MEU:
A GIS-Web-Platform for the Management and Planning of Urban Energy Systems

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Overview

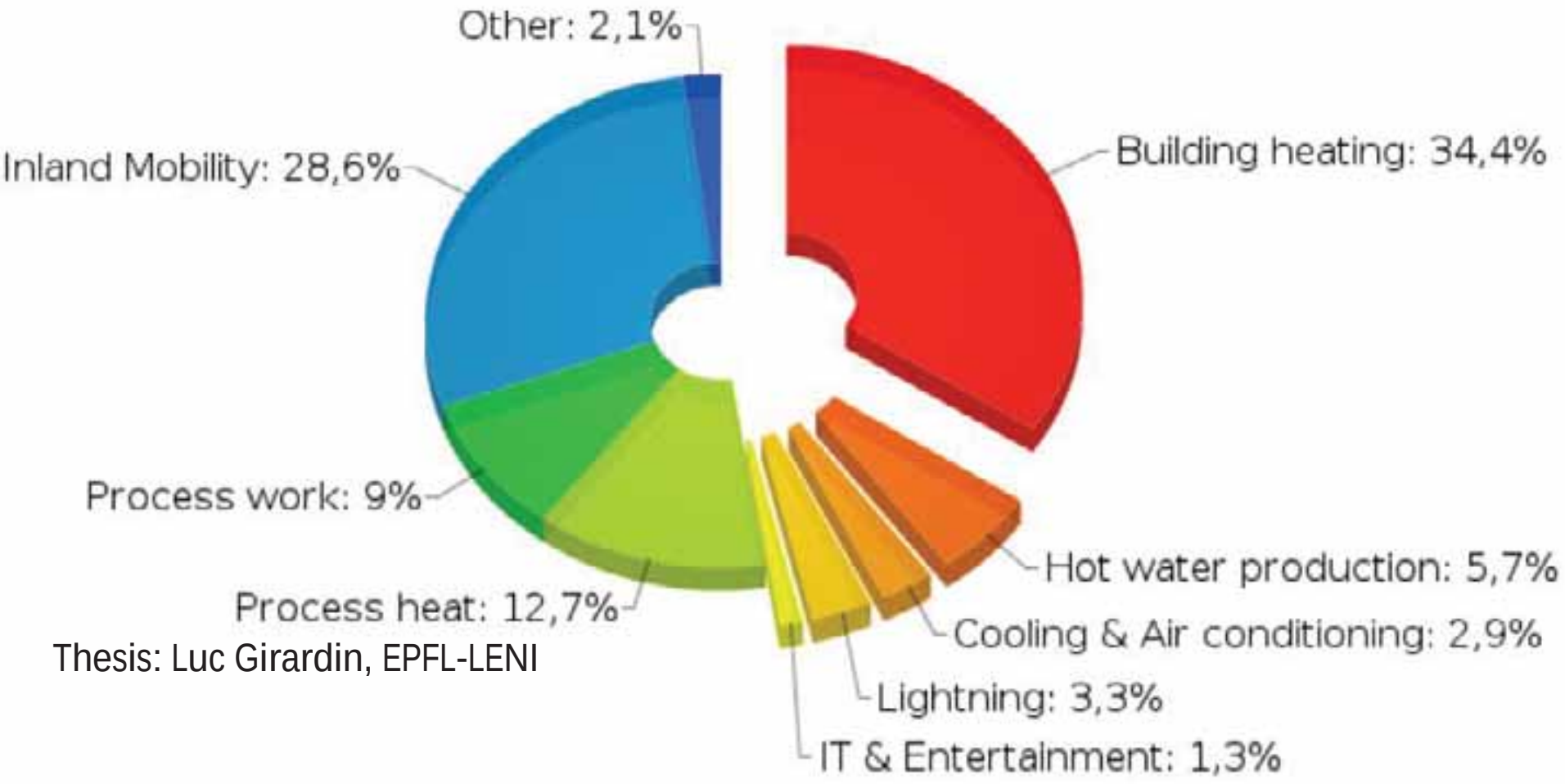
1. Introduction and Goal of the Project: Linking Demand and Supply
2. How to get the global Picture? Method
3. State of MEU
4. Outlook: Where to go?

1

Goal of the Project MEU: Linking Demand and Supply

Motivation

- Switzerland's Final Energy Consumption:



Thesis: Luc Girardin, EPFL-LENI

From Kyoto to 3*20

- No Nuclear Power by 2035 in CH
- 3 * 20: Covenant of Mayors for 2020 at least:
  - 20 % Coverage by Renewable Energy
  - 20 % Reduction in Primary Energy Use
  - 20 % Reduction of GHG Emissions based on 1990 Level
- But WHERE and HOW to start?

