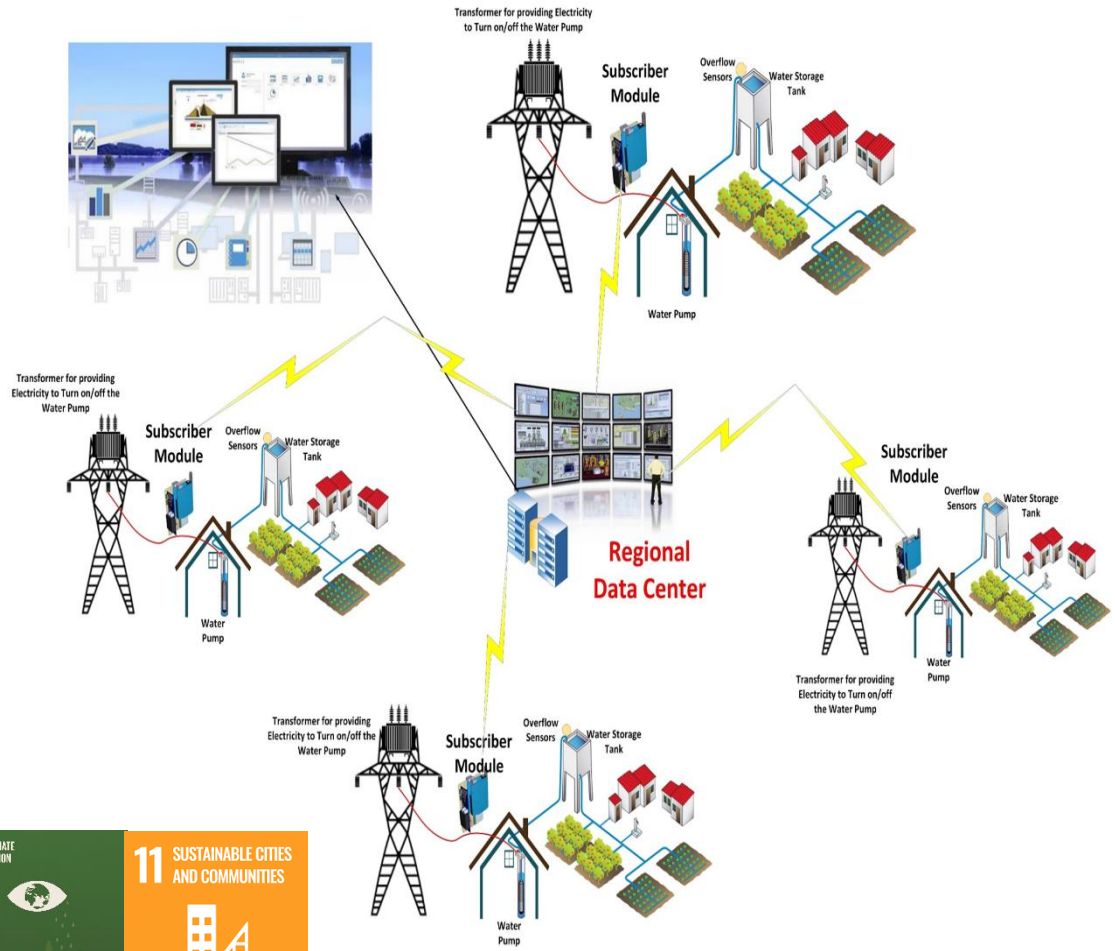
2023

GOVERNANCE TOOL- MANAGEMENT THROUGH TECHNOLOGY

Energy Management in Water Supply: A Case Study of Wireless SCADA Implementation in Khyber Pakhtunkhwa and Punjab

Municipal Energy Management via Digitization



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Energy Management in Water Supply:

A Case Study of Wireless SCADA Implementation in Khyber Pakhtunkhwa and Punjab

1. Introduction

Unveiling the Revolution: Water SCADA Case Study

In an era defined by rapid change, the specter of climate change poses an ever-expanding challenge. As our pursuit of modernization and citizen well-being unfolds, it becomes clear that it must not be at the cost of our environment. The clarion call for a "revolution in energy conservation, efficiency, and sufficiency" has never resounded more urgently.

This case study is penned with a resolute purpose - to unravel the ambitious journey undertaken by the municipalities of Pakistan as they confront the looming challenges of climate change mitigation and temperature stabilization. This endeavor revolves around the deployment of Water SCADA (Supervisory Control and Data Acquisition) systems, not merely to redefine the management of water systems but to chart a course that contributes profoundly to broader environmental and climate objectives.

The motives behind this case study are twofold. First, to examine the magnitude of the transformative efforts undertaken by municipalities across Pakistan as they unite to implement Water SCADA systems on an unprecedented scale. The intended outcome is the optimization of water system operations, ensuring the efficient delivery of this precious resource to communities, while simultaneously making significant strides towards climate adaptation. This aligns resolutely with the global objectives encapsulated in Sustainable Development Goal 13 (SDG 13).

Secondly, to dissect the challenges faced on the path to sustainable progress. The integration of these global goals into the national policy agenda is a complex and ever-evolving process. The journey is marked by rigorous research and practical pilot policy testing, including an in-depth exploration of consumer and organizational behavior. The objective is to design and implement effective policies by employing ex-ante and ex-post evaluation methods. Furthermore, the case study evaluates both existing policies and newly devised ones, drawing upon empirical evidence gleaned from these pioneering pilot projects.

The backdrop for this case study is the resilience and innovation displayed by municipalities in Pakistan as they courageously chart a course towards a more sustainable and climate-resilient future. It underscores the pivotal role of Water SCADA systems in this endeavor and accentuates the importance of integrating global environmental goals into national policy agendas.

1.1 Background of the Project:

To facilitate this transformative journey, the GIZ, under its REEE Scale project titled "Energy Efficiency through Digitization," endeavors to revolutionize energy efficiency practices within municipalities. This project works hand in hand with local governments and relevant stakeholders to introduce the Water SCADA systems. Through capacity-building initiatives, training, and knowledge transfer, municipalities will gain the indispensable skills to operate and maintain these systems effectively.

In this context, the project "Energy Efficiency through Digitization" is led by the Centre for Intelligent Systems and Network Research (CISNR), which emerges as a vital catalyst in advancing digitization efforts across different municipalities in Punjab and Khyber Pakhtunkhwa. This project provides monitoring and control solutions for essential infrastructure components like water pumping stations, streetlights, fuel tanks, and solid waste vehicle routes. CISNR's initiative aims to provide invaluable energy utilization statistics and analytics, promising not only to enhance the efficiency of existing municipal infrastructure but also to propose necessary remedial upgrades. This aligns the performance of municipalities with NEECA's target of achieving three million tons of oil equivalent (TOE) energy savings by 2025. The ultimate aim is to leverage technology as a catalyst for transformative change in Pakistan's energy landscape, concurrently benefiting the environment and the well-being of its citizens.

In summation, the project seeks to ignite a transformative shift towards energy efficiency through digitization in municipalities across Pakistan. By harmonizing energy management practices with global sustainability goals, this initiative strives to elevate the quality of life for residents, reduce environmental impact, and carve a path toward a more sustainable and energy-resilient future.

1.2 Background of the Problem

Unmasking the Challenges: Prelude to Transformation

The adoption of the Water SCADA (Supervisory Control and Data Acquisition) system by municipalities in Khyber Pakhtunkhwa and Punjab was driven by the pressing need to address the unique challenges they faced in managing their water supply networks.

In both provinces, municipalities were grappling with outdated and inefficient water management systems. These systems were characterized by manual operations and lacked real-time monitoring and control capabilities. As a result, municipalities encountered significant challenges related to energy and manpower efficiency. The existing processes were highly labor-intensive, consuming valuable human resources for routine tasks like monitoring water flow and pressure, as well as managing equipment.

These manual processes not only led to inefficiencies but also resulted in energy wastage, often through over-pumping or the inability to optimize resource utilization effectively. Manpower inefficiencies further strained municipal budgets and hindered their ability to deliver reliable water services to their communities. Moreover, the unreliability of these systems meant that breakdowns, leakages, and equipment failures were commonplace, disrupting water supply and incurring significant maintenance costs.

In response to these challenges, municipalities in Khyber Pakhtunkhwa and Punjab recognized the Water SCADA system as a transformative solution. The adoption of Water SCADA marked a significant shift in their approach

to water management. By implementing this advanced technology, municipalities could automate and optimize their water supply networks.

Water SCADA systems allowed municipalities to achieve several key objectives:

1.3 Key Objectives

Energy Efficiency: The system's real-time monitoring and control capabilities enabled precise management of water flow and pressure. This reduced energy consumption and minimized wastage, aligning with broader sustainability goals by conserving resources and lowering operational costs.

Manpower Optimization: Automation and remote monitoring reduced the need for constant manual oversight. Municipalities could allocate their human resources more effectively, focusing on strategic planning and addressing critical issues.

Reliability Improvement: Water SCADA systems provided municipalities with the ability to detect and respond to anomalies promptly. This enhanced the reliability of water supply networks, minimizing disruptions, and ensuring consistent service delivery to communities.

Data-Driven Decision-Making: The SCADA system's data collection and analysis capabilities offered valuable insights into system performance, enabling municipalities to make informed decisions regarding maintenance, repairs, and future infrastructure investments.

By adopting Water SCADA systems, municipalities in Khyber Pakhtunkhwa and Punjab demonstrated their commitment to modernizing and improving the efficiency and reliability of their water supply networks. This transformative solution not only addressed their immediate challenges but also positioned them to meet the long-term sustainability and service quality goals demanded by their communities. The successful adoption of the Water SCADA system exemplified the municipalities' dedication to providing reliable and efficient water services while simultaneously advancing their environmental and energy conservation objectives.

2. Needs Assessment and Problem Identification

Illuminating the Gaps: A Strategic Evaluation

The Centre for Intelligent Systems and Network Research (CISNR) embarked on a comprehensive journey to address challenges surrounding the implementation of the Water SCADA system in municipalities across Khyber Pakhtunkhwa and Punjab. In this process, CISNR collaborated closely with municipal stakeholders to develop bespoke solutions tailored to each municipality's distinct needs. The journey began with a thorough needs assessment and problem identification:

Before introducing the Water SCADA system, the technical team meticulously evaluated the existing water supply management system. This evaluation encompassed a deep examination of various system components, infrastructure, and operational processes. Key areas of scrutiny included pump scheduling practices, which revealed irregularities, motor pump capacities that lacked clear guidelines, the absence of real-time energy consumption monitoring, issues with wastewater flow measurement accuracy, and limitations of data logging

with mechanical flow meters. Moreover, it became evident that government-level policies needed improvement, with the need for sponsorship and approval mechanisms, training programs, budget allocation, and clear documentation.

