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Energy Distribution – Challenges for the Civil Engineer

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Introduction – the Geotechnical Perspective



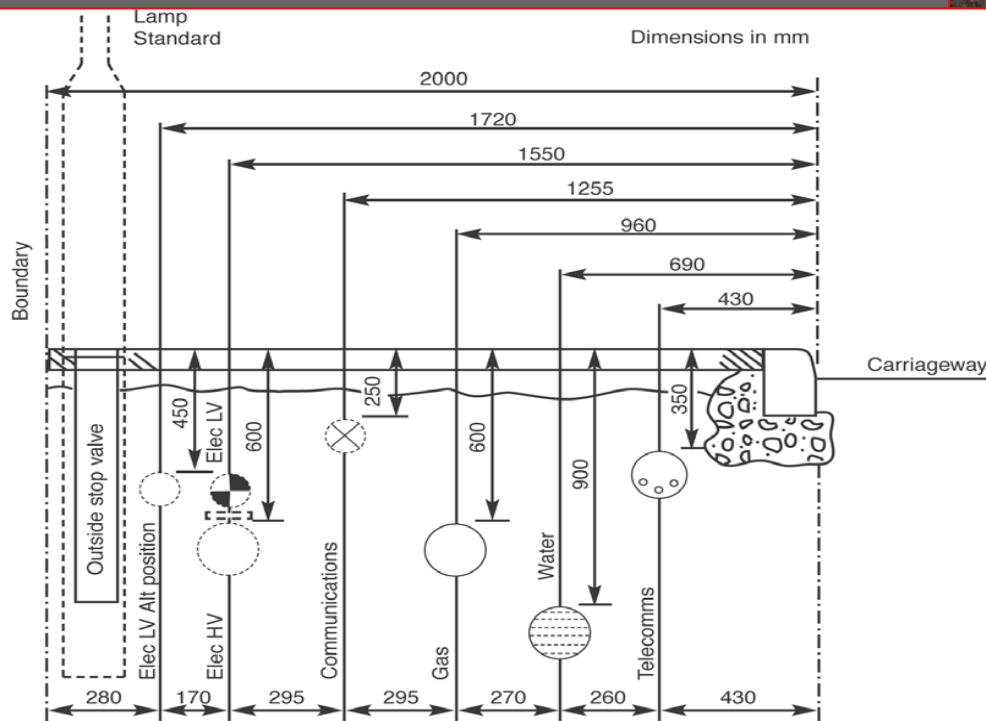
- Energy distribution means cables and pipelines – *utility infrastructure*
- National, regional and local scales offer different challenges
- Issues of protection (weather, accidental damage) and aesthetics
 - burial resolves most of these issues – essential in urban areas
 - long distance HV cables are put on pylons – cooling, costs less
... *but to whom* (economy, society, environment), *and why?*
- We are grappling with several of the challenges
 - *installation of HV cables using trenchless technologies*
 - *location and mapping of the buried utility infrastructure*
 - *use of underground space for more sustainable cities*
 - *alternative local infrastructures*
 - *artificial lightscares – what needs to be lit at night?*
 - *future relevance of today's infrastructures*

Cable Pipes – ‘No More Pylons’

