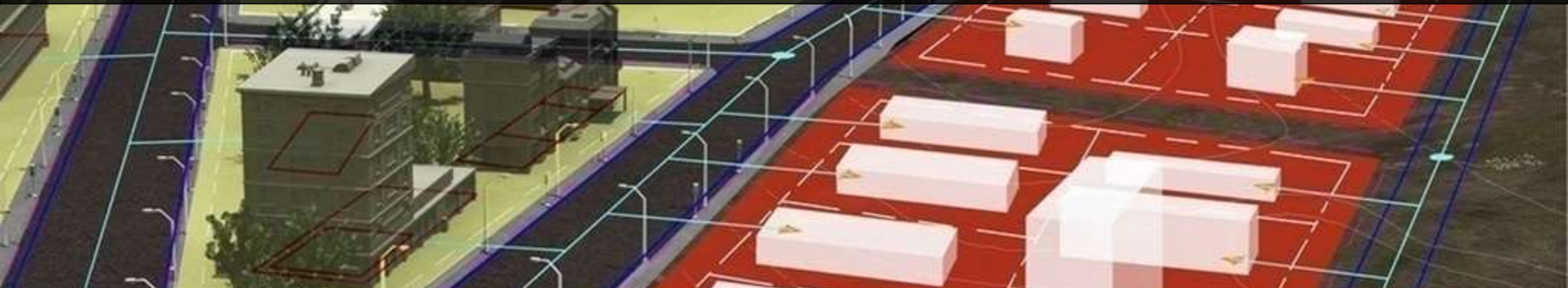


- Geospatial+BIM key to transforming
- construction to ensure resilience

Geoff Zeiss
Principal
Between the Poles



Massive urban development is happening

Delhi-Mumbai Industrial Corridor (DMIC)

- US\$ 90 billion project
- 180 million people will be affected
-
- 1,500 km in length between Delhi and Mumbai.
- Nine large Industrial zones of about 200-250 km²
- High speed freight line, three ports, six airports and a 4,000 MW power plant.
- Intended to be a smart city



30% rise in global energy demand to 2040

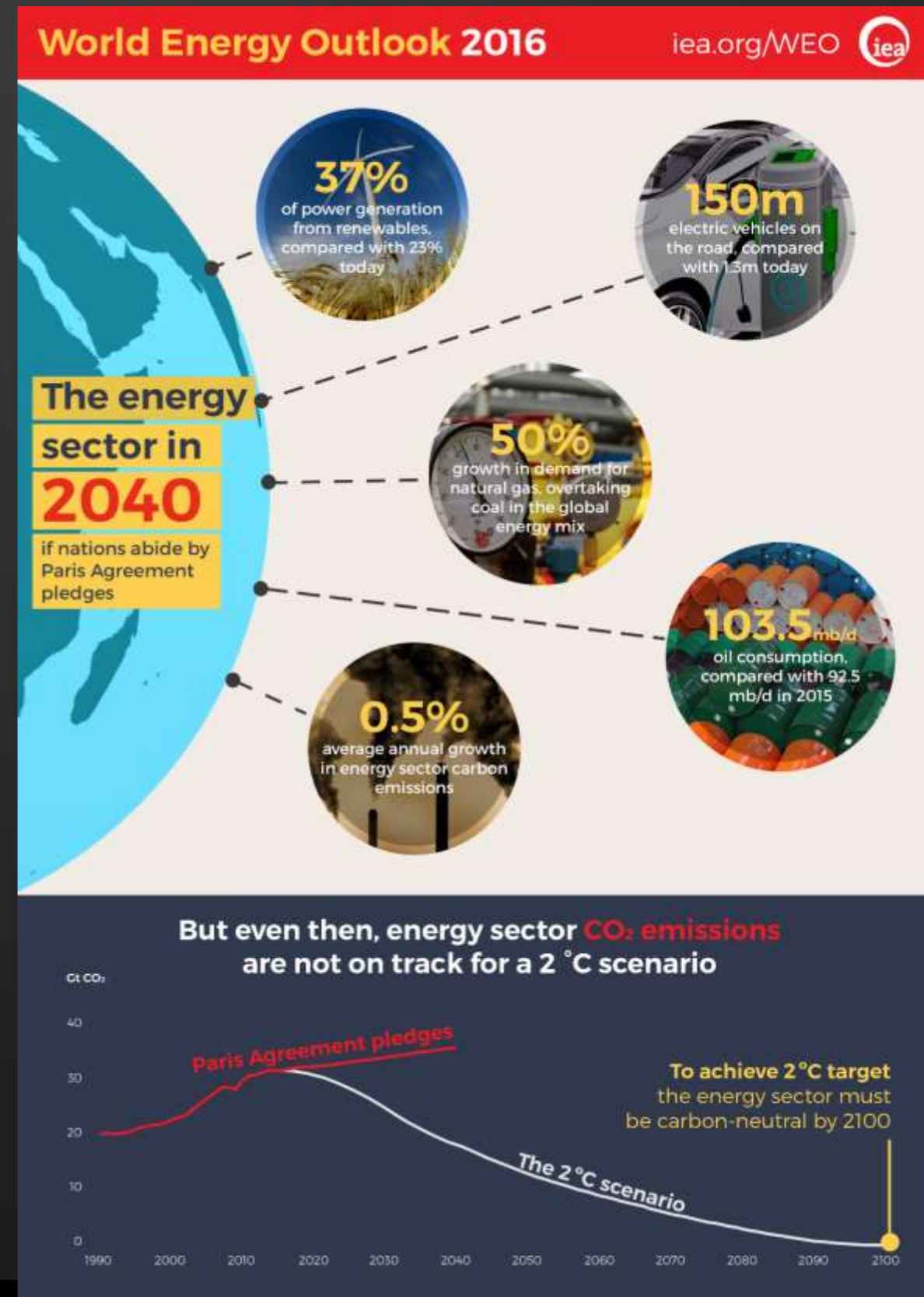
Includes COP21 pledges

- Energy-related emissions will grow by 0.5% per year.
- Projects 2.7 ° C of warming

\$44 trillion for global energy supply over next 15 years

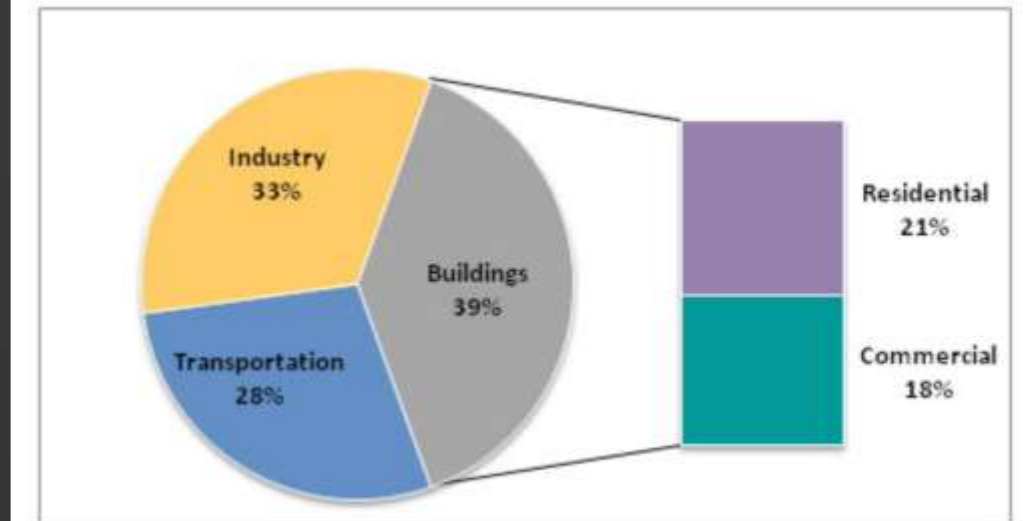
- Additional \$23 trillion for energy efficiency improvements.
- Additional \$12 trillion for 2 ° C
- Requires redirecting investment from fossil fuels to renewables

