quality, communal civic places and countless other aspects. Ultimate novel ecological agenda is the “*Anthropocene and geo-political Imagination of Earth*”; for global politics referred to as “*the endangered world, the entangled world, and the extra-activist world*”⁹. With this contextual basis sustainable growth necessitates development in harmony within the conservation equilibrium, humanoid growth, fiscal atmosphere and falling natural assets.

⁵Nevens, Frank, NikiFrantzeskaki, LeenGorissen, and DerkLoorbach, "Urban Transition Labs: co-creating transformative action for sustainable cities," *Journal of Cleaner Production* 50 (2013): 111-122.

⁶Viljoen, Andre, and Joe Howe, eds, “Continuous productive urban landscapes,” *Architectural Press MA 01803 – 2005, Routledge, 2012*: 251-275.

⁷David, “Climate change in urban areas,”¹⁵.

⁸Griffiths, “Future low-carbon Masdar city,” 2.

⁹Lövbrand, Eva, MalinMobjörk, and Rickard Söder, "The Anthropocene and the geo-political imagination: Re-writing Earth as political space," *Earth System Governance* (2020): 100051 (1-5).

Maintainable growth objects must maximize the fulfillment of the inhabitants, more so an effective use of incomes¹⁰. City of Abu Dhabi has lately adapted planning patterns meant at building an innovative pathway towards metropolitan sustainability. Masdar pursues an extra profitable model that however retains emphasis on supportable inner-city project as a leading city in the adaption of solar energy as a cradle for energy. Concurrently, the politico-economic dimension shall be examined for the Pakistan's legal and political agendas, brief functioning of grid infrastructure, demand and generation, mainly solar generation potential. Federal government's efforts to unbundle the energy sector, establish independent regulatory and administrative bodies, establishment of a competitive market, as well as develop coherent, comprehensive legal and policy frameworks for renewable energy development within the sustainable urban development basis shall be analytically viewed.

Literature Review

The keyword co-occurrence maps clearly show the power of 'sustainable city' as a comprehensive umbrella concept addressing the ecological, economic and social dimensions or pillars of sustainable development¹¹. Taking into account details of six main shades of cities type, let's explore their extent and domain:

Sustainable City

Sustainable city develops into an independent financial, communal and ecofriendly advanced featured urban dwelling recognized with guidelines which efficiently decrease the assets required in maintaining (energy, materials etc.) generated within city frontiers. Environmentally welcoming installed with pointers for contaminating carbon production, energy, aquatic feeding, H2O excellence, and power mix. Leftover bulks of waste, reprocessing, green

¹⁰Liu, Hongling, Guanghong Zhou, Ronald Wennersten, and BjörnFrostell, "Analysis of sustainable urban development approaches in China," *Habitat international* 41 (2014): 24-32; Martos, A., R. Pacheco-Torres, J. Ordóñez, and E. Jadraque-Gago, "Towards successful environmental performance of sustainable cities: Intervening sectors. A review," *Renewable and Sustainable Energy Reviews* 57 (2016): 479-495.

¹¹De Jong, Martin, Simon Joss, DaanSchraven, Changjie Zhan, and Margot Weijnen, "Sustainable-smart-resilient-low carbon-eco-knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization," *Journal of Cleaner production* 109 (2015): 25-38.

spaces proportions, main woodlands and cultivated land-living loss. ‘Green city’ displays a robust linking with both the ‘sustainable and eco’ city with emphasis on the atmosphere augmented with classical upcoming as zero release of carbon, zero landfills in urban policy design, encouraging solid energy-efficient urban development looking for to change and re-engineer current metropolitan regions and reestablish the post-business city epicenter presence.

Eco City

Calculated design and community transport arrangement, city stocks wholly carbon-neutral and renewable source; supply preservation; liquid and excess solid waste reprocessing; native city cultivation; inexpensive housing for all; better occupation chances for deprived and simple way of life. World Bank (2010) journal has agreed it a more practical: they reflect the economically sustainable city is feasible if it is also thriftily vibrant one, ‘eco2 city’ (‘ecological cities as economic cities’). This clarification, then, swings the eco city nearer to that of the sustainable city.

