

## Towards a “comprehensive” and smart platform for coordinated waste management in construction in Geneva? A case study.

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### Zusammenfassung

### Résumé

### Abstract

In order to reduce environmental and financial costs caused by construction material flow, web platforms have been created. Their objective is to increase the visibility of materials available on construction sites and promote their reuse. A benchmark of existing national and international platforms - considering functional aspects, effectiveness and how the platform interacts with local construction community - has been established by the research team. Strengths and weaknesses of each analyzed platform have been identified, giving an up-to-date picture. The benchmark points out, that no “comprehensive” platform, providing material exchange services as well as support for a large and strong user community, exists. Such a platform could be enhanced by several features – like linking it to geographical information systems and technical assistance, creating a coordinated waste management among construction sites thereby. The Great Geneva Area has been identified as an ideal location to implement the concept and an action plan has been proposed.

Dans le but de réduire l'impact environnemental et financier lié au flux de matériaux, des plateformes en ligne ont été créées pour augmenter la visibilité des matériaux disponibles sur les chantiers et optimiser leur recyclage et leur valorisation. Un benchmark de plateformes existantes au niveau national et international - concernant le fonctionnement, l'efficacité et les interactions entre utilisateurs - a été mené. Les forces et les faiblesses de chacune ont pu être identifiées et dressent un tableau de la situation actuelle. L'étude met en évidence l'absence d'une plateforme « globale » qui fournirait à la fois un service d'échange de matériaux tout en fédérant une communauté d'utilisateurs. Avec les systèmes d'informations géographiques et un service d'assistance technique, une telle plateforme pourrait favoriser la mise en place d'une gestion coordonnée. Pour plusieurs raisons, le Grand Genève a été identifié comme un lieu privilégié pour mettre en place le concept de plateforme « globale ».

# 1. Scope

## 1.1 Recycled material and circular economy

Sustainable development and resilience are important and challenging objectives in construction. A huge effort is being made to improve building methods in order to reduce negative environmental impacts and numerous good practices exist. They help to build efficiently and to reduce environmental impacts in terms of energy consumption, water management, natural resources, etc.

Construction materials impact significantly the building's carbon footprint in terms of embodied energy and greenhouse gas. Their selection is a key factor, influencing scarcity of natural resources. As an example, the exploitation of gravel pits in the Great Geneva Area<sup>1</sup> can be cited: if it continues at the current rate, natural reserves will be exhausted in 30 years (GESDEC, 2013). It is therefore important to set up global strategies and long-term actions.

The use of recycled materials in construction is a necessity to preserve natural resources. Depending on its quality, construction site waste can be used at different steps of the building realization. Building codes are constantly being updated, mainly based on experiences made with pilot projects, like ECOMAT<sup>GE</sup> initiated and managed by the *Service cantonal de géologie, sols et déchets du Canton de Genève* (GESDEC, 2013, 2016). ECOMAT proposes applications showing the re-use of construction site waste and how to better manage material flow.

The use of recycled rock aggregate, coming from different operations including demolition, is a promising approach as well. To obtain the MINERGIE-ECO® building label, structural concrete elements have to be partially produced using recycled aggregates. This can be considered as an interesting action lever towards sustainable development integrating economic, social and environmental aspects (VARESANO, 2013). Actually, no legal obligation to use recycled aggregate exist. Only a client requiring to obtain the MINERGIE-ECO® label obliges AEC – architecture, engineering and construction - industry to use this type of material. The client might be motivated to ensure high ethical standards or simply by the hypotheses that the economic value of his construction will be higher than the value of a comparable building without the label.

Other good examples of recycled construction materials are earth and straw. Both are cheap and eco-friendly natural materials, product of recycling and they benefit of well-documented and up-to-date literature (ATBA, 2009, VOLHARD, 2016). They are in vogue and can be used for many construction parts. Terrabloc in Geneva produces bricks of raw earth and offers concrete and reliable applications which values earthy excavation materials.

Books, like *Matière Grise* (CHOPPIN, 2014), are proposing a set of good practices for the application of recycled materials in construction. Examples are based on executed projects. A very interesting point is that numerous recycled materials are used to build the supporting structure of the construction, such as recycled steel and wood beams, composite materials made from rubble, straw, paper, glue. Choppin points out that employing recycled materials needs an open creative and innovative spirit.

