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Digitalisation in the Construction Sector: challenges and opportunities

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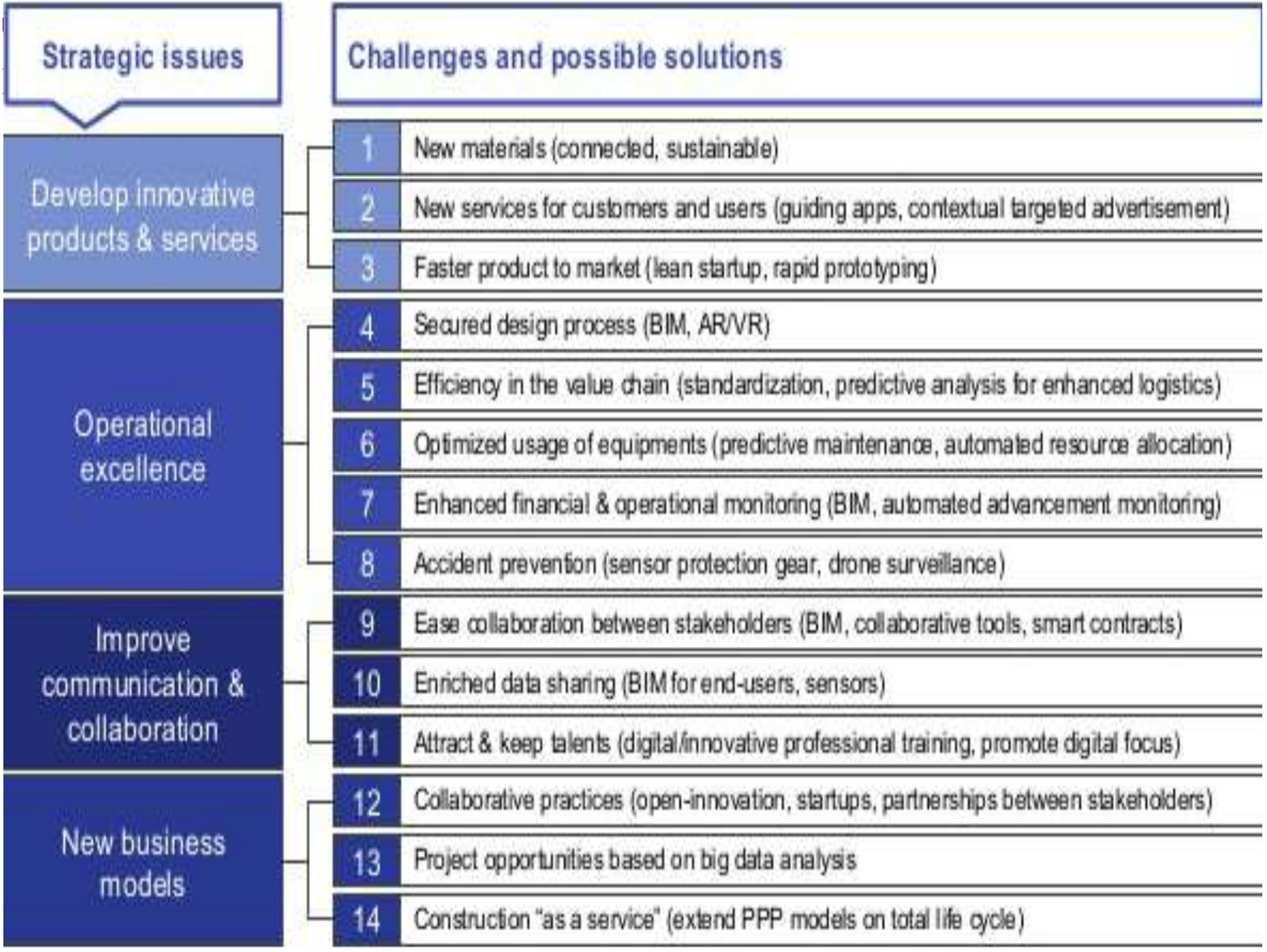
What is digitalisation?

