

# Russian Federation: Assessment of Glass Recycling and Energy Efficiency in Glass Production

## Stakeholder summary document

October 2012

For the European Bank of Reconstruction and Development

**Contract C21162/CATC-2010-10-07**

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Date: 10/10/2012

Version: 1

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## Executive Summary

A consortium of international glass industry and environmental consultants from British Glass, Glass Technology Services, COWI and SKM Enviros are undertaking a study into the market for glass recycling in the Russian Federation on an assignment for the European Bank for Reconstruction and Development. The overall objective of the project is:

“to assist industry in developing and implementing a glass recycling scheme in Russia. The main objective of this assignment is to develop a road map for the establishment of a glass collection and recycling system in the Russian federation to reduce waste and increase energy efficiency of glass packaging production; as well as to outline the steps required to establish such a system. This will include an assessment of the existing institutional capacity and the need for the establishment of an adequate infrastructure. The consultant will work with industry representatives and ultimately relevant government agencies with the capability to implement such a system.”

The Russian Federation is committed to a programme of improved environmental action including that of waste management. The glass manufacturing industry is a significant user of raw materials and energy. The glass manufacturing process is such that it can, with little difficulty, recycle glass recovered from the domestic waste stream. Glass recycling has several environmental benefits. No new quarried raw materials are required if new glass is remade from old. It requires less fuel to remelt glass than it does to produce glass from virgin raw materials. Carbonates in the raw materials also release the Green House Gas (GHG) CO<sub>2</sub> during mineralogical transformation; such non fuel associated gases normally being referred to as “process CO<sub>2</sub>”. Recycled glass produces no process CO<sub>2</sub> when remelted. Furthermore, as less energy is required to melt, compared to raw materials, less CO<sub>2</sub> from combustion is emitted.

In order to maximise these benefits the glass returned to the factory must be relatively free of contamination e.g. metals, plastics, food waste, bricks and stones. In practice this means putting in place a dedicated collection system for glass. Establishing and maintaining an effective collection and recycling system is by necessity a major undertaking; involving significant costs. Glass collection and recycling systems are already commonplace in many countries indicating that viable economic models exist. One of the inherent advantages of glass, namely that it is made from low cost and plentifully available raw materials, means that recycled glass (cullet) must also compete in price in that market. Therefore recycled glass will never command the high prices that are able to drive the recycling process for materials such as steel and aluminium. Other drivers are usually needed and Governmental pressure is now increasingly common in many countries. Governmental “incentives” may include such measures as recycling targets or mandatory deposits on drinks containers whilst “disincentives” or indirect drivers may include punitive landfill tax and putting a charge on CO<sub>2</sub> emissions through financial instruments such as taxation or trading.

The authors conducted a review of the benefits, market demand and existing infrastructure for glass recycling in the Russian Federation and concluded that.

- Recycling glass results in a reduction in the amount of virgin raw materials than need be purchased i.e. 1 tonne of cullet replaces 1.2 tonnes of virgin materials;
- A reductions in the amount of fuel needed to melt the glass: 322kWh per tonne of cullet used;
- A reductions in the CO<sub>2</sub> emissions from both fuel and displaced raw materials; 0.246 tonnes of CO<sub>2</sub> per tonne of cullet used (CO<sub>2</sub> trading potential); and
- A reduction in the need to landfill empty bottles and any associated costs.
- The average cost of cullet is currently equal or slightly higher than that of virgin material. Approximately €64 per tonne in Europe for cullet compared to €62 for virgin materials. (accurate Russian prices have not been available to the project team)
- This differential is offset by energy savings from cullet use. The potential saving equates to approximately €2.5 per tonne at current Russian gas prices.
- Increasing gas prices will make cullet use more attractive. A 10% rise in gas price will yield an extra saving of approximately €1 per tonne.
- The investment and additional processing required to produce "furnace ready" cullet in Russia is expected to increase the price of cullet beyond the current €2.5 cost advantage provided by energy cost saving. (Here "furnace ready" refers to cullet of a quality that would be accepted in furnaces in Europe).
- In Europe glass manufacturers are all subject to carbon trading. At current carbon prices carbon trading adds a further €3 per tonne glass packed. Thus use of cullet becomes cost effective. Environmental fiscal policies such as this are likely to be the major driver for increased cullet use

Having considered the above factors in the context of the current situation in the Russian Federation, the authors proposed a collection system linked with other recyclable material collection as is common in many regions. The potentially higher revenues from the sale of materials such as plastic and aluminium may make the glass recycling system more financially viable and self-sustaining. The use of regulatory instruments similar to those employed in other countries will also be required to make recycling more attractive. Such instruments will include the taxation of landfilling as a method of waste disposal control and the use of trading certificates to encourage environmental improvement.

A review of glass recycling schemes in countries across the world was carried out. These studies concluded that the following elements are crucial to the success of glass recycling schemes:

- Education, Outreach and Public awareness campaigns- these are essential to ensure recycling schemes have high participation rates and the glass collected is of high quality.
- Employing local ambassadors/managers, having a known person overseeing a recycling scheme in a particular building or area encourages participation and reduces abuse of recycling facilities. It also potentially provides employment opportunities.
- Implementing regulations and incentives- in countries like the Russian Federation where there is no current culture of recycling the use of regulation and/or incentives are necessary to encourage participation.
- Convenience for consumers - for recycling schemes to be successful it is critical that they do not involve excessive work for the householders, the collection containers must be close to residences without occupying too much space and segregation procedures must not be complicated.
- Early segregation of different recyclable materials - in order to minimise contamination and maximise revenue recyclable materials should be separated as early as possible in the collection process, ideally by the householders.
- Producer responsibility - the majority of international schemes place responsibility on the packaging supply chain to arrange and fund recycling schemes either directly or via membership of "green dot" compliance schemes.

For a successful recycling scheme to operate in the Russian Federation a wide range of stakeholders will need to be involved and we would like to encourage a wide variety of different stakeholders to our workshop session to gather their thoughts on our findings and proposals, likely interested parties include

- Municipalities
- Federal agencies
- Legislative bodies including the Customs Union (Russia, Belarus, Kazakhstan)
- Waste/recyclables collectors and transporters
- Operators of landfills
- Material Processors
- Housing Associations
- Supermarkets
- Hospitality establishments
- Street kiosk operators

- Equipment suppliers
- Brand owners
- Third sector NGOs and charitable organisations
- Glass manufactures and other cullet users
- Large event organisers

**Please note whilst this report deals with the recycling of glass it is essential that when considering legislative measures that all packaging materials are included to avoid distortion of markets. This is particularly important where taxes, deposit schemes and other financial mechanisms are being considered. Fees should be based on the volume of packed material rather than the weight of packaging itself.**

# 1. Key Lessons from International and Historic Glass Recycling Schemes

From the studies of international glass recycling schemes it is evident that a few general factors are common to all successful recycling schemes. The countries with the highest recycling rates have a combination of bottle banks and deposit return schemes with limited use of kerbside collection. Such schemes rely on the willingness of a population to recycle and the ease of its ability to do so. These factors are not necessarily self-evident in the Russian Federation so several different options will need to be investigated to identify the most suitable recycling schemes for the Russian Federation.