2.1 Collaborative Problem-Solving Workshops:

Bridging Perspectives: Stakeholder Convergence

To gain a holistic understanding of the issues faced by municipalities, CISNR organized collaborative workshops and meetings with municipal stakeholders from CDA Islamabad, TMA Mansehra, WSSC Mardan, WASSA Lahore, GOJRA and WSSC Abbottabad, creating a platform for open discussions. These sessions facilitated the sharing of experiences, pain points, and expectations, enabling the identification of the root causes of their challenges.

2.2 Customized Solutions Development:

Precision Crafting: Tailored Solutions Unveiled

Leveraging the insights from these collaborative workshops, the project team worked hand in hand with municipalities, including CDA Islamabad, TMA Mansehra, WSSC Mardan, PDA Peshawar, WASSA Lahore, GOJRA, TMA and WSSC Abbottabad. These solutions were meticulously designed to address the specific challenges faced by each municipality, ensuring a harmonious alignment of the Water SCADA system with their unique requirements.

2.3 Seminars for Knowledge Dissemination and Stakeholder Engagement:

Ripple Effect: Educating and Empowering

Knowledge dissemination and stakeholder engagement were pivotal aspects of CISNR's strategy. Informative and interactive seminars were conducted to educate municipal stakeholders, including those from CDA Islamabad, TMA Mansehra, WSSC Mardan, PDA Peshawar, WASSA Lahore, GOJRA, TMA and WSSC Abbottabad, about the benefits and functionalities of the Water SCADA system. These seminars also provided a platform for networking, enabling municipalities to connect with peers considering or already implementing the system. This peer-to-peer interaction encouraged the sharing of best practices, enriching the collective knowledge and expertise within the municipalities.

2.4 Road Show:

Mobilizing change: On Road to Awareness

Under the guidance of the Project Manager, roadshow was meticulously organized which covered 32 municipalities, emphasizing the practical application of wireless SCADA technology in municipal operations (Figure: 1-4). This focus primarily targeted the management of water pumping stations and Street Light Management. The roadshow's objectives encompassed introducing wireless SCADA for heightened energy efficiency, promoting digitization within municipal operations, and initiating discussions with Chief Officers to explore the potential implementation of SCADA systems. The comprehensive range of activities, including municipality visits, presentations, stakeholder engagement, and data collection, played a pivotal role in achieving positive outcomes.

Figure 1: Meeting with Arif Abbas; Director Works, WASA Multan on 21.10.2023

Figure 2: Meeting with Saleem, Deputy Managing Director WASA Rawalpindi on 4.9.2023

Figure 3: Meeting with Superintendent MC Sirai Alamgir on 5.9.2023

Figure 4: Meeting with Ashfaq Ahmad, CO DC Gujrat on 6.9.2023

DATE	DISTRICT	MUNICIPALITY	FOCAL PERSON	DESIGNATION	CONTACT NO.	NO. OF WATER PUMPS	NO. OF STREETLIGHTS	NO. OF VEHICLES
4.9.2023	Attock	MC Hazro	Khan Badshah	CO	0301-5566788	5	2219	
4.9.2023	Rawalpindi	MC Taxila	Khalil Ur Rehman	MOI	0336-5187041	4	2200	
4.9.2023	Rawalpindi	WASA Rawalpindi	Saleem	Deputy MD				
5.9.2023	Rawalpindi	DC Rawalpindi						
5.9.2023	Rawalpindi	MC Gujjar Khan	Sadaf Abbas	MO		23	2600	
5.9.2023	Gujrat	MC Sirai Alamgir	Liaqat Hussain	MO	0321-3525124	7	3000	
5.9.2023	Gujrat	MC Kharian	Khawar Javed	CO	0300-9621208	11	585	
5.9.2023	Gujrat	MC Lala Musa	Umair Dildar	CO		9	200	
6.9.2023	Gujrat	DC Gujrat	Ashfaq Ahmed	CO				
6.9.2023	Gujrat	MC Gujrat	Fayyaz Ahmed	CO				
6.9.2023	Gujrat	MC Kunjah	Naveed Ashraf	CO	0300-6272164	7	53	
6.9.2023	Gujrat	MC Dinga	Majid Raffique	MO	0332-4543564	7	50	
6.9.2023	Mandi Bahauddin	MC Mandi Bahauddin	Muhammad Abubakar	PA to CO	0321-7742075	6	1500	
6.9.2023	Mandi Bahauddin	DC Mandi Bahauddin	Tariq Zia	CO				
18-10-2023	Kasur	MC Phool Nagar	Habib Ahmed	Head Clerk / PA to CO	0333-4302478	7	497	6
19-10-2023	Kasur	MC Pattoki	Muhammad Amir Sohail	Tube Wells In charge	0321-4146977	7	1200	10
19-10-2023	Okara	MC Renala Khurd	Rao Umer Farooq	CO	0321-1111933	7	100	9
19-10-2023	Okara	MC Okara	Hafiz Talat Mehmood	MO	0308-4986443	19	2435	47
20-10-2023	Sahiwal	MC Sahiwal	Shehzad Muneer	MO Services	0321-7318390	45	72	80
20-10-2023	Sahiwal	DC Sahiwal	Muhammad Nawaz Khan	CO	0300-7659385	0	57	0
20-10-2023	Sahiwal	MC Chichawatni	Shamshad Rasool	Suptd / PA to CO	0345-7432712	26	1700	15
20-10-2023	Khanewal	MC Mian Channu	Sajjad Hussain Shah	Suptd / PA to CO	0300-8394807	16	5300	10
21-10-2023	Multan	MC Multan	Ch. Farmaish Ali	CO	0336-6607013	0	24000	0
21-10-2023	Multan	WASA Multan	Arif Abbas	Director Works	0301-7777896	84	0	9
21-10-2023	Khanewal	MC Khanewal	Muhammad Awais Iqbal	CO	0300-8797256	11	4500	33
23-10-2023	Multan	MC Shujabad	Malik Amir Rauf	CO	0333-8574146	3	0	14
23-10-2023	Multan	MC Jalalour Pirwala	Muhammad Mohsin	MO	0333-1706114	14	0	5
23-10-2023	Lodhran	MC Lodhran	Muhammad Mohsin	MO	0333-1706114	2	606	12
24-10-2023	Muzaffargarh	MC Muzaffargarh	Dr. Abdul Ghaffor	Suptd / PA to CO	0300-6864065	1	2700	18
24-10-2023	DG Khan	MC DG Khan	Ghulam Qamber	MOI	0335-7113455	28	1163	5
24-10-2023	DG Khan	MC Kot Chatta	Jawad Ul Hassan Gondal	CO	0333-6484556	0	0	5
25-10-2023	Multan	DC Multan	Ajaz Hussain	Suptd / PA to CO	0300-8739867	3	0	8

Table-1: Municipality wise Data on Infrastructure, Showing the capacities of municipalities.

This table provides a detail municipal infrastructure data, showcasing information on various districts, municipalities, focal persons, designations, contact numbers, and the quantity of water pumps, streetlights, and

vehicles as of specific dates. The data is organized in columns, with each row representing a different municipality.

2.5 Outcomes:

These results encompassed increased awareness, a surge in interest towards digitization, the establishment of commitments for future collaborations, and overwhelmingly positive feedback from municipalities. For instance, some of the outcomes mentioned here include:

2.5.1 Increased Awareness:

- Chief officers and stakeholders gained a comprehensive understanding of Wireless SCADA technology.
- Majority of chief officers were initially unaware of SCADA systems but expressed inclination towards adoption after the roadshow.

2.5.2 Interest and Engagement:

- Municipalities exhibited keen interest in digitization, recognizing the potential for cost savings and improved service delivery.
- Point of contacts (POCs) were identified for each municipality, fostering government-to-government business relationships.

2.5.3 Commitments for Future Collaboration:

- Some municipalities expressed immediate interest, while others sought further discussions and collaborations for Wireless SCADA implementation.
- Virtual and in-person meetings were planned to address concerns and facilitate adoption.

2.5.4 Positive Feedback:

- Overall feedback from municipalities indicated a positive reception towards the roadshow's objectives and the potential integration of Wireless SCADA into their operations.

2.6 Challenges:

2.6.1 Resistance to Change:

- Municipal structures exhibited inherent resistance to adopting new technologies, and overcoming this challenge necessitated strategic approaches, including comprehensive training programs, awareness campaigns, and continuous communication.

2.6.2 Budget Constraints:

- Tight municipal budgets posed challenges in allocating funds for new technologies. However, recommendations included exploring alternative funding sources, advocating for subsidies, and proposing phased implementations to spread financial burdens.

2.6.3 Technical Expertise:

- Concerns about the technical expertise required for successful SCADA implementation were identified, and solutions involved capacity-building initiatives. These initiatives included tailored training programs for municipal staff, emphasizing both technical and operational aspects.

2.7 Recommendations:

- Continued Support and Capacity Building:
- After SCADA device installations, ongoing support through workshops, training sessions, and access to resources should be provided.
- Empowering municipal staff is essential for effective utilization of SCADA systems.
- Financial Assistance:
- Exploring funding options, grants, subsidies, and partnerships with private entities or other government bodies can alleviate budget constraints.
- Emphasis on viewing financial assistance as a means to eventual financial independence.

Implementing the recommended actions strategically is expected to mitigate challenges encountered during the roadshow and pave the way for a smoother and more successful integration of digitization in municipal operations. This case study serves as a valuable reference for municipalities and organizations aiming to drive technological advancements in traditionally structured environments.

3 System Design and Integration:

Blueprint for Transformation: Seamless Integration

CISNR's technical experts collaborated closely with municipal engineering teams from CDA Islamabad, TMA Mansehra, WSSC Mardan, PDA Peshawar, WASSA Lahore, GOJRA, TMA and WSSC Abbottabad to seamlessly integrate the Water SCADA system into existing infrastructure. The system was configured to provide real-time monitoring and control capabilities tailored to the operational requirements of the municipalities.

3.1 Training and Capacity Building:

Empowering the Guardians: Skill Enhancement Programs

Recognizing that the successful adoption of the Water SCADA system hinged on the skills and knowledge of municipal staff, CISNR conducted extensive training programs for personnel from CDA Islamabad, TMA Mansehra, WSSC Mardan, PDA Peshawar, WASSA Lahore, WSSC Swat, WSSC Kohat, WSSP Peshawar, GOJRA, TMA and WSSC Abbottabad. These sessions empowered municipal personnel to effectively operate, maintain, and troubleshoot the system.

3.2 Continuous Feedback and Improvement:

Team CISNR maintained an open line of communication with municipalities, including CDA Islamabad, TMA Mansehra, WSSC Mardan, PDA Peshawar, WASSA Lahore, WSSC Swat, WSSC Kohat, WSSP Peshawar, GOJRA, TMA and WSSC Abbottabad, throughout the implementation process. Regular feedback sessions and

performance evaluations allowed for continuous improvement and fine-tuning of the system to meet evolving needs.

