Energy Anlysis and Reduction in the Built Environment: The case for BIM and Visulisation Technologies

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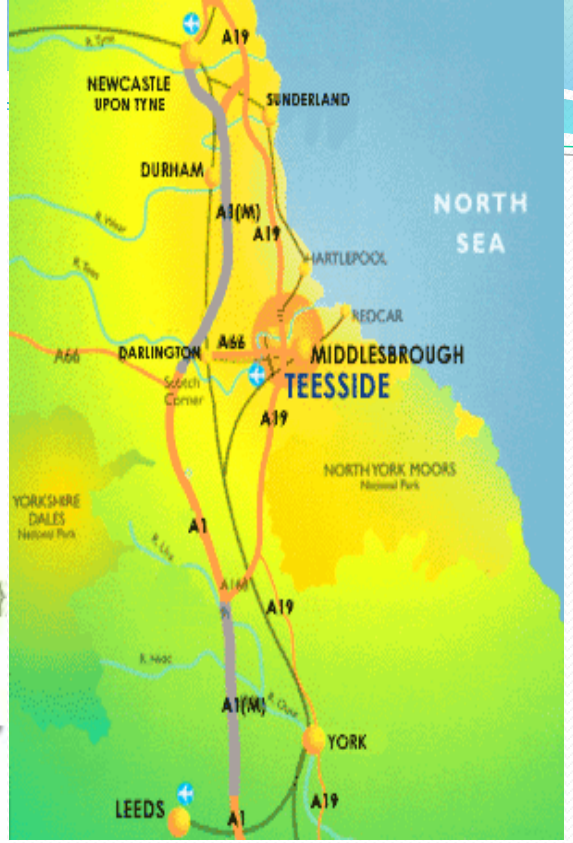
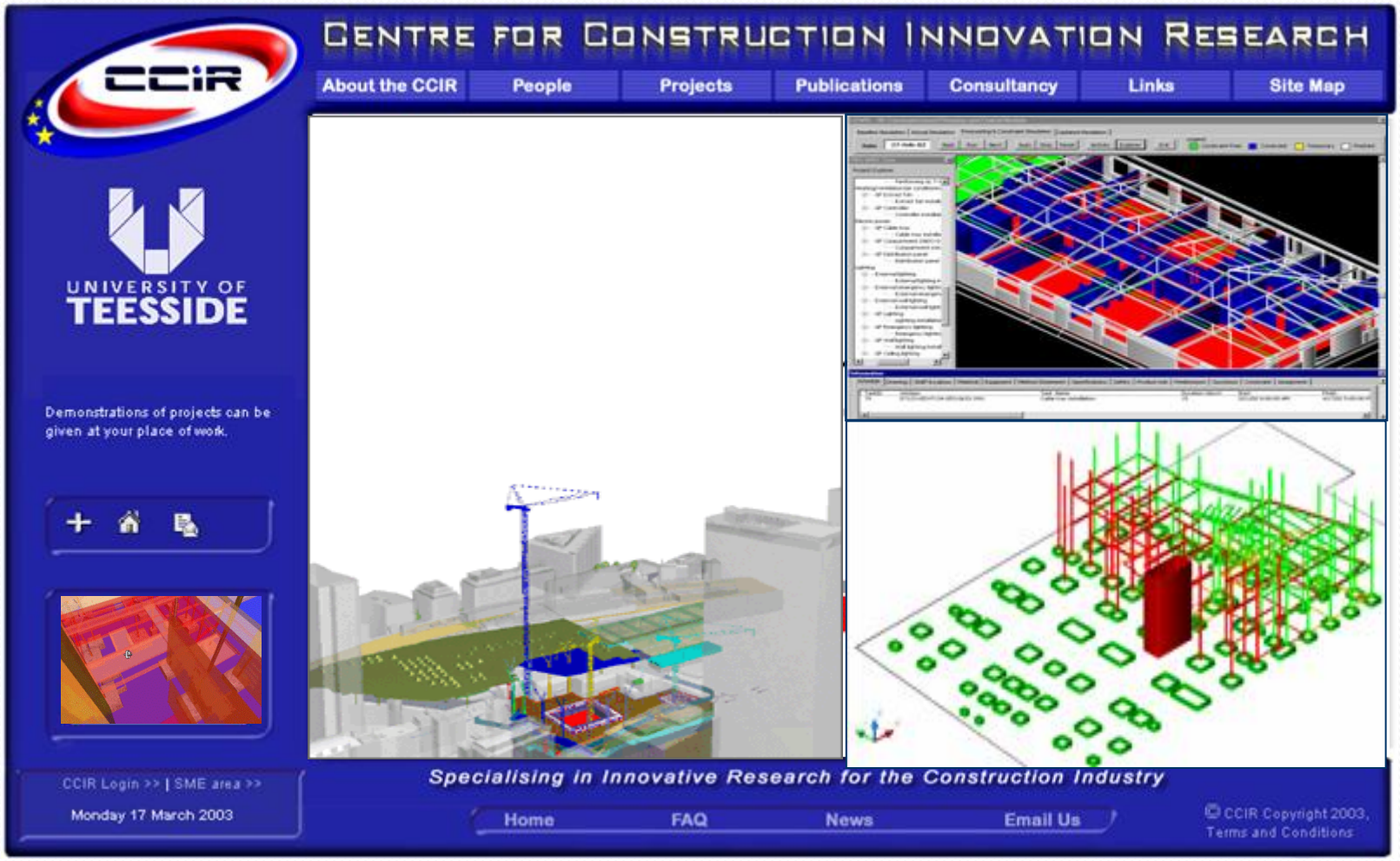


Centre for Construction Innovation & Research

Brief Introduction to the Centre for Construction Innovation and Research



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Aim

- Assess and ultimately reduce the energy consumption and CO_2 emissions in the Built Environment through the use of ICT (BIM, integrated databases, visualisation techniques and Geographical Information System) and intelligent approaches

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Objectives

- Intelligent analysis of energy information for a single building (WLCA)
- Identification of tools and methods for the classification of domestic and non-domestic building stock in a neighbourhood;
- Identification of the energy profiling tools and techniques required to estimate energy consumption and CO_2 emissions from the building stock within the neighbourhood;
- Identification of energy efficiency and renewable energy interventions and their energy savings, CO_2 emission reduction potential and associated costs;
- The development of an optimisation approach to support stakeholder decision making in the selection of energy efficiency and renewable energy interventions;
- The development of a framework and prototype to integrate building classification and energy profiling techniques and an optimisation approach to select combination of energy efficiency and renewable energy interventions.

