IMPLEMENTING TRANSITIONS FOR THE NEW ENERGY ECONOMY

LEVERAGING TECHNOLOGY FOR SMART GRID PLATFORMS, CITIES AND COMMUNITIES

ASPEN INSTITUTE ENERGY DAYS

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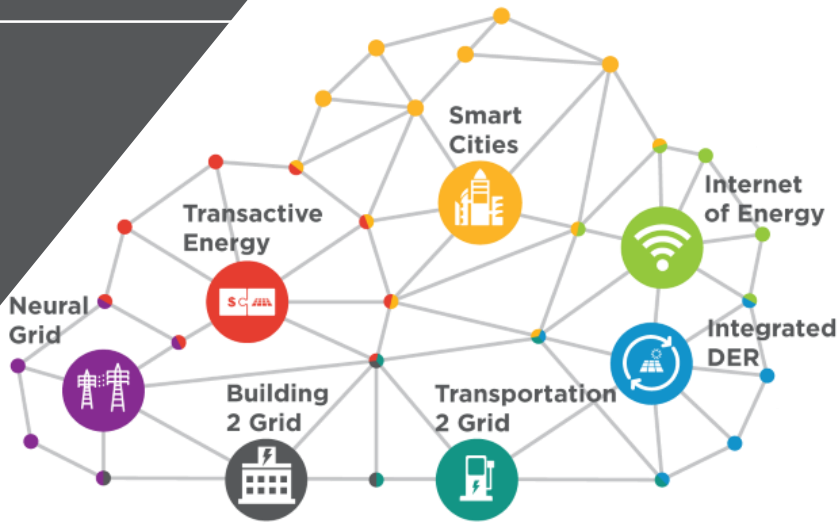

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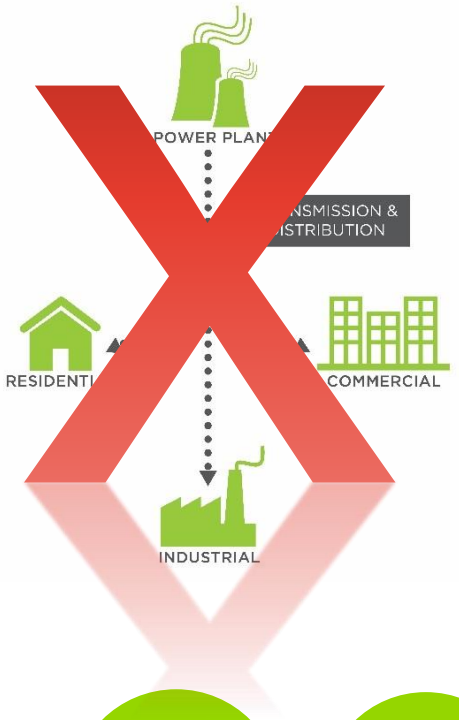
A REMINDER OF WHERE WE ARE : IN THE ENERGY CLOUD

TOWARD A CLEAN, DECENTRALIZED, INTELLIGENT & MOBILE GRID

PAST: Traditional Power Grid
Central, One-Way Power System

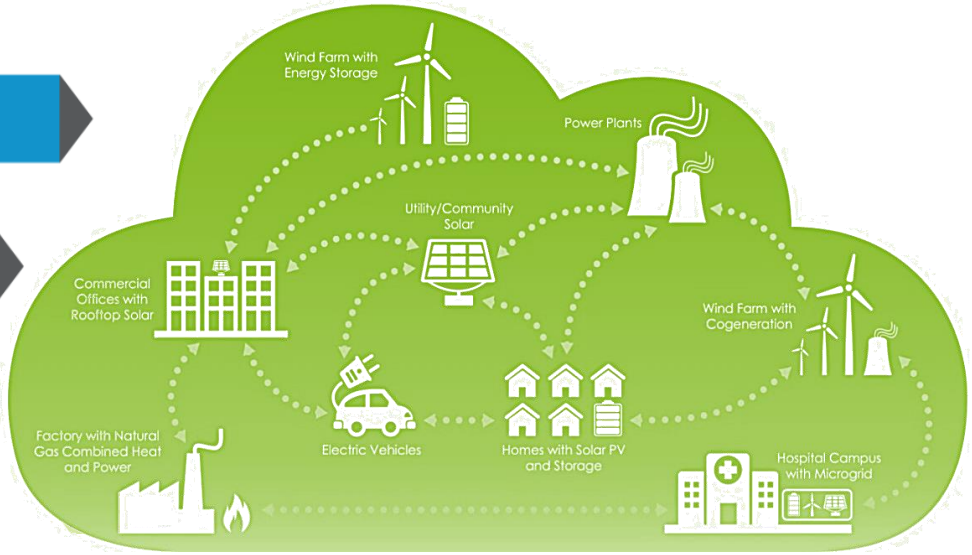
TODAY: The Energy Cloud
Distributed, Cleaner, Two-Way Power Flows



