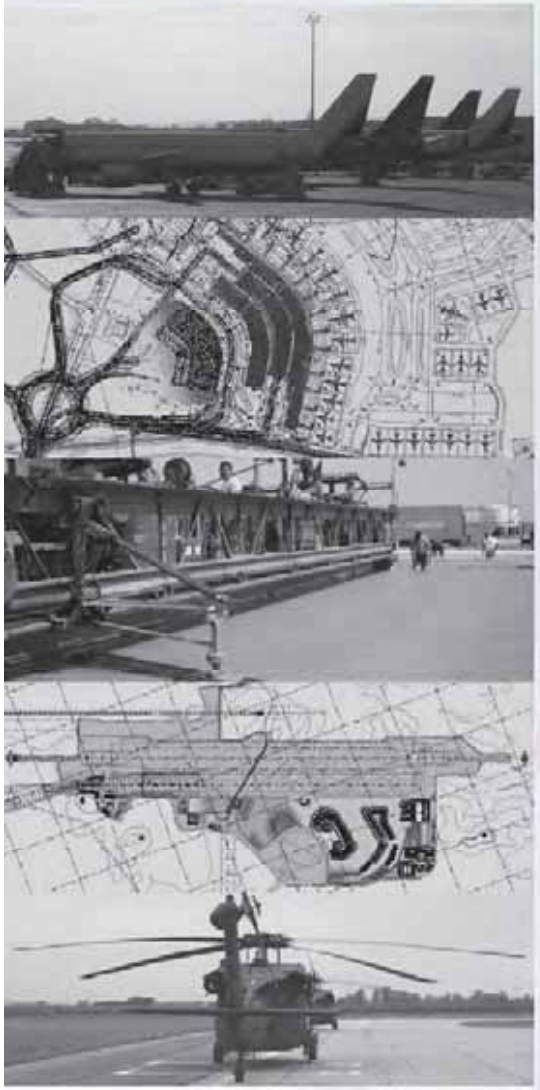
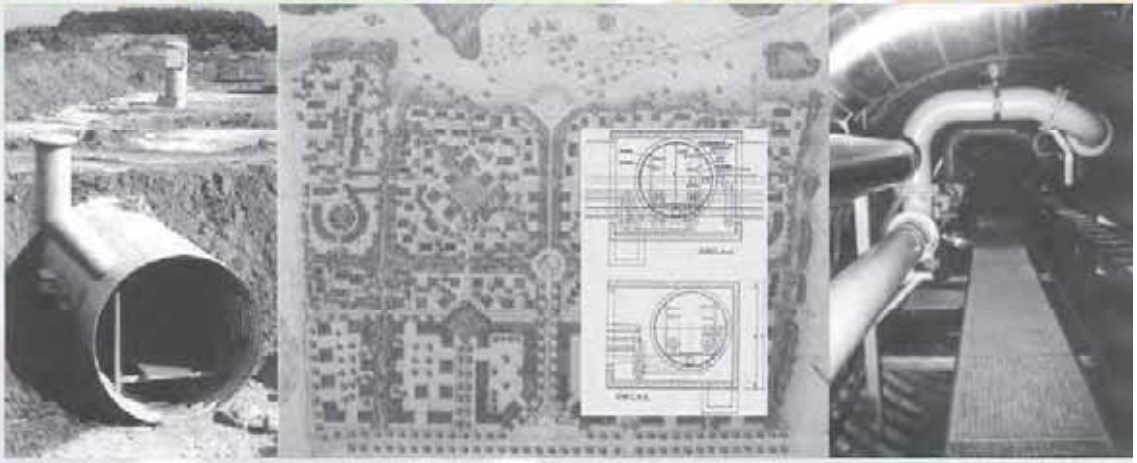




proven sustainability above and below ground

UTILITY TUNNELS

WHAT IS A UTILITY TUNNEL ?

a historical depiction

THE ECONOMY OF UTILITY TUNNELS

understanding the LC-costs of urban development

PERFORMANCE OF UTILITY TUNNELS

methods and materials
& how they hold up over time

ATTACHMENT: COMPREHENDING DIVERSITY

a multitude of solutions for world of tasks

Climate Change

International Panel on Climate Change (IPCC) Report 2007

- Climate Change is HERE!
- So how is our future going to be?
- News Last Week:

1. Global Temperature = +2° in 2050 now expected – not in 2100 – react now immediately or accept the consequences. ("2052 - A Forecast for the Next Forty Years" byJorgen Randers - Club of Rome)

2. New Antarctic Ice Shelf Melting Mechanism discovered – much faster melting processes and glaciers speeds sliding off Antarctica are now expected (Alfred-Wegener-Institute for Polar and Ocean Science – Bremerhafen / Germany)

Source:
International Panel on Climate Change(IPCC) – WMO / UNEP; "Climate Change 2007";
ISBNs: 978 0521 88009-1; 70596-7; 88010-7; 70597-4; 88011-4; 70598-1 http://www.ipcc.ch
(last access 21.09.2009)
http://www.clubofrome.de/aktuelles.html (last access 15.05.2012)
"**Klimawissenschaftler entdecken neue Schwachstelle des antarktischen Eisschildes**"
http://www.awi.de/de/aktuelles_und_presse/pressemitteilungen/detail/item/climate_scientists_discover_new_weak_point_of_the_antarctic_ice_sheet/?cHash=c3926d4358d21e4cf4b63315ac3761bb (last access 15.05.2012)

MULTI-MODEL AVERAGES AND ASSESSED RANGES FOR SURFACE WARMING

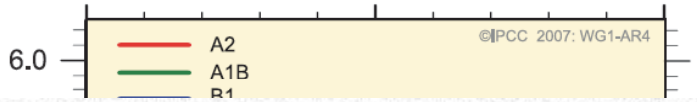


Table SPM.3 *Projected global average surface warming and sea level rise at the end of the 21st century. {10.5, 10.6, Table 10.7}*

Case	Temperature Change (°C at 2090-2099 relative to 1980-1999)[a] Best estimate	Likely range	Sea Level Rise (m at 2090-2099 relative to 1980-1999) Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations[b]	0.6	0.3 – 0.9	NA
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Table notes:
[a] These estimates are assessed from a hierarchy of models that encompass a simple climate model, several Earth System Models of Intermediate Complexity and a large number of Atmosphere-Ocean General Circulation Models (AOGCMs).
[b] Year 2000 constant composition is derived from AOGCMs only.

G8 commitment ⇨ as given in 2007 ⇦
now no longer achievable ?!

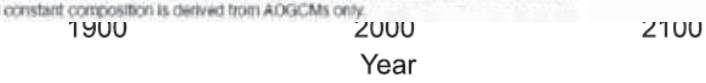


Figure SPM.5. *Solid lines are multi-model global averages of surface warming (relative to 1980–1999) for the scenarios A2, A1B and B1, shown as continuations of the 20th century simulations. Shading denotes the ±1 standard deviation range of individual model annual averages. The orange line is for the experiment where concentrations were held constant at year 2000 values. The grey bars at right indicate the best estimate (solid line within each bar) and the* ***likely*** *range assessed for the six SRES marker scenarios. The assessment of the best estimate and* ***likely*** *ranges in the grey bars includes the AOGCMs in the left part of the figure, as well as results from a hierarchy of independent models and observational constraints. {Figures 10.4 and 10.29}*

Climate Change

International Panel on Climate Change (IPCC) Report 2007

- Climate Change is HERE!
- A closer look at the consequences to our lives!
- Any temperature change above (maybe at) 2°C has likely serious consequences on a SPECIES level !

And this means the HUMAN SPECIES !!

Source:
International Panel on Climate Change(IPCC) – WMO / UNEP; "Climate Change 2007"; ISBNs: 978 0521 88009-1; 70596-7; 88010-7; 70597-4; 88011-4; 70598-1 http://www.ipcc.ch (last access 21.09.2009)

Climate Change

International Panel on Climate Change (IPCC) Report 2007

- Climate Change is HERE!
- A closer look at the consequences to our lives!
- Any temperature change above (maybe at) 2°C has likely serious local consequences on a SPECIES level !

Effects and Politics:

Plus for the HAVES

Minus for the HAVENOTS

G8 commitment

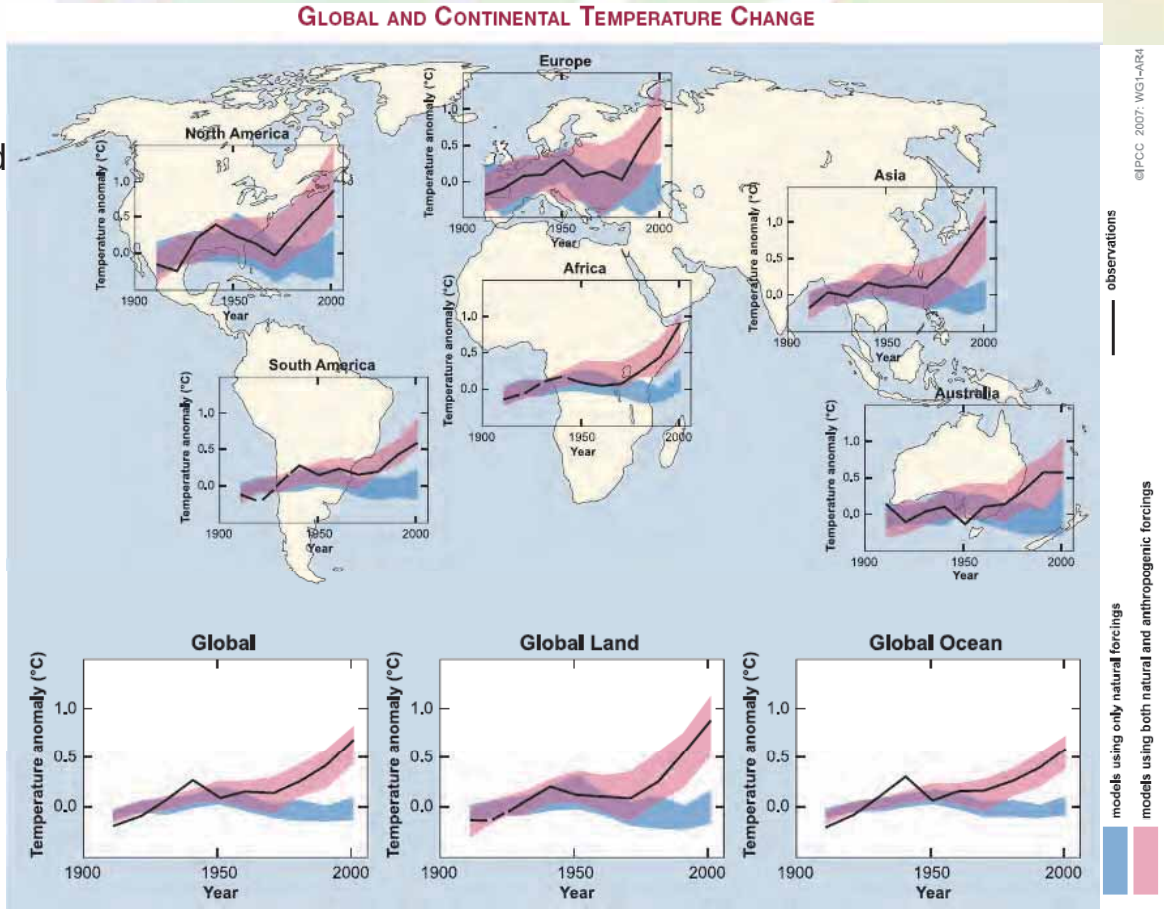
Examples of regional impacts [T20.9]. See caption for Table TS.3.