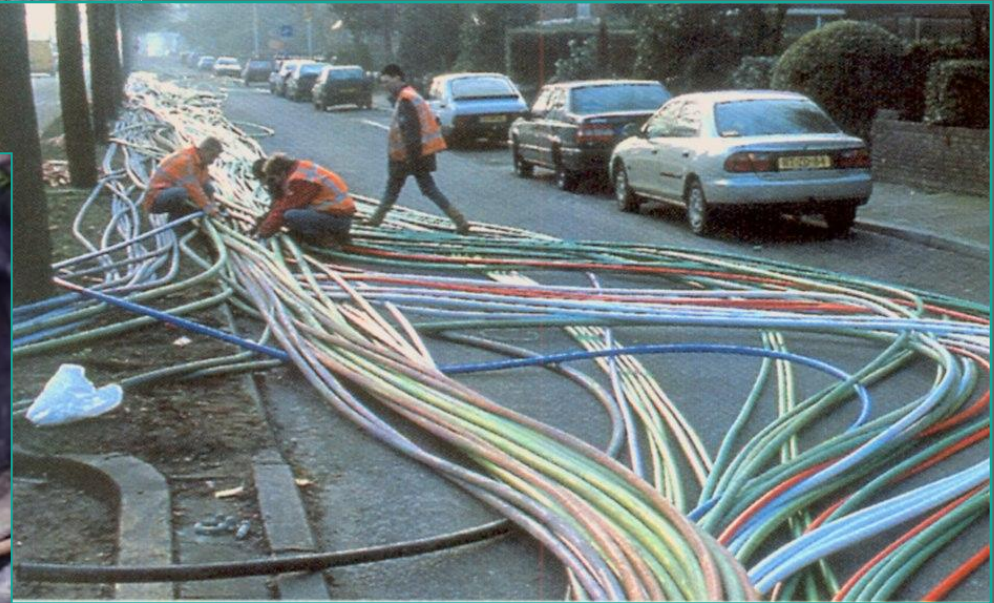


- A feasibility study investigated *the installation and operation of HV cables over long distances using trenchless technologies*
 - factors limiting drive lengths
 - issues with multiple HV cables in a single conduit
- Conventional tunnelling is used ... but is very expensive
- Combining *Horizontal Directional Drilling (HDD)* and *Microtunnelling (MT)* technologies could provide a feasible solution
- Newcastle University studied the conduit, forced cooling, HVDC, ...
- We studied plastic pipe pull-in forces (HDD)
 - *steering and alignment, bore stability, friction reduction*
- We also studied extruded concrete linings (MT)
 - *polymer concrete for rapid curing, strength gain with time, deformations of the extruded liner*

Utility Service Congestion



Utility Service Congestion



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Utility Service Congestion

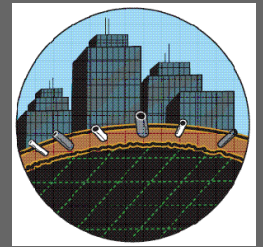


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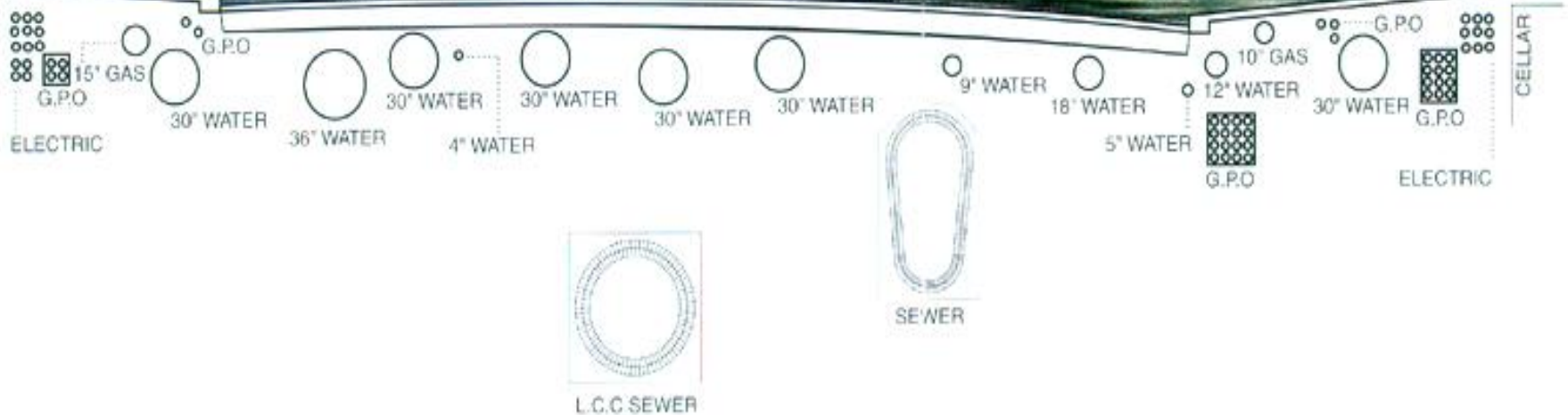
Mapping the Underworld

