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Best Practice Fundamentals in Smart Grids For a Modern Energy System Development in Jordan

Faisal Y. Alzyoud, NesreenAlsharman, and ALMofleh Anwar

Abstract:*The incoming technologies and the fifth generation in telecommunication systems are characterized by the spread of IoT sensors and the application of IPv6, as internt will be eveywhere with zero cost. But, unfortuntly the proliferation of IoT devices will consumes a lot of energy, and embrace toxic pollution and E-waste. To utilize the benefits of smart devices and reduce the harmeful of their applications, there isatendecy to apply green IoT devices and green energy aspects. Smart grid starts to arise in the horizon and a plenty of researches are done to utilizethe use of energy, so smardgrids technology is considered an important and dominant factor for modern community to achieve several objectives like energy security, cost eduction, and economic factors that mitigate climates changes by reducing the emission of CO2. Smart grids can adapt to the profliration of energy consumption resources by integratingdifferent renewable energy resources and applying recharging systems like electric vehicle in transportation, so smart grid is considered a good solution in countriesdevelopment through applying technology regulations and rules. Jordan is one of gowing countries indeveloping green energyresourcess, itstarts touse different green energy resources like sun and wind, so Jordan substantially begains to utilize the smart grids practices, reduce energy costs and migitate the environmental pollutions.*

Key words:**IoT, JNES,PV , RES , SGNs**

Introduction

Electricity is considered as one of the vital aspects for human life , since every part of our life style will need energy source and electricity. the demand for electricity will rise for the incoming years; due to the increase of Internet of Thing (IoT) devices and sensors which depend on electricity [1]. To fulfill with the energy sources shortage and the increase in energy cost, there is an important needs for a smarter approach to increase and utilize the energy efficiency, these needs develop smarter energy management solutions to adapt the developmentof technologies like smart grids.SmartGrid Networks (SGNs) will be a good alternative for the transmission systems in new century;since SGNsdepend mainlyon renewable energy resources such as wind and sun. SGNs optimizethe use of electricity generation and search for solutions to reduce the cost of power in kilowatts,also SGNstry to engagethe consumer with electricity generation process. smart meters are used as electronic devices to record energy consumption, and establish a communication with electricity suppliers for monitoring and billing proposes. The number of smart meters in the grid is expected to reach around 240 million in Europe, 150 million in North Africa, and about 400 million in China by year 2020 [2].

Electricity was often generated byplants are layedfaraway from urban and industrial communities ; as electric plants require special environmental conditions such as: production facilities, places for water dams, etc. Initially, electric power was generated by medium voltage range, then this voltage can be raised to high voltage by voltage lifting transformers in order to move it over long distances range from hundreds tothousands kilometers, after electricity moved to the target position, it is then reduced to medium used volyageusing voltage reduction transformers to fulfildifferent requirements in both nomadic and industrial demand limits [3]. Due to the promsing aspects of implementing IoT, and smart cities concepts; There is a crucial need to developgreen IoTandlow-carbon emission technologies to handle different aspects related to energysuch as energy security, adapting toclimate changes and the growth in economy [4]. Smart grids are considered one of the important technologies including low-carbon energy technologies and renewable energy sources such asElectric Vehicles (EV). Smart grid uses different digital technologies to manage and control electric generation, transportation, and use as smart grid uses the

following techniques to enhance energy efficiency used and apply greenIoT features such as [5]:

- Smart power transmission systems.
- Implementing efficient distribution protocols.
- Implementing efficient computing techniques.
- Nodes scheduling
- Nodes switching from sleeping mode to active mode.
- Adapimg energy efficiency techniques.
- Utilizing CR techniques in energy harvesting [6].
- Adapting new renewable energy sources [16].

Intelligent Networks (INs)play as coordinater to handle and utilize the capabilities of INs's generators, INs's operators, INs'send users and INs'sstakeholders in the electricity market to achieve costs reduction, reliability, stabilityand reduce the environmental impacts. Power grids deploy massive Advanced Metering Infrastructure (AMI) to measure power consumption techniques such as smart meters which collect and gather electrical measurements [7]. AMI collected electrical data combined with other non-electrical data sources such as weather see Figure 1.

