CITY OF BELLEVUE WASHINGTON

Planning for a Smarter City

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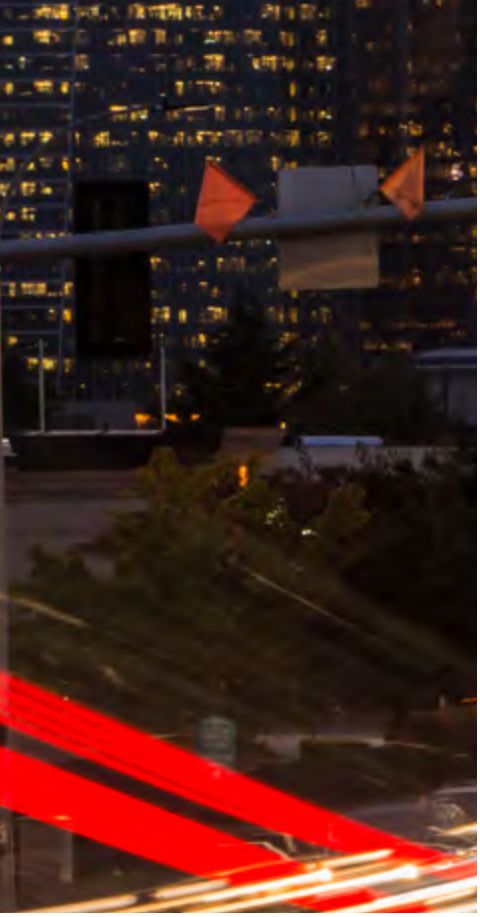
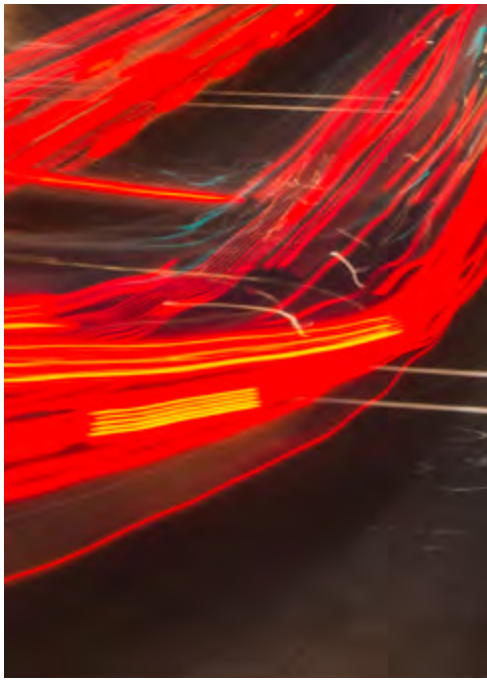




Executive Summary

BELLEVUE

SMART

Executive Summary

Cities, nationally and globally, are embarking on smart city efforts to harness the benefits of rapidly emerging technologies to improve quality of life, increase operational efficiency, enhance economic vitality and improve sustainability. Bellevue particularly benefits from its high tech economy with companies advancing many of these capabilities, residents who take advantage of new technology and a talented workforce that expects its city to effectively benefit from technology. A smart city leverages advances in sensors, devices controllers and instruments that are connected to the internet and to other systems – essentially the Internet of Things (IoT) technologies – to produce data that can be analyzed to inform decisions, improve services and optimize operations. Advances in analytics and machine learning will support the city in moving from reactive to proactive and eventually to predictive operations.

Bellevue Smart: Planning for a Smarter City covers smart city strategies and implementation actions to achieve improved livability, sustainability and resiliency in a world that is increasingly digital, mobile, connected and urban. A smart city effort can foster increased innovation, citizen involvement and collaboration with public, private and academic partners in the city and regionally. Further, it contributes to achieving the City Council **Vision** for the community:

> Bellevue is a "smart city" with a clean, high-quality environment and excellent and reliable infrastructure that supports our vibrant and growing city, including high-tech connectivity. The city has a connected multi-modal transportation system, which blends seamlessly with its buildings, plazas and parks.

As Bellevue becomes a recognized leader in developing and implementing innovative smart city developments, this effort will support the city's economic development strategies of attracting and retaining technology companies and world-class talent to benefit businesses and residents. Smart technology enhances critical services provided by the city, from traffic management, to water delivery and emergency response to much more. Creating the smart technology portfolio requires more than a single budget cycle to achieve the anticipated benefits. This smart city plan takes a phased, iterative approach to allow the careful planning of major investments, while building in the flexibility to take advantage of opportunities that arise or to adjust tactics because of rapid technology changes.

DESIRED OUTCOMES

Desired Outcomes describe the end results of a smart city effort and the benefits to the community. The plan includes specific details on how to achieve these outcomes, including measurable indicators:

- **Livability:** Smart technologies improve the safety, health, convenience and quality of life for the community, while increasing our economic competitiveness.
- **Sustainability:** The city delivers excellent, long-term services by reducing waste, increasing efficiencies and protecting the environment.
- **Resiliency:** The city is able to respond more effectively to emergencies and recover faster from disruptive events.

ELEMENTS

Recognizing that smart technologies potentially impact every aspect of city services to promote a high quality of life and economic vitality for Bellevue, this smart city plan matches the **Community** and **Council Vision** with existing city services and focuses the smart city effort on the following six elements. Each element includes its own set of objectives, strategies and indicators which, over time, will overlap to form a smarter Bellevue.

Where it makes sense strategically and economically, these elements will be integrated to achieve the desired outcomes. For example, transportation and public safety currently rely on interconnected systems to give emergency vehicles signal preemption, with more sophisticated and seamless integration to come. Data integration can also tie various elements together, such as linking water, buildings and energy-use data to enhance conservation efforts.

CONNECTIVITY

Increasing communication network speed, capacity and availability

Improve consumer services and communications infrastructure, through an emphasis on increasing high-speed communications:

- Expand Wi-Fi to reduce digital divide
- Grow fiber-optic network
- Increase high-speed broadband availability
- Integrate smart city networks to increase efficiencies and monitor emerging capabilities
- Provide improved citizen-information access

TRANSPORTATION

Moving people smarter, safer and faster, while providing more choices, better real-time information, lowering emissions and raising efficiencies

Improve ways for people to move around the city:

- Enhance adaptive traffic signal operations
- Improve traveler information
- Integrate multi-modal travel options to improve mobility
- Advance Vision Zero to provide safer mobility for vehicles, pedestrians and bike riders

PUBLIC SAFETY

Reducing response time, increasing survival rate, reducing crime rate, increasing emergency capabilities

Further integrate infrastructure, services, agencies, and personnel that cities call on to keep people safe:

- Improve 911 services
- Enhance communications networks for greater interoperability and backup
- Increase incident situational awareness for effective response
- Enhance data-driven policing practices
- Improve hazmat awareness and mitigation

WATER

Delivering high-quality and reliable water, protecting critical infrastructure, conserving resources

Ensure high-quality delivery of water services to homes and businesses to minimize disruptions and increase customer service:

- Integrated asset management to improve efficiencies
- Smart system operations
- Advanced metering allows frequent readings, leak detection and increases customer awareness of options

BUILDINGS

Optimizing building performance, decreasing wasted energy and water, increasing comfort and safety

Enhance building systems and analytics to improve building systems performance and resource conservation and efficiencies:

- Building energy data benchmarked to influence conservation/ resource savings
- Building water data benchmarked to influence conservation/ resource savings

ENERGY

Improving grid reliability, increasing efficiency, connecting renewables

Improve and integrate energy systems to ensure sufficient, efficient and reliable energy that power all systems our modern digital society requires:

- Implement smart grid system operations for increased reliability
- Energy conservation and efficiency and increase in renewables
- Two-way automated metering increases communication with energy partners like PSE

PRINCIPAL STRATEGIES

The smart city plan is centered on four **Principal Strategies** that apply across all the elements. All elements deploy these common strategies, albeit with appropriate variations.

Focus on proactive and adaptive. A smart city shifts from reactive mode, responding when a problem is reported, to a proactive, even predictive, mode able to anticipate and adapt in real-time to changing conditions. In order to be proactive and adaptive, systems must be integrated and interoperable to achieve the greatest benefits in safety, service and convenience. Systems also need to be designed for high levels of reliability and resiliency because of the low tolerance for disruption and cascading impacts if critical systems do not function properly.

Drive with data. The proliferation of smart devices like controllers, sensors, devices and vehicles connected to the internet, produce enormous amounts of data that enable a smart city to improve operations, services and infrastructure. Embedded machine learning and artificial intelligence can also enhance automation and drive efficiencies of systems and enhance staff productivity. Increasing competency by using data effectively to drive decision making is necessary. Without this increase in competency, the volume and velocity of data streaming from smart systems will overwhelm the city's ability to turn data into meaningful and useful information.

Pursue partnerships. The impact of IoT on city infrastructure systems, community homes and buildings, vehicles on city roads and real-time information expectations is challenging the city's normal, forward-thinking approach to technology adoption. Fortunately, this high-tech region, with an abundance of technology innovators, opens up partnership opportunities to help shape industries,

services and technologies that can keep Bellevue in the forefront of innovation. The city already sustains an entrepreneurial and talented workforce with many innovative startups. This community influences how the city pursues technology to meet service expectations and fulfill the Community Vision. Bellevue has been and will continue to be a testbed for pilot projects.

Leverage regional relationships. Ultimate goals, like clean water and a safe community, require relationships and interactions that extend well beyond Bellevue's boundaries. Crime and congestion does not stop at the city's borders, and regional solutions should be leveraged. Bellevue has a solid history of being a regional collaborator. The city provides services to other cities, like water utilities; receives services from other organizations, such as NORCOM for 911 service; and relies on mutual aid agreements with other agencies in the case of fire services. Systems like roads, water, energy and fiber-optic networks also cross city boundaries. Existing regional organizations, professional associations and projects offer great forums to continue advancing smart city objectives, and many of these share similar interests in building smarter communities.

LONG-RANGE STRATEGY

→ 1. FOCUS ON PROACTIVE AND ADAPTIVE SOLUTIONS (OR SYSTEMS)

Provide proactive and adaptive urban systems that create interoperable systems for the highest levels of performance, optimal customer experience and resiliency from major disruptions.

Connectivity

- Continue expanding fiber-optics network in the city and throughout the region to future-proof infrastructure for smart city networks and increase resiliency.

Transportation

- Leverage the upcoming ITS Master Plan update to define the next set of advanced capabilities – performance monitoring, data and information sharing, smart streetlights, parking management, multi-modal integration – to advance Bellevue's transportation system into proactive mode and ready the system for autonomous and connected vehicles.

Public safety

- Support regional and national efforts to upgrade public safety communications systems with an enhanced radio network and a dedicated public safety wireless network to improve interoperability.
- Monitor grant opportunities for next-generation first responders' technologies.
- Further optimize response times by integrating traffic signal prioritization with emergency vehicles.
- Pilot new air quality monitoring technologies as part of re-planning processes in select areas of the city.
- Monitor developing smart building technology, understanding that the city will need to be able to communicate with a variety of systems and seek opportunities for data standardization.

Water

- Upgrade the Supervisory Control and Data Acquisition (SCADA) system to replace aging technology for greater system-wide reliability while improving data collection and analysis capabilities.
- Implement Advanced Metering Infrastructure (AMI) for improved customer service, real-time usage tracking and proactive leak detection.
- Integrate technology systems – customer information, assets, GIS, etc. – for increased analytics, efficiencies and operational response.

Energy

- Foster opportunities for micro-grid and district energy pilots to enhance energy resiliency.
- Expand electric vehicle charging stations to support clean transportation goals.

→ 2. DRIVE WITH DATA

Turn the enormous volume of data coming from smart city systems into useful information to optimize systems and drive decision making to achieve the desired outcomes of the smart city plan.

Transportation

- Implement enhanced pedestrian and bike operations monitoring and analytics to support multi-national Vision Zero initiative to end traffic fatalities.

Public safety: Police

- Enhance data-driven policing to improve efficacy and increase the community's sense of safety.

Buildings

- Collect data on smart building technology adoption in Bellevue businesses and provide building performance data to the community to influence behavior and decision making.

→ 3. PURSUE PARTNERSHIPS

Foster public-private partnerships that are advantageous to deploying emerging technologies, align with the city's interests, mission and objectives and allow Bellevue to continue being a technology leader and innovator.

Connectivity

- Partner with private sector service providers to continue enhancing and expanding services in Bellevue.
- Expand Wi-Fi amenities to enhance gathering places and expand options for connecting to the internet, especially for low-income students and seniors.
- Establish partnerships with other local jurisdictions and education institutions for enhanced regional data sharing and analysis.

Transportation

- Use public and private partnership pilots to improve the transportation system's reliability, mobility and safety while supporting the development of new technologies. The specific focus will be on connected- and autonomous-vehicles technology, first/last mile travel solutions and data sharing with companies building relevant travel applications.
- Coordinate with Puget Sound Energy (PSE) to pilot and deploy a streetlight management system.
- Leverage existing third-party traveler information providers and app services to share Bellevue traffic data and disseminate more accurate construction and incident information.
- Pursue transportation technology partnerships for ride sharing and electric vehicle charging.

Buildings

- Expand on partnerships with PSE and others to increase smart buildings and energy savings through programs like Urban Smart Bellevue.
- Develop performance-based pilots and policies to grow the stock of advanced green buildings.

Energy

- Continue programs to expand renewable energy and develop policies and targets on fossil-fuel-free energy.
- Continue PSE collaboration on electrical reliability and piloting smart grid technologies in Bellevue.

→ 4. LEVERAGING REGIONAL RELATIONSHIPS

Advance smart city interests through regional relationships and cultivate a shared vision for smarter communities throughout the region.

Connectivity

- Continue seeking opportunities to connect schools, hospitals and government facilities to ensure they have the high speed connectivity to serve our residents effectively well into the future, including increasing resiliency for communications networks that form the foundation for all smart systems
- Expand public Wi-Fi to low-income housing property to expand options for connecting to the internet for low-income students and seniors in partnership with King County Housing Authority and Bellevue School District. Also expand Wi-Fi to select business corridors and parks to enhance amenities at gathering places throughout the community.

Transportation

- Continue leadership on regional transit projects impacting the Eastside to achieve multimodal objectives and first/last mile connectivity.
- Identify emerging technologies that could benefit from partnering with Sound Transit through the ST3 "Innovation and Technology Program" aimed at improving ridership, transit service and regional mobility.

Public safety

- Continue to partner with public safety agencies in the region to improve information accuracy, response times and effectiveness.

PERFORMANCE MEASURES

The city uses performance management to monitor effectiveness and efficiency of city services. The following measures and indicators track progress on accomplishing the objectives within each element. In some instances, measures signify the city's direct impact on objectives, such as traffic collision measures related to safety goals. Other indicators more loosely gauge the city's ability to influence or facilitate more wide-ranging outcomes, such as broadband adoption rate and availability of competition for consumer internet services that can also be shaped by other factors. Measures are continually re-evaluated as new systems bring advancements and additional data that can be used to improve measures.

CONNECTIVITY

- Broadband adoption rate indicating availability of competition for consumer services
- Smartphone ownership rate as indicator of increasing connectivity demand
- Free-access Wi-Fi access points within the community

TRANSPORTATION

- Number of fatal and serious injury collisions to quantify road safety and attainment of Vision Zero goals
- Miles of designated bike paths/lanes, supporting availability of multimodal transportation choices
- Single-occupant vehicle rate reflecting effectiveness of transportation choices

PUBLIC SAFETY

- Patrol response time to life-threatening emergencies
- Violent crimes and property crimes rate as a measure of community safety
- Percentage of fire response time in six minutes or less, from call to arrival
- Cardiac arrest survival rate as an effectiveness measure of emergency medical services

WATER

- Regulatory compliance monitoring drinking water quality
- Unplanned water service interruptions avoided due to leak detection
- Wastewater overflows mitigated due to SCADA warnings

BUILDINGS

- Number of Energy Star-rated buildings in Bellevue as indicator of smart building efficiencies in the community
- Median energy use for municipal buildings achieved through the adoption of smart building systems/practices

ENERGY

- Residential, commercial, industrial energy, as indicators of efficiencies from conservation practices and systems, such as advanced metering
- Frequency of electrical service interruptions
- Duration of interruptions to monitor impacts to customers

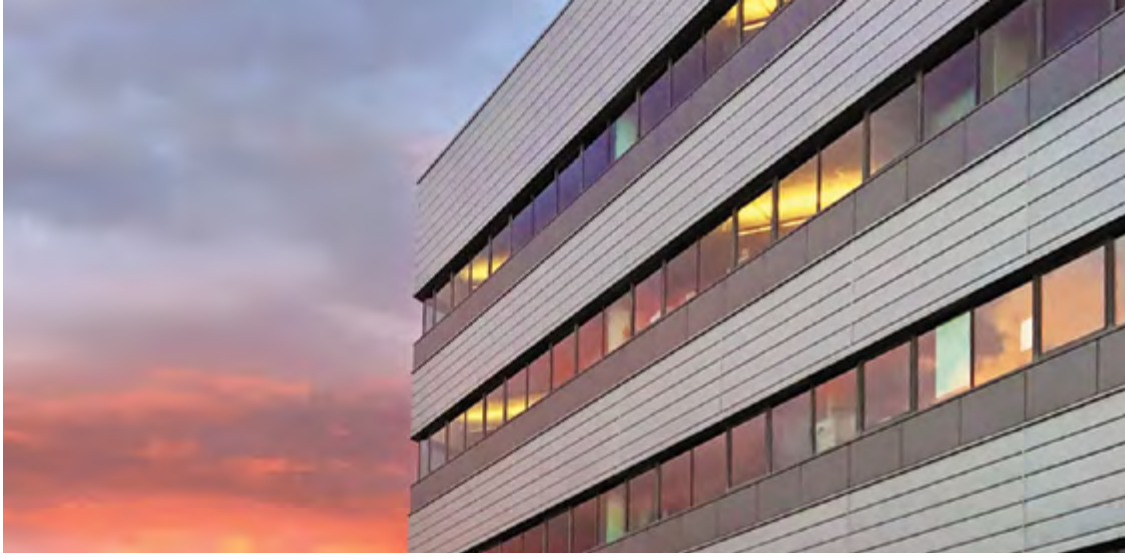
LOOKING FORWARD

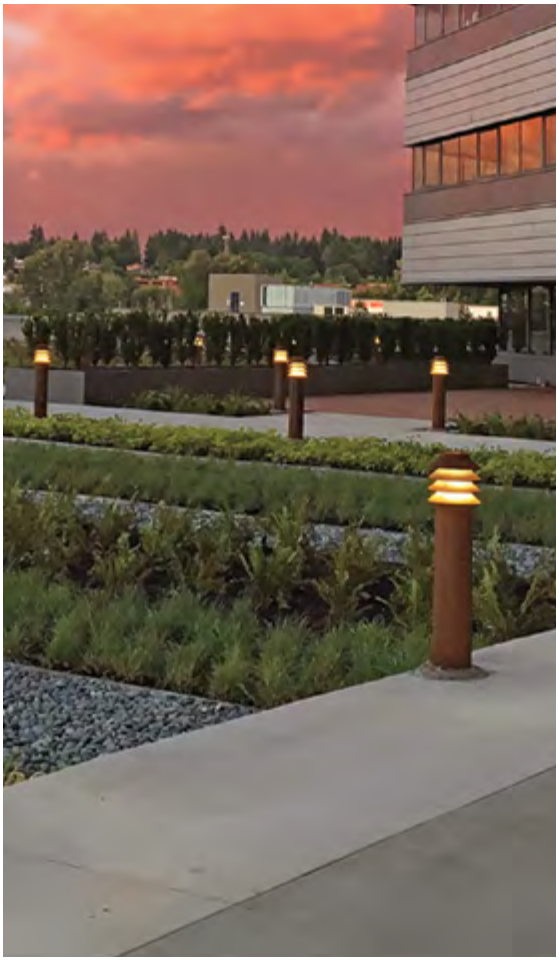
The smart city plan is a phased, iterative approach to achieving the community and Council's longer term goals of becoming a smarter city. This approach allows enough structure to plan for major projects while remaining nimble enough to take advantage of opportunities that arise; accelerating to achieve objectives more quickly or adjusting to a rapidly changing landscape.

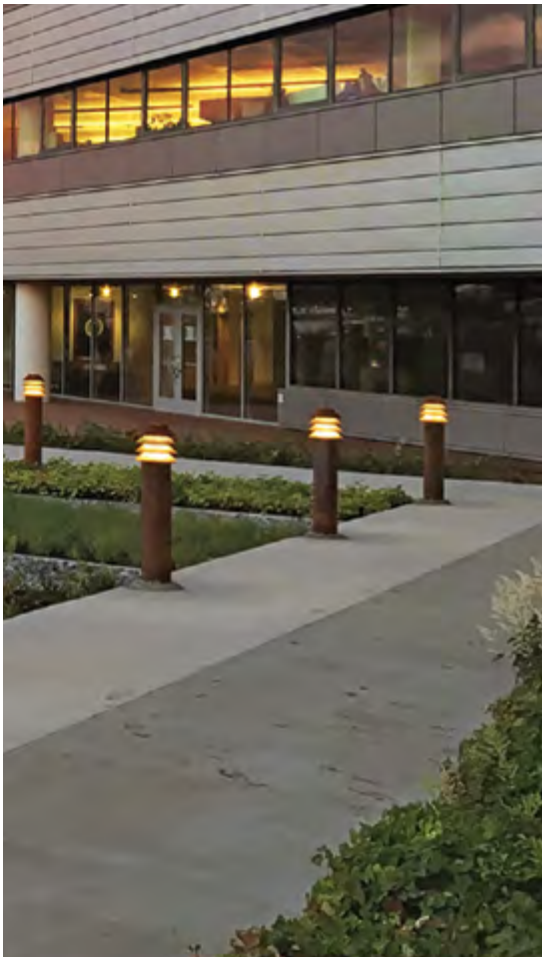
While the following three general phases comprise this longer-range plan, there will logically be times where a system or project matures and crosses over into another phase. Major investments like the Advanced Metering Infrastructure project and traffic signal integration discussed in Phase 1, will move into integrated and interoperable capacity in later phases.

- Phase 1-Investing in Foundational Systems
- Phase 2- Integrating for Efficiencies
- Phase 3-Achieving Proactive, Adaptive and Interoperable Capabilities

This plan brings together a focused vision, clear strategies to achieve that vision, defined objectives for each element and ways to monitor progress. The smart city plan drives Bellevue further down the smart continuum and, in the process, nurtures an environment, an "ecosystem," for innovation and improvement for the long-term benefit of the community.







Background

BELLEVUE

SMART

A smart city uses IoT, data and connectivity to improve city services and systems to make a city more livable, sustainable and resilient.

Background

OBJECTIVE: Creating a community that is future ready, connected and enduring for all.

PLANNING PROCESS

A smart city vision figured prominently in the City Council's *Bellevue 2035 – The City Where You Want to Be* supporting the Council and Community goal of creating a High Quality Built Environment. The council also established a path to realizing this longer-term goal by focusing priorities within the two-year budget cycle. In 2014, the priority to **develop the Smart City strategy to include high-speed data options to support business and residents and determine implementation steps** set this plan in motion.

ALIGNING VISION WITH EFFORT

To achieve the council vision, the initial focus was to evaluate emerging and innovative technologies to gain a clearer picture of what "smart city" could be and to discover the potential for these technologies to best address Bellevue's needs. Bellevue's smart city approach also tailors focus areas to the priorities articulated in the community vision as captured in the Comprehensive Plan.