Each location or region will exhibit its own practical and demographic challenges which must be addressed if a recycling scheme is to become successful. Factors that are common to successful recycling schemes include the following:

## Public Awareness

All the successful schemes identified involve raising public awareness about not only the importance of recycling but also the correct way to recycle material. In many cases recycling organisations have dedicated publicity and training teams who visit householders, schools and participate in community events in order to spread the recycling message. In many countries the importance of recycling is included in the primary school curriculum and the expectation is that children take this message home and put pressure on parents to recycle. Glass recycling education is also commonly supported by national trade associations. For example, in the UK, British Glass supports UK initiatives and multinational campaigns such as "Friends of Glass" for which promotional literature and other material is produced, which can be used by all sectors of the recycling scheme including the public and businesses. Canada, Poland and Honk Kong are good examples of recycling schemes that prioritise education and public awareness as part of their strategy.

## City of Toronto, Canada

Recycling Policy
Recycling polices in Canada are set at federal, provincial and municipal levels but in practice waste management is primarily regulated at the provincial level. Waste management and recycling regulations in Ontario generally relate to the two areas where wastes are generated, namely the residential and the industrial, commercial and institutional (IC&I) sectors.

Residential waste management and recycling services are mandated by the provincial government, but are carried out by local municipalities. Each municipality develops its own waste management program which could include: kerbside collection, depot drop-off, pay-as-you-throw or any combination of these elements as long as the program is in compliance with the requirements the Environmental Protection Act. Members of the Industrial, Commercial and Institutional (IC&I) sectors are individually responsible for complying with waste related regulations and their compliance obligation is determined by their size. The recent introduction of stewardship and/or extended producer responsibility (EPR) regulations has extended the traditional responsibilities of many IC&I businesses. IC&I businesses that are producers of product and/or packaging are increasingly mandated to take physical and/or financial responsibility for the wastes that their products and or packaging create.

#### **Details of Recycling Schemes**

Properties must purchase their own collection containers to ensure that recyclables are collected. In March 2009 the city delivered 132,062 bags and 201,675 plastic containers for waste separation in multi-occupancy housing. Collections take place as follows:

- Single Family Households have compostable kitchen waste collections once a week, recyclables are collected fortnightly and leaf and garden waste seasonally;
- Multi-occupancy buildings are serviced by communal container collection covering some 4,000 buildings; and,
- The remaining properties have smaller wheeled containers as they can't accommodate front-end-lift container collections.

#### **Observations**

The city of Toronto's Communications department has 12 staff that carry out qualitative research on recycling including the public's attitude to recycling. The department is also responsible for organising and implementing public education schemes. These schemes have included the training of 3R (recycling) ambassadors for buildings to encourage uptake of recycling schemes and an outreach programme including surveys, focus groups and seminars on effective waste management.

A levy for recycling was introduced and has to be paid by all multi-occupancy buildings. Failure to pay the levy results in waste collections being entirely suspended. The levy is charged on a volume waste which is above 0.65m<sup>3</sup> compacted (1.6m<sup>3</sup> un-compacted) per household unit per year. The fee covers collection of general waste, recyclables, garden waste, green bin organics, bulky items, electronics, white goods and household hazardous waste. It is an all or nothing service if a building doesn't have recyclables collected they also have to look for a new way to dispose of all waste. In July 2010 411,757 units were receiving city waste collection services (out of 526,000 which equates to just over 78% but under the target of 88%).

Problems that have arisen:

1. There is little space for storage of recyclables in multi-occupancy homes and,
2. Chute systems are more convenient than taking rubbish to the group floor for recycling and therefore residents often throw recyclables in with general waste.

## Krakow, Poland

### Recycling Policy

The Polish constitution states that it will ensure the protection of the natural environment and principles of sustainable development. Recycling is organised by public private partnerships with municipalities being responsible for the collection of waste. Landfill charging is being used as an instrument to make recycling a more attractive option than disposal.

Poland is relatively new to the EU and has adopted waste and packaging legislation targets for recycling based on 2002 levels of glass in the Polish waste stream. Businesses in the packaging supply chain are charged if they do not meet their recycling obligations, they are charged only for the shortfall not the total amount of packaging used.

Poland and Hungary are the only countries in the EU that have no law defining who the owner and therefore responsible person of the waste is.

### Details of Recycling Schemes

Bottle banks are the main form of collection with approximately 1 set of banks per 500 people. Different coloured bins are used for different recyclables, the colours are standardised across the country. They operate a 2 bring bank scheme for glass: clear and coloured. Between 75-80% of the population is served by bring banks and the remainder have some form of kerbside collection in segregated bags.

Public awareness and education are seen as key to ensuring quality and therefore financial viability of schemes. Recycling is taught in schools and teachers receive specific training. The children pass the message on to adults when they return home. The Polish glass industry association provides information on recycling best practice. Educational material is also available on the MPO cooperative (a Polish waste collection company) website.

In Krakow glass is mainly collected via 600 bring bank sites. 10% of total waste is diverted for recycling: approximately 65 tonnes per day, which is similar to the national average.

Of this material:

- 75% is sold as recyclables
- 22% is incinerated
- 3% is contamination and is landfilled

60% of the bring bank sites are serviced by the MPO co-operative. Selected neighbourhoods have kerbside collections for recyclables including glass which are free as long as material is segregated over 4cm in size and clean. There have been some complaints from residents about the siting of the banks, both associated with location: either as a source of noise or too far away.

### Observations

Poland illustrates a country that is relatively new to recycling. It has chosen to mainly use a bottle bank scheme with some additional kerbside collection. Poland provides a good example of where clear policy has been implemented through strategic use of the educational system. Teacher training has taken place and materials provided with the intention of the message being carried home to other generations.

## Hong Kong

### Housing Stock

Due to its very high, population density almost all of the housing in Hong Kong consists of large high rise multi-occupancy housing.

### Recycling Policy

The Hong Kong authorities have recently started to act on the growing problem of increasing waste and reducing space for disposal by promoting recycling. However there is no government scheme to deal with glass waste. There are several independent organisations arranging glass recycling, although these are mainly aimed at the production of glass sand rather than remelt.

### Details of Recycling Schemes

The glass recycling industry in Hong Kong currently supplies cullet for use in the sand (aggregates) industry. The remainder, an estimated 100,000 tonnes per year of container glass, is sent to landfill. The Hong Kong Environmental Protection Department has been exploring recovery methodologies via several pilot and sponsored schemes.

The Glass Container Recycling Program (GCRP) began in November 2008 and operates in conjunction with the Hong Kong Hotel Association, it is organised and funded by the hotels involved. Currently 23 hotels participate in the scheme. Hotels segregate the glass and store it before collection by a contractor who passes it on to the glass sand producer.

A total of 13,800 tonnes of solid waste are produced in Hong Kong each day of which 40% is

domestic waste. In 2010 a scheme started in conjunction with the Green Power Company an independent organisation which promotes environmental behaviour and provides educational information to private housing estates. The Green Power Company an environmental charity runs The "Go Recycling" campaign which promotes source separation and recycling. The campaign initially targeted 10 high rise estates and now covers 30 estates which are served by recycling education road show vehicles providing education and encouraging recycling. There is also a website which contains educational material.

A 12 month trial recycling campaign is being conducted on public housing estates. The trial began in 2011 and bins were placed at entrances and lobbies of residential blocks to collect glass and other recyclables.

The "Green Glass Green" organisation was started by the Hong Kong Dumper Truck Drivers Association they were not allowed to set up bring banks due to the limited space. Collections are made from bars in the financial district twice a week by volunteers using bags. 2 to 3 tonnes per week are collected. The EPA has provided some funding to this scheme.