Low Carbon City

Low carbon metropolitan variations, ‘zero carbon city’, and even ‘negative carbon city’ – can be seen as a straight reply to the superfluous climate transformation discussion, connected with character of towns. Reducing the human-inflicted carbon footmark, removing the usage of non-renewables ; Low carbon city’ and ‘eco city’ as mainly similar and tends to be absorbed more on energy challenges with industrial and financial thought. The logical difficulty of the ‘low-carbon city’ may be that the idea does not include conservational and environmental issues other than energy, such as liquid/ water, biodiversity, and efficient use of natural resources. However, energy use hints on nearly every feature of culture, the low-cost supportive aspects and the ‘low carbon city’ category’s latent potential renders environmental improvements and damages as quantifiable.

Smart City

Smart city comparatively is new as a concept, though it stems as a progressive replacement of the ‘information, digital and intelligent’, city categories. City can be definite as ‘smart’ with contemporary information and wire substructure; produces sustainable commercial growth and a great excellence of life with endorsing sensible administration of usual incomes.

Extravagant and urbane ICT-facilities are fashioned everywhere which permit businesses to cooperate and invent, to deliver healthier facilities to people allowing admittance to digital data and information to the degree that they can thoughtfully deliberate.

Knowledge City

Information towns have been well-defined as combined metropolises that actually and institutionally associate with the purposes of knowledge square with public and housing roles. Notion of ‘knowledge city’ not only motivates on the information economy and manufacturing structure, but also pressures deepened anthropological wealth, a lively and assorted socio-cultural setting, upkeep of the normal surroundings, a high-quality made atmosphere, convenience, broadmindedness, reception of multiculturalism and social evenhandedness with information cities necessitate a robust consolidating ability to establish trust between community and private actors. Academic world and the broader communal at large together demand; information transmission and understanding at the same time, stable monetarily, socio-spatial excellence and administrative excellence to grow in a workable way.

Resilient City

Strong metropolis validates the various perspectives implied i.e responding to ecological difficulties; management of vulnerabilities and catastrophes; surviving with surprises in the progress of city markets; endorses spirit through urban power and associations. Buoyant city in fact is a multifaceted and multidisciplinary scheme necessitating a combined method to let experts to treat fears and weaknesses; highlights being: (1) adaptation (2) 4-D development (3) maintainable city format (density, compactness, varied acreage use, variety, passive solar design, greening, regeneration and consumption) as the three unified mechanisms for emergent procedures to promote the ‘resilient city’.

Masdar

After brief introduction to typology of urban formative order; Masdar as a city has been shortlisted for comparison with the Pakistan’s solar urban interface. In Abu Dhabi, Masdar city is found often branded as an eco-city in the creation. Masdar City, meaning ‘source city’ in Arabic, is a planned city project and sustainable mixed-use growth by its specific grid with optimal carbon customized emission within permissible limits. Today, Masdar City has moved away

from its unique dream of being zippo carbon and zero surplus waste, but retains its emphasis on sustainability¹². Maintainable development necessitates change for a healthier environment and workforce surroundings for the deprived, plus reasonable access to, improved lodging, conditioned upkeep, water, hygiene, and electricity¹³. 22-hectare (54-acre) field of 87,777 solar panels, power Masdar with a support of extra panels from rooftops. Masdar is void of light buttons or water taps in the city; movement instruments, regulates illumination and aquatic systems to disconnect electricity and water consumption with an aim to achieve 51 and 55 percentage correspondingly. Chief planner Gerard Evenden¹⁴, states that the new strategy for Masdar called for driving the whole city through on-site means such as roof solar panels; developers later appreciated it's much more well-organized to shape solar field on the ground in the mid of the desert and clean them off each day, somewhat trying and having access everybody's structures separately, make certain that solar plates are successively at their total peak; suitable than constructing and later maintaining solar sections on each construction in the city". Masdar picked to make effort on fair non-polluting energy plan for growth and investment rather than to try to compete in hardware engineering of thin-film PV Business Company; Masdar PV which was shut down in 2014 due to Chinese hardware affordability. Masdar Power as a plan for solar panels venture came up as a distinct component alongside Masdar Carbon and brought under the canopy of Masdar Clean Energy in 2013. Metropolis's working arrangement was modernized in 2010 when the town's corporate model was altered by wide use of subcontracting and planned businesses as in contrast to the "self-growth and clutch" idea, which formed the unique Property Expansion Component.

