iGUESS – An integrated Geospatial Urban DEcision Support System for Smart City Energy Planning

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Let's start with the MUSIC Project

MUSIC

–

Mitigation of CO_2 Emissions in **U**rban Areas:

Solutions for **I**nnovative **C**ities

A partnership of European cities and research institutes that takes the lead in innovative CO_2 reduction!

Mitigation of CO_2 Emissions in **U**rban Areas: **S**olutions for **I**nnovative **C**ities

The MUSIC Project

- **is** an INTERREG IVB NWE project of 5 European cities (Rotterdam, Ghent, Aberdeen, Montreuil, Ludwigsburg) supported by 2 research institutes (DRIFT & Tudor);
- **aims** at reducing CO_2 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_2 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.

Let's look into iGUESS

iGUESS

–

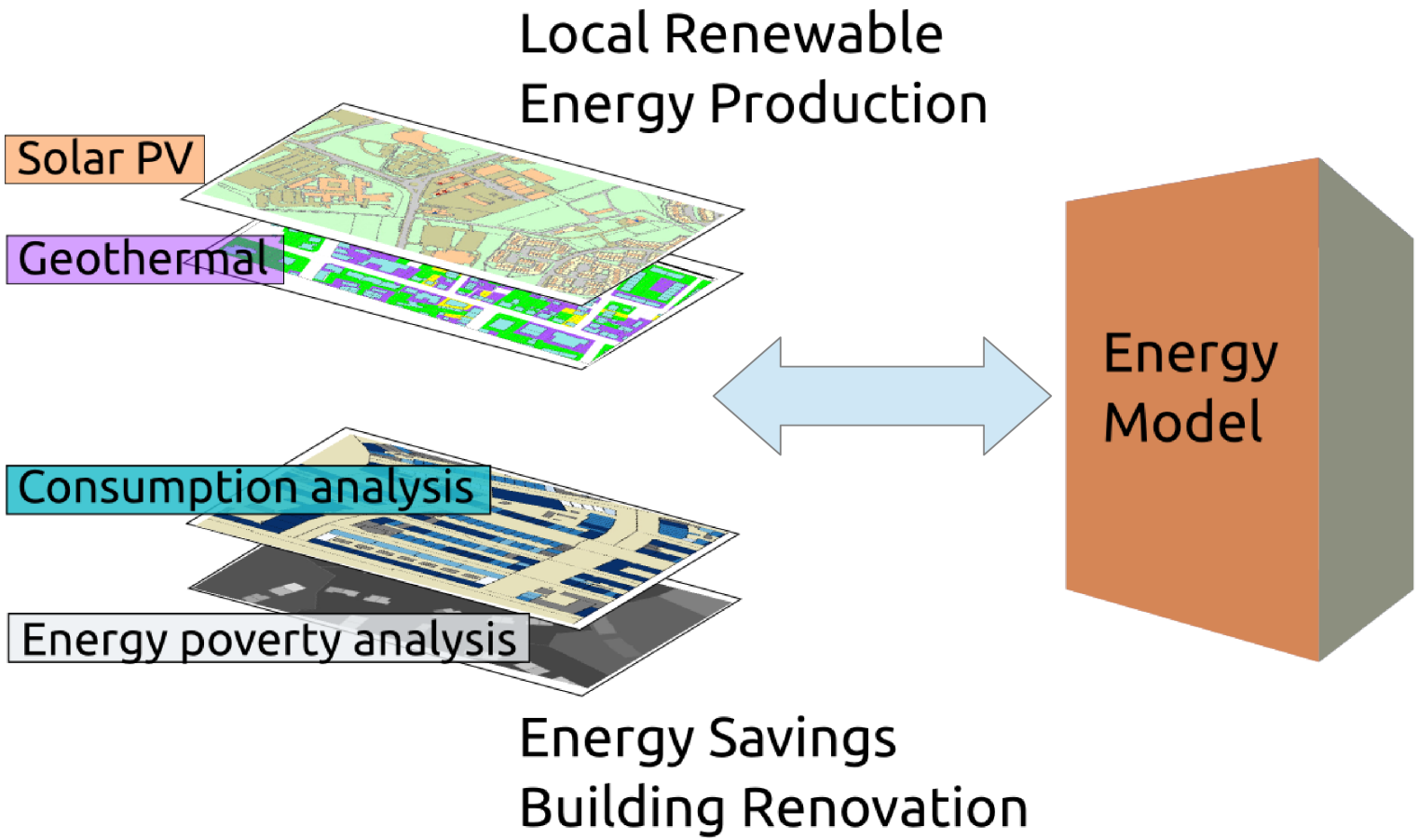
An **i**ntegrated **G**eospatial **U**rban **E**nergy information and decision **S**upport **S**ystem

iGUESS Objectives

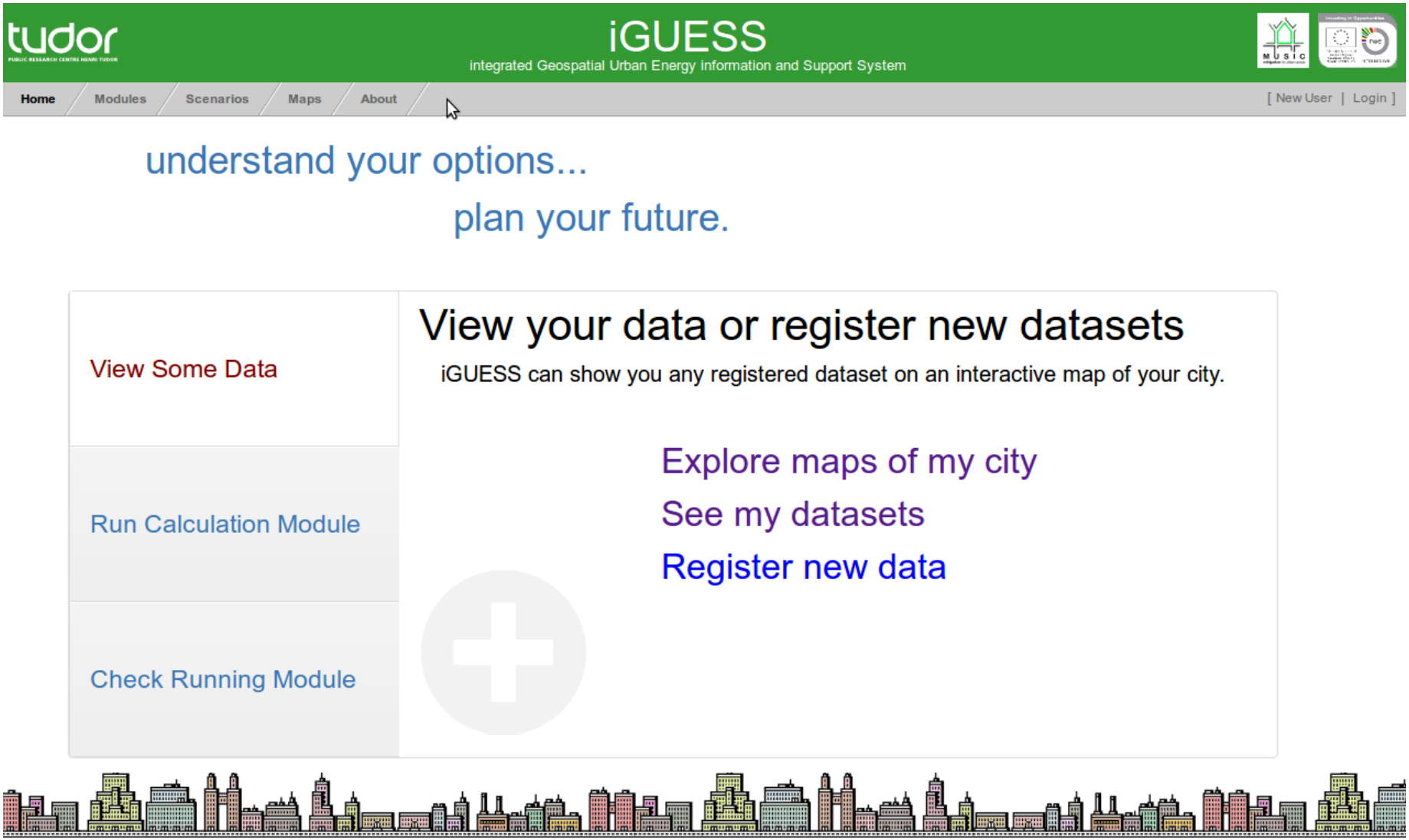
iGUESS – a decision support system which provides:

- **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.

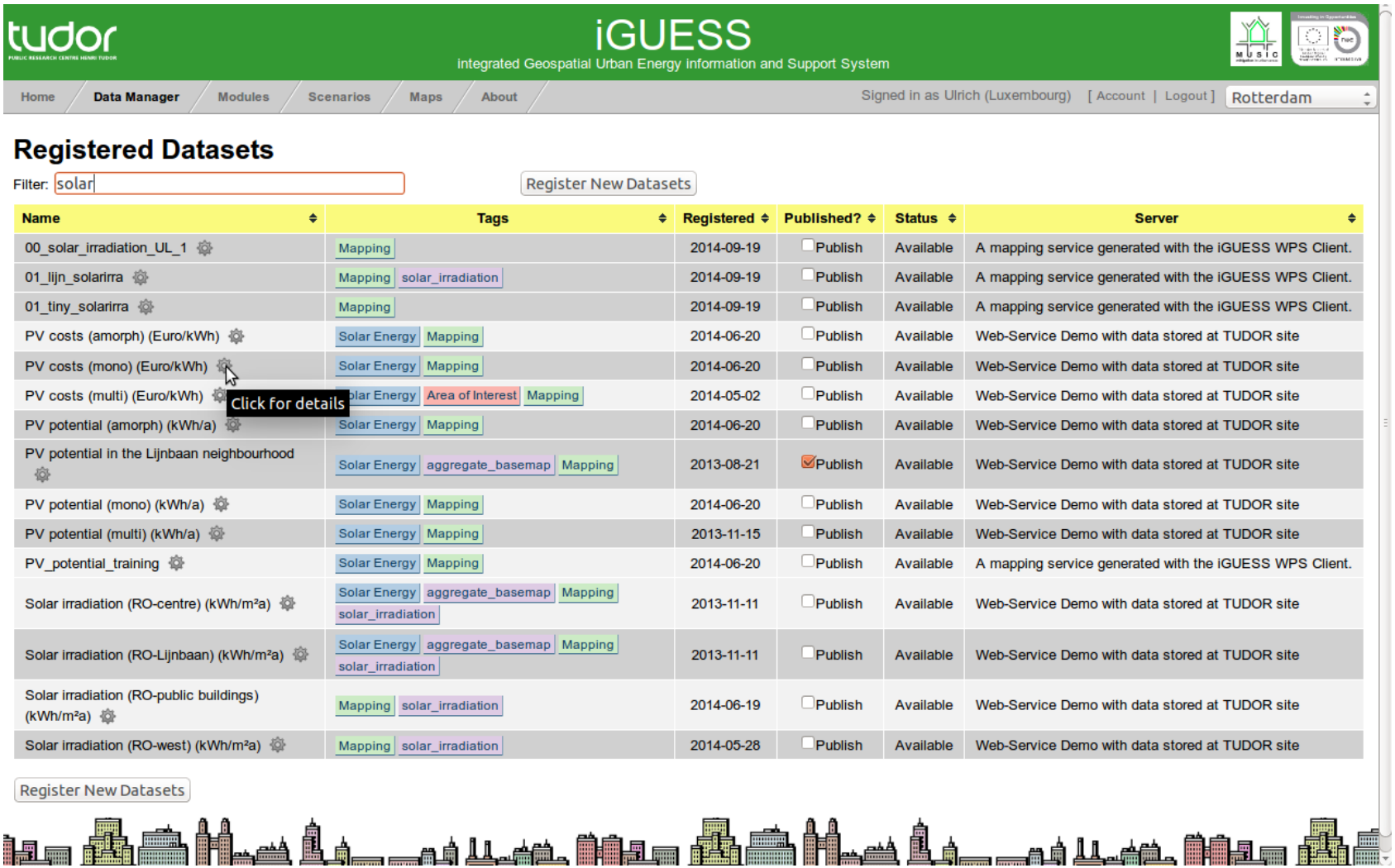
iGUESS – An integrated web based modular framework