Goals

- Structure existing data for the urban energy planning
- Comparing different scenario of energy supply and refurbishment to increase the energy efficiency of a given zone
- Give access to EPFL tools, software and methods

Project MEU – Partners

Project Direction

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Energy Center

4 Partner Cities and their utilities

VILLE DE MARTIGNY

Lausanne

Ville de Neuchâtel

viteos toutes vos énergies

LA CHAUX-DE-FONDS

2 National Institutions

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Département fédéral de l'environnement, des transports, de l'énergie et de la communication

Swiss Federal Office for Energy, SFOE

FOGA
Forschungs-, Entwicklungs- und Förderungsfonds der schweizerischen Gasindustrie
Fonds de recherche, de développement et de soutien de l'industrie gazière suisse

5 EPFL Laboratories and Research Institutions

Hes·so VALAIS WALLIS

cem

LESO-PB

MIR

1 entreprise de software GIS

esri Suisse

2

Methodology and Data Model

Approach

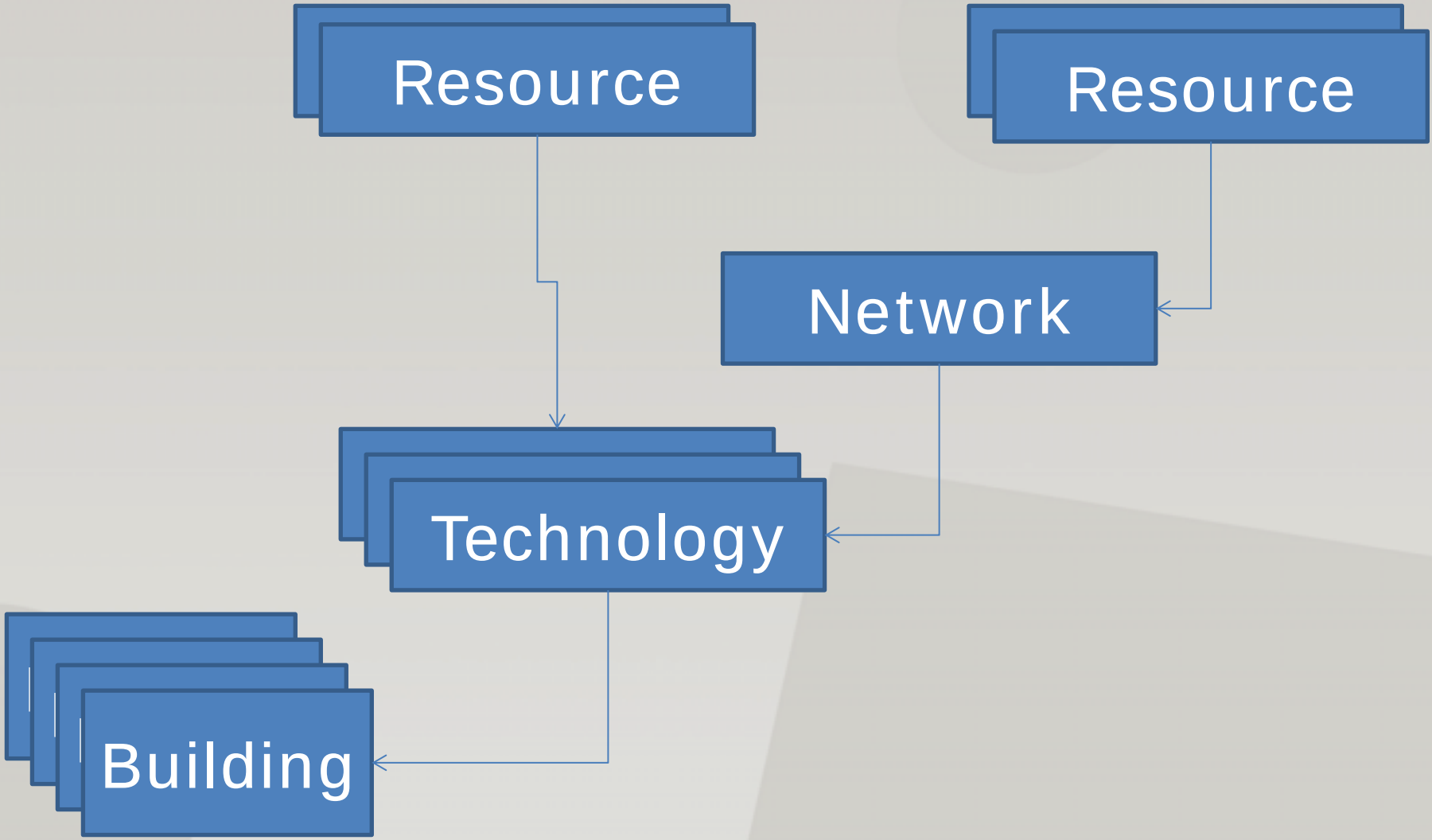
- Top-down: Comparing different Energy Demand and Supply Solutions via Scenarios
- Bottom-up Building Model for the Cities and Energy Utilities

