

Sustainable Redevelopment of an Uncontrolled Dumping Site into an Integrated Waste Recycling and Treatment Centre, Moen, Belgium.

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The Intermunicipal Waste Organization IMOG exploits in Western Flanders a landfill site for hazardous and non-hazardous waste, sorting and recycling facilities, as well as a composting unit and distribution centre. IMOG's services cover 11 municipalities with a surface area of 387 km² and ca. 227.000 inhabitants. Adjacent to the site is an operational clay pit that serves the local brick industry. The site is located near a navigable waterway and at short distance from a waste incineration plant. The clay pit will be used in the future as an additional confined disposal facility, and next to solid waste, it will also accept non-polluted sediments from maintenance dredging. These materials will be used for sealing layers according to EU and Flemish legislation, according to the cradle-to-cradle principle. Eventually, the site will be converted to a green area and a (solar) energy park. In the past, the site was heavily polluted due to uncontrolled dumping of various types of waste, but through the application of innovative remediation techniques, the environmental burden has been reduced to zero. Currently, the separate collection and recycling of more than 40 different waste streams and the production of renewable energy from biomass are the main activities. Much of the success of IMOG is related to the good communication strategy with the local population and authorities, but also to capacity building with other waste operators in various countries in Europe and Asia.

Key words: Recycling / Waste streams / Sanitary landfill / Renewable energy

1. Introduction

IMOG is an intercommunal organization for waste in South-West Flanders (Belgium) for eleven municipalities with 227.000 inhabitants. IMOG operates on two sites in Moen and Merelbeke (**Table 1**) and has also an extensive network of selective collection points. IMOG has a yearly turnover of 26 million euro (2009) and employs about 200 people.

Table 1 : Operations of IMOG in different locations

On the site in Harelbeke	On the site in Zwevegem-Moen	In all communities; separate collection
Waste incinerator Sorting plant for packaging Sorting plant for paper and board Sorting and baling plant for plastics. Waste-knowledge-center Sensitization- and communication-office Educational-center Waste administration	Landfill Clay quarry Waste water treatment plant for the site Sorting plant for waste wood Composting plant Biomass-center Sorting plant for bulky waste and similar waste from the industry Clustering of domestic chemical waste residues Clustering plant for electric and electronic waste Reverse logistics : collection trucks for waste glass bottles, trucks for collection of 30 m ³ containers, road-sweepers, garbage trucks Waste administration	<i>At home :</i> Residual waste Paper and board (two-weekly) Packaging (plastic bottles, metal cans, beverage bricks) (two-weekly) Garden waste collected in containers (180 l-280 l) <i>On crucial points (1 point for 1000 inhabitants):</i> Glass bottle collection bulbs (white and colored) Textile collection <i>Container parks (civic amenity sites):</i> Bulky waste Garden waste Concrete and demolition waste Metals Wood Domestic chemical waste (hazardous household waste) Paper and cardboard Plastics : HDPE, LDPE, PP, PVC, PS, EPS Plastic film Window glass Glass (white and colored bottles) WEEE (Waste electric and electronic equipment) Textiles

Figure 1 : Location of intermunicipal organization IMOG and its 11 constituting municipalities

The objectives of IMOG are the treatment of household waste by the principle of sustainable waste management, following the waste hierarchy of the Lansink ladder principle. The main pillars are prevention and reuse, separate collection and recycling and residual waste treatment through incineration, composting and finally landfilling. In the last decades various new technologies and practices have been developed and implemented in the activities of IMOG in collaboration with Flemish environmental consultancy and engineering companies, such as Ecorem.

Public awareness and capacity building have always been important pillars of the waste management strategy of IMOG. Moreover, IMOG has been sharing technical and operational know-how with developing and transition countries on waste management projects.

Figure 2 : Sustainable waste management system of IMOG

2. History

2.1. Founding of IMOG

In 1969 the province of West-Flanders began to organize its waste and waste water management, aiming at a regional complete solution including waste collection and removal. In South-West Flanders this led to the foundation of the intercommunal organization IMOG (inter-municipal company for public health). In Harelbeke a site was selected for the construction of a waste incineration and water purification plant. This location was ideal for its central situation with respect to the main waste producers, good road connections and the proximity of the Leie river which could be used for the discharge of purified waste water and cooling water (Soenens, 2009).

2.2. Foundation of Moen site

As from the 1980s waste became the responsibility of the Public Waste Agency of Flanders (OVAM) which regulates and controls landfills. Since the available incineration site provided no adequate solution for certain materials such as inert and incombustible bulky waste, grass and garden waste, the need for an intercommunal landfill increased.

A landfill location was provided by the community of Moen in a former clay pit which was already used for dumping of industrial waste and household waste. After some basic infrastructure works and surveys, permits were issued to bring the landfill into service. In 1986 IMOG obtained the permission for full exploitation of the site in accordance with the regulations in force at that time. Even in these early years of exploitation attention was always paid to the treatment of various waste types and to the self-sufficiency of the site (Soenens, 2009).

3. Management of the Moen site

Gradually the site at Moen was improved and new activities were developed according to new environmental regulations, market possibilities, changing public awareness towards waste management and new principles and techniques. Ecorem performed an integrated environmental impact assessment for the entire site (Ecorem, 1998a) followed by a demand for renewal of the environmental permit (Ecorem, 1998b). The site now covers 27 ha.

Figure 3 : Overview of the current activities at IMOG and the consecutive landfill expansions

3.1. Operation, expansion and covering of landfill

The delivery of waste to the landfill was very high as from the start and soon the landfill had to be extended. On the other hand several initiatives for reducing the amounts of waste were taken. In the mean time the filled parts of the old landfill were covered.

Figure 4: Yearly amount of total landfilled waste and the fraction of organic material in the landfill

A business plan was developed (Ecorem, 2000a) for further operation of the clay quarry and subsequent expansion of the landfill to the clay quarry. Permission was obtained through an environmental permit (Ecorem, 2004) for enlarging the landfill pit by further clay exploitation. The clay was used in the ceramic industry and will also be used for sealing and covering of the landfill.

Landfilling continued in the first part of the landfill expansion. By this time the delivery of category 1 waste (industrial waste) was reduced and the emphasis was on the expansion of the landfill for category 2 waste (household waste).

The environmental permits of the first part of the landfill expansion expired in 2008, thus necessitating a cover to isolate landfilled waste. Together with IMOG, Ecorem developed a master plan for future use of the covered landfill as a treatment centre for dredged sediments (Ecorem, 2008a).

Permission was obtained from the Minister of Environment to postpone the construction of the landfill cover until all environmental permits are obtained for the treatment centre for dredged sediments.

The second part of the landfill expansion was constructed in the clay excavation. The basic design, the detailed engineering and the supervision of construction works was performed by Ecorem (Ecorem, 2006). This part will be landfilled with mainly non-hazardous household wastes, but also with fixed asbestos and will serve as a final disposal site for non-reusable residue from the treatment of dredged sediment.

Figure 5 : Construction of the confined waste disposal site, Moen: (a) land leveling and profiling, (b) layout of HDPE liner, (c) construction of drainage liner, (d) final result (2006).

3.2. Impermeable wall

Studies of Ecorem showed that the pollution of the groundwater with heavy metals and ions/salts from landfill leachates constituted a risk for the environment and specifically for the neighboring waterway, which is used for drinking water production.

In order to stop the spreading of the pollution a soil remediation project was developed which consisted of a full geohydrological isolation of the whole landfill site (Ecorem, 2000b). The isolation was realized by means of an impermeable cement-bentonite slurry wall all around the landfill. Works were conducted and supervised by Ecorem between 1999 and 2002. The wall reached a depth of about 20m below ground level up to the impermeable Ypresian clay formations. A quality control procedure was set up to ensure that the required depth was attained, the cement-bentonite mud was hardened sufficiently and the wall was effectively impermeable.

To check the effectiveness of the wall the groundwater flow and the water levels were calculated by means of a geohydrological model (Ecorem, 2002) and compared to field data.

Figure 6 : Construction of the circular impermeable cement-bentonite slurry wall

3.3. Wastewater treatment

Wastewater, including (rain) water seeping through the landfill, runoff from pavements, but also water from the wheel washing and the green composting plant and domestic waste water are evacuated to a biological wastewater treatment plant.

The treatment plant consists of two WITOX basins, where the wastewater is aerated, two parallel macrophyte beds and subsequently two parallel helophyte beds. Before discharge, the water is additionally treated with two active carbon filters. The wastewater treatment plant is intensively operated and monitored to ensure optimal treatment efficiency (Ecorem, 2009).

Because of the expansion of activities on site the wastewater treatment was optimized using best available technology, but without entailing excessive cost. (Ecorem, 2008b)

Figure 7 : Biological waste water treatment

3.4. Mitigation of visual hindrance

In 2009 a green buffer area with a width of 6m was constructed around the Moen site. It forms a visual barrier between the activities and the surroundings and in the end the whole IMOG site will be integrated in the existing landscape. In order to maximize the ecological potential it consists of diverse, native plantings such as pioneer plants (e.g. Black alder (*Alnus glutinosa*), Grey alder (*Alnus incana*), Wild pivet (*Ligustrum vulgare*), Poplar (*Populus spp.*), Wild cherry (*Prunus avium*), Black locust (*Robinia pseudoacacia*), Willow (*Salix spp.*), Elder (*Sambucus nigra*), ...), half-pioneer species (e.g. Field maple (*Acer campestre*), Sycamore maple (*Acer pseudoplatanus*), ...) and better hardwood species (e.g. European ash (*Fraxinus excelsior*), Poplar (*Populus spp.*), Norway maple (*Acer platanoides*), Northern red oak (*Quercus rubra*), Linden (*Tilia spp.*,...)). Moreover it will serve as a green corridor for fauna. (Ecorem, 2010a & 2010b)

Figure 8: Buffer zone surrounding the landfill site

4. Management of waste fractions

Different waste fractions are selectively collected or sorted in order to allow for maximum reuse and recycling. The door-to-door collection is basically organized by a specialized company. IMOG also operates civic amenity sites which are also for individuals (**Table 2**).

Table 2 : Total processed and produced amounts of IMOG

Processing through incineration	1.6 billion kg
Production of electricity	600 million kwh
Removal through landfill	1.5 billion kg
Selective collection of paper and cardboard	220 million kg
Selective collection of glass bottles and jars	100 million kg
Composting of green waste	300 million kg
Producing and marketing of compost	75 million kg

The waste fractions that are currently treated in the two sites of IMOG are shown in **Figure 9**.

Figure 9 : Overview of activities conducted by IMOG

4.1. Collection through civic amenity sites

IMOG operates 16 civic amenity sites in the region, who organize separate collection of about 40 different waste fractions. At the request of the member municipalities, about 15 IMOG park rangers are operating in the civic amenity sites. In both Harelbeke and Moen civic amenity sites for MSE's are also installed. These sites operate the system of 'differential pricing', which means that every user pays according to the type and quantity of supplied materials, following the principle of 'the polluter pays, the preventer saves'.

Figure 10 : Civic amenity site

In Moen a "waste street" is installed, which encourages individual people to bring sorted materials, such as mattresses, plastics, flower pots, CD's, cork, batteries, etc.

Figure 11: Collected quantities of waste fractions from civic amenity sites of IMOG (in tons in 2009) (source: IMOG, 2009).

