Smart cities – at the confluence of energy, environment, and internet of things

Dr. Mani Vadari

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Meet the Author:

An IEEE Fellow, electricity industry visionary, and leader, Dr. Mani Vadari delivers strategic services to a global set of utilities, vendors, and service providers seeking deep subject matter expertise in setting the business and technical direction to develop the next-generation electric/energy system. As a Business Architect, Dr. Vadari has been delivering solutions focusing on Transmission/ Distribution/ generation operations, Energy markets, and Smart Grid for over 35 years. In addition, he is an Adjunct Professor at Washington State University and an Affiliate Professor at the University of Washington. He has published two popular books, "Smart Grid Redefined: Transformation of the Electric Utility" and "Electric System Operations – Evolving to the Modern Grid, 2nd Edition", in addition to over a hundred industry papers, articles, and blogs. His books are serving as textbooks at several universities in the US and around the world

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The Smart Cities Council defines a Smart City as one that uses information and communications technology (ICT) to enhance its livability, workability, and sustainability.

In simplest terms, there are three parts to that job: collecting, communicating, and "crunching." First, a smart city collects information about itself through sensors, other devices, and existing systems. Next, it communicates that data using wired or wireless networks. Third, it "crunches" (analyzes) that data to understand what's happening now and what's likely to happen next. For these three parts to happen seamlessly, the world is slowly and steadily moving towards what is now known as the Internet of Things (IoT).

Cities around the world are already making tremendous progress in achieving economic, environmental, and social sustainability, as they move towards improving city living standards and economies. This is not being done to support a fad of any kind but more because the present way of doing things is not sustainable either from a process perspective or from an environmental perspective. Energy and environment are two of the most important areas of the Smart City as it impacts all key responsibilities such as the built environment, transportation, water/solid waste/wastewater, public safety, and others.

Very often, it has been found that these two (Energy and Environment) are also inextricably linked to each other. Cities grow because they provide significant access to a broad variety of jobs through their transition into major industrial and commercial hubs and access to culture and entertainment among other diverse activities for all of its citizens. Cities also generate 75% of the world's GDP having become nuclei of innovation in themselves by attracting the best and brightest across the world.

However, all is not good with cities. Approximately 5 Million people move to cities every month resulting in about 50% of the world's population living in cities expecting to rise to about 70% over the next several years. This in turn is causing major issues such as growing pollution from increased carbon emissions, increased traffic congestion, and also resulting in 70% of global consumption.

So – why is all of this important?

The key takeaway from all of this is that given all of this change and the rapidity with which this is happening – the present approach of tackling change is not sustainable.

This is where IoT comes in.

As mentioned earlier – the Smartness in a Smart City comes from its ability to collect, communicate and crunch to enhance the livability, workability and sustainability of its citizens.Fundamental to the ability to collect and communicate is enabled by the IoT that derives its power from (1) instrumentation and control (2) universal connectivity (3) interoperability among the devices and networks and (4) managing data. Analytics and computing resources and other aspects. Let us now look at energy and environment, two of the more critical aspects of the Smart City and how it is influenced by IoT.

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Energy:

The energy sector is going through rapid advancement. With the advent of the smart grid, new and game-changing technologies are transforming the energy industry. Some of these technologies include distributed generation, community energy storage, microgrids, demand response, smart meters, etc. Distributed generation and microgrids provide energy locally closer to the load, leading to greater grid reliability, and reduced line congestion. Energy storage helps integrate greater amounts of renewables by compensating for their unpredictable intermittent nature. Microgrids help shorten power outages by providing energy locally. Demand response and smart meters reduce costs to consumers, by helping optimize energy usage. Sensors and controls enabled by IoT allow the energy equation to be always in the balance between the myriad of centralized, distributed (some renewable and some not) sources of supply and the load. These same sensors also inform the operator of existing and impending outages to reduce outage times thereby improving the overall energy experience of the citizen

Environment:

As more renewable sources are brought onto the grid (both transmission and distribution), this same IoT comes back into play by allowing the system operator to tackle a new challenge – balancing the intermittency of renewable sources of energy by better control algorithms that can leverage newer mechanisms of control such as Demand Response and even energy storage. Innovative disruptive technologies such as energy to hydrogen and back as fuel cells are also being investigated to take advantage of surplus energy when it is generated and convert it to service load when the wind or solar is not available.

And then to conclude -

We are moving to a new paradigm – as we move to the next generation of cities, we have found that we need to take advantage of newer technologies such as IoT to tackle the next generation of energy solutions that enhance the livability of its citizens and also result in a more sustainable environment. Moving the dial here will also deliver direct and improved solutions in other aspects of the Smart City such as houses/buildings, transportation solutions, water/waste/wastewater, and public safety and health.

Useful reading material on Smart Cities –
·Smart Cities Readiness Guide – The planning manual for building tomorrow's cities today published by the Smart Cities Council
·Alan Rose, Mani Vadari, Lorie Wigle, "How the Internet of Things Will Transform Energy Efficiency and Energy Services", 2014 ACEEE Summer Study on Energy Efficiency in Buildings