Green IoT: Transforming the World for Sustainability and Smart Living

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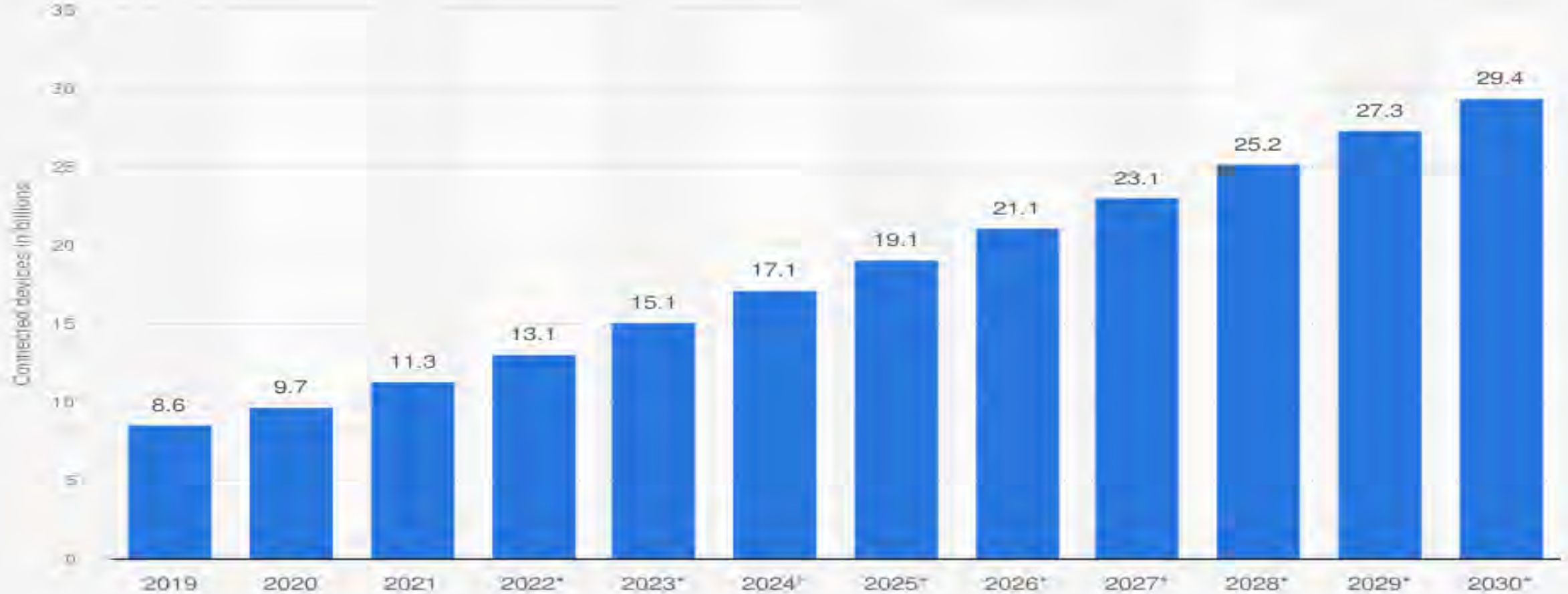
Tonnies

Communication & Connectivity

EVERYTHING WILL BE CONNECTED TO EVERYTHING ELSE

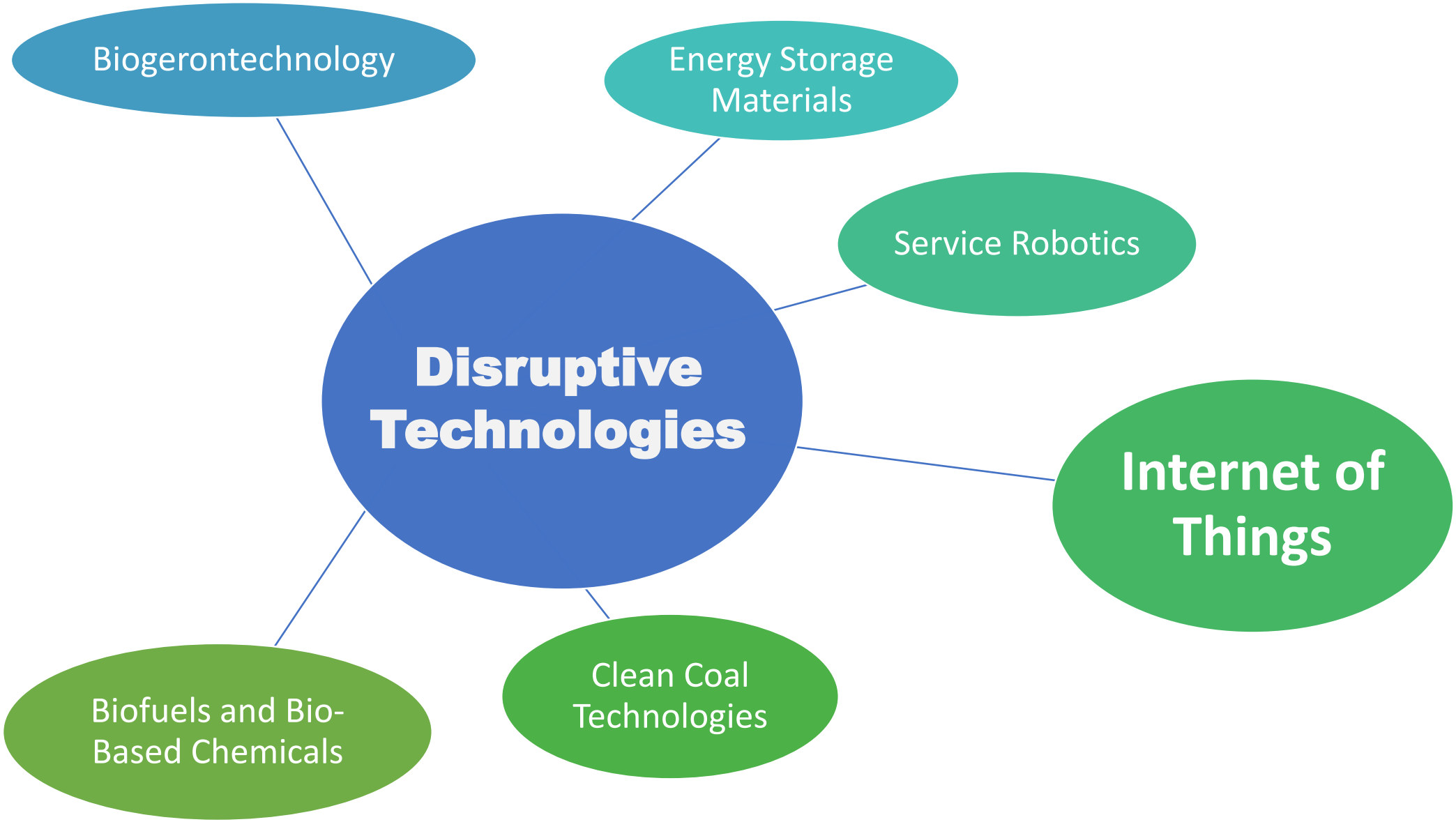
Number of Internet of Things (IoT) connected devices worldwide from 2019 to 2021, with forecasts from 2022 to 2030 (in billions)



