

Geo-dependent Heat Demand Model of the Swiss Building Stock

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University of Geneva



Organisers:



International Co-owners:



Final energy due to Space heating and domestic hot water production of the Swiss building stock?

What amount

Where

When

More information on spatial and temporal constraints



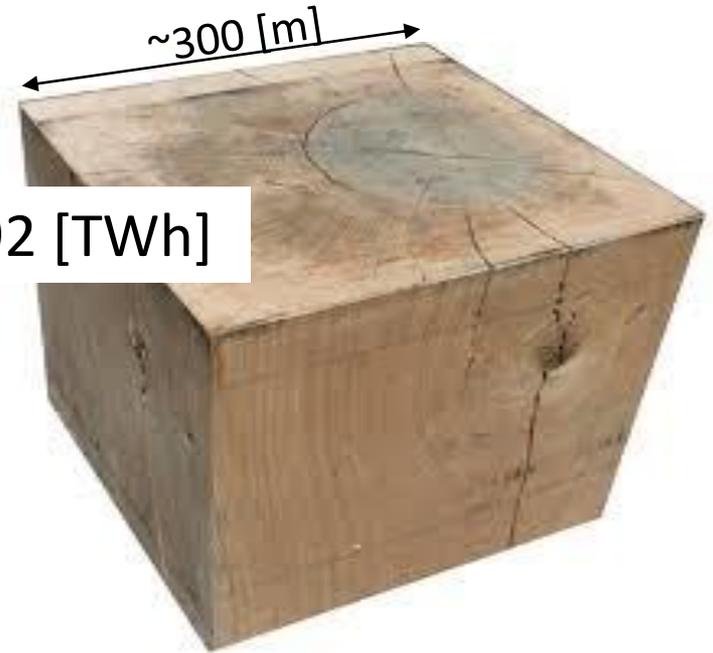
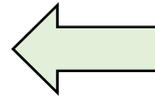
Organisers:



International Co-owners:



Final energy: What amount?



Estimation using national energy consumption statistics^[1]

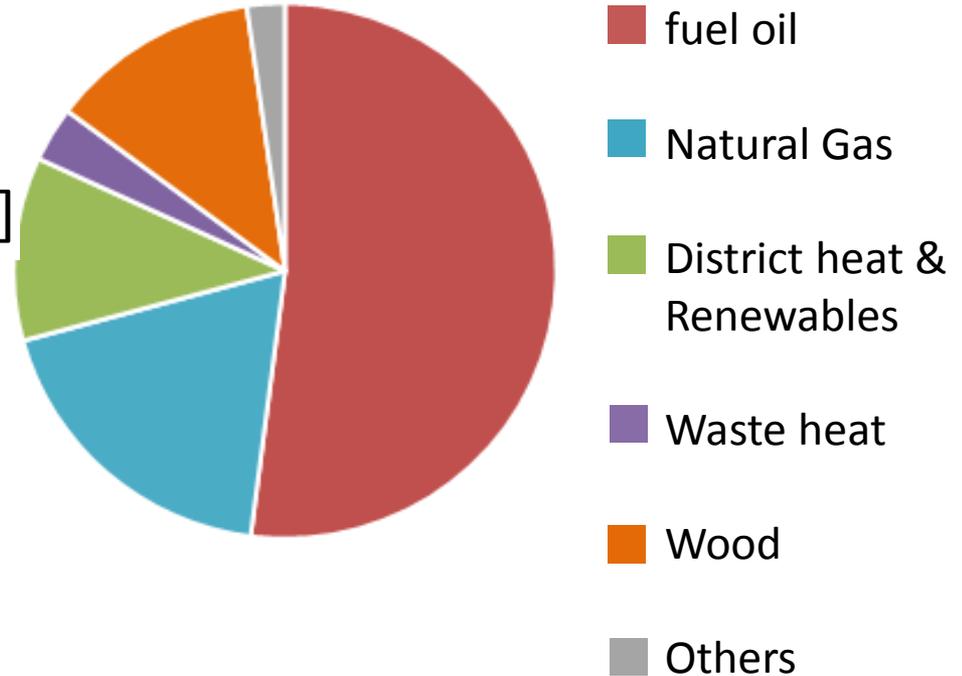
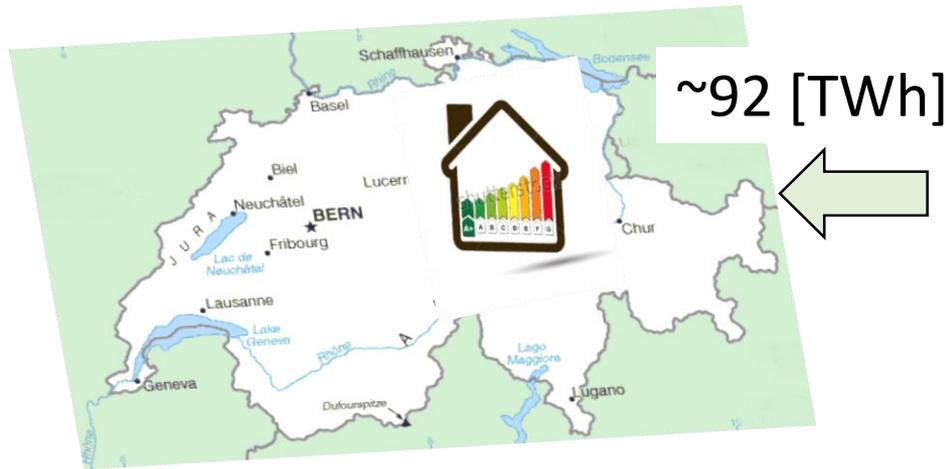
[1]: A. Kemmler, A. Piégsa, A. Ley, P. Wüthrich, M. Keller, M. Jakob, and G. Catenazzi. 2014. "Analyse Des Schweizerischen Energieverbrauchs 2000 - 2013 Nach Verwendungszwecken". Bundesamt für Energie Bern



International Co-owners:



Final energy: What amount?

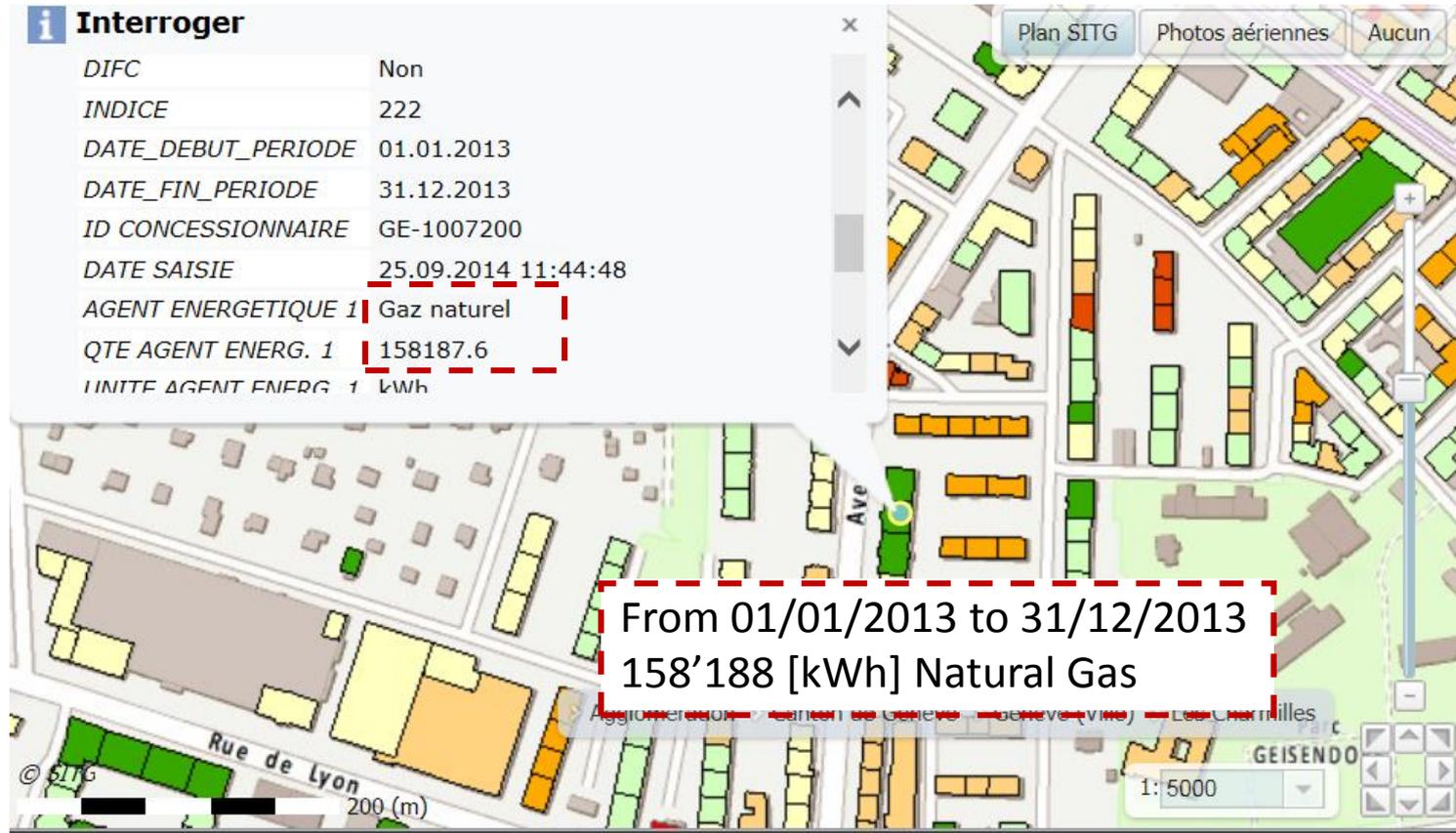


Estimation using national energy consumption statistics

Final energy: Where?

Partially available:

- SITG Geneva
- GEAK
- Town of Basel
- MEU



At Swiss level?