- **More than BIM**, visualisation tools, big data analysis
- **Different things** for different people
- '**Digital construction** comprises new technology hardware and software, data-led processes and equipping staff with the skills and competences needed to maximise digital applications'
- **Collaborative digital systems**
- **Document sharing platforms**
- **Needs collaborative legal public procurement framework**

"BIM is an intelligent 3D model-based process that gives architecture, engineering and construction professionals the insight and tools to more efficiently plan, design, construct and manage buildings and infrastructure."


Strategic issues
Challenges and possible solutions
Develop innovative products & services
1 New materials (connected, sustainable)
2 New services for customers and users (guiding apps, contextual targeted advertisement)
3 Faster product to market (lean startup, rapid prototyping)
Operational excellence
4 Secured design process (BIM, AR/VR)
5 Efficiency in the value chain (standardization, predictive analysis for enhanced logistics)
6 Optimized usage of equipments (predictive maintenance, automated resource allocation)
7 Enhanced financial & operational monitoring (BIM, automated advancement monitoring)
8 Accident prevention (sensor protection gear, drone surveillance)
Improve communication & collaboration
9 Ease collaboration between stakeholders (BIM, collaborative tools, smart contracts)
10 Enriched data sharing (BIM for end-users, sensors)
11 Attract & keep talents (digital/innovative professional training, promote digital focus)
New business models
12 Collaborative practices (open-innovation, startups, partnerships between stakeholders)
13 Project opportunities based on big data analysis
14 Construction "as a service" (extend PPP models on total life cycle)

Five trends that will shape construction and capital project

Higher-definition surveying & geolocation
Rapid digital mapping and estimating

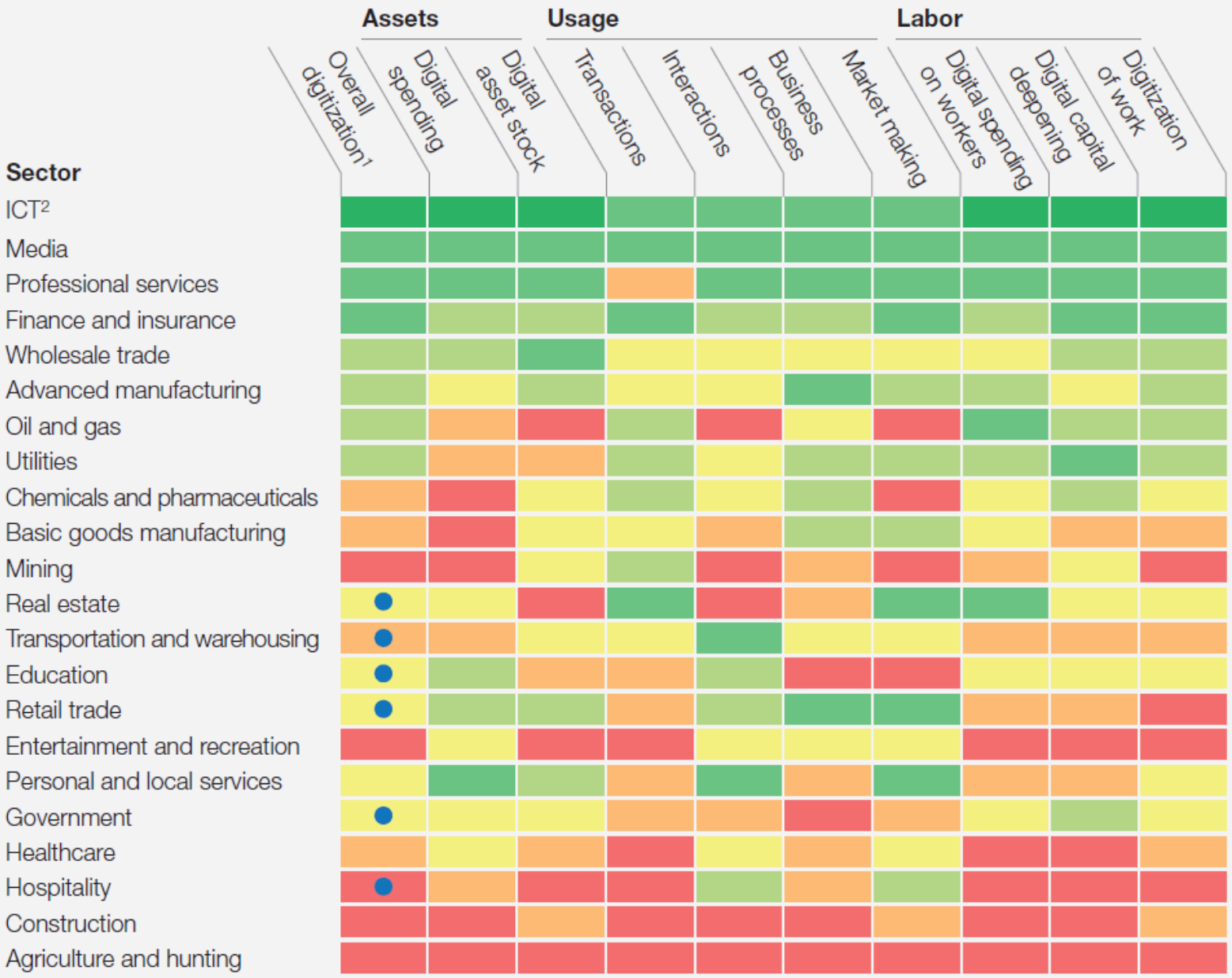
Next-generation 5D Building Information Modeling
Design platform for the future