EPSRC

Engineering and Physical Sciences
Research Council



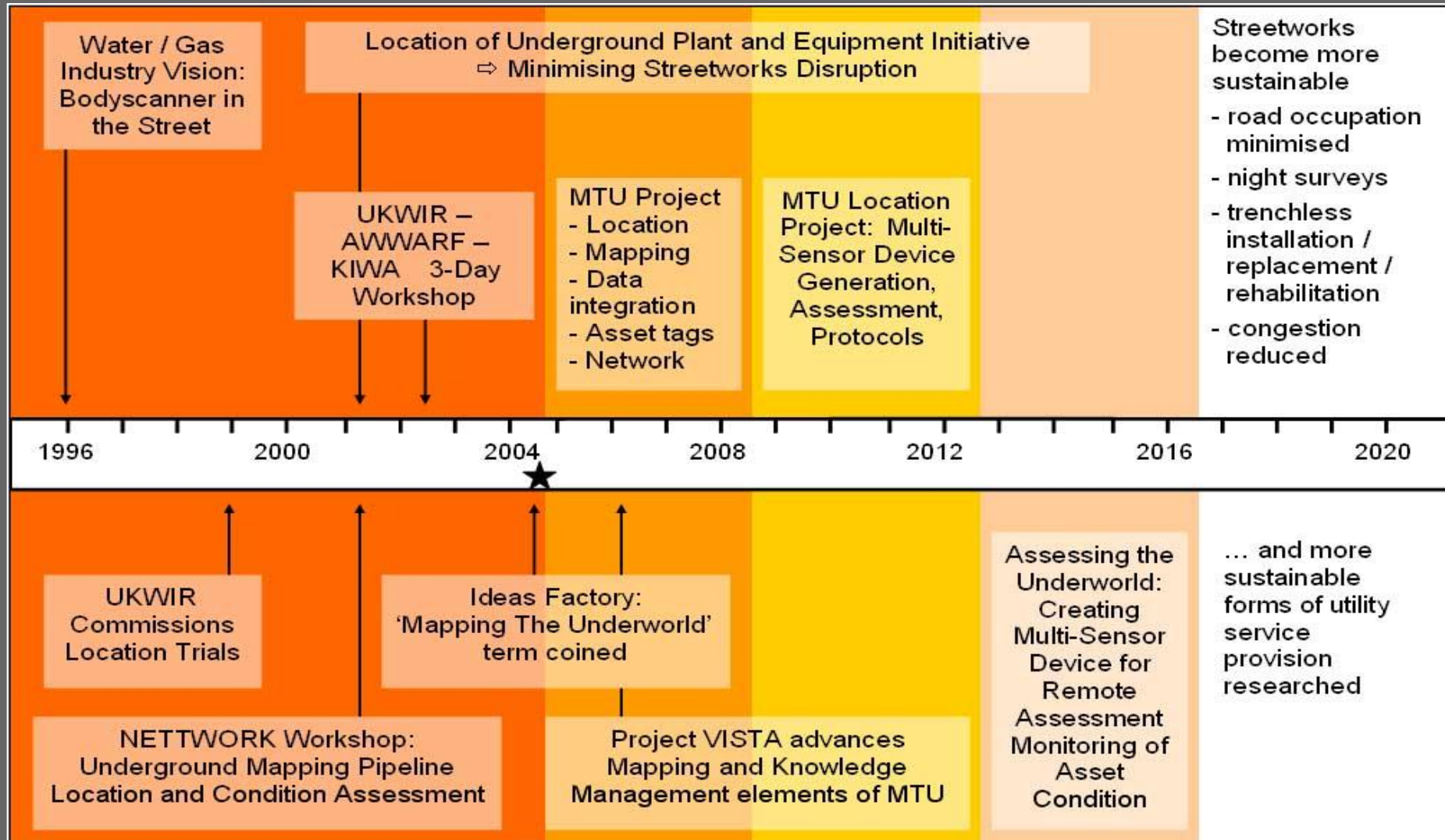
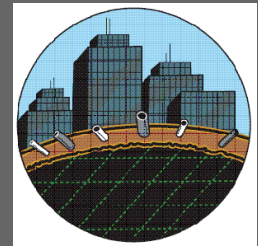
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Mapping the Underworld

