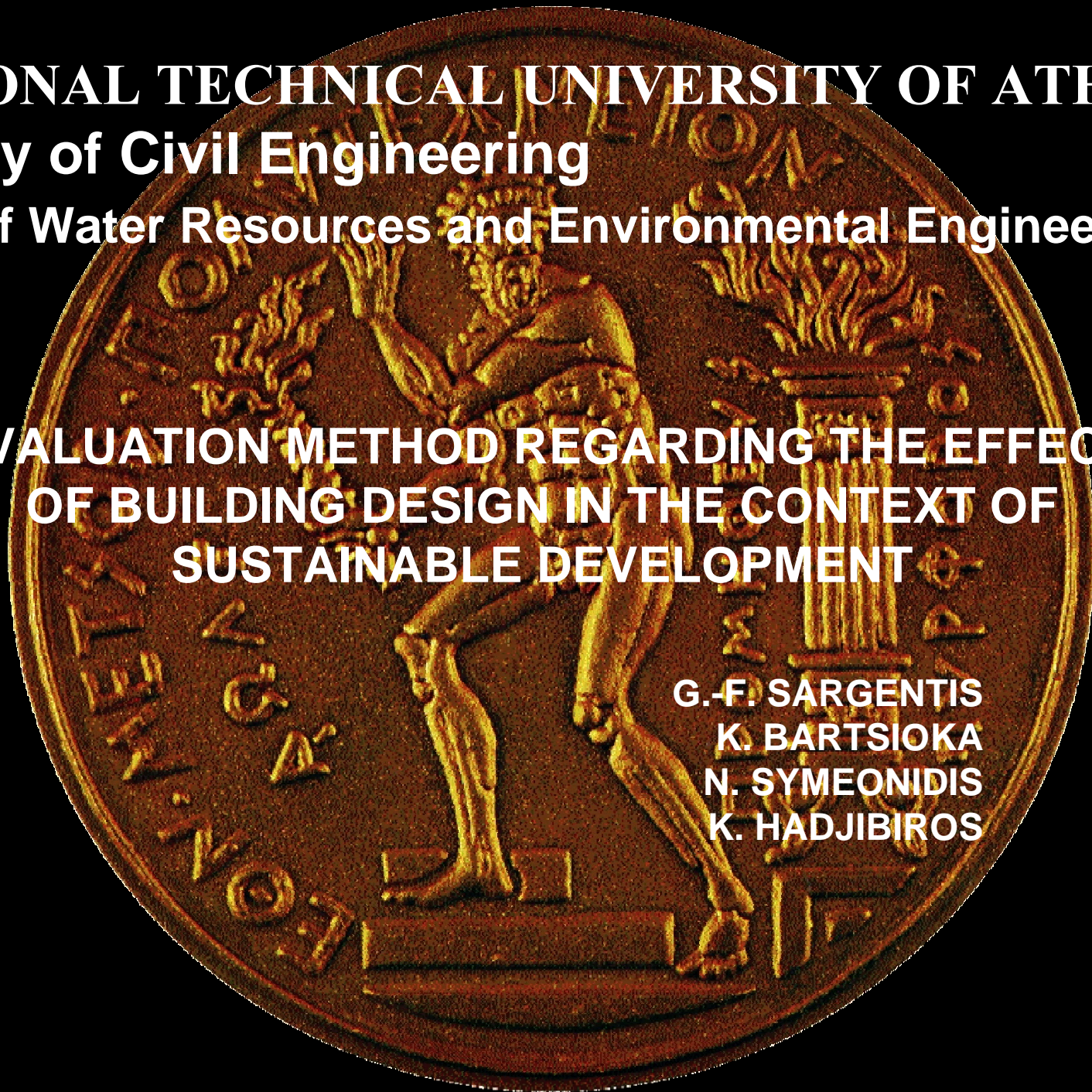**NATIONAL TECHNICAL UNIVERSITY OF ATHENS**
**Faculty of Civil Engineering**
**Dept. of Water Resources and Environmental Engineering**

**EVALUATION METHOD REGARDING THE EFFECT OF BUILDING DESIGN IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT**

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**K. BARTSIOKA**
**N. SYMEONIDIS**
**K. HADJIBIROS**

❑ **INTRODUCTION**

❑ **METHOD OF ANALYSIS**

    ❑ **Parameters**
    ❑ **Analysis and models**
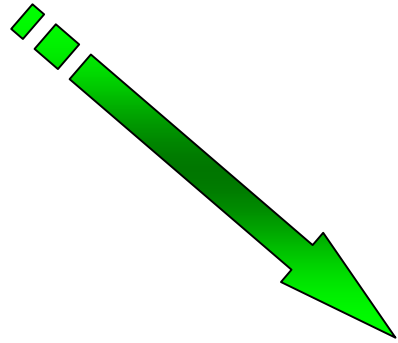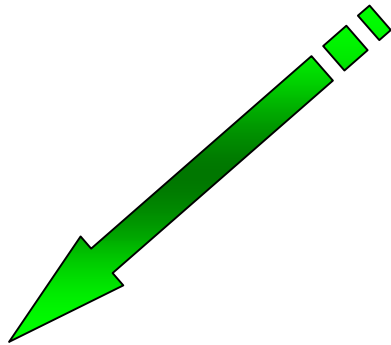    ❑ **Calculations and evaluation**