Six elements were identified that best align with the community and council vision. These elements provide a structure that focuses efforts, clarifies objectives and helps organize strategies. The scope of the elements are defined below and cross-walked to established vision statements.

Smart city element	Vision statement
CONNECTIVITY Broadband internet, Wi-Fi and other connectivity services direct to the consumer and enabling communications infrastructure with an emphasis on high-speed communications.	**Community:** *Bellevue is a hub for global business and innovation.* **Council** • Bellevue is a "smart city" with a clean, high-quality environment and excellent and reliable infrastructure that supports our vibrant and growing city, including high-tech connectivity • Our institutes of higher learning are connected physically and digitally.
TRANSPORTATION All systems that move people around the city. This includes networks of streets, rails, buses, bike paths, sidewalks, traffic signals and safety systems that ensure safety on these networks, including signage.	**Community:** *Moving into, around and through Bellevue is reliable and predictable.* **Council** • Providing a highly-functioning transportation system • The city has a connected multi-modal transportation system, which blends seamlessly with its buildings, plazas and parks. • A state-of-the-art, intelligent transportation system moves people through the city with a minimum of wait times and frustration.
PUBLIC SAFETY All the infrastructure, services, agencies and personnel that cities call on to keep people safe, including police and fire departments, emergency medical services, and disaster preparedness and prevention.	**Community:** *Bellevue is a community that cares.* **Council** • Our residents live in a safe, clean city that promotes healthy living. The perception of safety contributes to the success of businesses and neighborhoods. Police, fire, and emergency personnel are seen by citizens every day and we ensure that these services reflect high standards and pride.
WATER Systems that deliver high-quality water to homes and businesses and appropriately handle waste and storm water.	**Community:** *Bellevue has the public and private utilities that meet the needs of a growing economy.* **Council** • Infrastructure is ample and in excellent condition, including roads, rails, high-speed data, reliable electricity and clean water. • We have superb infrastructure to support growing businesses and desirable residential opportunities.

BUILDINGS Intelligent building systems and analytics that improve quality of life and sustainability while providing significant cost savings.	**Community:** *Bellevue embraces its stewardship of the environment by protecting and retaining natural systems, and building for a sustainable future.* **Council** • Bellevue has it all. From a livable high-rise urban environment to large wooded lots in an equestrian setting, people can find exactly where they want to live and work in Bellevue. The diverse and well-balanced mix of business and commercial properties and a wide variety of housing types attract workers and families who desire a safe, sustainable and accessible community.
ENERGY Energy powers all the technology used in a smart city. Intelligent systems ensure sufficient, efficient and reliable energy for the community.	**Community:** *Bellevue has the public and private utilities that meet the needs of a growing economy.* **Council** • Infrastructure is ample and in excellent condition, including roads, rails, high-speed data, reliable electricity and clean water.

ESTABLISHING HIGH-LEVEL OBJECTIVES

After defining the six elements, high-level objectives outlining what should be achieved through the smart city plan implementation were developed.

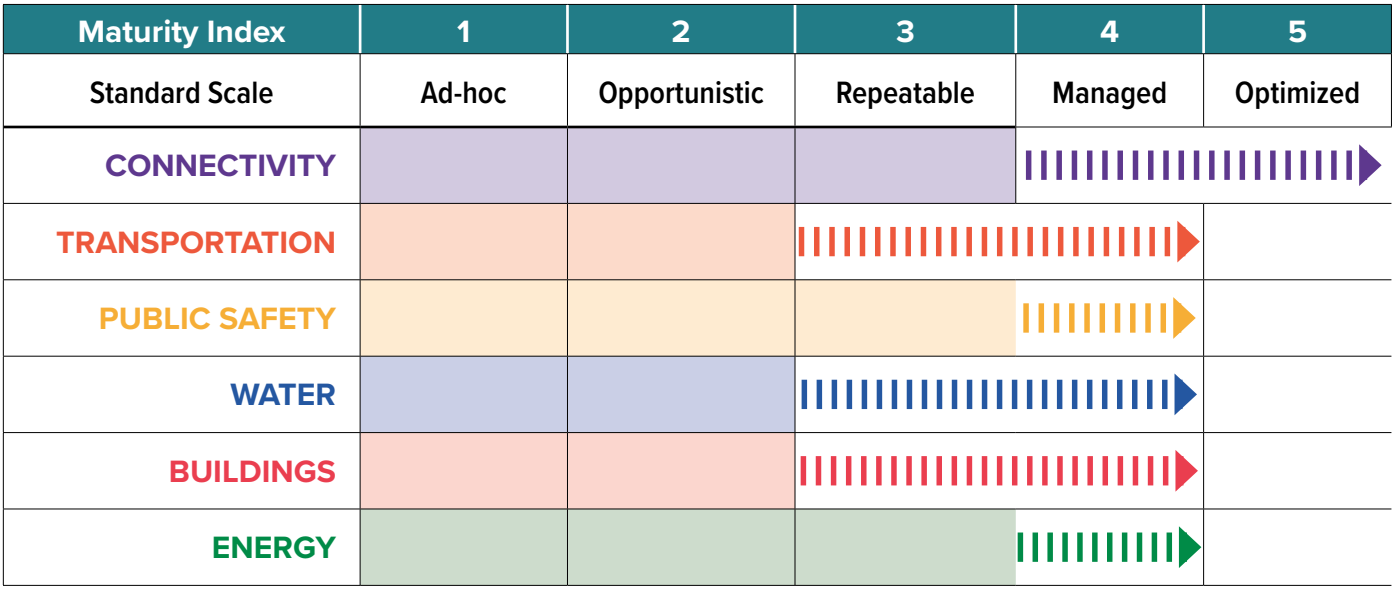
Element	Objectives
CONNECTIVITY	Increasing communication network speed, capacity and availability
TRANSPORTATION	Moving people smarter, safer and faster, while providing more choices, better real-time information, lowering emissions and raising efficiencies
PUBLIC SAFETY	Reducing response time, increasing survival rate, reducing crime rate, increasing sense of safety
WATER	Delivering high quality and reliable water, protecting critical infrastructure, conserving resources
BUILDINGS	Optimizing building performance, decreasing wasted energy and water, increasing comfort and safety
ENERGY	Improving grid reliability, increasing efficiency, connecting renewables

BENCHMARKING BELLEVUE: SMART CITY MATURITY ASSESSMENT AND GAP ANALYSIS

In order to define strategies for each smart city element, it was important to start by asking: "How smart is the city right now?" By understanding the current state, a more informed approach for each element could be tailored to address its distinct needs and achieve the overall objectives. A maturity assessment tool was developed to define gaps and shape strategies. Maturity levels were defined from basic services at the Ad-hoc level 1 to the highest capabilities of Optimized level 5. At the highest level, services and systems are proactive, real-time adaptive, resilient and interoperable, establishing an ideal long-term, end-state for each element.

The overall maturity assessment results are below, with solid filled boxes representing where Bellevue is today. Aspirations for the next three to five years are represented by hashed arrows. The intent is to pragmatically move towards the managed and optimized states to achieve increasing capabilities.

These levels and gaps guided the development of strategies, including budget proposals and other funding possibilities. Elements were broken down into corresponding sub-elements, with details provided in each element chapter.



SMART CITY PORTFOLIO

Addressing the smart city gaps identified through the maturity assessment requires an orchestrated strategy of both near-term and long-range future focused investments. To achieve success, efforts emphasized the following attributes:

- Delivering customer benefits
- Promoting interoperability of different technology systems
- Leveraging technology investments already made and technologies that benefit multiple elements

- Maximizing resources through a flexible approach that takes advantage of grant opportunities, public-private partnerships, regional partnerships and other funding opportunities
- Reducing risk through careful project timing based on technology maturity and industry readiness

The table highlights where Bellevue's smart city investments are included in the 2017-2018 Budget:

Council Priority	Operating or CIP	Existing investment	New investment
Bring a "smart city" strategy to the Council for its consideration for inclusion in the 2017/2018 budget	**OPERATING** (2017-18)	• 090.08NA Network Services and Security ($570K out of total $5.7M)130.11NA Intelligent Transportation Systems (ITS) ($1.5M) • 130.24NA Signal Operations and Engineering ($955K) • 140.25NA Utilities Telemetry and Security Systems ($1.5M)	• 070.31NA Electronic Records for Patient Care ($76K out of total $124K) • 130.500NA Telecommunications and Franchise Advisor($291K) • Transportation Technology Partnership ($300K)
	CIP (to 2023)	• G-93 Community Network Connectivity ($400K out of total $500K) • PW-M-20 Minor Capitol – Signals and Lighting ($1.4K out of total $2.9M) • PW-R-156 ITS Master Plan Implementation Program ($2.85M out of total $3.17M) • G-38 Expanded Community Connectivity ($1M out of total $1.3M) • CD-37 Downtown Community Implementation ($155K out of $4.15M)	• 140.69A Advanced Meter Infrastructure Implementation ($23.1M) • Neighborhood Levy for Transportation Technology ($3.5M)

Other funding sources: Research surfaced additional funding opportunities include grants, public private-partnerships, competition prices and revolving loan programs. Areas being actively monitored include grants from the National Institute of Standards Technology/Global Cities Team Challenge, Department of Energy and the National Science Foundation. Current public/private partnerships include various PSE initiatives as well as the development of a transportation role specifically tasked with discovering new opportunities, competing for prizes like the Georgetown University Energy Prize and exploring loan programs like King County's revolving loan options.

PERFORMANCE MEASURES

Bellevue's progress toward the **Desired Outcomes** can be tracked using community indicators and performance measures as described below. The city will track and report on these measures through the city's performance dashboard and through updates of this plan. Additional measures are detailed under each element.

Desired outcome	Measures	2016 Current state
LIVABILITY	**CONNECTIVITY**	
	• Broadband adoption rate[1]	**88%** Higher is better
	• Smartphone ownership rate[2]	**81%**
	WATER	
	• Compliance with state and federal regulations[3]	**100%**
	TRANSPORTATION	
	• Single-occupant vehicle rate[4]	**62%** Lower is better
	• Miles of designated bike paths/lanes[5]	**42**
SUSTAINABILITY	**BUILDINGS**	
	Number of Energy Star-rated buildings[6]	**70** Higher is better
	Median energy use for 27 municipal buildings[7]	**65.5 kBtu/square foot** Lower is better
	ENERGY	
	• ELECTRICITY[8] ◍ Total residential use	**520.5M kWh** Lower is better
	◍ Total residential use	**22.5M kWh** Lower is better
	◍ Total residential use	**1,045.4M kWh** Lower is better
	• NATURAL GAS[9]	
	◍ Total residential use	**27M therms** Lower is better
	◍ Total residential use	
	◍ Total residential use	**15.3M therms** Lower is better
	PSE renewable electricity source percentage[10]	**9%** Higher is better

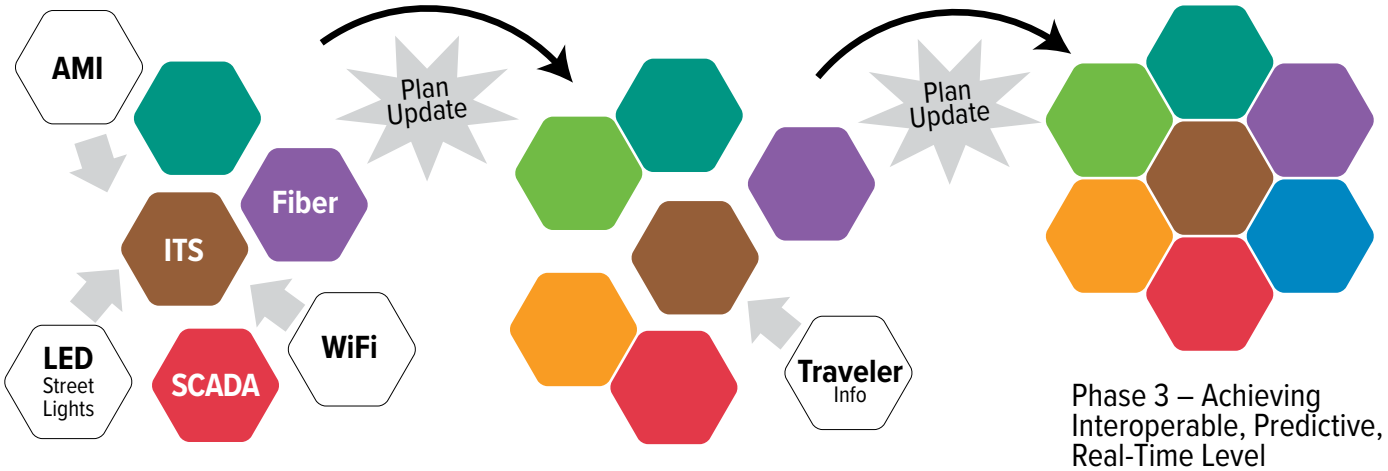
Desired outcome	Measures	2016 Current state
RESILIENCY	**ENERGY**	
	Frequency of electrical service interruptions[11]	
	Duration of electrical service interruptions[12]	**186.9 min.** Lower is better
	PUBLIC SAFETY: POLICE AND FIRE	
	Violent crimes and property crimes rate per 1,100 residents	**8.25** Lower is better
	Cardiac arrest survival rate[13]	**58%** Higher is better
	Percentage of fire response time in six minutes or less, from call to arrival[14]	**64.25%** Higher is better
	TRANSPORTATION	
	Serious injury collisions and related fatalities[15]	**24** Lower is better
	WATER	
	Unplanned water service interruptions per 1,000 customers[16]	**0.64** Lower is better
	Wastewater overflows per 1,000 customer accounts caused by system failures[17]	**0.135** Lower is better

FUTURE-FOCUSED APPROACH

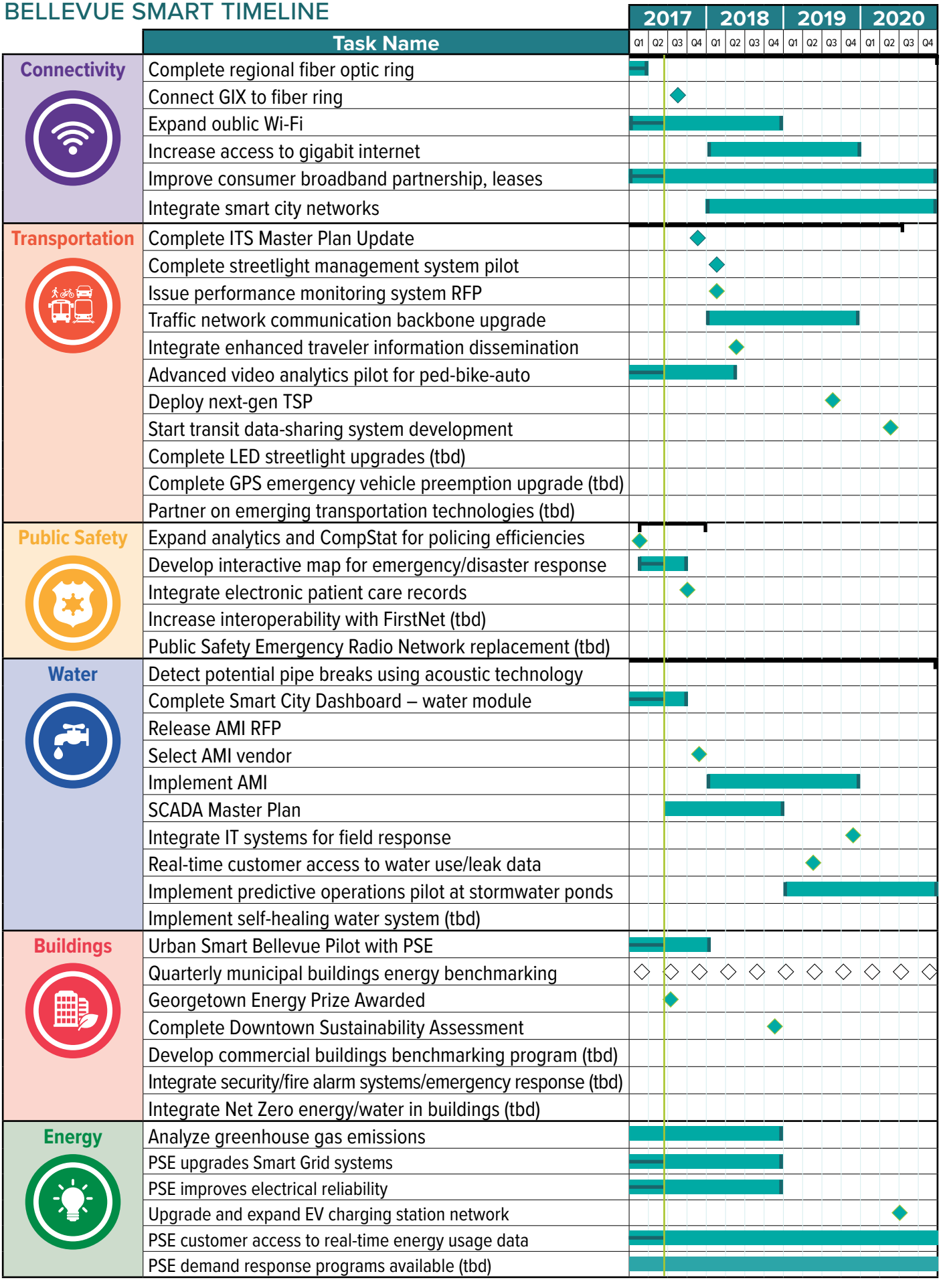
Due to the complexity of integrating systems and adopting emerging technologies, becoming a smarter city will take longer than a year or a single budget cycle, and must be done in a phased iterative approach that allows for planning of major projects while building in enough flexibility to take advantage of opportunities that arise or adjust tactics based on rapid changes. At least three phases are envisioned in the **Bellevue Smart: Planning for a Smarter City:**

1. Phase 1 – Investing in Foundational Systems
2. Phase 2 – Integrating for Efficiencies
3. Phase 3 – Achieving Proactive, Real-time Adaptive, Resilient and Interoperable Capabilities

This smart city plan focuses on Phase 1, where major investments are being made in critical systems and plans, such as Advanced Metering, the Intelligent Transportation System Master Plan Update and others. Some system and data integration efforts are already underway for increased levels of service. Phase 2 of this plan will build on those efforts. During Phase 3, the city achieves hoped-for levels of services and system capabilities, but can accelerate tactics depending on emerging capabilities and partnership opportunities that might arise.



BELLEVUE SMART TIMELINE



Connectivity

Bellevue is a growing urban center and high tech and economic hub, with vibrant neighborhoods and talented workforce all needing to be connected.

OBJECTIVE: Increasing communication network speed, capacity and availability

BACKGROUND

Connectivity describes the combination of network systems and services directly operated by the City of Bellevue, and the services provided by the private sector where the city functions as influencer, facilitator or, in some cases, regulator. Wi-Fi is offered by the City of Bellevue as an amenity service inside city facilities and in select outdoor locations. High-speed internet and wireless broadband are consumer services provided by the private sector. The city owns the right-of-way used by most telecom providers and manages the land use codes and permitting process for use of the right-of-way, so partnership is essential to achieve connectivity goals.

WHY CONNECTIVITY MATTER

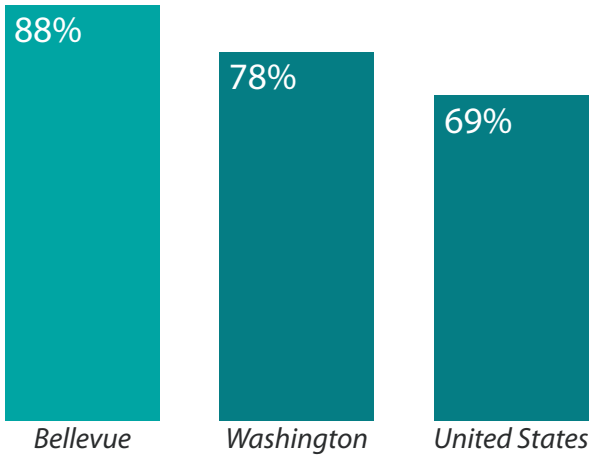
- Over 1,100 tech startups opened in Bellevue in the past seven years as Bellevue shifts from suburban to urban center.[18]
- Information technology companies are the largest and fastest-growing employers in Bellevue.
- Highly educated and trained workforce with over 60 percent of adults with bachelor's or higher degrees.[19]
- All smart systems need connectivity to the internet and to each other.

RELEVANT INFORMATION

- The December 2015 Community Broadband Assessment found that broadband internet adoption is 88 percent, exceeding statewide and national adoption rates. Unfortunately, 10 percent of residents do not have easy access to the internet. This 'digital divide' is most pronounced along income and age demographics.

2015 broadband adoption rate

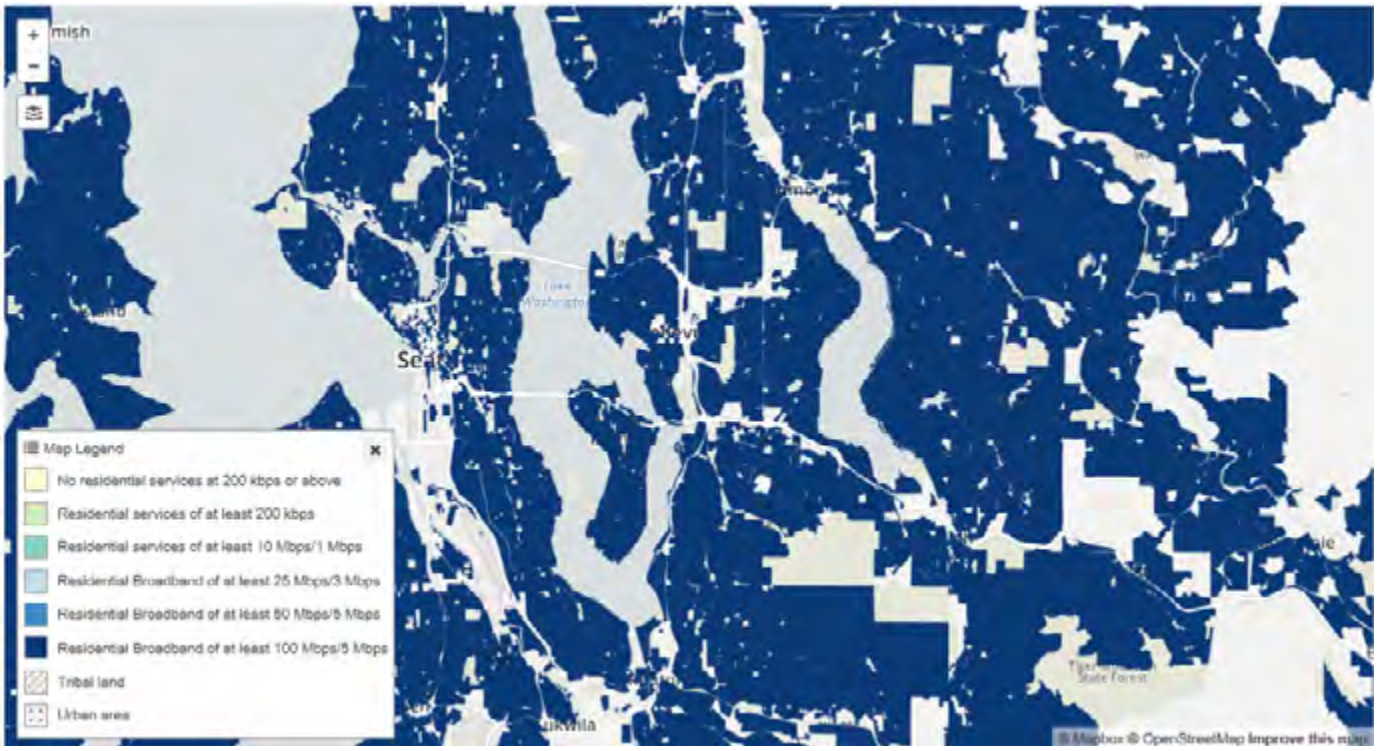
Bellevue broadband adoption rate exceeds state and nation.