Figure 12 : Various fractions brought to civic amenity site

4.2. Sorting centers for bulky waste

The sorting centre consists of a bulky waste sorting line, a wood waste sorting and a cleaning line.

In the bulky waste sorting plant a manual and mechanical sorting is conducted for paper and cardboard, inert building materials such as concrete, wood, plastics, The non-recyclable fraction is sent to a compactor and transported to the licensed incinerator of IMOG Harelbeke for energy production.

Figure 13 : Fractions sorted from bulky waste (in tons in 2009) (source: IMOG, 2009).

4.3. Sorting centre for wood

Wood waste is separated into "untreated wood", "uncontaminated treated wood" and "contaminated treated wood". The wood is further crushed and sieved into different fractions, which are mixed to be used as biomass for subsequent energy production (see **paragraph 5.1**) or for production of MDF wood.

Figure 14 : Fractions sorted from wood waste (in tons in 2009) (source: IMOG, 2009).

4.4. Regional transfer station

Different small hazardous waste fractions and WEEE (Waste Electrical and Electronic Equipment) fractions are brought from civic amenity sites and electronics shops, and sorted and clustered in the regional transfer station for later recycling by specialized companies.

Figure 15 : Regional transfer station for WEEE

4.5. Composting

The importance of sorting and processing green waste became clear due to the increasing amount delivered to the landfill. Investment were made in new equipment (trucks, sieving and shredding machinery), designating new composting and maturation areas on former closed and covered landfill areas and building a covered area for the sieved compost. Moreover, a quality label was developed and the market for the produced compost was explored. In the mid-1990s home composting was

promoted and green waste was collected separately by IMOG. The separately collected green waste was composted into valuable quality compost. The discharged green waste was initially shredded and piled. Odor problems within the composting unit were initially solved by a mobile odor prevention system. In 2002 an active aeration under a half-permeable membrane was foreseen to solve the problem. Once the desired quality of compost is obtained, it is sieved into various fractions. In 2009, 30.000 tons of green waste were brought to the composting installation. Some 13.000 tons of compost and 3000 tons of wood chips were sold on the local market.

Figure 16: Compost

4.6. Treating of street and sweep refuse

Street sweep refuse is being picked up by brush or sweep trucks in the streets and on the site. This material consists of litter, sand, leaves and small branches. IMOG optimized its existing sorting line for bulky waste so that street and sweep refuse could also be sorted.

After cleaning, this waste is separated into a sand fraction, plastic, metal, green waste and combustible waste. The sand fraction is reused as a secondary raw material, for which Ecorem developed a certification procedure (Ecorem, 2007).

4.7. Processing of dredged sediments

In Flanders the demand for treatment possibilities of dredged sediments from navigable and non-navigable waterways is high and the currently available treatment capacity is not sufficient. As a result, much of these materials are landfilled or returned to the waterways, which is no sustainable solution. Moreover, distances between the dredging sites and treatment plants are often considerable, leading to unnecessary transportation costs.

Ecorem developed together with IMOG a master plan to transform covered and unused landfill areas into a treatment centre for dredged sediments (Ecorem, 2008a). In Moen dredged sediments from maintenance dredging will arrive by ship over the adjacent waterway. Dewatering will be conducted by turning over the dredged sediments, which stimulates evaporation and draining. After drying the material will be excavated and removed.

Optional dredged sediments can also be treated by mechanical dewatering through a on-site chamber filter press.

Depending on the environmental and technical quality, treated dredged sediments can be used as a final cover for the landfill or as filling materials, in road constructions or noise barriers.

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Figure 17 : 3D view of future outline of the waste management site at Moen

5. Green energy at Moen site

Besides the energy production from the household waste incineration site in Harelbeke, different sources of renewable energy have been developed in Moen, such as energy from biomass and a solar energy park. New initiatives for green energy production are planned: an extension of the solar energy park and the production of electricity using biogas from the landfill.

5.1. Biomass Centre

As from 1999, IMOG decided to focus on and improve the selective collection, sorting and treatment of wood waste.

Wood collected at the civic amenity sites is recycled (production of medium density fibre board). But there is still a wood waste stream that is not recyclable. Since 2005 this non-recyclable wood is used in the biomass power plant.

Here shredded prunings, originating from roadside verge maintenance or forestry, are sieved and mixed with wood scrap from the sorting and cleaning system for wood waste. The biomass is used as fuel for the production of green energy in the electricity company of Electrabel in Ruimen, which is easily accessible via inland waterways. Every year 30.000 tons of biomass are produced at Moen, allowing for more than 41 million kWh. This is the consumption of electricity of 32.000 people.

5.2. Landfill gas extraction

In the framework of the sustainable future development of the site, IMOG was equally looking for an efficient collection and/or use of the gas produced in its landfill. A landfill gas extraction system was installed during the exploitation of the landfill. Some 12 vertical extraction wells were constructed, of which three have been fully finished. At each of the wells, horizontal HDPE pipes were connected, leading to a central location where a collector, extraction pump and combustion engine will be installed (Ecorem, 2010c)

Figure 18 : Construction of landfill gas extraction

In order to assess the potential for landfill gas recuperation or flaring, the theoretical landfill gas capacity was calculated in a feasibility study. It was concluded that the maximum extraction of gas is approximately 1.800 m³/hr and that the production will remain above 500 m³/hour till 2020. It has been shown that the landfill gas can be converted in electricity by using a combustion engine. Heat extraction can further increase the efficiency. Should the production decrease below 500 m³/hr, a micro turbine can be used for electricity production, or the extracted gas can be discharged to a flare system. (Ecorem, 2010c)

Figure 19 : Potential for landfill gas extraction (m³/hour)

5.3. Solar energy park

When a landfill is to be closed, the owner is obliged to consider "after care" measures and monitoring for 30 years and to develop the site according to the local and regional planning regulations. IMOG installed 2 ha of solar panels on the part of the landfill which is already covered. The produced electrical energy is used on the site, and the excess electricity is distributed through the net. In the future, when the whole landfill is full and covered, some 10 ha of photovoltaic cells will be installed, resulting in green energy for at least 1500 families.

5.4. Energy use incineration plant Harelbeke

An energy plan for efficient use of the energy of the incineration site at Harelbeke is made in 2010.

6. Exporting forty years of knowhow

IMOG has a tradition to use various communication, sensitization and education means to encourage waste prevention and to improve the sorting at the base. This is very important for the quality of the secondary materials derived from primary waste products and to create a social basis for the current and future evolutions in waste management practices.

Along with other Belgian organizations and companies IMOG wishes to export the technical and operational knowledge which has been obtained during the last four decades to other regions and partners. A number of collaborations with partners in EU transition and developing countries has been set up (Balkan, Eastern Europe).

7. Conclusion

After four decades of waste management the intermunicipal organization IMOG has shown that waste can be more than a nuisance. Waste is wanted and it can be a source of new materials and renewable energy. It creates job opportunities and profit for the society.

Waste management is an investment which requires to take certain risks, and which needs the necessary technical skills and technology, as well as a good organization and control. Sustainable waste management is all about making the right choices. For each waste problem there is an appropriate solution. Therefore, it is important to make the best choice about what has to be done first, which technology has to be chosen and who will implement the project.

In the Moen site at Harelbeke it was shown that a landfill does not have to be closed and abandoned after filling. This site was integrated in the regional land use plans and used for new assignments. .

Last but not least, there is a major interest to share the skills and technical knowhow with other organizations, regions or countries organizing integrated waste management systems.

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FIGURES

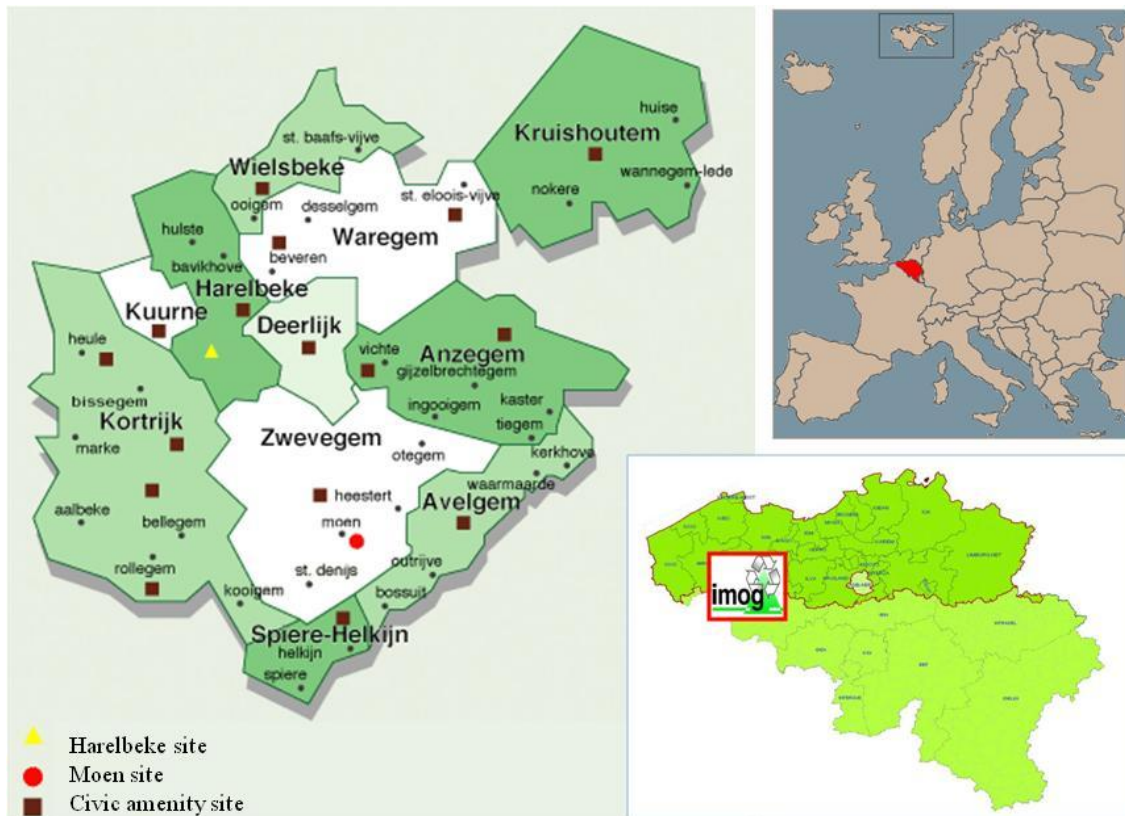


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Figure 2 : Sustainable waste management system of IMOG