IEA World Energy Outlook 2016



60% of world's greenhouse gas emissions sourced from infrastructure including buildings

Figure 1: Buildings Share of U.S. Primary Energy Consumption (2006)



Source: U.S. Department of Energy (DOE), 2008 Buildings Energy Data Book, Section 1.1.1, 2008.

New buildings in EU must be designed to be “nearly zero energy”

- 2018 - deadline for new public buildings
- 2020 - deadline for all new buildings



Energy Independence and Security Act of 2007 mandates

- 2030 - all new Federal facilities must be “net zero energy” buildings.

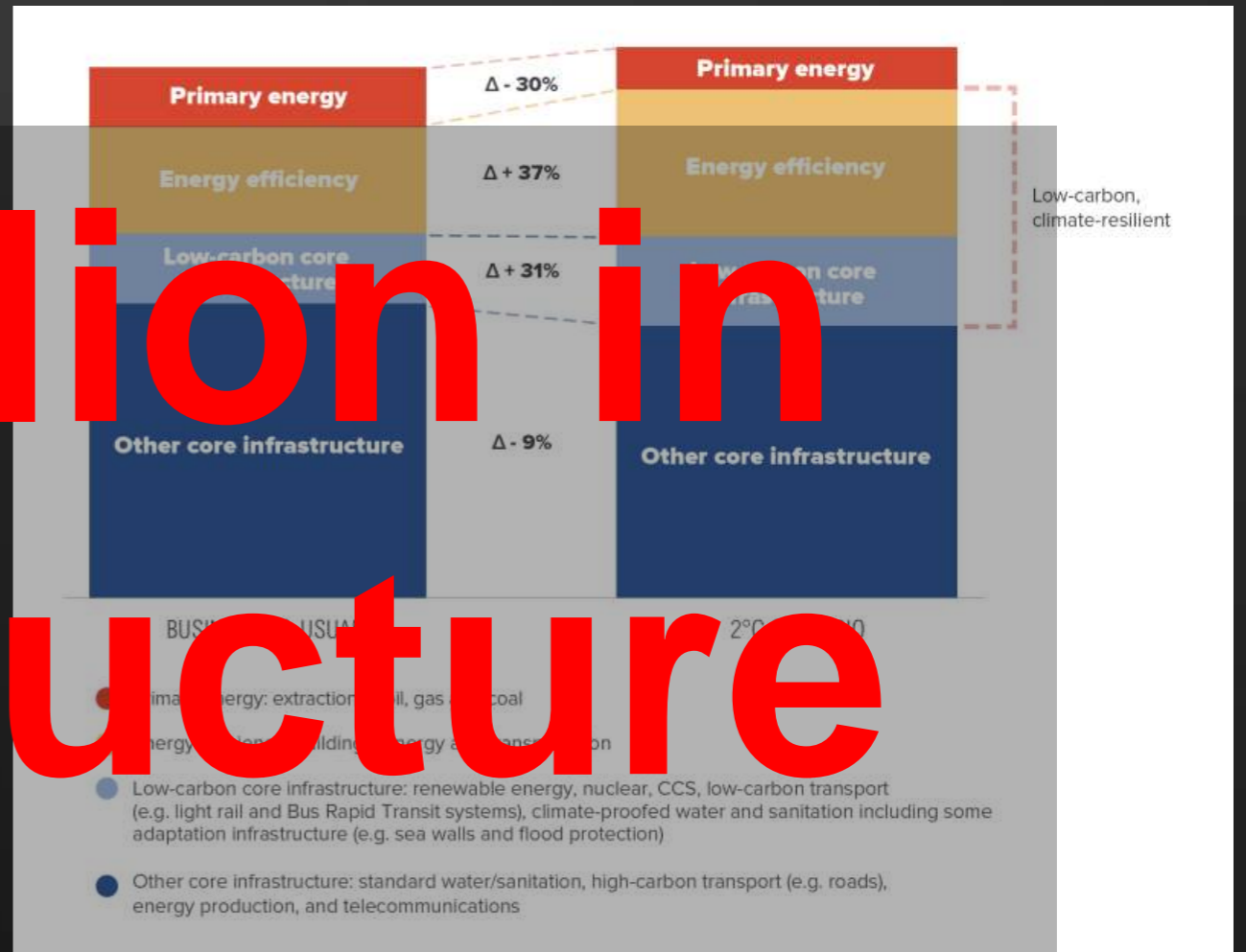


\$90 trillion in sustainable infrastructure investment required over the next 15 years

New approach to investment in sustainable infrastructure required

\$90 trillion in infrastructure next 15 years

Requires that the world's construction and financial sectors ensure that this money, increasingly private, is spent on low-carbon, energy-efficient project