Source:
International Panel on Climate Change(IPCC) – WMO / UNEP; "Climate Change 2007";
ISBNs: 978 0521 88009-1; 70596-7; 88010-7; 70597-4; 88011-4; 70598-1 http://www.ipcc.ch
(last access 21.09.2009)

Climate Change

International Panel on Climate Change (IPCC) Report 2007

- Climate Change is HERE!
- The Models are very well verified to observations



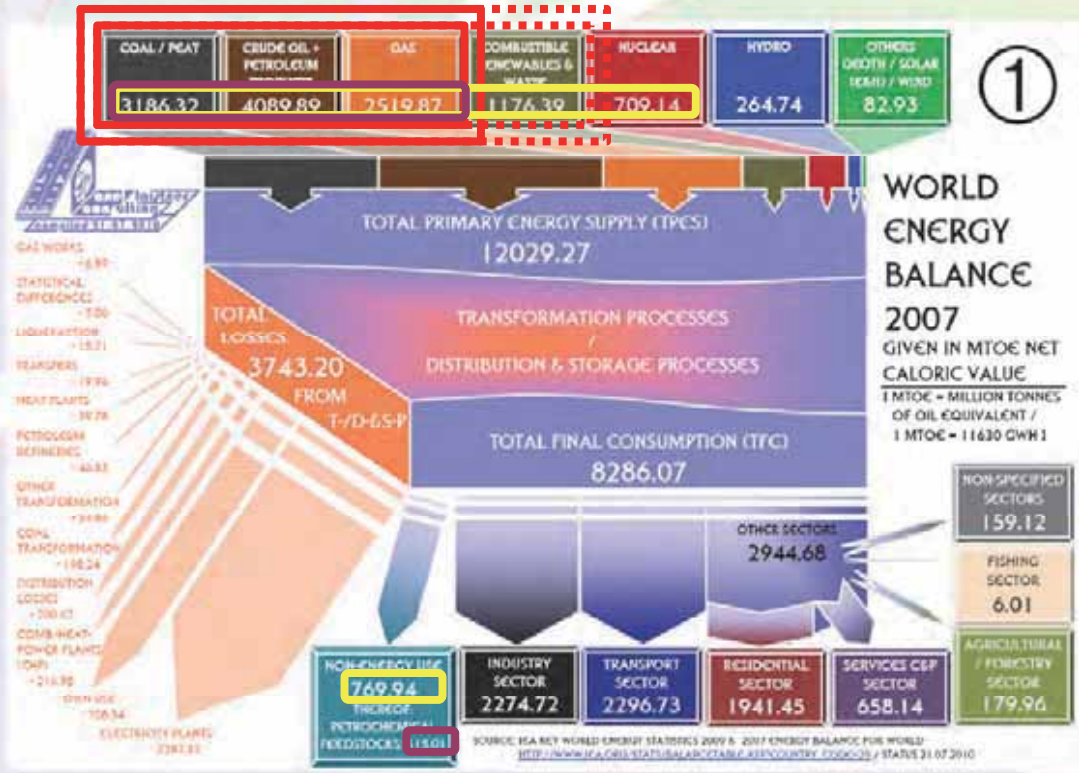
Source:
International Panel on Climate Change(IPCC) – WMO / UNEP; "Climate Change 2007";
ISBNs: 978 0521 88009-1; 70596-7; 88010-7; 70597-4; 88011-4; 70598-1 http://www.ipcc.ch
(last access 21.09.2009)

The Squandering of Our Inheritance

Energy Use of the World

- climate relevant energy sources:
  91.2% (81.4%)
- loss by energy use of raw-material resources each year:
  ~ 14 non-energy use materiel supply years
- loss by burning of total non-renewable petro-chemical raw material resources each year:
  ~ 18 non-energy use materiel supply years

Source: see diagram



The Squandering of Our Inheritance

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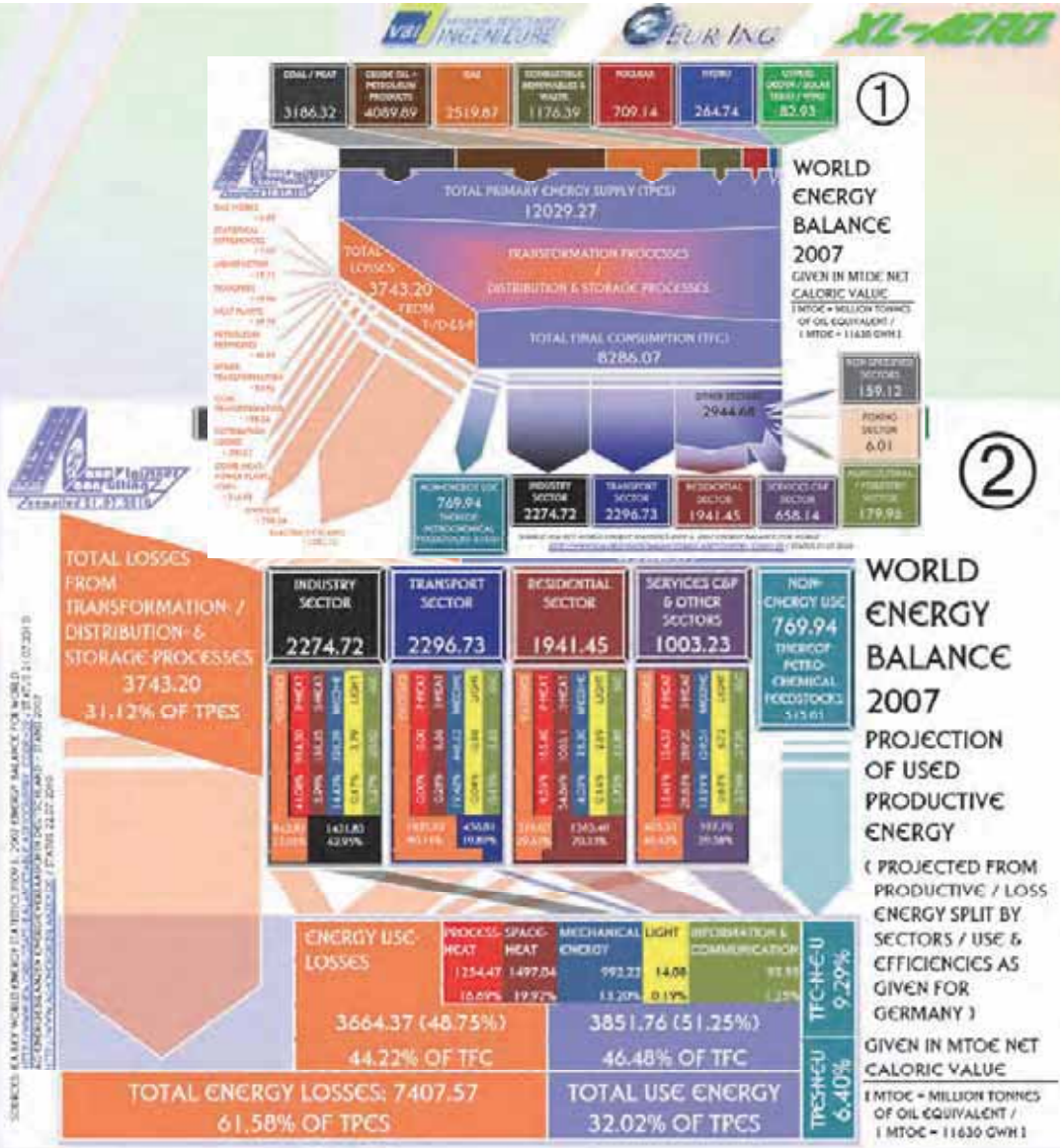
  ~ 14 non-energy use materiel supply years
- loss by burning of total non-renewable petro-chemical raw material resources each year:
  ~ 18 non-energy use materiel supply years

