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DEVELOPING A SATELLITE-ENABLED DIGITAL TWIN ECOSYSTEM FRAMEWORK FOR ENERGY MONITORING IN SMART CITIES IN SRI LANKA: A LITERATURE REVIEW

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ABSTRACT

Smart cities are at the forefront of sustainable urban development, yet energy monitoring remains a critical challenge for achieving efficiency and environmental goals. Current technologies, such as Internet of Things (IoT) and building management systems, often lack the city-wide perspective needed for comprehensive energy optimization. Similarly in Sri Lanka, energy consumption in smart cities presents a complex challenge, as urban areas account for a significant portion of global energy demand and contribute heavily to carbon emissions. Hence, effective real time energy monitoring is essential to enhance energy efficiency and reduce carbon emissions in smart cities. Among emerging technologies, the satellite-enabled digital twin ecosystem (SEDTE), powered by real-time satellite data, offers a transformative approach to energy monitoring. This study aimed proposing a satellite-enabled digital twin ecosystems (SEDTE) to enhance energy monitoring in smart cities in Sri Lanka. Accordingly, key peer-reviewed journal articles, conference papers, and reports published on satellite technology, digital twins, smart cities, energy monitoring and energy efficiency between 2015 and 2025 were comprehensively reviewed. As derived through literature review, data acquisition, real-time energy optimization, grid resilience, load balancing, demand response, renewable energy integration, and disaster preparedness of energy systems are the key applications of SEDTE in the context of smart city energy monitoring. Finally, a framework was proposed to adopt this advanced technology in the development of smart cities in Sri Lanka and similar settings as the key implication of the study.

Keywords: *Digital Twin Ecosystems; Energy Monitoring; Satellite Technology; Smart Cities; Urban Sustainability.*

1. INTRODUCTION

With cities growing rapidly, smart cities use advanced tech to boost efficiency and sustainability. Energy management is a key challenge, critical for cutting emissions and meeting climate goals. Smart cities rely on interconnected systems to manage energy across residential, commercial, and industrial sectors. Urban areas consume about 70%

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of global energy and produce 75% of carbon emissions. Rising populations, electric vehicles, and tech like IoT devices drive complex energy demands. Consumption varies by area and time—think business districts peaking daytime versus homes at night. This variability, plus the shift to renewables like solar, demands precise monitoring to avoid waste and ensure grid stability (Batty, 2018).

Monitoring energy use is vital for sustainable smart cities. It helps spot inefficiencies, balance supply and demand, and cut emissions. Real-time data supports strategies like dynamic pricing, easing grid stress (Mohammadi & Taylor, 2017). It also aligns with UN Sustainable Development Goals (SDGs 7 and 11) and aids renewable energy integration, like rooftop solar. At present, smart meters, building management systems (BMS) and graphic information systems (GIS) are applied for monitoring energy consumption in buildings and urban infrastructure, while ground-based remote sensing and IoT sensors have become increasingly popular (Alahakoon & Yu, 2016; Ejaz et al., 2017; Yamagata & Seya, 2013). However, these tools work well in isolation but lack the integration needed for city-wide, real-time monitoring, highlighting the need for solutions like digital twins (Qi et al., 2021). Satellite-enabled digital twins' virtual representations of urban systems enhanced by real-time satellite data which provide a revolutionary approach to monitor energy consumption. These systems provide city-wide insights and predictive tools (Tao et al., 2019; Sharma et al., 2024). The satellite-enabled digital twins system combines satellite imagery and virtual modelling to track city energy systems. Further, this technology can be used to monitor the entire city, detecting heat losses and solar efficiency. Possibility of integrating real-time data to predict energy demand or failures, cost effective use for diverse cities application of dashboard-aided planning can be highlighted as key benefits of the satellite-enabled digital twins ecosystem (SEDTE) which signifies the use of satellite-enabled digital twins for monitoring performance of building and infrastructure (Qi et al., 2021). Although several studies have been conducted on artificial intelligence, digital twins, energy monitoring and smart cities (Sghiri et al., 2025; Sayed et al., 2025; Noori et al., 2025), it is seldom in prevailing research studies that applying satellite-enabled digital twins for energy monitoring in smart cities. Similarly, the smart city in Sri Lanka also lacks modern energy monitoring mechanisms, thus exclaim the need of integrating with SDETE. Hence, the need to investigate how SEDTE can be applied for energy monitoring in smart cities was considered as the point of departure for this research. Hence, this study aims at developing a satellite-enabled digital twin ecosystem (conceptual) model for energy monitoring in smart cities in Sri Lanka. As the initial step, this paper aimed at achieving two (02) objectives as: (i) Review the concept of satellite-enabled digital twin ecosystem, its applications for energy monitoring in smart cities, (ii) Propose a conceptual framework of SEDTE for energy monitoring in smart cities in Sri Lanka.