Source
Transforma Insights
© Statista 2022

Additional Information:
Worldwide; 2019 to 2022

Disruptive technologies (NIC, US)



What is Fueling This IoT (R)evolution

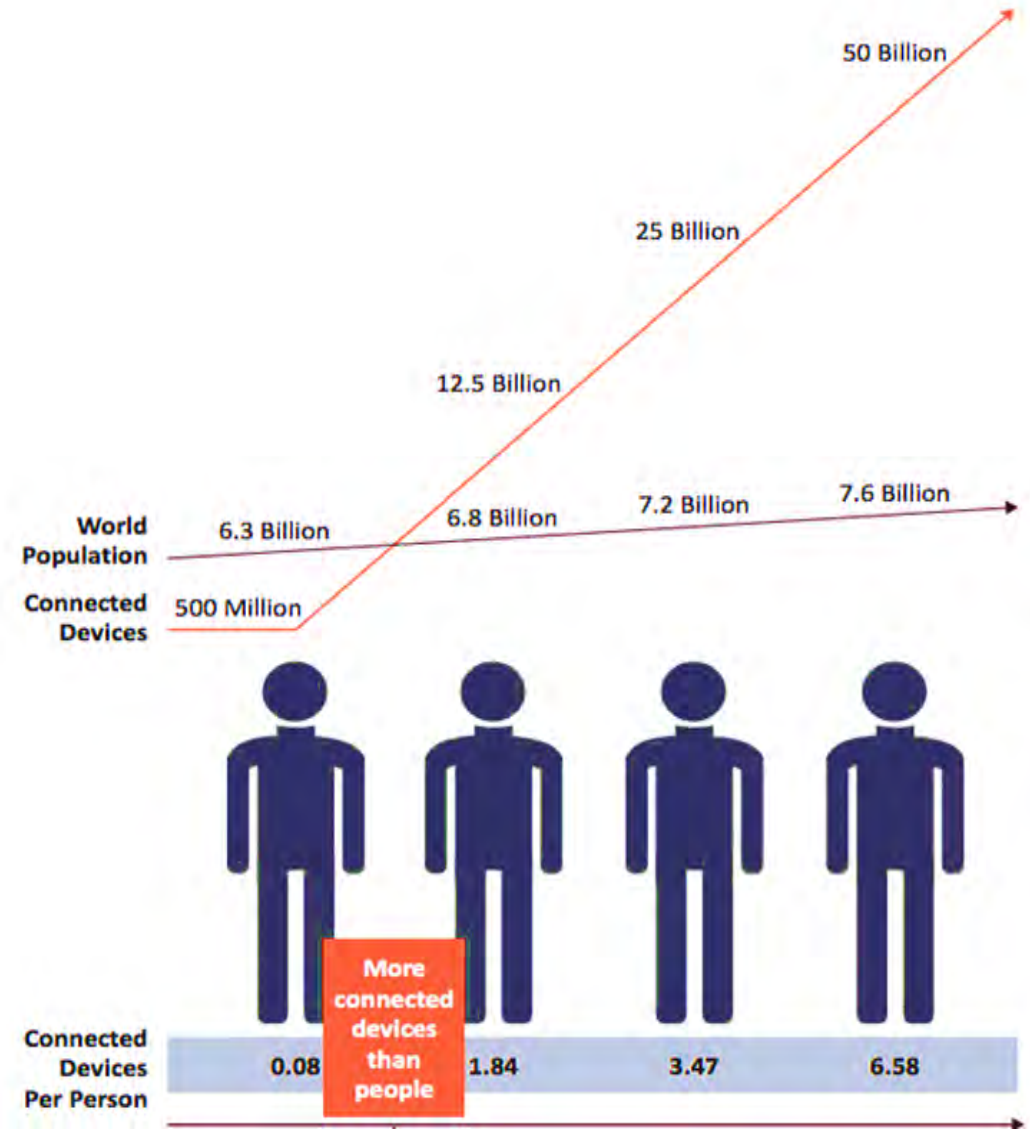
Electronics getting smaller, powerful, cheaper and widely available

+

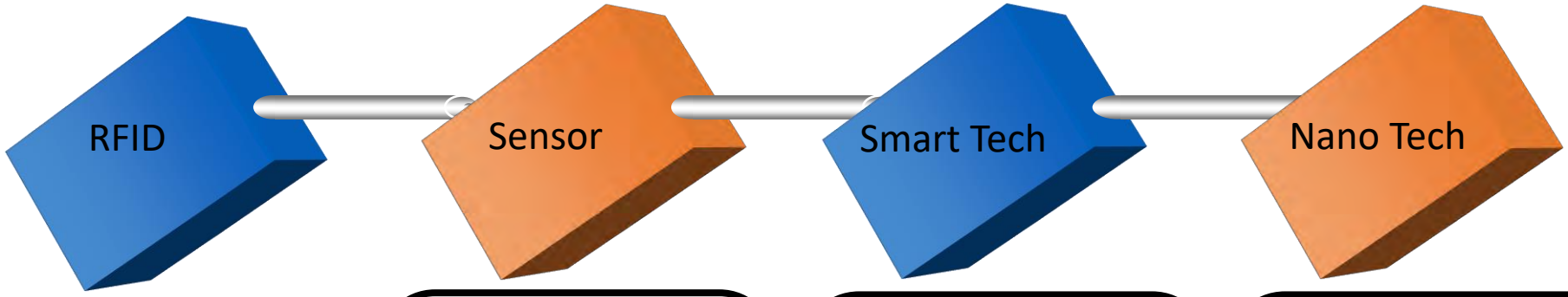
Strong and Matured Internet Infrastructure

+

Adoption of IPv6 increased the number of available identifiers from 4.3 billion addresses to 3.4×10^{38} addresses



Enabling Technologies



To identify and track the data of things

To collect and process the data to detect the changes in the physical status of things

To enhance the power of the network by devolving processing capabilities to different part of the network.

To make the smaller and smaller things have the ability to connect and interact.