-total world energy system losses:

estimated 62%

Source: see diagram

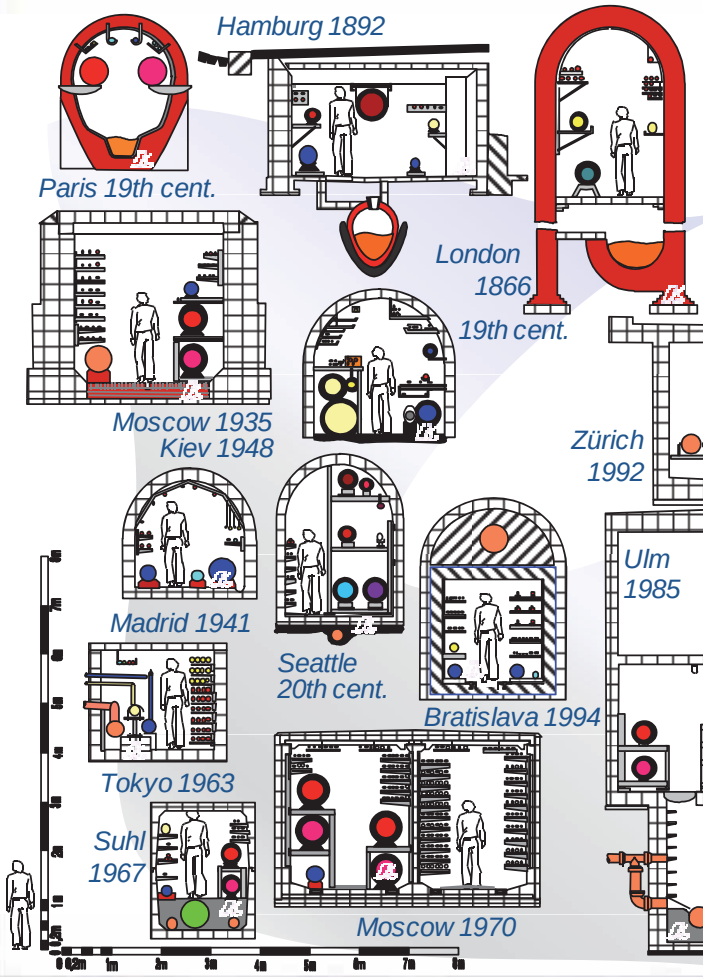


WHAT IS A UTILITY TUNNEL ?

a historical depiction

Utility Tunnels – the 2012 Status

utility tunnels built – since 1866



The first Mega-Cities reacting to social crisis
cholera, typhoid and the beginning of modern sanitation technology

Reacting to nature
Japan searches for earthquake proof solutions

H & A Laistner System & Engineering Developments 1990 to 2004

Speyer 2004
vaulted fiber reinforced concrete

Lauchheim 1995
PEHD

Fahrland 1994
corrugated steel
(zinc galvanized)
Wachau 1993

Collective technology in collective societies
the East goes precast with varied success, the West goes to universities and overboard in complexity?

Refurbishing cities
keeping inner cities alive through redevelopment

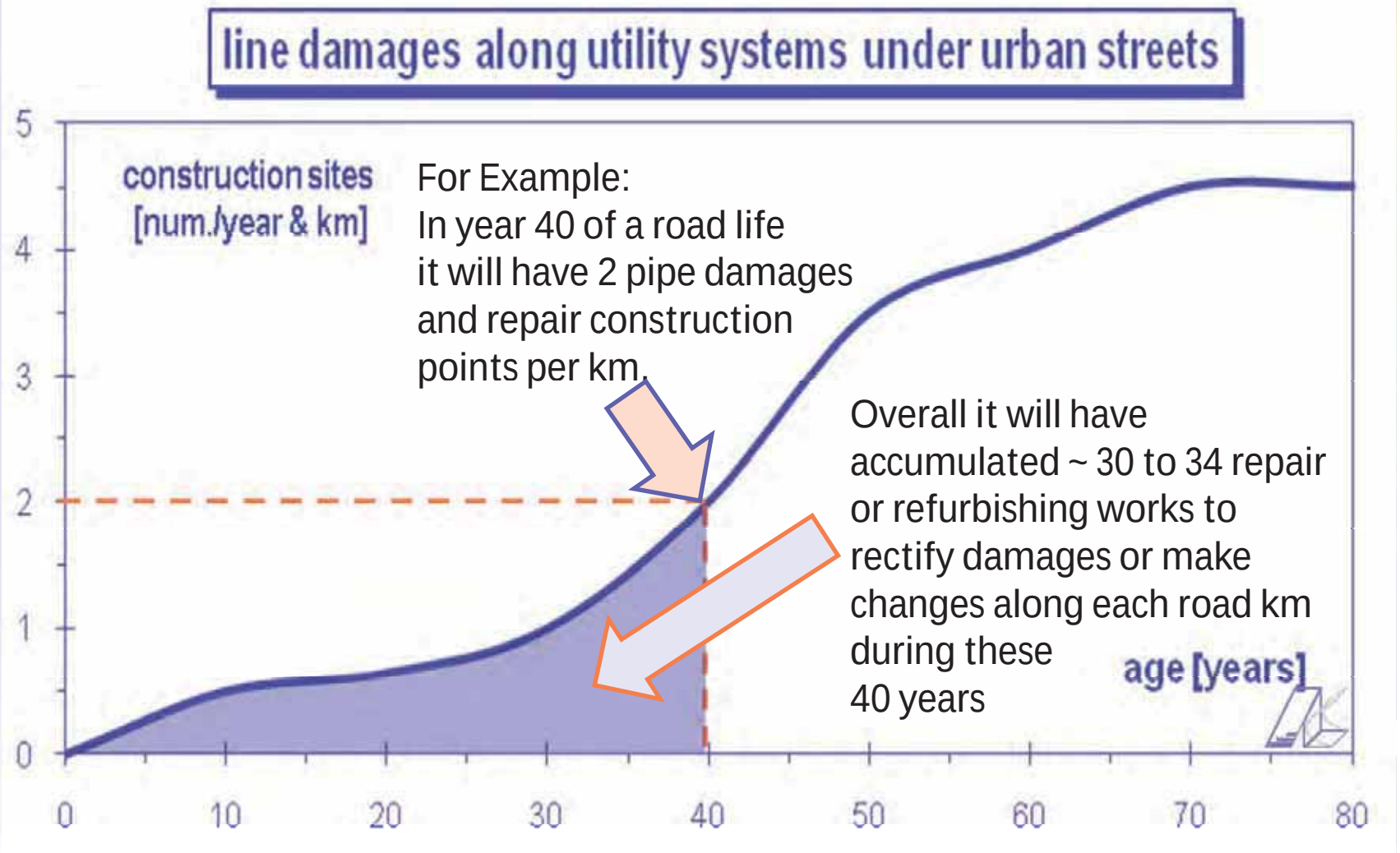
Developing Technologies
seizing creative oportunities in difficult times

WHAT IS A UTILITY TUNNEL ?

many cities – many situations – many ideas

THE ECONOMY OF UTILITY TUNNELS
understanding the LC-costs of urban development

Utility Tunnels – for how much ?



Sources: pictures © & data: alc UG(hb) – POET GmbH

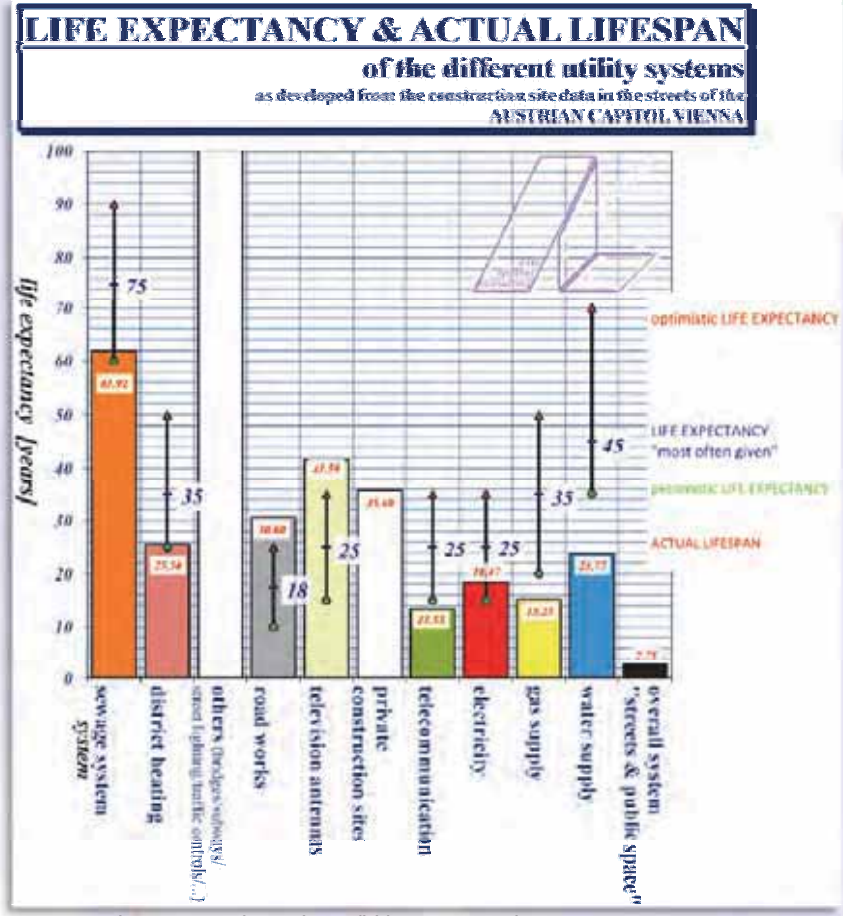
line damages along utility systems under urban streets

