UK Government
Centres of Expertise
Green Cities, Infrastructure and Energy

Potential AI use cases in green cities, infrastructure and energy sectors

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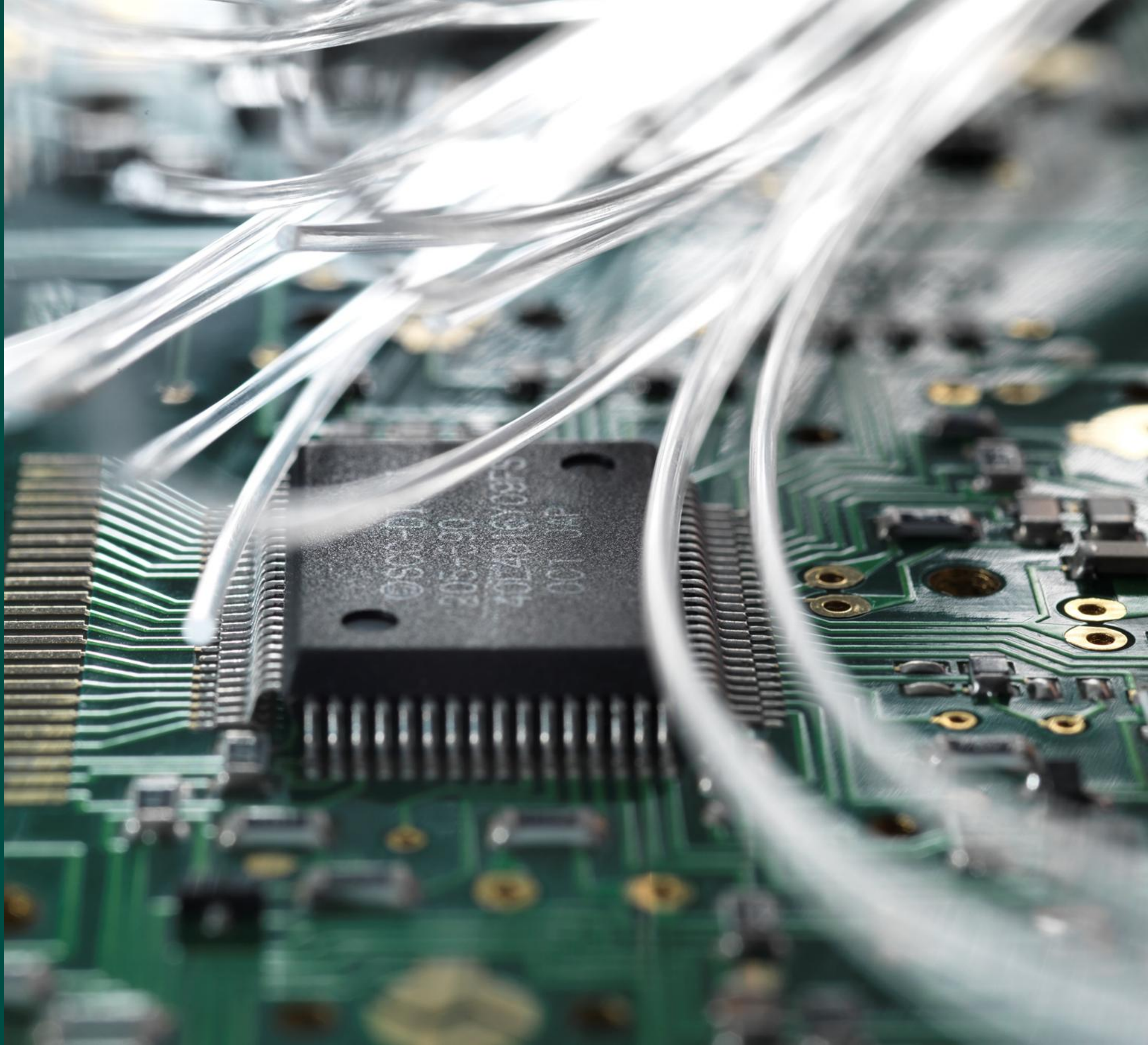
Purpose of this document

These pages provide an overview of potential applications of artificial intelligence (AI) across green cities, infrastructure and energy sectors, with a particular focus on contexts relevant to lower- and middle-income countries (LMICs). It is intended to provide examples to showcase how AI can drive sustainable development in **transport, energy, urban planning, water and waste management sectors** and how it can be applied in the **infrastructure planning** cycle and other cross-cutting sectors.

Disclaimer: The use cases presented are illustrative and do not constitute an exhaustive list. The examples are intended to highlight key opportunities and considerations, but there are many other possible applications of AI within these sectors that are not covered in this document.



