The European Union's Tacis programme for Ukraine

CAPACITY BUILDING IN DONETSK OBLAST FOR WASTE MANAGEMENT - UKRAINE

Guideline

Sizing of the collection equipments

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Warning

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1. Context and purpose

1.1. Context

The Tacis Programme: "Capacity Building in Donetsk Oblast for Waste Management" is a cooperation and assistance programme associating the authorities of the Donetsk Oblast and the consultants of the consortium Sogreah – Pöyry – Ademe. This programme is funded by EU. The authorities defined as the beneficiary are the State Department of Environment Protection and Natural Resources and the Department of Housing and Public Utilities. The Programme is scheduled from May 2005 to October 2007.

The overall objective is the improvement of the Solid Household Waste Management. The first Tacis Programme (2003-2004) has been concluded by a Regional Strategic Plan that has been adopted by the Regional Council on 25 February 2005. The implementation of the Regional Strategic Plan lies on 2 main tools: a Regional Sanitary Landfills Programme for the disposal of the waste; Local Action Plans for the collection of the waste.

The SHW must be managed by the local self-government bodies: municipalities and rayons. The previous situation is so that it's generally considered that 5 years of continuous efforts are necessary to get a real improvement. These efforts are programmed and coordinated within a Local Action Plan.

As old solutions have not solved all the problems, new solutions have been studied and tested as New Schemes for the SHWM. These New Schemes are described in the present Guidelines.

1.2. Situation

A collection truck shares its working time between the collection by itself (to empty the containers) and the transportation of the waste to the landfill. It fulfils these two different tasks. The necessary time for the trip between the populated areas and the landfill is (almost) the same whatever is the load of the truck. The usual trucks in Ukraine have a low load capacity: from 2 tonnes to 7 tonnes although it's currently 11 tonnes and more for EU collection trucks.

The collection trucks are associated to specific containers. The EU trucks use the more often roll-containers with a lid. The lid offers the advantage of hiding the waste, limiting the smell, forbidding cats and other animals to sort the waste. The containers are put at the kerbside and they have to be brought to the truck by the loaders: as they are more and more voluminous, so more and more heavy, they are equipped with rolls. The development of big roll containers is due to a search for better productivity of the collection in dense urban areas. In individual housing sectors (equivalent to Ukrainian private sector) and rural areas, other constraints are taken into account and the waste are collected in bags, in household bins, and so. The last evolution is the simultaneous collection of rough waste and sorted waste as packaging.

Picture 1: Roll containers used in EU

The usual Ukrainian system uses steel non-movable containers. They have the shape of an inverted truncated pyramid. At the top, a reinforced lip is pinched by the handling arm of the truck (Picture 2). But it also exists collection trucks using roll containers and loaded at the rear.

Picture 2: Usual container

1.3. Frequency of the collection

A majority of cities in Ukraine organise a daily collection: 365/365. From time to time, it's once a week or 2 or 3 times a week. Exceptionally, it's everyday excepted on Sunday and holidays. What's the best mode?

Between 2 collections, the waste must be stored. The longer is the duration between two collections, the bigger must be the storage capacity. The storage capacity is the number of containers and subsequently the size of the platform. The main advantage of the 365/365 collection is to minimize the investment in containers and platforms. The storage capacity must be calculated as 24 hours of SHW production, plus a margin for peak production (Christmas and so) and for delayed collection.

If there's a day-off as no collection on Sunday, the storage capacity must be 2-days. If the collection is done twice a week, the storage capacity must be 4-days. If the collection is once a week, the storage capacity must be 7-days.

The weekly collection is interesting for small villages that are:

- Small: the weekly production of SHW corresponds to the capacity of 1 truck;
- Far from the base of operation (the collection company): the most part of the working time is for the trip to the village.

In particular cases, collection twice a week may be interesting for small settlements according to the weekly production and the distance.

In EU, schemes of collection 2 or 3 times a week are preferred because it's very difficult to employ people on Saturday.

The main advantage of the daily collection is to minimize the investment in containers and platforms. The drawbacks are to very lightly increase the yearly mileage of the trucks, and to ask people to work on Saturdays and holidays.

1.4. Collection as a whole

The operator of SHW collection has to handle the waste from the inhabitant to the disposal. The inhabitant puts his waste in a container (let's say that refuse chutes have to disappear). The act of

collecting is done help to equipments that are the container, the platform, the truck; that must be coherent between themselves; that must be well sized for the particular location; that must be each one in a good state.

- Containers

There are several capacities: 550 litres, 750 litres, etc. Recently a problem appeared. As an effect of the economical recovery there is the development of renovation and construction works in the flats and the houses. People put their construction waste in the nearest container (if not in worse places!): it destroys the containers (the steel sheet thickness is not scheduled for such waste) and the handling arms of the trucks (too heavy containers). If construction waste are not managed in a better way, at least a reduction of the capacity of the containers should spare the handling arms of the trucks.

- Platforms

The containers are disposed on a platform in a yard (the most common scheme). The platform must be also easy to access for the collection trucks. A platform must be easy to clean. A platform for non-movable containers is not implemented like a platform for roll-containers. The roll containers have a weak point: the rolls. They break often and they must be repaired. So a platform for roll containers is settled as the trip from the platform to the truck has no step, has low slopes, is on smooth ground (concrete or asphalt without holes).

- Trucks

The truck collects the waste: it empties the containers. It carries the waste to the landfill. For the non-movable containers, the truck comes close and the handling arm goes to the container and takes it. For roll containers, workers push the containers to the truck at the handling equipment and then push them back to the platform. The more often, the truck enters in the yards and has to drive on the yard's lanes.