Sources: pictures © & data: alc UG(hb) – POET GmbH

THE ECONOMY OF UTILITY TUNNELS
understanding the performance of buried lines

Developing Concepts for Humane Cities

Understanding our current systems performance



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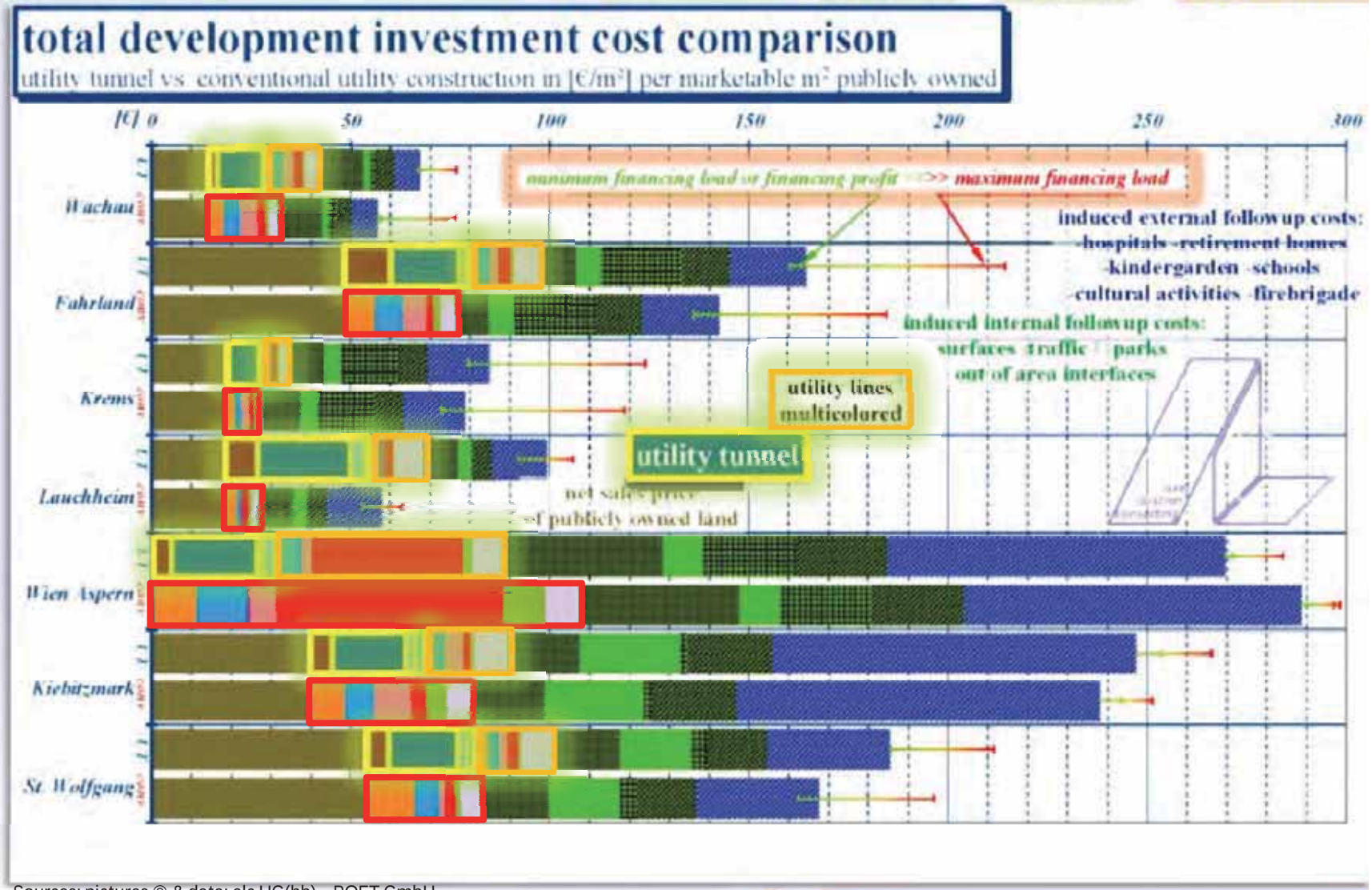
THE ECONOMY OF UTILITY TUNNELS

myths and realities of the lifetime of utility pipes



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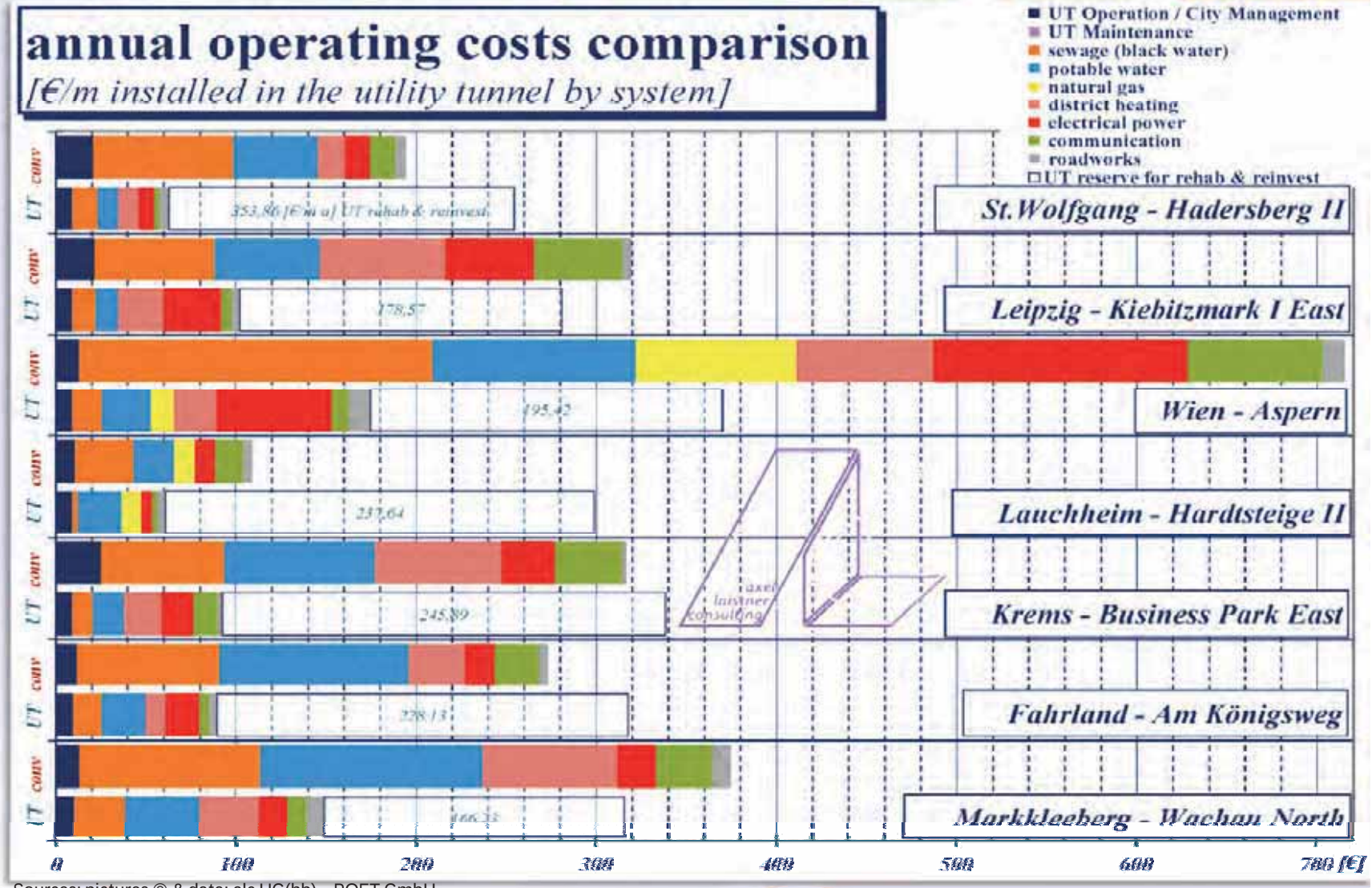
THE ECONOMY OF UTILITY TUNNELS

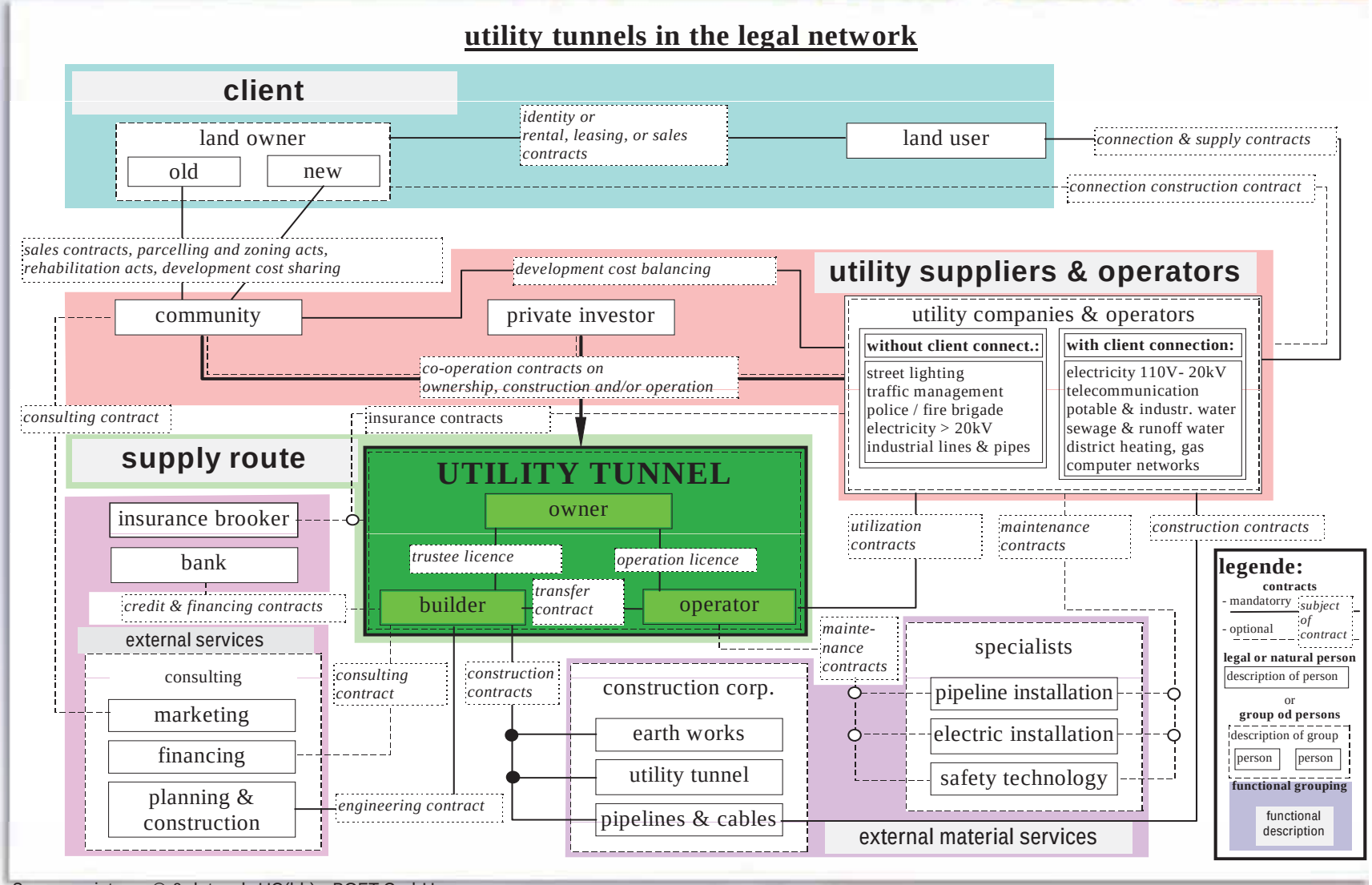
comparing UD-CAPEX: utility tunnel – conventional