Good practices using recycled materials exist. The negative aspect is, that most cases can be considered as down-cycling. Down cycling means that the material is used on a lower value level than in its original form. For instance, wood from demolition is often used to generate energy (heating or other). Besides the collective ignorance of the subject and the absence of a coherent legal framework (CHOPPIN, 2014), this is due to the lack of communication and consultation between various actors (ECODECHETS, 2002).

The counter proposal to “down cycling” is “circular economy”: one man's waste is another man's raw material. Circular economy aims to minimize resources, energy, and waste, by better integrating recyclable materials than in a down-cycling or a “take-make-waste” approach. Opportunities to explore and support the development of innovative – sustainable and resilient - solutions using more recycled materials exist. These innovative solutions can benefit from a

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<sup>1</sup> The Great Geneva Area is a vast territory of 2'000 km<sup>2</sup> which extends over the Swiss cantons of Geneva and Vaud, and the French departments of Ain and Haute-Savoie.

methodology which integrates in situ evaluation procedures and a coordinated waste management between construction sites.

## 1.2 The “Recycling-Urb” concept

The Recycling-Urb project is a research funded by the HES-SO. It unites a team from HEIG-VD (G2C, Yverdon), HEPIA (inPACT, Geneva), and HEIA (iTEC, Fribourg). In the scope of the study, the research team is focusing on an onsite and local material upcycling processes of mineral waste.

Results of the project include (1) an exhaustive review of recycling opportunities and their legal context, (2) a proposal of a method better integrating material evaluation and communication – cf. Figure 1 - (3) a rapid method to test material if it is appropriate for recycling and (4) propositions for applications (VIVIANI & AL, 2018).

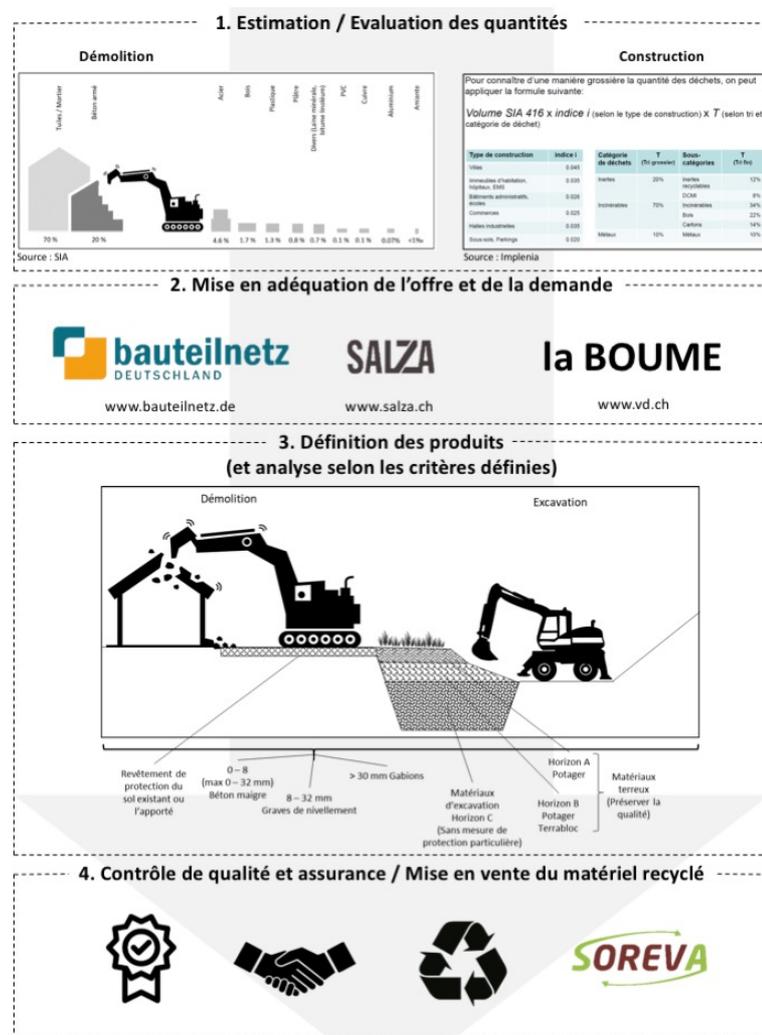


Figure 1 Results of the RecyclingUrb project : proposal of a method better integrating material evaluation and communication.