The transportation time depends on the average distance between the collection routes and the landfill, the power of the truck, the state of the roads.

On the landfill, the truck must go until the downloading place, and the more often it is on already disposed waste.

So the key parameters for the organisation of a waste collection are:

- Place of the containers according to the path from the entrance doors of the inhabitants;
- Type and maintenance of the containers;
- Design and maintenance of the platforms;
- Capacity of the yards lanes: bearing capacity of the asphalt, radius of the corners, size of the portals
- Type of truck:
    - Load capacity;
    - System of handling;
    - Number of people of the crew;
    - Average speed for transportation;
    - Driving capacity on un-compacted soils.

1.5. Techniques and economics

The objective of the method is to help to the best decision about the equipment for the SHW collection. The best decision is supposed to be the one that minimizes the cost of collection. But the minimum cost is not a static or eternal data although the choice of the equipments is a long-term decision. Everybody knows that only a part of the waste is today collected and there's a willing to target 100% collected within some years: the growth of the collected tonnage has an incidence on the number of equipments and the global cost. There's inflation and prices will grow up for the purchase of equipment, for the wages, for

energy. The turnover is based on the tariffs and the rate of paying inhabitants and there's also a willing to cover the costs and to reach 100% paid fees.

So the search for minimum cost must be understood as a dynamic perspective. A technical choice may be less costly today and too costly within several years. So the manager has to take the decision he thinks it will be globally the best for the future years.

The model further described is a help to decision. The only purpose is to simulate the economic impact of choices as for instance: if I put these objectives and I choose this model of trucks, how many trucks do I need and how much it will cost.

2. Using the model

The model is an Excel file. There's a scenario that is in fact a description of the collection activities. This scenario is characterised by data that are variables and parameters: parameters are constant and depending on the reality on the field as the number of inhabitants or the location of the platforms. Variables are decisions of management.

The model produces results that are figures. In aim to headlight them, some graphics provide an easier understanding of the results.

The model uses the mass of the waste (tonnes or kg) and not the volume. When necessary, the mass will be converted into volume, for instance for the volume of containers on a particular platform.

2.1. Hypotheses

Some hypotheses are "included" in the model as they represent good practices or good management uses.

2.1.1. Credits

The investments are done help to credit.

The first investment (eventually spread on the 4 first years) is paid with a credit. It is supposed that later the investments are self-funded help to the profit.

For this simulation, standard credit conditions have been defined (spreadsheet CRETruck) as for credit in UAH on 7 years with an interest rate of 15%.

2.2. Scenario

2.2.1. Characteristics of the waste collection area

Number of inhabitants

It must be the number of real inhabitants of the deserved area. Sometimes it's difficult to know the real number.

Production of SHW per inhabitant

It is the assessment of the production of SHW per inhabitant and per year in kg. Without any measure "on the field" it can be taken 350 kg/inh/y.

Evolution of the waste production

This rate indicates the growth of the individual production of SHW, depending on the evolution of the way of life.

Objectives of collection

Starting from a poor situation, the objectives of the service is to reach progressively 100% collected. It is indicated in that rate for each year.

Average distance between platforms

The model aims to determine the park of trucks and the average cost of the collection and not the routes for a particular truck. So it takes into account an average of the distance between 2 platforms during the SHW collection (red spots on Figure 1).

Average distance between the base and the collection areas

Starting the day, the truck goes from the base (blue spot on Figure 1), which is usually the garage of the municipal company, to the first collection area. For all the collection areas, there's an average distance from the base.

Average distance between the landfill and the collection areas: downtown

Average distance between the landfill and the collection areas: road

Between two rounds of collection, the truck goes to the landfill (green spot on Figure 1) for downloading. For all the collection areas, there's an average distance to the landfill. This trip includes a part downtown and a part of road and the average speeds are not the same depending on the conditions of traffic.

Distance from landfill to base

At the end of the day, for the last trip, the truck returns from the landfill to the base.

Volume of containers

Typical volume of the model of containers used in the collection area. The model of container depends on the model of truck.

Number of containers per platform

Average number of containers per platform in the collection area. The number of containers per platform determines the storage capacity of the platform and so it is linked to the frequency of the collection: volume of storage for 1 day, 2 days, etc.

Density in the containers

Average density of SHW in the containers before the collection.