The methodology adapted is explained subsequently.

2. RESEARCH METHODOLOGY

This research aims at developing a satellite-enabled digital twin ecosystem (conceptual) model for energy monitoring in smart cities in Sri Lanka answering the research question "how SEDTE can be applied for energy monitoring in smart cities in Sri Lanka?". Hence, qualitative approach was adopted. Accordingly, a non-systematic literature review was adopted as the methodological foundation for the present study. Non-systematic reviews are often referred to as narrative reviews in academic literature. These reviews aim to identify, synthesise, and summarise existing published work while also highlighting potential research gaps for future investigation (Ferrari, 2015). Further to the author, non-systematic reviews provide a theoretical and conceptual overview of the state of knowledge in a particular research area.

Hence, a non-systematic literature review was conducted on the satellite-enabled digital twin ecosystems (SEDTE) and its application for energy monitoring in smart cities. As this is new technology, due to limited literature, available key research papers were selected and reviewed to synthesise key insights, highlighting the research gap. Accordingly, key peer-reviewed journal articles, conference papers, and reports published on satellite technology, digital twins, smart cities, energy monitoring and energy efficiency between 2015 and 2025 in databases such as IEEE Xplore, ScienceDirect, Scopus, and Google Scholar and written in English were comprehensively reviewed. The search string was developed using the key words, such as Satellite-enabled digital twin ecosystems or SEDTE; Applications, Strategies, Energy monitoring and Smart cities. Themes were developed iteratively, guided by the review's objectives: understanding technological capabilities, applications and benefits. The review is limited by its reliance on published literature, which may exclude emerging but unpublished SEDTE applications.

3. SATELLITE-ENABLED DIGITAL TWIN ECOSYSTEM

A satellite-enabled digital twin ecosystem (SEDTE) is a sophisticated framework that integrates real-time satellite data with digital twins which can be used to enhance energy monitoring in smart cities. Digital twins are dynamic models that could mirror physical assets, such as buildings, energy grids etc, using data to simulate and optimise performance (Tao et al., 2019). SEDTE encompasses this concept by integrating satellite-driven data, such as weather, solar radiation, and air quality to provide a city-wide analysis on energy consumption. Unlike traditional systems, such as BMS, which focus on localised data, SEDTE provides a holistic view enabling predictive energy management and reducing carbon emissions (Deren et al., 2021). This ecosystem is essential for smart cities, where complex energy demands require scalable, real-time solutions to achieve efficiency and resilience (Ketzler et al., 2020).

3.1 SYSTEM INPUTS AND OPERATION

The SEDTE operates by processing diverse data inputs through advanced analytics to monitor and optimise building performance including energy consumption. According to key literature (Alahakoon & Yu, 2016; Yamagata & Seya, 2013), the key inputs of SEDTE include:

- Satellite data: This incorporates real-time data from low-earth orbit satellites, including high-resolution imagery, weather patterns, solar radiation, and air quality metrices. These data enable city-wide monitoring of energy related factors including heat losses and solar panel efficiency.
- Terrestrial data: This includes IoT sensors, smart meters and BMS, which provide building level insights, such as HVAC usage, lighting demands, occupancy patters etc.

- Contextual data: This considers urban planning data, energy grid performance and socio-economic factors (population density etc) which contextualise the energy needs across cities.

Operationally, SEDTE integrates these inputs into a unified digital twin platform, often powered by machine learning algorithms like Neural Networks or Random Forest. These algorithms analyse patterns to predict demand spikes, identify inefficiencies, and recommend optimizations, such as adjusting HVAC based on solar data or stabilizing grids with renewable energy inputs (Qi et al., 2021). Key functional capabilities include:

Real-Time Monitoring: Dashboards visualize energy trends, aiding stakeholders in decision-making (Deren et al., 2021), Predictive Analytics, such as forecasts energy needs and equipment failures, reducing waste by 15-25% (Sharma et al., 2024), and Scalability that covers entire cities cost-effectively, unlike localized systems (Ketzler et al., 2020).

