City of Phoenix Final Report

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Problem Statement

The City of Phoenix municipal operations are trying to reduce their total energy consumption. However, with the city population steadily growing over the last decade, reduction is difficult to do; therefore, it needs energy metrics that can indicate efficiency and intensity (City of Phoenix, 2021). To develop these new metrics, it is essential to identify the necessary data points and provide a compelling rationale for their introduction. These metrics, which will demonstrate efficiency and intensity, are crucial for the city's ongoing sustainability efforts.

Targeting the Gap

Phoenix has made investments in on-site solar energy generation systems, LED lighting projects to reduce consumption, and replacing HVAC units utilizing R-22 refrigerants with new more efficient units (City of Phoenix, 2021). These investments will help the City in its sustainability efforts, but it is still being determined if it believes it will reach its intermediate energy reduction milestones with its current investments. If the population remained constant, it would be easier to forecast if their goals would be obtainable with current investments. However, the variability and the increasing population trend make forecasting even more difficult. Applicable measurements for city-wide sustainability goals are required to establish progress and create actionable steps to improve. In the case of energy reduction, proper energy metrics in efficiency and intensity can enable the City of Phoenix to take strides in the right direction.

Key Concepts

“Intensity” is the amount of energy to produce a unit of output (U.S. Department of Energy, n.d.). “Efficiency” is when services are provided with a reduced amount of input or when services are improved for a given amount of energy input (U.S. Department of Energy, n.d.).

Metrics allow us to track and measure performance (Energy Star, 2024). For facility operations, key performance indicators such as energy use and costs, water use and costs, waste and materials, and greenhouse gas emissions are commonly used to create metrics (Energy Star, 2024).

Benchmarking is a practice of comparing measured performance of a facility to itself or others, with a goal of learning and influencing performance improvement (Seattle, n.d.a). Energy benchmarking will help owners understand inefficiencies and opportunities to reduce energy waste, emissions, and lead to energy savings (Seattle, n.d.a). The ability to compare to others and the transparency benchmarking creates can help spark motivation for action (Seattle, n.d.a).

City Metrics

If the City's population were to remain constant, total energy consumption would reflect efficiency investments. However, the City's population is an independent variable, and energy consumption is a dependent variable. As the City's population grows, municipal energy consumption may need to increase to support the city residents served. Implementing per capita energy metrics will help reflect intensity and efficiency investments. Per capita metrics are already being used and reflecting efficiencies for the City. In the City's 2021 Climate Action Plan, GHG emissions per capita are being reported and showing a reduction from 2012 to 2018 (City of Phoenix, 2021). Also the City's Water Services Department reports per capita usage metrics and has seen a decrease over the last 30 years (City of Phoenix, 2024f). Reporting per capita energy metrics in terms of usage and cost, is something that can be done now with current available data.

For example, in 2020, municipal operations consumed 598,395,569 kWh while supporting a population of 1,612,337 people (City of Phoenix, 2021; City of Phoenix, 2024a).

Therefore, the City consumed 371 kWh per city resident (served) on average that year. This metric can be used to benchmark itself far back and into the future if these two corresponding data points are known.

This metric will not only help the City benchmark itself, but it will also help benchmark it against other cities. In 2020, the City of Houston, the fourth largest city in the U.S., consumed 1,117,754,342 kWh, while supporting a population of 2,304,580 people (City of Houston, 2022; EPA, 2024). Therefore, the City of Houston consumed 485 kWh per city resident (served) on average that year.

In addition to energy consumption per capita, the City can start tracking its energy costs per city resident (served). For example, in 2020, municipal operations spent $60,192,179 while supporting a population of 1,612,337 people (C. Aguiar, email, June 13, 2024; City of Phoenix, 2024a). Therefore, the City spent $37 per city resident (served) on average that year. As the City continues to implement on-site solar generation and reduce their electric utility providers dependence, this metric will reflect cost efficiency.