Environmental Challenges

CONNECTED DEVICES

ENERGY CONSUMPTION

USE OF BATTERIES

ELECTRONIC APPLIANCES PRODUCTION

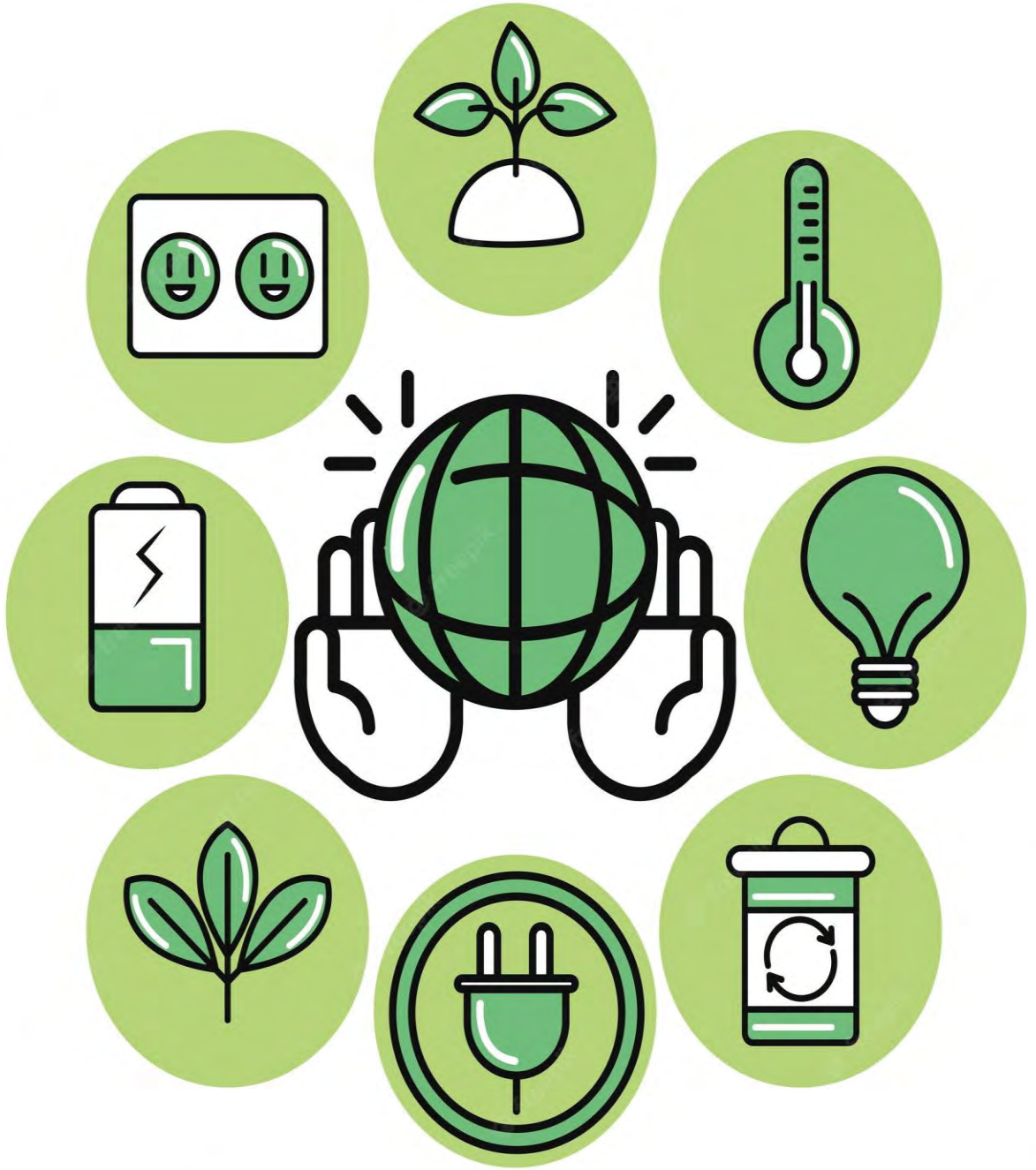
E-WASTE

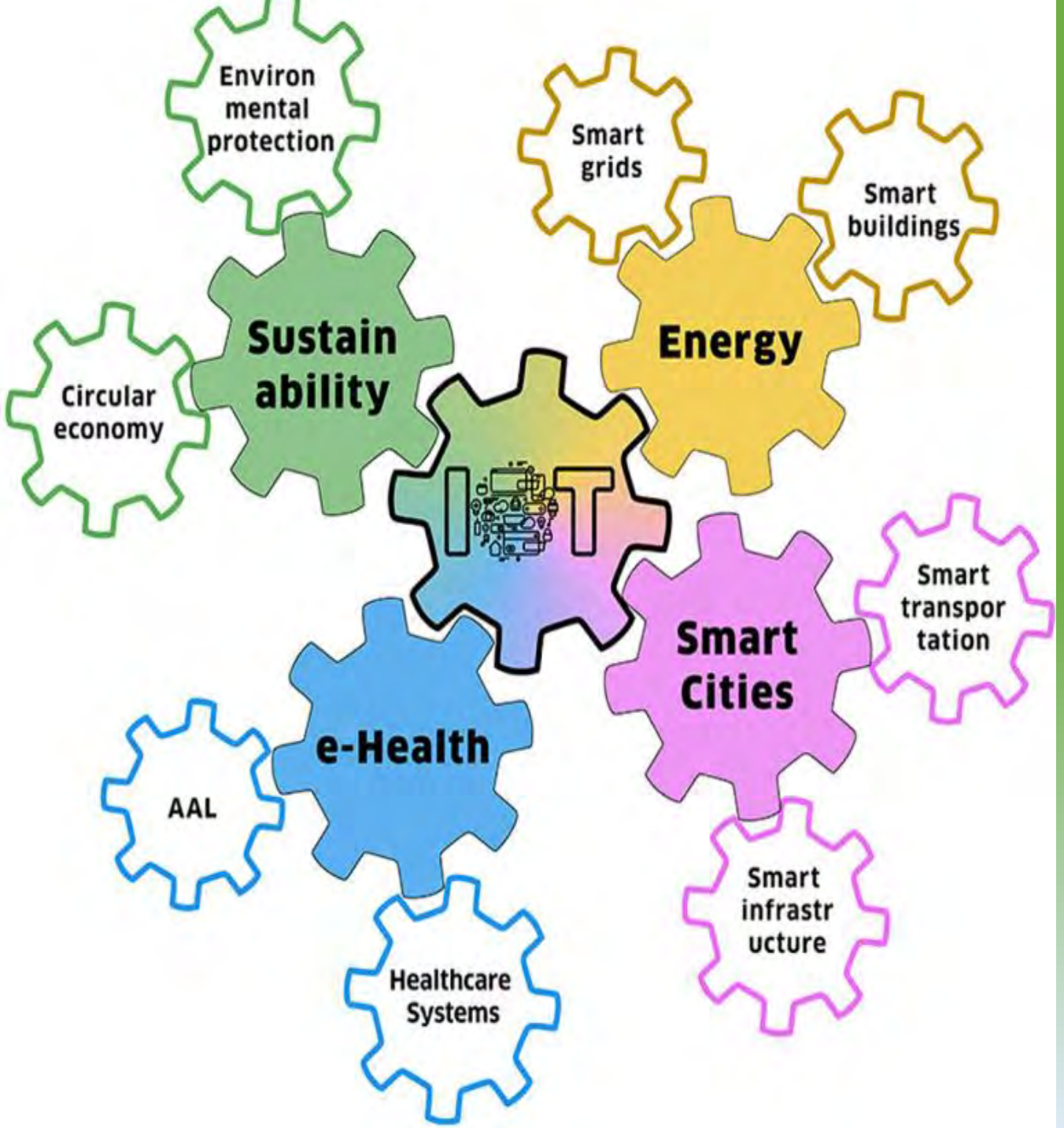
GREEN HOUSE GASES EMISSION

SOLUTION???