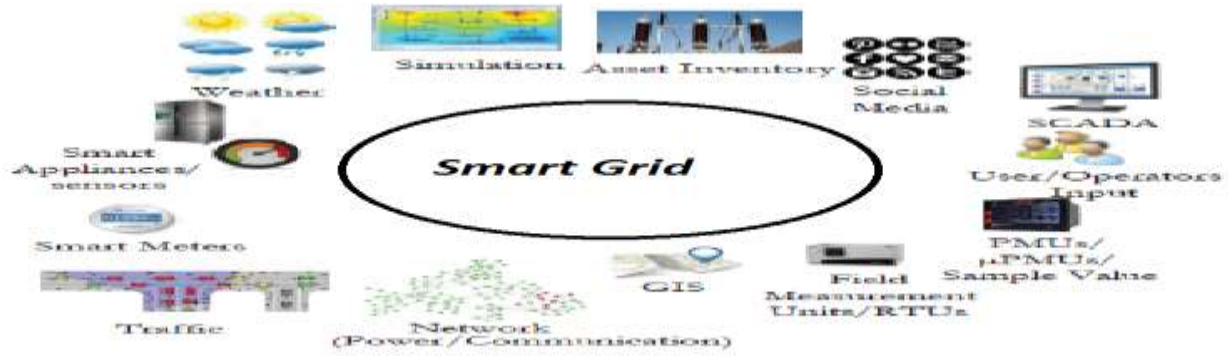

Figure 1: Smart Grid electric and non-Electric Sources

Jordan as most of the world countries starts to plan and add further investment in smart grid; since adapting and implementing smart grids will havea set of technologies that will be used in different environments fields around the world including: local business, adapting strategies compatibile with existing infrastructures, regulations rules developments, and increase investment in smart grid as depicted in Figure 2, whichrepresents the evolutionary nature of elegantsmarter grids.

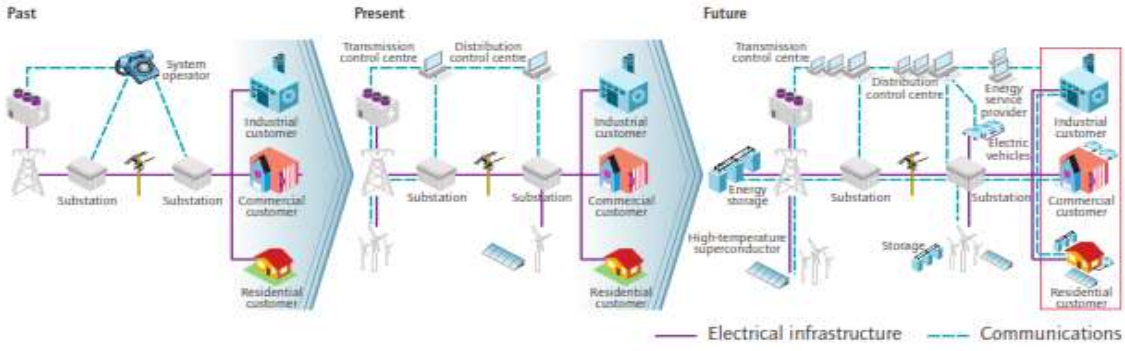

Figure 2: Smart Electricity Systems Evoltion

The evolution in electric system grids are addressed by many challenges related to technical, financial and the regulations for each region. Smart grids are characterized by high data volume reaching terabytes or more (Big Data) with a valuable values [8]. Smart grid are characterized by several features shown in Table 1.

Table 1:Smart Grids Features

Smart Grids Feature	***Details of Smart Grids Feature***
Customers Participation	- Smart grids systems enable their consumers to modify and adapt their requirement according to balance supply and demand intervals. Smart grids develop new technologies to produce information about consumers electricity utilize, and supply users by new forms of and cost price and electricity pricing reduction incentives.
Scalability and Efficiency	- Smart grids are able to support the developing set of customer sited energy distributed resources. Also,to centralized power plants. Smart grids havedifferent energy power consumption sources like small-scale combined power and heat, renewals, and they contain energy storage devices that will rapidly growth during the value chain of smart grids starting from energy suppliers to marketers and customers.
Flexibilty and Management	- Smart grids are designed to operate with markets efficiently, and togenerate an opportunity for their consumers forselecting the best service among different competing services. Energy source, capacity, location, time, and quality are some of the smart grids variables that should be managed efficiently, somarkets play mainfactor in smart grids variables management. Flexibilty is needed for smart grids owners, operators, regulators, and consumers to enhance the rules and regulations of business suitable to market conditions.
Quality and Customer Satisfications	- Smart grids support differentpricesand grades of power because the cost of premium power-quality features is augmented withthe electrical service agreement, so advanced new control methods are needed to monitor necessary components, and to enable rapidly diagnosis solutions which will impact power quality like: switching surges,lightning, harmonic sources and line faults.
Optimize and Utilization	- Smart grids use the modern techniques toutilizetheir assets. Such energy utilization that can be attainedby dynamic ratings, andsensing loads increase rate Smart grids maintenance can be improved efficiently with condition-based maintenance through performing equipment maintenance at regular time.