4. SATELLITE-ENABLED DIGITAL TWIN ECOSYSTEM FOR ENERGY MONITORING

4.1 ENERGY CONSUMPTION AND MONITORING IN SMART CITIES

Energy consumption in smart cities poses a complex challenge, with urban areas accounting for approximately 70% of global energy demand and contributing to 75% of carbon emissions (International Energy Agency [IEA], 2023). This significant energy footprint stems from diverse sectors, including residential, commercial, industrial, and transportation activities.

Rapid urbanisation, and the widespread use of IoT-enabled devices further amplify energy needs (Batty, 2018). These factors create dynamic consumption patterns, with commercial districts peaking during the day and residential areas consuming more at night (Batty, 2018). The shift to renewable energy sources, such as solar and wind, adds complexity due to their weather-dependent and intermittent nature, requiring advanced systems to balance supply and demand in real time (Taylor et al., 2021). Effective energy monitoring is vital to identify inefficiencies, reduce waste, and achieve sustainability goals, such as those outlined in the United Nations Sustainable Development Goals (SDGs), specifically SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities) (United Nations, 2015). Without robust monitoring, smart cities risk grid instability, higher emissions, and weakened resilience, undermining efforts to build sustainable urban environments (Taylor et al., 2021). The adoption of SEDTE brings substantial advantages to smart city energy management. Through predictive analytics, it reduces energy waste by 15-25% by optimizing systems like HVAC and lighting, as well as improving grid operations. Unlike terrestrial systems, SEDTE scales cost-effectively across entire cities, making it adaptable to diverse urban settings (Ketzler et al., 2020). It also enhances decision-making by providing stakeholders with real-time insights through interactive dashboards, facilitating evidence-based policies and investments. Another key benefit is its support for renewable energy integration, as it aligns supply with demand to reduce reliance on fossil fuels, thereby strengthening grid stability (Yamagata & Seya, 2013). By minimizing inefficiencies and emissions, SEDTE contributes to urban resilience and aligns with global sustainability goals (Mohammadi & Taylor, 2017).

4.2 APPLICATIONS OF SEDTE FOR ENERGY MONITORING IN SMART CITIES

The SEDTE plays a crucial role in transform the energy monitoring process by giving real time access via digital Twin for Smart Cities. With thermal information and Satellite image over selected city area, SEDTE maps the Energy usage and detect building inefficiencies such as heat losses and poor infrastructure. It also optimizes the systems of renewable energy using solar radiation and weather data to maximize solar panel outputs or wind turbine operations for next level integration into city grids (Sharma et al., 2024). In addition, SEDTE utilizes machine learning to process satellite and ground data, including IoT sensor feeds, to forecast demand peaks and facilitate dynamic pricing or load shifting measures. It also adjusts to the environment by utilizing air quality and urban heat island information to modulate ventilation or cooling systems, improving energy efficiency while making cities more liveable (Deren et al., 2021).

As reviewed in key literature, 11 key applications of SEDTE for energy monitoring were identified as summarised in table 1.

Table 1: Applications of SEDTE for energy monitoring

Applications of SEDTE	Source of Reference
Using satellites to obtain energy monitoring data	[1], [2], [3], [4]
Facilitating real-time energy optimization and predictive analytics	[5], [6]
Increasing grid sustainability and resilience	[7], [8], [9]
Solar energy monitoring	[2], [4], [5], [6]
Facilitating dynamic load balancing and demand response	[2], [4], [5], [7]
Maximising the integration of renewable energy	[2], [6], [8], [10]
Providing an energy-efficient approach to urban planning	[4], [11], [12], [13]
Effective planning for energy systems	[2], [6], [9]
Providing electric vehicle (EV) support	[5], [6], [8]
Ensuring climate resilience and disaster preparedness	[2], [7], [9]
Reducing carbon footprint and reporting sustainability	[4], [8]

Reference: [1] Mayer & Gróf, 2021; [2] Boccalatte, 2023; [3] Tian et al., 2021; [4] Zhou et al., 2022; [5] Alola et al., 2023; [6] Gao & Huang, 2023; [7] Sghiri et al., 2025; [8] IEA, 2023; [9] Batty, 2018; [10] Taylor et al., 2021; [11] Li et al., 2020; [12] Hosseini Haghighi et al., 2023; [13] Tian et al., 2021

These applications show that SEDTE can offer a complete view of the whole city, going beyond what local systems like Building Management Systems can do. The applications showed in Table 1 in the context of energy monitoring in smart cities are described subsequently.