In 2010 the glass recycling rate in Hong Kong was 3% of glass in the waste stream which is used by Tiostone to produce 4000 tonne/year of glass sand.

#### **Observations**

The situation in Hong Kong shows the ability of small organisations and NGOs to be part of the glass recycling chain and how such a system can operate in a very densely populated area. The use of educational material and roadshows should also be of relevance to future schemes in the Russian Federation. The fact that glass is currently used only for aggregate production could reflect the low tonnages collected and lack of local glass container factories. Raw materials in China are relatively low cost so there is little incentive to transport cullet large distances

#### **Local Ambassadors**

In addition to full time, paid employees (specifically tasked with recycling responsibilities) successful recycling schemes, particularly those affecting large multi occupancy buildings, involve members of that community. These people will oversee, promote and encourage recycling. Recruiting a local contact who is known to residents and who is seen to "own" the recycling scheme, encourages participation and as such rules are more likely to be followed. Recruiting local recycling ambassadors may also provide employment opportunities. Depending on the level of input required by the ambassadors some form of incentive or remuneration is likely to be needed particularly where physical works such as moving of containers in large housing blocks is required. New York City is a good example of the use of local recycling advocates to encourage recycling.

## New York City, USA

### Recycling Policy

The USA has Federal waste policies but the policies do not include specific requirements for the collection and recycling of materials. Individual states have however enacted their own initiatives which do have the force of law. New York State has enacted a law that requires that waste should be 'separated or segregated into recyclable, reusable and other components'.

### Details of Recycling Schemes

New York City operates kerbside and containerised collections of paper and three commingled materials: metals, glass and plastic. Also special provisions are made for textiles, electrical equipment and garden waste. Kerbside collections are made two or three times a week for refuse and once a week for recycling. Collected waste is brought together at one of the city's fifteen sorting stations. Waste is then road hauled or rail transported to outside the city to private processors. Waste is only collected from individual households there are no common use bins in the streets, for recycling, since:

1. Such high density population means there is limited space for them,
2. Bins are likely to be misused and,
3. There is no historical practice for this type of recycling.

To kick off the recycling scheme the city advertised for people living in multi-occupancy housing (of 3 units or more) to be recycling leaders in their buildings. They would be responsible for educating residents and facilitating recycling in the buildings and would be trained in ways to encourage recycling. They were then expected to implement this in their building and educate the rest of the residents to ensure recycling took place. Large numbers of staff, such as caretakers, volunteered for the programme, despite not living in the buildings themselves. It is unclear what incentives were provided for volunteers, but it is not thought that the roles were salaried.

### Observations

New York has a population density very similar to that of Moscow. The City has a budget of US\$ 156 per person per year for waste collection (this also needs to cover the cost of clearing roads (e.g. snow) and other such expenses). Waste and recycling is funded out of general taxation.

The 2010 Mayor's management report details the following costs associated with recycling and waste:

- Refuse collection cost per ton (0.9 metric tonnes)- US\$228
- Recycling collection cost per ton - US\$516
- Paper and cardboard revenue per ton - US\$10
- Refuse disposal cost per ton - US\$148
- Recycling processing cost per ton - US\$60

Research has found that higher income areas (such as Manhattan) have higher recycling rates than lower income areas (e.g. South Bronx). It is thought that the reason for this is linked to the level of service provided by building staff. Caretakers' and building managers' responsibility depends on the owners of the complex and lower costing housing usually share building staff between buildings. There are therefore fewer staff to help maintain and implement something a recycling system in lower cost areas compared to higher cost residences which have more staff dedicated to providing services to residents.

### **Regulation/ incentives**

Most of the schemes identified particularly where consumers are required to bring their glass to sites away from the home, require either regulations to make recycling compulsory or a deposit type incentive to ensure high collection rates. A further incentive could take the form of reduced taxes for waste disposal where households participate in such recycling schemes. This could be partly funded by money earned from the sale of recycled goods.

Any regulations that are implemented must encompass all packaging materials not only glass. This is essential to prevent market distortion which could have an adverse effect both economically and also environmentally by favouring less recyclable materials. Belgium is a good example of a country that uses regulation to compel households to recycle, whilst Switzerland and Denmark are amongst many countries that use a deposit system to encourage the recycling of bottles.

### **Liege, Belgium**

#### **Recycling Policy**

Belgium has the highest recycling rate in Europe at 96% for glass. Belgian waste policy is designed to meet EU packaging and packaging waste legislation. From January 2010, sorting of waste was made compulsory for all citizens living in Brussels this obligation now covers the rest of the country. All waste must be segregated for recycling including the colour separation of glass. Recycling is coordinated by Fost Plus a private organisation with members from the packaging supply chain who pay a fee to Fost Plus in order to take on their responsibility for packaging waste. Municipalities are responsible for the collection of recyclables and are paid by Fost Plus to undertake this work from the fees collected from their members.

#### **Details of Recycling Schemes**

All glass bottles and jars in Belgium are collected using bottle banks, below are further details:

- One bottle bank site per 700 inhabitants; where the population density is greater than 200 inhabitants/km<sup>2</sup>;
- One bottle bank site per 400 inhabitants in inter-municipalities with a population density of less than 200 inhabitants/km<sup>2</sup>;

- Glass collected composed of 45% clear glass and 55% coloured glass;
- Glass is always collected colour separated at the bring bank in Belgium;
- The average cost (administrational/communication, collection and transportation costs) for separate glass collection amounted to 49.33 €/tonne (1973.2 Roubles/Tonne) in 2010;
- Kerbside collection includes residual waste, organic waste and dry recyclables;
- 'Pay as you throw': established for the collection of residual waste ( also known as a pay-per-bag scheme);
- Underground bottle banks are mainly in urban centres;
- 68 of the 227 collection sites in Liege are underground;
- Glass collected (2010) - 27,361 (24,762 tonnes from bottle banks and 2,598 tonnes from municipal recovery sites);
- Approximately 27 kg per person/year;
- Overall cost for running a material separated collection scheme is estimated at €1,384,693 (55million Rub);
- Overall cost equates to €1.39n(55.6 Roubles) per inhabitant, or €50.6 (2024 Roubles)/tonne of glass collected; and,
- In 2010 the price of glass cullet for the glass melters was calculated at €14.57 (583 Roubles) per tonne.

#### **Observations**

The situation in Belgium demonstrates the impact of compulsory legislation on recycling. This has resulted in one of the highest recycling rates in the European Union using a bring bank scheme for glass.

### **Canton of Geneva, Switzerland**

#### **Recycling Policy**

Switzerland is not part of the European Union and is subject to different laws. It has the second highest recycling rate in Europe, at 94%. Reusable packaging, including glass bottles, is subject to a deposit and an obligatory marking, the system is designed to reduce the number of single trip bottles in the supply chain. All glass bottles are subject to a prepaid disposal fee (PDF) defined in a separate ordinance this acts as a tax on non-refillable bottles as these cannot be returned and the fee refunded as a deposit.

### Details of Recycling Schemes

Manufacturers, distributors and importers who supply beverages to consumers must pay a recycling fee to produce and import containers into Switzerland. However, refillable containers are excluded from this fee. The recycling fee is received by recycling organisations that must use the fee only for the following activities:

- Collection and transport of post-consumer glass;
- Cleaning and sorting of intact glass containers;
- Cleaning and preparation of cullet for the manufacture of containers and other products;
- Information and education; particularly to promote the reuse and the recycling of glass beverage containers. No more than 10% of the annual income from the fee may be used for information activities; and,
- Refunding the deposit to consumers ensuring that the producers not the consumers have to pay for recycling activities.