Digital collaboration and mobility
Moving to paperless projects, from the office to the workforce

DIGITAL CONSTRUCTION ORGANIZATION
Developing next generation of digital-native leaders to deliver projects of the future

Future-proof design and construction
Designing with materials and methods of the future

The Internet of Things and advanced analytics
Intelligent asset management and decision making



[1]Based on a set of metrics to assess digitization of assets (8 metrics), usage (11 metrics), and labor (8 metrics).
[2]Information and communications technology.

Source: AppBrain; Bluewolf; Computer Economics; eMarketer; Gartner; IDC Research; LiveChat; US Bureau of Economic Analysis; US Bureau of Labor Statistics; US Census Bureau; McKinsey Global Institute analysis

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Where is digitalisation happening in construction?

- **Land surveying**: cut down from 2 days to 20 minutes with unmanned aerial vehicles and drones
- **Highways**: use of
  - asset condition data to predict/optimise maintenance programmes;
  - network traffic simulation tools
- **Integrated delivery:**
  - using GPS equipment and 3D control systems to share data from digital 3D models with earthmoving equipment on site.
  - Machines send survey data to office, allowing progress to be measured and visualised – saving 5x time involved in checking lines and levels + adopting changes
- **Digital site diaries:** on spreadsheets

BUT WHERE IS LABOUR?

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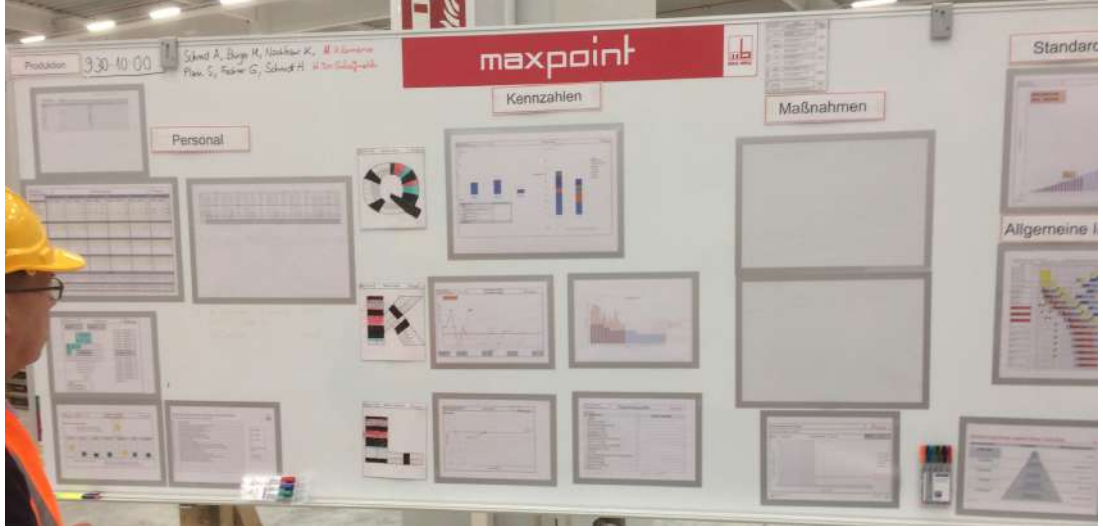
Visit to modular housing factory: Germany