AI in transport

Transport planning

AI predicts demand, assesses environmental impact and optimises transport system routes and scheduling to support evidence-based transport planning and decision making.

- **Demand forecasting:**
  Machine learning predicts freight volumes to improve capacity planning.
- **Public transport scheduling:**
  AI forecasts passenger demand and optimises bus or metro schedules to reduce overcrowding.
- **Route optimisation:**
  AI calculates optimal routes based on weather and congestion to minimises travel time and fuel costs.
- **Emission reduction strategies:**
  AI models simulate traffic flow changes to minimise fuel consumption and air pollution.

Traffic optimisation and safety

AI analyses traffic patterns to reduce accidents and emissions, enhancing safety and environmental sustainability in transport.

worldbank.org

- **Dynamic traffic signal control:**
  AI adjusts traffic lights in real time based on congestion patterns to reduce delays and emissions.
- **Accident hotspot prediction:**
  Machine learning analyses historical crash data and road conditions to identify high-risk zones.
- **Crowdsourced traffic data platforms:**
  AI aggregates data from mobile apps to provide real-time congestion updates.
- **Smart pedestrian safety systems:**
  Computer vision detects pedestrian movement at crossings and alerts drivers or adjusts signals.

Transport technologies

Wireless communication, sensors and web platforms enable better coordination and data sharing in LMIC transport networks.

- **Smart fleet management:**
  AI tracks vehicle health and optimises dispatch using internet of things (IoT) sensors.
- **Predictive infrastructure maintenance:**
  AI forecasts road deterioration and schedules repairs before failures occur.
- **Integrated transport platforms:**
  AI-powered apps combine bus, rail and ride-sharing options for multimodal journeys.
- **Low-cost sensor networks:**
  AI processes data from affordable sensors for rural road monitoring and safety alerts.

Freight and logistics automation

AI supports digitalisation and automation in intermodal transport, increasing efficiency and reducing operational costs.

researchgate.net

- **Automated freight scheduling:**
  AI optimises truck, rail and ship schedules for seamless cargo transfers.
- **Warehouse robotics and vision systems:**
  AI automates sorting and inventory management in logistics hubs.
- **Route optimisation for last-mile delivery:**
  AI minimises travel time and fuel costs for urban deliveries.
- **Port operations optimisation:**
  AI predicts cargo handling times and berth availability to minimise delays.
- **Digital customs clearance:**
  Natural language processing (NLP) automates document verification and compliance checks for cross-border trade.

Why these matter for LMICs:

- **Cost efficiency:** AI reduces fuel and maintenance costs in resource-constrained settings.
- **Safety and sustainability:** Predictive models prevent accidents and lower emissions.
- **Scalability:** Solutions can be adapted for both urban megacities and rural transport networks.
- **Digital inclusion:** Mobile-based AI platforms enable participation even in low-connectivity areas.

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AI in energy

Grid management and optimisation

AI optimises energy systems by managing grid loads, forecasting demand and integrating renewable energy sources for efficiency.

iea.org

- **Grid load balancing:**
  AI predicts peak demand and dynamically adjusts power distribution to avoid outages.
- **Energy demand forecasting:**
  Predictive analytics for electricity consumption to guide grid expansion and renewable integration.
- **Microgrid optimisation:**
  AI algorithms for load balancing and predictive maintenance in solar or wind-powered microgrids.
- **Energy theft detection:**
  AI analyses smart meter data to identify irregular consumption patterns and prevent losses.
- **Battery storage management:**
  AI optimises charging/discharging cycles for energy storage systems to extend battery life and reduce costs.

Climate and emissions management

AI supports climate goals via smart buildings and predictive maintenance, reducing peak energy use and emissions.

europa

- **Smart building energy management:**
  AI controls heating, ventilation and air conditioning (HVAC) systems and lighting based on occupancy and weather to reduce energy waste.
- **Predictive maintenance for energy infrastructure:**
  Machine learning detects faults in turbines, transformers and solar panels before failures occur.
- **Carbon emission tracking:**
  AI monitors emissions from power plants and transport systems, providing real-time compliance data.
- **Demand response programmes:**
  AI incentivises consumers to shift energy use during peak times, reducing the strain on energy grids.
- **Urban heat island mitigation:**
  AI analyses satellite and sensor data to guide cooling strategies in dense urban areas.

Green AI policy initiatives

Certification schemes and infrastructure investments ensure sustainable AI deployment in energy sectors of LMICs.

institute.global

- **AI sustainability certification:**
  Automated compliance checks for energy projects using AI to ensure ethical and green standards.
- **Energy efficiency audits:**
  AI-driven audits for industrial and municipal facilities to identify inefficiencies and recommend improvements.
- **Policy simulation tools:**
  AI models simulate the impact of renewable energy policies on emissions and economic growth.
- **AI lifecycle carbon assessment:**
  AI calculates the carbon footprint of AI systems themselves, guiding low-energy model deployment.