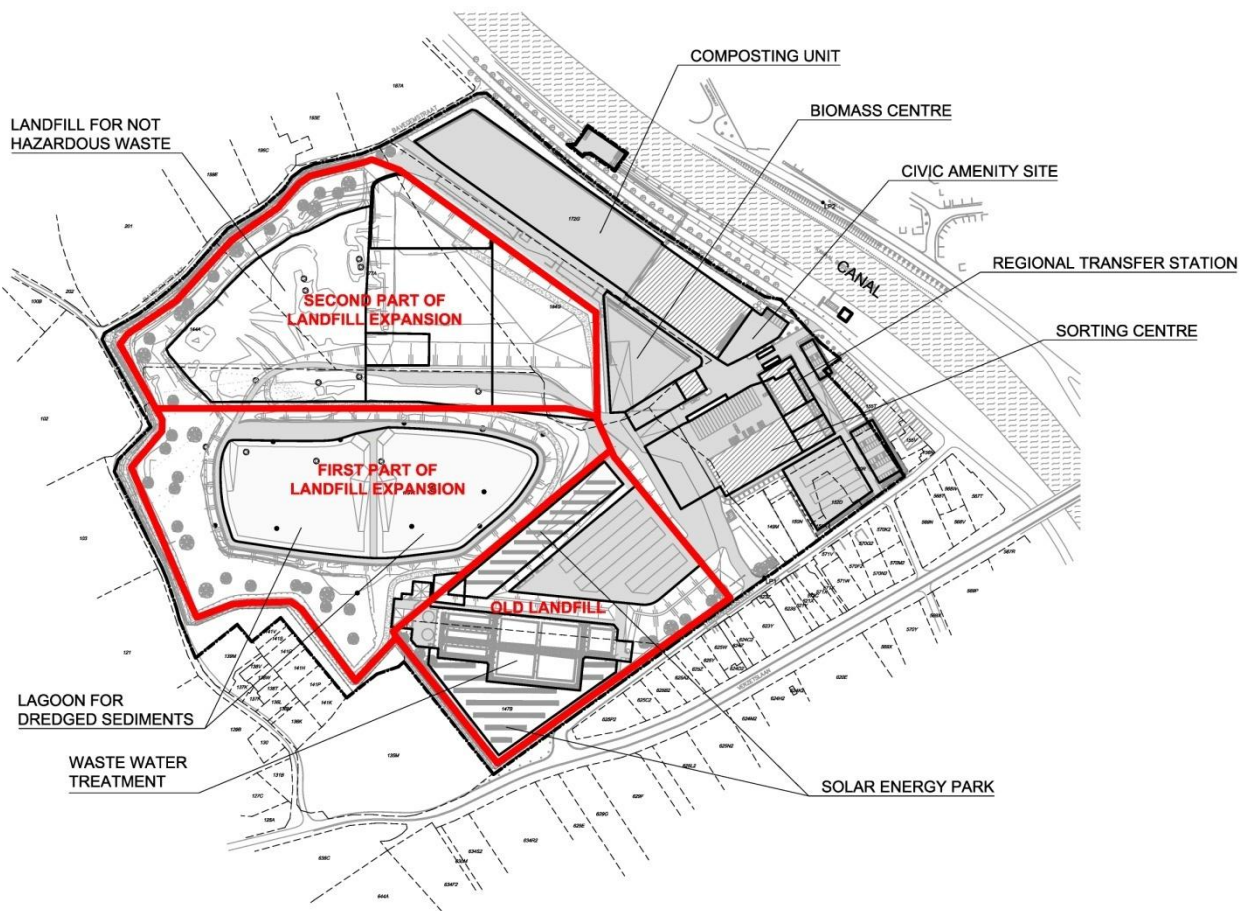


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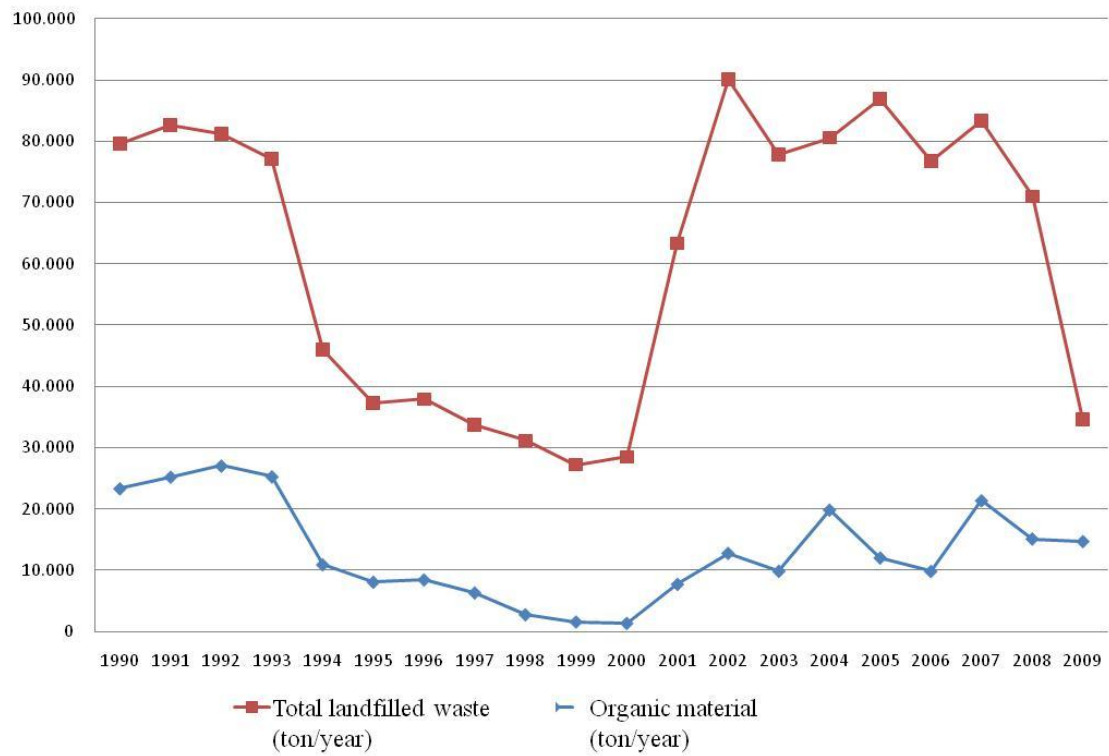


Figure 4: Yearly amount of total landfilled waste and the fraction of organic material in the landfill (1990-2009) in ton/year (Ecorem, 2010c)

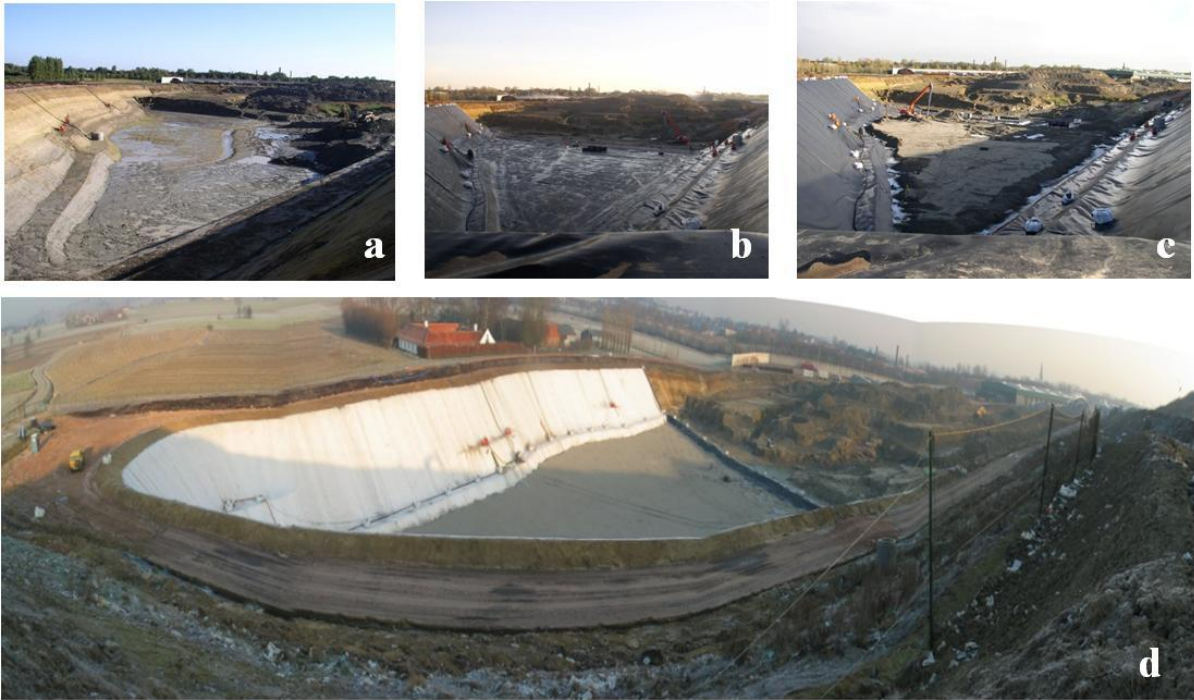


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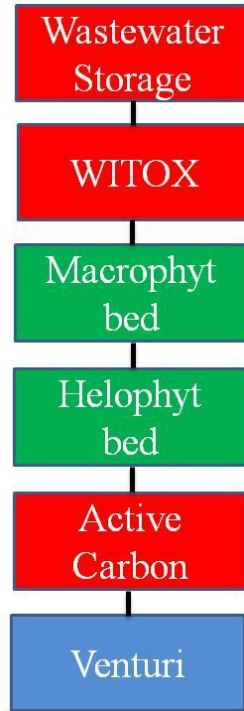


Figure 7 : Biological waste water treatment



Figure 8: Buffer zone surrounding the landfill site

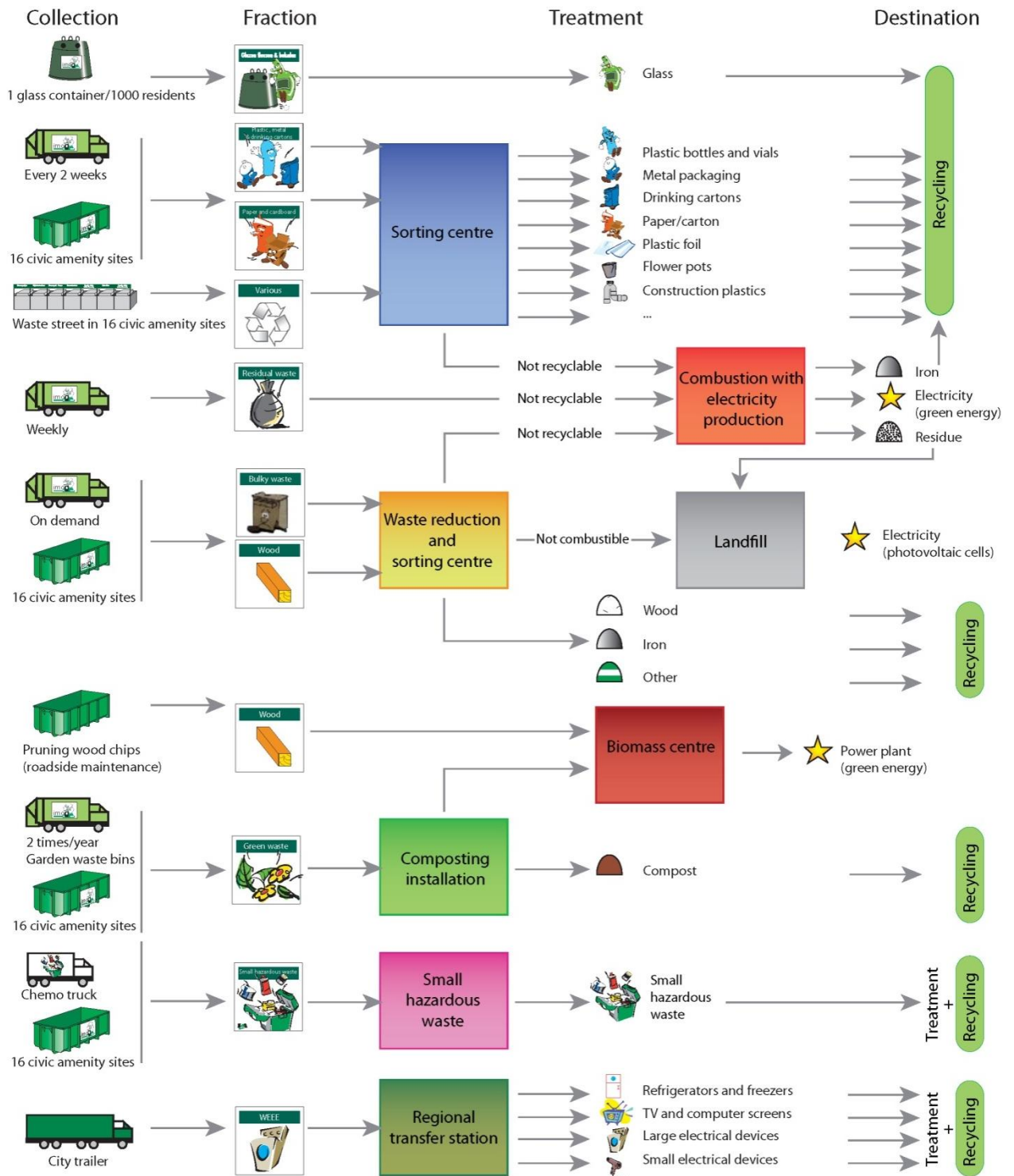


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Figure 10 : Civic amenity site