❑ **CONCLUSIONS**

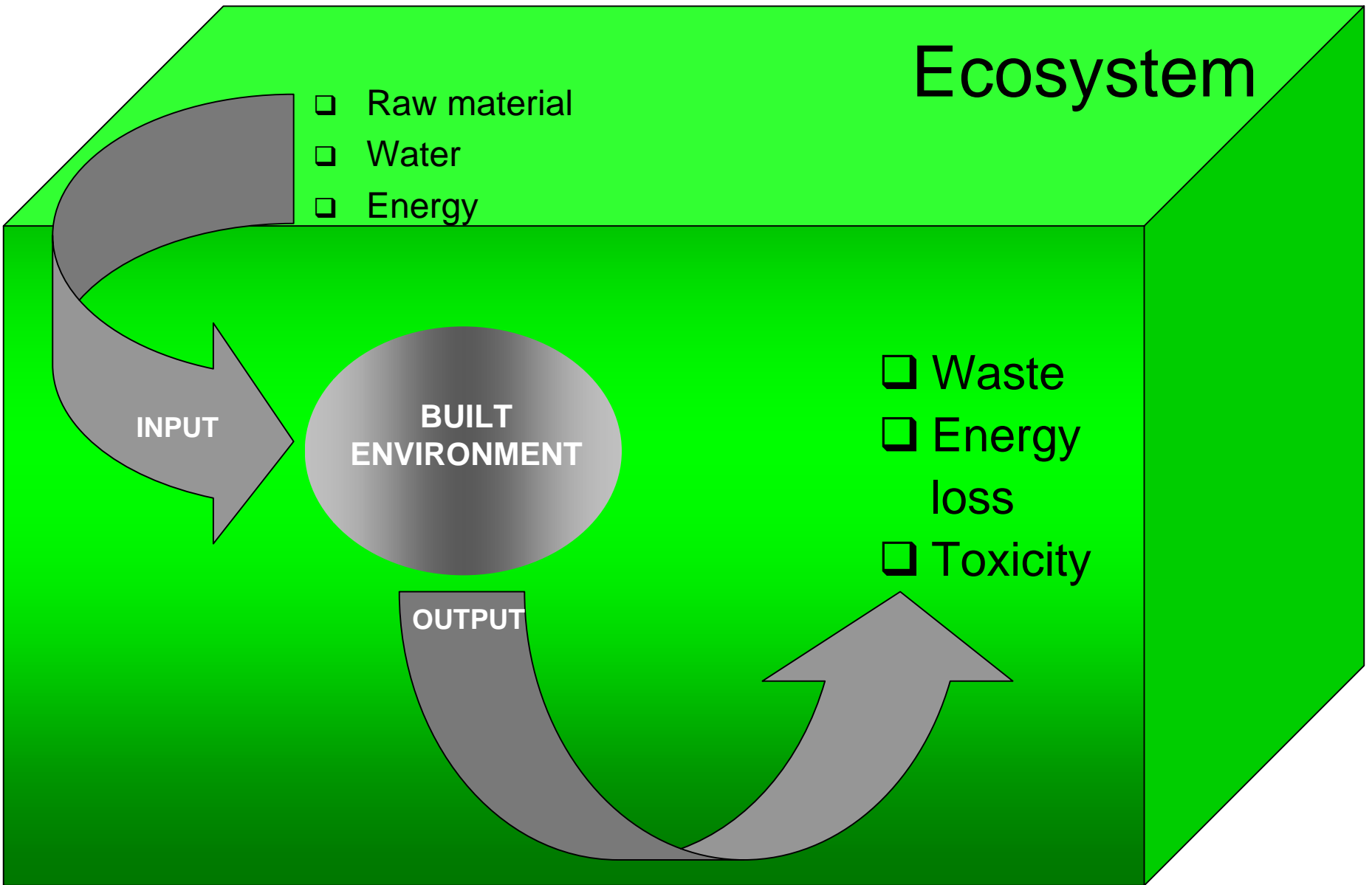# INTRODUCTION

Construction ▸▸▸ **Extremely polluting**

Technical knowledge of sustainable solutions

Sustainable and environmentally friendly technologies ▸▸▸ Positive results
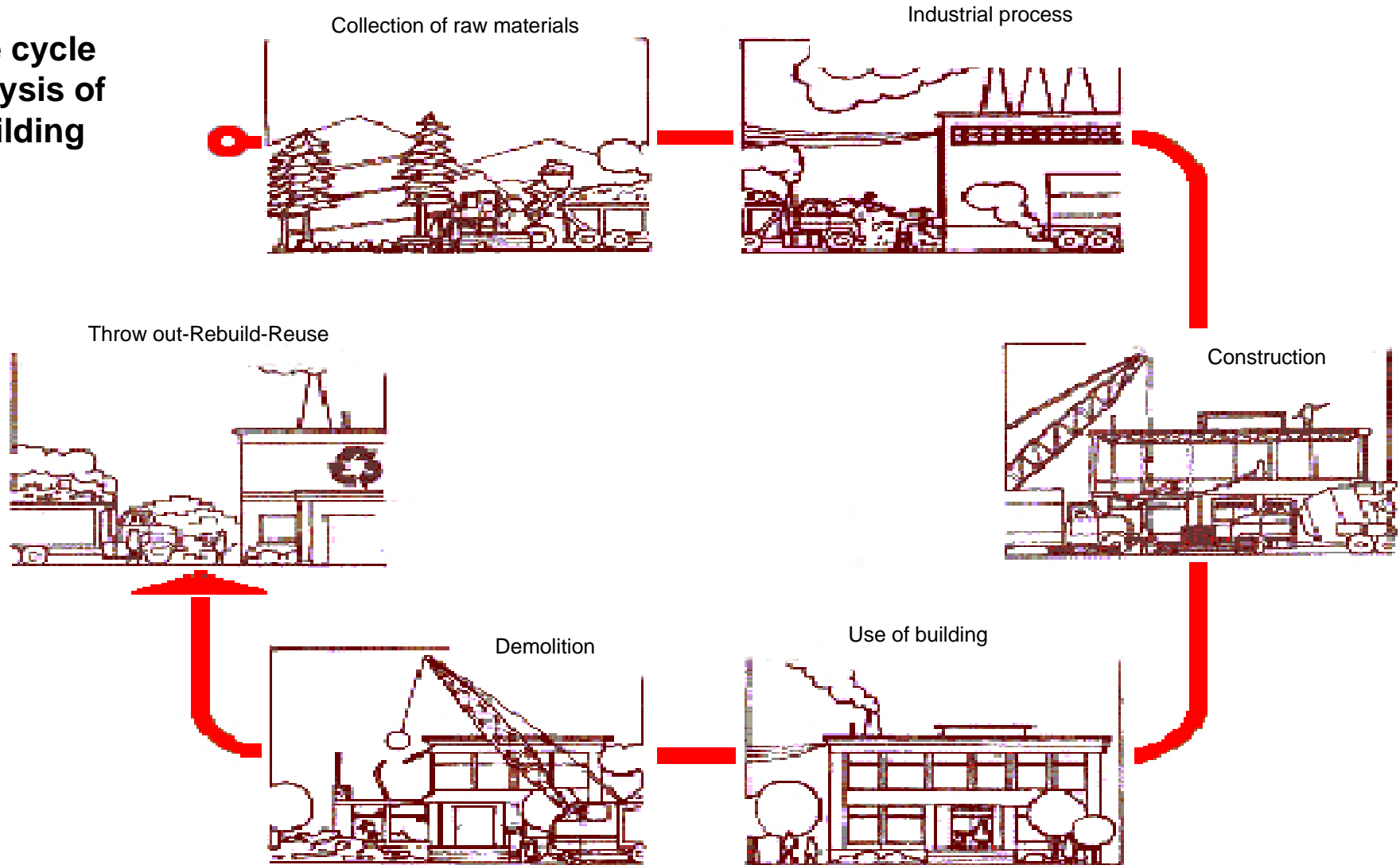
Relation between built environment and ecosystem