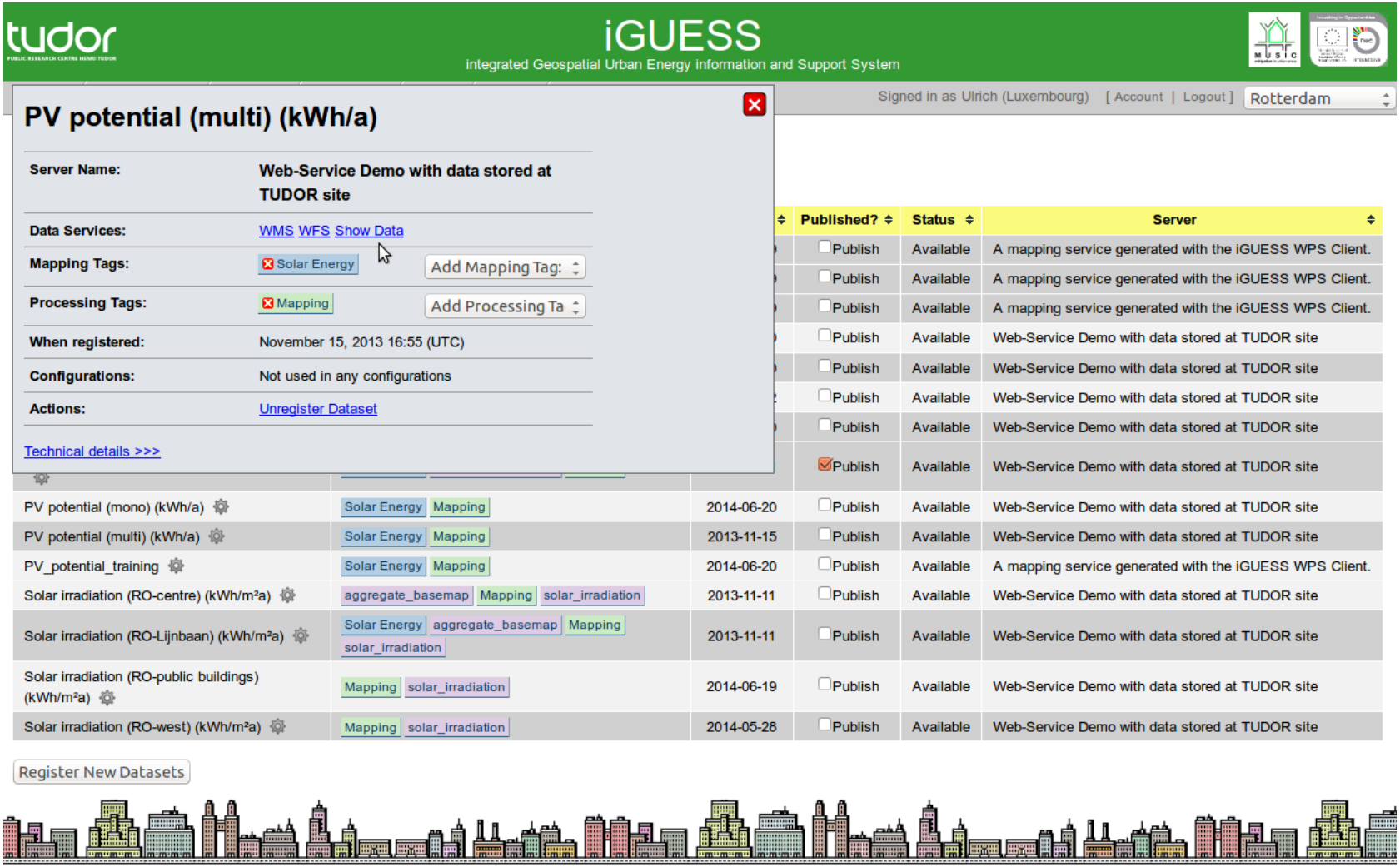
The iGUESS Start Page



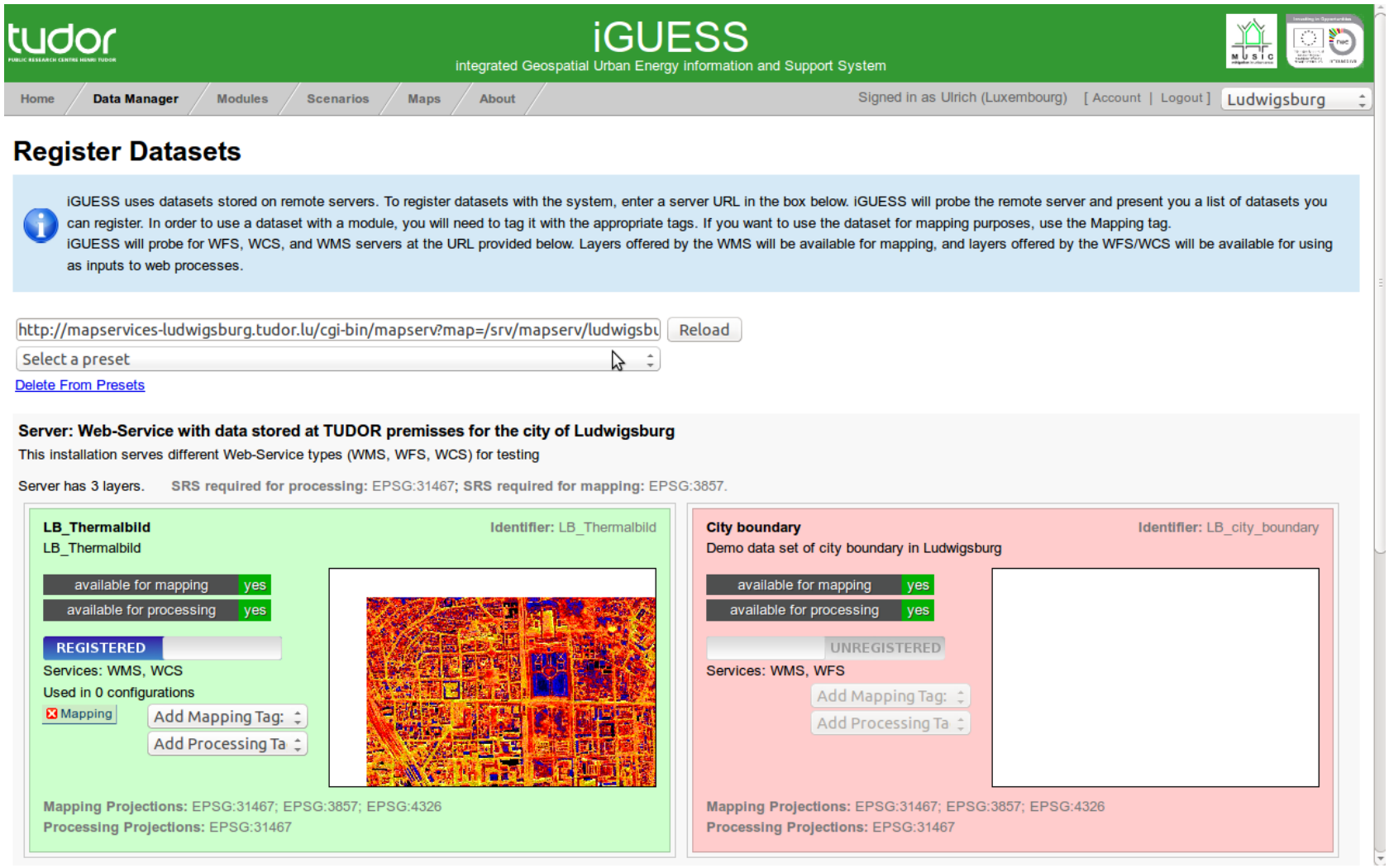
The iGUESS Data manager



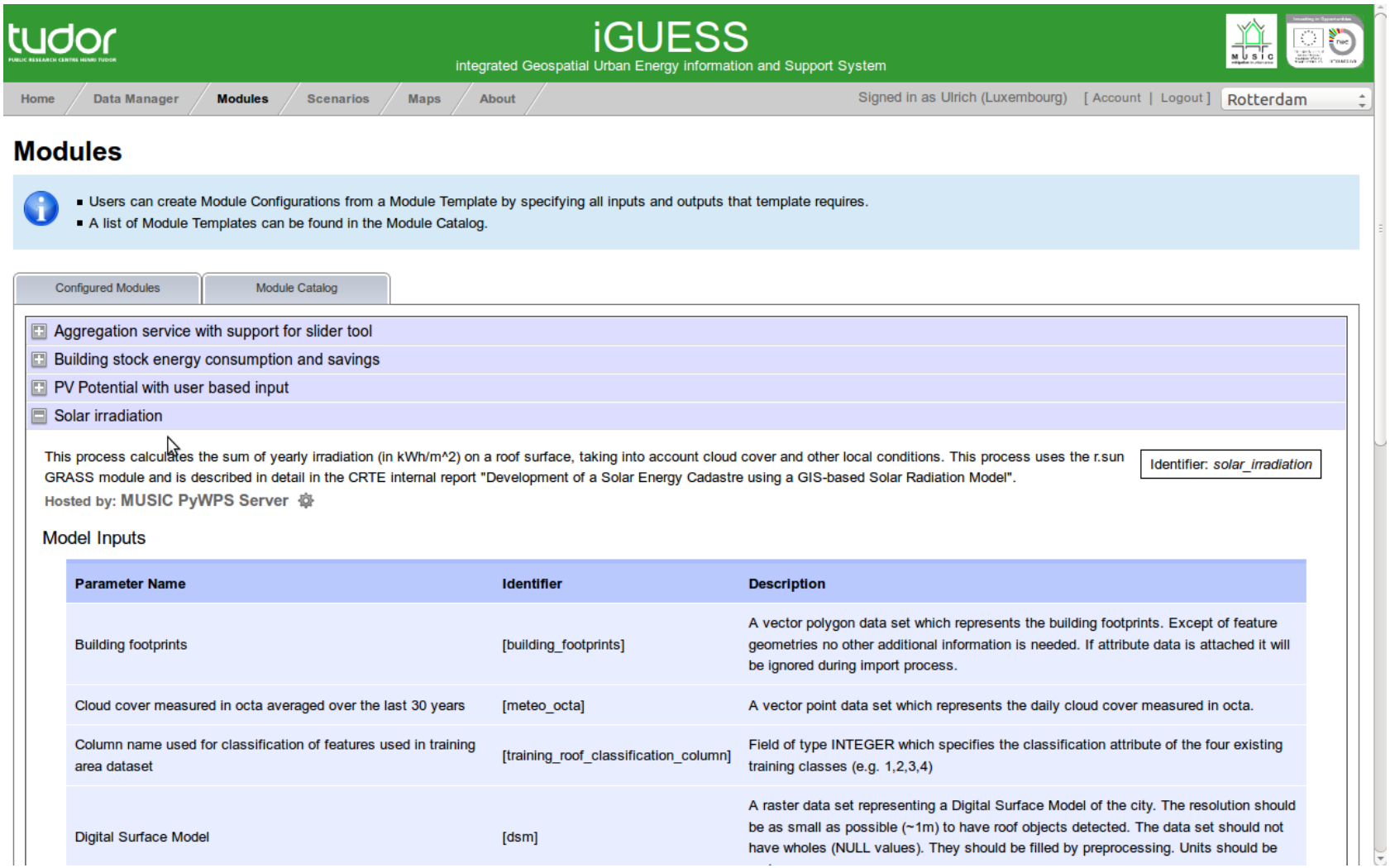
Retrieve information on data set



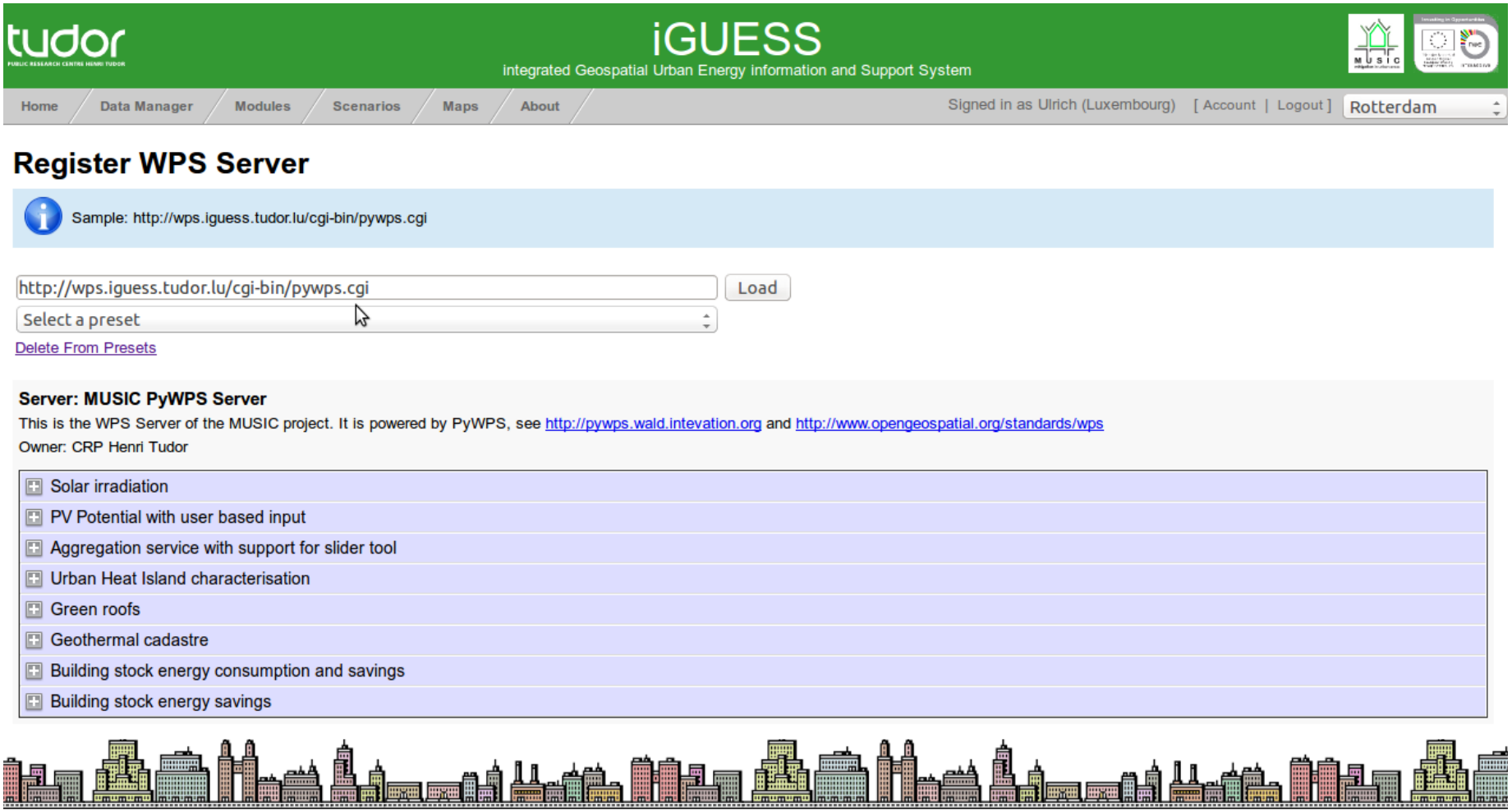
Register new Data Sets in iGUESS



Choosing a Renewable Potential Calculator



Linking in a Calculator across the Web



Registering the new Remote Calculator

Owner: CRP Henri Tudor

- Solar irradiation
- PV Potential with user based input
- Aggregation service with support for slider tool
- Urban Heat Island characterisation
- Green roofs

This module classifies roof patches that are suitable for different types of green roof installations.

Identifier: *green_roofs*

Model Inputs

Parameter Name	Identifier	Description
Roof patches with suitable area for green roof installations	[roof_patches]	A vector data set which delinates the suitable roof patches for a green roof installation. This input is an output of the solar irradiation module of iGUESS.
Maximum roof slope where green can be built	[max_roof_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 green roofs are not too expensive to be built. Above 10 degrees measures to prevent growing medium movement and erosion must be taken.

Model Outputs

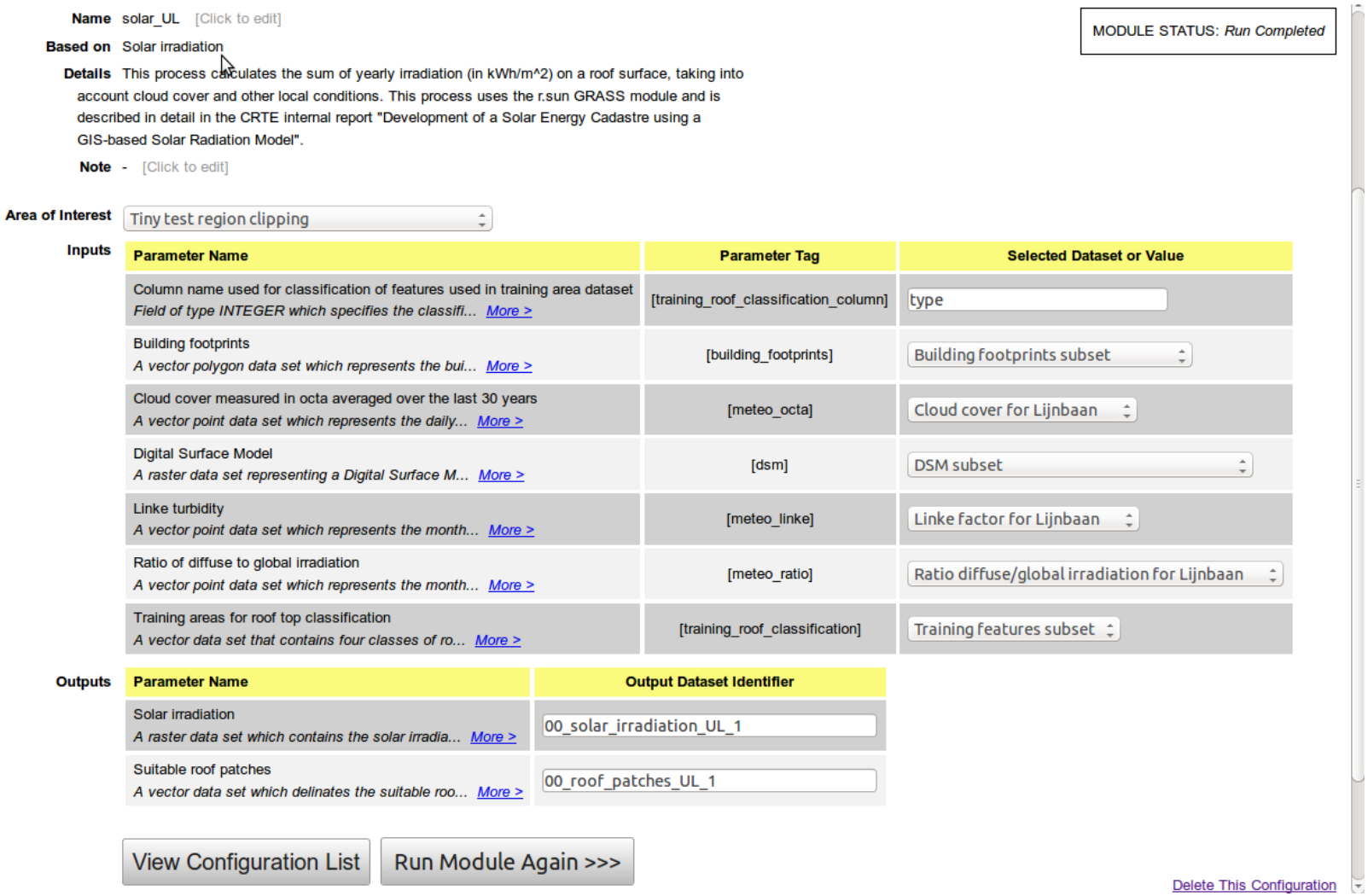
Parameter Name	Identifier	Description
Classification of possible green roof installations	[green_roofs_locations]	Possible locations of green roof installations. All patches with higher than the given max_slope are skipped (usually 10 degrees). According to different sources cultivation is then very expensive because of soil erosion and water issues. If a flat roof top is found a kind of horticulture should be placed where people could grow food. Intensive or extensive green roofs are classified if the third quartile of slope of the roof patch is not higher than max_slope.

UNREGISTERED

- Geothermal cadastre
- Building stock energy consumption and savings
- Building stock energy savings

iguess.tudor.lu/wps_servers/new#

Configuring a Renewable Calculator – Irradiation



Name solar_UL [Click to edit]

Based on Solar irradiation