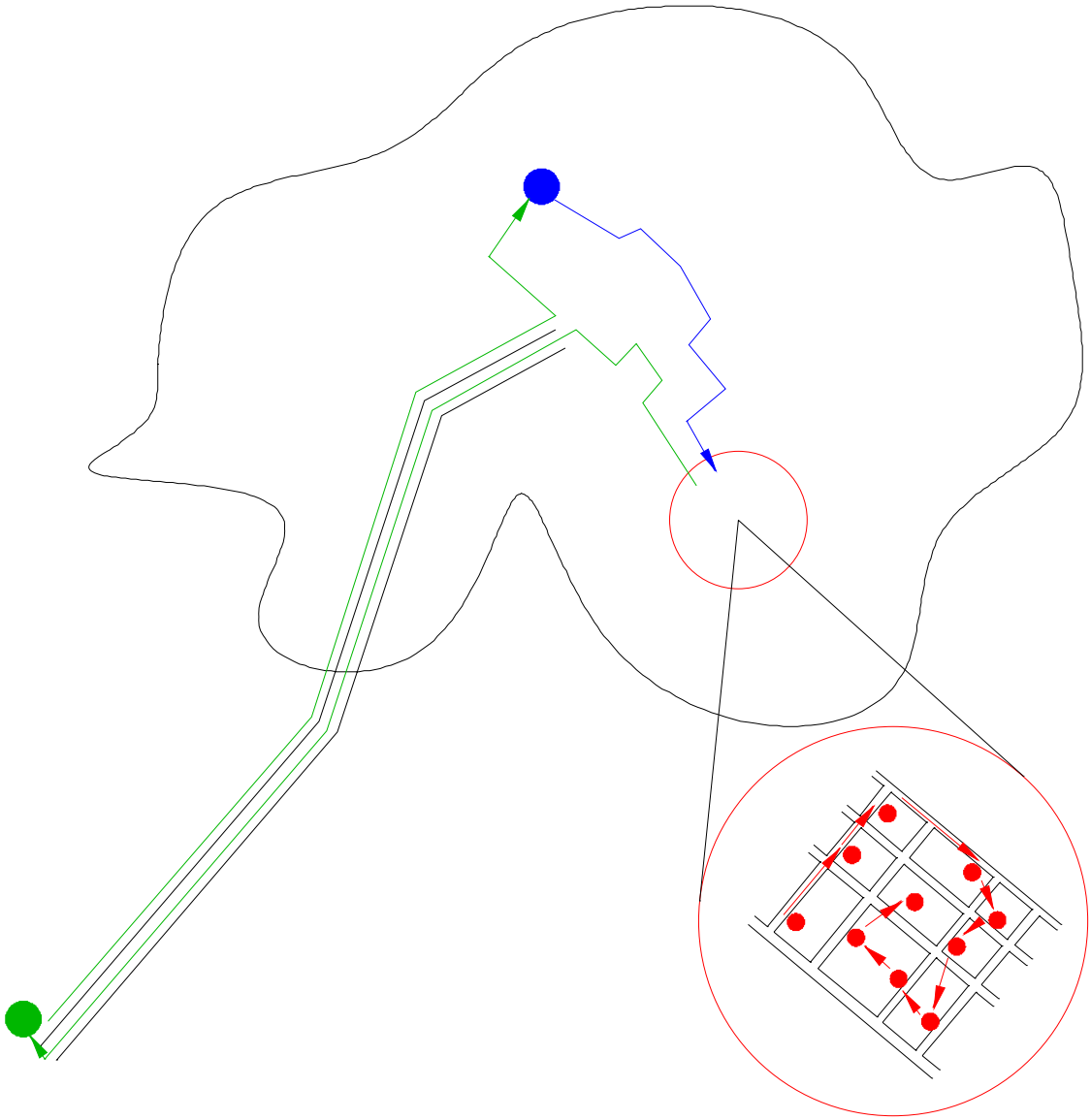


Figure 1: Scheme of the trips

2.2.2. Specifications of the truck

The truck has several "commercial" speeds that are the average speed depending on the conditions of circulation and the load. The winter conditions should be considered as abnormal conditions: an average between [normal conditions] and [exceptional conditions as snow or ice on the road] has no sense. It's more representative of the reality to consider that there's a normal average speed and that from time to time the weather conditions impose to organise the collection in a different way: additional trucks or extension of the working time.

Average speed during collection

Average speed when the truck goes from a platform to the next. As the distance is low (hundreds metres) and requires manoeuvres (corners in the yards, parking) this speed is very low.

Average speed downtown: full

Average speed under the conditions of downtown, when full.

Average speed downtown: empty

Average speed under the conditions of downtown, when empty.

Average speed on road: full

Average speed under the conditions on road, when full.

Average speed on road: empty

Average speed under the conditions on road, when empty.

Time for emptying containers

Average time for picking, emptying, disposing, 1 container on a platform.

Time for downloading at the landfill

Average time from the entrance of the landfill to the exit for all the operations of landfilling or downloading.

Time for downloading at the Transfer Station

Average time from the entrance of the transfer station to the exit for all the operations of downloading.

Fuel consumption: empty

Fuel consumption: full load

Usually manufacturers give the fuel consumption when empty and at full load. During the pure collection (emptying the containers from platform to platform), the truck starts and stops continuously and it's more representative to take into account the figure of fuel consumption at full load.

Purchase price of the truck

Complete price of the truck as purchased, including VAT and all delivery charges.

Maintenance days per year

Number of days a truck in a normal state is stopped per year for maintenance operations. It depends on the model of truck. Normal state means that the truck is maintained in good operation conditions, which is not comparable to the common past situation.

Volume of the waste box

Storage volume of the waste box of the truck.

Maximum payload of the truck

Maximum waste mass the truck can carry.

2.2.3. Organisation

Daily working time

Normal duration of the working time of the employees in minutes.

Employees

For each truck, there's a driver but for some cases, the crew of the truck includes 1 or 2 loaders, as for instance for roll-containers.

Wages

Monthly wages of the different categories of personnel.

Number

Number of employees of each different category of personnel.

Social charges

Social contributions (as pension fund) and taxes on wages.

Number of working days per year

According to the frequency of the collection, the trucks can be used everyday (365/365), or less if Sundays, holidays, week-ends, are not worked. It is linked to the number of containers per platform (volume of storage).

2.2.4. Economical conditions

Maintenance costs

The average budget of maintenance must be assessed.

For local trucks it's the more often a yearly assessment. A major part is the big repairs: engine, gearbox, that come often.

For EU trucks, it's often calculated par working day. But a major part of the budget is the tyres and it depends more on mileage than on time.