Market Demand

Technology Innovation

Policy & Regulation



2025

- 950 GW wind
- 700 GW distributed solar
- 150 GW distributed DR
- 60 GW distributed energy storage
- 3.5 GW C&I microgrid capacity
- 25m EVs
- +++

Source: Navigant 2017

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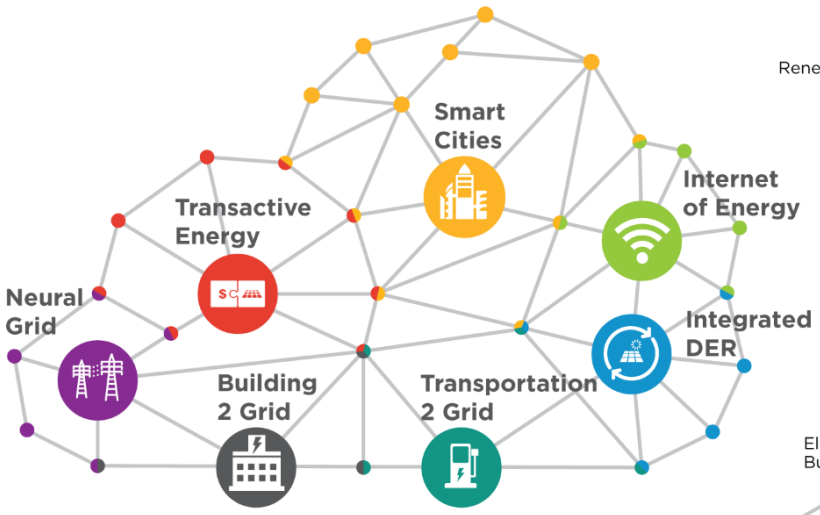
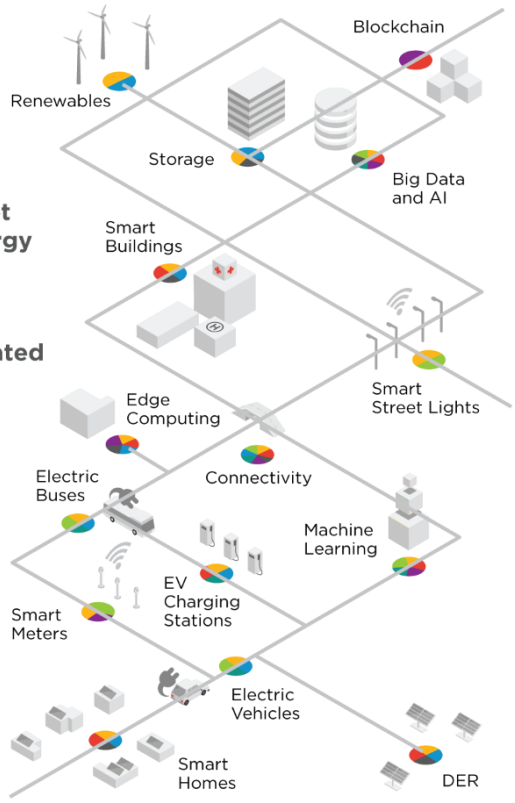
CAPTURING NEW BUSINESS VALUE IN THE ENERGY CLOUD





As a network of networks, the Energy Cloud leverages fast-emerging disruptive **customer-centric and technology enabled platforms** that have the potential to scale faster and yield greater profit margins than the traditional asset-focused and supply models.

