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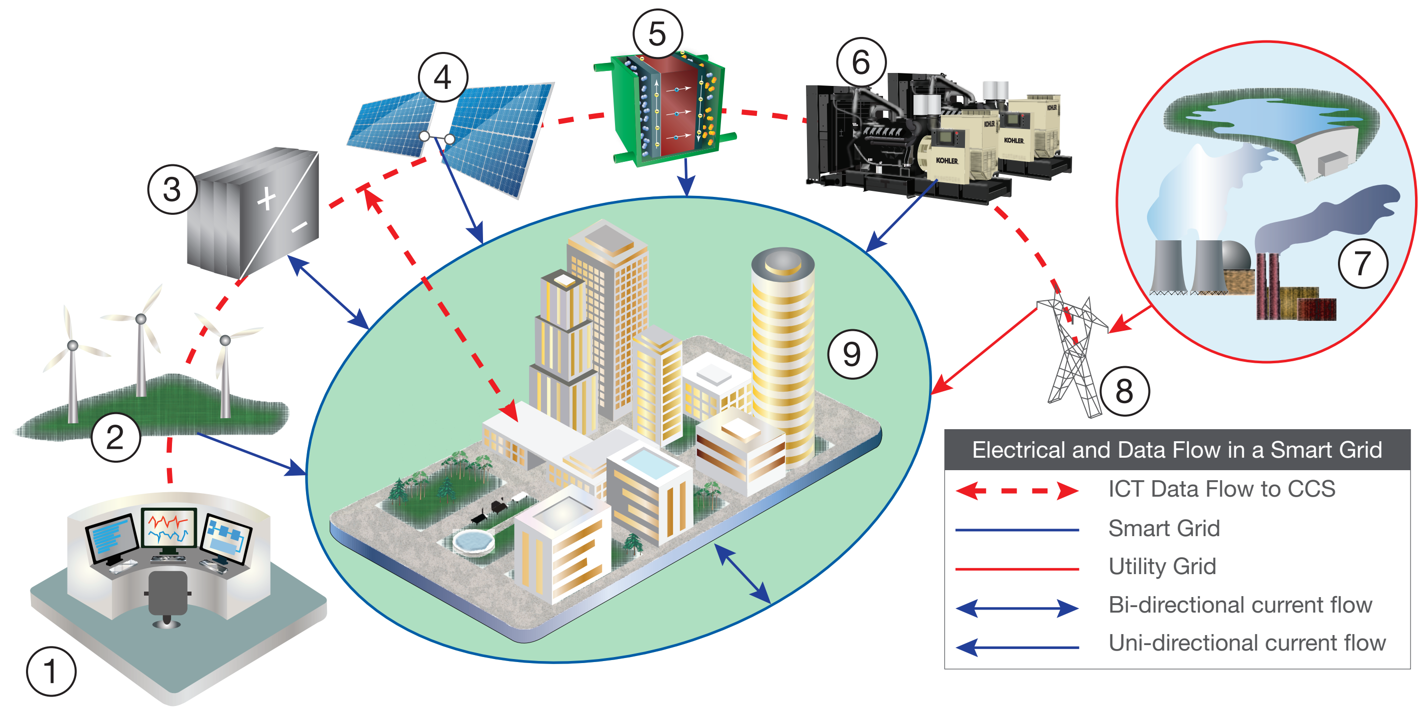
Reliable Power Professionals Since 1947

The concept of a Smart City in several world regions, including the US, is becoming a reality. The term Smart relates to applying Information and Communication Technologies (ICT) to increase operational efficiency within a municipality. When a Smart City adopts ICT, it can share information with the public and improve the quality of government services and citizen welfare. A city is a significant power consumer for heating, cooling, transportation, lighting, etc., and, as such, is highly dependent on a reliable power source. However, traditional methods to meet a city's power needs have resulted in emissions harmful to its citizen's health and high levels of carbon released into the atmosphere. This information sheet discusses how the application of ICT enables a Smart City to adopt more renewable energy sources, be less dependent on the Macrogrid, and the contribution engine-driven generator systems can make as cities move towards cleaner, more reliable power.

1.0 IBM COINED THE SMART CITY:

IBM is the company that initially coined the term "smart city." With its Smarter City Challenge program, the company has developed its vision of urbanization – based on data centralization, with a strong focus on security – worldwide. (Continued Over)

Diagram Giving Examples of Microgrid Power Inputs into a Smart City



Typical Power Sources and ICT Data Links to a Smart Grid Powering a Smart City

Item	Description	Item	Description	Item	Description
1	Central Control Center (CCS) for decision making, logistics and monitoring	4	Solar Array	7	Utility grid power stations for a utility connected Smart Grid
2	Wind Farm	5	Fuel Cells	8	Utility Power input to Smart Grid
3	Energy Storage System (ESS) bi-directional flow between Smart Grid	6	Engine driven generator systems paralleled to Smart Grid	9	Smart City receiving power form Smart Grid

The installation information provided in this information sheet is informational in nature only, and should not be considered the advice of a properly licensed and qualified electrician or used in place of a detailed review of the applicable National Electric Codes and local codes. Specific questions about how this information may affect any particular situation should be addressed to a licensed and qualified electrician.