RecyclingUrb integrates all phases of material recycling, starting with an estimation of potentially usable materials, the coordination of available and needed material, a definition of potential products (concentrating on excavated and mineral materials) and a quality control to cover legal aspects. Findings of the project point out, that the management of material flow has still to be improved. It was not yet possible to coordinate offer and demand, while minimizing transportation and guaranteeing material quality, on a satisfactory level.

### 1.3 Coordinated waste management and web-based platforms

Waste management includes activities of transportation, treatment and storage. As a consequence, material quantities to be managed in terms of weight and volume represent important financial and environmental costs. A potential to optimize recycling processes can be found in better coordinating waste management between construction sites.

The study *Le recyclage des matériaux de construction à Genève* (GESDEC, 2006) introduces the concept of coordinated waste management from a construction site to another as a solution to:

- 1) reduce landfill storage of excavated material,
- 2) protect natural aggregates by using recycled gravel for the production of concrete,
- 3) minimize transportation distances.

It relates story of two close construction sites studied by Ecodechets in 2002 (ECODECHETS, 2002). The study points out waste management could have been more effective - in terms of reducing transportation distances of materials (excavated materials, recycled concrete grave), reducing evacuation of mineral materials (excavated materials, recycled grave and reducing use of natural grave - with a coordination between both construction sites before and during construction.

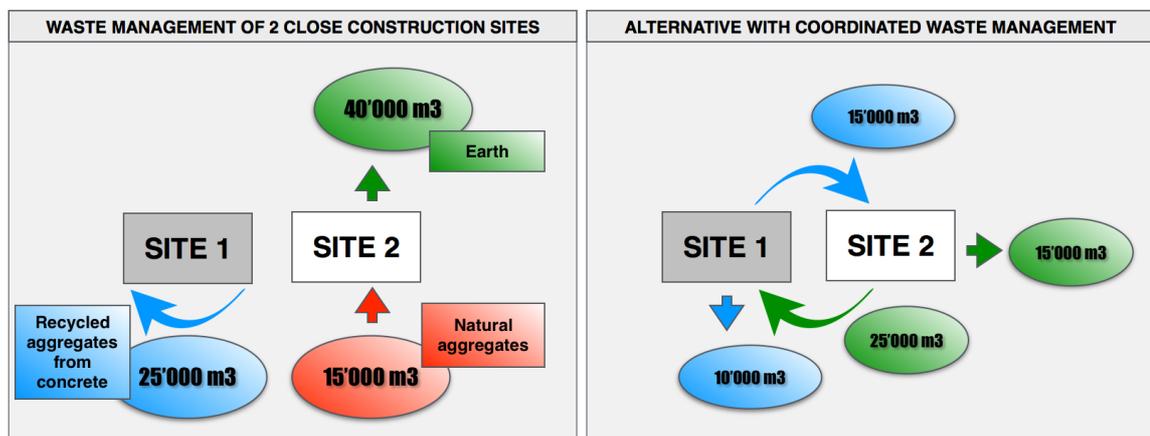


Figure 2 Study about Waste management on 2 close construction sites - source: ECODECHET, 2002.

More recently, web platforms have been created in order to facilitate the exchange of materials and to optimize waste management at different time of (de)construction and for different types of material. Their objective is to increase the visibility of materials available and prone their reuse. The concept appears to be popular at all institutional levels: associative, city, cantonal and national.

A first survey of existing platforms shows a variety of types and embedded functions. On a regional level, the cantonal administrations of Vaud and Jura develop and manage platforms for the exchange of mineral materials from construction sites. These platforms allow bilateral agreements between a seller and a buyer, with a strict non-interference policy from the cantonal side when it comes to economical agreements – cf. chapter 2.

Salza.ch represents another platform type and promotes trading building elements before and during deconstruction/demolition. Salza.ch does not provide storage space: in most cases, the buyer has to fetch the object at the sellers place.

In contrast to this, a “ressourcerie” – recycled materials centre - provides physical space for managing recycling, exposition and selling of second-hand materials. The concept is rather new and represented in Geneva by Materrium. Materrium is a local *ressourcerie*, located in the city center and has also developed a web site where materials initially intended to be thrown away can be reserved and bought. All the above mentioned platform can be categorized as “material exchange platforms”.