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Intelligent Energy Analysis through the whole life cycle

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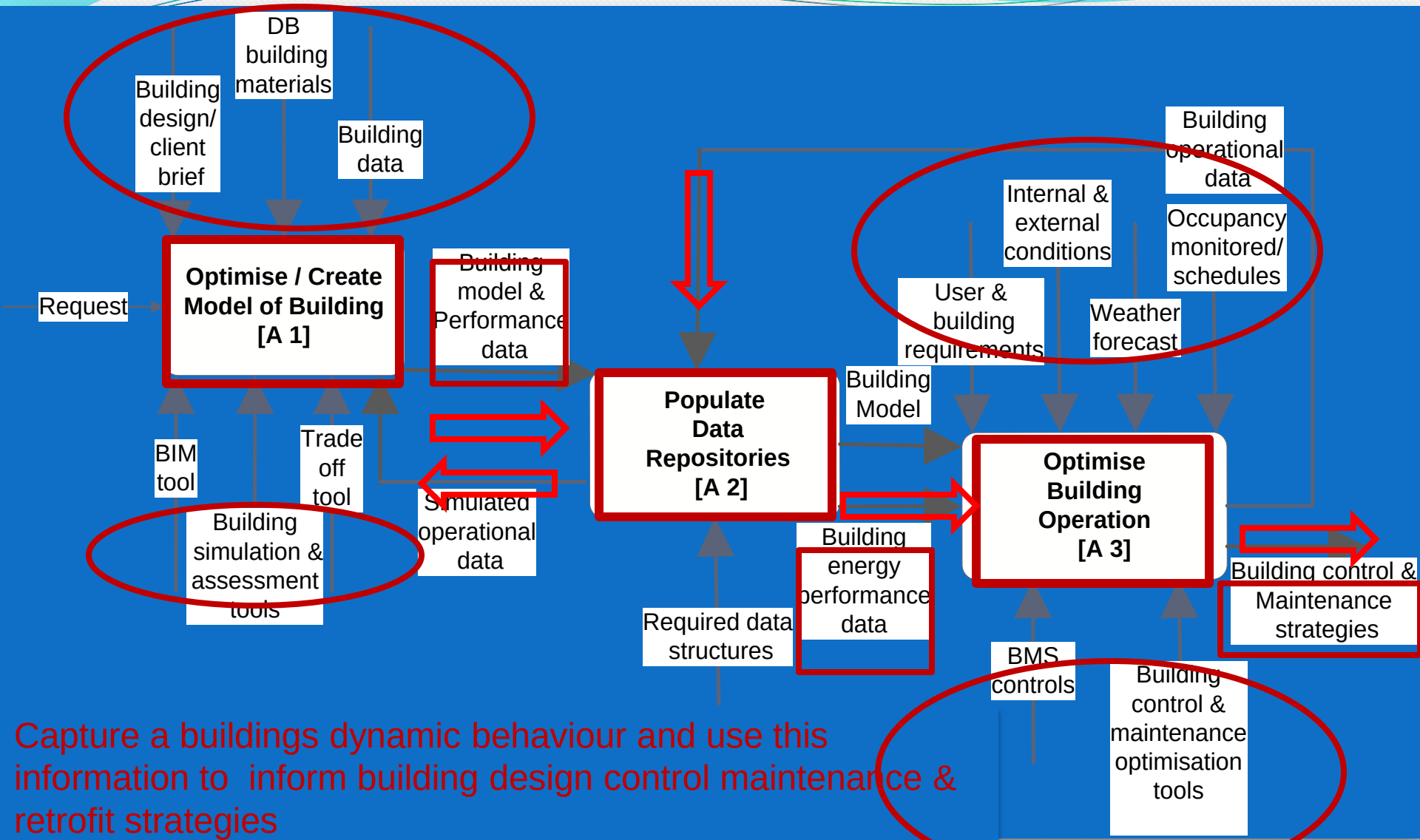
Simulation and Optimisation throughout lifecycle



Capture a buildings dynamic behaviour and use this information to inform building design control maintenance & retrofit strategies

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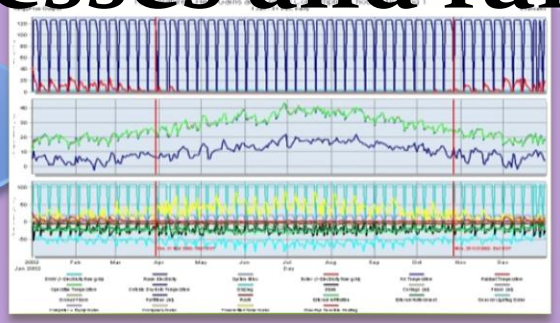
WLC Analysis: processes and functions