Documentation arrangement named Pearls, which is a basis for the maintainable plan for Masdar as a sustainable city for building and setup of structures, lodges, and localities; Pearl is a fact centered procedure that varies from 1 to 5 Pearls. Final Pearl assessment is calculated from

¹²Griffiths, "Future low-carbon Masdar city," 1-3.

¹³Revi, Aromar, and Cynthia Rosenzweig, "The urban opportunity: Enabling transformative and sustainable development," *Background Paper for the High-Level Panel of Eminent Persons on the Post-2015 Development Agenda. Prepared by the Sustainable Development Solutions Network-Thematic Group on Sustainable Cities* (2013): 1-42.

¹⁴Kherdeen, RiadMazen. "Masdar City: Oriental City of the Twenty-First Century." *Master's degree thesis, director: Jean-Louis Cohen, Institute of Fine Arts New York University* (2016): 1-51.

accrued score earned within seven groups. Masdar City started executing the eco-city agrarian aspects via numerous supportable farming key associates, counting the UAE Department of Food Safety with lead role, with an aim to emerge as zero-carbon and zero-waste city with 40,000 residents and 50,000 travelers every day in learning, labor and communal doings¹⁵. Masdar's 10 MW solar photovoltaic (PV) park and 1 MW of roof based PV in the urban environment substantiates buildup of solar PV in Abu Dhabi that will nurse unpolluted energy to the metropolitan extents¹⁶ which provides electricity equivalent to around 30% of the structures' energy requirements. Emirate today has one of the main operating solar plants globally (the 1.78GW Noor plant) where makers essentially are required to attain the 3 Pearl warranties, thus creating unique assembly of extremely valued constructions in the world¹⁷ a motivation for minor and medium sized cities universally and a strong influence on the upcoming cities of the planet¹⁸. Strategy outline included reformation adjustment to the task of bankrolling, multifaceted collaboration amongst homegrown, nationwide and international groups; request for huge entireties of straight investment and a recognition for medium and long-term returns. Governing actions included marketplace tools, shaping valuing buildings, duties and support grants for homes and manufacturing business, preventing the detrimental effect of climate change on assets, atmosphere and livings of current and upcoming occupants. An ideal metropolis with renewable liveliness additions; pragmatic construction modules can be prepared for new towns around to develop as bearable¹⁹ and attain climatic objectives²⁰. Mainstays for accomplishing position by Masdar are:

Fiscal Growth: Eco friendly creative development, formation of service, manufacture and delivery of renewable electricity, skill and novelty (R&D).

¹⁵Griffiths, "Future low-carbon Masdar city," 1-3.

¹⁶Ibid.

¹⁷David, "Predominantly urban world and its underpinnings," 7-21.

¹⁸Lee, Susan E., Peter Braithwaite, Joanne M. Leach, and Chris DF Rogers. "A comparison of energy systems in Birmingham, UK, with Masdar City, an embryonic city in Abu Dhabi Emirate." *Renewable and Sustainable Energy Reviews* 65 (2016): 1299-1309.

¹⁹Griffiths, "Future low-carbon Masdar city," 1-3.

²⁰David, "Predominantly urban world and its underpinnings," 7-21.

Communal Growth: Tutoring and fitness, nourishment and food, green accommodation and houses, aqua and hygiene, green community conveyance, green drive access, Refreshment areas and public care.

Metropolitan Authority: Development and devolution along with decrease of injustices, consolidation of public and partisan privileges, provision of native, nationwide, local and worldwide linkages and access.