Sources: pictures © & data: alc UG(hb) – POET GmbH

THE ECONOMY OF UTILITY TUNNELS

comparing OPEX: utility tunnel – conventional



Sources: pictures © & data: alc UG(hb) – POET GmbH

THE ECONOMY OF UTILITY TUNNELS

utility tunnel – in the legal network

Summary on sustainable urban construction:

1. Our current buried systems are far more vulnerable and less dependable than is assumed
2. Construction at utilities & utility down times have a significant economic ripple effect in the productive urban economy – and can KILL businesses !
3. Conventional utility lines are MURDER on road surfaces
4. The higher CAPEX of Utility Tunnels is in many cases recovered already by the higher construction speed and the faster area marketing or minimized business impact
5. Utility Tunnels are operational assets – their OPEX is chargeable to both service providers and the connected
6. Utility Tunnels must be managed both in their creation and in their maintenance – they require joint coordination

PERFORMANCE OF UTILITY TUNNELS

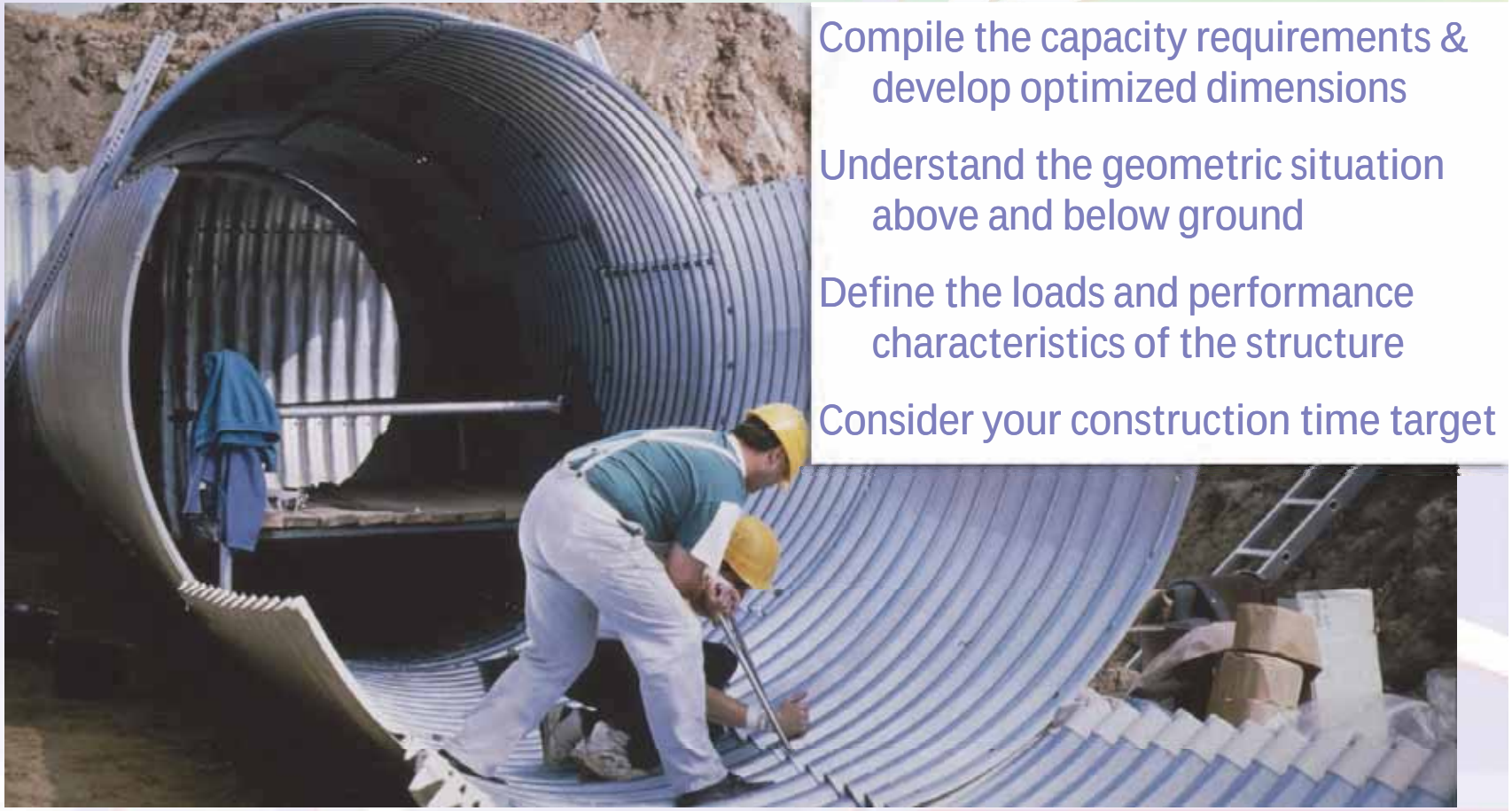
methods and materials

& how they hold up over time

The how to, why & what of UTs

Building a “Hole in the Ground” called Utility Tunnel

Understanding the Utility Tunnel hull system



- Compile the capacity requirements & develop optimized dimensions
- Understand the geometric situation above and below ground
- Define the loads and performance characteristics of the structure
- Consider your construction time target

Sources: pictures ©: POET GmbH

Building a “Hole in the Ground” called Utility Tunnel

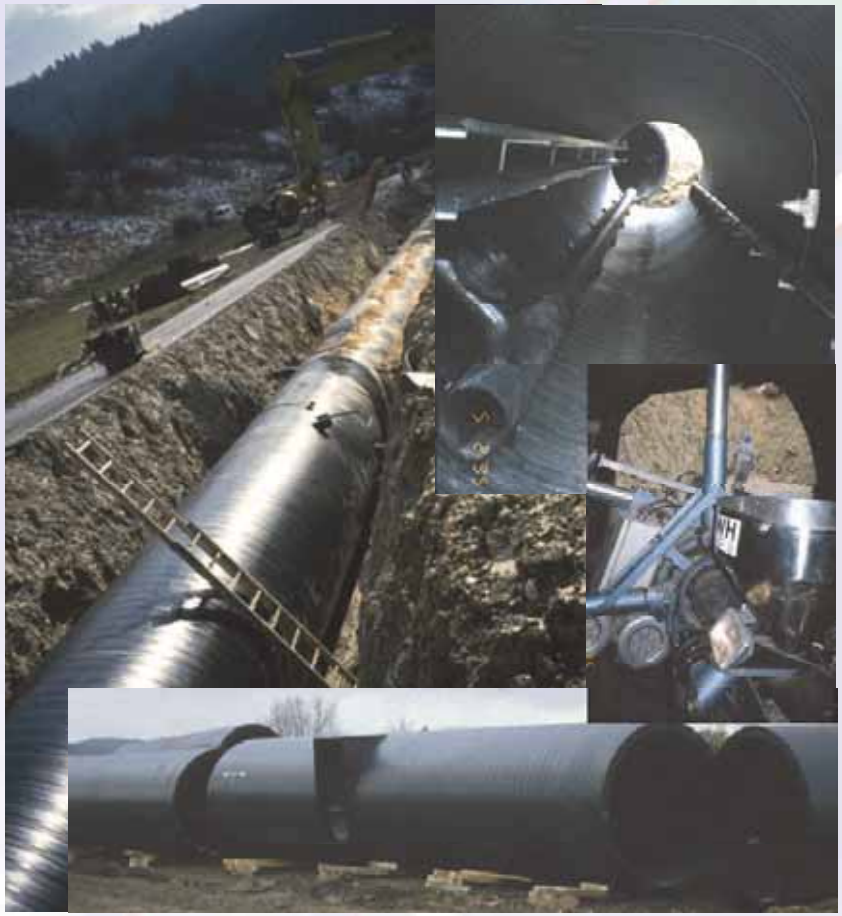
Sources: pictures © & data: alc UG(hb)

Understanding the Utility Tunnel - steel hull

A puzzle with thousands of parts:

- Gives amazing **flexibility** in shape and situation adaptation
- Has a medium to high construction **speed**
- Is cost dependant on the world steel **price** market
- Performance and lifetime **dependant on the production quality** of the galvanization or paint and the proper backfill compaction
- **light weight & easy transportable**
- Has **many joints** and requires high quality joint manufacture and sealing
- Needs a high **quality of design**, pre-planning and pre-manufacturing
- **Good heat & electricity Conducter**
- Builds an electrical **Faradays’ cage**

Building a “Hole in the Ground” called Utility Tunnel



Sources: pictures © & data: alc UG(hb)

Understanding the Utility Tunnel PEHD hull

A puzzle with hundreds of parts:

- Gives amazing **flexibility** in shape and situation adaptation
- Has a very high construction **speed**
- Is cost dependant on the world oil **price** market
- Performance and lifetime dependant on the **quality of the backfill compaction** and shouldn’t be stored long in open direct **sunlight** and heat
- **light weight** **high transport volume**
- Has only welded joints and is **fully sealed**
- Needs a high **quality of design**, pre-planning and pre-manufacturing
- **Poor heat & electricity conducter**
- Builds **no Faradays’ cage** electrically

Building a “Hole in the Ground” called Utility Tunnel

Sources: pictures ©: POET GmbH, Carl Dupré GmbH

Understanding the Utility Tunnel fibre concrete hull

Creating pre-cast quality in-situ:

- Has a **machine determined cross section** and requires **extra structures** at bends and cross sections
- Has a medium construction **speed**
- Is cost not dependant on the world oil or steel **price** markets
- Is performance and lifetime dependant on the **quality of the concrete**, fiber additives and curing process
- **Very heavy**
- Has test seal-band joints and is fully **sealed**
- Needs a low **quality of design** and pre-planning - no pre-manufacturing
- **Poor heat & electricity conducter**
- Builds **no Faradays’ cage** electrically