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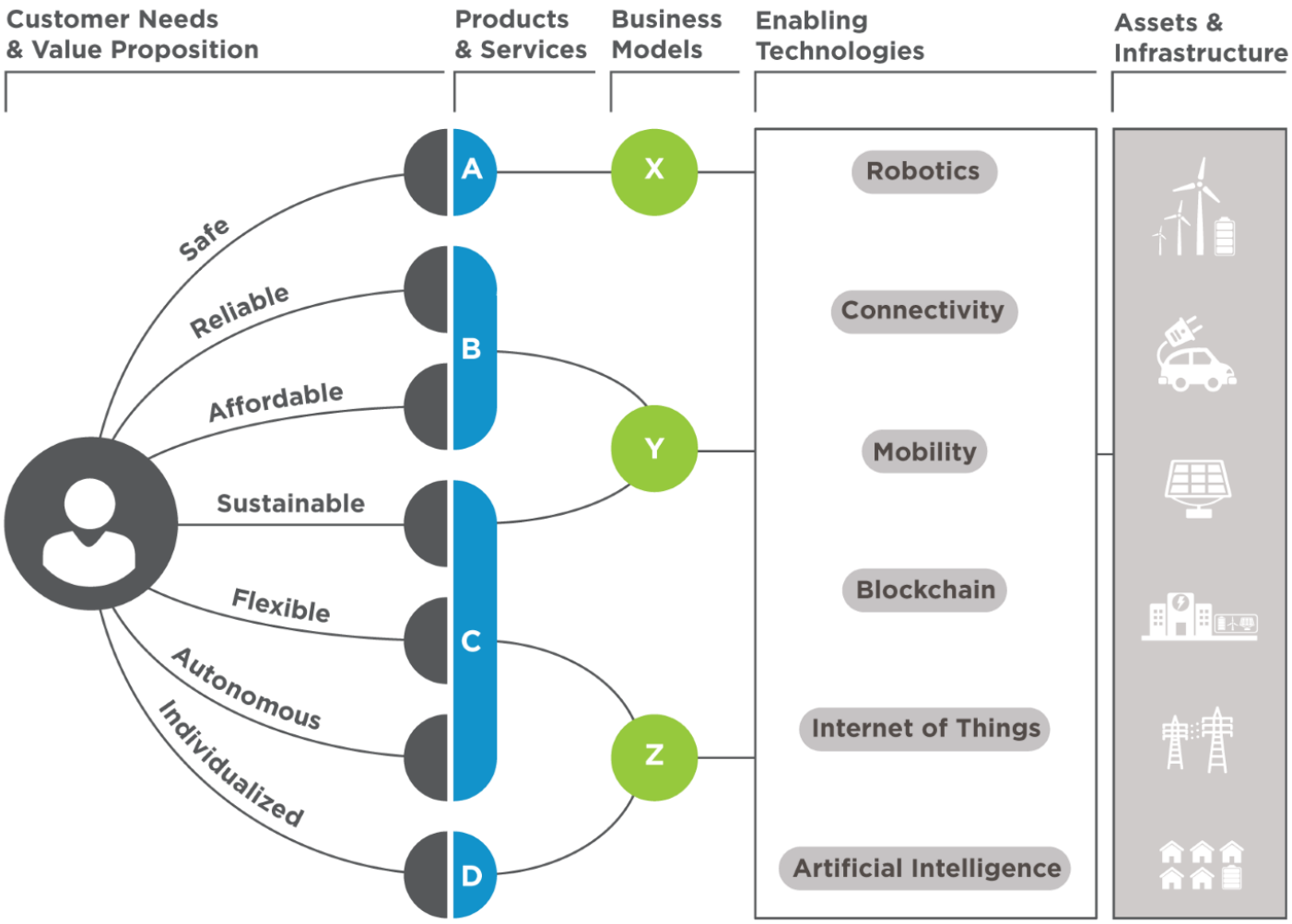
HOW DO YOU BUILD A CUSTOMER-CENTRIC ECOSYSTEM?

START WITH THE CUSTOMER VALUE PROPOSITIONS



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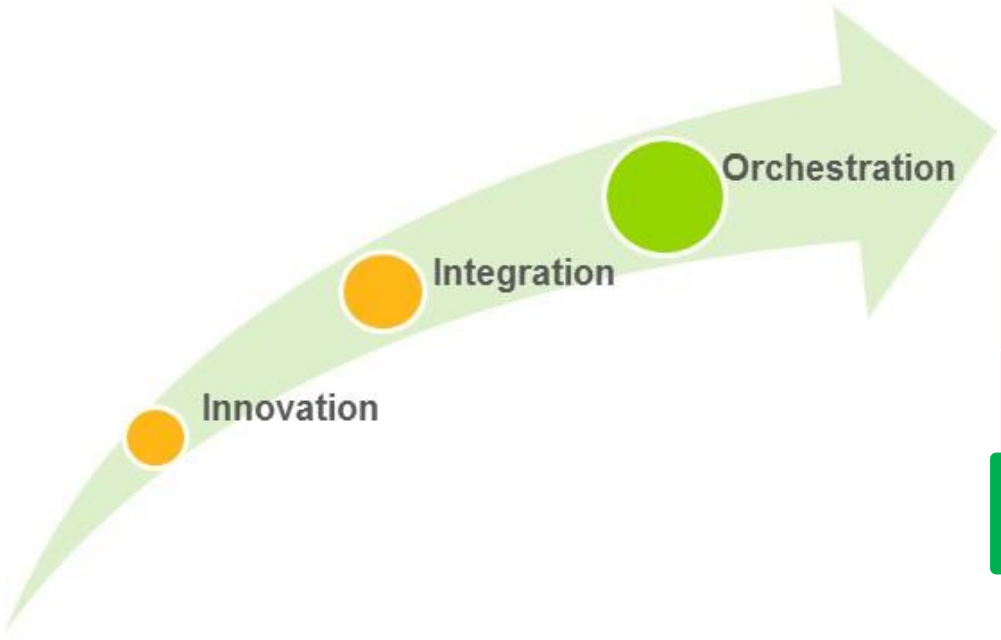
CHANGE THE GAME – ENERGY CLOUD PLATFORMS

