

# **IGUESS – AN INTEGRATED GEOSPATIAL URBAN DECISION SUPPORT SYSTEM FOR SMART CITY ENERGY PLANNING**

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The World on a map – Umweltkadastro fir Gemengen – March 12, 2015

LUXEMBOURG  
INSTITUTE  
OF SCIENCE  
AND TECHNOLOGY



# Outline

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- 1 The MUSIC project
  - Overview
  - Objectives
- 2 iGUESS
  - Objectives
  - Framework
  - Web interface
- 3 The DEADALUS Project
- 4 iGUESS for Tangible Tables
- 5 Conclusions

# Let's start with the MUSIC Project



# MUSIC

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**M**itigation of CO<sub>2</sub> Emissions in **U**rban  
Areas: **S**olutions for **I**nnovative **C**ities



**A partnership of European cities and research institutes that takes the lead in innovative CO<sub>2</sub> reduction!**

## The MUSIC Project

- ▶ **is** an INTERREG IVB NWE project of 5 European cities (Rotterdam, Ghent, Aberdeen, Montreuil, Ludwigsburg) supported by 2 research institutes (DRIFT & LIST);
- ▶ **aims** at reducing CO<sub>2</sub> emissions in urban areas by 2030 and beyond;
- ▶ **involves** urban stakeholders starting with frontrunners;
- ▶ **adds** energy as a geospatial layer to urban planning;
- ▶ **develops** innovative strategies for sustainable planning.

# MUSIC is about creating opportunities

- ▶ Prepare for energy transition;
- ▶ Look for business opportunities;
- ▶ Reduce socio-economic and health impacts, e.g. energy poverty; urban heat island effects.
- ▶ Create a sustainable city with high quality of life;
- ▶ Explore and develop the city together.

# MUSIC explores questions

- ▶ How to create a common understanding of problems and potentials for change?
- ▶ How to mobilise different types of actors and renewable energy potentials to work towards a sustainable future?
- ▶ How to get support within your organisation for an innovative approach to reduce CO<sub>2</sub> emissions?
- ▶ How to use decision support tools for a participatory planning process?
- ▶ How to estimate and localise renewable energy potentials to develop adequate policies and business opportunities?

# What are the objectives of MUSIC?

- ① **Institutional innovations:** carbon reductive /energy governance with **stakeholder based vision** via transition management.
- ② **Technical innovations:** Geospatial Urban Energy **information and decision Support** System (iGUESS) for scenario analysis and decision support across different scales.
- ③ **Learning** from **pilot projects** by using implementation and assessment using transition management and iGUESS.

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# Let's look into iGUESS

# iGUESS

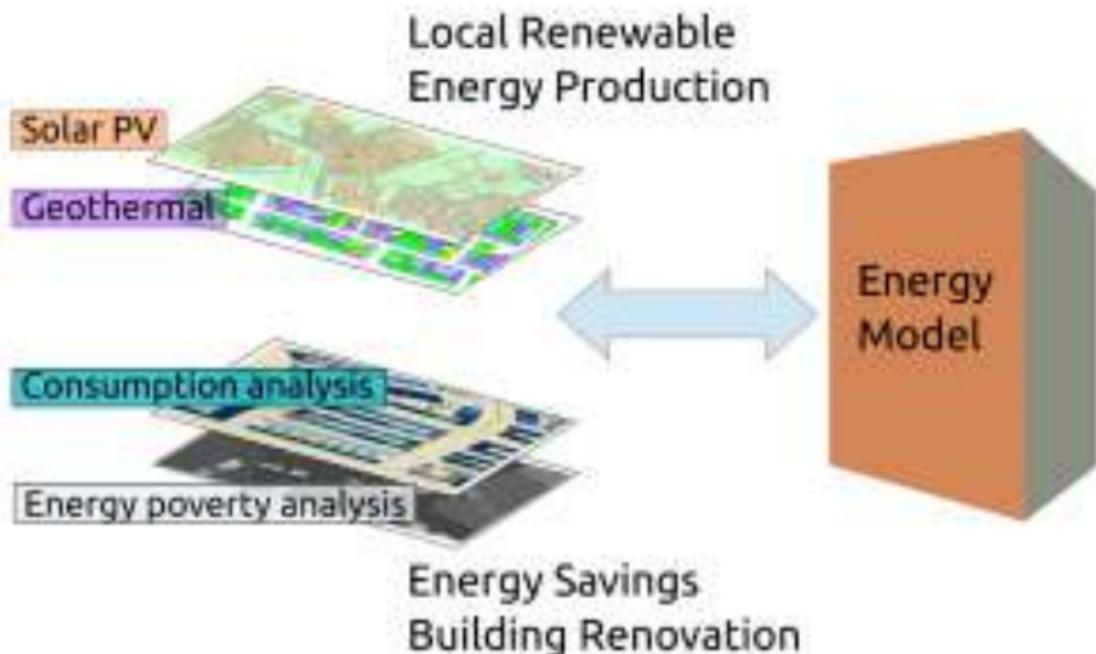
—

An **i**ntegrated **G**eospatial **U**rban **E**nergy  
information and decision **S**upport **S**ystem

iGUESS – a decision support system which provides:

- ▶ **smart tools** to explore opportunities across different scales;
- ▶ a **simple interface** to complex, distributed information for sustainable urban development;
- ▶ an **open source platform** assuring interoperability and improved interaction with stakeholders.