Why these matter for LMICs:

- **Cost savings:** AI reduces operational inefficiencies in resource-constrained energy systems.
- **Climate resilience:** Predictive models help manage variability in renewable energy supply.
- **Scalability:** AI solutions can work for both national grids and rural microgrids.
- **Policy alignment:** Supports LMICs in meeting the United Nations Sustainable Development Goals (SDGs) and Paris Agreement targets.

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AI in water and waste management

AI in water and drainage management

AI predicts pollutant removal efficiency and detects faults, improving environmental outcomes and costs.

- **Predictive flood modelling:** AI models can analyse weather forecasts, topography and historical data to predict flood risks in real-time.
- **Smart drainage monitoring:** Sensors embedded in drainage systems can feed data to AI systems that detect blockages, overflow risks or structural failures.
- **Demand forecast and supply optimisation:** AI can forecast water demand based on population growth, weather and consumption patterns.
- **Urban planning integration:** AI can simulate how new urban development plans (housing, transport, energy) will affect stormwater runoff and drainage capacity to allow sustainable urban design.

AI in water quality monitoring

AI models analyse sensor data to detect pollutants and optimise water treatment processes in real time.

unesco.org

- **Real-time pollutant detection:** AI models process IoT sensor data to identify contaminants like heavy metals, nitrates or pathogens in rivers and reservoirs.
- **Clean water and sanitation** AI monitors water quality and forecasts contamination risks for rural and urban water systems.
- **Predictive water safety alerts:** Machine learning forecasts contamination risks based on rainfall, industrial discharge patterns and upstream activities.
- **Remote monitoring for rural areas:** AI-powered platforms analyse low-cost sensor data for communities without centralised water treatment.

AI in wastewater treatment

AI predicts pollutant removal efficiency and detects faults, improving environmental outcomes and costs.

iwaponline.com

- **Dynamic process control:** AI adjusts aeration, chemical dosing and sludge removal in real time to maximise pollutant removal efficiency.
- **Fault detection and predictive maintenance:** Machine learning identifies anomalies in pumps, valves and sensors before failures occur.
- **Energy optimisation:** AI minimises energy use in aeration and pumping by predicting load variations.
- **Effluent quality prediction:** AI models forecast treated water quality based on influent characteristics and operational parameters.
- **Decentralised treatment systems:** AI enables small-scale, modular wastewater plants in peri-urban areas to operate autonomously.

Smart water networks

AI enables predictive maintenance and leak detection, reducing water loss and energy consumption.

whitecase.com

- **Leak detection and localisation:** AI analyses pressure and flow data to pinpoint leaks in aging distribution networks.
- **Predictive maintenance scheduling:** Machine learning predicts pipe failures based on historical data, soil conditions and usage patterns.
- **Demand forecasting:** AI predicts water consumption trends to optimise pumping schedules and reduce energy costs.
- **Non-revenue water reduction:** AI identifies illegal connections and billing anomalies through pattern recognition.

Why these matter for LMICs:

- **Cost efficiency:** AI reduces operational costs in resource-constrained utilities.
- **Scalability:** Solutions can be deployed in both urban and rural contexts.
- **Climate resilience:** Predictive models help manage water stress during droughts and floods.
- **Public health impact:** Real-time monitoring prevents outbreaks linked to contaminated water

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AI in urban planning and design

AI-driven urban informatics

AI integrates spatial, behavioral and environmental data to support sustainable urban development in LMICs.

link.springer.com

- **Urban growth prediction:**
  AI models forecast population density and land-use changes using satellite imagery and census data.
- **Air quality monitoring:**
  AI analyses IoT sensor data to predict pollution hotspots and inform mitigation strategies.
- **Mobility pattern analysis:**
  AI processes global positioning system (GPS) and mobile data to optimise public transport routes and reduce congestion.
- **Disaster risk mapping:**
  AI combines climate and geospatial data to identify flood-prone or landslide-risk areas.

Smart urban planning

AI can greatly improve urban geospatial mapping, particularly where traditional mapping methods are costly, slow and incomplete, and can then integrate and assess data alongside existing datasets.

- **Automated satellite image analysis**
  AI models can process satellite and aerial imagery to monitor urban sprawl, land use changes with less manual surveys and mapping.
- **Real-time mapping with drones:**
  AI-powered drones can capture high-resolution images to create three-dimensional models for areas with poor accessibility.
- **Smart urban planning:**
  AI can integrate geospatial data with demographic, economic and environmental data to suggest optimal location for infrastructure and urban planning.
- **Land use classification:**
  Machine learning can classify land use types to support zoning enforcement, urban growth and policy.