However, the new trends in smart grid development are to replace carbon-based generators by renewable energy from sun and wind that are characterized by: intermittent, uncontrollable uncertainty, as they have virtually no marginal costs [9].

Jordanian Scenariosfor smart Grids

Smart grids technologies implementation generatesseveral beniftsrelating to operation, security and adapting new renewable energy polices in many fields such as solar energy marketing, butunfortuntly, bulk smart grids may facedrawbacks such ascomplexity in monitoring, operations and control of combined set of power grids planets. In general,the cost of energy production, and electric energy in specific are growing rapidly;due to the reduce in fossil fuelworld resources, the rise demand for energy in the world, the price cost per kWh, so energy production from traditional resources becomes more expensive because their scarcity. Jordan as a part of the world, its demand for energy increases rapidly. It is anticipated that the annual development rate of the electrical loads will reach (3.7%) in average by the year 2040as depicted in Figure 3.

The maximum demand is expected at summer season; since in this interval the electric consumption is increased due to the use of air conditions and other electric devices [10].

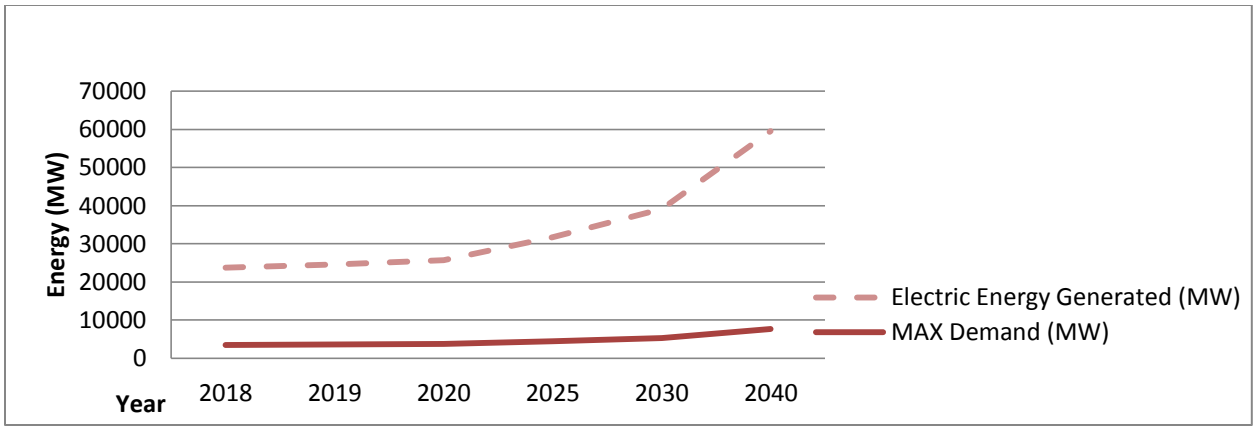

Figure 3: Jordan Electricity Demand Forecast

Jordan plans toreduce its dependence on natural energy fuel supply (Diesel,N.Gas, and Heavy Fuel Oil) which is estimated to exceed 90% before 2016 [18] see Figure 4. Jordan adaped several starategies to reduce its dependency on energy imported resources by applying a strategies plans to use renewable energy sources. Jordan government started to implement its energy strategy, so it applied several steps to increase its renewable energy electricity production sources using wind and solar energy[17].Jordan government signed many agreements to encourage the use of renewable energy by developing many projects to produceelectric energy with capacity of about (418) MW, in addition many projects are assigned to utilizeJordan natural sources of energylike oil shale, sooil shale canantecipate in covering about (30%) of the all energy generation by the year 2025 in Jordan[10] [19].