In 2009 the glass collected for recycling was 345,443 tonnes, which equates to approximately 44 kg. per person/year and compares with a total glass packaging consumption of 367,000 tonnes in Switzerland.

From a study based on the Canton of Geneva the following was reported:

- Glass packaging consumed (2009) - 20,935 tonnes;
- Approximately 47 kg per inhabitant per year;
- Glass recycling rate - 81%.

There is no door to door collection. There are 567 bottle banks located in the 45 communes, with a ratio of 820 inhabitants per bottle bank. The cost is approximately €120 to 130 (4800-5200 Rub) per tonne of glass collected.

### Observations

The results for Switzerland are significant in the study as Switzerland, whilst occupying a similar regional position within the EU, is not directly subject to its legislative constraints or recycling incentives. It does however have the second highest recycling rate in Europe. As with other countries it illustrates that high recycling rates can be achieved with bottle banks if the culture is right.

## Odense, Denmark

### Recycling Policy

The EU Danish recycling policy is designed to comply with EU packaging and waste law. The Danish glass recycling rate was 88% in 2010.

A deposit-return system operates for single-trip beverage container packaging (plastic and metals) and multi-trip bottles (glass and thick plastic).

It does not however cover fruit squash, juice, cocoa, wine and spirits. The deposit system is mainly operated for standard beer bottles via reverse vending machines outside supermarkets. A tax is levied on all **new** packaging produced in the country or recorded as imported through an official entry point. The tax is charged per unit of packaging and at a rate that depends on the size of the container. For example: cans, glass and plastic bottles under 1, litre €0.13 (5 Roubles) and cans, glass and plastic bottles of 1 litre and over €0.40 cents (16 Roubles).

Both domestic and foreign companies have to pay the fees for the system. In 2007 the annual registration fee amounted to 2000 DKK (€270).

The packaging tax on new wine and spirits bottles of glass was - €0.2 (8 Roubles) per unit since the system began. In 2011 the Danish government lowered the tax to €0.11 (4 Roubles) per unit.

### **Details of Recycling Schemes**

A study undertaken on a recycling scheme in the City of Odense established the following:

- Glass packaging collected in 2009 was 2494 tonnes (estimated);
- Approximately 13 kg per person/year. This is low due to the impact of the deposit system which is recorded separately;
- Glass recycling rate 70%; and,
- The total cost of glass collection from bottle banks is €254,413 (10,176,520 Rub).

This cost covers the collection/handling, transportation of post-consumer glass packaging waste to the recycling facility (but not the treatment of glass). This equates to €103 (4120 Rub) per tonne, 1.34 (53.6 Rub) per inhabitant.

The glass waste is currently collected through three different methods:

- Bottle Banks of which 1,114 tonnes is collected annually (2009) from 150 banks in Odense. The mixed colour is separated at treatment plant; and,
- Civic Amenity centres – 1,310 tonnes are collected annually (2009).

Returnable 106% in 2010

### **Observations**

Denmark was chosen as a case study as the country runs a deposit return system for selected types of glass bottles using reverse vending machines for refillable (e.g. beer) bottles similar to historic systems seen in the Russian federation. Because there remains a culture of returning bottles, a high recycling rate is achieved despite the lack of kerbside collection. The fiscal amendment reducing the tax on new bottles by half has made it much less attractive to try to recover bottles for refilling through the collection system showing how finely balanced the financing of recycling schemes is.

## **Collection methodology at or near the householder**

Collection methodology, the frequency of collection and the type of containers used are crucial factors that affect householder and influence participations rates. In smaller houses and multi occupancy buildings, the number and size of recycling containers needs to be kept to a minimum. They should ideally be located in communal areas, in very close proximity to individual accommodation but designed to minimise noise. In smaller accommodation the use of bags rather than boxes is recommended as these generally take up less space.

## **Source separated or comingled**

Comingled collections tend to be easier for the transporter to operate and, as they produce a higher total yield, tend to gain favour if the collection regime is governed by simplistic overall recovery targets. Unfortunately, the quality of the various materials subsequently recovered from the comingled feed is poor and in general cannot very economically be returned to the original use. Indeed total rejection of the load may take place. Glass recovered from comingled sources is invariably too contaminated for remelting without extensive processing and must go for secondary uses which command a far lower resale price and has lower environmental benefit.

Source separated materials are in general more expensive to collect but their quality requires lower post-collection processing costs and produces higher financial returns. Source segregated collections should always be the first choice for collections. Where space is limited, this can be achieved by using compartmentalised containers. If mixed or comingled collection is used then careful consideration must be given to the materials which are to be mixed together and what is available in terms of transport and separation to ensure the highest possible output quality.

## **Charges on packaging producers**

Few recycling schemes are self-financing. If funding is not provided from central or local government then a mechanism to fund the schemes must be found. One possible option is to put an obligation on the producers and users of the packaging, and this approach is used in many European countries. The exact mechanism suitable for the Russian Federation and to whom it will apply needs to be investigated and discussed further. It is beyond the scope of this project to define in detail. In most European Countries a "green dot" scheme operates allowing companies to discharge their responsibility for packaging to a 3<sup>rd</sup> party company who handles and arranges recycling on their behalf.

## **Targets for municipalities**

In order to incentivise municipalities to increase the levels of recycling there should be some form of enforceable target. This should cascade down from a federal level and will need to identify recycling as the best waste avoidance method. Targets will need to be legally enforceable and be linked to

financial instruments which could either be punitive or rewarding in order to be to be effective. Simplistic overall recovery targets that do not identify and encourage material separation and best environmental outcome should be strongly avoided. Targets must include all packaging materials not just glass to ensure there is no distortion in the market. Examples from the UK and Portugal show how different municipalities deal with their responsibilities.

## **Portsmouth and London, United Kingdom**

### **Recycling Policy**

In the UK each local authority is responsible for meeting targets for the recycling of waste. UK recycling policy is designed to meet the countries obligations under EU packaging and packaging waste legislation. Each local authority (municipality) must meet targets based on weight for the recovery and recycling of materials which are designed to enable the UK as a whole to meet its targets set by EU. Local authorities are obliged to provide collections of at least 2 recyclable materials in addition to municipal waste. It is left to the discretion of the individual authority to decide on the collection and processing methodologies which are often contracted out to private companies. Waste and recycling collections are funded from general taxes and income from the sale of recyclable materials. There is a tax on material sent to landfill which incentivises the recovery of material. The UK has a glass recycling rate of 61% of material estimated to be in the waste stream (2010). The 2 studies below relate to areas of high density housing in an inner London Housing Estate and Portsmouth City.

In the UK one of the drivers of recycling is the Packaging Recovery Note (PRN) system which allows packaging users to meet their responsibilities for recycling by purchasing PRNs to meet their legal responsibilities for recycling.

## **Portsmouth**

### **Details of Recycling Schemes**

Communal refuse and recycling points exist in multi-occupancy houses. Refuse is collected weekly and residents can choose to use a 240-litre, 180-litre or 140-litre wheeled bin for refuse. Recycling is collected fortnightly and residents can choose to use one or two 55-litre boxes for recycling. Paper, card, cans and plastic bottles are currently collected. There are no kerbside collections for glass. There are 51 bring bank locations across the city where individuals can recycle glass and textiles.