Ecological Administration: Plantation and earth administration, leftover and reprocessing supervision, H2O administration (counting water from stream), atmospheric value preservation and moderation of weather change.

Masdar meant to be “Least Gaseous” with the resulting goals:

- Decrease by 15% in personified carbon of metropolis building ingredients
- Lessening by 30% in the embodied carbon of structure constituents used in the structure of its houses.
- Energy intake cheaper by 40% of its constructions (comparative to structures in Abu Dhabi).
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- Savings on use of water internally by 40% within buildings through digitization.

Pakistan’s Matrix for Electricity Generation Sector

Pakistan’s power market is endowed with solar photovoltaic distributed generation (PV-DG) systems²¹ and onshore and offshore wind energy potential; even then past decade has seen a persistent gap between electricity demand and supply that has negatively impacted economic growth, insufficient financing, policy making and physical infrastructure to deploy sufficient renewable generation to address this gap. National renewable energy policy frameworks have been developed and implemented since 2006 and have attempted to develop competitive power markets and a robust renewable energy sector. Net Metering and Feed-in Tariff frameworks have

²¹Katiraei, Farid, and Julio Romero Agüero, "Solar PV integration challenges," *IEEE Power and Energy Magazine* 9, no. 3 (2011): 62-71.

been developed to encourage small-scale on-grid renewable generation, with a particular focus on solar PV generation. Country's electricity system consists of two interconnected power systems operated by PEPCO and K-Electric respectively. The PEPCO system is estimated to contain approximately 90% of the systems total installed generation capacity of approximately 25,000 MW in 2017 and service approximately 92% of the country's total customer base. Power system is regulated, administered and operated by a set of Federal level regulatory agencies and bodies: NEPRA, NTDC, CPPAG and AEDB. Brief introduction to respective bodies functioning includes²²:

National Electric Power Regulatory Authority (NEPRA)

Electric power sector of Pakistan is regulated and controlled for transparent and judicious commercial principals and formulation of policies at National level by NEPRA. Aims and goals of NEPRA remain to advance excellence of life for people so as to meet communal objectives and offer opportunities for quality of growth and development. The powers and few functions of the Authority as defined:

- Stipulate actions and principles for electric power facilities, assist and advice the Federal Government, in the preparation of national electricity plan.
- Enforcement of efficient price arrangements and market strategy for adequate fluidity in market; adopt procedures, standards for investment program for generation companies and public enumerated under this act.
- Performance standards implementation for businesses for generation and folks approved or listed under NEPRA act.
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²²Pakistan Renewable Energy Systems, "A Market & Roadblock Analysis", by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Renewable Energy and Energy Efficiency (REEE) Project, Islamabad, Pakistan, downloaded from <https://pgref.org/> on 15.5.2020: 5-60.

National Transmission & Dispatch Company (NTDC)

National Transmission & Dispatch Company (NTDC) is organized to take over all the properties, rights and assets obligations and liabilities of 220 KV, 500KV Grid Stations and Transmission Lines/Network owned by Pakistan Water and Power Development Authority (WAPDA).

Central Power Purchasing Agency Guarantee Limited (CPPAG)

Central Power Purchasing Agency Guarantee Limited (CPPA), created by Government of Pakistan since 1984 is solely responsible for implementing and administering the “Single Buyer Plus” market mechanism (ultimately leading to competitive market operations). CPPAG is to be acknowledged as a trusted, professional and efficient agency owing to its internationally accepted working procedures, non-discriminatory and transparent business operations, and excellent performance standards.

Alternative Energy Development Board (AEDB)

Designed to be a "one window" workstation, at Federal level for all renewable projects for Issuance of Letters of Intent (LOI) and Letters of Support for renewable projects was established in May 2003 with the key objective to ease, encourage and inspire growth of Renewable Energy in Pakistan with a task to present Alternative and Renewable Energies (AREs) at an accelerated rate.