- Up to **80% building costs can be in pre-construction stage**, so preplanning/ prefabrication means drastic cost reduction
- Prefabrication since 2015, following **computerisation of pre-building process**
- **Energy saving**; claims better than passive house standard
- 6,000 employees, including:
  - in factory 40 planning, 120 assembly, 12 trainees + 3-4 subcontractors
  - For wind turbine production, 1,500 skills workers (e.g. electricians)
- **Skill shortages**; CEO 'I have a *Beruf*, workers have 'job'
- **Module** = 20sqm, can make 4,000pa, c1,000 housing units

Visit to BIM site in Britain

Observation 1: work bench in corridor with metal vice and tube cutter. Explained that could be too expensive to install modular piping, fitters measured space and cut and fixed pipe to fit

Observation 2: bankruptcy of bathroom pod manufacturing firm meant extra 6,000 hours. 250 bathroom pods planned, only 20 delivered, though programme depended on them, including lifting in. Meant fitting out bathrooms traditionally, circumscribed by original pod dimensions specified. Firm set up experimental bathroom fitting out room, considered building pods at workshops

Observation 3: all joints initialled by fitters and dimensions, instructions etc. handwritten on wall rather than i-pad use(only 2 on site) and often in different languages

Observation 4: no apprentices on sites

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What are the requirements for a digitally qualified workforce?

- **Basic technical understanding** for everyone
- **Flexible thinking**: curiosity, problem-solving, creativity, communication
- **Understanding tools and data**:
  - knowledge of specific technologies;
  - range of technologies available;
  - how data supports technological development;
  - collecting storing, sharing, using data
- **Assess which tools to use in which circumstances**
- **Manage data flows** to and from use of tools:

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Problems with digital implementation in construction

- **Lack of investment**
- **Reluctance to innovate**
- **Data not shared**, including for problem-solving/issues
- **Lack of effective data management**
- **Factional professional silos, trades, and fragmented labour process**
- **Adversarial supply chain**
- **Contractual divisions*:***
  - agency labour/ self-employed, labour-only subcontracting, long supply chains →
    - reinforcing trade/ sectoral divisions
    - impeding integrated teamwork needed

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Industries set to experience the highest job demand growth (absolute) (ILO WESO 2018)

Sector	Jobs (millions)
Construction	6.5
Manufacture of electrical machinery and apparatus	2.5
Mining of copper ores and concentrates	1.2
Production of electricity by hydropower	0.8
Cultivation of vegetables, fruit, nuts	0.8
Production of electricity by solar photovoltaics	0.8