Source: Bellevue 2015 Community Broadband Assessment

- The City of Bellevue has over 80-miles of fiber and conduit installed throughout the city. This extensive and robust infrastructure was installed to support Bellevue's Intelligent Transportation System and provides a foundation for public Wi-Fi, future smart city systems and connects major facilities like schools, hospitals and the Global Innovation Exchange (GIX).
- Bellevue participates in the Community Connectivity Consortium, a regional organization dedicated to connecting community institutions – schools, hospitals, cities – to create a vibrant and competitive region.
- At least nine internet providers offer residential services and at least fifteen offer business services in Bellevue, according to www.broadbandnow.com, a site aggregating data on service providers.
- According to FCC, residential broadband speeds currently exceed 100 Mbps/5Mbps (see map of Bellevue and region from www.fcc.gov).

Source FCC 2016 Broadband Progress Report
(https://www.fcc.gov/reports-research/maps/bpr-2016-fixed-speed)

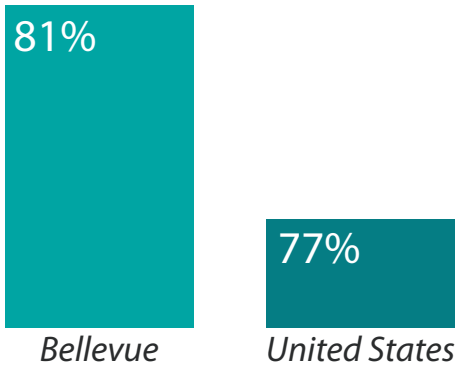


- Bellevue currently has cable franchises with Comcast and CenturyLink, and many residents get internet service through their cable plans. Frontier, WaveBroadband and Dish also offer internet services in sections of Bellevue.

- Consumers are increasingly relying on their mobile devices, and four major cellular carriers operating in Bellevue — Verizon, AT&T, T-Mobile and Sprint — are planning expansion or upgrade projects to keep up with demand. The City of Bellevue's December 2015 Community Broadband Assessment found that 94 percent of Bellevue residents own cell phones and 81 percent own smartphones, exceeding the national benchmark of 77 percent according to a Pew Research Center survey in 2016 on technology adoption.

Smartphone ownership in Bellevue 2016

Bellevue smartphone ownership is higher than the national average.



Source: 2017 Pew Research Center Mobile Fact Sheet

CONNECTIVITY'S SUB-ELEMENTS

Expanded Wi-Fi – The availability of Wi-Fi service for public use and internal operations

Fiber-optic Network – The availability of fiber and conduit network to connect city facilities, traffic management systems, streetlight systems, and support public and private partnership to enchance the digital economy

Consumer Services – The availability, performance, and options for high speed internet, cellular wireless, and Wi-Fi to residences and businesses from telecommunications, internet, cable and wireless service providers

Integrated Smart City – The availability, performance, and interoperability of various communications networks for Smart City systems, such as public safety radio, advanced metering and connected vehicles

CURRENT STATE AND FUTURE PLANS

Now	Future
Broadband adoption rate exceeds state and national rates	Choices available for internet provider and gigabit internet available in major business areas
Public Wi-Fi in City Hall, Community Centers, Fire stations and all of Downtown	Public Wi-Fi available in low-income housing, most parks, and select business corridors
Fiber infrastructure for traffic signal system, city facilities and public institutions	Fiber infrastructure available on all city streetlights to support small cell wireless, smart sensors and more.

STRATEGIES TO ACHIEVE FUTURE STATE

These are specific actions that the city will take to achieve the future state.

Principal strategy	Connectivity strategic actions
FOCUS ON PROACTIVE AND ADAPTIVE SOLUTIONS (OR SYSTEMS)	• Continue expanding fiber-optics network in the city and throughout the region to future-proof infrastructure for smart city networks and increase resiliency.
PURSUE PARTNERSHIPS	• Partner with private sector service providers to continue enhancing and expanding services in Bellevue. • Expand Wi-Fi amenities to enhance gathering places and expand options for connecting to the internet, especially for low-income students and seniors. • Establish partnerships with other local jurisdictions and education institutions for enhanced regional data sharing and analysis.
LEVERAGING REGIONAL RELATIONSHIPS	• Continue seeking opportunities to connect schools, hospitals and government facilities to ensure they have the high speed connectivity to serve our residents effectively well into the future, including increasing resiliency for communications networks that form the foundation for all smart systems. • Expand public Wi-Fi to low-income housing property to expand options for connecting to the internet for low-income students and seniors in partnership with King County Housing Authority and Bellevue School District. Also expand Wi-Fi to select business corridors and parks to enhance amenities at gathering places throughout the community.

ASSESSING MATURITY

Bellevue conducted a Smart City Maturity Assessment to gauge the current state of each element and further inform future strategies (see Appendix).

Connectivity overall assessment: Level 3 (Repeatable)

Target: Level 5 (Optimized) within three to five years

CONNECTIVITY SUB-ELEMENT MATURITY SCORES

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
EXPANDED WI-FI				→	
FIBER OPTIC NETWORK				→	
CONSUMER SERVICES				→	
INTEGRATED SMART CITY		→	→	→	

PLANNED PROJECTS/PROGRAMS

The following projects/programs are planned to close the gaps and reach our target level as identified through the maturity assessment:

EXPAND PUBLIC WI-FI: CONNECTING PEOPLE AND REDUCING THE 'DIGITAL DIVIDE'

Streetlights hold traffic cameras and Wi-Fi

The 2015 Community Broadband Assessment revealed a 'digital divide' amongst residents that falls along income and age lines. Expanding Bellevue's free-access Wi-Fi provides more opportunities for all residents to connect to the internet.

Extending the existing free-access Wi-Fi into gathering places such as parks, community centers and selected business corridors can enrich resident and visitor experiences, serving the needs of the always-connected, high-tech citizens of Bellevue, as well as bridging the divide for those who may not always be able to pay for access. Free-access Wi-Fi can help provide a connectivity safety net.

Bellevue already provides public Wi-Fi service at City Hall, throughout downtown and in community centers through over 350 access points. In collaboration with the Bellevue School District and King County Housing Authority, the city will expand Wi-Fi service in select apartment complexes to support low-income students with in-home connectivity while also reaching some senior citizens in

the same complex. The project also extends to eleven Boys and Girls Club sites. Leveraging existing infrastructure to expand Wi-Fi also provides readiness for rapid deployment as future smart city projects and opportunities surface.

FIBER-OPTIC NETWORKS: CONNECTING FACILITIES

Global Innovation Exchange is opening in the Spring District in the fall of 2017.

Bellevue deployed a fiber network to street intersections to support the intelligent traffic system. This network lays the foundation for other systems, such as Wi-Fi, streetlight management and advanced metering, while connecting community institutions like Bellevue College campuses, schools in the Bellevue School District, Overlake Hospital and the University of Washington medical clinics. Additionally, commercial service providers augment their networks and cable and phone networks by leasing space on the city's network. Continuing to expand and fill gaps in the fiber network supports connectivity needs for residents, businesses, public institutions and city systems.

CONSUMER SERVICES: FACILITATING INVESTMENTS IN BELLEVUE

Consumer services for internet, wireless, cable and phone are made available to the residents and businesses of Bellevue by private sector providers. The city facilitates these services through various roles, including cable franchise regulation, permitting right-of-way and leasing the use of city facilities. The city's long-standing goal is to improve competition and choice, improve services and enhance access for all. In pursuit of that goal, the city has entered into various lease agreements with service providers to leverage existing infrastructure when feasible, such as fiber conduit leases for internet providers or master lease agreements for access to city-owned streetlight poles to expand small-cell wireless in high-demand areas.

SMART CITY NETWORKS: PREPARED FOR FUTURE NEEDS

Fiber infrastructure connects today's systems and ready for tomorrow.

As the city deploys more smart systems, additional communications networks will likely be required. A Wi-Fi network used by humans has different needs than a communications network used by smart water meters or connected vehicles. The challenge is to integrate these emerging standards and implement networks that achieve interoperability across these systems.

IMPLEMENTATION

Connectivity projects will be phased in over the next two years and beyond. The rapid pace of change, such as wireless transitioning from 4G to 5G over the next few years, and growing demand will pressure the portfolio of connectivity projects to keep up with emerging capabilities and needs. The challenge is to stay aware of maturing technologies, be opportunistic and ready to adapt quickly.

BUDGET

The following budget items were approved as part of the City of Bellevue's 2017-18 Budget to augment existing programs in the Information Technology (IT) and Transportation Departments to enhance connectivity.

Budget Proposal Title	Description	Outcome	Total Budget	How much for Smart City?	
CIP			**(to 2023)**	**%**	**Amount**
EXPANDED COMMUNITY CONNECTIVITY	As part of Expanded Wi-Fi plan, expands Wi-Fi in 4 housing properties, 8 parks and community centers and 3 business corridors	G-38	$ 1,297,000	80%	$1,000,000
COMMUNITY NETWORK CONNECTIVITY	Expands fiber and conduit network to fill gaps and provide backhaul for streetlights, Wi-Fi and other Smart City networks	G-93	$500,000	80%	$400,000
Operating			**(2017-18)**		
NETWORK SERVICES AND SECURITY	Provides technical resources to support broadband projects, integrated communications networks for smart systems, and enhance security program for critical infrastructure	090.08NA	$ 5,719,338	10%	$570,000

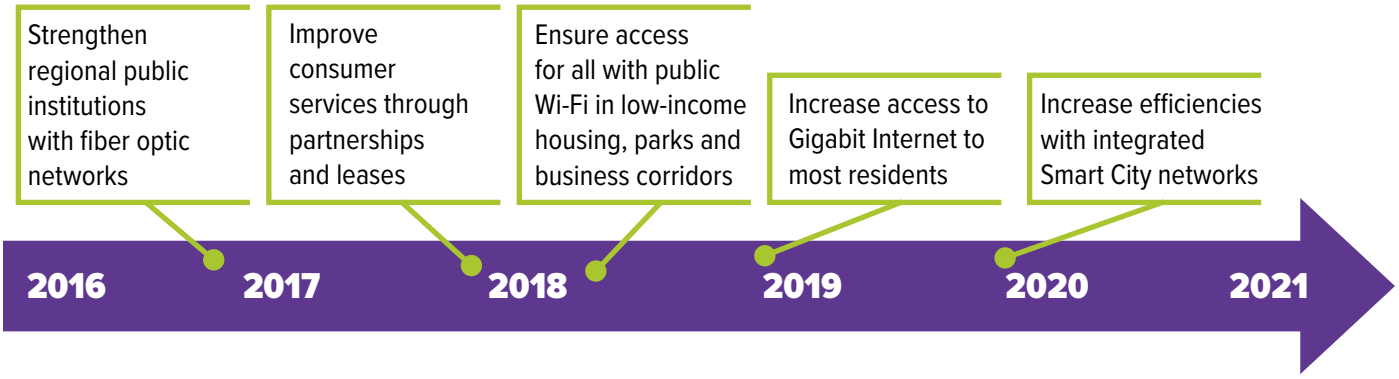
PURSUING ADDITIONAL FUNDING

In addition to the budget, staffing and organizational capacity needed to achieve the connectivity goals, other opportunities are also being pursued:

- **Grants:** Staff are monitoring grant announcements related to smart cities that come out of the U.S. Department of Transportation, National Science Foundation, National Institutes of Standards and Technology (NIST), Department of Energy (DOE) and others. Bellevue was successful in winning grants from NIST and DOE in 2015.

- **Public Partnerships:** Through regional organizations like the Community Connectivity Consortium (C3) Bellevue worked with 24 other member organizations to achieve increased speeds, choice and resiliency for connecting public institutions throughout the region. C3 builds, expands and operates fiber networks, including the recently completed, high-capacity fiber-optic ring around Lake Washington. As a node on this strategic ring, Bellevue is able to allow institutions like the Global Innovation Exchange to connect to the world.
- **Private Partnerships:** Joint public-private partnerships share costs and leverage existing infrastructure for the greater good. Fiber and conduit lease agreements that allow faster time to market because they minimize construction, or master lease agreements for small-cell wireless leveraging city streetlight poles, will continue to be supported.

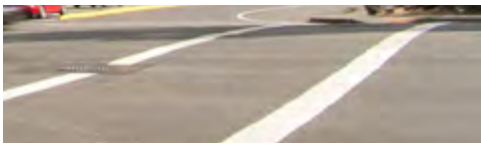
SCHEDULE



FUTURE

What possibilities can connectivity open up?

- Schools that connect to each other through the fiber-optic ring to share online curriculum or participate in virtual reality classrooms. What if eighth graders from Bellevue, Renton and Redmond could dive into a DNA molecule and be given a virtual tour of its structure by a professor on the other side of the country?
- Hospitals that can quickly share records, data and images to instantly consult with specialists in other medical centers.
- Cities that share massive real-time data sets on transportation or water with university research teams to analyze and find trends or optimizations to make streets and water safer.
- Getting gigabit internet at home without tearing up streets, sidewalks or yards because the high-speed service can be delivered wirelessly.
- A ubiquitous and superfast 5G wireless network that can handle the demand generated by connected and autonomous vehicles and increased IoT devices in building systems that also provides additional broadband service choices for consumers and is able to support future IoT implementations yet to be defined by the city and the business community.



Transportation

OBJECTIVE: Moving people smarter, safer and faster, while providing more choices, better real-time information, lowering emissions and raising efficiencies

Second Generation Traffic Signal Control System, early 1980s

Bellevue started leading the region in traffic operations management back in the 1970s by deploying one of Washington state's first central control systems for traffic management. Since then, Bellevue's evolved from a punch-card-managed system to a fully adaptive traffic-signal-control system operating over a high-speed, fiber-optic network.

Driving the system in use now is the city's 2004 Intelligent Traffic System Master Plan. Then, Bellevue served a population of 116,912 on a primarily copper-interconnect system with 170 traffic signals and 20 traffic surveillance cameras. A year after the Sydney Coordinated Adaptive Traffic System (SCATS) went live in 2010, the city saw a 15 to 45 percent reduction in travel time along the major arterials included in the first two phases of deployment. But keeping those gains remains an ever-expanding challenge as land use changes and the economy grows.

INTELLIGENT TRAFFIC NETS INITIAL GAINS

Travel time through major Bellevue arterials dropped 15 to 45 percent after the Sydney Coordinated Adaptive Traffic System (SCATS) went live in 2010, but those gains are challenged today by increases in population and commuters.

Corridor	Time	Travel Time Reduction
N.E. 8th St. – Bel Way to 112th	2 p.m. to 6 p.m.	43%
N.E. 4th St. – Bel Way to I-405	2 p.m. to 6 p.m.	16%
Factoria Blvd. – SE 32nd to Newport Way	5 p.m. to 6 p.m.	36%
N.E. 8th St. – 116th to 124th	Noon to 6 p.m.	35%

SOURCE: SCATS Phase 1 and 2 Deployment floating car travel time study results, 2011

Since 2004, Bellevue's seen a 22 percent increase in population. Job growth might have dipped during the 2008-2010 recession, but overall, Bellevue jobs have grown by 9 percent since 2004. Both numbers indicate an increasing number of residents and commuters with transportation needs.

Despite the 2008 economic downturn, Bellevue continued to invest in transportation's future, through the upgrade of the traffic signal system and the underlying communication network. Working with public and private partners, Bellevue completely replaced the copper-interconnect system with over 80-miles of optical fiber, resulting in fast-Ethernet communication to all traffic signals and surveillance cameras. The system now includes 200 traffic signals and over 70 traffic surveillance cameras. While many U.S. cities, counties and states are planning for or have deployed adaptive traffic management technology, as of 2017, Bellevue is the only mid to large-sized city operating a 100 percent adaptive traffic signal system—an achievement made possible by 12 years of strategic investments.

RELEVANT BACKGROUND

The majority of high- and medium-priority elements for the 2004 ITS Master Plan are now complete. This plan and the upcoming ITS Master Plan Update will determine the direction for the next generation of Bellevue's transportation technology, with opportunities to integrate technology into transportation management far exceeding 2004 possibilities.

Public agencies are faced with surging interest in connected and autonomous vehicles and data dissemination with a push to respond to requests for research and development. The big question is when to invest. Jump in too soon and the city risks finding that the industry evolved in a different direction. Jump in too late and the city constantly plays costly catchup. Connected vehicles, self-driving and shared mobility services are transportation disruptors that have enormous promises if the city is aware, prepared and poised to take advantage of this rapidly changing sector.

Generational change is driving the need for more travel-mode options, dramatically shifting many main industry variables. Multiple federal funding agencies want to invest in creative ideas that can accelerate the development of a safer and more efficient transportation network. Bellevue will need to position itself to take advantage of grants, quickly create partnerships and pursue opportunities as they arise. To expedite public-private partnerships and pursue emerging opportunities, the city has created a new position to focus on engaging local and national private technology companies and regional public agency partners to advance the deployment of transportation technology in Bellevue and the broader Eastside. This new transportation technology partnership manager will work with staff in Transportation, Economic Development, Information Technology, the City Manager's Office and external partners to advance these efforts.

Bellevue's job will be to support the safe and reliable operations of all current- and future-modes of travel. Bellevue's Transportation department has prided itself on being a leader in the ITS industry. The city intends to continue this practice.

WHY CONNECTED VEHICLES MATTER

- According to the National Highway Traffic Safety Administration CrashStats, there were 35,092 traffic fatalities in the US in 2015, with 568 fatalities in Washington State. This same study found that 94 percent of all crashes were attributed to driver error.
- As documented in Bellevue's Vision Zero Crash Map portal, there were 188 serious injury collisions between 2006 and 2015 in Bellevue and 16 traffic fatalities in that period.
- Connected-vehicle technologies offer increased safety with 360-degree awareness, crash avoidance and in-vehicle alerts for roadside conditions such as whether or not the traffic signal is about to turn red, speed-limit change warnings when entering a school zone and the indication of construction workers along the roadway.
- As more connected vehicles enter the market, Bellevue is likely to see rapid adoption amongst its tech-savvy population, with the expectation that the city will keep pace with these emerging technologies.

TRANSPORTATION SUB-ELEMENTS

Five transportation technology focus areas have been identified as the initial sub-elements for the Smart Cities Strategy. These focus areas were selected to leverage investments that have already been made to advance these initiatives.

Traffic Management – Cameras & Signals Systems – The operations and management of the adaptive traffic signal and video surveillance systems used for traffic management on Bellevue streets, including the communication network used to support these systems and system performance monitoring. This includes the distribution of data to support connected vehicle technology.

Streetlights Management – The operations of a smart streetlight system that allows lighting levels to be dynamically adjusted and provides the ability to use other smart streetlight technology, such as parking management.

Traveler Information – The distribution of traffic data and travel information to the public through city-managed services and third-parties.

Multimodal Transportation – Transit — The collection and distribution of on-board and vehicle-to-roadside data used for managing the operations of transit vehicles, as well as identifying solutions for completing first- and last-mile connections for commuters. This includes planning for future autonomous shuttles that can fill the last mile gap.

Multimodal Transportation – Pedestrian/Bikes — The use of pedestrian and bicycle monitoring technology to improve mobility and safety.

CURRENT STATE AND FUTURE PLANS

Now	Future
Fully deployed adaptive traffic signal system	Traffic-signal system performance monitoring and distribution of performance and operational data
49 percent of PSE- and COB-owned streetlights converted to LEDs	Fully upgraded streetlight network with management of both COB and PSE fixtures
Weekly distribution of construction traveler info through COB website	Real-time distribution of accurate traveler information through third party providers
Transit signal priority (TSP) for King County Metro RapidRide buses	• Next-gen transit signal priority tech integrated • Improved data-sharing and performance monitoring of TSP and transit operations
Near-miss motor vehicle/pedestrian and bicycle collision pilot project for Vision Zero underway	Fully deployed near miss monitoring, including turning movement counts for pedestrians, bikes and vehicles
Center-to-center connection for sharing of signal system data in support of connected vehicle applications.	Vehicle-to-infrastructure distribution of real time Signal, Phase and Timing (SPaT) data.

Incremental deployment of GPS based emergency vehicle preemption.	Improved traffic signal response for emergency vehicles through predictive routing supported by GPS preemption system
Traditional ridesharing available through rideshareonline.com, workplace options like Microsoft's Connector shuttles and a handful of ridesharing apps.	Data-driven shared mobility to improve first/last-mile commute trips
Some buses receive signal priority to improve transit times. All transit vehicles driven by humans.	Testing of autonomous transit vehicles that move through signals according to data-driven priorities, adjusting speeds to achieve scheduling and conservation goals.

STRATEGIES TO ACHIEVE FUTURE STATE

These are specific actions that the city will take to achieve the future state.

Principal strategy	Transportation strategic actions
FOCUS ON PROACTIVE AND ADAPTIVE SOLUTIONS (OR SYSTEMS)	• Leverage the upcoming ITS Master Plan update to define the next set of advanced capabilities – performance monitoring, data and information sharing, smart streetlights, parking management, multi-modal integration – to advance Bellevue's transportation system into proactive mode and ready the system for autonomous and connected vehicles.
DRIVE WITH DATA	• Implement enhanced pedestrian and bike operations monitoring and analytics to support multi-national Vision Zero initiative to end traffic fatalities.
PURSUE PARTNERSHIPS	• Use public and private partnership pilots to improve the transportation system's reliability, mobility and safety while supporting the development of new technologies. The specific focus will be on connected- and autonomous-vehicles technology, first/last mile travel solutions and data sharing with companies building relevant travel applications. • Coordinate with Puget Sound Energy (PSE) to pilot and deploy a streetlight management system. • Leverage existing third-party traveler information providers and app services to share Bellevue traffic data and disseminate more accurate construction and incident information. • Pursue transportation technology partnerships for ride sharing and electric vehicle charging
LEVERAGING REGIONAL RELATIONSHIPS	• Continue leadership on regional transit projects impacting the Eastside to achieve multimodal objectives and first/last mile connectivity.

ASSESSING MATURITY

Bellevue conducted a Smart City Maturity Assessment to gauge the current state of each element and further inform future strategies (see Appendix).

Transportation overall assessment: Level 2 (Opportunistic)

Target: Level 4 (Managed) within three to five years

TRANSPORTATION SUB-ELEMENT MATURITY SCORES

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
TRAFFIC MANAGEMENT–CAMERAS & SIGNALS SYSTEMS				→	
STREETLIGHTS MANAGEMENT			→		
TRAVELER INFORMATION		→			
MULTIMODAL TRANSPORTATION–TRANSIT				→	
MULTIMODAL TRANSPORTATION–PEDESTRIAN/BIKES			→		

PLANNED PROJECTS/PROGRAMS

The following projects/programs are planned to close the gaps and reach our target level as identified through the maturity assessment:

EXISTING PROJECTS

- **SCATS Traffic Count Data Management:** The city recently purchased a program that enhances the extraction and distribution of traffic count data from the SCATS system. This tool will help generate functional operational data that supporting Bellevue's Open Data program and data needs for multiple city departments.
- **Network Security and Redundancy Upgrade:** To support future needs, the Transportation and Information Technology departments are combining efforts on a traffic network access security upgrade and more robust network design. These upgrades are being funded through the 2016 Neighborhood, Safety, Connectivity and Congestion Levy.
- **Signal System Performance Monitoring:** The Traffic group is evaluating products that allow real-time traffic signal system performance monitoring. Hardware or software solutions will be purchased with funds from the 2016 Neighborhood Levy.

