Smart Grid and IoT for the Integration of Renewables in Saudi Arabia

Keynote Speech

International Webinar Prince Sultan University, Saudi Arabia 16 September 2020

Professor Saifur Rahman

Director, Advanced Research Institute, Virginia Tech, USA President, IEEE Power & Energy Society 2018 & 2019

www.srahman.org

www.ieee.org/elections





What is a Smart Grid

"Smart grid" is a concept with many elements where monitoring and control of each element in the chain of generation, transmission, distribution and end-use allow the electricity delivery and use to be more efficient.

Electric Power Grid



Source: www.sxc.hu

Motivation for a Smart Grid

Desire to make the grid smarter, safer, reliable and more <u>cost-effective</u> using advanced sensors, communication technologies and distributed computing.

Difference Between a Normal Grid And a Smart Grid





Normal Phone

Smart Phone

©Saifur Rahman

5

Starting and End Points of a Smart Grid



Smart Grid Building Blocks



Evolution of the Grid



Source: Altalink, Alberta, Canada

Intelligent Interconnected Microgrids





Merging Power Flow with Information Flow:

Integrated Communications

Electric Power & Communication Infrastructures

1.Power Infrastructure



Source: EPRI

Changing Landscape for the Electric Utility









In-depth look at Solar PV in KSA



2-MW Roof-top Solar PV plant at KAUST

Clean Panel Solar PV Output (100kWp) Riyadh Area

PV AC Power Output During One Sunny Week



14

Dust-covered Solar PV Output (54kWp) Riyadh Area



15

Solar PV Panels in Saudi Arabia





Reality Check

Solar PV Panel Cleaning (when?)



IoT-based Building Automation Systems

- In KSA the roof-top solar is gaining popularity
- Roof-top solar helps with mitigating peak loads
- Building Automation Systems (BAS) help to maintain comfortable/healthy indoor environment
- Low-cost customizable BAS systems exist

Solar PV System at Virginia Tech



IoT Device Integration for Building Automation



BAS User Interface



21

Energy Savings from Lighting Control

Location: Arlington, VA

Area: 5,000 sq ft

Deployed Devices

- 3 Lighting controllers
- 1 Power meter





An average energy savings of 35% was achieved through dimming control

Oct 2016	Nov 2016	Dec 2016	Jan 2017	Feb 2017	Mar 2017	Apr 2017	May 2017	Jun 2017	AVERAGE
33.7%	33.9%	34.4%	33.4%	35.9%	36.2%	35.0%	36.0%	36.3%	34.5%

Energy Savings by Controlling Light Intensity

Month	Total Measured Energy Consumption (kWh)	Total Calculated Energy Consumption without Dimming (kWh)	Energy Savings by Dimming (%)
October 2016	264.37	399.90	33.89%
November 2016	278.13	423.78	34.37%
December 2016	280.76	426.40	34.16%
Total (October- December)	823.26	1250.08	34.14%

<u>Note:</u> Scheduled dimming level from 6:30am to 9:00pm. Open office area A: 50%; Open office area B: 45%; Chief office's desk area: 60%; Chief office's meeting area: 50%; Conference room A: 50%; Conference room B: 45%. Lights are off after 9:00pm.

Managing Battery Storage from a BAS Platform





www.bemcontrols.com

Battery Storage Data Access from BAS Network



www.bemcontrols.com

Battery Storage Monitoring & Control



Campus-wide Energy Management



www.bemcontrols.com

New Paradigm for the Power System

- Historically: Demand driven supply (supply responds to demand)
- New Reality: Supply driven demand

(demand needs to adjust to meet fluctuating supply with help from storage)

THE SMART GRID ECOSYSTEM

THE SMART GRID ECOSYSTEM



Supported by ICT and distributed networks of intelligent sensors, data centers/clouds

Smart grid: Bi-directional flows of energy, remote control/automation of power, integrated distributed energy...

Smart city: Complex system of interconnected infrastructures and services...

Smart Campus: A collection of buildings managed by the same facility manager...

Smart buildings: Intelligent building automation systems, smart devices, productive users, grid integration...



IEEE President-elect Candidate 2020

Vote at: www.ieee.org/elections



Past-President of IEEE Power & Energy Society Past-Chair, IEEE Publication Services & Products Board

PES accomplishments: PES University PES Corporate Engagement Program PES Chapters' Councils in China, India, Africa and Latin America

website: https://www.srahman.org.