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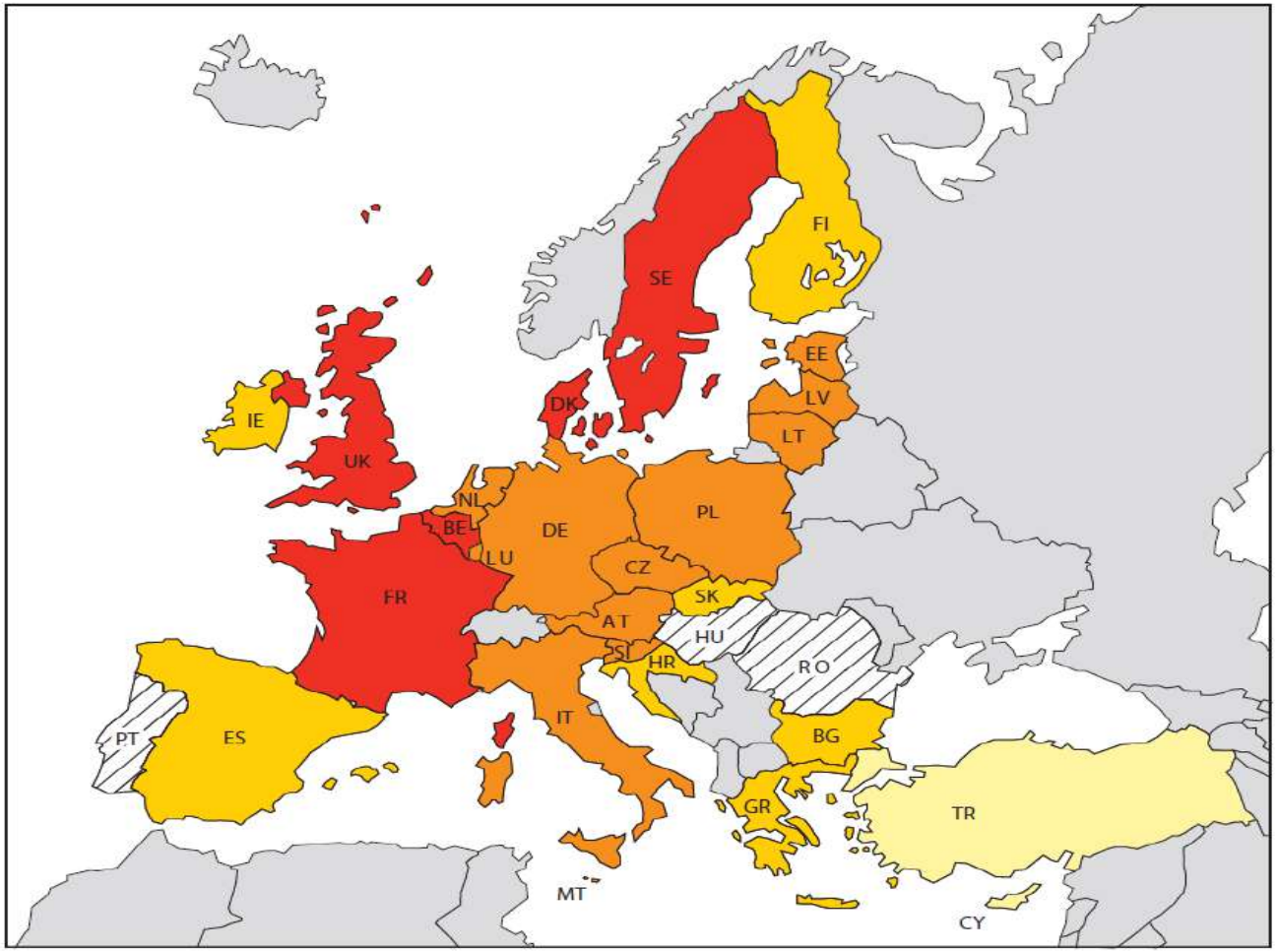
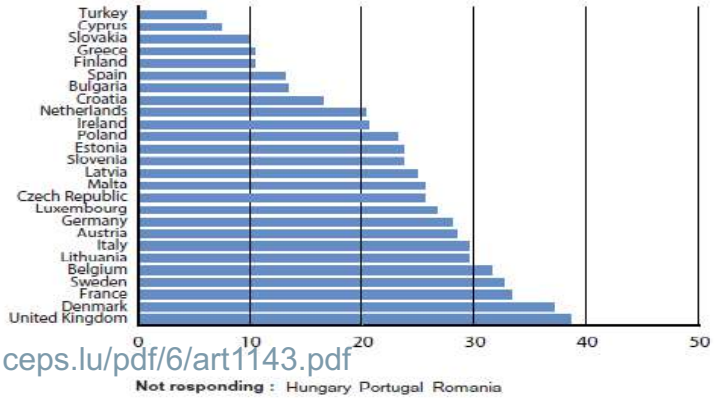
EU dwellings built before 1945 generally "Hard to Heat" Add "Fuel Poverty" HUGE WORK POTENTIAL