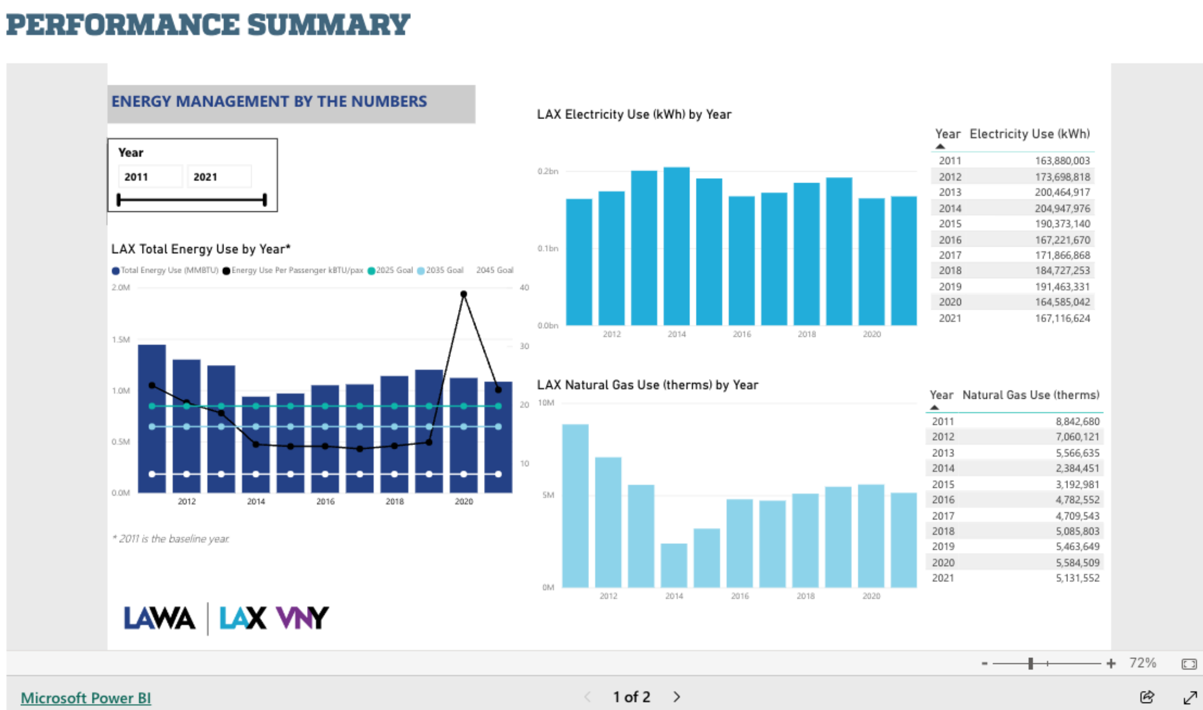
Furthermore, at the city level; tracking, reporting and focusing on renewable energy percentage of total electricity usage as a metric can have the greatest impact on the City's sustainability. This metric most closely aligns with the City's Climate Action Plan of being carbon neutral by 2050. (City of Phoenix, 2024c). With renewable energy sources emitting little to no GHG, transitioning to 100% RE supports the 2050 carbon neutral goal (United Nations, n.d.). In addition to benchmarking itself, the City will be able to compare their progress to other cities through the EPA's Green Power Partnership (EPA, 2024). Green Energy Partners provide their percentage of renewable energy usage and description of their energy approach (EPA, 2024). This can also be a resource for idea creation and power purchase agreement opportunities (EPA, 2024).

In addition to reducing environmental impact, renewable energy consumption will likely support a healthier and happier city. Non-renewable energy usage contributes to air pollution that impacts people's health (United Nations, n.d.). In 2023, The American Lung Association ranked Phoenix as the fifth worst ozone air quality in the nation over a three-year span (American Lung Association, n.d.). Also, the Institute for Quality of Life uses five themes in its ranking to create its Happy City Index, Environment is one of these themes (Happy City Index, n.d.). The Environment theme evaluates renewable energy usage and by-products of electricity consumption such as emissions and air quality (Happy City Index, n.d.). Reducing non-renewable energy usage will likely contribute to happier residents.

Operational Metrics

The City of Phoenix has over 50 departments that manage and maintain their day-to-day operations (City of Phoenix, 2024g). These include areas like aviation, water services, and convention, to name a few. Each department focuses on goals to help the City maintain and improve the services provided to its constituents. The goals are aligned with the Climate Action Plan and the need to reduce energy consumption.

The City of Phoenix has a total of three airports: Phoenix Sky Harbor (PHX), Goodyear Airport (GYR), and Deer Valley Airport (DVT). GYR and DVT are sizable airports that typically see use from general aviation, air carriers, and military (Deer Valley Airport, 2023; Goodyear Airport, 2023). PHX is a much larger airport with several buildings and hangars and primarily facilitates commercial airline flights. In 2023, the airport had 48.6 million passengers (Phoenix Sky Harbor International Airport, 2024). In the same year, it was ranked the 14th most visited airport in the U.S., out-pacing LaGuardia, Houston, and Boston airports (Port Authority NY NJ, 2023). The number of passengers is expected to increase throughout the remainder of 2024. Based on the table below, Deer and Goodyear airports have seen small changes in electricity usage while Sky Harbor's usage has steadily increased since 2020. The 2021 electricity use at Sky Harbor is comparable to the use at LAX, only being about 29 million difference in energy use despite LAX being ranked 10 places higher in passenger traffic (*Energy management,* 2021).