4.2.1 Using Satellites to Obtain Energy Monitoring Data

Satellites that carry sophisticated sensors, for instance, multispectral and hyperspectral imaging systems, gather useful environmental data which has an impact on energy use in smart cities (Mayer & Gróf, 2021). For example, satellites monitor solar conditions like solar irradiance, cloud cover, and atmospheric aerosol load directly impacting photovoltaic (PV) electricity generation at specific geographic sites (Boccalatte, 2023).

These tools are used to display the amount of solar energy available at any given time on buildings, cities, or solar farms. And satellites track weather data like wind direction and speed. Thermal imaging can also identify energy waste or building heat loss. Satellites can map out city roads and buildings using technologies like LiDAR and Synthetic Aperture Radar. These maps' details offer a clear picture of energy consumption (Tian et al., 2021). Satellite data is used to monitor energy use. S The information is transmitted to a digital twin system and analysed using machine learning and big data techniques. The digital twin integrates satellite information with information from smart meters, building management systems, and EV charging stations to provide a real-time overview of the city's energy environment (Zhou et al., 2022). According to the authors, a digital twin can illustrate the interplay between solar energy production, grid demand, and storage capacity. It considers fluctuations in sunlight as tracked by satellites (Zhou et al., 2022). This lets energy operators and urban planners predict changes in renewable energy supply and modify system operations in advance.

4.2.2 Real-Time Energy Optimization and Predictive Analytics

Satellite information used via digital twins streamlines energy usage in real time by creating an ongoing feedback loop between the physical city and virtual twin. (Alola et al., 2023). Satellites can see when solar energy drops and watch clouds. So, the digital twin can plan other ways to send out energy, like charging batteries or using backup power. The authors say that deep learning helps predict this by showing how energy is used and made. It does this by using old and new satellite data. (Alola et al., 2023). These models can identify when rare events occur, such as sudden bursts of energy usage or problems with building insulation, so early action can be taken to prevent waste. Also, digital twins use satellite data on land use to maximize where renewable energy installations are placed. (Gao & Huang, 2023). A digital twin can recommend the optimum locations for solar panels s based on a city's layout, population, and solar energy potential. This ensures that you get maximum energy without land use issues. Space needs to be considered in crowded cities because there is little land, and the energy infrastructure must be fitted into the city without causing issues.

4.2.3 Increasing Grid Sustainability and Resilience

The digital twin system backed by satellites helps keep our power grid strong by showing how energy moves through the city. Satellites can check how microgrids are working in real-time and spot problems or overloads before they affect the bigger grid. This system uses that info to run simulations for balancing energy use, making sure power stays reliable and outages are avoided. (Sghiri et al., 2025). By tracking energy consumption that produces high carbon emissions, the system helps shift towards cleaner energy, which is in line with the world's desire to limit carbon emissions. (IEA, 2023). Satellite-enabled digital twins are a good fit for smart cities, where energy systems are complicated and connected. Unlike regular monitoring systems that tend to zoom in on local data, satellites give us a wide view of the entire city, showing how energy works together and how different areas are affected by the environment. (Batty, 2018). This view helps city leaders create energy management plans that can handle local and regional needs, making the city more resilient and sustainable.

4.2.4 Solar Energy Monitoring

Satellites continuously monitor solar conditions, such as irradiance values and cloud cover, over the geographic spread of the city (Boccalatte,2023). This information is sent to the digital twin. The digital twin has a virtual representation of the city's energy system. This includes rooftop solar systems, big solar farms, and grid-connected storage devices (Zhou et al., 2022). The digital twin, as described by the authors, combines satellite images with real-time weather station and smart meter data to come up with an estimate of how much solar energy each building and zone will produce. (Zhou et al., 2022). The digital twin predicts a small drop in solar energy output and figures out how that might impact grid stability when satellite images show clouds coming in. It might also recommend increasing battery storage or adjusting energy use in less important areas. (Alola et al., 2023). Also, it can recommend increasing energy draw from battery storage or activating demand-response programs to reduce consumption in non-essential loads. Conversely, during peak irradiance times of the day, the digital twin modifies the energy supply to prioritize EV fleet charging or storing excess energy for nighttime use (Gao & Huang, 2023). The adaptive interaction between satellite data and digital twin analytics optimizes energy use, reduces losses, and enables the city to achieve its sustainability goals (United Nations, 2015).