FROM INNOVATION TO ORCHESTRATION – SEVERAL EVOLVING PLATFORMS



INTEGRATED DER	**Integrated DER** platforms could support more than $3-4 trillion in value within the next two to three decades.
TRANSPORTATION2GRID	By 2020, more than 6,000 GWh of electricity is expected to be consumed by plug-in EVs annually in the US, giving rise to **Transportation2Grid.**
BUILDING2GRID	**Building2Grid** means leveraging more than $50 billion of anticipated investments in behind-the-meter integrated energy assets for residential and commercial customers within the next five years.
INTERNET OF ENERGY	More than $1 trillion in projected cumulative global revenue is at stake over the next decade across **Internet of Energy** platforms.
TRANSACTIVE ENERGY	**Transactive energy** platforms are expected to see billions of dollars in software-related investments, technology integration, and fees by 2030.
SMART CITIES	More than $250 billion in cumulative investments focused on **smart cities** energy projects alone are anticipated through 2030.
NEURAL GRID	Investments in **neural grid** infrastructure and emerging technologies through 2030 are expected to exceed $700 billion.

Why Energy Cloud platforms?

- ✓ Margins on individual technologies will erode even faster going forward (e.g. rooftop solar, storage)
- ✓ Difficult to scale and build a sustainable business around individual (siloed) technologies
- ✓ Need for orchestration, to unlock **full value** out of these platforms and technology ecosystems

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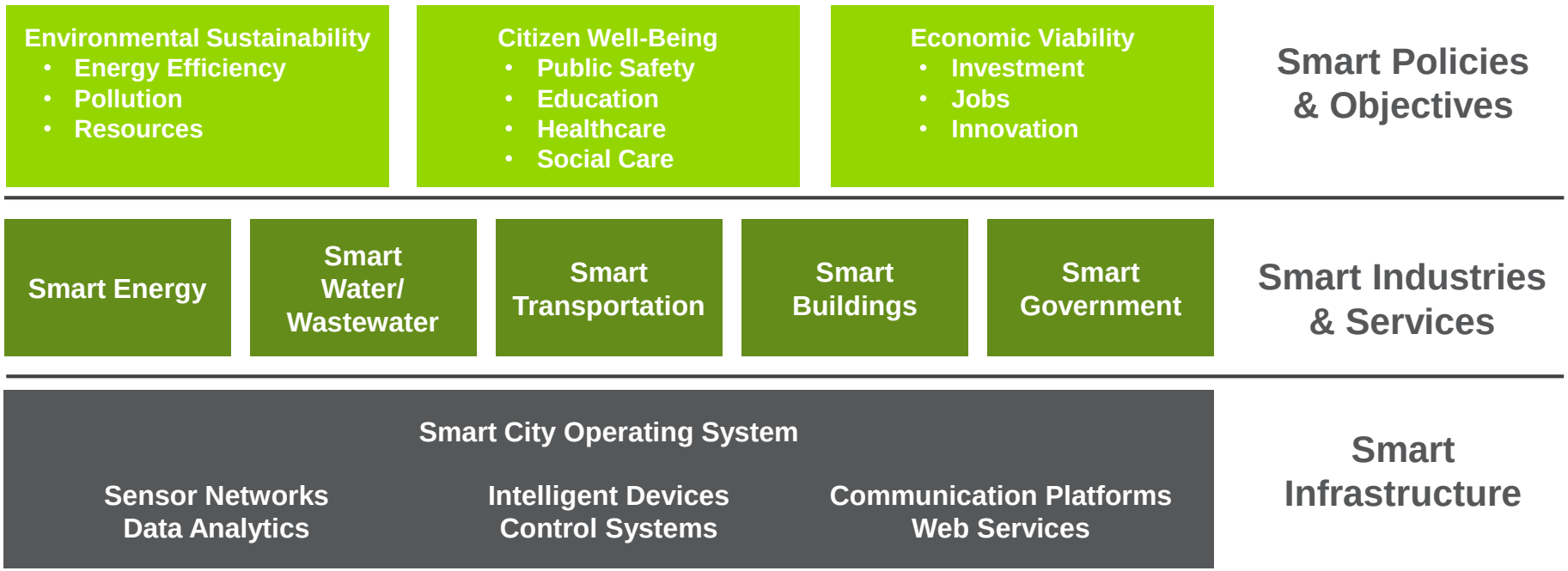
NAVIGANT'S SMART CITY / COMMUNITY DEFINITION

A smart city or community is characterized as the integration of technology into a strategic approach to sustainability, citizen well-being, and economic development.