Anyway, for the assessment, the cost of maintenance is indicated by a % of the purchase price of the truck.

Assurance

Cost of the yearly insurance premium for the model of truck.

Price of fuel

Average price of the fuel, gasoline or diesel depending on the model of truck.

Inflation

As previously said the decisions must be taken within a dynamic perspective, i.e. with a projection on several years. For these next years, inflation will modify the structure of the costs but in parallel there's a policy aiming at an extension of the waste collection and a growth of the tariffs.

All that is forecast in a table of coefficients of inflation for: general inflation, wages, energy, tariffs for fees.

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Energy	1,0800	1,1664	1,2597	1,3605	1,4693	1,5869	1,6662	1,7495	1,8370	1,9289	2,0253	2,1266	2,2329	2,3445	2,4618
Wages	1,2000	1,3200	1,4520	1,5972	1,7569	1,9326	2,1259	2,3385	2,5723	2,8295	3,1125	3,4237	3,7661	4,1427	4,5570
Inflation	1,1000	1,1990	1,2949	1,3856	1,4687	1,5421	1,6038	1,6519	1,6850	1,7187	1,7530	1,7881	1,8239	1,8603	1,8976

Table 1 Rates of inflation

Wages and social charges

Three wages are defined for the foreman of the transfer station, the drivers (collection trucks, transfer trucks, machines) and the loaders for the collection. The social charges are calculated with a coefficient on the wages.

Cost of containers

Two models of containers can be used: non movable containers of 750 litres and roll-containers of 1100 litres.

2.2.5. Case of a transfer station

2.2.5.1. Principle

A key parameter for the calculation of a park of trucks is the existence of a transfer station. It considerably reduces the trips of the collection trucks, and by the way the duration of the collection rounds. There are two models of transfer station: the "full" one for the big cities and the "simplified" one for the small cities.

The "full" transfer station is associated with a park of semi-trailers of 80-90 m^3. The "simplified" transfer station is associated with a multipurpose truck and a park of movable tips.

2.2.5.2. "Simplified" transfer station

The simplified transfer station is a place managing a difference of levels for the downloading of the collection truck. The simplest is as on Picture 3. If it's installed in the premises of the MC, there's nothing to do excepted to clean it from time to time.

Picture 3 "Simplified" transfer station and multipurpose truck

The parameters and variables for the "simplified" transfer station are:

Cost of construction of the transfer station

It's mainly civil works.

Equipments

The only one necessary equipment is a high pressure cleaner.

Supplies

The supplies are electricity and water for the cleaning of the transfer station. So the variables are:

Tariff of electricity

Consumption of electricity

Tariff of water

Consumption of water

Maintenance

It's necessary to repair the concrete and the asphalt of the transfer station, and there's some maintenance for the high pressure cleaner. The cost of maintenance is calculated with a ratio on the purchase price of the investment, majored with the coefficient of general inflation.

2.2.5.3. Transfer trucks

The transfer is done help to a Western truck equipped with a handling arm for movable tips. A specialized trailer allows to load 2 movable tips of 30 m^3 capacity: 1 on the truck, 1 on the trailer. So the carriage can transfer 20 tonnes at each trip to the landfill. The minimum is to get 4 movable tips: 2 standing by at the transfer station while 2 are carried to the landfill.

Equipped with a crane, the truck is a multipurpose truck. The transfer will use the truck part-time: from 20% to 50%. As a multipurpose truck, the MC will develop other activities with the truck as construction waste collection, cleaning of dumpsites, green waste removal, and etc. These activities should generate their own incomes. So for the calculation of the cost of the transfer, are taken into account:

- The fuel consumed for the transfer;
- A share of all the other costs (amortization, wages, maintenance, etc.) according to a rate of use calculated as the time for the transfer /8 hours.

The parameters and variables for the transfer truck are:

Price of the truck

Complete price of the truck as purchased, including VAT and all delivery charges.

Price of the trailer

Complete price of the trailer as purchased, including VAT and all delivery charges.

Price of movable tips

Complete price of the movable tips as purchased, including VAT and all delivery charges.

Capacity Base TRW 38 t

Maximum waste mass the truck + trailer can carry, under the limit of TRW 38 t.

Average speed downtown: full

Average speed under the conditions of downtown, when full.

Average speed downtown: empty

Average speed under the conditions of downtown, when empty.

Average speed on road: full

Average speed under the conditions on road, when full.

Average speed on road: empty

Average speed under the conditions on road, when empty.

Time for loading at transfer station

Average time for downloading empty tips and picking full tips at the transfer station.

Time for downloading at the landfill

Average time from the entrance of the landfill to the exit for all the operations of landfilling.

Fuel consumption: empty

Fuel consumption: full load

Usually manufacturers give the fuel consumption when empty and at full load. During the pure collection (emptying the containers from platform to platform), the truck starts and stops continuously and it's more representative to take into account the figure of fuel consumption at full load.

Employees

For each truck, there's a driver.

Wages

Monthly wages of the driver. It is supposed to be the same than for the collection.

Number

There's one driver for each truck.

Social charges

Social contributions (as pension fund) and taxes on wages. It is supposed to be the same than for the collection.

Assurance

Cost of the yearly insurance premium for the model of truck.

Maintenance days per year

Number of days a truck in a normal state is stopped per year for maintenance operations. It depends on the model of truck. Normal state means that the truck is maintained in good operation conditions.