3.3 Monitoring and Evaluation:

Post-implementation, CISNR continued to collaborate with municipalities, including CDA Islamabad, TMA Mansehra, WSSC Mardan, PDA Peshawar, WASSA Lahore, WSSC Swat, WSSC Kohat, WSSP Peshawar, GOJRA, TMA and WSSC Abbottabad, to monitor the system's performance and assess its impact on energy efficiency, reliability, and overall operations. This data-driven approach ensured that any issues or optimization opportunities were promptly addressed.

3.4 Knowledge Sharing:

CISNR fostered knowledge sharing among municipalities, including CDA Islamabad, TMA Mansehra, WSSC Mardan, PDA Peshawar, WASSA Lahore, WSSC Swat, WSSC Kohat, WSSP Peshawar, GOJRA, TMA and WSSC Abbottabad, creating a community of practice where they could learn from each other's experiences and best practices. This collaborative environment encouraged the adoption and effective use of the Water SCADA system.

In summary, CISNR's approach to addressing challenges related to the Water SCADA system's adoption was systematic and collaborative, rooted in a deep understanding of each municipality's unique needs. Active engagement with municipal stakeholders, including those from CDA Islamabad, TMA Mansehra, WSSC Mardan, PDA Peshawar, WASSA Lahore, WSSC Swat, WSSC Kohat, WSSP Peshawar, GOJRA, TMA and WSSC Abbottabad, and the development of customized solutions tailored to their specific challenges resulted in successful adoption and substantial improvements in energy efficiency and water supply network management.

4 Site Survey

Ground Truthing: Mapping the Terrain

Following a comprehensive needs assessment, a site survey was conducted by Team CISNR in different municipalities of KP and Punjab was a fundamental step in the case study, providing the necessary data and insights to inform the recommendations and policy changes aimed at optimizing the water supply management system. Several key recommendations were proposed to address various challenges and optimize water supply across different districts, all of which were documented in survey reports by the Team CISNR. This encompassed a comprehensive summary of the survey sites, survey parameters, and the recommended solutions for improving the water supply infrastructure.

4.1 Mardan Survey Report:

The Mardan Survey Report focused on evaluating the water supply management system in WSSC Mardan. The survey was conducted through a comprehensive assessment of pumping practices, and operational processes within the district. Key findings from the survey included issues related to inefficient pumping, and operational inefficiencies. In response, the report recommended measures such as enforcing systematic pump scheduling, developing motor pump selection guidelines, conducting regular system audits, and providing training programs

for operators. These recommendations aimed to enhance the efficiency and sustainability of the water supply system in Mardan.

4.2 WSSC Abbottabad Survey Report:

The WSSC Abbottabad Survey Report centered on assessing the water supply management at WSSCA Abbottabad. The survey primarily focused on evaluating pumping practices and equipment specifications within the district. Data collection for the survey involved site inspections and in-depth data analysis. Key findings from the survey revealed issues such as inefficient pumping practices, motor pump capacity concerns, and the need for flow meters. To address these challenges, the report recommended systematic pump scheduling, the development of motor pump selection guidelines, the installation of Variable Frequency Drives (VFDs) and ultrasonic flow meters, and the implementation of operator training programs. These recommendations aimed to optimize the water supply management system in Abbottabad.

Figure 5: The Director CISNR; Dr. Gul Muhammad discussing SCADA systems with the CEO of WSSC

4.3 WASA Lahore Survey Report:

The WASA Lahore Survey Report concentrated on evaluating the wastewater network within WASA Lahore. The survey aimed to assess the accuracy of flow meters and identify maintenance requirements within the wastewater network. Data collection for the survey involved field assessments and data analysis. Key findings highlighted accuracy issues with mechanical flow meters and maintenance challenges. To address these issues, the report recommended upgrading to ultrasonic flow meters, developing a comprehensive maintenance plan, optimizing the positioning of flow meters, allowing flexible installations, and improving data handling. These recommendations were designed to enhance the accuracy and efficiency of the wastewater network in WASA Lahore.

Figure 6: CISNR team visited the current SCADA control room in WASA Lahore

Figure 7: The CISNR team visited the existing infrastructure of WASA Lahore

4.4 Technical Survey Report Mansehra:

The Technical Survey Report for Mansehra District encompassed an assessment of the water supply management system. The survey employed field assessments and data analysis to understand water distribution challenges. Moreover, the key findings from the survey included issues related to uneven water distribution, water theft, inefficient pumping practices, and unsafe installations. In response, the report recommended measures such as balanced water distribution, anti-theft measures, smart pumping practices, modernized pumps, flow measurement improvements, and energy monitoring. These recommendations aimed to enhance

the overall efficiency and sustainability of both the water supply and street light management systems in Mansehra.

5 Installation

Building the infrastructure

Following the completion of the survey, Team CISNR's technical experts installed SCADA (Supervisory Control and Data Acquisition) systems while documenting the installation process. The installation reports played a crucial role in providing valuable insights into system compatibility for various applications across diverse locations. This installation significantly improved motor efficiency, power theft detection, and the overall quality of water supply services, becoming an essential addition to the facilities.

5.1 Water SCADA System:

The installation of the Water SCADA systems proved highly suitable for addressing energy management shortcomings in municipalities in Khyber Pakhtunkhwa and Punjab. It had a remarkable impact on improving energy efficiency and operational effectiveness. The system effectively identified and rectified electrical parameters causing inefficiencies, such as voltage and current imbalances, power factor issues, and over/under capacity operations, which were common energy-related challenges in these regions. This system previous successes demonstrated its ability to prevent energy waste, reduce operational costs, and ensure a consistent water supply, contributing to enhanced system reliability.

The three most significant advantages of implementing the Water SCADA system were:

Energy Efficiency Improvement: Real-time monitoring and management of electrical parameters significantly improved energy efficiency, helping municipalities conserve energy resources and reduce operational costs.

Proactive Maintenance: Timely detection of inefficiencies allowed for proactive maintenance, minimizing the risk of system failures and disruptions in water supply, ensuring reliable service to the community.

Data-Driven Decision-Making: The system provided valuable data for making informed decisions, allowing municipalities to optimize energy use, reduce expenses, and plan for infrastructure improvements effectively.

Customer experiences with the Water SCADA system in these regions showed noticeable improvements in energy conservation, cost savings, and enhanced service reliability, making it a valuable tool for mitigating energy challenges and improving water infrastructure management.

5.2 VFD (Variable Frequency Drive):

VFDs were selected for their ability to control the speed and power of electric motors, making them ideal for regulating water pumps to match the required flow rate. The best practices included mounting the VFD vertically, with two connection pins for three phases. One was for input connection, and the other was for output connection. The input connection was taken from the power panel, and the output connection was given to the water pump. The VFD acted as a bridge between the water pump and the power panel. In the past, VFDs were configured according to the datasheet, and a run test was performed to ensure proper operation.

5.3 Flow Meter:

Flow meters were chosen for their suitability in measuring and monitoring the flow rate of water in pipes, crucial for tracking water consumption and ensuring efficient operation. In the past, best practices for flow meters involved fixing them on the outlet water pump using the drilling and welding process to monitor water flow rate. This installation method ensured accurate measurements while maintaining the integrity of the pipe. Flow meters continuously provided accurate monitoring of water flow, aiding in the early detection of anomalies or leaks, which was essential for efficient water management.

6. Impact

Our case study also evaluates the impact of SCADA systems, which has revealed substantial positive changes in various dimensions and aspects, including:

Technical Aspect

- Asset management
- Real time audit
- Improved quality of service
- Protection of equipment

Policy Aspect

- Technical
- Organizational
- Behavioral

Financial Aspect

- Energy Savings
- Return On Investment
- Future Savings and Forecasting
- Forecasting trend reports

6.1 Technical Aspect

The technical impact of SCADA systems encompassed several policy points designed to optimize water supply management and enhance operational efficiency.

- Guidelines were developed to ensure the selection of appropriate motor pump capacities and the strict adherence to recommended motor specifications for all tubewells. Furthermore, the installation of Variable Frequency Drives (VFDs) and ultrasonic portable flow meters was prioritized to promote equipment consistency and improve overall efficiency. We have also incorporated pressure sensors to ensure the quality of service.

- Remote monitoring capabilities were introduced to upgrade pumping efficiency, enabling predictive maintenance and reducing downtime, thereby ensuring efficient performance. Mechanical flow meters

were replaced with ultrasonic portable flow meters, enhancing the accuracy and reliability of water flow rate measurements. This not only improved pump performance assessment but also increased water distribution efficiency.

- Furthermore, the introduction of energy monitoring not only enhanced the system's security by deterring theft and tampering but also ensured the efficient use of resources. These technical policy points collectively contributed to the significant impact of SCADA systems on the water supply management infrastructure, fostering efficiency, reliability, and sustainability.

6.2 Policy Aspect:

The energy policies are fundamental to our case study. The formulation of these policy points emerged from a series of successful workshops, seminars, and roadshows conducted by Team CISNR. These events provided a platform for knowledge exchange and engagement with various stakeholders, fostering a collaborative approach to addressing energy-related challenges within our organization. The insights gained from these interactions contributed to the development of comprehensive energy policies, encompassing three vital dimensions: technical, organizational, and behavioral.

1. **Technical Policies:**
    - **Adoption of Energy-Efficient Technologies:** The workshops and seminars facilitated discussions on the latest energy-efficient technologies and their practical implementation within the organization. This led to the formulation of policies that prioritize the adoption of advanced, sustainable technologies to enhance energy efficiency.
2. **Organizational Policies:**
    - **Adaptation to New Systems:** The workshops and roadshows highlighted the need for organizational policies that support the seamless integration of new energy systems. We recognized the importance of accommodating changes by revising procedures and practices to ensure optimal utilization of these systems.
3. **Behavioral Policies:**
    - **Promoting Energy Conservation:** Through the collaborative efforts of the workshops and roadshows, a shift in behavior among technical staff and end-users was observed. The increased awareness of energy conservation and adherence to recommended practices has influenced our behavioral policies. These policies are designed to encourage sustainable energy practices and ensure that energy-conscious behavior is an integral part of our organizational culture.

In summary, the policies addressing technical, organizational, and behavioral aspects of our energy landscape emerged as a result of the collective knowledge and insights gained from workshops, seminars, trainings and roadshows conducted by CISNR. These events served as a catalyst for policy development, enabling us to proactively address energy-related challenges and align our organization with the principles of innovation and sustainability.

6.3 Financial Aspects

The financial aspect of our case study centers on savings and return on investment (ROI). Energy savings directly impact the ROI of our installations and serve as a metric to demonstrate the effectiveness of our investments in energy-efficient technologies. These savings also play a crucial role in reducing operational costs and the environmental impact of our operations.