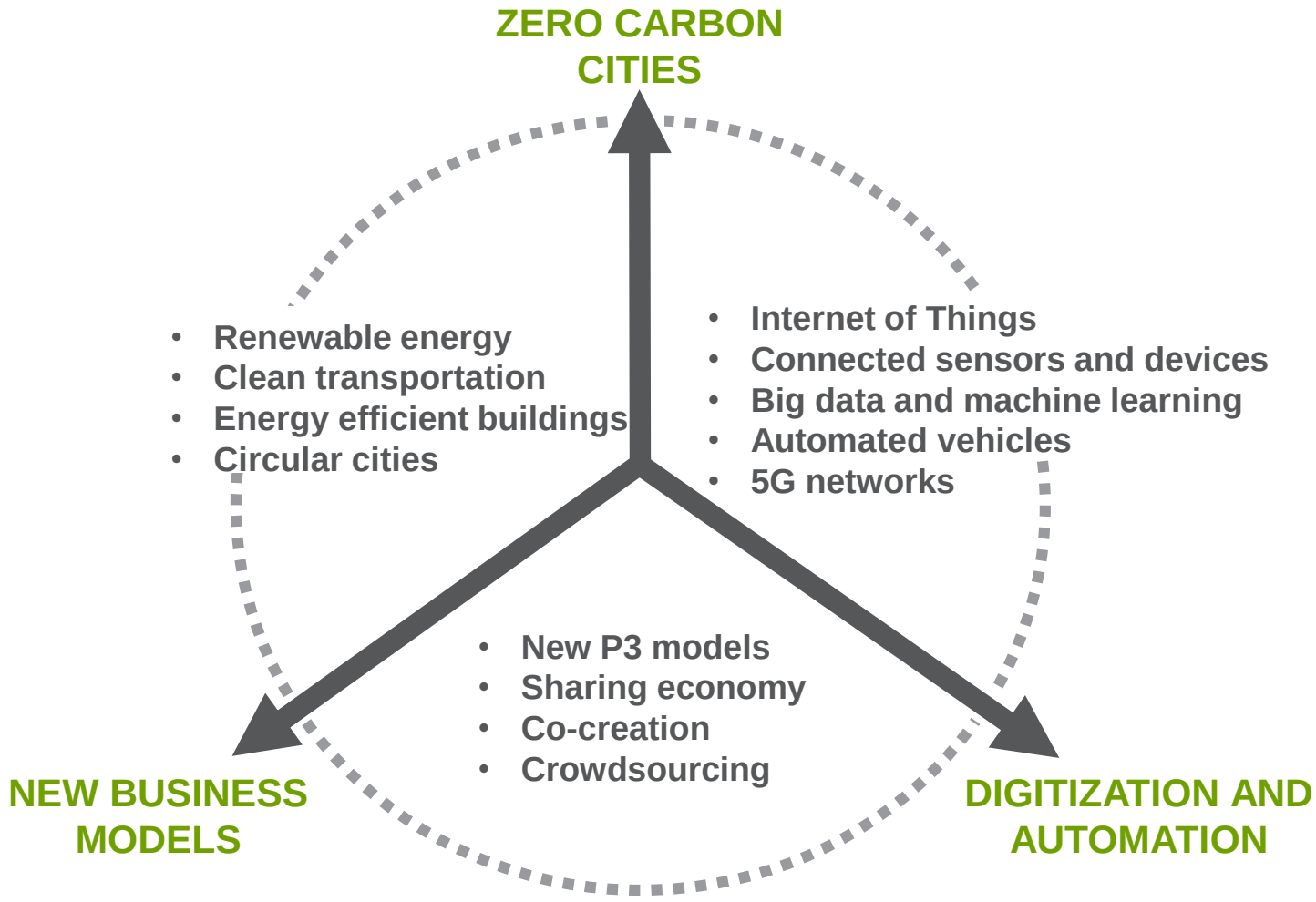
(Source: Navigant Research)

Smart cities/communities should be viewed as a complex confluence of several existing markets, as well as drivers for new planning methods, advanced solutions, and emerging business models.