Another identified platform type does not develop any activity in material exchange services but reinforces links between operators in the field of circular economy and ecological industry. Examples are the Building Material Reuse Association, “working to create a vibrant building materials economy as part of a world without waste” (USA), Optigede (France), Genie.ch (Geneva, Switzerland). This type of platform can be categorized as a “community oriented platform”. Genie.ch generates collaboration among a community of professional, academic and institutional actors and proposes regular meetings.

The creation of a web-based coordinated waste management does not hold any major technical challenges and platforms are identified as an important element towards this type of circular economy. The question to be answered is which functionality it should provide to be operational? An in depth analysis is given in the next chapter.

## 2. Benchmark of web-based coordinated waste management

As part of the RecyclingUrb project, a benchmark of seven national and international material platforms has been established. Functional aspects, effectiveness and how each platform interacts with the local construction community have been considered. In addition to web-based research, semi-structured interviews with different stakeholders from the public, private and academic sector have been conducted. Results are shown in Figure 2.

The following main criteria have been used for comparison:

- Material exchange service: a material exchange service is a tool that allows economical transactions between a vendor and a “recycler”.
- Community management: operations to team and stimulate a community of stakeholders and users.
- Documentation: represents all form of information about recycled materials and feasible applications.
- Coordinated management: active involvement of the platform operator with the objective to match supply and demand.
- Spatio-temporal dynamics of materials: material flow management considering space and time (e.g.: minimizing transport distances between offeror and user).

	<b>BOUME</b>	<b>BAMM</b>	<b>Optigede</b>	<b>BMRA</b>	<b>Materrium</b>	<b>salza.ch</b>	<b>genie.ch</b>
	www.vd.ch/boume	bamm.jura.ch	www.optigede.ademe.fr	bmra.org	materium.ch	www.salza.ch/fr	www.genie.ch
	Mineral materials stock exchange  <i>Bourse aux matériaux minéraux de chantier</i>	Mineral materials stock exchange  <i>Bourse aux matériaux minéraux de chantier</i>	Tools and user feedback exchange  <i>Plate-forme d'échanges et de diffusion d'outils et de retours d'expérience</i>	Building Materials Reuse Association	Recycled materials centre  <i>Association « Ressourcerie »</i>	Platform for the re-use of construction element before demolition.  <i>Plateforme pour le ré-emploi d'élément de construction avant démolition.</i>	Geneva Network of Industrial Ecology
<b>Origin</b>	CH - Vaud	CH - Jura	FR	USA	CH - Geneva	CH	CH - Geneva
<b>Organizational form</b>  <b>Forme organisationnelle</b>	Cantonal Service of Vaud  <i>Service cantonal du canton de Vaud</i>	Cantonal Service of Vaud  <i>Service cantonal du canton de Jura</i>	Public services, ADEME  <i>Service public, ADEME</i>	Non-profit organization  <i>Association à but non-lucratif</i>	Non-profit organization  <i>Association à but non-lucratif</i>	SARL	Non-profit organization  <i>Association à but non-lucratif</i>
<b>Material exchange service</b>  <b>Bourse aux matériaux</b>	Yes  <i>Oui</i>	Yes  <i>Oui</i>	No  <i>Non</i>	No  <i>Non</i>	Yes  <i>Oui</i>	Yes  <i>Oui</i>	No  <i>Non</i>