→ Bottom up extrapolation model GIS heat demand estimation

Final energy: Where? Estimation using a bottom-up model

[1] GWR, Swiss Federal Statistical Office

Swiss national building register (GWR)^[1]

- *EGID* : National building identifier
- *Type*: Building type
- *Age*: Building age
- A_{Gross} : Ground surface * Nb. floors
- $A_{Dwelling}$: Dwelling surface
- (x,y) : Building coordinates
- Main energy carrier

Around 2 millions buildings

Calibration

- SITG IDC Database
- CECB/GEAK Database

Around 27'000 buildings

Estimated heated surface (A_E)

A_E function of

- *Type*: Building type
- A_{Gross}
- $A_{Dwelling}$

Estimated heat demand per m²

E_{hww} function of

- *Type*: Building type
- *Age*: Building age

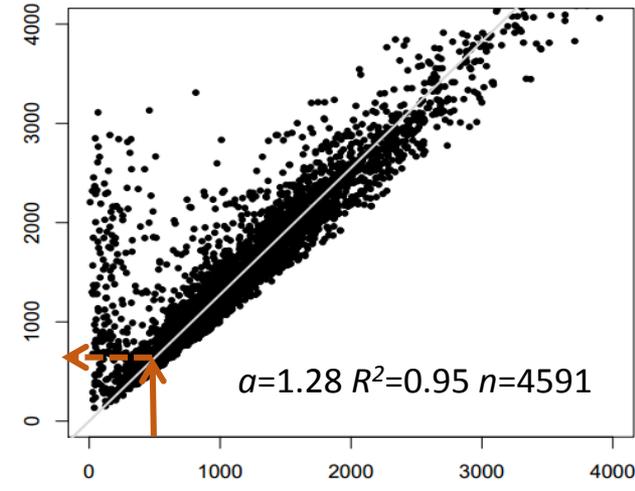
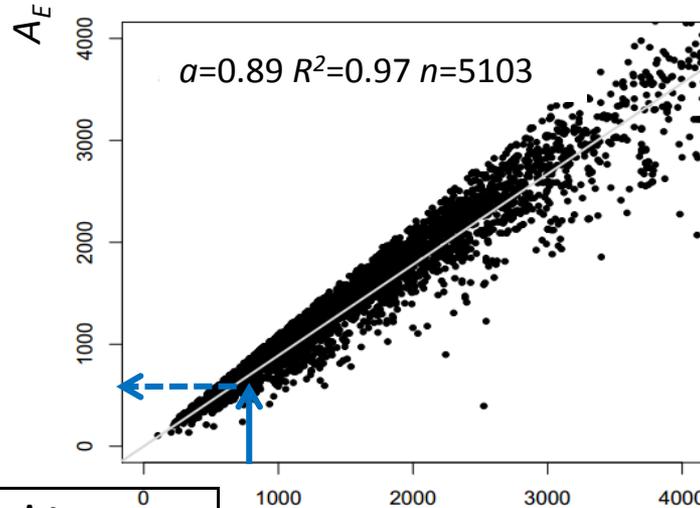
Estimated heat demand of building

$$E = A_E \times E_{hww}$$

Estimated heat demand of a Pixel

- Sum of all buildings within a pixel
- Estimation of a confidence interval

A_E estimation: an example with a collective residential building



Total surface

Dwelling surface

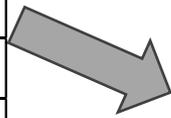
Calibration SITG IDC

Swiss national building register	
Kanton	BS
EGID	111111111
Address	Musterstr. 1
Building type	Collective residential
Building age	1919-1945
Total surface	740 ←
Dwelling surface	492 ←
GKODX	610205
GKODY	267341
Main energy carrier	District heat

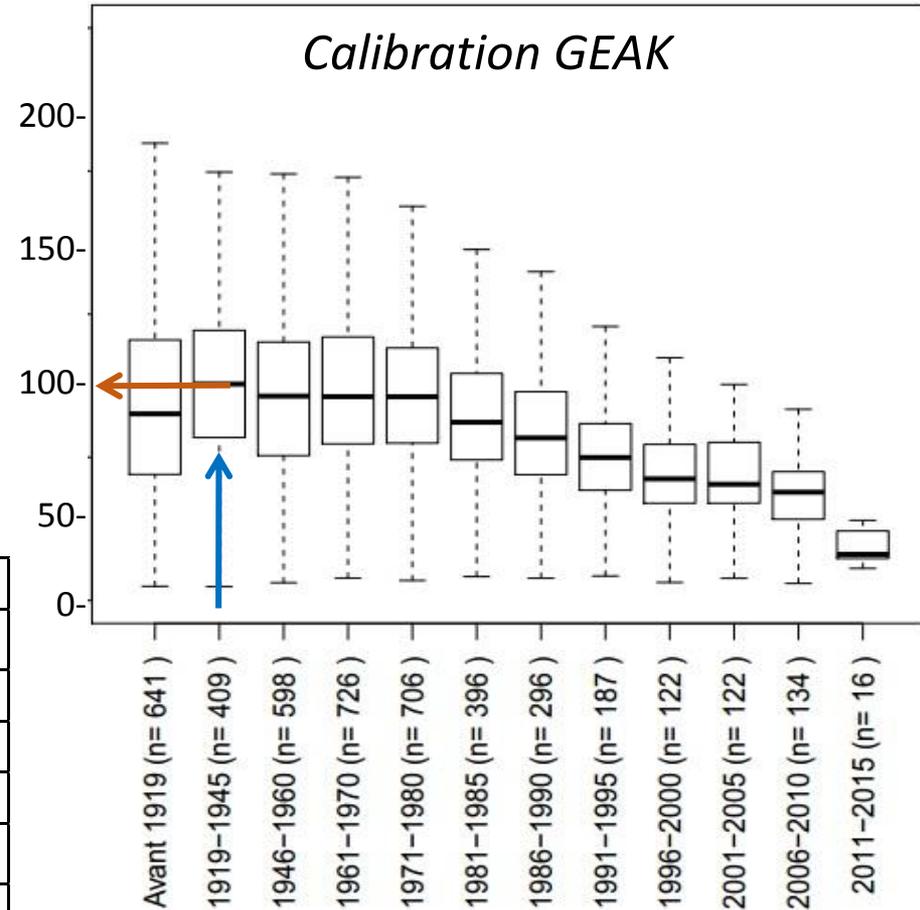
Heated surface	
Slope of linear regression 1	0.89
Slope of linear regression 2	1.28
Estimation 1 = 0.89 x 740	658.9 ←
Estimation 2 = 1.28 x 492	627.5 ←
Estimation of heated surface	658.9

Heat demand estimation: an example with a collective residential building

Swiss national building register	
GDEKT	BS
EGID	111111111
Address	Musterstr. 1
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Q_h (HDD GE) [kWh/m²]



Heat demand	
Q_h (HDD GE)	97 [kWh/m ²]
Heating degree days (GE)	2863 [K Tag]
Heating degree days (BS)	2932 [K Tag]
Climate correction = 2932.3/2863	1.02
Q_h (BS) = 348.8 x 1.024 =	99 [kWh/m ²]
Q_{ww} (SIA 380/1)	21 [kWh/m ²]
$Q_{hww} = Q_h + Q_{ww} = 357.2 + 75 =$	120 [kWh/m ²]
$E_{hww} = Q_{hww} \times 1/Nu$	126 [kWh/m ²]
E [kWh / year] = $E_{hww} \times A_E = 451.9 \times 658.9$	82'705 [kWh]



International Co-owners:



Sustainable Buildings and Climate Initiative



Global Alliance for Buildings and Construction

Analogue models for other building types

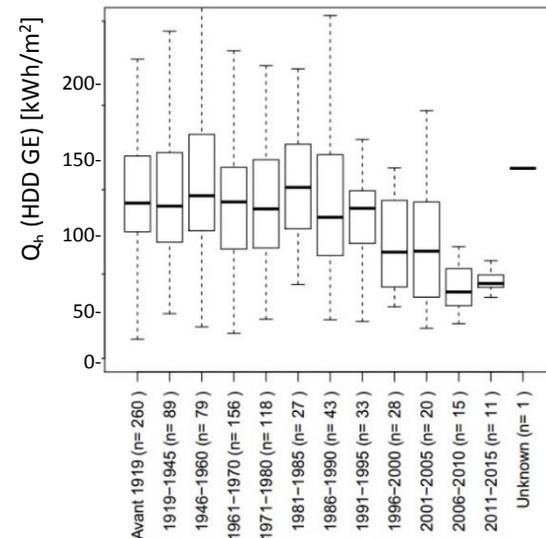
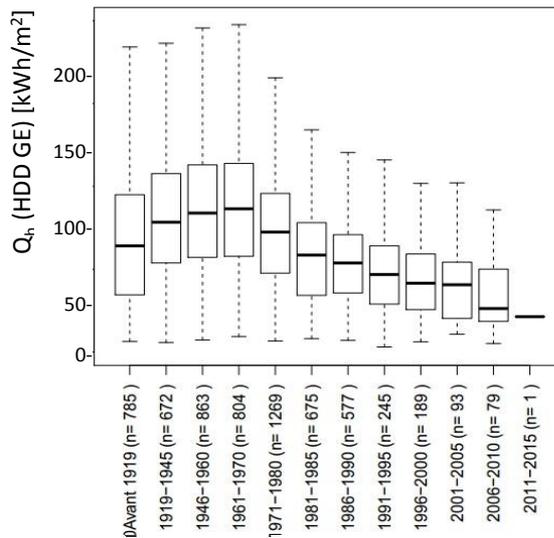
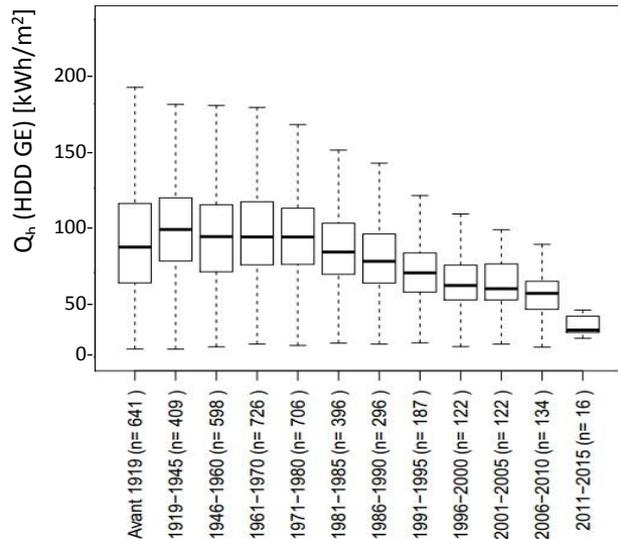
Collective residential