OPERATIONAL AREAS AND APPLICATIONS

Industry/Operational Area	Smart City Applications	Key Technologies	City Examples
Smart Energy	Demand management, electric vehicle (EV) support, energy efficiency program, renewable energy integration	Smart meters, home energy management (HEM), distribution automation, grid analytics, demand response (DR) systems	Austin, San Diego, Bristol, Bilbao, Lyon, Malaga, Manchester, Vienna, Yokohama
Smart Water/ Wastewater	Water system upgrades, consumption monitoring, wastewater treatment, environmental safety systems, flood management	Smart water meters, sensor and communication networks, water monitoring and management systems, water system analytics, weather forecasting	Barcelona, Cincinnati, Dubuque, San Francisco, Washington D.C., Barcelona, Paris, Nice, Singapore
Smart Transportation	Traffic monitoring and management, congestion management, road user charging, carsharing, emergency response, public information systems, smart parking, integrated traffic light management	Intelligent transportation systems (ITSs), EV charging systems, road use pricing systems, sensors networks, monitoring and management parking, traffic monitoring, predictive analytics, vehicle telematics, public portals and smart apps, open data platforms	Dallas, San Francisco, Amsterdam, Hamburg, Helsinki, London, Milton Keynes, Stockholm, Singapore, Shenzhen, Toyota, Rio de Janeiro
Smart Buildings	Public sector energy management programs, grid integration for renewables, EV charging stations, lighting/waste/water management	Building energy management systems (BEMSs), building automation systems (BASs), energy performance management, grid integration, intelligent lighting systems	Boston, Amsterdam, London, Vienna, Songdo, Tokyo, Yokohama
Smart Government	Public safety, social care, tele-heath, e-education, open data, smart street lighting, citizen portals, smart waste management	Sensor networks, cloud computing services, data analytics, open data platforms, lighting networks, emergency response systems	Chicago, Philadelphia, New York, Amsterdam, Barcelona, Glasgow, Copenhagen, Helsinki, Busan, Seoul, Rio de Janeiro, Cape Town

THREE VECTORS OF CHANGE



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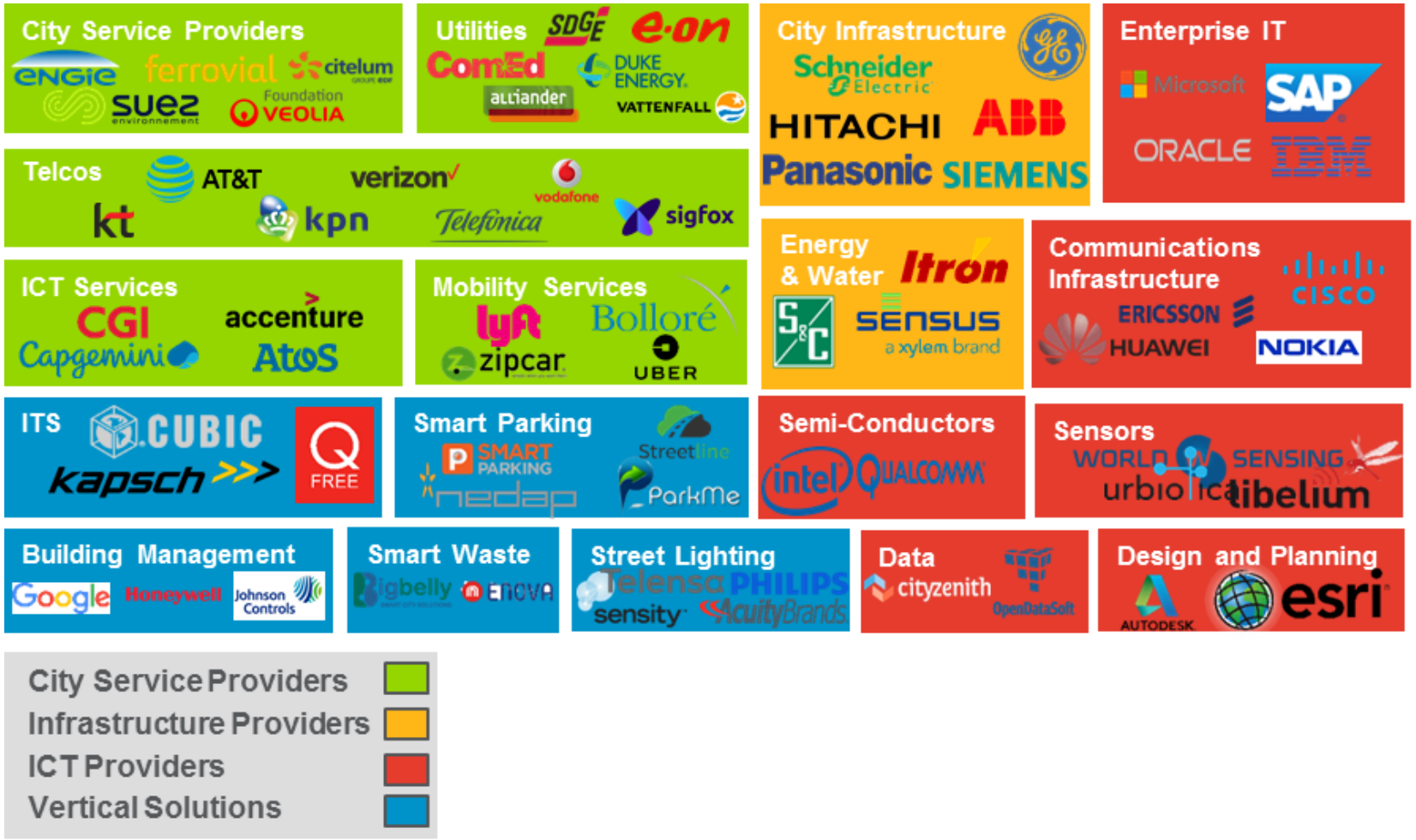
SUPPLIER ECOSYSTEM