# Method

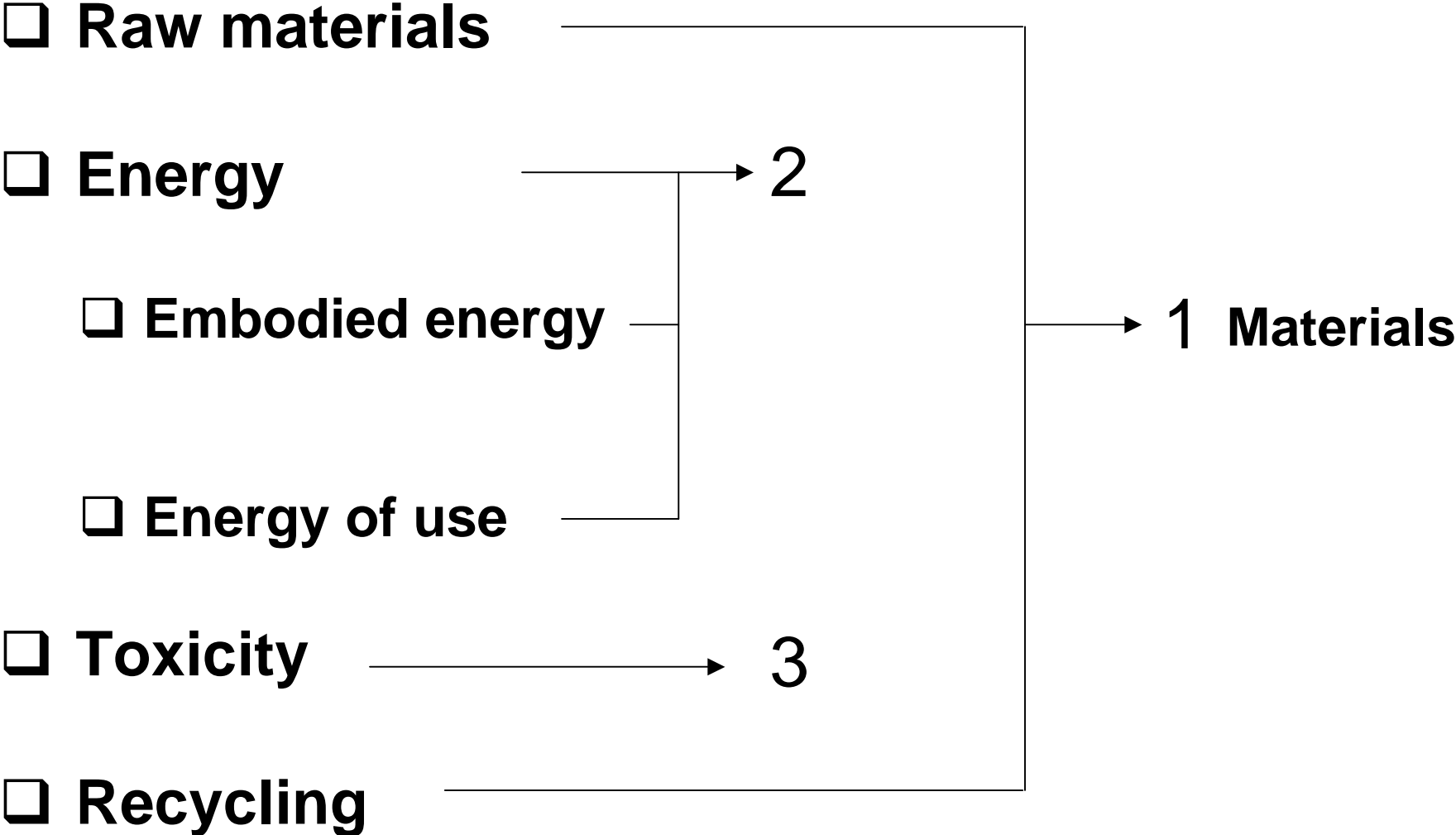→ **Evaluation of building design**

**Crucial parameters of design** → **Environmental impact**

**Life cycle analysis of building**



Collection of raw materials

Industrial process

Construction

Use of building

Demolition

Throw out-Rebuild-Reuse

# METHOD OF ANALYSIS

# Parameters

- ❑ **Raw materials**

- ❑ **Energy**

  - ❑ **Embodied energy**

  - ❑ **Energy of use**

- ❑ **Toxicity** → 3

- ❑ **Recycling**

→ 2

1 **Materials**

# Parameters

## 1. Materials

☐ **Raw materials**
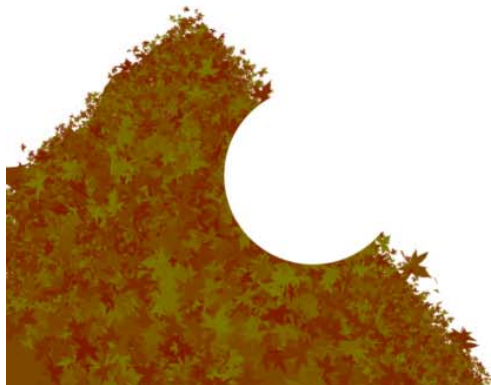
☐ **Recycled materials**
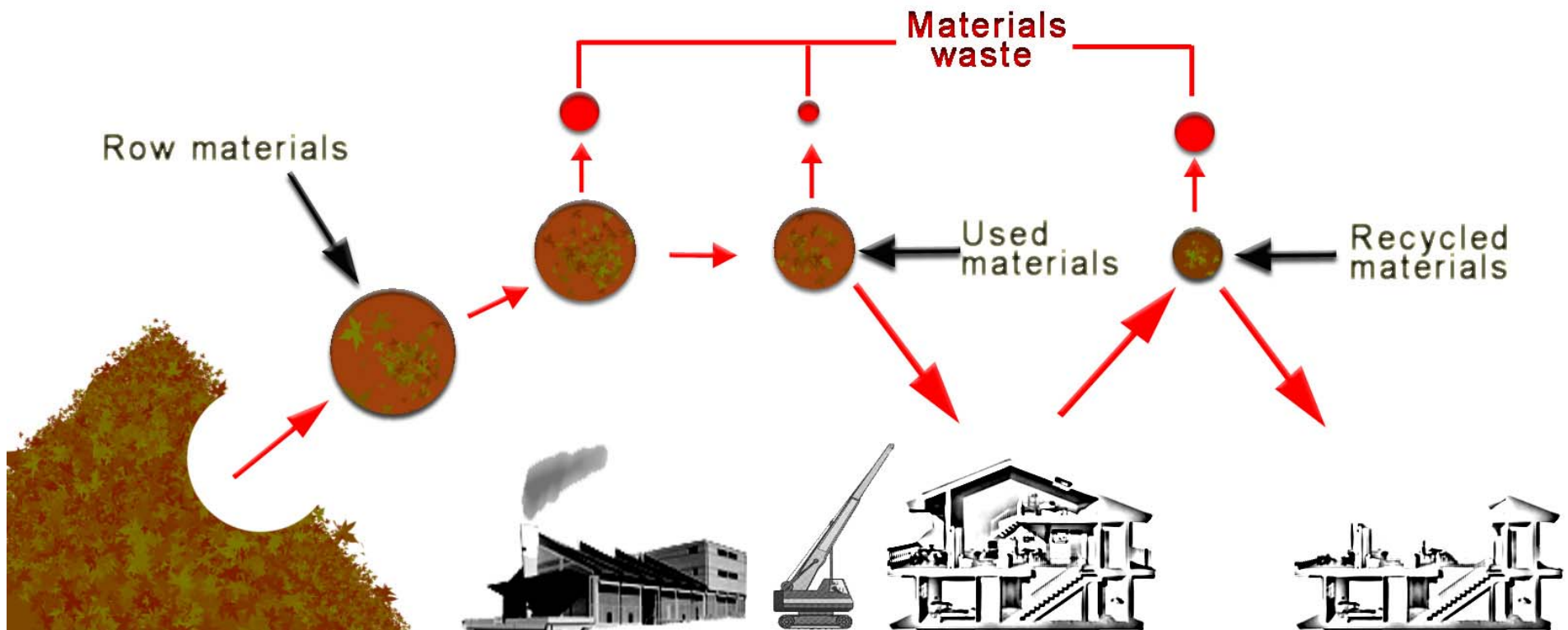
# Parameters

## 2. Energy

❑ **Embodied energy**

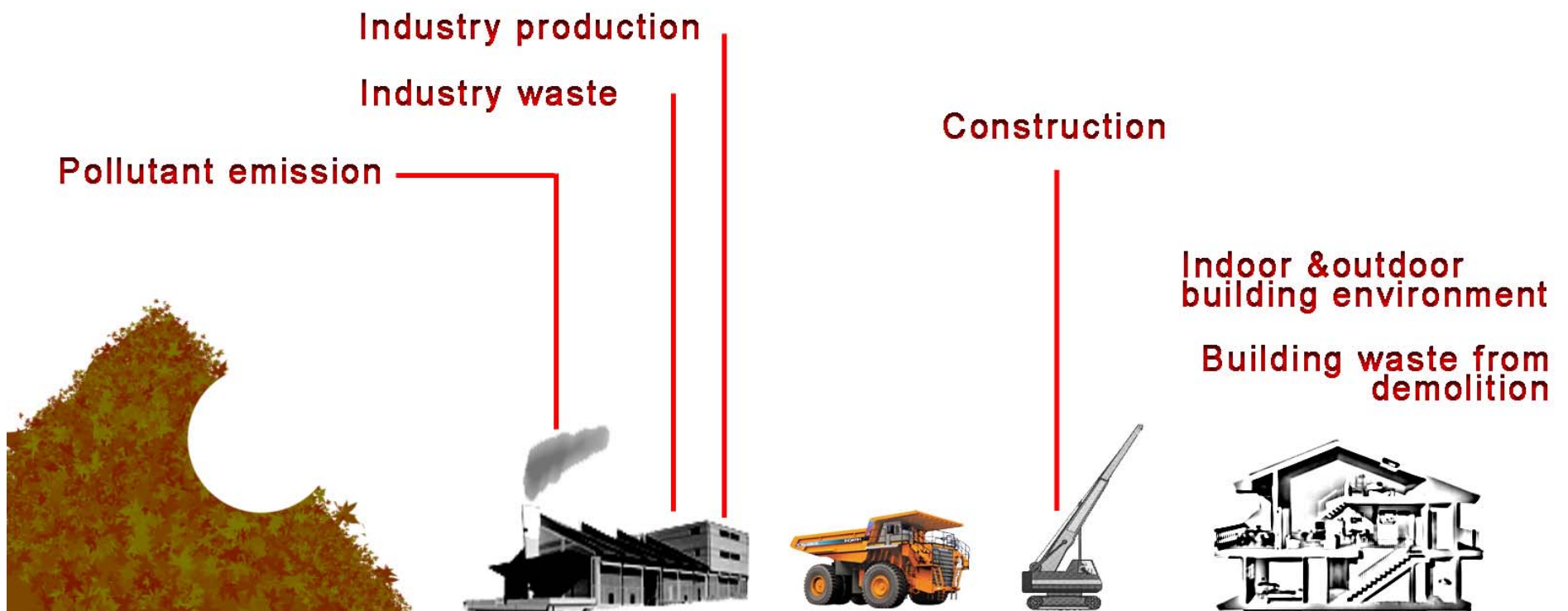❑ **Energy of use**

Embodied energy        Energy of use

# Parameters

## 3. Toxicity

**Stages to examine toxicity and pollutant emission**

# Analysis and models

Buildings of similar geometrical characteristics ground floor, 60,5m$^2$ but constructed with different techniques and materials are being compared.