- **ITS Master Plan Update:** Having achieved the majority of high- and medium-priority elements in the 2004 ITS Master Plan, the Traffic Engineering group is defining a future set of projects and programs to fill the transportation gaps identified in the Smart City Maturity Assessment. The ITS Master Plan update will be completed by the end of 2017.
- **King County Metro Next Generation Transit Signal Priority:** King County Metro is developing their next generation of transit signal priority (TSP) technology design, with the goal of improving integration between local agency signal systems and their back-office systems. This integration will lead to an improved ability to share performance data for transit speed and reliability.
- **Pedestrian and Bicycle Video Analytics Pilot Project:** The city, Microsoft Research and the University of Washington have combined efforts to develop a video-based analytics system to track near-miss events between pedestrians, bicycles and cars, while generating turning-movement data for all three modes of travel. If this innovative pilot using leading edge machine learning, artificial intelligence and crowd-sourcing is successful, this system could be applied anywhere Bellevue has a high-definition, 360-degree traffic surveillance camera.
- **Connected Vehicle System Integration:** Bellevue is currently working with two connected vehicle vendors to test their ability to process real-time adaptive traffic signal system data for use in their in-vehicle and mobile connected-vehicle applications. Both vendors are attempting to monitor the real-time state of a traffic signal and count down the time until a traffic signal will turn green. In addition, the systems will provide an estimated travel speed to pass through downstream signals while the traffic signal is still green. This integration is being done through a center-to-center link with the SCATS servers.
- **Parking information:** As part of the Downtown Livability implementation, the city will conduct a comprehensive study on parking in downtown and identify opportunities for smart city technology to assist in the more efficient identification and use of parking.

FUNDING PROGRAMS

- **ITS Master Plan Implementation Program (PW-R-156):** This CIP program allows Bellevue to incrementally expand the existing transportation system and fund pilot programs for testing new technology. This program is currently funding gradual expansion of traffic surveillance cameras and GPS-based emergency vehicle preemption equipment, the ITS Master Plan update and a pilot test of a smart streetlight monitoring system.
- **Minor Capital – Signals and Streetlights (PW-M-20):** This CIP program is helping fund the upgrade of existing city-owned streetlights to LED, allowing for future integration of smart streetlight technology. The city recently partnered with PSE to upgrade half of the PSE-owned streetlights to LED in Bellevue, resulting in nearly half of all streetlights becoming more energy efficient. This program also funds the enhancement of the GPS-based traffic signal capability for the emergency vehicle signal preemption system.

- **Transportation Safety, Connectivity and Congestion Levy:** Bellevue residents approved a 20-year Levy in 2016 to provide funding for sidewalks, bicycle facilities, neighborhood traffic safety, neighborhood congestion relief, ITS and crosswalks. The bicycle facility funding will support construction of the Bicycle Rapid Implementation Program. ITS funding will further enhance the existing system and fund deployment of new elements identified through the ITS Master Plan Update.

NEAR-TERM (2017-2020) INVESTMENTS

The City is actively working on an update to the ITS Master Plan, which will likely surface additional projects and programs that will help define the future of transportation management in Bellevue. These projects could be phased in as budget allows, with funding through existing CIP programs, the Neighborhood Levy and potential grants or financial partnerships. The following projects are already programmed through existing funding sources. For some projects, full deployment would extend beyond 2020 without additional funding.

CURRENT FUNDING LEVELS SUFFICIENT FOR COMPLETION

- Traffic signal system performance monitoring
- Improved dissemination of traveler information
- Improved dissemination of traffic data
- Integration of next generation TSP technology

COULD TAKE 5-10 YEARS TO COMPLETION AT CURRENT FUNDING

- Continued gradual deployment of LED streetlights and the selection of a streetlight management system to provide dimming capabilities, outage alerts and other controls.
- Continued gradual deployment of GPS-based emergency vehicle preemption equipment.
- Upgrade of existing traffic signal communication network to support resiliency of existing communication and capacity for future needs such as broader deployment of traffic surveillance cameras and vehicle-to-infrastructure communications for connected vehicles.
- Continued expansion of traffic video surveillance system using 360-degree cameras

NO ADDITIONAL COSTS

- Integration with connected-vehicle vendors using center-to-center communications to feed data into their connected-vehicle applications

NO KNOWN COSTS

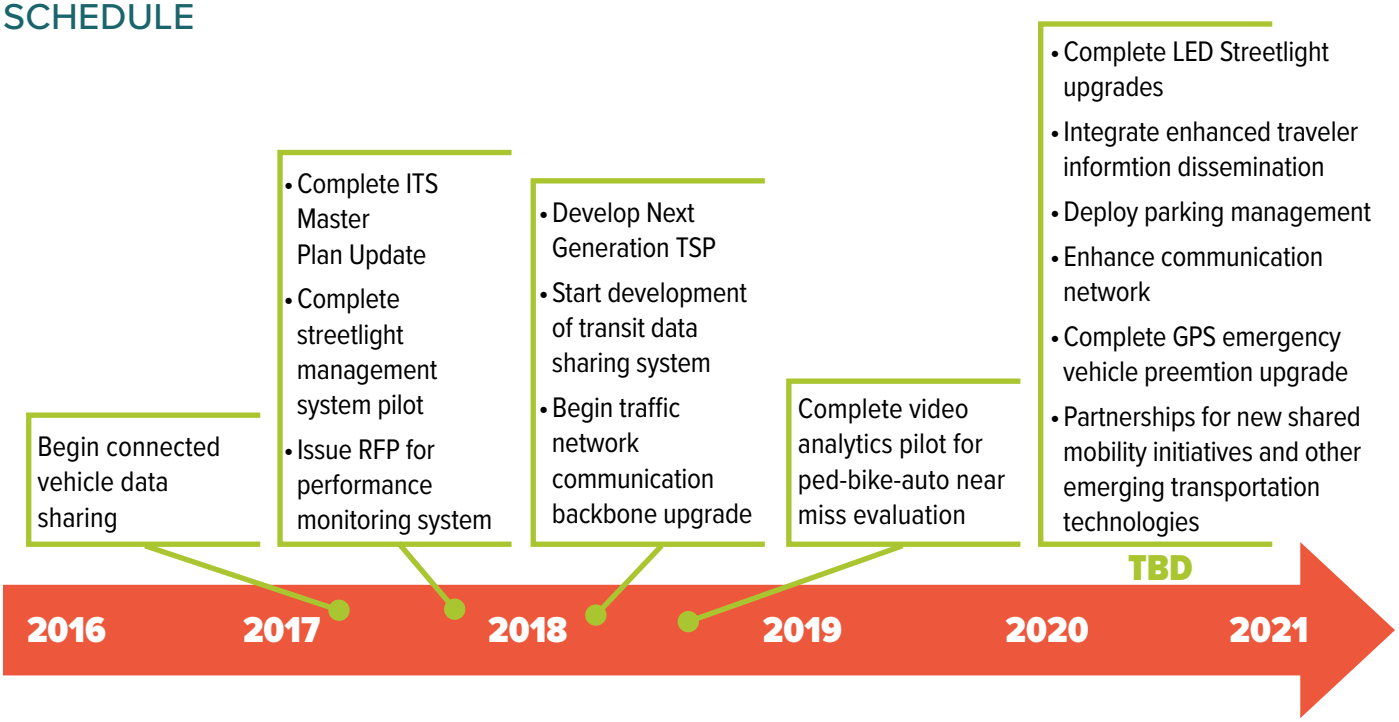
- Support global Vision Zero initiative to end traffic fatalities and serious injuries through enhanced monitoring of pedestrian and bicycle operations
- Partnerships for new shared mobility solutions to support commute trip reduction and the first/last mile of a commute trip

IMPLEMENTATION

BUDGET

Budget Proposal Title	Description	Outcome	Total Budget	How much for Smart City?	
Operating				**2017-18**	
INTELLIGENT TRANSPORTATION SYSTEMS	Operations and maintenance of the ITS, including adaptive signal system, cameras, and transit prioritization	130.11NA	$1,507,686	100%	$1,507,686
SIGNAL OPERATIONS AND ENGINEERING	Operations and engineering of traffic signals and streetlights	130.24NA	$954,755	100%	$954,755
TRANSPORTATION TECHNOLOGY PARTNERSHIP MANAGER POSITION	Development of public and private partnerships to support new transportation technology	New Add	$300,000	100%	$300,000
CIP			**(to 2023)**	**%**	**Amount**
MINOR CAPITOL - SIGNALS AND LIGHTING	Replaces city-owned streetlights with LED and intelligent management to increase efficiencies and ready for GPS-based capabilities for emergency vehicle signal preemption system.	PW-M-20	$ 2,909,130	50%	$1,454,565
ITS MASTER PLAN IMPLEMENTATION PROGRAM	Updates ITS Master Plan to define roadmap for next set of enhancements–real-time traveler info, localized weather sensors, etc.	PW-R-156	$ 3,171,002	90%	$ 2,850,000
NEIGHBORHOOD LEVY	Approximate allocation of Levy money toward Transportation Technology	PW-R-199	~$3,500,000	100%	~$3,500,000

SCHEDULE



POTENTIAL LONG-RANGE OPPORTUNITIES

The ITS Master Plan update will identify specific long-range objectives and projects. The Transportation department will continue to look for additional technology partnerships that will support mobility, safety and reliability for Bellevue's transportation system.

FUTURE

What could be in store for smart transportation?

- Connected vehicle integration where the city's transportation infrastructure communicates with smart vehicles to provide accurate location and roadway conditions, and alerts to unsafe situations, such as a pedestrian crossing the road or construction.
- As traditional car ownership wanes and adoption of autonomous vehicles increases, this opens mobility services markets where the focus shifts to the ease of getting to places, instead of owning a vehicle that sits idle most of the time.
- Self-driving circulator shuttles connecting East Link stations with neighborhood gateways, business hubs and points of interests.
- Increased variety of transportation choices, including the ability to easily shift between modes using apps that facilitate commute choices by offering real-time event info, the ability to reserve a parking spot or a seat on a vanpool.
- Integrated origin/destination data that defines travel patterns in Bellevue, allowing the city to craft data-driven transportation solutions that best meet travel needs.

Public Safety

OBJECTIVE: Reducing response time, increasing survival rate, reducing crime rate, increasing emergency capabilities

BACKGROUND

Achieving public safety requires response services from police, fire, emergency medical services (EMS) and 911 and other services that can support or prevent emergencies. Since the early 90s, technology has enhanced day-to-day public safety services in Bellevue, with continuing improvements to dispatching, automatic vehicle location (AVL), access to national and regional databases and mobile applications. Taking advantage of smart technology builds on a long track record of effectively using the latest advanced technologies to increase safety in the city and surrounding communities.

BELLEVUE POLICE DEPARTMENT

The Bellevue Police Department provides high quality law enforcement, community education and support services, with 184 police officers and 41 civilian staff, to keep the fifth largest city in Washington, with a population of over 139,400, safe. This internationally accredited law enforcement agency has also received CALEA's (Commission on Accreditation for Law Enforcement Agency) Gold Standard rating for maintaining continuous accreditation for 15 years. Bellevue Police Department's mission is to reduce crime, reduce the fear of crime and increase the quality of life in Bellevue.

BELLEVUE FIRE DEPARTMENT

The Bellevue Fire Department, with 232 personnel, provides fire suppression, rescue and emergency medical service to city residents and surrounding communities, including Beaux Arts, Clyde Hill, Hunts Point, Medina, Newcastle and Yarrow Point. The department also handles fire suppression system maintenance inspections, new construction inspections and fire reviews in addition to providing advanced life support services with Medic One units serving 250,000 people in the Eastside and Snoqualmie Valley. The department has been internationally accredited by CFAI (Commission of Fire Accreditation International) continuously since 1998.

911 CALL CENTER

NORCOM (North East King County Regional Public Safety Communication Agency) is the regional 911 call center handling 911 calls, dispatching responders, tracking resources and coordinating information for police, fire and EMS in Bellevue and other areas. It serves the population of 640,000 people and handles over 175,000 calls per year. Roughly half of police calls are for the Bellevue Police Dept., with approximately a quarter of fire calls requesting the Bellevue Fire Dept.[20]

Several other organizations and services also work to ensure public safety in Bellevue. The Development Services Department provides plan review and building inspection alongside the fire inspections provided by the Fire Department. The Fire Department's Office of Emergency Management readies Bellevue for emergencies and pollution monitoring is handled through the Washington Department of Ecology.

RELEVANT INFORMATION

- According to the 2016 Performance Measures Survey, the sense of safety is high in Bellevue, with 95 percent of residents agreeing that Bellevue is a safe community according to the city's 2016 Performance Measures Survey. Bellevue enjoys a relatively low crime rate. Total Part 1 UCR violent crime averages 144 cases per year, while property crime averages 4,234 over the same five year period.[21] Bellevue police officers have a suite of technologies to increase their productivity, from access to national data bases via computers in their vehicles to mobile apps on their smartphones enabling secure chat. Use of photo enforcement cameras has also reduced speeds and increased safety in select intersections and school zones.
- Bellevue Police Department uses data-driven policing to improve operations and services. The Crime Analysis Unit pulls available data from the city, region and state to detect emerging crime patterns and trends and shares analysis results with law enforcement agencies throughout the region since crime often crosses jurisdictional boundaries. The unit recently used its data-driven methods to help catch the "Rock Smash Burglary Crew" suspected of over 123 robberies of luxury homes in the region and netting over $3M in stolen goods.

- Cardiac arrest survival rates are high, with a 58 percent survival rate in 2016, and fire-response times remain consistent at 64.2 percent with response time less than six minutes in 2016. Bellevue's cardiac resuscitation rate is one of the best of the United States. Maintaining that rate requires enormous coordination of agencies, processes and technologies to keep Bellevue safe.
- NORCOM call takers and dispatchers work effectively with Bellevue fire, EMS and police. The CAD system (Computer Aided Dispatch) recommends the closest response unit with appropriate personnel and resources for that incident to allow dispatchers to get first responders to the scene quickly. Technology integration with Bellevue's traffic signal system and the Opticom signal preemption system shaves critical seconds for emergency vehicles responding to a call.
- Fire vehicles are equipped with mobile computers and tablets loaded with the city-created Pre-fire mobile app displaying building diagrams and providing critical structural- and access-information to help with response tactical planning and situational awareness.
- King County is in the process of replacing the aging analog radio system with a modern system. The Public Safety Emergency Radio Network (PSERN) will replace 20,000 radios county-wide. The fully digital radios will offer encryption capabilities across multi-band, 800MHz service via UHF and VHF for interoperability with federal agencies.
- FirstNet has achieved a significant milestone with the selection of AT&T to build the broadband network dedicated for public safety. Each governor will be given a state plan and have to decide whether to opt in to FirstNet or build their own network for their state.
- Air quality sensors from the Washington State Department of Ecology measure particulate matter at two locations in Bellevue.
- King County Office of Emergency Management offers an emergency notification and alert system called CodeRed that allows people to sign up and receive real-time notification regarding hazards and threats impacting them.

PUBLIC SAFETY SUB-ELEMENTS

911 Service – Emergency response system that handles 911 calls, dispatching and coordination of fire, police and emergency medical responders and managing real-time information flow to responders

Interoperable Communications – Communications networks, including radio and wireless broadband, used by emergency responders to coordinate in real-time across various agencies and disciplines.

Incident Situation Awareness – Essential situation information, such as map of incident scene, location and status of resources, critical infrastructure, weather, terrain, hazards, etc., needed by on-scene incident commanders and emergency coordinators

Data-driven Policing – Using data effectively and proactively to enhance policing efforts by applying advanced analytics methods to increase awareness, improve patrol efficiency and investigations as well as command operations.

Hazmat Awareness and Mitigation – Specialized emergency response service to deal with hazardous materials (toxic, combustible, illegal or dangerous nuclear, biological or chemical agents) that have been either intentionally or accidentally released into the environment.

CURRENT STATE AND FUTURE PLANS

Now	Future
Communications	
911 calls include address location info. First responders can be dispatched using automatic vehicle location and maps with routing information.	King County's next-gen 911 enables text, video, telematics and other interactions with 911 call centers
Dispatchers, police, fire and EMS use dedicated public safety emergency radio.	PSERN upgrade ensures more reliable coverage, enable additional bands (VHF, UHF) for interoperability with federal agencies and ability to support additional data such as location and texting and integration capabilities.
Critical access to commercial cellular networks gets overwhelmed during emergencies.	FirstNet, a national effort to build a dedicated wireless network for public safety use, will support voice and data communications.

Real-time alerts available for residents and commuters with mobile devices by signing up for King County's Office of Emergency Management CodeRed service.	Maturing connected technologies allow public safety officials to reach residents and commuters through connected vehicles, variable signage, smart buildings and mobile devices.
EMS personnel gather patient information and relay to medical team upon arrival at hospital/emergency room.	Patient info shared in real-time between EMS responders and hospitals, enabling medical teams to triage effectively, provide better guidance in route and focus on care.
Traffic routing	
Opticom allows police, fire and EMS vehicles to preempt traffic signals in Bellevue to facilitate travel through intersections. Automated GPS capabilities are added when new vehicles are purchased.	Automatic traffic system integration with emergency vehicles using GPS location for signal prioritization.
Police and Fire	
Pre-fire app allows the download of building diagrams providing critical structural and alarm system information for fire responders.	Common operating picture available for incidents commanders on scene and integrated with the emergency operations center for better information coordination and incident management.
Fire Department has experimented with drones at a fire incident, but the city is still establishing policies and procedures on drone use.	Drones provide police with tactical support and assist with security at events like Snowflake Lane and Fourth of July. Drones provide situational data during and after fires, search and rescue operations and other large-scale incidents.
Body camera and dash-cam pilot records events that can be used as evidence. Current public records law and state of redaction technology places a significant administrative burden on law enforcement agencies. The pilot has ended.	Redaction of videos matures sufficiently to allow body camera and dash-cam use. Connectivity is sufficient and secure to allow real-time video sharing with incident command staff.
Crime Analysis Unit looks at a variety of existing data to inform patrol, investigation and command staff to drive improvements. Automatic alerts and continuous data monitoring allow earlier awareness of emerging trends, such as increased level of car prowls or other crimes that inform officers going on shift.	Use of the CompStat managerial model, which relies on analysis products, for increased awareness in the department and throughout the community to reduce crime and improve quality of life.
Pollution	
Air pollution sensors from Dept. of Ecology measure particulate matter as part of Puget Sound Clean Air program	Air pollution data is shared with public on the city's Smart City Dashboard.

STRATEGIES TO ACHIEVE FUTURE STATE

These are specific actions that the city will take to achieve the future state.

Principal strategy	Public Safety strategic actions
FOCUS ON PROACTIVE AND ADAPTIVE SOLUTIONS (OR SYSTEMS)	• Support regional and national efforts to upgrade public safety communications systems with an enhanced radio network and a dedicated public safety wireless network to improve interoperability. • Monitor grant opportunities for next-generation first responders' technologies • Further optimize response times by integrating traffic signal prioritization with emergency vehicles. • Pilot new air quality monitoring technologies as part of re-planning processes in select areas of the city • Monitor developing smart building technology, understanding that the city will need to be able to communicate with a variety of systems and seek opportunities for data standardization.
DRIVE WITH DATA	• Enhance data-driven policing to improve efficacy and increase the community's sense of safety.
LEVERAGING REGIONAL RELATIONSHIPS	• Continue to partner with public safety agencies in the region to improve information accuracy, response times and effectiveness.

ASSESSING MATURITY

Bellevue conducted a Smart City Maturity Assessment to gauge the current state of each element and further inform future strategies (see Appendix).

Public Safety overall assessment: Level 3 (Repeatable)

Target: Level 4 (Managed) within three to five years

PUBLIC SAFETY SUB-ELEMENT MATURITY SCORES

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
911 SERVICE				→	
INTEROPERABLE COMMUNICATIONS					
INCIDENT SITUATION AWARENESS			→		
DATA-DRIVEN POLICING				→	
HAZMAT AWARENESS AND MITIGATION					

PLANNED PROJECTS/PROGRAMS

The following projects/programs are planned to close the gaps and reach our target level as identified through the maturity assessment:

911 SERVICE IMPROVEMENTS

King County is in the process of developing the ten-year E-911 Strategic Plan that will include strategies for phased deployment of NextGen911 capabilities that can include text, photos and connected vehicle telematics.

INTEROPERABLE COMMUNICATIONS UPGRADE

Public safety communications will receive several upgrades in the next several years for the radio network replacement (PSERN) and a dedicated public safety wireless broadband network (FirstNet).

REAL-TIME MEDICAL INFO SHARING WITH HOSPITALS

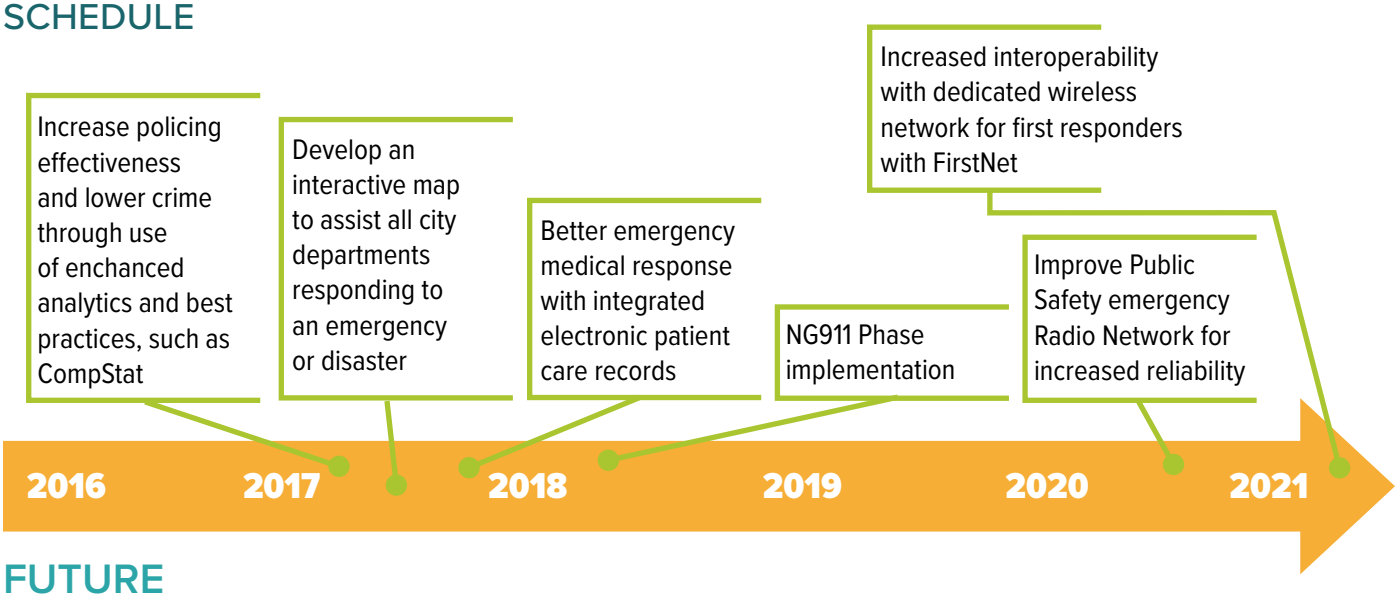
Patient info shared in real-time between EMS responders and hospitals with the deployment of the Electronic Records for Patient Care system.