## **London (Borough of Southwark)**

### **Details of Recycling Schemes**

Refuse for large multi-occupancy buildings was historically managed through storage cupboards and chutes which emptied into large containers. Many cupboards were broken and dirty and sometimes used by homeless individuals. It was also reported that chutes were narrow and got blocked frequently. In a survey carried out none of the people questioned had used the local household waste recycling centre (HWRC), which was 800m away.

This was principally because all but one resident did not know about it, but also because of lack of transport to carry materials to the recycling site.

A pilot scheme was set up for the purpose of research as follows:

- Transparent plastic bags marked with the required content (paper, card, cans, plastic and glass) were posted through household doors;
- Bags were then left outside in corridors and collected once a week;
- The pilot resulted in nearly 50% of residents participating in the scheme and approximately 38tonnes of recyclables being collected each week;
- The annual costs of such a scheme were estimated at €39.42 (1389 Rub) per household in 2005, with costs per tonne ranging from €206 to €371 (10591-15838 Roubles) depending on tonnage collected.

The study concluded that the main factors affecting participation rates were:

- Container choice:
  - Choice of collection container- and if they are small enough to fit easily in homes;
  - Where containers were stored i.e. inside or outside the home;
  - Whether additional containers were used inside the home.
- Convenience- if bring banks in communal areas are placed near entrances or on frequently used routes there was a higher collection rate. However, elderly residents described climbing down several flights of stairs only to find the banks were full or had been closed; and,
- Trade-offs between convenience and cost-effectiveness. Bring banks are more cost effective but collections from door step (like the one in London) are more convenient for residents.

### **Observations**

These two recycling schemes highlight many of the issues that affect recycling from high density multi-occupancy housing and will be relevant to similar housing units in the Russian Federation. It highlights that collections at point of source are more effective in terms of collection rate than bring banks in areas not accustomed to recycling and that convenience and choice are critical to participation.

## **Greater Porto, Portugal**

### **Recycling Policy**

As with other EU countries Portugal must comply with EU packaging and waste law. Portugal's glass recycling rate was 57% in 2010.

Overall the glass waste collection is under the responsibility of the municipalities rather than the waste management company. Transportation of glass to the recycling industries is responsibility of recycling industries/ companies.

The running and promotion of recycling is organised by SOCIEDADE PONTO VERDE (SPV) a non-profit-making company in order to achieve recycling and recovery targets defined in Portuguese Law. The mission of SPV is, on behalf the supply chain to organise and manage the take-back and recovery of all packaging through the integrated system known as the Green Dot system.

### **Details of Recycling Schemes**

Sociedade Ponto Verde (SPV) is a non-profit-making company whose aim it is to promote recycling of packaging waste in Portugal. SPV works with municipalities or their contractors, who are responsible for the collection and sorting of waste. The system is financed through the payments made by fillers/importers. The tariff applied to the glass packaging waste in 2010 was €18 (720 Roubles) / per tonne

From a study of Greater Porto the following was reported:

- Glass packaging collected (2010)-19,448 tonnes;
- Approximately 20 kg per/ people/yr.;
- Glass recycling rate 59%;
- 3.24% by weight of glass is still found in a typical residential refuse bin; and,
- August 2011 the average sale price for glass cullet was €35.94 (1438 Roubles)/tonne. The minimum selling price is defined by a formula based on population and amounts collected which is legally binding.

LIPOR is the inter-municipal waste management company of the Greater Porto area, and is established as an association of eight Municipalities it runs the following systems.

- Door to door: green plastic bags (for glass) are provided to homes and some buildings which have space allocated for container storage. In 2010: 570 tonnes of mixed colour glass containers were collected;
- Bring Banks: 3456 bring banks are allocated across Porto in 2010;
  - 1 bring bank for 281 inhabitants,
  - 17,023 tonnes of glass was collected in 2010,
  - There were also 21 Civic Amenity sites across the region; and,
  - 673,50 tonnes of container glass waste were collected in 2010.
- Non household glass collections are by request in Portugal. In 2010, around 1,148 tonnes of container glass waste were collected on request from non-household addresses in the Greater Porto region.

**Observations**

The example of Portugal shows how a combination of kerbside and bring bank collections can work in a city of mixed housing. It demonstrates how the setting of minimum prices for the sale of recycled material can help to ensure a recycling scheme has certainty for companies collecting recyclables.

## 2. Suggestions on the Best Ways to Implement a Recycling Programme in the Russian Federation

This section serves as a discussion document on how domestic glass recycling schemes could best be introduced in the Russian Federation. Based on our studies of the situation in the Russian Federation and international experience the project considered 5 scenarios which collectively, as the authors believe, would offer recycling opportunities to a significant proportion of the general public. The report seeks to identify the important issues that would need to be addressed by each of the proposed schemes. The authors do, however, recognise that the fine detail of any scheme will vary depending upon local circumstances.

Making recycling the cost effective option is critical. In order for a glass recycling scheme to be financially viable the resale value of the cullet must be higher than the cost of collection and processing or the cost of disposal of the glass to landfill.

Such conditions are only likely to be achieved where a mandatory fiscal obligation is placed upon supply chain stakeholders or disposal to landfill carries an additional financial penalty.

Based on existing successful models it is suggested that one or both of the following steps be implemented:

A charge should be spread across the packaging supply chain. This should be based on the quantity by capacity not weight of packaging put on the market. A financial penalty should be placed on each unit of material sent to landfill. This should be set at a level that raises the total cost of landfill of packaging above that of recycling.

The revenue generated should be used to support the recycling schemes. Administration should be at municipal level. The financial impact should ideally affect the final consumers of packaging e.g. individual residents, in the form of increased/decreased taxes or identifiable payments for waste collection and disposal services.

### **Education and Outreach**

A national or regional educational campaign is important to raise general awareness of the need to recycle glass and other materials. In addition there should be specific educational and promotional campaigns for individual schemes. The campaigns should be thoroughly prepared taking into consideration the lessons learned from trial projects in various regions of Russia. The following methods are recommended.

#### **Road shows**

One element of the public awareness campaign should be a road show vehicle that would tour schools, public places and events promoting glass recycling.

This could be sponsored by the glass supply chain e.g. manufacturers, fillers, collectors. This approach has been used with success in Hong Kong. Any road show should be eye catching and equipped with multimedia facilities to allow videos and cartoons to be displayed highlighting the benefits of recycling. It should include multimedia presentations showing the glass making and recycling process as a closed loop.

The road show should create a carnival atmosphere to attract children and their parents, small/low cost recycling related gifts could be given away as an added incentive or souvenir. Containers for segregation of recycling materials in the home might also be given out. The road show should be manned by enthusiastic advocates of recycling trained to answer questions about recycling and counteract arguments against recycling. The vehicle should visit schools and deliver recycling based lessons to children to supplement the normal curriculum. School children have proved a useful conduit for passing on the recycling message in both Poland and the UK.

Some of these educational initiatives could, with added benefit, be linked with the Sochi 2014 Winter Olympics. The Russian government has pledged to leave a legacy of environmental awareness throughout the Krasnodar region and across Russia as a whole.

It is envisaged that a team of recycling advocates will be employed and trained to work on the road show in each region. This will ensure continuity of message and create employment for skilled and environmentally aware people.