Pakistan Electric Power Company (PEPCO)

PEPCO owns and operates a significant amount of Pakistan’s generation, transmission and distribution assets, including NTDC, all 10 of Pakistan’s public distribution companies (DISCCOs) and four of Pakistan’s generation companies (GENCOs), which own and operate thermal electricity generation assets. However, due to practical difficulties of segregation of its function from NTDC, the Company could not be operationalized till June 2014.

Public Distribution Companies (DISCOs)

DISCOs function revolves around acquisition of power from the Water and Power Development Authority, independent power producers (IPPs) or PEPCO and vends it to clients in their respective geographical zones. DISCOs are particularly relevant for the integration of

renewable power from small and midsize installations such as rooftop solar power (both residential and industry sector). There are 10 Public Distribution Companies or DISCOs in Pakistan. Each DISCO is a separately corporatized public company and is accountable for the supply of electricity to inhabited, commercial and industrial consumers in their respectively allocated geographic areas.

Water and Power Development Authority (WAPDA)

WAPDA is currently responsible for maintaining and developing water and hydropower resources in Pakistan. Two of the largest hydroelectric power dams in Pakistan, Tarbela and Mangla dam, are owned and operated by WAPDA. Established in 1958 and was, until 2007, a steeply combined government owned public utility responsible for aquatic, hydropower and thermal power for all of Pakistan with the exception of Karachi.

Karachi Electric (K-Elec)

K-Elec originally recognized in 1913 to serve Karachi, was state-owned in 1953 and functioned as a openly owned, upright united utility until 2005 when it was privatized (with the government retaining a 26% stake). Nowadays, under permits from NEPRA, K-Electric is accountable for conduction, delivery and generation, to 22 million customers in the city area of Karachi, the main urban area in Pakistan. Looking for to endorse extra renewable generation since 2017 as federal government has worked to establish and grow a more modern and competitive power sector with a central regulatory authority, public transmission network and market operators, distribution companies and independent power producers (IPPs).

The significant roadblocks identified include:

Organizational and Operational Level: Slow and overly bureaucratic regulatory, approval and licensing process; critical shortage of personnel capacity, technical expertise at the regulatory and administrative agencies i.e NEPRA, NTDC, AEDB and DISCOs; lack of policy, regulatory inconsistency and existent disharmony.

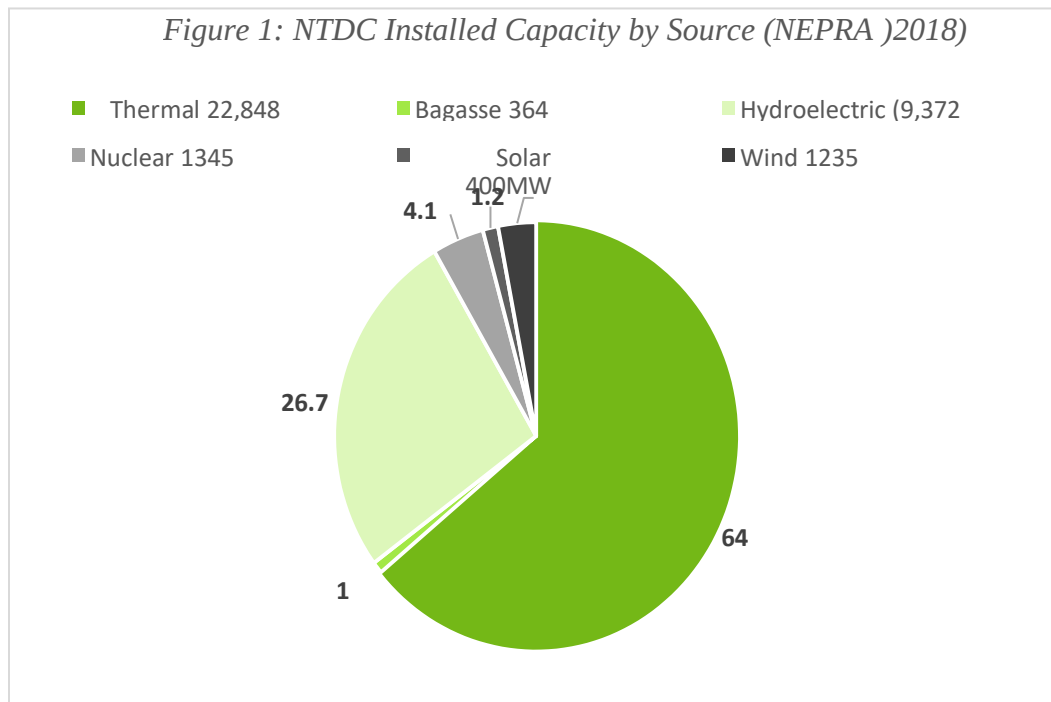
Financial: High cost of capital for renewable energy projects, Inadequate and risk averse financing, high exchange rate fluctuation between the PKR and major international currencies and short investment time horizons.