Energy Simulation

Energy Optimisation



Model relationship and optimal design parameters for energy optimisation

Operational Phase

Users Behaviour

Design, materials

Energy BIM model

Outline/Design Phase

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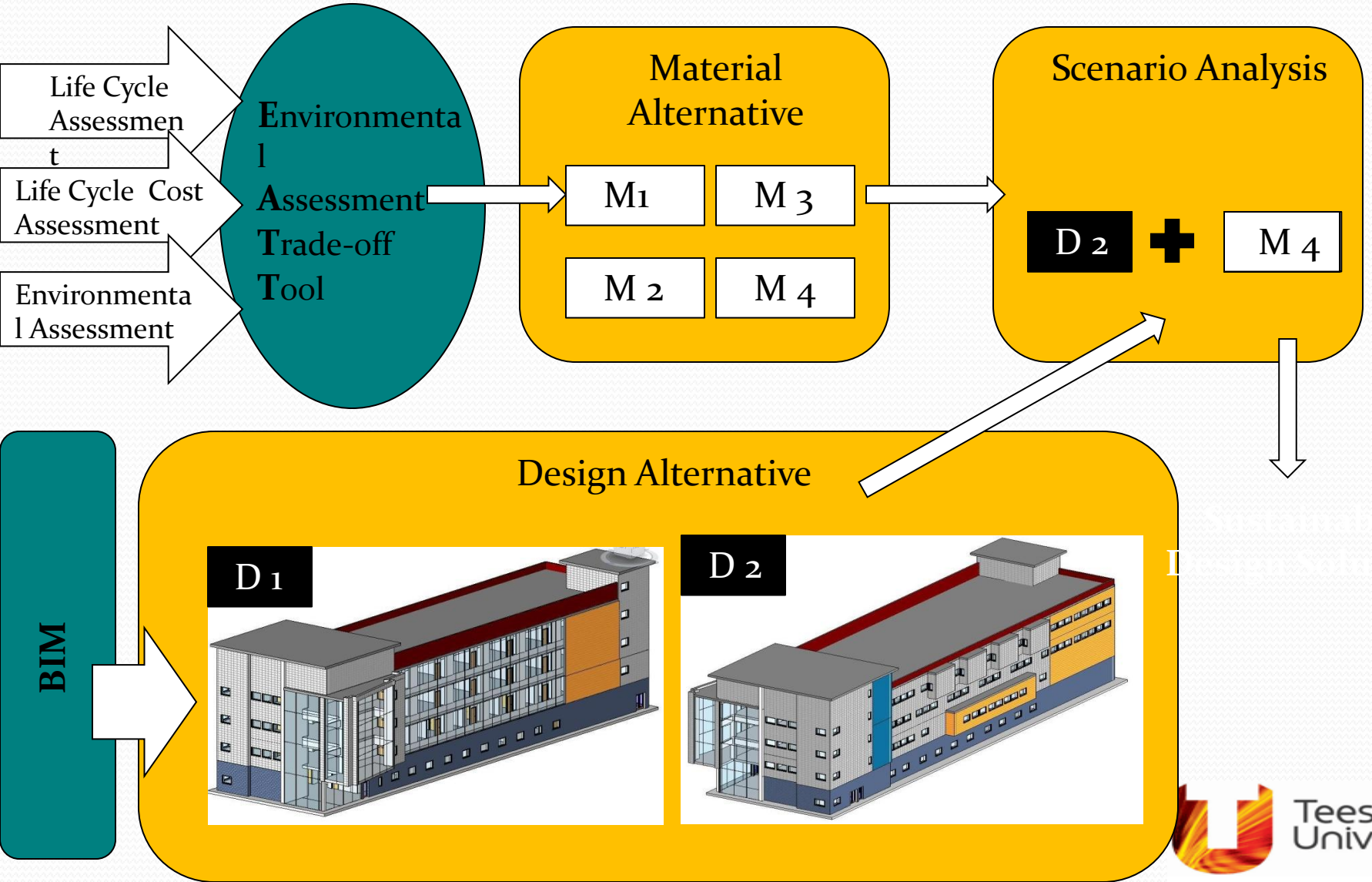
Process Flow Chart



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IBMS

BIM server

Human interface

Core IBMS

BIM

Data Base

Plug-Ins

OPC Server

Data Acquestion

Wireless monitoring System

Equipment, SHW, HVAC, Shading...

HAS (Home Automation System)

Infrared Camera Other raw data...

New Data

Design phase for new buildings

Operation Phase

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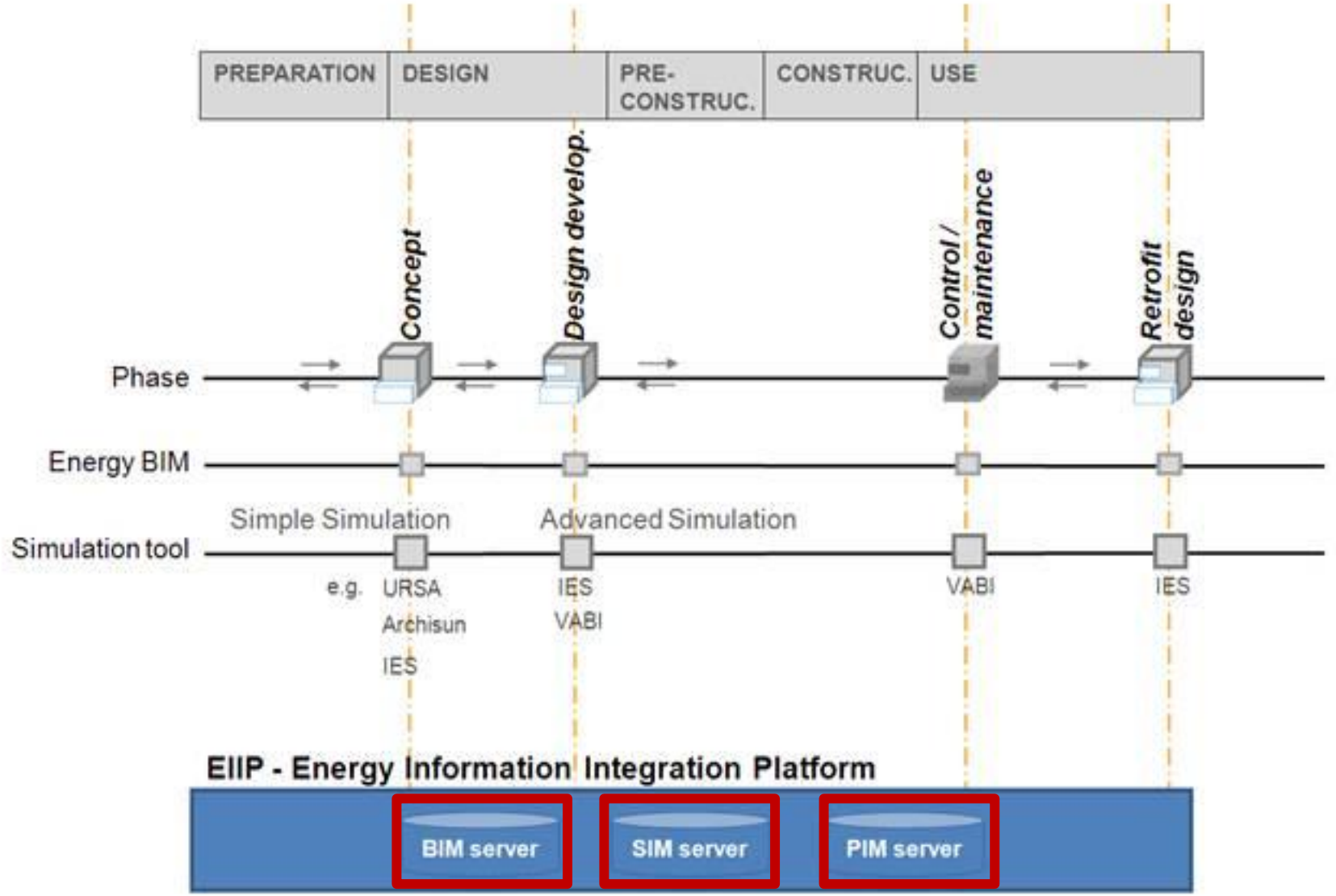
Energy Information Platform