### **Helpline**

In order to help householders to recycle properly a helpline should be set up which could be staffed, for instance, by the same advocates who work on the road shows. The helpline will provide support to recycling ambassadors and individual households. Part of the role of the helpline team will be to monitor the progress of the scheme and produce updates and feedback to households in the form of newsletters. It will also carry out surveys to gather feedback from scheme participants and to allow improvements to take place over time. This is an effective part of the successful scheme in Toronto.

### **Promotional Television**

Television is the most popular form of media in Russia and short entertaining programs should be broadcast to promote recycling. As the state has a large stake in the most popular TV channels in the Russian Federation, it is felt that this may be a relatively low cost option for reaching a large audience.

### **End Markets, cullet quality, processing and financial considerations**

The principal market for the recycled glass should always be the manufacturers of glass bottles and jars who will return the cullet back to their furnaces to make new glass bottles and jars. This process is known as "closed loop" recycling and gives the greatest environmental benefit. It should also enable the highest price to be achieved for the recycle. The schemes suggested by the authors are designed to produce glass cullet of sufficient quality for this market but with the lowest amount of processing.

Any glass recycling system will produce some material that is unsuitable for the intended end market. In most cases there are options for the use of this residual material rather than sending it to landfill.

The best environmental and highest value option for cullet that is sufficiently uncontaminated (i.e. meets the contamination standards for glass container manufacture), but does not meet the colour specification, is to use it to produce glass fibre insulation. This end use gives similar environmental benefits for the manufacture of new glass and also provides environmental benefits during its operational life, as it reduces energy consumptions of buildings. The disadvantage of this option is that the glass can only be reused once rather than repeatedly, as there is currently no technology to remove the coatings applied to the fibres were the insulation materials ever to be removed separately from the building upon demolition or refurbishment.

For collected glass that is rejected because for instance:

- it does not meet contamination standards;
- it is rejected by the sorting process; and,
- it is of too small a particle size (<10mm) to be sorted effectively.

The most common outlet is as an aggregate substitute. In this case the glass is crushed and screened to the required size and substituted for other building products or combined with asphalt for use in road construction. As with fibre glass manufacture this option is basically a "one time" process and does not generate the continued environmental savings inherent in remelting to produce new glass. It should therefore be considered as a last option before landfilling.

Other more specialised uses can be found for cullet, but they generally require additional processing and are not considered commercially viable at this time. However, one "spin off" from the financial infrastructure associated with a successful recycling scheme may be the funding of local universities or small companies to commercialise these technologies.

Given the large transport distances involved in the Russian Federation it will be preferable to identify early in the process suitable end users of cullet in the locality of the proposed recycling schemes. In

this way collection and processing methods will be appropriate to the end use. End users may include: glass manufacturers, fibre glass manufacturers and aggregate producers.

### **Processing plants: nature and cost**

For all the recycling schemes identified below some form of processing plant will be required. The exact nature of the plant is will vary, depending upon the input, throughput and end use. However, processing plants will tend to consist of similar equipment.

The cost of a processing plant varies greatly depending on the throughput required, quality of the incoming material and the specification for the output material. It will be in the region of 2 to 4 million Euros (82.7-165.5M Roubles) for the initial set up. Although plants contain sophisticated, automated sorting equipment, they typically still require manual sorters on picking lines and carrying out inspections; so the process is relatively labour intensive with associated labour costs, as well as occupational health and safety management costs. In addition the abrasive nature of glass means that regular maintenance and replacement of parts is critical and this cost must be taken in to account. Additional costs will include: energy, disposal of rejected material, transport and fuel, as well as measures for compliance with any environmental and waste permits with associated pollution control aspects.

When designing a plant, options for public educational visits should be considered, for example the provision of viewing windows and presentation/classrooms.

### **Required Participants**

Experience from other recycling projects carried out in the Russian Federation and other countries underlines the importance of identifying and then obtaining the willing cooperation of all involved parties. In some instances 1 organisation may carry out more than 1 role. The authors predict that the following organisations are likely to be involved in recycling schemes in the Russian Federation.

#### **Municipality**

As the party having direct responsibility for waste collection in Russia, municipalities will need to approve any recycling scheme and as such their active participation is essential. Great care must be taken to identify and contact all the relevant departments within the municipality, and the scheme organisers should be aware that the different branches of local government may have overlapping and even conflicting responsibilities in this area. Their involvement will add authority to any scheme. They may be instrumental in enforcing relevant regulations and they may help pay for and/or provide some of the educational/promotional materials.

#### **Waste and Recyclables Transporter**

A collector/transporter will be required to collect the recyclable materials from the designated collection areas and transport them to the processing plant or bulking station. Ideally the trucks used

for this task will be dedicated and as such could also be used as mobile advertisements to promote the particular scheme. The involvement of the drivers would vary between schemes and may be limited to a simple haulage task, but could involve sorting, for instance at kerbside collection, and even promotional activities. Where interaction with the public is foreseen, consideration should be given to providing the operatives with some basic awareness training.

### **Processor**

As mentioned previously, the type and scale of processing plant required is dependent on input and output characteristics.

Collection methodologies that produce a colour sorted glass generally contain few non-glass contaminants and any that are present are relatively large and easily removed at the bulking stage. Such glass stream will command a relatively high price. Post collection processing in these cases would be limited to the use of magnetic and eddy current equipment to remove metal contamination and an automatic or manual scan to remove any ceramic contamination.

Collection methodologies that produce a colour-mixed glass will command a lower price than their colour-sorted counterparts. Non-glass contaminants will tend to be greater than that experienced with the colour sorted schemes, but are generally manageable and can be removed at the bulking stage. However, as an unsorted mixed fraction, the only route back to the melting furnaces is via green glass furnaces which, for technical reasons, are the only ones able to accommodate significant quantities of mixed colour glass. The loss of the ability to recycle back to clear and amber glass furnaces will undoubtedly reduce the overall value of the collected glass. Dependent upon the colour mix of the glass collected and the local demand for clear and amber glass it may be cost effective to install colour sorting technology for those schemes collecting mixed coloured glass.

Our information suggests that new plant may be required to meet the demand for processing facilities, as currently only one such facility exists in the Russian Federation. It is however believed that other modern facilities are planned. These start-up organisations will be ideal candidates for participation in initial trials, because their operators are likely to be open to new ideas.

### **Housing Associations**

Housing Associations and housing management companies control many of the high density apartment blocks which house a large proportion of Russia's population. From a practical point of view the active participation of the building's owners will be needed in order to allocate and maintain the space required for the collection of the containers (skips, bins etc.) and also possibly to provide the resources of a caretaker to act as the recycling ambassador.

### **Supermarkets**

Supermarkets have been identified as possible hosts for the collection points in the bring bank scheme. As participants they must be willing to provide the space to locate the bring banks and encourage their customers to combine shopping and recycling. It is hoped, if not essential, that they will also designate a member of staff to monitor the situation and notify the collector when the collection banks are full. Furthermore, the designated employee(s) after some basic training could promote the scheme by answering customer's recycling queries. A further option to explore is the provision by the supermarkets of redeemable stores vouchers as an incentive to encourage recycling.

### **Hospitality Establishments**

Hospitality establishments have been identified as possible sources of recyclable glass. The scheme will focus on collecting empty bottles from bars, hotels and restaurants in tourist destinations.