# iGUESS – A modular framework



# The iGUESS Start Page



The screenshot shows the iGUESS web application interface. At the top is a green header with the 'tudor' logo on the left and 'iGUESS' in large white letters in the center. Below 'iGUESS' is the tagline 'Integrated Geospatial Urban Energy Information and Support System'. On the right side of the header are two small icons: one with a green leaf and the word 'CO2', and another with a blue 'E' and a green leaf. Below the header is a navigation bar with links for 'Home', 'Access', 'Registration', 'Maps', and 'About'. The main content area features the text 'understand your options...' and 'plan your future.' in a light blue font. Below this is a large white box with a light blue border. On the left side of this box is a vertical sidebar with three buttons: 'View Some Data', 'Run Calculation Module', and 'Check Running Module'. The main part of the box contains the heading 'View your data or register new datasets' followed by the text 'iGUESS can show you any registered dataset on an interactive map of your city.' Below this text are three links: 'Explore maps of my city', 'See my datasets', and 'Register new data'. A large, light blue plus sign icon is positioned to the left of these links. At the bottom of the page is a colorful silhouette of a city skyline.

tudor

iGUESS  
Integrated Geospatial Urban Energy Information and Support System

Home Access Registration Maps About

understand your options...  
plan your future.

View Some Data

Run Calculation Module

Check Running Module

View your data or register new datasets

iGUESS can show you any registered dataset on an interactive map of your city.

Explore maps of my city  
See my datasets  
Register new data

# The iGUESS Data manager



**Registered Datasets**

Home | Data Manager | Databases | General | Help | About

Name	Type	Registered	Platform	Usage	Notes
PI - local (massive) data (1)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (2)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (3)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (4)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (5)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (6)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (7)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (8)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (9)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (10)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (11)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (12)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (13)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (14)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (15)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (16)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (17)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (18)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (19)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client
PI - local (massive) data (20)	History	2014-06-10	Python	Desktop	A mapping service generated with the GUESS RFP Client

# Retrieve information on data set



The screenshot displays the iGUESS web application interface. At the top, the Tudor logo and the iGUESS title are visible. The main content area is titled "PV potential (multi) (kWh/a)" and shows a summary for a site named "Wind-Service-Dome with data set of 17000 sites". The summary includes details such as the data version (2013-01-01), mapping type (2D Mapping), processing type (2D Mapping), data acquisition (November 11, 2010), and staff (140 users). A table on the right lists the data sets, with columns for "Published", "Status", and "Name". The table contains several rows of data, each representing a different data set for the site.

Published	Status	Name
Public	Available	2D Mapping service generated with the iGUESS 2D Mapping Tool
Public	Available	2D Mapping service generated with the iGUESS 2D Mapping Tool
Public	Available	2D Mapping service generated with the iGUESS 2D Mapping Tool
Public	Available	Wind-Service-Dome with data set of 17000 sites
Public	Available	Wind-Service-Dome with data set of 17000 sites
Public	Available	Wind-Service-Dome with data set of 17000 sites
Public	Available	Wind-Service-Dome with data set of 17000 sites
Public	Available	Wind-Service-Dome with data set of 17000 sites
Public	Available	Wind-Service-Dome with data set of 17000 sites
Public	Available	Wind-Service-Dome with data set of 17000 sites

# Register new Data Sets in iGUESS



**Register Datasets**

18\_Thermobios  
18\_Thermobios

CIP Inventory  
CIP Inventory



# Linking in a Calculator across the Web



**tudor** **iGUESS**  
Integrated Geospatial Urban Energy Information and Support System

Home Site Overview Modules Services Maps About | Sign In or Create Account | Search | Home | **Register**

## Register WPS Server

Example: <http://geps.iguess.tudor.edu/cgi-bin/pywps.cgi>

Select a preset

[Get More Presets](#)

**Server: MUSIC PyWPS Server**

This is the WPS Server of the MUSIC project. It is powered by PyWPS. See <http://www.musrc.tudor.edu/> and <http://www.iguessportal.org/wordpress/ignp/>

Owner: GEP Terry Tudor

- Solar irradiation
- PV Potential with user based input
- Aggregation service with support for slider tool
- Urban Heat Island characterization
- Green roofs
- Geographical website
- Building stock energy consumption and savings
- Building stock energy savings



# Registering the new Remote Calculator

Model (2017-08-01 10:00)

State Evaluation  
 Fit Physical with your model input  
 Aggregation linking with support for state fact  
 Group/Model input transformation  
 Direct built

The model registers two (or more) data sets for different types of geospatial instances.

### Model Input

Parameter Name	Identifier	Description
Leaf position with variable area for green roof installation	[roof_pos]([area])	A raster dataset which indicates the suitable roof positions for a geospatial installation. The field is an output of the raster calculator function of iGUSS.
Maximum roof slope where green roof can be built	[roof_slo]([slope])	Maximum slope angle of the roof where a green roof can be installed. The default is set to 10 degrees (which is usually a threshold where geospatial data can be registered to be built. Above 10 degrees measures to prevent geospatial relation measurement and measurement to be built.

### Model Outputs

Parameter Name	Identifier	Description
Calculation of possible green roof installations	[green_mats]([mats])	Presence location of green roof installations; all patches with higher than the green_mats_slope are considered to be possible. According to different vertical coefficient to the very important because of not consider land water areas. If a building is to build a type of installation should be possible where people could grow food, improve air quality, green roofs can be built on the roof surface of view of the roof patch is not higher than roof_slope.