Energy Anlysis and Reduction in the Urban Developements

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Building Stock Classification

- It is widely acknowledged that similar type of buildings have comparable energy consumption levels;
- To identify the energy profile of an area, it is thus essential to classify the buildings into various categories;
- Building stock can be broadly classified into domestic and non-domestic building stock;
- Domestic stock can be further classified based on age, size and type;
- Non-domestic building stock can be further classified based on public sector, private sector and the nature of usage;

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Urban Energy Analysis

- Building Classification
  - Domestic
    - Age
    - Size
    - Type
  - Non – domestic
    - Private Sector
    - Public Sector
- Energy Profiling
  - Domestic
    - BREDEM / SAP
  - Non Domestic
    - BREEAM

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Energy Profiling

- For the domestic building stock, most widely used energy calculation engine is the Building Research Establishment Domestic Energy Model (BREDEM);
- Standard Assessment Procedure (SAP) is adopted by Government as the UK methodology for calculating the energy performance of domestic dwellings and is based on BREDEM;
- For the non-domestic building stock, Simplified Building Energy Model (SBEM) and Building Research Establishment Energy Assessment Model (BREEAM) is widely used;

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Gaps in Current Research

- Several models have been developed since the introduction of BREDEM in 1990's. However, most of them are targeted to energy reduction only in domestic building stock;
- These models rely on national statistics to identify the classes of buildings and their thermal levels;
- Thus, the models do not identify the energy profile on a geographical level i.e. Energy consumption is calculated only for the types of building stock and then aggregated. It does not necessarily tell how many types of buildings exist in a particular area and then their energy consumption;

Way Forward

- To overcome the barrier of building identification and classification, it is proposed to identify and classify the building stock based on Ordinance Survey (OS) maps and aerial and terrestrial images through use of image recognition;
- The image recognition tools are integrated in GIS software such as ArcGIS / MapInfo which will provide an platform to input OS maps and aerial and terrestrial images;
- A virtual 3D model of the neighbourhood / city is being developed to undertake further energy calculations;
- Using Multi-Criteria Decision Analyses (MCDA) optimum energy efficiency and renewable energy interventions will be identified.

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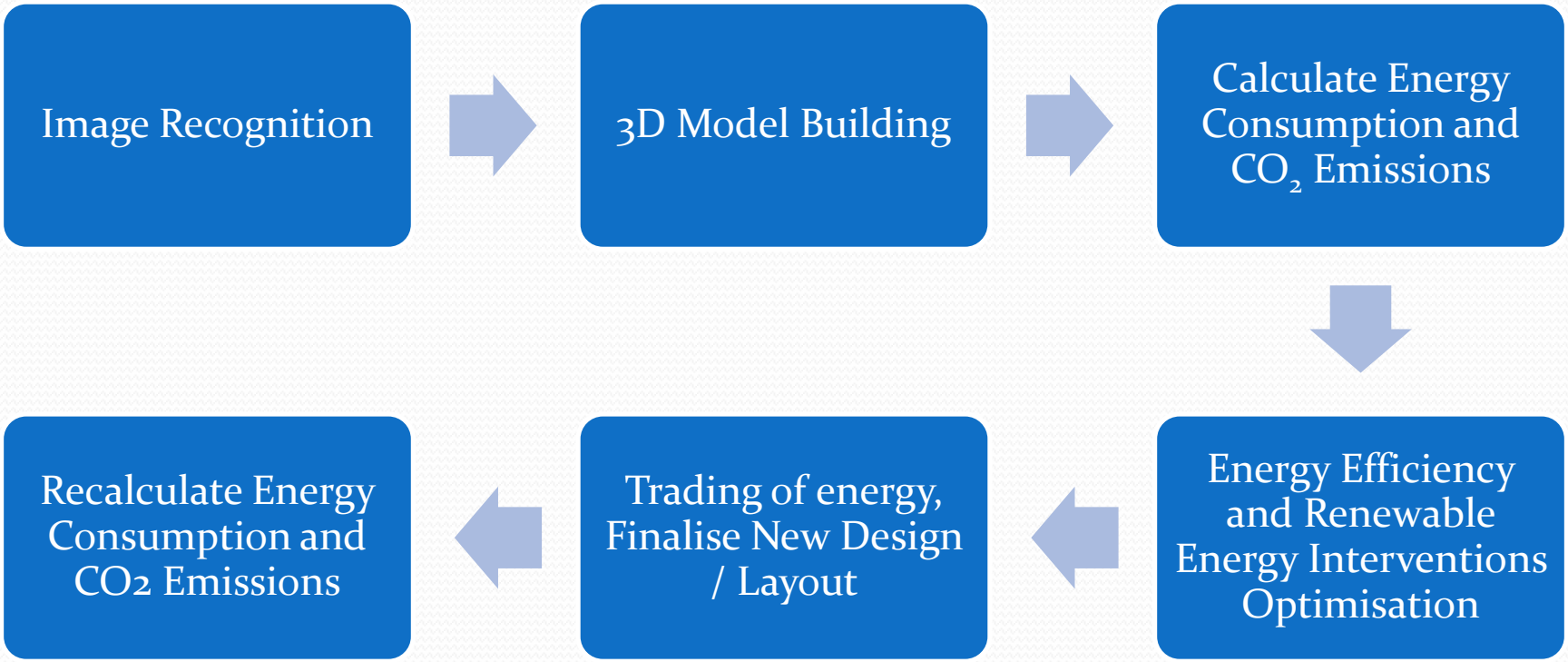
System Framework