IMPLEMENTATION

BUDGET

Budget Proposal Title	Description	Outcome	Total Budget	How much for Smart City?	
Operating			(to 2023)	%	Amount
ELECTRONIC RECORDS FOR PATIENT CARE	Provides devices and software to integrate with King County EMS electronic patient care records program for secure data capture and sharing with hospitals and other partners	070.31NA	$76,941	100%	$76,941

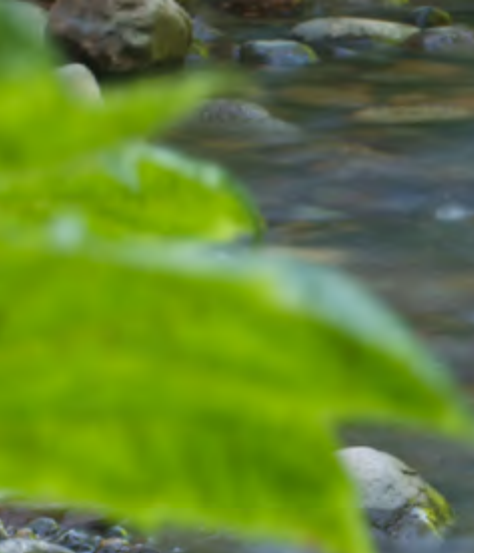
SCHEDULE

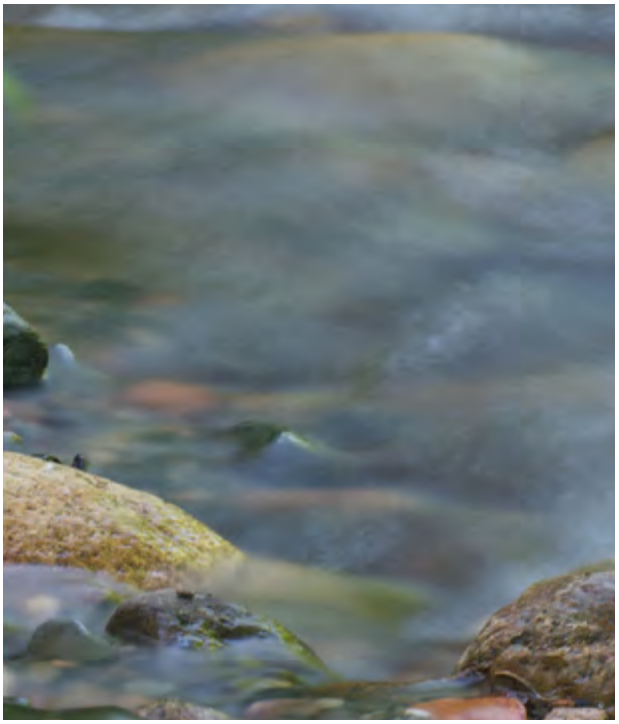


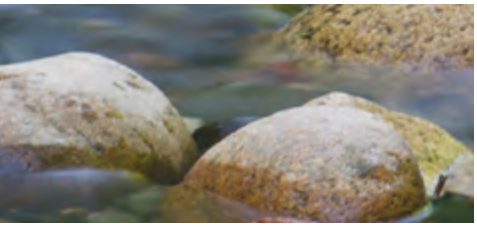
FUTURE

What could be in store for smart Public Safety?

- NextGen First Responder technologies evolve with hazards sensors, location tracking and augmented displays for increased protection of personnel.
- Interoperable communications achieved with PSERN and FirstNet so a major disaster response with multiple federal agencies, crews from states and non-governmental organizations can effectively coordinate.
- Advance vehicle technologies with increased surveillance and awareness are available in police vehicles.
- Smart streetlights that give incident commanders managing collision scenes at night the ability to turn up light levels for increased safety and effectiveness.
- Integrated building alarms that provide precise location information and type of alarm that can be passed to 911 system and to emergency responders.
- Connected vehicle sensor data can be easily accessed to augment traffic collision investigations.







Water

OBJECTIVE: Delivering high-quality and reliable water, protecting critical infrastructure, conserving resources

BACKGROUND

Water is an essential service for any city. Systems must deliver high-quality water to homes and businesses and appropriately handle wastewater and storm water. The water element focuses on the strategic use of technology and communications infrastructure to successfully manage Bellevue's utilities systems with the goal of delivering safe drinking water to customers and collecting and conveying wastewater and stormwater.

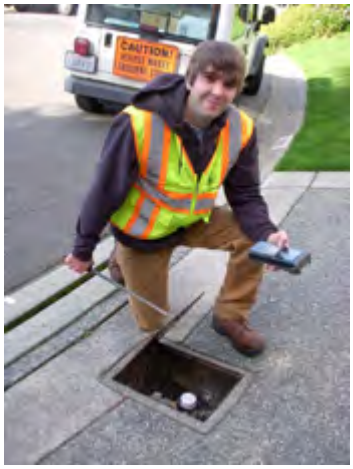
WHY SMART WATER MATTERS

The collection, communication, and analysis of data play a vital role in the reliable operation, maintenance and renewal/replacement of Bellevue's utilities systems.

- Water operators monitor data 24 hours a day to ensure that the water system provides adequate flow, pressure and water quality to Bellevue's business and homes and stores sufficient water for fire protection. Similarly, wastewater operators monitor data to ensure that wastewater pumps are conveying sewage away from homes and businesses.
- Engineering staff use data on the failure history and the condition of pipes, pump stations and reservoirs to decide which assets to rehabilitate or replace when they reach their end of life.
- Metering and billing staff use data from water meters measure the volume of water that customers are consuming and appropriately charge for water usage.

Smart water technology is essential to making sure that there are minimal interruptions in water and sewer service, customers receive safe and healthy drinking water, and streets and buildings do not flood during storm events.

RELEVANT INFORMATION



- The City of Bellevue owns, operates, and maintains the drinking water, wastewater, and storm and surface water systems that supply drinking water, and collect and convey wastewater and stormwater for the residents and businesses in Bellevue, and the communities of Medina, Clyde Hill, Yarrow Point, and Hunts Point.
- Bellevue's utilities systems consists of more than 1,500 miles of pipeline, 25 water reservoirs, 68 pump stations and 11 regional detention facilities.

- The city has three important service levels for its water, wastewater, and stormwater utilities:
    - **Water:** Three or fewer unplanned water service interruptions per 1,000 customer accounts
    - **Wastewater:** 0.75 or fewer wastewater overflows per 1,000 customer accounts caused by system failures.
    - **Stormwater:** Two or fewer surface water claims paid due to system failure.
- The city operates a Supervisory Control and Data Acquisition (SCADA) system that provides remote monitoring and control of the water, wastewater and stormwater systems. The SCADA system is mission critical to minimizing water service interruptions, wastewater overflows, and surface flooding incidents.
- The city maintains and manually reads approximately 40,000 water meters on a bi-monthly basis. The data from those meters is used to determine billing charges for customers.
- In 2016, customer water leaks wasted approximately 88-million gallons of water.
- The city captures data on asset condition and failures in two major information systems (Maximo and Granite XP). For example, the city videos an average of 50 miles of storm and sewer pipeline per year to check for potential defects or maintenance issues.

WATER SUB-ELEMENTS

Metering – The measurement of water usage volume for residential, commercial and industrial customers for billing.

Asset Management – The short-term and long-term planning process to optimize asset life and minimize asset cost while meeting customer service levels and maintaining the appropriate risk management strategy.

System Operation – The collection and communication of data to monitor and control water supply and distribution operations, including maintenance scheduling, emergency response and other activities.

CURRENT STATE AND FUTURE PLANS

Now	Future
Manual meter reading every two months	Advanced meters capable of frequent readings and proactive leak detection
Asset condition is collected periodically on an interval basis (e.g., once every 10 years)	SCADA system uses sensors deployed at critical locations to provide real-time information on the condition of pipes, pump stations or other critical assets.
SCADA system monitors water/storm/sewer system performance and provide alarms	SCADA system is able to perform predictive operations through integration with real-time forecasting systems, such as weather forecasts.

STRATEGIES TO ACHIEVE FUTURE STATE

These are specific actions that the city will take to achieve the future state.

Principal strategy	Water strategic actions
FOCUS ON PROACTIVE AND ADAPTIVE SOLUTIONS (OR SYSTEMS)	Upgrade the SCADA system to replace aging technology for greater system-wide reliability while improving data collection and analysis capabilities. Implement Advanced Metering Infrastructure (AMI) for improved customer service, real-time usage tracking and proactive leak detection. Integrate technology systems – customer information, assets, GIS, etc. – for increased analytics, efficiencies and operational response.

ASSESSING MATURITY

Bellevue conducted a Smart City Maturity Assessment to gauge the current state of each element and further inform future strategies (see Appendix).

Water overall assessment: Level 2 (Opportunistic)

Target: Level 4 (Managed) within three to five years

WATER SUB-ELEMENT MATURITY SCORES

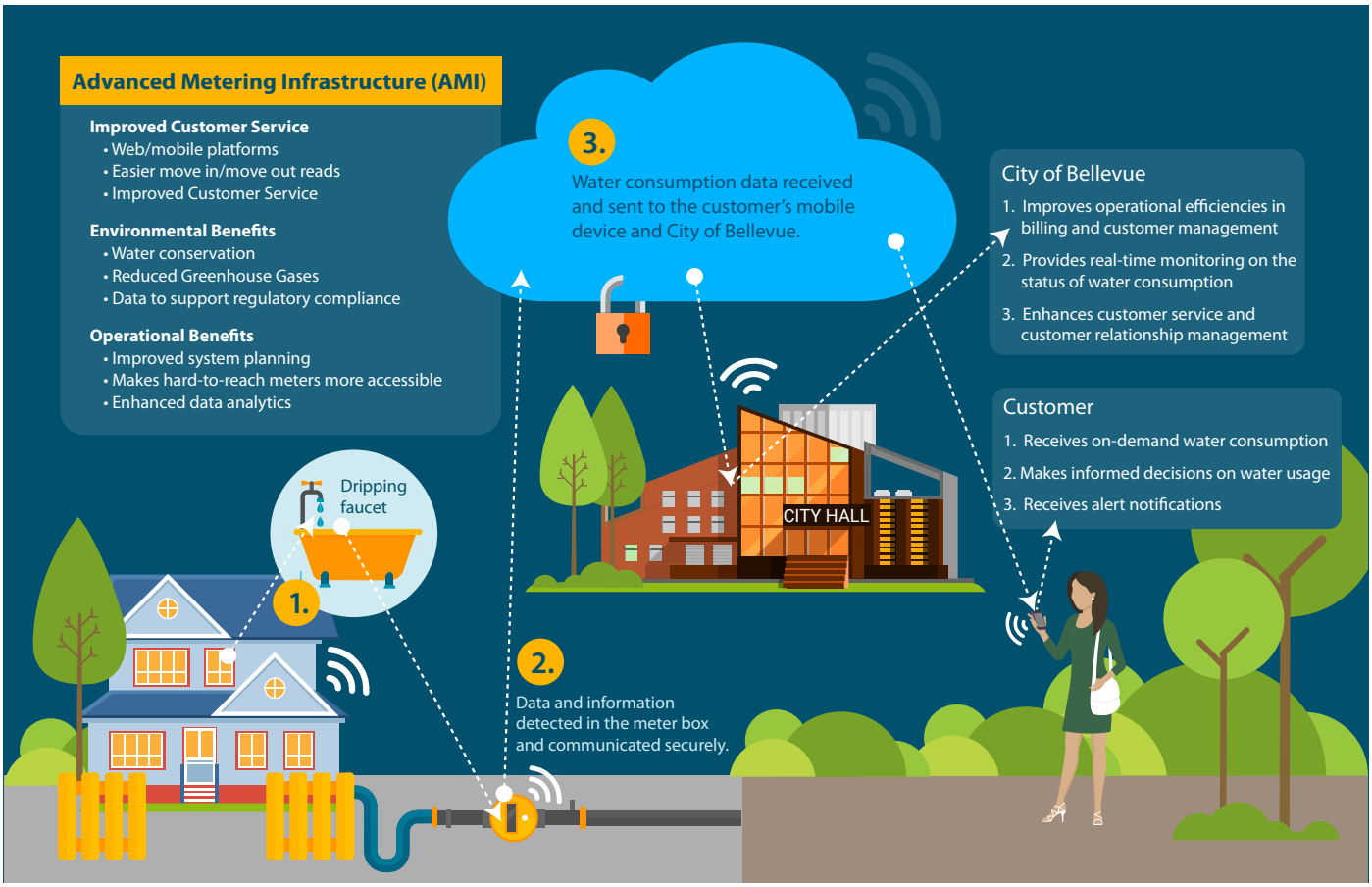
Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
INTEGRATED ASSET MANAGEMENT			→		
SYSTEM OPERATION				→	
METERING			→		

Each of the sub-elements was evaluated with respect to the city's collection and use of digital technology and communications to achieve the goals of the sub-element. For example, the maturity of the metering sub-element was evaluated based on the city's movement towards implementing an AMI network for water metering.

PLANNED PROJECTS/PROGRAMS

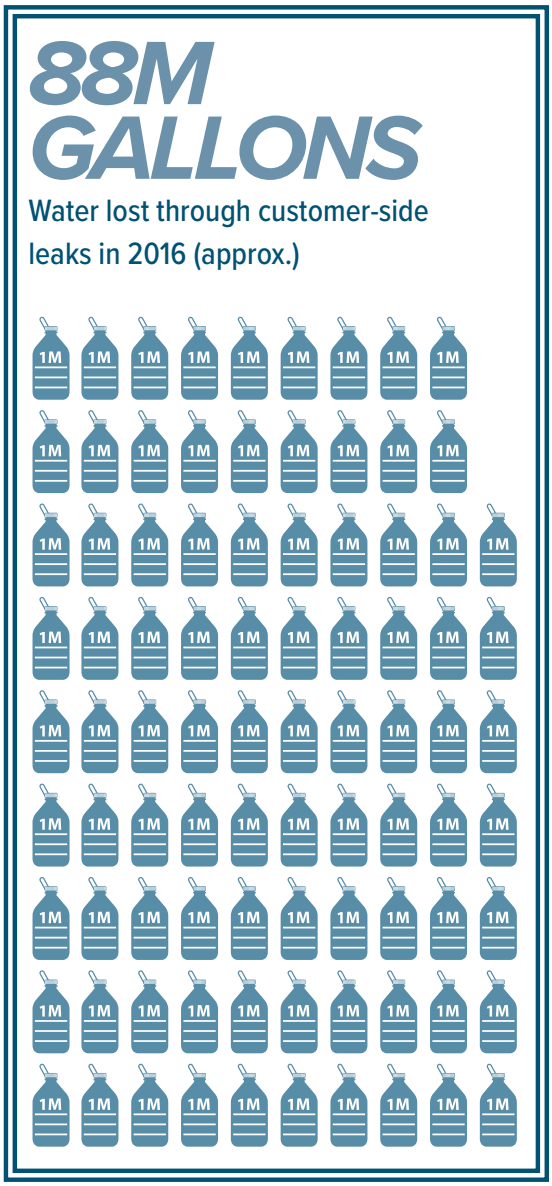
The following projects/programs are planned to close the gaps and reach our target level as identified through the maturity assessment:

ADVANCED METERING INFRASTRUCTURE (AMI)



The most significant water investment is the replacement of the city's existing manual-read water meters with a new AMI system. The AMI system qualifies as a smart city technology investment, because it incorporates electronic collection of water consumption data with wireless radio frequency communications to accomplish water metering, as opposed to a traditional manual read system which is very labor intensive. Adding data analysis tools to the metering system will also provide a base for demand management, which could lead to "time-of-use" pricing, water conservation, drought response and behavior change incentives. The AMI system will have the following immediate benefits to the city and its customers:

- Proactively detects leaks to avoid long, wasteful and costly leaks for customers
- Provides an easily accessible customer portal for viewing water consumption and setting alerts
- Promotes conservation by providing customers with daily/hourly water consumption data
- Improves ability to analyze data for system-wide leak detection and operations optimization
- Improves the accuracy of meter reading data, which promotes greater equity in customer billing
- Significantly reduces labor and vehicle costs for manual meter reading



SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

In the last five to 10 years, the aging of the city's existing SCADA system as well as advances in software, telecommunications, and electronic hardware have elevated the need for the city to both plan for and begin implementing a significant overhaul of the existing SCADA system. The city plans to improve the existing SCADA system and consider upgrades which would increase reliability, take advantage of newer communications technologies, and also increase data analysis with the goal of optimizing operations. The development of a SCADA vision and master plan would help to guide the city's investments in SCADA system improvements.

PREDICTIVE OPERATIONS AT STORMWATER PONDS

Utilities will begin a pilot program for implementing predictive operations at its stormwater ponds in 2019-2020. The pilot program will include selection of an engineering consultant and vendor in 2019, to assist with the predictive operations implementation in 2020.

INTEGRATION AND INTEROPERABILITY OF TECHNOLOGY SYSTEMS

The city should explore solutions to integrate SCADA, GIS (Geographic Information System), Maximo, the AMI meter data management system and other systems without compromising security and privacy. An integrated information system has the advantage of preventing information asymmetry and non-transparency. This interoperability will allow the utility to consider a high-level overview of operations, further enhance the capacity for system failure response and lead to more proactive management of demand changes and abnormal scenarios.

IMPLEMENTATION

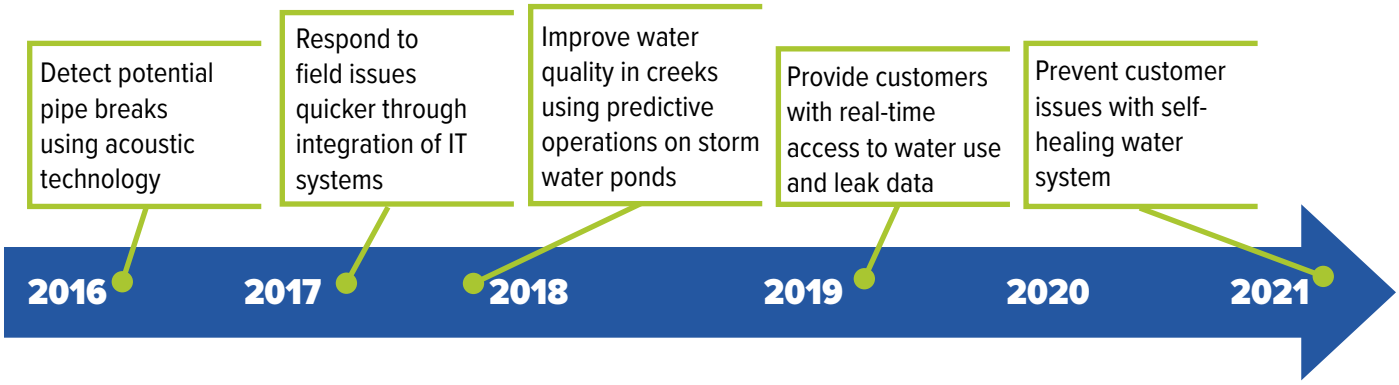
SCADA update: The city is proposing approximately $1.6M for the "Utilities Telemetry and Security Systems." Approximately half of that budget is directed to staff to operate and maintain the existing SCADA system. The remaining half will be used to replace critical, aged SCADA infrastructure and prepare a SCADA Master Plan, which will guide the longer-term overhaul of the SCADA system.

AMI system: The total capital cost for the AMI system is approximately $23M from 2017-20. However, the "smart city" portion of the investment is estimated at $12M, or roughly half of the overall investment. The majority of the investment will be offset by operational savings for manual meter reading and increased revenue from more accurate meter reads. Funding AMI will not require a rate increase. The majority of the move will be funded by savings from the decrease in labor and vehicles to read the meters.

BUDGET

Budget Proposal Title	Description	Outcome	Total Budget	How much for Smart City?	
Operating					
UTILITIES TELEMETRY AND SECURITY SYSTEMS	Operates and upgrades the SCADA system that controls the water system	140.25NA	$1,584,392	100%	$1,584,392
CIP			**(to 2023)**	**%**	**Amount**
ADVANCED METERING INFRASTRUCTURE IMPLEMENTATION	Replaces traditional water meters with cell-enabled meters to enable automatic data collection, better analytics, and enhanced customer services	140.69A	$23,100,000	50%	$11,550,000

SCHEDULE



FUTURE

What possibilities are created by moving to smart water technologies?

In the long-term, the city will benefit from enhancing the utilization of technology in the following areas of water services:

- **Proactive Leak Detection:** The AMI system can potentially be leveraged and/or enhanced to assist with proactive leak detection in the water distribution system. This can be accomplished through computational models that focus on flow balancing using a combination of "master meters" and the customer meters. Alternatively, the AMI system can be paired with acoustic leak detection technologies which can alert the utility when there are leaks. These technologies and approaches should be carefully monitored for cost-effectiveness and operational feasibility in the upcoming years, since they can greatly assist in the city's Asset Management Program.
- **Integration and Interoperability of IT Systems:** The city currently operates a number of information technology (IT) systems that can be integrated to increase interoperability. Examples of systems that could be further integrated include the SCADA system, GIS, Maximo, the new AMI meter data management system and the Customer Information System (CIS). Improving the interoperability of systems has the potential for increasing operational efficiencies, improving diagnosis of system issues, increasing speed of access to information and increasing the availability of information to customers.
- **Predictive Water Operations:** SCADA technologies are continuing to advance to allow for more predictive operations, especially when paired with advanced computational models. The city should continue to monitor these technologies in the SCADA arena, since it has the potential for greatly increasing the speed of operational response and preventing water system issues before they occur.
- **Rapid response and proactive management:** This interoperability will allow the utility to consider a high-level overview of operations, further enhance the capacity for system failure response, and lead to more proactive management of demand changes and abnormal scenarios.

Buildings

OBJECTIVE: Optimizing building performance, decreasing wasted energy and water, increasing comfort and safety

BACKGROUND

At the national scale, buildings account for 40 percent of the energy consumption[22]. In Bellevue, buildings account for 49 percent of our geographic-based greenhouse gas emissions. The commercial energy sector accounts for about 28 percent of greenhouse gas emissions, residential energy use accounts for 20 percent and industrial energy use accounts for 1 percent. Efficient building operations can therefore have a significant effect on sustainability and energy use in Bellevue. Moreover, energy efficiency is important for Bellevue's economy.

According to most estimates, 17 jobs are added to the economy for every million dollars per year saved in utility bills.[23] This stands in contrast to the estimated 11 jobs for each million dollars invested in the economy-at-large through methods like business tax breaks.[24] If we assume that Bellevue commercial buildings are consistent with the national average and waste thirty percent of energy[25], about $30M could be returned to Bellevue's economy instead of being spent on utility bills, creating more than 500 jobs.

The challenge is scaling energy efficiency technology and smart building strategies to the number and type of buildings in Bellevue.