For the purpose of this assessment of the means for the collection, this information cannot be taken into account. When the transfer truck will be blocked for maintenance, another organisation must be defined: the collection trucks will have to go directly to the landfill, or additional tippings can be used for a storage of the waste in the transfer station, or…

Cost of Maintenance

Usually it is assessed "per working day" and the usual rate is 20 €/d, covering cleaning, repairs, oil, tyres.

2.2.5.4. "Full" transfer station

The full transfer station is a "mini" plant. The principle is also to manage a difference of levels for the downloading of the collection trucks but the streams of waste are so that it's designed for optimisation of the streams.

Picture 4: "Full" transfer station and semi-trailers

The parameters and variables for the "full" transfer station are:

Cost of construction of the transfer station

It's building, civil works, and connection to the public networks (water, sewage, electricity, phone).

Equipments

The necessary equipments are:

- a pusher;
- a high pressure cleaner;
- a weighbridge is useful for a follow-up of the waste collection in the housing areas;
- minimum furniture for the office corner.

Employees

A full transfer station works with a minimum of 3 people for the control of the trucks, the control of the waste, the loading of the semi-trailers.

Wages

Monthly wages of the different categories of personnel.

Number

Number of employees of each different category of personnel.

Social charges

Social contributions (as pension fund) and taxes on wages.

Supplies

The parameters and variables are:

Tariff of electricity

Consumption of electricity

Electricity for the lighting, weighbridge, cleaning of the transfer station, and the sanitary of the employees.

Tariff of water

Consumption of water

Water for the cleaning of the transfer station, and the sanitary of the employees.

Consumption of fuel

Fuel for the pusher.

Phone

In case of problem, the transfer station has to call emergency services, the hierarchy, and to daily transfer the data of the registration of the trucks to the main office.

Office supplies

For the reporting of the activity.

Maintenance

It's necessary to repair the premises and the lanes of the transfer station, and there's some maintenance for the equipments. The cost of maintenance is calculated with a ratio on the purchase price of the investment, majored with the coefficient of general inflation.

2.2.5.5. Transfer semi-trailers

The transfer is done help to a Western truck and a specialized semi-trailer.

The waste are carried out by specialised semi-trailers. They have a big capacity: 80-90 m^3. Their floor is a moving floor so they download on the landfill without to tip. It's important because to tip a 12 m long tipping at >60° would be very hazardous on the unstable ground of a landfill. The carriage can transfer 25 tonnes at each trip to the landfill.

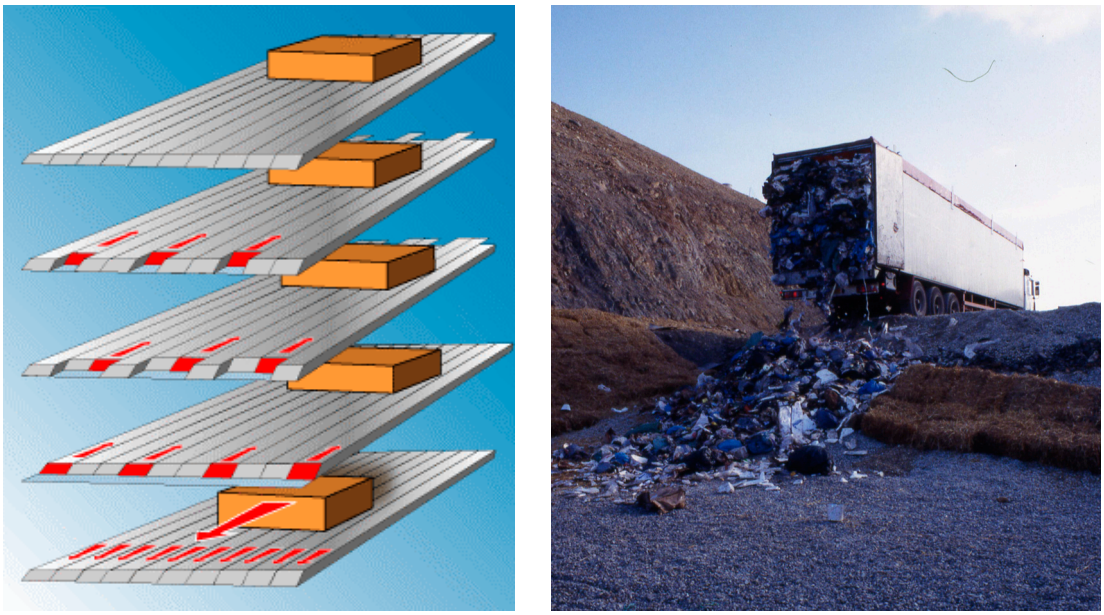


Figure 2: Principle of the moving floor

The parameters and variables for the transfer truck are:

Price of the truck

Complete price of the truck as purchased, including VAT and all delivery charges.

Price of the semi-trailer

Complete price of the trailer as purchased, including VAT and all delivery charges.

Capacity Base TRW 38 t

Maximum waste mass the truck + trailer can carry, under the limit of TRW 38 t.

Average speed downtown: full

Average speed under the conditions of downtown, when full.

Average speed downtown: empty

Average speed under the conditions of downtown, when empty.

Average speed on road: full

Average speed under the conditions on road, when full.

Average speed on road: empty

Average speed under the conditions on road, when empty.

Time for loading at transfer station

Average time for loading at the transfer station.

Time for downloading at the landfill

Average time from the entrance of the landfill to the exit for all the operations of landfilling.