Using technology for a better tommorow

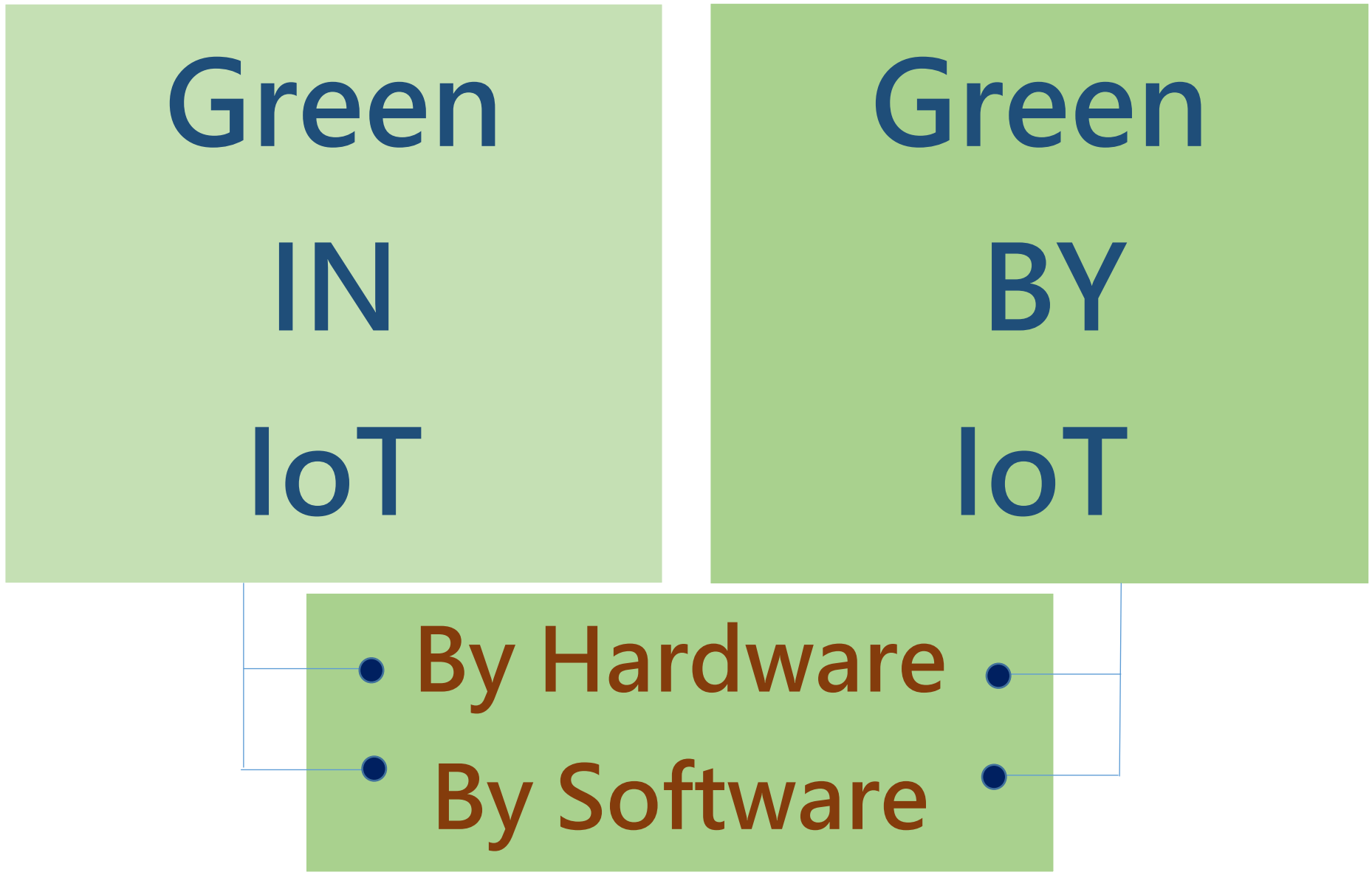
Go Green: make world smart, safe and sustainable