Energy management, 2021

Utility Airport Electricity Usage

Site Name	2019	202	2021	2022	2023	UoM
PHX Sky Harbor	136,060,635	130,713,499	138,251,776	146,419,756	160,525,755	kWh
Deer Valley	1,804,633	1,756,346	1,776,749	1,649,975	1,394,601	kWh
Goodyear	1,687,127	1,644,243	1,472,395	1,420,393	1,55,774	kWh

Nathan Svenson. Personal Communication. June 27, 2024.

The increased use of each of these airports highlights how important it is to properly define energy intensity to reduce consumption by 2030. The energy intensity varies throughout each airport building. Many of them need more information that could be helpful in the calculation, such as building area (*Energy Consumption*, 2020). Having the number of passengers in the other smaller airports could aid in determining the total passenger count for the whole Aviation Department and lead to better energy intensity metrics.

The Convention Department helps to manage several event buildings within the city limits. A recent study has shown the actual value of the convention center, which led to a three-phase expansion plan (City of Phoenix, 2022). Two out of three phases were completed and awarded for their sustainable construction process (City of Phoenix, 2024h). However, more data is still needed to properly assess the whole department's energy intensity. The north, west, and south buildings have clear metrics, while the others have little information (*Energy Consumption*, 2020). This lack of information could be due to the database's limitations on which building types to apply the metrics.

The City of Phoenix has distributed clean water to customers across industries and homes for over 115 years (City of Phoenix, 2024i). This department has focused on conservation and responsible water use as well as planning for the water needs of the city accordingly (Phoenix, 2024i). Each month, the Water Services Department produces and treats hundreds of millions of gallons (*Water - Total Produced, 2020*). Due to the nature of the data set, the water services department currently does not have an energy intensity measurement (*Energy Consumption*, 2020). However, electricity and natural gas usage are reported. This available information could inform a new metric to assess better the energy intensity of the water used for the city and its constituents.

Other Metrics for Energy Reduction

As with many large cities, Phoenix is at the forefront of the transition to renewable energy, seeking ways to limit its use of fossil fuels while developing innovative strategies to reduce, measure, and evaluate its energy consumption. Despite the challenges posed by the city's expanding infrastructure and rising population (Makropoulus, 2023), Phoenix is determined to expand its clean energy usage and explore more reliable techniques and metrics surrounding its renewable and non-renewable sources. Our ongoing research on energy consumption in the Phoenix area is a testament to this commitment, as we evaluate various forms of data and trends to gain a comprehensive understanding of the region's energy usage and its differing sources of generation.

Currently, fossil fuels are the leading electricity provider for the City of Phoenix, with a 54% share of the grid generation (Energy Information Administration, n.d.). However, the City is determined to create sustainable initiatives that will not only reduce energy consumption but also limit their reliance on natural gas and coal electrification (Carlos Aguiar, interview, 2024). To achieve this goal, the Phoenix energy team is striving to integrate the best metrics for measuring the area's energy consumption (Carlos Aguiar, interview, 2024), demonstrating their commitment to a greener future.

Phoenix can utilize various feasible metrics to understand the city's energy usage better. Some metrics may be better suited for various types of infrastructure. By monitoring large energy consumers such as airports, stadiums, and other substantial building complexes, they may find that using consumption per square foot or meter could provide the most efficient outcome (Energystar, 2024). For example, the attendance of a sporting event at Chase Field would not create a dramatic shift in energy consumption; therefore, calculating the usage per square meter could provide the city with accurate calculations.

Once the energy metrics and calculations have been established, energy reduction targets can be implemented and measured to evaluate progress. Copenhagen Airport recently developed strategies to reduce energy consumption by 17% (Rasmussen, 2021) by implementing metrics to analyze the consumption per square meter, replacing outdated equipment, and frequently analyzing multiple data points through a KMD Energy Management Suite (Rasmussen, 2021). Phoenix could develop a similar strategy to help diagnose and reduce energy needs at extensive facilities like the convention center, airport, and wastewater treatment plant.