Details This process calculates the sum of yearly irradiation (in kWh/m^2) on a roof surface, taking into account cloud cover and other local conditions. This process uses the r.sun GRASS module and is described in detail in the CRTE internal report "Development of a Solar Energy Cadastre using a GIS-based Solar Radiation Model".

Note - [Click to edit]

MODULE STATUS: *Run Completed*

Area of Interest Tiny test region clipping

Inputs

Parameter Name	Parameter Tag	Selected Dataset or Value
Column name used for classification of features used in training area dataset *Field of type INTEGER which specifies the classifi... More >*	[training_roof_classification_column]	type
Building footprints *A vector polygon data set which represents the bui... More >*	[building_footprints]	Building footprints subset
Cloud cover measured in octa averaged over the last 30 years *A vector point data set which represents the daily... More >*	[meteo_octa]	Cloud cover for Lijnbaan
Digital Surface Model *A raster data set representing a Digital Surface M... More >*	[dsm]	DSM subset
Linke turbidity *A vector point data set which represents the month... More >*	[meteo_linke]	Linke factor for Lijnbaan
Ratio of diffuse to global irradiation *A vector point data set which represents the month... More >*	[meteo_ratio]	Ratio diffuse/global irradiation for Lijnbaan
Training areas for roof top classification *A vector data set that contains four classes of ro... More >*	[training_roof_classification]	Training features subset

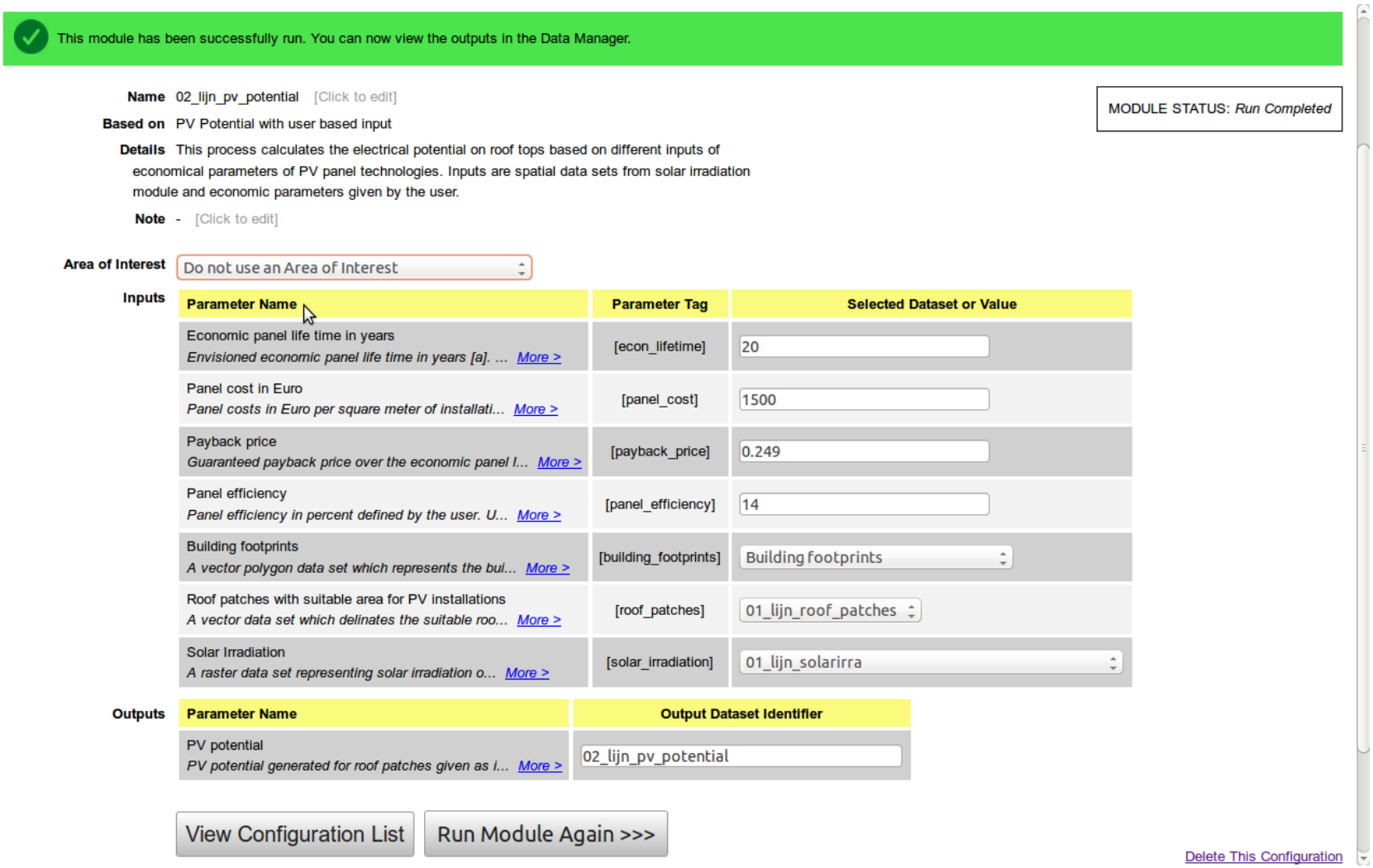
Outputs

Parameter Name	Output Dataset Identifier
Solar irradiation *A raster data set which contains the solar irradia... More >*	00_solar_irradiation_UL_1
Suitable roof patches *A vector data set which delinates the suitable roo... More >*	00_roof_patches_UL_1

View Configuration List | Run Module Again >>>

Delete This Configuration

Configuring a Renewable Calculator – PV potential



This module has been successfully run. You can now view the outputs in the Data Manager.

Name 02_lijn_pv_potential [Click to edit]

Based on PV Potential with user based input

Details This process calculates the electrical potential on roof tops based on different inputs of economical parameters of PV panel technologies. Inputs are spatial data sets from solar irradiation module and economic parameters given by the user.