Building a “Hole in the Ground” called Utility Tunnel

Sources: pictures ©: alcUG(hb), POET GmbH, Carl Dupré GmbH

Understanding the Utility Tunnel end user connections

Connecting the users:

- Understand the real **end user demand expectation**
- **pre-planning** of pre-fabricated utility tunnel elements
- **Provide for the future** additional services or demand changes
- Should provide for **connection modification without digging** in the public road space => hull pipes to the properties
- Can be in **separate or combined** utility connectors to the properties
- Should **not connect buildings** in an unsecured walk-able or crawl-able way
- **Require coordination** in regard to internal main line placing of services

Building a “Hole in the Ground” called Utility Tunnel

Sources: pictures ©: alcUG(hb), POET GmbH

Understanding the Utility Tunnel access points

Getting people and material in and out:

- There is a requirement for main access points and secondary and emergency escape points
- How does one get standard pipe lengths into a utility tunnel ?
- There are utility tunnels with internal fire walls and such without
- Utility tunnel access must be restricted and controlled
- Consider the internal ventilation – surface exhaust gases must not be allowed to enter
- All openings need to be rodent protected – in certain cases also barriers against snakes and insects are needed

PERFORMANCE OF UTILITY TUNNELS methods and materials

Building a “Hole in the Ground” called Utility Tunnel

Sources: pictures ©: alcUG(hb), POET GmbH

Understanding the Utility Tunnel outfitting

Installing the pipes and cables:

The easy part is the straight un-interrupted stretch

But there are main connection points – e.g. for 18 kV lines to transformer stations

And utility tunnel intersections – that need to be walk-able

And for real maintenance there are internal light and control systems

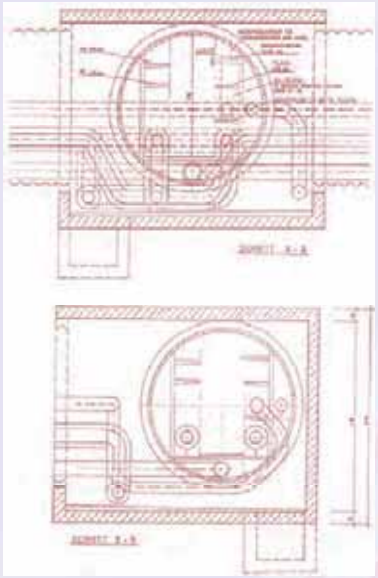
So how do we mount all these elements ?

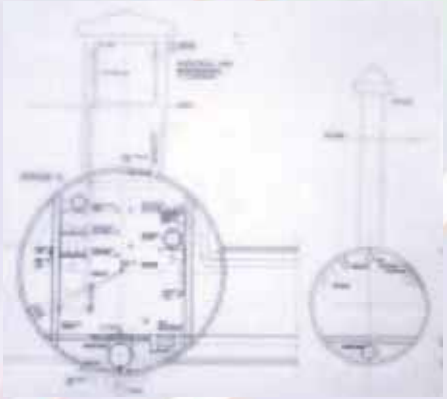
And how do they move ?

And what effects can they have on each other ?

So how do we arrange them to create an efficient use of the available space and retain future modification flexibility

Addapting a “Hole in the Ground” called Utility Tunnel





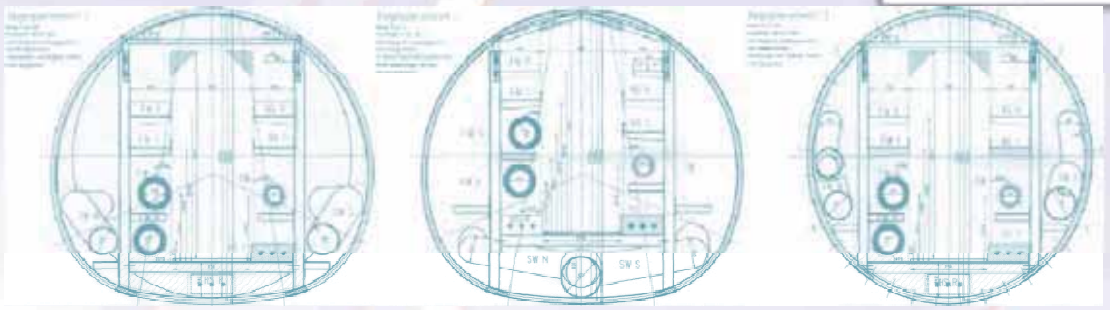
Understanding the Utility Tunnel application

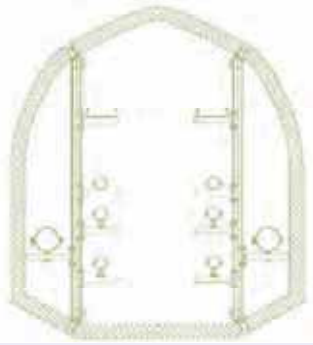
Installing the pipes and cables:

Many situations = many different solutions

Understanding the complexity of interactions, interference, safety, security and operational stability to achieve optimized supply and retain maximum flexibility for change in the future

➢ Creating a sustainable technology





Sources: pictures ©: alcUG(hb), POET GmbH, Carl Dupré GmbH

Constructing a “Hole in the Ground” called Utility Tunnel

The Reality of Time & Life: -> The Unexpected

Utility Tunnel on the move:

A sealed UT floats like a submarine

Understand your construction environment and its hazards - and understand your construction process and their interdependence

This UT under construction was moved up to 0.8 m sideways over a length of ~ 120 m by a differential water pressure of 0.1 bar (1 m water) between both sides of the construction ditch during a rain event

Why - because it had a double folded segregation plastic foil between it and the lean concrete base, to ensure later earthquake movement flexibility
One plastic layer would have been enough but would have meant to cut the plastic lengthwise

Result - the outside water seals either disconnected from the concrete or ripped completely on more than 50% of the joints between moved UT segments and needed to be repaired, and a permanent kink in the UT remained

Maintaining a "Hole in the Ground" called Utility Tunnel

The Reality of Time & Life: -> The Expected

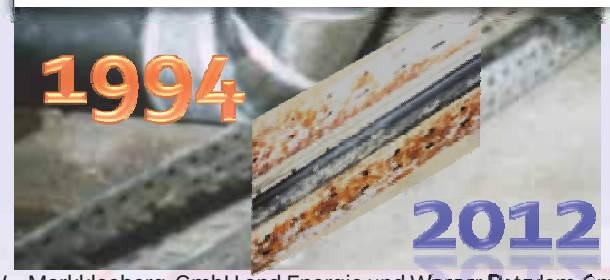
Corrosion and Degradation:

Revisiting the systems build between 1991 and 1995 in 2007 and 2012 – only few points of corrosion could be found:

- Cable trays on cement crossing crawlable side connectors – only directly in crossing
- Emergency exit door hinge-pins

Localized evidence of water incursion was seen and found to be either still from construction or due to faulty maintenance procedures, NOT due to pipe faults

No general degradation of building or installations could be found



Sources: pictures ©: alcUG(hb), POET GmbH, 2012 picture with the permission of EGW – Markkleeberg GmbH and Energie und Wasser Potsdam GmbH

Maintaining a “Hole in the Ground” called Utility Tunnel

The Reality of Time & Life: -> The Expectable ?

Vandalism and Access Protection:

Many UT have problems with casual vandalism & intrusion

Unprotected or easily detectable elements like these Emergency Exits and the outside drainage control shaft will and have been abused – need to be hidden, secured & monitored
2009 a lot of small rubbish dumped in –
2012 additional longer wood pieces thrown on top – virtually uncleanable

Graphity is also inside the UT – so unauthorized intrusion has taken place

Sources: pictures ©: alcUG(hb), POET GmbH, 2012 pictures with the permission of Energie und Wasser Potsdam GmbH

PERFORMANCE OF UTILITY TUNNELS
how they hold up over time

Maintaining a "Hole in the Ground" called Utility Tunnel

The Reality of Time & Life: -> The Unexpected

Design info unknown to a new UT operator
= existence of pumps & drains unknown
result after some years:
>> 1 pump missing & 1 pump inoperative
>> no drainage inside of ground water seal
>> spot water penetration of collected rain water through UT-hull
- additional sealing activities
DYSFUNCTION IN OPERATIONAL SAFETY
due to loss of information
Situation rectified immediatly after information recovery 2012
??>2012
Operation with partial system information

Water were non should be I:
When Information gets lost between design & construction and operations – maintenance can't happen and damage develops unnecessarily
As yet no damage to UT & systems

Steel UT hull: non pressured water seal
inside drainage with 2 pumps for redundant operational safety installed and comissioned
UT buoyancy safety volume & ground water protection
ground water seal
1995
Design & Construction

Sources: pictures ©: alcUG(hb), POET GmbH, 2012 picture with the permission of Energie und Wasser Potsdam GmbH

PERFORMANCE OF UTILITY TUNNELS
how they hold up over time

Maintaining a City above the "Hole in the Ground"

The Reality of Time & Life: -> The Expected

2009

Pristine Surfaces after 18 Years:

Where Urban Coordination really saves money – NO DIGGING UP PIPES

2012

2006

Sources: pictures ©: alcUG(hb), POET GmbH

PERFORMANCE OF UTILITY TUNNELS how they hold up over time

Maintaining a City above the "Hole in the Ground"

The Reality of Time & Life: -> The Unexpected

Water were non should be II:

When Urban Coordination looses the know-ledge about its own systems - strange things happen e.g. a swimming pool and a sudden material access problem over a utility tunnel

As yet no damage to UT & systems

Sources: pictures ©: alcUG(hb), POET GmbH

PERFORMANCE OF UTILITY TUNNELS how they hold up over time

Between 1991 and 2008 A. & H. Laistner were involved in the development and / or modification of 10 utility tunnel systems

We were responsibly involved in the design of ~31 km of utility tunnels and constructed ~ 13.5 km to date.

We experienced utility tunnels in ground water & earthquakes

We encountered unknown, or unexpected hazards.