Solutions Analysis

At the city level, we evaluated implementing per capita metrics. The City is currently using per capita metrics with GHG emissions and water consumption, both of these metrics have helped indicate efficiency improvements (City of Phoenix, 2021; City of Phoenix, 2024). We reviewed energy usage and energy costs per city resident. These metrics are feasible with current available data and will also help indicate efficiency and intensity. Additionally, we assessed tracking the City's percentage of renewable energy consumption. This metric ranked more strategic than the per capita metrics because it also can be an environmental impact indicator (EPA, 2024).

The City of Phoenix operations focus on each department's energy intensity, efficiency, and possible metrics to help reach the City's upcoming sustainability goals. The energy of sustainable efforts of each department is essential; however, highlighting larger departments like aviation and convention can offer insight into smaller departments. The aviation department is proposed to rely on building size and passenger count provided through airport reporting statistics and city-provided information. This metric is feasible as it allows for a reliable source for determining energy intensity. A deeper focus is taken on the convention and water departments. The convention center metrics will rely on guest count and revenue. The water departments will feature a metric used city-wide, per capita. Each of these has a high feasibility.

Determining load, or the combined draw on electricity at any given meter can allow us to manage the timing of sizable electric equipment such as air conditioning units, allowing for more control. Six units simultaneously turning on is more expensive than staggering their use to cool a space. Smart meters can help break down the total draw and the source of the drawdown and provide better analytics. Thermostats that satisfy the psychological need for a person to be in control of their working environment and control the intensity of energy needed by controlling the speed of how a space is cooled (or heated) provide a revenue-preserving approach to reducing electricity costs.

Finally, with these different metrics employed, the City of Phoenix can empower the community by involving them in adding their metrics. This inclusive approach, where the community can compare its energy use and make informed decisions, may alert them to the need for adding solar energy, expose them to the barriers to installation, and ultimately provide an avenue through supported legislation to make solar power sources a necessity in city buildings.

City of Phoenix Energy Metrics Project

✓ Favorable
? Unknown (until initiated)
NA Not Applicable

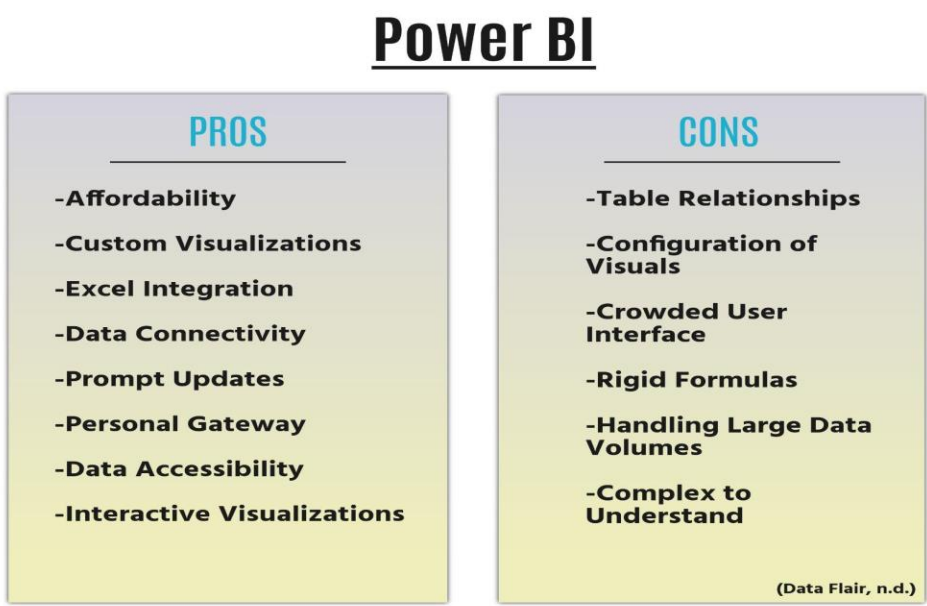
Strategic Options		Efficiency Indicator	Intensity Indicator	Social	Implementation	Environmental	Feasibility	ROI	Rank
City Metrics	kWh/ Resident	✓	✓	?	✓	?	✓	✓	2A
	kWh Cost/ Resident	✓	✓	?	✓	?	✓	✓	2B
	% RE Consumption	✓	✓	?	✓	✓	✓	✓	1
Operational Metrics	kWh/ Resident (Water)	✓	✓	✓	✓	?	✓	?	NA
	kWh/ Passenger (Aviation)	✓	✓	?	✓	✓	✓	?	NA
	kWh/Guest (Convention)	✓	✓	?	✓	?	✓	?	NA
Energy Management	SCADA/IoT	✓	✓	NA	✓	✓	✓	✓	1
	Power BI	✓	✓	NA	✓	✓	✓	?	2
	Other Energy Mgmt. Software	✓	✓	NA	✓	✓	?	?	3
Community Engagement	Data Collection	✓	✓	✓	✓	?	✓	✓	1
	Marketing Strategy	✓	?	✓	✓	?	✓	✓	2B
	Total Community Solar	✓	✓	✓	?	?	✓	✓	2A