Note - [Click to edit]

MODULE STATUS: *Run Completed*

Area of Interest Do not use an Area of Interest

Inputs

Parameter Name	Parameter Tag	Selected Dataset or Value
Economic panel life time in years *Envisioned economic panel life time in years [a]. ...* More >	[econ_lifetime]	20
Panel cost in Euro *Panel costs in Euro per square meter of installati...* More >	[panel_cost]	1500
Payback price *Guaranteed payback price over the economic panel l...* More >	[payback_price]	0.249
Panel efficiency *Panel efficiency in percent defined by the user. U...* More >	[panel_efficiency]	14
Building footprints *A vector polygon data set which represents the bui...* More >	[building_footprints]	Building footprints
Roof patches with suitable area for PV installations *A vector data set which delinates the suitable roo...* More >	[roof_patches]	01_lijn_roof_patches
Solar Irradiation *A raster data set representing solar irradiation o...* More >	[solar_irradiation]	01_lijn_solarirra

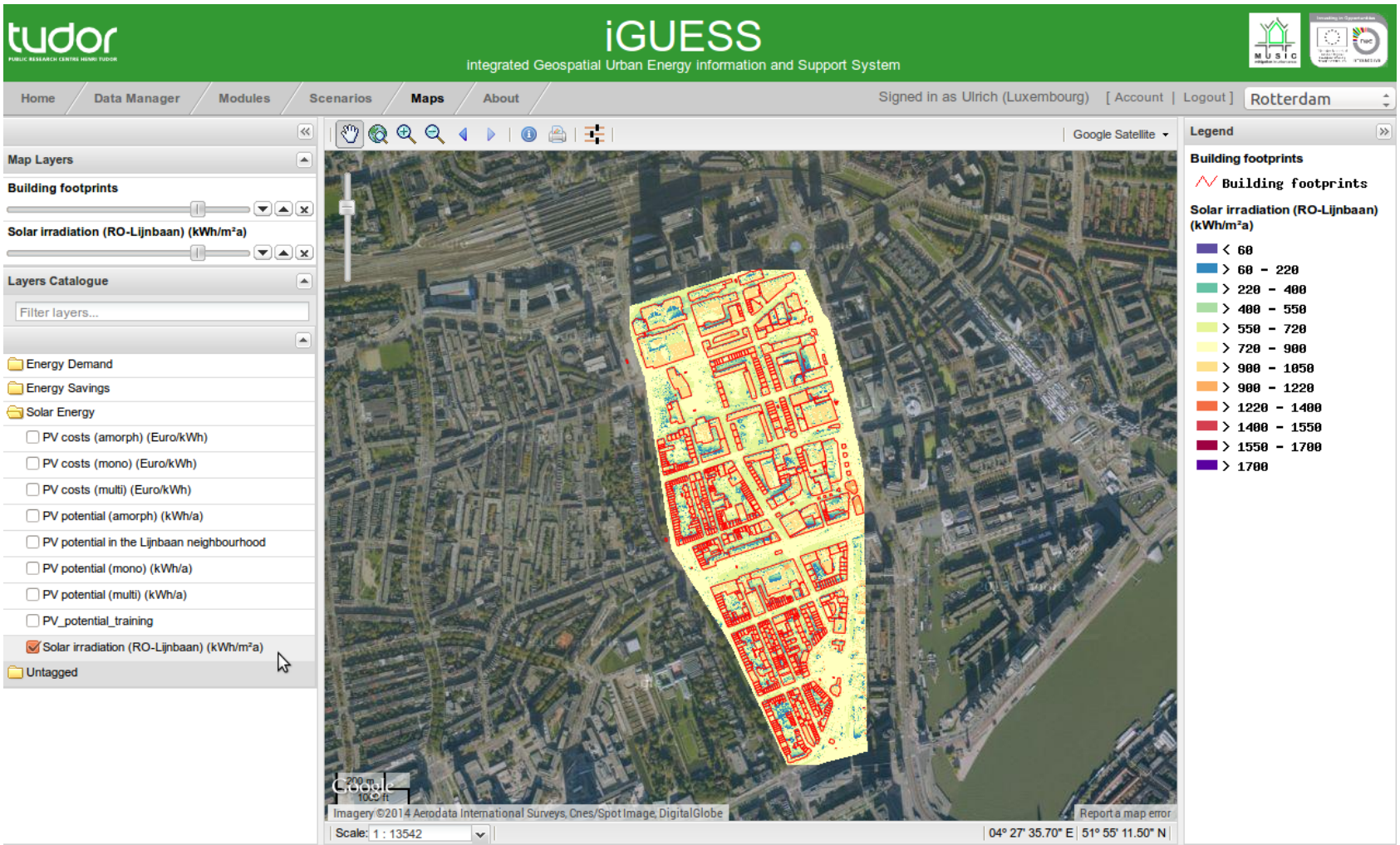
Outputs

Parameter Name	Output Dataset Identifier
PV potential *PV potential generated for roof patches given as i...* More >	02_lijn_pv_potential

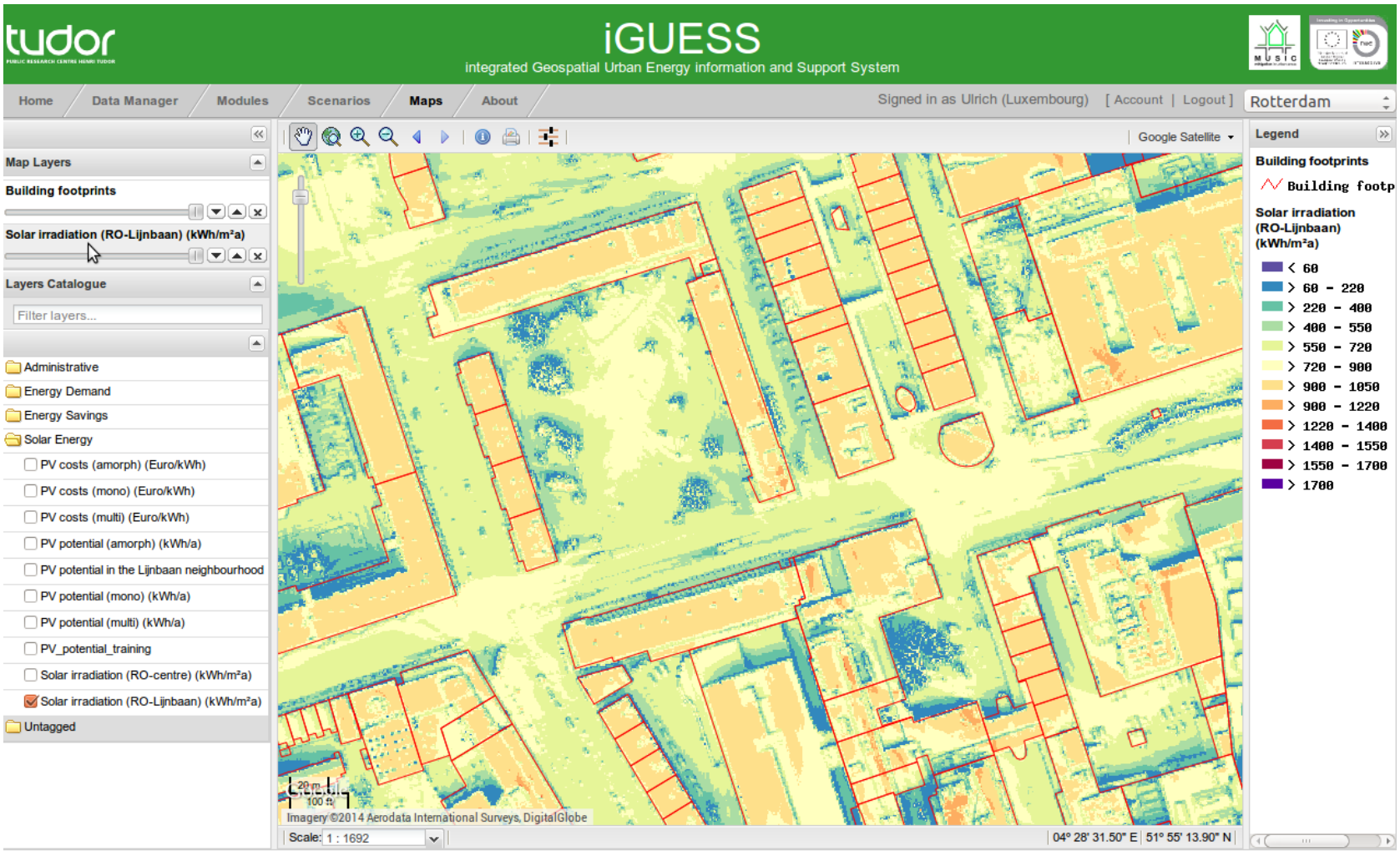
View Configuration List | Run Module Again >>>

Delete This Configuration

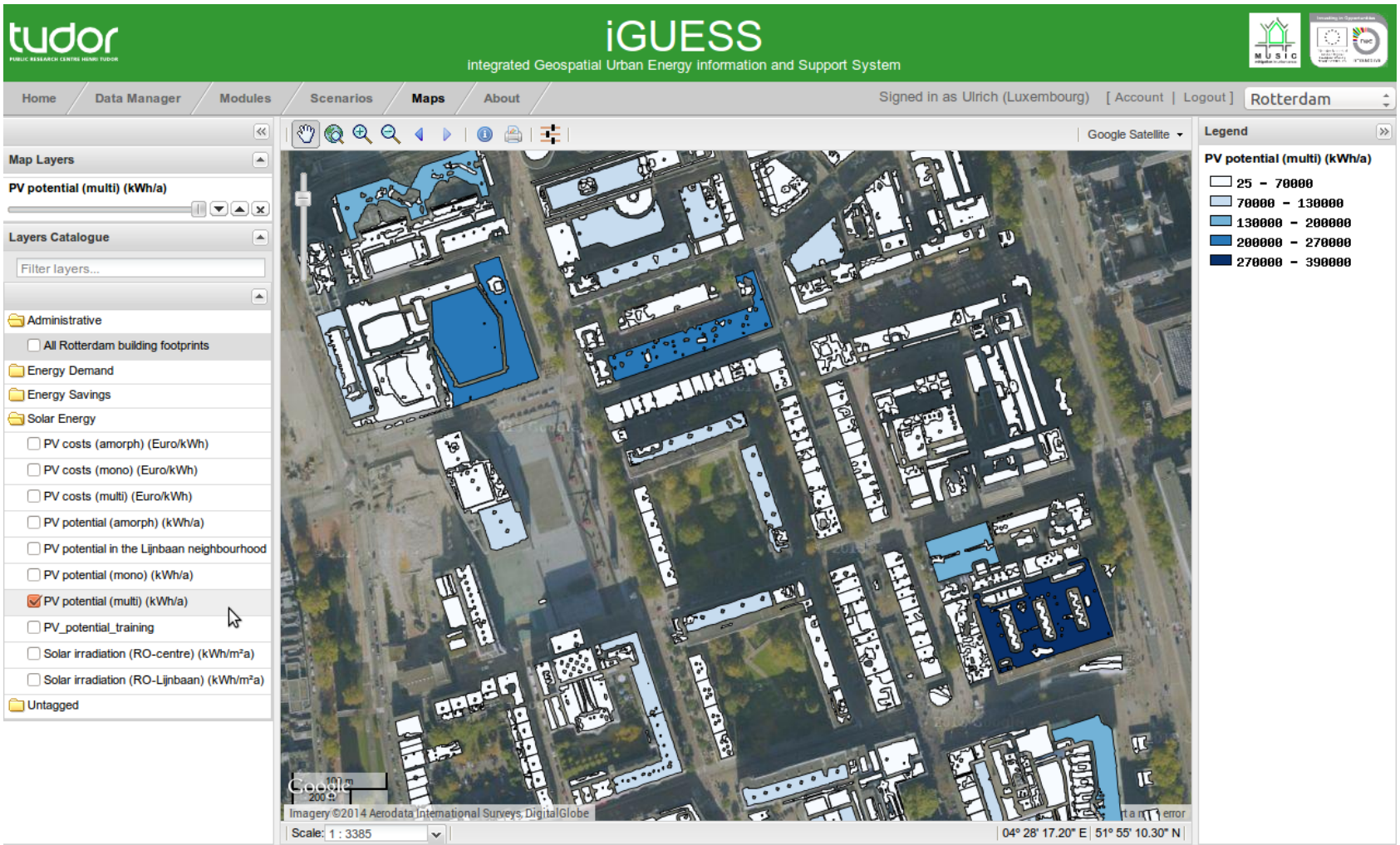
Exploring Solar Energy Potential within the City