For instance, in the case of Water SCADA system, the ROI analysis for implementing SCADA devices in municipal tubewells underscores their robust financial benefits. These devices lead to significant cost savings by optimizing energy consumption, reducing maintenance costs, and enhancing operational efficiency. With a remarkably short payback period of under 2-5 months of the initial investment in SCADA systems ensuring results in a positive return on investment. This financial analysis highlights that the adoption of SCADA technology is not only a prudent but also a financially sound choice for municipalities managing tubewells.

- **Energy Metrics:**

Within the framework of our case study, the evaluation of energy metrics is pivotal for gauging the effectiveness of the deployed systems. These metrics offer intricate insights into the contributions of diverse systems, such as SCADA, VFD, and flow meters, towards enhancing energy efficiency. Examining individual metrics enables a comprehensive understanding of the unique energy consumption patterns exhibited by each system. Simultaneously, collective metrics provide a broader perspective, highlighting the cumulative decrease in energy consumption. Beyond the environmental advantages of diminishing the necessity for energy production, these reductions translate into substantial cost savings for our organization.

- **VFD Impact**

The case study demonstrates the positive impact of VFD installation on water pump operations. The reduction in energy consumption not only translates to cost savings but also contributes to a more environmentally friendly operation. Furthermore, the maintenance of consistent water pressure ensures that the water supply system can meet demand without fluctuations or interruptions.

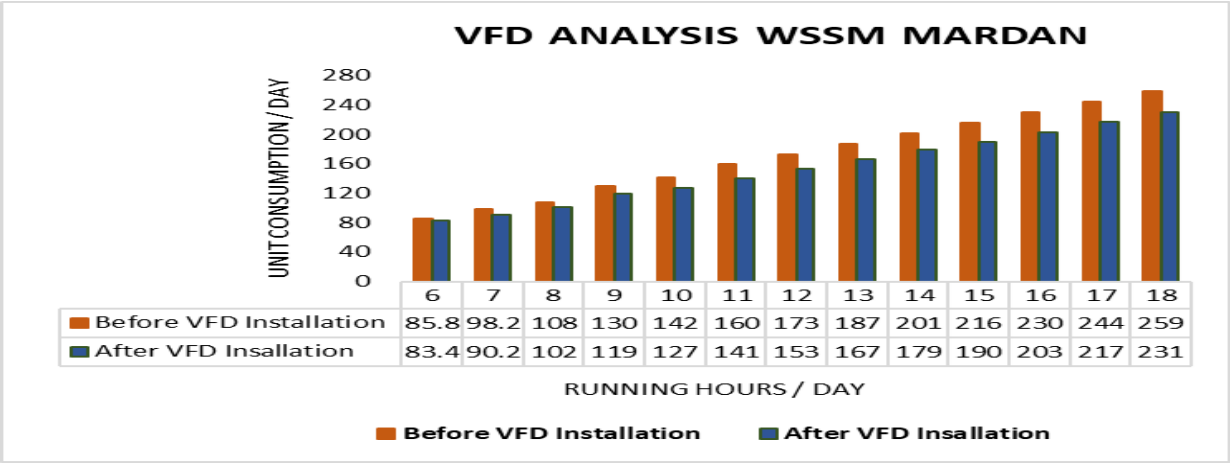

Figure 6. Graph representing VFD Analysis pre/post Installation at WSSM Mardan

Unit Saving per day (kWh)	Unit Saving per month (kWh)	Unit Saving per Year (kWh)	Cost Reduction per year (kWh * 60 Rs/kWh)	Payback Period (500000 / 604800) (year)
28	840	10,080	604,800	0.8

Table-2: Showing the ROI of VFD

The Graph shows a statistical analysis of VFD installation and their impact on pumping motor. Energy consumption was reduced for the same number of running hours after VFD installation, it is due to the reduction in motor starting losses and constant water pressure maintained by VFD.

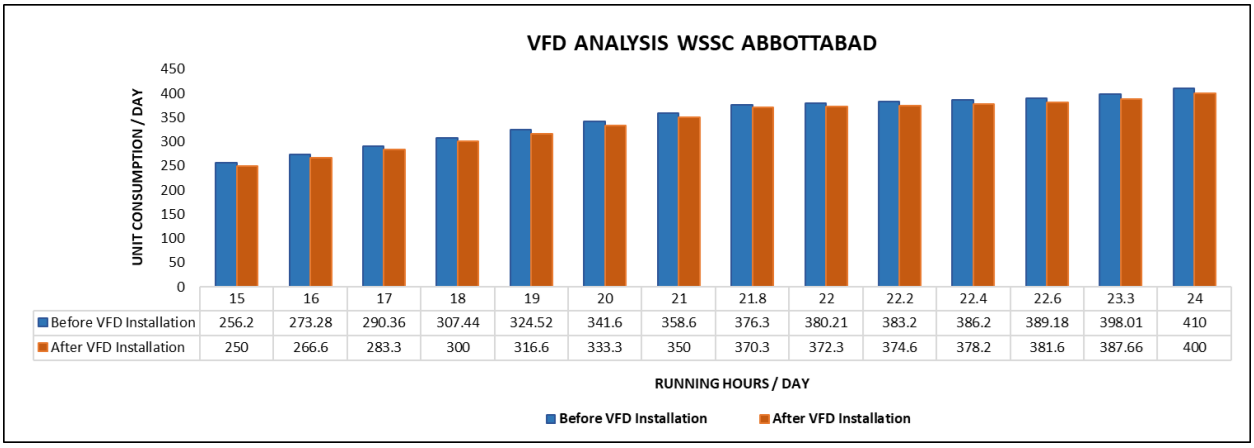

Figure 7: Graph representing VFD Analysis pre/post Installation at WSSC Abbottabad.

The installation of VFD reduce the number of units for same running hours in WSSCA as shown in the graph.

7. Energy Savings:

Similarly, energy savings represent a key quantitative metric in our case study. The implementation of energy-efficient systems, such as VFDs, has resulted in substantial reductions in energy consumption. These savings are indicative of the successful impact of our project in terms of cost savings and environmental sustainability.

A two-month analysis was conducted on two municipalities, WSSM Mardan and CDA Islamabad, focusing on the technical and financial aspects. Parameters such as pump rating, usage hours, cost of electricity per unit (kWh), and SCADA system cost per unit (PKR)were considered. The findings reveal that the installation of a SCADA unit for tubewell operations lead to a substantial reduction in electricity consumption. Moreover, the return on investment (ROI) is notably instant, with cost recovery occurring in less than a year.

7.1 Water and Sanitation Service in Mardan

For instance, in July the project team gathered pertinent data from various locations in Mardan to analyze the technical and financial aspects of the service, including the return on investment (ROI). The following information pertains to different sites:

#	TW ID	Pump Rating (hp)	Usage hours (hrs)	Web based Unit Consumption (kWh)	Bill Units (kWh) 2023	Bill Units (kWh) 2022	Technical Aspects (Saved Units)	Financial Aspects (Cost Saved) (@Rs 45 /kWh) (Rupees)	ROI (@150,000) (Months)
1	Peerano Chowk	20	348.3	7,558	8,132	10,450	2,318	104,310	1.5
2	Gaju khan	20	228.3	3,881	5,063	5,849	786	35,370	4.5
3	Town Hall	30	0	0	4,947	5,703	756	34,020	4.5
5	Serai Korona	20	177.6	3,370	3,587	6,178	2,591	116,595	1.3
6	Dagai Korona	30	175.8	3,435	3,882	6,066	2,184	98,280	1.6

Table 3: Performance and Efficiency of Water and Sanitation Services in Mardan

This data showcases the performance and efficiency of water and sanitation services in different locations in Mardan, highlighting the savings achieved, energy consumption, and the relatively short return on investment periods. It is a critical case study for evaluating the effectiveness and sustainability of these services in the region.

Similarly, In September, the team gathered crucial data for the Water and Sanitation Service in Mardan. This data is essential for assessing the technical and financial aspects of the service, including the return on investment (ROI). Below, we present information from different locations:

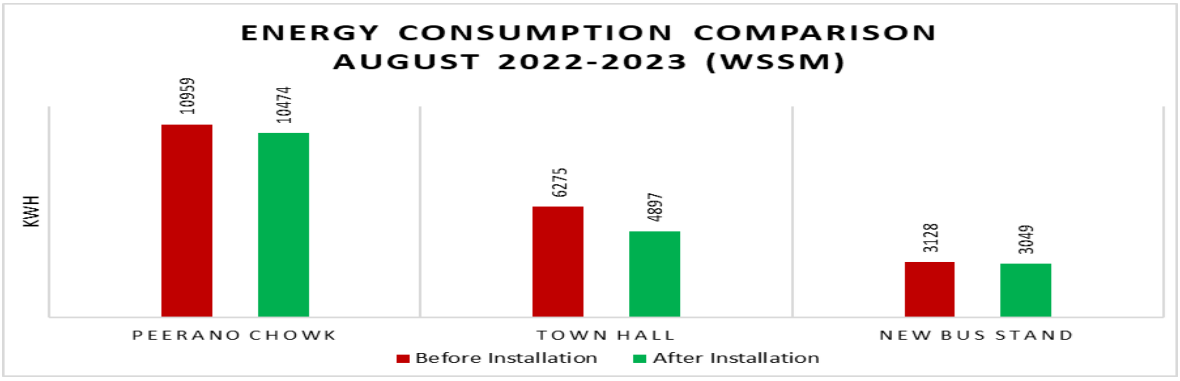

Figure 8: Graph illustrating the comparison of energy consumption at WSSM from August 2022 to August 2023.

The given graph shows the variation in energy consumption at WSSM during two consecutive August periods in 2022-2023, both before and after installation. Specifically, at Peerano Chowk, the consumption decreased from 10,959 KWH to 10,474 KWH, at Townhall from 6,257 KWH to 4,897 KWH, and at the New Bus Stand from 3,128 KWH to 3,049 KWH.

#	TW ID	Pump Rating (hp)	Usage hours (h)	Web based Unit Consumption (kWh)	Bill Units (kWh) 2023	Bill Units (kWh) 2022	Technical Aspects (Saved Units)	Financial Aspects (Cost Saved) (@Rs 45 /kWh) (Rupees)	ROI (@150,000) (Months)
1	Peerano Chowk	20	441.3	9,532	10,474	10,959	485	21,825	7
2	Town Hall	30	296.6	4,110	4,897	6,275	1,378	62,010	2.5
3	New bus stand	20	223.6	3,158	3,049	3,128	79	3,555	43

Table 4: Energy Consumption and Cost Analysis for Pump Stations WSSM (2022-2023)

Table 4 provides details on pump stations, including pump rating, usage hours, web-based unit consumption, bill units for 2023 and 2022, technical aspects (saved units), financial aspects (cost saved at Rs 45/kWh), and Return on Investment (ROI at Rs 150,000) over the specified period.