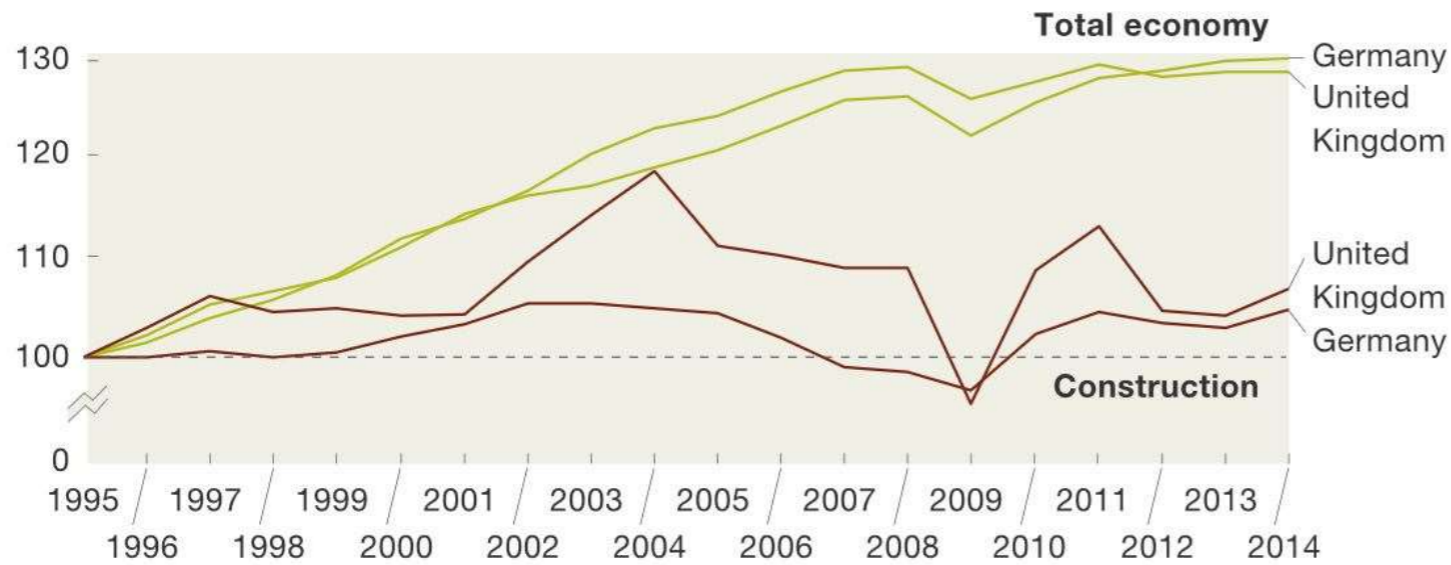


Who is going to do all this ?



Historical Productivity in Construction

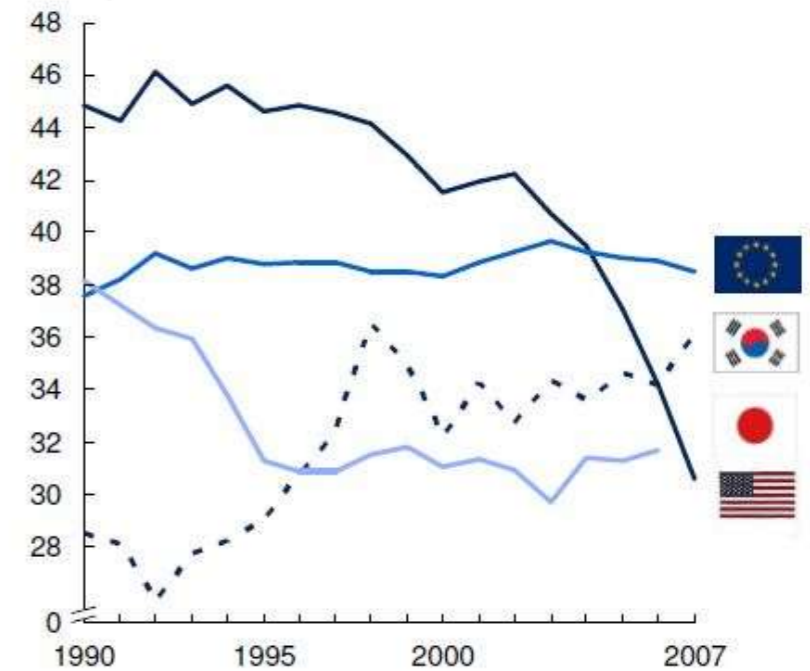
Labor productivity, gross value added per hour worked, constant prices,¹
index: 100 = 1995



¹Based on 2010 prices.

McKinsey&Company | Source: Organisation for Economic Co-operation and Development

Construction productivity
GVA per hour worked in 2007 PPP \$



SOURCE: EUKLEMS; Associated General Contractors of America, 2011; U.S. Bureau of Labor Statistics

Funding increasingly private

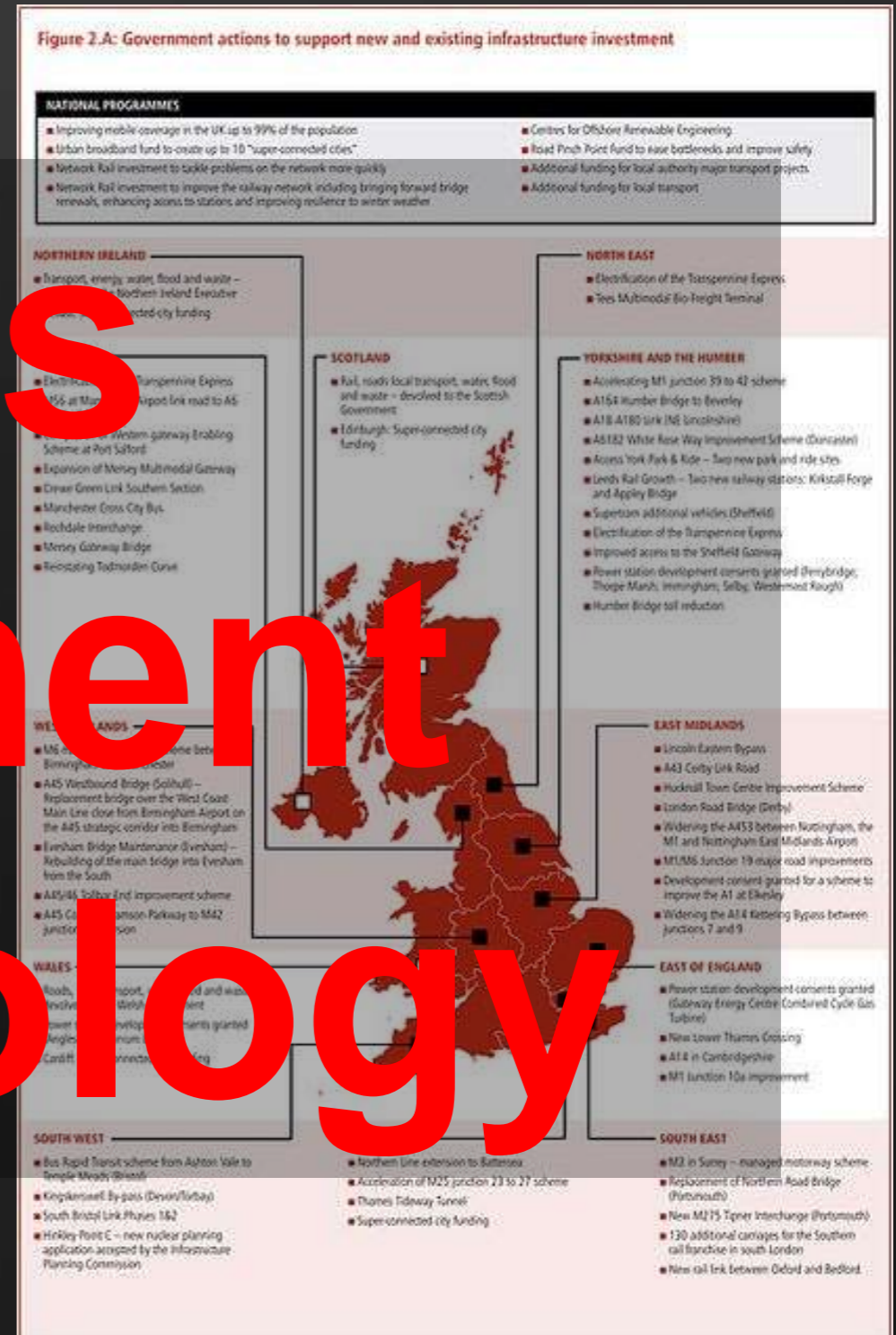
The National Infrastructure Plan brings together the first ever comprehensive cross-sectoral analysis of the UK's infrastructure networks and sets out a clear pipeline of over 500 infrastructure projects worth over £250 billion over the next 5 years.