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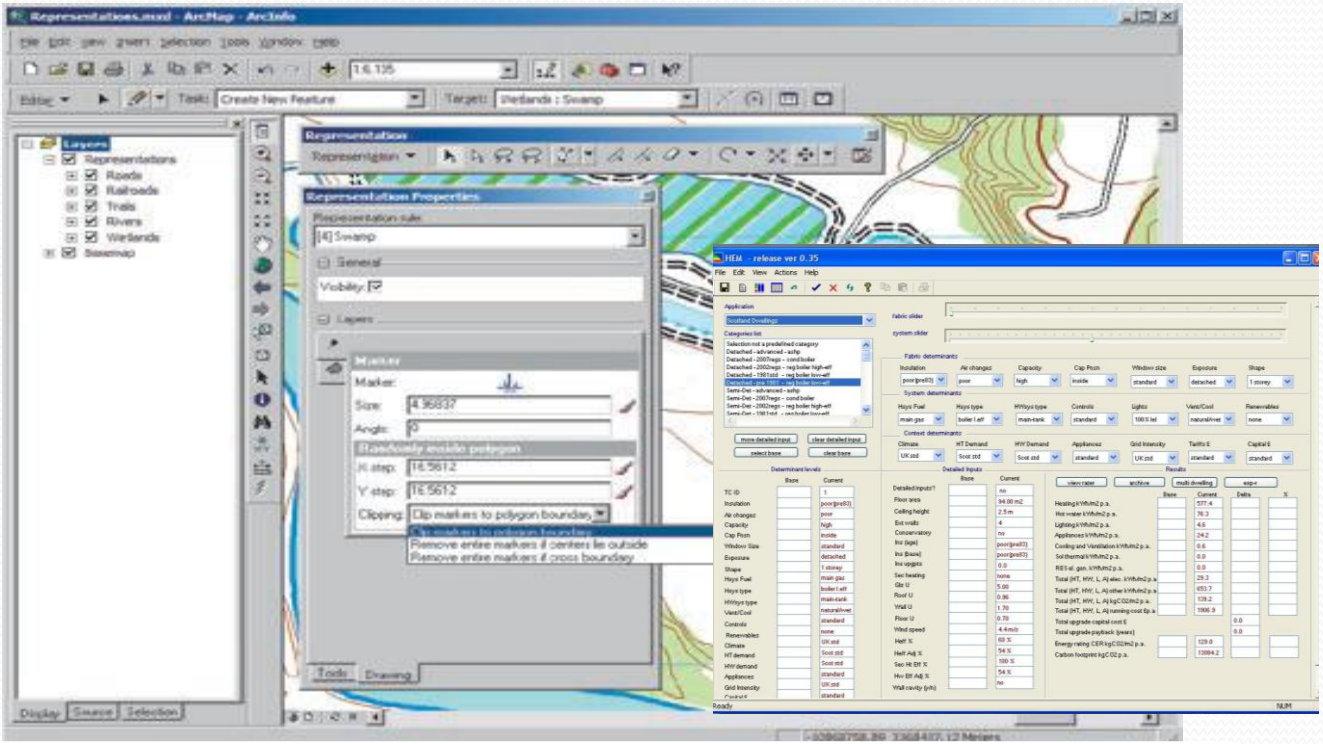
Tools Integration



Integrate Image Recognition / Processing (e.g. HALCON) and Energy Profiling Software (BREDEM and SAP) within GIS Software e.g. (ArcGIS / MapInfo)

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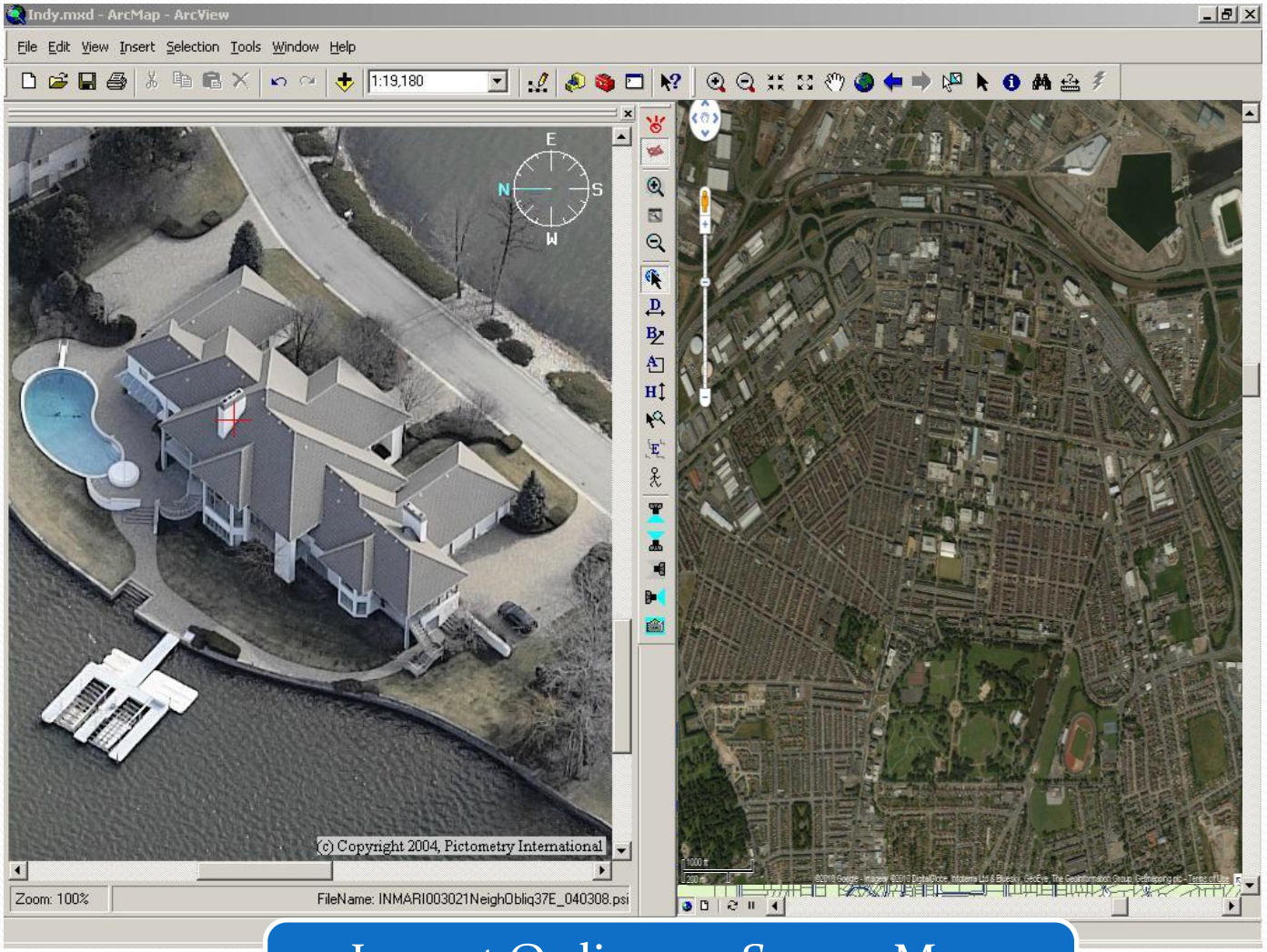
Image Recognition