Do not register  
 Building used energy consumption and savings  
 Data set name and location

[https://lists.its.lest.ac.uk/pipermail/2017\\_08/000001.html](https://lists.its.lest.ac.uk/pipermail/2017_08/000001.html)

# Renewable Calculator – Solar irradiation

Name: 
Advanced Solar PV Calculator

Based on: Solar irradiation

Details: This physics calculator (the rule of yearly irradiation in Germany) as a web tool, taking into account local time and other factors. The calculator uses the solar (PV) irradiation as a standard function to the PV (Photovoltaic) Technology of a solar energy module using a spreadsheet application.

Web:

Area of interest:

Input	Parameter Name	Parameter Tag	Selected Element or Value
Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>
	Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>
Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>
	Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>
Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>
	Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>
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Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>
	Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>
Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>
	Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	<input type="text" value="2.000 kWh/m²/a"/>

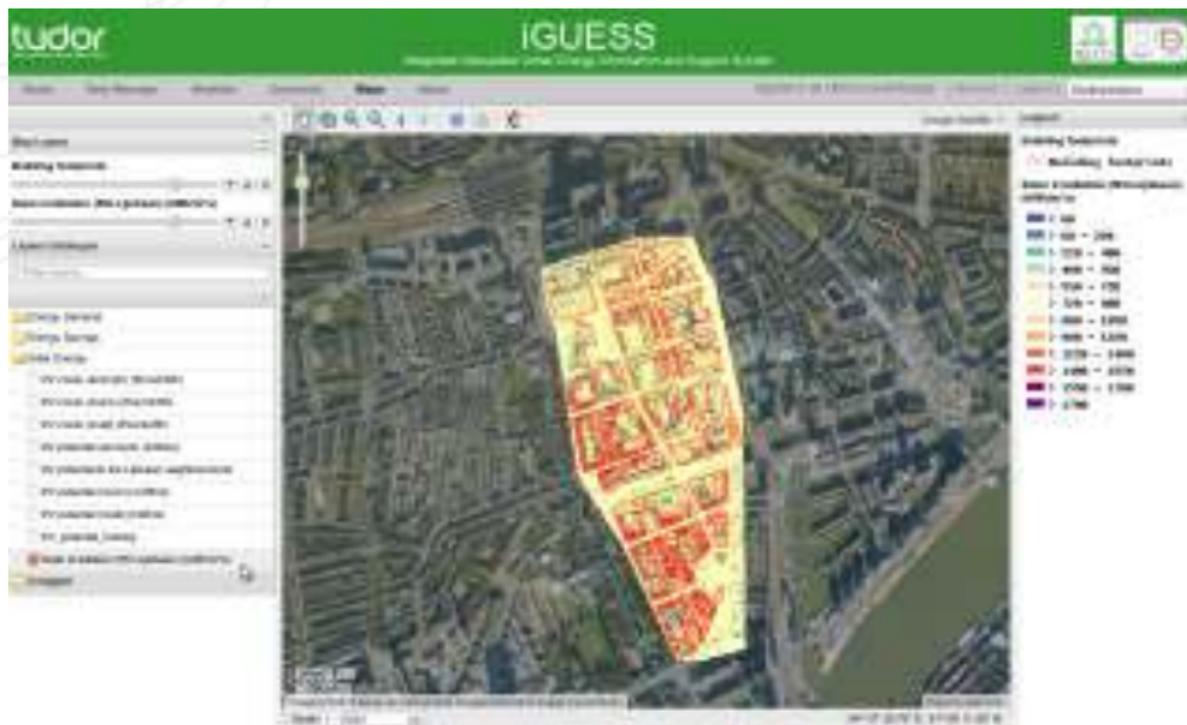
  

Output	Parameter Name	Output Element Identifier
Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	Global solar radiation (GHI)
	Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation (GHI)
Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation	Global solar radiation (GHI)
	Global solar radiation (Global Horizontal Irradiation) It is the sum of direct and diffuse radiation. <a href="#">Help</a>	Global solar radiation (GHI)

[Return To Home](#)