The Government will use all the tools at its disposal to facilitate the private investment that will finance the majority of the UK's infrastructure.

£400 billion over next decade

Target 70% private funding

Drives investment in technology



Geospatial and BIM are key to transforming construction

❖ Construction is ripe for disruption

❖ key technologies: Geospatial and BIM

- Reality modeling using phodar and LiDAR technologies
- Above and below-ground: Ground-penetrating radar, magnetometers, and other equipment, integrated with LiDAR
- 5D BIM
- Geocoordination enables full-lifecycle BIM - integrating BIM and geospatial by georeferencing everything



[Imagining construction's digital future](#), McKinsey & Company

McKinsey: 5D BIM key for construction transformation



Global BIM Adoption



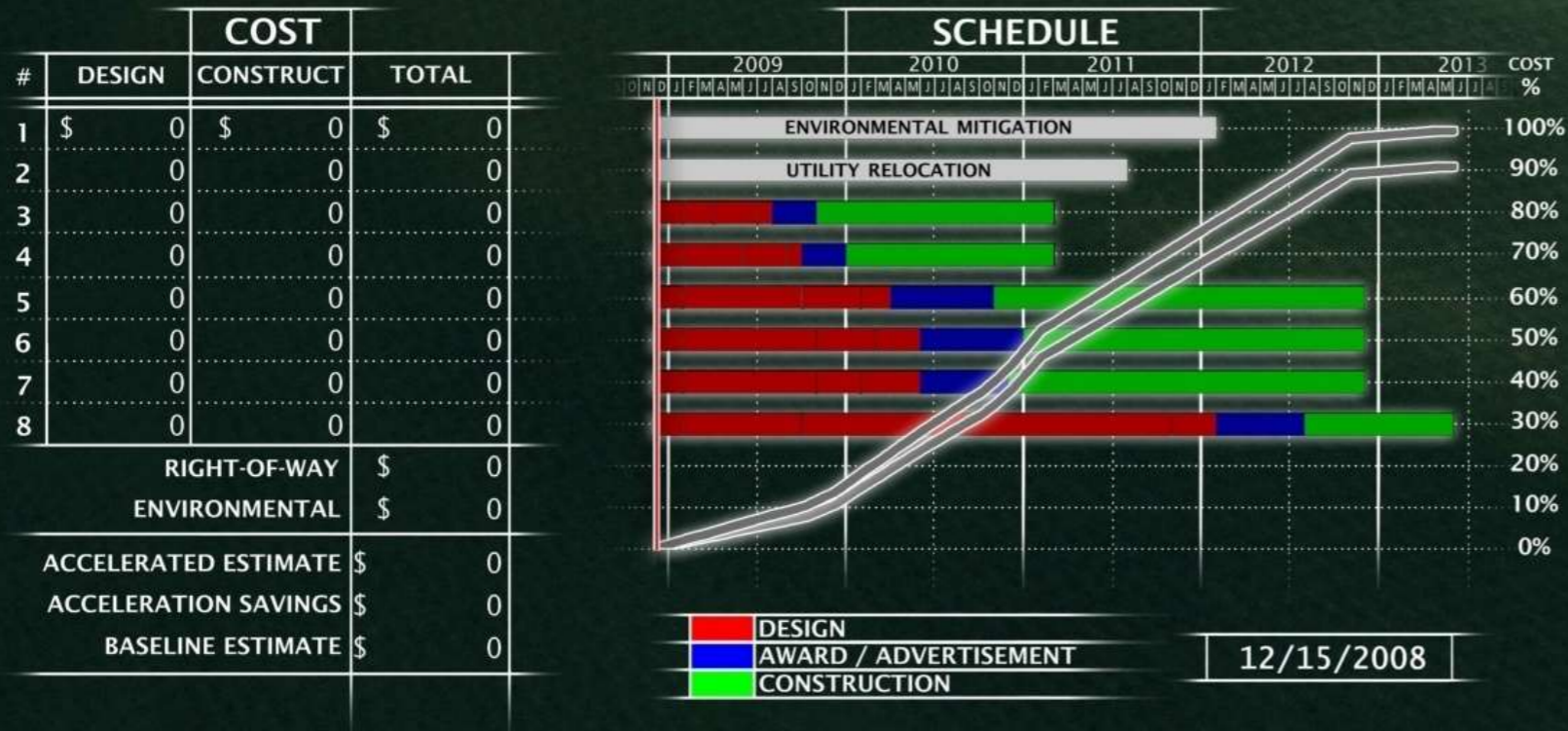
- **United States**
 - 2006 GSA mandated BIM for new buildings
- **Singapore**
 - 2008 BCA implements e-submission
 - 2013 BIM mandated for large bldgs
- **United kingdom**
 - 2016 BIM mandated for public projects
- **Norway**
 - 2010 BIM adopted for government projects
- **Russia**
 - 2018 for public projects
- **EU**
 - 2015 European Parliament recommends *BIM Mandate* for publicly funded building
- **Denmark**
 - 2013 State agencies require BIM for their projects
- **Finland**
 - 2007 State Property Services Agency requires BIM for its projects
- **Hong Kong**
 - 2014 Housing Authority requires BIM for all new projects
- **South Korea**
 - 2016 Public Procurement Service made BIM compulsory for all projects over S\$50 million and for all public sector projects
- **France**
 - 2017 mandated for public procurement
- **Germany**
 - 2020 mandated for transportation projects

McKinsey: 5D BIM a key technology

SF Presidio Parkway Project



PRESIDIO PARKWAY



McKinsey: New geospatial technologies
key for construction transformation



Reality modeling (AKA phodar)

PhoDAR (phtogrammetric detection and ranging) based on Structure from Motion (SfM)



New imaging laser scanner lowers bar

Full-color panoramic images on a high accuracy point cloud

- Infrared sensors for thermal imaging
- 360,000 points per second
- Range of 60 meters with 4 mm accuracy
- Weighs one kilogram