Dwellings built before 1945 (%)

- < 10
- 10 - 19
- 20 - 29
- > 30
- Not responding



*Source: GEODE 2005,*http://www.ceps.lu/pdf/6/art1143.pdf

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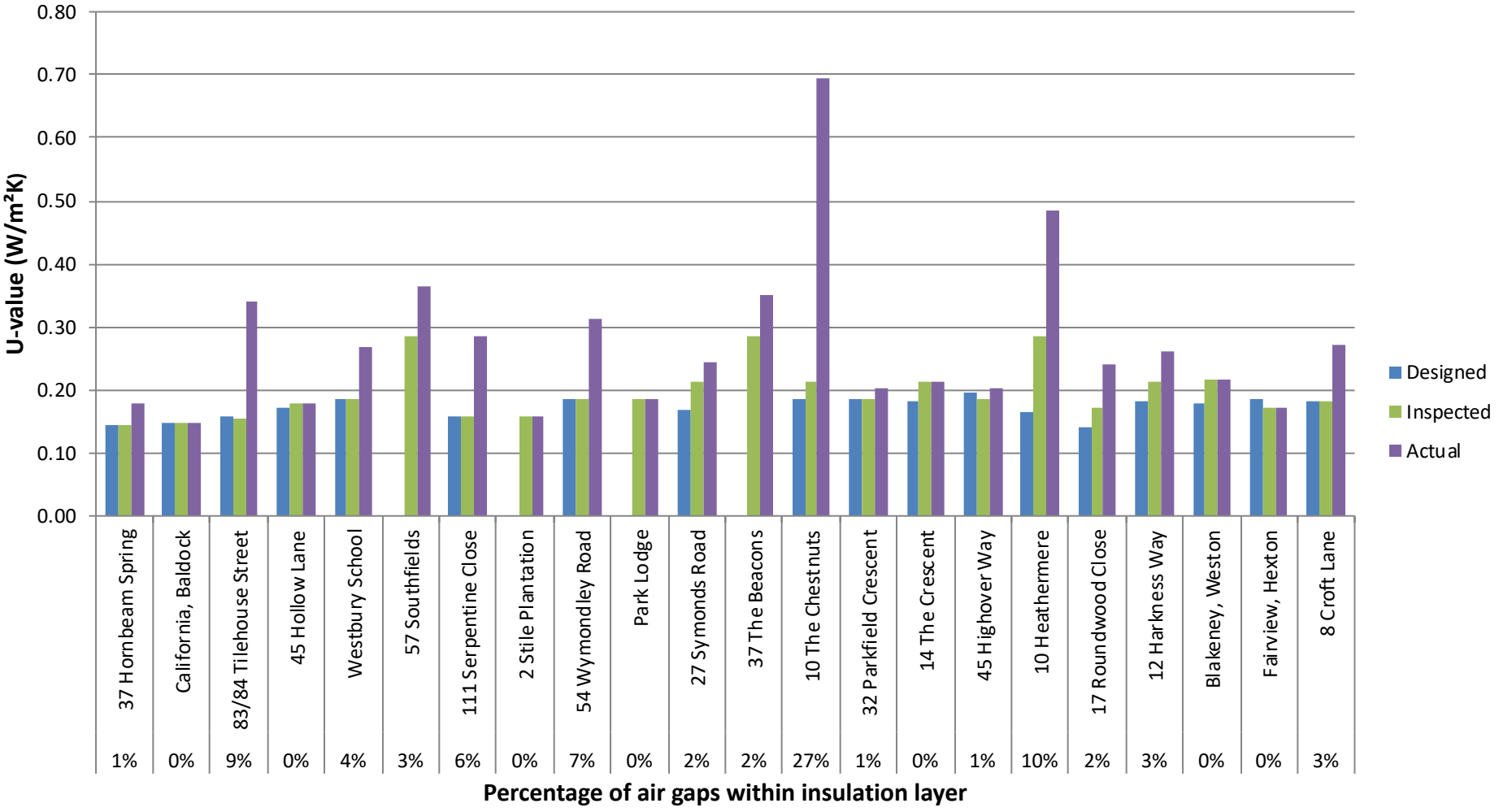
Designed and actual performance