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Resilience Through Innovation

Critical Local Transport and Utility Infrastructure



□ Cross-Disciplinary Feasibility Account

- *“flexible funds to enable established cross-disciplinary research groups to support a suite of short-term research activities”*

It embraces engineering, social sciences, planning, business, innovation, climate change, security, sustainable urban environments, ...

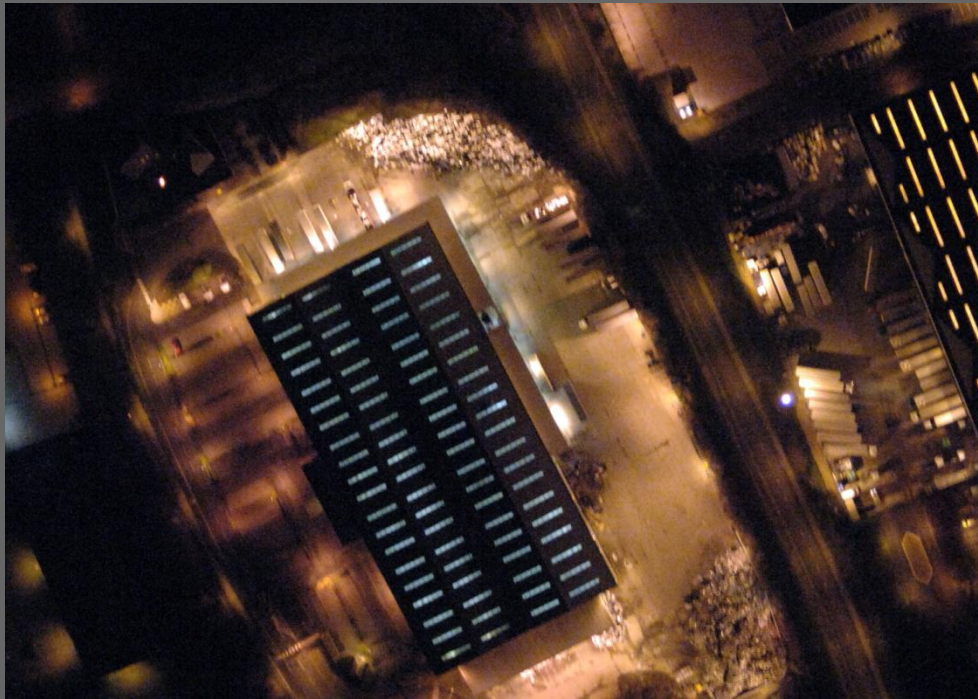
- There is much emphasis on national infrastructure ... legacy, and ageing, and investment, and adaptation, and interdependencies
 - *is a national infrastructure appropriate for all local contexts?*
 - *what would local arrangements have look like?*
- *Modelling of Local Infrastructure Systems*
- *Bottom-Up / Scale-Up / Emergent Organisations*

Artificial Lightscares



- As urban areas have grown, so has the area and intensity of artificial lighting. Along with the obvious benefits, there are costs:
 - *energy consumption and supply*
 - *health and quality of life*
 - *ecosystem function and ecosystem services*
- It has severe implications for plants, animals and humans who have evolved in ecosystems that were essentially unlit at night and where the diurnal variation in the light-dark-cycle were predictable.
- Altering the quantity, quality (i.e. spectra) and timing of light and dark could mitigate problems
 - *what light do we want, and where, and when?*
- We will secure high-resolution maps depicting the intensity and spectral quality of artificial lighting for several UK urban areas.

Artificial Lightscares



Urban Futures



- Sustainability is about putting in place now (energy) solutions that will yield a positive rather than negative future legacy

The essential underlying question is:

“how sustainable are these solutions?”