Anticipated retail price of scanner and software \$15,990/€15,000

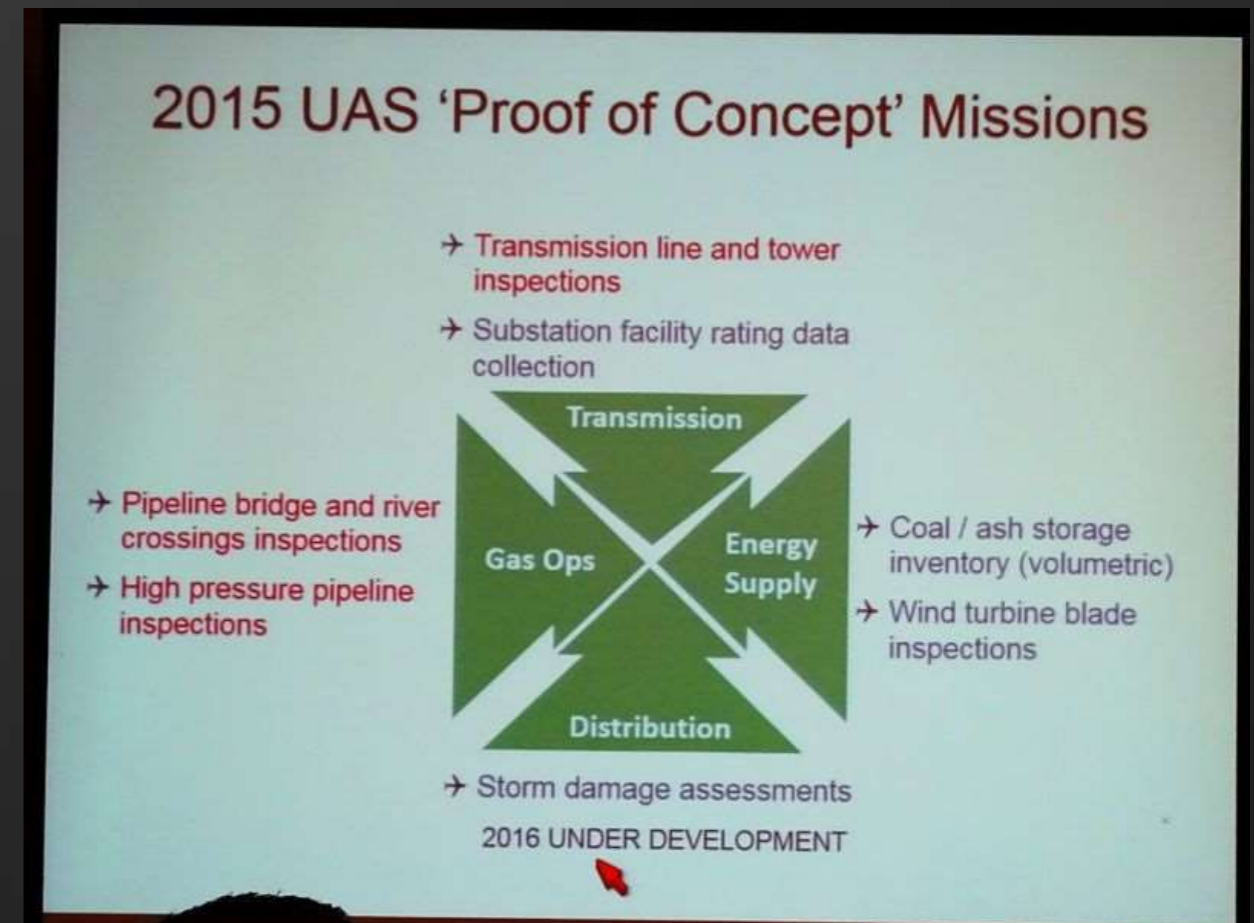


[BLK360, Leica Geosystems+Autodesk](#)

UAVs - Beyond visual line of sight (BVLOS)

Beyond visual line of sight (BVLOS) pilots

- Feb 3, 2016 Xcel completed the first beyond visual line of sight mission with UAV flights over 20 miles of transmission lines.
- Convinced that FAA will permit commercial BVLOS flights in the near future.



Xcel launched UAV Proof of Concept project in 2015 with seven UAV missions in 2015

Advances in Earth-observation satellites

Digital Globe

- Revisit same place four times per day with 30 cm resolution
- Online access to 16 years of earth imagery, about 90 petabytes



Planet Labs

- Whole Earth imagery every hour (future)



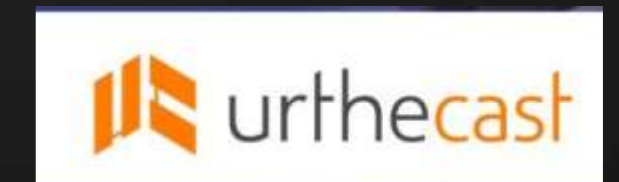
Terra Bella – was Skybox, acquired by Google

- Frequent high-resolution imagery

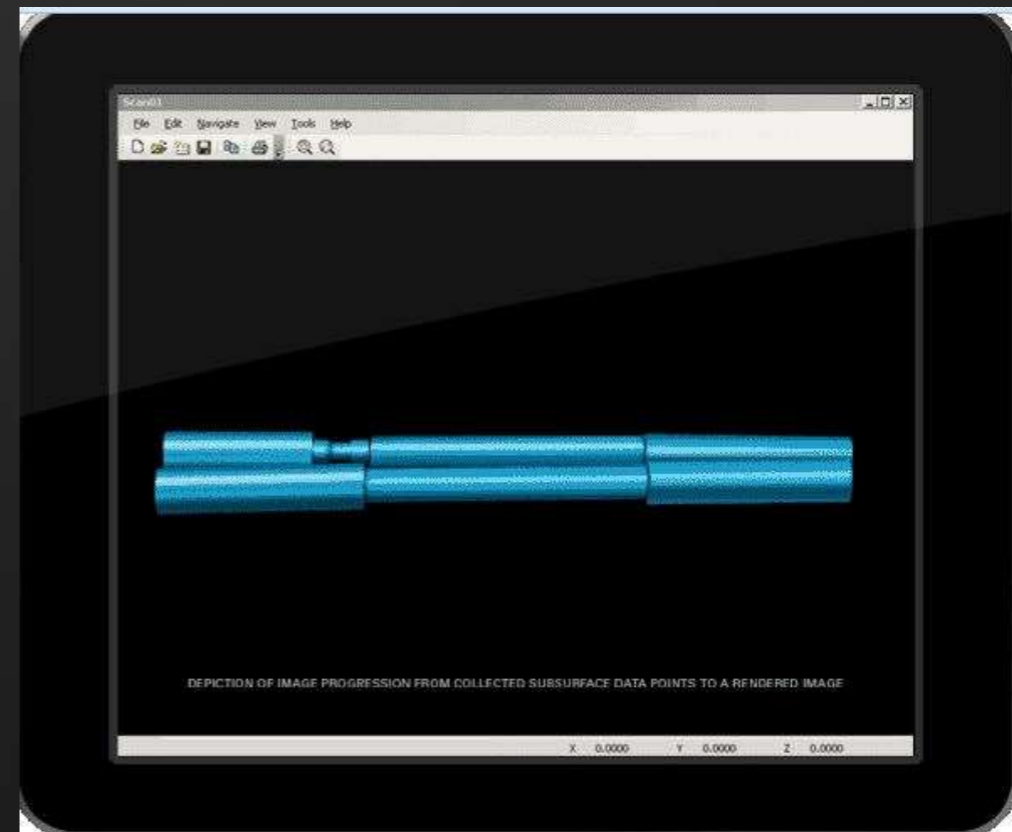
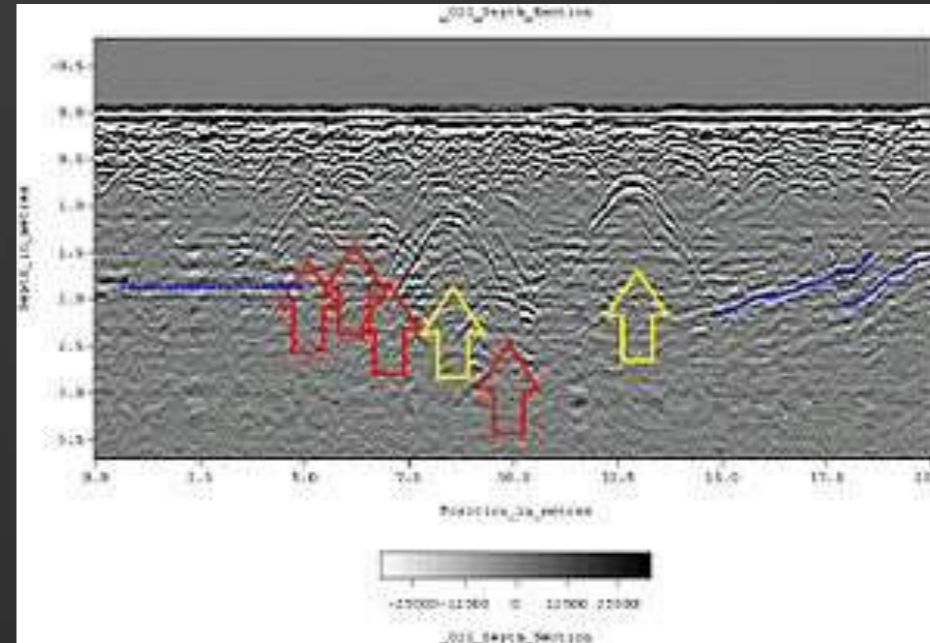