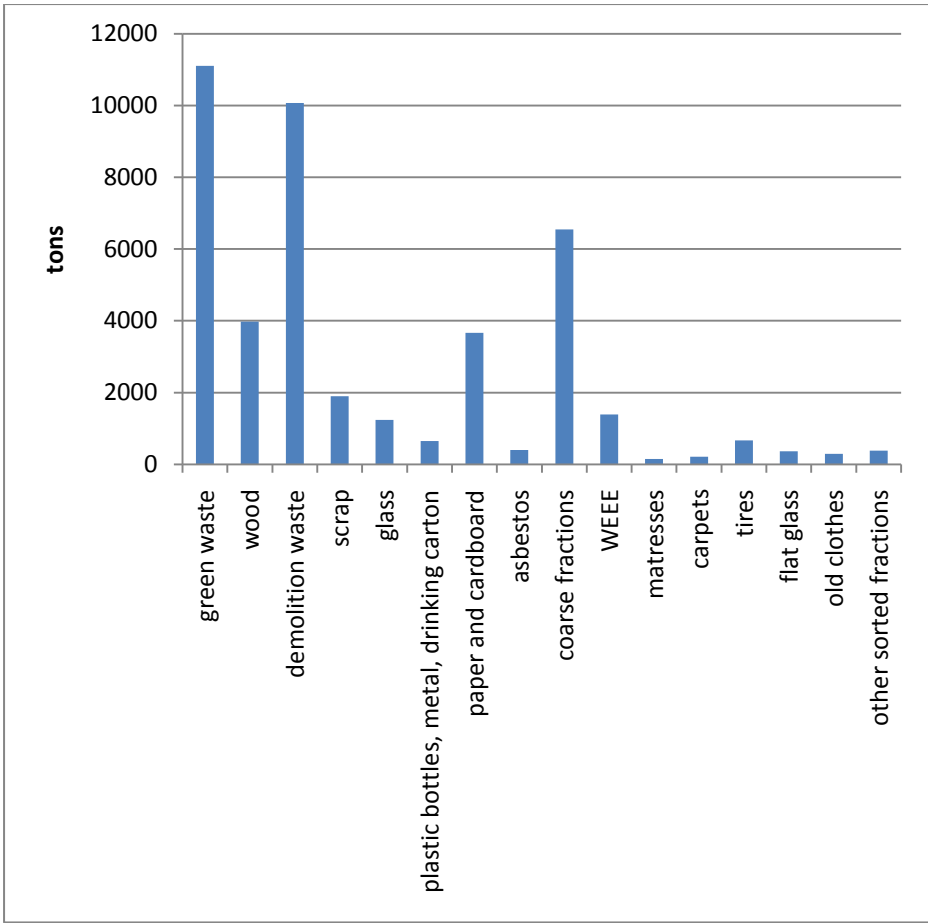


Figure 11: Collected quantities of waste fractions from civic amenity sites of IMOG (in tons in 2009) (source: IMOG, 2009).

Payable



Obligation for taking back



Reuse/recycle



Small hazardous waste



Figure 12 : Various fractions brought to civic amenity sites

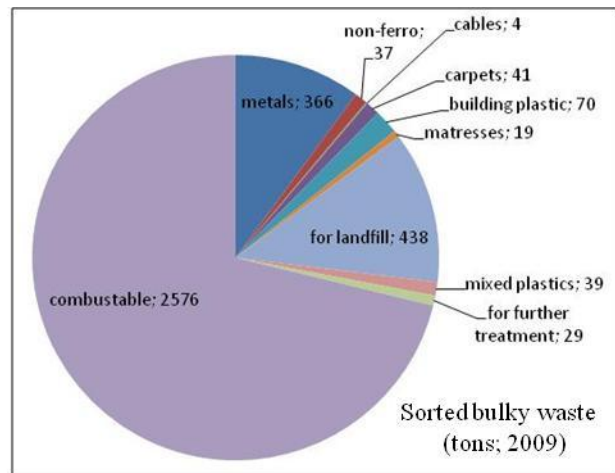


Figure 13 : Fractions sorted from bulky waste (in tons in 2009) (source: IMO, 2009).

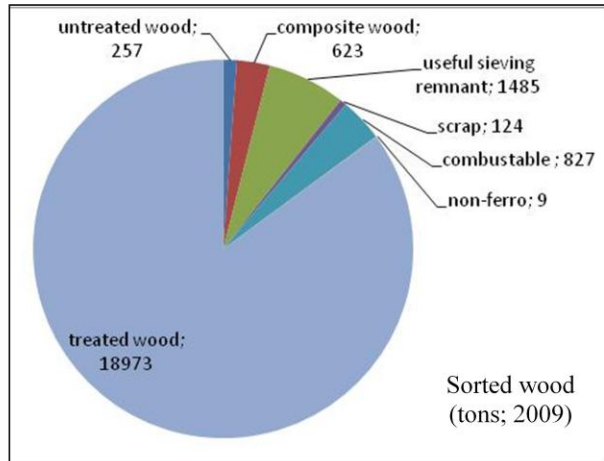


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Figure 15 : Regional transfer station for WEEE



Figure 16: Compost production



Figure 17 : 3D view of future outline of the waste management site at Moen



Figure 18 : Construction of landfill gas extraction well

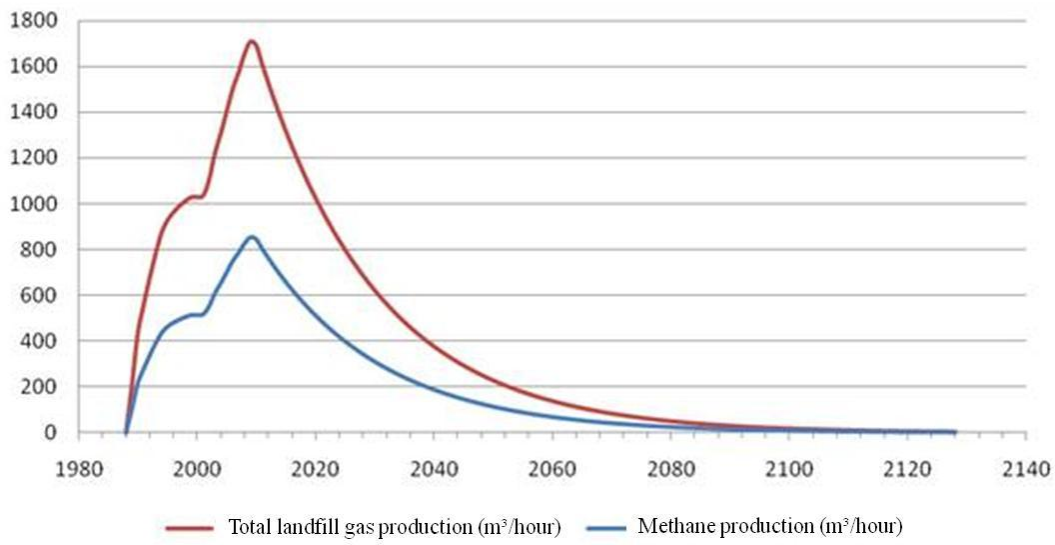


Figure 19 : Potential for landfill gas extraction (m³/hour) (Ecorem, 2010c).

ODRŽIVOST RAZVOJA NEKONTROLIRANIH ODLAGALIŠTA U CJELOVITE CENTRE ZA
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Sažetak

Intermunicipal Waste Organization (IMOG) koristi odlagalište opasnog i neopasnog otpada, kompostanu i opskrbeni centar u zapadnoj Flandriji. IMOG-ove usluge pokrivaju 11 općina površine 387 km² i oko 227.000 stanovnika. U susjedstvu ove lokacije je glinokop koji opskrbljuje lokalnu industriju proizvodnje cigle. Lokacija se nalazi blizu odlivnog kanala i relativno blizu postrojenja za spaljivanje otpada. Glinokop će se u budućnosti koristiti kao dodatno postrojenje za odlaganje, koje će, osim krutog otpada, prihvaćati i nezagađeni sediment od jaružanja. Ovi materijali koristit će se kao brtveni slojevi u skladu s EU i Flamanskom legislativom, prema kolijevka-kolijevci principu. U konačnici će se lokacija zazeleniti i pretvoriti u (solarni) energetska park. U prošlosti je ova lokacija bila teško onečišćena zbog nekontroliranog odbacivanja različitih vrsti otpada, ali primjenom inovativnih sanacijskih tehnika, opterećenje okoliša je svedeno na nulu. Trenutno su glavne aktivnosti odvojeno sakupljanje i recikliranje više od 40 različitih tokova otpada i proizvodnja obnovljive energije iz biomase. Većinu svog uspjeha IMOG duguje dobroj komunikacijskoj strategiji s lokalnim stanovništvom, te proširenju suradnje s drugim operaterima koji se bave otpadom u različitim zemljama u Europi i Aziji.

Ključne riječi: Reciklaža, tokovi otpada, sanitarno odlagalište, obnovljiva energija

1. Uvod

IMOG je međuopćinska organizacija za otpad u jugo-zapadnoj Flandriji (Belgija) za 11 općina s 227.000 stanovnika. IMOG posluje na dvije lokacije: Moen i Merelbeke (**Table 1**) I ima raširenu mrežu točaka za sakupljanje otpada. IMOG ima godišnji promet od 26 milijuna Eura (2009) I zapošljava oko 200 ljudi.