... while the answer inevitably is:

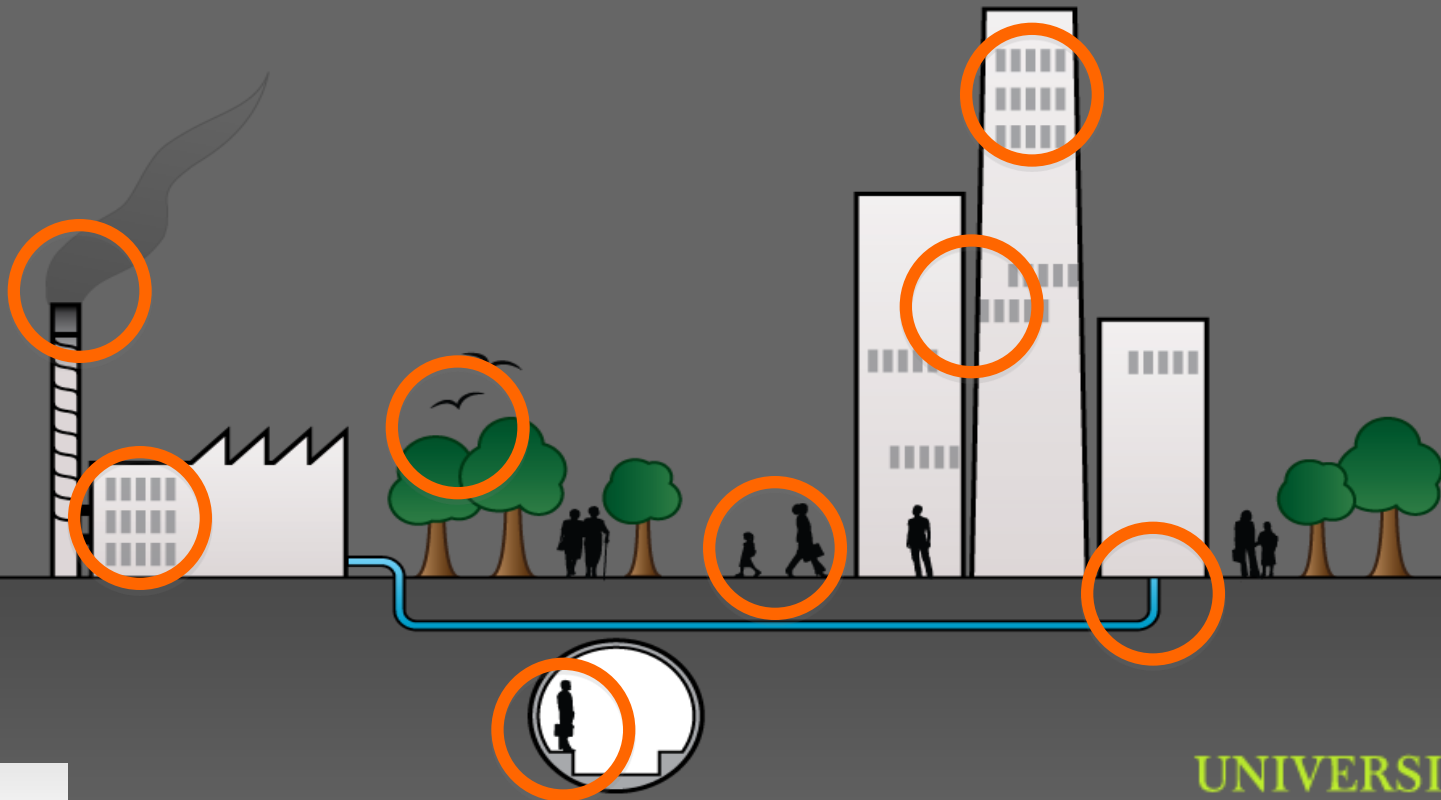
“it depends on how the future develops”

- Engineers deal with design lives; designs are predicated on *the current*
... trends, thinking, way of life, projections
- If the future is very different, will our current solutions be redundant ?
 - ‘no’ means a robust, perhaps resilient design
 - ‘yes’ would cause concerns ... for the future
- *We are seeking to adjust current designs so that they remain relevant no matter what the future holds*