urthecast

- Four cameras on ISS
- Near-real time - 0.75 m resolution
- OptiSAR constellation - optical + radar (future)



Ground penetrating radar (GPR)



Geotec

Between The Poles

Indoor navigation

Wearable reality-capture technology combines five high-dynamic cameras and two LiDAR profilers

- Creates a 3D view indoors or outdoors for engineering or professional documentation
- Uses SLAM (simultaneous localisation and mapping) to determine position in GNSS-denied areas.



Map the interior of buildings by simply walking through the building

Full-lifecycle BIM requires integrated
geospatial+ BIM



Full-lifecycle BIM: Netherlands

Design, build, finance and maintain (DBFM)

- Contractor responsible for designing, building, financing, and maintenance.



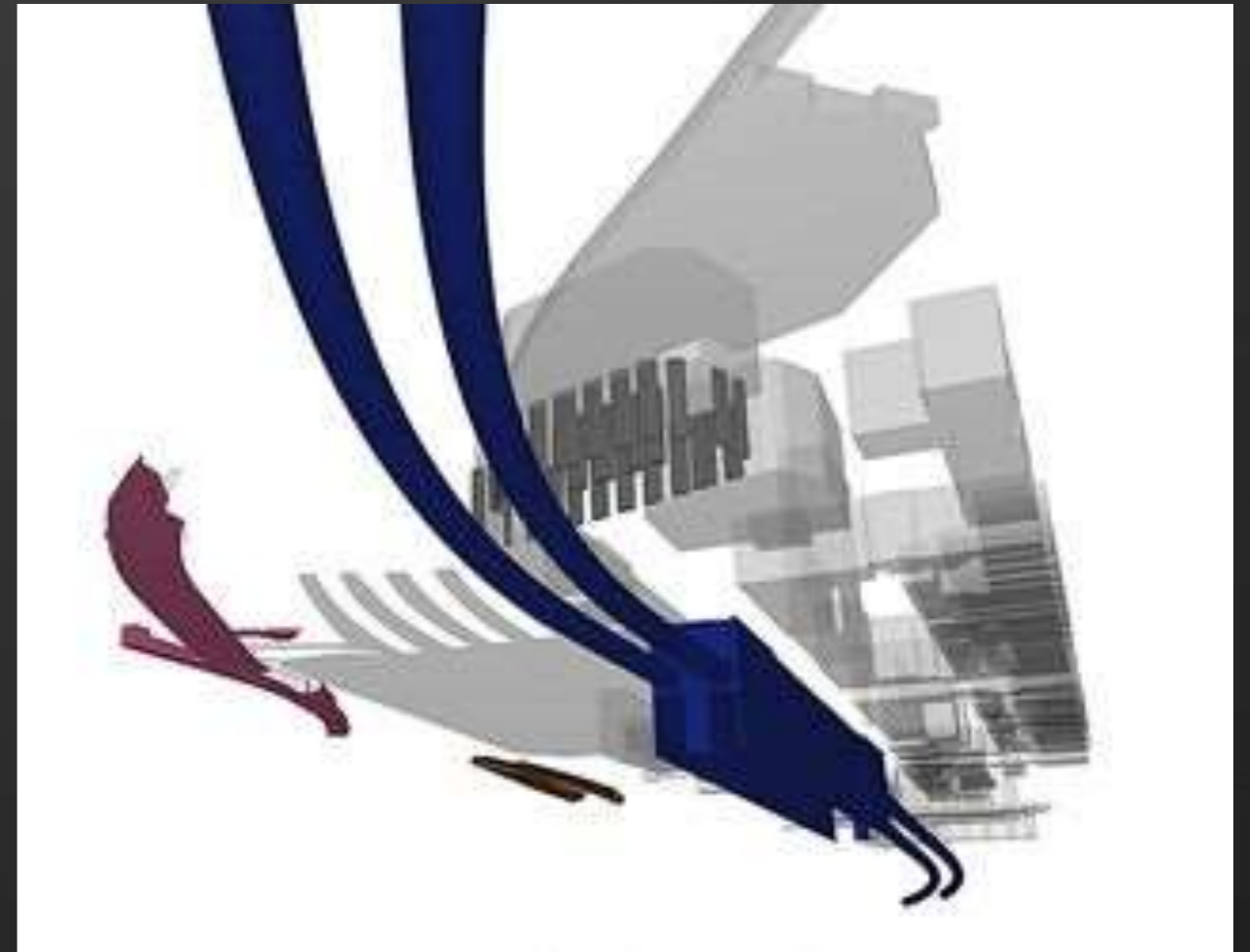
Royal BAM Group nv / BAM Infraconsult

- BIM for Infrastructure process based around a geospatially-enabled database.
- Everything georeferenced
- Data collected during design and construction migrated to an integrated GIS+FM system for maintenance activities
- Reality capture at the beginning of the project, before design, using laser scanning.