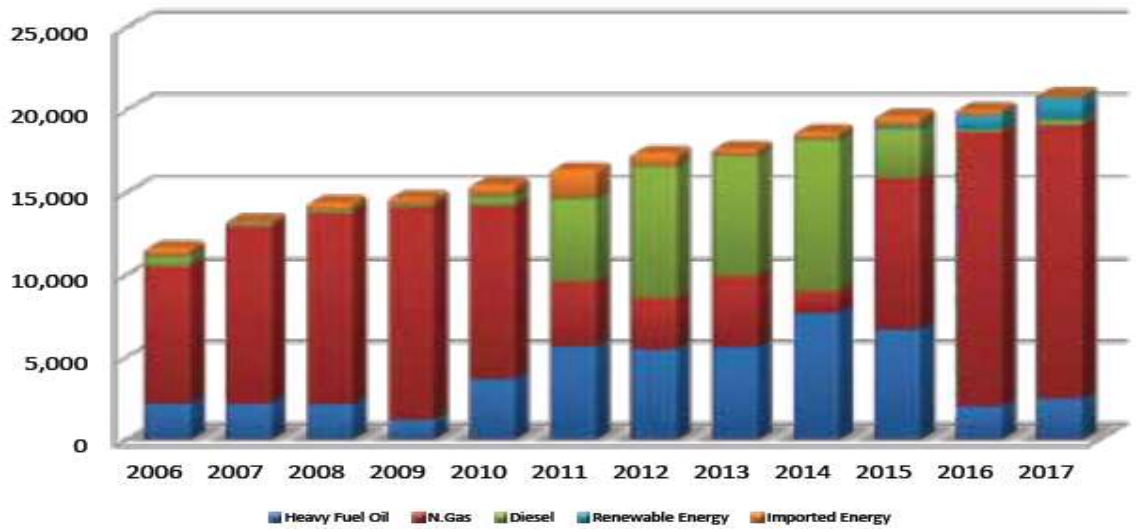

Figure 4:Jordan Electrical Energy Resource Typesfrom 2006-2017

Jordan National Energy Strategy (JNES)

The energy costs consume about 52.8% of Jordan's economic revenue as it is shown fromJordan Ministry of Energy and Mineral Resourcesannual report in the year 2015. This report shows that most of energy cost comesfromthe country's imports,so Jordan adopted a strategy that depends on using itsgreen natural resources such as its sunny weather and windswept laying on eastern and northern areas in Jordan; these weather conditions are considered asbestsolutions for photovoltaic (PV)andwind turbine solar projects [11]. The basicgoalsfor Jordan planare to reduce using imported oil,reduce energy waste, and develop renewable energy sources to reach 10% as energy production source by 2020, and enhance energy efficiency to reach 20% in 2020 [12].Jordan National Energy Strategy (JNES) is built on the following steps [13]:

- Increase the security for sustainable supply of petroleum products and enhance the competition in energy commercial sector.
- Achieve the security of electric power supply.
- Achieve security of natural gas supply and diversify the resources for importing.
- Utilize the renewable energy sources.
- Exploit the oil shale to generate electricity
- Introduce nuclear energy to generate electricity
- Raise the energy efficiency.

Jordan is considered as one of the most discriminator countries in Middle East which invests in Green Financing. Green financing means using all the financial products and services like insurance,loans, bonds in green projects, stocks, andprivate equity. JNES concentrates on improving energy performance, consumption reduction , and improving the participation of renewable energy sources to the total used energy resources .

Smart Grid Sustainable Development in Jordan

Pricing is an important incentive factor inrenewable energy promotionpolcies,China is the fastest growing country that invests in renewable energy resources in the world [20], so it reduced electric grid prices; to promote its electric grid renewable energy resources, so the promoted pricing models which are suitable toforrenewable energy can be adapted to renewable energy source s[14].