Data Model

Complex Model because:

- As realistic as necessary
- Bi-temporal:
  - When was the action taken?
  - Which Duration does it have?
- Connection between Buildings requiring different services that are provided by technologies that are linked to resources or networks…
  - Representation as a Graph

Schematic Energy Flow Graph



Calculations

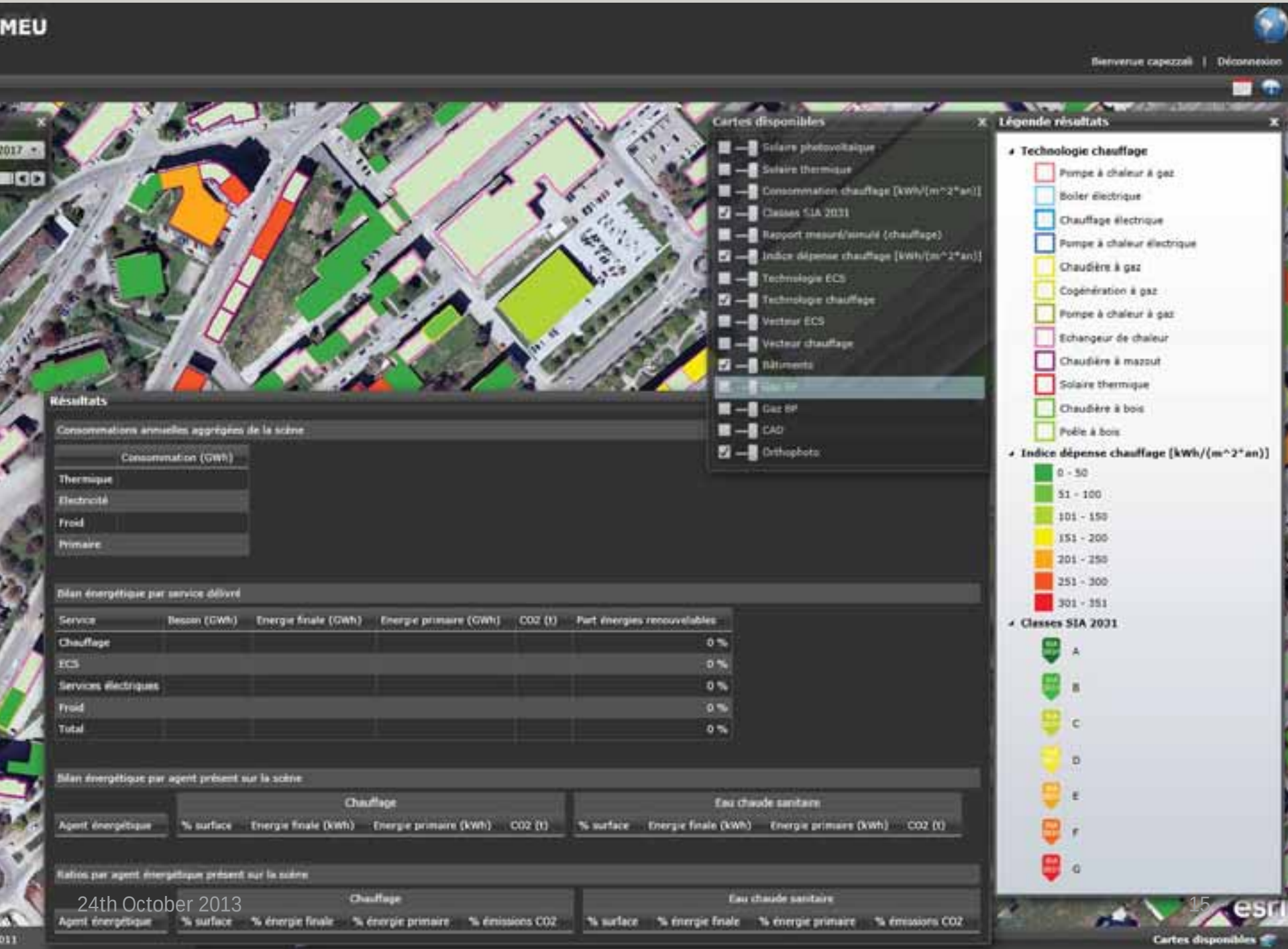
- Estimation of the Building's energy demand via CitySim
- Performance Estimation of the Energy Conversion Systems
- Indicator Calculation for each Building and the whole Scene:
  - Primary Energy Use
  - Final Energy Use
  - Green House Gas Emissions

