Objectives

Detailed objectives for the study include:

• Identify & quantify the growth of smart cities implementation
  • By category/ component

• Identify & highlight both drivers and challenges to smart cities’ adoption

• Forecast current & projected future growth of copper in smart cities (in metric tonnes)

• Provide conclusions & recommendation regarding future position of copper in the future evolution of smart cities
Defining the “Smart City”

A smart city is an urban area that utilizes IoT sensors, actuators, and different types of electronic Internet of Things technology to connect components across the city. It impacts every layer of a city, from underneath the streets, to the air that citizens are breathing. Data from all segments is collected and analyzed, then insights and patterns are detected to better manage assets, resources and services efficiently.

“Smart cities are those that use new information and communication technologies to solve pressing problems - such as housing, transportation, and energy - in urban planning and governance.”

Krishna Jayakar, professor of telecommunications, Penn State
Driving Forces
Why are cities trying to become ‘smart’?

**Safety**
Cities strive to maintain/improve the safety of everyone in and around a city: pedestrians, drivers, business owners, citizens, and visitors. Increasing rates of urbanization are shedding light on the urgency of this.

**Environmental Impact**
Smart cities aim to reduce their carbon footprint and become as sustainable as possible. Many are under strict government regulations that they must meet to avoid fines.

**Social Welfare**
One way to sum up the main goal is to improve people’s lives: better jobs, better healthcare, better waste management, electricity around the clock, etc.

**Reduce Costs**
Smart cities know that investing in new technologies will lead to lowered costs in the longer term – lower energy bills, maintenance costs, repair/replacement costs for city infrastructure, etc.

**Local Business**
A major perk of the smart city is attracting, welcoming, and keeping local businesses. These businesses bring jobs and are extremely beneficial to the local economy.
Challenges
It’s not easy being smart

However, cities have many challenges implementing technologies to make them ‘smart’:

- **ROI** – the nature of technology investments can prove murky ROI for a budget-conscious city
- **Data** – lack of availability, transparency, concerns over privacy of citizens – who owns the data?
- **Turnover** – hard to make long-term investments, plans, or changes when city terms can be limiting
- **Equitable distribution** – upgrades and technology should serve all citizens, not just the wealthy/powerful
- **Lack of funding** – need to deploy limited resources intelligently and efficiently
- **Accountability** – very few ‘smart city’ leaders or teams at the city level
Types of Smart Cities

**Essential Services**
- Use mobile networks in emergency management programs and digital healthcare services; focus on communication infrastructure (and 5G)
- Examples include Tokyo and Copenhagen

**Smart Transportation**
- Emphasize initiatives to control urban congestion through smart public transportation, car sharing, smart parking, and self-driving cars
- Examples include Singapore and Dubai

**Broad Spectrum**
- Emphasize urban services such as water, sewage, waste, and pollution control; high civic participation
- Examples include Barcelona, Beijing, and Vancouver

**Business Ecosystem**
- Use information & communication technologies to jumpstart economic activity
- Examples include Amsterdam, Edinburgh, and Cape Town

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## Smart City Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Goals</th>
<th>Technology Types (not an exhaustive list)</th>
<th>Example</th>
<th>Copper Usage?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mobility/Transportation</strong></td>
<td>Solve lack of parking, monitor traffic, reduce congestion, reduce vehicle-related deaths, reduce pollution</td>
<td>Smart traffic lights, smart parking spaces, app-connected buses</td>
<td>Smart traffic lights that monitor traffic can use predictive analytics to help improve traffic flow</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>Higher efficiency, use less energy</td>
<td>Smart grids, smart meters</td>
<td>Installing LED bulbs in streetlights – pays itself back in a few years</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>5G/ Wi-Fi connectivity for all</td>
<td>5G towers, sensors, ISP networks</td>
<td>Internet connectivity for all citizens</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Smart Buildings</strong></td>
<td>Save energy, improve sustainability, extend capital life, improve safety/security, provide access to information</td>
<td>IoT sensors, WiFi, building automation,</td>
<td>Improved access control to only allow specific people in specific areas of a building</td>
<td>Yes</td>
</tr>
</tbody>
</table>
OVERVIEW
Mobility and transportation solutions are being developed to help pedestrians, drivers, and riders move around cities efficiently and safely.

Key Technologies

<table>
<thead>
<tr>
<th>Tech</th>
<th>Wire</th>
<th>Copper Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart streetlights</td>
<td>Required</td>
<td>1.5 – 2.9</td>
</tr>
<tr>
<td>Smart parking meters</td>
<td>Required</td>
<td>0.2 – 0.5</td>
</tr>
<tr>
<td>EV Charging Station</td>
<td>Required</td>
<td>3.4 – 6.8</td>
</tr>
<tr>
<td>Micro-mobility Charging Station</td>
<td>Required</td>
<td>1.1 – 2.3</td>
</tr>
<tr>
<td>Sensors (mass transit)</td>
<td>N/A</td>
<td>0.1 – 0.2</td>
</tr>
</tbody>
</table>

City Fit: Bigger cities with limited streets/ parking, and high population or visitor/ tourism activity

Challenges looking to solve:
• Traffic flow
• Congestion
• Limited parking

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OVERVIEW
Cities, major energy consumers, need to prioritize reducing environmental impact while increasing renewable energy resources utilizing existing infrastructure.