Import Ordinance Survey Maps and Satellite Imagery in ArcGIS / MapInfo

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Image Recognition

Import Street View Images

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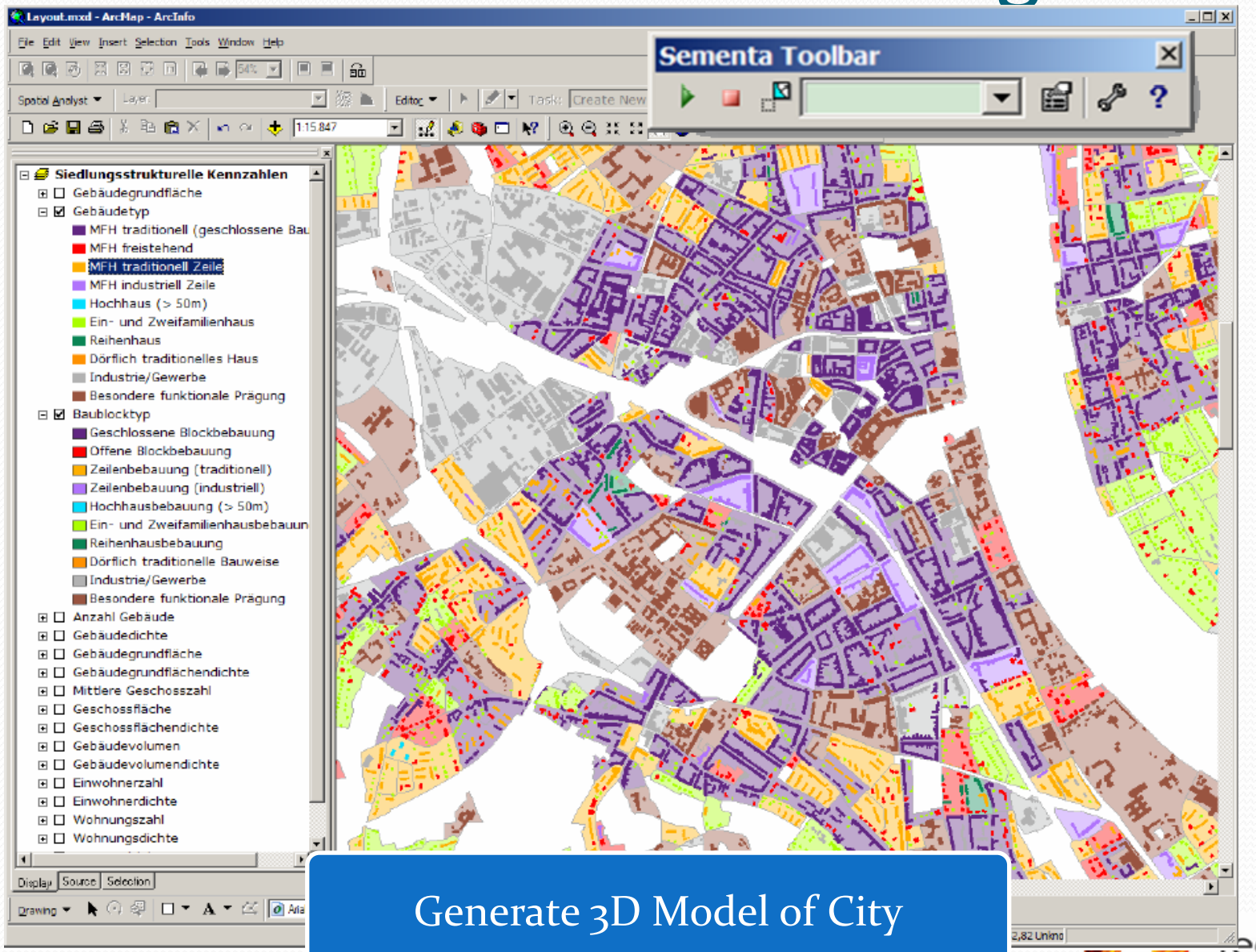
3D Model Building