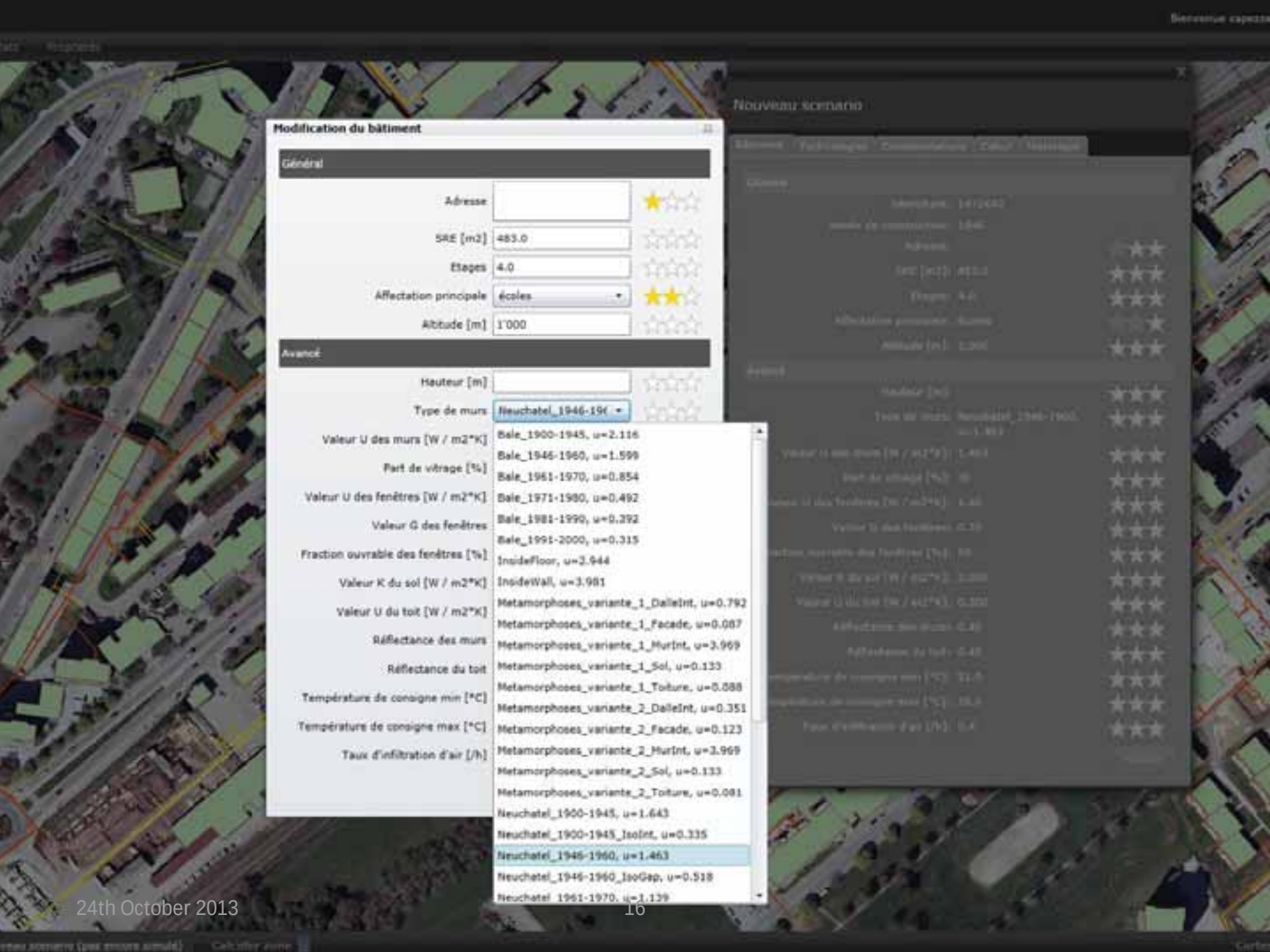
3

Calculations and Results

Results

- Representation on Maps via a web interface
- Summary tables for each Building or the whole scene
- Different Scenarios