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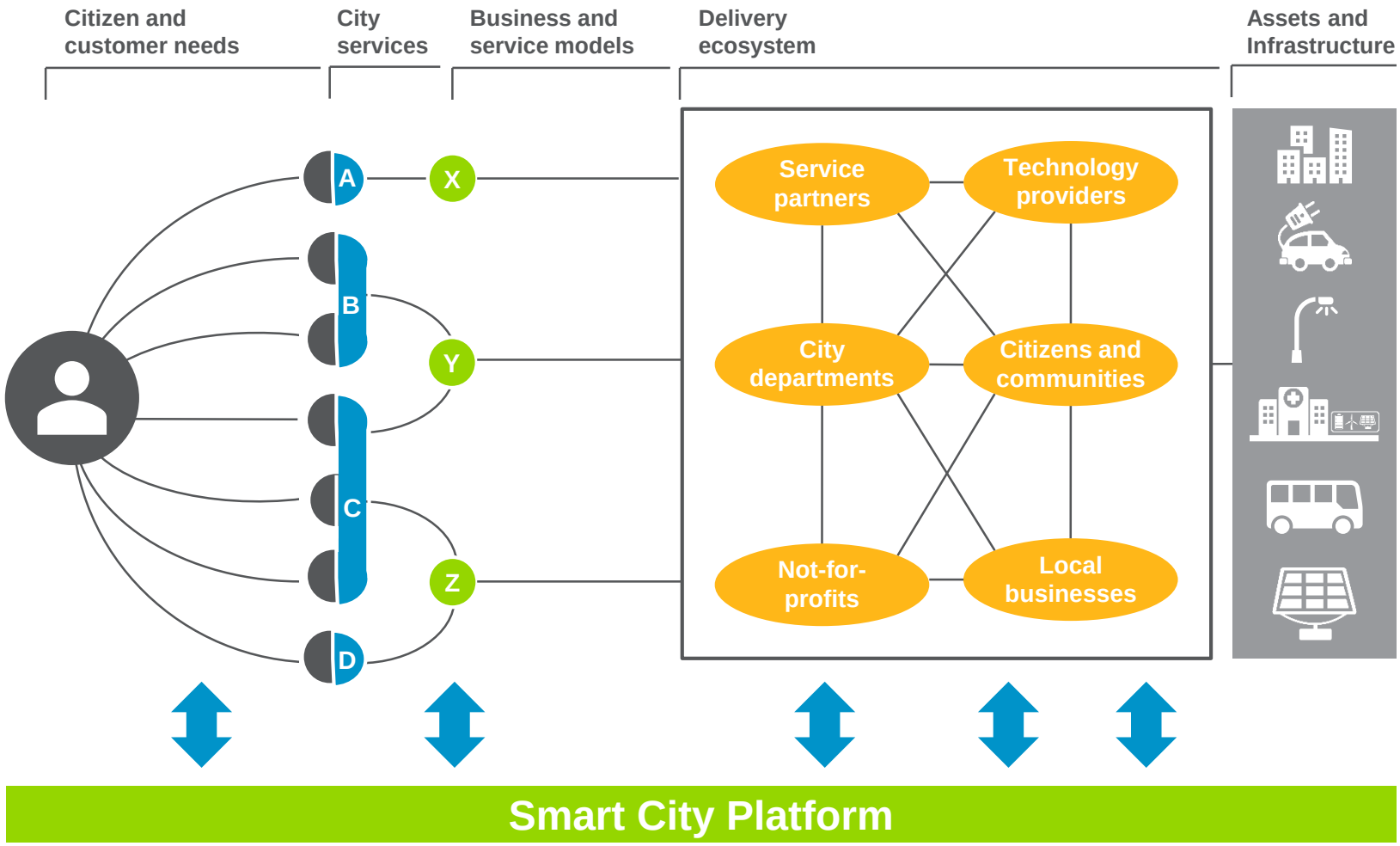
SMART CITY / COMMUNITY AS A SERVICE

PLATFORM-ENABLED VALUE CREATION AND SERVICE INNOVATION



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THE BUILDING BLOCKS FOR SMART CITIES / COMMUNITIES

The interplay between city platforms and energy cloud innovations will be key to urban energy transformation. This interaction opens up new roles for the energy sector.