# Exploring Solar Energy Potentials



# Zoom-in Solar Potential at building level



# PV Electricity Production Potential



# Looking at Geothermal Potential within the City





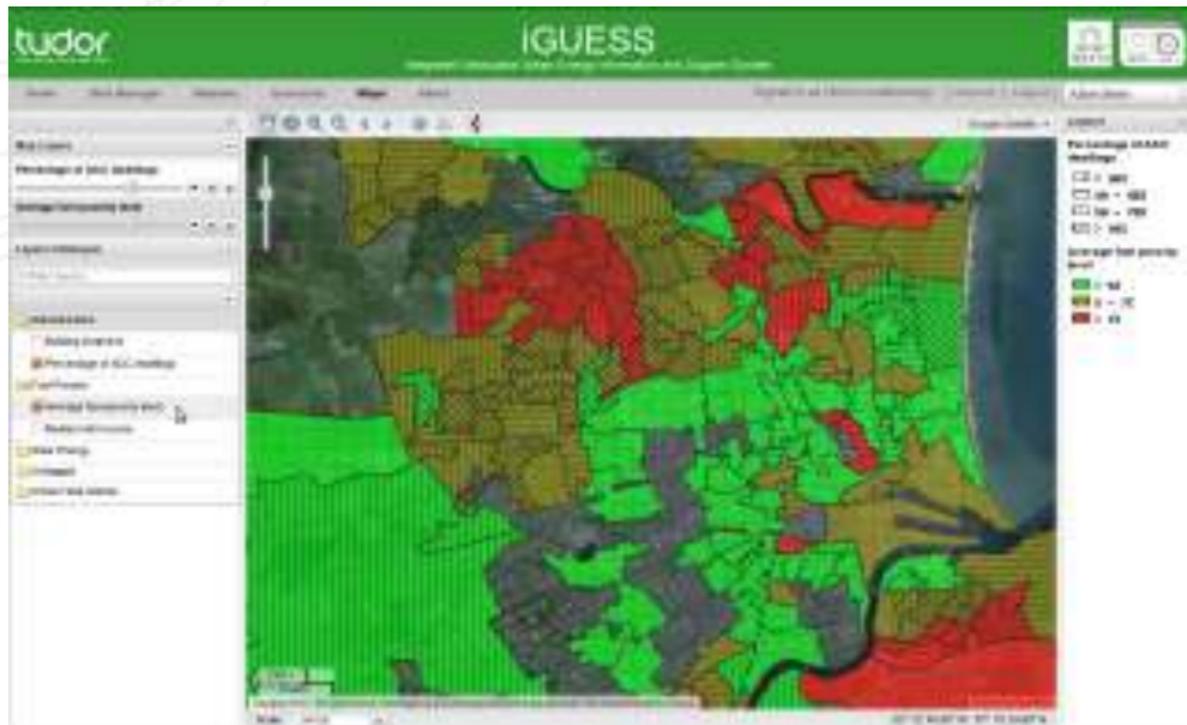
# Exploring Energy Saving Potentials



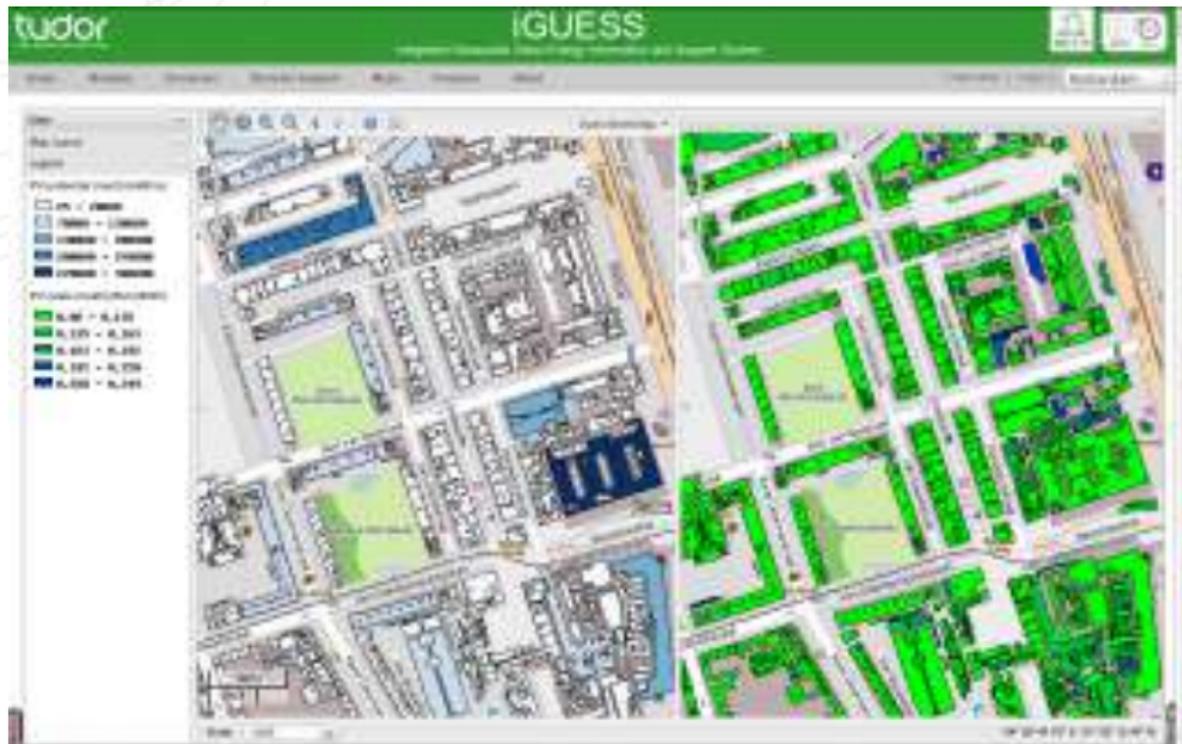
# Looking at Retrofit Investment Costs



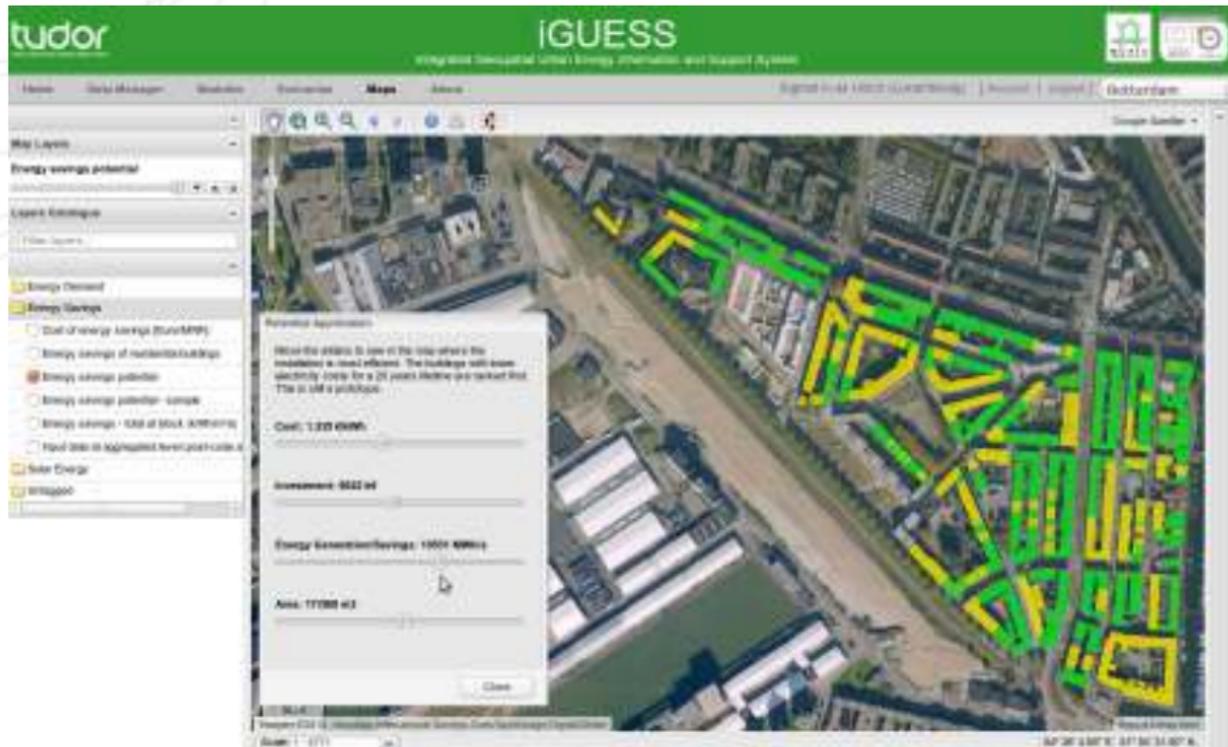
# Explore Energy Poverty across the City



# Comparing potentials to associated costs



# Planning neighbourhoods



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iGUESS

Energy-based simulation of urban Energy Performance and Storage Systems

Home Data Management Simulation Maps About

Sign in (4) (Logout) (Settings) (Profile) (Help) (Get started)

Map Layers

Energy savings potential

Energy savings

Energy savings potential

Energy savings potential - average

Energy savings - GAS of B20K kWh/yr

Fixed costs in kWh/m2 floor area per year

Solar Energy

Batteries

Parameter Approximation

How the values to use in the tool where the conditions are most relevant. The tool will save exactly only for a 20 years future you cannot find the 100% prediction.

Cost: 1.220 kWh/m2

Investment: 6522 M

Energy Generation/Savings: 1000 kWh/m2

Area: 17700 m2

Close

Scale: 1 : 1711

54°26' 5.67" N, 1°17' 51.34" E

# Develop CO<sub>2</sub> Scenarios

**Energie Klimaschätz in der Schule**

Name der Schule:   
 Schuljahr:   
 Schulort (Land):   
 Schulart:  [Schularten](#)  
 Land, in dem Sie leben:  [Länder](#)  