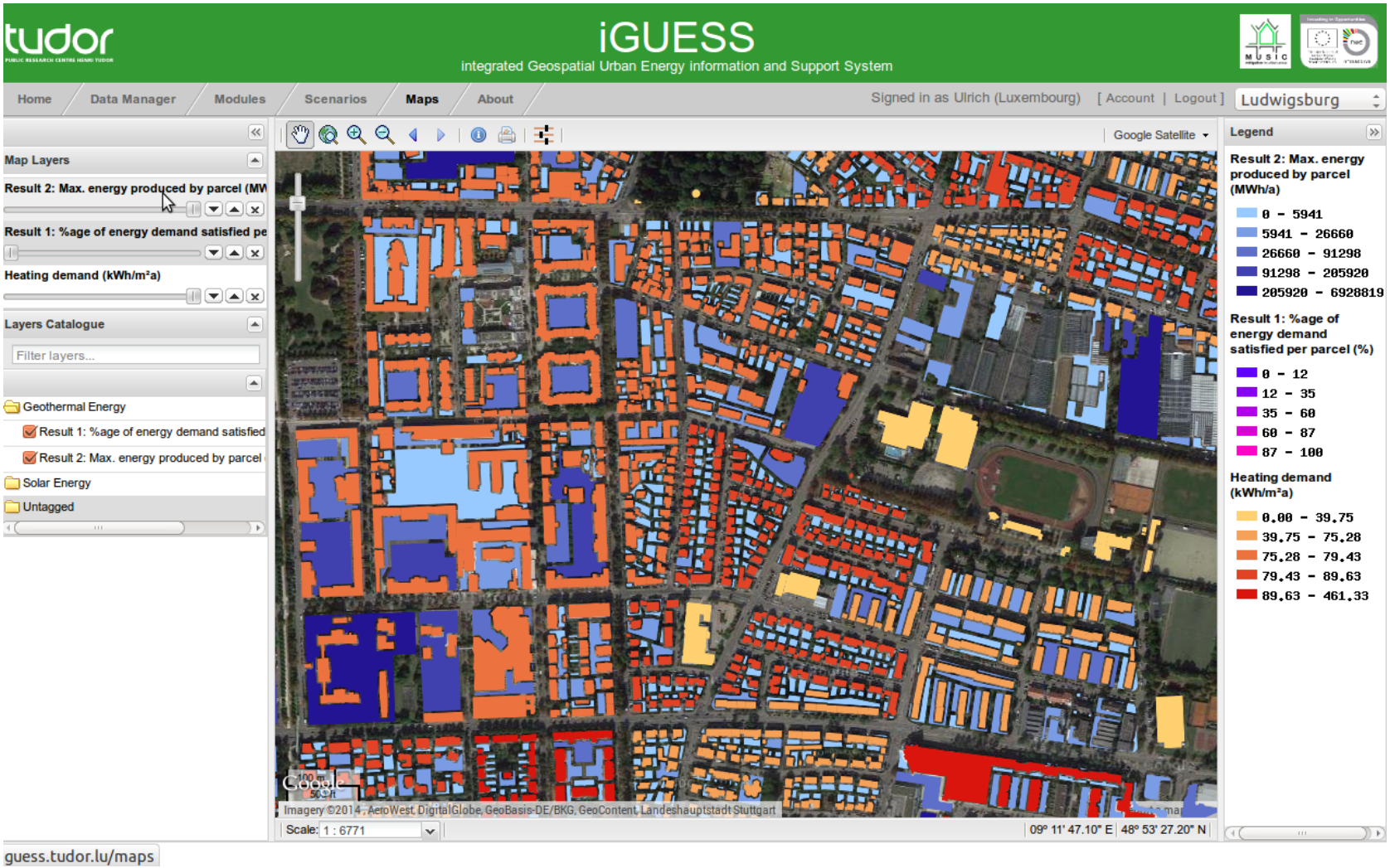
Zooming in to Solar Potential at building level



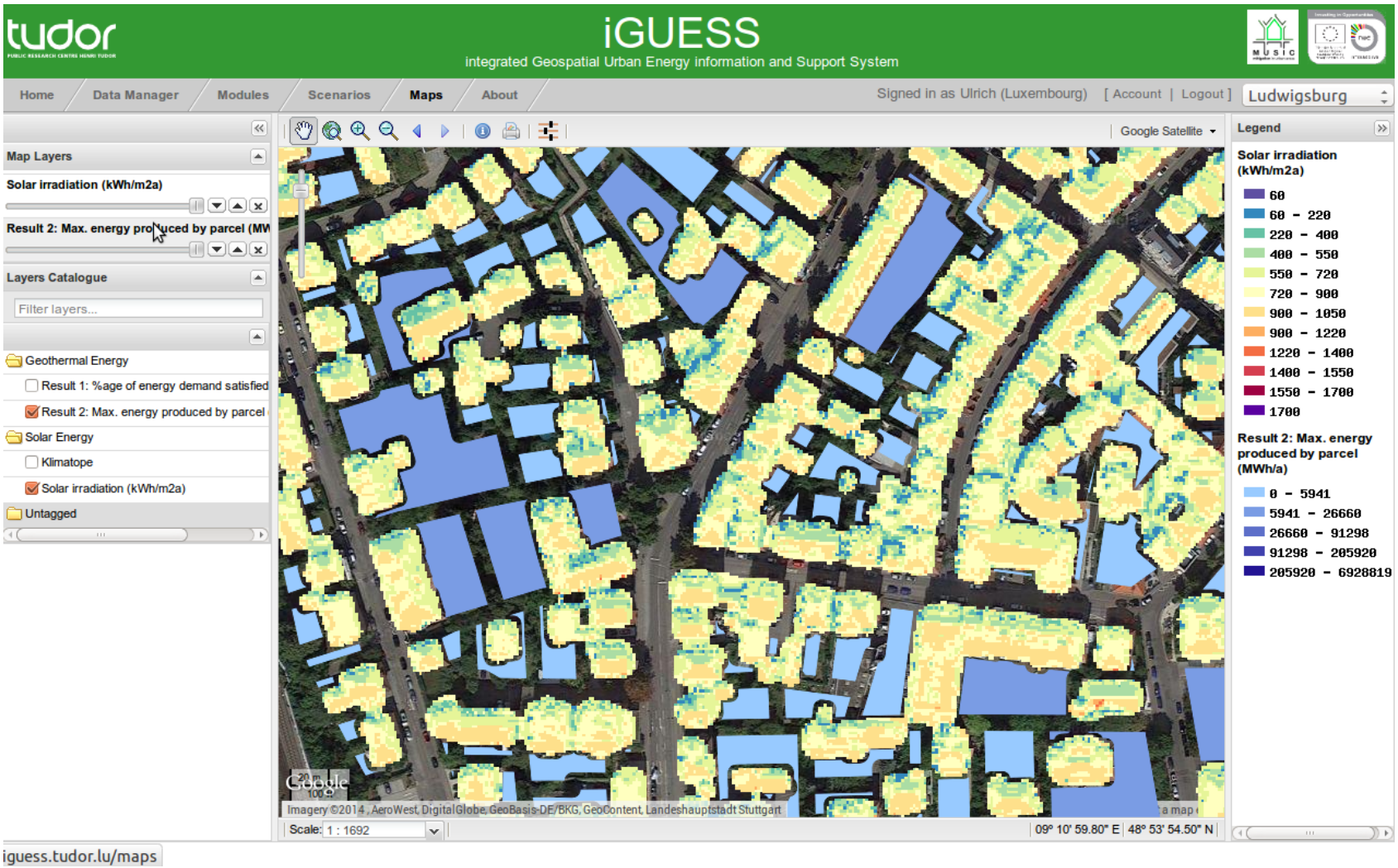
PV Electricity Production Potential



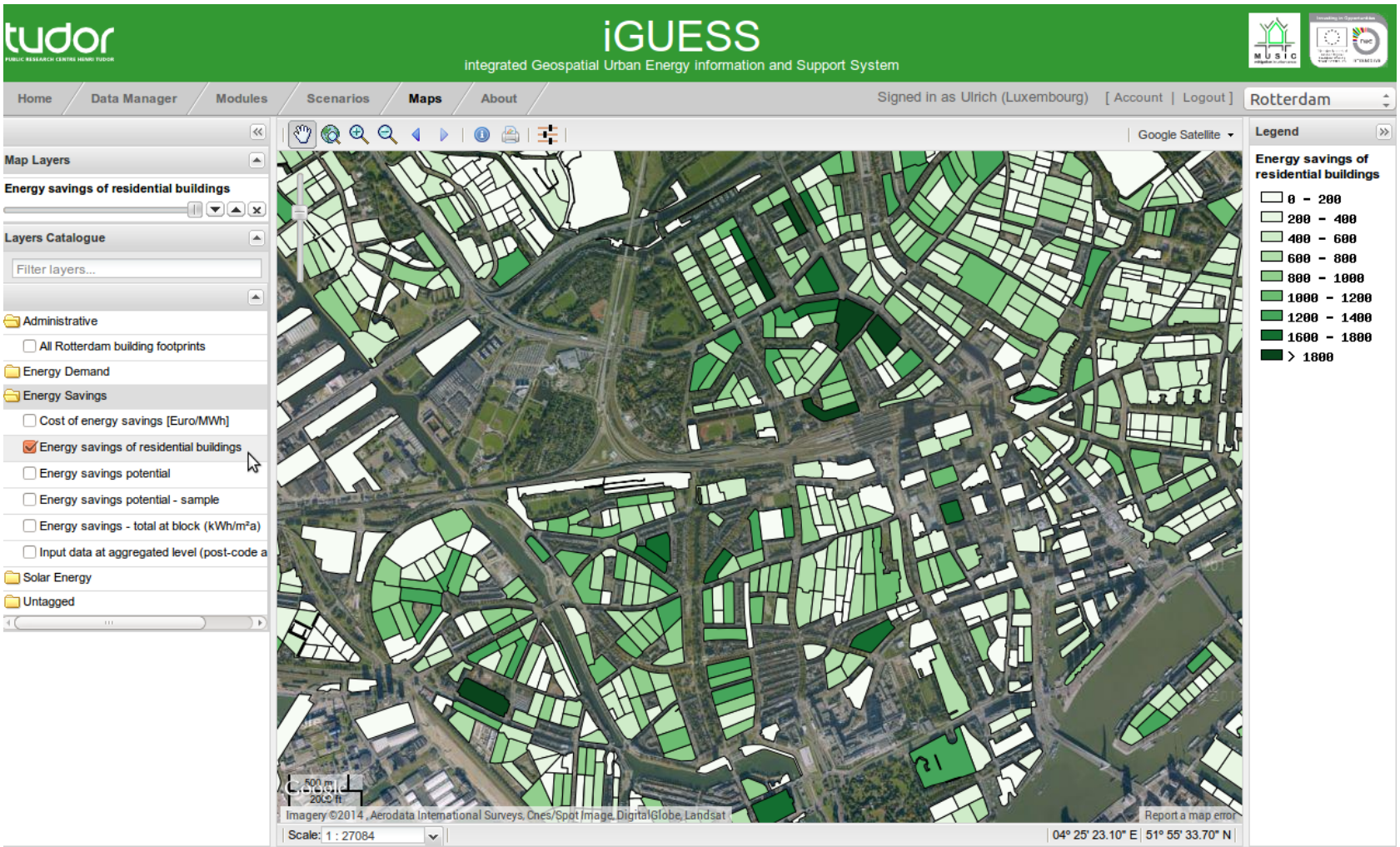
Looking at Geothermal Potential within the City