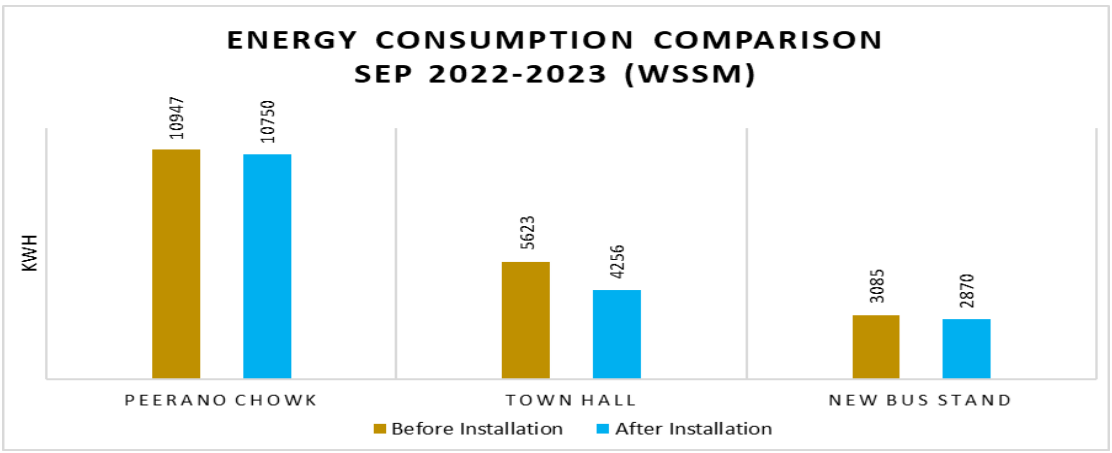

Figure 9: Graph illustrating comparison of Energy Consumption at WSSM from September 2022 to September 2023.

The graph depicts the variation in energy usage at WSSM during consecutive Septembers. A notable reduction in kilowatt-hours (KWH) is evident. Prior to installation, the figures stood at 10947 KWH, 5,623 KWH, 3085 KWH plummeting to 10750 KWH,4256 KWH and 2870 KWH in the year 2023.

7.2 CDA Islamabad

In July, the Capital Development Authority (CDA) Islamabad collected data on energy consumption and savings related to various pump installations. The following data represents technical and financial aspects along with the return on investment (ROI):

S.No.	TW ID	Pump Rating (hp)	Usage hours (h)	Web based Unit Consumption (kWh)	Bill Units (kWh) 2023	Bill Units (kWh) 2022	Technical Aspects (Saved Units)	Financial Aspects (Cost Saved) (@Rs 45 /kWh) (Rupees)	ROI (@150,000) (Months)
2	159	50	547	10,830	8,698	9,962	1,264	56,880	3
3	93	25	582.5	4,000	5,218	5,558	340	15,300	10

Table 5: Energy Consumption and Cost Analysis for Pump Stations CDA (2022-2023)

The table presents an analysis of energy consumption and costs for pump stations managed by the Capital Development Authority (CDA) during the years 2022 and 2023. Comparatively, in 2022, the energy consumption was higher at 8,698 kWh. The technical improvements led to the saving of 1,264 units. The corresponding cost saving, calculated at Rs 45 per kWh, amounts to Rs 56,880. The Return on Investment is projected to be recovered within 3 months, based on the total investment of Rs 150,000.

In September, the CDA continued its assessment of energy consumption and savings in pump installations. The following data reflects the technical and financial aspects, as well as the return on investment (ROI):

S.No.	TW ID	Pump Rating (hp)	Usage hours (h)	Web based Unit Consumption (kWh)	Bill Units (kWh) 2023	Bill Units (kWh) 2022	Technical Aspects (Saved Units)	Financial Aspects (Cost Saved) (@Rs 45 /kWh) (Rupees)	ROI (@150,000) (Months)
1	41	25/40	401.2	6,212	10,180	12,900	2,720	122,400	1.3
2	159	50	355.7	7,599	7,932	9,859	1,927	86,715	1.8

Table 6: September Energy Assessment: CDA Islamabad Pump Installation Overview

These datasets highlight the energy savings, cost reductions, and return on investment for various pump installations under the Capital Development Authority in both July and September. It is essential data for evaluating the energy efficiency and economic impact of these pump installations.

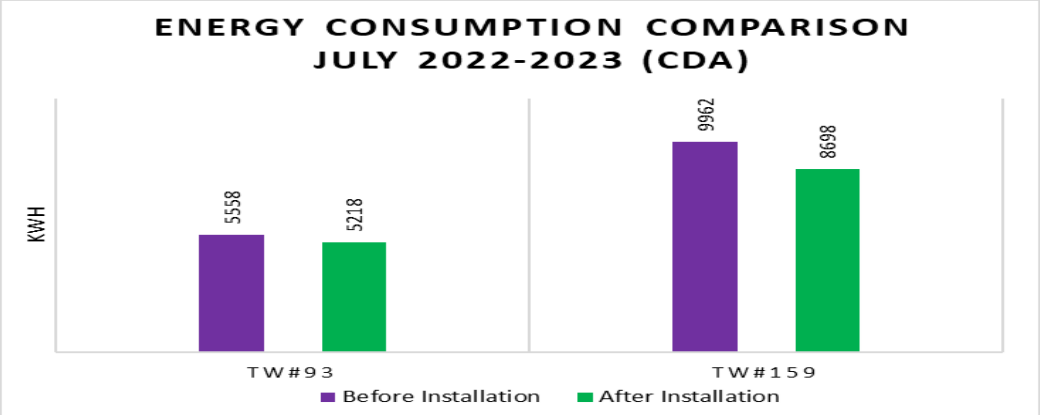

Figure 9: Energy Consumption Comparison Observed at CDA between Month of July 2022-2023

The chart depicts the variation in energy usage at CDA during consecutive month of July. A notable reduction in kilowatt-hours (KWH) is evident. Prior to installation, the figures stood at 5558 KWH, 9,962 KWH, plummeting to 5218 KWH and 8698 KWH in the year 2023

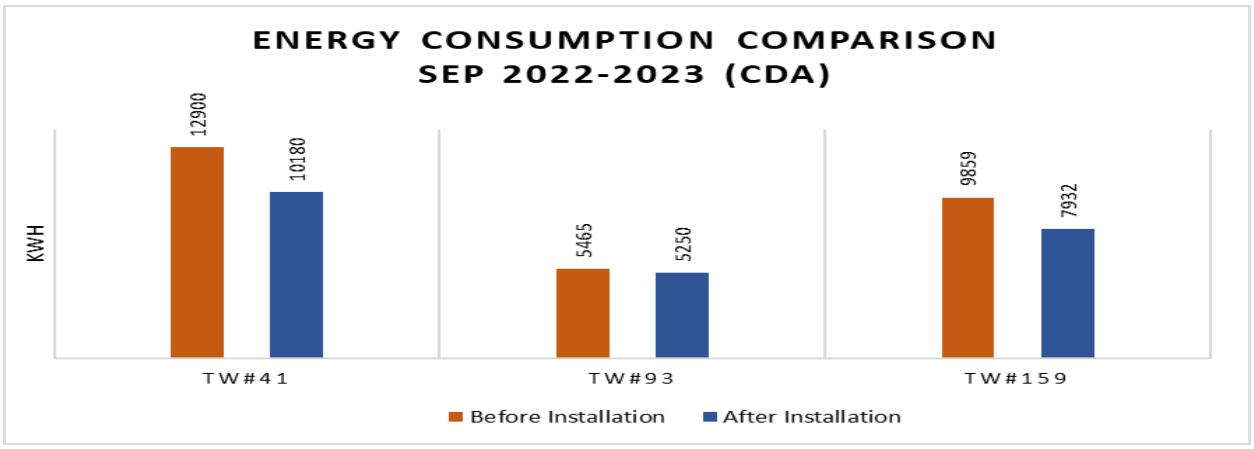

Figure 10: Energy Consumption Comparison Observed at CDA between Month of September 2022-2023

The chart depicts the variation in energy usage at CDA during consecutive Septembers. A notable reduction in kilowatt-hours (KWH) is evident. Prior to installation, the figures stood at 12,900 KWH, 5,465 KWH, and 9,858 KWH, plummeting to 10,180 KWH, 5,250 KWH, and 7,932 KWH in the year 2023.

WSSP

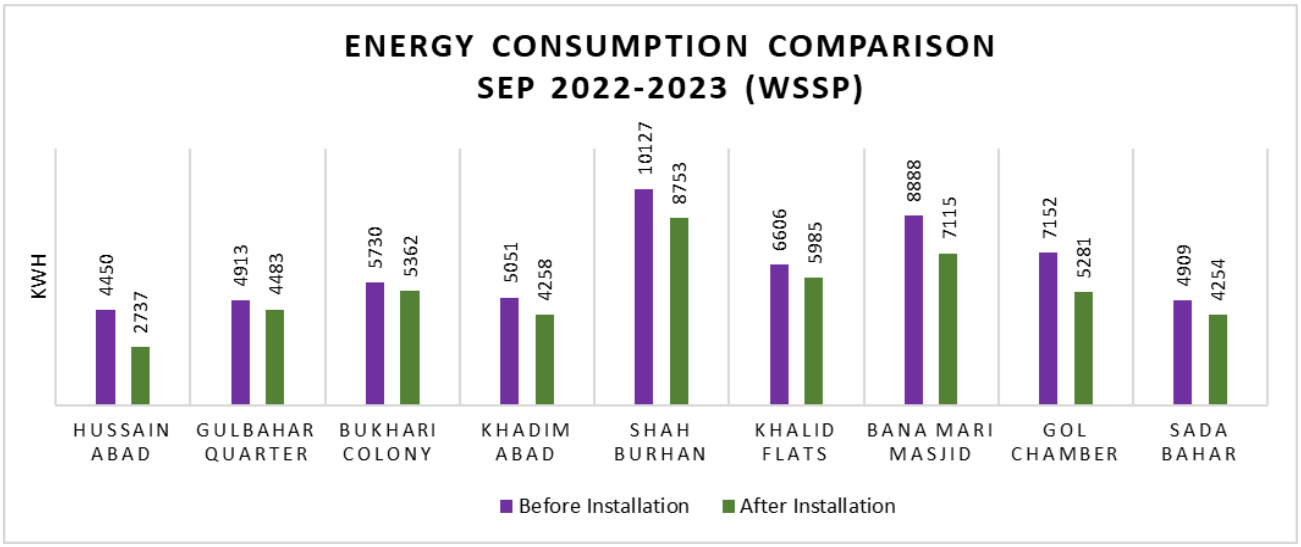

Figure 11: Impact of Water SCADA Device on Kilowatt-Hour Consumption Across Multiple Locations

The reductions in kilowatt-hour (KWH) consumption post the implementation of the water SCADA device are graphically depicted as a substantial improvement in energy efficiency across multiple locations. Each location, represented on the horizontal axis, shows a decrease in energy consumption measured in KWH on the vertical axis. The graphical representation illustrates a consistent downward trend in energy consumption for each area.