 Schulniveau:  [Schulniveaus](#)

Region	Wachstum Wachstums- stufen	Effizienz Energie	Netto- Emissionen
Österreich	0.2	0.2	0.8
Deutschland	0.1	0.2	0.8
Frankreich	0.1	0.2	0.8
Italien	0.1	0.2	0.8
Spanien	0.1	0.2	0.8
Polen	0.1	0.2	0.8
Ungarn	0.1	0.2	0.8
Slowakei	0.1	0.2	0.8
Tschechien	0.1	0.2	0.8
Estland	0.1	0.2	0.8
Litauen	0.1	0.2	0.8
Letland	0.1	0.2	0.8

**Energy Production (%)**

Region	Coal	Oil	Gas	Nuclear	Hydro	Wind	Solar	Bioenergy	Geothermal	Other	Renewable	Hydrogen	Other	Other	Other	Other	Other	Other
Österreich	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deutschland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Frankreich	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Italien	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spanien	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ungarn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slowakei	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tschechien	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Litauen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Letland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

# Develop CO<sub>2</sub> Scenarios

## Energy Production (%)

Year	Coal	Oil	Gas	Nuclear	Wind	Solar	Hydro	Geothermal	Bioenergy	Other	Waste	Other renewables	Total
2000	50	20	10	10	0	0	0	0	0	0	0	100	
2010	45	15	15	10	5	0	0	0	0	0	0	100	
2020	35	10	20	10	15	0	0	0	0	0	0	100	
2030	25	5	25	10	30	0	0	0	0	0	0	100	
2040	15	0	30	10	45	0	0	0	0	0	0	100	
2050	5	0	35	10	50	0	0	0	0	0	0	100	