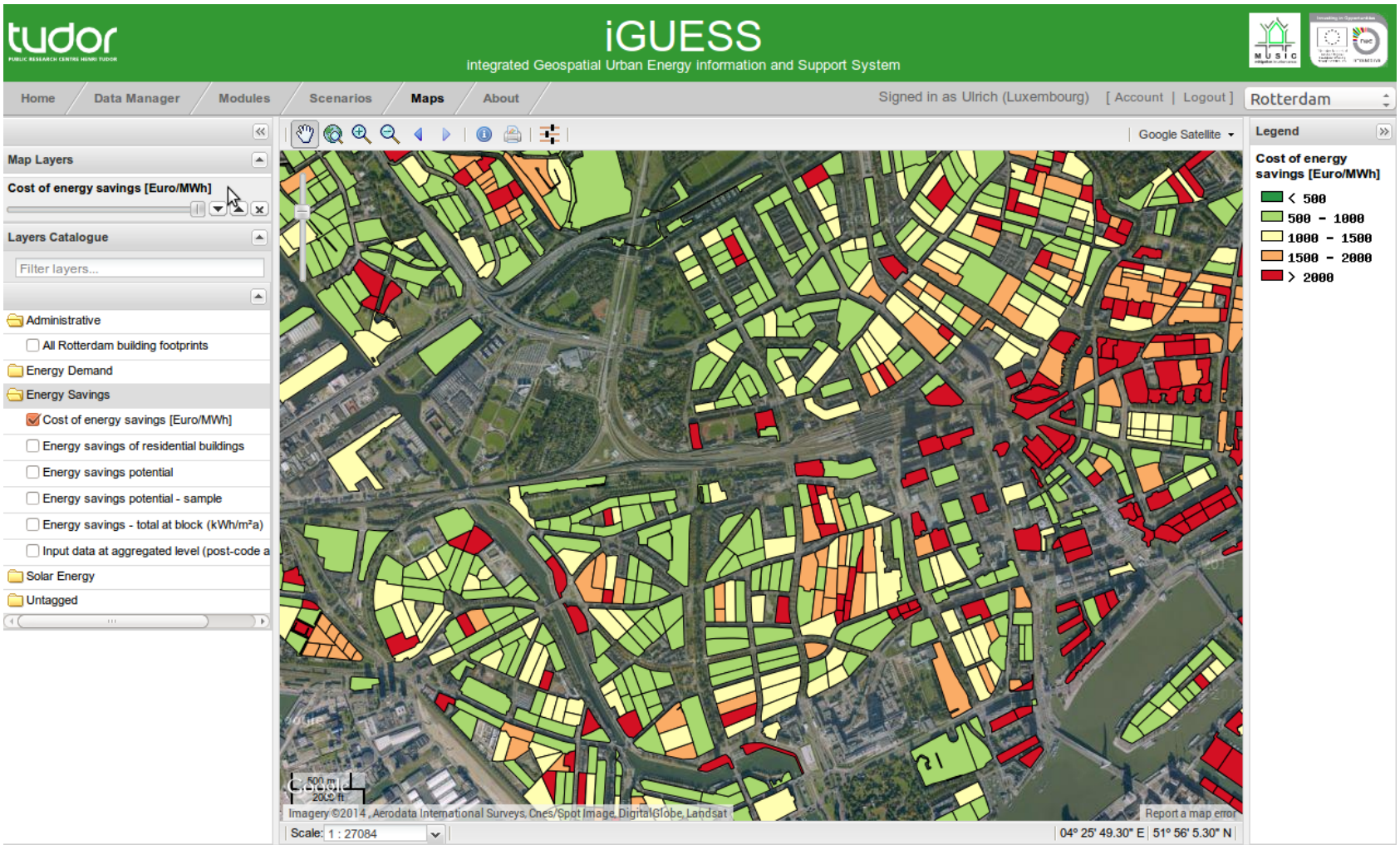
Combining Solar and Geothermal potentials



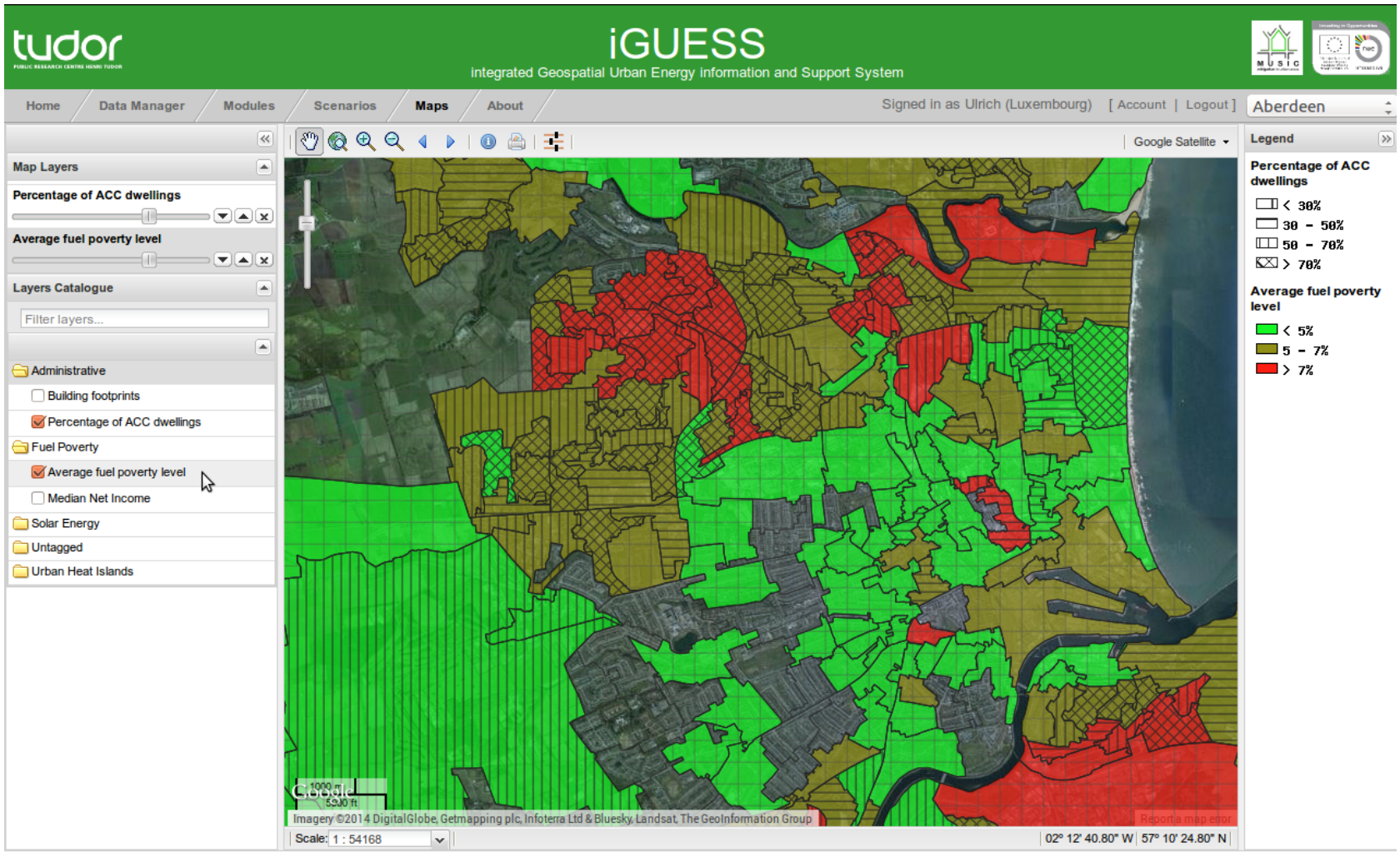
Exploring Energy Saving Potentials across the City



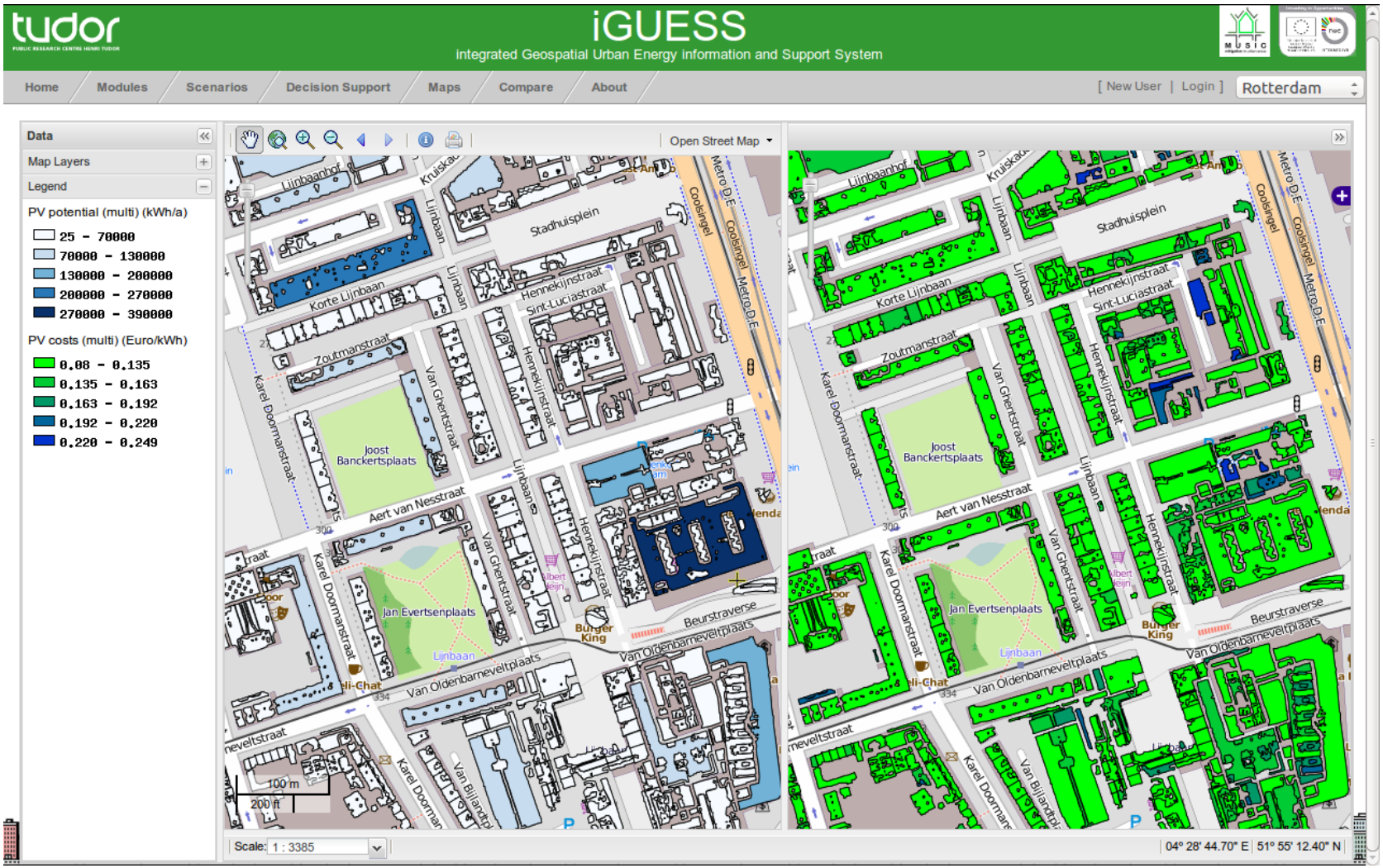
Looking at investment costs across the City