Full-lifecycle BIM: Crossrail

UK Government mandated
BIM Level 2 April 2016

- Expects 20% savings on design and construction
- Biggest benefit 40% savings during operations and maintenance



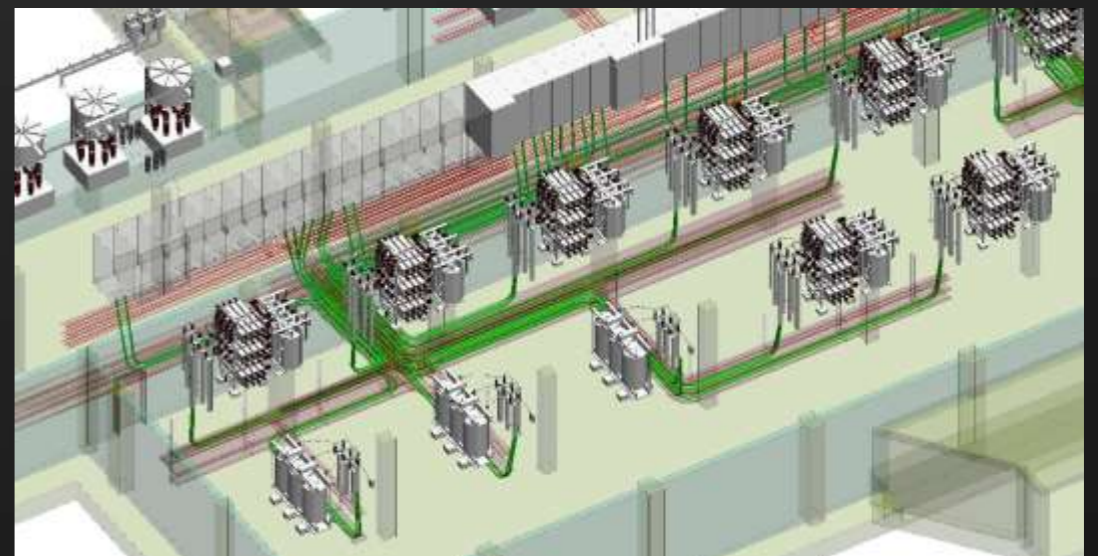
Crossrail largest engineering project in Europe

- Full-lifecycle BIM - 3D model used during design and construction intended for operations and maintenance

Full-lifecycle BIM: Substation in downtown Wuhan

Miaoshan 220kV Secondary Transformer Substation

- Everything geolocated (geocoordination)
- Design and construction model and associated data brought into FM application
- Enabled efficient management of plant data, technical specifications, operation and maintenance manuals and other detailed information for operation and maintenance management

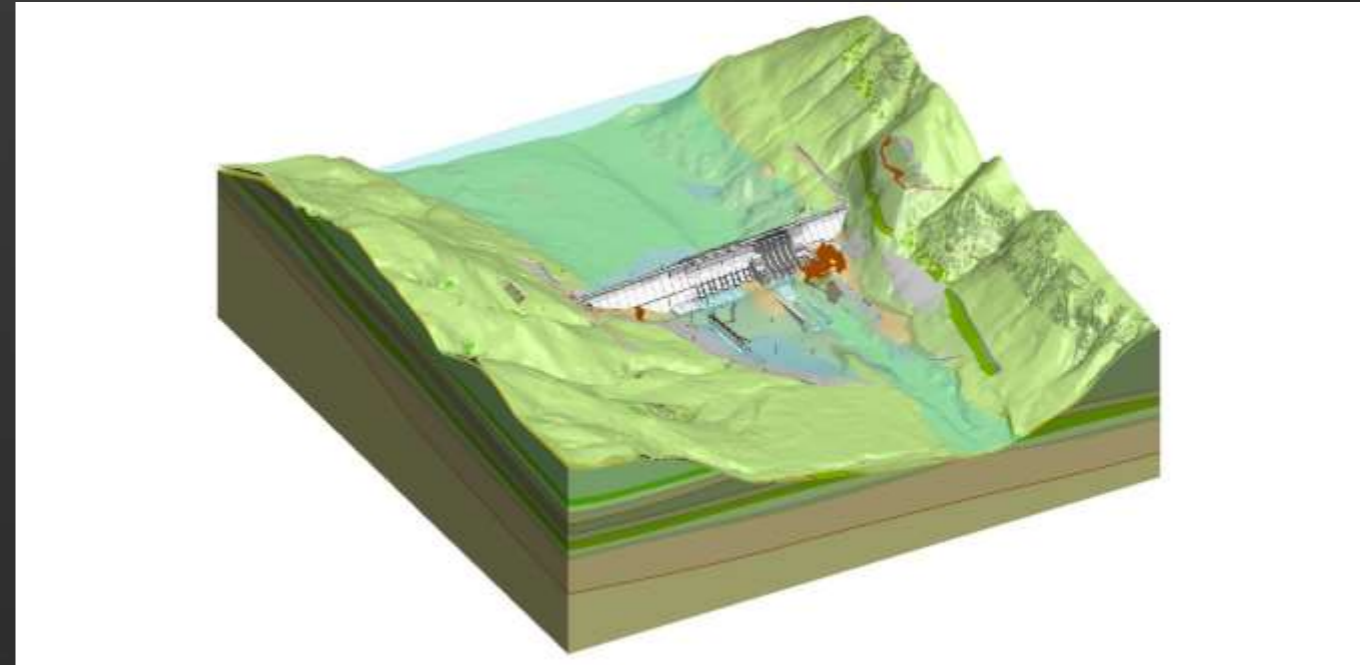


Full-lifecycle BIM: Hydropower generation plant

Longkaikou Hydropower Station

- 3D BIM design shortened design cycle, improved project and service quality, and reduced construction costs
- Everything geolocated (geocoordination)

BIM model provided the basis for digital operation and maintenance of the facility by the owner.



Modeling existing infrastructure




Scan to BIM

Mollenhauer sees a major future business opportunity

- Has identified major business opportunity in energy performance modeling for existing buildings.
- “Scan to BIM” model is the starting point for energy performance modeling and redesign

MOLLENHAUER GROUP – Metrics



- Demanding 12 week program schedule for Phase I
- Approx. 750 scans and 800 GB data in total
- 38 km of piping
- 57 km of structural framing
- Model used by an International team of architects and engineers

MOLLENHAUER

THE BEVERLY CENTER

The Beverly Center Shopping Mall, Los Angeles





MOLLENHAUER

Modeling underground infrastructure



ACROSS THE UNITED STATES

THE CONCERNS

- UNDERGROUND UTILITY LINE HIT EVERY 60 SEC 
- ANNUAL COST DUE TO UTILITY DAMAGE RANGES IN THE BILLION\$ 
- INACCURATE RECORDS AND LOCATING
- UTILITIES NOT MARKED
- CROWDING WITHIN THE RIGHT OF WAY

Las Vegas 3D infrastructure model



International Efforts to Geolocate Underground Facilities

- France – A nation-wide multi-billion euro project is underway to map France's underground utility infrastructure to 40 cm.
- Penang, Malaysia – Penang's Sutra D'Bank (Penang State Government Subterranean Data Bank) is maintained by a joint venture company EQUARATER (PENANG).
- Bahrain - Bahrain's Intelligent Decision Support System (iDSS) provides single repository for all underground facilities.
- Sao Paulo, Brazil – The City of Sao Paulo's GeoCONVIAS project integrates data from 20 to 30 utilities which operate in the city of Sao Paulo.
- Rio de Janeiro, Brazil - The City of Rio de Janeiro has a similar project GeoVias funded by the government of the City of Rio de Janeiro and four utilities.