Energy Management Platform

As we continue to research the energy metrics surrounding the City of Phoenix, we have also had the opportunity to explore innovative ways to collect and measure this information. Managing massive amounts of data requires innovative technology to limit delays and unexpected shutdowns while maximizing and improving efficiency (Chen et al. ,2014). Supervisory Control and Data Acquisition, or SCADA, can provide reliable continuous energy consumption monitoring (Prescinto, 2023). Phoenix can conduct feasibility studies, encourage stakeholder engagement, and develop a pilot program before full-scale implementation (A. DeRobbio, interview, 6/20/2024). The City could also enhance its energy management strategies through the utilization of Power BI. Power BI, with its ability to connect to data sources and create visualizations for their desired metrics, is a powerful tool that can further boost its energy efficiency metrics (Softweb Solutions, n.d.). In addition to SCADA and Power BI, alternative energy management software methods could be explored to help customize the best option to meet the city's needs.

Power BI

Like SCADA, Power BI can transform information into customized visualizations that enable the City to easily access and review various data sets related to energy management and water consumption (Microsoft, 2024). Although Power BI can connect to and analyze data, it is not designed for data capture. Combining this tool with cloud-based platforms could also provide the capabilities to analyze and report data for the City of Phoenix. Power ON, created by Insight Software, integrates with Power BI to enhance its capabilities, allowing for efficient real-time data analysis, extensive formatting and reporting options, Key Performance Indicator (KPI) measurements, and forecasting processes (Insight Software, n.d.).

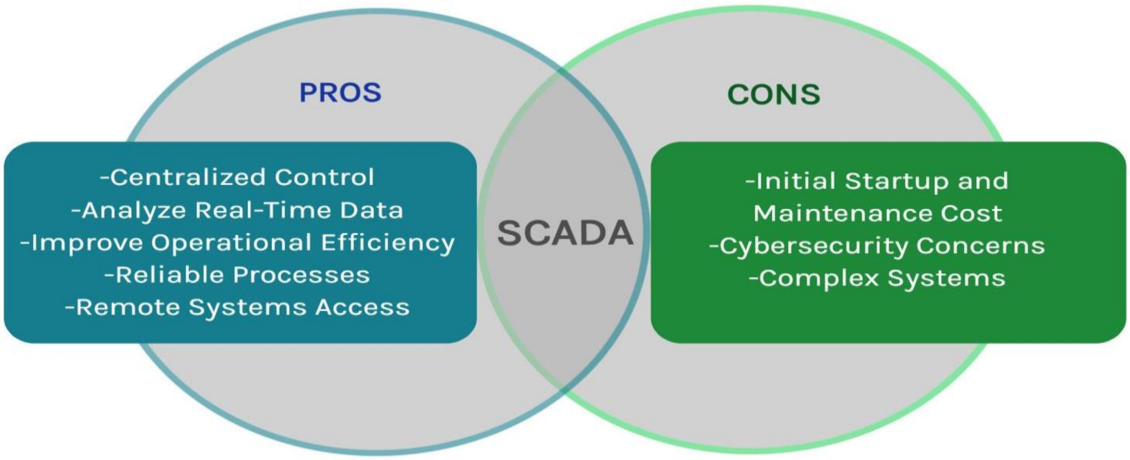


SCADA Systems

As industrial automation continues to expand, the ability to monitor and control these processes must also continue to evolve. Through the use of SCADA systems, Phoenix can monitor its power generations, as well as its wastewater treatment facilities, giving them the capabilities of integrating reduction strategies and mitigating possible risks (Ragno, 2023).

As stated by Maggie Ragno, there are six main functions of the SCADA systems:

1. Data Acquisition- The SCADA system's integration can collect and analyze massive amounts of data through a vast array of smart meters, sensors, and other technological infrastructure, allowing for simplified real-time monitoring at the Human Machine Interface (HMI) (Cubizolles, 2020)
2. Transmit Data- Programmable Logic Controllers (PLCs) can convert the data into readable information such as kWh and gallons.
3. Process Data- SCADA can also interpret the data to create figures, tables, graphs, and other visualizations for review.
4. Controlling/Monitoring- Phoenix can view real-time data through a Human Machine Interface (HMI) touchscreen. Deviations or data gaps trigger alarms, allowing for proper troubleshooting and adjustments.
5. Feedback Loop- This application allows data acquisition to respond to any sudden changes in the system.
6. Historical Data—This allows Phoenix to pull previously recorded data, simplifying the process of analyzing specific trends, reviewing benchmarking performance, and troubleshooting capabilities (Ragno, 2023).