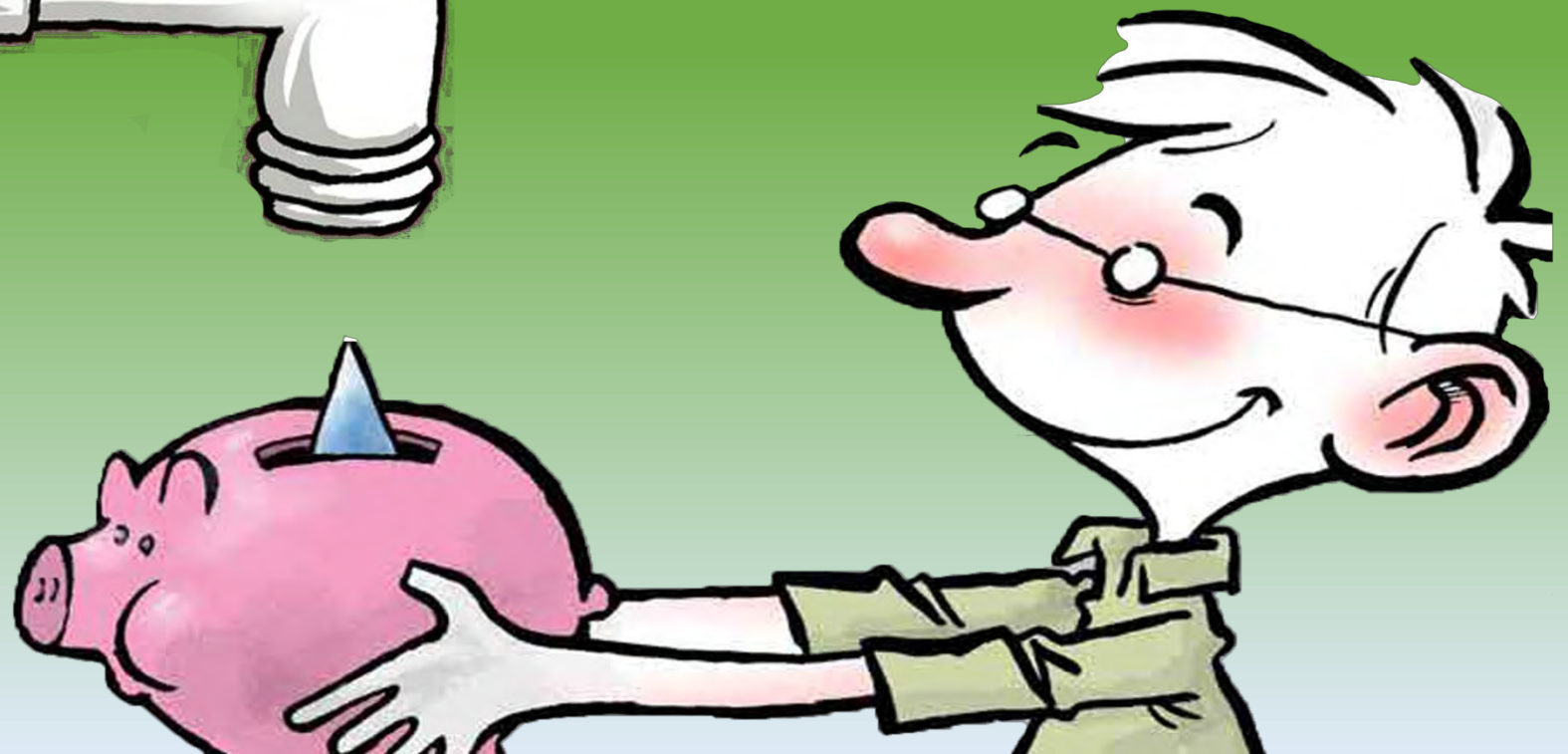
Green IoT

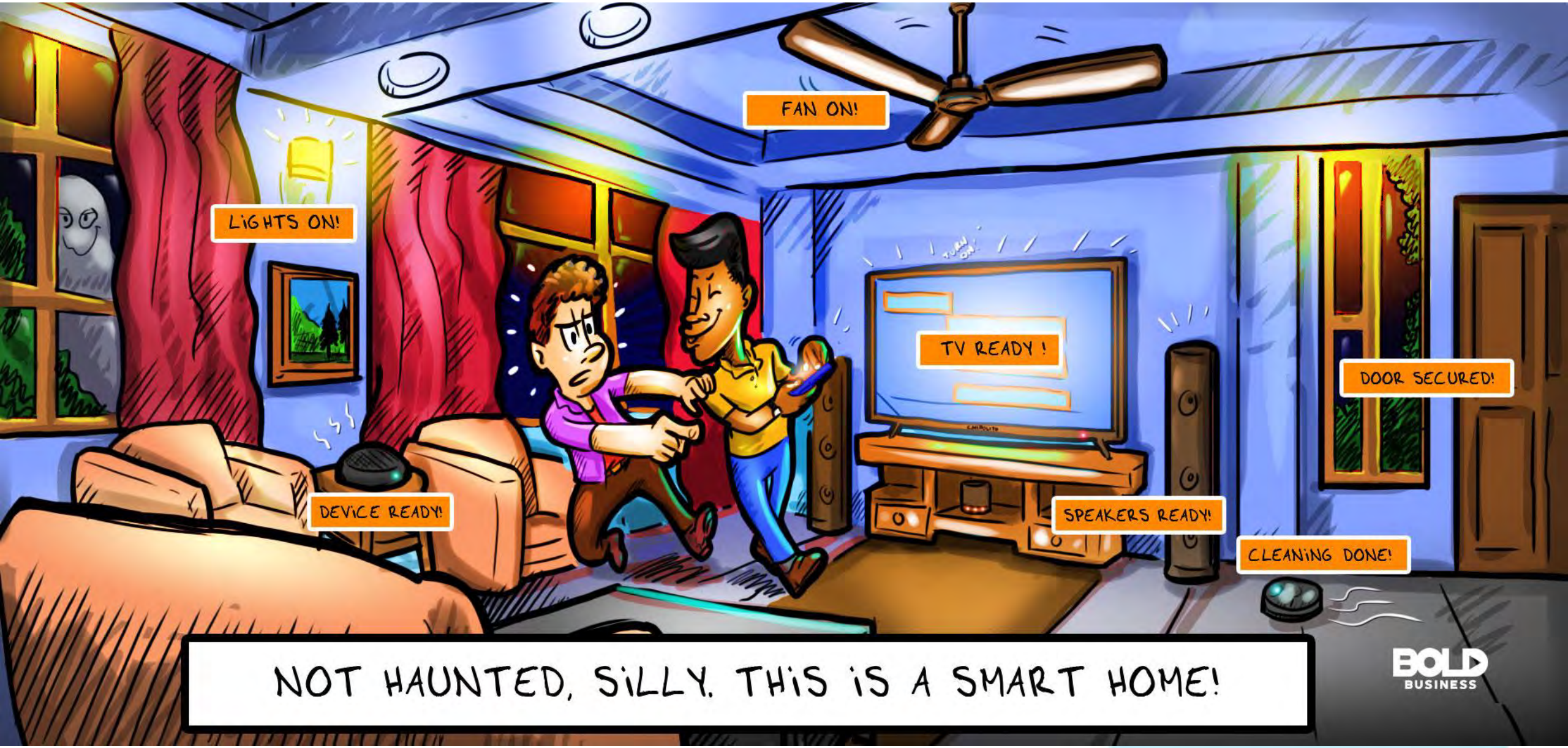
- Sustainable & Energy efficient procedures adopted by IoT
- Reduces greenhouse effect of applications
- Developing energy sources for millions - even billions of sensors: Solar, Wind, hydro-electric
- Reduces energy consumption and carbon emission
- Makes world SMART as well as SAFE.