4.2.5 Dynamic Load Balancing and Demand Response

SEDTE balances energy consumption by depicting real-time energy demand and supply (Sghiri et al., 2025). Satellites monitor weather, such as sunshine and windspeed, that impacts how much renewable energy is generated (Boccalatte, 2023). The digital twin combines this with data from smart meters to forecast busy hours and potential shortages in energy (Zhou et al., 2022). If there is an unexpected decrease in solar energy due to clouds, SEDTE can initiate software to automatically decrease energy consumption in less crucial areas such as commercial lighting or HVAC systems (Alola et al., 2023). This stabilizes the grid and enhances energy consumption at peak hours.

4.2.6 Maximizing the Integration of Renewable Energy

The varying levels of renewable energy such as sun and winds pose challenges for smart cities (Taylor et al., 2021). SEDTE utilizes satellite data to monitor weather to forecast how much energy will be generated from renewables (Boccalatte, 2023). By observing solar radiation in locations, digital twin optimizes roof-top solar systems as well as massive installations to generate maximum amounts of energy. During more energy is generated, SEDTE stores additional energy in storage units or targets high-priority needs, such as car chargers. (Gao & Huang, 2023). This application develops the efficiency of renewable energy systems and reduces reliance on backup power based on fossil fuel, aligning with the city's standards for decarbonization (IEA, 2023).

4.2.7 An Energy-Efficient Approach to Urban Planning

SEDTE helps lower energy use in buildings and other structures by spotting problems through thermal satellite images that show heat patterns. (Tian et al., 2021). Satellites have thermal sensors that can spot where heat is escaping from buildings. This helps identify spots with bad insulation or heating and cooling systems that aren't working well, as mentioned by Li et al. (2020). A digital twin uses real-time data from building management systems to give energy-saving advice, like adjusting the heating or recommending upgrades. (Zhou et al., 2022). In cities, SEDTE shows how energy is used in different neighbourhoods. This helps urban planners spot areas that use a lot of energy and kick off projects to improve efficiency, like upgrading buildings or putting in better streetlights. (Hosseini Haghighi et al., 2023).

4.2.8 Effective Planning for Energy Systems

SEDTE is working on energy infrastructure by using land data from satellites and keeping an eye on urban building projects. Their digital twin helps identify the best spots for setting up new renewable energy sources, like solar farms or wind turbines, ensuring they generate plenty of energy while causing less impact on the land and environment. (Gao & Huang, 2023). The system can spot good roofs for solar panels or find open areas with steady winds for putting up turbines. (Boccalatte, 2023). The system can spot the best roofs for solar panels or areas with steady winds for wind turbines. It also predicts how new buildings will affect the city's energy grid, letting planners check for reliability and sustainability in the long run before they start building. (Batty, 2018).

4.2.9 Electric Vehicle (EV) Support

More electric vehicles in smart cities means we need smarter energy solutions for EV charging stations. (IEA, 2023). SEDTE makes it easy to share energy for EV charging by providing real-time info on renewable energy availability. When the sun's out, the system makes sure that energy goes to the EV chargers first before anything else, helping to make the most of clean energy. (Gao & Huang, 2023). When energy levels are low, SEDTE plans charging during off-peak hours or uses stored energy to reduce stress on the grid. (Alola et al., 2023). This helps make transportation greener and keeps the grid stable when a lot of people are using electric vehicles. (IEA, 2023).

4.2.10 Climate Resilience and Disaster Preparedness

SEDTE helps with climate resilience by spotting early signs of energy system issues caused by extreme weather. (Sghiri et al., 2025). Satellites check out weather patterns like heatwaves or storms that could affect the electricity supply or increase demand. (Boccalatte, 2023). The digital twin simulates how the city's energy system works, looking for weak spots like overloaded microgrids or broken solar panels. (Sghiri et al., 2025). By planning for options like using advanced battery storage or adjusting energy flows, SEDTE makes sure there's a steady energy supply during disasters. This is key to staying strong against climate issues. (Batty, 2018).