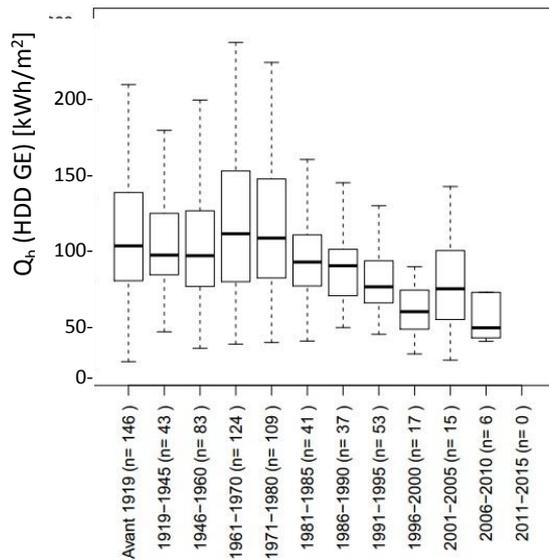
Individual residential



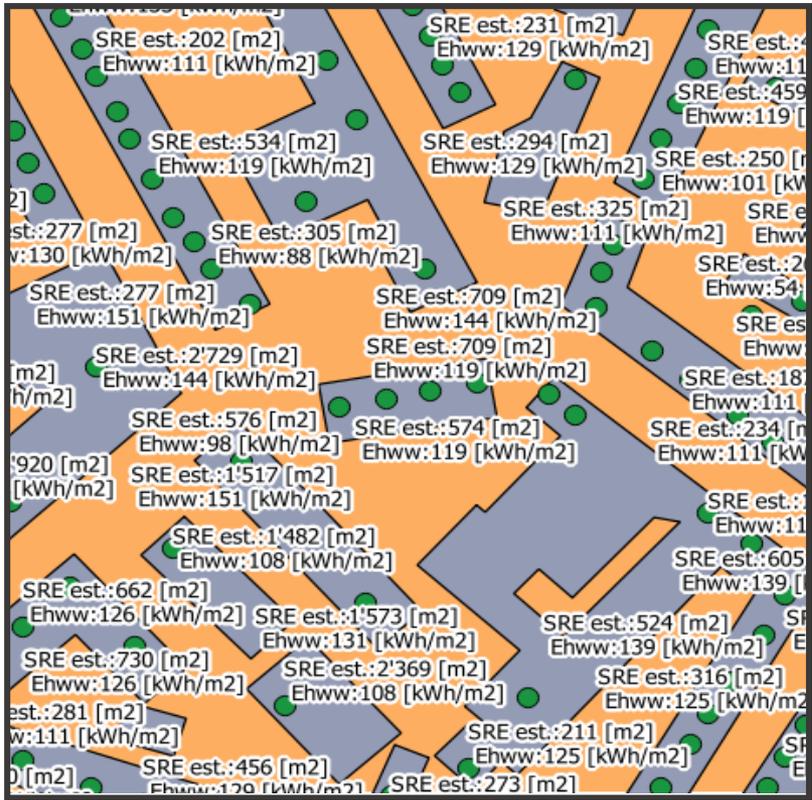
Mixed usage



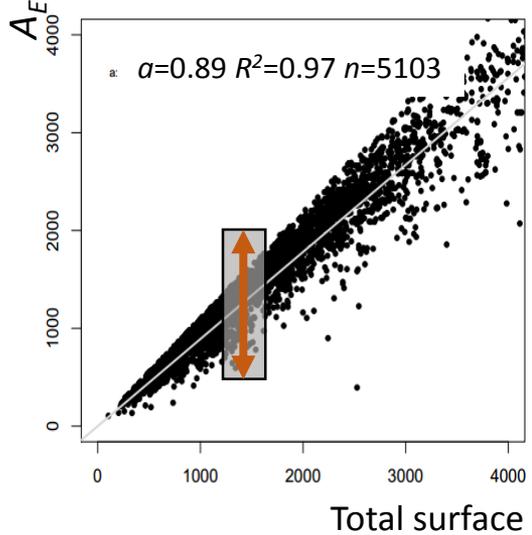
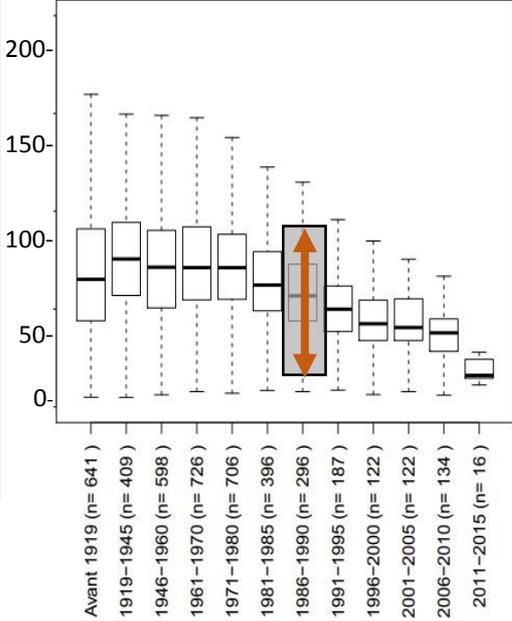
Industry, hotels,



Heat demand estimation: Pixel = Sum of estimation for each building located in the pixel



Confidence interval computed with a bootstrap resampling algorithm



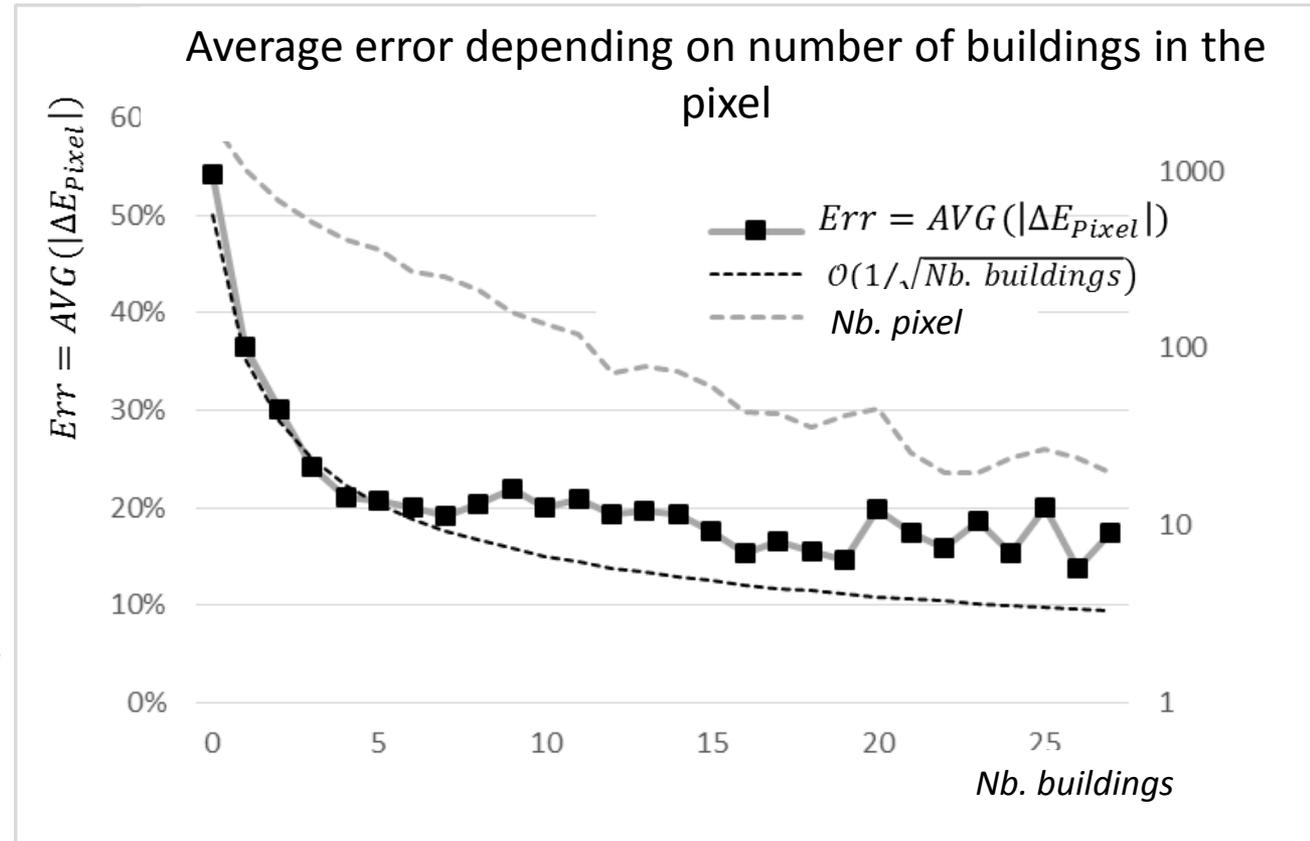
How accurate is the estimation?