For instance, in Hussain Abad, there was a reduction from 4450 KWH to 2737 KWH. Similarly, Gulbahar Quarter experienced a decrease from 4913 KWH to 4483 KWH. The trend continues across other locations such as

Bukhari Colony, Khadim Abad, Shah Burhan, Khalid Flats, Bana Mari Masjid, Gol Chamber, and Sada Bahar, where energy consumption consistently decreased after the introduction of the water SCADA device.

7.3 Return on Investment (ROI) Analysis

The implementation of the Water SCADA system has yielded substantial positive impacts on the municipalities, as evident from the documented data. In the case of the Capital Development Authority (CDA), the system led to a monthly reduction in consumed units from 12,900 kWh (September 2022) to 10,180 kWh (September 2023), resulting in an impressive savings of 2,720 units. This translated into a monthly cost savings of Rs 122,400 at a rate of Rs 45 per kWh. The return on investment (ROI) was achieved in just 1.3 months based on the initial investment of Rs 150,000. Similarly, other municipalities, such as the Provincial Development Authority (PDA) and Water Supply and Sewerage Companies (WSSM and WSSP), experienced notable reductions in consumed units, leading to substantial cost savings and swift returns on investment. These tangible outcomes underscore the transformative impact of the Water SCADA system, not only in optimizing energy consumption but also in achieving significant financial benefits for the municipalities involved.

The data presented here pertains to the Savings and Return on Investment (ROI) analysis of a Water Scada device implementation. This information is crucial for evaluating the financial viability and success of the project. The data is as follows:

S.No.	*Municipality*	*Consumed Units (kWh) Sep 2023*	*Consumed Units (kWh) Sep 2022*	*Units saved per month*	*Cost saved per month (@Rs 45 /kWh)*	*ROI (@150,000) (months)*
1	CDA	10,180	12,900	2,720	122,400	1.3
2	CDA	7,932	9,859	1,927	86,715	1.8
3	PDA	16,168	18,940	2,772	124,740	1.2
4	PDA	18,980	22,240	3,260	146,700	1.1
5	WSSM	4,256	5,623	1,367	61,515	2.4
6	WSSP	2,737	4,450	1,713	77,085	2
7	WSSP	4,258	5,051	793	35,685	4.2
8	WSSP	8,753	10,127	1,374	61,830	2.4
9	WSSP	7,115	8,888	1,773	79,785	1.8
10	WSSP	5,281	7,152	1,871	84,195	1.7
11	WSSP	4,254	4,909	655	29,475	5

Table 7: The table illustrates the savings and return on investment (ROI) analysis for the implementation of Water SCADA Devices across various municipalities.

7.4 Energy Savings:

The data illustrates a noteworthy reduction in energy consumption due to the installation of the Scada system. This reduction signifies a significant achievement, resulting from effective scheduling and preventive maintenance of the water pumping system. The graph demonstrates that the Scada system has successfully curtailed energy consumption in various tubewells of WSSM Mardan through timely maintenance. This data plays a pivotal role in assessing the financial feasibility and the overall success of the project, showcasing the tangible savings and the relatively short ROI period for each municipality.

7.5 Technical and Financial Auditing:

Technical and financial auditing are integral components of our case study. The pre-installation analysis was a critical phase that allowed us to identify areas for improvement and establish baseline data for energy consumption and financial performance. Post-installation analysis, on the other hand, served to evaluate the performance of the installed systems and quantify the energy savings and financial benefits achieved. This data-driven approach is essential for providing a comprehensive understanding of the impact of our energy-efficient technologies.

8. SWOT Analysis:

Our case study employs SWOT analysis to delve into the strengths, weaknesses, opportunities, and threats associated with our energy-efficient systems. Strengths encompass the improvements in energy efficiency, cost savings, compliance with regulations, and the enhancement of service quality. On the flip side, weaknesses include the initial investment costs, the need for staff training, and potential technical issues. Opportunities lie in the expansion of energy-efficient technologies and the availability of grants and incentives for sustainability, while threats encompass changing regulations, technological obsolescence, and unforeseen environmental factors. This analysis forms a valuable framework for understanding the internal and external factors influencing our energy landscape.

Our SWOT analysis evaluates the strengths, weaknesses, opportunities, and threats associated with implementing the recommendations from the CDA Islamabad and Mansehra District surveys in the context of water supply management systems.

8.1 Strengths:

Cost Efficiency: The installation of the SCADA system introduces significant cost-efficiency benefits. By optimizing energy consumption, reducing maintenance costs, and enhancing operational efficiency, municipalities can efficiently allocate their resources, leading to cost savings that can be reinvested in other essential services and infrastructure projects.

Diversified Revenue Stream: The SCADA system creates opportunities for municipalities to generate a diversified revenue stream. By effectively managing and monitoring water resources, municipalities can introduce innovative pricing models and revenue collection mechanisms. This not only helps in sustaining the water supply infrastructure but also reduces the burden on public finances.

Increased Connectivity: The integration of connected objects and the Internet of Things (IoT) into the SCADA system enhances its capabilities. Real-time data and remote monitoring allow improved decision-making and resource allocation. The increasing connectivity of objects ensures that the system remains adaptable and responsive to changing demands and conditions.

Attracts Public & Private Sector Investment: The SCADA system attracts investment from both the public and private sectors. Public sector investment is bolstered by the system's potential to improve service delivery and resource management. Simultaneously, the involvement of the private sector leads to innovative financing models and technological advancements, driving further improvements in water supply infrastructure.

8.2 Weaknesses:

Early Stages Awareness Issues: In the initial phases of implementing the SCADA system, municipalities encountered awareness challenges. There was limited understanding among local stakeholders, including residents and authorities, about the benefits and functioning of the system. Overcoming these awareness issues required effective communication and education campaigns to ensure community buy-in and support.

Compatibility Challenges: Integrating various components and technologies within the SCADA system posed compatibility challenges. Ensuring that all hardware and software elements worked seamlessly together was a complex task. Different manufacturers, standards, and technologies needed to be harmonized, requiring technical expertise and careful planning to prevent system malfunctions and data inconsistencies.

Costly Solutions: The cost associated with acquiring and implementing SCADA solutions proved to be a significant barrier for many municipalities. Some advanced solutions and technologies came with substantial price tags, which strained the financial resources of local governments. Balancing the need for high-quality systems with budgetary constraints was a persistent challenge.

8.3 Opportunities:

Versatile Applications: The implementation of the SCADA system offers versatile applications across various sectors and industries. Beyond its primary function in water resource management, the system can be adapted to address the specific needs of different verticals, such as agriculture, industry, and municipal services. This adaptability opens doors for diverse applications and ensures a broader reach and impact.

Subsector Product Markets: The SCADA system can catalyze the development of subsector product markets. This includes the creation of innovative technologies, components, and services that complement the system. As the demand for water management solutions grows, a market for specialized products and services emerges, presenting opportunities for local businesses and entrepreneurs to contribute to this evolving ecosystem.

Efficient Process Management: The system enables the efficient management of various processes related to water supply, from monitoring and distribution to maintenance and resource allocation. This heightened efficiency not only enhances service delivery but also results in cost savings and resource optimization. Municipalities can streamline their operations, reduce waste, and improve resource utilization, ultimately leading to enhanced sustainability and service quality.

8.4 Threats:

Resistance to Technology Adoption: The fear of adopting new technology can pose a significant threat to the successful installation of the SCADA system. Some stakeholders, including local communities and government officials, may resist embracing technology due to a lack of familiarity or apprehensions about its complexity. Overcoming this fear requires effective communication, training, and demonstrating the user-friendliness and benefits of the system.

Security Concerns: The installation of the SCADA system introduces potential security vulnerabilities. Unauthorized access, data breaches, or cyber-attacks on the system's infrastructure can compromise the

integrity of water supply operations. Ensuring robust cybersecurity measures and continuous monitoring is essential to safeguard against security threats.

Lack of Technical Expertise: The lack of technical expertise poses a direct threat, as adversaries could exploit vulnerabilities in the Wireless SCADA systems which may lead to operational disruptions compromising the functionality of the SCADA systems.

In conclusion, this SWOT analysis underscores the importance of strategically navigating the strengths, weaknesses, opportunities, and threats associated with implementing recommendations from the CDA Islamabad and Mansehra District surveys. Recognizing these factors is crucial to developing a more robust and resilient SCADA system. Addressing weaknesses, seizing opportunities, and proactively mitigating threats will make our energy-efficient systems more effective and sustainable in the long run.

9. Net Energy Savings across Municipalities:

Our case study extends its focus into the future by calculating energy savings in each month of 2023. These calculations provide valuable insights into the long-term sustainability of the installed systems. This approach not only ensures the continuity of cost and energy savings but also supports our organization's commitment to sustainability and compliance with evolving regulations.

Months	Pump #1 (TW 41)	Pump #2 (TW 159)	Pump #3 (TW 93)	Pump #4 (TW 70)	Pump #5 (TW 44)
January	1380	2652	1084	1329	2080
February	1315	2784	1210	1358	2179
March	1250	2917	1337	1387	2277
April	1185	3050	1464	1416	2376
May	1120	3182	1590	1445	2474
June	1055	3315	1717	1474	2573
July	990	1264	340	1503	1391
August	1500	2974	230	1155	1785
September	2720	1927	514	1271	1588
October	160	2055	831	1213	1785
November	1920	2387	974	1273	1883
December	1575	2519	957	1300	1982
Total Saving Per Year	**16,170**	**31,024.8**	**12,250.8**	**16,124**	**24,375**

Total Energy Saving in CDA = 99,944.6 kWh

Table 8: Energy Saving (kWh) Per Month in CDA (2023)

Months	Pump #1 (TW06)	Pump #2 (TW08)	Pump #3 (D5 Site)	Pump #4 (D2 New)	Pump #5 (E1 Donga)
January	258.6	2174.9	2642	1459	800.5
February	149.8	2343.3	3079	1653.5	746.5
March	558.2	2511.7	3516	1848	692.5
April	966.6	2680.1	3953	2042.5	638.5
May	1375	2848.5	2390	2237	548.2
June	1783.4	3016.8	2827	2431.5	529.3
July	2191.8	3185.2	2264	2626	476.3
August	2772	777	200	292	1330
September	1562	2361	894	681	578
October	730	1619	1768	1070	1061
November	1688	1585.6	1788	1110	989
December	667	2006.6	2205	1264.5	854.5
Total Saving Per Year	**14,702.4**	**27,110**	**26,826**	**18,715**	**9,282**

Total Energy Saving in PDA = 96,635.4 kWh

Table 9: Energy Saving (kWh) Per Month in PDA (2023)