(Source: Navigant)

	Direct – utility may take a leading role due to clear connection of the platform to utility operations.
	Secondary – Opportunity to partner with the city in a platform where utility has limited operations.
	Not Current Focus – No clear path today but may be a future opportunity

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ORCHESTRATION ROLE FOR UTILITIES? OTHERS?

5. Ecosystem partners:
widen and deepen connections

6. Data aggregation:
gather, analyze, protect, react, grow

4. Channels to market:
deliver value to multiple stakeholder groups

3. Dynamic portfolio of products and services: connect value to value

2. Integrate assets:
aggregate a network of diverse technologies

1. Customer centricity:
identify emerging demand profiles

ORCHESTRATOR SUCCESS FACTORS

- Embrace agility and move rapidly to the energy system of the future (the time is now).
- Stay close to the customer and adapt products and services to cater to shifting demand.
- Maximize the information benefits offered by the digitization of the energy system.

(Source: Navigant)

KEYS TO SUCCESS AND EMERGING TRENDS

Key to Success	Leading Practices	Emerging Trends
Strong leadership from city leaders and executives is vital to develop a coherent and sustainable smart city strategy	• Guiding vision statement, roadmaps • Public/ private working groups • Linking innovation to city priorities	Bridging the gap between smart city programmes and strategic city priorities
Build on existing priorities and assets to develop a distinct smart city vision that is aligned with local needs and goals	• Recognise existing skills and resources • Align with economic priorities • Embed digital view in capital projects	Taking a holistic view across transport, health, energy, housing
Work with local communities in all aspects, from initial strategy to project design, deployment, and data collection	• Emphasize co-creation of services • Extend digital inclusion programs • Demo programs as blueprints for scale	Strengthening regional perspectives – city regions, state/county initiatives
Bring together public sector agencies, the private sector, and academia to form a network of partnerships	• Develop innovative approach to public-private sector partnerships • Closer collaboration with universities	Integrating universities into project design, management and analysis
Focus on innovative uses of ubiquitous data for policy development and the creation of new services	• Evolving open data strategies • Building platforms for IoT data • Exploring the use of advanced analytics	Developing smart city platforms and communication infrastructure

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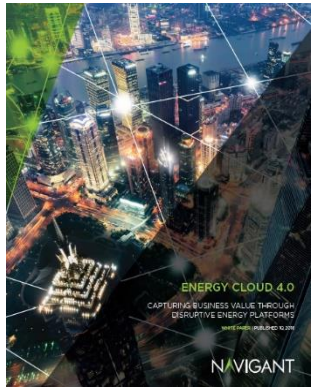
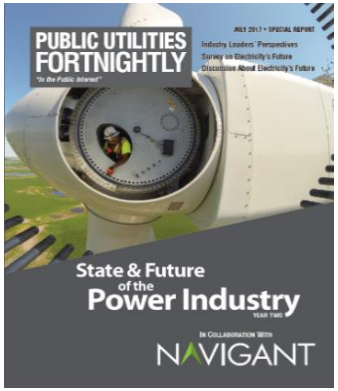
RELEVANT THOUGHT LEADERSHIP

Business Value through Disruptive Energy Platforms



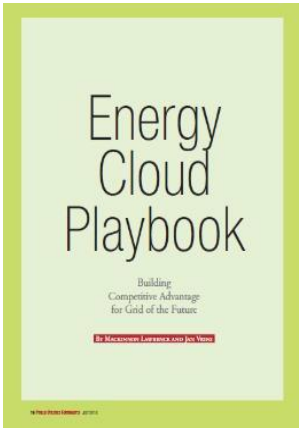
March 2018

State & Future of the Power Industry



July 5, 2017

Energy Cloud Playbook

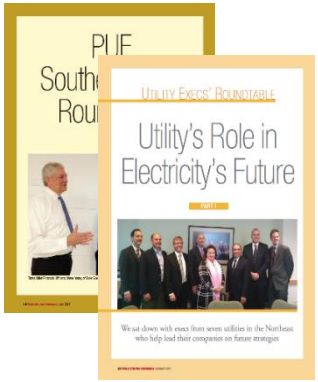


July 2016

Defining the Digital Future of Utilities

April 2017

Utility's Role in Electricity's Future



Q1 & Q2 2017

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