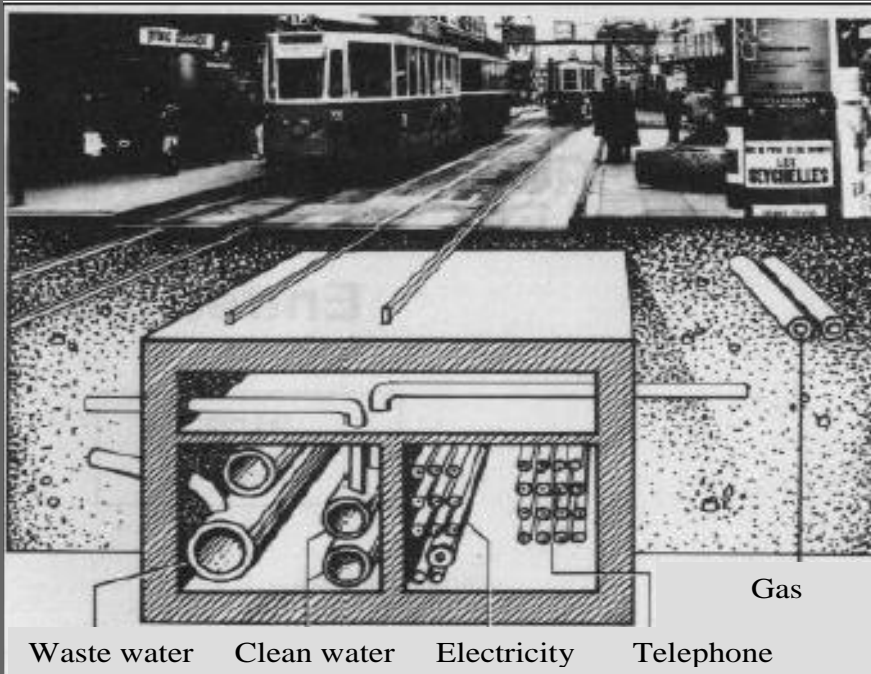
Urban Futures



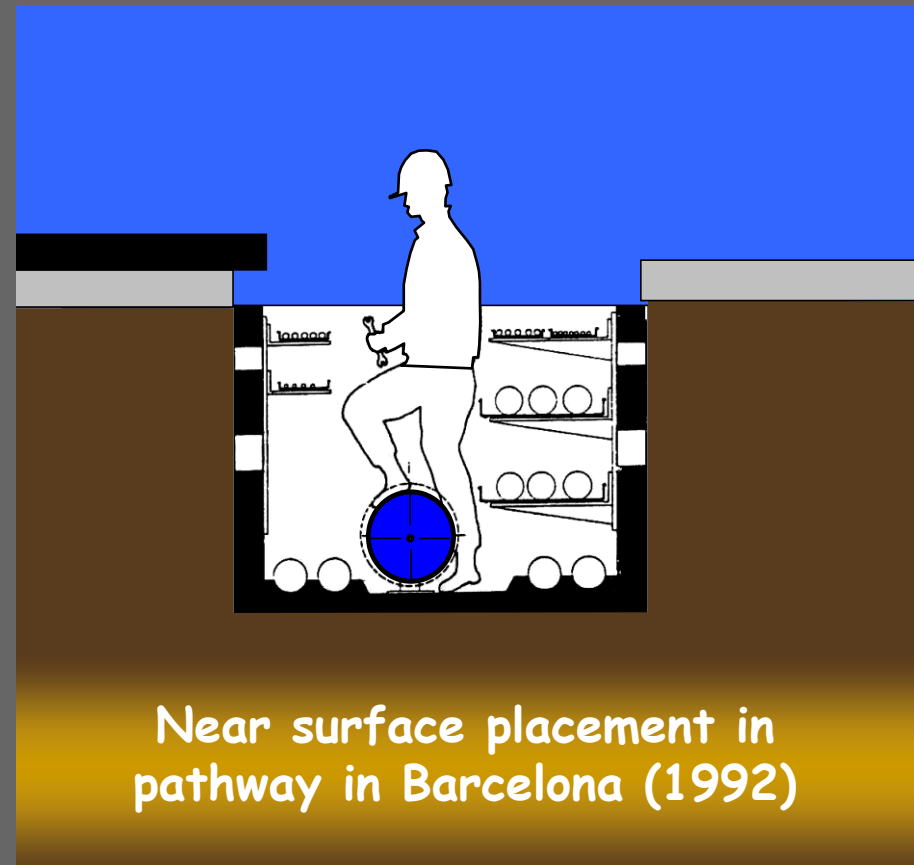
- *Urban regeneration*
- *Sustainability*
- *Future scenarios*