(Electricalvoice, 2022)

SCADA and the Internet of Things (IoT)

In order to maximize the potential of SCADA systems, Phoenix could integrate the Internet of Things (IoT), which is capable of monitoring and analyzing enormous amounts of data before sending the relevant information to the cloud (Jain, 2024). The IoT could then use this data to generate visualizations and a variety of recommendations for energy efficiency (Jain, 2024). These recommendations could include the installation of smart thermostats, Energy Star appliances, and various other energy reduction opportunities (Arizona Technology Council, n.d.). SOAR Energy, an Arizona-based automation company, is implementing IoT software to provide residents with reports to evaluate potential savings (Arizona Technology Council, n.d.).

Although SOAR Energy's application focuses on residential properties, IoT software can also benefit commercial buildings and renewable operations. SCADA and IoT EMS were developed to provide more efficient and reliable operations. However, they ultimately serve different functions while synchronously managing the collected data. IoT enables the stakeholders to view SCADA's information through the HMI touchscreen or remotely through another device, all while being stored in the historical database in the cloud (Cubizolles, 2020). HVAC, water management, temperature monitoring, and smart meters/smart lighting can be synced to the software, ensuring the information is easily translated for the end user (Dusun, 2023). Also, unlike SCADA equipment, IoT software and remote monitoring capabilities are affordable for data collection and analysis (Archer, 2021).

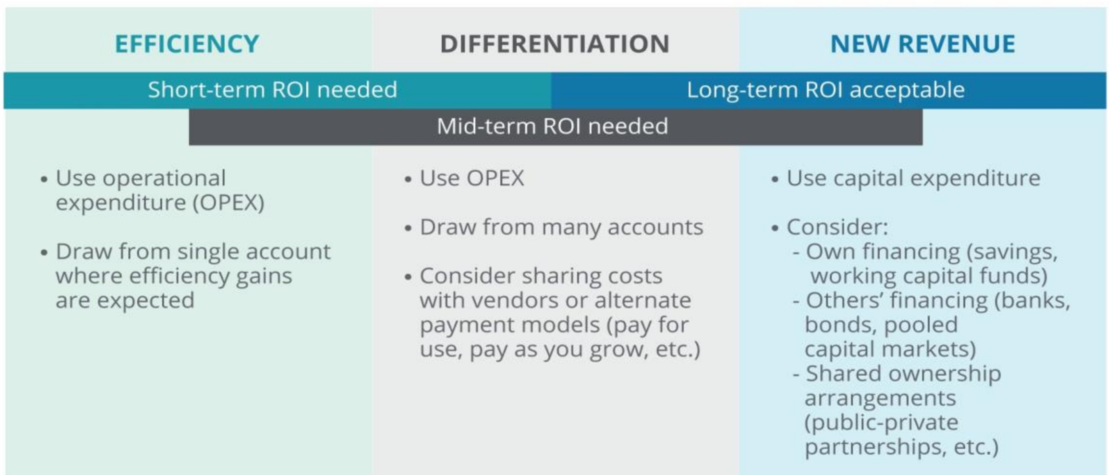
SCADA and IoT have been widely used to create more efficient energy systems around the world, including:

- Santa Margarita, California- The Topaz Solar Farm has been using SCADA and IoT systems to identify maintenance needs, minimize downtime, predict panel adjustments, and optimize its energy production. The 550 Megawatt operation has had continued success with an average annual overperformance of 7% (Fitch Ratings, 2024).
- Rajasthan, India- Currently the largest solar project in the world, the Adani Group has integrated IoT EMS into its operations to help produce roughly 1.2 million Mwh annually (Smart Cities Council, 2017). IoT and ABB's Symphony Plus SCADA software are considered to be the digital backbone of its supported facility (Smart Cities Council, 2017).
- San Diego, California- Due to the significant amount of data needed to track energy consumption at Petco Park, the stadium has turned to Edge Gateways and IoT to help develop strategies to reduce water and utility consumption. This software has

contributed to the city's ability to reduce operational costs by roughly 25% (Engineering.com, 2016).