Fuel consumption: empty

Fuel consumption: full load

Usually manufacturers give the fuel consumption when empty and at full load. During the pure collection (emptying the containers from platform to platform), the truck starts and stops continuously and it's more representative to take into account the figure of fuel consumption at full load.

Employees

For each truck, there's a driver.

Wages

Monthly wages of the different categories of personnel.

Number

Number of employees of each different category of personnel.

Social charges

Social contributions (as pension fund) and taxes on wages.

Assurance

Cost of the yearly insurance premium for the model of truck.

Maintenance days per year

Number of days a truck in a normal state is stopped per year for maintenance operations. It depends on the model of truck. Normal state means that the truck is maintained in good operation conditions.

For the purpose of this assessment of the means for the collection, this information cannot be taken into account. When the transfer truck will be blocked for maintenance, another organisation must be defined: the collection trucks will have to go directly to the landfill, or additional tippings can be used for a storage of the waste in the transfer station, or…

Cost of Maintenance

Usually it is assessed "per working day" and the usual rate is 20 €/d, covering cleaning, repairs, oil, tyres.

2.3. Parameters

Parameter	Unit	Spreadsheet
Depending on the city		
Number of deserved inhabitants	N	Objectives
Production of SHW per inhabitant	kg/inh/y	Objectives
Evolution of the waste production	%/y	Objectives
Objectives of collection	%	Objectives
Average distance between platforms	km	Parameters
Average distance between the base and the collection areas	km	Parameters
Average distance between the landfill and the collection areas: downtown	km	Parameters
Average distance between the landfill and the collection areas: road	km	Parameters
Distance from landfill to base: road	km	Parameters
Distance from landfill to base: downtown	km	Parameters
Daily working time	minutes	Parameters
Density in the containers	t/m^3	Parameters
Economic		
Price of fuel: diesel	UAH/l	Parameters
Price of fuel: 92	UAH/l	Parameters
Wages Foreman	UAH/m	Parameters
Wages Drivers	UAH/m	Parameters
Wages Loaders	UAH/m	Parameters
Rate Social charges	%	Parameters
Cost of 750 l container	UAH	Parameters
Cost of 1100 l roll-container	UAH	Parameters
Number of working days per year	d	Parameters
Inflation coefficient: general inflation	-	Coeff
Inflation coefficient: wages	-	Coeff
Inflation coefficient: energy	-	Coeff
Inflation coefficient: fees	-	Coeff
Inflation coefficient: tonnage	-	Coeff
Inflation coefficient: Carbon Rights	-	Coeff
"Simplified" transfer station		

Tariff of electricity	UAH/kWh	Small TS
Tariff of water	UAH/m^3	Small TS
Maintenance	%	Small TS
"Large" transfer station		
Tariff of electricity	UAH/kWh	Full TS
Tariff of water	UAH/m^3	Full TS
Maintenance	%	Full TS

2.4. Variables

Variable	Unit	Spreadsheet
Depending on the truck		
Price of the truck	UAH	Truck
Average speed during collection	km/h	Rounds
Average speed downtown: full	km/h	Rounds
Average speed downtown: empty	km/h	Rounds
Average speed on road: full	km/h	Rounds
Average speed on road: empty	km/h	Rounds
Time for emptying containers	min	Rounds
Time for downloading at landfill	min	Truck
Time for downloading at TS	min	Truck
Fuel consumption: empty	l/100 km	Truck
Fuel consumption: full load	l/100 km	Truck
Purchase price of the truck	UAH	Truck
Maintenance days per year	d	Truck
Volume of containers	m^3	Rounds
Number of containers per platform	N	Rounds
Volume of the waste box	m^3	Truck
Maximum payload of the truck	tonnes	Truck
Maintenance costs	%/y	Truck
Assurance	UAH/y	Truck
"Simplified" transfer station		
Cost of construction of the transfer station	UAH	Small TS
Equipments	UAH	Small TS
Consumption of electricity	kWh	Small TS
Consumption of water	m^3/y	Small TS
Transfer trucks		
Price of the truck	UAH	Transfer Truck
Price of the trailer	UAH	Transfer Truck
Price of movable tips	UAH	Transfer Truck
Speed downtown empty	km/h	Transfer Truck
Speed downtown full	km/h	Transfer Truck
Speed road empty	km/h	Transfer Truck
Speed road full	km/h	Transfer Truck
Consumption full load	l/100 km	Transfer Truck
Consumption empty	l/100 km	Transfer Truck
Time for loading at transfer station	min	Transfer Truck
Time for downloading at landfill	min	Transfer Truck
Capacity Base TRW 38 t	tonnes	Transfer Truck
Assurance	UAH/y	Transfer Truck
Maintenance	UAH/d	Transfer Truck
"Full" transfer station		
Cost of construction of the transfer station	UAH	Full TS
Equipments	UAH	Full TS
Consumption of electricity	kWh	Full TS
Tariff of electricity	UAH/kWh	Full TS
Consumption of water	m^3/y	Full TS
Tariff of water	UAH/m^3	Full TS
Consumption of fuel	l	Full TS

Phone	UAH	Full TS
Office supplies	UAH	Full TS
Maintenance		Full TS
Transfer trucks		
Price of the truck	UAH	Semi-Trailer
Price of the semi-trailer	UAH	Semi-Trailer
Speed downtown empty	km/h	Semi-Trailer
Speed downtown full	km/h	Semi-Trailer
Speed road empty	km/h	Semi-Trailer
Speed road full	km/h	Semi-Trailer
Consumption full load	l/100 km	Semi-Trailer
Consumption empty	l/100 km	Semi-Trailer
Time for loading at transfer station	min	Semi-Trailer
Time for downloading at landfill	min	Semi-Trailer
Capacity Base TRW 38 t	tonnes	Semi-Trailer
Maintenance	UAH/d	Semi-Trailer
Assurance	UAF/y	Semi-Trailer

2.5. Comments on the spreadsheets

In aim to make easier the use of the spreadsheets:

- The parameters and variables are underlined in red;
- The data coming from other spreadsheets are underlined in yellow;
- The data submitted to the inflation rates are underlined in the relevant colour.