Green
IN
IoT
Green
BY
IoT
By Hardware
By Software

IoT as a game changer

- HOUSEHOLDS
- OFFICES/INDUSTRIES
- SEA LEVEL
- WASTEWATER MANAGEMENT



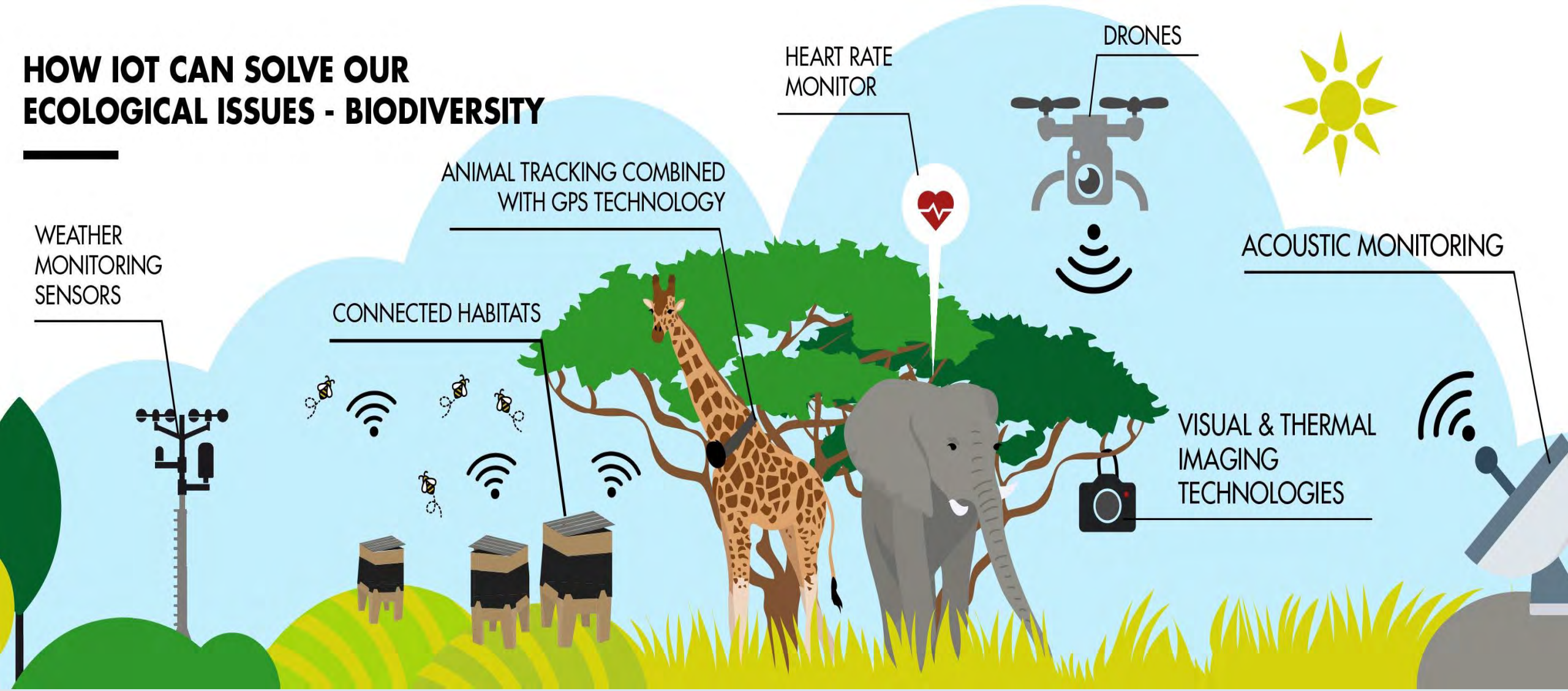

FAN ON!
LIGHTS ON!
TV READY !
DOOR SECURED!
DEVICE READY!
SPEAKERS READY!
CLEANING DONE!
NOT HAUNTED, SILLY. THIS IS A SMART HOME!
BOLD
BUSINESS

Smart Healthcare

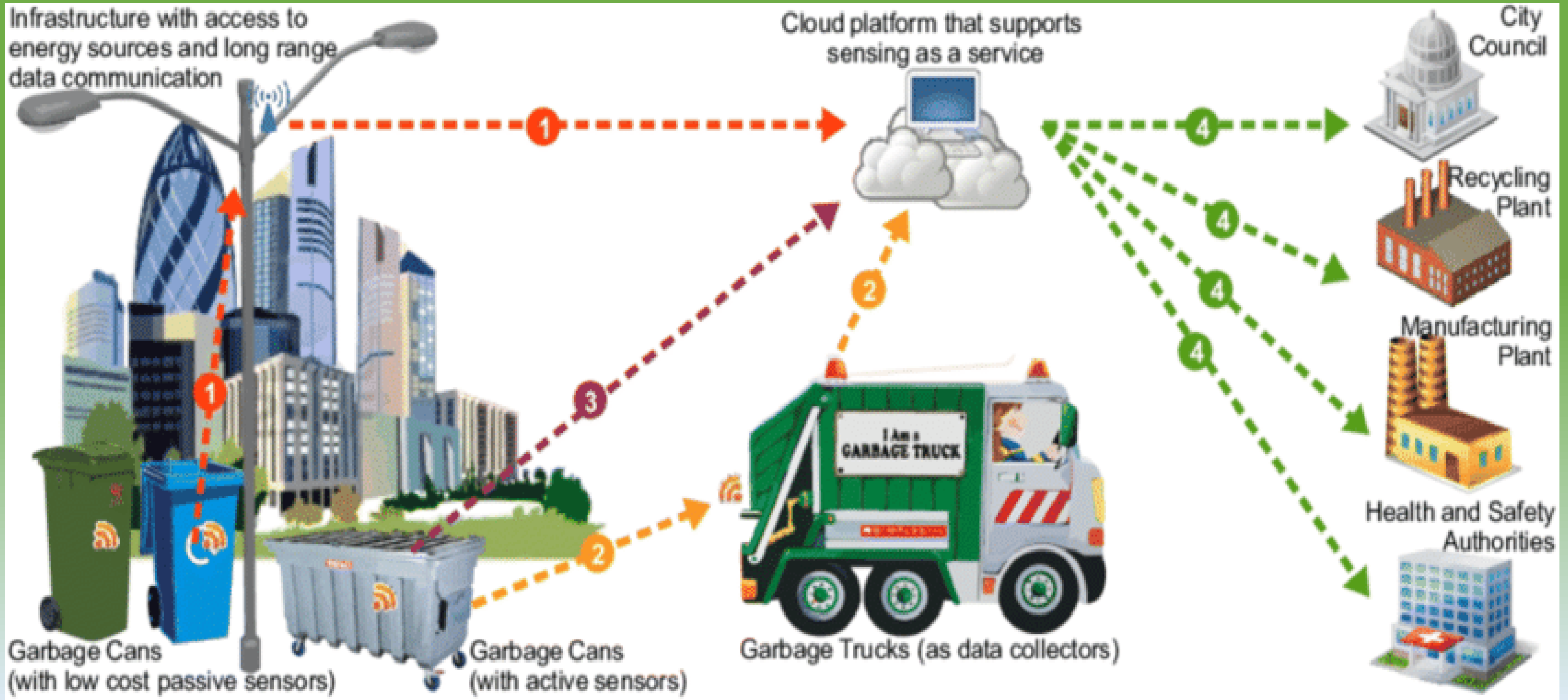
- Health monitoring systems & Telemedicine services.
- Building preventative healthcare services for the betterment of society.
- Uses Big Data and Analytics for quicker diagnosis of health issues.
- Reduces healthcare expenses for hospitals.