	<b>BOUME</b>	<b>BAMM</b>	<b>Optigede</b>	<b>BMRA</b>	<b>Materrium</b>	<b>salza.ch</b>	<b>genie.ch</b>
<b>Type of materials</b>	Mineral materials	Mineral materials	All types	Building materials	Recovered materials without immediate market value.	Secondary building materials	All types of materials and flows
<b>Matériaux concernés</b>	<i>Matériaux minéraux</i>	<i>Matériaux minéraux</i>	<i>Tout type</i>	<i>Matériaux de construction</i>	<i>Matériaux donnés, sans valeur marchande immédiate.</i>	<i>Matériaux de construction du second œuvre.</i>	<i>Tout type de matériaux et les flux</i>
<b>Community Management</b>	No	No	Yes	Yes	Online articles	Online articles	Thematic discussion group with moderator
	<i>Non</i>	<i>Non</i>	<i>Oui</i>	<i>Oui</i>	<i>Blog</i>	<i>Blog</i>	<i>Forum de discussion thématique avec modérateur</i>
<b>Operation</b>	Networking and external bilateral agreement, devolved materials.		Online documentation and Thematic discussion group with moderator.		Recycled materials centre, centralized materials, on site and online sales.	Online ad, online sales, decentralized materials, on-site recovery	Individualized profile, thematic discussion group.
<b>Fonctionnement</b>	<i>Mise en relation et accord bilatéral externalisé sur la base de matériaux décentralisés.</i>		<i>Documentation disponible en ligne et forum de discussion et d'échanges.</i>		<i>Ressourcerie physique – centralisation des matériaux - et vente en ligne.</i>	<i>Annonce en ligne par opérateur et vente en direct insitu – matériaux décentralisés.</i>	<i>Profil individualisé, forum thématique.</i>
Storage	Decentralised		NA		Centralised	Decentralised	NA
<i>Stockage des matériaux</i>	<i>Décentralisé</i>		<i>NA</i>		<i>Centralisé</i>	<i>Décentralisé</i>	<i>NA</i>
	<b>BOUME</b>	<b>BAMM</b>	<b>Optigede</b>	<b>BMRA</b>	<b>Materrium</b>	<b>salza.ch</b>	<b>genie.ch</b>
Material exchange mode	Bilateral agreement between a materials owner and a buyer		NA		Onsite and online sales	Online sales	NA
<i>Mode d'échange de matériaux</i>	<i>Accord bilatéral entre l'offreur et le demandeur</i>		<i>NA</i>		<i>Vente sur place et en ligne</i>	<i>Vente en ligne</i>	<i>NA</i>
Relation	Online ad, webmaster connects operators.		NA		Website and onsite meeting.	Website and onsite meetings.	NA
<i>Mise en relation</i>	<i>Annonce en ligne et mise en contact entre opérateurs par webmaster.</i>		<i>NA</i>		<i>Web platform et présence au magasin.</i>	<i>Web platform et présence au magasin.</i>	<i>NA</i>
<b>Cost of use</b>	Free of charge	Free of charge	Free of charge	Membership fees	Free of charge	Online publication fees	Free of charge
<i>Cout de l'utilisation</i>	<i>Gratuit</i>	<i>Gratuit</i>	<i>Gratuit</i>	<i>Cotisation</i>	<i>Gratuit</i>	<i>Frais de publication pour les offreurs</i>	<i>Gratuit</i>
<b>Funding</b>	Public	Public	Public	Private, membership fees	Mixed, materials sales	Private, publication fees	Donation publique et par des sociétés privés
<i>Mode de financement</i>	<i>Public</i>	<i>Public</i>	<i>Public</i>	<i>Privé Membership fees</i>	<i>Mixte, vente de matériaux</i>	<i>Privé, frais de publication</i>	
<b>Documentation</b>	No	Partially	Tools, user feedback exchange.		No	Partially	Yes
<i>Documentation</i>	<i>Non</i>	<i>Partiellement</i>	<i>Outils, méthodes, retour d'expérience, recommandations</i>		<i>Non</i>	<i>Partiellement</i>	<i>Oui</i>
<b>Newsletter</b>	No	No	No	Yes	No	No	Yes
<i>Newsletter</i>	<i>Non</i>	<i>Non</i>	<i>Non</i>	<i>Oui</i>	<i>Non</i>	<i>Non</i>	<i>Oui</i>
<b>Coordinated waste mgmt</b>	No	No	No	No	No	No	No
<i>Gestion concertée</i>	<i>Non</i>	<i>Non</i>	<i>Non</i>	<i>Non</i>	<i>Non</i>	<i>Non</i>	<i>Non</i>

Figure 3 Benchmark of seven web-based platforms in the field of waste management – summary table.

The benchmark identified very positive and relevant concepts regarding existing web-based platforms and there is not wrong elements. For instance, build a community of sensitive users and provide material exchange service are undoubtedly important useful to improve waste management. However, it is obvious that no platforms allows implementation of coordinated waste management. There are weaknesses and it seems that only a combination of positive elements identified for each platform will be really successful and influential.