Tablica 3 : Poslovanje IMOGa na različitim lokacijama

Harelbeke	Zwevegem-Moen	U svim općinama; odvojeno sakupljanje
Spalionica otpada	Odlagalište	<i>Kod kuće :</i>
Postrojenje za sortiranje ambalaže	Glinokop	Ostatni otpad
Postrojenje za sortiranje papira I kartona	Postrojenje za obradu otpadnih voda	Papir I karton (dvo-tjedno)
Postrojenje za sortiranje I baliranje plastike	Postrojenje za sortiranje otpadnog drva	Ambalaža (plastične boce, metalne limenke,) (dvo-tjedno)
Centar o otpadu	Kompostana	Otpad iz vrtova sakupljen u kontejnere (180 l-280 l)
Office za senzibilizaciju I komunikaciju	Centar za Biomasa	<i>Na kritičnim točkama (1 točka za 1000 stanovnika):</i>
Edukacijski centar administracija	Postrojenje za sortiranje glomaznog otpada i sličnog otpada iz industrija	Sakupljanje staklenih boca (bijele i obojene)
	Grupiranje ostataka kemijskog otpada	Sakupljanje tekstila
	grupiranje električnog I elektroničkog otpada	<i>Reciklažna dvorišta:</i>
	Reverse logistika : vozila za sakupljanje otpadnih staklenih boca, vozila za sakupljanje 30 m ³ kontejnera, kamioni za smeće	Glomazni otpad
	administracija	Vrtni otpad
		Građevinski otpad I otpad od rušenja
		Metali
		Drvo
		Kemijski otpad iz kućanstava (opasni otpad iz kućanstava)
		Papir I karton
		Plastika : HDPE, LDPE, PP, PVC, PS, EPS
		Plastični filmovi
		Prozorsko staklo
		Staklo (bijele I obojene boce)
		WEEE (električna I elektronička oprema)
		Tekstil

Figure 1 : Location of intermunicipal organization IMOG and its 11 constituting municipalities

Ciljevi IMOGa su obrada otpada iz kućanstava po principu održivog gospodarenja otpadom, poštujući hijerarhiju otpada po Lansink ladder principu. Misli vodilje su prevencija i ponovna uporaba, odvojeno sakupljanje i reciklaža, obrada ostatnog otpada spaljivanjem, kompostiranjem i na koncu odlaganjem. U zadnjem desetljeću razvijen je i implementiran veliki broj novih tehnologija u aktivnostima IMOGa, u suradnji s Flamanskim konzultantskim i projektantskim okolišnim tvrtkama, poput Ecorem-a.

Javna svijest i proširenje mogućnosti su uvijek bile nositelji strategije gospodarenja otpadom IMOGa. Pored toga, IMOG je rado dijelio svoja tehnička i operativna znanja s zemljama u razvoju i tranzicijskim zemljama na projektima gospodarenja otpadom.

Figure 2 : Sustainable waste management system of IMOGa

2. Povijest

a. Stvaranje IMOGa

1969. godine provincija zapadna Flandrija počela je organizirati svoj otpad i gospodarenje otpadnim vodama, u svrhu postizanja rješenja za sakupljanje i obradu otpada na regionalnoj razini. U jugozapadnoj Flandriji je stoga formirana međuopćinska organizacija IMOG (inter-municipal company for public health). U Harelbeke-u je odabrano mjesto za izgradnju spalionice otpada i postrojenja za pročišćavanje otpadnih voda. Ova lokacija bila je idealna zbog njenog centralnog smještaja u odnosu na glavne proizvođače otpada, dobre prometne veze i blizinu rijeke Leie koja se može koristiti odvod pročišćene otpadne vode i rashladnih voda (Soenens, 2009).

b. Uspostavljanje lokacije Moen

Od 1980ih otpad je postao obveza Javne agencije Flandrije (OVAM) koja regulira i kontrolira odlagališta. Obzirom da dostupne spalionice ne osiguravaju adekvatna rješenja za određene materijale poput inertnog i negorivog glomaznog otpada, zelenog i vrtnog otpada, porasla je potreba za uspostavljanjem međuopćinskog odlagališta.

Lokaciju odlagališta je dala općina Moen, na mjestu starog glinokopa koje je već bilo korišteno za odlaganje industrijskog otpada i otpada iz kućanstava. Nakon osnovnih infrastrukturnih radova i istraživanja, ishodene su dozvole koje su omogućile da odlagalište krene s radom. 1986. godine IMOG je ishodio dozvolu za potpuno iskorištavanje lokacije u skladu s regulativom koja je u tom trenutku bila na snazi. Čak i u tim ranim godinama eksploatacije posebna pažnja je bila usmjerena na obradu različitih vrsti otpada i neovisnost lokacije (Soenens, 2009).

3. Upravljanje lokacijom Moen

Postupno se lokacija Moen oplemenila i razvile su se nove tehnologije koje udovoljavaju okolišnim propisima, mogućnostima tržišta, promjeni javnog mijenja prema gospodarenju otpadom. Ecorem je proveo cjelovitu analizu utjecaja na okoliš za čitavu lokaciju (Ecorem, 1998a) za potrebe ishoda okolišne dozvole (Ecorem, 1998b). Gradilište se prostire na 27 ha.

Figure 3 : Overview of the current activities at IMOG and the consecutive landfill expansions

a. Pogon, širenje i prekrivanje odlagališta

Dovoz otpada na odlagalište je bio izrazito velik od samog početka te se uskoro pojavila potreba za proširenjem odlagališta. Istovremeno su pokrenute određene aktivnosti za smanjenje količina otpada. U međuvremenu zapunjeni dijelovi odlagališta su se prekrili.

Figure 4: Yearly amount of total landfilled waste and the fraction of organic material in the landfill

2000. godine je donesen poslovni plan (Ecorem, 2000a) za daljnji rad glinokopa i daljnjeg širenja odlagališta na glinokop. Dozvola za povećanje odlagališta daljnjom eksploatacijom gline je ishoda kroz okolišnu dozvolu (Ecorem, 2004). Glina se koristila u keramičkoj industriji, a također se predvidjelo korištenje gline za izgradnju brtvenih i prekrivnih slojeva odlagališta.

Tijekom prve faze proširenja odlagališta, nastavljeno je s odlaganjem otpada. Do danas je smanjen dovoz otpada 1. kategorije (industrijskog otpada) i naglasak je stavljen na širenje odlagališta na otpad 2. kategorije (otpad iz kućanstava).

Okolišne dozvole za prvi dio ekspanzije odlagališta su istekle 2008. godine, te se pojavila potreba za prekrivanjem odlagališta kako bi se izolirao otpad. Ecorem, u suradnji s IMOGom je donio master plan za buduće korištenje prekrivenog odlagališta kao centra za obradu sedimenata od jaružanja (Ecorem, 2008a).

Ishoda dozvola od Ministarstva zaštite okoliša odgodilo je izgradnju prekrivnog sloja sve dok nisu ishoda sve okolišne dozvole za centar za obradu sedimenata od jaružanja.

Drugi dio ekspanzije odlagališta izgrađen je u iskopištu gline. Ecorem je izradio glavni projekt, te je proveo detaljno projektiranje i nadzor nad izvođenjem radova (Ecorem, 2006). Na ovaj dio odlagališta predviđa se da će se odlagati većina neopasnog otpada iz kućanstava, i fiksirani azbest te će se isto koristiti kao konačno mjesto za odlaganje ne-oporabljivih ostataka iz obrade sedimenata od jaružanja.

Figure 5 : Construction of the confined waste disposal site, Moen: (a) land leveling and profiling, (b) layout of HDPE liner, (c) construction of drainage liner, (d) final result (2006).

b. Npropustan zid

Studije Ecorema pokazale su da onečišćenje podzemnih voda teškim metalima i ionima/solima iz odlagališnih procjernih voda sačinjavaju rizik po okoliš i posebno za susjedni vodeni kanal, koji se koristi za proizvodnju pitke vode.

Kako bi se zaustavilo širenje onečišćenja, napravljen je projekt sanacije tla koji se sastojao od potpune geohidrološke izolacije čitavog odlagališta (Ecorem, 2000b). Izolacija je završena postavljanjem nepropusnog cementnog-bentonitnog zida oko čitavog odlagališta. Radove je izvodio i nadzirao Ecorem u periodu između 1999 i 2002. Zid je bio dubok 20m, ispod razine tla. Uspostavljena je procedura kontrole kvalitete kako bi se osiguralo postizanje potrebne dubine, cementni-bentonitni mulj je uspješno stvrdnjen i zid je bio učinkovito nepropustan.

U svrhu provjere učinkovitosti zida geohidrološkim modelom su izračunati tokovi podzemnih voda i razine voda (Ecorem, 2002) i uspoređeni su s podacima na gradilištu.

Figure 6 : Construction of the circular impermeable cement-bentonite slurry wall

c. Obrada otpadnih voda

Otpadne vode, uključujući (kišnica) vodu koja prolazi kroz odlagalište, vodu koja otječe s kolnika, ali i vodu iz uređaja za pranje kotača i s kompostane, kao i sanitarnu otpadnu vodu, se odvođe na postrojenje za obradu otpadnih voda.

Postrojenje za obradu otpadnih voda se sastoji od dva WITOX bazena u kojima se otpadna voda aerira, dva paralelna makrofitna ležaja i dva paralelna helofitna ležaja. Prije ispusta, voda se dodatno

tretira s dva filtra s aktivnim ugljenom. Postrojenje za obradu otpadnih voda radi intenzivno I njegov rad se nadzire kako bi se osigurala optimalna učinkovitost obrade (Ecorem, 2009).

Zbog proširenih aktivnosti na gradilištu, postrojenje za obradu otpadnih voda je optimizirano koristeći najbolje raspoložive tehnologije, bez da je isto uzrokovalo dodatne troškove (Ecorem, 2008b)

Figure 7 : Biological waste water treatment

d. Ublaživanje vizualne smetnje

2009. godine izgrađen je zeleni međuprostor širine 6m na lokaciji Moen. On tvori vizualnu barijeru između aktivnosti na lokaciji I okoline I na kraju će se kompletna IMOG lokacija uklopiti u postojeći krajolik. Kako bi se maksimizirao ekološki potencijal, to područje sadrži raznovrsne, izvorne biljke (e.g. Black alder (*Alnus glutinosa*), Grey alder (*Alnus incana*), Wild pivet (*Ligustrum vulgare*), Poplar (*Populus spp.*), Wild cherry (*Prunus avium*), Black locust (*Robinia pseudoacacia*), Willow (*Salix spp.*), Elder (*Sambucus nigra*) ,...), half-pioneer species (e.g. Field maple (*Acer campestre*), Sycamore maple (*Acer pseudoplatanus*) ,...) and better hardwood species (e.g. European ash (*Fraxinus excelsior*), Poplar (*Populus spp.*), Norway maple (*Acer platanoides*), Northern red oak (*Quercus rubra*), Linden (*Tilia spp.*,...)). Štoviše, ovo područje će služiti kao zeleni koridor za faunu. (Ecorem, 2010a & 2010b)

Figure 8: Buffer zone surrounding the landfill site oko odlagališta

4. Gospodarenje frakcijama otpada

Različite frakcije otpada se odvojeno sakupljaju ili sortiraju kako i se osigurala maksimalna uporaba ili reciklaža. Sakupljanje od vrata do vrata je organizirano od strane specijalizirane tvrtke. IMOG također upravlja reciklažnim dvorištima namijenjenim građanima (**Table 2**).