Months	Pump #1 (Peerano Chowk)	Pump #2 (Gaju khan)	Pump #3 (Town Hall)	Pump #4 (New bus stand)	Pump #5 (Dagai Korona)
January	439.7	471.8	1272	863.3	451.2
February	278.4	237.6	1308.5	1003	850
March	117.1	113.4	1345	1142.7	1248.8
April	44	230.7	1381.5	1282.4	1647.6
May	205.3	465	1418	1422.1	2046.5
June	2318	2318	756	19	2184
July	366.6	699.2	1454.5	1561.8	2445.3
August	485	933.4	1378	79	2844.1
September	197	410	1367	215	460
October	1339	1147	1003	905	190
November	1084.7	1291.6	1126	304.5	944.6
December	600.9	706.1	1235.5	723.6	152.4
Total Saving Per Year	**7,476**	**9,024.1**	**15,045**	**9,521.4**	**15,464.7**

Total Energy Saving in WSSM = 56,531.2 kWh

Table 10: Energy Saving (kWh) Per Month in WSSM (2023)

Months	Pump #1 (Hussain Abad)	Pump #2 (Gulbahar Quarters)	Pump #3 (Bukhari Colony)	Pump #4 (Khadim Abad)	Pump #5 (Khalid Flats)
January	1170.5	503	419.7	927.5	688.25
February	1062	576	471.5	1062	755.5
March	953.5	649	523.2	1196.5	822.7
April	845	722	575	1331	890
May	736.5	795	626.7	1465.5	957.2
June	628	868	678.5	1600	1024.5
July	519.5	941	730.2	1734.5	1091.7
August	411	1014	782	1869	1159
September	1713	138	161	255	352
October	1279	430	368	793	621
November	1496	284	264.5	524	486.5
December	1279	430	368	803	721
Total Saving Per Year	**12,093**	**7,350**	**5,968.5**	**13,561**	**9,569.5**

Total Energy Saving in WSSP (Zone B) = 48,542 kWh

Table 11: Energy Saving (kWh) Per Month in WSSP (Zone B) (2023)

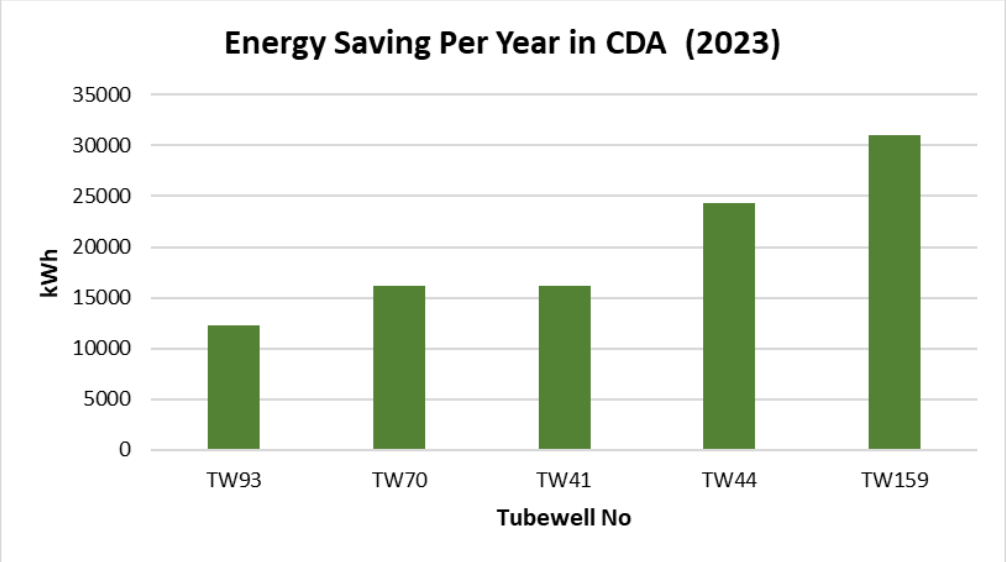

Figure 12: A strategic look to the energy savings at CDA in 2023

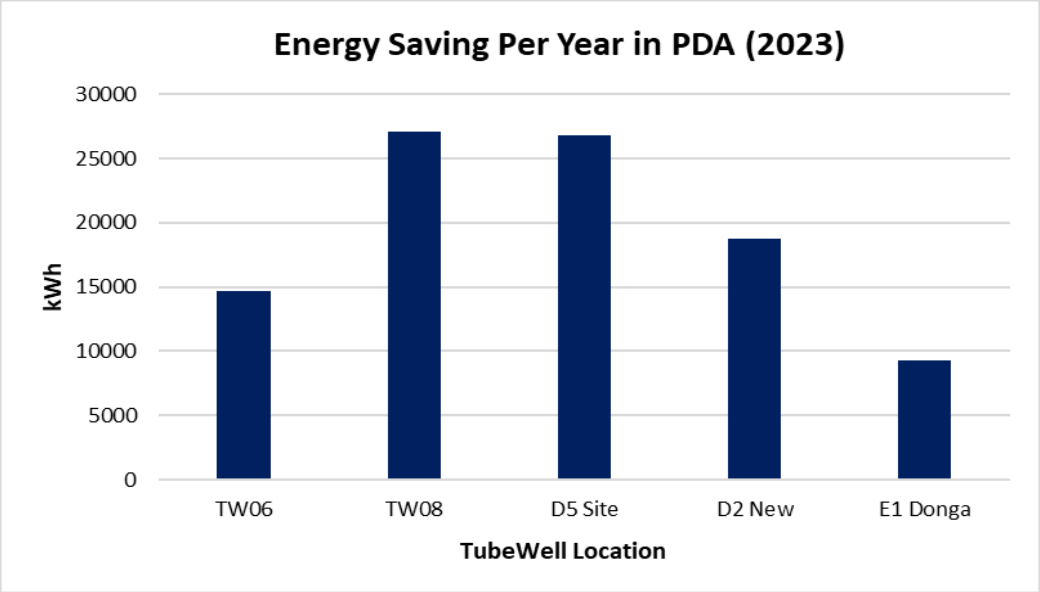

Figure 13: A strategic look to the energy savings at PDA in 2023

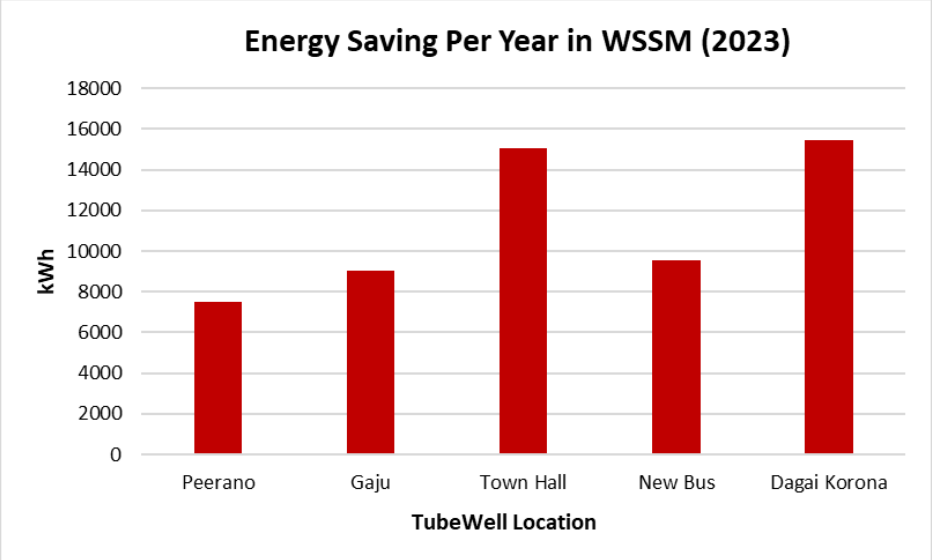

Figure 14: A strategic look to the energy savings at WSSM in 2023

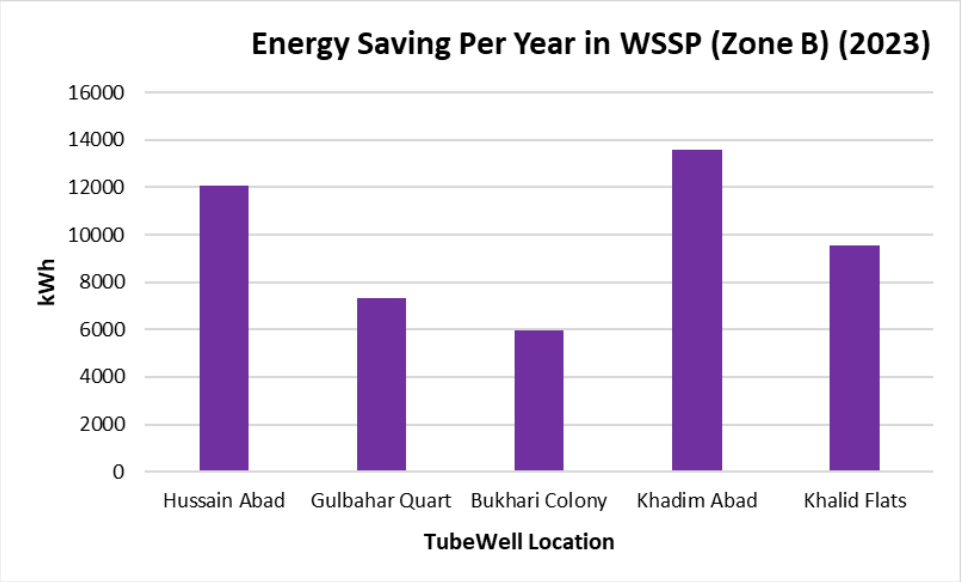

Figure 15: A strategic look to the energy savings at WSSP (Zone B) in 2023

S.no	Municipality	Energy Saving per Year (2023)
1	CDA	99,944.6
2	PDA	96,635.4
3	WSSM	56,531.2
4	WSSP (Zone B)	48,542

Table 12: Total Energy Saving (kWh) in Each Municipality

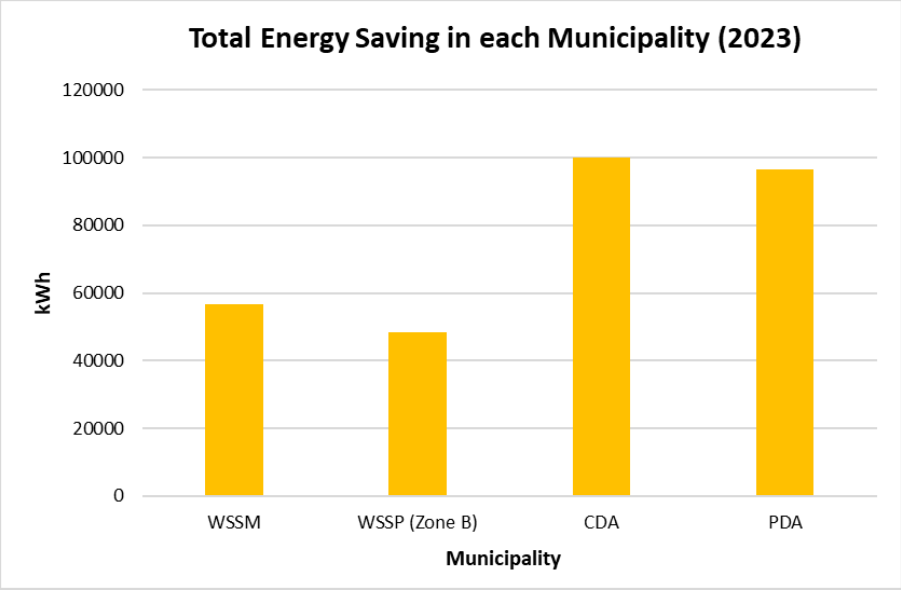

Figure 16: Overall picture of energy saving at four municipalities in 2023

10.Future Energy Development

SCADA projects optimizing energy use and reducing CO2 emissions, which form the cornerstone of future energy development. Their precision enhances sustainability, aligning with global environmental goals. This reduced carbon footprint not only showcases the energy sector's commitment to the planet but also fosters economic resilience through cost-effective operations. Additionally, carbon credits from SCADA projects incentivizes a shift from fossil fuel to renewable energy, fostering a cleaner, more responsible energy landscape. This transition not only supports sustainability but also positions the industry as a key player in addressing climate challenges. SCADA projects continual evolution further propels us toward a smarter, interconnected, and eco-conscious energy future, making the blend of efficiency, sustainability, and carbon credits vital for shaping a resilient energy infrastructure.