This project could prove to be a timely move as the Customs Union including Russian Federation, Belarus and Kazakhstan has made an attempt to introduce a regulation, scheduled for becoming effective from July 2012, banning the reuse of glass containers meant for alcoholic drinks or baby food. In case the regulation is enforced, the hotels and bars having arrangements to return their empty bottles to the local breweries would have to find other outlets or face a large increase in their waste disposal costs.

### **Street stalls/kiosks**

Street stalls/kiosks for collection of glass containers are traditionally popular in Russia. However, in recent times and due to various governmental regulations a decline in their numbers is evident. Despite the obvious official disapproval of these basic retail outlets they remain popular with the general public and are obvious and convenient points from which to operate small scale recycling ventures. Furthermore, with income declining, the operators of these kiosks may welcome the chance to investigate a potential source of revenue or a least an opportunity to attract additional customers whose primary intention is recycling. Existing stall or kiosk owners interested in protecting and expanding their businesses against the decrease in returnable bottles will be ideal trial partners.

### **Reverse Vending Operators**

Reverse vending machines (RVM's) are a simple and effective method of providing an incentive to recycle. RVM's, are automated machines which identify, accept, sort, and process used beverage containers. They have been used in Europe for over four decades. Typically RVM's are used in packaging markets that have deposits on beverage containers and they can be used by supermarkets or even small kiosk operators to automatically provide cash or redeemable vouchers. Such technology is familiar in Western Europe and the North America and very useful, however it had only limited success in Russia (e.g. in Moscow), when the RVMs were placed outside the shopping centres, in the street and were affected by vandalism.

### **Brand Owners**

All leading brand owners are keen to be seen as raising their environmental standards, and recycling schemes are typical part of their strategy. Brand owner participation in recycling schemes is often done in conjunction with retail outlets. Therefore, brand owners should be approached early on in any proposed scheme.

### **Third Sector/Charitable Organisations**

The potential incomes and job creation opportunities of new recycling schemes may be an area of interest for organisations working with disadvantaged groups in the community. In countries such as the UK and the United States not for profit groups operate recycling collections and at the same time provide training and an income to members of society who might otherwise struggle to gain employment. It is suggested that these groups should be engaged in discussions about proposed recycling schemes at an early stage to give them the opportunity to become involved.

### **Event organisers**

Large events such as sporting tournaments and music festivals are potential sources of large quantities of glass for recycling. By recruiting organisers of these events at an early stage in their planning it will be possible to organise recycling of beverage containers at these events ensuring that this material is not wasted.

A trial could be staged to coincide with an event such as the Winter Olympics to be held in Sochi in 2014. This would provide high profile publicity, were it to prove successful. Certain international festival organisers (World Music and Dance) and operators of famous amusement parks (e.g. Tivoli in Copenhagen) regularly apply deposits to glass and plastic drinking vessels resulting in the complete elimination of this type of waste within the festival area.

### 3. Hypothetical Collection Methodologies for Discussion

Based on the research carried out five different hypothetical collection methodologies have been proposed and compared. The schemes proposed below take into account the knowledge and experience gained from initiatives around the world, including those in Russia. This information has then been applied to the demography and culture in the Russian Federation. Assumptions and generic data have been used where appropriate to allow comparison with the different schemes. Whilst the studies/proposals below details the collection and processing of glass, but the principles are relevant to other materials collected in conjunction with glass.

#### **Collection of glass from multi occupancy buildings.**

The proposed scheme is designed to collect glass from households occupying large multi household housing blocks. It utilises ambassadors from the local community to encourage recycling and to assist with the transfer of glass from convenient collection **points on** each floor to ground level ready for collection by waste collection organisations for delivery to a recycling plant. It is envisaged that where space is available the glass will be collected in 3 separated colours. Where space is short then glass will be collected as mixed colour and separated latter.

#### **Single Occupancy Houses Kerbside Scheme**

This scheme is designed to collect glass from single occupancy housing and will run alongside traditional waste collection. Households will be provided with additional collection containers for different recyclable materials. Depending on the density of housing and current waste collection arrangements additional containers will either be provided 1 per household or 1 for several households which will be collected on a rota by a recycling organisation.

#### **Bring Banks Situated at Communal Sites**

This scheme suggests installing collection banks at communal sites specifically supermarkets and schools where householders can take their empty glass for recycling. This may be in conjunction with some form of reward either for individuals or communities. This scheme may involve the use of reverse vending machines to provide rewards in exchange for recycling and could be linked to a deposit scheme.

#### **Bring Bank/Kiosk deposit return scheme**

There is an existing network of kiosks set up in parts of the Russian Federation whose role is to collect empty glass bottles for refilling (including some for recycling). This scheme proposes using and expanding this network to collect bottles for recycling. As in the previous scheme this may include the use of reverse vending machines and the creation of some form of deposit scheme to encourage the return of bottles.

#### **Hospitality Sector**

This final proposal considers the potential for collecting glass from hotels, restaurants and bars. This will involve bar staff segregating glass into separate containers behind the bar and this glass will be

collected by the recycling organisation. The scheme may involve the use of small scale crushers to reduce the space needed to store the glass between collections.

These scenarios are hypothetical and several assumptions have had to be made about costs to carry out the comparisons but the following general conclusions can be drawn.

This study has determined that there is a potential opportunity for the introduction of an effective glass recycling scheme in the St Petersburg and Krasnodar regions and in the City of Sochi. There is potential for these schemes to be adapted to serve other areas of the Russian Federation. In order to capitalise on this opportunity it is essential that engagement of all stakeholders from Policy Makers to glass manufacturers is undertaken as soon as practicable.

## 4. Comparison of Different Schemes

The different suggested schemes have been compared in order to consider financial costs and rewards, environmental and energy savings and number of jobs created. The comparison has been carried out using the best available data, by making educated assumptions and generalisations where specific information is not available. For example exact collection route distances are not available as these will depend on the actual collection area and vehicles used, therefore standardised distances have been used to allow the comparison of the different scenarios. The comparison model is set up to allow it to be easily updated as data changes and to allow different variables to be compared.

From the comparisons it is evident that the bring bank system offers the lowest cost per tonne for collection and processing, whilst the kiosk system gives the highest price per tonne. This is to be expected as the bring bank system has the lowest manpower requirement and the kiosk system has the largest need for personnel. However, it should be noted that kiosks already exist in St Petersburg and many other Russian towns and cities, they provide a viable and traditional system for the collection of bottles, they also perform additional services and that the employees in the kiosks are likely to have other roles, and this cannot be accounted for by the model so direct comparison is difficult

All the multi occupancy schemes result in a financial loss when cullet cost is set at a cost to be equal to raw material costs and this is assumed to be €50 (2000 Rub) per tonne. However, the breakeven cullet price for the multi occupancy schemes is close to €50 (2000 Rub), and potentially could be offset regulatory changes or manufacturing cost savings. These offsets have not been calculated in the current study.

The cullet prices calculated do not include delivery to the glass plant, but this cost will be incurred whether cullet or raw materials are used.

In the comparison, cullet unsuitable for glass bottle manufacture has been given a price of half that for the cullet destined for bottle manufactures. This is irrespective of whether it is being used for aggregates, fibreglass or being disposed of to landfill. If collections and processing operates effectively, then very little material should be disposed of to landfill and the cost of this will be offset by the sale of material to other end uses giving a net positive value.