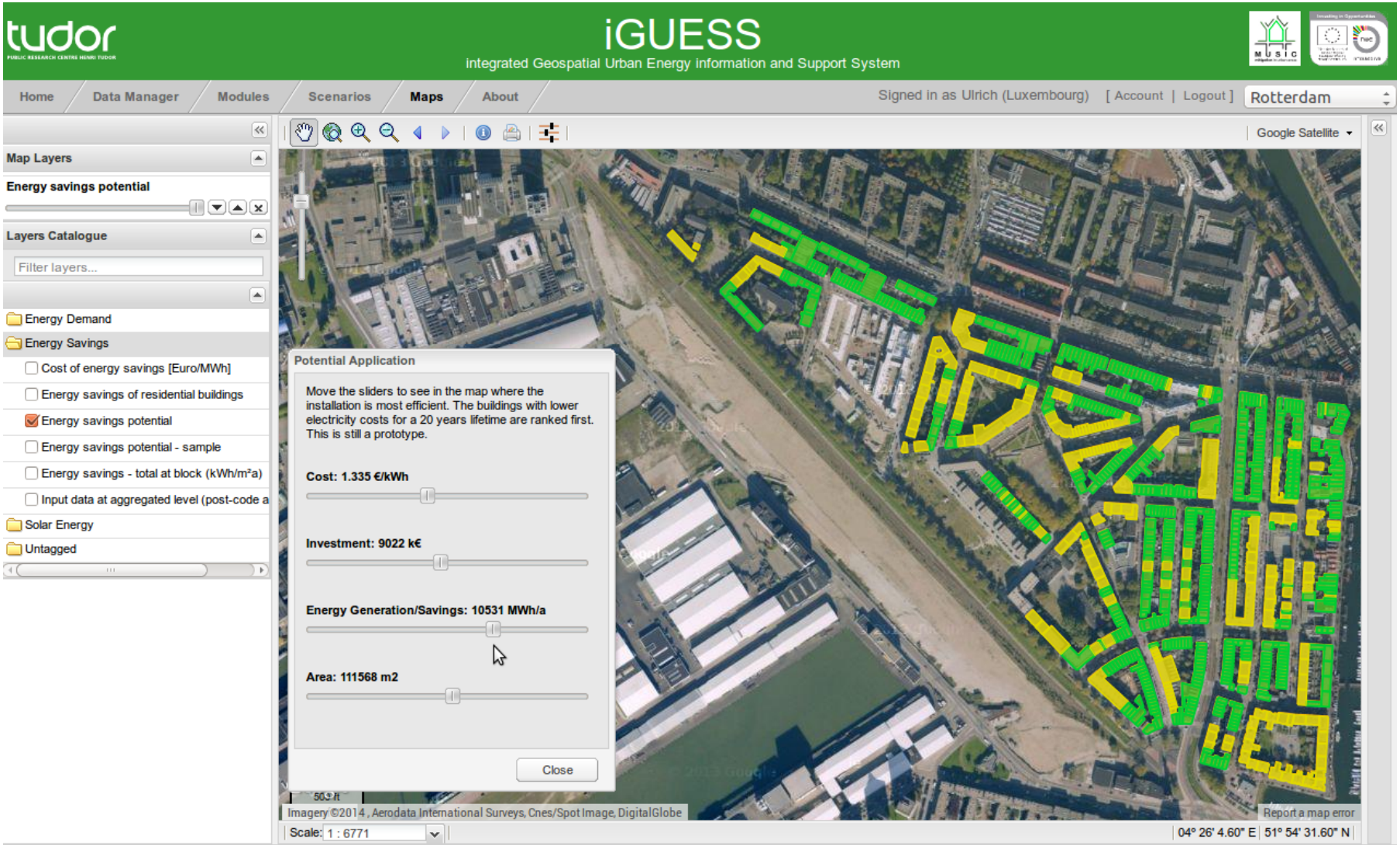
Explore Energy Poverty across the City



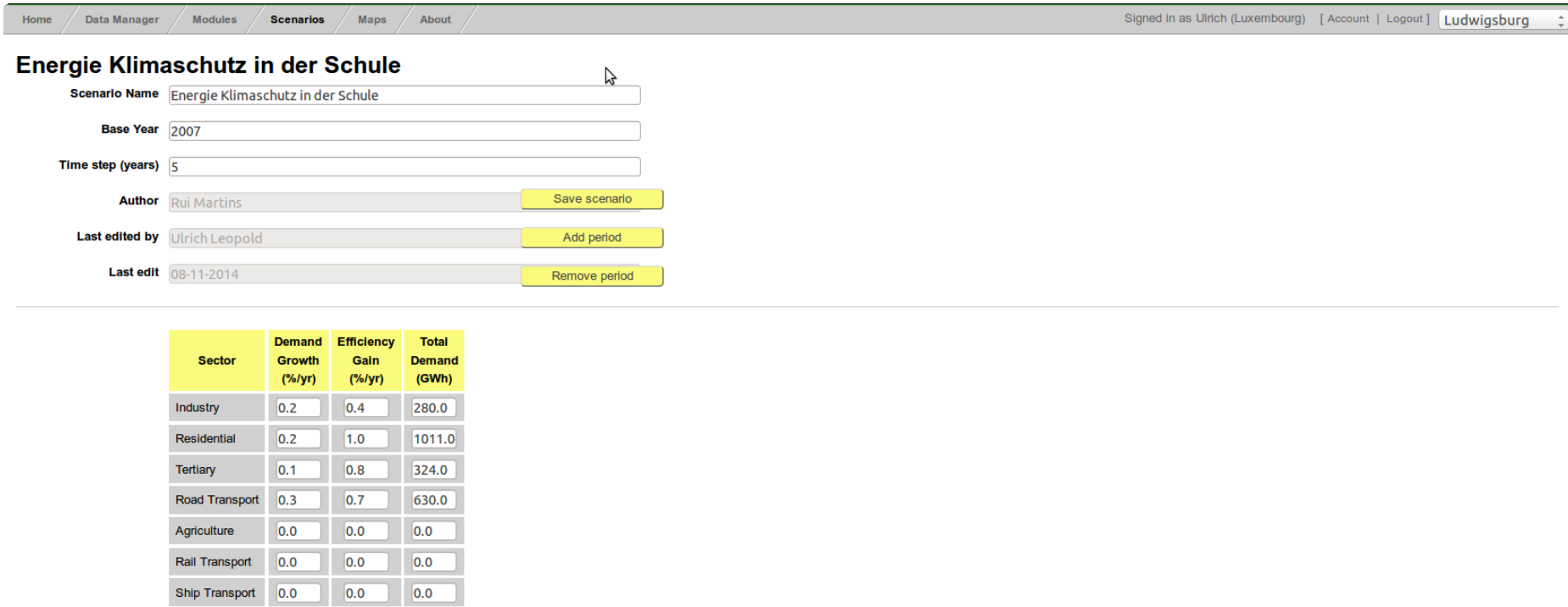
Comparing potentials to associated costs



Planning neighbourhoods



Develop CO_2 Scenarios



Develop CO_2 Scenarios

Energy Production (%)

Electricity | District Heating

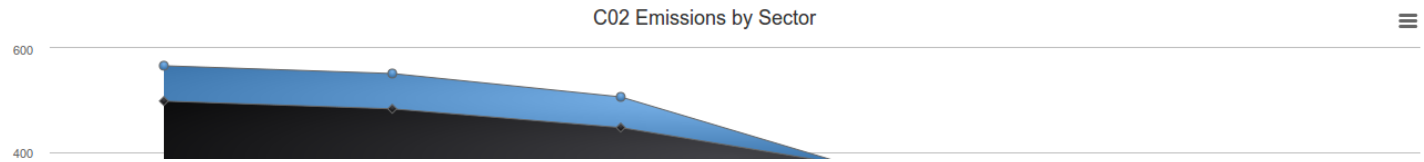
Period	Coal	Gas	CHP	Crude Oil	Biogas	Waste	Imports	Other Fossil	Geothermal	Hydraulic	Solar	Wind	Wood	Other renewables	Total
2007	0.0	6.05	0.0	0.0	0.0	0.0	86.93	0.0	0.0	5.22	0.14	1.66	0.0	0.0	100.00
2012	0.0	4.2	0.0	0.0	0.0	0.0	86.11	0.0	0.0	6.08	0.38	3.16	0.0	0.0	99.93
2017	0.0	2.15	0.0	0.0	0.0	0.0	85.27	0.0	0.0	7.03	0.68	4.85	0.0	0.0	99.98
2022	0.0	2.0	0.0	0.0	0.0	0.0	84.0	0.0	0.0	7.0	2.0	5.0	0.0	0.0	100.00
2027	0.0	2.0	0.0	0.0	0.0	0.0	81.0	0.0	0.0	7.0	5.0	5.0	0.0	0.0	100.00
2032	0.0	2.0	0.0	0.0	0.0	0.0	56.0	0.0	0.0	7.0	30.0	5.0	0.0	0.0	100.00

Energy Consumption per Sector (%) Toggle units to MWh

Industry | Residential | Tertiary | Road Transport | Agriculture | Rail Transport | Ship Transport

Period	Coal	Gas	CHP	Crude Oil	Diesel	Gasoline	LPG	Biogas	District Heating	Electricity	Other Fossil	Geothermal	Wood	Other renewables	Total
2007	0.0	18.0	0.0	41.2	0.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	99.20
2012	0.0	18.5	0.0	41.1	0.0	0.0	0.0	0.0	0.0	40.3	0.0	0.0	0.0	0.0	99.90
2017	0.0	18.5	0.0	41.2	0.0	0.0	0.0	0.0	0.0	40.3	0.0	0.0	0.0	0.0	100.00
2022	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	0.00
2027	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	0.00
2032	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	0.00

+ Emission Factors



Develop CO_2 Scenarios

Energy Production (%)

Electricity | District Heating

Period	Coal	Gas	CHP	Crude Oil	Biogas	Waste	Imports	Other Fossil	Geothermal	Hydraulic	Solar	Wind	Wood	Other renewables	Total
2007	0.0	6.05	0.0	0.0	0.0	0.0	86.93	0.0	0.0	5.22	0.14	1.66	0.0	0.0	100.00
2012	0.0	4.2	0.0	0.0	0.0	0.0	86.11	0.0	0.0	6.08	0.38	3.16	0.0	0.0	99.93
2017	0.0	2.15	0.0	0.0	0.0	0.0	85.27	0.0	0.0	7.03	0.68	4.85	0.0	0.0	99.98
2022	0.0	2.0	0.0	0.0	0.0	0.0	84.0	0.0	0.0	7.0	2.0	5.0	0.0	0.0	100.00
2027	0.0	2.0	0.0	0.0	0.0	0.0	81.0	0.0	0.0	7.0	5.0	5.0	0.0	0.0	100.00
2032	0.0	2.0	0.0	0.0	0.0	0.0	56.0	0.0	0.0	7.0	30.0	5.0	0.0	0.0	100.00

Energy Consumption per Sector (%) Toggle units to MWh

Industry | Residential | Tertiary | Road Transport | Agriculture | Rail Transport | Ship Transport

Period	Coal	Gas	CHP	Crude Oil	Diesel	Gasoline	LPG	Biogas	District Heating	Electricity	Other Fossil	Geothermal	Wood	Other renewables	Total
2007	0.0	18.0	0.0	41.2	0.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	99.20
2012	0.0	18.5	0.0	41.1	0.0	0.0	0.0	0.0	0.0	40.3	0.0	0.0	0.0	0.0	99.90
2017	0.0	18.5	0.0	41.2	0.0	0.0	0.0	0.0	0.0	40.3	0.0	0.0	0.0	0.0	100.00
2022	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	0.00
2027	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	0.00
2032	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	0.00

- Emission Factors

CO2 (t/MWh) | CH4 (g/MWh) | N2O (g/MWh)

Period	Coal	Gas	CHP	Crude Oil	Diesel	Gasoline	LPG	Biogas	Excess Heat	Waste	Imports	Other Fossil	Geothermal	Hydraulic	Solar	Wind	Wood	Other renewables
2007	0.3406	0.266	0.0	0.263	0.266	0.249	0.227	0.196	0.0	0.33	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	0.3406	0.266	0.0	0.263	0.266	0.249	0.227	0.196	0.0	0.33	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	0.3406	0.266	0.0	0.263	0.266	0.249	0.227	0.196	0.0	0.33	0.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2022	0.3406	0.266	0.0	0.263	0.266	0.249	0.227	0.196	0.0	0.33	0.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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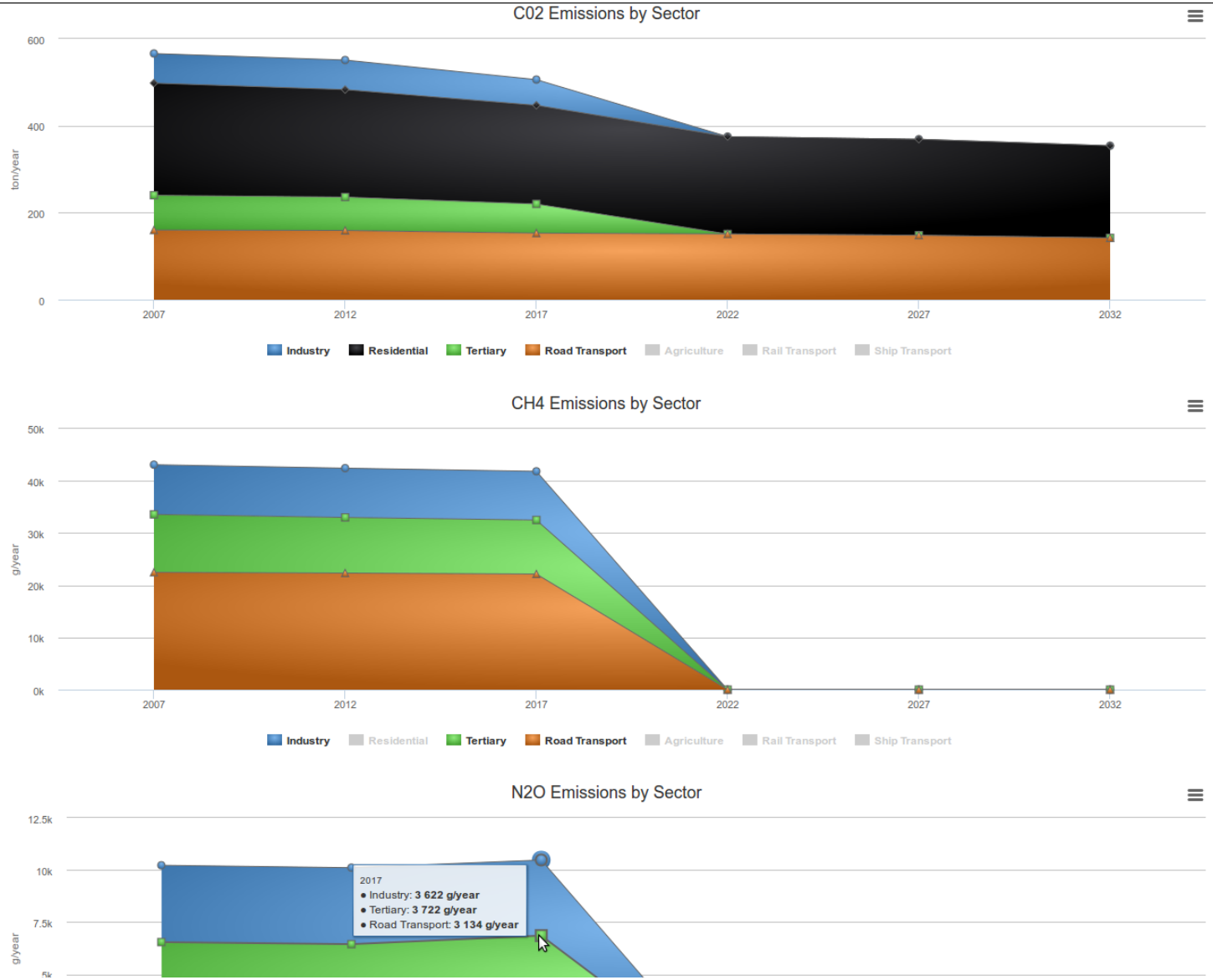
Develop CO_2 Scenarios