## Energy Consumption per Sector (%)

Year	Coal	Oil	Gas	Nuclear	Wind	Solar	Hydro	Geothermal	Bioenergy	Other	Waste	Other renewables	Total
2000	50	20	10	10	0	0	0	0	0	0	0	100	
2010	45	15	15	10	5	0	0	0	0	0	0	100	
2020	35	10	20	10	15	0	0	0	0	0	0	100	
2030	25	5	25	10	30	0	0	0	0	0	0	100	
2040	15	0	30	10	45	0	0	0	0	0	0	100	
2050	5	0	35	10	50	0	0	0	0	0	0	100	

## CO<sub>2</sub> Emissions by Sector



# Develop CO<sub>2</sub> Scenarios

**Energy Production (%)**

Scenario	Coal	Oil	Gas	Nuclear	Hydro	Wind	Solar	Bio-Energy	Geothermal	Hydro-Gen	Wind-Gen	Solar-Gen	Other	Other	Other	Other
Scenario 1	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	
Scenario 2	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	
Scenario 3	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	
Scenario 4	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	
Scenario 5	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	
Scenario 6	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	
Scenario 7	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	

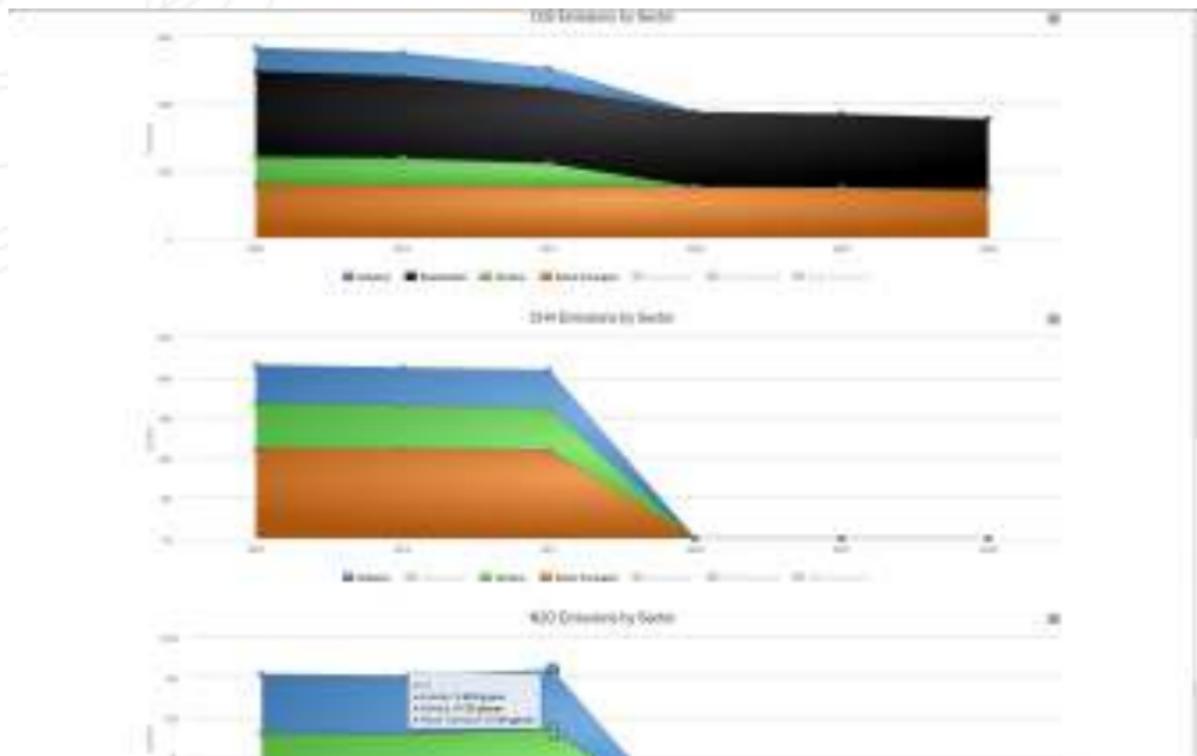
**Energy Consumption per Sector (%)**

Scenario	Coal	Oil	Gas	Nuclear	Hydro	Wind	Solar	Bio-Energy	Geothermal	Hydro-Gen	Wind-Gen	Solar-Gen	Other	Other	Other
Scenario 1	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Scenario 2	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155
Scenario 3	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
Scenario 4	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165
Scenario 5	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Scenario 6	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175
Scenario 7	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180