Urban Futures

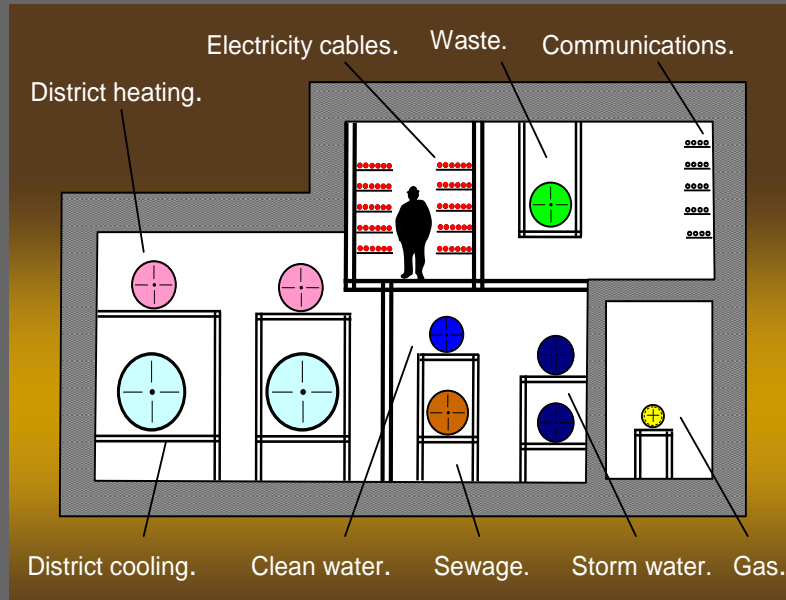


Near surface placement under tramway in Geneva (1972)

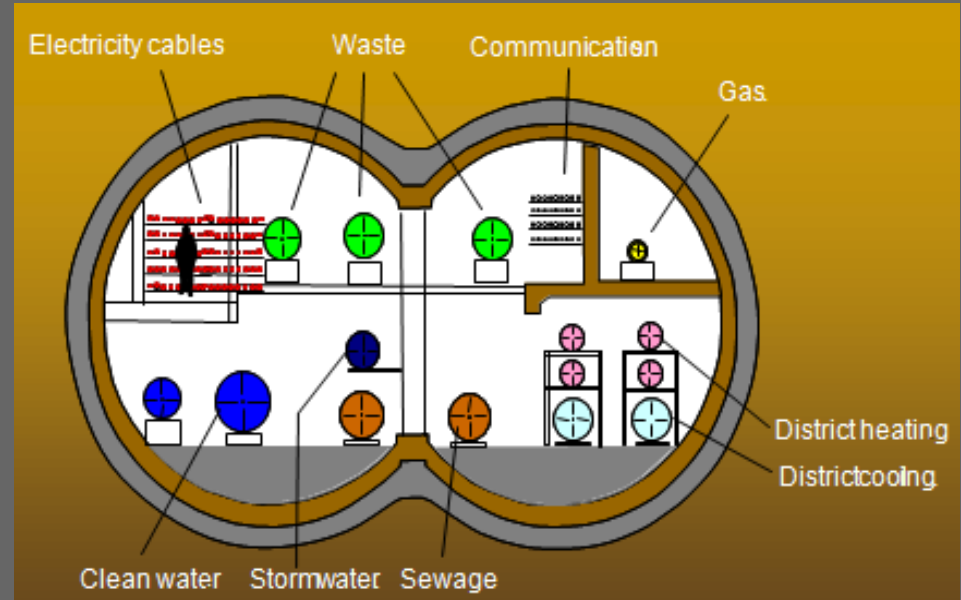


Near surface placement in pathway in Barcelona (1992)