Generative design and digital twins

These technologies enable rapid prototyping and simulation, improving infrastructure planning accuracy and responsiveness.

www.sandtech.com

- **Affordable housing design:**
  Generative AI creates cost-effective, climate-resilient housing layouts tailored to local conditions.
- **Smart city simulation:**
  Digital twins model traffic, energy and water systems to test policy interventions before implementation.
- **Climate adaptation scenarios:**
  AI simulates urban heat island effects and designs cooling strategies for vulnerable areas.
- **Construction optimisation:**
  AI predicts material requirements and timelines to reduce waste and delays.
- **Public space planning:**
  Generative design tools optimise layouts for parks and green corridors to improve liveability.

Ethical and inclusive AI use

Responsible AI applications ensure equitable urban development benefiting all residents through cross-disciplinary collaboration.

pure.tudelft.nl

- **Bias auditing in urban services:**
  AI checks for discriminatory patterns in housing, transport and energy distribution.
- **Participatory planning platforms:**
  AI-powered tools aggregate citizen feedback for inclusive policy design.
- **Privacy-preserving data sharing:**
  Federated learning enables urban analytics without compromising personal data.
- **Accessibility mapping:**
  AI identifies gaps in infrastructure for persons with disabilities and vulnerable groups.
- **Ethical AI certification:**
  Automated compliance checks for urban AI projects to meet global standards.

Why these matter for LMICs:

- **Rapid urbanisation:** AI helps manage growth sustainably in resource-constrained cities.
- **Climate resilience:** Predictive models guide adaptation strategies for extreme weather.
- **Cost efficiency:** AI reduces waste and optimises infrastructure investments.
- **Social inclusion:** Ensures equitable access to housing, transport and utilities.

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Cross-cutting use cases

Policy and capacity building

AI is helping LMICs build local capacity, improve governance and evidence-based decision making.

- **Data-driven policy design:** AI can analyse large datasets to inform evidence-based policymaking, helping governments prioritise interventions and allocate resources more effectively.
- **Tailored learning and training:** AI can tailor training content to the specific needs of partner governments through adaptative learning platforms, microlearning modules and language localization.
- **Institutional knowledge management:** AI can support governments in organising and accessing institutional knowledge through NLP, chatbots and access to global datasets.
- **Monitoring, evaluation and learning (MEL)** AI can enhance MEL through automatic data collection, machine learning powered analysis and prediction of future performance.

Infrastructure planning and delivery lifecycle

Global assessments promote people-centered, ethical AI adoption in cities to address local needs responsibly. UN-Habitat's global assessment outlines how cities can adopt people-centred AI responsibly.

unhabitat

- **Infrastructure planning:** AI can improve infrastructure planning through business case development, scenario modelling, risk analysis, as well as cost and revenue forecasting to enable better decision making.
- **Infrastructure prioritisation:** AI can draw on historic datasets to set up multi-criteria assessment (MCA) frameworks, conduct environmental and societal impact assessments and analyse public feedback through NLP tools.
- **Delivery monitoring:** AI can analyse real-time data through sensors to monitor construction progress, financial spend and environmental impact.
- **Operations and maintenance:** AI can monitor real-time usage and assess asset condition based on usage and weather conditions to predict defects, enabling predictive maintenance.

GEDSI and inclusivity

AI enables equitable urban planning, inclusive infrastructure design and wider access to public services. When locally governed and responsibly deployed, AI supports sustainable development while amplifying marginalised voices and reducing systemic bias.

- **Inclusive service delivery:** AI-powered civic technology enables more accessible and equitable public service through voice and image recognition, multilingual NLP tools and predictive analytics.
- **Gender-sensitive design:** AI improves gender-disaggregated data collection for equitable service design, detecting bias in existing policies and infrastructure and simulate impacts n gender groups to avoid unintended consequences.
- **Monitoring and accountability:** AI can help track progress on gender, equity, diversity and social inclusion (GEDSI) goals through automatic reporting tools, AI audits and real-time dashboards.
- **Ethical AI and capacity building:** AI models can be used to provide capacity building on ethical use and deployment of AI through local training, building in diverse voices and establishing safeguards to prevent algorithmic discrimination.

Why these matter for LMICs:

- **Data scarcity solutions:** AI can work with limited or imperfect datasets using transfer learning and synthetic data.
- **Cost efficiency:** Predictive models reduce waste and optimise resource allocation.
- **Local empowerment:** AI tools tailored for local languages and contexts improve adoption and inclusivity.