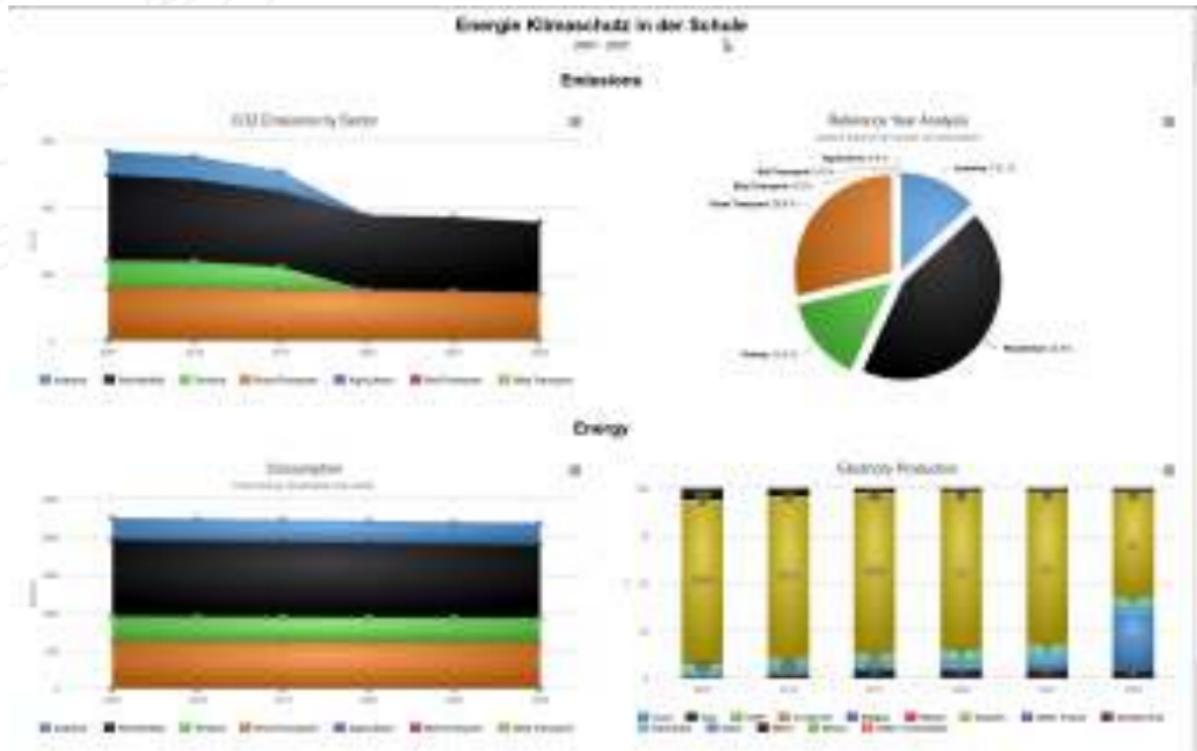
**Emission Factors**

Scenario	Coal	Oil	Gas	Nuclear	Hydro	Wind	Solar	Bio-Energy	Geothermal	Hydro-Gen	Wind-Gen	Solar-Gen	Other	Other	Other
Scenario 1	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Scenario 2	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155
Scenario 3	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
Scenario 4	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165
Scenario 5	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
Scenario 6	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175
Scenario 7	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180

# Develop CO<sub>2</sub> Scenarios



# Assess Scenarios



# Outline

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- 1 The MUSIC project
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- 2 iGUESS
  - Objectives
  - Framework
  - Web interface
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- 4 iGUESS for Tangible Tables
- 5 Conclusions

# DEADALUS – Project overview

Postdoctoral project AFR/FNR

Dr. Alessio Mastrucci

Supervisor: Dr. Enrico Benetto

Partner institution: MINES ParisTech (France)

Duration: 2 years, 10/2014 - 09/2016

## • OBJECTIVE:

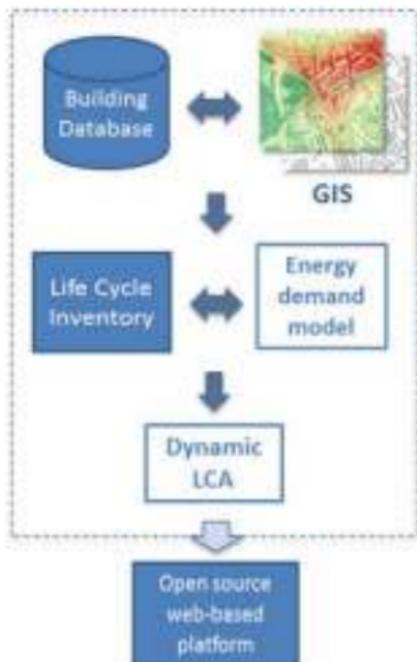
Evaluate the effect of **retrofitting residential buildings on the environmental impact at the city scale** in space and time considering their **whole life cycle** for decision support in sustainable urban planning.

## • METHODOLOGY:

Integrated approach:

- Dynamic Life Cycle Assessment (LCA),
- Energy modelling,
- Geographical Information Systems (GIS),
- Web-based open-source platform.

**Case Study:** Esch-sur-Alzette (Luxembourg)



# DEADALUS – Expected outcomes

**Tool to predict energy savings and environmental impact reduction** of the residential sector for decision support in sustainable urban planning implemented in **iGUESS**.