In 2011, there was 67.5M square feet of commercial and multifamily building space and 59,000 housing units in Bellevue.[26] By 2016, the city had grown to 75.2M square feet of commercial and multifamily buildings spread across 2,256 buildings, and 62,149 housing units.[27] Only 30 percent of the buildings in Bellevue are over 20,000 square feet, but these buildings account for 85 percent of the total square footage spread across commercial and office buildings and could offer a more strategic target audience for deploying efficient building practices.[28]

RELEVANT INFORMATION

When people think of smart buildings, they typically think of connected or "learning" thermostats, intelligent lighting systems, integrated security and fire alarms and advanced commercial building energy management systems. As market demand for these technologies is grows, the home energy management market is seeing rapid growth — forecasted to grow from five percent of homes today to 19 percent by 2021.[29] Annual investments in energy management systems for commercial buildings is projected to triple by 2024, totaling 3.21 billion nationwide.[8]

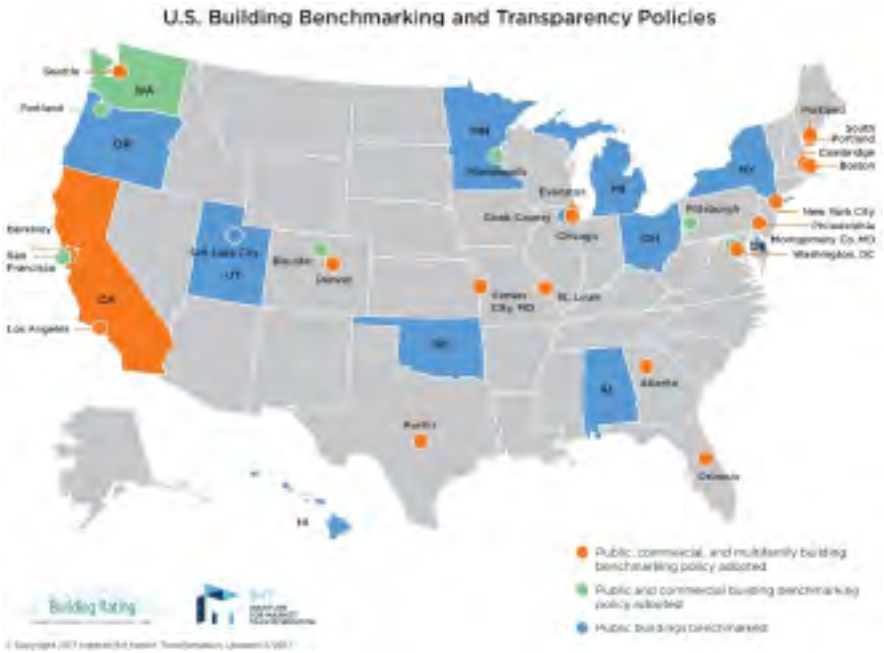
Building owners and tenants faced with vetting the best sensor technology and software-enabled fault detection and timing system deployments can sidestep potential losses by avoiding proprietary systems as not all firms will survive the rush to market. Rapid improvements to sensor battery life, coupled with decreasing costs will likely launch even more activity in this space.

BENCHMARKING: THE BENEFIT OF GATHERING DATA

Beyond the purchase of smart systems and technology, smart buildings can also include a focus on building performance data. Benchmarking is the process of using monthly energy or water data and building characteristics to compare a building to like buildings. Knowing how well buildings are performing in comparison to like buildings can reveal cost- and energy-saving opportunities to tenants and building operators, enabling them to make more informed choices about potential improvements.

Benchmarking can apply to commercial buildings through programs like the Environmental Protection Agency's (EPA) Energy-Star Portfolio Manager or Department of Energy's (DOE) Commercial Building Energy Asset Score; tenants through programs like the EPA's Tenant Star; and single-family homes through EPA's Home Performance with Energy Star and Home Energy Yardstick, or the Home Energy Rating System (HERS Index). Typically, these programs rely on federal databases to do the comparison and ranking, with user inputs of actual energy use with varying levels of public transparency.

- **Commercial building benchmarking trends:** Forty-two jurisdictions[30] around the United States have already required public disclosure of commercial energy data and have had success with the data-centric approach.



Source: http://buildingrating.org/graphic/us-building-benchmarking-policy-landscape

- **Residential benchmarking**: Energy data disclosure can also apply to residential homes. On Dec. 14, 2016, the Portland City Council unanimously adopted an ordinance requiring home energy scores for single-family homes listed for sale. The score points details energy use and includes recommendations for potential savings. Portland is in the process of developing their own home energy format, but used the DOE shown at right as a potential guide.

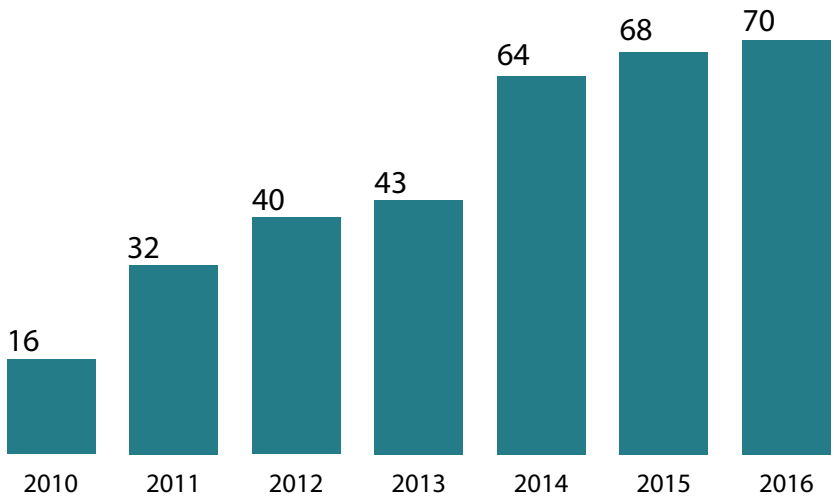
- **Mandatory benchmarking benefits**: While voluntary benchmarking programs are important and can be quite successful, they do not have the reach of mandatory programs.

MANDATORY PROGRAMS PACK A BIGGER IMPACT

City	Type	Program/policy	Buildings included	Floor area included (millions of s.f.)
BOSTON	Voluntary	Challenge for Sustainability (2009-2013)	97	27
	Mandatory	Building Energy Reporting and Disclosure Ordinance (2013)	1,600	250
MINNEAPOLIS	Voluntary	BOMA of Greater Minneapolis Kilowatt Crackdown (2012)	80	25
	Mandatory	Commercial Building Rating and Disclosure Ordinance (2013)	625	110
SEATTLE	Voluntary	Seattle Kilowatt Crackdown (2009)	53	18
	Mandatory	Council Bill 116731 (2010	3,600	295

Source: Caroline Keicher, "Emerging Best Practices: Energy Benchmarking and Disclosure in U.S. Cities" (presented at the Building Energy 14, Boston, MA, March 6, 2014) as reported in Keystone Energy Alliance and KEEA Energy Education Fund "Tracking Energy to Take Action: A Guide to Energy Benchmarking for Pennsylvania" November 2014 report.

In 2016, 70 commercial buildings in Bellevue achieved an Energy Star rating, meaning they scored 75 or greater on a scale of one to 100 for their building type. The Energy Star program reports that, on average, certified office buildings use 35 percent less energy, generate 35 percent fewer greenhouse gas emissions than other like buildings and cost $0.54 less per square foot to operate while garnering higher rental and occupancy rates. Not all buildings can achieve the rating due to unique building characteristics or operations that do not have a comparative score in the rating system. Some building owners that have benchmarked have elected not to pursue certification due to the small cost, nervousness about publishing the data, or that the buildings score less than 75.



Source: EPA Energy Star database, 2010-2016

Bellevue is well-poised to take on commercial data disclosure but not residential home energy scores, as PSE already provides automated data downloads to EPA's Portfolio Manager benchmarking tool. Bellevue is also leading by example and has benchmarked 27 municipal buildings under Resolution 9186, passed in November 2016.

BUILDINGS SUB-ELEMENTS

Building Energy Data – The energy meter/building management system interface and its impact on overall community building energy use. Focuses on energy data available to the building operator, city, and utility.

Building Water Data – The water meter/building management system interface and the impact on the overall community water use. Focuses on water data available to the building operator, city and utility. This includes irrigation water used in landscaping.

Networked Building Systems (not assessed)

- **Facility Management** – Technologies that save time, money, and energy for building operators and the community at large, as well as those that improve building system performance.
- **Security & Safety** – Technologies that increase safety, security, and knowledge of risk in the building, for first-responders and building operators, for occupants, and for the community at large.

CASE STUDY

MICROSOFT HQ (88 ACRES)

Microsoft's Redmond headquarters provides an illustration of both possibility and challenge. Faced with coordinating the care of 125 buildings, then Facilities and Energy Director Darrell Smith considered replacing the 30,000 varied sensors spread across the 500-acre campus and discovered that "ripping and replacing" equipment for smooth integration would cost more than $60M. He and a team of engineers built smart building software that now handles 500M data transactions every 24 hours. The system turned back fast savings, discovering a fan that had been mistakenly left had blown through $66,000 worth of energy. Elsewhere, a five-minute fix in the chilled water system netted $12,000 in yearly savings.

CURRENT AND FUTURE STATES

Now	Future
Urban Smart Bellevue available for Downtown properties through December 2017	• Continue partnership with PSE to build on success of Urban Smart • Large commercial buildings benchmark their energy use information and make 3-5% improvements annually, market transparency achieved
Energy data portal available through PSE (MyData)	• Real-time energy and water usage data available for building owners through AMI
Qualified city buildings benchmark and disclose their energy use information	• City buildings use analytics to detect real-time faults that waste energy, water or cause security issues • Leaks and faults are self-healing; building isolates issue before damage spreads
Pre-fire App provides Fire Dept. with PDFs of building plans	• Security and fire systems are integrated with 911 so responders know exact issue before arrival to the scene

STRATEGIES TO ACHIEVE FUTURE STATE

These are specific actions that the city will take to achieve the future state.

Principal strategy	Buildings strategic actions
DRIVE WITH DATA	• Collect data on smart building technology adoption in Bellevue businesses and provide building performance data to the community to influence behavior and decision-making.
PURSUE PARTNERSHIPS	• Expand on partnerships with PSE and others to increase smart buildings and energy savings through programs like Urban Smart Bellevue. • Develop performance-based pilots and policies to grow the stock of advanced green buildings.

ASSESSING MATURITY

The maturity index below is a "best-guess" at the current market state, and maturity in these areas varies significantly from building type and size. Larger, Class A, or tech-savvy office buildings, like Microsoft, are more likely to have deployed some type of smart building technology. Neither of the networked building systems sub-elements of facilities management or security & safety could be evaluated for maturity due to a lack of data.

Buildings overall assessment: Level 2 (Opportunistic)

Target: Level 4 (Managed) within three to five years

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
BUILDING ENERGY DATA			→	→	
BUILDING WATER DATA			→		

PLANNED PROJECTS/PROGRAMS

The following projects/programs are planned to close the gaps and reach our target level as identified through the maturity assessment:

- **City of Bellevue municipal buildings benchmarked.** As part of the King County Cities Climate Collaboration (K4C), Bellevue participated in the energy benchmarking subcommittee and implemented the recommended action of enacting a resolution to disclose municipal energy use performance in November 2016.
- **Continue partnership with PSE to build on success of Urban Smart.** Bellevue is collaborating with a recently launched PSE program (UrbanSmartBellevue.com) to bring real-time meter information to downtown businesses. The program engages employees and operators with technology through action plans, an app and community-based, social-marketing strategies. With 10.3M square feet in the Central Business District[31], over half of the district — 5M square feet or 72 buildings — is affected by the voluntary program Urban Smart Bellevue. If the program proves successful, it could expand to other communities, or advance related initiatives such as commute-trip-reduction tracking, Regional Envirostars recognition, benchmarking or LEED Dynamic Plaque building performance monitoring and scoring.
- **Understanding the state of networked building systems and smart building practices in privately-owned buildings.** As mentioned above, the core team had hoped to evaluate the maturity in two areas of networked building systems but found that there was not enough data available to make an accurate assessment. Unfortunately, there is no central data source for status of the market adoption of smart building practices throughout Bellevue. Even the

knowledge of square footage and building type and energy use intensity is difficult to find. Without this knowledge, it is difficult to begin to properly incentivize and encourage smart building practices as city staff cannot pinpoint the gap between the current status quo and the future of smarter buildings.

- **Facility Management** – Technologies that save time, money, and energy for building operators and the community at large, as well as those that improve building system performance.
- **Security & Safety** – Technologies that increase safety, security, and knowledge of risk in the building, for first-responders and building operators, for occupants, and for the community at large.

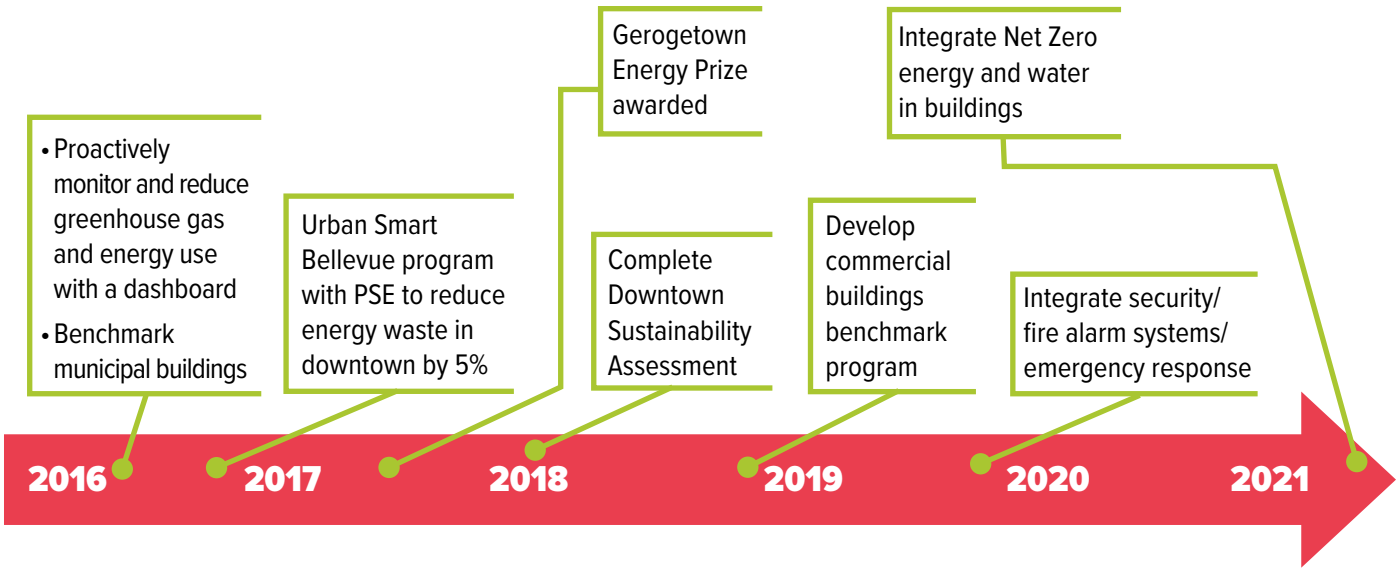
IMPLEMENTATION

BUDGET

Currently, programming and policy initiatives focused on smart buildings are funded only through existing staff resources, utility funding, and small amounts of grant money.

The Environmental Stewardship Strategic Plan 2013-2018[32] recognizes the value and need for of a revolving loan fund to help with energy conservation investments, which could include smart building and data efforts. City staff are exploring alternative ways of funding energy efficiency and deep green retrofits through internal and external revolving loan funds.

SCHEDULE



FUTURE

What could be in store for smart buildings?

- **Benchmarking policy leadership.** Looking to best practices on benchmarking disclosure programs, the city could streamline the process for building owners, possibly through a help desk and automatically linking existing data files to reduce errors. Commercial buildings over 20,000 square feet could make three- to five percent improvements annually if engaged with the data and committed to making improvements.
- **Survey commercial business smart building practices.** Conducting an initial survey of smart building practices amongst Bellevue commercial businesses could also provide better understanding of market conditions and gaps, and where the City can best facilitate action.
- **Use data analytics to detect real-time faults that waste energy, water or cause security issues.** Tuning City Hall's ability to detect faults in the HVAC will provide more comfort, streamline maintenance and optimize performance. The city is exploring applying the technology at the Bellevue Service Center, and could expand to other facilities and stations.
- **Leaks and faults are self-healing; building isolates issue before damage spreads.** If there is a major water leak or excessive use by a piece of equipment, the building control system realizes it and isolates the leak automatically and switches to a redundant piece of equipment or shuts off that irrigation zone.
- **Real-time water and energy usage data available for building owners through AMI.** Data is connected with building operators in a simple and meaningful way that is timely, relevant, easy-to-understand and comparative.

CASE STUDY

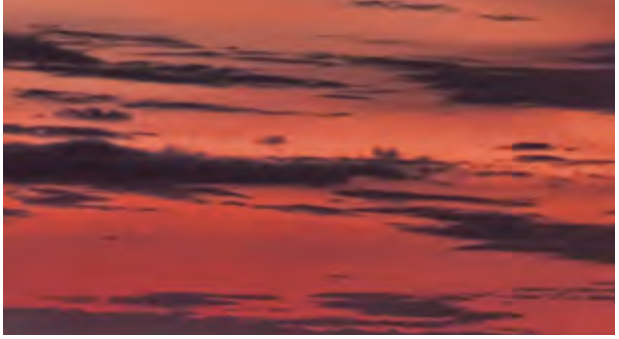
ACCESSIBLE DATA MOTIVATES EFFICIENCIES IN SEATTLE

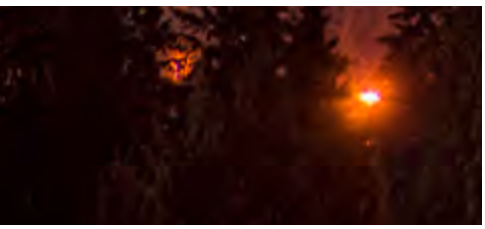
The City of Seattle's found that clear, accessible data can help motivate building energy efficiency improvements citywide. Netting the 2017 Energy Star Award for Excellence in Data Innovation, Seattle's data visualization allows users of their benchmarking site (http://bit.ly/2q78xCX) to filter, sort and download addresses, floor areas and age and building-use characteristics to energy performance metrics, including energy use intensity (EUI), Energy Star score and greenhouse gas emissions.

Just-posted 2015 data shows an overall increase in building efficiency with a drop in energy consumption for the 3,300 properties reporting data. With a 99 percent compliance rate over three years, Seattle's also increased the number of Energy Star certification-eligible buildings by 13 percent between 2015 and 2016.

Seattle's Building Energy Benchmarking and Reporting Program requires commercial and multifamily buildings of more than 20,000 square feet to conduct and report energy performance tracking through the Energy Star Portfolio Manager.

- **Support smart building workforce development.** The city could partner with at the college level and professional organizations to increase smart building training which would support smart building adoptions while creating employment opportunities.
- **Providing data at-scale to community.** City-scale data develops specific energy, safety and water "maps" for the community that would allow for better comprehension and local action. Possible topics include: energy grid resiliency, peak demand, real-time pricing, energy performance of buildings, places of community refuge in the case of disaster, evapotranspiration information and solar access through initiatives like Google's Project Sunroof.
- **Gaining insights from comparing data with other cities.** The city recently finished competing in the Georgetown University Energy Prize, a national prize program to rank similar-sized communities on energy performance. Each community will receive a "score," which could deliver insights about weather-adjusted energy use per capita relative to other cities and what policies and programs might create the difference.
- **Security and fire systems are integrated with 911 so responders know exact issue before arrival to the scene.** The quickest, safest/quickest routes of travel in the building and to the nearest hospital are delivered via integrated devices. Key medical information is in the process of being made available for first responders. (See the Public Safety element).
- **Net zero energy and net zero water building incentives; performance based incentives.** Green building incentives reduce barriers for developers and the City is able to provide a model Living Building Ordinance[33], encourages Net Zero Energy[34] and PassiveHaus[35] designs, incentivizes water-efficient landscaping certifications such as Sustainable Sites[36], LEED, WaterSense, and demonstrates successful municipal projects such as Salmon Safe, green roofs or green walls.
- **Explore code amendment opportunities** and incentives to reflect new technologies like electric vehicle charging and rooftop solar.
- **Monitor and look for opportunities to advocate for creative financing opportunities to incentivize smart building investments.** The city could encourage smart building practices through advocating for programs such as Property Assessed Clean Energy (PACE), an incentive program used in other states like California and Michigan.





Energy

OBJECTIVE: Improving grid reliability, increasing efficiency, connecting renewables

Whether coming from electricity, gas or renewables, energy powers all the technology used in a city. Applying intelligent energy systems to those sources can help ensure sufficient, efficient, and reliable energy for the community. The City of Bellevue is working closely with Puget Sound Energy (PSE), the electrical and gas utility provider, on two-way advancing metering for both gas and electricity as well as the implementation of PSE's Smart Grid plan. A smart grid allows customers to more effectively manage energy use while increasing reliability. Ensuring the energy grid reliability is critical for any smart city. Improving the operation and control of the grid to allow for greater distributed generation and communication will increase efficiency and can mitigate the need to add more infrastructure.

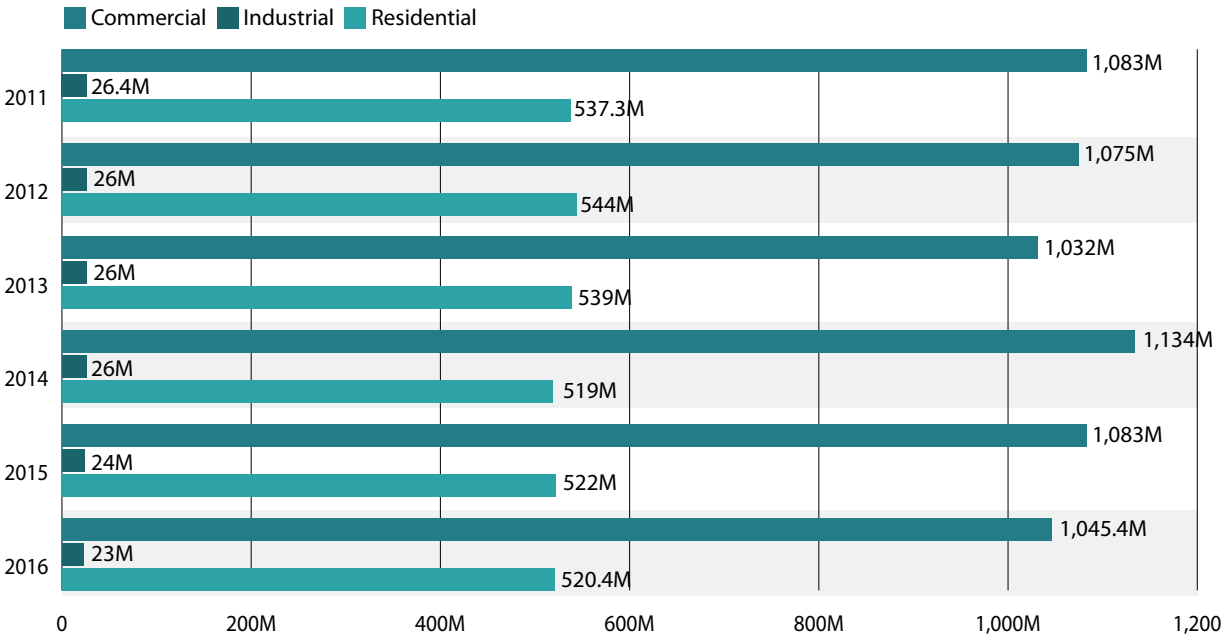
Bellevue Way in 1986

Downtown Bellevue at night 2016

As Bellevue shifts from a suburb to an increasingly urban economic hub, electricity that powers businesses, homes and all the smart technology needed for today's modern life is essential. According to PSE's Integrated Resource Plan, growth in demand has been concentrated on the Eastside. At times of peak demand, such as on cold winter days, and with Bellevue's high-tech business community that requires 24/7 connectivity, electrical reliability is a key performance indicator for energy for the smart city.