4.2.11 Reducing Carbon Footprint and Reporting Sustainability

SEDTE helps smart cities reach their sustainability goals by giving them real-time data on energy use and carbon output. (IEA, 2023). The digital twin keeps an eye on how well renewable energy systems are working and spots any energy waste, allowing for real-time management of the city’s carbon footprint. (Zhou et al., 2022). SEDTE makes it simple for cities to report on sustainability by providing a complete look at energy use, renewable energy sources, and cuts in emissions. This helps cities show how they are doing with global agreements like the SDGs and their own local climate plans. (United Nations, 2015).

4.3 THE PROPOSED FRAMEWORK

Based on the literature reviewed, a framework was proposed to adopt the SEDTE for energy monitoring in smart cities. As shown in Figure 1, satellites continuously monitor solar conditions, such as irradiance levels and cloud cover, across the city's geographical area. These data are relayed to the digital twin, which maintains a virtual model of the city's energy infrastructure, including rooftop solar panels, utility-scale PV farms, and grid-connected storage systems. The digital twin integrates satellite data with real-time inputs from smart meters and weather stations to calculate expected solar energy output for each building and district. If satellite data indicate an approaching cloud cover event, the digital twin predicts a temporary drop in solar generation and simulates its impact on grid stability. It may recommend increasing energy draw from battery storage or activating demand-response programs to reduce consumption in non-critical sectors. Conversely, during periods of high solar irradiance, the digital twin optimizes energy distribution to prioritize charging EV fleets or storing excess energy for nighttime use. This dynamic interplay between satellite data and digital twin analytics ensures efficient energy utilization, reduces waste, and supports the city's sustainability goals.