International Efforts to Geolocate Underground Facilities (cont.)

- Tokyo, Japan (now deployed in major Japanese cities) – Many years ago Tokyo developed the mainframe-based Road Administration Information Center (ROADIC) system
- Sarajevo, Bosnia – Over 40 years ago as part of the permitting process, Sarajevo mandated the recording the location of all utility and telecommunications infrastructure in the city.
- Calgary, Alberta – A number of years ago the City Government passed a by-law which mandated that all utilities and telecoms working within city limits must provide data showing the geolocation of their infrastructure to the city's Joint Utility Mapping Project (JUMP).
- State of Jalisco, Mexico - The Instituto de Información Territorial del Estado de Jalisco developed an integrated infrastructure database for the State of Jalisco.
- Edmonton, Alberta - Edmonton, Alberta has a shared facilities mapping database.

Intelligent cities



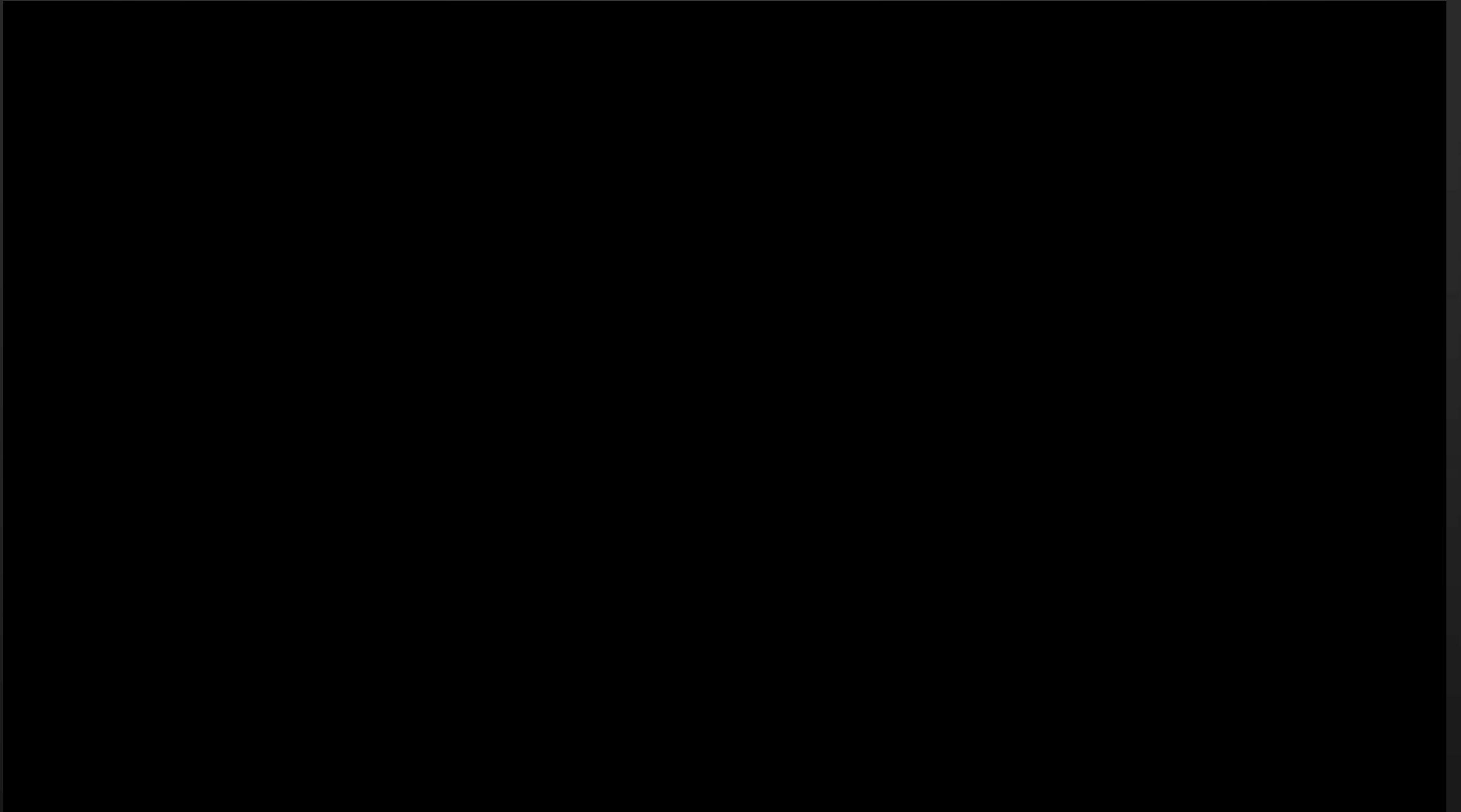
Energy performance modeling of entire cities

Den Haag, Netherlands

Project to model one square kilometer of downtown to reduce and manage energy demand



Modeling entire cities



Maintained infrastructure/building information models are essential for resilience

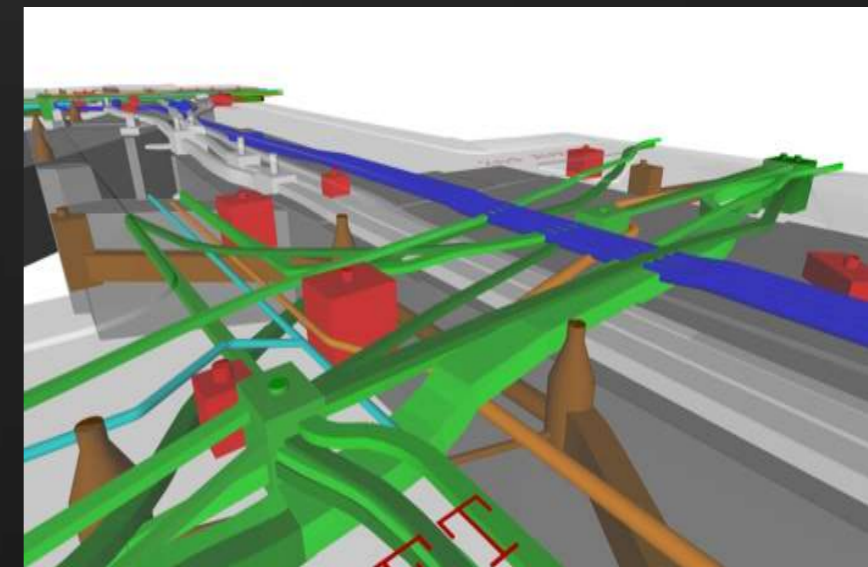
Urbanization and environmental challenges means massive investment in infrastructure

- More private investment
- Drives investment in technology

Advances in construction productivity

- BIM + geospatial technologies
- Full-lifecycle BIM model
- Requires underground infrastructure modeling
- Maintained above and below ground models

Intelligent infrastructure models enable resilient cities



Geoff Zeiss, Principal Between The Poles

geoff.zeiss@betweenthepoles.info

<http://geospatial.blogs.com>