Tablica 4 : Ukupne procesuirane i proizvedene količine od strane IMOGa

Procesiranje kroz spaljivanje	1.6 bilijuna kg
Proizvodnja električne energije	600 milijuna kwh
Odlaganje na odlagališta	1.5 bilijuna kg
Odvojeno sakupljanje papira i kartona	220 milijuna kg
Odvojeno sakupljanje staklenih boca i tegli	100 milijuna kg
Kompostiranje zelenog otpada	300 milijuna kg
Proizvodnja i prodaja komposta	75 milijuna kg

Frakcije otpada koje se trenutno obrađuju na dvije IMOGove lokacije prikazane su na **Figure 9**.

Figure 9 : Overview of activities conducted by IMOG

a. Sakupljanje putem reciklažnih dvorišta

IMOG upravlja s 16 reciklažnih dvorišta u regiji, na kojima se odvojeno sakuplja oko 40 različitih frakcija otpada. Na zahtjev općina, oko 15 IMOGovih čuvara parkova radi na reciklažnim dvorištima. U Harelbek-u i Moen-u izgrađena su reciklažna dvorišta za komunalni otpad. Ova dvorišta rade na principu “diferencijalnih cijena”, što znači da svaki korisnik plaća prema tipu i količini donesenih materijala, prema principu “onečišćivač plaća, preventer štedi”.

Figure 10 : Civic amenity site dvorišta

U Moen-u je izgrađena “ulica za otpad”, koja potiče građane da donose sortirane materijale poput madraca, plastike, tegli od cvijeća, CD, pluta, baterija itd.

Figure 11: Collected quantities of waste fractions from civic amenity sites of IMOG (in tons in 2009) (source: IMOG, 2009).

Figure 12 : Various fractions brought to civic amenity site

b. Centri za sortiranje glomaznog otpada

Centar za sortiranje sastoji se od linije za sortiranje glomaznog otpada, sortiranje otpadnog drva i linije za čišćenje.

Na postrojenju za sortiranje glomaznog otpada izvodi se ručno i mehaničko sortiranje papira i kartona, inertnih građevinskih materijala poput betona, drva, plastike, ... Nereciklična frakcija se šalje na kompaktor i prevozi se do IMOGove spalionice Harelbeke.

Figure 13 : Fractions sorted from bulky waste (in tons in 2009) (source: IMOG, 2009).

c. Centar za sortiranje drva

Drveni otpad se dijeli na “neobrađeno drvo”, “nezagađeno obrađeno drvo” i “onečišćeno obrađeno drvo”. Drvo se nadalje drobi i prosijava na različite frakcije, koje se miješaju i koriste kao biomasa za kasniju proizvodnju energije (vidi **paragraf 5.1**) ili proizvodnju MDF drva.

Figure 14 : Fractions sorted from wood waste (in tons in 2009) (source: IMOG, 2009).

d. Regionalne transfer stanice

Različite male frakcije opasnog otpada i frakcije EEO (Električni i Elektronični otpad) se iz reciklažnih dvorišta i dućana s elektronikom dovode do regionalnih transfer stanica gdje se sortiraju i grupiraju za kasniju reciklažu od strane specijaliziranih tvrtki.

1.1. Figure 15 : Regional transfer station for WEEE

1.2. Kompostiranje

Važnost zelenog otpada postala je jasna zbog povećane količine tog otpada dovezene na odlagalište. Investirano je u novu opremu (kamioni, mašinerija za prosijavanje i usitnjavanje), određena su nova područja za kompostiranje i dozrijevanje na bivšim zatvorenim i prekrivenim prostorima odlagališta i osigurano je područje za prosijani kompost. Nadalje, postignuta je određena kvaliteta komposta i istraženo je tržište za proizvedeni kompost. Sredinom 1990-ih promovirano je kompostiranje kod kuće i IMOG je počeo odvojeno sakupljati zeleni otpad. Odvojeno sakupljeni zeleni otpad se kompostirao i z njega se dobivao kvalitetan kompost. Odbačeni zeleni otpad se u početku usitnjavao.

Problemi s neugodnim mirisima unutar jedinice za kompostiranje su u početku bili riješeni mobilnim sustavom za suzbijanje neugodnih mirisa. 2002. godine problem je riješen aktivnom aeracijom ispod polu-propusne membrane. Kad bi se postigla potrebna kvaliteta komposta, kompost bi se prosijavao na različite frakcije. 2009. godine, 30.000 tona zelenog otpada je doneseno na kompostanu. Oko 13.000 tona komposta i 3000 tona drvnog iverja prodano je na lokalnom tržištu.

Figure 16: Compost

1.3. Obrada otpada s ulica i otpada iz čistilica

Otpad iz čistilica se kupi putem četki ili kamiona čistilica na ulicama i na gradilištu. Ovaj materijal se sastoji od sitnice, pijeska, lišća i malih grančica. IMOG je optimizirao postojeću liniju za sortiranje glomaznog otpada na način da se na njoj može sortirati otpad iz čistilica.

Nakon čišćenja, ovaj otpad se odvaja na pješčanu frakciju, plastiku, metal, zeleni otpad i gorivi otpad. Pješčana frakcija se ponovno koristi kao sekundarni sirovi materijal, (Ecorem, 2007).

1.4. Procesuiranje sedimenata od jaružanja

U Flandriji postoji velika potražnja za mogućnostima obrade sedimenata od jaružanja iz plovnih i ne-lovnih vodenih putova i trenutno dostupan kapacitet za obradu nije dovoljan. Kao rezultat toga, velika količina ovih materijala se odlaže ili vraća u vodene kanale, što ne predstavlja održivo rješenje. Nadalje, udaljenosti između područja jaružanja i postrojenja za obradu često predstavljaju nepotrebne troškove za transport.

Ecorem je zajedno s IMOGom razvio master plan kako transformirati prekrivena i nekorisćena područja odlagališta u centre za obradu sedimenata od jaružanja (Ecorem, 2008a). U Moen-u se sedimenti od jaružanja dopremaju brodom preko obližnjeg vodenog kanala. Odvodnjavanje se izvodi prevrtanjem sedimenata od jaružanja, čime se stimulira isparavanje i drenaža. Nakon sušenja, materijal se iskapa i odstranjuje.

Alternativno, sedimenti od jaružanja se mogu obrađivati mehaničkim odvodnjavanjem na licu mjesta komorom s filter prešom.

Ovisno o okolišnoj i tehničkoj kvaliteti, obrađeni sedimenti od jaružanja mogu se koristiti kao završni pokrov za odlagališta ili kao materijali za ispunu u izgradnji cesta ili za zvučne barijere.

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Figure 17 : 3D view of future outline of the waste management site at Moen

2. Zelena energija na lokaciji Moen

Osim proizvodnje energije iz spalionice u Harelbeke-u za obradu otpada iz kućanstava, razvijeni su i drugi različiti izvori obnovljive energije u Moen-u, poput energije iz biomase i parkovi solarne energije. Planiraju se i nove inicijative za proizvodnju zelene energije: proširenje parka solarne energije i proizvodnja električne energije koristeći bioplin iz odlagališta.

2.1. Centar za biomasu

Od 1999. godine, IMOG je pažnju usmjerio na poboljšanje odvojenog sakupljanja, sortiranje i obradu drvenog otpada.

Drvo sakupljeno u reciklažnim dvorištima se reciklira (proizvode se vlaknaste ploče srednje gustoće), no još uvijek postoji dio drvenog otpada koji nije recikličan. Od 2005. godine ovo ne-reciklično drvo se koristi na postrojenjima za biomasu.

Usitnjeni dijelovi, koji potječu od održavanja rubnika ili šuma, se siju i miješaju s drvenim ostacima iz sustava sortiranja i čišćenja drvenog otpada. Biomasa se koristi kao gorivo za proizvodnju zelene energije u tvrtki Electrabel u Ruimen-u. Svake godine, u Moen-u se proizvede 30.000 tona biomase, od koje se dobije više od 41 milijuna kWh što predstavlja potrošnju električne energije za 32.000 ljudi.

2.2. Iskorištavanje odlagališnog plina

U okvirnom prijedlogu za održivi budući razvoj lokacije, IMOG je dio pažnje usmjerio na učinkovito sakupljanje i/ili korištenje plina proizvedenog a njegovom odlagalištu. Sustav iskorištavanja odlagališnog plina instaliran je tijekom eksploatacije odlagališta. Izgrađeno je 12 vertikalnih zdenaca za otplinjavanje, od kojih su tri u potpunosti završena. Na svakom zdencu spojene su horizontalne HDPE cijevi, koje vode do centralne lokacije na kojoj će se instalirati kolektor, crpka i motor (Ecorem, 2010c)

Figure 18 : Construction of landfill gas extraction

Kako bi se procijenio potencijal odlagališnog plina za obnovu ili spaljivanje, napravljena je studija izvodljivosti u kojoj je izračunat je teoretski kapacitet odlagališnog plina. Zaključeno je da maksimalno iskorištenje plina iznosi oko 1.800 m³/sat i da će proizvodnja odlagališnog plina iznositi preko 500 m³/satu do 2020 godine. Prikazano je da se odlagališni plin može pretvoriti u električnu energiju koristeći motor za izgaranje. Ekstrakcija topline može dodatno povećati učinkovitost. Ako proizvodnja odlagališnog plina padne ispod 500 m³/sat, može se koristiti mikro turbina za proizvodnju električne energije, ili se iscrpljeni plin može spaliti na baklji (Ecorem, 2010c)

Figure 19 : Potential for landfill gas extraction (m³/hour)

2.3. Park solarne energije

Kad je odlagalište blizu zatvaranja, vlasnik je obvezan u obzir uzeti mjere “nakon zatvaranja” i monitoring tijekom 30 godina i razviti lokaciju prema lokalnim i regionalnim planovima. IMOG je ugradio 2 ha solarnih panela na dio odlagališta koji je već prekriven. Proizvedena električna energija se koristi na licu mjesta, a višak električne energije se distribuira u mrežu. U budućnosti, kada čitavo odlagalište bude prekriveno, bit će ugrađeno oko 10 fotovoltnih ćelija, što će rezultirati proizvodnjom zelene energije za najmanje 1500 kućanstava

2.4. Spalionica Harelbeke

Energetski plan za učinkovito korištenje energije na postrojenju za spaljivanje otpada Harelbeke napravljen je 2010. godine.

3. Izvoz četrdeset godina znanja

IMOG ima tradiciju korištenja različitih komunikacijskih, senzibilizacijskih i edukacijskih mjera za poticanje sprječavanja nastanka otpada i poboljšanja sortiranja na mjestu nastanka. To je vrlo važno za kvalitetu sekundarnih materijala dobivenih iz primarnih proizvoda otpada i za izgradnju socijalne baze za sadašnje i buduće evolucije u praksi gospodarenja otpadom.

Zajedno s ostalim belgijskim organizacijama i tvrtkama IMOG želi podijeliti tehničko i operativno znanje koje je stekao tijekom zadnja četiri desetljeća, na druge regije i partnere. Već su ostvarene brojne suradnje s partnerima iz tranzicijskih zemalja i zemalja u (Balkan, istočna Europa).

4. Zaključci

Nakon četiri desetljeća gospodarenja otpadom međuopćinska organizacija IMOG je dokazala da otpad može iti više od obične smetnje. Otpad može biti izvor novih materijala i obnovljive energije. On otvara nova radna mjesta i profit za društvo.