Key Technologies

<table>
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<tr>
<th>Tech</th>
<th>Wire</th>
<th>Copper Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart grids</td>
<td>Yes</td>
<td>1,000 – 1,500</td>
</tr>
<tr>
<td>Smart streetlights</td>
<td>Yes</td>
<td>1.5 – 2.9</td>
</tr>
<tr>
<td>Smart meters</td>
<td>Yes</td>
<td>0.2 – 0.5</td>
</tr>
<tr>
<td>Solar grids</td>
<td>Yes</td>
<td>2,495 – 5,000</td>
</tr>
<tr>
<td>Wind turbine wiring</td>
<td>Yes</td>
<td>2,225 – 4,500</td>
</tr>
</tbody>
</table>

City Fit: Cities looking to improve electricity distribution and efficiency; cities with residential renewable energy sources

Challenges looking to solve:
• Higher efficiency
• Reduction in energy usage/consumption

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The goal of smart infrastructure is to optimize city infrastructure and assets for efficiency, sustainability, and safety.

**City Fit:** Cities who prioritize connectivity and Wi-Fi for all; primarily driven by 5G implementation

**Challenges looking to solve:**
- Implement and roll out 5G
- Provide Wi-Fi for public use if possible

### Relevant Technologies

<table>
<thead>
<tr>
<th>Tech</th>
<th>Wire</th>
<th>Copper weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5G</td>
<td>Yes</td>
<td>31 – 62</td>
</tr>
<tr>
<td>ISP Networks</td>
<td>Yes</td>
<td>12 – 23</td>
</tr>
</tbody>
</table>
OVERVIEW

Smart buildings use automated processes to automatically control the building’s operations including heating, ventilation, air conditioning, lighting, security, and other systems.

Smart building technology is expected to grow at ~15-30%* per year, depending on the tech.

Relevant Technologies

<table>
<thead>
<tr>
<th>Tech</th>
<th>Wire</th>
<th>Copper Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAS</td>
<td>Yes</td>
<td>21 – 31</td>
</tr>
<tr>
<td>BAS/HVAC</td>
<td>Yes</td>
<td>23.5 – 35.3</td>
</tr>
<tr>
<td>ISP</td>
<td>Yes</td>
<td>48 – 72</td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>Yes</td>
<td>11 – 16.5</td>
</tr>
<tr>
<td>Smart Access Control</td>
<td>Yes</td>
<td>37 – 55.5</td>
</tr>
<tr>
<td>IoT Networks</td>
<td>Yes</td>
<td>4.5 – 6.8</td>
</tr>
<tr>
<td>IP Video Surveillance</td>
<td>Yes</td>
<td>19.5 – 29.3</td>
</tr>
<tr>
<td>LED &amp; UVC Lighting</td>
<td>Yes</td>
<td>186 – 279</td>
</tr>
</tbody>
</table>

*Source: IIoT World

City Fit: Cities with forward-thinking companies; cities that house many large buildings looking to reduce carbon footprint or improve security

Challenges looking to solve:
- Higher efficiency, reduced energy consumption
- Improved safety and business/operational efficiency
Martec conservatively expects copper demand to grow from 250k tonnes in 2020 to 750k tonnes in 2030.

- Figures are on an annual basis, not a cumulative sum

- Annual growth stretches from ~10% to ~12% in the next 10 years
Martec expects copper demand from smart city technologies to grow from 2.7M tonnes in 2019 to 4.8M tonnes in 2025.

Estimates out to 2030 have lower confidence levels, primarily due to the unknown impact of COVID.
As of now, Asia and Europe lead in smart city development, and thus, copper demand from smart cities.

Over the coming 10 years, experts believe that North America will likely steal share from the other regions and become the leader in smart city technology implementation, and thus copper demand for smart city applications.
Buildings and mobility are the two categories gaining share over the coming 5 years – primarily due to continued growth of further evolving technology.

- Experts indicate that technologies in these categories are only scratching the surface and will continue to develop.

- Infrastructure loses share, as this is mostly driven by the implementation of 5G towers; growth is strong over the next few years but quickly drops off as we approach 2030.

- Energy remains stable – continued implementation of renewable energy and slower, sustainable growth of smart grids and microgrids contribute to these figures.

Copper Demand by Smart City Category

Source: The Martec Group
Key Takeaways

So what does it all mean?

1. You can’t define a smart city – each is unique and focuses on solving the problems of its constituents

2. Cities are slowly changing to incorporate smart city leaders, but this process takes time

3. 5G, and with it, better access to faster Wi-Fi, will be a key enabler to smart cities

4. The impact of COVID is still being determined

5. Copper demand is expected to grow from 2.7M tonnes in 2019 to 4.8M tonnes in 2025 due to its performance and reliability
Thank you!

Emily Bielak
The Martec Group