Generate 3D Model of City

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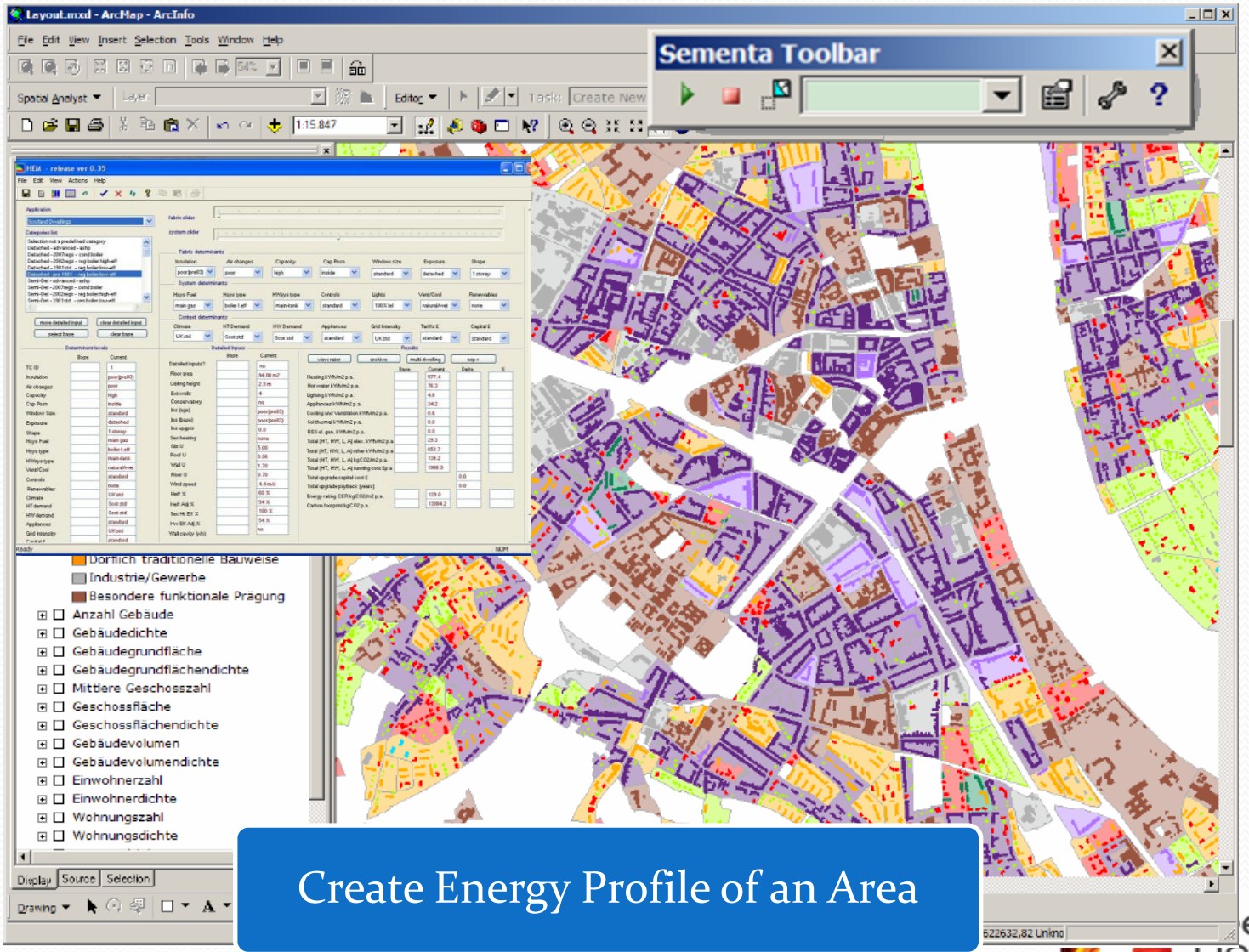
Building Classification



Create Energy Profile of an Area

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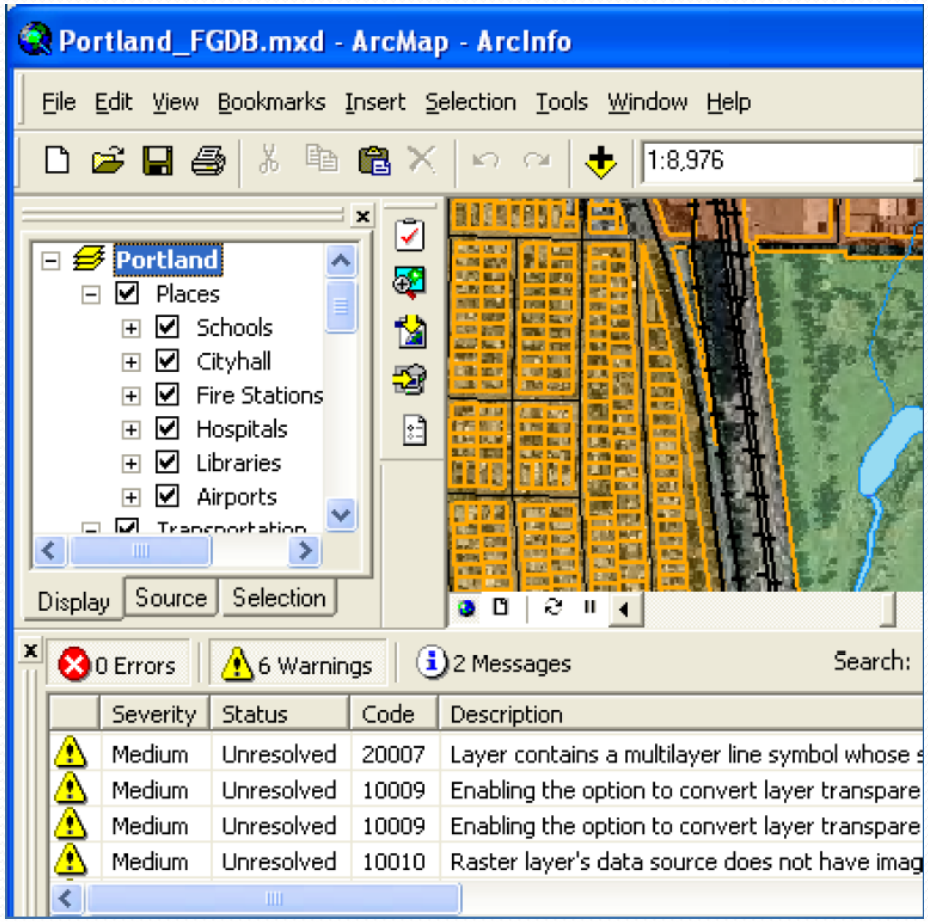
Optimisation