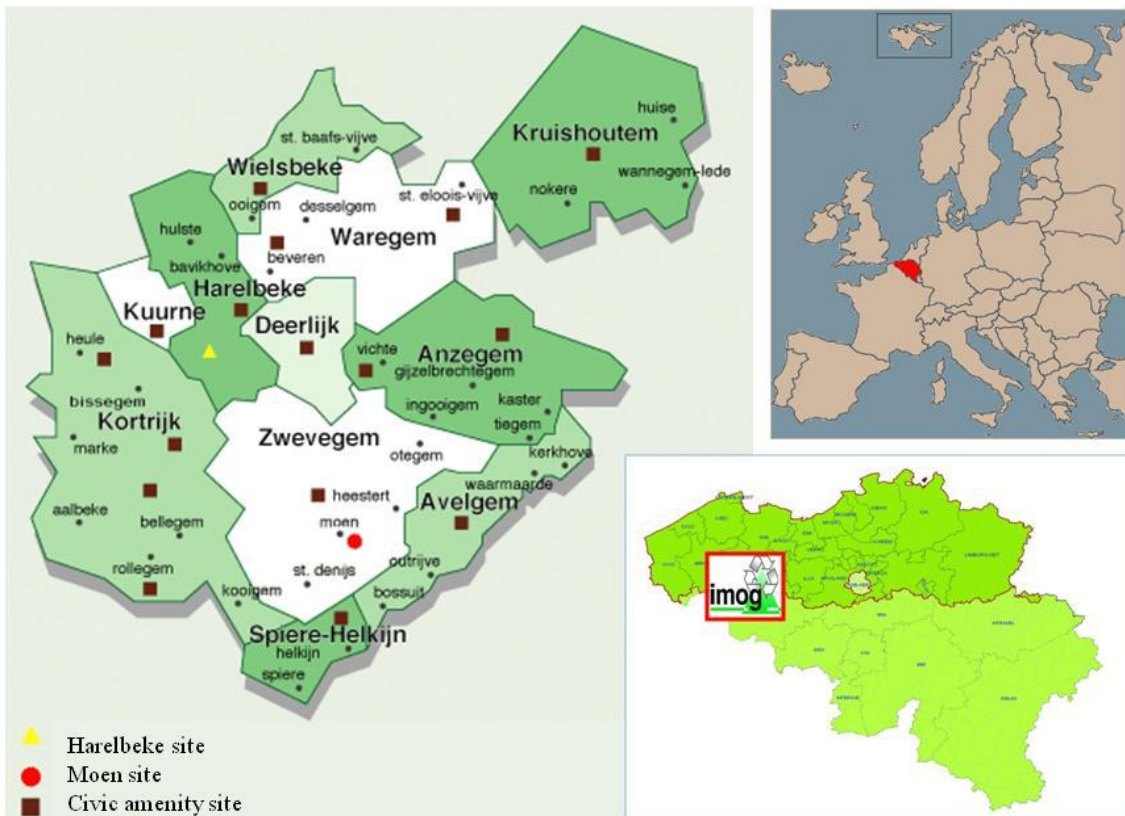
Gospodarenje otpadom je investicija koja zahtjeva poduzimanje određenih rizika, i koja zahtjeva određene tehničke vještine i tehnologije, kao i dobru organizaciju i kontrolu. Održivo gospodarenje otpadom predstavlja pravilno odabiranje. Za svaki problem s otpadom postoji odgovarajuće rješenje. Stoga je važno donijeti najbolju odluku što se prvo treba napraviti, koju tehnologiju odabrati i tko će provesti projekt.

Na lokaciji Moen u Harelbeke-u prikazano je da odlagalište ne treba zatvoriti i napustiti nakon što se ono napuni. Ovo odlagalište je integrirano u regionalne planove.

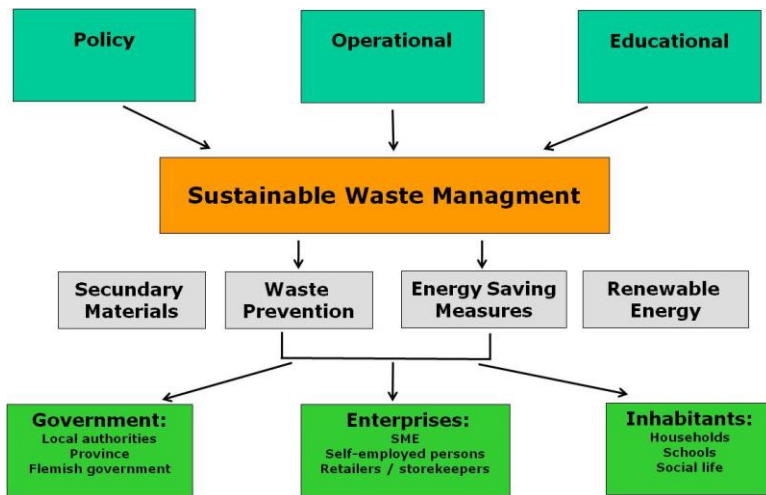
5. Reference

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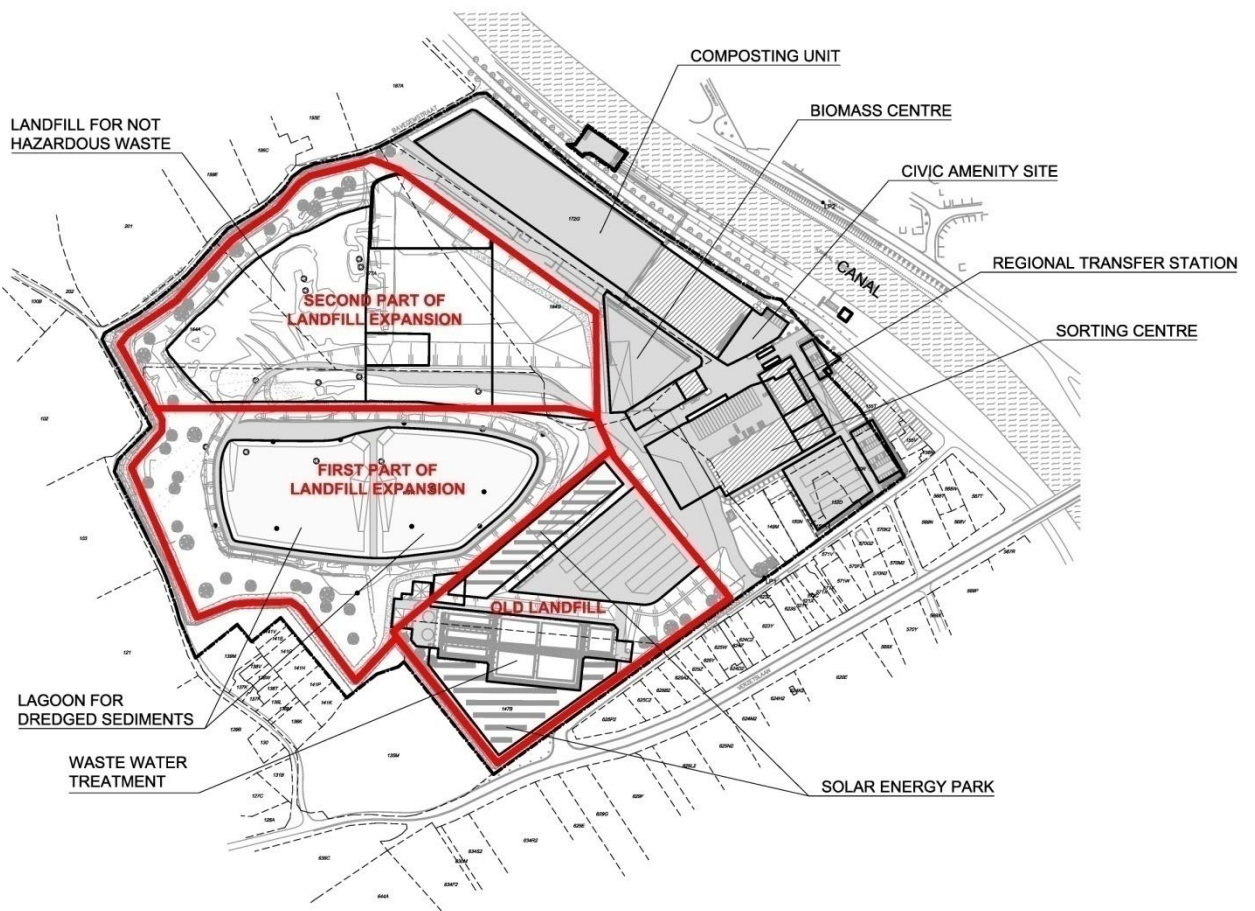
SLIKA