Model 1. Typical contemporary construction
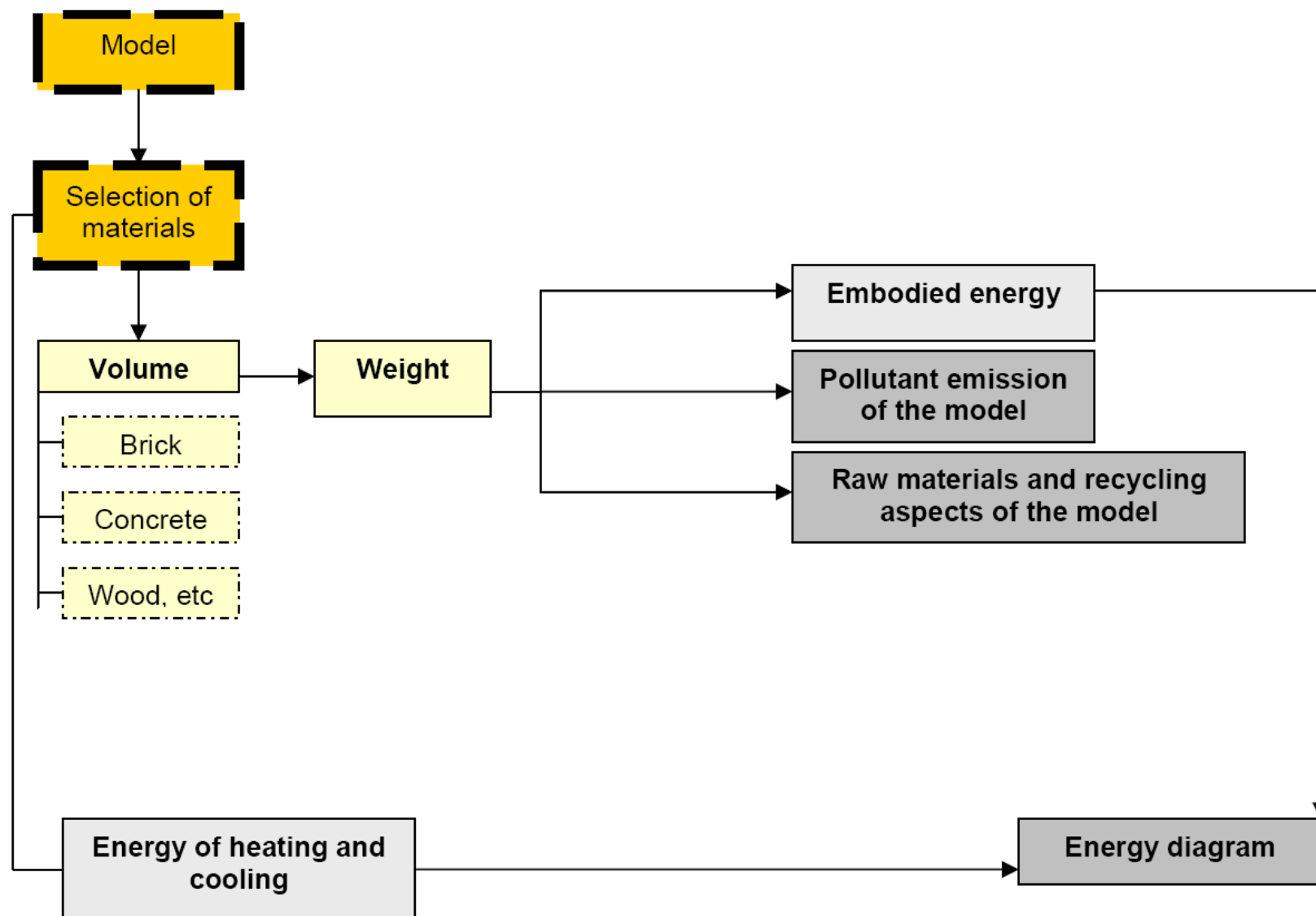


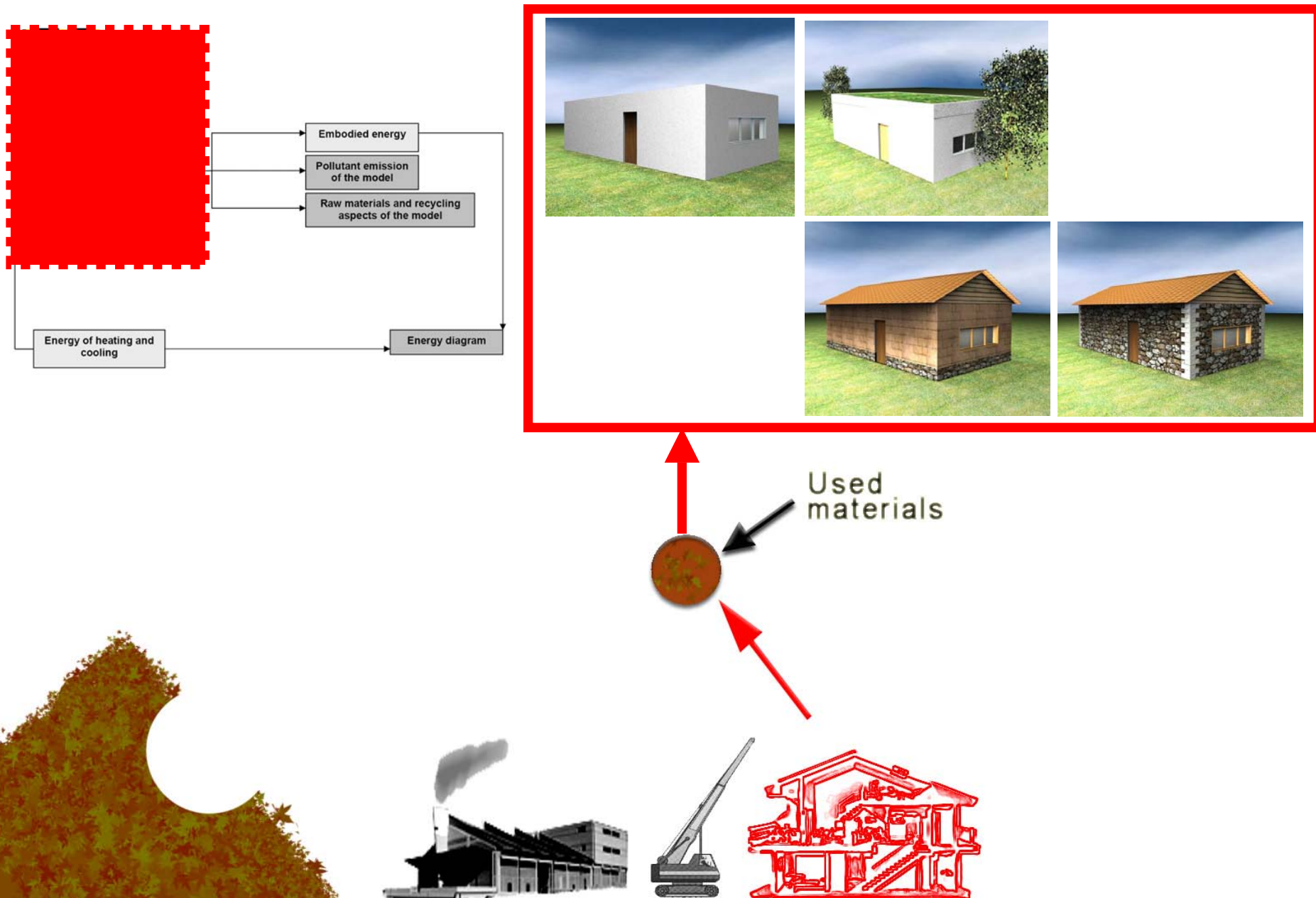Model 2. Bioclimatic construction



Model 3. Plinth construction



Model 4. Natural stone construction
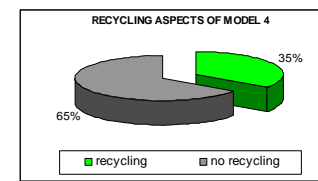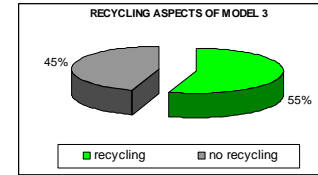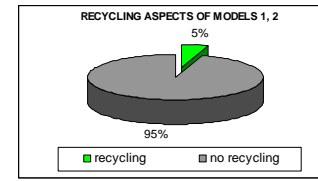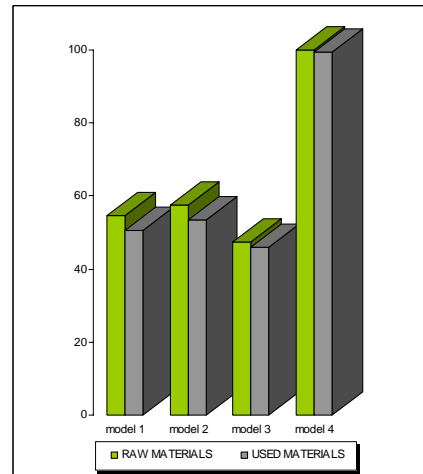
# Calculations and evaluation