FIGURE 7

A framework for structuring IoT funding options (Krimmel et al., 2019)



Source: Deloitte analysis.

Deloitte Insights | deloitte.com/insights

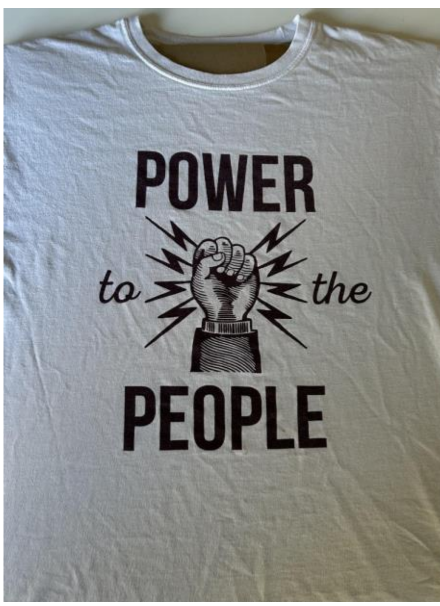
Alternative Systems

Building Management System (BMS)—The BMS is an innovative platform that could offer real-time data for the City of Phoenix. Much like SCADA and other energy systems, BMS uses sensors and various other sources to relay information back to a central location that can monitor lights, HVAC, and various other operations (Rao, 2024).

Automation Systems (AS)—This system is designed to minimize human interaction and increase productivity. The City of Phoenix could use AS to help offset peak demands. Unlike delay past systems that used periodic information transmission, AS can transmit this data without delay (Eaton, n.d.).

Community Engagement

“Citizens should be partners, not just service recipients” (*Creating Sustainable Citizen Engagement: Involve City Residents in Solving Problems*, 2019). The City of Phoenix has the opportunity to combine forces with Arizona State University School of Sustainability to create this program where sharing the opportunity with city residents to include their homes' distinct metrics with the City of Phoenix in the form of energy efficiency calculations and Home Smart ratings is a step in the direction towards forming this inclusive relationship. A program whereby residents can earn points or recognition through the receipt of graphic shirts, bumper stickers, or home certification decals announcing their successful participation. This would involve networking with the university, employing a budget for the graphics design department in the City of Phoenix, and engaging the community through local news networks.



The initial goal for success will be to include a majority of homeowners in the program. Arizona is the sunniest state in the country (Glover, 2024). The unintended success may be resident support for the City of Phoenix to install solar panels on all of its properties, including rooftops, and create parking structure paneling despite the restrictions placed by APS or SRP, the two leading energy providers in the City of Phoenix. Residents have the power to support legislation that could more quickly produce results in efficiency measures by requiring the submission of data from all structures of a minimal size in the required areas.

This long-term strategy could awaken the community and recruit their support for legislation to push businesses and residents towards a more sustainable future within the Valley of the Sun. Other local governments may join the effort by adopting the same strategy and improving sustainability throughout the large metropolitan area. ASU already has graphics from an undergraduate program that can be shared, lowering the initial expense from the design department for a t-shirt. The above photos are taken from a t-shirt from a program initiated by the undergraduate student government at ASU. Borrowing this design, coordinating efforts, and including the public interest in energy efficiency has the potential to produce a popular movement.

Final Recommendations

Energy usage and cost per capita metrics should be implemented in the short term to help support the city's tracking and reporting efforts. Utilize data from previous years to create a historical baseline and keep tracking going forward. Additionally prioritize the tracking of the percentage of renewable energy consumption. This metric connects to the City's Climate Action Plan's 2050 carbon-neutral goal. To support the City's metrics and data collection, acquire the ability to utilize Power Bi. Power Bi can help connect EnergyCap and internal department data sources to assist metric reporting. Furthermore, It is essential to have easy access to the needed energy information to enable a smooth implementation of each of these recommendations. While sharing the data management system does help, the lack of accessible and efficient communication avenues might hinder progress. Creating a consistent, reliable group within the city's departments to discuss energy metrics is needed. This group would allow for the flow of conversation and innovation about the City of Phoenix's energy consumption to thrive.

In the mid-term, interpreting and analyzing data is critical for the City of Phoenix's ability to implement these metrics. Energy consumption and efficiency, peak demand, various energy sources (renewable/non-renewable), and environmental impact are all measurements that should be considered when integrating new systems. Incorporating the best possible energy management system can ensure the city continuously monitors and improves its energy reduction strategies. IoT and SCADA systems can help Phoenix eliminate the high cost of manual monitoring while providing consistent, efficient, and reliable data to the city.