Municipality	Energy Saving per Year (2023) (kWh)	Reduction in CO2 Emission (Metric Ton)	No. of Carbon Credits (1 CC = 1 metric ton of CO2)
CDA	99,944.6	29.5	29.5
PDA	96,635.4	28.5	28.5
WSSM	56,531.2	16.6	16.6
WSSP (Zone B)	48,542	14.31	14.31

Table 13: Total Carbon Credit Calculations in each Municipality in 2023

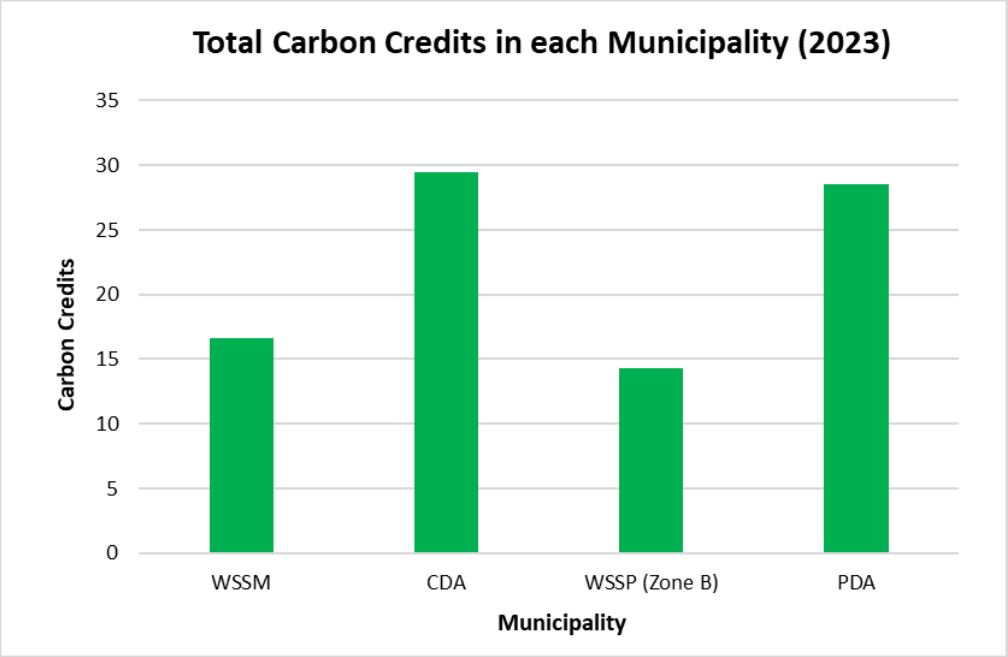

Figure 17: Calculated Carbon Credits at the four municipalities in 2023

11.Key Emergent Insights

Riding the Waves: Insights Shaping the Horizon

These insights reflect not only the challenges that have been successfully surmounted but also offer valuable prescriptions for scaling up similar installations in analogous settings. In this endeavor, the critical role of data and statistics becomes paramount, providing concrete evidence to substantiate the claims of success, offering a foundation for informed decision-making, and guiding future endeavors towards more efficient and effective systems implementation.

Challenges

The installation of the SCADA (Supervisory Control and Data Acquisition) system at the Capital Development Authority (CDA) Islamabad posed various challenges to the technical staff, as highlighted in the installation report. Notable issues included the lack of protective equipment for motors, inadequate earthing for secure device operation, and problems related to cabling and jointing. These hurdles required careful problem-solving to ensure the successful implementation of the system.

Overall, the challenges encountered during the installation of the SCADA system at CDA Islamabad were met with effective solutions, resulting in numerous benefits that improved service quality and compliance with regulatory standards.

PDA Peshawar, 2023

The installation of Variable Frequency Drives (VFDs) and a flow meter in PDA Peshawar posed challenges such as the meticulous configuration of VFDs based on datasheets and the precision required in mounting and integrating devices. However, overcoming these challenges yielded significant benefits. VFDs maintained consistent water pressure, ensuring a reliable flow and improving service quality. They also reduced motor starting losses, enhancing operational efficiency. Simultaneously, the integrated flow meter enabled real-time monitoring of water flow rates for better resource management. The installation resulted in substantial energy savings, cost reductions, and improved sustainability. Despite the initial challenges, the overall impact was a notable enhancement of water supply services in PDA Peshawar, aligning with user expectations and advancing sustainable water resource management practices in the region.

WSSC Mardan District, 2022

In the year 2022, the water supply management system at WSSC Mardan District encountered a significant challenge. The system operated without a structured pump scheduling approach, which led to the over-pumping of water resources. The CISNR technical team played a pivotal role in facilitating improvements within the system. In response to this challenge, they enforced a systematic pump scheduling to safeguard water resources. This approach effectively limited pumping durations, reducing the likelihood of over-pumping and ensured sustainable water usage within the district.

WSSCA Abbottabad District, 2022

During the same year, Abbottabad District faced a unique challenge in its water supply system related to motor pump capacities and recognized the need for guidelines to assist in selecting suitable motor pump capacities for its water supply. The CISNR technical team played a crucial role in facilitating these improvements. To address this challenge, comprehensive guidelines were developed for selecting motor pump capacities. Additionally, strict adherence to recommended motor specifications was enforced, optimizing the performance of the water supply system within the district.

WASA Lahore, 2023

The implementation of Water SCADA devices in WASA Lahore faced challenges such as integrating diverse infrastructure, addressing data migration issues, providing adequate personnel training, and mitigating flow turbulence in certain areas. Despite these challenges, the benefits following the installation of portable ultrasonic flow meters were substantial. However, after the installation of Water Scada it was observed that the new technology significantly enhanced the accuracy and reliability of wastewater flow measurements, reducing maintenance requirements through the elimination of moving components. The advanced data logging capabilities streamlined monitoring efforts, enabling real-time analysis and more informed decision-making. Additionally, the flexibility of ultrasonic flow meters allowed for easier installation in various conditions, contributing to improved water resource management in the WASA Lahore wastewater network.

TMA Mansehra, 2022

During the same year, TMA Mansehra District faced several interconnected challenges within its water supply system. These included uneven water distribution, incidents of water theft, and inefficient pumping practices, which resulted in potential water wastage. The CISNR technical team played a pivotal role in facilitating these improvements. To address these challenges, solutions were put in place. An equitable water distribution plan was established using flow control devices and pressure valves to ensure fair access to all areas. Moreover, security was enhanced with tamper-proof meters, inspections, and penalties to deter unauthorized connections and water theft. The optimization of pumping schedules also led to an efficient use of water resources in the district.

CDA Islamabad, 2022

In the same year, CDA Islamabad confronted a multifaceted set of challenges within its water supply system. These challenges included irregular pump scheduling, over pumping, and safety issues within its electrical systems. The. Solutions involved optimizing pump scheduling, developing motor pump capacity guidelines, and implementing safety measures for electrical systems. These solutions collectively enhanced the performance and safety of the water supply system within CDA Islamabad.

In each of these municipalities, the CISNR technical team played a crucial role in facilitating improvements, ensuring that past challenges were met with targeted solutions that significantly improved the efficiency and effectiveness of their respective systems. These solutions have collectively contributed to the optimization of water supply, wastewater management, and other vital aspects within the municipalities.

12.Recommendations and Upscaling

The installation reports provided essential insights into the challenges faced and the benefits reaped from these systems at various locations. The installation of SCADA systems in various contexts, as outlined in the reports, presented both opportunities and challenges for improving operational efficiency and ensuring the safety of equipment and personnel. To successfully upscale the implementation of SCADA systems, several key recommendations emerged. These recommendations encompassed the need for proper protective equipment for motors, ensuring secure earthing for device operation, and addressing issues related to improper cabling and jointing. Furthermore, attention to safety concerns such as dust, open wiring, and water leakages in installation sites was imperative to prevent equipment damage and potential accidents. Moreover, it was essential to monitor and assess electrical parameters continuously to maintain motor efficiency and prevent losses. Additionally, incorporating real-time monitoring, accurate billing systems, and compliance with regulations was crucial to achieving the full benefits of SCADA installations, while also aiding in detecting and preventing power theft. Overall, successful upscaling of SCADA system installations required meticulous attention to safety, equipment maintenance, and effective data monitoring for optimal performance and benefits.

a. Way forward

In conclusion, this case study has highlighted the transformative potential of SCADA technology in water supply management. By implementing SCADA systems, we have witnessed substantial improvements in operational efficiency, real-time monitoring, and data-driven decision-making. The seamless integration of SCADA technology not only enhances the overall performance of water supply systems but also addresses critical challenges, such as leak detection, pressure management, and system reliability.

Furthermore, our policy recommendations, emphasizing structured pumping schedules, motor pump capacity guidelines, Variable Frequency Drives (VFDs), flow meter upgrades, and the use of portable power loggers, provide a comprehensive roadmap for sustainable and efficient water supply management. Routine system audits and operator training programs ensure the continued success of these improvements.

The partnership with CISNR, an industry leader with a track record of excellence in SCADA system installation, is a testament to the commitment to innovation and technology. By collaborating with CISNR, water supply systems can not only implement these recommendations effectively but also achieve long-term sustainability and reliability.

b. Sailing into the future: A blueprint for progress

As we move forward, we encourage stakeholders and decision-makers to embrace these insights and take proactive steps to enhance their water supply systems. By doing so, we can ensure access to clean and reliable water while reducing operational costs and minimizing environmental impact. This case study demonstrates that with the right technology, policies, and partnerships, we can create a brighter and more sustainable future for water supply management in Pakistan.