### 3. Results

The study reveals a delicate situation of material exchange platforms. Although there are some success stories, it seems to be difficult to find appropriate materials at the right moment, in the correct shape and in sufficient quantity for projects in their construction phase. Material exchange platforms are mainly driven by public sector initiatives. They do neither give details about experiences made (best practices) nor provide any quality control procedures concerning the material to be recycled.

Additionally, construction industry prefers to work with its on networks and is therefore not a frequent user of public platforms. Some companies already apply recycling on a construction site as part of another operation. The most common example is the use of excavated materials from one site as an embankment on another site. This generally reduces the costs for landfill. Some large companies crush mineral materials on site for immediate reuse. In this case, the implementation of an infrastructure is governed by the financial profitability.

However, the above mentioned operations can be classified as “one shots” and are not yet considered as “business as usual”. Companies follow ecological guidelines but coordinate each other only on the scale of small networks. A lack of anticipation is detected particularly for small and medium-size operations.

Interviews identified organizational issues as well. Setting up an automated management of potentially recyclable materials between multiple projects is very time consuming and complex. Low profit margins of construction companies and the fact that projects are always pressed for time, delay the introduction of such tools. Actually, initiators for recycling activities are technicians on construction sites. Unfortunately, they are at the lower end of the hierarchy, pressed by their management to avoid additional costs rather than developing supplementary efforts for an uncertain amount of savings. Competitive thinking among companies does not help either.

Other findings of interviews were that guidelines have only a consultative role. They lack action levers and assistance by public authorities. At a technical level the construction market is reticent to modify proven construction methods. This is particularly true for concrete mixtures. Technical progress and evolution of construction codes is essentially made in the framework of pilot site application (GESDEC, 2013, 2016, ESREC, 2007). Since building codes are meant to represent a “secured” state of the art they do not develop fast. In addition to that, changing habits takes some time.

Construction professionals contacted are generally interested in setting up new solutions to improve waste management and reduce environmental impacts. But their attitude can be characterized as “no pain – but gain”: using recycled materials shall have no negative effects on quality, schedule and budget.

Combining a platform for material exchange with a community oriented platform could help to overcome coordination and networking issues detected. This leads to the proposal for a “comprehensive” platform for coordinated waste management.

## 4. Proposal of a “comprehensive” and smart platform for coordinated waste management in Geneva

### 4.1 Optimized “comprehensive” and smart platform

The benchmark did not identify a “winning platform” but suggests to combine material exchange with community oriented features. Such a “comprehensive” platform could be extended with the following features:

- Integration of real time and geographical data to calculate transport cost and environmental impacts, allowing to study best options in terms of transportation distance, storage, etc.
- User assistance and community management, animated by a forum, access to building codes and best practices, technical assistance provided by a team of multidisciplinary construction specialists (competence center).

- Digitized data for an intelligent management of operations and information sharing, getting feedback about operation success, helping to improve procedures. Proposing different possibilities for recycling, based on available material, user needs and distances. Detection of the most appropriate “recycler”.

A comprehensive platform, enhanced with the above-mentioned features, could be referred to as a “comprehensive” and smart platform.

#### 4.2 Geneva as the ideal location for a comprehensive smart platform?

The Geneva canton has been identified as an ideal location for the pilot implementation of a comprehensive smart platform. With 7 billion cubic meters of new construction and several important urban projects on a limited surface, Geneva needs to apply the concept of urban mining in order to avoid environmental and other issues.

Several projects, publications, directives and recommendations have been developed and the field of ecological industry and circular economy is growing. GESDEC, and their authorized representatives from private and academic sectors, are continuously publishing on the subject since 2003. Their main objective is to better understand the local context and improve construction habits. The ECOMATGE publications are illustrating this ambition. They explain how to use recycled aggregates from concrete and bituminous mix (GESDEC, 2013) and the latest edition covers excavated materials (GESDEC, 2016) and could be integrated in a smart approach.

At the present time, stakeholders in Geneva plan to implement a comprehensive smart platform as described above. The community includes representatives from industry, administration and academics, as there are:

- GESDEC – representing administration – interested to evaluate the impact of ECOMATGE and improve recommendations for construction industry (GESDEC, 2013, 2016),
- Companies from construction industry like Implenia Suisse SA,
- Genie.ch as an existing community,
- HEPIA, representing the scientific part of the platform.