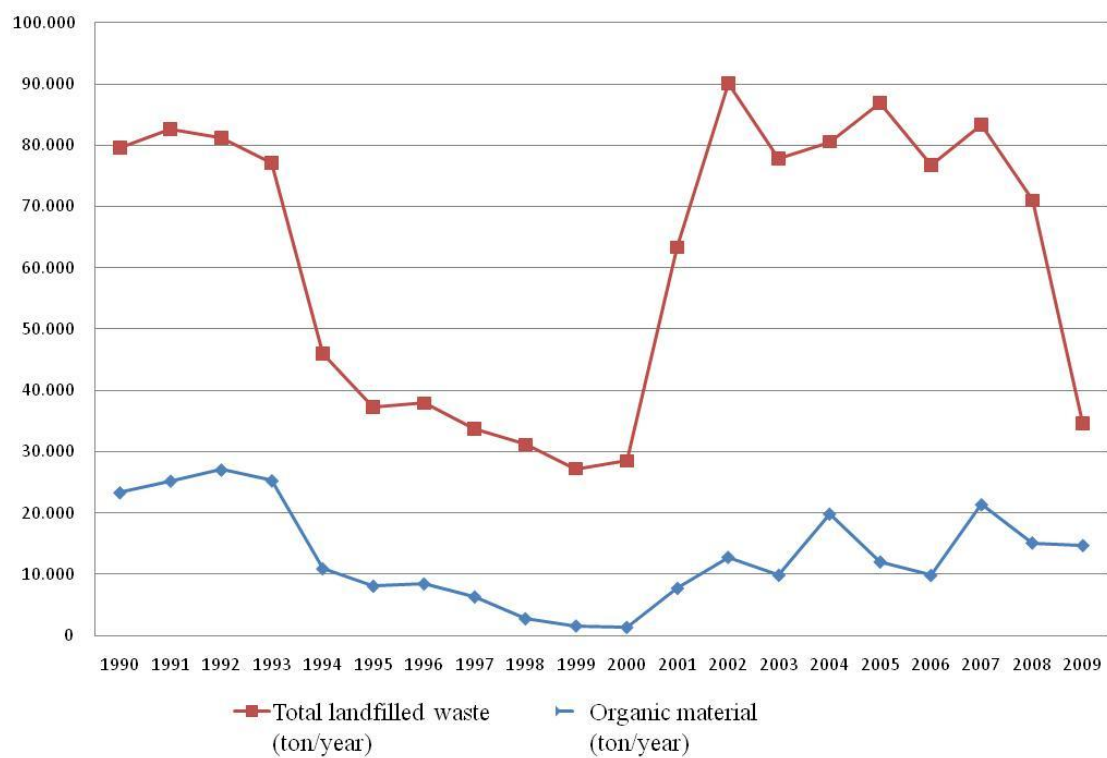
Slika 20



Slika 21



Slika 22



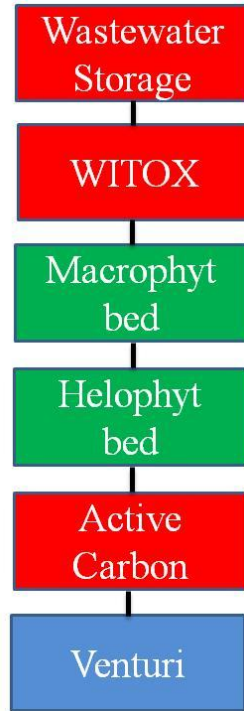
Slika 23



Slika 24



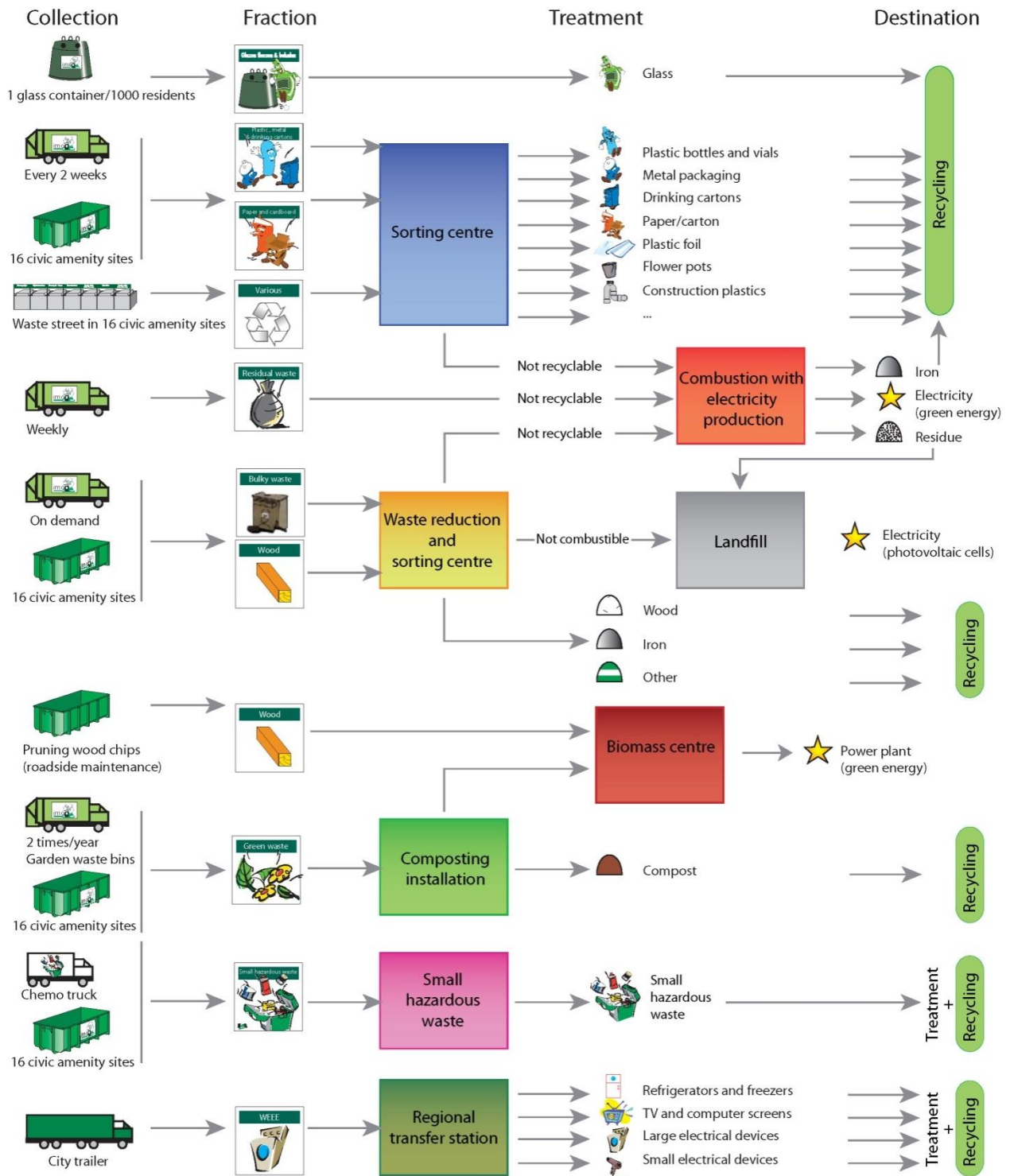
Slika 25



Slika 26



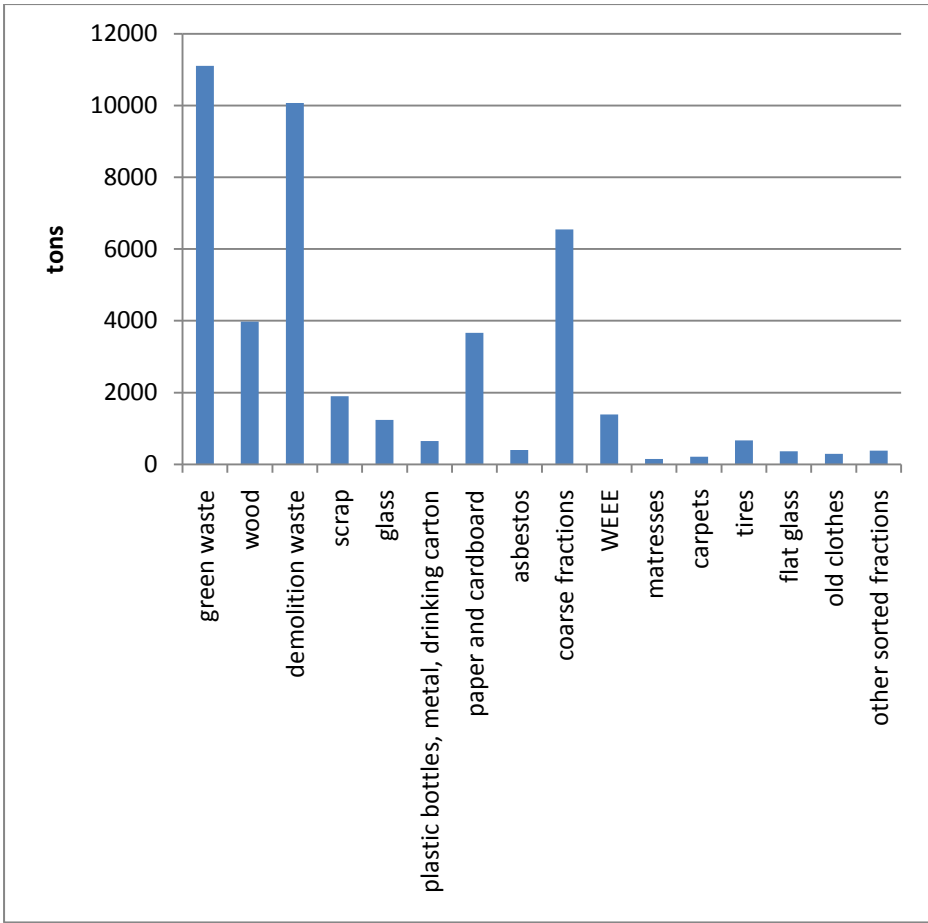
Slika 27



Slika 28



Slika 29



Slika 30

Payable



Obligation for taking back



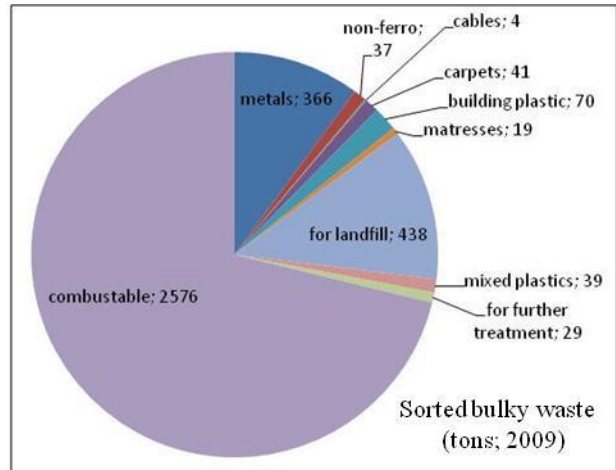
Reuse/recycle



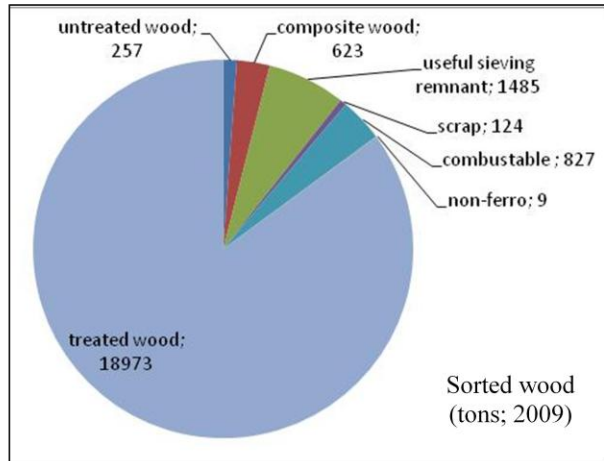
Small hazardous waste



Slika 31



Slika 32



Slika 33



Slika 34



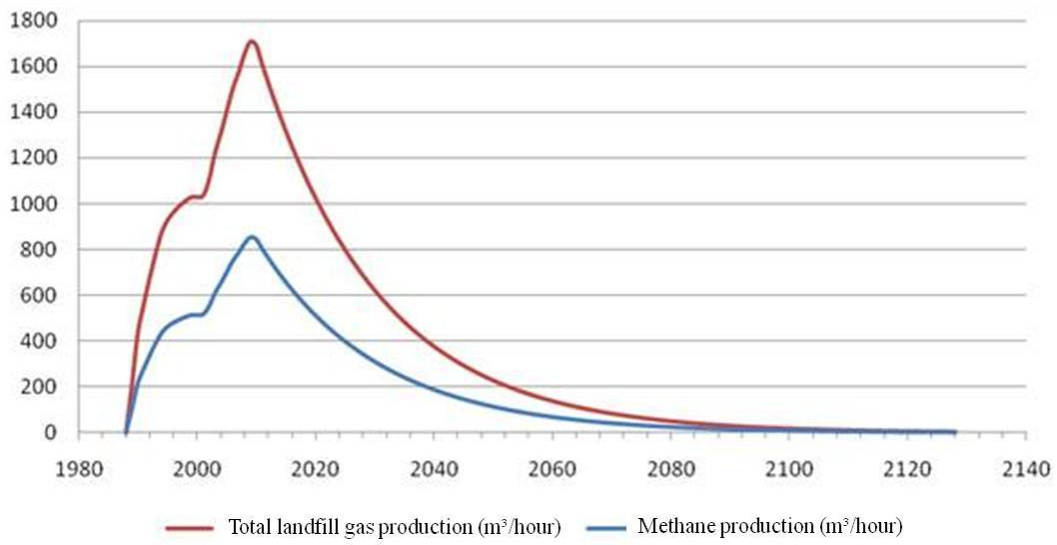
Slika 35



Slika 36



Slika 37



Slika 38