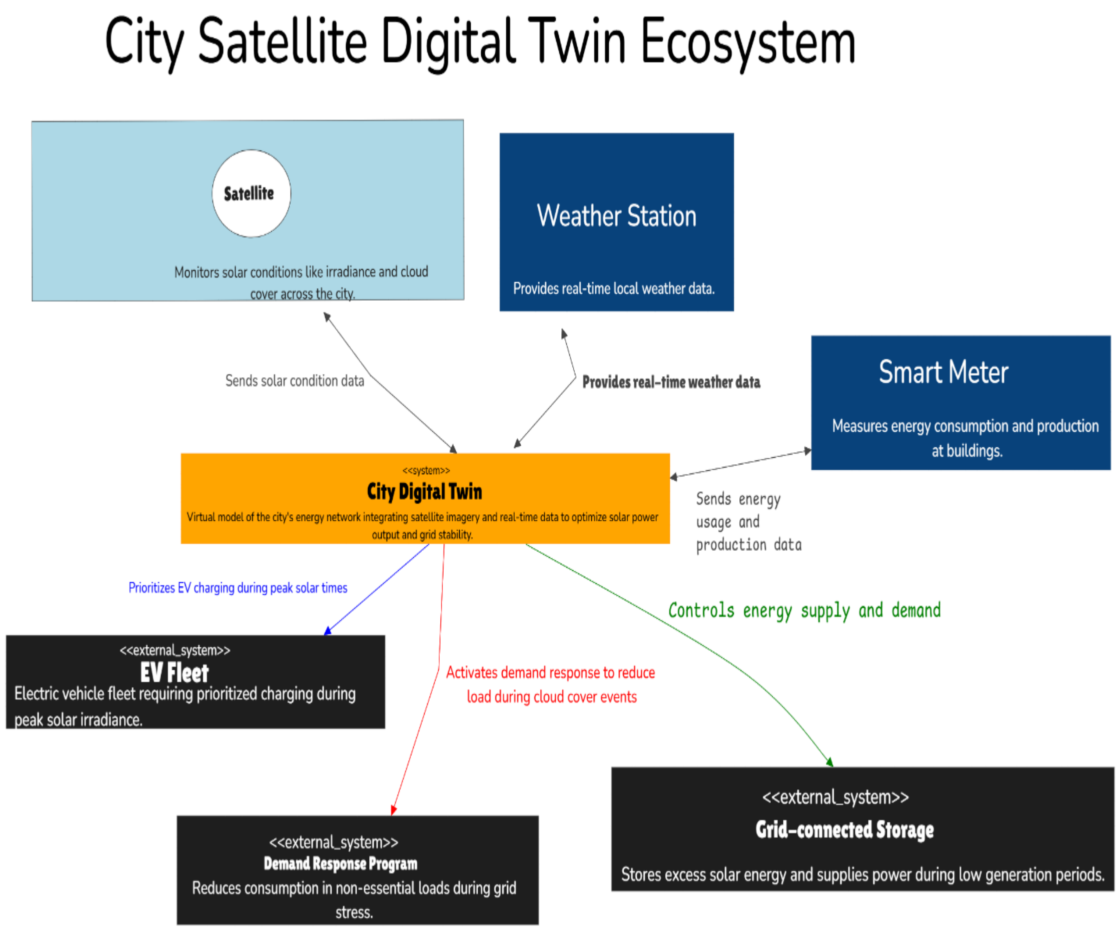

Figure 1: Proposed CITY satellite digital twin ecosystem framework (Author constructed)

In the proposed framework, sensors on satellites can capture solar irradiance, cloud cover movements, atmospheric moisture, and temperature gradients. The data received aids in forecasting solar photovoltaics (PV) energy production and estimating times during which the grid may require power or have excess supply potential. This allows smart cities to accurately forecast the need and supply. Sentinel-2 provides images pertinent to cloud cover and reflectance as well as MODIS onboard Terra/Aqua for aerosol data.

GOES and Himawari also provide real-time cloud and moisture profiles. Both satellites are equipped with global coverage and have a timely temporal resolution, making them ideal for monitoring solar potential over cities like Colombo, Kandy and Galle. Then, the data collected from satellites is integrated into a City Digital Twin, which is essentially a virtual model of the smart city integrated with GIS (Geographic Information Systems). This twin aids in monitoring the solar energy availability and forecasting its impact on the electricity grid, hence optimizing the management of the city's energy systems. Other than satellite data, weather stations and smart meters along with IoT devices installed in buildings provide essential information to fuel this digital twin. The forecasts provided by the digital twin along with other real-time data-driven decisions are sent to Building Management Systems (BMS) for automatic adjustments to energy consumption. Overall, this dual approach enhances the eco-friendliness and sustainability of cities while reducing waste. Following energy simulations, the digital twin forwards control signals to a building's BMS. These systems communicate through industry standards such as BACnet for real-time energy modification. Scheduled optimizations include pre-emptive cooling of buildings during photovoltaic downtimes, demand throttling on elevators, optimistic charging from batteries during peak solar times, and A/C sparing. This enables continuous sky feedback driven optimization of citywide energy economical building operation coordination.

5. CONCLUSIONS AND A WAY FORWARD

Energy consumption in smart cities poses a complex challenge, with urban areas accounting for high energy demand and contributing to excessive carbon emissions. Effective energy monitoring is vital to identify inefficiencies, reduce waste, and achieve sustainable development goals. Hence, monitoring energy use is vital for sustainable smart cities. Real-time monitoring has gained momentum in decision making related to building and infrastructure performance, especially for achieving energy saving and carbon emission reduction targets. Among the other technologies, satellite-enabled digital twins ecosystem powered by real-time satellite data offer a game-changing way to monitor energy use. The SEDTE revolutionizes energy monitoring by integrating real-time satellite data with digital twin technology, enabling innovative applications for smart cities. As a pathway for this newest technology adaptation, this study aimed at identifying the applications of SEDTE for energy monitoring in smart cities by reviewing key literature. Key applications of SEDTE in the context of smart city energy monitoring include data acquisition, real-time energy optimization, grid resilience, load balancing, demand responding, renewable energy integration, resilience and disaster preparedness of energy systems. The proposed framework also provides a basis for building and infrastructure professionals, policy makers towards facilitating this uphold technology adaptation in smart city development in Sri Lanka and similar contexts. However, challenges, such as data privacy concerns and high initial setup costs remain, underscoring the need for further research to ensure broader implementation. Thus, the next stage of the research will investigate the practical implementation of SEDTE in smart city development in Sri Lanka, focusing on its technological capabilities, socio-economic challenges, and strategies for successful technology adaptation.

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