The idea is to build on the Genie.ch platform – cf. chapter 3. Genie.ch teams, the above-mentioned stakeholders and the community already exists.

#### 4.3 SOREVA: applied research and development – Ra&D - as an action plan towards the proof of concept!

SOREVA – *S*outien au *RE*cyclage et à la *VA*lorisation des matériaux de construction – is the initiative to realize a comprehensive smart platform for the management of construction waste, covering the region of Great Geneva. This idea started in 2013 with a first concept of a web platform in Geneva, based on the concept of coordinated waste management.

Over the past four years, a network supporting SOREVA has been created. Network partners are all active in waste management and contribute through their expertise to the development and implementation of the SOREVA platform. The network integrates professional, academic and administrative partners.

A beta version, combining a database management system with a first user interface, has been developed – cf. Figure 4. The prototype contributed to define the corporate identity of SOREVA and to identify and plan further operations for a full implementation.

SOREVA contacted the civil engineering department of HEPIA to integrate recent research findings concerning waste management. These subjects are in line with the research interests of HEPIA, like future energy efficient buildings and life cycle analysis. A student project dealing with recycling processes<sup>2</sup> as well as the RecyclingUrb project are examples for collaboration.

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<sup>2</sup> *Master of Science HES-SO en ingénierie du territoire, Optimisation des processus et des filières de recyclage des déchets de chantier, Jalal El Bahjaoui.*

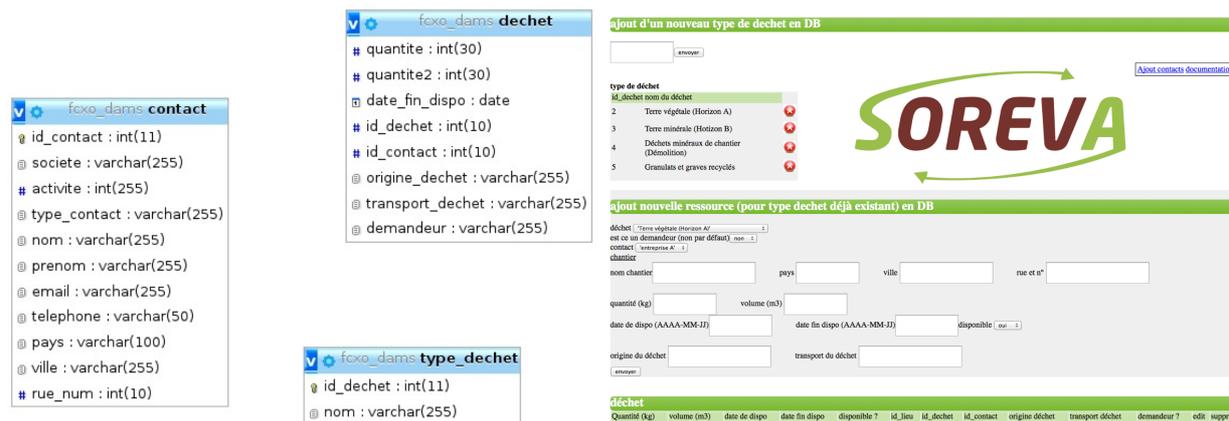


Figure 4 Illustrations of the SOREVA web-platform Beta version - to the left, basic database architecture, to the right user interface Beta version.

The Information Technology Engineering (ITI) department of HEPIA has been contacted in order to help with the technological development of the platform. The high quality of spatial and temporal information is a key factor for the success of SOREVA. It is intended to integrate real-time data and geographical information into the system via student project work.

As an industrial partner, Implenia Suisse SA has confirmed its interest in SOREVA. Before and during a construction, Implenia Suisse SA will give access to spatial and temporal data regarding material flux on its construction sites at Geneva. This is a big opportunity for a feedback analysis and to integrate the needs of industry into the development.

The GESDEC supports SOREVA as an administrative partner. Based on the ECOMATGE publication, a review of recycling practices, lessons learned as well as the value creation process is planned. Finally, the report will include an analysis of the potential of the envisioned SOREVA web platform.

SOREVA has the potential to fully exploit the technological possibilities of web based platforms and offer technical assistance (intelligent advice) for coordinated construction waste management.

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