Infrastructure and Grid Operation: Inadequate capacity and flexibility of the electricity grid, lack of faster and more reliable interconnection facilities and services, limited integration due to a lack of digital infrastructure, planning and forecasting capability and curtailment of renewable energy generation.

Market Structure: Centralized power sector, Institutional reluctance to provide support to renewable generation and dearth of domestic supply manufacturers.

Other Significant Roadblocks: Underdeveloped political lobbying, limited availability of training and continued education opportunities, lack of quality control and standards for equipment.

Installed capacity and its out lay²³:



Pakistan has been unable to match renewable generation to its potential; power generation was adopted in 2006 (REP 2006). Intended to provide a solitary, clear policy framework to govern and encourage the growth and deployment of renewable energy. Federal government of Pakistan is in the process of finalizing the Alternative Renewable Energy Policy

²³Renewable Energy and Energy Efficiency (REEE) Project, Islamabad, Pakistan, downloaded from <https://pgref.org/> on 15.5.2020: 23.

of 2019 (AREP 2019). AREP 2019 is intended to improve upon the 2006 framework and provide a more coherent and proactive framework for renewable energy development. AREP 2019 launched a renewable energy generation target of 20% of generation capacity by 2025 and 30% of generation capacity by 2030. Secondly, AREP 2019 intend establishing a framework to integrate all relevant agencies i.e. NEPRA, NTDC, DISCOs, and AEDB into the planning and procurement process coherent planning, transmission, distribution capacity and support, in contrast to the inert 2006 framework. AREP 2019 establishes three categories of project development options: (1) Federally procured projects (2) provincially sponsored projects (3) private sector off-grid projects. Eligible distributed generation projects are required to submit applications to the public DISCO responsible for distribution services in the project area. Approved projects must enter into an agreement with the DISCO and apply to NEPRA for a generation license. The DISCO is responsible for installing and commissioning the interconnection facility for the approved project. To date, AEDB estimates that 33 MW of net-metered generation capacity has been connected to the grid and over 2300 Net Metering applications have been processed, the majority of which are residential (AEDB 2018).

Data Analysis

Several categories of roadblocks to renewable energy development identified are interrelated, however; have been grouped into following five categories: (1) Legal and political Overview for Investors (2) Financial (3) Infrastructure and Grid operation (4) Market Structure – Over Centralized (5) Training and Education Challenges.

Overview for Investors

The slow and overly bureaucratic regulatory sector, critical shortages of human resource capacity and technical expertise and a lack of policy and regulatory consistency. Domestic financing for medium and small-scale projects is frustrated by high interest rates and reluctant lenders. Inadequate and outdated grid procedure further frustrates renewable integration through inadequate planning, interconnection services and non pro-active support of renewable generation results in delays for budgets and capacity building.

Financial Roadblocks

High cost of capital for renewable energy projects as renewable energy investors still struggle with high interest rates and cost of capital with standard financing at a very unfavorable interest rates of 15-16%; however off late State Bank of Pakistan has introduced special renewal and alternate energy loan at 6%. High exchange rate fluctuation between the PKR and major international currencies has once devalued, dearth of domestic manufacturing; as a result, developers and contractor rely on imported equipment, which is made relatively expensive due to the devalued PKR.