The ultimate goal of installing solar throughout the community is to engage with the community to begin an interconnected relationship, improved data collection throughout the City, and the potential for City-wide support of removing the barriers to installation on City properties. Incorporating this solar strategy can include mapping Phoenix's infrastructure and listing the potential surface area totals to generate the total solar potential of municipal properties. This can create an opportunity cost metric and ROI profile for all municipal locations.

On a long-term basis, the City of Phoenix can explore other potential opportunities to integrate into its energy program. The neighboring City of Mesa operates its own electric utility group. Mesa can be a case study to better understand these independent municipal operations and overcome regulation restrictions to advance their energy needs. Also, the City can survey the potential of forming an energy cooperative. An energy cooperative will reduce dependence on utility companies and increase renewable energy usage.

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Appendix A

Setting Up a SCADA System for Energy Management

1. **Parameters to Measure:**
    - **Energy Consumption:** Total and per capita.
    - **Energy Efficiency:** Usage per square meter.
    - **Peak Demand:** Times of highest energy use.
    - **Source of Energy:** Renewable vs. non-renewable.
    - **Environmental Impact:** Emissions related to energy consumption.
2. **Proposed Data Collection Method:**
    - **Smart Meters:** Installed in homes, businesses, and public buildings to provide real-time data.
    - **Sensors:** Placed at various points in the city's infrastructure (e.g., power substations, grid points).
    - **IoT Devices:** Can supplement data collection with environmental data (e.g., temperature, humidity).
3. **System Integration:**
    - **Communication Protocols:** Ensure compatibility between different devices and the SCADA system (e.g., Modbus, Ethernet IP, etc.)
        - The data architecture will be critical to ensure reliability and uptime.
    - **Data Aggregation:** Centralized system to collect and process data from all sources.
        - This needs to include redundant data centers.
        - These have a major draw; I would look to construct these with some type of renewable energy or a blend with utility. Biggest draw is cooling and server power.
4. **Data Analysis and Visualization:**
    - **Dashboards:** Visualize data for easy interpretation (e.g., energy consumption trends, peak usage times).
    - **Analytics:** Use machine learning algorithms to predict trends and provide recommendations. This can include AI.
    - **Reporting:** Automated reports to inform city officials and stakeholders.
5. **Recommendations for Reductions:**
    - **Usage Patterns:** Identify inefficient usage patterns and suggest optimizations.
    - **Technology Upgrades:** Recommend upgrades to more energy-efficient appliances and systems based on system usage.

- E.g., if certain homes in a certain area are consuming more energy it could be due to year built and the need to install insulation, update HVAC systems, appliances, etc.
  - You could offer incentive programs for people

· **Behavioral Changes:** Encourage energy-saving behaviors among residents.

- Offer free Smart thermostats that can automatically recognize when folks are home, asleep, etc. and regulate temperature based on actual needs.
  - This could provide a significant cost reduction as HVAC is typically the largest draw in any home.

6. **Security and Compliance:**

· **Cybersecurity:** Implementing a robust security measure to protect the system from cyber threats will be critical since this is a public utility.

· **Regulatory Compliance:** Ensure the system complies with energy regulations.

- **Federal Energy Regulatory Commission (FERC):**
  - Regulates interstate transmission of electricity, natural gas, and oil.
  - Ensures reliable and efficient energy supply.
- **Department of Energy (DOE):**
  - Oversees energy production, distribution, and development of energy technology.
  - Implements policies related to energy efficiency and renewable energy.
- **Environmental Protection Agency (EPA):**
  - Regulates environmental aspects of utility operations, such as emissions and water quality.
  - Enforces regulations to protect public health and the environment.
- **State Public Utility Commissions (PUCs):**
  - Regulate utilities within individual states.
  - Oversee rates, services, and ensure reliable utility provision.
- **Local Municipalities:**
  - May own and operate public utilities.
  - Manage local water, sewage, and sometimes electricity services.

7. **Implementation Steps**
   - **Feasibility Study:** Assess the specific needs and capabilities of a city.
   - **Stakeholder Engagement:** Involve all relevant parties, including city officials, utility companies, and residents.
   - **Pilot Project:** Start with a smaller area to test the system before a full-scale rollout.This could include a specific city or target a certain borough of a city.
   - **Full Deployment:** Scale the system city-wide based on pilot results.
   - **Continuous Monitoring and Improvement:** Regularly review system performance and make necessary adjustments.

(Information received from A. DeRobbio, WM Corporate Automation Engineer IV, 2024)