BELLEVUE COMMUNITY ELECTRICITY USE (KWH)

Since 2011, Bellevue's experienced an overall reduction in residential commercial and industrial energy use, despite a growing population and job base.



Sourcse Puget Sound Energy

BELLEVUE ELECTRICAL RELIABILITY TRENDS COMPARED TO PSE'S ENTIRE SERVICE TERRITORY

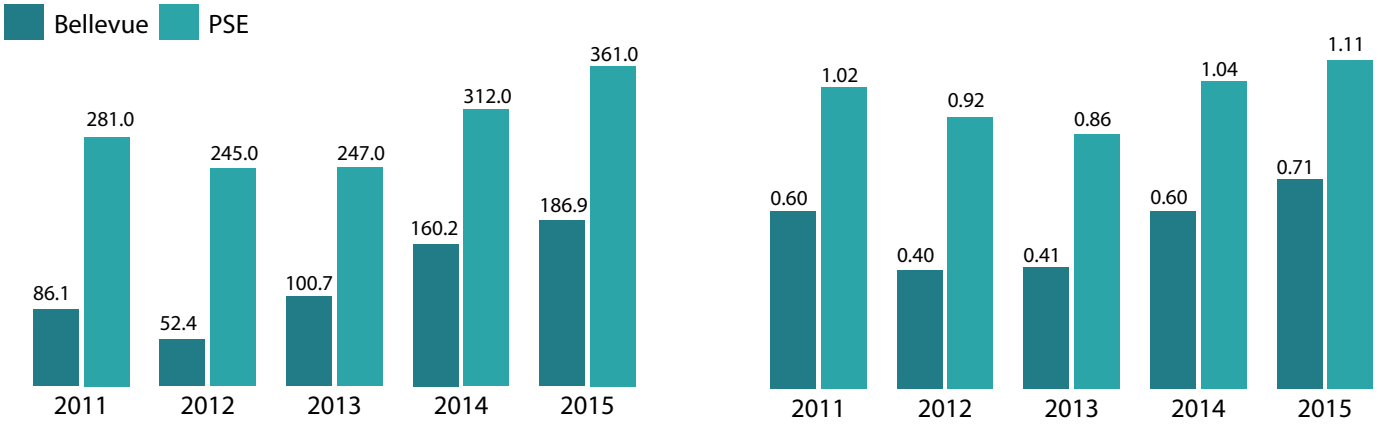
The city uses several performance metrics to track progress toward achieving the Smart City goals for energy, including grid reliability[37], electricity consumption, natural gas consumption, renewable energy deployed in Bellevue, number of residents and businesses purchasing green power from PSE and citywide greenhouse gas emissions. For the past 10 years, Bellevue's service reliability as measured by the System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) has exceeded that of all PSE customers in aggregate.

SAIDI

A five-year, rolling average figure, expressing the number of minutes customers might be without power, including storm outages.[38]

SAIFI

The measure of how often the average customer in an area is out of service during the course of a year, excluding storm outage events.[39]



Source: 2015 Bellevue Electrical Reliability Report

RELEVANT INFORMATION

SMART GRID INVESTMENTS

As the electricity and natural gas utility for Bellevue, PSE will lead all smart grid investments in the network. PSE's smart grid efforts are comprised of the following activities over the next 10 years[40]:

- Deploy two-way automated metering technology to refresh the aging legacy automatic meter reading infrastructure.
- Enhance the customer experience by automatically providing information and services to the customer related to outage notification, starting/stopping service, usage data and other capabilities.
- Expand deployment of self-healing technology that automatically reroutes power during outages to improve electric system reliability.
- Deploy energy storage pilot projects and continue to research and evaluate emerging energy storage technologies.

- Provide customers with easy-to-use energy management tools and information.
- Integrate customer equipment, such as electric vehicles and customer-owned power generation.
- Upgrade and replace aging infrastructure as needed – for IT networks, back-end information systems and the electric and natural gas systems – with consideration to implementing a smarter grid.
- Evaluate and selectively deploy other customer energy management programs and pilot projects

INCREASING RENEWABLE ENERGY

The City of Bellevue works with PSE to support its ongoing energy efficiency, renewable energy outreach and education programs and has partnered with PSE on the Green Power Challenge to encourage Bellevue residents and business to purchase green power from wind energy. The City of Bellevue also facilitated 90 solar installations in Bellevue through two Solarize campaigns, in partnership with Northwest SEED.

BELLEVUE'S ROLE IN PSE'S INTEGRATED RESOURCE PLANNING

Through regular participation in the PSE's Integrated Resource Planning process, city representatives meet with PSE's in-house economists, energy specialists and demographers to provide input into a regional forecast and plan for natural gas and electricity use and supply that looks two decades into the future.

ENERGY ELEMENT SUB-ELEMENTS

Grid System Operation – The monitoring and controlling of grid transmission using computer-based remote control and automation.

Energy Conservation and Renewables – Conservation is the reduction in energy consumption resulting from increases in the efficiency of end use, production or distribution. Renewable energy is energy produced from solar, wind, geothermal, tidal, wave, renewable biogas and biomass and low-impact hydropower. Conservation and renewable energy can increase the reliability of the grid system and reduce carbon emissions

Metering – The measurement of power and natural gas usage for residential, commercial and industrial customers for billing. PSE was an early adopter of Automated Meter Reading (AMR) in 1998, and is now in the process of upgrading to two-way automated meter reading.

CURRENT AND FUTURE STATES

Now	Future
Electronic billing, some meters are available in 15-min. intervals	• Smart energy meters provide daily readings • Smart Grid • Demand response programs to lower peak energy curves and balance grid • Real-time pricing • PSE's automatic integration system allows two-way communication
Over 1.8 MW of solar installed in Bellevue with net metering available through PSE.	• More rooftop solar and community solar installations • Additional green power purchases from PSE by Bellevue residents and businesses • Battery storage
Electric Vehicle (EV) charging stations for city fleet and public use	• Ample EV charging stations around the city • Increased adoption of EVs by people living and working in Bellevue
Annual electrical reliability report for Bellevue	• Continued electrical reliability reporting and development of strategies for improving reliability

STRATEGIES TO ACHIEVE FUTURE STATE

These are specific actions that the city will take to achieve the future state.

Principal strategy	Energy strategic actions
FOCUS ON PROACTIVE AND ADAPTIVE SOLUTIONS (OR SYSTEMS)	• Foster opportunities for micro-grid and district energy pilots to enhance energy resiliency • Expand EV charging stations to support clean transportation goals.
PURSUE PARTNERSHIPS	• Continue programs to expand renewable energy and develop policies and targets on fossil-fuel-free energy. • Continue PSE collaboration on electrical reliability and piloting smart grid technologies in Bellevue.

ASSESSING MATURITY

Bellevue conducted a Smart City Maturity Assessment to gauge the current state of each element and further inform future strategies (see Appendix).

Energy overall assessment: Level 3 (Repeatable)

Target: Level 4 (Managed) within three to five years

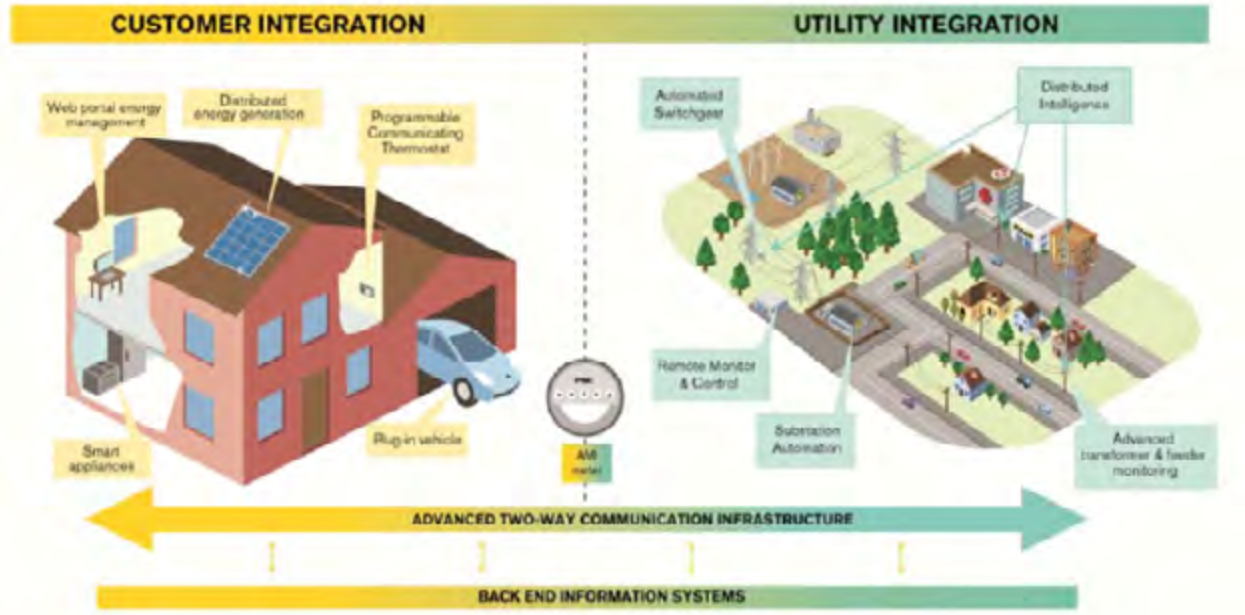
ENERGY SUB-ELEMENT MATURITY SCORES

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
GRID SYSTEM OPERATION				→	
ENERGY CONSERVATION AND RENEWABLES				→	
METERING				→	

PLANNED PROJECTS/PROGRAMS

The following projects/programs are planned to close the gaps and reach our target level as identified through the maturity assessment:

GRID SYSTEM OPERATION



Source: Puget Sound Energy 2016 Smart Grid Technology Report

Partnering with Puget Sound Energy will be necessary to support the rollout of Smart Grid technology. The City of Bellevue will seek opportunities to pilot new Smart Grid technologies in Bellevue and will continue to promote and seek funding for energy efficiency, conservation and renewable energy programs. The city will also seek partnership opportunities for expanding electric vehicle charging infrastructure, by partnering with other jurisdictions and the private sector.

- Improvements in the coordination and development of system-wide grid system operation plans, building on the current work-group level or geographic location level planning.
- Ongoing improvements in data analysis and management.
- Improved fault detection in cases of natural disasters or extreme weather events.
- Expand EV charging infrastructure throughout the city.

ENERGY CONSERVATION AND RENEWABLES

- **Purchasing wind power to reduce the city's carbon footprint.** The city is reducing its carbon footprint through participation in Green Direct, PSE's initiative allowing local governments and major commercial customers to directly purchase renewable energy. Bellevue plans to purchase 10.3M kilowatt hours, or half of its total energy usage, starting in 2019, reducing overall municipal emissions by approximately 30 percent. Additional cities and large organizations have opted to purchase the wind power produced by the program. Ultimately, the project is expected to produce enough renewable energy to power 30,000 homes.[41]

- **Continue to promote energy efficiency and conservation for Bellevue residents and businesses**. PSE's Green Power and other programs provide a tangible means of supporting efficiency efforts.
- **Promoting solar through SolSmart.** The city will participate in a regional effort led by Northwest SEED to achieve SolSmart recognition, a designation for "solar-friendly" cities.
- **Seeking opportunities to incentivize green building**. Identifying opportunities to strengthen building and energy codes for energy efficiency and renewable energy.

METERING

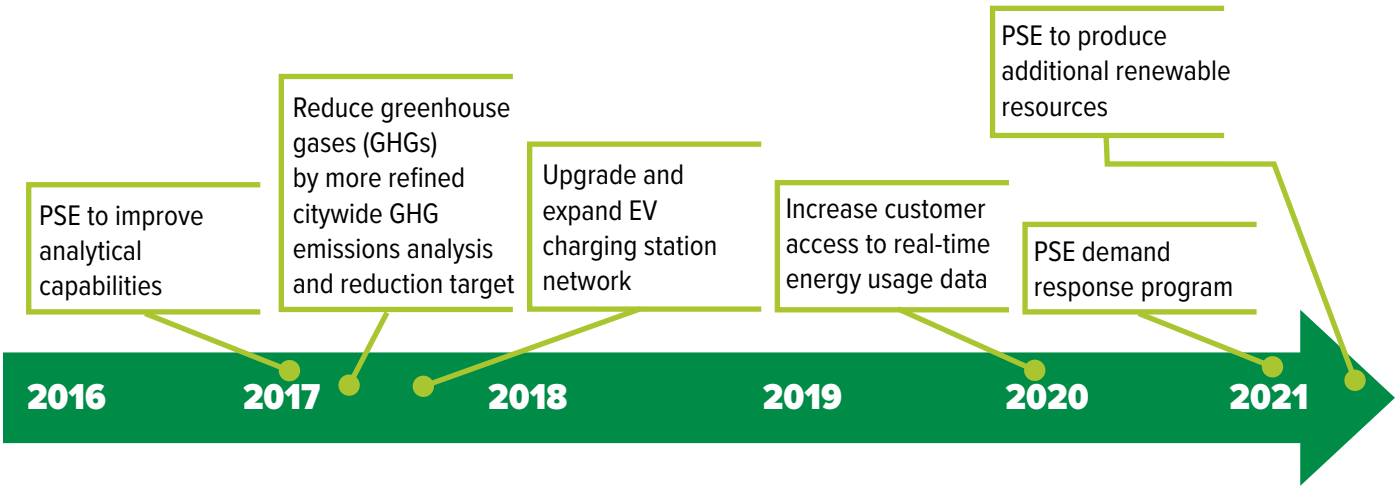
- **Partnering with PSE for Advanced Metering.** PSE currently has a plan for advanced metering infrastructure and identified possibilities for partnership with the city on shared communications infrastructure for advanced metering for energy and gas. PSE also plans to create an automatic integration system that will enable two-way communication in the next three to five years.

IMPLEMENTATION

BUDGET

Budget Proposal Title	Description	Outcome	Total Budget	How much for Smart City?		Element
		CIP	(to 2023)	%	Amount	
DOWNTOWN COMMUNITY DEVELOPMENT IMPLEMENTATION	As part of Downtown Livability implementation, conducts studies on parking availability, location of EV charging stations, and intelligent recycling and garbage locations	EC CD-37	$4,152,500	3.7%	$155,000	Energy/ Transportation

SCHEDULE



FUTURE

What could be in store for smart energy?

- **Benefitting from solar through collaboration.** Currently, PSE customers can take advantage of net metering, which credits customers for electricity generated by their solar panels, representing a step forward in promoting distributed renewable energy. Through collaboration with PSE, the city could develop targets for distributed renewable energy, along with aligning targets and opportunities for energy conservation.
- **Increasing efficiency.** Improved analysis of transmission losses and peak load demands and interoperability across systems, along with increased efficiency in homes and commercial buildings.
- **Helping create county-wide renewable strategies.** The city will participate in a King County-led renewable energy transition planning effort to develop strategies for significantly enhancing the percentage of renewables in the region to 90 percent of the electricity supply by 2030.
- **Analyzing data at-scale to community.** During 2017, participation in the Georgetown University Energy Prize mentioned under the Buildings section will provide Bellevue with a dataset surrounding residential and municipal building energy use that can be compared and contrasted with 49 other communities. The city will likely draw additional insights from that data comparison that will suggest other avenues for improvement.
- **Preparing for outages through enhanced resiliency.** During weather outages or other emergencies, the city deploys a system of planned battery and renewable use to support basic integrated system functionality and communication needs.

Security, Privacy and Data

Becoming a smarter city opens up new risks and opportunities for City of Bellevue systems and data to be addressed as part of executing projects defined under each of the smart city elements. These parallel and foundational efforts focusing on security, privacy and data support all smart city efforts.

SECURITY

The City of Bellevue has a mature IT security program versed in protecting data and IT systems. The IT security program currently ensures compliance with requirement from the FBI on Critical Justice Information System, the payment card Industry on credit card information, Health Insurance Portability and Accountability Act and various professional accreditations for departments. As the smart city plan moves IT from information systems into operation systems, the security program must adapt to new vulnerabilities and requirements.

The next focus of the IT Security Program is to adapt critical infrastructure security policies and practices to protect smart, connected physical infrastructure. The network has expanded beyond city facilities and is now out in the public right-of-way and other locations, with IoT devices, sensors and controllers capable of short-term storage of data and processing before sending to central systems and databases.

The City of Bellevue IT Department is in the process of expanding the IT security program funded under the IT budget to adapt to these emerging needs. This includes adjustments to scope of security risk assessments, modifications to standard operation procedures and review of critical infrastructure compliance requirements from Department of Homeland Security. It also includes ensuring security is embedded as part of any new system implementation.

PRIVACY

More information about people will now be available from smart city systems, including real-time water usage, location of devices on the Wi-Fi network and video streams of pedestrians in our traffic cameras. Given the amount of data involved, Bellevue is aware of the significant risks if privacy and access to personal identification, behavior or communications is not planned for and carefully monitored. To that end, work has begun on privacy principles that will provide clarity on roles and responsibilities and guide processes the city follows to protect privacy.

The City of Bellevue complies with current laws for privacy protection, such as the federal Identity Theft and Assumption Deterrence Act, and with Washington State's Open Records Act and the personal information exemptions included in the act. Bellevue also monitors legislation that will affect privacy and development of privacy best practices to minimize privacy risks for all.

DATA

Smart city systems will be producing enormous quantities of data that can be stored, analyzed and aggregated with other data. This "big data" burden has technology, staff and cost impacts. From a technology perspective, new big data tools for analysis and visualizations continue to emerge, and these put pressure on staff to select, learn and be productive with these in their analysis work. The cost growth from increasing data sets must also be planned for and budgeted.

On the positive side, smart city data can be made available to residents, businesses, research organizations, non-profit agencies and many others to their benefit and the city's. This leverages Bellevue's open data portal (https://data.bellevuewa.gov/) and reinforces the City of Bellevue's commitment to data transparency. Additional data may reveal areas of need while providing a foundation to effectively address community concerns.

SHORT-LIST OF STRATEGIES THAT ADDRESS GROWING SECURITY AND PRIVACY CHALLENGES

- **Updating the scope of security risk assessments to include the public right-of-way, including IoT devices, sensors and controllers.** This is adaptive strategy expands to include new devices and/or methods of collecting data as the smart city system expands. The success indicator continues to be avoidance of security breaches and continuing to receive high marks on independent external scans, risk assessments and accreditation results.
- **Clarifying privacy principles as well as roles and responsibilities.**
- **Complying with current privacy protection laws, while monitoring legislation to develop privacy best practices.**
- **Continuing education around the collection and analysis of big data to enable staff to clearly see opportunities for efficiency, conservation and possible economic development opportunities.**
- **Develop centralized data repository and analytics tools.**

Conclusion

BELLEVUE

SMART

OBJECTIVE: Technology, data analytics, integrated systems, working together, informed decisions

While this current two-year phase of the smart city plan focuses on foundational investments, the capability for integrating these systems and achieving greater interoperability is already in planning. In many ways, past system deployments mean that Bellevue is already a smart city. The ongoing challenge is to continue getting smarter. In addition to the projects detailed earlier, putting together this plan has also emphasized several best practices for preparing Bellevue for future smart city phases.

BEST PRACTICES

Planning: Developing the smart city plan reinforced the value of integrated long-range planning. The ITS Master Plan of 2004 put in place key infrastructure pieces, fiber-optic network and vehicle detectors that are critical for today's smart systems, such as SCATS and Wi-Fi. The 2016 Water System Plan recommended implementing AMI for greater efficiencies, earlier proactive detection of customer leaks and improved accuracy. Strategic plans for Enterprise Technology, Fire Department, Environmental Stewardship Initiative and Police Department also clarify needs and a future vision so planning for major projects and taking advantage of opportunities that arise can happen coherently. Future planning efforts will also shape additional smart city projects. For example, resiliency planning can define climate change adaptation strategies and identify opportunities to decrease overall vulnerabilities of city systems.

Monitoring: Technology is maturing quickly, with new capabilities constantly emerging. Industry standards and professional best practices are still developing. A technology that may not be mature one year, may be ready for implementation the following year. Taking advantage of emerging capabilities requires monitoring the technology maturity and direction of industry sectors, including autonomous vehicles, 5G wireless, battery technology and many more.

Partnerships: Partnerships provide opportunities to advance long-term interests. Private sector partners developing new technologies and services look for opportunities to mature their offerings. In some cases Bellevue can be that testbed, as it has been in the advanced video analytics pilot to recognize vehicles, bicyclist and pedestrians better. Many smart systems go beyond city borders, making regional collaboration important. Bellevue will continue to leverage existing public partnerships, like the Community Connectivity Consortium, NORCOM and more, to share risks and rewards and achieve a larger benefit than by Bellevue going alone.

GETTING THE SMART CITY ELEMENTS TO WORK TOGETHER

With the smart city systems deployed and more in planning, there are two primary ways, besides process integration, to integrate systems:

DATA INTEGRATION

Smart city systems, whether from AMI, SCATS or intelligent building systems, will produce enormous data sets. Through the NIST grant to develop a smart city dashboard, data can be used by staff and the public for real-time status. For example, Utilities staff can monitor water quality data provided by

Seattle Public Utility and Bellevue's own sensors to make adjustments and continually keep quality at the desirable levels. Additional dashboard modules for transportation, energy and buildings are planned, combining data from city systems and external sources, such as Washington Department of Ecology, King County Public Health, and many other sources to provide as full a picture of status the smart city elements. Data sets can also be made available to external parties or to the city's open data portal.

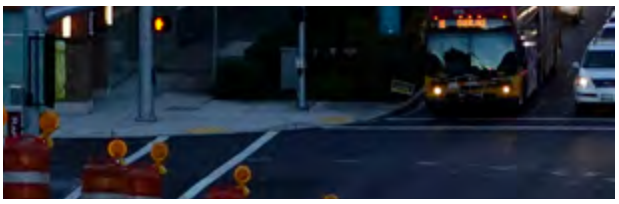
SYSTEM INTEGRATION

Solid data and system integration capabilities enable better handling of the toughest scenarios that can challenge a city. Integrating these systems increases productivity and efficiency from automation, seamless processes and data sharing. Adhering to open architectures and data standards better enables these systems to achieve these gains. The city is already employing system integration through the integration of emergency vehicle traffic signal preemption into the city's adaptive traffic management system. In the near-term, an electronic patient care system will allow EMS to send real-time patient data while en route to the hospital. Here's how smart tech will shortly allow the city to be more effective:

Currently, a multi-vehicle collision with a fire and numerous injured drivers and passengers relies on a mix of human and technological interactions to dispatch needed police, fire and EMS to the scene and coordinate their efforts once they're there. Smart technology is operating in the background to help the injured and impacted travelers. Emergency vehicle preemption shaves critical seconds off the time it takes for first responders to reach the scene. With advances in signal prioritization technology, even more time can be saved through a more proactive and responsive approach to preempting traffic signals. EMS teams can coordinate with medical teams at Overlake Hospital and other medical centers, safely sharing data and records in real-time. Police and transportation staff can coordinate response to mitigate gridlock. Smart systems make it easier for firefighters to get additional resources from neighboring agencies, including a hazmat team to deal with a potential spill. Smart city technology makes it easier for the city to respond faster and effectively meet the emergency demands and return the city to a normal state.