- Might be important on individual buildings

- Under and over estimations may compensate

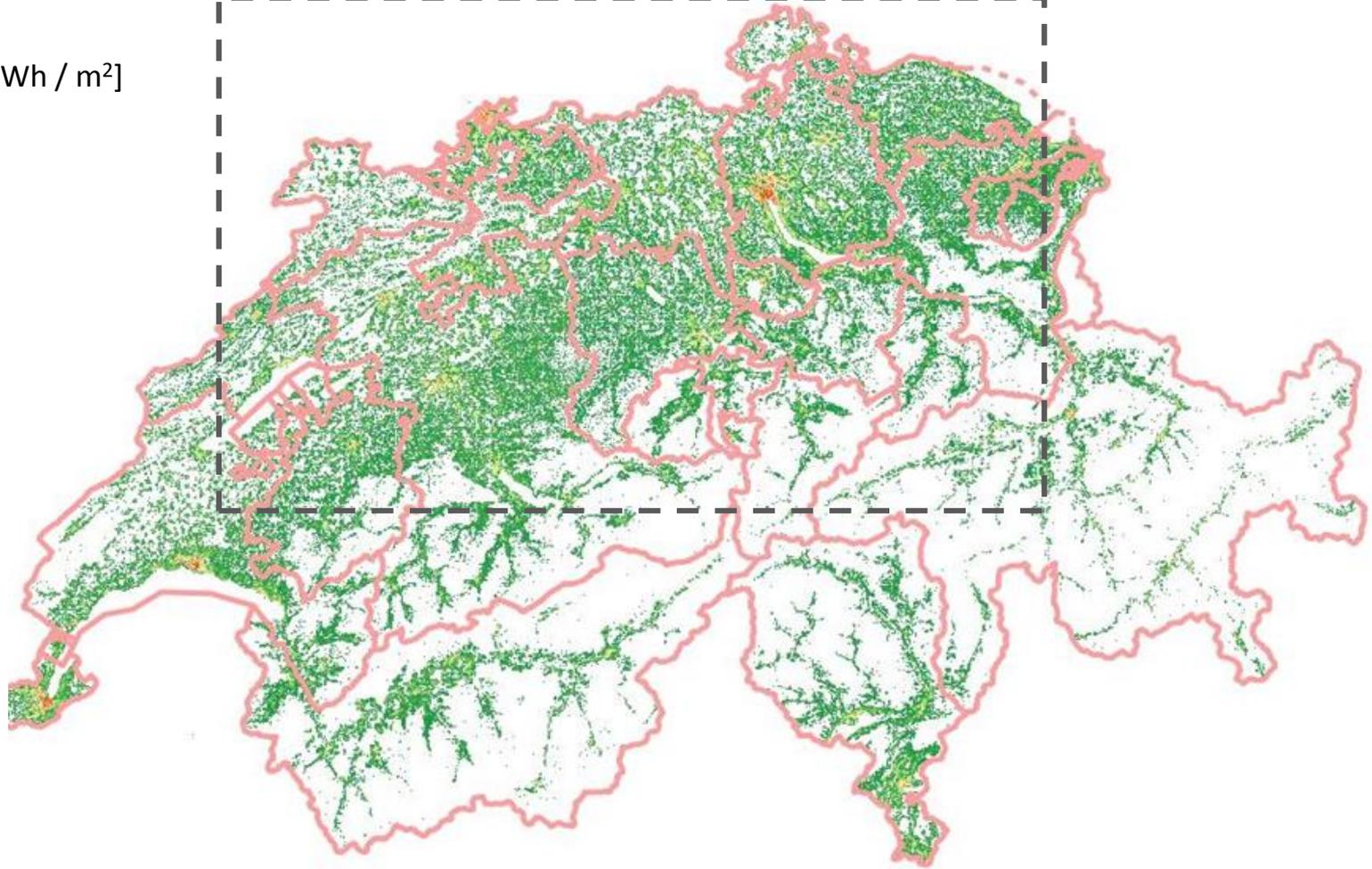
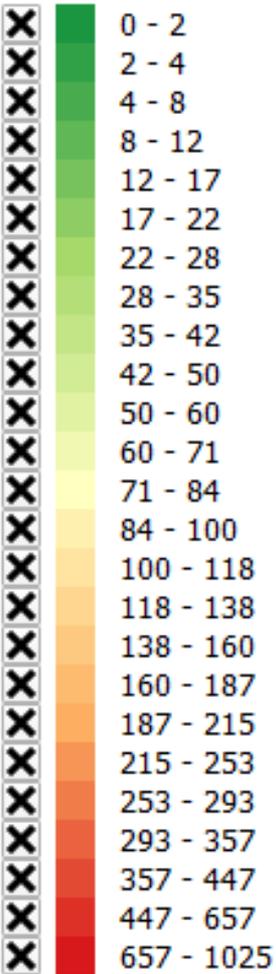
- Central limit theorem

$$Err = \mathcal{O}(1/\sqrt{Nb. buildings})$$



Final energy: Where? GIS-Maps of Switzerland

Heat demand [kWh / m²]



Sum over all buildings: 94 [TWh / year]



Organisers:

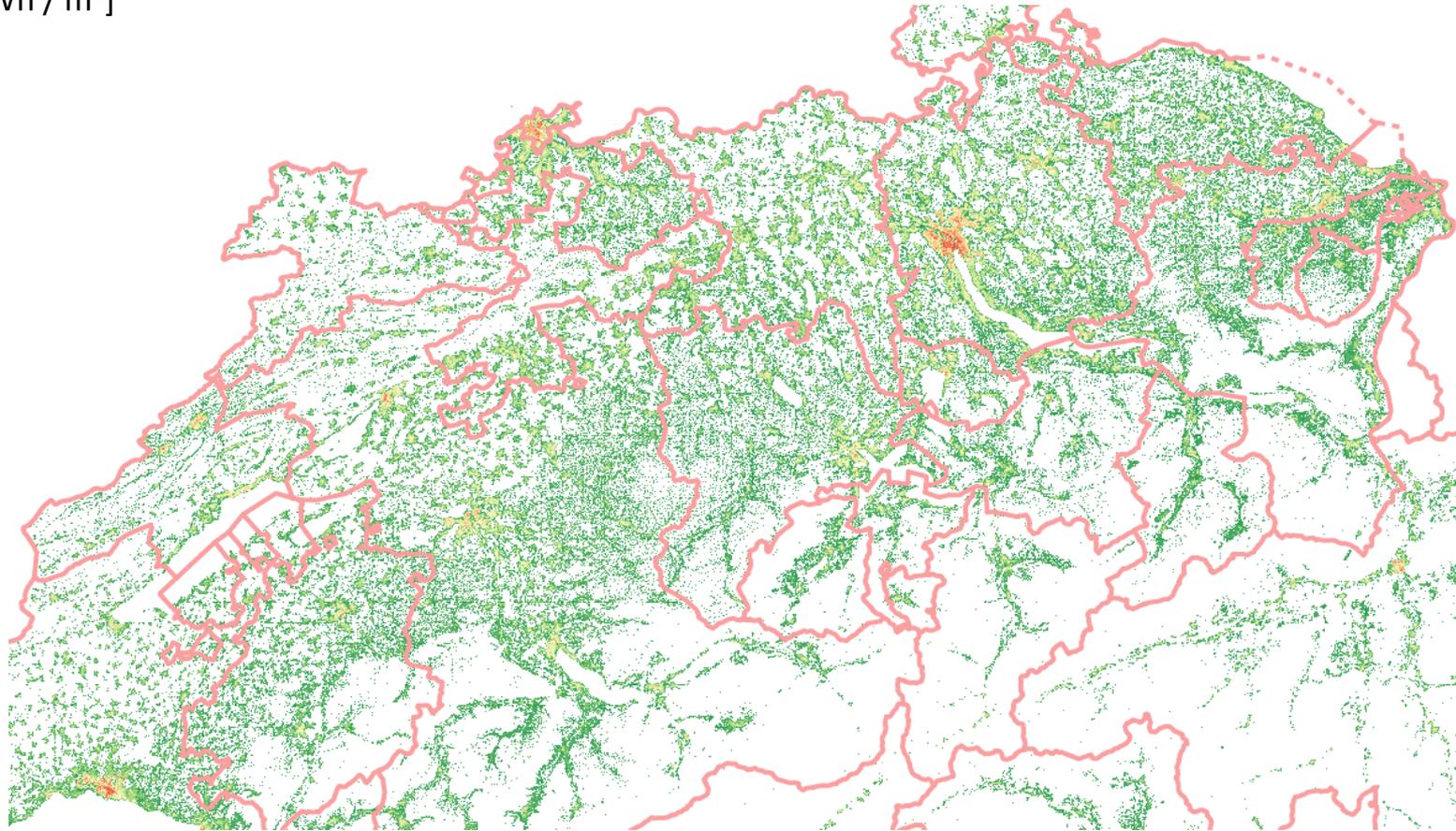
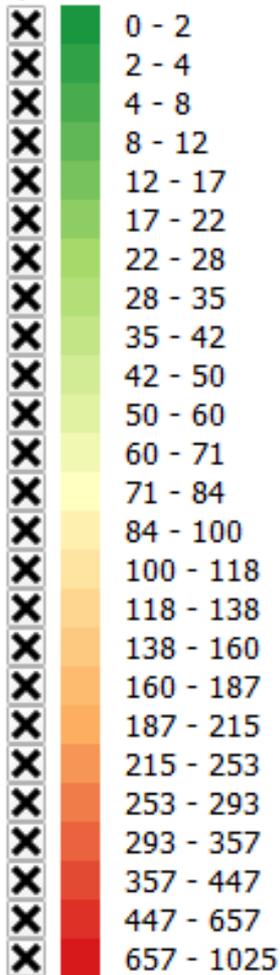


International Co-owners:



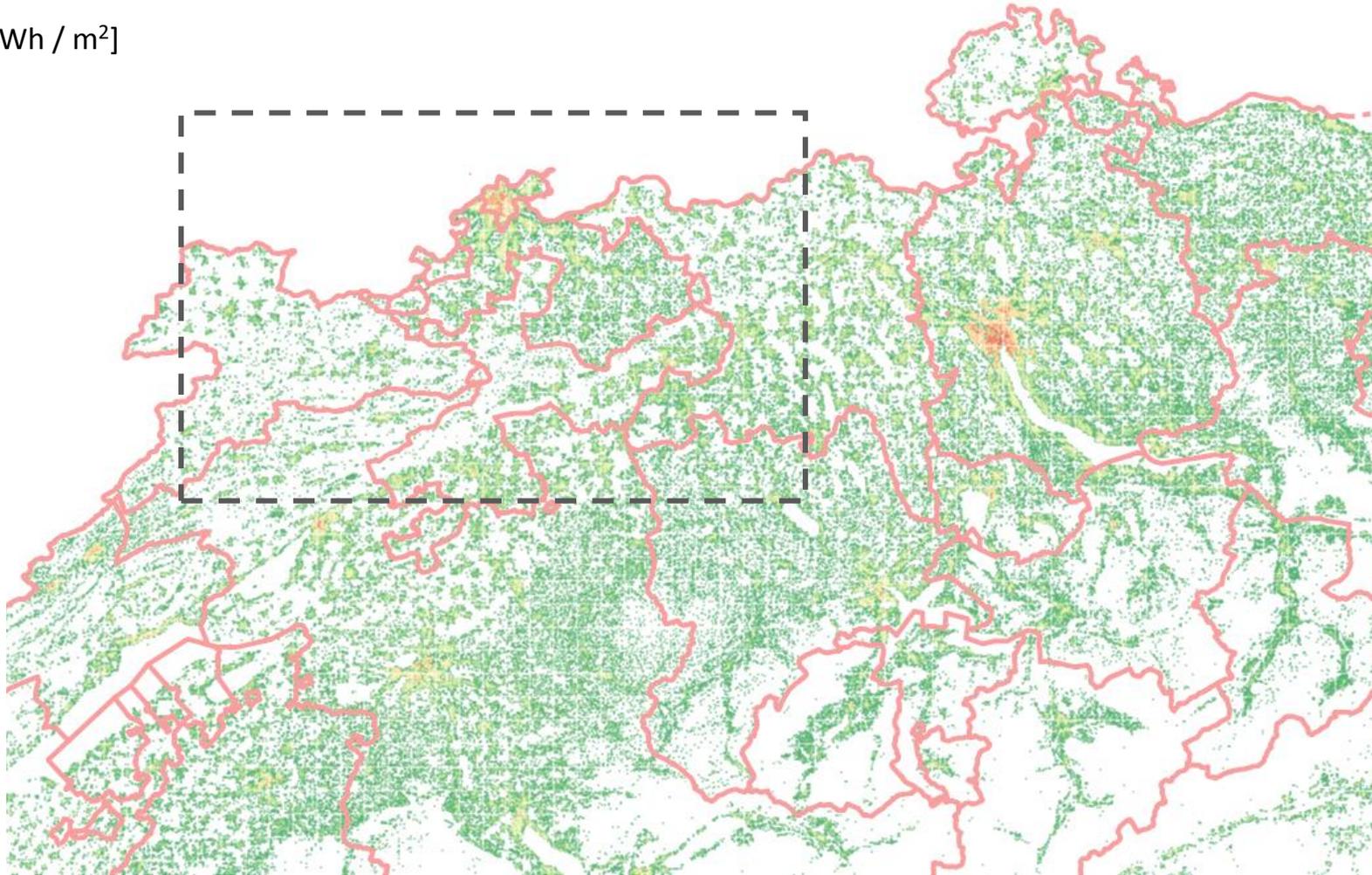
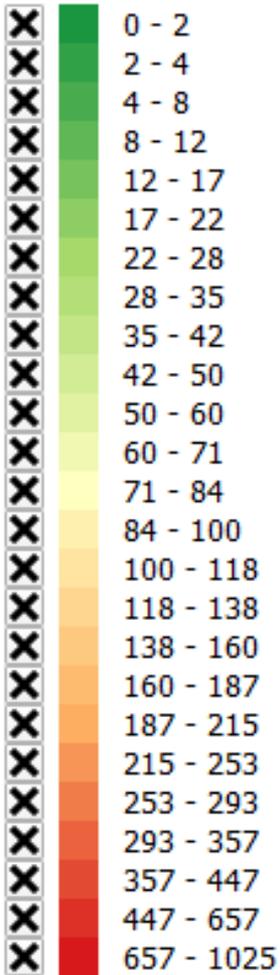
Final energy: Where? GIS-Maps of Switzerland

Heat demand [kWh / m²]



Final energy: Where? GIS-Maps of Switzerland

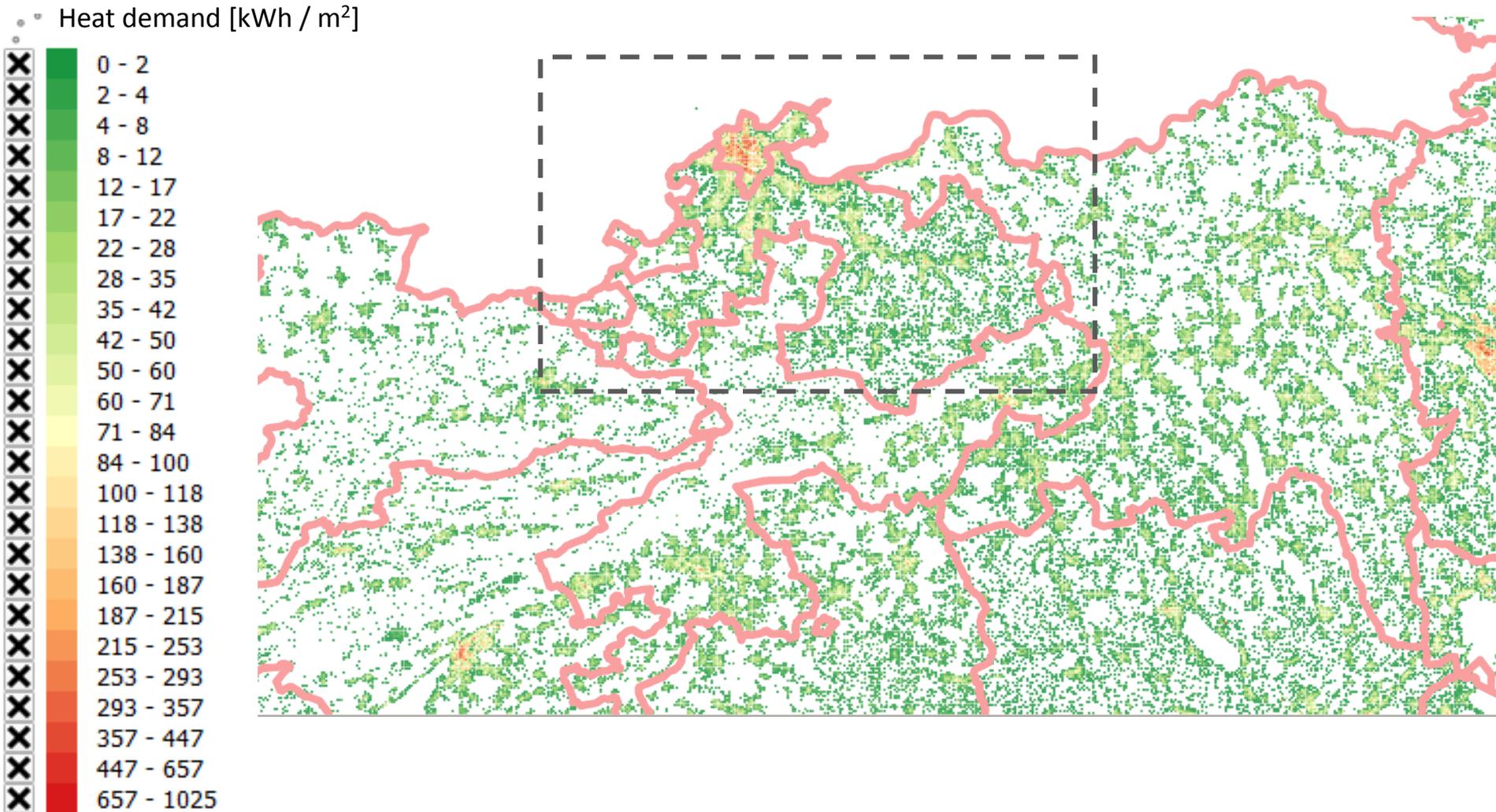
Heat demand [kWh / m²]



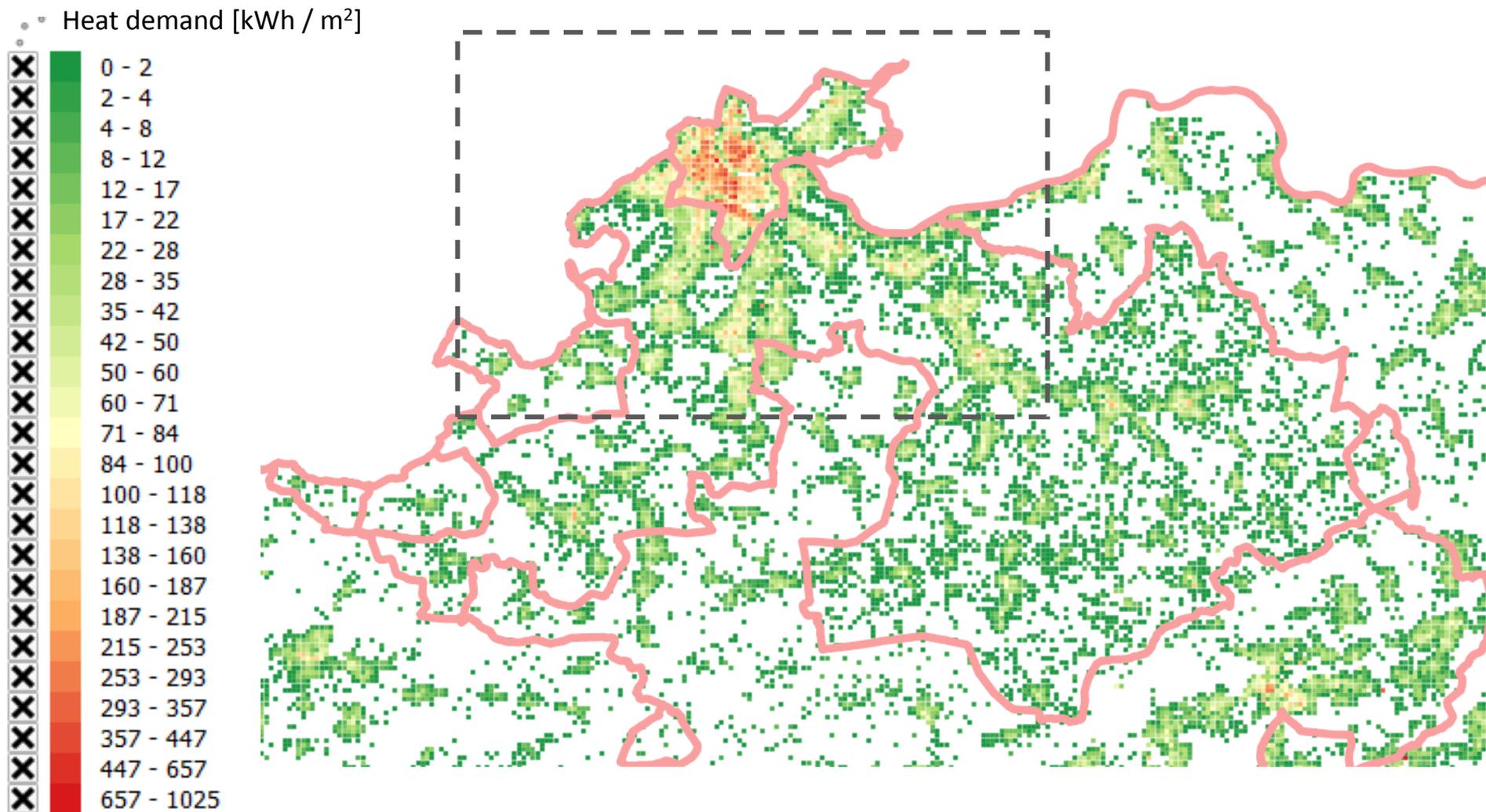
Organisers:

International Co-owners:

Final energy: Where? GIS-Maps of Switzerland

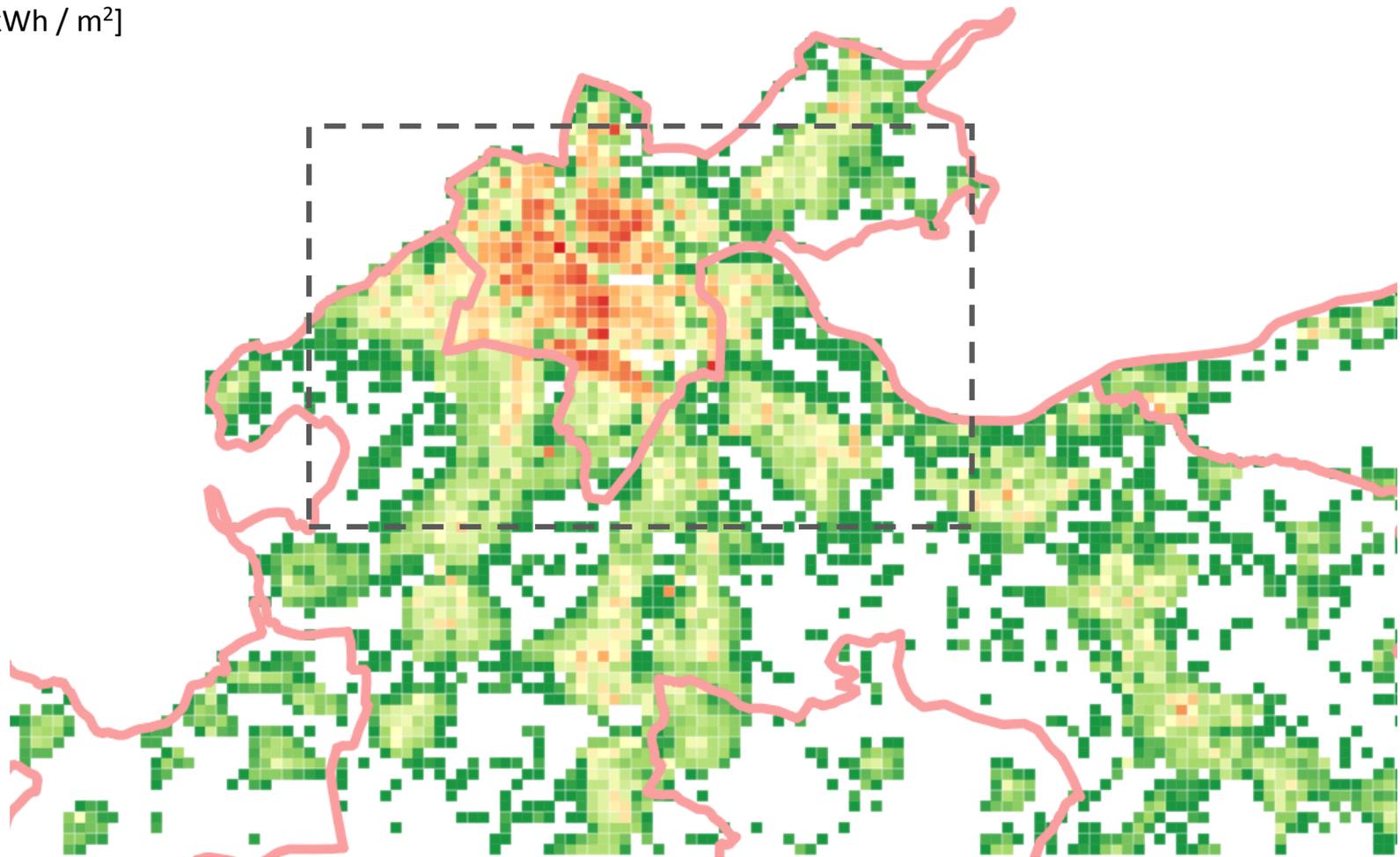
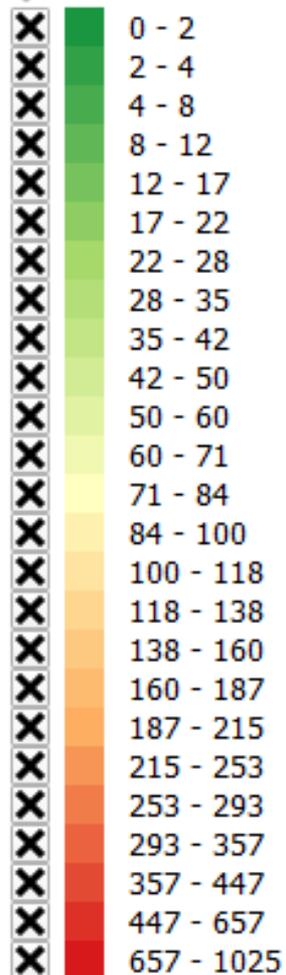


Wärmebedarf: Wo? GIS- Karten der Schweiz



Final energy: Where? GIS-Maps of Switzerland

Heat demand [kWh / m²]

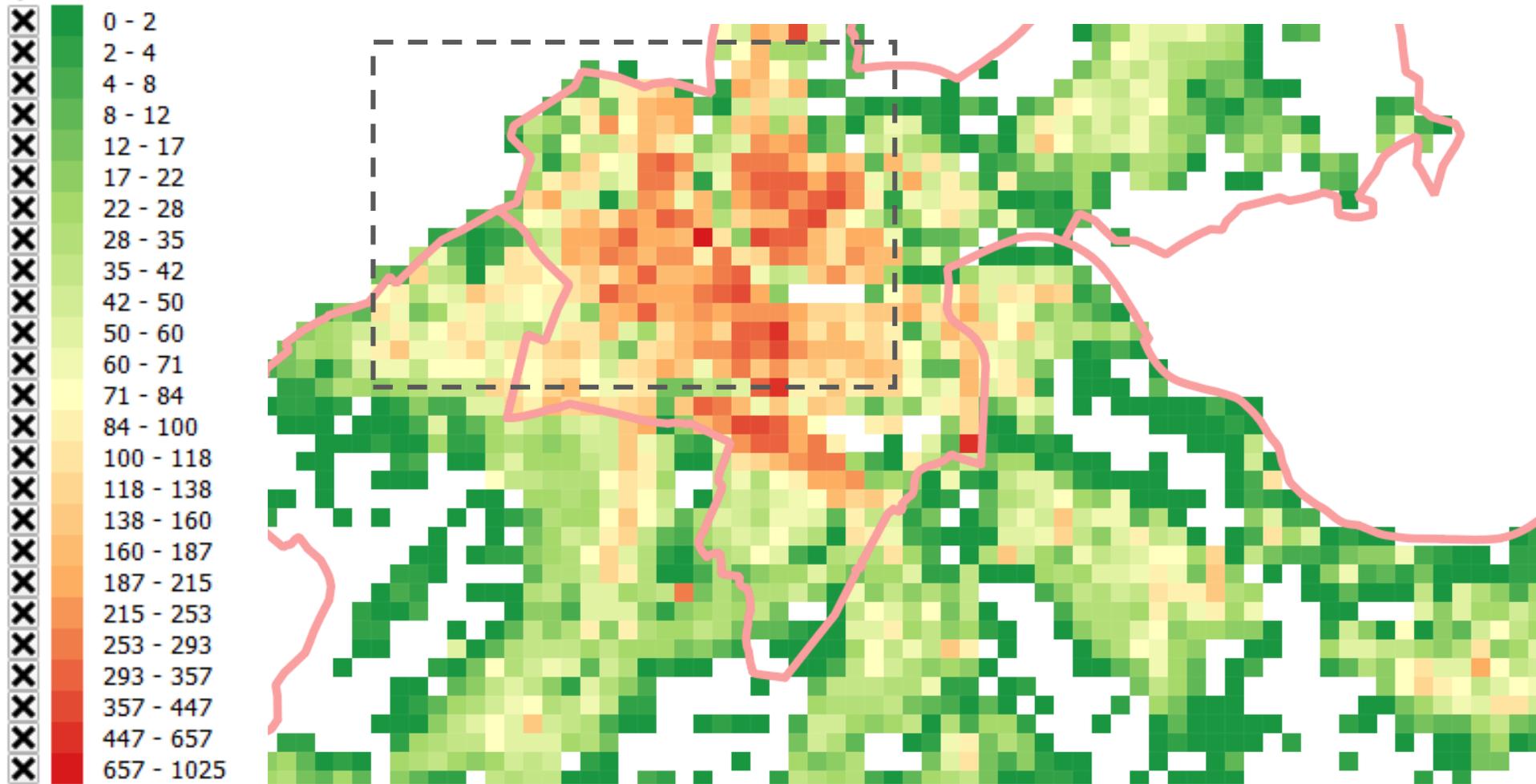


Organisers:

International Co-owners:

Final energy: Where? GIS-Maps of Switzerland

Heat demand [kWh / m²]



Organisers:



International Co-owners:

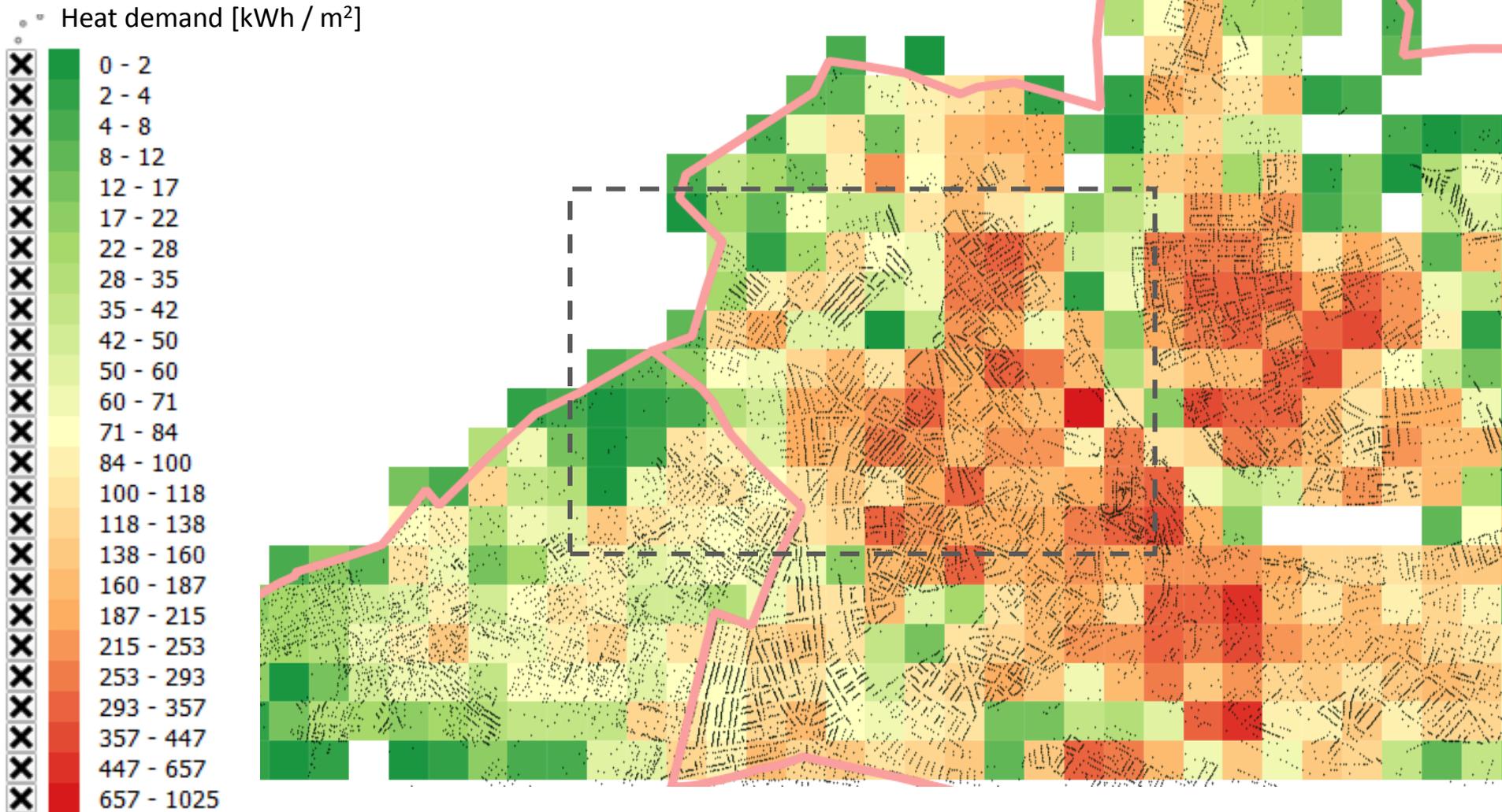


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Final energy: Where? GIS-Maps of Switzerland



Organisers:

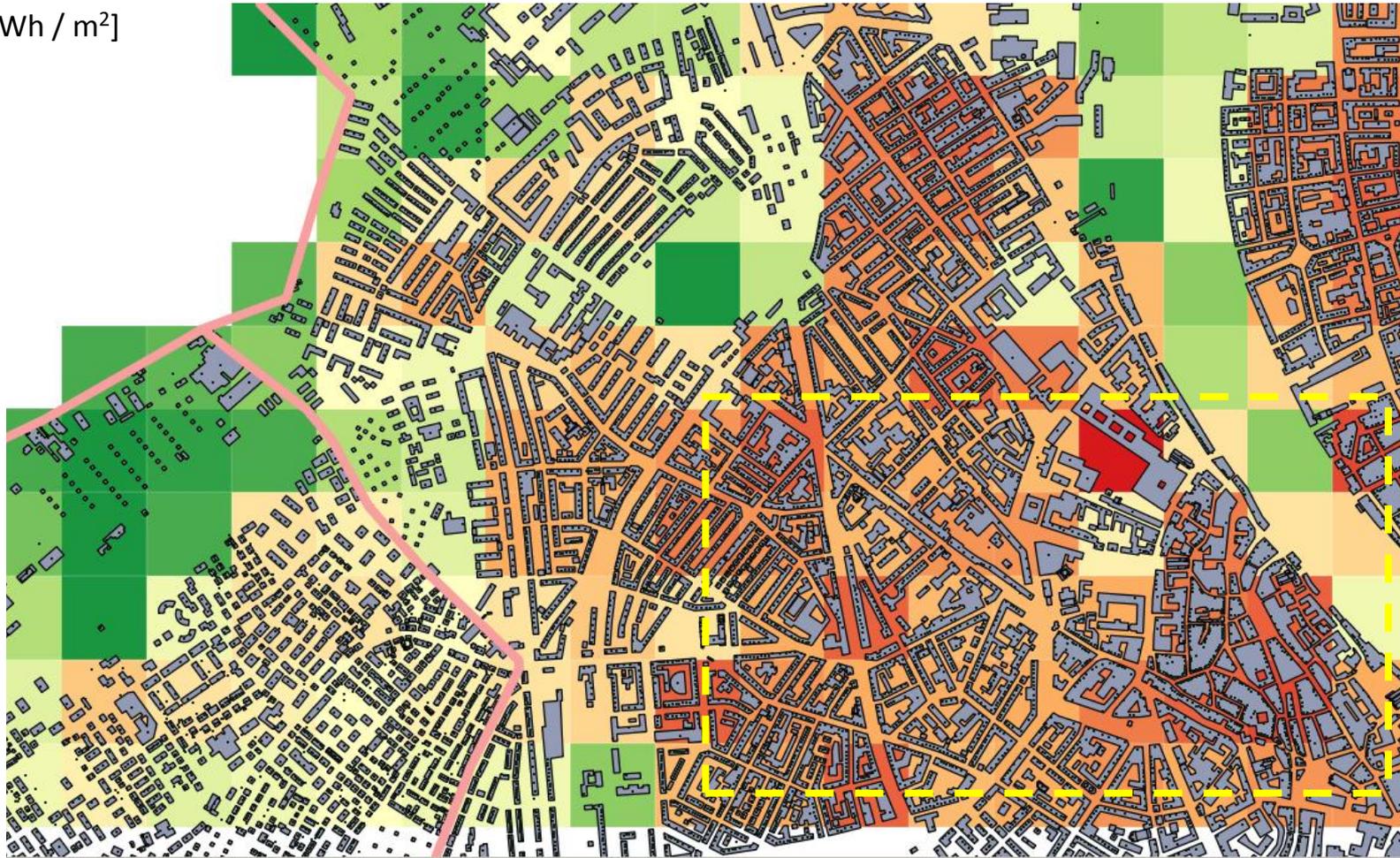
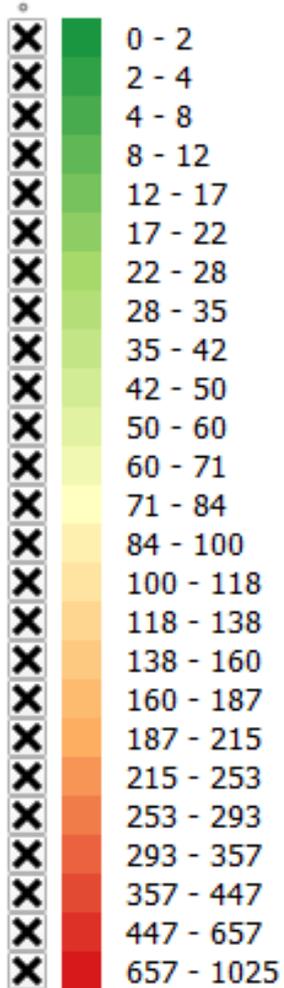


International Co-owners:



Final energy: Where? GIS-Maps of Switzerland

Heat demand [kWh / m²]



Organisers:

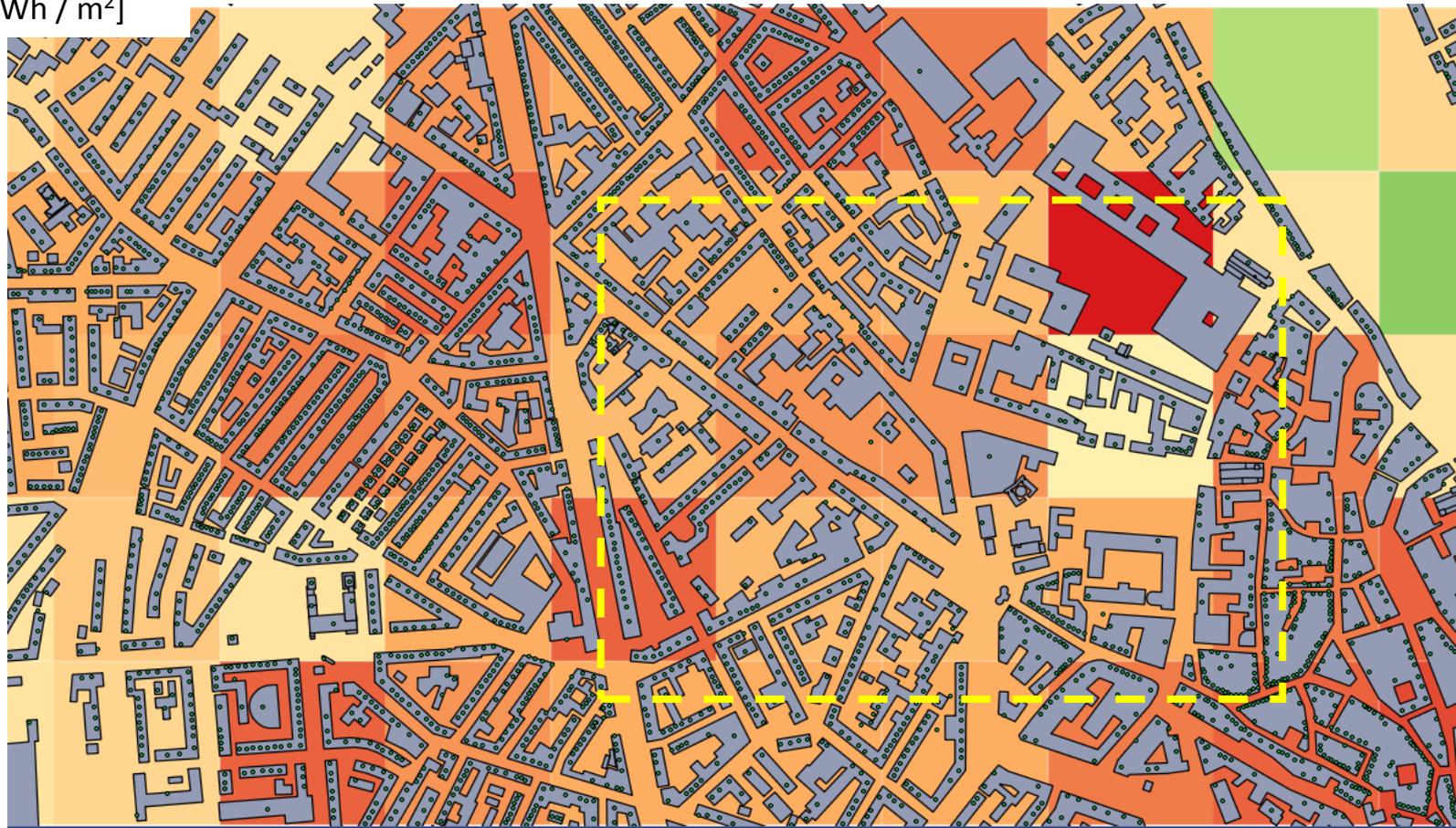
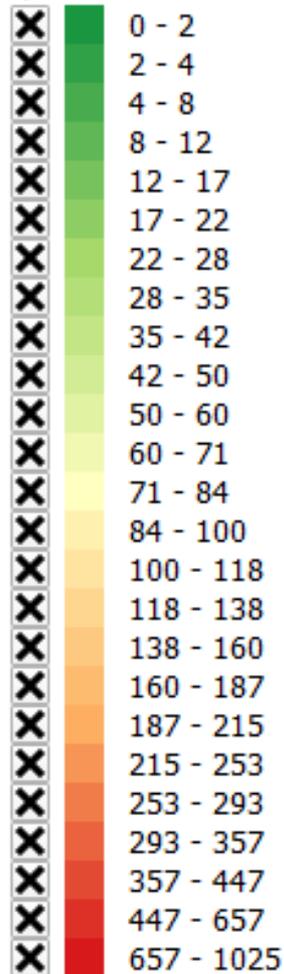


International Co-owners:



Final energy: Where? GIS-Maps of Switzerland

Heat demand [kWh / m²]



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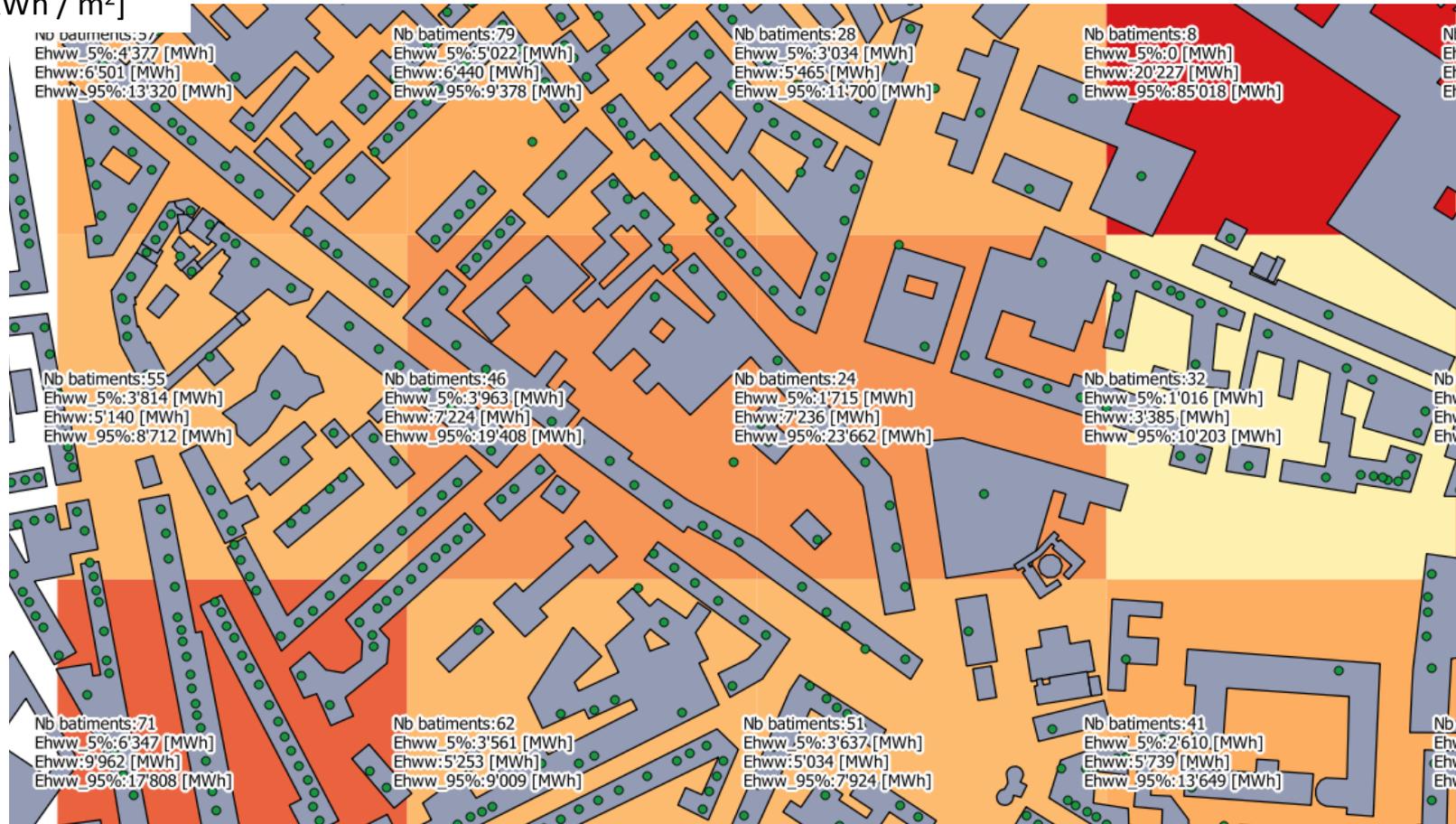
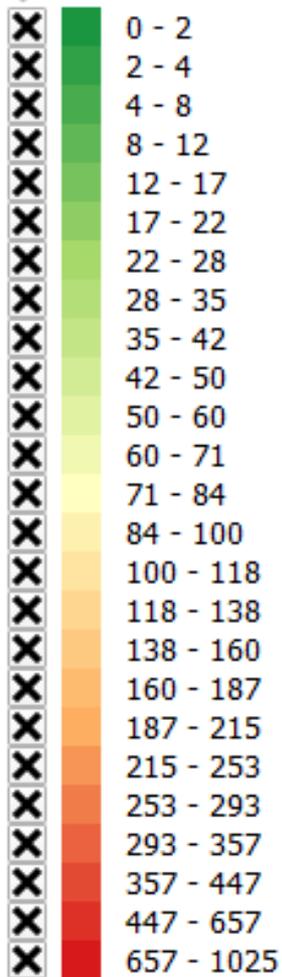


International Co-owners:



Final energy: Where? GIS-Maps of Switzerland

Heat demand [kWh / m²]



Organisers:



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Final energy due to space heating and domestic hot water production, conclusions and next steps

What amount

Bottom-up model

Where

Simple and flexible

Results close to national statistics

When

Hourly temperatures

Thermal inertia

Solar gains



Organisers:



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and Climate Initiative
Promoting Policies and Practices for Sustainability



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Thank you

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Granted by fund: KTI.2014.0119

UNIVERSITÉ DE GENÈVE

Geo-dependent energy supply / demand
Web Service

EPFL
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Welcome to the geo dependent energy supply/demand web service ©

Documentation for using the web service is available on the IUCS platform.
To access the web service description page with function list and WSDL file follow this link
Sample of client software to query service is available here

x_coord, y_coord

Event Size



Organisers:



International Co-owners:

