A hybrid tool combining EMFA and Carbon Footprint to assess neighborhood projects

Matthieu Bugel
1. Context

1.1 Key figures

- Urban areas cover 2.8% of the land surface of the planet and house more than 50% of the world population [UNEP, 2009].

- Urban areas are responsible for high resource consumption and environmental pressures. According to the IEA*, they contribute between 67% to 71% of global emissions of greenhouse gases (GHG).

This last observation has led to work at different scales from building scale to city scale to tackle GHG emissions.

Between these two scales, neighborhood scale has appeared as an important scale interconnected with the two others and it includes key drivers to reduce resources consumption and GHG emissions.

* World Energy Outlook, IEA, 2008
1. Context

1.2 2EI: know-how and competences

- Veolia Environnement has a dedicated consulting department (2EI, Eco Environnement Ingénierie) tailored to assist and bring in its knowhow to urban planners throughout the course of their projects.

- 2EI advises and supports local authorities or private partners to choose the environmental solutions for their urban development programs.

Private project: Parc des Portes de Paris
Client: ICADE (French Real Estate Investor)
Mission: Environmental diagnosis, International benchmark, environmental strategy and technical and economic evaluations of solutions

Public Project: District of Grenoble (France)
Client: Municipality of Grenoble
Mission: Diagnosis, definition of the municipality’s environmental strategy for the site, monitoring of environmental performance
2. Overview of existing tools

2.1 Description of the categories

- In a previous study, 12 existing tools and methods were analyzed.

- 3 categories can be distinguished:
  - Qualitative assessment tool
  - Semi-qualitative assessment tool
  - Eco-design tool

- Qualitative assessment tool (1st category):
  These tools aim to ease the participation of different actors during the decision process and to set goals. They define categories of objectives and in general their related issues.

Example: Grille Ecoquartiers

Source: http://www.label-ecoquartier.developpement-durable.gouv.fr/
2. Overview of existing tools

2.1 Description of the categories

- **Semi-qualitative assessment tool (2nd category)**
  These tools define targets for an urban project which are quantitative (as the energy-consumption of the building) and qualitative. They have been largely used by the building sector.

  **Example**: LEED Neighborhood

- **Eco-design tool (3rd category)**
  These tools mainly focus on the project phase and allow assessing transversely various targets on a same basis of indicators. The challenge is to use them during early phases when few data are available.

  **Example**: ARIADNE (Mines de Paris), ELP (KTH)


Source: Contribution à l'analyse du cycle de vie des quartiers, E. Popovici, 2006
2. Overview of existing tools

2.2 Limits of qualitative and semi-qualitative assessment tools

- Qualitative and semi-qualitative assessment tools are relevant tools to set goals but they don’t offer a global environmental performance assessment.

Q: Do these solutions improve the environmental performance of my neighborhood?
3. Methodological framework

3.1 General description

- **Key2- Ecoquartier®** belongs to « eco-design tool » category and allows to assess the environmental performance of an **existing / retrofitted** or **new neighborhood**.

- The environmental performance assessment is in **link with the work of the French AFNOR commission « Ecoquartier dans son territoire »**
  - Efforts on water use, waste production and energy consumption are assessed within a flows analysis
  - GHG emissions are assessed and expressed by inhabitants and employees

- **Biodiversity evaluation** is not included in the tool because 2EI already use a specific approach based on regulatory diagnosis, on-site biodiversity assessment and a « trame verte et bleue » tool.
3. Methodological framework

3.1 General description

- **Key2- Ecoquartier®** includes 2 steps of analysis:
  - 1\(^{st}\) step analysis: Direct Flows analysis
  - 2\(^{nd}\) step analysis: Greenhouse gases (GHG) emission analysis
3. Methodological framework

3.2 Flows analysis

- **Energy Material Flow Analysis** (EMFA) allows assessing the material and energy flows within a system defined in space and time. This analysis has been used at national scale and then has been extended to urban scales [BARLES, 2009]*.

In the tool, this methodology is adapted to neighborhood scale and takes into account **4 categories of flows**:

- Material / waste flows
- Water flows
- Energy flows
- Transport flows

* Urban Metabolism of Paris and Its Region, Barles S. 2009
3. Methodological framework
3.2 Flows analysis

- **Materials / waste flows**
  - Mass conversation principle applied
  - \[ \sum m_{\text{input}} = \sum m_{\text{output}} + \sum m_{\text{storage}} \]
  - Mass of materials stored in buildings and infrastructures
  - Compost production and land reuse *(included)*

- **Water flows**
  - Mass conversation principle applied too
  - Local wastewater treatment solutions *(included)*
  - Rainwater and grey water harvesting *(included)*

- **Energy flows**
  - Balance based on final energy consumption
  - Auto-consumption of on-site electricity production *(included)*
  - Heat losses due to buildings and vehicules *(included)*

- **Transport flows**
  - Flows are quantified on a half-day
  - Two types of transport flows are distinguished
  - Means of transport are dissociated
3. Methodological framework
3.3 Carbon footprint analysis

- The tool assess the GHG emissions of 6 activities:
  - Building (construction, renovation, consumption and demolition)
  - Local energy production
  - Transportation (public and private)
  - Waste treatment
  - Water production and waste water treatment
  - Maintenance of public spaces

- Guidelines compliance:
  - GHG emissions analysis for buildings follow the guidelines given by the document « Guide Bilan Carbone® appliqué au bâtiment »
  - Biogenic carbon flux (land use, land use change and vegetation) are taken into account as recommended in the International Local Government GHG Emissions Analysis Protocol (IEAP) – ICLEI

- Emissions factors come from the following two main sources:
  - National emissions factors (ABC, DPE)
  - Internal emissions factors for urban services and local solutions
3. Methodological framework

3.3 Carbon footprint analysis

**Local energy production**

**Upstream processes**

**Downstream processes**

**Neighborhood**

**Electricity production**

- Micro wind turbines
- Solar PV

**Heat production**

- Solar thermal panel
- PAC (Eau de surface, Géothermique)
- Heat boiler

**Fuel supply**

**Heat production**

**Electricity network**

GESKIA tool (DALKIA) can be used to take into account GHG emissions due to the manufacturing of the systems.
3. Methodological framework

3.3 Carbon footprint analysis

- **One specificity of the tool is to consider GHG emissions due to urban services** and thus to allow a wider analysis than other tools such as GES Opam (CERTU)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Scope 1</th>
<th>Scope 2</th>
<th>Scope 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building</td>
<td>X</td>
<td>X</td>
<td>X (materials and equipment manufacturing)</td>
</tr>
<tr>
<td>Local energy production</td>
<td>X</td>
<td>X</td>
<td>X (equipment manufacturing)</td>
</tr>
<tr>
<td>Transportation</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Waste treatment</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Water production and wastewater treatment</td>
<td>X</td>
<td>X</td>
<td>X (materials for water and wastewater network)</td>
</tr>
<tr>
<td>Maintenance of public spaces</td>
<td>X</td>
<td></td>
<td>X (materials used for pathways)</td>
</tr>
</tbody>
</table>

**Scope 1**: All direct GHG emissions  
**Scope 2**: Indirect GHG emissions from consumption of purchased electricity, heat or steam  
**Scope 3**: Other indirect emissions not covered in Scope 2, such as the extraction and production of purchased materials and fuels, electricity-related activities, outsourced activities, waste disposal.
4. Use of the tool in the decision-making process

4.1 General scheme
4. Use of the tool in the decision-making process

4.2 Project assessment

- The tool can be used during the **diagnostic phase** of an existing neighborhood and during the **project phase** to assess different scenarios.

- **2EI**
  - Techno-economic study

  → **Diagnosis**
  → **Scenario**
    - Technical proposal of solutions
    - Cost assessment

- **VERI**
  - Environmental assessment

  1st step analysis → Flows analysis

  2nd step analysis → Comparison of scenarios

- **2EI**
  - Presentation of the results

  Decision of the project owner
This analysis allows **to identify** and **to discuss with the project owner the actions** to reach an **efficient metabolism**.
5. Conclusions / Perspectives

**Conclusions:**

- Local solutions reduce in general the amount of flows coming in and out of the neighborhood. **Key2- Ecoquartier® allows by providing a flows analysis to identify the relevant solutions and to discuss them with the project owner.**

- Local solutions such as solar PV, composting and wastewater treatment should be subjected to a GHG emissions analysis before to be integrated. **Key2- Ecoquartier® allows to assess the relevance of their integration.**

**Perspectives:**

- A case study is being conducted in the « Ile de France » region.

- Future solutions assessed in terms of GHG emissions by VERI will be updated in the tool.

- **Water footprint methodology (WIIX) is being regarded to be implemented in the tool so that to extend the environmental impact analysis and shade results obtained with a mono-criteria analysis.**
Thank you for your attention

Questions?

Contact:  matthieu.bugel@veolia.com
         marion.bouquet@2ei.com
Annex
3. Methodological framework

3.3 Carbon footprint analysis

**Water distribution & wastewater treatment**

**Upstream processes**
- Water production plant
- Rainwater harvesting

**Downstream processes**
- Local wastewater treatment plant
- Wastewater treatment plant

EC’Eau (VEOLIA Eau) can be used to assess GHG emissions due to water production.

Carbone 6 (SADE) can be used to assess the GHG emissions due to water and wastewater construction and maintenance.

EC’Eau (VEOLIA Eau) can be used to assess GHG emissions due to wastewater treatment.