The calculations include results but also intermediary data that can be interesting for the user.

Basically, the main criterion is the size of the collected area. A key-variant is the decision to implement or not a transfer station. According to the production of SHW, it should be a small transfer station or a big transfer station as they are defined respectively in §2.2.5.2 and §2.2.5.4. So in aim to limit the size of files and as people are either in one or the other situation, there are 2 Excel files:

- [070321 Sizing Small.xls] for small cities based on the simplified transfer station, and
- [070321 Sizing Large.xls] for large cities based on the "full" transfer station.

In this pat we'll comment some peculiarities and give some explanation about the hypotheses and calculations.

2.5.1. Parameters

All prices are given in 2006 value. It's average values for the year.

The wages are given for 3 categories of personnel and will be the same for all economic calculations, specifically for the drivers of trucks and machines.

2.5.2. Objectives

The yearly production of waste is assessed on the base of the number of inhabitants. But attention must be paid to distinguish "production" and "collection".

Basically, the production is assessed as 350 kg/inh/y in 2006.

Socio-economic factor may increase the production per inhabitant, and it's a first line of coefficients.

The today's situation is that only a part is collected (from 30 to 40%) and the objective of 100% is targeted. It's a second line of coefficients.

All that determines a yearly quantity to be collected and disposed.

2.5.3. Coeff

The table of coefficients is a scenario by itself and moreover on the next 15 years! But anyway, it's clear that Ukraine is in economic transition and for some years there will be a significant inflation and a strong growth of the wages. In parallel, the costs of energy should continue to climb up at international level. So everybody can propose his own forecast. We have put a one that seems realistic according to what we can know today.

2.5.4. Truck

In this spreadsheet are filled the main characteristics of 3 models of collection trucks that we have named:

- KO-413: it's the small usual truck equipped with a side loader for non movable containers of 750 l;
- KO-435: it's the big usual truck equipped with a side loader for non movable containers of 750 l;
- EU 26: it's a standard European truck equipped with a back loader for roll-containers of 1100 l.

2.5.5. Rounds

Here is calculated the capacity of collection of 1 truck.

The meaning is to assess what can do a truck during 1 shift. The main part is the time required to download the containers in the truck. It is supposed that the truck has a route with the number of containers corresponding to its payload: 3.3 tonnes, 7.5 tonnes, 12.3 tonnes (for the samples we took). So we get the duration of 1 round (collection + transportation + downloading of the truck). It is also supposed that the truck makes an integer number of rounds during a shift: there's no partial round.

Once the number of containers per round and the number of rounds per shift are determined, it gives the collection capacity of the truck during 1 shift in number of containers, and in tonnes.

With the number of containers and the number of platforms for 1 shift, it's possible to calculate their cost that includes amortization and maintenance.

2.5.6. KO-413, KO-435, EU 26, EU 26 2

In these spreadsheets are calculated the number of trucks and the cost of collection. It's also there that are simulated the cases of the implementation of a transfer station or not.

The first step is that the number of necessary trucks is calculated year by year, based on the possible number of rounds per day per truck. It gives a park of trucks.

To get this park means to make investments of trucks. The local trucks are replaced after 7 years of service. The EU trucks are replaced after 10 years of service. So they are amortized respectively on 7 and 10 years. The amortization is calculated according to international accounting norms and not according to the fiscal Ukrainian way.

During the 4 first years, the trucks are bought help to a credit. It is supposed to be a credit in EUROS on 7 years at 4.8% rate. So the reimbursements in UAH are calculated with the coefficient of inflation in aim to represent the evolution of UAH/EURO.

From the 5th year, the investments are supposed to be self-funded, so without credit.

The global cost of collection adds the cost of the trucks, the cost of platforms and containers, and eventually the cost of the transfer station and transfer trucks.

In EU it's usual the collection trucks are used 2 shifts a day. So a simulation is also done in such a case on the spreadsheet "EU 26 2".

2.5.7. Small TS and Transfer Truck

The transfer is done help to a multipurpose truck, which is partially used for the transfer, and a specific trailer. So the investment is divided between what is specific to the transfer and what is common for all uses.

According to the capacity of the carriage (truck + trailer), are calculated the time used for the transfer and the distance, and so the fuel consumption. According to the time for transfer, it's considered that all the remaining time is valued for other operations of the multipurpose truck and the rate of use for transfer is calculated.

So, the fuel used for transfer and the amortization of the equipments specific to the transfer (trailer and movable tippings) is taken into account for the cost of the transfer. For all other charges, a *pro rata* is calculated in aim to share them between the transfer and the other activities of the truck.

All that gives a global cost of the transfer.

Number of movable tips

It's the number of necessary 30 m^3 capacity movable tips. By experience, it is calculated as a number of pairs of tippings for each 40 tonnes a day.

It's admitted that the number of rounds of transfer is not an integer number. In fact, it's possible to let for the night tippings that are not completely filled.