MEU
Bienvenue capezzali | Déconnexion
Cartes disponibles
Solaire photovoltaïque
Solaire thermique
Consommation chauffage [kWh/(m^2*an)]
Classes SIA 2031
Rapport mesuré/simulé (chauffage)
Indice dépense chauffage [kWh/(m^2*an)]
Technologie ECS
Technologie chauffage
Vecteur ECS
Vecteur chauffage
Bâtiments
Gaz BP
CAD
Orthophoto
Légende résultats
Technologie chauffage
Pompe à chaleur à gaz
Boiler électrique
Chauffage électrique
Pompe à chaleur électrique
Chaudière à gaz
Cogénération à gaz
Pompe à chaleur à gaz
Echangeur de chaleur
Chaudière à mazout
Solaire thermique
Chaudière à bois
Poêle à bois
Indice dépense chauffage [kWh/(m^2*an)]
0 - 50
51 - 100
101 - 150
151 - 200
201 - 250
251 - 300
301 - 351
Classes SIA 2031
A
B
C
D
E
F
G
Résultats
Consommations annuelles aggrégées de la scène
Consommation (GWh)
Thermique
Electricité
Froid
Primaire
Bilan énergétique par service délivré
Service
Besoin (GWh)
Energie finale (GWh)
Energie primaire (GWh)
CO2 (t)
Part énergies renouvelables
Chauffage
ECS
Services électriques
Froid
Total
0 %
Bilan énergétique par agent présent sur la scène
Chauffage
Eau chaude sanitaire
Agent énergétique
% surface
Energie finale (kWh)
Energie primaire (kWh)
CO2 (t)
Ratios par agent énergétique présent sur la scène
% énergie finale
% énergie primaire
% émissions CO2
esri
Cartes disponibles


Modification du bâtiment
Général
Adresse
SRE [m2] 483.0
Etages 4.0
Affectation principale écoles
Altitude [m] 1'000
Avancé
Hauteur [m]
Type de murs Neuchatel_1946-19(
Valeur U des murs [W / m2*K]
Part de vitrage [%]
Valeur U des fenêtres [W / m2*K]
Valeur G des fenêtres
Fraction ouvrable des fenêtres [%]
Valeur K du sol [W / m2*K]
Valeur U du toit [W / m2*K]
Réflectance des murs
Réflectance du toit
Température de consigne min [°C]
Température de consigne max [°C]
Taux d'infiltration d'air [/h]
Bale_1900-1945, u=2.116
Bale_1946-1960, u=1.599
Bale_1961-1970, u=0.854
Bale_1971-1980, u=0.492
Bale_1981-1990, u=0.292
Bale_1991-2000, u=0.315
InsideFloor, u=3.944
InsideWall, u=3.981
Metamorphoses_variante_1_DalleInt, u=0.792
Metamorphoses_variante_1_Facade, u=0.087
Metamorphoses_variante_1_MurInt, u=3.969
Metamorphoses_variante_1_Sol, u=0.133
Metamorphoses_variante_1_Toiture, u=0.088
Metamorphoses_variante_2_DalleInt, u=0.351
Metamorphoses_variante_2_Facade, u=0.123
Metamorphoses_variante_2_MurInt, u=3.969
Metamorphoses_variante_2_Sol, u=0.133
Metamorphoses_variante_2_Toiture, u=0.081
Neuchatel_1900-1945, u=1.643
Neuchatel_1900-1945_IsoInt, u=0.335
Neuchatel_1946-1960, u=1.463
Neuchatel_1946-1960_IsoGap, u=0.518
Neuchatel_1961-1970, u=1.139
Nouveau scenario

4

Current State of MEU and Where to go?