Labour costs used are based on average wages reported in the 2011 Census. It has been assumed that the recycling ambassador roles are unsalaried, but appropriate safety equipment is provided. There is an opportunity to involve third sector organisations working with disadvantaged sections of society by providing training and wages to those who may otherwise find it difficult to find employment. It is suggested that the recycling ambassador roles required by many of these schemes

would provide ideal opportunities to increase employment levels for disadvantaged individuals.

The costs of recycling schemes produced by the model are in the correct range compared to reported costs from international recycling schemes, and are therefore considered by the authors to be suitable for comparison purposes. However, before any decisions are made to progress to trials or make investment in a recycling scheme, more specific values and prices should be used to check the viability the proposed system.

## 5. Recommended Legislative and Commercial Steps Required to Implement a Recycling Programme

Raw materials for glass making are comparatively cheap, even taking into account fuel usage for melting. Therefore, it has not historically proven cost effective to collect and process waste glass to a quality that is acceptable to glass packaging manufacturers.

In order to overcome this significant financial barrier, some form of financial instrument will be needed to readjust the differential between recycling, landfill, raw material extraction and fuel consumption.

It is important to note that any instrument must impact on all packaging materials not only glass to prevent market distortion.

On the positive side there is already a cost to collection and disposal of waste that can be taken into account or avoided all together, and there are existing manufacturing fuel costs which will be reduced by the use of cullet.

The financial instruments most required to incentivise packaging recycling may effectively be based on...

- A tax on the disposal of material to landfill. This will increase the cost of disposal and therefore incentivise the reduction in weight of municipal waste by encouraging the removal of material that may be recycled.

And

- Placing a levy on packaging. A producer obligation scheme for the packaging supply chain is introduced whereby a levy is paid on each container placed on the market. The money raised shall then be used to fund the recycling schemes. The producer obligation scheme should in principle apply to all packaging materials in order not to, in the first instance, destabilise the different packaging material markets.

Furthermore:

- The two instruments above strike directly at the packaging stakeholder chain but further financial mechanisms may be considered which will exert indirect on pressure on the supply chain through increasing costs of one or more inputs or outputs that can be specifically reduced by the use of recycled content. Examples in the EU include; raw materials taxation, fuel and/or carbon emission taxation and carbon trading associated with emission caps.

The exact mechanism for these measures needs further investigation, but it is suggested that they take advantage of experienced gained in the EU. Whichever mechanism is chosen it should apply to all packaging materials not just glass in order to avoid distortion in the packaging market.

## 6. Recommendations and Next Steps

This study has determined that there is a potential opportunity for the introduction of an effective glass recycling scheme in the areas studied St Petersburg and Krasnodar regions and specifically in the City of Sochi (located in Krasnodar region) associated with the 2014 Winter Olympics. There is potential for these schemes to be adapted to serve other areas of the Russian Federation. In order to capitalise on this opportunity it is essential that engagement of all stakeholders from Policy Makers to glass manufacturers is undertaken as soon as practicable. The list below sets out the next steps that must be undertaken: The first 3 of which are addressed by the November stakeholder event.

1. Circulate proposals to engaged stakeholders for comment,
2. Produce non-technical summaries for circulation to wider stakeholders,
3. Organise a wider stakeholder event to gather feedback on proposals,
4. Summarise and amend report/recommendations based on feedback,
5. Recruit interested parties with a view to running small scale trials,
6. Gather accurate cost data based on the proposed trials,
7. Based on the specific data gathered for each trial we will model the feasibility of the schemes at a commercial scale; and, (not sure this makes sense....)
8. Assuming that trials appear feasible, fund small scale monitored schemes with a view to rolling these out on a wider scale.

## Glossary

Term	Definition
Amber	Brown glass
Borosilicate glass	Glass where boron replaces some of the silica in the composition altering the thermal properties of the glass. Used in some cooking ware and laboratory equipment
Bring bank or bottle bank	Special bins usually situated in public places where consumers take their empty glass bottles and jars for recycling
Closed loop recycling	Production of new glass products from recycled glass
Cullet	Waste glass that can be put back into the furnace to make new glass containers. This can either be waste glass generate at a glass factory, referred to as internal cullet or waste glass that has been collected from consumers after use and may have been cleaned and processed in some way ready for remelting referred to as foreign or external cullet. (Note the ultimate objective in some reasons is to move away from the term waste altogether in order to eliminate such resource from the waste stream.)
Fibre glass	Fine strands of glass known as "continuous filament glass fibre" (CFGF) used as a continuous strand for reinforcement of composite materials or chopped and used to produce for example electronic circuit boards. It may also refer to glass fibre used for insulation and known as glass fibre insulation or glass wool
Flat glass	Glass used in windows
Flint (clear)	Colourless glass and also referred to as clear glass
Foreign Direct Investment (FDI)	Investment from outside the domestic country
Glass consumption	An estimate of the quantity of glass each individual in the Russian Federation consumes on an annual basis. This takes into consideration all glass food jars and all bottles from drinks consumption
Glass containers	Glass bottles and glass jars that are used to contain food, beverages and pharmaceuticals
Green Dot Scheme	Under this scheme a packaging stakeholder deffers its responsibility to recycle its packaging under the European "Packaging and Packaging Waste Directive ", to a compliance scheme run by an external company. This type of schem operates under different names in a the majority of European countries.

Greenhouse gas trading scheme	Is a market-based approach used to control GHGs by establishing economic incentives to reduce emissions. A limit or cap is set on the volume of GHGs that may be emitted. The cap is allocated or sold to firms in the form of emissions permits (allowances or credits). Companies are required to surrender a number of permits equivalent to their emissions. Companies that exceed their cap must buy permits from the market. The aim of the scheme is to make reductions where it is most cost effective to do so.
Kerbside recycling	Waste glass is collected from individual households (at the kerbside) by a collection company
Post-consumer glass	Glass that has been used by a consumer is no longer needed and has been returned for recycling.
PRN	Packaging Recovery Note, traded unit for packaging waste in the UK
Process emissions (Process CO <sub>2</sub> )	Gas given off as a result of the chemical change that takes place during the decomposition of virgin raw materials in the furnace. Particularly used when referring to the CO <sub>2</sub> produced by the breakdown of carbonates
Processing	Taking waste glass and removing any contaminants so it is ready to be returned to the furnace
Processing equipment	That equipment used to convert waste glass into furnace ready glass. It may include conveyors, crushers, sieves, magnets, lasers and optical detection equipment to remove contaminants from cullet and to sort different colours of glass. (further details on processing equipment can be found in appendix 1)
Processor	An operator or business that takes waste glass and removes contaminants to make it suitable for return to a glass furnace. The processor may also crush the glass to a size specification to ease handling and remelting
Pyroceramics	Materials that appear similar to glass but have much higher melting points. These cause production problems if mixed with cullet destined which is destined for standard soda lime silica furnaces
Recycling	The conversion of segregated material into new product.
Recyclate	Recycled material
Recovery	The diversion of segregated material from waste going to landfill.
Remelting	Cullet put back into the furnace to be melted back down to molten glass, then used to produce new containers

Reprocessor	An organisation that turns the cullet into a new product eg new bottle or jar.
Soda lime glass	Glass produced mainly from silica, sodium carbonate and calcium carbonate. The most common type of glass used in bottles and jars, windows and drinking glasses
Virgin materials	Minerals that are put in to the furnace and produce molten glass. The main three minerals being sand, soda ash and limestone.