Limited integration and limitation due to lack of digital infrastructure

NTDC has plans to upgrade the system operation software to more recent versions of Siemens SCADA grid operation software, as well as additional programs designed to help manage and plan renewable energy grid integration but has yet to begin the upgrade. In addition to updated software, staff training and capacity building in order to use the software is a great challenge.

Over Centralized Power Sector

Electricity sector in Pakistan remains centralized and still in the nascent stages of developing a competitive power market. The new AREP 2019 policy is expected to result in an even more centrally regulated power sector, with regulatory and operational authority being further centralized with NEPRA, NTDC, CPPA and AEDB, results due to underdeveloped political lobbying by trade associations are relatively weak and do not constitute a major capacity building player.

Limited availability of training and continued education opportunities

Limited availability of training and continued education opportunities, including specialized degrees and vocational training, for renewable energy professionals in Pakistan. This has led to limited domestic technical expertise. Only large-scale developers have invested in training human resource and project operation and maintenance standards, leading to poorly installed and managed renewable generation.

SWOT²⁴ Analysis of the Pakistani Model for Alternate Energy Regime

Strengths: Natural resources potential (especially solar, wind, hydro), Good business case (10 years cost recovery), Existence of preferential loans, Existing political will to develop RES due to high energy demand and current account deficit, Support of bank and local investors availability, Net-metering scheme and Government Initiatives, Technical experience in hydro is handy and Large domestic market.

Weaknesses: Lack of experience of grid operators to manage volatile production, few DSOs are reluctant to implement net-metering, Fear of the unknown regarding new RES, deficient electricity infrastructure (regular shortages), lack of educational and awareness programs, lack of awareness about energy efficiency, lack of coordination between public agents and Government. Missing energy efficiency regulation, transmission and distribution constraints, long and complex permitting procedures, lack of domestic manufacturers for solar installations, lack of skilled manpower with difficult access to loans for individuals and transmission/ distribution losses.

Opportunities: Off-grid solutions in remote areas, urgent need of energy to develop the society, rising demand for low cost energy, use of solar plants to reduce the cost of water pumps, reduction of environmental pollution, better access to energy as decentralized plants, new job and investment opportunities, technology cost- reduction and decrease of the basket price,

Threats: Missing coordinated strategy between agencies, inconsistent governmental policies and political decision making, aging distribution grid, line losses and theft, law and order situation/ perception, competition in PV solar equipment and too low prices with lack of quality control.

Conclusion

Renewable energy and climate change concepts have been introduced as a regional player for energy and technological investment by Masdar city so as to kindle development and reformist atmosphere in energy, environment and transportation planning; which is imminent

²⁴Renewable Energy and Energy Efficiency (REEE) Project, Islamabad, Pakistan, downloaded from <https://pgref.org/> on 15.5.2020: 54-60.

need for maintainable growth for urban development²⁵. Lessons of Masdar city signify far-fetched lessons for new cities around biosphere looking for becoming supportable. Indeed Masdar as city has shown the importance of persistence in building a sustainable city and is iconic for interest to energy sector investors and to countries that aim for very low carbon cities to achieve their climate goals²⁶. Pakistan on the other hand is striving to excel and recoup with emerging energy needs; however, Masdar can be followed as a role model and the gaps in Policy, execution and investor's domain may be looked into with top priority. Actors and interest groups identified with bureaucratic essence need to be neutralized with leading world practices with digitized and modern upgradation to aptly channelise the very dormant energy sector. Road blocks identified alongwith strength, weaknesses, opportunities and threats this sector is subject too is required to be reconnoitered with *integrational mindset* to reduce the fatigue of installation and investment and the factor adds into the basic essence of a sustainable cities that its livable, energy efficient and eco-friendly cities emerge on the map of Pakistan as sustainable indeed.

²⁵David, "Predominantly urban world and its underpinnings," 7-21.

²⁶David, "Predominantly urban world and its underpinnings," 7-21.