Sustainable energy depends on natural sources that replenish themselves rapidly, whileRenewable or green energy can support electricity consumers with low costs. Electricity pricing or tariff includes marginal cost, load pattern, and social criteria [15]. Green powers aredeliberate environmentally as they are socially and friendlyacceptable;renewable energy sources include:biomass, wind, sun, Geo – thermal and hydro. Renewable powersources can support smart grid with the following features:

- Utilization the storage of RER resource output remotly
- Renewable Energy Systems (RES) functionality improvement facilitated
- Energy Provision facilitation and classification
- Redistributionof grid energy
- Facilitating storage of electric grid energy
- Functionality enhancement for electric vehicles with plugging hybridsystems

Renewable Energy Projects in Jordan

Energy sector in Jordan occupies important part in economic and renewable energy starts to play a significant progress since 2017; the basic sources of renewable energy in Jordan are Wind and solar energys. Jordan started to put new strategies migitatedwith the new plansdeveloped from the long term comprehensive national strategy for the sector of energy during the years (2016 - 2025), as it is depicted by applying different renewable and green energy projects to be an alternative solutions for natural gas, heavy fuel and diesel oil as shown in table 2 [13].

It is noted from these projects the implementation of renewable energy sources is auspicious and can be a good alternative to support Jordan with its energy requirement. These new projectsare compatable with the context issues permanent law for renewable energy No.(13) for the year 2012, whichpromotes incentives forinvestment in the infrastructure ofrenewable energy projects, in addition the government force the electricity companies to buy all the generated electrical energy from these. The aim of these incentives is to speed upthe growth of renewable energy sector as it is shown in table 3. It is noted that the energy mix in Jordan will occupy about (20%) of energy .

Table 2: Jordan Performed Renewable Energy Projects during(2015-2018) [19]

	Project name		Capacity (MW)	Operation Date
Wind Energy Projects	Tafilawind project		117	Sep/2015
	Al-Hussein wind project		88	First Quarter/2016
Solar Energy Projects	First round of the direct offers,(12)PV projects.		200	First Quarter/2016
	Second round of the direct offers,(4)PV projects: - Mafraq development projects(150)MW		200	Mid/2018
	Quwireh PV Project		103	First Quarter/2018
	Large Industries	Al-Rashadih	17	Third Quarter/2017
		Al-PotashCo.	33	First Quarter/2018
	Small Solar Systems(<5MW)	Net Metering	154	--
		Welling	49	--

Table 3:Jordan Future Renewable Energy Projects (2019–2021) [19]

	Project name		Capacity(MW)	Operation Date
Wind Energy Projects	First round of the direct offers,(6)PV projects: - Al-Rajafproject - Shobakproject - Al-Fajeejproject		82 45 89	
	Third round of the direct offers		100	2020/2021
Solar Energy Projects	Baynouna Project		200	Mid/2019
	Third round of the direct offers,(4)PVprojects		200	End/2020
	Al-Risha PV Project		50	Mid/2019
	East Amman Project		40	2019
	Al-Qatranna PV Project		30	--
	Philadelphia PV Project		50	Mid/2020
	Universities Projects		40	
	Welling Projects/NEPCO,sTransmission Lines		393	
	Small Solar Systems(<5MW)	Net Metering Projects	116	--
		Welling Projects	128	--

Conclusion and Future Work

The solar PV system is considered as an optimistic renewable energy system solution for the generation of electricity as it has a resource with clean energy and no CO2 emission.However, there is a severe problem of applying the resources of the renewable energyinto the current grids of the power system. It was noticed that the generation and consumption of energy energy in jordanreached a peak due to the crtical increment in the amount of population in addition to the political matter in the region.Jordan hasconcerns as what othercountriesin the world have,

especially those related to theclimat changes that are affected with the increment levels of CO2 and other gasses. Hence, Jordan has began to replace its dependence on fossil fuels to renewable energy fashion.Due to the limitation of energy resources in Jordan and the poor energy infrastructure,Smart Grid technology is considered as convenientsolution to overcome the current grid technology. In addition to that, smart grid reduces line losses and this would help to: (1)avoid the shortage of prevailing power (2) improve the reliability of supply (3)the enhancement of energy quality and its management, and finally (4)protecting revenues and preventing theft. Hence, it is possible to implement global smart grid system in away that exploits financial and technical resourcesof neighbor countries, in addition to the variation of their renewable energy sources. In the future a further analysis using various simulation tools and mathematical models to investigate the advantages of applying smart grid techniques is required.

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NesreenAlsharman was PHD Student at New MexicoState Universityand she is interested in network, AI, and logic fields.

Faisal Yousef Alzyoud received his Ph.D. with honority in Computer Networks from Universiti Sains Malaysia on June 2011, Faisal research interests are in the field of wireless networks, Ad hoc networks, AI, and logic fields.