We've seen utility tunnels float in their construction ditches, and suffer from water incursion because the outside drainage protection system had been forgotten

With all this experience through 20 years we can unequivocally state:

There is no more effective, efficient, economic, safe, supply secure, environmental and sustainable urban supply and support systems technology than the UTILITY TUNNEL !

Why don't we use more it – we wonder ?

What's holding us back ?

A world wide lack of knowledge and comprehension of system complexity as synergy generator & driver

So listen-up educators !
We need to teach what is needed –
not what is comfortable !

SUSTAINABLE CITIES OF THE FUTURE
need creative cross-educated engineers & planners

SPEAKERS DETAILS

professional experience

20 years
in urban development
and airport projects
with a 100 % proven track
record of
– ON TIME – IN BUDGET –
– STATE OF THE ART –

educated in

mechanical & civil
engineering
business administration

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Thank You for Your Attention !

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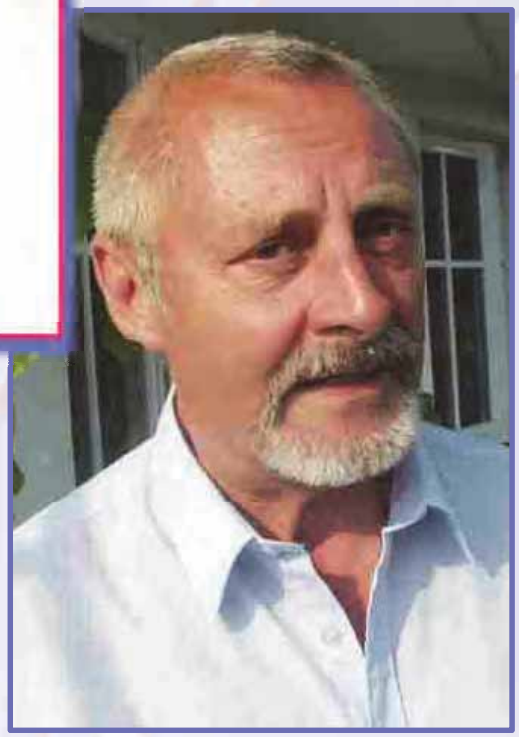


professional experience

52 years
in urban development
and civil engineering projects

43 years
as legal expert witness
for civil engineering

27 years
as elected member of town
and regional councils

educated in

civil engineering & surveying

Thank You for Your Attention !

WHAT IS A UTILITY TUNNEL ?

POET Ing GmbH / axel laistner consulting UG(hb):
Dr. Axel Laistner (POET/alcUG) – all graphics and texts unless specifically referenced otherwise. 1993 – 2012

THE ECONOMY OF UTILITY TUNNELS

Dr. Axel Laistner – www.laistnerconsult.de :
Utility Tunnels long-term investment or short-term expense?
The new economic feasibility of an old idea
1996 INFRA'96 Les Infrastructures Urbaines Montreal
Einsatz begehbarer Leitungsgänge / Infrastrukturkanäle in der öffentlichen Ver- und Entsorgung
1996 Doktorarbeit an der Technischen Universität Wien Fakultät für Bauingenieurwesen Wien
Both source-texts reappraised in 2012 and diagrams converted to €-values

PERFORMANCE OF UTILITY TUNNELS

POET Ing GmbH / axel laistner consulting UG(hb):
Dr. Axel Laistner (POET/alcUG) or Hermann Laistner (POET) – all photos, graphics and texts unless specifically referenced otherwise. 1993 – 2012
– photos of the utility tunnel Wachau and experiences & event discussion of 2012
with permission of EGW GmbH
– photos of the utility tunnel Fahrland and experiences & event discussion of 2012
with permission of Energie und Wasser Potsdam GmbH

Carl Dupré Bau GmbH & Co.KG - Franz-Kirmeier-Str. 17, 67346 Speyer:
- Pictures fibre concrete utility tunnel hull construction
- Cross section Drawing of the fibre concrete utility tunnel

ATTACHMENT: COMPREHENSIVE DIVERSITY & EXPERIENCE

POET Ing GmbH / axel laistner consulting UG(hb):
Dr. Axel Laistner (POET/alcUG) – all graphics and texts unless specifically referenced otherwise. 1993 - 2012

Christian Lindecke:
http://de.wikipedia.org/w/index.php?title=Datei:Lichtraumprofil_EBO.png&filetimestamp=20090521162803 – last accessed 24.03.2011 - Lichtraumprofil_EBO.png

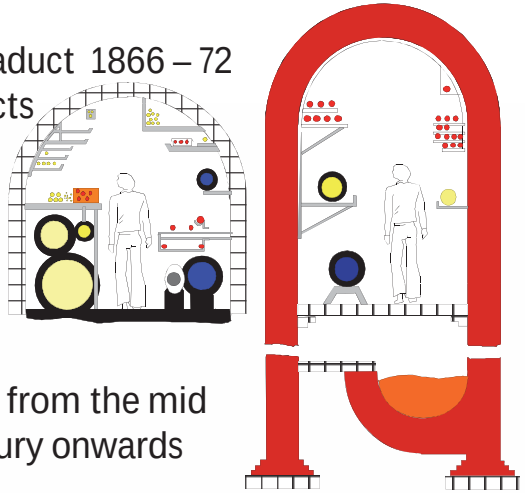
COMPREHENDING DIVERSITY
a multitude of solutions for world of tasks

Utility Tunnels – where else ?

The 1800s' – Utility Tunnels a good idea gets started

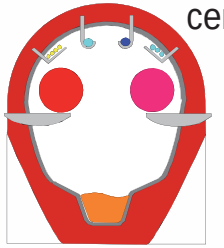
London

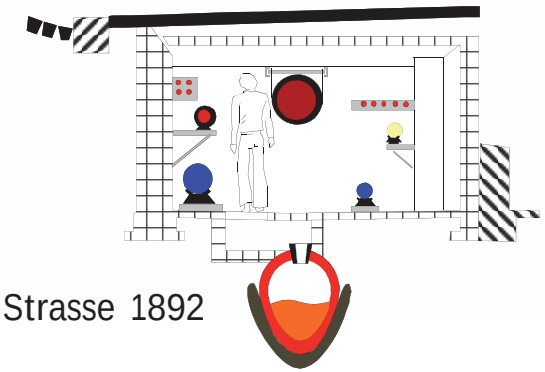
The Holburn-Viaduct 1866 – 72 and other projects throughout the century



Paris

Sewage System from the mid century onwards





Hamburg

Kaiser Wilhelm Strasse 1892

Sources: pictures © & data: alc UG(hb) – POET GmbH

Cholera in Europe - how calamity drives technology

London:

Together with the elevation of parts of the Holburn Street urban utility tunnels were erected along both sides of the viaduct. The adjacent buildings were connected directly to the tunnels. The remaining space in between both tunnels was rented out to commercial users. The Viaduct passes over two Streets, a double railway track and the canalized Fleet River. Its total length amounts to approximately 400m.

Other utility tunnels were built with urban infrastructure development at various places in London and surrounding boroughs ever since.

Paris

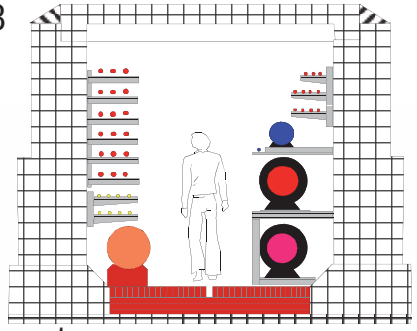
Following the Cholera epidemic of 1832, construction on the Paris sewage system was begun. Its mains vary in diameter between 5 x 6m and 2,5 x 1,5m. The system is additionally used for the placement of telephone-, telegraph-, water- and district heating mains. The total net length amounts to approximately 2000 km.

Hamburg

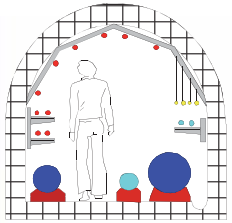
With the expansion of urban main roads a utility tunnel was erected under the Kaiser Wilhelm Strasse as new main thoroughfare to avoid future disturbances. Like London and Paris, Hamburg developed the sewage system following a devastating outbreak of the Cholora.

The 1900s' – Utility Tunnels a good idea gets going

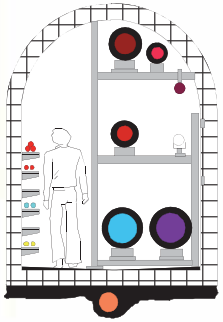
Moscow 1935 / Kiev 1948



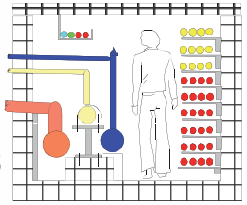
Madrid 1941



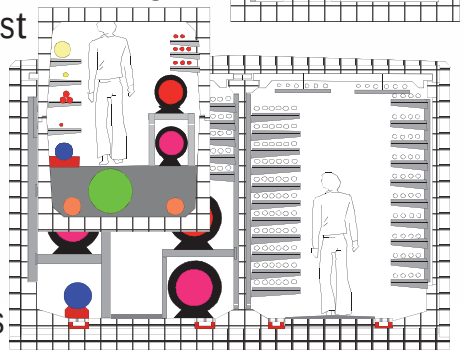
Seattle UofW in the 20th century



Tokyo 1963



1960s - the East goes precast



Suhl 1967 /
Moscow 1970 /
Halle-Neustadt 1970s
Leipzig-Grünau 1980s

Sources: pictures © & data: alc UG(hb) – POET GmbH

City Management – spurts, starts and fits of technology

Moscow / Kiev / Suhl / Leipzig / Halle

The main standardization efforts on utility tunnels were made in the former eastern block states. The Academy on Civil Engineering of the GDR completed the development of a comprehensive technical standard on utility tunnels in 1976. Main interest originated with the realization of the utility tunnels positive effect on national economy as a whole.

Madrid

Utility tunnels were chosen to counter the problem of extensive soil settlement in the Madrid region. The security gained by the tunnel justified the higher investment expenses. The surface streets above were stabilized and their lifespan extended two- to threefold.