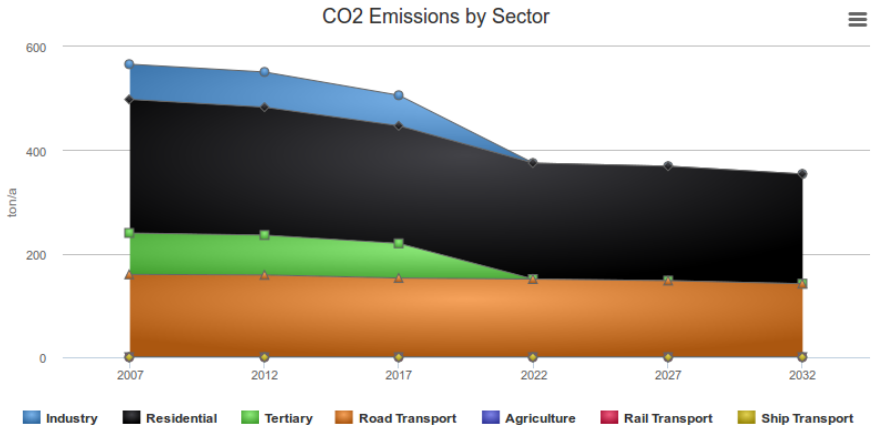


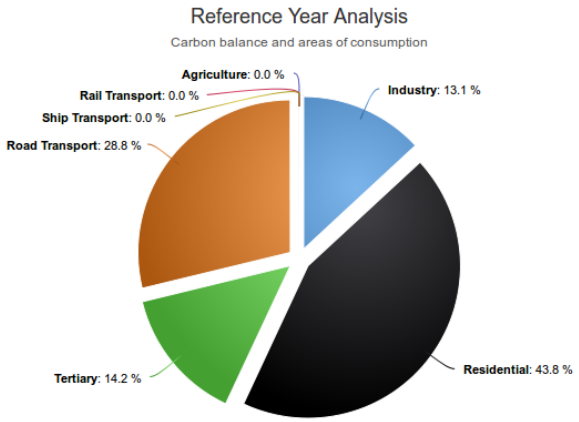
Assess Scenarios

Energie Klimaschutz in der Schule

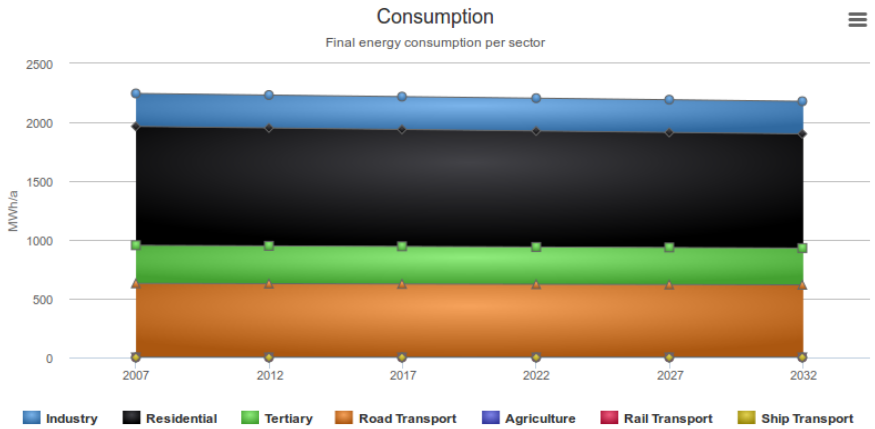
2007 - 2037

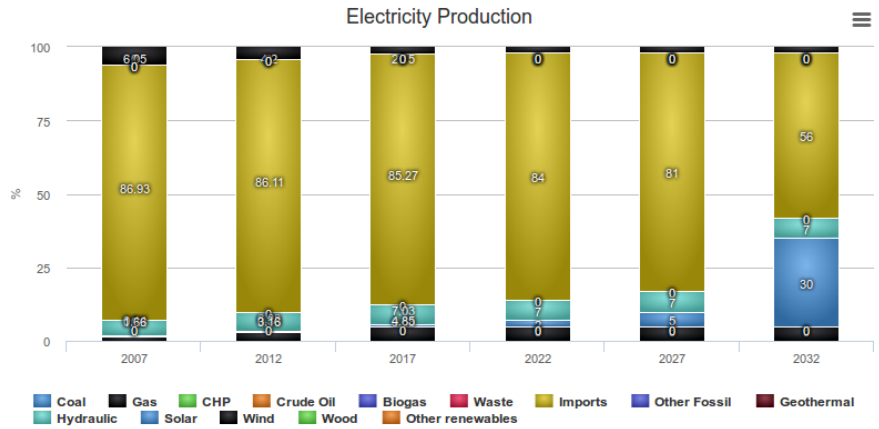
Emissions



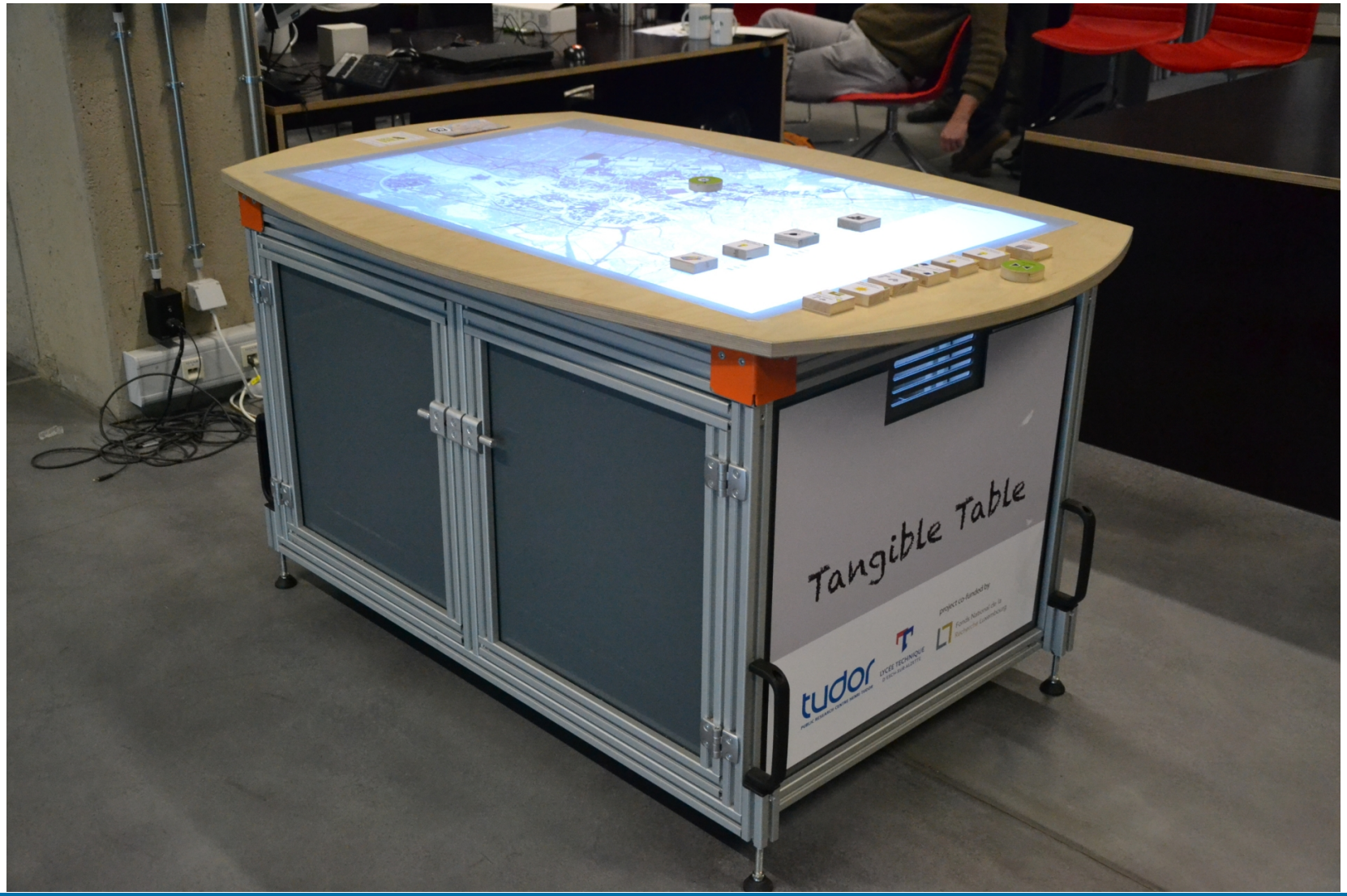


Energy



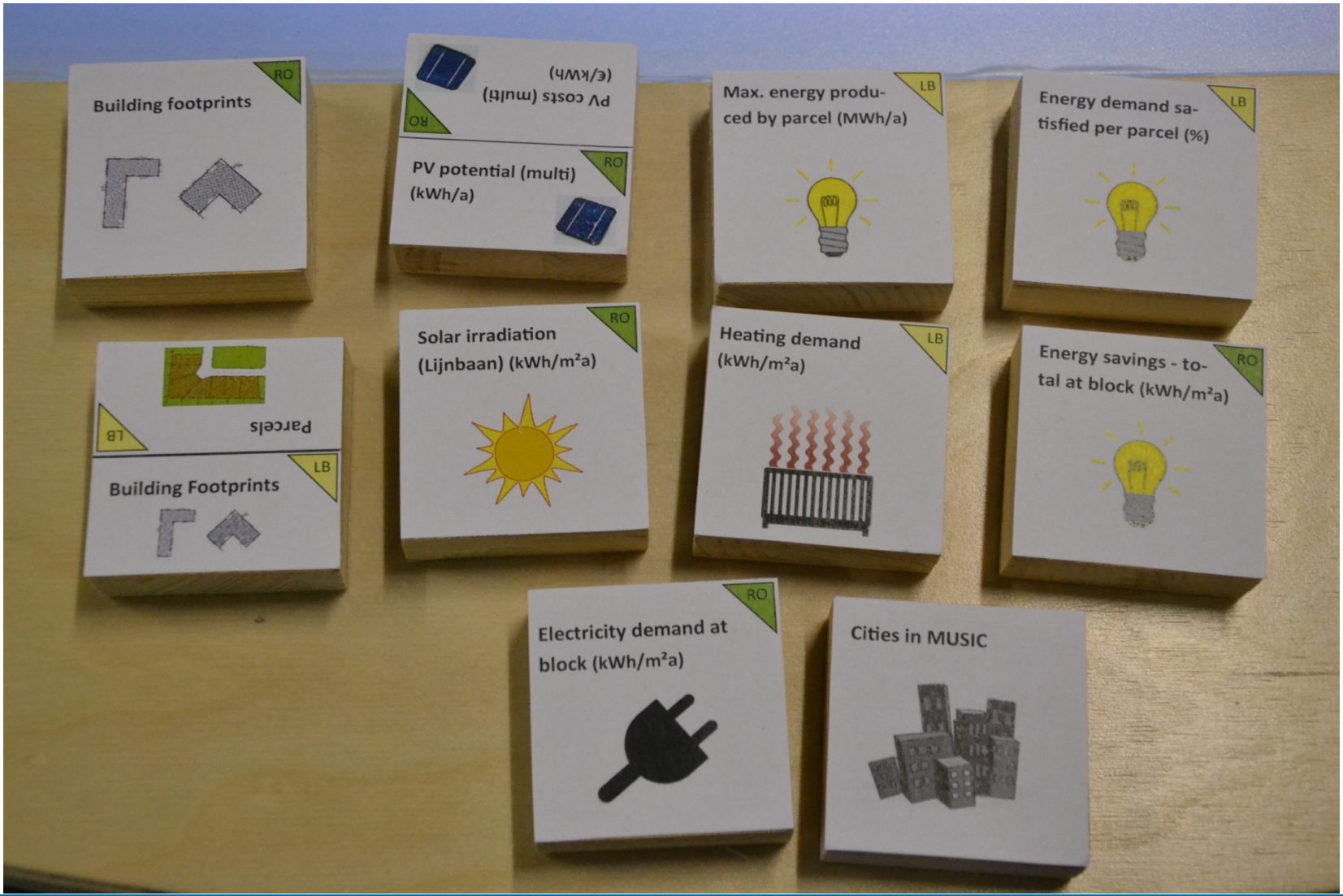


iGUESS for Tangible Tables



iGUESS for Tangible Tables – Maps and Objects

iGUESS for Tangible Tables – Objects



iGUESS for Tangible Tables – Zoom to map

iGUESS impacts

- iGUESS can help finding answers to complex questions;
- iGUESS helps cities to develop innovative strategies, e.g. open data access, mobile app developments, Solar PV for social housing, strategic CO_2 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 cities and new opportunities.

Thank you for your attention!

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