Identify the Optimum Energy Efficiency and Renewable Energy Interventions

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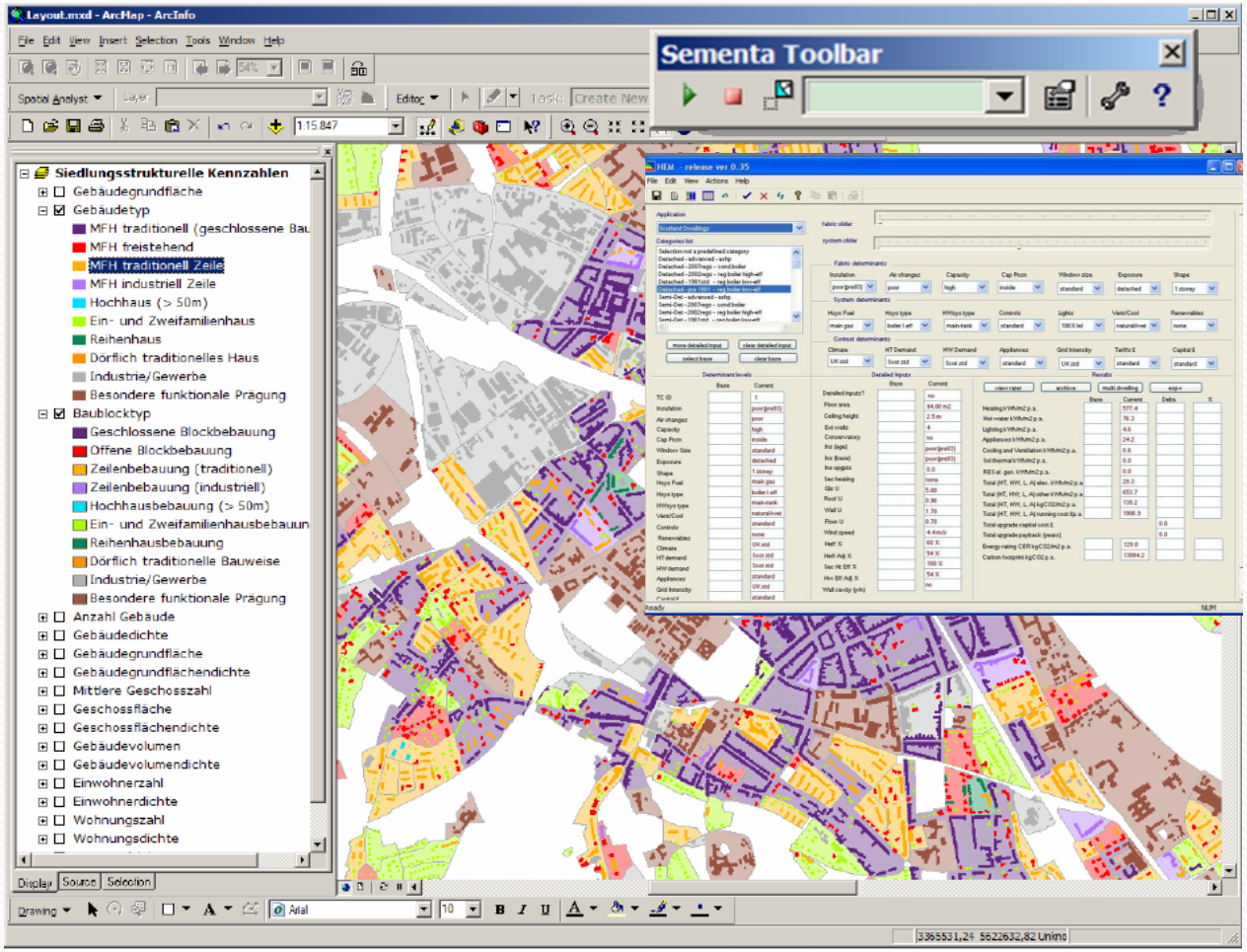
Final Design



Recalculate Energy Profile of the Area including Energy Efficiency and Renewable Energy Measures

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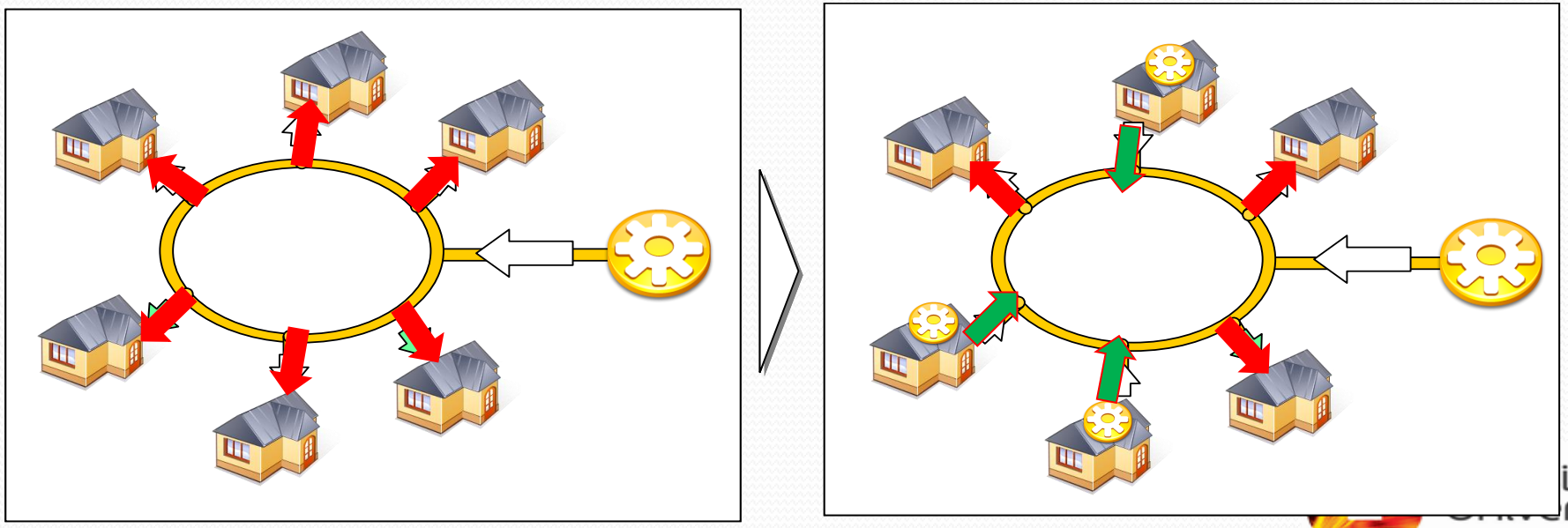
Concept of Urban energy anlaysis:

- Tools exist to manage distributed electricity production
- No tools to manage distributed heat production or heat trading



Conclusions

- BIM, Optimisation and visualisation of energy performance in both building operation and design set to play a major role in carbon footprint reduction.
- The research project is set to contribute to the 20% reduction by deploying ICT for energy efficient buildings
- WLCA for energy analysis in buildings is vital for any potential energy reduction.
- Neighborhood Management Systems for efficient distributed energy production and optimal energy transfers among buildings

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