Seattle

Utility tunnels are most frequently used to service the supply needs of enclosed areas. Use in industrial plants is common, as well as at public installations like this cross section of utility tunnels at the University of Washington in Seattle. Utility tunnels are standard construction elements at many industrial plants and especially airports and civic centers.

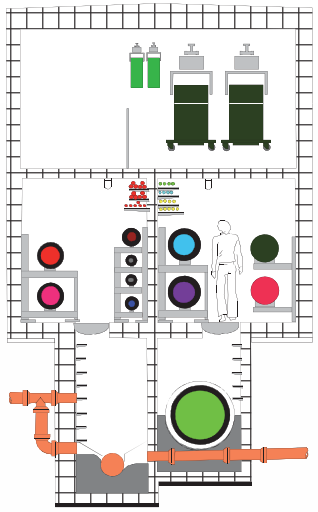
Tokyo

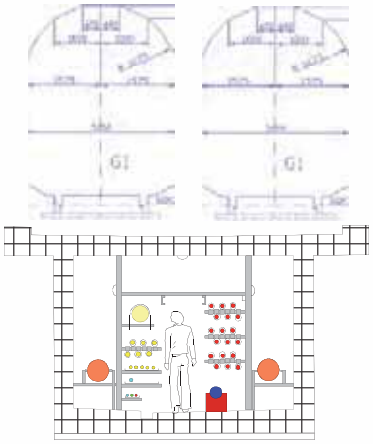
In 1963 utility tunnels were named the preferable construction system for city utilities in Japanese law. The intention was to reduce the surface construction sites along roads and the minimization of so induced traffic problems. Researches had shown, in 1962 Tokyo had 1713 construction sites along utility lines of 1253 km total length in a street net of roughly 500 km; amounting to ~ 3 each km.

The 1980s' – Utility Tunnels a good idea gets ambitious

Ulm University Medical Centre
Eselsberg 1985

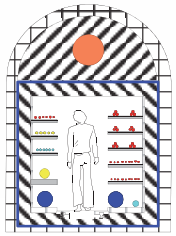
- the most complete and ambitious UT I know of





Zurich – Löwenstrasse 1992
a UT carries the tram!

Bratislava 1994
a UT System 24 m underground



Sources: pictures © & data: alc UG(hb) – POET GmbH, Christian Lindecke - wikipedia

City & Facility Management – discovering potentials

Ulm – the all-rounder

Setting the most complete standard of subsurface supply systems yet. All supplies needed for four hospitals, lots of university institutes and two industrial research centers – all are transferred underground to insure a healthy environment for recuperation and studies.

Three automated cargo transport systems distribute pharmaceutical supplies, medical supplies, soiled and cleaned utensils, food and mail to all hospitals from a central technical complex. Two waste disposal systems collect clinical and normal wastes to a central disposal station.

Zurich – city center renewal – Werkleitungsstollen - Löwenstraße

In the heart of the city – in front of the main RR-Station – this UT had to be erected while maintaining the normal accessibility and supply situation to all adjacent buildings and shops.

High ground water and a shallow sewage line impacted the design. The design is based on the SIA 205 Swiss standard.

At both ends connections to other UT exist. The tramway tracks are placed on a floating bedding on top of the UT.

Bratislava – historic inner city utility reconnection

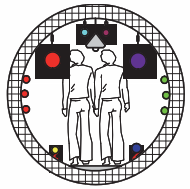
Utility tunnels were excavated as mine shafts and tunnels at ~ 24m below ground level under the historic city center.

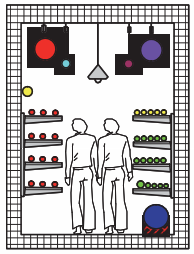
With minimal disturbance above ground and no ground movement problems due to the depth all buildings were connected by horizontal drilling from below.

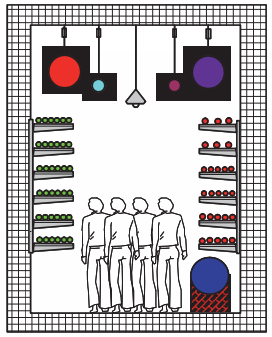
155 years – Utility Tunnels a good idea gets experience

Other more out of the ordinary UT constructions:

White Sands – NY – 1967-70
UT as nuclear blast proof fall out shelters







Listing of military Installation UTs:

former Base-Hospital Ulm (now Uni Ulm Michelsberg)
Eielson Air Force Base Fort Wainwright
U.S. Air Force Academy

Listing of civic & admin center complexes with UTs:

Civic Center Area, Denver - City & County Buildings, Denver – Colorado State Capitol Buildings

NASA Johnson Space Flight Center – Houston

UTs are also used on many airports around the world – but a listing is not given due to security considerations

Sources: pictures © & data: alc UG(hb) – POET GmbH

UT operational performance – it runs & runs & runs .....

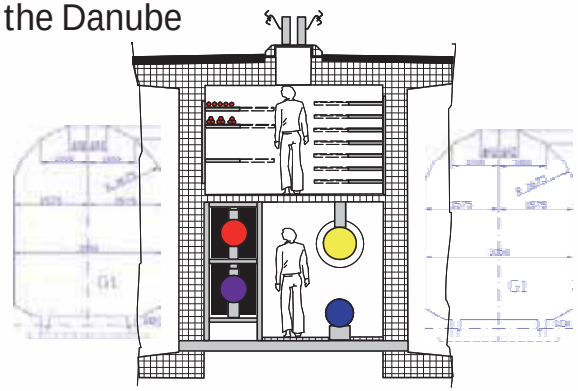
<u>General operational performance history of Utility Tunnels world wide (as researched and experienced by POET & alcUG in own and others' UTs) :</u>

- More than 90% better performance of individual supply pipe / cable life.
- No more micro-leakage in wet systems.
- Full continuous corrosion and degradation control
- Possibility of preventive maintenance of utility systems
- Possibility of using older systems for new purposes - e.g. London Embankment – using an old gas main as a cable casing pipe for high performance IT backbone cables
- 80% cheaper expansion, renewal, replacement costs
- 99% avoidance of pipe / cable repair costs through normal degradation
- 99% avoidance of pipe / cable repair costs through external damaging influence
- 200% to 300% life extension of road surfaces above – no excavations and other surface disturbances other than traffic loads

155 years – Utility Tunnels a good idea gets experience

Other more out of the ordinary UT constructions:

Vienna – Reichsbrücke 1978-80
a bridge is a UT & carries the metro and 6 traffic lanes across the Danube



Listing of University UTs:

Ruhr-Universität Bochum J.Liebig Universität Gießen
Universität Stuttgart Vaihingen Universität Ulm
University of Alaska University of Arizona
University of California Florida Atlantic University
Georgia Institute of Technology Purdue University
Michigan State University University of Minnesota
University of Missouri University of Oregon
University of Texas University of Washington

UT operational performance – what if – it happened .....?

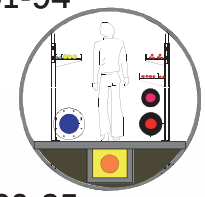
Current list of known mishaps in Utility Tunnels in Germany (as researched and experienced by POET & alcUG in own – between 1993 to 2011 – and others' UTs) :

- Leipzig Grünau in the 1980s – Cable Fire
  – destroyed ca. 30m of all cabling before extinguishing itself due to lack of oxygen. Piping of water supply and district heating was not impacted.
- Ruhr University Bochum in the 1980s – Water Main Break (d 300mm)
  filled the whole 6.5km UT system completely with water within 30 minutes. Effects: extensive cleaning of the UT & repair of the water main, some secondary support structure corrosion effects over the next year.
- ISK Wachau since 1993 – cable joint explosions
  – 2 cable joint explosions in 20 years – due to faulty cable joint manufacture – effect: cable joint repair – some minor damage to the UT hull inside galvanization at the lightning footpoint. Repairs both times fully effected within hours of fault.
- NO OTHER MISHAPS HAVE BEEN REPORTED OR FOUND IN PUBLICATIONS WORLD WIDE – IT IS LIKELY THAT SOME OCCURRED, but not even in London during the WW2 bombing much damage seems to have occurred in UTs.

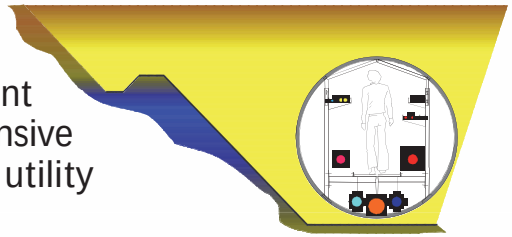
Sources: pictures © & data: alc UG(hb) – POET GmbH, Christian Lindecke - wikipedia

The 1990s' – Utility Tunnels a good idea gets cheaper

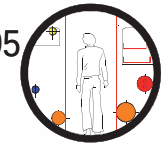
POET UBP & ISK-Project Wachau 1991-94
assuring economic success by being faster and cheaper in a tight property market



POET UHP & ISK-Project Fahrland 1993-95
proving that a steel hull UT urban development is exactly as expensive as a conventional utility construction – even in a high ground water table



POET RHP & ISK-Project Lauchheim 1995
setting a new speed record by using PEHD & section prefabrication



POET UHP & ISK-Project Speyer 2004
making concrete work without steel and saving cost & time

Sources: pictures © & data: alc UG(hb) – POET GmbH

New materials & methods – time = money = savings

POET Engineering Consultants and DI(FH). DI(FH). Hermann Laistner:

DI(FH). DI(FH). Hermann Laistner had first "re-invented" the idea of utility tunnels on a napkin over a beer, while in conversation with his professors during the completion of his second engineering degree as civil engineer in 1968 – being at the same time at the head of the college student body in a tumultuous political situation.

Back then already he combined the technical needs of the engineer with the understanding of political and fiscal realities and requirements of an urban environment – and came, like others before and after him, to the logical conclusion:

The only thing that makes sense in the long run is a UTILITY TUNNEL.

Throughout his professional and political life he kept on the front end pushing new technical understanding and implementations – while finally capping his personal political & technical involvement by becoming the German delegation leader on urban development to the OECD.

Being well known and well respected as practical researcher on the leading edge – he saw and took the chance of German reunification – and designed and built a whole new generation and technological leap of sustainable urban development areas – including under ground a new generation of utility tunnels