Average architect's design u-value 0.19W/m²K; Average u-value as constructed on site 0.27 W/m²K = 39% higher

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Modularisation, BIM and energy performance gap requirements

- **Preplanning**
- **Precision** due to fine tolerances
- **Integrated teamworking** and team managers
- **Improved site co-ordination and communication**
- **Overcome performance gap:** no deviation from design
- **High quality workmanship**
- Use of **Accredited Construction Details**
- **Broader skills and competencies** at different levels:
  - not just tech-specific e.g. problem solving
  - greater digital and energy literacy more important than skills for specific technology
- Understanding data management
- **Digital competency frameworks**

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Transformation needed for digital and zero energy construction

- **Need for 'knowledge'** and **'know how'** not generally in VET curriculum
- **Integrated team-working** through regulating subcontract chain and direct employment
- **Bridge professional-operative divide** and create permeability
- **Transformation of VET to develop broad occupational capacity:** understanding of overall project and occupational interactions i.e. comprehensive, high standard VET, broad occupations
- **Labour as agent of production key to transforming labour process:** i.e. need to include workers, trade unionists and educationalists in transition

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Constraints on transition to digital, zero energy, and inclusive construction labour market

- Domination and mushrooming of **small/micro firms** (95-98%),
- Extensive **self-employment:** 49% of workforce UK, 43% IT, 13% DK, 11% D
- Severe **skill shortages**
- **Recruitment crisis:** Aging workforce, fewer young people, very small female workforce
- **Declining training**, problems of employer engagement
- ***Varying skill/qualification levels*:** from highly qualified (e.g. B, D) to low
- ***Varying VET models:*** from school-based to predominantly work-based
- ***Different approaches to developing skilled workforce:***
  - Taylorist i.e. training for particular skills, heavy supervision, labour as commodity
  - Developing labour potential/capacity, valuing labour
- ***Different approaches to digital VET4ZEB provision & delivery:*** generally very low level, though depends on whether:
  - mainstreamed i.e. more long-term
  - dependent on short courses i.e. more short-term
- ***Performance gap*** between design intention and implementation

TECHNICAL CONSTRUCTION OCCUPATIONS (SOC 2010) IN BRITAIN	ALL	FEMALE	MALE	% FEMALE
Total Technical occupations	307,107	74,666	232,441	24.3
Engineering technicians	49,513	4,400	45,113	8.9
Building and civil engineering technicians	12,221	2,228	9,993	18.2
Quality assurance technicians	23,431	9,026	14,405	38.5
Planning, process and production technicians	25,156	6,419	18,737	25.5
Science, engineering & production technicians nec	114,521	30,739	83,782	26.8
Architectural and town planning technicians	21,481	6,191	15,290	28.8
Draughtspersons	60,784	15,663	45,121	25.8

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Transition pathways to digital, ZEB and inclusive economy

- **Market based**
  Market forces, with state regulation, training on demand, labour passive instrument of implementation

- **Ecological modernisation** (Mol et al, 2009)
  State lead, assumes pro-active investment by private companies, re-training for workers, 'just transition'

- **Radical transformation** (Hampton, 2015)
  Interests of labour and the environment intertwined: labour centred narrative

Actors in green transitions: Importance of worker agency and coalitions of actors

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Implications

- **Not just 'job creation' and 'green or digital jobs'** but chance to transform and improve employment and working conditions in construction i.e. decent work is a necessity
- **Not just 'skills' development** but knowledge and competences and upgrading vocational education and training programmes i.e. digital and energy literacy for entire workforce obligatory if targets to be met and performance gap overcome
- **Need for greater involvement of unions and workforce** if teamwork and hierarchies to be broken down and radical transformation achieved
- **Need for 'just transition'** for those impacted
- **Need for inclusivity**, recruiting all those excluded, especially women