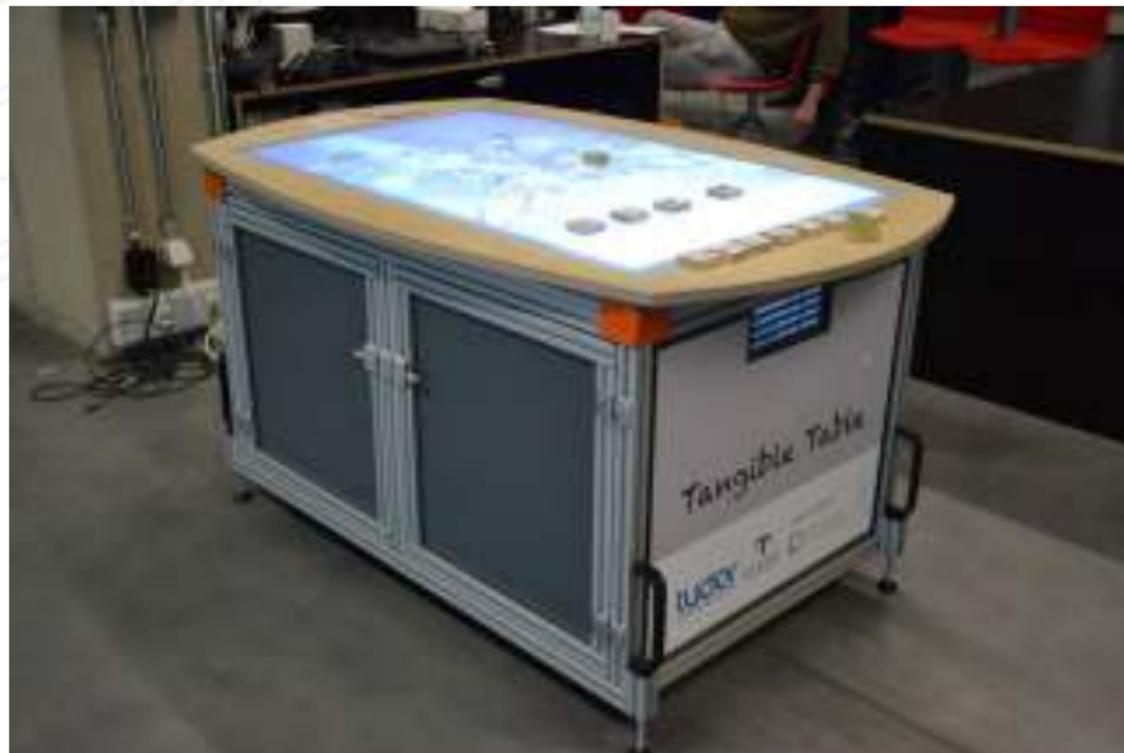


# Outline

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- 1 The MUSIC project
  - Overview
  - Objectives
- 2 iGUESS
  - Objectives
  - Framework
  - Web interface
- 3 The DEADALUS Project
- 4 iGUESS for Tangible Tables**
- 5 Conclusions

# iGUESS for Tangible Tables



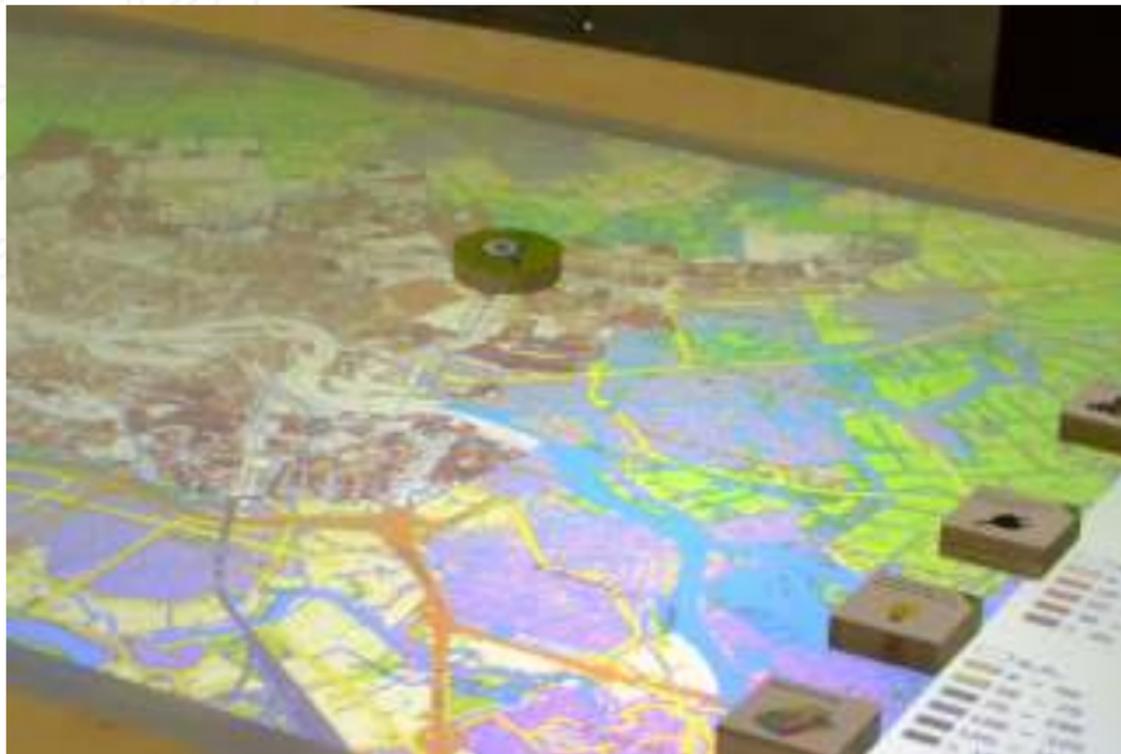
# iGUESS Tangible Table – Maps and Objects



# iGUESS Tangible Table – Objects



# iGUESS Tangible Table – Zoom to map



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## iGUESS impacts

- ▶ iGUESS can help finding answers to complex questions;
- ▶ iGUESS helps municipalities to develop innovative strategies, e.g. open data access, mobile app developments, Solar PV for social housing, strategic CO<sub>2</sub> emission reduction scenarios, link fuel poverty with renewables and energy savings;
- ▶ iGUESS provides a flexible framework for integration of other topics, e.g. water management, air quality, transportation;
- ▶ iGUESS is looking for new municipalities and new opportunities.

Thank you for your attention!



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