# Calculations and evaluation



Embodied energy

Pollutant emission of the model

Raw materials and recycling aspects of the model

Energy of heating and cooling

Energy diagram

Used materials

# Calculations and evaluation

# Calculations and evaluation

# Calculations and evaluation

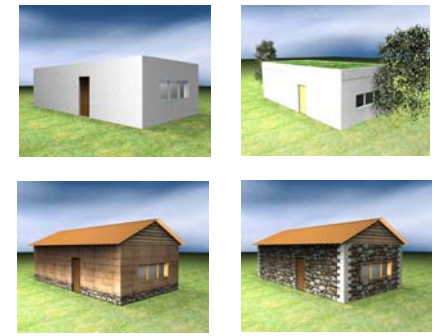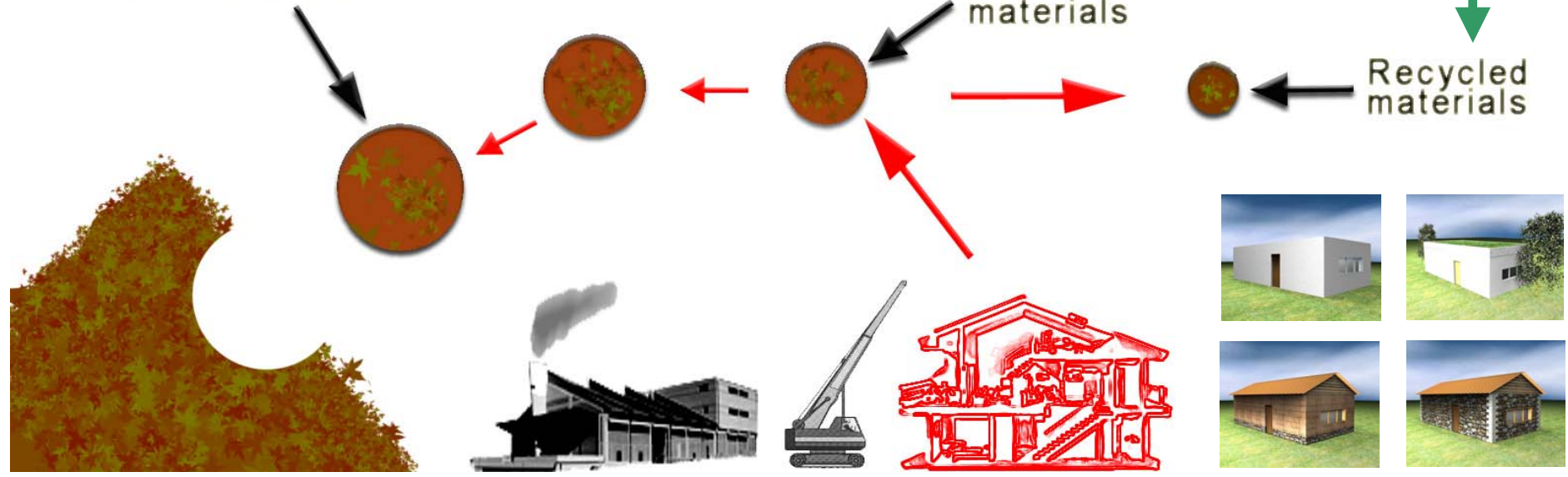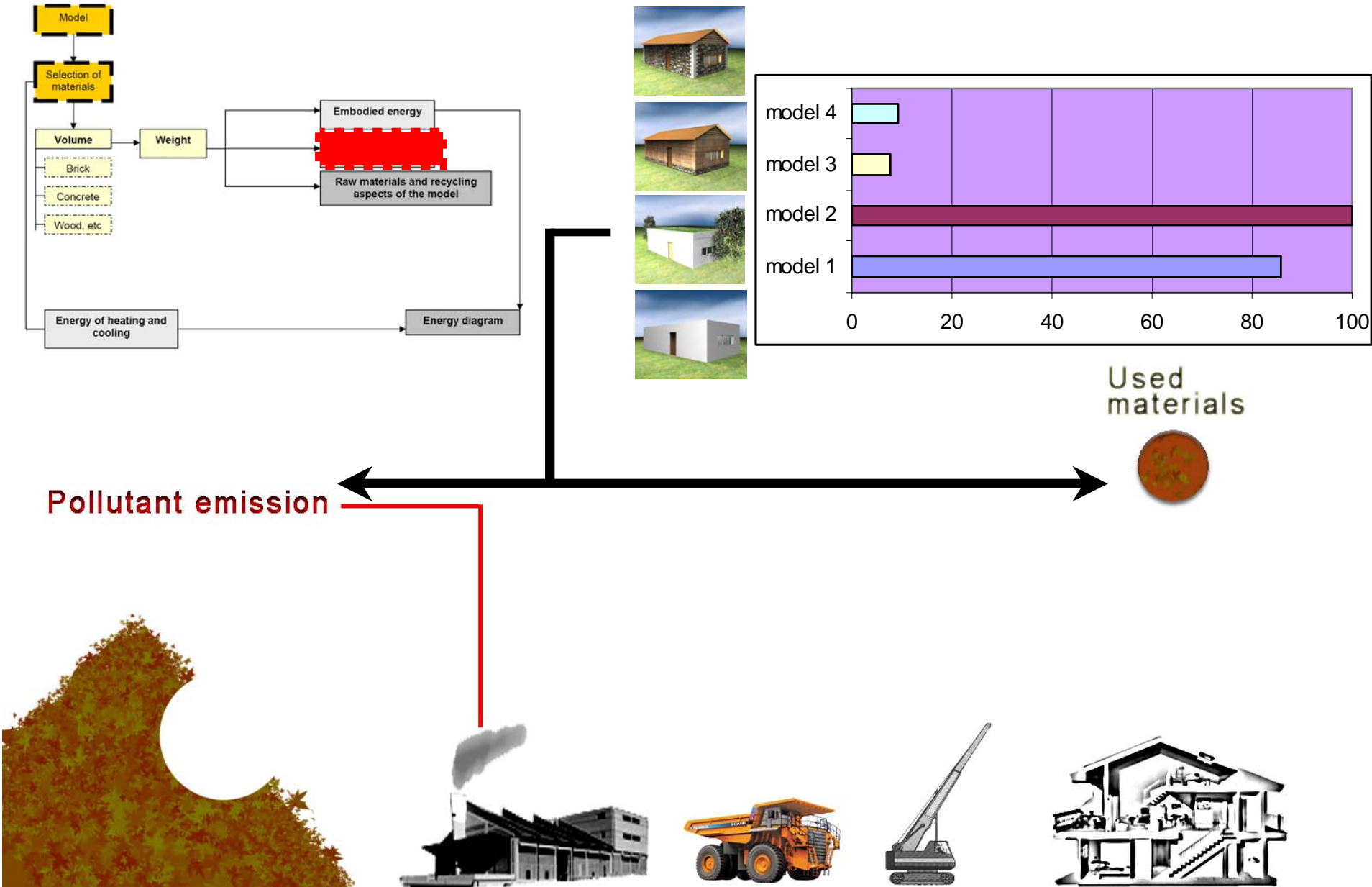Materials of bioclimatic building