Smart City

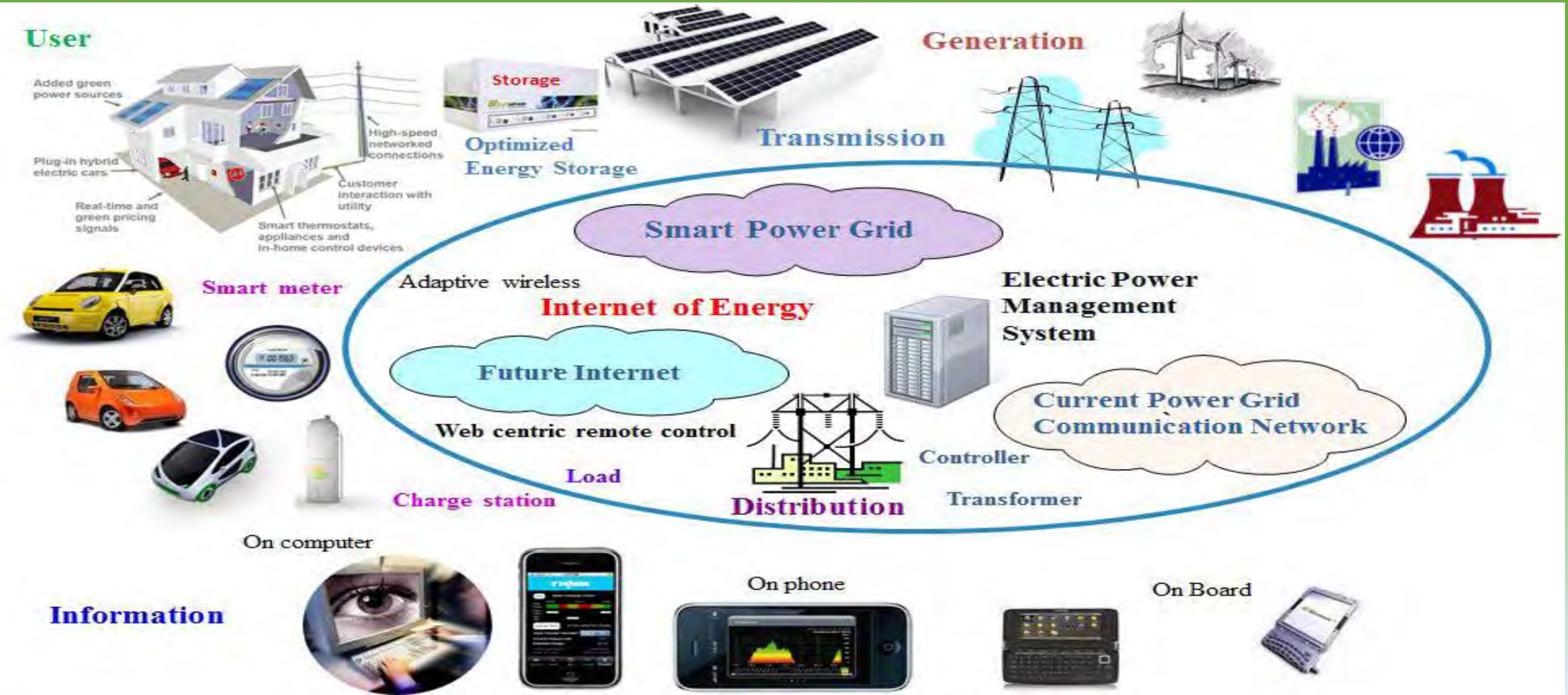
Wildlife/Marine Organisms



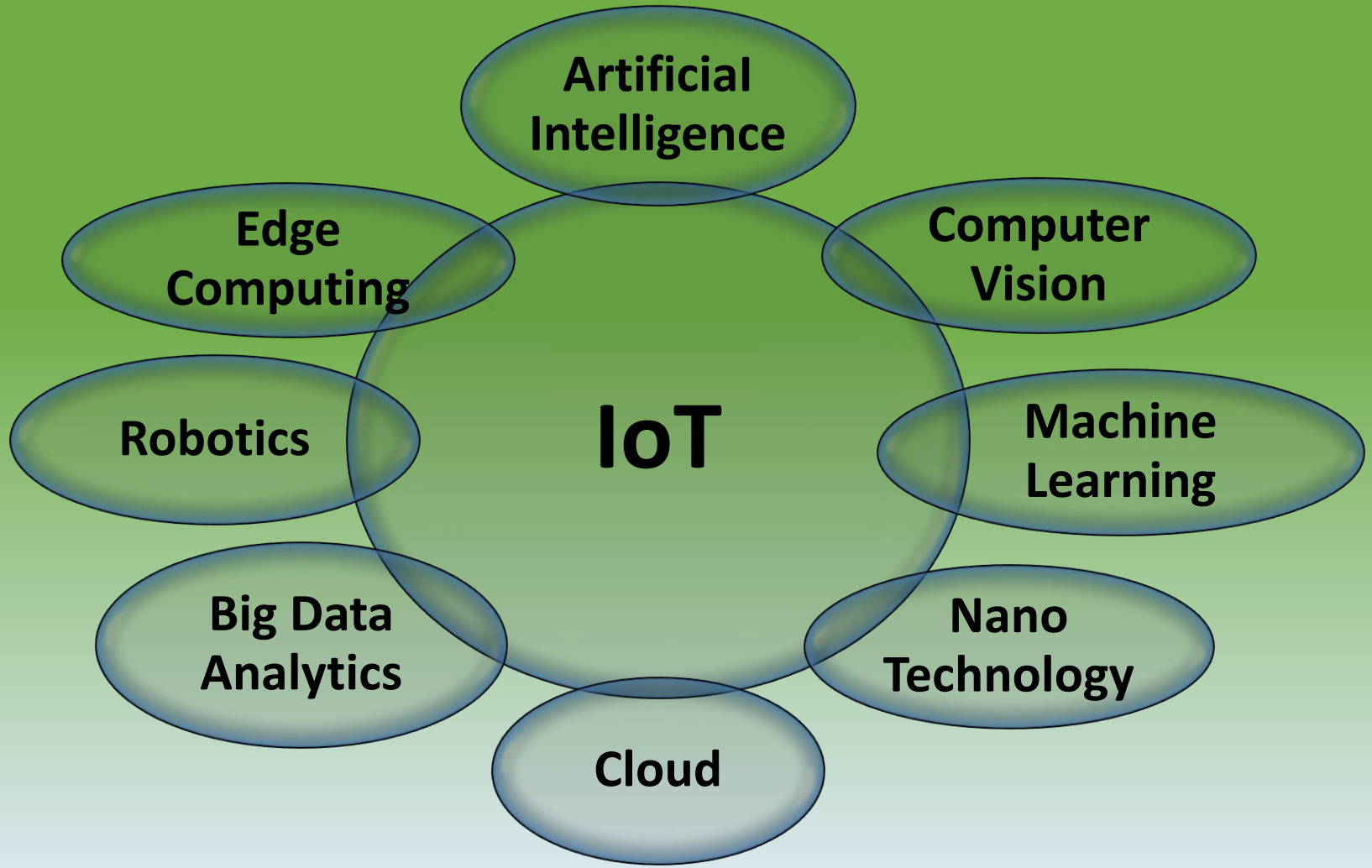
Smart Waste Management



Internet of Energy



G-IOT Allied Technologies



G-IoT Lifecycle

- Green Design
- Green Production
- Green Deployment
- Green Disposal

Green in IoT

- Hardware-based
- Software-based
- Habitual-based
- Awareness-based
- Policy-based
- Recycling-based