Error Analysis

Converting Energy Demand Simulation to measured Energy Consumption with the help of the Energy Flow Graph

Different Cases:

$$Measurement * \eta_{technology} = Simulation$$

$$Measurement * \eta_{technology} * Fraction_{heating} = Simulation$$

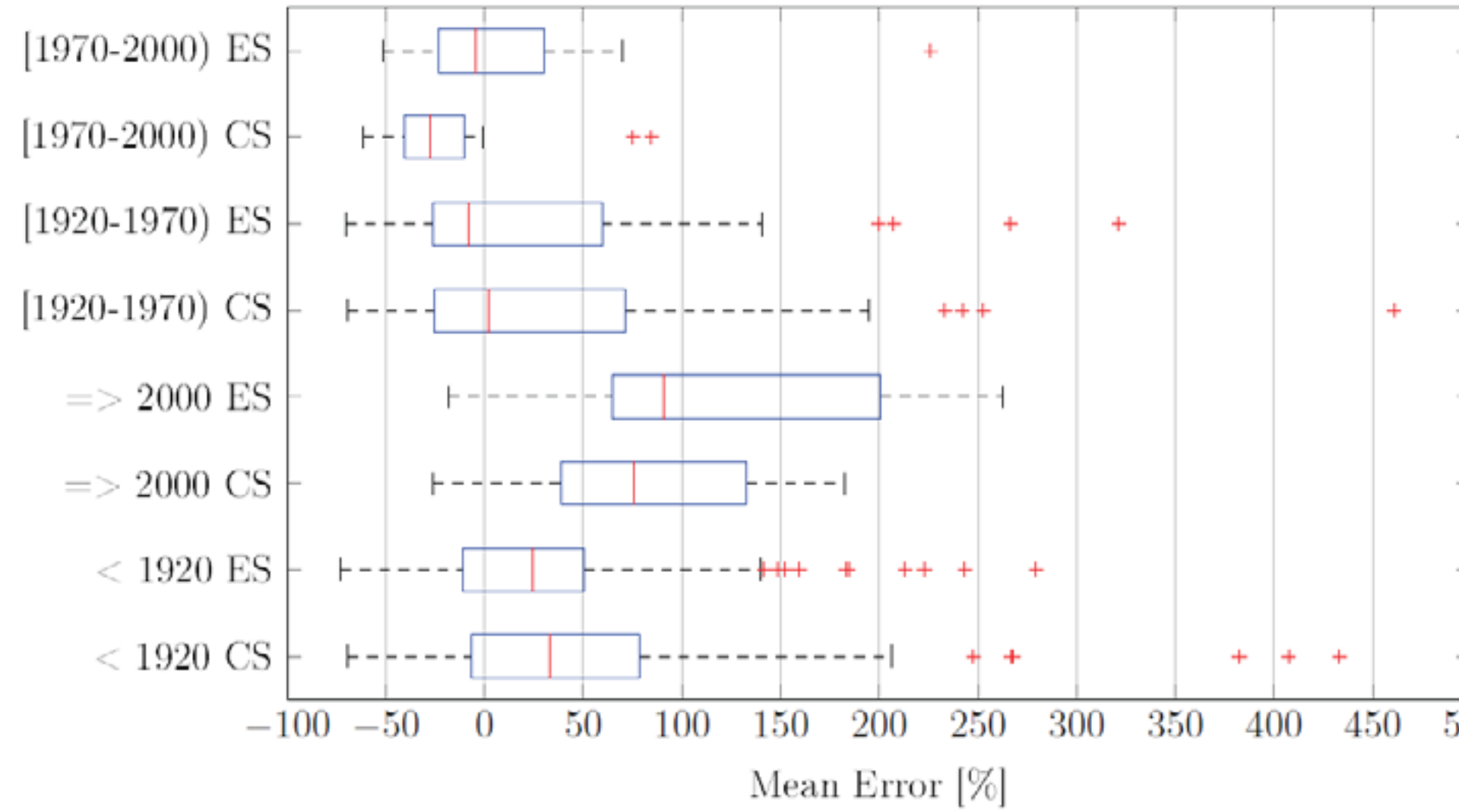
$$Measurement * \eta_{technology} * Fraction_{heating} * Fraction_{Building} = Simulation$$

Error: $\frac{Measurement - Simulation}{Measurement}$

Existing Building Stock

- Poor quality approximation of energy consumption based on default data sets
- Why?
  - Technical reason: Only limited data available
  - No data collection in the budget

Energetic Signature vs CitySim



Is this enough for Planning?

- For more than 30 to 40 buildings, a pre-dimensioning can be made: Power required & Resource pre-selection
- More and better input data on building needed for more precise studies

Recommendation

- Use CitySim when Planning new, not existing neighborhoods where all Values are known
- Use Energetic Signature with Default Values
- Teach Users how to use Meu so that they get aware of the correct input data

Thank you for your attention.

Do you have any Questions ?