Embodied energy ⟷ Used materials
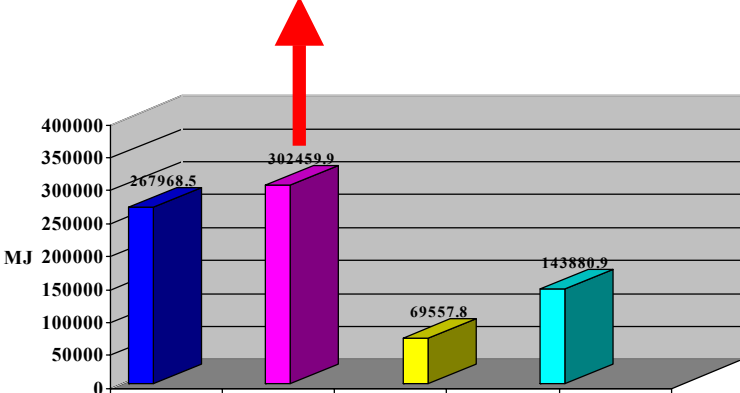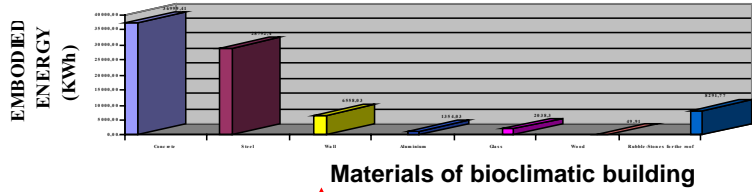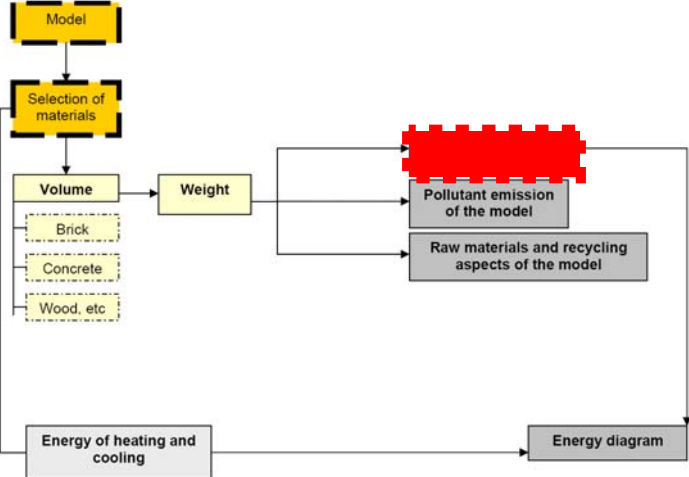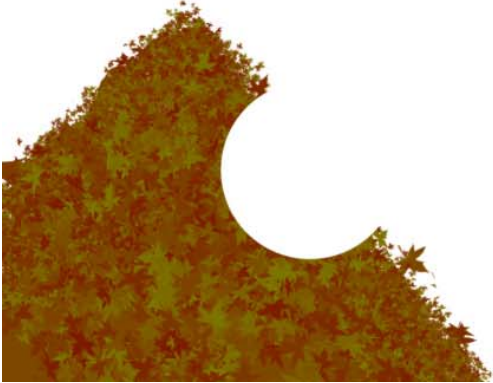
# Calculations and evaluation
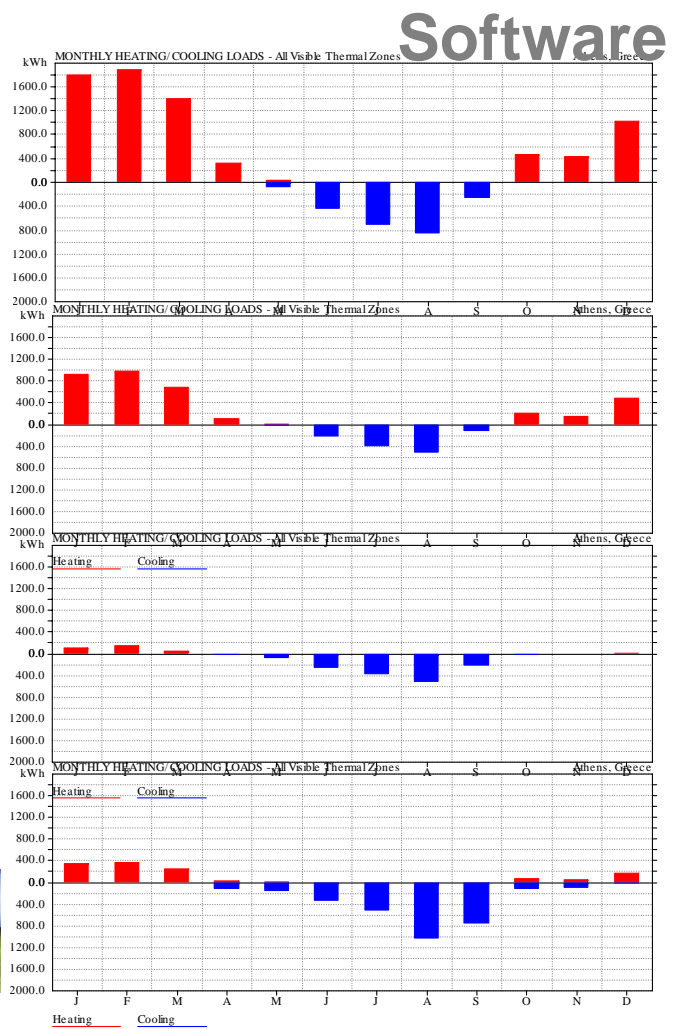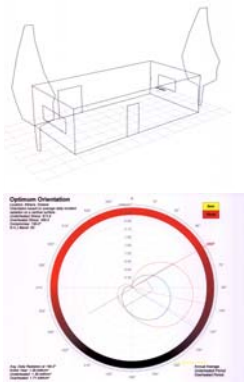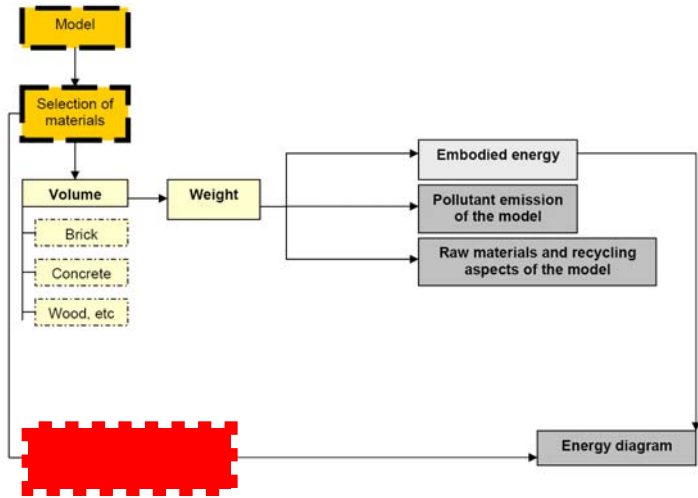
Energy of use

# Calculations and evaluation



Model

Selection of materials

Volume → Weight

Brick
Concrete
Wood, etc

Pollutant emission of the model

Raw materials and recycling aspects of the model

**Legend:**
- Typical contemporary residence
- Bioclimatic built
- Plinth construction
- Natural stone construction

ENERGY [KWh]
LIFE-CYCLE
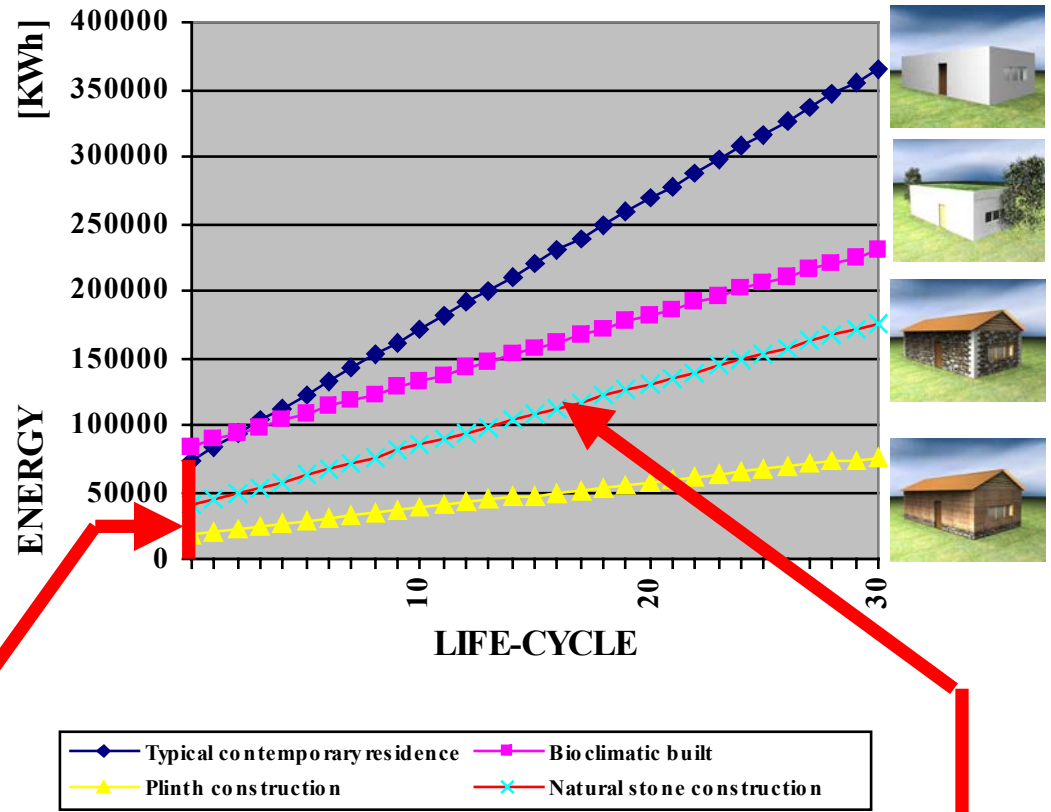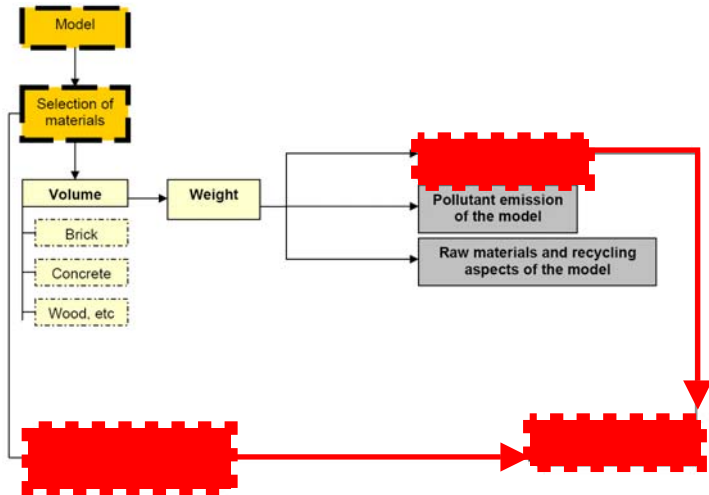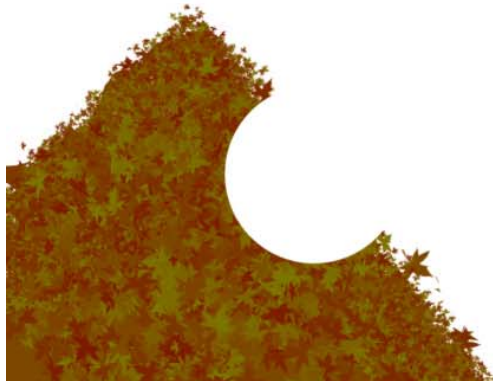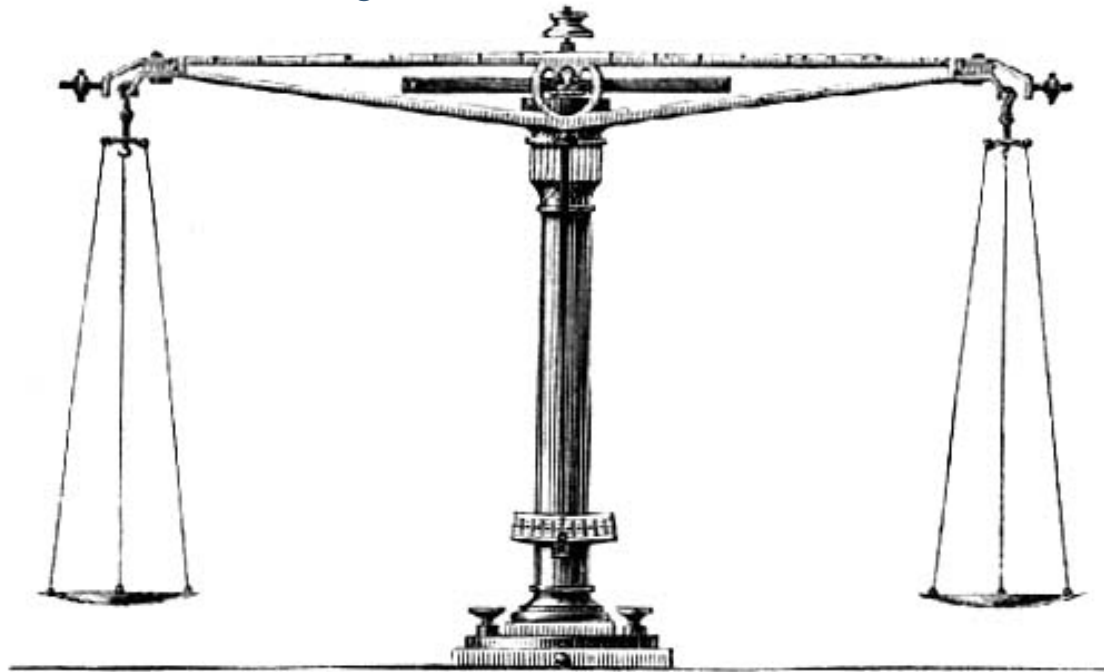
Embodied energy                    Energy of use

# Available evaluation methods

- Willingness to pay (WTP)