Enabling G-IoT

- Green RFID :
  - ✓ reducing size of RFID tags
  - ✓ Use biodegradable material
- Green Wireless sensor network :
  - ✓ Adopt battery-free wireless solutions.
  - ✓ Utilise Energy awareness & harvesting mechanisms
  - ✓ sensors nodes can be in the sleep mode when not operational.
- Green M2M communication :
  - ✓ adjusting power transmission at the minimum level

Enabling G-IoT

- Green Data center :
  - ✓ Context-aware sensing platforms
- Green Cloud Computing :
  - ✓ Resource virtualization
  - ✓ Adoption of recycled items
  - ✓ On demand assignment to promote efficiency in utilization.
  - ✓ Solution to decrease communication latency

Greenness in Software

Build Applications that are:

- Hardware Efficient
- Carbon Efficient
- Energy Efficient
- Reduce Network distance
- Spreads carbon-awareness
- Optimise each step of software development

Green Coding

Low code Development **+** **Automated Software Quality monitoring**

- Design & coding options
- Choice of Language
- AI models
- Software development Techniques
- Energy consumption monitoring

- Zero waste code
- Benefit driven visual content
- Low footprint resources
- Greener Methodologies

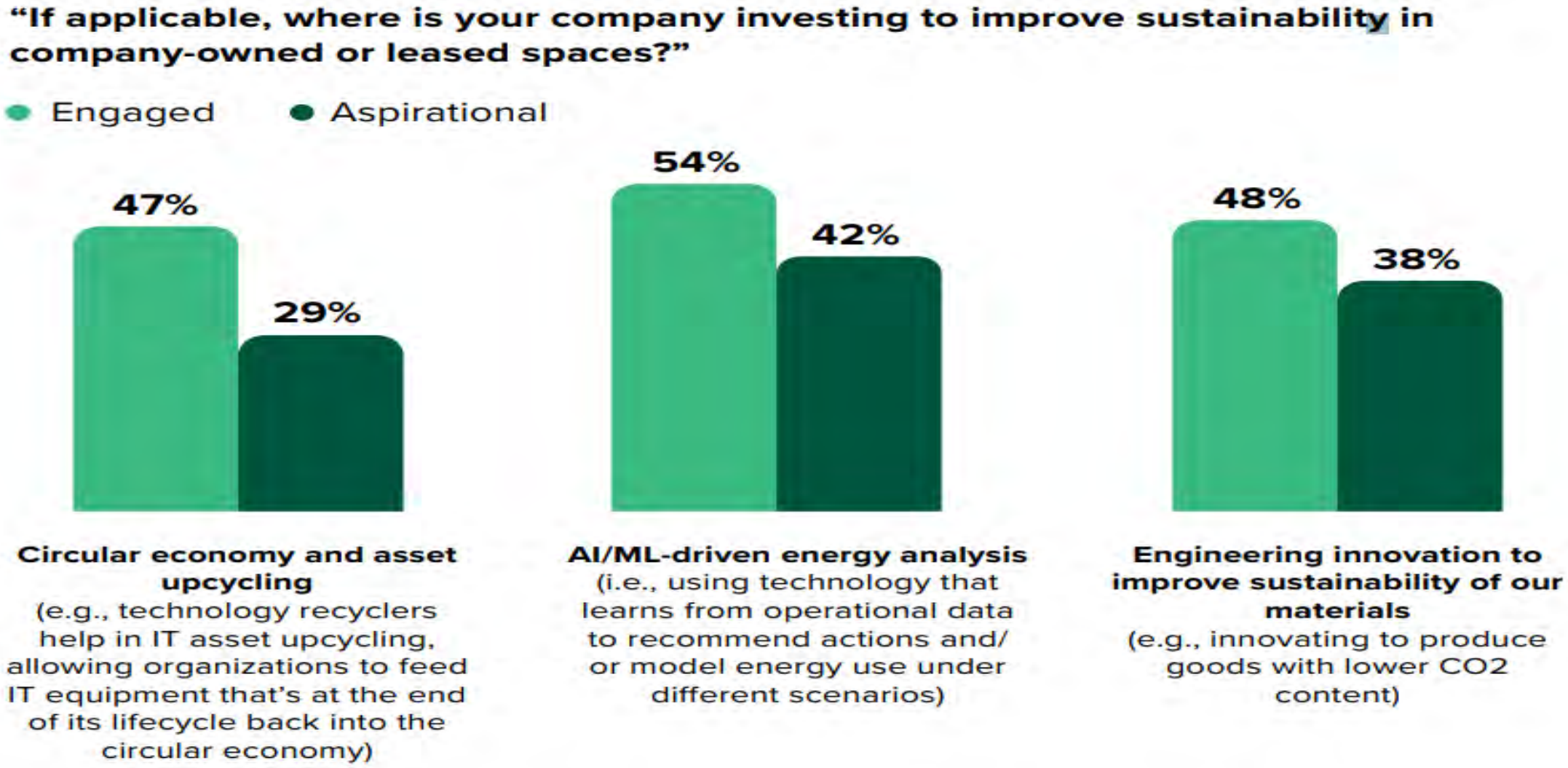
Green Software Testing

- Effective Test Case Execution to achieve near-zero-defect quality software
- requires: infrastructure, computing resources, related software and hardware components
- emits carbon footprint in the environment for each of the test case executions.

Usage of cloud virtualization for the green testing process:

- Cost effective and efficient testing on-demand
- Standardized test processes based on the type of testing
- No need for individual set-up of test tools and test environments
- Reduction of dedicated infrastructure
- On-demand based test case execution reduces carbon emission.

Green Business Model



Base: 479 global sustainability decision-makers at organizations that prioritize corporate sustainability
Source: A commissioned study conducted by Forrester Consulting on behalf of Johnson Controls, September 2021

Principles to follow

- Turn off facilities that are not needed (e.g. sleep scheduling)
- Send data that are needed (e.g. Predictive data delivery)
- Minimizing length of data path (e.g. routing schemes)
- Trade off processing for communication (e.g. data fusion)
- Advanced communication technology (e.g. MIMO)
- Renewable green power sources (e.g. solar energy, wind energy)
- Raise awareness on lowering energy use (eg. Smart metering)

Future of IoT

- AIoT
- Green Social Network as a Service
- UAVs
- Green Connectivity
- Data and context-awareness
- Nano Devices

Future Research

- Energy issues such as energy harvesting and low-power chipsets are central to the development of the IoT.
- Development of novel and more efficient, compact energy storage like batteries, fuel cells, and printed/polymer batteries.
- Development of new energy generation devices coupling energy transmission methods and energy conversion.

GO GREEN

There is no Planet B

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