2.0 THE WORKINGS OF ICT:

ICT covers any product that will store, retrieve, manipulate, transmit, or receive information electronically in a digital form - for example, personal computers, digital television, e-mail, and robots. So ICT is concerned with storing, retrieving, manipulating, transmitting, or receiving digital data. Examples of how this can be applied to a municipality's power requirements are:

2.1 CENTRAL MONITORING OF ALL USERS OF POWER:

Within a Smart City, all power consumers transmit to a Central Control Station (CCS) the status of all their connected loads, along with any standby power status, Energy Storage System (ESS), etc. In addition to monitoring the connected loads, the CCS will monitor and control all inputs into the grid system supplying the city. The CCS ensures the city's real-time and predicted power consumption can be met. By sharing the status of all the connected loads and power sources, the CSS can switch between various power inputs.

2.2 MANAGING A SMART CITY'S MICRO GRID:

Smart Cities are looking to more effectively manage their power needs and reduce the impact on the environment and health of their citizens. They must use more renewable energy sources, such as wind and solar, to achieve these objectives. In many areas, the macro or utility grid has a high percentage of its electrical power supplied from fossil fuel power stations.

ICT enables the CCS to coordinate a variety of power inputs to a microgrid dedicated to the Smart City. ***(See Figure-1)*** The microgrid can be operated in island mode, separate from the macrogrid, but also can tap into the macrogrid on a required basis, either for receiving additional power or supplying the Macro Grid when it requires power.

3.0 SMART GRID OPERATION:

The difference between a Smart Grid and a traditional utility (macrogrid) is the direction of power flow. In a traditional grid, the power flows to the consumer's connected load in only one direction. However, in a Smart Grid, power flows both from the grid and also into the grid. The following are examples of how a Smart Grid with CCS manages two-way flow:

3.1 RENEWABLE ENERGY SUPPLY LIMITATIONS:

Cities wanting to reduce emissions with a lower carbon footprint adopt renewable energy sources such as solar and wind. However, these power sources are inconsistent; frequently, the sun doesn't shine, and the wind doesn't blow. To manage the variations in renewable energy supply, the microgrid has additional connected power sources such as:

- Energy Storage Systems (ESS) - Batteries, Fuel Cells, Hydro Electric
- Engine Driven Generator systems
- Macrogrid

The CCS monitors energy flow into the microgrid from renewable energy sources. When it senses a reduction, other power sources are fed into the microgrid.

3.2 POWER FLOW IS BI-DIRECTIONAL FROM AND TO THE SMART MICROGRID:

The CCS reads data from all the power sources, even those that are normally net electric power users from the microgrid. Many consumers have their own backup systems to supply power if their primary power source goes offline. If renewable energy is reduced, such as solar power during the night hours, the CCS can draw down power from user's standby power systems. This means the users of power have to share their data with the CCS and permit the CCS to start their standby power systems remotely to feed into the microgrid for the benefit of all users.

3.3 MINIGRIDS WITHIN A MICROGRID:

Energy customers within a microgrid frequently generate their own power from renewable energy sources with their own ESS for backup power. Under normal operation, they operate independently in Island Mode. However, they use the microgrid for the final backup power. In exchange, a Smart City uses ICT to take control of these minigrids, and when required, switch them from Island Mode to grid connected mode to feed the microgrid.

3.4 USING MICROGRID CONSUMERS ESS :

As more commercial and residential users use ESS, such as batteries, for emergency power and have electric-powered vehicles (EV) connected to chargers linked to the Smart Grid through the CCS, the Smart City uses this backup capacity as an additional power source. Users will permit the CCS to tap into the ESS/EV within a Smart City.

4.0 ENGINE DRIVEN GENERATOR SYSTEMS WITHIN A SMART GRID:

Even though Smart Cities are looking to renewable energy sources and a lower carbon footprint, the practicalities of providing a reliable power source with minimal interruptions can increase the requirement for a backup engine-driven generator system. In a worst-case scenario when there is limited to no wind and solar energy, the ESS backup is discharged and the macrogrid is off-line, the benefits of a backup generator are:

A series of generators (diesel or gas fueled) can be paralleled as required to meet all the microgrid requirements.

- Power can be very quickly brought on line.
- Sufficient fuel can be stored on-site to ensure worst-case scenario power demands are met.
- Engines can be run on net zero carbon fuels such as HVO.

5.0 HUMAN FACTORS TO CONSIDER AND THE VULNERABILITY OF SMART CITIES:

For ICT to work, you have to get the inhabitants of a Smart City to accept sharing of all their data and let a CCS use this data to control power flowing to and from their place of work or home. The benefits of working as a community have to be seen as worth it to give up privacy and independence. In addition to privacy concerns, a Smart City has to ensure bad actors cannot hack into the CCS. It will take time to build confidence and ensure systems are secure.

To fulfill our commitment to be the leading supplier in the power generation industry, the Buckeye Power Sales team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our Information Sheets are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.

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