FUTURE STATE

Many of the smart city benefits increase the quality of life in the city, attracting businesses to Bellevue and the talented workforce these businesses need. As smart city technology is seamlessly integrated into ongoing services and operations, much of it will become a natural part of daily life. As the city moves through the rapid adoption of changing technologies for each of the elements, planned and coordinated smart initiatives will lead to services that go unnoticed by most people because they work as expected, increasing quality of life, enhancing convenience and making the city safer. The data generated by these initiatives can be used to measure future performance and provide insights that result in unexpected cost savings, conservation, and the ability to deliver services more effectively to Bellevue's residents, businesses, organizations and visitors.



Appendix

BELLEVUE

SMART

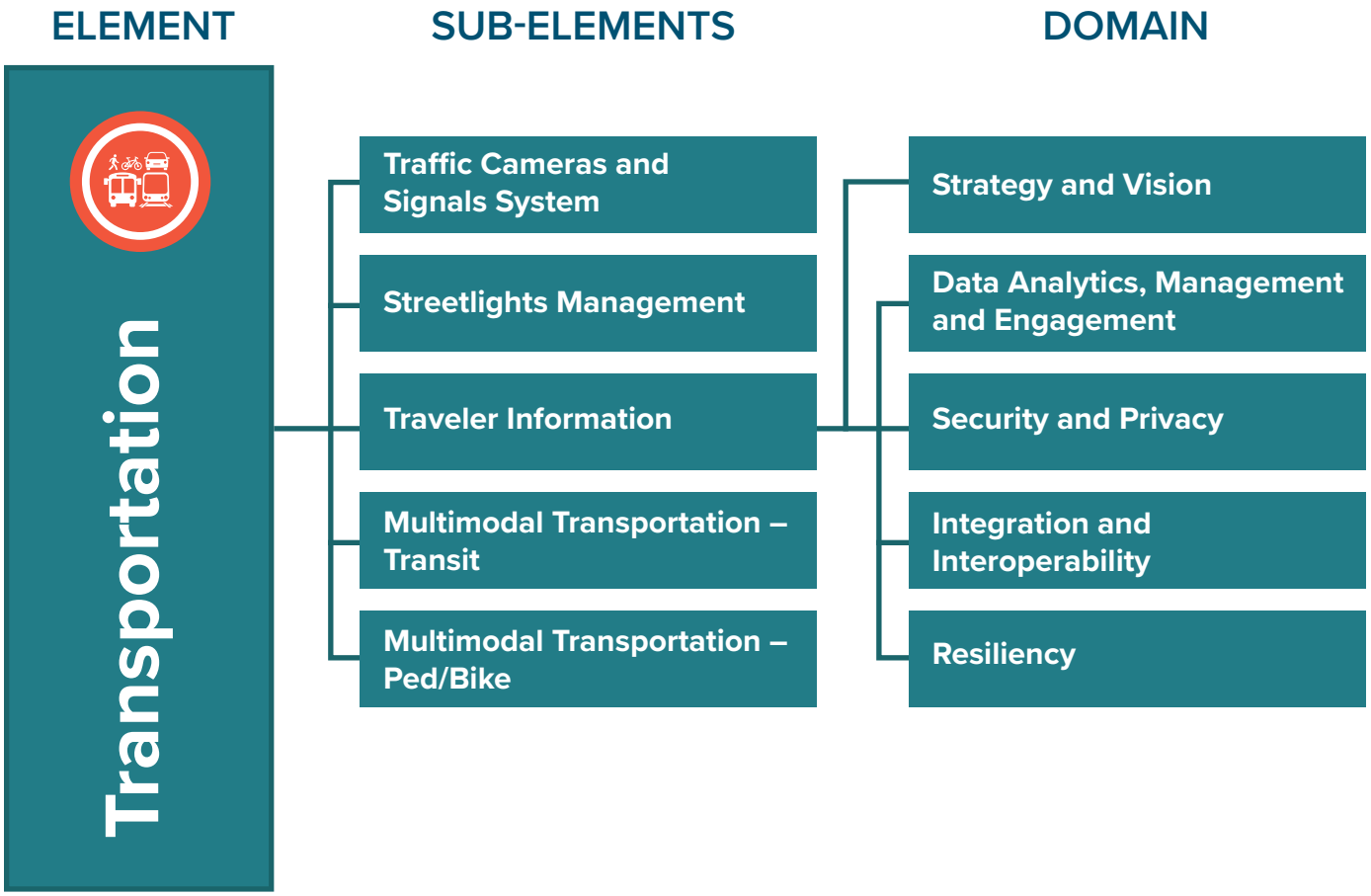
Appendix

SMART CITY MATURITY ASSESSMENT

> If you want to know your future - look into your present actions. –Buddhist Saying

The framework for the Smart Cities maturity assessment is based on the Carnegie Mellon Software Engineering Institute (SEI) Smart Grid Maturity Model. The Capability Maturity Model (CMM) is a framework for organizing evolutionary steps into maturity levels that lay successive foundations for continuous process improvement.

The maturity model that the Smart City team created to assess the City of Bellevue's systems is comprised of three components: elements, sub-elements, and domains. An example of each of those components is shown in the figure below.



ELEMENTS AND SUB-ELEMENTS

The six smart city elements — Connectivity, Transportation, Public Safety, Water, Buildings, and Energy – are further divided into sub-elements, with the goal of evaluating the maturity at a more detailed level. The sub-elements are shown in the table below.

Smart City Element	Sub-Elements
CONNECTIVITY **High-speed communications**	• Expanded Wi-Fi • Fiber-optic network • High speed broadband • Integrated smart city
TRANSPORTATION **Moving people around the city safely and efficiently**	• Traffic management (traffic cameras and signals system) • Streetlights management • Traveler information • Multimodal transportation – transit • Multimodal transportation – pedestrian/bicycle
PUBLIC SAFETY **Keeping people and properties safe**	• 911 service (call location, dispatch and vehicle location) • Interoperable communication networks (radio and cellular) • Incident situational awareness • Data Driven Policing • Hazmat Awareness and Mitigation
WATER **High quality water systems**	• Integrated asset management • System operation • Metering
BUILDINGS **Efficient buildings**	• Building energy data • Building water data • Networked buildings systems – security and safety • Networked buildings systems – facility management
ENERGY **Reliable energy systems**	• Grid system operation • Energy conservation and renewables • Metering

DOMAINS

Domains represent logical groupings of capabilities or characteristics were applied horizontally across each sub-Element further evaluate even deeper actionable gaps and opportunities within each sub-element. The five domains are:

- **Strategy and vision** —The organization's capability to align vision and long-term planning with implementation projects and programs.
- **Data analytics, management and engagement** — The organization's collection and use of data to inform operations, deliver services, set performance targets, increase efficiencies, benchmark and make decisions.
- **Security and privacy** —The ability to securely operate systems and manage confidential, sensitive and personal information appropriately.
- **Integration and interoperability** — How systems and operations are integrate to achieve cross-discipline interoperability.
- **Resiliency** — The system's ability to recover quickly from disruption.

MATURITY LEVELS

Each sub-element was scored during gap analysis workshops, conducted by a University of Washington Evans School team with members of Bellevue staff. These scores, between Level 1 (Ad-hoc) and Level 5 (Optimized) revealed the maturity of each sub-element along each domain. The maturity levels are defined as:

1	**Ad Hoc:** Organization is taking the first implementation steps toward incorporating smart technologies within a domain.
2	**Opportunistic:** Organization is implementing smart technology features within a domain that will enable it to achieve and sustain modernization.
3	**Repeatable:** Organization's smart technology deployment within a given domain is being integrated across the organization.
4	**Managed:** Organization's smart technology implementation within a given domain is being tuned and used to further increase organizational performance.
5	**Optimized:** Organization is breaking new ground and advancing the state of the practice within a domain.

Prior to the self-assessment workshops, the UW Evans School team worked with Bellevue staff to define the expected characteristics for each level of each domain to better facilitate the workshop discussions.

During the workshops, Bellevue staff identified the current maturity level as well as the desired or targeted maturity level within the next three- to five-year timeframe.

MATURITY ASSESSMENT AND GAP ANALYSIS RESULTS

Connectivity

Bellevue's Smart City Connectivity element was evaluated in four sub-elements:

- **Expanded Wi-Fi** – The availability of Wi-Fi service for public use and internal operations.
- **Fiber-optic Network** – The availability of fiber and conduit network to connect city facilities, traffic management systems, streetlight systems, and support public and private partnerships.
- **High-speed Broadband** – The availability, performance, and options for broadband services, such as internet, cellular wireless and Wi-Fi, to residences and businesses from telecommunications, internet, cable and wireless service providers.
- **Integrated Smart City** – The availability, performance, and interoperability of various communications networks for smart city systems, such as public safety radio, advanced metering and connected vehicles.

On average, the Connectivity element is assessed as **Level 3 (Repeatable)**, with its sub-elements of Expanded Wi-Fi at Level 3, Fiber-Optic Network at Level 3, High Speed Broadband at Level 3, and Integrated Smart City Networks at Level 1. The element's target is to achieve **Level 5 (Optimized)** in three to five years.

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
EXPANDED WI-FI				→	
FIBER OPTIC NETWORK				→	
CONSUMER SERVICES				→	
SMART CITY NETWORKS		→			

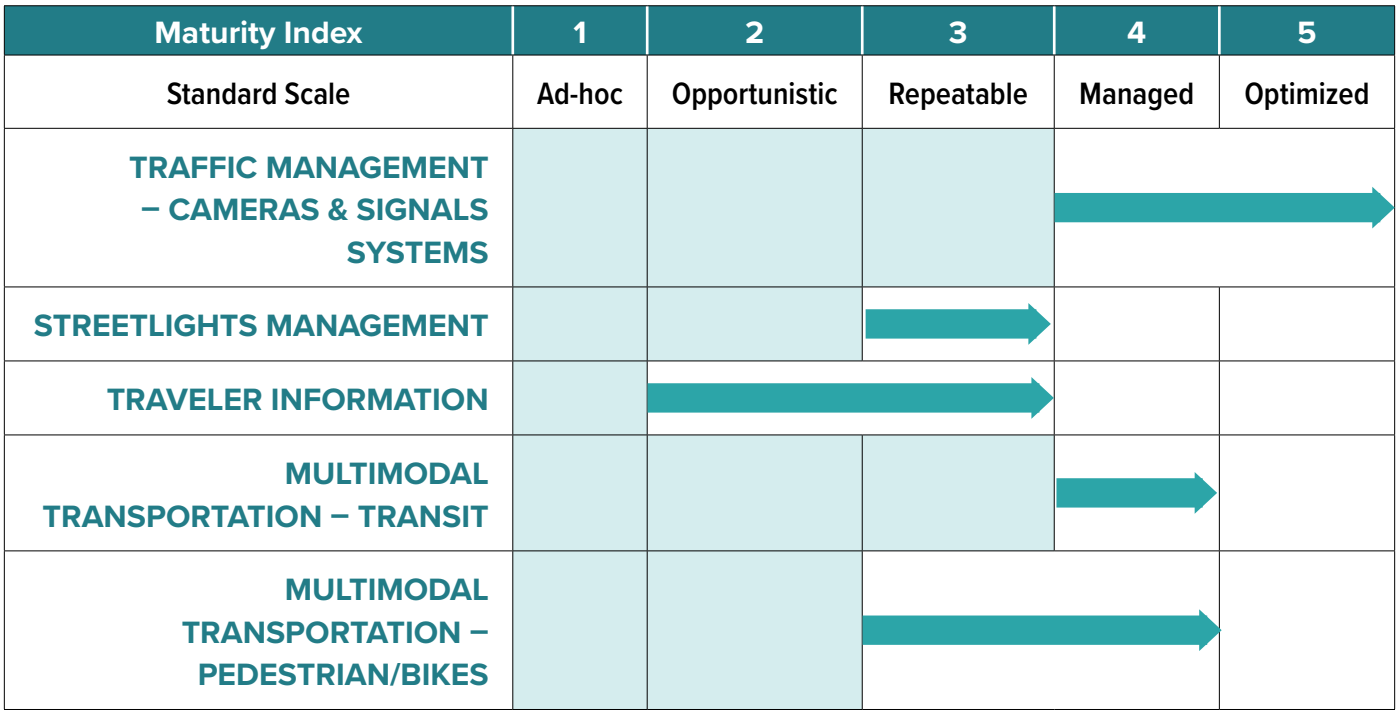
Transportation

Bellevue's Smart City Transportation element was evaluated in five sub-elements:

- **Traffic Management – Cameras & Signals Systems** – The operations and management of the adaptive traffic signal and video surveillance systems used for managing traffic on local streets. This also includes the communication network used to support these systems.
- **Streetlights Management** – The operations of a smart streetlight system that would allow lighting levels to be more dynamically adjusted and provide the ability to use other smart streetlight technology, such as parking management.
- **Traveler Information** – The distribution of traffic data and travel information to the public.
- **Multimodal Transportation - Transit** – The collection and distribution of on-board and vehicle-to-roadside data used for managing the operations of transit vehicles.

- **Multimodal Transportation – Pedestrian/Bikes** – The use pedestrian and bicycle monitoring technology to improve mobility and safety.

On average, the Transportation element is assessed as **Level 2 (Opportunistic)**, with its sub-elements of Traffic Management as Level 3, Streetlights Management as Level 2, Traveler Information as Level 1, Transit as Level 3, and Ped/Bikes as Level 2. The element's target is **Level 4 (Managed)** in the next three to five years.



PLANNED PROJECTS/PROGRAMS

Public Safety

Bellevue's Smart City Public Safety element was evaluated in five sub-elements:

- **911 Service** – The emergency response system that handles 911 calls, dispatching and coordination of fire, police and emergency medical responders, and managing real-time information flow to responders.
- **Interoperable Communications** – The communications systems, including radio and wireless broadband, used by emergency responders to coordinate in real-time across various agencies and disciplines.
- **Incident Situational Awareness** – A system to provide essential situation information, such as map of incident scene, location and status of resources, critical infrastructure, weather, terrain, hazards, etc., needed by on-scene incident commanders and emergency coordinators.
- **Data Driven Policing**– **Data Driven Policing**–Using data effectively and proactively to enhance policing efforts by applying advanced analytics methods to increase awareness, improve patrol efficiency and investigations as well as command operations.

- **Hazmat Awareness & Mitigation** – A specialized emergency response service to deal with hazardous materials (toxic, combustible, illegal or dangerous nuclear, biological or chemical agents) that have been either intentionally or accidentally released into the environment.

On average, the Public Safety element is assessed as **Level 3 (Repeatable)**, with its sub-elements of 911 Service at Level 3, Interoperable Communications at Level 4, Incident Situational Awareness at Level 2, Predictive Policing at Level 3, and Hazmat Awareness and Mitigation at Level 3. The element's target is **Level 4 (Managed)** in the next three to five years.

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
911 SERVICE				→	
INTEROPERABLE COMMUNICATIONS					
INCIDENT SITUATION AWARENESS			→		
DATA-DRIVEN POLICING				→	
HAZMAT AWARENESS AND MITIGATION					

Water

Bellevue's Smart City Water element was evaluated in three sub-elements:

- **Integrated Asset Management** – The short-term and long-term planning process to optimize asset life and minimize asset cost while meeting customer service levels and maintaining the appropriate risk management strategy.
- **System Operation** – The collection and communication of data to monitor and control water supply and distribution operations, including maintenance scheduling, emergency response, and other activities.
- **Metering** – The measurement of water usage volume for residential, commercial, and industrial customers for billing.

Each of the sub-elements was evaluated with respect to the city's collection and use of digital technology and communications to achieve the goals of the sub-element. For example, the maturity of the metering sub-element was evaluated based on the city's movement towards implementing an Advanced Metering Infrastructure (AMI) network for water metering.

On average, the maturity of the Water element is assessed as **Level 2 (Opportunistic)**, with its sub-elements of System Operation as Level 3, Integrated Asset Management as Level 2, and Metering as Level 2. The general target is to achieve **Level 4 (Managed)** in three to five years.

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
INTEGRATED ASSET MANAGEMENT			→		
SYSTEM OPERATION				→	
METERING			→	→	

Buildings

Bellevue's Smart City Buildings element was evaluated in four sub-elements:

- **Building Energy Data** – the energy meter/building management system interface and its impact on overall community building energy use. Focuses on energy data available to the building operator, city and Utility Dept.
- **Building Water Data** – the water meter/building management system interface and the impact on the overall community water use. Focuses on water data available to the building operator, city and Utility Dept. This includes irrigation water used in landscaping.
- **Networked Building Systems - Facility Management** (not assessed)– technologies that save time, money, and energy for building operators and the community at large, as well as those that improve building system performance.
- **Networked Building Systems - Security & Safety** (not assessed) – technologies that increase safety, security and knowledge of risk in the building, for first-responders and building operators, for occupants and for the community at large.

On average, the Buildings element is assessed as **Level 2 (Opportunistic)**, with its sub-elements of Building Energy Data as Level 2 and Building Water Data as Level 2. The element's target is **Level 4 (Managed)** in the next three to five years. The Networked Building System sub-elements have not yet been evaluated by the city due to lack of knowledge about the adoption of these technologies within the Bellevue business community. This will be a future focus to gather this data.

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
BUILDING ENERGY DATA			→		
BUILDING WATER DATA			→		

Energy

Bellevue's Smart City Energy element was evaluated in three sub-elements:

- **Grid System Operation** – The monitoring and controlling of grid transmission using computer-based remote control and automation.
- **Energy Conservation and Renewables** – Conservation is the reduction in energy consumption resulting from increases in the efficiency of end use, production or distribution. Renewable energy is energy produced from solar, wind, geothermal, tidal, wave, renewable biogas and biomass and low-impact hydropower. Conservation and renewable energy can increase the reliability of the grid system and reduce carbon emissions.
- **Metering** – The measurement of power and natural gas usage for residential, commercial, and industrial customers for billing.

On average, the Energy element is assessed as **Level 3 (Repeatable)**, with its sub-elements of Grid System Operation as Level 3, Energy Conservation and Renewables as Level 3, and Metering as Level 3. The general target is to achieve a **Level 4 (Managed)** in three to five years.

Maturity Index	1	2	3	4	5
Standard Scale	Ad-hoc	Opportunistic	Repeatable	Managed	Optimized
GRID SYSTEM OPERATION				→	
ENERGY CONSERVATION AND RENEWABLES				→	
METERING				→	

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Endnotes

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ENDNOTES

1. Bellevue Community Broadband Assessment for 2015
2. 2017 Pew Research Center Mobile Fact Sheet for 2016
3. City of Bellevue Performance Indicator Dashboards
4. City of Bellevue Commute Trip Reduction Plan (http://www.bellevuewa.gov/gtec.htm)
5. Bellevue's existing bicycle network also includes 65 miles of wide lanes and shoulders shared with motor vehicles according to the 2016-2019 Bellevue Bicycle Rapid Implementation Plan
6. EPA ENERGY STAR database, 2010-2016
7. As of December 2016, City of Bellevue and http://www.smartbuildingscenter.org/smart-efficient/benchmark-support/city-bellevue-benchmarking/
8. Puget Sound Energy
9. Puget Sound Energy
10. UTC docket I-937 reporting, 2015 https://www.utc.wa.gov/_layouts/15/CasesPublicWebsite/GetDocument.ashx?docID=51&year=2016&docketNumber=160757
11. *2015 Bellevue Electrical Reliability Report*
12. *2015 Bellevue Electrical Reliability Report*
13. 2016 Fire Dept. Annual Report, City of Bellevue
14. 2016 Fire Dept. Annual Report, City of Bellevue
15. 2015 Vison Zero, City of Bellevue Home page (https://cobgis.maps.arcgis.com/apps/MapSeries/index.html?appid=8964b232b8ec4a0180e0b56b1c29071d)
16. Q1, 2017, City of Bellevue Performance Indicator Dashboards
17. 2016, City of Bellevue Performance Indicator Dashboards
18. Bellevue Tech Startups interactive map, City of Bellevue, King County ESRI, Garmin, NGA, USGS, NPS
19. City of Bellevue Planning & Community Development Department
20. NORCOM 2016 Annual Report
21. Part 1 UCR Violent Crimes include Homicide, Rape, Robbery, Aggravated Assault, Part 1 Property crimes encompass Burglary, Larceny, Auto Theft and Arson. The five years average is based on reporting between 2012 and 2016.
22. Energy Information Administration, last updated: April 6, 2016. "How much energy is consumed in residential and commercial buildings in the United States?" https://www.eia.gov/tools/faqs/faq.php?id=86&t=1, Accessed April 10, 2017
23. Energy Pro3: The Economic Impact of EE Investments in the Southeast. Publication. Southeast Energy Efficiency Alliance, 2013. Web. 3 November 2015. http://www.seealliance.org/wp-content/uploads/SEEA-EPS-EE-Report.pdf ; How Does Energy Efficiency Create Jobs? Publication. American Council for an Energy Efficient Economy, 2009. Web.3 November 2015. http://aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf ; Laitner, Skip, and Marshall Goldberg. Regional Energy and Economic Self-Sufficiency Indicators in the Southeastern United States. Tech. US Department of Energy, May 1996. Web. 3 November 2015. https://books.google.com/books?id=OShZJsdrwQcC&lpg=PP1&pg=PP1#v=onepage&q&f=false
24. Mackres, Eric. "Energy Efficiency and Economic Opportunity." American Council for an Energy Efficient Economy. N.p., Sept. 6, 2012. Web. 03 November 2015. http://aceee.org/blog/2012/09/energy-efficiency-and-economic-opport and Estimating Job Creation. Rep. Portland-Milwaukee Light Rail Transit Project, n.d. Web. http://trimet.org/pdfs/pm/economicbenefits/PMLR_job_creation_estimate.pdf
25. https://energy.gov/eere/buildings/about-commercial-buildings-integration-program
26. City demographer, Gwen Rousseau, and Census data.

27. Smart Building Center, Vamsi Surapaneni, April 2017 and Gwen Rousseau, City of Bellevue Demographer April 2017
28. King county assessor data
29. Ethan A. Rogers and Eric Junga. April 2017. Intelligent Efficiency Technology and Market Assessment. http://aceee.org/sites/default/files/publications/researchreports/ie1701.pdf Accessed April 26, 2017
30. Buildingrating.org
31. T. Matthews, Feb. 2, 2017. Colliers Crunches The Numbers On Downtown Bellevue Office Space http://425business.com/downtown-bellevue-office-space/ Accessed April 2017
32. http://www.bellevuewa.gov/environmental.htm
33. https://living-future.org/lbc/basics/
34. https://energy.gov/eere/buildings/downloads/common-definition-zero-energy-buildings
35. http://www.phius.org/what-is-passive-building-/the-principles
36. http://www.sustainablesites.org/ , http://www.usgbc.org/credits/healthcare/v4/water-efficiency , https://www.epa.gov/watersense/outdoors , https://www.salmonsafe.org/
37. Electrical reliability is measured by the metrics of System average interruption duration index (SAIDI) & System average interruption frequency index (SAIFI).
38. This figure is calculated using the total number of outage minutes for the previous four years, divided by the total number of customers for the previous four years. PSE SAIDI figures for 2011 - 2015 are five-year, rolling-average figures with the exception of 2011-2012 Bellevue SAIDI figures, which were calculated as single year figures. The 2013 Bellevue SAIDI figure was calculated as a four-year, rolling-average for years 2010 - 2013.
39. The System Average Interruption Frequency Index (SAIFI) indicates how often an average customer is without power and is based on the number of affected customers divided by the total number of customers, excluding storm outages.
40. Puget Sound Energy, 2016 Smart Grid Technology Report.
41. City of Bellevue “Green Direct” press release, April 25, 2017

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