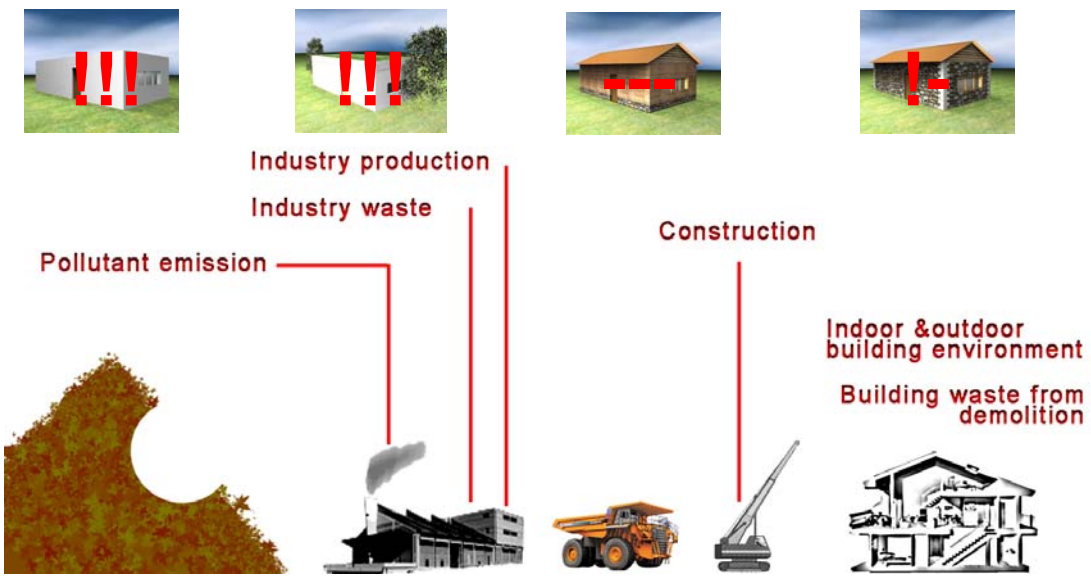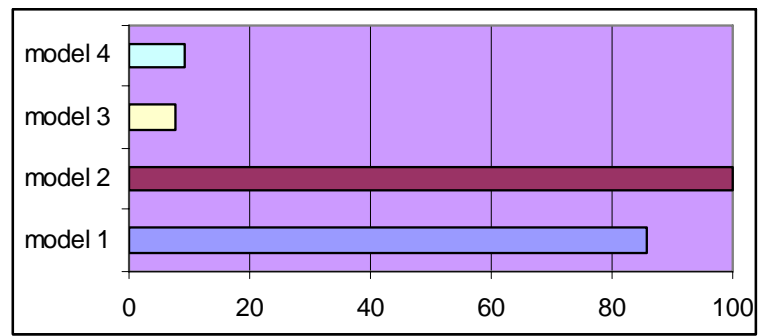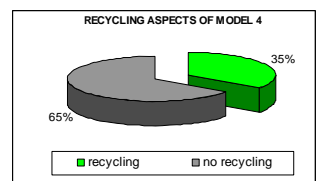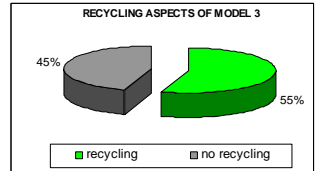- Hedonic Property Method
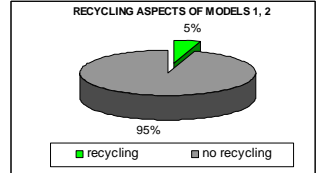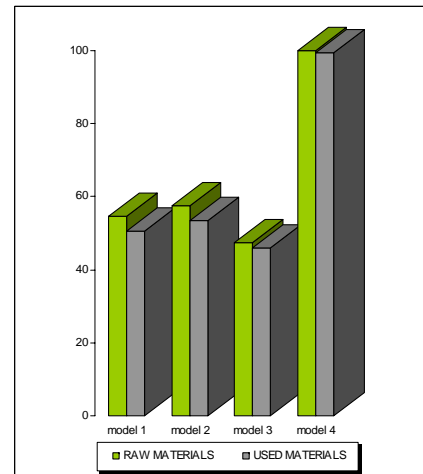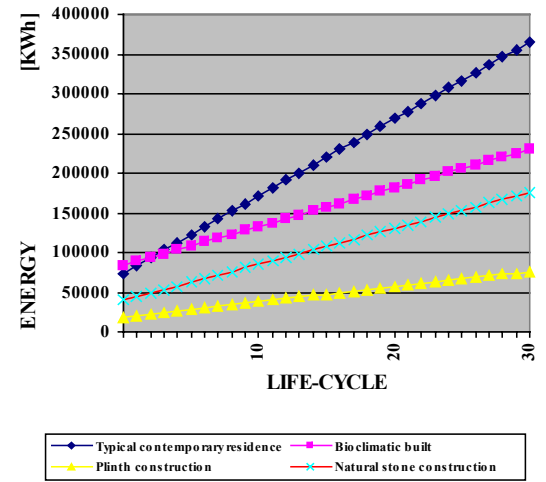
- Multi-criteria decision analysis



## Aristophanes

Until we'll found the precision balance of criteria, it is useless to speak about objective approach

# Evaluation

## Multicriterion tableau for deciding the optimum construction



Model 1
Model 2
Model 3
Model 4

Energy evaluation diagram of models

Raw materials and recycling aspects of the model Evaluation table

Pollutant emission of the model Evaluation table

Quality aspects of toxicity in the life time of the constructions

Analysis-Results

Pollutant emission

Industry production
Industry waste

Construction

Indoor &outdoor building environment

Building waste from demolition



Typical contemporary residence — Bioclimatic built
Plinth construction — Natural stone construction

RECYCLING ASPECTS OF MODELS 1, 2
5%
95%
recycling    no recycling

RECYCLING ASPECTS OF MODEL 3
45%    55%
recycling    no recycling

RECYCLING ASPECTS OF MODEL 4
35%
65%
recycling    no recycling

RAW MATERIALS    USED MATERIALS

# CONCLUSIONS

# CONCLUSIONS

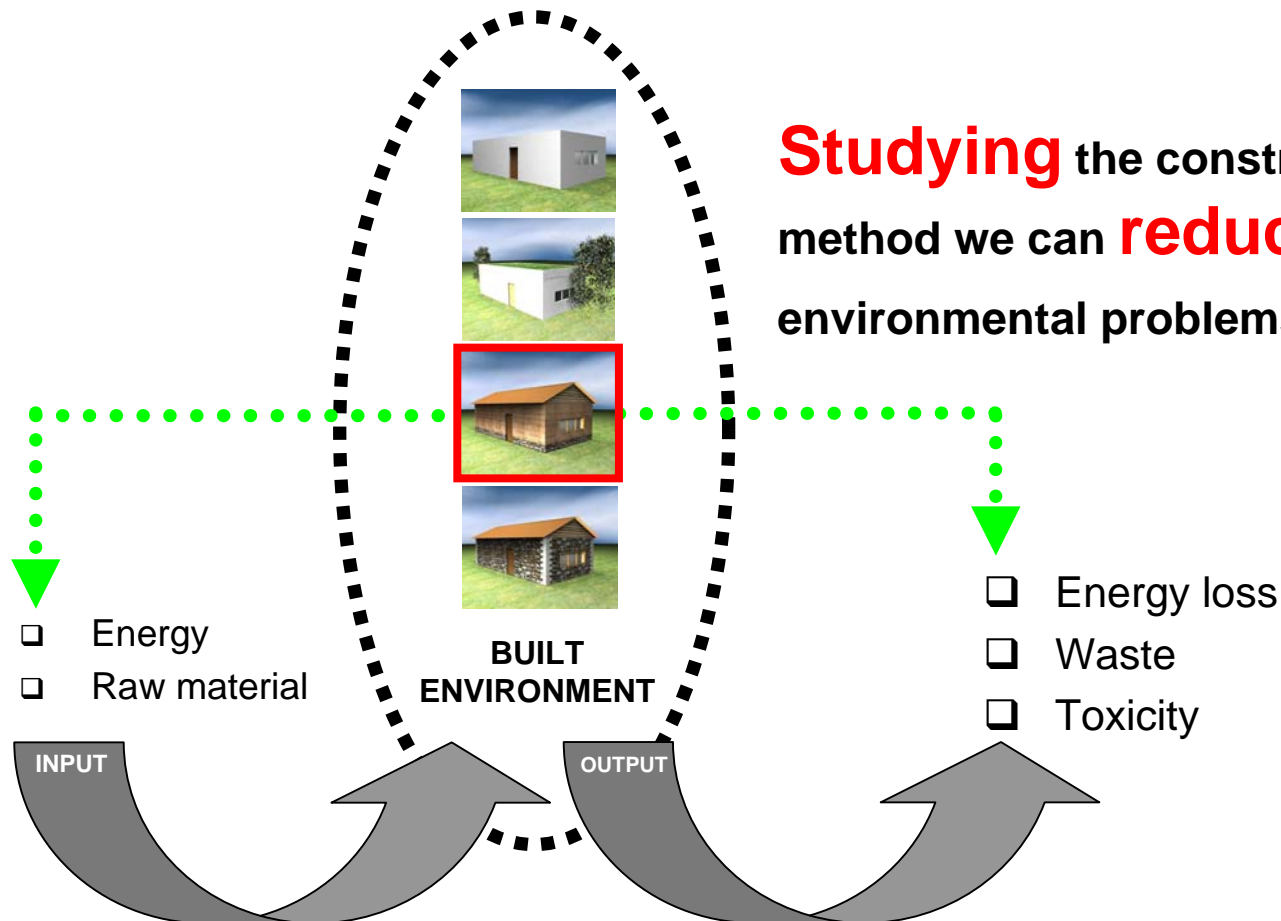**EVALUATION METHOD REGARDING THE EFFECT OF BUILDING DESIGN IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT**

Useful
Easy
**INDICATOR**

Evaluates with parameters of sustainability the technical solutions

**Studying** the construction with this method we can **reduce** the main environmental problems of **construction**



INPUT

- Energy
- Raw material

**BUILT ENVIRONMENT**

OUTPUT

- Energy loss
- Waste
- Toxicity