2.5.8. Full TS and Semi-Trailer

By difference with the simplified transfer station, this one employs people (usually: 1 foreman, 1 pusher driver, 1 sorter). This kind of transfer station is sized for some 50,000 t/y. So it's necessary to implement additional transfer stations as the tonnage increases.

Another difference is that the transfer is done with specialized semi-trailers that cannot be used for anything else (normally) and they have to make an integer number of rounds per day.

2.6. Results

The results are recapped on the spreadsheet "Recap". These are tables giving year by year:

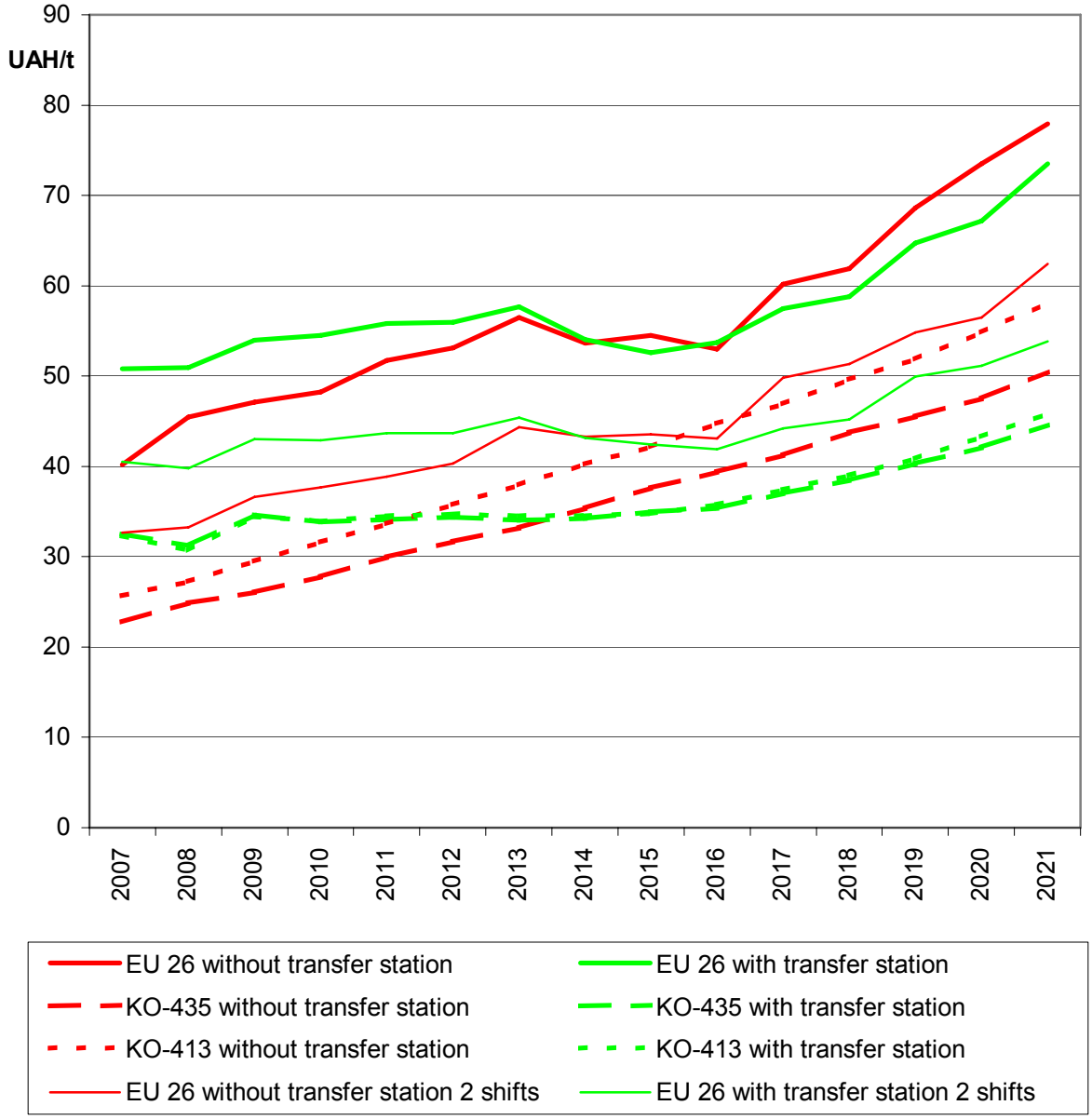
- Cost of collection in UH/t;
- Park of necessary trucks;
- Global investment trucks + containers + transfer station + transfer trucks.

3. Example of calculation

The following table and graph show the necessary park of collection trucks according to the model and the corresponding evolution of the collection costs.

Park	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
EU 26 without transfer station	1	2	3	3	4	4	4	4	4	4	4	4	4	5	5
EU 26 with transfer station	1	2	2	2	3	3	3	3	3	3	3	3	3	3	4
KO-435 without transfer station	3	4	5	7	8	8	8	9	9	9	9	10	10	10	11
KO-435 with transfer station	2	3	4	5	5	6	6	6	6	6	6	7	7	7	7
KO-413 without transfer station	3	4	6	8	9	9	10	10	10	10	11	11	11	12	12
KO-413 with transfer station	2	3	4	5	6	6	7	7	7	7	7	7	8	8	8
EU 26 without transfer station 2 shifts	1	1	2	2	2	2	2	2	2	2	2	2	2	2	3
EU 26 with transfer station 2 shifts	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2

Table 2 Park of necessary trucks



Graph 1 Evolution of the cost depending on the choice of truck