Urban Futures



'cut and cover' in Japan (2002)



'DOT tunnelling' in Japan (2002)

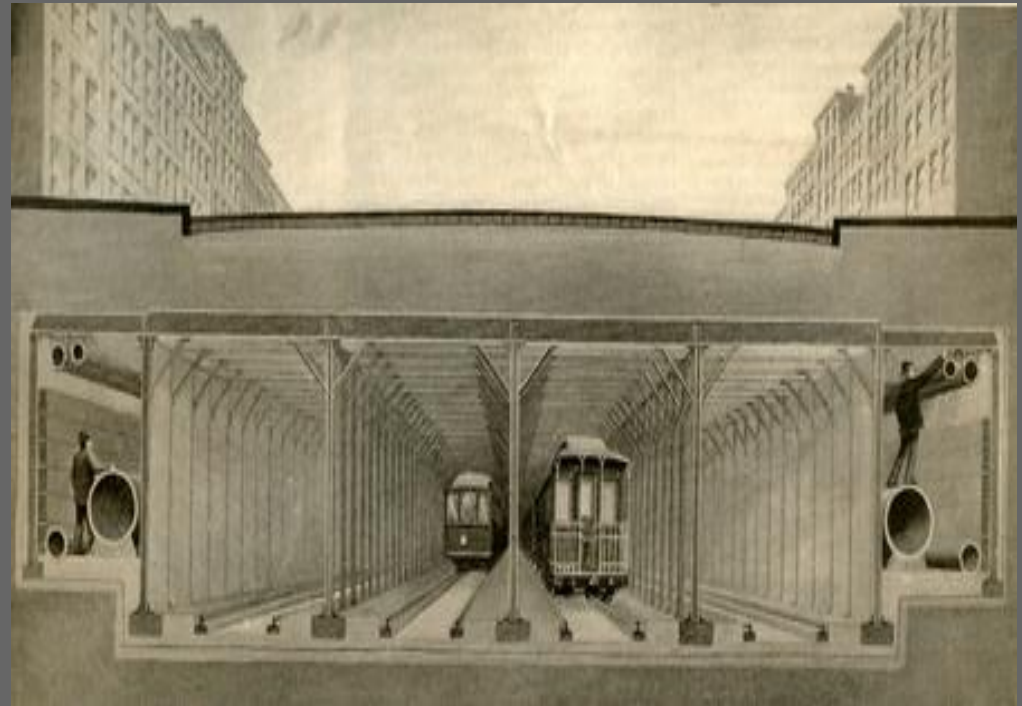
Urban Futures



The concept for alternative approaches existed over 100 years ago...

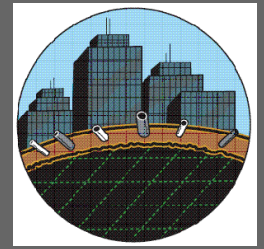


Traditional placement
method in 1880s



Concept design for a multi-utility tunnel
in 1901 (Scientific America)

Conclusions



- ❑ There are many civil engineering challenges in energy distribution
- ❑ There are equally challenges associated with moving to a *more sustainable, balanced approach to energy* supply and usage
- ❑ There are inevitable *tensions and trade-offs*
- ❑ Buried distribution networks compete for space, yet need stability
 - *accurate mapping and minimising disturbance* are vital
- ❑ Long-distance, cost-effective trenchless HV cable installation would help
- ❑ Local solutions could prove far more effective – *a catalyst for change?*
- ❑ More intelligent lighting of cities at night could yield multiple benefits
- ❑ Future scenarios analysis can help to *future-proof today's investments*
- ❑ Greater / better use of underground space would leave more room for ...
... *well, whatever we like to do, or see, or feel in our cities*